3: Networking Options

Introduction

You should already be familiar with TCP/IP and Ethernet networking before you set up your SNAP PAC System. If you're using Wired+Wireless controllers and brains, you should already be familiar with wireless networking; and if you are using serial I/O, you should know about serial networking. If you are not familiar with these subjects, we strongly suggest you consult some of the many commercially available resources to learn about them.

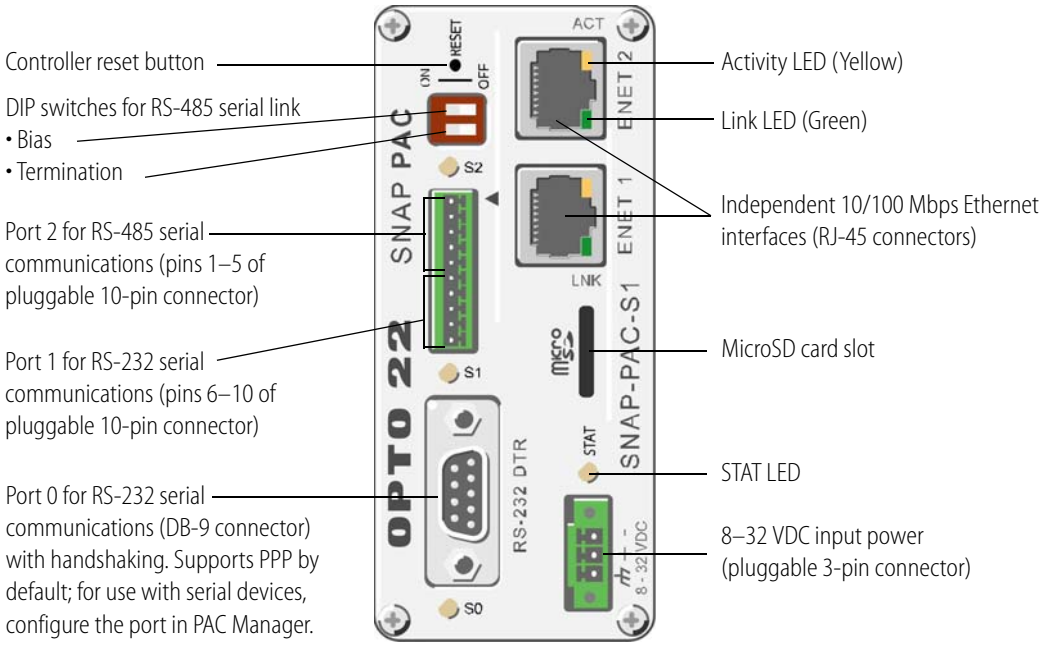
If your SNAP PAC System will be part of an existing Ethernet network or will communicate with an existing network, be sure to work closely with your system administrator before setting up the network or assigning IP addresses.

This chapter discusses some optional Ethernet and serial networking arrangements for the SNAP PAC System. The chapter includes the following:

Network Interfaces on SNAP PAC Controllers and Brains

SNAP-PAC-S1 Controller—Network Interfaces and Ports

Also applies to SNAP-PAC-S1-FM. See page 47 for the SNAP-PAC-S1-W.



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

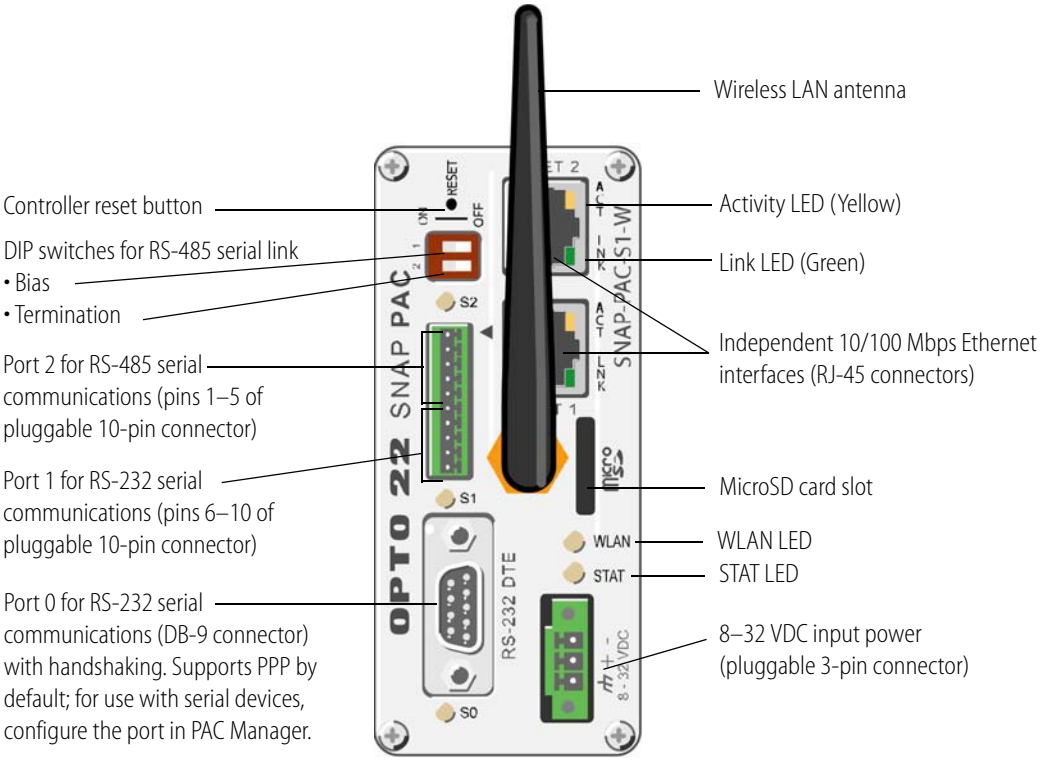
* RI signal does not occur on PACs with a microSD card slot

