

SNAP PAC S-SERIES CONTROLLER USER'S GUIDE

SNAP-PAC-S1
SNAP-PAC-S2
SNAP-PAC-S1-FM

Form 1592-211027–October 2021

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SNAP PAC S-Series User's Guide
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1: Overview

INTRODUCTION

The SNAP PAC S-series programmable automation controllers provide powerful, real-time control and communication to meet your industrial control, monitoring, and data acquisition and exchange needs. As part of the Opto 22 SNAP PAC System, one of these compact, industrially hardened controllers can handle multiple control, automation, and data tasks involving digital and analog control, serial string handling, PID, and enterprise connectivity.

Connecting to Opto 22 serial- and Ethernet-based I/O systems, a SNAP PAC S-series controller runs control programs written in Opto 22's PAC Control™ software to monitor and control a wide range of devices and equipment. SNAP PAC S-series controllers are well suited to original equipment manufacturers (OEMs), system integrators, and end-users in process control, discrete manufacturing, or hybrid industries and applications.

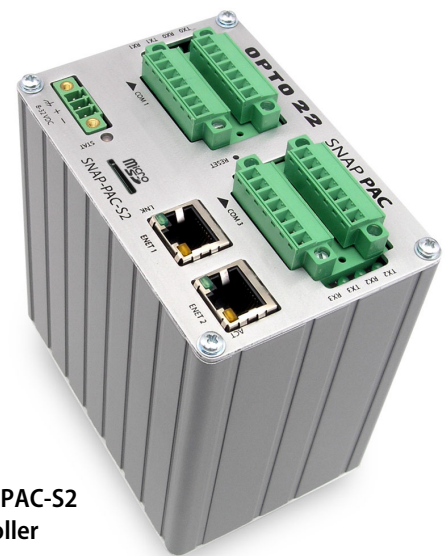
A SNAP PAC S-series controller simultaneously runs up to 32 PAC Control flowcharts, although a PAC Control strategy can actually contain a much larger number of flowcharts. The total number of flowcharts is limited only by the controller memory available for strategy storage.

Two S-series PACs of the same part number can be used together as redundant controllers. One controller runs the strategy while the other runs in tandem, ready to take over if the first one fails.

Ethernet Communication

All SNAP PAC S-series programmable controllers communicate over standard 10/100 Mbps Ethernet networks and can be attached to an existing wired Ethernet network or wireless LAN (local area network). The controllers can also be used in an independent control network built with standard, off-the-shelf Ethernet hardware.

SNAP PAC S-series controllers include two 10/100 Mbps Ethernet interfaces for networking through an Ethernet switch to Ethernet hosts, as well as SNAP PAC brains and I/O, which provide local intelligence and the connections to digital and analog sensors and actuators as well as serial devices. These independent Ethernet ports have separate IP addresses that can be used with PAC Project™ Professional software to set up redundant



**SNAP-PAC-S2
controller**

network links to safeguard the availability and reliability of an I/O system, or to segment a control system's network from the enterprise LAN.

Supported protocols over Ethernet include EtherNet/IP™, Modbus®/TCP, SMTP, SNMP, FTP, and OptoMMP.

- Using EtherNet/IP, SNAP PAC S-series controllers can share data with Allen-Bradley® Logix PLCs and other PLC systems based on the EtherNet/IP protocol.
- Using Modbus/TCP, S-series PACs can share data with Ethernet-based Modbus hardware and software.
- SMTP (Simple Mail Transfer Protocol) is used for email, and SNMP (Simple Network Management Protocol) lets the network monitor the PAC just as it would monitor network computer hardware.
- FTP can be used to manipulate files and data in the PAC's file system.
- OptoMMP is an open, documented protocol used by all Opto 22 Ethernet-based controllers and brains.

Serial Communication

SNAP PAC S-series controllers provide RS-232 and RS-485 communication as follows:

- The **SNAP-PAC-S1** and **SNAP-PAC-S1-FM** have two RS-232 serial ports that support general-purpose communication with serial devices; you can send and receive data from one or two serial devices connected directly to the controller. By default, Port 0 is set to be connected to a modem using Point-to-Point Protocol (PPP) for creating TCP/IP networks over serial or PSTN (Public Switched Telephone Network) lines. To connect Port 0 to serial devices, change the port configuration in PAC Manager. The S1 PACs also have one pluggable two-wire RS-485 port that can be used for SNAP PAC SB-series serial brains and legacy Opto 22 *mistic*™ I/O units, including the serial B3000 brain and remote *mistic* bricks. The SNAP-PAC-S1-FM is Factory Mutual approved.
- The **SNAP-PAC-S2** has four serial ports that can each be configured using PAC Manager as either RS-232 or RS-485 (2-wire or 4-wire). These ports can be used for either I/O or general-purpose serial communication. Configured as RS-232, the ports support remote serial device communication, and any one of the ports can be configured as a PPP modem connection. Configured as RS-485, the serial ports connect to SNAP PAC serial brains and to *mistic* I/O units. If you have a substantial number of serial I/O units, the PAC S2 is the controller to use. For the default configuration settings of these ports, see [“Assigning Serial Ports on SNAP-PAC-S2 Controllers” on page 26](#).



For additional serial interfaces, you can add one or more SNAP serial communication modules on attached SNAP Ethernet-based I/O units.

Backward Compatibility

S-series controllers have RS-485 serial interfaces for connecting to Opto 22's legacy *mistic* I/O units. The SNAP-PAC-S1 and SNAP-PAC-S1-FM have one RS-485 port, and the SNAP-PAC-S2 can be configured with up to four.

This connectivity with legacy serial-based I/O systems, combined with PAC Control Professional's ability to import control programs (or *strategies*) written in OptoControl™ software, provides a migration path to integrate older Opto 22 I/O systems into modern control hardware running on Ethernet networks. For detailed information on updating control strategies and integrating legacy control hardware into modern systems, see form 1692, [FactoryFloor to PAC Project Migration Technical Note](#).

Forward Compatibility

SNAP PAC S-series controllers are also compatible with newer [groov EPIC](#) processors and [groov RIO](#) edge I/O units, which add industrial IoT data communications and security features to your system. Both [groov EPIC](#) and [groov RIO](#) can be used as I/O units with an S-series controller.

If you're not using serial-based I/O units with your system and don't require controller redundancy, consider purchasing a [groov EPIC](#) processor instead of a SNAP PAC S-series controller. For more information, see the [groov EPIC system](#) on our website or contact our pre-sales engineers.

I/O Unit Compatibility

The combination of Ethernet (both wired and wireless) and serial network interfaces gives SNAP PAC S-series controllers the ability to control current and many legacy Opto 22 I/O units. All S1s have one RS-485 port, and S2s can be configured with up to four.

The following table lists I/O units supported by S-series controllers:

S-Series Controller	On an Ethernet Network	On a Serial Network	
	SNAP-PAC-R1	GRV-R7-MM1001-10	SNAP-PAC-SB1*
	SNAP-PAC-R1-B	GRV-R7-MM2001-10	SNAP-PAC-SB2*
	SNAP-PAC-R1-FM	G4EB2	B3000**
	SNAP-PAC-R2	G4D32EB2	B3000-B**
SNAP-PAC-S1	SNAP-PAC-R2-FM	G4D32EB2-UPG	SNAP-BRS**
SNAP-PAC-S1-FM	SNAP-PAC-EB1	SNAP-UP1-ADS**	B100**
SNAP-PAC-S2	SNAP-PAC-EB1-FM	SNAP-B3000-ENET**	B200**
	SNAP-PAC-EB2	SNAP-ENET-D64**	G4D16R**
	SNAP-PAC-EB2-FM	SNAP-ENET-S64**	G4D32RS**
	GRV-EPIC-PR1	SNAP-ENET-RTC**	G4A8R**
	GRV-EPIC-PR2		

* For information about data transfer speed when using a controller to communicate with a serial brain, see [page 37](#).

** Legacy I/O processors; not recommended for new development

This connectivity with legacy serial-based I/O systems, combined with PAC Control Professional software's ability to import control programs (or *strategies*) written in OptoControl™ software, provides a migration path to integrate older Opto 22 I/O systems into modern control hardware running on Ethernet networks.

For detailed information on updating control strategies and integrating legacy control hardware into modern systems, see the [FactoryFloor to PAC Project Migration Technical Note](#) (form 1692).

Redundant Controllers

Two identical SNAP PAC S-series controllers can be used in a redundant system, where one controller actively runs the control program and the other is ready to take over if the first one should fail. Besides two identical PACs, a redundant system requires PAC Project Professional R9.0 or newer (see "[PAC Project Software](#)," below) and the SNAP PAC Redundancy Option Kit.

The PAC Control Professional strategy developed for a redundant system makes use of special redundancy features, such as checkpoint blocks and persistent/redundant variables. The developer has complete flexibility in programming, tagging specific data for redundancy and placing checkpoint blocks at precise points in the logic where synchronization is to occur.

See [page 10](#) for a diagram of a redundant system. Also see the [SNAP PAC Redundancy Option Kit Data Sheet](#) (form 1901) and the [SNAP PAC System Redundancy User's Guide](#) (form 1831).

PAC PROJECT SOFTWARE

SNAP PAC controllers use Opto 22's **PAC Project** Microsoft® Windows® -compatible automation software for programming, human-machine-interface (HMI) development, and OPC connectivity.

Two versions of PAC Project are available on our website, www.opto22.com: PAC Project Basic is free to download; PAC Project Professional is available for purchase and download.

- **PAC Project Basic** includes PAC Control™ for developing control programs, PAC Display™ for creating operator interfaces, and PAC Manager™ configuration software.
- **PAC Project Professional** adds expanded versions of PAC Control and PAC Display plus a SoftPAC software-based controller for PC-based control, OptoOPCServer™ software for exchanging data with OPC 2.0-compliant client software applications, and OptoDataLink™ for exchanging SNAP PAC System data with databases (including Microsoft SQL Server, Microsoft Access, and MySQL), text files, and email systems).

You can also purchase PAC Control Professional, PAC Display Professional, SoftPAC, OptoOPCServer, and OptoDataLink separately. For details, see the [PAC Project Data Sheet](#) (form 1699).

PAC Control Basic is a graphical, flowchart-based programming tool for machine control and process applications. Using PAC Control, you create, download, and run strategies on a SNAP PAC or *groov* EPIC controller. In addition to flowchart programming with subroutine capability, PAC Control includes a powerful, built-in scripting language based on C and other procedural languages.

PAC Control Professional adds the ability to import legacy OptoControl strategies, support for older *mistic*™ serial I/O units, and support for the dual independent Ethernet ports on a SNAP PAC controller.

The number of PAC Control flowcharts that can simultaneously run depends on the controller, but the PAC Control strategy can contain a much larger number of flowcharts. The total number of flowcharts is limited only by the memory available for strategy storage.

PAC Display Basic is an intuitive HMI package for building operator interfaces, or *projects*, for communicating with a SNAP PAC controller. PAC Display offers a full-featured HMI including alarming, trending, and a built-in library of 3,000 industrial automation graphics.

PAC Display Professional adds the ability to import projects created in OptoDisplay, part of the legacy Opto 22 FactoryFloor® software suite, and using redundant Ethernet communication links on SNAP PAC controllers. PAC Display Professional can also connect to Ethernet-based FactoryFloor controllers running OptoControl strategies.

SoftPAC is a software-based programmable automation controller (PAC) designed for PC-based control. Programmed just like an Opto 22 hardware controller, SoftPAC runs your PAC Control strategy independently on an embedded or standalone PC. SoftPAC takes advantage of a PC's speed and file capabilities for applications requiring extended file storage, frequent access to files, or math-intensive processes.

OptoOPCServer is a fast, efficient OPC 2.0-compliant server for communicating with many Opto 22 products, including SNAP PAC controllers and I/O units, plus legacy Opto 22 Ethernet-based controllers and I/O. Using OptoOPCServer, you can consolidate data from all these Opto 22 systems into the OPC client software of your choice, such as third-party HMI and data acquisition packages, and custom software applications you create with tools such as Visual C++®.

OptoDataLink is a software application that makes it easy to share data from the SNAP PAC System with commonly used databases, including Microsoft SQL Server, Microsoft Access, and MySQL, as well as text files. The I/O points and strategy variables already created in your PAC Control strategy are automatically available for OptoDataLink to use for data exchange.

PAC Manager is a utility application for assigning IP addresses to SNAP PAC controllers and brains, reading or changing basic controller configuration, and configuring and testing I/O.

For information about documentation, see [page 12](#).

FOR DEVELOPERS: SNAP PAC REST API

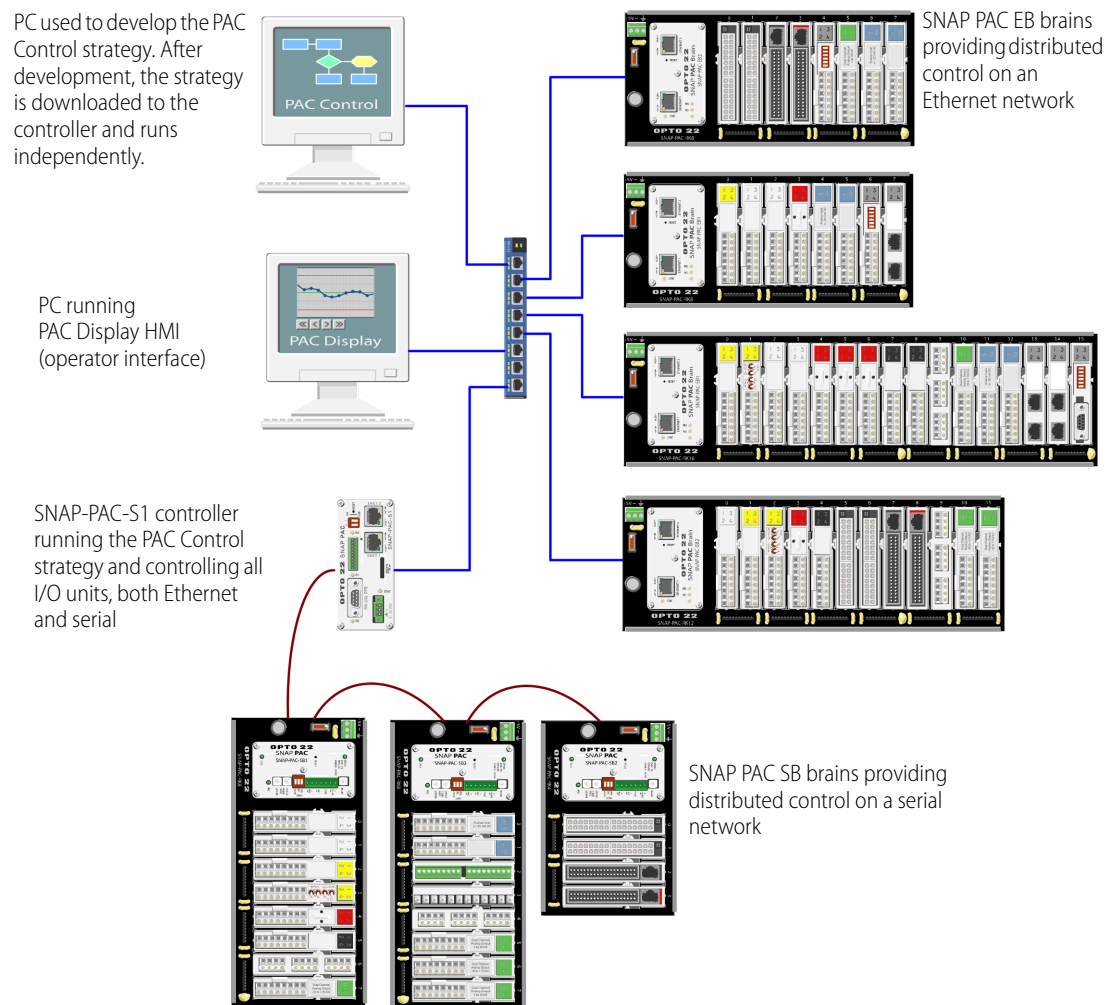
If you're a developer who'd like to use PAC Control strategy tags in communications with other devices, the Opto 22 SNAP PAC REST API is a secure and powerful way to do just that. The API is available in SNAP PAC R-series and S-series controllers with PAC firmware R9.5a and higher. To configure https access to your PAC's RESTful server and learn how to call the API, visit developer.opto22.com.

ARCHITECTURAL DIAGRAMS

Because SNAP PAC S-series controllers have multiple Ethernet and serial interfaces, these controllers are suitable for use in a variety of system layouts and architectures. Dual independent Ethernet interfaces, for example, let you configure a network for link redundancy or segmented networking. A PPP serial interface provides a dial-up modem link for remotely located control systems, while two-wire RS-485 support integrates existing Opto 22 *mistic* serial-based I/O units into contemporary Ethernet-based systems.

Basic Control System

In this basic system, the SNAP-PAC-S1 controls several SNAP PAC I/O units, some on a wired Ethernet network and some on a serial network. PAC Project Basic is all you need.

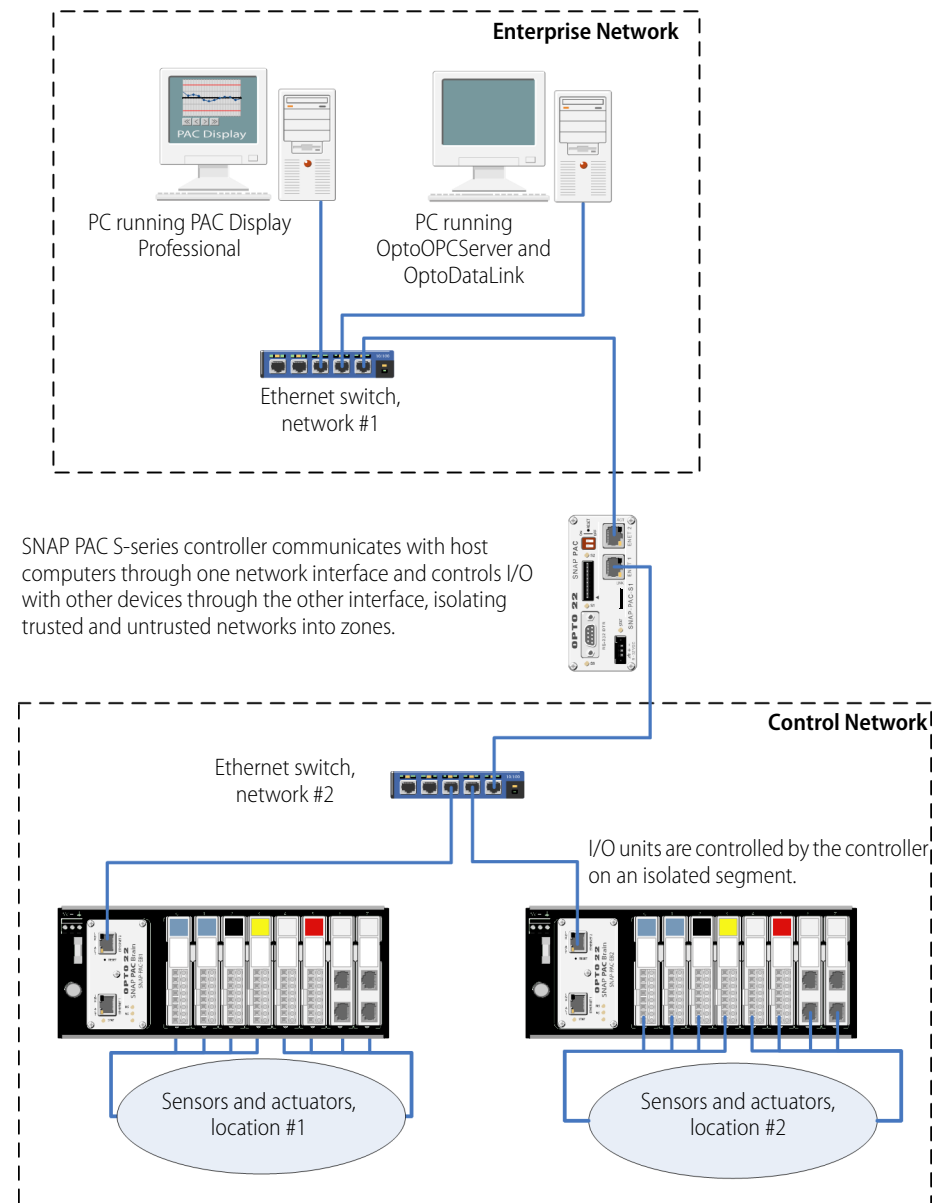


Isolating Ethernet Networks into Zones

This diagram shows multiple Opto 22 SNAP I/O units connected together over an Ethernet network and controlled by a SNAP PAC S-series controller running a control strategy. The controller is also connected to a larger, separate enterprise Ethernet network to provide data to two PCs running Opto 22's PAC Display HMI software and OptoOPCServer.

