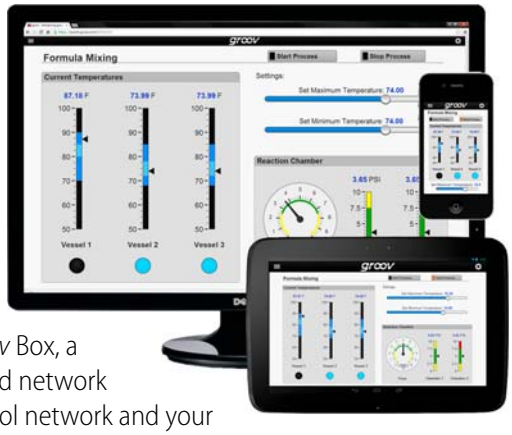
Building a *groov* HMI for Allen-Bradley Logix Systems

About *groov*

Opto 22's *groov* makes it easy to build and deploy simple, effective operator interfaces for your system. *groov* is browser-based and uses only Internet standards (HTML5, CSS3, SVG, SSL). That means:

- You build *groov* screens using a modern web browser and you view them using a web browser. No additional software or plugins (like Java, Silverlight, or Flash) are required.
- Operators can use *groov* screens on virtually any browser-based device—smartphone, tablet, iPod touch, computer, large-screen TV—any device, any screen size, from any manufacturer. The only requirement is that it can run a modern web browser like Firefox, Chrome, or Safari.



- All software is contained in the *groov* Box, a small-footprint, industrially hardened network appliance that plugs into your control network and your computer network using independent Ethernet interfaces, either wired or wireless.
- To build an operator interface, you drag a gadget, such as a gauge or button, from a built-in library of gadgets and drop it on the screen. All gadgets are designed to work either with a mouse or a touchscreen. Once placed, you can move gadgets around for best viewing on a PC or tablet versus a handheld device.
- When viewed, everything on the screen—gadgets, text, images, labels, even live video from a network IP camera—automatically scales to match the size of the device it will be viewed on. At the same time, gadgets and text never become too small to use or read on a smartphone.

Operator interfaces built with *groov* are ideal as a supplement to an existing HMI for technicians, managers, or other people who need to securely monitor or control parts of your system. You can also use *groov* to build a complete HMI.

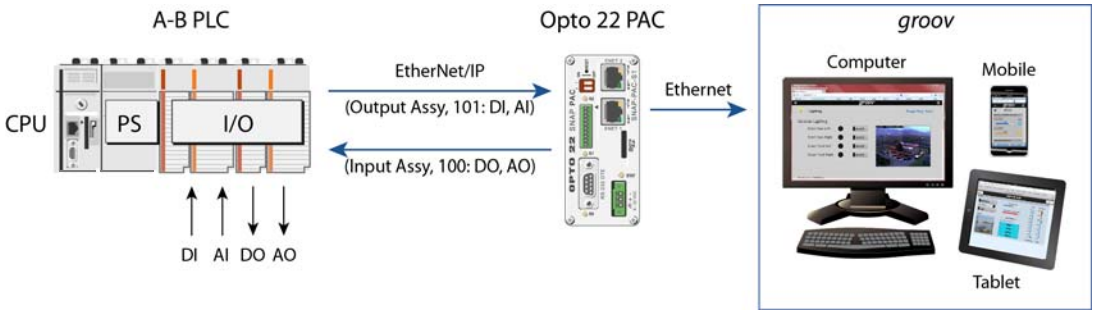
For more information on *groov*, visit groov.com.

A-B Systems and *groov*

The initial release of *groov* provides intuitive connections to Opto 22 SNAP PAC Systems and OptoEMU energy monitoring units. For these systems you simply point *groov* to the SNAP PAC controller or OptoEMU unit and to a tag database file that already exists, and the complete tag database is copied into the *groov* Box. When you place a gadget on the screen, you can tag it with any element in the tag database.

A later release of *groov* will include OPC UA compatibility, so any OPC UA-enabled system can be similarly used.

But right now you can use *groov* to create screens for an Allen-Bradley Logix system by adding a SNAP PAC controller as an intermediary. This is possible because SNAP PAC controllers communicate natively using EtherNet/IP.



Here's how it works:

- The A-B system writes data to and reads data from the PAC's internal Scratch Pad using EtherNet/IP.
- The PAC translates Scratch Pad data to variables.
- In *groov*, you use these variables to tag gadgets when you build your screens.
- Since data can go in both directions, an operator can use *groov* screens for both monitoring and controlling the A-B system.

The rest of this technical note shows an example of how to set up these parts so they work together to give you a simple, effective operator interface to your A-B system.

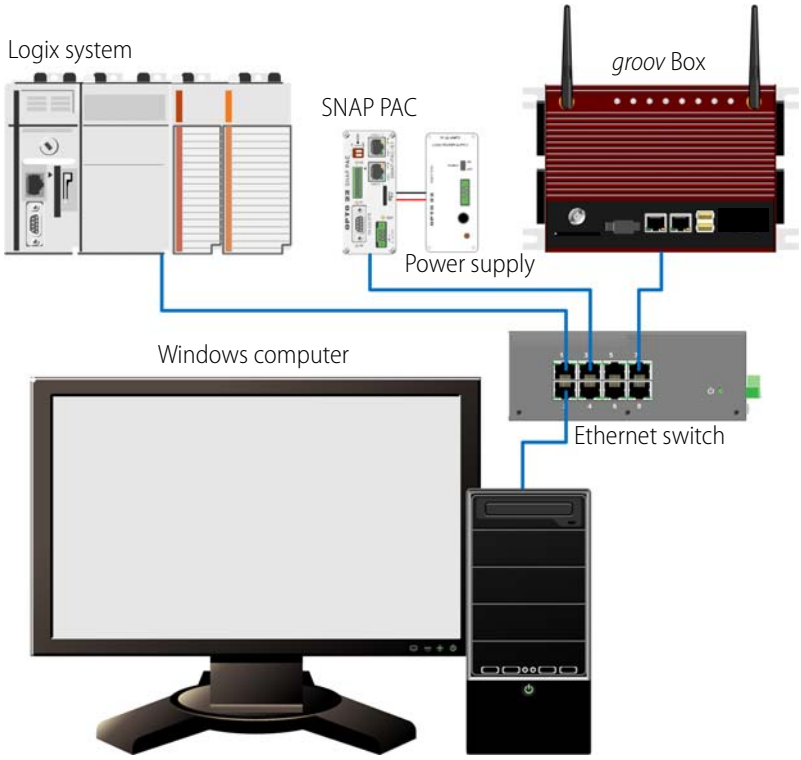
System Setup Example

Hardware

You can use any Logix system and any SNAP PAC controller, including the software-based controller SoftPAC, to achieve the same result as in this example. For this example, we used the following hardware:

- Rockwell CompactLogix L32E controller with power supply
- Opto 22 SNAP-PAC-S1 controller
- Opto 22 SNAP-PS24 power supply
- Opto 22 *groov*
- Computer with Windows OS
- Ethernet switch, power supply, and four Ethernet cables

NOTE: Since Opto 22 supports Explicit Messaging, you can similarly connect to SLC 5/05 and MicroLogix 1100 and 1400 systems.



Software

You'll need the following software:

- Opto 22 EtherNet/IP Configurator and PAC Control Basic (This software comes on the CD with the SNAP PAC controller or can be downloaded from the Opto 22 website.)
- RSLogix5000
- Web browser (Firefox or Chrome recommended)

Opto 22 Documents

These documents will help you set up *groov*4ab. The first four are included in the PAC Project Basic download. If you don't have a document, follow the link in the table or go to www.opto22.com and search on the form number.