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-S1-W Controller—Network Interfaces and Ports



Status and Activity LEDs

LED	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
WLAN	Wireless LAN status

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	NC*	

* No connection

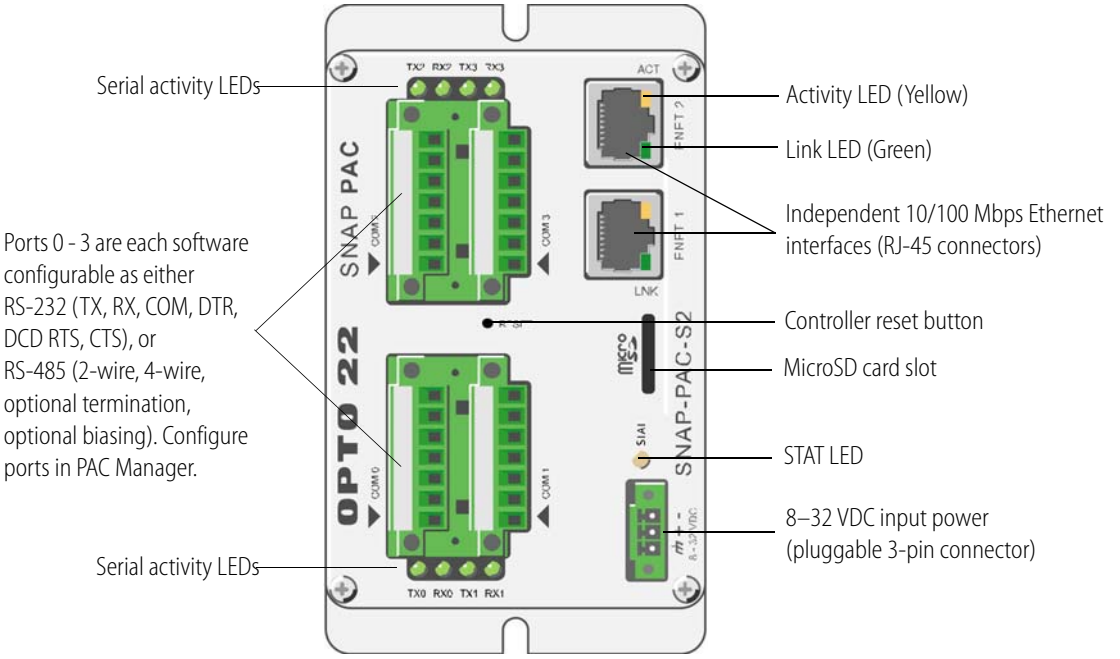
Ports 1 and 2 for RS-485 and RS-232 serial

	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 Controller—Network Interfaces and Ports

See page 49 for the SNAP-PAC-S2-W.



RS-485 and RS-232 Ports[1]

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.)

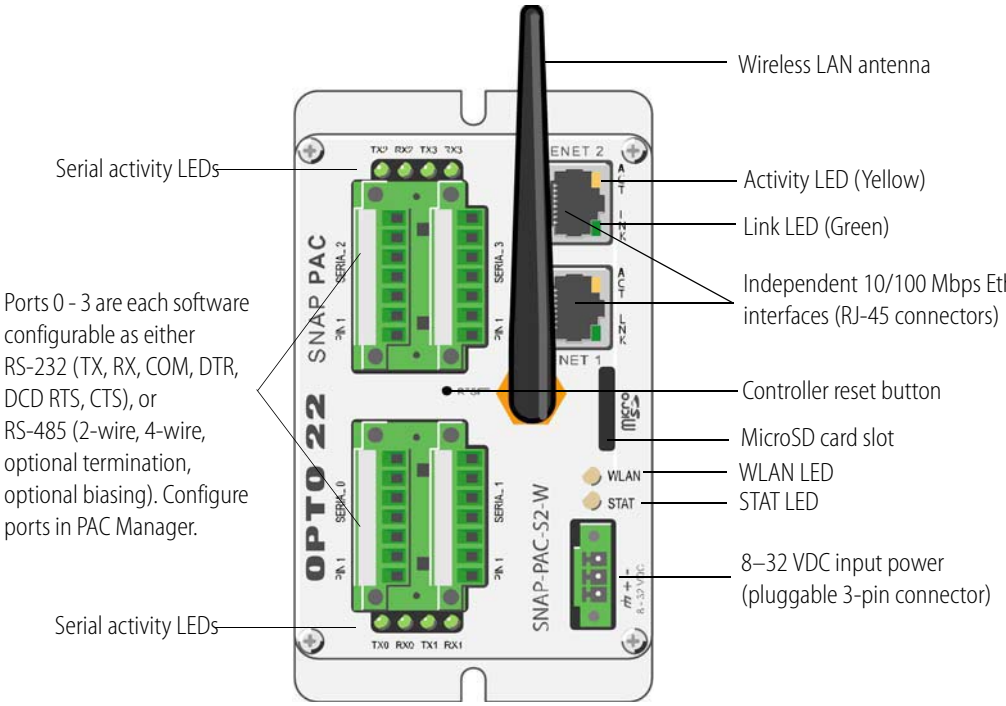
*Legacy OptoControl Controllers:

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

SNAP-PAC-S2-W Controller—Network Interfaces and Ports



RS-485 and RS-232 Ports[1]

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:

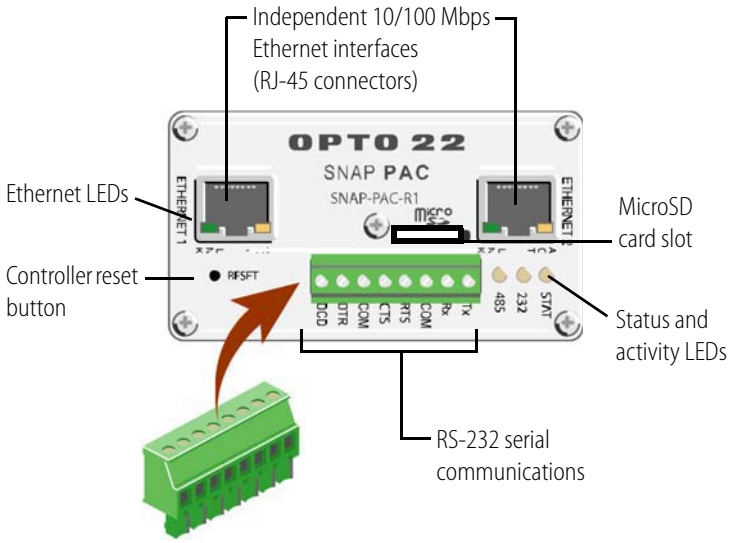
G4LC32	G4LC32ISA-LT	M4RTU
G4LC32SX	M4	SNAP-LCM4
G4LC32ISA	M4IO	SNAP-LCSX/PLUS

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
WLAN	Wireless LAN status

SNAP PAC R-Series Controllers—Network Interfaces and Ports

The following diagram applies to all SNAP PAC R-series on trollers except Wired+Wireless models (part numbers ending in -W). For Wired+Wireless, see page 51.



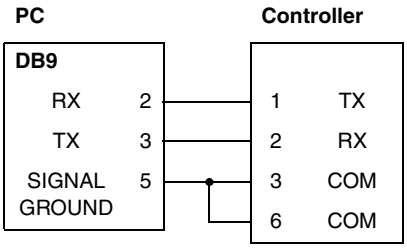
RS-232 Port (Port 0)

Pin	Description
1	TX
2	RX
3	COM
4	RTS
5	CTS
6	COM
7	DTR
8	DCD

Status and Activity LEDs

Indicator	Description
ACT	Ethernet network activity
LNK	Link established with Ethernet network
STAT	Startup status, control program operational status, MicroSD card access
232	RS-232 serial activity
PPP	PPP status

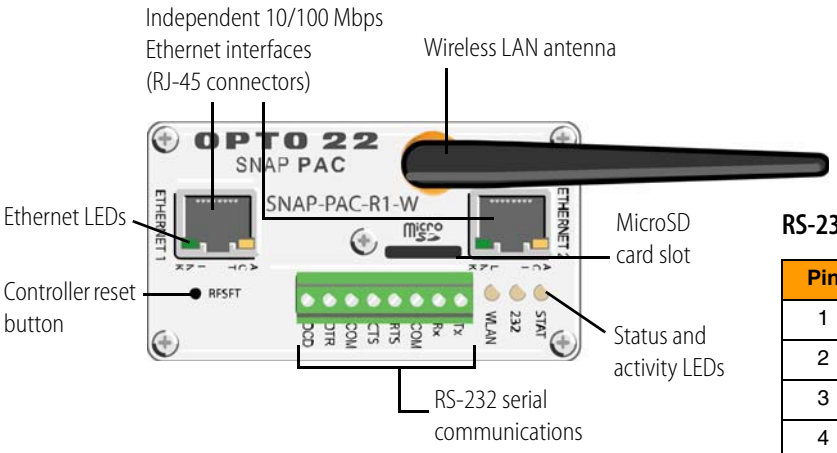
RS-232 Serial Cable Wiring*



* Minimum requirements for an RS-232 connection. To connect the controller to a modem, see form #1595, the *SNAP PAC R-Series Controllers User's Guide*, for all eight pin connections.

SNAP PAC Wired+Wireless R-Series Controllers—Network Interfaces and Ports

The following diagram applies to SNAP-PAC-R1-W and SNAP-PAC-R2-W controllers.



LEDs*

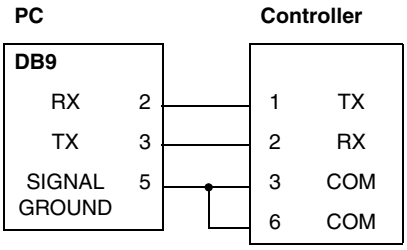
Indicator	Description
ACT	Ethernet network activity
LNK	Link established with Ethernet network
STAT	Startup status, control program operational status, MicroSD card access
232	RS-232 serial activity
WLAN	Wireless LAN status

* The WLAN LED replaces the PPP LED on -W models. These models can still communicate using PPP even though they do not have the indicator.

RS-232 Port (Port 0)

Pin	Description
1	TX
2	RX
3	COM
4	RTS
5	CTS
6	COM
7	DTR
8	DCD

RS-232 Serial Cable Wiring**



** Minimum requirements for an RS-232 connection. To connect the controller to a modem, see form #1595, the *SNAP PAC R-Series Controllers User's Guide*, for all eight pin connections.