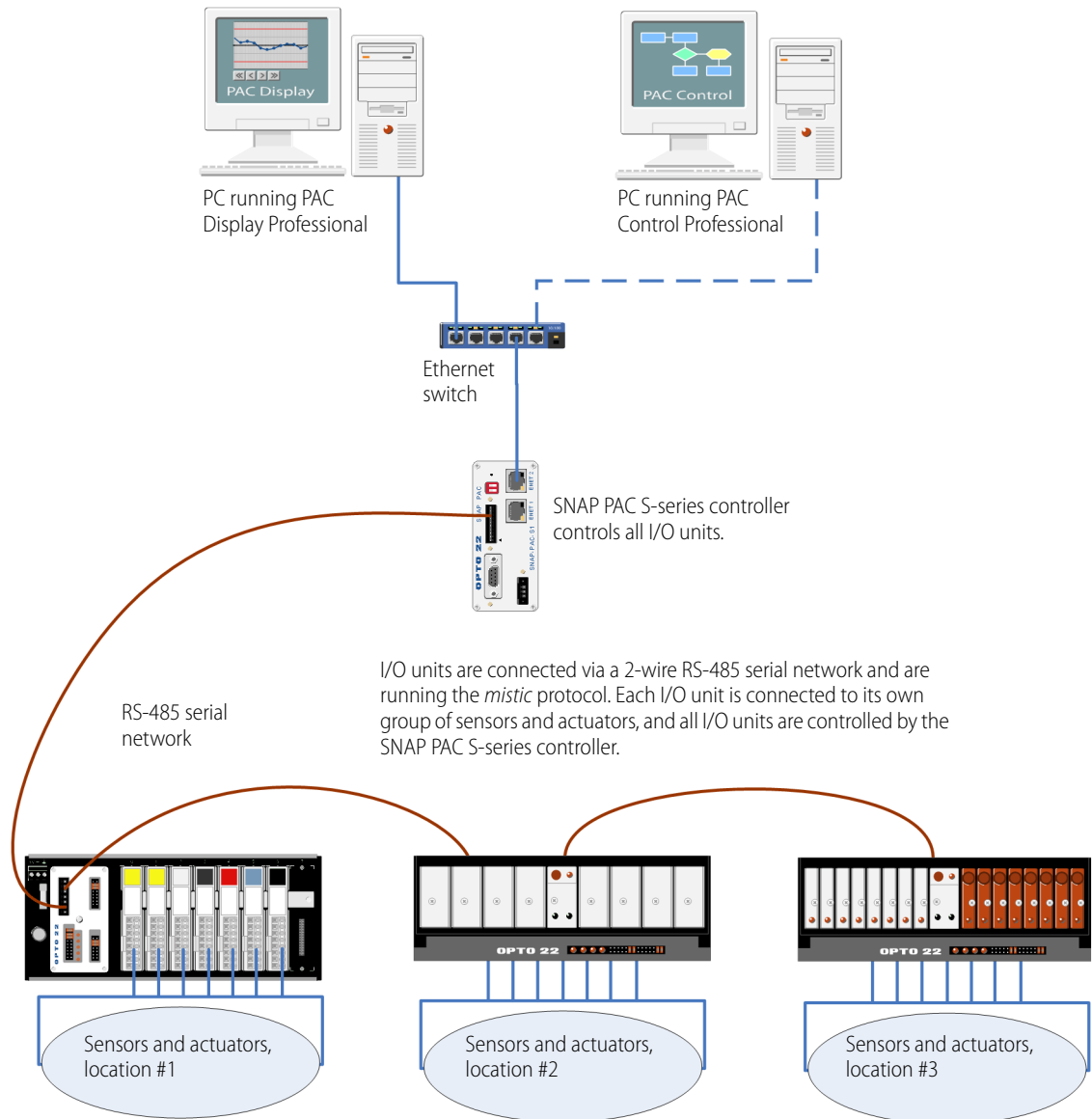
Sitting between the two networks, the SNAP PAC S-series controller isolates I/O and control traffic on the trusted network from the untrusted enterprise network, and vice versa.

For this system, PAC Display must be configured to access the I/O through the controller rather than directly from the I/O units, since they are on a separate network.



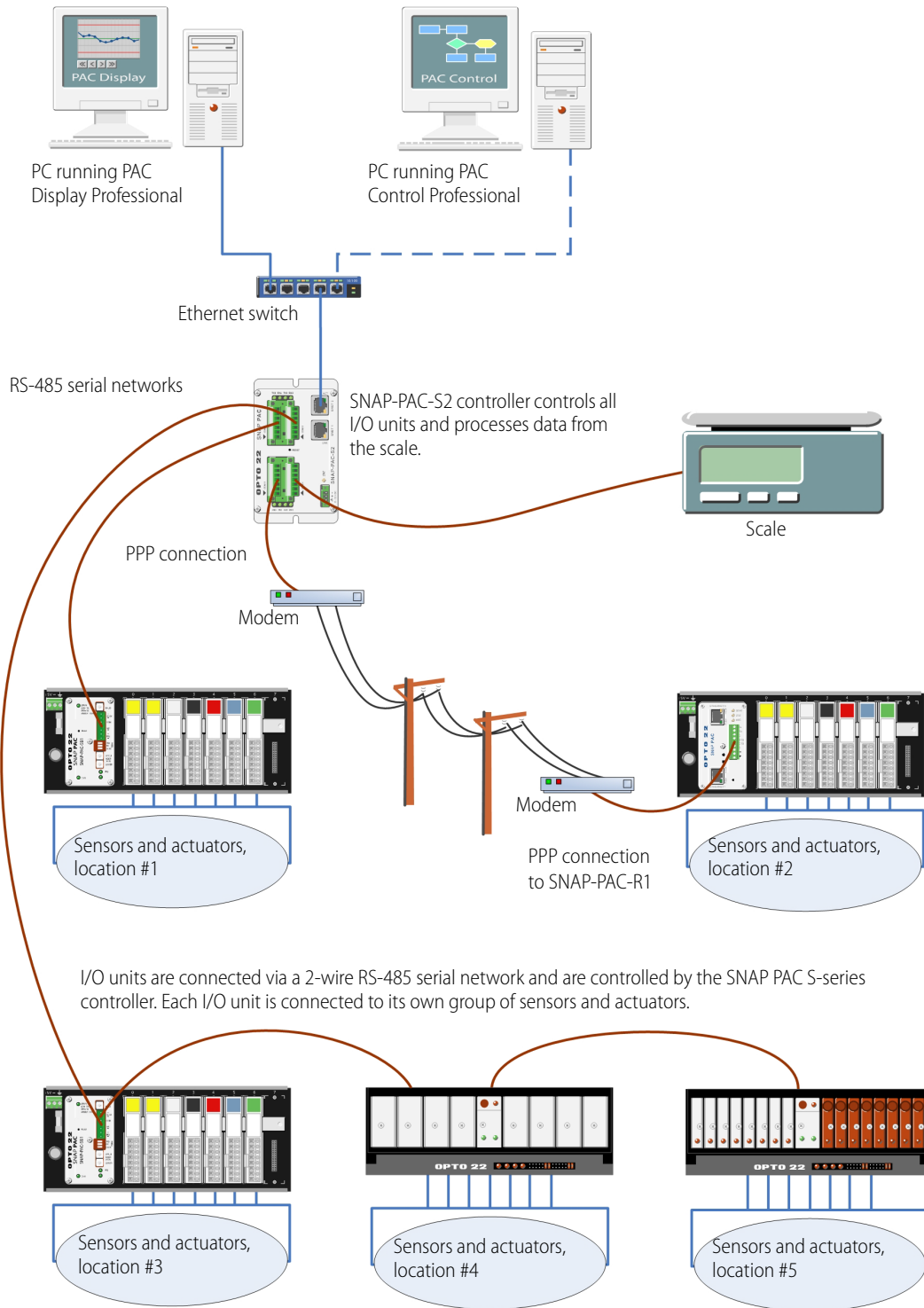
Connections to Legacy Serial-based I/O Units

In the following diagram, a SNAP PAC S-series controller is connected to Opto 22 legacy serial-based I/O units over an RS-485 serial network. The controller is also connected to a larger, separate enterprise Ethernet network to provide process data to a PC running Opto 22's PAC Display HMI software.



SNAP-PAC-S2 Connections to Serial-based I/O Units

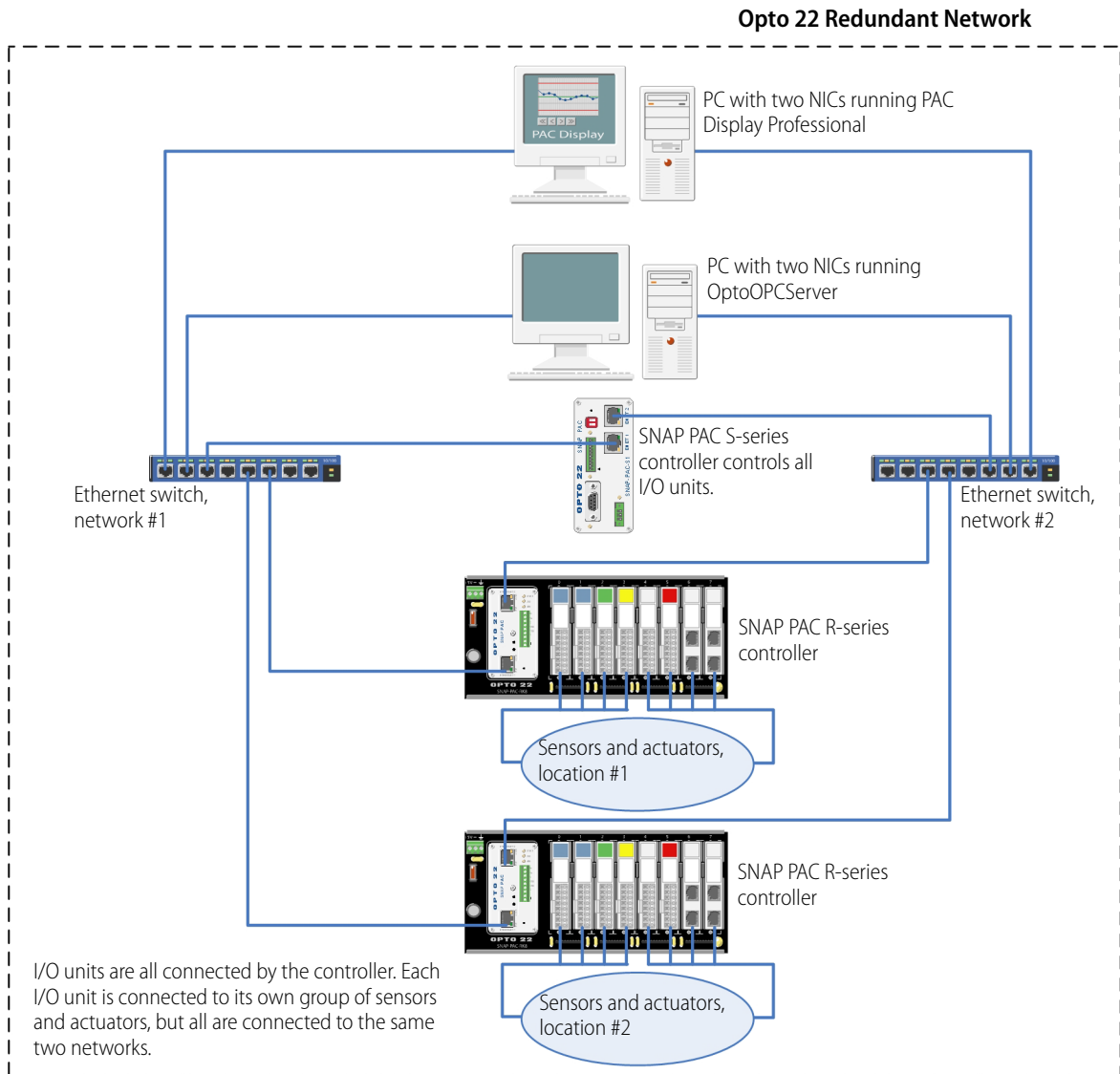
The following diagram shows a SNAP-PAC-S2 controller connected to multiple Opto 22 serial-based I/O units over two RS-485 serial networks, a remote SNAP Ethernet-based I/O unit over a modem using the Point-to-Point Protocol (PPP), and a serial-based industrial scale.



Ethernet Link Redundancy

The following diagram shows a SNAP PAC S-series controller connected to two separate Ethernet network links. This configuration addresses the concern that an Ethernet network may fail or need maintenance, leaving the PC running OptoOPCServer, the PC running PAC Display, the controller, and the I/O units unable to communicate. In this configuration, if one link goes down, devices can still communicate on the other. Each PC has two network interface cards (NICs), and the SNAP PAC S-series controller and the I/O units (SNAP-PAC-R1 and -R2 controllers) have two network interfaces as well.

For an example of controller redundancy, see the following page.

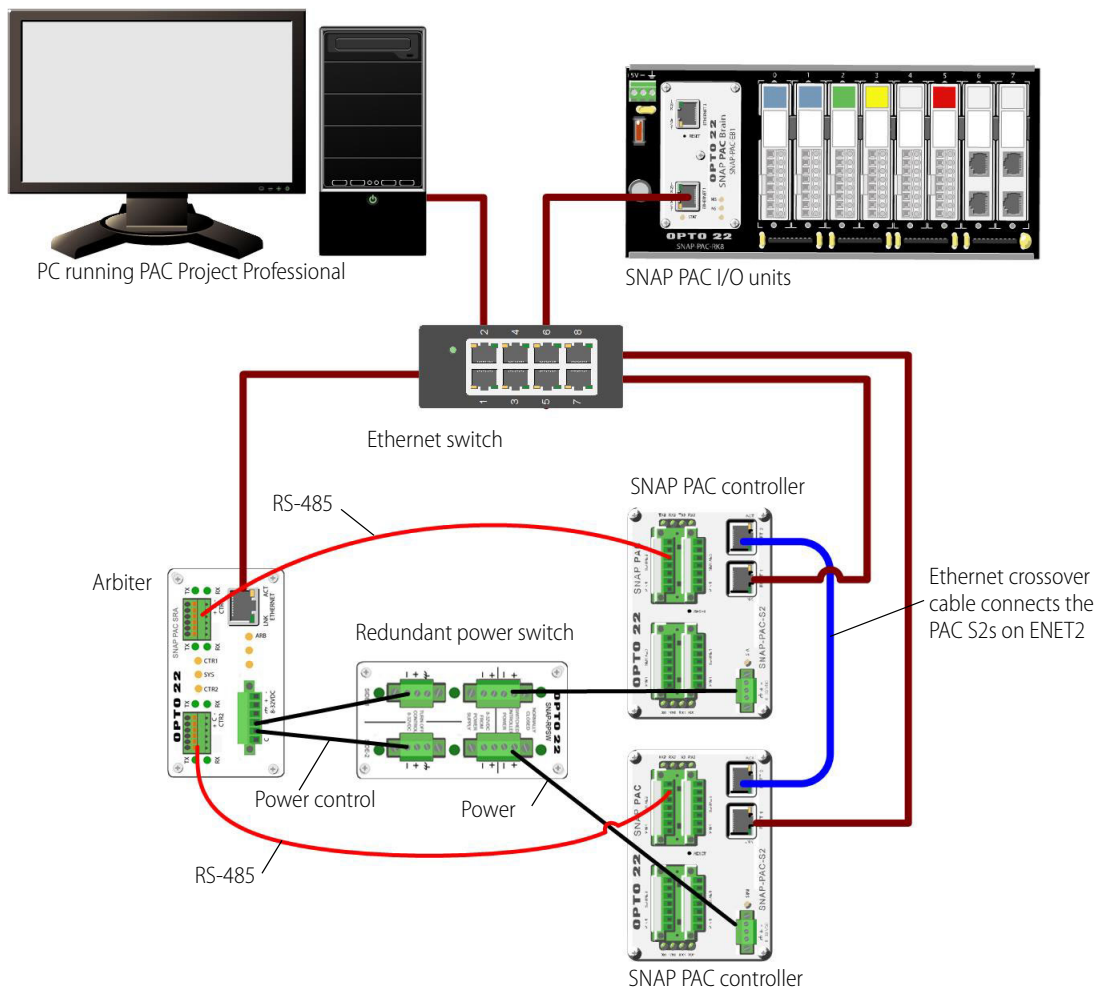


Controller Redundancy

In this diagram, two S-series controllers are operating redundantly. One is the active controller, while the other acts as a backup, ready to take over should the first one fail.

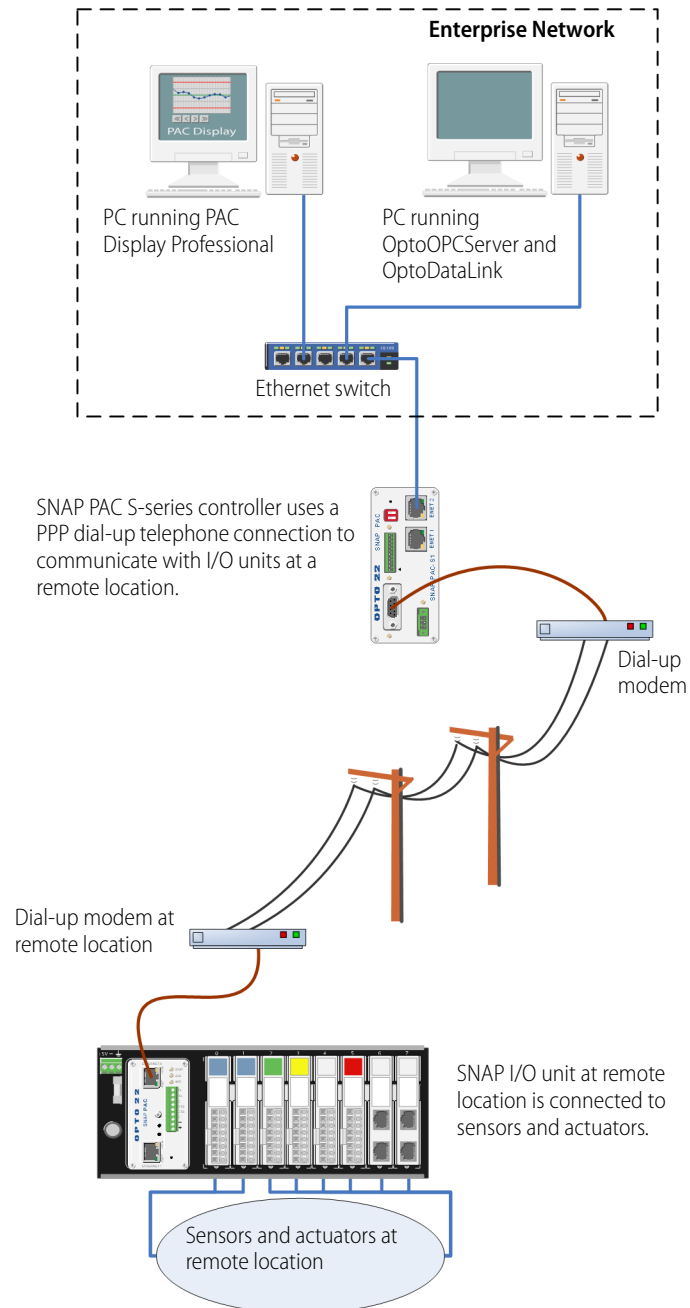
Controller redundancy requires PAC Project Professional R9.0 or newer and the Redundancy Option Kit, which includes the arbiter and the redundant power switch in the diagram below. PAC Redundancy Manager, a software utility for setting up and maintaining the system, is included in PAC Project Pro. The two controllers you use must be exactly the same part number (for example, two SNAP-PAC-S2 controllers).

As you can see, one advantage of an Opto 22 redundant system is that it uses standard PACs, standard cabling, and standard I/O. Another advantage is that either controller can act as the active or backup controller; you can switch their roles at any time for maintenance, for example. For detailed information on redundancy, see the [SNAP PAC System Redundancy User's Guide](#) (form 1831).



Remote Host and I/O Unit Connections Using PPP

For remote monitoring and control, you can use a SNAP PAC S-series controller to connect to a remote host such as a PC or to a SNAP Ethernet-based I/O unit using a dial-up link. For this use, the controller communicates using the Point-to-Point Protocol (PPP) over a modem.



ABOUT THIS GUIDE

See the following sections for basic information on setting up and maintaining a SNAP PAC S-series controller:

Chapter 2: Quick Start—installing and configuring SNAP PAC S-series controllers.

Chapter 3: Maintenance and Troubleshooting—troubleshooting problems while installing or using the SNAP-PAC-S1 controller on an Ethernet or serial network; getting device information, loading new firmware, changing the controller’s IP address, and other maintenance procedures.