For this	See Document	Form #
Installing the SNAP PAC controller	*SNAP-PAC S-series Controllers User's Guide*	1592
Programming the PAC	*PAC Control User's Guide*	1700
Assigning an IP address to the PAC, and EtherNet/IP messaging	*IO4AB User's Guide*	1909
Information on using the Scratch Pad	*PAC Manager User's Guide*	1704
Setting up & using *groov*	*groov User's Guide*	2027

Before You Begin

1. **Write down the network IP addresses or device names (hostnames)** you will use for each of these:
   - Logix PLC
   - SNAP PAC controller (must be a fixed IP address)
   - PC
   - *groov* Box (default hostname is on the label on the Box's top)
2. **Make sure you have installed everything from the CD** that came with the SNAP PAC controller. If you don't have the CD, download the following file from the Opto 22 website: PAC Project Basic (Or go to www.opto22.com and search on PACPROJECTBAS.)
3. **Install the SNAP PAC controller** following steps in the Quick Start chapter of the controller's user guide (from the Start menu, choose > Programs > Opto 22 > PAC Project > Manuals > SNAP PAC User's Guide). But don't give it an IP address yet.

What You Will Do

In this example we'll do the following:

- Simulate a discrete input to the Logix system, called *switch*. Its state will be viewable in *groov*.
- Simulate a discrete output from the Logix system, called *actuator*. Its state will be controlled from *groov*.
- Simulate an analog input to the Logix system, called *Temperature*. Its value will be viewable in *groov*.
- Simulate an analog output from the Logix system, called *Heater*. Its value will be controlled from *groov*.

To set up these inputs and outputs, we'll complete the following steps:

Step 1: Configure Assembly Instances in EtherNet/IP Configurator page 5

Step 2: Configure the Logix System to Communicate with the PAC Controller in RSLogix5000 page 6

Step 3: Configure the SNAP PAC Controller in PAC Control page 9

Step 4: Configure groov for Logix Data page 15

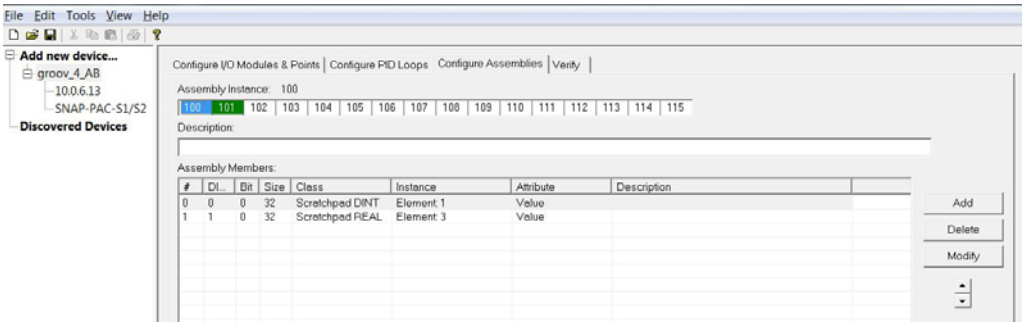
Let's get started.

Step 1: Configure Assembly Instances in EtherNet/IP Configurator

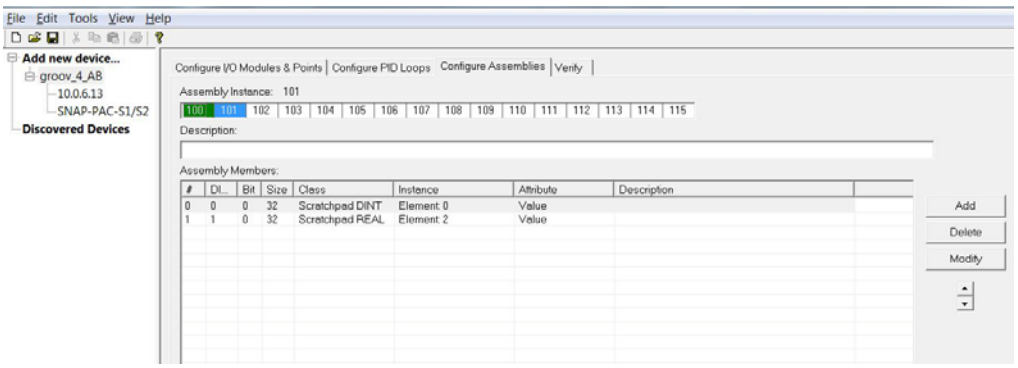
In this step you will configure data transfer between the SNAP PAC controller and the Logix controller.

1. From the Start menu, choose Programs > Opto 22 > EtherNet-IP > EtherNet-IP Configurator.
2. Open the *IO4AB User's Guide* (Start > Programs > Opto 22 > EtherNet-IP > IO4AB User's Guide). Following steps in "Adding an Opto 22 Device" in Chapter 3, discover the SNAP PAC controller, give it the fixed IP address you wrote down, and name it: `groov_4_AB`
3. Click the Configure Assemblies tab. In Assembly Instance 100, add two Assembly Members:
   - Scratchpad DINT (class), Element 1 (instance)
   - Scratchpad REAL (class), Element 3 (instance)

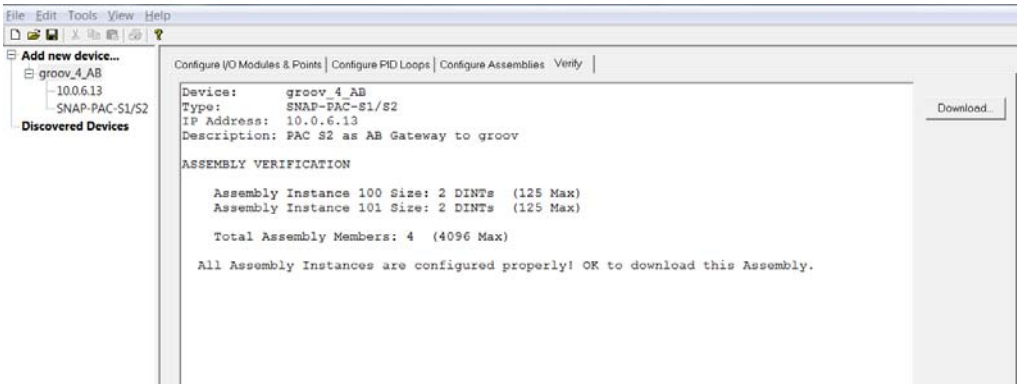
   NOTE: For more detailed steps and more options, see Chapter 6 in the IO4AB User's Guide.