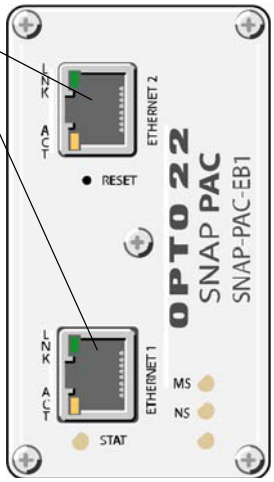
SNAP PAC EB Brains—Interfaces

Also applies to -FM versions of EB brains. For -W models, see below.

Switched Ethernet network interfaces

Brains can be networked in a daisy-chain configuration or in a standard star configuration using either Ethernet interface. Both interfaces use the same IP address.

NOTE: When using a daisy-chain configuration, be aware that if power to a brain is lost, all brains beyond it on the network will also lose communication. Firmware on daisy-chained brains must be updated one at a time.

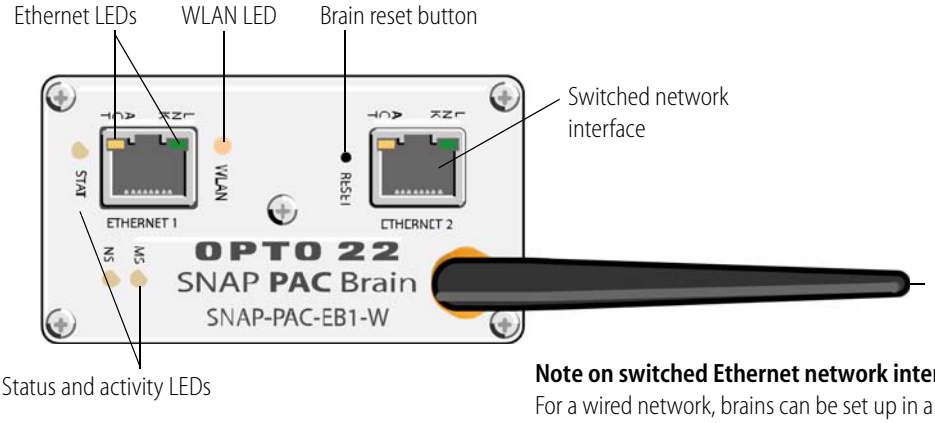


LEDs

LED	Indicates
LNK	Link established with Ethernet network
ACT	Activity on Ethernet network
STAT	Brain status
MS	EtherNet/IP Module Status
NS	EtherNet/IP Node Status
Unnamed	Reserved for future use

SNAP PAC Wired+Wireless EB Brains—Interfaces

Applies to SNAP-PAC-EB1-W and SNAP-PAC-EB2-W.



LEDs

LED	Indicates
LNK	Link established with Ethernet network
ACT	Activity on Ethernet network
STAT	Brain status
MS	EtherNet/IP Module status
NS	EtherNet/IP Node status
WLAN	Wireless LAN status

Note on switched Ethernet network interfaces

For a wired network, brains can be set up in a daisy-chain configuration or a standard star configuration using either the Ethernet1 or Ethernet2 network interface. Both interfaces use the same IP address.

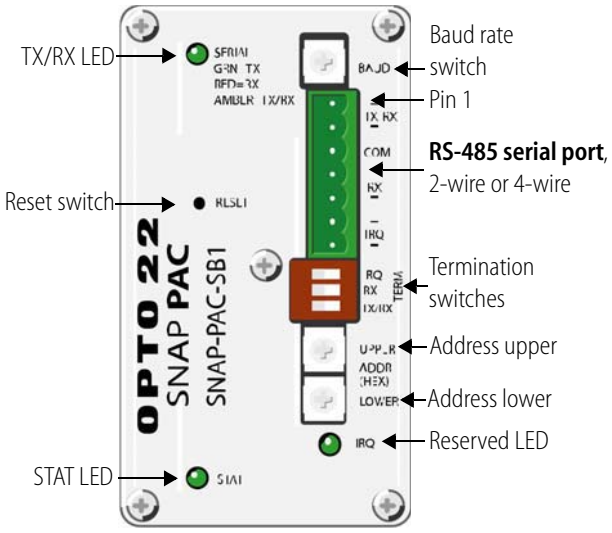
When using a daisy-chain configuration, be aware that if power to a brain is lost, all brains beyond it on the network will also lose communication. Firmware on daisy-chained brains must be updated one brain at a time.

The WLAN interface does not provide access to other brains in a daisy-chain configuration, as this interface has a separate IP address.

SNAP PAC SB Brains—Ports

LEDs

LED	Indicates
SERIAL	Green = Transmit Red = Receive Amber = Transmit/Receive
STAT	Brain status
IRQ	Reserved for future use



Bias is always ON.

Ethernet Networking Options

Standard Ethernet Network Usage

In an Ethernet network, SNAP PAC System controllers and EB brains can be used just like any other device, and they are subject to exactly the same rules for physical connections and communication. SNAP PAC System devices communicate using TCP/IP and UDP/IP over standard Ethernet networks. (They can also communicate using Modbus®/TCP; for more information, see Opto 22 form #1678, the *Modbus/TCP Protocol Guide*.)