Appendix A: Technical Specifications—specifications, connectors, indicators, pinouts, and dimensions.

RELATED DOCUMENTATION

You’ll find most of the documentation to build and maintain your control system in the PAC Project folder that’s added to your Windows Desktop when you install PAC Project. While using PAC Project applications, you can get online help by clicking Help in the menu bar or the Help buttons in dialog boxes, or simply by pressing the F1 key.

Here’s a brief list of documents you may find helpful. You can also download other documents, sample files, software utilities, technical notes, integration kits, and much more from the [Opto 22 website](#).

TIP: To easily find documents on our website, search on the form number.

For this information	See this guide	Form #
Assigning IP addresses, loading new firmware, configuring SNAP I/O points and system functions	PAC Manager User’s Guide ¹	1704
	PAC Control User’s Guide ¹	1700
Designing flowchart-based control programs for the system	PAC Control Command Reference ¹	1701
	PAC Control Commands Quick Reference	1703
Securely accessing data in the PAC via its REST API	developer.opto22.com	–
Programming your own applications by using either: <ul style="list-style-type: none"> • The OptoMMP protocol for memory-mapped controllers and brains • One of the OptoMMP Software Development Kits (SDKs) 	OptoMMP Protocol Guide	1465
Using redundant controllers	SNAP PAC System Redundancy User’s Guide	1831
Installing and using SNAP PAC S-series controllers	SNAP PAC S-series Controller User’s Guide	1592
Installing and using SNAP PAC R-series controllers	SNAP PAC R-series Controller User’s Guide	1595
Installing and using SNAP PAC EB- and SB-series brains	SNAP PAC Brains User’s Guide	1690
Communicating with I/O units using OPC	OptoOPCServer User’s Guide	1439
Communicating with I/O units using Modbus/TCP	Modbus/TCP Protocol Guide	1678
Communicating with I/O units using EtherNet/IP	EtherNet/IP for SNAP PAC Protocol Guide	1770
Moving to the SNAP PAC System with older hardware and software	SNAP PAC System Migration Technical Note	1688

¹ If you are using a SNAP PAC controller with legacy I/O units (for example, *mistic* I/O units or Ultimate I/O), use the Legacy versions of these documents instead:

- [Legacy Edition, PAC Control User’s Guide](#), form 1710
- [Legacy Edition, PAC Control Command Reference](#), form 1711
- [Legacy Edition, PAC Manager User’s Guide](#), form 1714

FOR HELP

If you have problems installing or using a SNAP PAC S-series controller and cannot find the help you need in this guide, contact Opto 22 Product Support.

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

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

Email: support@opto22.com

Opto 22 website: www.opto22.com

When calling for technical support, you can help us help you *faster* if you provide the following information to the Product Support engineer:

- A screen capture of the Help > About dialog box showing software product and version (available by clicking Help > About in the application's menu bar).
- Opto 22 hardware part numbers or models that you're working with.
- Firmware version:
 - For SNAP controllers and brains: available in PAC Manager by clicking Tools > Inspect.
 - For *groov* EPIC processors and *groov* RIO modules: available in *groov* Manage by clicking Info and Help > About.
- Specific error messages you received.
- Version of your computer's operating system.
- For PAC Control, PAC Display, OptoOPCServer, or PAC Manager, you may be requested to provide additional information, such as log or dump files. You can find these files in a support files sub-folder:
 - a. On your Windows Desktop, double-click the PAC Project 10.4 folder.
 - b. Double-click Support Files.
 - c. Double-click on the appropriate shortcut to open the sub-folder containing the requested files.

Note: *PAC Control, PAC Display, OptoOPCServer, and PAC Manager create appropriate sub-folders when they create diagnostic log or dump files. If they have not created these files, the sub-folder may not exist; in this case, the shortcut will not work.*

FOR HELP

2: Quick Start

WHAT YOU WILL NEED

- PC running Microsoft® Windows® 10 Professional or Windows 7 Professional (32-bit or 64-bit), with a 10/100 MB Ethernet interface, the TCP/IP protocol installed, and a valid IP address, on the same subnet as the controller
- Crossover cable (for direct connection to the PC) or an available connection to a standard 10BASE-T or 100BASE-TX Ethernet network
- SNAP PAC S-series controller
- 8–32 VDC power supply (see “Power Supply Recommendations” on page 15 for specific information and recommendations)
- Small flathead screwdriver
- One or more of the following, depending on your I/O system requirements:
 - Opto 22 SNAP PAC, *groov* EPIC, or *groov* RIO I/O units on the same Ethernet network as the controller.
 - Opto 22 legacy SNAP Ethernet-based I/O units—SNAP Simple I/O, SNAP Ethernet I/O, or SNAP Ultimate I/O units—on the same Ethernet network as the controller.
 - Opto 22 RS-485 serial-based I/O units—SNAP PAC serial brains, serial B3000, SNAP-BRS, B100/B200 brains, or *mistic* remote bricks (G4D16R, G4D32RS, G4A8R)—on a two-wire RS-485 network.
- (Recommended) [PAC Project Basic](#) or [PAC Project Professional](#) (available from the Opto22 website)

POWER SUPPLY RECOMMENDATIONS

Opto 22 recommends that the SNAP PAC S-series controller be powered with an Opto 22 SNAP-PS24 or SNAP-PS24U power supply. In place of one of these power supplies, Opto 22 recommends an 8-32 VDC linear supply with adequate current ratings for the load. For more information on power requirements, see [Appendix A: Technical Specifications](#).

Change to SNAP-PAC-S1 Power Input Range

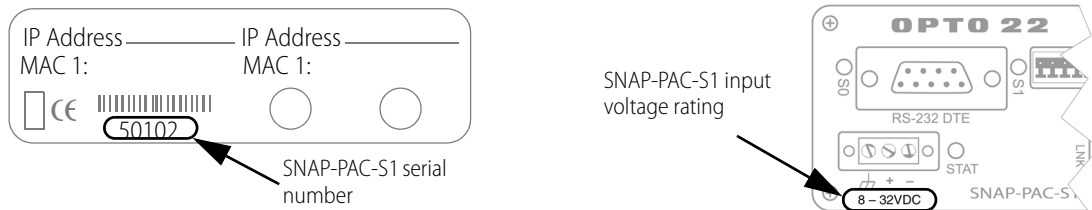
Current SNAP-PAC-S1 controllers have an 8–32 VDC input range, but earlier SNAP-PAC-S1 controllers use an 8–24 VDC input range. **Before applying power to the controller, confirm that the input voltage is within the voltage range shown on the faceplate.**

The voltage input rating can also be determined based on the SNAP-PAC-S1’s serial number as follows:

- SNAP-PAC-S1 controllers *with serial number 500000 and higher* have an 8–32 VDC voltage input rating.
- SNAP-PAC-S1 controllers with serial numbers lower than 500000 have an 8–24 VDC input rating. **Using an input voltage above this range will cause damage that is not covered by the warranty.**

INSTALLING HARDWARE

The SNAP-PAC-S1 serial number appears on the sticker on the side of the unit. The input voltage rating is shown on the top cover of the controller.




INSTALLING HARDWARE

NOTE: If you are using redundant controllers, see steps in the [SNAP PAC System Redundancy User's Guide \(form 1831\)](#).

1. Install Opto 22 I/O units according to instructions in the device's user's guide.¹
2. Choose a convenient mounting location for the SNAP PAC S-series controller and either panel-mount or DIN-rail mount it according to the diagrams on [page 27](#) and [page 29](#).
3. Confirm that the power supply to be used with the controller is turned off or unplugged, and discharge any residual charge that may remain in the power supply.
4. With the power supply off or unplugged, connect the power supply to the controller.

CAUTION: Reversing wire polarity may cause damage to your controller. This damage is not covered by Opto 22's warranty. If you are not certain about the polarity of the wires on your power supply, check with a meter.

- a. With the power supply off or unplugged, connect the + (positive) lead from the power supply (normally red) to the + (positive) terminal on the face of the controller.
- b. Connect the COM wire from the power supply (normally black) to the - (negative) terminal on the face of the controller.
- c. Connect a lead from a known chassis ground to the  (ground) terminal on the face of the controller.

IMPORTANT: Do not turn on power to the controller.

5. Using Category 5 or superior solid unshielded twisted-pair cable, connect the SNAP PAC S-series controller in one of the following ways:
 - Connect to a PC directly using Ethernet port ENET 1. S-series Ethernet interfaces support Auto MDI-X, which means you can use a standard straight-through Ethernet cable; a crossover cable is not needed for direct connection to a PC.
 - Connect to a standard 10BASE-T or 100BASE-TX Ethernet network that has a PC on the same subnet as the controller and does NOT have a Dynamic Host Configuration Protocol (DHCP) server.

Maximum cable or segment length is 100 meters; minimum cable length is one meter.

NOTE: When connecting the controller to a managed switch, make sure the managed switch's port configuration is set to Auto for the Duplex setting and Auto for the Speed setting.

6. If the controller will connect to I/O units on an RS-485 serial network, connect the serial cable following the instructions in "[RS-232 and RS-485 Serial Networking](#)" below.

IMPORTANT: Do not turn on power to the controller.

¹ You can download user's guides, data sheets, and other helpful documents from our website at www.opto22.com.

7. **Before** turning on power to the controller, follow steps in the *PAC Manager User's Guide* (form 1704) to assign the controller an IP address. Note that you can use PAC Manager to assign IP addresses to the controller and I/O units at the same time.

RS-232 AND RS-485 SERIAL NETWORKING

SNAP PAC S-series controllers provide both RS-232 and RS-485 serial communication interfaces. For serial communication ports and their corresponding wiring pinouts, see [“Connectors, Indicators, and Pinouts” on page 20](#).

RS-232 Connections

You can use the RS-232 ports on a SNAP PAC S-series controller to:

- Direct connect to a device that supports RS-232 communication.
- Connect to a modem and make a serial Point-to-Point Protocol (PPP) connection to a remote PC or other device that supports PPP.

Use PAC Manager to configure the RS-232 ports for the way you want to use them. (For instructions, see the *PAC Manager User's Guide*, form 1704.) Note that the controller cannot make a direct RS-232 serial connection with an Opto 22 I/O unit; however, it is possible to connect to an Opto 22 I/O unit that supports PPP communications.

Attaching a Modem to the Controller

To work properly with the SNAP PAC S-series controller, a modem must be able to store settings in non-volatile RAM (NVRAM) and default to those settings on reset.

IMPORTANT: *Any modem used with the controller must implement the Carrier Detect (CD) signal or use a custom cable that connects CD to Data Terminal Ready (DTR).*

1. Connect the modem to the controller using a modem cable with female DB-9 connector. If necessary, see [“Connectors, Indicators, and Pinouts” on page 20](#) for pinout details.
2. Store configuration settings to the modem's NVRAM, following instructions in the user's guide for your modem.

NOTE: Configuration settings must be stored to the modem's NVRAM so they will be loaded when the controller sends a reset command to the modem.

RS-485 Connections

You can use an RS-485 serial port on a SNAP PAC S-series controller to connect to Opto 22 I/O units on a two-wire, RS-485 serial network. These I/O units include SNAP PAC SB-series brains, serial B3000 brains, and *mistic* remote bricks such as the G4D16R, G4D32RS, and the G4A8R. Both the PAC S1 and PAC S2 support optional *mistic* signal interrupts. In addition, on the SNAP-PAC-S2 controller you can use PAC Manager to configure up to four RS-485 ports either as 2-wire or 4-wire connections.

Bias and Termination

Bias: Bias the RS-485 network at one location (device) only. This is typically done at the device that is the RS-485 master, which is normally the controller.

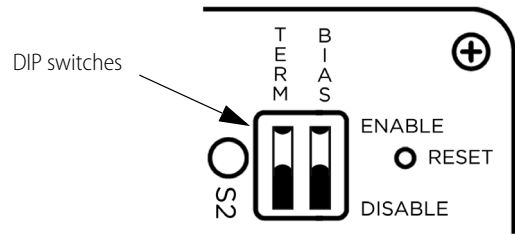
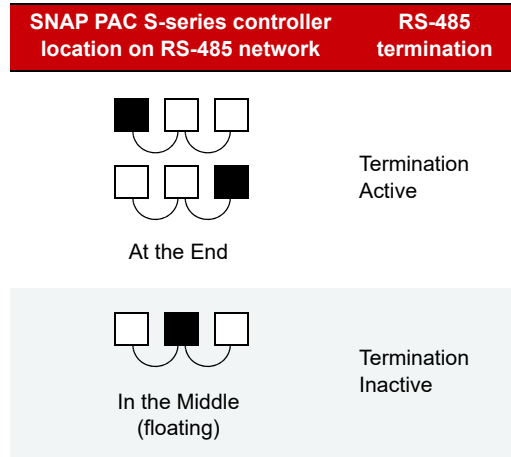
Termination: Configure termination at the devices that are located at both ends of the RS-485 network. For more information, please see the appropriate data sheet or user's guide for configuring the I/O unit or brain that is at the end of the link.

NOTE: Bias and termination settings on S-series controllers take effect immediately.

Configuring RS-485 Connections on SNAP-PAC-S1 Controllers

RS-485 bias and termination settings are configured using two DIP switches located on the top of the controller.

Switch	Position	Description
BIAS	ENABLE	Bias: active
	DISABLE	Bias: inactive
TERM	ENABLE	Termination: active
	DISABLE	Termination: inactive



(Portion of top view)

Configuring RS-485 Connections on SNAP-PAC-S2 Controllers

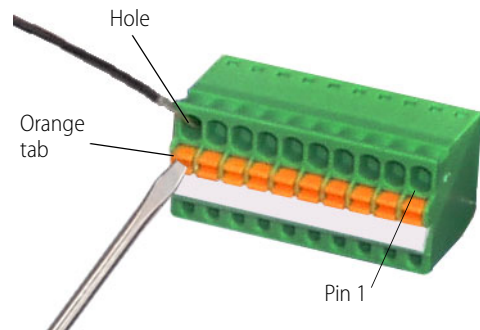
The serial ports on SNAP-PAC-S2 controllers are software configurable using PAC Manager. This includes mode, termination, and bias. For more information, see the [PAC Manager User's Guide](#) (form 1704). See also, ["Assigning Serial Ports on SNAP-PAC-S2 Controllers"](#) on page 26.

Wiring the 10-pin Serial Connector on SNAP-PAC-S1 Controllers

Serial ports 1 and 2 on SNAP-PAC-S1 controllers share a 10-pin pluggable connector (Phoenix Contact, part number FK-MC 0.5 - 2.5, supplied with the controller). When inserting and removing wire leads into this connector, do the following:

1. Completely depress the small orange tab for the appropriate opening with a small screwdriver.
2. While holding the tab down with the screwdriver, insert or remove the wire as needed.
3. Release the orange tab.

For a pinout of the connector, see ["Connectors, Indicators, and Pinouts"](#) on page 20.



Wiring the 7-pin Serial Connector on SNAP-PAC-S2 Controllers

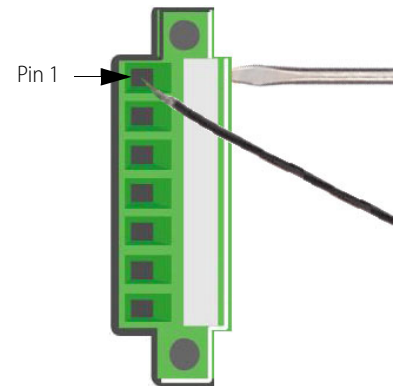
Each of the four serial ports on SNAP-PAC-S2 controllers uses a 7-pin pluggable connector supplied with the controller (EBY part number EB1381M-07-500 or equivalent). Using the screws on the side of the connector, insert or remove the wires as needed.

For a pinout of this connector, see “Connectors, Indicators, and Pinouts” on page 20.

CAUTION: Do not use communication port connectors from a legacy OptoControl controller. Legacy connectors will fit in a SNAP-PAC-S2, but the pin orientation is different. Instead, use the connectors supplied with the SNAP-PAC-S2 controller.*

**Legacy OptoControl Controllers*

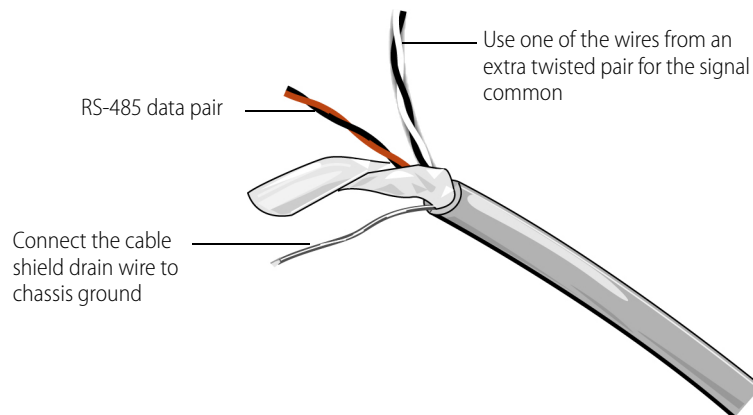
G4LC32	G4LC32ISA-LT	M4RTU
G4LC32SX	M4	SNAP-LCM4
G4LC32ISA	M4IO	SNAP-LCSX/PLUS



Guidelines for Grounding SNAP PAC Brains and Controllers

Power supply side: The DC output of the power supply to the I/O unit (or controller) should be “floating,” which means the negative output terminal is not tied to ground.

RS-485 serial cable side: Connect the signal common from the controller to the signal common on each of the I/O units using an insulated wire that is part of the serial cable. Though sometimes hard to find, there are cables that have a twisted pair for serial communication plus an additional insulated wire for common. However, it might be easier to obtain a cable that has an extra twisted pair and then use one of the wires from this extra pair for the signal common connections.

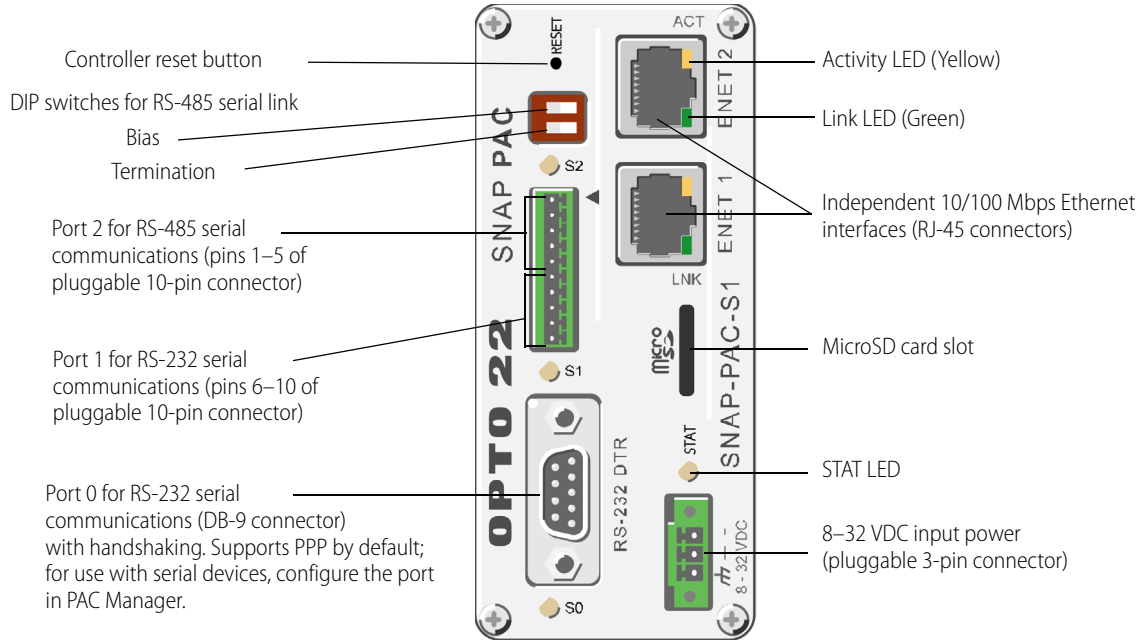


NOTE: Make sure there are enough wires in the cable for a separate insulated signal common wire. Do not connect the signal common wire to chassis ground. Do not use the overall cable shield drain wire as the signal common.

Connect the cable shield drain wire of the serial cable to chassis ground at one location only. If the shield is not continuous from one I/O unit to the next, then the shield of each segment will need to be tied to chassis ground at one location only per segment.