4. In Assembly Instance 101, add two Assembly Members:
   - Scratchpad DINT (class), Element 0 (instance)
   - Scratchpad REAL (class), Element 2 (instance)



5. Click the Verify tab, then click the Download button.

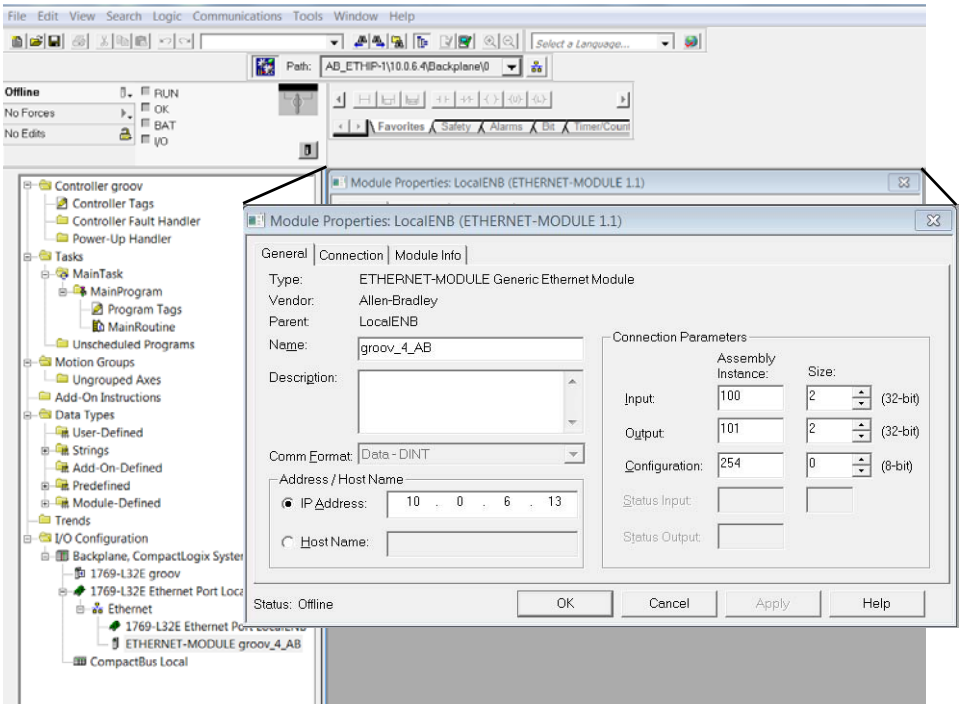


6. In the download confirmation dialog box, click Close.
7. Click Save and close EtherNet/IP Configurator.

Step 2: Configure the Logix System to Communicate with the PAC Controller in RSLogix5000

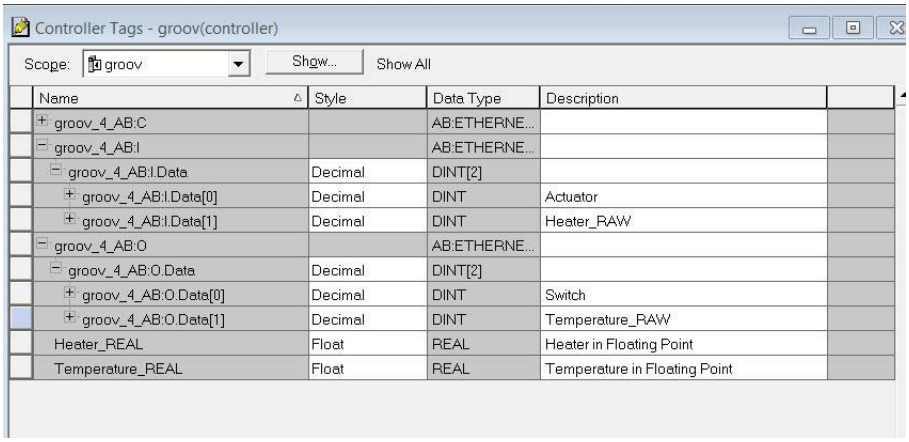
In this step you will configure the Logix system to communicate with the SNAP PAC controller over EtherNet/IP. You will also configure tags to simulate the inputs and outputs from I/O cards in the Logix chassis, which will interact with *groov*.

1. Open the RSLogix5000 project that is associated with your Logix PLC.
2. Right-click the Network icon in the program tree that represents the Logix Ethernet port, and choose New Module.
3. Double-click Communications, and scroll down to select Generic Ethernet Module.
4. In the Module Properties box, enter the following information:
   - Name: `groov_4_AB`
   - Comm Format: `Data - DINT`
   - IP Address: the IP address of the SNAP PAC controller
   - Input Assembly Instance: `100` with a Size of `2`
   - Output Assembly Instance: `101` with a Size of `2`
   - Configuration Assembly Instance: `254` with a size of `0` (not used by Opto 22)



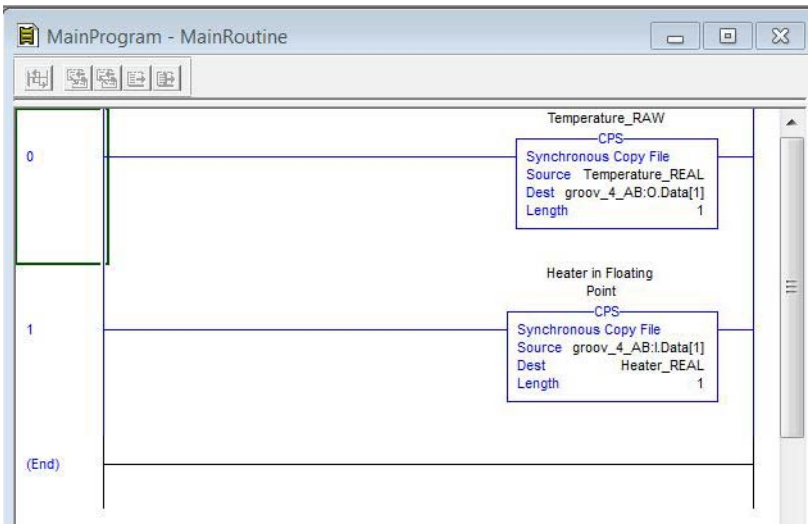
5. Click OK. When you're asked for a Requested Packet Interval (RPI), enter `200` (ms) and click OK.
6. In the program tree, double-click Controller Tags and enter the following descriptions:
   - Input Tag [0]: `Actuator`
   - Input Tag [1]: `Heater_RAW`
   - Output Tag [0]: `Switch`
   - Output Tag [1]: `Temperature_RAW`

   Since we selected Data – DINT in the Generic Ethernet Module Comm Format, we must create floating point tags for the Temperature and Heater values, which are analog.
7. In the program tree, right-click Controller Tags and choose New. Create a tag called `Temperature_REAL` of data type REAL. Repeat and create a tag called `Heater_REAL` of data type REAL.
8. Go back to the Controller Tags list and assign descriptions to these new tags: `Temperature in Floating Point` and `Heater in Floating Point.`



9. In the program tree, double-click Main Routine. Add a rung of ladder logic with a CPS block. Set the Source as Temperature_REAL, the Destination to Output Tag [1], and the length to 1.

10. Add a second rung of ladder logic with another CPS block. Set the Source to Input Tag [1], the Destination to Heater_REAL, and the length to 1.



11. Save the RSLogix5000 project.

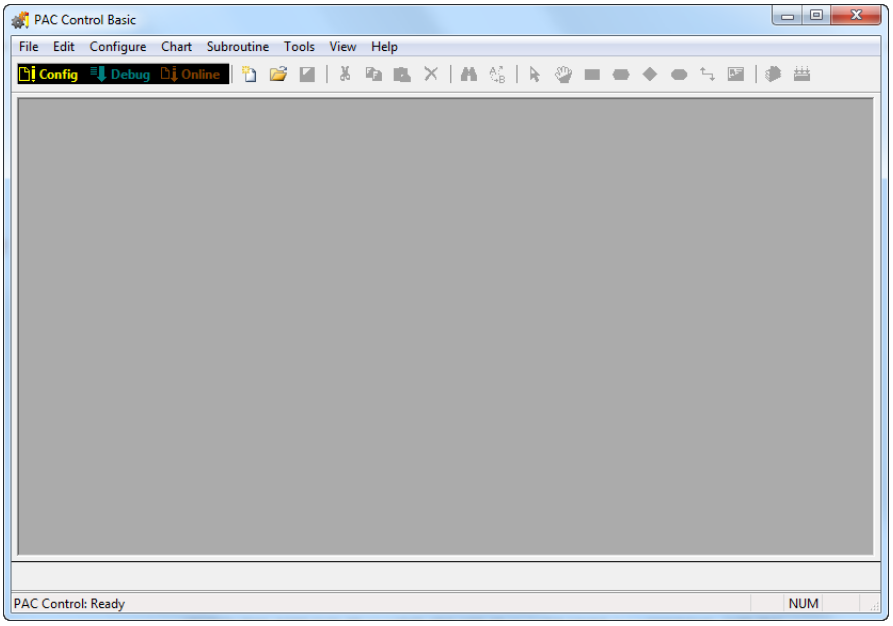
12. Download the RSLogix5000 program to the Logix PLC, but leave it in Program Mode for now.