Most devices used on an Ethernet network have one network interface, usually with an RJ-45 connector. But as shown in the previous diagrams, SNAP PAC controllers and EB brains each have two interfaces—two RJ-45 connectors. However, the two interfaces on controllers and brains are set up differently.

- **SNAP PAC Controllers**—The two interfaces on a SNAP PAC S-series or R-series controller are *independent* interfaces that have separate IP addresses. To use the controller like any other Ethernet device, plug a Category 5 or newer cable into the connector marked *Ethernet 1*. You must use Ethernet 1, not Ethernet 2, because the controller sends a BootP request for an IP address from Ethernet 1 only.
- **SNAP PAC Brains**—The two interfaces on SNAP PAC EB brains are *switched* interfaces that use the same IP address. To use the brain like any other device, plug a Cat 5 or newer cable into either connector. It doesn't matter which one you use.

Wired+Wireless Network Interfaces

As you can see by comparing the diagrams for Wired+Wireless models to those for their wired cousins (page 46 through page 52), the Wired+Wireless brains and controllers have exactly the same RJ-45 connectors, but in addition, they have an independent wireless LAN interface—the antenna.

Because a Wired+Wireless brain or controller sends its BootP requests for an IP address only through its wired interface, you must first connect to it on a wired network. You can then assign IP addresses for use on both the wired and wireless networks.

- **Wired+Wireless controllers** have *three* independent interfaces—two wired and one wireless—each with a separate IP address. Use *Ethernet 1* for initial configuration.
- **Wired+Wireless brains** have two switched wired interfaces plus an independent wireless interface. Use either wired interface for initial configuration.

Alternatives to Standard Usage

While SNAP PAC controllers and brains can be networked as described using only one Ethernet interface—just like any other Ethernet device—their dual (or triple) interfaces also offer options for network design, which you may choose to use. In addition, SNAP PAC controllers and brains can communicate with both Modbus/TCP and Allen-Bradley® Logix® systems using EtherNet/IP. All these options are discussed in the following sections.

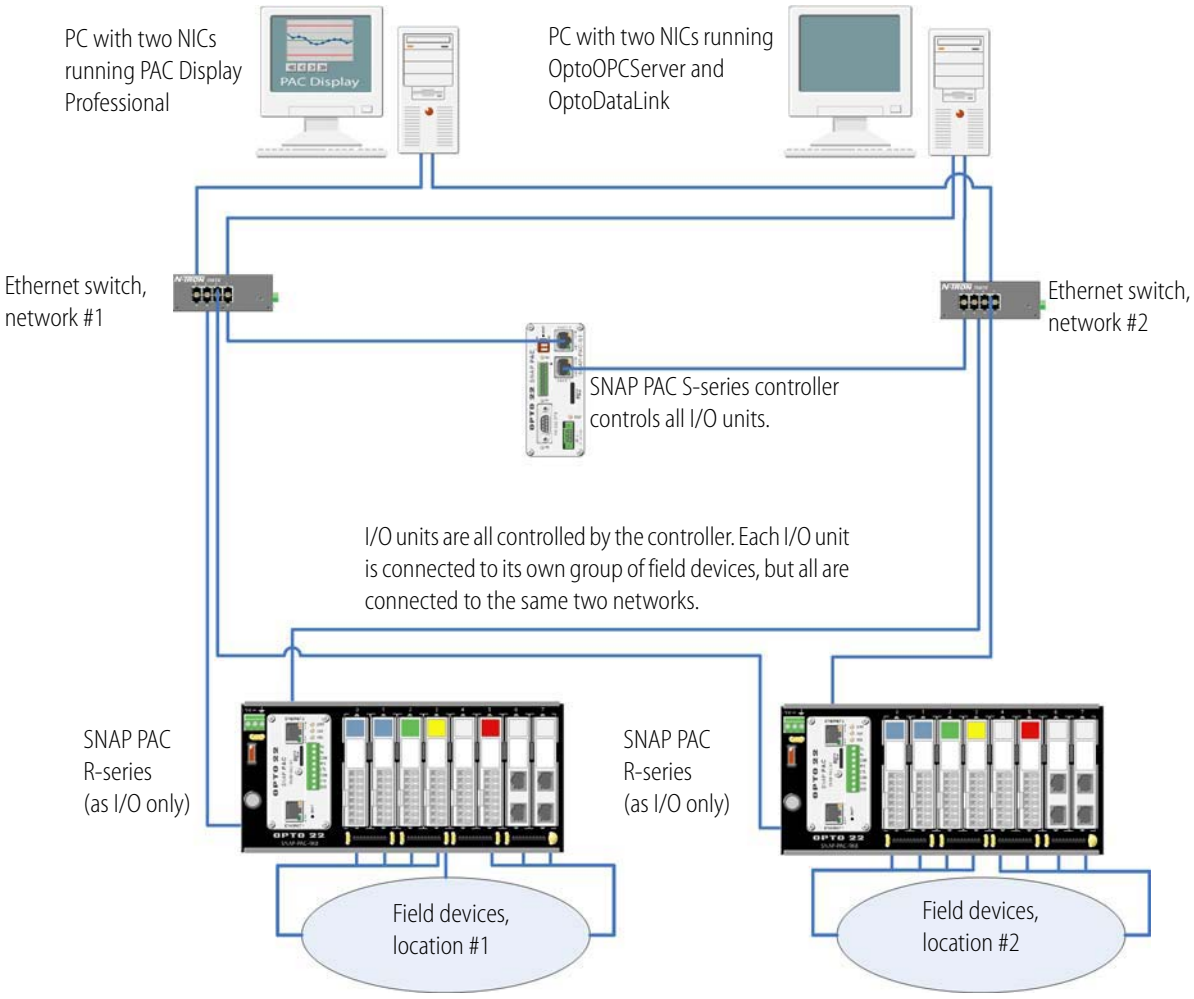
Using Redundant Ethernet Network Links

Redundant network links help address the concern that an Ethernet network may fail or need maintenance, leaving the controller, the I/O units, and PCs (running PAC Display, OptoOPCServer, and OptoDataLink) unable to communicate.