CONNECTORS, INDICATORS, AND PINOUTS

SNAP-PAC-S1 and SNAP-PAC-S1-FM



Status and Activity LEDs

Indicator	Description
S0	RS-232 serial activity on port 0
S1	RS-232 serial activity on port 1
S2	RS-485 serial activity
STAT	Startup status and control program operational status
ACT	Ethernet network activity
LINK	Link established with Ethernet network

Port 0 for RS-232 serial (DB-9 connector)

Pin	Description	Signal Direction
1	DCD	In
2	RX	In
3	TX	Out
4	DTR	Out
5	COM	
6	DSR	In
7	RTS	Out
8	CTS	In
9	RI*	In

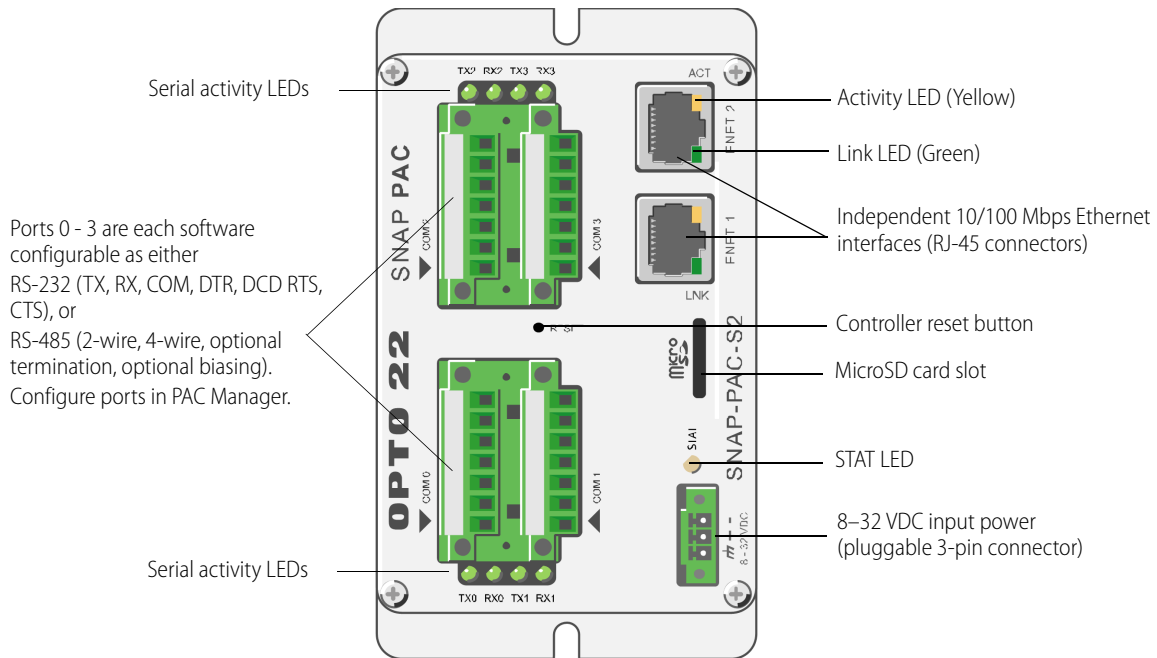
* RI signal does not occur on PACs with a microSD card slot

Ports 1 and 2 for RS-485 and RS-232 serial

	Pin	Description	Signal Direction
Port 2 for RS-485 serial (2-Wire)	1	TX/RX+	In/Out
	2	TX/RX-	In/Out
	3	SIG COM*	
	4	IRQ+	In
	5	IRQ-	In
Port 1 for RS-232 serial	6	TX	Out
	7	RX	In
	8	GND	
	9	RTS	Out
	10	CTS	In

* Isolated ground

SNAP-PAC-S2



RS-485 and RS-232 Ports¹

Pin	RS-232	Signal Direction	RS-485	Signal Direction
1	TX	Out	TX/RX+	In/Out
2	RX	In	TX/RX-	In/Out
3	COM ²		COM ²	
4	RTS	Out	RX+ (4 wire)	In
5	CTS	In	RX- (4 wire)	In
6	DTR	Out	IRQ+	In
7	DCD	In	IRQ-	In

¹ **CAUTION: Do not use communication port connectors from a legacy OptoControl controller*.** Legacy connectors will fit in a SNAP-PAC-S2, but the pin orientation is different. Instead, use the connectors supplied with the SNAP-PAC-S2 controller.

² Isolated ground. (Each channel is isolated from the others.)

*Legacy OptoControl Controllers:

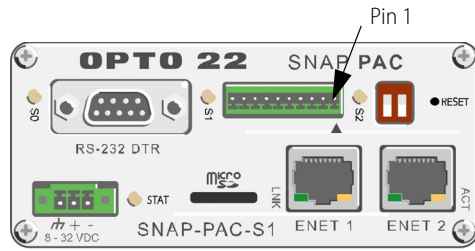
G4LC32	G4LC32ISA-LT	M4RTU
G4LC32SX	M4	SNAP-LCM4
G4LC32ISA	M4IO	SNAP-LCSX/PLUS

Status and Activity LEDs

Indicator	Description
TX0/RX0	Serial activity on port 0
TX1/RX1	Serial activity on port 1
TX2/RX2	Serial activity on port 2
TX3/RX3	Serial activity on port 3
STAT	Startup status and control program operational status
ACT	Ethernet network activity
LINK	Link established with Ethernet network

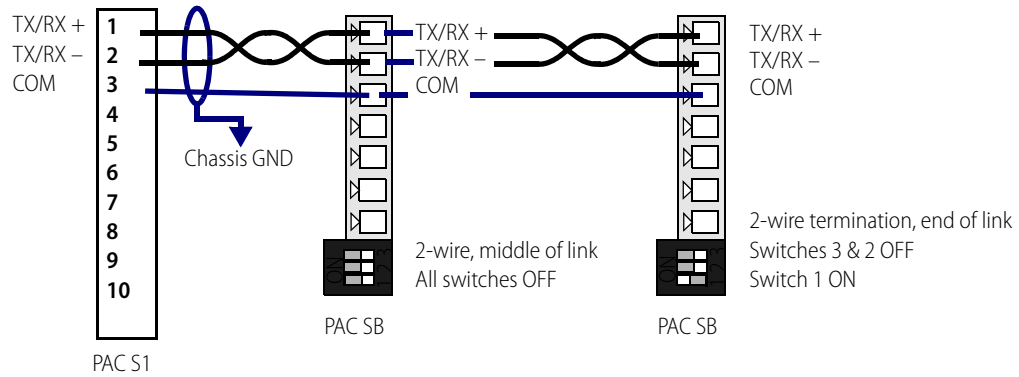
PAC S1 SERIAL WIRING DIAGRAMS

NOTE: SNAP-PAC-S1 controllers support only 2-wire RS-485.

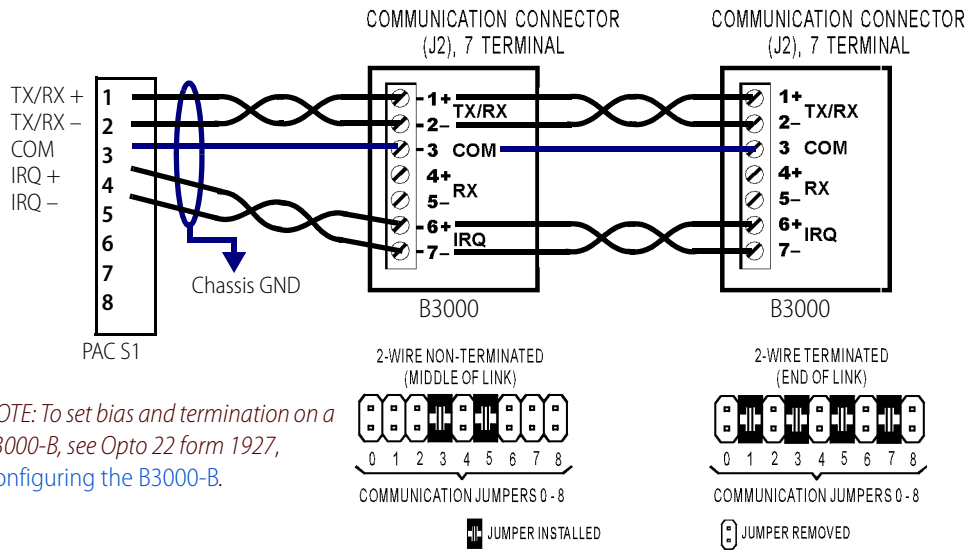


Make sure to verify the location of pin 1, which is indicated on the controller with a label or a small triangle. To be certain of pin 1's locations, insert the connector into the controller and then mark the location of pin 1 on the connector itself.

Wiring a PAC S1 Controller to SB-Series Brains



Wiring a PAC S1 Controller to B3000 *mistic* Brains with an Interrupt Line

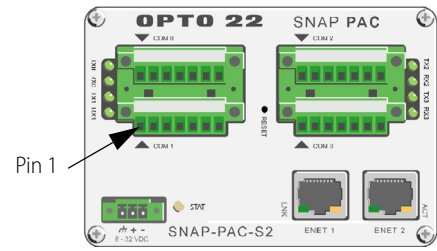


NOTE: To set bias and termination on a B3000-B, see Opto 22 form 1927, [Configuring the B3000-B](#).

PAC S2 SERIAL WIRING DIAGRAMS

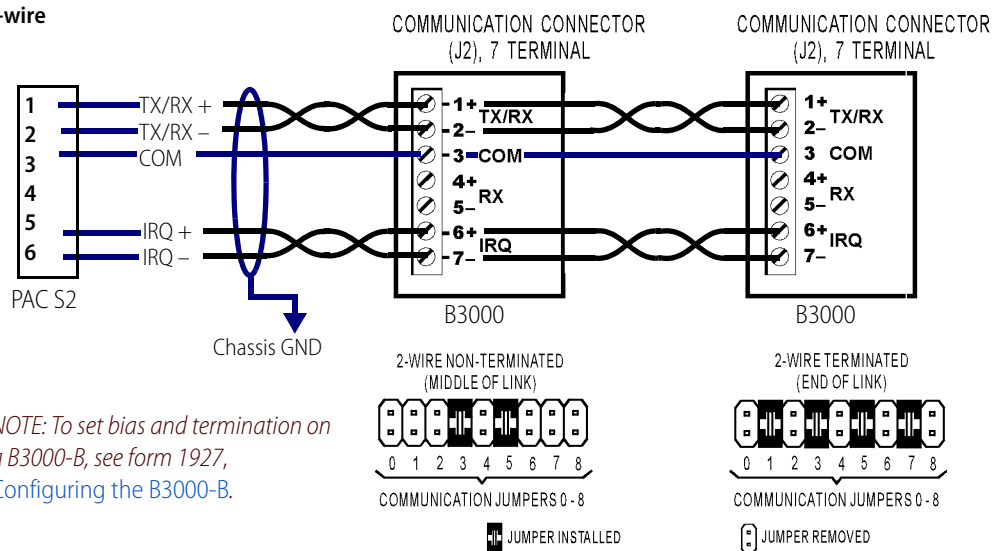
Make sure to verify the location of pin 1, which is indicated on the controller with a label or a small triangle. To be certain of pin 1's locations, insert the connector into the controller and then mark the location of pin 1 on the connector itself.

Brains in the middle of the link should not be biased or terminated. The devices at both ends of the network should be terminated. In addition, the RS-485 link should be biased at one location only, which is typically at the controller.



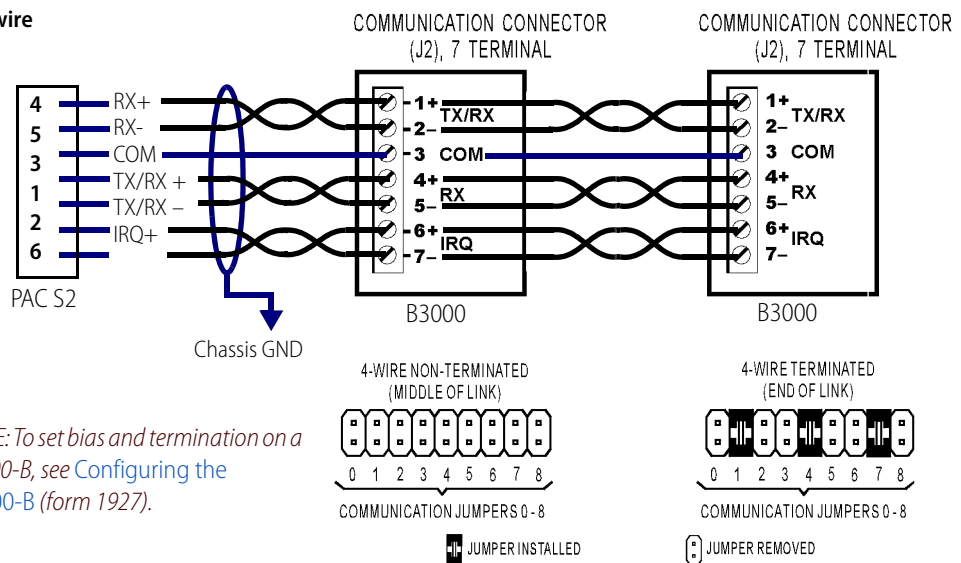
PAC S2 Controller to B3000 *mistic* Brains with an Interrupt Line

Two-wire



Four-wire

NOTE: The connector pins on an actual SNAP-PAC-S2 are in a different order than shown here.

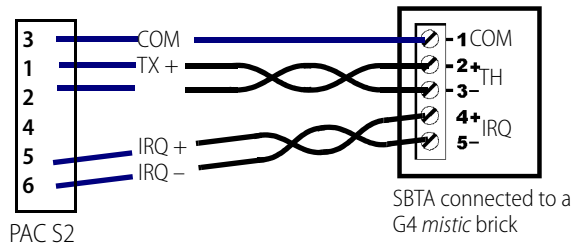


PAC S2 Controller to G4 *mistic* Bricks

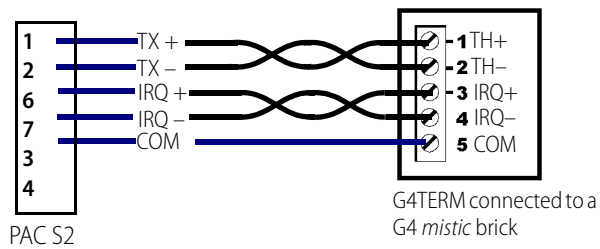
To locate pin 1 on the PAC S2, see [page 23](#).

See also, “Connectors, Indicators, and Pinouts” on [page 20](#).

PAC S2 to SBTA



PAC S2 to G4TERMR or G4TERML



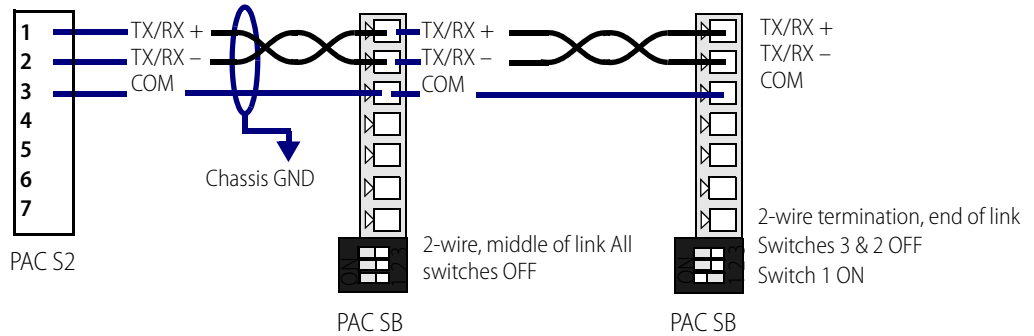
NOTE: For termination information, see the [Mistic Installation Guide \(form 595\)](#).

PAC S2 Controller to PAC SB-Series Brains

To locate pin 1 on the PAC S2, see [page 23](#).

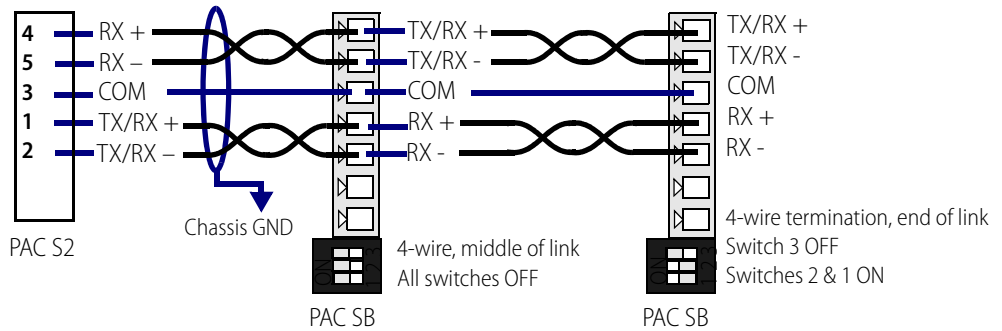
See also, “Connectors, Indicators, and Pinouts” on [page 20](#).

Two-wire



Four-wire

NOTE: The connector pins on an actual SNAP-PAC-S2 are in a different order than shown here.



ASSIGNING AN IP ADDRESS

See instructions in the *PAC Manager User's Guide* (form 1704) to assign IP addresses to the SNAP PAC S-series controller using a wired Ethernet connection. (If you are using redundant controllers, use the PAC Redundancy Manager utility instead of PAC Manager. The PAC Redundancy Manager is part of PAC Project Professional R9.0 and higher.

SNAP PAC controllers have two independent Ethernet network interfaces, labeled on the top of the controller as ENET1 and ENET2. Wired+Wireless PACs have a third network interface for the wireless LAN. You can use these separate interfaces to segment the control network from the company network or for other purposes. Use PAC Manager to assign the secondary and wireless addresses and configure settings. Make sure each interface is on a separate IP subnet and receives a unique IP address.

ASSIGNING SERIAL PORTS ON SNAP-PAC-S2 CONTROLLERS

See instructions in the *PAC Manager User's Guide* (form 1704), to configure serial ports for SNAP-PAC-S2 controllers.

Each of the four serial ports on a SNAP-PAC-S2 can be configured either as an RS-232 serial port or an RS-485 serial port. Up to four ports on the SNAP-PAC-S2 can be used for I/O, and up to four ports can be used for general purpose serial communication. Only one port on the SNAP-PAC-S2 can be used for PPP communication.

By default the serial ports are as follows:

Port	Factory Default Mode
0	RS-232 (PPP)
1	RS-232 (not PPP)
2	RS-485 (2-wire 485 with termination and bias)
3	RS-485 (2-wire 485 with termination and bias)

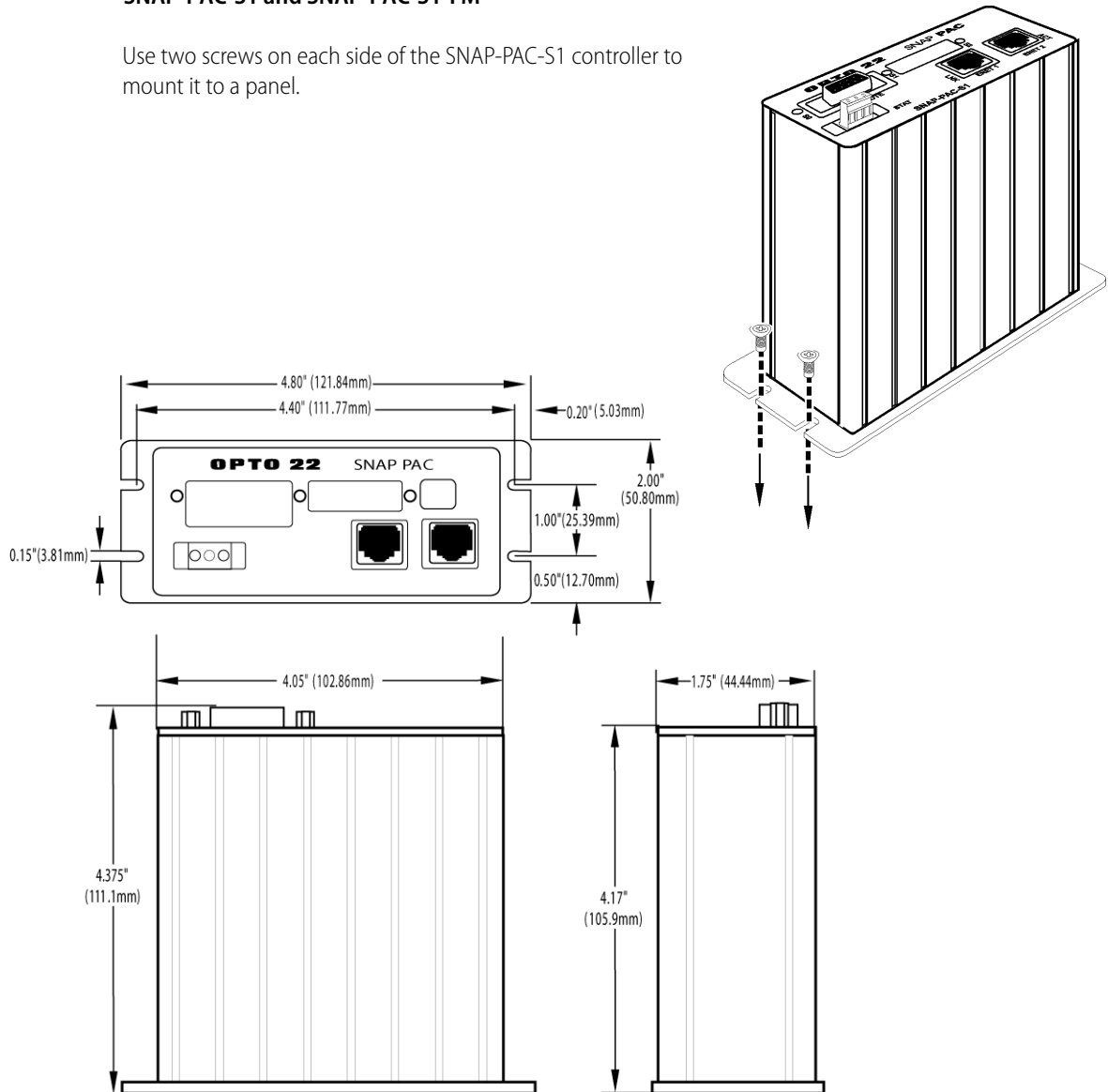
MOUNTING THE CONTROLLER

The SNAP PAC S-series controller can be panel mounted or mounted on a DIN rail. DIN-rail mounting requires an adapter clip, part number SNAP-PSDIN (not included).