Step 3: Configure the SNAP PAC Controller in PAC Control

In this step you will configure the SNAP PAC controller to make the Logix data available to *groov*.

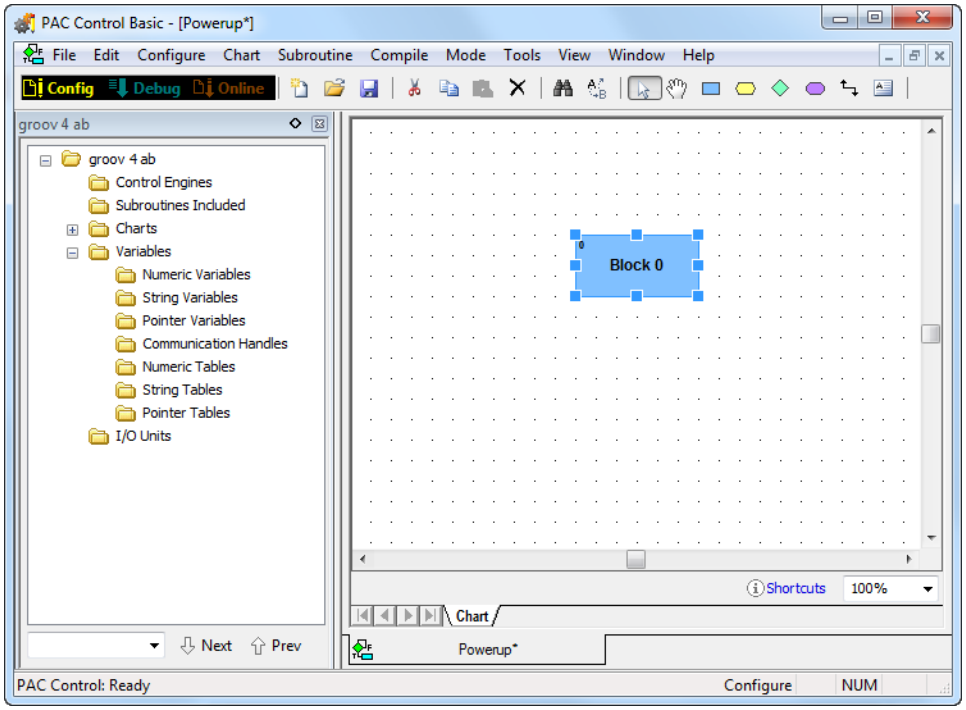
1. From the Start menu, choose > Programs > Opto 22 > PAC Project > PAC Control Basic.

   PAC Control Basic opens:

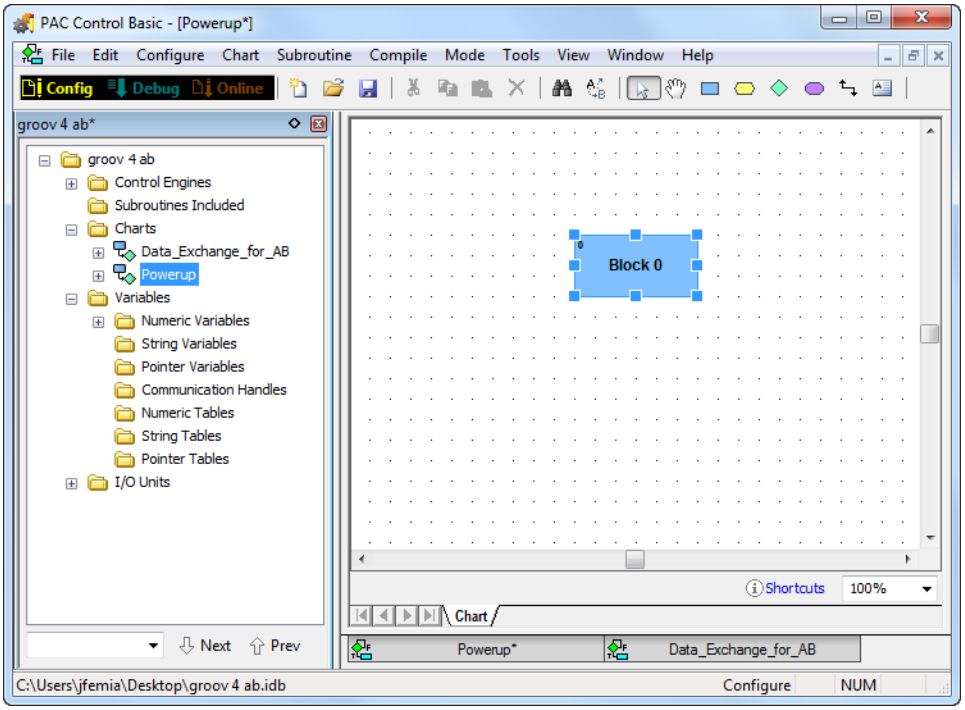


2. Choose File > New Strategy. Create a new PAC Control strategy called: `groov 4 AB`

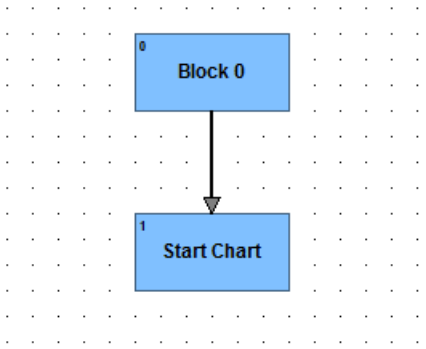
   If you need help, see the *PAC Control User's Guide* (Start > Programs > Opto 22 > PAC Project > Manuals > PAC Control User's Guide).



3. In the Strategy Tree at left, right-click Control Engines and add a control engine with the name `S1 for AB groov` and the IP address you assigned to the SNAP PAC.
4. In the Strategy Tree, right-click I/O units and add an I/O Unit with the name `S1_Scratchpad` and the IP address `127.0.0.1` (Leave Type as SNAP-PAC-R1.)
5. In the Strategy Tree, right-click Charts and choose New. Create a new chart named `Data_Exchange_for_AB`.
6. In the Strategy Tree, right-click Numeric Variables and add a variable with the name `Status_Trashcan` and type Integer 32.
7. Click the plus sign next to Charts and double-click Powerup.