SNAP PAC S-series and R-series controllers, used with PAC Project Professional, offer an option to address this concern. Each SNAP PAC controller has two independent Ethernet network interfaces. Because they are independent, each interface has a separate IP address. Redundant Ethernet links can be created using both interfaces on each device.

The following diagram shows an example. The SNAP PAC S-series controller is the main controller of the system, with SNAP PAC R-series controllers acting as distributed I/O processors. Each SNAP PAC controller is connected to two separate Ethernet network links, and each PC has two network interface cards (NICs) connected to the same links. In this configuration, if one link goes down, devices can still communicate on the other.

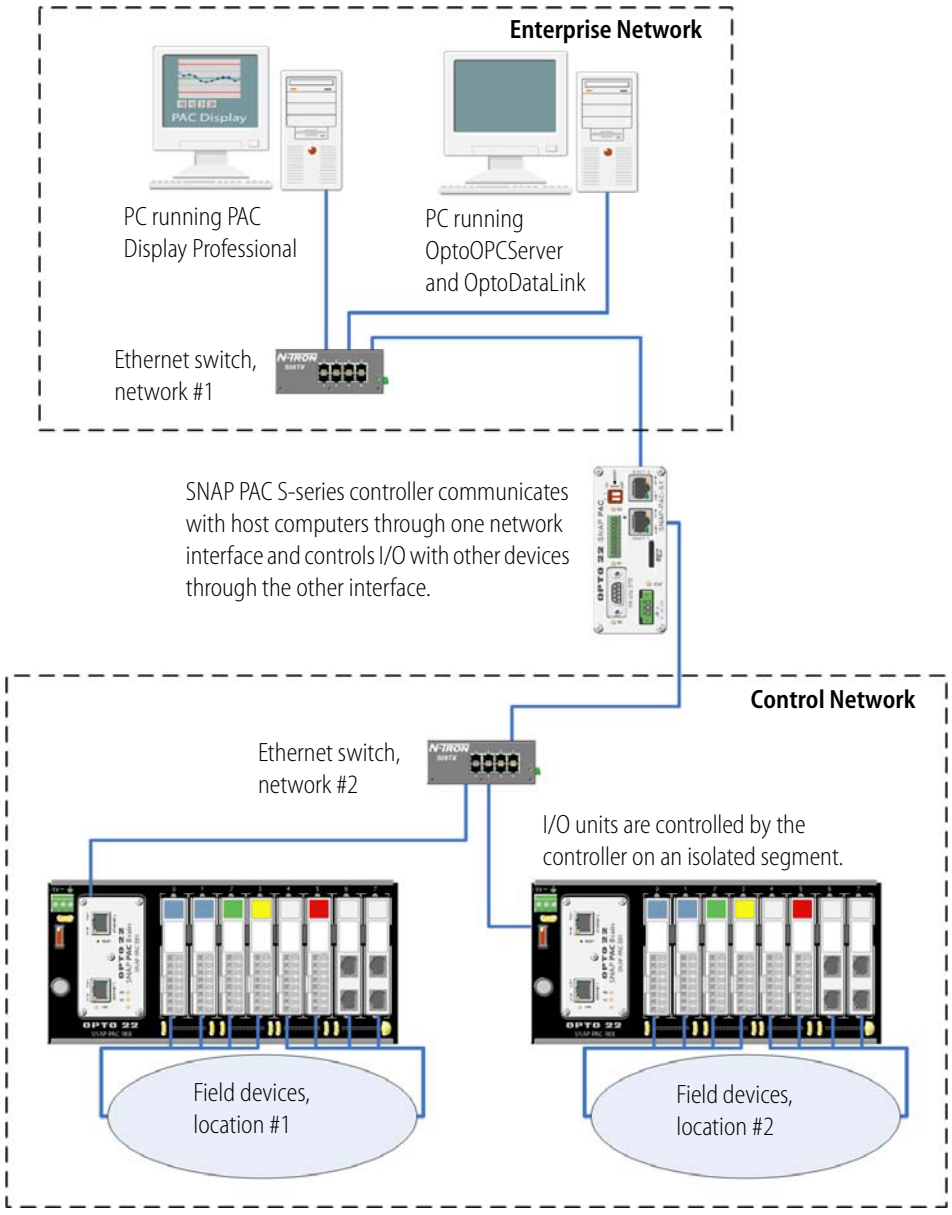
Opto 22 Redundant Network



Segmenting Ethernet Networks

Another concern with using Ethernet networks may be mixing control networks with enterprise computer networks. One answer may be to segment the two so that they are not directly connected.

Either a SNAP PAC S-series or R-series controller can be used for this purpose, since both have two (or three) independent Ethernet network interfaces with separate IP addresses. One interface can be connected to the computer network and provide communication with PCs running PAC Display, OptoOPCServer, or OptoDataLink. The other network interface can be connected to I/O units to provide communication and control to the control network, as shown in the following diagram.