Panel Mounting and Dimensions

SNAP-PAC-S1 and SNAP-PAC-S1-FM

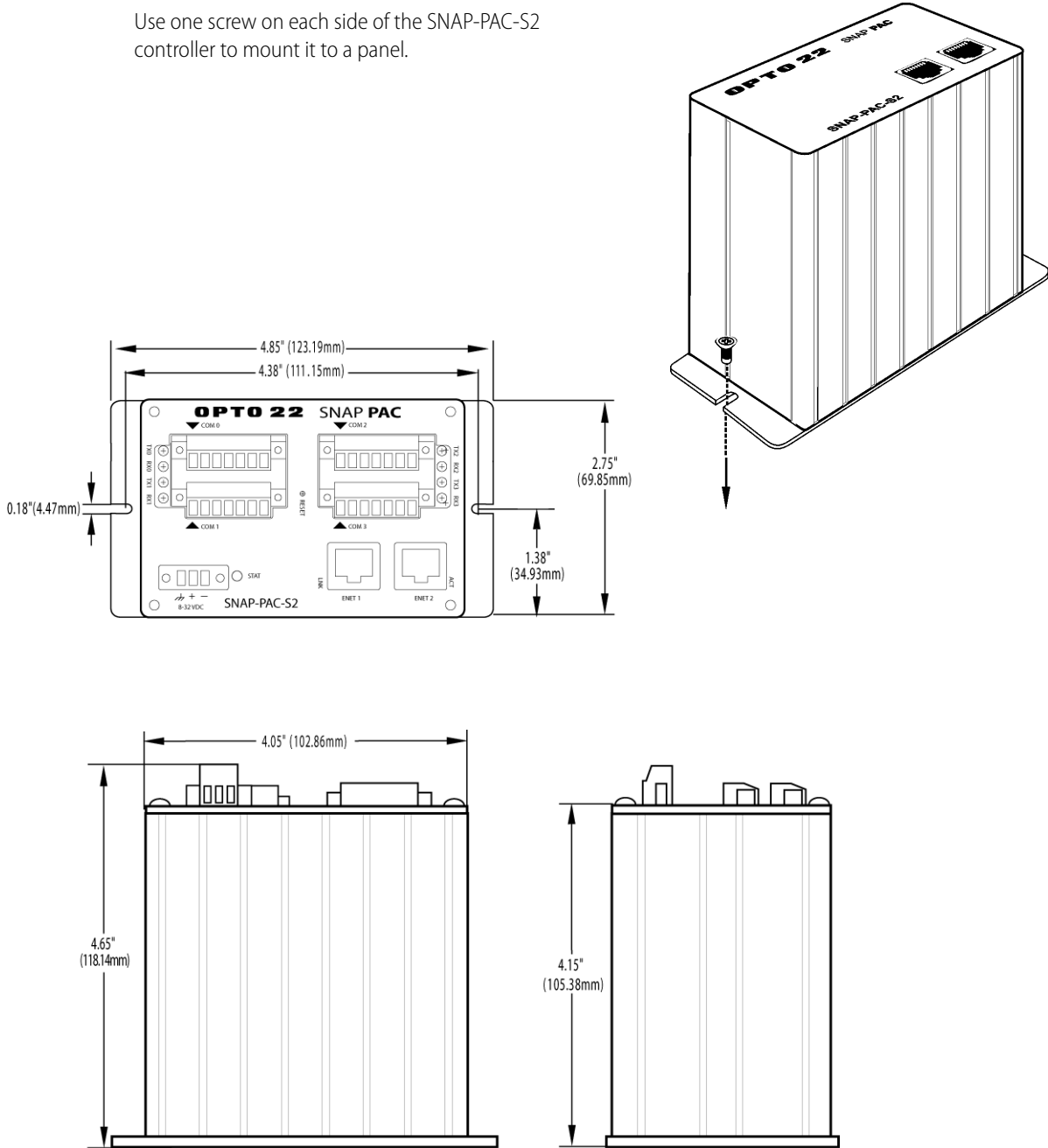
Use two screws on each side of the SNAP-PAC-S1 controller to mount it to a panel.



Panel Mounting and Dimensions (continued)

SNAP-PAC-S2

Use one screw on each side of the SNAP-PAC-S2 controller to mount it to a panel.



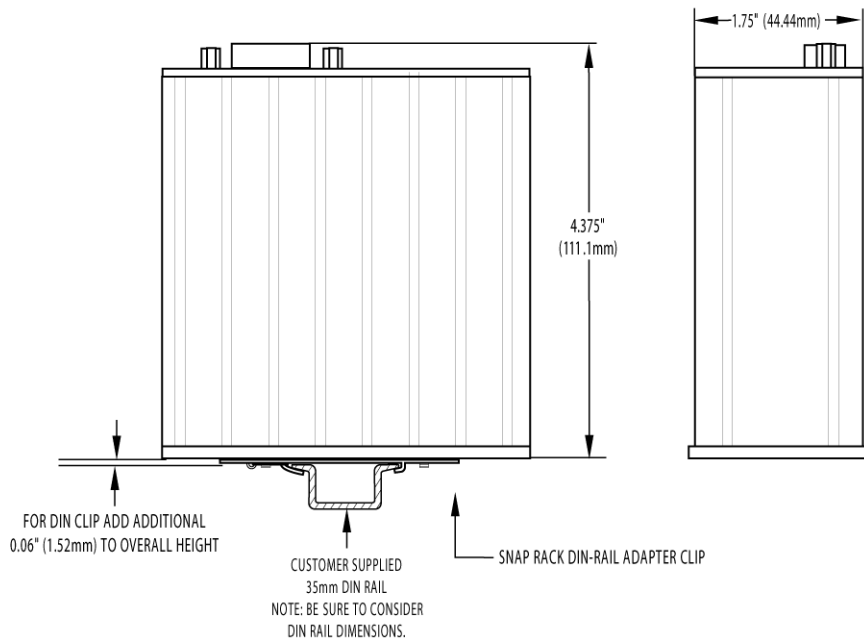
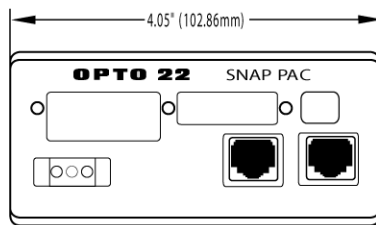
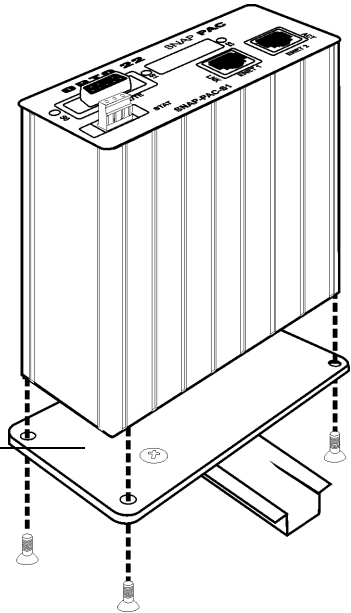
DIN-Rail Mounting and Dimensions

SNAP-PAC-S1 and SNAP-PAC-S1-FM

DIN-rail mounting requires an adapter clip, part number SNAP-PSDIN (not included).

For DIN-rail mounting, remove the four screws that fasten the panel mounting base plate to the controller. **Save screws.** Remove the base plate.

Use the four screws to fasten the DIN-rail adapter clip to the bottom of the controller, as shown.



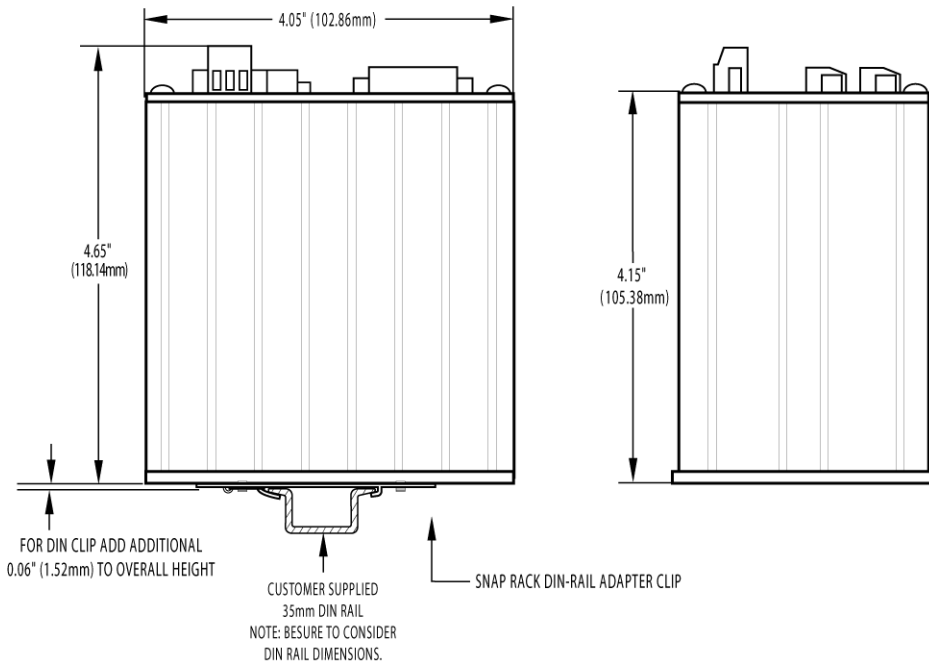
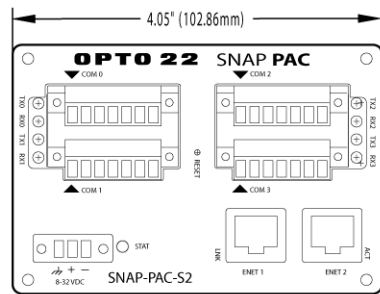
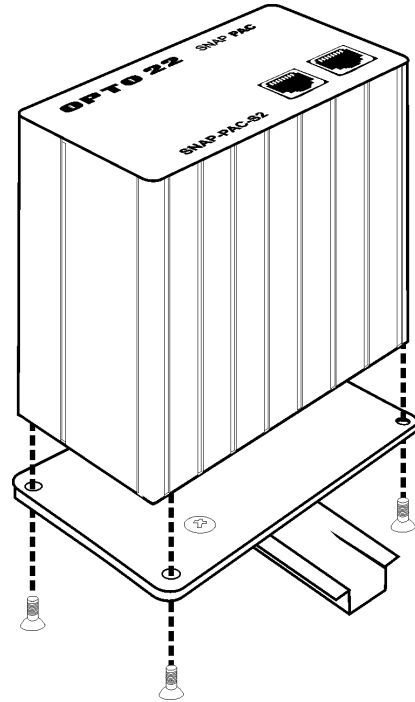
DIN-Rail Mounting and Dimensions (continued)

SNAP-PAC-S2

DIN-rail mounting requires an adapter clip, part number SNAP-S2DIN (not included).

For DIN-rail mounting, remove the four screws that fasten the panel mounting base plate to the controller. **Save screws.** Remove the base plate.

Use the four screws to fasten the DIN-rail adapter clip to the bottom of the controller, as shown.



ABOUT THE CONTROLLER'S MEMORY MAP

Like SNAP Ethernet-based brains, a SNAP PAC S-series controller uses a memory mapped system for storing data and making that data available to other devices on the Ethernet network. This data includes configuration data, status information about the controller itself, and PAC Control strategy variable data that may be needed by a peer on the network.

Although SNAP PAC S-series controllers are designed to run PAC Control strategies, you can also write your own software applications to communicate with the controller's memory map, either instead of or in addition to using PAC Control. You can use the OptoMMP Communication Toolkit or the IEEE 1394-based protocol for writing your applications. Both are explained in the *OptoMMP Protocol Guide* (form 1465) which also includes complete details of the memory map. Although this guide is written for I/O units, you can use the same information for a SNAP PAC S-series controller. Just be aware that many sections do not apply, since the controller's memory map doesn't include any I/O point or related information.

The SNAP PAC S-series controller's memory map includes only the following areas:

Status Area Read	PPP Configuration
Communications Port Configuration	PPP Status
Date and Time Configuration	microSD Card
Status Area Write	IP Settings
Security Configuration	WLAN Configuration
Scratch Pad	WLAN Status

Using Data for Peer-to-Peer Communication

Scratch Pad areas within the SNAP PAC S-series controller's memory map provide a way for other devices on the Ethernet network to access data in the controller. For descriptions of the Scratch Pad areas—bits, integers, floats, and strings—see the *PAC Manager User's Guide* (form 1704). For help in using PAC Control commands to access Scratch Pad areas, see "I/O Unit—Scratch Pad Commands" in the *PAC Control User's Guide* (form 1700).

If you are not using PAC Control but writing your own software applications to access the Scratch Pad areas, see the *OptoMMP Protocol Guide*. This guide is written primarily for I/O units, but much of the same information on programming applies to SNAP PAC S-series controllers. The Scratch Pad areas of the memory map are described in the programming guide's appendix.

If you're communicating between an Allen-Bradley Logix-based PLC and an S-series PAC, see the *EtherNet/IP for SNAP PAC Protocol Guide* (form 1770).

WHAT'S NEXT?

Your controller is now ready for use.

- To create PAC Control strategies to run on the controller, see the *PAC Control User's Guide* (form 1700) and the *PAC Control Command Reference* (form 1701). Both are available for download from the Opto 22 website at www.opto22.com.
- To securely access data from I/O points and variables in the PAC's control strategy, visit developer.opto22.com, where you'll find instructions to set up the PAC's HTTP/HTTPS server and complete documentation for the RESTful API.
- See the *PAC Manager User's Guide* (form 1704) for instructions to work with:
 - Secondary network interfaces and port configuration
 - File system and FTP
 - Security settings

WHAT'S NEXT?

3: Maintenance and Troubleshooting

To **troubleshoot problems** that may have occurred, see [“Troubleshooting,”](#) below.

For maintenance information about the SNAP PAC S-series controller, see the section [“Maintaining the Controller”](#) on page 38.

TROUBLESHOOTING

If you encounter a problem while installing or using the SNAP PAC S-series controller, check the information in this section. To contact Opto 22 Product Support, see [“For Help”](#) on page 13.

Checking Power

When troubleshooting any problem with your controller, first check that the required power is correctly supplied.

IMPORTANT: The current version of the SNAP PAC S-series standalone controller requires 8–32 VDC power, not the 5 VDC power used by previous SNAP controllers and controller/brains. If you are replacing an older SNAP controller or controller/brain with a SNAP PAC S-series controller, make sure that 8–32 VDC power is supplied. Note that S-series controllers with serial numbers below 500,000 use 8–24 VDC.

1. Review the information in [“Power Supply Recommendations”](#) on page 15 and the power requirements listed in [Appendix](#) . Confirm that the power supply used with the SNAP PAC S-series controller meets these requirements.
2. Confirm that all leads connected to the controller and the power supply are securely attached. These connections are described in [“Installing Hardware”](#) on page 16.
3. Verify that the controller’s ground terminal is connected to a known chassis ground as described in [“Installing Hardware”](#) on page 16.
4. Confirm that two Phillips-head screws are installed on the wide sides of the case, one screw per side. (These screws secure and ground the controller’s internal components.)

Communicating on an Ethernet Network

If you attempt to connect to the controller using its IP address and you cannot, first check the following:

- Make sure the controller has been turned on, the STAT LED is lit and not blinking, and the LNK LEDs for the connected Ethernet interfaces are lit. (See LED information on pages [“Connectors, Indicators, and Pinouts”](#) on page 20.)
- Verify that you typed in the correct address for the controller. Check the label on the side of the controller, where the IP address should be written.

- Make sure the controller has been assigned a valid IP address and subnet mask. SNAP PAC S-series controllers come from the factory with a default IP address of 0.0.0.0, which is invalid. The default subnet mask is 255.255.255.0. To assign IP address and subnet mask, see the [PAC Manager User's Guide](#) (form 1704).
- Make sure you have up-to-date drivers installed on your computer's Network Interface Card (NIC). Contact your system administrator or the manufacturer of the card for help.
- Make sure any firewall in the computer (such as the built-in firewall in Windows 10) is temporarily disabled before you try to assign or change IP addresses, load firmware using PAC Manager's Maintenance window, or work with files on the controller. BootP and FTP cannot function through a firewall in the PC. Firewalls in a router are less likely to be a problem unless certain ports (such as FTP client) have been blocked, either by default or on purpose.

Pinging the Controller

If you still cannot communicate with the controller after you have checked these items, try to reach it using the PING application.

1. Choose Start > Run and type `cmd` to open a command prompt.
2. At the prompt, type: `ping [controller's IP address]`
For example, type: `ping 10.192.54.40`

At this point be sure to check for other devices on the Ethernet network that may have the same IP address.

If the controller responds, go to ["Maintaining the Controller"](#) on page 38.

If the PING command cannot be found, choose Start > Control Panel > Network. Make sure TCP/IP is configured as a protocol and that an IP address and subnet mask are assigned.

If you see the message "Destination host route not defined," the controller probably has an inappropriate IP address and subnet mask. Make sure the IP address and subnet mask on the controller are compatible with those on the computer. Follow directions in the [PAC Manager User's Guide](#) (form 1704) to check the IP address and subnet mask on the controller and change them if necessary.

If you see the message "No response from host," check the following:

- Are the computer and controller correctly connected? Is the controller turned on?
- Are the IP address and subnet mask on the controller compatible with those on the computer?
- Is the controller in bootloader mode? (If the reset button is held down for too long, the controller will enter bootloader mode, which is indicated by the STAT LED blinking seven times quickly.)

If you still cannot ping the controller, contact Opto 22 Product Support. (See ["For Help"](#) on page 13 for contact information.)

Solving Network Problems

If there are recurring problems in communicating with the controller, check your network. The wires, switches, and other parts in your Ethernet network are not part of the Opto 22 hardware, but any problems in your network may affect communication with Opto 22 products.


Create a Network Diagram

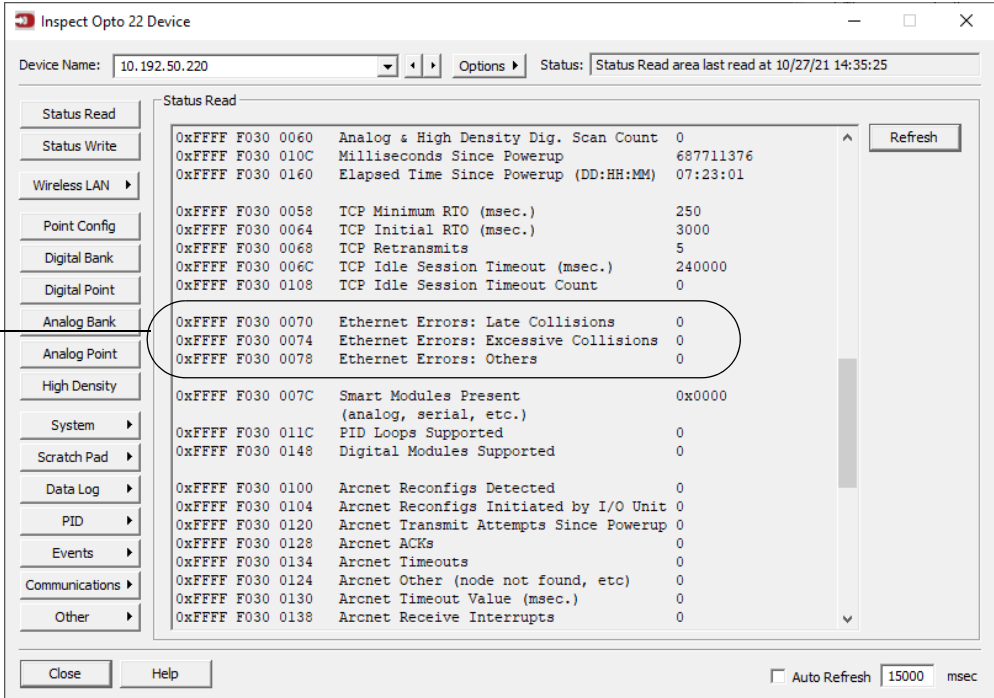
First, create a network diagram and verify the following:

- Cable connectors are firmly inserted.
- The switch has power. Switch LEDs indicate that the connection is up.
- Neither the PC nor the controller unit uses the switch's uplink port.
- The controller's LNK LED is lit.