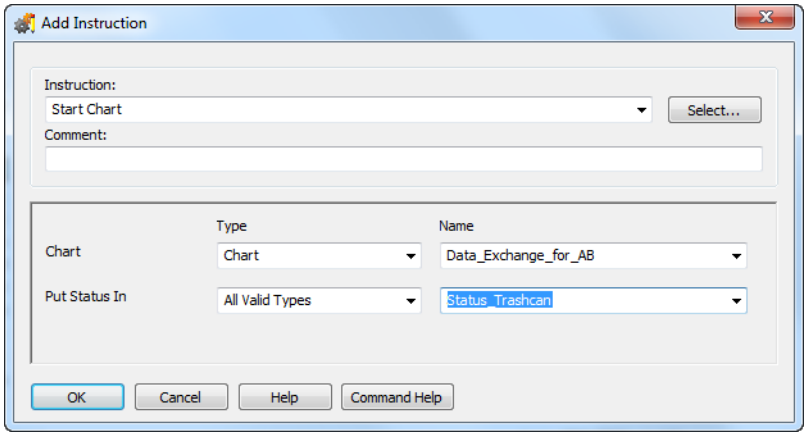


8. Add an action block (blue rectangle) and use the connection tool to connect Block 0 to it with a down arrow. Right-click the new block and name it Start Chart.

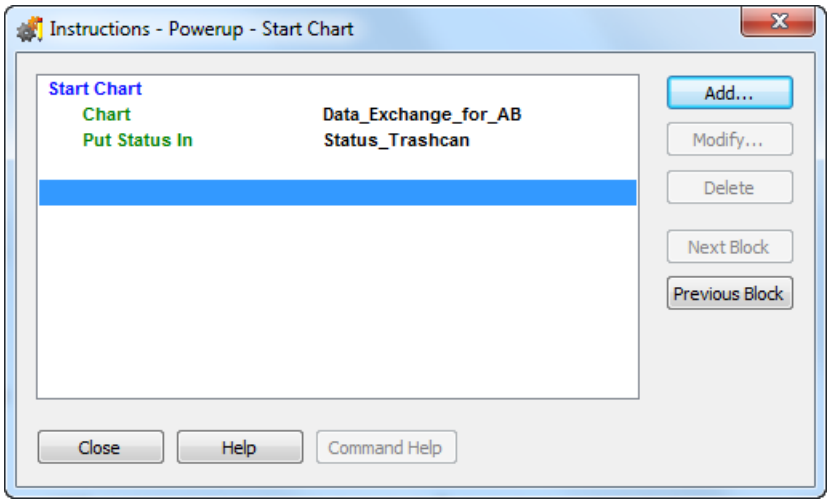


9. Double-click the Start Chart block and add a Start Chart command to start the chart Data_Exchange_for_AB. For Put Status In, choose Status_Trashcan.

NOTE: The easiest way to find the command is to start typing it in the Instruction field, and then choose it from the dropdown list.



10. Click OK.

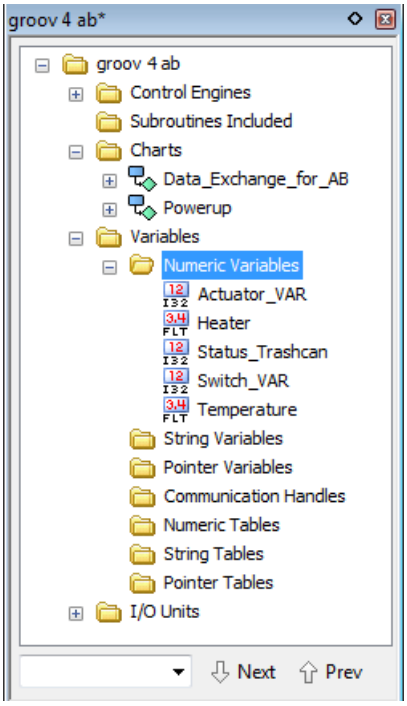


11. Click Close.

12. In the Strategy Tree, right-click Numeric Variables and add the following four variables:

- Name: `Switch_VAR` Type: Integer 32.
- Name: `Actuator_VAR` Type: Integer 32
- Name: `Temperature` Type: Float
- Name: `Heater` Type: Float

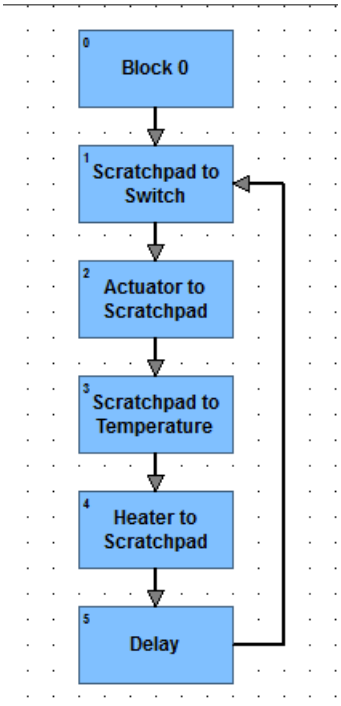
13. Click the plus sign next to Numeric Variables to see all the variables you've created.



14. In the Strategy Tree under Charts, double-click Data_Exchange_for_AB.

15. Below Block Zero, add five action blocks as shown at right and name them, in order:

- Scratchpad to Switch
- Actuator to Scratchpad
- Scratchpad to Temperature
- Heater to Scratchpad
- Delay



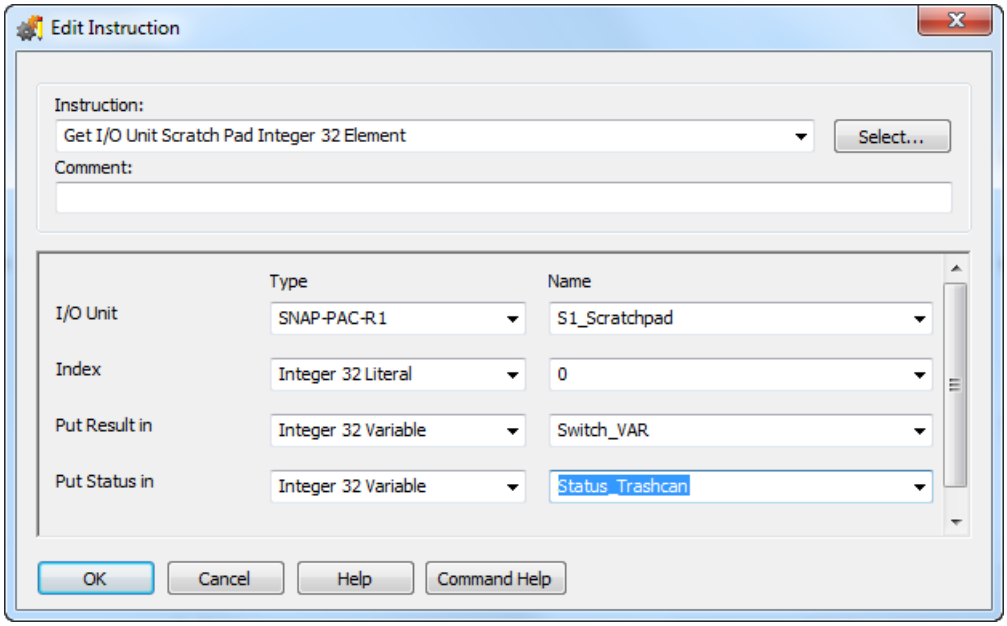
NOTE: If you prefer scripting to flowcharting, you can use an OptoScript block instead, and add code as shown on page 20.

16. Connect the blocks with down arrows, and loop the last block (Delay) back up to the first block you added (Block 0 is simply the starting block).