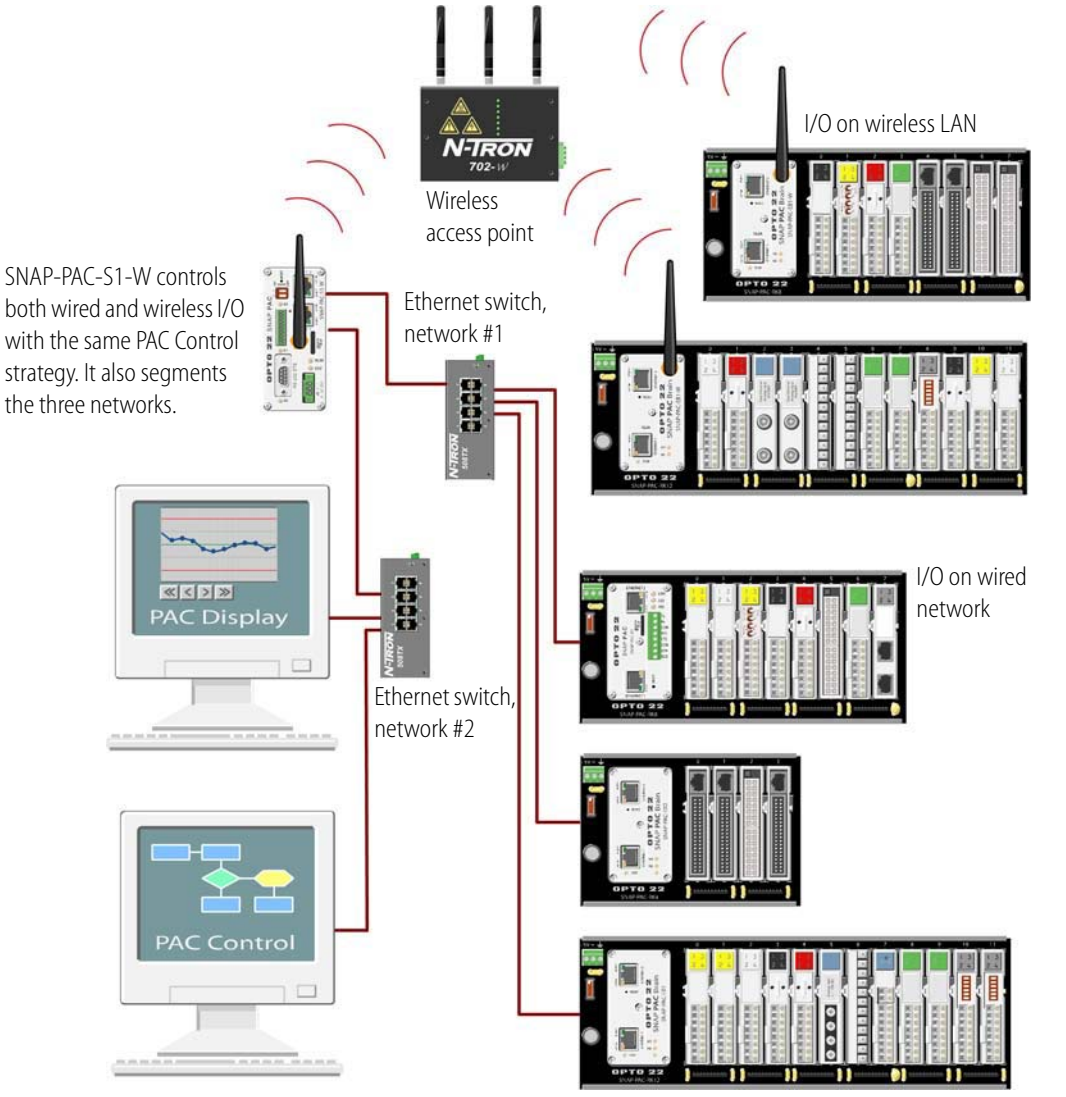
Using Wireless Networking

Wireless networking is useful for communicating with mobile equipment, like lift trucks, or devices in areas difficult to reach with Ethernet cable, such as remote tanks or pumps. Wireless can also be a good way to prototype a system addition, since it usually involves less expense than running wires.

Before you use wireless, make sure you understand the wireless standards, especially in regard to interference and security. Also, survey the area to properly set your wireless access points.

Wired+Wireless SNAP PACs and brains can be used either on a wired network, on a wireless LAN, or both. No matter how they are used, they have the same functions and run the same software—in the same way a laptop computer can be used wirelessly or plugged in, and still run Microsoft Excel, for example. All SNAP I/O modules and racks work either wired or wirelessly, and the same PAC Control strategy runs in the same way. You don't even have to change program logic.

This flexibility means you don't have to decide up front which network to use, nor purchase different or extra automation hardware. It also means you can integrate wired and wireless data. In the diagram below, the PAC controls both wired and wireless I/O and has segmented networks as well.