Check Ethernet Errors

Next, use PAC Manager to check any Ethernet errors reported. These errors indicate network problems. You will need to know the controller's IP address.

1. Choose Start > Programs > Opto 22 > PAC Project Software > PAC Manager.
2. In the PAC Manager main window, click the Inspect icon .
3. In the IP Address field, type the IP address of the controller. Click Status Read.
4. Scroll down until you see the items Ethernet Errors: Late Collisions, Ethernet Errors: Excessive Collisions, and Ethernet Errors: Others.



The screenshot shows the 'Inspect Opto 22 Device' window. The 'Status Read' section contains the following data:

0xFFFF F030 0060	Analog & High Density Dig. Scan Count	0
0xFFFF F030 010C	Milliseconds Since Powerup	687711376
0xFFFF F030 0160	Elapsed Time Since Powerup (DD:HH:MM)	07:23:01
0xFFFF F030 0058	TCP Minimum RTO (msec.)	250
0xFFFF F030 0064	TCP Initial RTO (msec.)	3000
0xFFFF F030 0068	TCP Retransmits	5
0xFFFF F030 006C	TCP Idle Session Timeout (msec.)	240000
0xFFFF F030 0108	TCP Idle Session Timeout Count	0
0xFFFF F030 0070	Ethernet Errors: Late Collisions	0
0xFFFF F030 0074	Ethernet Errors: Excessive Collisions	0
0xFFFF F030 0078	Ethernet Errors: Others	0
0xFFFF F030 007C	Smart Modules Present (analog, serial, etc.)	0x0000
0xFFFF F030 011C	PID Loops Supported	0
0xFFFF F030 0148	Digital Modules Supported	0
0xFFFF F030 0100	Arcnet Reconfigs Detected	0
0xFFFF F030 0104	Arcnet Reconfigs Initiated by I/O Unit	0
0xFFFF F030 0120	Arcnet Transmit Attempts Since Powerup	0
0xFFFF F030 0128	Arcnet ACKs	0
0xFFFF F030 0134	Arcnet Timeouts	0
0xFFFF F030 0124	Arcnet Other (node not found, etc)	0
0xFFFF F030 0130	Arcnet Timeout Value (msec.)	0
0xFFFF F030 0138	Arcnet Receive Interrupts	0

All three of these items should have a value of zero. If any of these items has a value other than zero, you may have a network problem.

Analyze Communication Packets

If it appears that you have network problems, Opto 22 recommends using the open-source network protocol analyzer (or “packet sniffer”) Wireshark (www.wireshark.org) to log and analyze network communication packets on your network.

Have Your Network Certified

If you suspect network problems, you may need to have your network professionally certified. Opto 22 does not offer network validation or certification services, but many network hardware manufacturers do. Contact the manufacturer of your Ethernet network hardware to have them diagnose, fix, and certify your network.

If you continue to have problems communicating with the controller or I/O units after your network is certified, contact Opto 22 Product Support. (See [“For Help” on page 13.](#))


TCP Settings

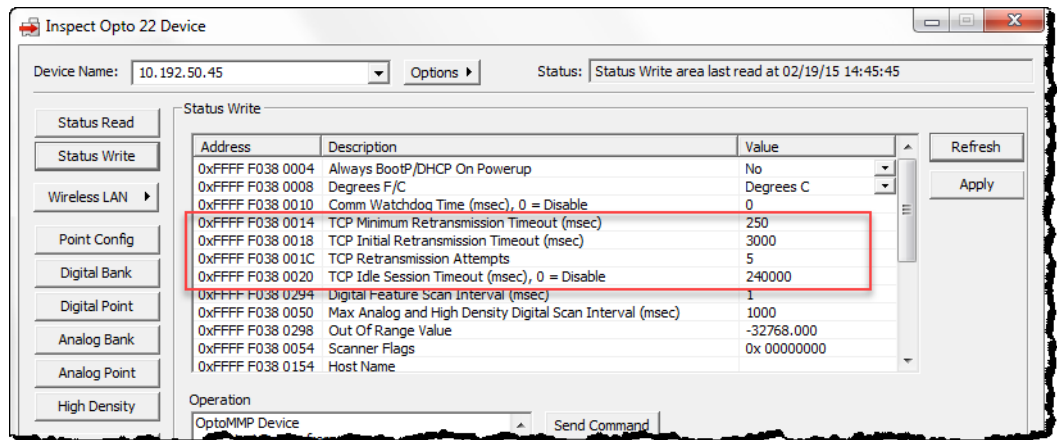
Retransmit timeout (RTO) refers to the length of time the controller waits while communicating before timing out. The RTO is determined by the controller's TCP/IP stack, and the stack continually recalculates the RTO

based on recent network traffic. If the network becomes busier, for example, the stack automatically adjusts the RTO to a higher value.

If the TCP/IP stack times out while trying to transmit data, it doubles the current RTO and tries again. This process continues for five retries; after that, the controller stops trying and sends a timeout message.

If you are receiving frequent timeout messages from the SNAP PAC S-series controller, you can change the TCP parameters in PAC Manager.

1. Choose Start > Programs > Opto 22 > PAC Project Software > PAC Manager.
2. In the PAC Manager main window, click the Inspect icon .
3. In the IP Address field, type the IP address of the controller. Click Status Write.



CAUTION: Note the following recommended settings:

TCP Minimum Retransmission Timeout (msec):	250
TCP Initial Retransmission Timeout (msec):	3000
TCP Retransmission Attempts:	5
TCP Idle Session Timeout (msec):	240,000

If you set these fields too low, you may not be able to communicate with the controller at all, even though PAC Manager, to fix the settings. Then you would have to reset the controller to factory defaults.

4. Change these four fields as necessary:
 - TCP Minimum Retransmission Timeout** sets an absolute minimum value for the RTO. The controller's calculated RTO will never go below this value.
 - TCP Initial Retransmission Timeout** sets the RTO for the first communication try. Be careful: since all future tries are based on this value, if you set it too low for network conditions, a connection will never be made.
 - TCP Retransmission Attempts** sets the number of times the controller retries communication. Larger, busier networks need a higher number of retransmits than smaller networks with less traffic.
 - TCP Idle Session Timeout** sets how long (in milliseconds) the controller allows a session to remain open without any activity. After this time, the controller closes the unused session. The default is 240,000 milliseconds, or four minutes.
5. Click the Apply button to write your changes to the controller.
6. In the Operation Commands list, highlight Store configuration to flash. Click Send Command.
7. In the Operation Commands list, highlight Restart I/O Unit from powerup. Click Send Command. The new TCP parameters are set.

Communicating on a Serial Network

If a SNAP PAC S-series controller fails to connect using either an RS-232 serial interface for PPP host communication or an RS-485 serial interface for I/O unit communication, check the following:

Indicators—Depending on the port(s) being used on a SNAP-PAC-S1 controller, LED S0, S1, or S2 should be red (for receive data) and green (for transmit data). On a SNAP-PAC-S2, there are separate LEDs for Transmit and Receive for each port. Green indicates activity.

Power—Make sure that both the controller and the device it is connected to have been turned on.

Physical Connections—Check that the connectors on each end of the serial link are firmly attached to the controller and the other connected device.

RS-232 Configuration—RS-232 communication on a SNAP PAC S-series controller is configured using PAC Manager software, and ports must be configured correctly for their use, or they won't work. See "Configuring Direct Communication to Serial Devices" in the *PAC Manager User's Guide* (form 1704).

NOTE: Port 0 is set by default to communicate using PPP. If you're connecting to serial devices with Port 0, you must change its configuration in PAC Manager.

RS-485 Configuration—On a SNAP-PAC-S1, RS-485 serial network bias and termination are configured using DIP switches on the top of the unit. Confirm that DIP switches are set to the correct positions for the controller's location in the RS-485 network. See "[RS-485 Connections](#)" on page 17 for information. On a SNAP-PAC-S2, all port configuration is performed using PAC Manager. For details, see the *PAC Manager User's Guide* (form 1704).

Timeout Errors when Communicating with a Serial Brain

- To avoid timeout issues when communicating from a controller to a serial brain, you should configure matching turnaround delays in both the controller and the brain. (Turnaround delays are typically required at 9600 baud—and sometimes needed at higher baud rates when your RS-485/422 bus is using repeaters.)
 - Configure the controller's turnaround time in PAC Manager > Tools > Inspect > Status Write button > Turn-Around Delay for Port <#> (msec). <#> represents the port number that the controller is using to connect to the brain.
 - Configure the same turnaround time for the brain in PAC Manager > Tools > Inspect > Status Write button > Turn-Around Delay for Port <#> (msec).

The amount of turnaround time you'll need depends on the RS-485 cable connecting the devices (turnaround time increases with the length of the cable). Start with a 1 millisecond delay, and then, if you're still experiencing issues, increase the turnaround time until the connection is satisfactory.

- If you get a timeout error when trying to establish communication between an S-series controller and a serial brain (for example, a SNAP-PAC-SB2), the problem could be configuration-related.
 - If you get the error when trying to run a PAC Control strategy, make sure that the baud rate on the brain's Baud Rate Switch is the same as the baud rate configured in your PAC Control strategy (File > Strategy Options > Serial I/O Ports tab). For example, if the brain's baud rate is set at 115,200 Kbs, then the serial I/O (RS-485) port in your strategy must also be configured for 115,200 Kbs.
 - If you get a timeout error when using PAC Manager to communicate with the brain via a controller:
 - a. Check that the baud rate setting on the brain is the same as the baud rate configured in PAC Manager (Tools > Inspect > Communications > PPP Configure > Serial Port Speed).
 - b. If that doesn't solve the problem, then make sure the brain's baud rate setting is the same as the baud rate in the controller's strategy (File > Strategy Options > Serial I/O Ports tab).

When you've configured the same baud rate for the brain, the strategy, and PAC Manager, you then need to cycle power to the controller. Cycling power releases a lock previously put on the configured communication port, and allows the new connection to succeed.

MAINTAINING THE CONTROLLER


Backup Battery

SNAP-PAC-S1 controllers with a serial number of 625654 or higher, and all SNAP-PAC-S2 controllers, have a rechargeable battery that receives charging current whenever the brain has power. It will retain data for up to one year with the power off.

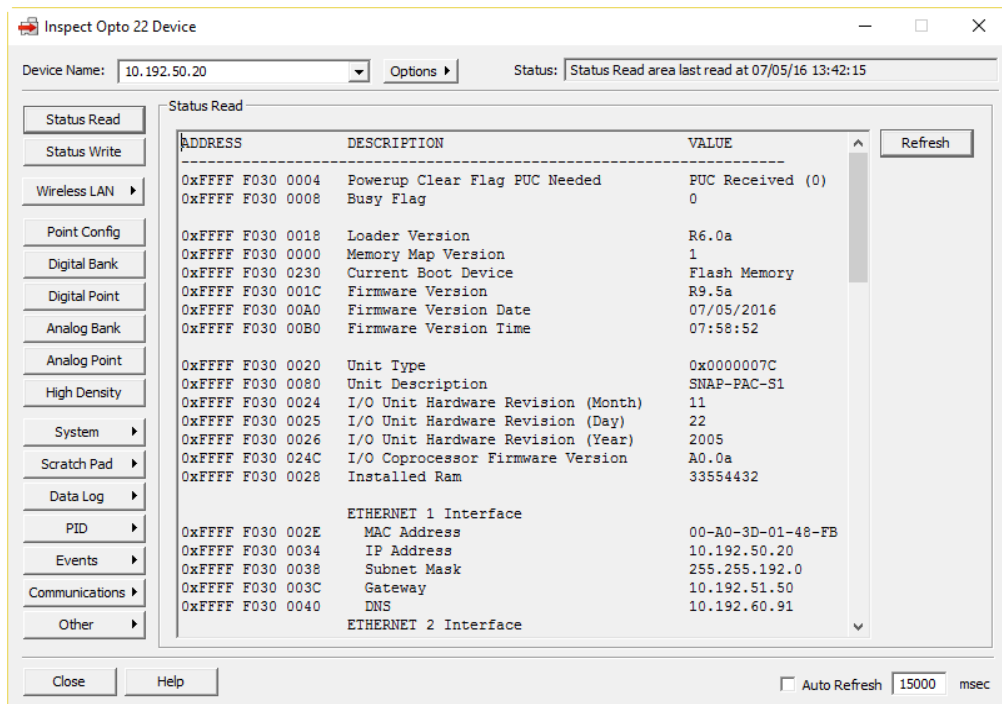
SNAP-PAC-S1 controllers with a serial number of 625653 or lower have a user-replaceable 3.6-volt TL 5242 /W lithium battery that will retain data for a minimum of 10 years. Replacement part number is G4BATT32.

Getting Device and Firmware Information

If you need to contact Opto 22 Product Support for assistance in using a controller, it is helpful to have device and firmware information at hand before you call.

1. Choose Start > Programs > Opto 22 > PAC Project Software > PAC Manager.
2. In the PAC Manager main window, click the Inspect icon .
3. In the IP Address field, type the IP address of the device. Click Status Read.

This example shows a SNAP-PAC-S1; other devices are similar.



Keep this window open on your screen when you call Product Support. See the note on the next page.

NOTE: Because the Status Read area is used for both standalone controllers and Ethernet-based I/O units, some items apply to some devices and not others. The following items do not apply to standalone controllers:

- | | |
|-----------------------------------|--|
| <i>Degrees F/C</i> | <i>PID Loops</i> |
| <i>Comm Watchdog Time (msec.)</i> | <i>Smart Modules Present</i> |
| <i>Scanner Flags</i> | <i>Arcnet data</i> |
| <i>Digital Scan Counter</i> | <i>Digital resets and failures since powerup</i> |
| <i>Analog Scan Counter</i> | |

For detailed information about items in the Status Read area, see the [PAC Manager User's Guide](#) (form 1704).

Changing the Controller's IP Address

If you know the SNAP PAC S-series controller's IP address, see the [PAC Manager User's Guide](#) (form 1704) for instructions to change it. (If you are using redundant controllers, use the PAC Redundancy Manager instead of PAC Manager.)

If you do not know the IP address, first check the label on the side of the controller in case the IP address has been written there. If you still don't know the controller's IP address, reset the controller to factory default settings following the instructions in "Resetting the Controller" on page 39 and then set the IP address as described in the [PAC Manager User's Guide](#).

Resetting the Controller

1. Carefully insert a straightened paperclip or stiff wire into the small hole labeled RESET. Inside the hole you can feel the paperclip push down on a button that resets the controller.

CAUTION: Do not power on the controller while holding down the reset button. This will deactivate battery power, which will cause the loss of contents in battery-backed RAM and stop the real-time clock.

2. Depending on the type of reset you need, press and hold down the reset button as described below. DO NOT hold the button down too long.

NOTE: Do not reset the brain to hardware test mode unless Opto 22 Product Support tells you to.

Reset type	How to use the reset button	What happens	Notes
Simple reset	Press and release immediately	Controller restarts. Any files and the strategy are erased unless they have been stored to flash memory. Archived strategies are not erased.	
Restore factory defaults	Press just until STAT LED turns solid green (1-2 sec)	Controller restarts. If a microSD card is present and contains configuration, firmware, and/or strategy files—Files on the microSD card overwrite what is in flash memory and other files in flash memory are not erased. Data files on the card are not affected.* If no microSD card is present containing configuration, firmware, or strategy files—All files, strategy, archived strategy, persistent variables, and I/O configuration are erased from RAM and flash memory, and IP addresses are reset to 0.0.0.0 and subnet masks to 255.255.255.0.	If no microSD card is present containing configuration, firmware, or strategy files, you must reassign the IP address and subnet mask.
Failsafe bootloader mode	Press and wait while LED turns solid green. Release when LED starts to blink (2-5 sec)	Controller restarts. Any files and the strategy are erased unless they have been stored to flash memory. Archived strategies are not erased.	Cycle power to recover. Result is the same as a simple reset.
Hardware test mode	Press and hold until LED starts blinking orange rapidly and continuously (> 5 sec)	Controller restarts. Any files, strategy, archived strategy, and persistent variables in RAM and flash memory are erased. I/O configuration in flash is erased (R-series). Data files on a microSD card are not affected. IP addresses are reset to 0.0.0.0 and subnet masks to 255.255.255.0.	To recover, restore to factory defaults as described above. You also must reassign the IP address and subnet mask.

* Example of Restoring factory defaults when a microSD card is present: Suppose the card contains a firmware file but no configuration or strategy files. Restoring to factory defaults will leave the controller with the firmware from the card and configuration and strategy files from flash memory. You will not have to reassign an IP address or download a strategy.

Loading New Firmware

Each SNAP PAC S-series controller contains firmware (sometimes referred to as the *kernel*), which is similar to an operating system. If the firmware should become damaged, or if a new version of the firmware is released, you can load new firmware to the controller following instructions in the *PAC Manager User's Guide*. You can also load new firmware via the microSD card, if the controller has one. See "Updating Firmware" on page 48.

CAUTION: Loading new firmware deletes your PAC Control strategy (even if stored to flash memory) and your persistent variables. Make sure you have **archived** your strategy before loading new firmware.

Using the microSD Card Slot

SNAP PAC controllers with a manufacturing date code of 11/08 (November 2008) and newer have a microSD card slot in the top of the controller's case. On a controller with a microSD card slot, the STAT LED blinks briefly about once every five seconds, indicating that the controller is checking to see if a card is in place.



IMPORTANT: Since the first release, card behavior has changed. If you are using firmware older than R9.0a, follow the instructions in [Using microSD with Older Controller Firmware Technical Note](#) (form 2018) instead of this document.

To determine firmware version, see [page 43](#). To download the latest firmware (recommended), go to www.opto22.com/site/downloads and filter by Firmware.

Card Type and Format

Use only cards with the microSD or microSDHC logos (shown above right). Also, be aware that card capacity, formatting, and filename limits vary depending on your controller, its firmware and loader, and the card type you are using:

Controller firmware	Compatible cards	Card format	Max card capacity	Filename limits
Firmware 9.4a or higher and loader 6.1a or higher	microSDHC	FAT32	32 GB	Long names OK
	microSD	FAT32 or FAT16	2 GB	Long names OK
R9.0a to R9.3e	microSD	FAT16	2 GB	8 dot 3*
Lower than R9.0**	microSD	FAT16	2 GB	8 dot 3*

* All files stored on the microSD card must be named with a maximum of eight characters in the name plus three characters in the extension (8 dot 3 format), for example: datafile.txt

** The card behaves differently using firmware lower than R9.0. Follow the instructions in [Using microSD with Older Controller Firmware Technical Note](#) (form 2018) instead of this document.

IMPORTANT: Minimum controller firmware version R9.4a and loader version R6.1a are required to use microSDHC cards. For more information, see [OptoKnowledgeBase article KB83929](#).

MicroSD/SDHC Card Uses

Note minimum requirements in the table above. The card can be used for several purposes:

- To store data or files, which you can access using PAC Control commands or an FTP client. (PAC Manager cannot be used to access data, because it cannot see the card's directory.)
- To quickly commission a replacement controller in the unlikely event that a controller fails.
- To update firmware on the controller. The card provides a convenient way to update firmware on non-networked controllers. It's also useful if PAC Manager is not available to update firmware.
- To temporarily boot the controller from firmware on the microSD card rather than from the firmware in the controller, for example to test new firmware.

- To update, run, or test new PAC Control strategies if the controller is not on the network, if PAC Control isn't available, or if you want to test a new strategy without erasing the existing one.

The following table summarizes how to use the card; see the page in the last column for steps.