17. Double-click the Scratchpad to Switch block. Add the command Get I/O Unit Scratch Pad Integer 32 Element, and enter or choose the following parameters (you may need to enlarge the dialog box to see them all):

- I/O Unit (All Valid Types): `S1_Scratchpad`
- Index (Integer 32 Literal): `0`

- Put Result in (Integer 32 Variable): `Switch_VAR`
- Put Status in (Integer 32 Variable): `Status_Trashcan`



18. Click OK., and then click Close.
19. In the same way, double-click the following blocks and add the commands and parameters shown.
    a. Actuator to Scratchpad block. Add the command Set I/O Unit Scratch Pad Integer 32 Element and enter or choose the following parameters:
        - I/O Unit (All Valid Types): `S1_Scratchpad`
        - Index (Integer 32 Literal): `1`
        - From (Integer 32 Variable): `Actuator_VAR`
        - Put Status in (Integer 32 Variable): `Status_Trashcan`
    b. Scratchpad to Temperature block. Add the command Get I/O Unit Scratch Pad Float Element, and enter the following parameters:
        - I/O Unit (generic OptoMMP Device): `S1_Scratchpad`
        - Index (Integer 32 Literal): `2`
        - Put Result in (Float Variable): `Temperature`
        - Put Status in (Integer 32 Variable): `Status_Trashcan`
    c. Heater to Scratchpad block. Add the command Set I/O Unit Scratch Pad Float Element, and enter the following parameters:
        - I/O Unit (generic OptoMMP Device): `S1_Scratchpad`
        - Index (Integer 32 Literal): `3`
        - From (Float Variable): `Heater`
        - Put Status in (Integer 32 Variable): `Status_Trashcan`
    d. Delay block. Add the command Delay (mSec), and for the parameter enter Integer 32 Literal: `100`

20. Click the Save Strategy icon in the top toolbar (or choose File > Save Strategy), and click OK to save the strategy and charts.
21. Click Debug 

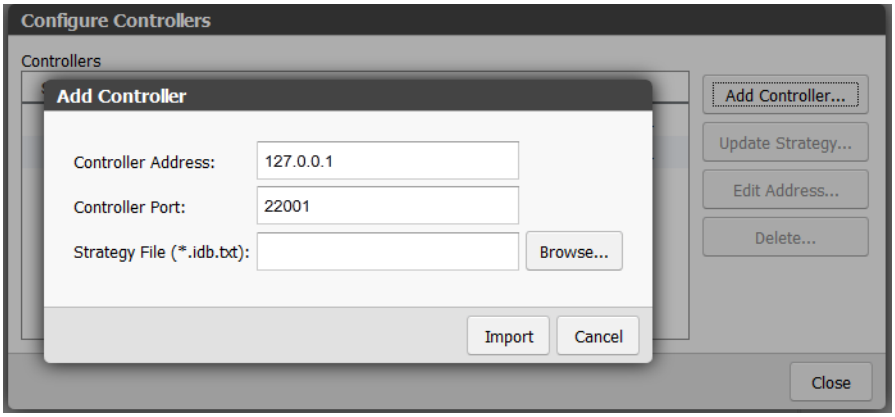
to download the strategy to the PAC controller.
22. Click Run  .

    The strategy begins running on the SNAP PAC.
23. Minimize or close PAC Control Basic.
24. Go back to RSLogix5000 and put the Logix controller into Run Mode.

Step 4: Configure *groov* for Logix Data

In this step you will configure *groov* to view and control the Logix data through the SNAP PAC controller. You must have Editor or Admin rights in order to access *groov* Build.

1. If you have not yet set up *groov*, follow steps in the *groov Quick Start* to attach the *groov* Box to your networks and to power, and to open a web browser, log in, and change the password. If you need additional help, see the *groov User's Guide*.
2. In the upper right of the *groov* screen, click the settings icon  and choose Switch to *groov* Build.
3. In *groov* Build, click the Configure menu and choose Controllers. In the Configure Controllers dialog box, click Add Controller.

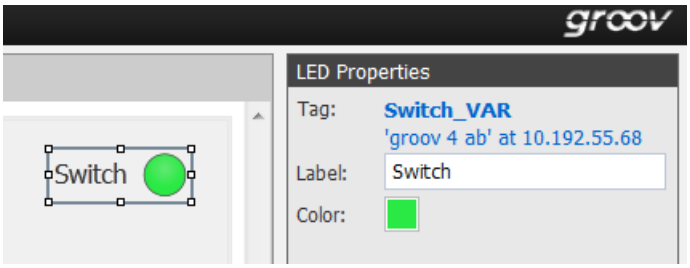


4. Enter the fixed IP address of your SNAP PAC controller. Leave the controller port at 22001. Browse to and select the **groov 4 AB.idb.txt** file for the strategy you created. (Make sure you choose the .idb.txt file, not the .idb file. Both files are in the folder where you saved your strategy.)
5. In the Pages pane at left, click Add Page, and name it: `groov AB`.
6. In the Gadget Palette at the lower right (Tags tab), expand the Tag tree so you can see all the tags in your strategy.

7. Click Switch_VAR, choose LED from the list of gadgets, and drag it onto the Desktop & Tablet workspace. In LED Properties at the upper right, do the following:

- For Label, enter `Switch`
- For color, choose green.

If the label overlaps the LED, click one of the grab points with your mouse and drag the box so it's large enough to fit.



8. Similarly, for the remaining three data points, add the following gadgets and properties:

a. For Actuator_VAR, choose a Button gadget.

- Label: `Actuator`
- Color: Red

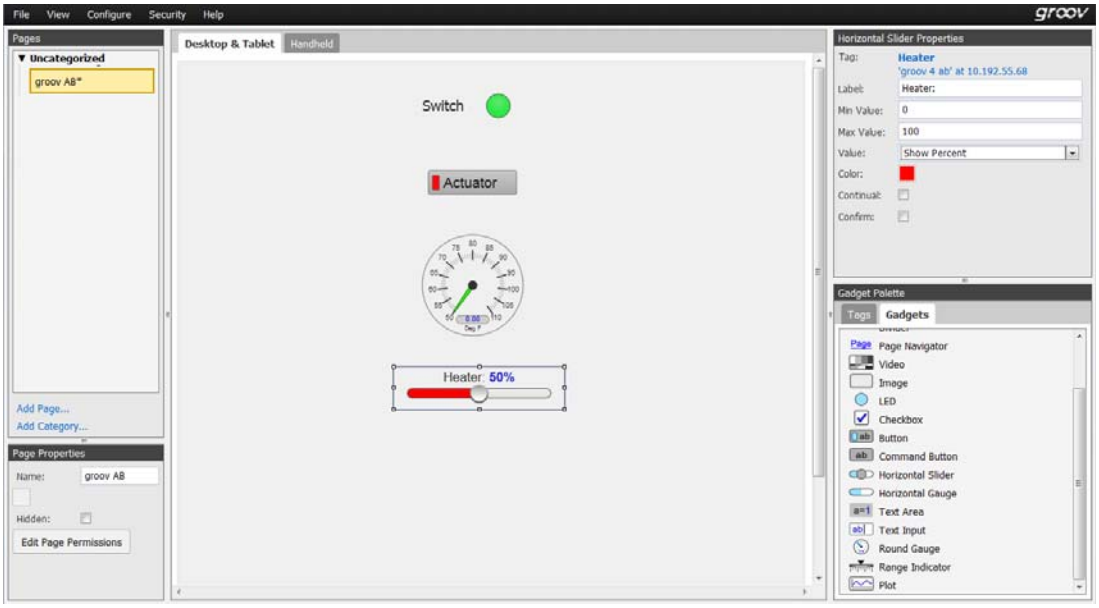
b. For Temperature, choose a Round Gauge.

- Min Value: `50`
- Max Value: `110`
- Needle color: green
- Show Value: checked
- Precision: `2`
- Units: `Deg F`

c. For Heater, choose a Horizontal Slider.

- Label: `Heater`
- Min Value: `0`
- Max Value: `100`
- Value: `Show Percent`
- Color: Red

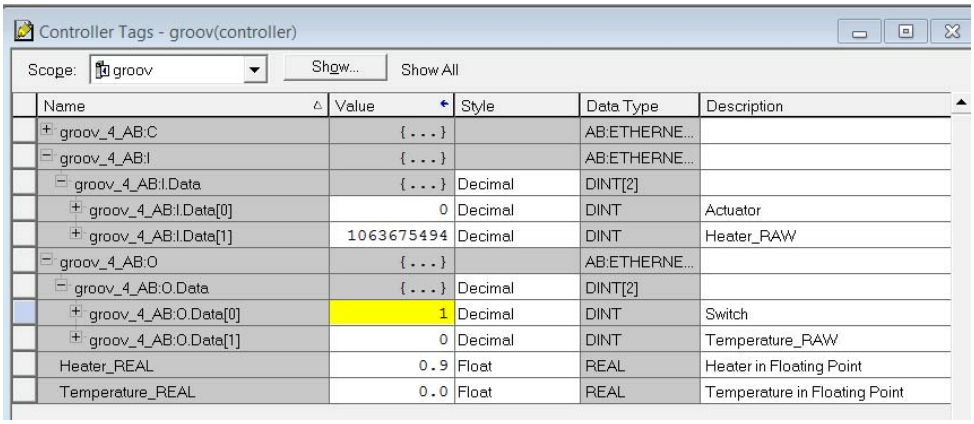
Extend the horizontal slider by clicking and dragging one of its side grab points.



9. From the File menu, choose Save All Changes and Switch to *groov* View.

Step 5: Use *groov* with your Allen-Bradley System

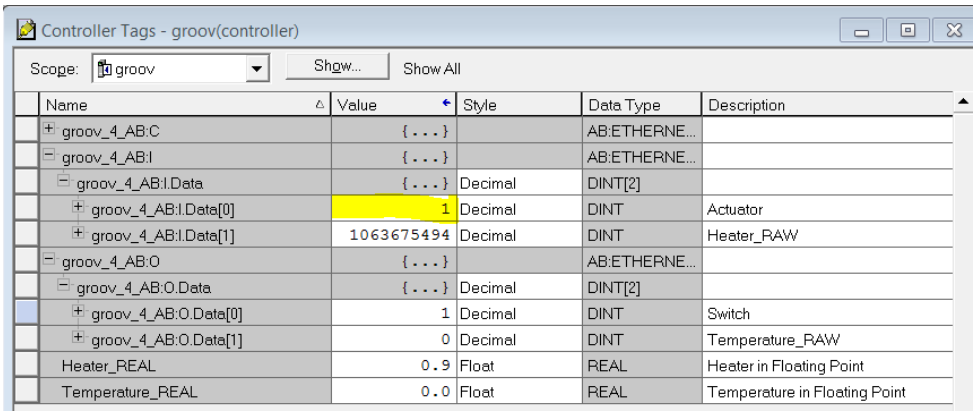
1. In the RSLogix5000 Controller Tags *Monitor Tags* tab, change the Switch value from 0 to 1.



Name	Value	Style	Data Type	Description
groov_4_AB:C	{...}		AB:ETHERNE...	
groov_4_AB:I	{...}		AB:ETHERNE...	
groov_4_AB:I.Data	{...}	Decimal	DINT[2]	
groov_4_AB:I.Data[0]	0	Decimal	DINT	Actuator
groov_4_AB:I.Data[1]	1063675494	Decimal	DINT	Heater_RAW
groov_4_AB:O	{...}		AB:ETHERNE...	
groov_4_AB:O.Data	{...}	Decimal	DINT[2]	
groov_4_AB:O.Data[0]	1	Decimal	DINT	Switch
groov_4_AB:O.Data[1]	0	Decimal	DINT	Temperature_RAW
Heater_REAL	0.9	Float	REAL	Heater in Floating Point
Temperature_REAL	0.0	Float	REAL	Temperature in Floating Point

2. In *groov* View, notice that the switch LED has changed color from black to green.

3. Still in *groov* View, click the Actuator Button. (It turns red.) In the RSLogix5000 Controller Tags, notice that the Actuator has changed from 0 to 1.

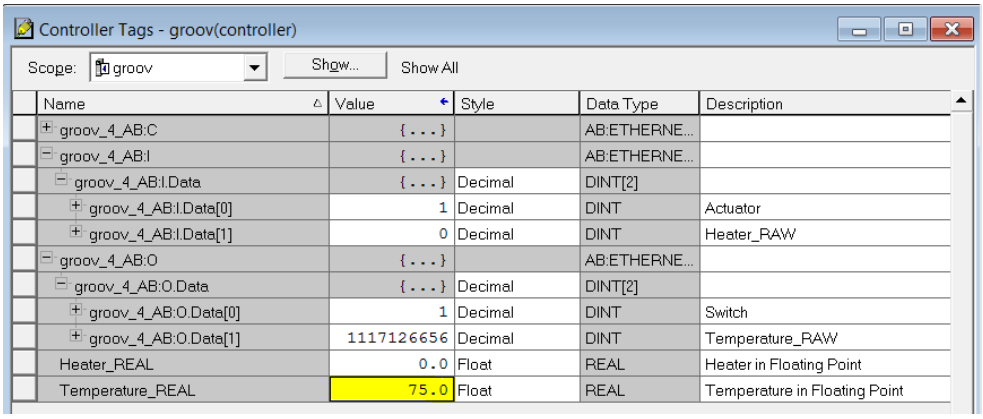


Controller Tags - groov(controller)

Scope: groov | Show... | Show All

Name	Value	Style	Data Type	Description
groov_4_AB:C	{...}		AB:ETHERNE...	
groov_4_AB:I	{...}		AB:ETHERNE...	
groov_4_AB:I.Data	{...}	Decimal	DINT[2]	
groov_4_AB:I.Data[0]	1	Decimal	DINT	Actuator
groov_4_AB:I.Data[1]	1063675494	Decimal	DINT	Heater_RAW
groov_4_AB:O	{...}		AB:ETHERNE...	
groov_4_AB:O.Data	{...}	Decimal	DINT[2]	
groov_4_AB:O.Data[0]	1	Decimal	DINT	Switch
groov_4_AB:O.Data[1]	0	Decimal	DINT	Temperature_RAW
Heater_REAL	0.9	Float	REAL	Heater in Floating Point
Temperature_REAL	0.0	Float	REAL	Temperature in Floating Point

4. In the RSLogix Controller Tags, change the Temperature in Floating Point to 75.0.

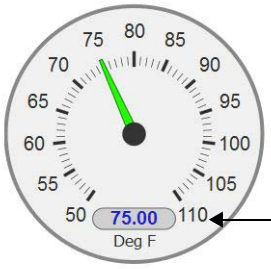


Controller Tags - groov(controller)