To do this	When	Put card in...	Use this method	See pg
Store/access data	Anytime	Controller	Automate data storage and retrieval in PAC Control logic: Use PAC Control commands and file communication handles. Or use PAC Control FTP communication handles.	42
		Controller ¹	From a PC, use an FTP client.	
		PC with card reader	Use Windows Explorer.	
Replace failed controller using a prepared card	In advance	Controller ¹ PC with card reader	1. Use PAC Manager Inspect window to store IP address and configuration data to card. 2. Use PAC Control to make controller download (.cdf) file. 3. Create a command file to load firmware. 4. Copy .cdf file, command file, and firmware file to card.	44
	If controller fails	Controller	1. Replace failed controller with a new one (must be exactly same part number; must have minimum firmware R9.x and loader R6.x). 2. Insert prepared card and turn on power. 3. Use controller's Reset button to reset to defaults from card. Strategy is saved to flash memory.	
Try out controller firmware without replacing current firmware	In advance	Controller ¹ or PC with card reader	Use Windows Explorer or FTP client to copy new firmware to card.	48
	To use	Controller	Insert prepared card into controller and cycle power. Controller runs firmware on card. To go back to older firmware, remove card and cycle power again.	
Try out new strategy without replacing current strategy ⁴	In advance	Controller ¹ or PC with card reader	Use PAC Control to make controller download (.cdf) file; then use Windows Explorer or FTP client to put .cdf file on the card.	49
	To use	Controller	Insert prepared card into controller and cycle power. Controller runs strategy from card. To go back to older strategy, remove card and cycle power again.	
Update non-networked controller with new firmware ⁴	In advance	PC with card reader	Create command file; copy it and the firmware file to card.	46
	To use	Controller	Insert card into controller. Controller runs firmware from card until reset. Use controller's Reset button to save firmware to flash. ²	
Update non-networked controller with new strategy ⁴	In advance	PC with card reader	Use PAC Control to make controller download (.cdf) file; then use Windows Explorer to copy .cdf file to the card.	49
	To use	Controller	Insert card into controller and cycle power. Controller runs new strategy from card until reset. Use controller's Reset button to save strategy to flash memory. ^{2, 3}	

1 Controller must be on same network segment as PC.

2 CAUTION: Before resetting, make sure you know what is on the card! ALL IP address and configuration information, firmware, and strategy that exist on the card are saved to flash memory.

3 If you have firmware R9.x but a loader older than 6.x, the controller runs the new strategy from card until reset, but the strategy cannot be saved to flash memory.

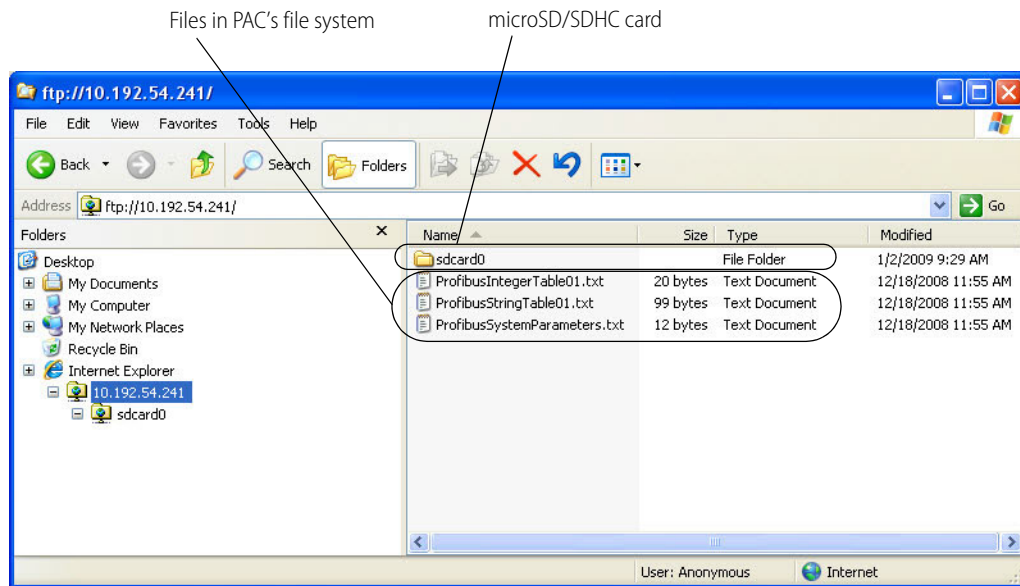
4 CAUTION: Persistent variables will be deleted.

Storing and Accessing Data or Files

When inserted into the controller and accessed from a PC using FTP or PAC Control, the card appears as a directory in the controller’s file system named: `sdcard0`. Just like a PC might show a thumb drive as a directory named Removable Disk (E:), for example, the controller shows the card as a directory named `sdcard0`.

IMPORTANT: Do NOT try to create this directory. When you look at the card in the controller, the card appears as a directory named `sdcard0`. When you look at the card in a card reader attached to your PC, you see the card reader’s directory instead. When the card is in a card reader, you are already in the root of the card (that is, you are already inside the `sdcard0` directory).

For example, suppose you are looking at a card in a SNAP PAC controller with IP address 10.192.54.241. You can see that this controller has three files in its regular file system, plus the card:



Within the `sdcard0` directory on the controller (or the root if the card is in a card reader), you can create other directories and create or add files. For a card formatted with FAT16, you can have up to 512 files or directories in the root directory, and each subdirectory can have up to 65,534 files. Cards formatted with FAT32 have no restrictions on the number of files in the root. Note filename requirements in “Card Type and Format” on page 40.

When the card is in the controller, you can access files on the card through PAC Control commands and from a PC using FTP.

Use PAC Control commands just as you would with any other file in the controller’s file system. For help, see “Using the Control Engine’s File System” in the *PAC Control User’s Guide* (form 1700). Remember to include the card’s directory name in the path in the file communication handle, for example:

```
file:a,/sdcard0/VoltLog.txt
```

Note that the path separator is a forward slash (/), not a backward slash (\).

You can also use the FTP communication handle in PAC Control to manipulate files. See the section “Moving Files via FTP,” also in the *PAC Control User’s Guide*.

To move files to or from a PC, use any standard FTP software. (Don’t use PAC Manager as the FTP client, as it cannot see directories within the controller’s file system). Remember to include the card’s directory name, for example: `ftp://192.168.1.1/sdcard0/`

NOTE: If you access the card when it is not in the controller (for example, in a card reader), the `sdcard0` directory does not appear. Do NOT create it. The controller treats the card as a folder in the controller's file system.

Displaying Free Space on the Card

If you need to know how many free bytes are left on a microSD/SDHC card, you can use PAC Control or PAC Manager to read this data from an address in the controller's memory map. In a PAC Control strategy, for example, you could notify an operator if the card needs replacing, based on the number of bytes still unused.

1. Make sure the card is in the controller.
2. In PAC Control, use the command Read Number from I/O Unit Memory Map to read memory map address F7002204. Use Integer 32 Variable in Argument 2.


For more information, see "I/O Unit—Memory Map Commands" in the *PAC Control User's Guide*, and see "Read Number from I/O Unit Memory Map" in the *PAC Control Command Reference* (form 1701).

3. In PAC Manager, open the Inspect window for the controller. Click Other and choose Generic Read/Write from the popup menu. In the Address field, type F7002204. From the Type list, choose 32-bit Integer. Leave the Length as 1. Click Refresh.

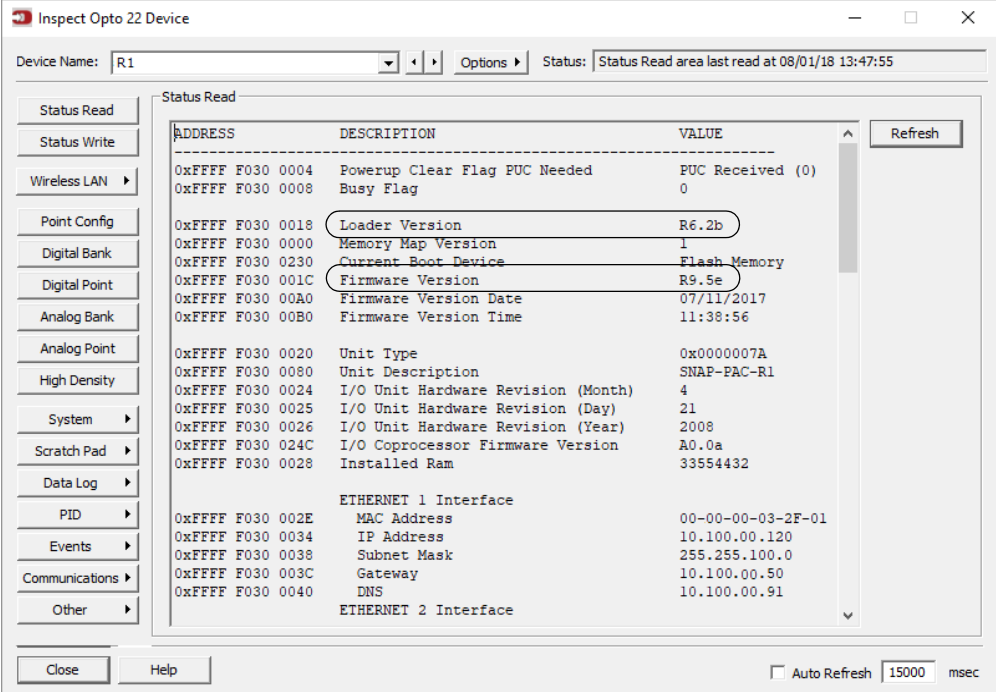
The number of bytes appears in the Value column.

Checking Firmware and Loader Versions

Compatible cards and card functions depend on the controller's firmware and loader versions. Here's how to check them. The controller must be on the same network segment as the PC with PAC Manager.

1. Open PAC Manager and click the Inspect icon .
2. In the Device Name field, enter the controller's name or IP address, or choose it from the drop-down list. Click Status Read.

Loader and firmware version numbers appear near the center of the window:



ADDRESS	DESCRIPTION	VALUE
0xFFFF F030 0004	Powerup Clear Flag PUC Needed	PUC Received (0)
0xFFFF F030 0008	Busy Flag	0
0xFFFF F030 0018	Loader Version	R6.2b
0xFFFF F030 0000	Memory Map Version	1
0xFFFF F030 0230	Current Boot Device	Flash Memory
0xFFFF F030 001C	Firmware Version	R9.5e
0xFFFF F030 00A0	Firmware Version Date	07/11/2017
0xFFFF F030 00B0	Firmware Version Time	11:38:56
0xFFFF F030 0020	Unit Type	0x0000007A
0xFFFF F030 0080	Unit Description	SNAP-PAC-R1
0xFFFF F030 0024	I/O Unit Hardware Revision (Month)	4
0xFFFF F030 0025	I/O Unit Hardware Revision (Day)	21
0xFFFF F030 0026	I/O Unit Hardware Revision (Year)	2008
0xFFFF F030 024C	I/O Coprocessor Firmware Version	A0.0a
0xFFFF F030 0028	Installed Ram	33554432
ETHERNET 1 Interface		
0xFFFF F030 002E	MAC Address	00-00-00-03-2F-01
0xFFFF F030 0034	IP Address	10.100.00.120
0xFFFF F030 0038	Subnet Mask	255.255.100.0
0xFFFF F030 003C	Gateway	10.100.00.50
0xFFFF F030 0040	DNS	10.100.00.91
ETHERNET 2 Interface		

New firmware versions and some new loader versions are available from our website, www.opto22.com. To update the loader, see *Updating the Loader on a SNAP Device* (form 1789). For firmware, see "Loading New Firmware" on page 40. Contact Opto 22 Product Support with any questions.

Replacing a Controller


A microSD/SDHC card can be used to quickly commission a replacement controller in the unlikely event that an existing controller fails. The card rapidly configures the replacement with the original controller’s IP address, firmware, configuration, and strategy.

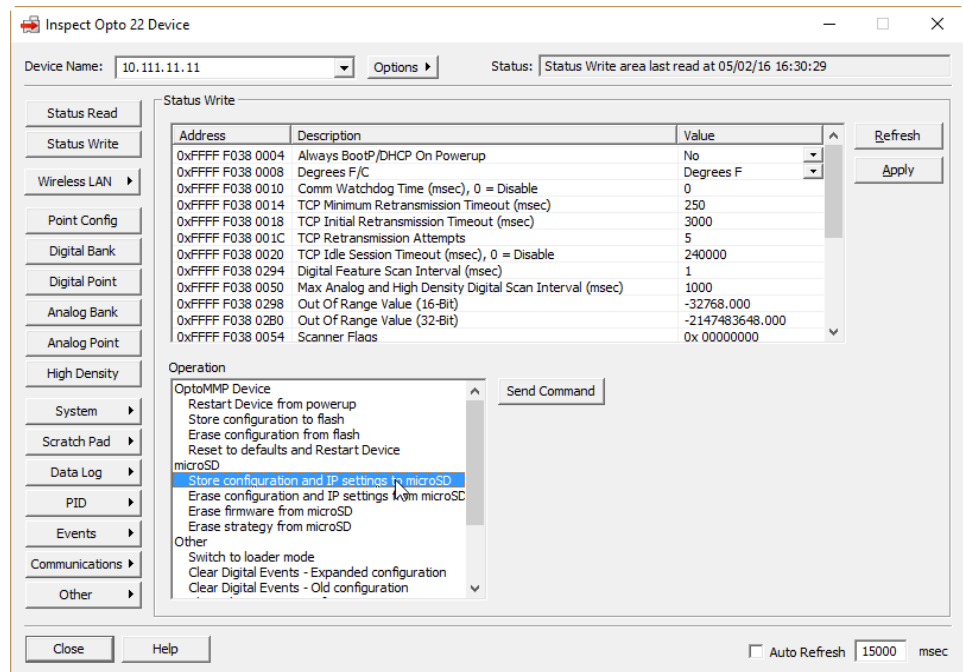
Preparing the card requires PAC Manager R9.0 or higher. You must prepare the card in advance and then keep it in a safe place in case the controller fails.

The replacement controller must have exactly the same part number as the old controller (for example, a SNAP-PAC-S1 must be replaced by a SNAP-PAC-S1), and it must have minimum firmware R9.0a and loader 6.0a. See page 43 to check versions.

CAUTION: Use the commissioning card only to replace a controller; it assigns the new PAC controller the same IP address as the old one.

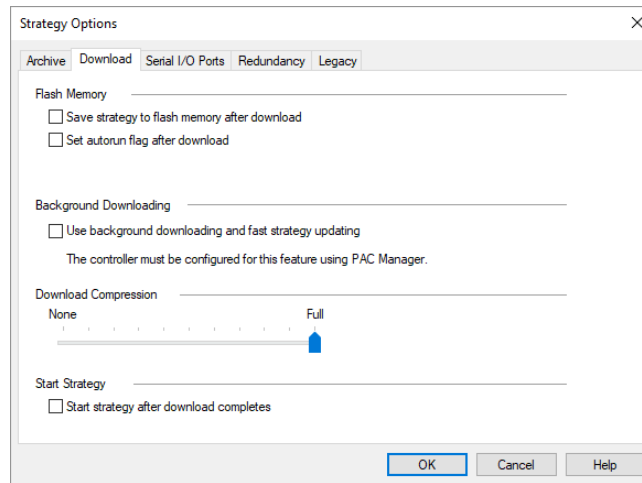
Prepare the Card In Advance.

1. Put a blank card into the controller that you may need to replace.
2. Copy configuration data as follows:
 - a. Open PAC Manager if needed. In the main window, click the Inspect icon .
 - b. In the Device Name field, type the name (or IP address) of the device. Click Status Write.
 - c. In the Operation Command list, highlight Store configuration and IP settings to microSD.



- d. Click Send Command.
The controller’s IP settings and all configuration data are saved to the card in a file located at `/sdcard0/opto22/config/config.cfg`.
3. Prepare the strategy file:

- a. Open your strategy in PAC Control. In Configure mode, choose File > Strategy Options. Click the Download tab.



- b. Check the Set autorun flag after download box. Click OK.
- c. Choose one of the following:
 - If you're using PAC Terminal Secure Strategy Distribution (SSD), follow the steps in *PAC Terminal SSD Technical Note* (form 1762, available with purchase of [PAC Terminal SSD](#)) to create a download file with the file extension .ssd.
 - Otherwise, compile the strategy as a Control Engine Download file (.cdf) by right-clicking the name of the control engine in the Strategy Tree and choosing Compile Control Engine Download File from the pop-up menu.

The file is created in the same folder as the strategy, with a .cdf extension and a filename consisting of the strategy's name and the control engine's name (for example, MyStrategy.MyEngine.cdf).
- d. (Firmware below R9.4a only): Rename the .cdf or .ssd strategy file to fit the 8 dot 3 filename format for the microSD card (see ["Card Type and Format"](#) on page 40).

IMPORTANT: You must retain the correct file extension (.cdf or .ssd).

4. Remove the card from the controller and put it in a card reader attached to the PC. Prepare the firmware file:
 - a. Locate the firmware file you want to upgrade to.
 - b. (Firmware below R9.4a only): Rename the file to fit the 8 dot 3 filename format. For this file, do not keep the same file extension. Recommended naming scheme: PPP-TMM.mmb where:

PPP = controller type (R1, R2)
 T = R for release (or B for beta)
 MM = major revision number
 mm = minor revision number
 b = build letter

Example of an original firmware filename: snap-pac-r2-R9.0a.bin

Example of the same firmware file, renamed: R2-R9.0a

5. Create the firmware command file:
 - a. Using Notepad or a similar editor, create a text file named: command
 In the command file, type the following command (CASE SENSITIVE):

Krn <file>

<file> is the firmware path and filename as the card sees it, so do not include the `sdcard0` directory in the path. If you're using Secure Strategy Distribution, <file> must include a valid signature. Here is a sample command file:

```
Krn R2-R9.0a
```

- b. In Windows Explorer, delete the `.txt` extension from the command file. Then right-click the command file filename and choose Properties. In the General tab, click to put a checkmark in the Read-only box. Click OK.
6. Copy files to the card:
- a. Copy the command file to the `sdcard0` directory in the controller's file system.
 - b. Copy the firmware file to the `sdcard0` directory. This directory must contain only one firmware file.
 - c. In the `sdcard0` directory on the card, create a new directory and name it: `strategy`. Copy the renamed strategy file (`.cdf` or `.ssd`) to the `sdcard0/strategy` directory.

The card is now ready to be used as a commissioning card to replace the controller.

Replacing the Failed Controller.

Before you start, make sure that the replacement controller:

- Has *exactly the same part number* as the old controller (for example, a SNAP-PAC-S1 must be replaced by a SNAP-PAC-S1)
- Has *minimum firmware R9.0a and minimum loader R6.0a*. To check firmware and loader versions in PAC Manager, see [page 43](#). You can download new firmware from our website; if you need a newer loader, contact Product Support.

Follow these steps to replace the failed controller:

- 7. Turn off the controller that failed. Put the new controller in its place but DO NOT apply power. Attach network cables.
- 8. Insert the prepared microSD/SDHC card and turn on power to the controller.
- 9. Without waiting, carefully insert a straightened paperclip or stiff wire into the small hole on the controller labeled RESET. Press and hold the Reset button just until the STAT LED turns solid green, and then immediately release the button.

The IP address is assigned to the controller, and firmware, configuration data, and strategy are loaded into RAM, in that order.

- In firmware R9.2c and newer, IP address, firmware, configuration, and strategy are stored to flash and the controller reboots running the new firmware. The STAT LED blinks steadily during this process and then blinks two sets of three blinks—green to indicate success, or red to indicate failure.
- In firmware R9.0–R9.2b, IP address, firmware and configuration are stored to flash and the controller reboots running the new firmware and loads the new strategy. To store the strategy to flash, use the Reset button again in exactly the same way.

When finished, a folder named `backup` is placed in the root directory of the card. The controller restarts.

- 10. Wait until the STAT LED blinks only once every five seconds, and then remove the card.

Updating Firmware

The card can also be used to update firmware if the controller is not on the network, or if PAC Manager isn't available.

CAUTION: Before updating firmware, make sure you know what is on the card! Any IP address, configuration data, and strategy on the card will be saved to flash memory along with the firmware. If you want only the firmware saved, delete configuration and strategy files from the card.

CAUTION: Updating firmware deletes your PAC Control strategy (even if stored to flash memory) and your persistent variables. Make sure you have **archived** your strategy before loading new firmware.

1. Obtain the correct firmware file from our website, www.opto22.com. If you are using Secure Strategy Distribution (SSD), the firmware must have the correct signature.
2. (Firmware below R9.4a only): Rename the firmware file to fit the 8 dot 3 filename format (see “Card Type and Format” on page 40).

The original file extension does not have to be retained. To make sure the file is clearly identified, we recommend a name such as the following: `PPP-TMM.mmb` where:

PPP = controller type (R1, R2)
 T = R for release (or B for beta)
 MM = major revision number
 mm = minor revision number
 b = build letter

Example of an original firmware filename: `snap-pac-r2-R9.0a.bin`

Example of the same firmware file, renamed: `R2-R9.0a`

3. Copy the firmware file to a blank card. If you don't have a blank card, delete the following directories and their contents if they appear on the card:

```
/sdcard0/strategy
/sdcard0/boot
/sdcard0/opto22/config
```

You can write to the card in one of two ways: either use your PC to FTP files to the card in the controller, or use a card reader with your PC and simply copy files with Windows Explorer.

4. Using Notepad or a similar text editor, create a command file named `command.txt` and save it in the root directory of the card. (If you are looking at the card in a card reader, save it in the root directory. If you are looking at the card in the controller, save it in the directory named `sdcard0`).
5. In the `command` file, include the following command. All commands are CASE SENSITIVE.

To do this	Use command	Details
Install controller firmware	<code>Krn <file></code>	<p><code><file></code> is the firmware path and filename as the card sees it, so do not include <code>sdcard0</code> directory in the path. The firmware file can be compressed in gzip format or uncompressed.* If you're using Secure Strategy Distribution, <code><file></code> must include a valid signature.</p> <p><i>NOTE: Controller firmware will be installed only if it differs from the current firmware.</i></p>
<p>* To gzip a file on Windows, use the utility at http://gnuwin32.sourceforge.net/packages/gzip.htm. SNAP PAC cannot decompress files that were compressed with WinZip</p>		

The following sample command file updates firmware on the controller.

```
Krn R2-R9.0a
```

- In Windows Explorer, delete the `.txt` file extension from the file so that the complete filename is only: `command`. Then right-click the command file and choose Properties. In the General tab, click to put a check in the Read-only box. Click OK.

CAUTION: *Make sure you know what is on the card before updating firmware! Any IP address, configuration, or strategy data that exists on the card will also be saved to flash memory along with the firmware.*

- To update firmware, insert the card in the controller's card slot. Carefully insert a straightened paper clip or stiff wire into the small hole on the controller labeled RESET. Press and hold the Reset button just until the STAT LED turns solid green, and then immediately release the button.
Firmware is updated and saved to flash memory. (If IP address, configuration, or strategy files are on the card, they are also saved to flash memory.) When finished, a file named `response` is placed in the root directory of the card; this file indicates the success or failure of commands in the command file. Then the controller restarts.
- Wait until the STAT LED blinks only once every five seconds, and then remove the card.

Booting from Firmware on the Card

You can also boot the controller from firmware on the card, rather than from the firmware in flash memory, for example to test new firmware before updating it on the controller.

You can write to the card in one of two ways: either use your PC to FTP files to the card in the controller, or use a card reader with your PC and simply copy files with Windows Explorer.

NOTE: Controllers configured for Secure Strategy Distribution (SSD) cannot boot from the card.

- Locate the firmware file you wish to boot from.
- (Firmware below R9.4a only): Rename the file to fit the 8 dot 3 filename format (see ["Card Type and Format" on page 40](#)).

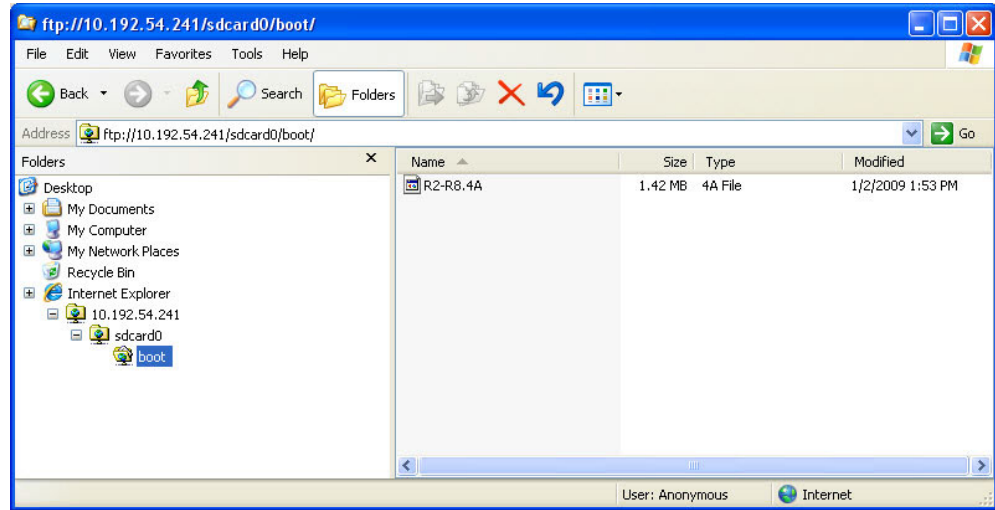
Recommended naming scheme: `PPP-TMM.mmb` where:

PPP	= controller type (R1, R2)
T	= R for release (or B for beta)
MM	= major revision number
mm	= minor revision number
b	= build letter

Example of an original firmware filename: `snap-pac-r2-R9.0a.bin`

Example of the same firmware file, renamed: `R2-R9.0a`

- Create a directory on the card in the root and name it: `boot`
Remember, if you are looking at the card *in the controller*, you create the `boot` directory in the `sdcard0` directory. If you are looking at the card *in a card reader*, create the `boot` directory at the top level. The controller's file system treats the card as a directory named `sdcard0`.
- Copy the renamed firmware file to the `sdcard0/boot` directory on the card.
Here's how it might appear if you are looking at the card in the controller:



IMPORTANT: The boot directory must contain only one firmware file. If it contains more than one, the wrong firmware may be loaded.

5. If the card contains a command file or any other firmware files, delete them.
6. To boot the controller from firmware on the card, turn the controller off and insert the card in the controller's card slot. Turn the controller back on. (Or insert the card and then quickly push and release the controller's Reset button.)

If the boot directory exists on the card, the STAT LED blinks green three times, quickly. Firmware is loaded. If the STAT LED blinks red, see "Blink Codes" in this chapter to determine the problem.

If the STAT LED blinks green two times, either the boot directory is not present, the firmware file is invalid or does not match the controller, or the controller is an SSD controller.

When the STAT LED no longer blinks steadily, but blinks only once every five seconds, you can remove the card. When the card is removed, the controller continues running the firmware on the card until power is cycled or the controller is reset. If you need to know whether the controller booted from the card or from flash memory, use PAC Manager's Inspect window to check the Status Read area. See the *PAC Manager User's Guide* for instructions.

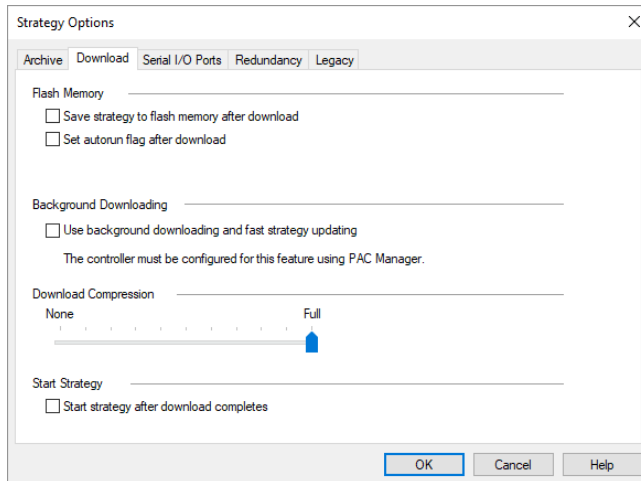
Updating, Running, or Testing a Strategy

The card can also be used to update, run, or test a PAC Control strategy. This ability is useful when the controller is not on the network or PAC Control isn't available. Both regular strategies and Secure Strategy Distribution (SSD) strategies can be used.

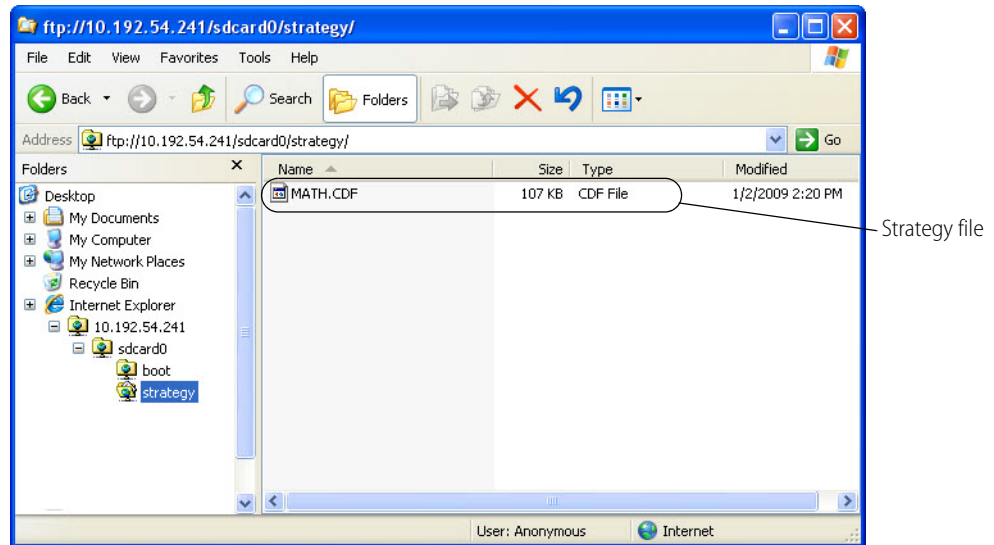
You can write to the card in one of two ways: either use your PC to FTP files to the card in the controller, or use a card reader with your PC and copy files with Windows Explorer.

CAUTION: Before saving to flash memory, make sure you know what is on the card! ALL IP address, configuration data, and firmware on the card will be saved to flash along with the strategy. If you want only the strategy saved, delete configuration and firmware files from the card.

1. In PAC Control Configure mode, choose File > Strategy Options. Click the Download tab.



2. If you want to set the strategy to autorun, check the box **Set autorun flag after download**.
 Autorun works if you insert the card and then turn on the controller; it has no effect if you insert the card when the controller is already turned on. (If the controller is already turned on, the new strategy follows the status of the existing strategy: if the existing strategy was running when the card was inserted, the new strategy will run; otherwise, it will not.)
 If you use background downloading, the controller will switch to the new strategy when the card is inserted.
3. Click **OK**.
4. Choose one of the following:
 - a. If you're using PAC Terminal Secure Strategy Distribution (SSD), follow the steps in *PAC Terminal SSD Technical Note* (form 1762, available with purchase of [PAC Terminal SSD](#)) to create a download file with the file extension `.ssd`.
 - b. Otherwise, compile the strategy as a Control Engine Download file (`.cdf`) by right-clicking the name of the control engine in the Strategy Tree and choosing **Compile Control Engine Download File** from the pop-up menu.
 The file is created in the same folder as the strategy, with a `.cdf` extension and a filename consisting of the strategy's name and the control engine's name (for example, `MyStrategy.MyEngine.cdf`).
5. (Firmware below R9.4a only): Rename the `.cdf` or `.ssd` strategy file to fit the 8 dot 3 filename format for the microSD card (see ["Card Type and Format"](#) on page 40).
IMPORTANT: *You must retain the correct file extension (`.cdf` or `.ssd`).*
6. Create a directory on the card in the root and name it: `strategy`
 Remember, if you are looking at the card *in the controller*, you create the `strategy` directory in the `sdcard0` directory. If you are looking at the card *in a card reader*, create the `strategy` directory at the top level. The controller's file system treats the card as a directory named `sdcard0`.
7. Copy the renamed strategy file to the `sdcard0/strategy` directory on the microSD card.
 Here's an example of a strategy file in the strategy directory, looking at the card in the controller:



8. If you plan to save the strategy to flash memory, delete the following files and directories if they are on the card:

Command file and firmware files
 /sdcard0/boot
 /sdcard0/opto22/config

NOTE: If the controller has firmware R9.0a or newer and a loader version older than R6.0a, you cannot save the strategy from the card to flash memory.

9. To update, run, or test the strategy, turn off the controller, put the card in, and turn the controller back on. The controller loads the strategy from the card (verifying the signature if it is an .ssd file), switches to the new strategy if you're using background downloading, and runs the new strategy if you set it to autorun. If it's not set to autorun, you can start the strategy manually using PAC Control or PAC Terminal. The STAT LED blinks steadily while the strategy is loading and then blinks two sets of three blinks—green to indicate success, or red to indicate failure. When the STAT LED no longer blinks steadily, but blinks only once every five seconds, it has finished.
10. If you want to save the strategy to flash memory, carefully insert a straightened paperclip or stiff wire into the small hole on the controller labeled RESET. Press and hold the Reset button just until the STAT LED turns solid green, and then immediately release the button. The strategy is saved to flash memory. (If IP address, configuration, or firmware files are on the card, they are also saved to flash memory.) Then the controller restarts.
11. Wait until the STAT LED blinks only once every five seconds, and then remove the card.

Disabling or Enabling Firmware and Strategy Updates Via the Card

If you do not want anyone to be able to update firmware or strategies using a microSD/SDHC card, you can disable this feature in the controller. (Enabled is the default.)

1. In PAC Manager, open the Inspect window for the controller.
2. Click Other and choose Generic Read/Write from the popup menu.
3. In the Address field, type F7002200. Choose 32-bit Integer as the Type.
4. To disable firmware/strategy updates: In the Value column next to the address, type 0 (zero). Click Apply.

- To enable firmware/strategy updates: In the Value column, type any value other than zero and click Apply.

Setting Time and Date

The SNAP PAC S-series controller’s built-in clock is set at the factory. To change the time and date, see the instructions in the [PAC Manager User’s Guide](#).

STAT LED Blink Codes

The STAT LED on the top of the SNAP PAC S-series controller uses blink codes to indicate controller operation and status conditions. The blink codes can be useful during normal operation and when troubleshooting.

- When the STAT LED steadily glows green it indicates that one or more flowcharts are running.
- When the STAT LED steadily glows orange, it means the controller is on, and either:
 - There isn’t any strategy in the controller, or
 - The strategy in the controller is stopped, or
 - The strategy in the controller has run, and no flowcharts are currently running.

If your S-series PAC has a microSD card slot, the STAT LED:

- Briefly blinks off once every five seconds when it checks to see if a card has been inserted into the card slot.
- Rapidly blinks when it is reading or writing to the card.

For more information on microSD, see [“Using the microSD Card Slot” on page 40](#).

Different blink codes can occur in sequence. For example, two fast green blinks followed by three slow red blinks show the firmware loading at startup followed by a firmware error.

If the STAT LED blinks green when the controller starts up, it indicates the following:

Number of Blinks	Speed of Blinks	Means
2	fast	Loading firmware (kernel) from Flash memory to SDRAM.
5	fast	Default settings have been successfully restored.
7	fast	(Loader versions 5.1n and older) Entering failsafe bootloader mode (see “Resetting the Controller” on page 39).

If the STAT LED is blinking orange, it indicates the following:

Number of Blinks	Speed of Blinks	Means
(continuous)	slow*	There is a problem with the bootloader. Contact Product Support.
(continuous)	fast	No IP address is assigned to the controller. This may also indicate the controller is in hardware test mode.

* About once per second

If the STAT LED blinks red and green alternately, it indicates the following:

Number of Blinks	Speed of Blinks	Means
(continuous)	fast	(Loader versions 5.1c and newer) Entering fail-safe bootloader mode. (See “Resetting the Controller” on page 39 .)

If the STAT LED is blinking red, it indicates the following:

Number of Blinks	Speed of Blinks	Means	Problem and Workaround
2	slow	Flash programming failure	Flash chips failed to erase properly or program properly. Contact Product Support.
3	slow	Firmware CRC check failed.	The firmware in the device is damaged. See Replacing Damaged Firmware in chapter 6 of the <i>PAC Manager User's Guide</i> (form 1704).
4	slow	Invalid MAC address or hardware revision.	Contact Product Support.
5	slow	Fatal error	Firmware or hardware problem. Check the power supply and connections before restarting. Call Product Support if the error is repeated.
6	slow	RAM error	Contact Product Support.
7	slow	Loader problem	Firmware or hardware problem. Confirm Ethernet cables are connected. Try turning off power to the controller and turning it back on again. Call Product Support if the error is repeated.
8	slow	WLAN failure	(Wired+Wireless models only) Try restoring the PAC to factory defaults (see "Resetting the Controller" on page 39). If that doesn't work, contact Product Support.
11	slow	Firmware failed to initialize communications on ENET 1.	Contact Product Support.
12	slow	Firmware failed to initialize communications on ENET 2.	Contact Product Support.
13	slow	Real-time clock failure	Contact Product Support.
16	slow	Serial EEPROM failure	Contact Product Support.
17	slow	Serial port 0 failure	Contact Product Support.
18	slow	Serial port 1 failure	Contact Product Support.
19	slow	Serial port 2 failure	This error appears if your PAC-S has a microSD card slot and you are using firmware R8.2 or lower. Follow steps in the <i>PAC Manager User's Guide</i> (form 1704) to install firmware version R8.3 or higher using Install Firmware via Failsafe Bootloader Mode.
21	slow	I/O expander failure	(PAC-S2) Contact Product Support.
22	slow	Serial port 3 failure	(PAC-S2) Contact Product Support.
23	slow	Watchdog reset failure	Contact Product Support.

Serial Port LEDs

The S0, S1, and S2 LEDs on a SNAP-PAC-S1 controller indicate serial port operation as follows:

- **Green**—Transmit
- **Red**—Receive
- **Amber**—Transmit and Receive (the LED is actually changing rapidly between green and red, which appears amber)

Each serial port on a SNAP-PAC-S2 has two green LEDs to indicate Transmit and Receive activity for that port.

A: Technical Specifications

Processor	266 MHz 32-bit ColdFire® 5475 with integrated floating-point unit (FPU)
Memory	SNAP-PAC-S1 and SNAP-PAC-S2 Total RAM: 32 MB Total RAM for PAC Control Strategies: 16 MB Battery-backed RAM: 8 MB RAM File Storage: 2.5 MB Flash File Storage: 4 MB
Removable storage	(Models with manufacture dates of June 2014 and newer. Requires firmware R9.4a or higher and loader R6.1a or higher) MicroSD card slot: supports microSD or microSDHC cards to 32 GB. (Models with manufacture dates of November 2008 through May 2014 with firmware R8.4 or higher) microSD card slot: supports microSD cards up to 2 GB.
Backup battery	SNAP-PAC-S1s with serial number 625654 or higher and all SNAP-PAC-S2s: Rechargeable (recharges whenever the brain has power), 1-year power-off data retention (replacement part number: SNAP-PAC-BATTERY-ML2430). SNAP-PAC-S1s with serial number 625653 or lower: User-replaceable 3.6-volt TL 5242 /W lithium, 10-year minimum power-off data retention (replacement part number: G4BATT32).
Ethernet Communication to host and I/O	Two independent 10/100 Mbps Ethernet network interfaces (RJ-45 connectors). Each interface has a separate IP address (separate subnet). Supports Auto MDI-X (crossover cable not needed).
Serial Communication	SNAP-PAC-S1 RS-232 serial: Two RS-232 serial ports (one DB-9 and one pluggable connector); one port has full handshaking. PPP is supported only on port 0. Buffer size: 512 bytes each for RX and TX. RS-485 serial: One RS-485 serial port (pluggable connector); two-wire RS-485; optional <i>mistic</i> signal interrupts. Range (serial multidrop): 32 stations maximum on a segment (including PC, controller, and I/O units); up to 3000 ft (914 m) on a segment. Buffer size: 512 bytes each for RX and TX. SNAP-PAC-S2 Four serial ports that can be used as general purpose ports or for serial I/O units; each port is software configurable as either RS-232 (Tx, Rx, COM, DTR, DCD, RTS, CTS) or as RS-485 (2-wire, 4-wire, optional termination, optional biasing); optional <i>mistic</i> signal interrupts. Buffer size: 512 bytes each for RX and TX.
Power requirements	8–32 VDC \pm 0.5, 11.3 VA maximum (SNAP-PAC-S1 controllers with serial numbers below 500,000 use 8–24 VDC)

Operating temperature	-20 °C to 60 °C
Storage temperature	-40 °C to 85 °C
Humidity	0% to 95% relative humidity, non-condensing
Software	
PAC Project Basic	Includes programming, HMI software, and configuration software; included with purchase of controller.
PAC Project Professional	PAC Project Basic plus OPC 2.0-compliant OPC server, OptoControl strategy and OptoDisplay project importing, support for serial <i>mistic</i> I/O units, and Ethernet link redundancy support.
RESTful API*	Use HTTPS to access data (read/write or read-only) from controller tags using your chosen programming language. Data returned in JSON. More information at developer.opto22.com
Number of charts that can run simultaneously	32
Other features	Multiple protocol support including TCP/IP, HTTP/HTTPS, FTP, SNMP v2.0c (with firmware 8.2a), Modbus/TCP, EtherNet/IP™, and OptoMMP™ Real-time clock FTP server/client with file system (in RAM and in removable storage) Ethernet link redundancy or network segmenting
Agency certifications	(-FM models only) Factory Mutual approved All models: CE, RoHS, DFARS
Warranty	30 months from date of manufacture

* Requires firmware R9.5a or higher

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