Scope: groov | Show... | Show All

Name	Value	Style	Data Type	Description
groov_4_AB:C	{...}		AB:ETHERNE...	
groov_4_AB:I	{...}		AB:ETHERNE...	
groov_4_AB:I.Data	{...}	Decimal	DINT[2]	
groov_4_AB:I.Data[0]	1	Decimal	DINT	Actuator
groov_4_AB:I.Data[1]	0	Decimal	DINT	Heater_RAW
groov_4_AB:O	{...}		AB:ETHERNE...	
groov_4_AB:O.Data	{...}	Decimal	DINT[2]	
groov_4_AB:O.Data[0]	1	Decimal	DINT	Switch
groov_4_AB:O.Data[1]	1117126656	Decimal	DINT	Temperature_RAW
Heater_REAL	0.0	Float	REAL	Heater in Floating Point
Temperature_REAL	75.0	Float	REAL	Temperature in Floating Point

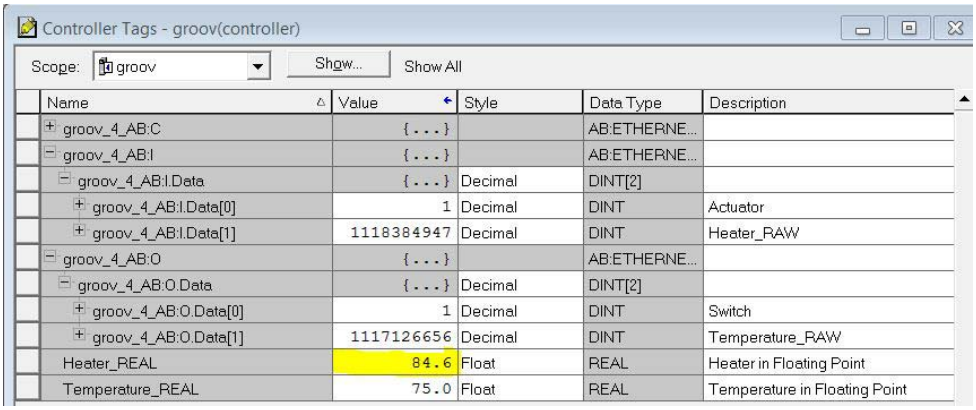
5. In *groov* View, notice that the temperature gauge now shows 75 degrees F.



The live value from the controller is shown in blue text. All live values from the system are shown in blue.

6. In *groov* View, move the Heater slider bar to the right, to about 85%.

7. In the RSLogix5000 Controller Tags, notice that the Heater in Floating Point has changed to match the *groov* heater control slider.



Name	Value	Style	Data Type	Description
groov_4_AB:C	{...}		AB:ETHERNE...	
groov_4_AB:I	{...}		AB:ETHERNE...	
groov_4_AB:I.Data	{...}	Decimal	DINT[2]	
groov_4_AB:I.Data[0]	1	Decimal	DINT	Actuator
groov_4_AB:I.Data[1]	1118384947	Decimal	DINT	Heater_RAW
groov_4_AB:O	{...}		AB:ETHERNE...	
groov_4_AB:O.Data	{...}	Decimal	DINT[2]	
groov_4_AB:O.Data[0]	1	Decimal	DINT	Switch
groov_4_AB:O.Data[1]	1117126656	Decimal	DINT	Temperature_RAW
Heater_REAL	84.6	Float	REAL	Heater in Floating Point
Temperature_REAL	75.0	Float	REAL	Temperature in Floating Point

8. Now try logging into *groov* View with your smartphone or tablet to view and control your Allen-Bradley system data from there!

Lots of Options

A-B Systems and PAC Controllers

We've already mentioned that an assortment of Allen-Bradley products can be used with SNAP PACs and *groov*: ControlLogix, CompactLogix, and even SLC 5/05 and MicroLogix 1100 and 1400 systems.

The intermediary Opto 22 controller can be any SNAP PAC standalone, rack-mounted, or software-based programmable automation controller:

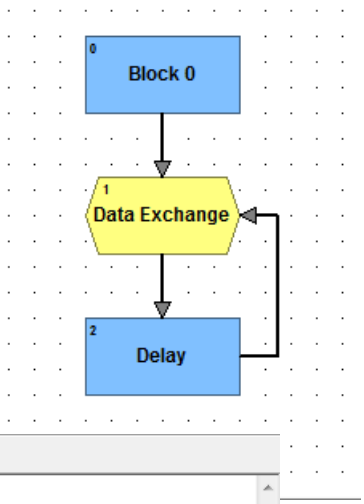
- Standalone PACs are SNAP PAC S-series controllers like the one used in this example.
- Rack-mounted PACs are SNAP PAC R-series controllers, which also control analog, digital, and serial SNAP I/O modules on the same rack.
- SoftPAC is a software-based controller that runs on your PC.

Scripting

PAC Control provides programming options as well.

For example, you can enter commands using scripting in a single OptoScript block (a yellow hexagon) instead of a series of action blocks (blue rectangles).

Then your chart would look like the one at right.



The code in your OptoScript block for this example would be similar to the following:

OptoScript Code:

```
while (1 == 1) // loop forever

  // Step 1: Get 'Switch_VAR' from ScratchPadInt32[0]
  GetIoUnitScratchPadInt32Element( S1_Scratchpad, 0, Switch_VAR );

  // Step 2: Put 'Actuator_VAR' into ScratchPadInt32[1]
  SetIoUnitScratchPadInt32Element( S1_Scratchpad, 1, Actuator_VAR );

  // Step 3: Get 'Temperature' from ScratchPadFloat[2]
  GetIoUnitScratchPadFloatElement( S1_Scratchpad, 2, Temperature );

  // Step 4: Put 'Heater' into ScratchPadFloat[3]
  SetIoUnitScratchPadFloatElement( S1_Scratchpad, 3, Heater );

  // Don't forget a short delay (as long as is reasonable for this application)
  // so this chart doesn't hog the CPU
  DelayMsec( 100 );

wend
```

The Scratch Pad

The Scratch Pad in the SNAP PAC controller is simply an area in the PAC's memory map that you can use in any way you want. It includes the following five sections to accommodate different types of data:

- Scratch Pad bits—a 64-bit mask
- Scratch Pad strings—a table of 64 elements. Each element can hold 128 characters or 128 bytes of binary data.
- Scratch Pad floats—a table of 10,240 elements; each float is four bytes
- Scratch Pad 32-bit integers—a table of 10,240 four-byte elements
- Scratch Pad 64-bit integers—a table of 1024 eight-byte elements

In this example we used indices 0 and 1 of the Scratch Pad 32-bit integers table and indices 2 and 3 of the Scratch Pad floats table. These are arbitrary choices; we could have used any indices that we aren't already using.

As you can see, you can accommodate a lot of data from your A-B system in the Scratch Pad.

For More Information

For more information on *groov*, visit groov.com.

For questions about integration with A-B systems, contact your local Opto 22 distributor or an Opto 22 pre-sales engineer. There is no charge for pre-sales engineering.

- Phone (toll-free in the U.S. and Canada): **800-321-6786**
- Phone (outside the U.S. and Canada): 951-695-3000
- Email: systemseng@opto22.com

Product Support

If you've already purchased Opto 22 products, are having problems, and can't find the answers you need in this technical note or the reference documents listed on page 3, please contact Opto 22 Product Support.

- Product support for *groov* for one year is included in the initial purchase price. After the first year, purchase maintenance (including product support and all updates) annually.
- Product support on Opto 22 SNAP PAC controllers and I/O is free.

Phone:	800-TEK-OPTO (800-835-6786) 951-695-3080 (Hours are Monday through Friday, 7 a.m. to 5 p.m. Pacific Time)	*NOTE: Email messages and phone calls to Opto 22 Product Support are grouped together and answered in the order received.*
Fax:	951-695-3017	
Email:	support@opto22.com	
Opto 22 website:	www.opto22.com	