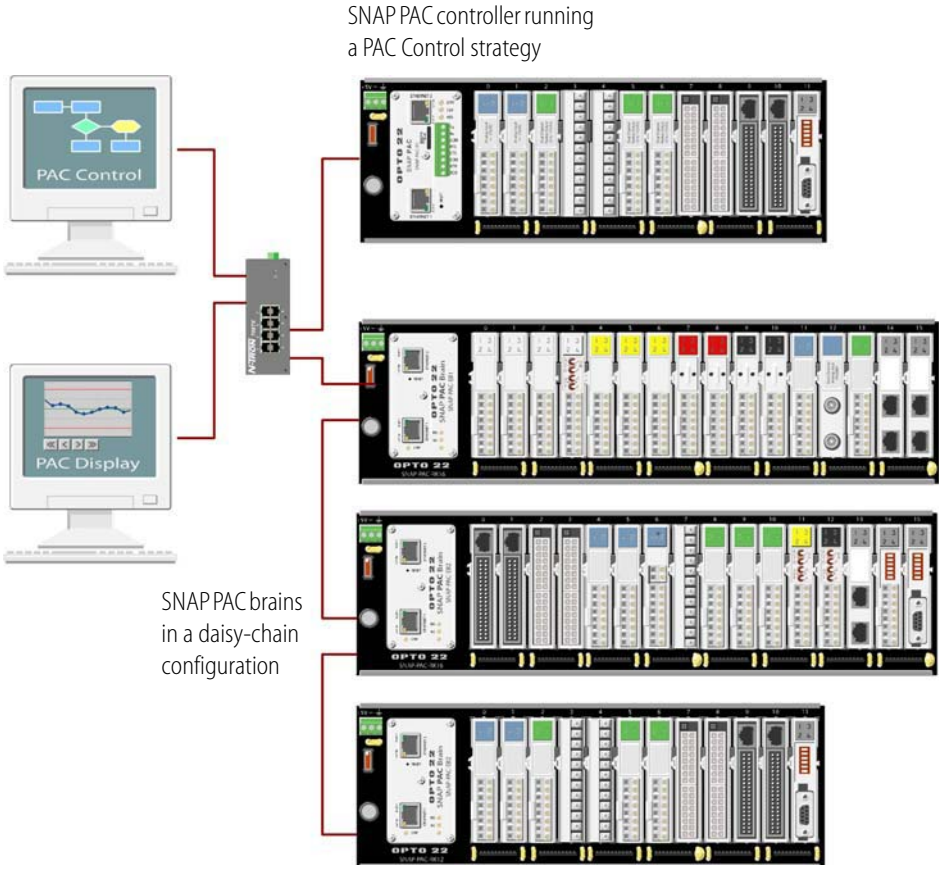


Daisy-Chaining Distributed Ethernet I/O

Standard networking for Ethernet devices is in a star configuration, with an Ethernet switch or router as the center of the star. Another option is offered by SNAP PAC EB brains: a daisy-chain configuration, similar to serial networks. SNAP PAC EB brains give you this option because of their two switched Ethernet network interfaces, which share the same IP address and work just like an Ethernet switch. For a standard star configuration, you use just one interface. For daisy-chaining, you use both to link I/O units without the need for a separate switch.

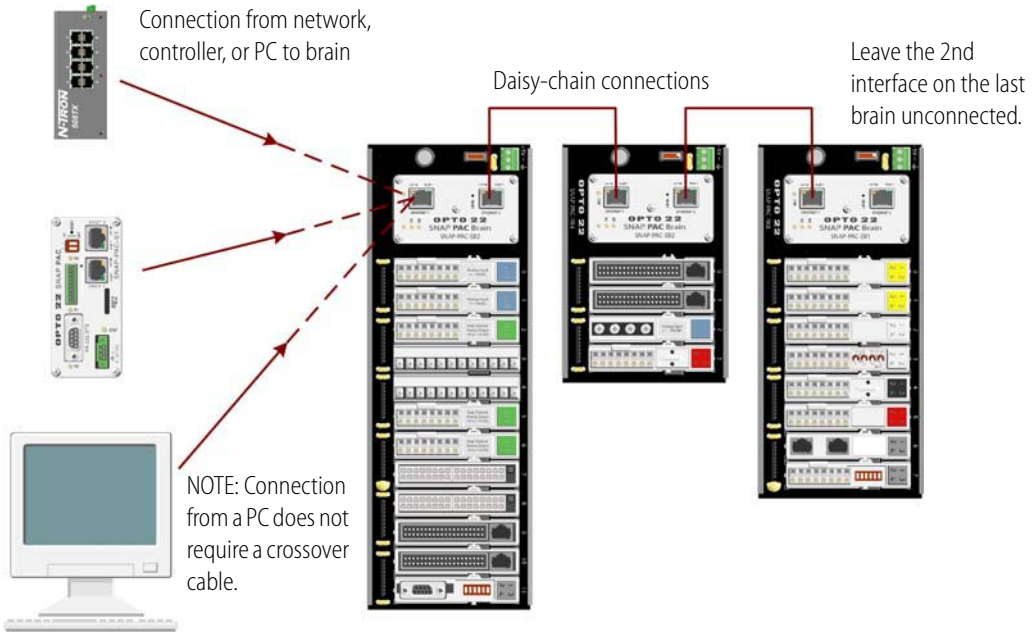
Daisy-chaining offers advantages and disadvantages. The primary advantage is the reduced expense, because you don't need to purchase Ethernet switches. The primary disadvantage is that, as in a serial network, if you lose communication with a brain, all the brains after that one in the chain are also unreachable.

The following diagram shows a SNAP PAC System with brains connected by daisy-chaining.



IMPORTANT: *If you choose a daisy-chain configuration, make certain that the brains are connected correctly. Incorrect connections can produce major problems on the network. Make sure that daisy-chain connections are made in a simple open-ended chain, as shown in the diagram on the following page.*

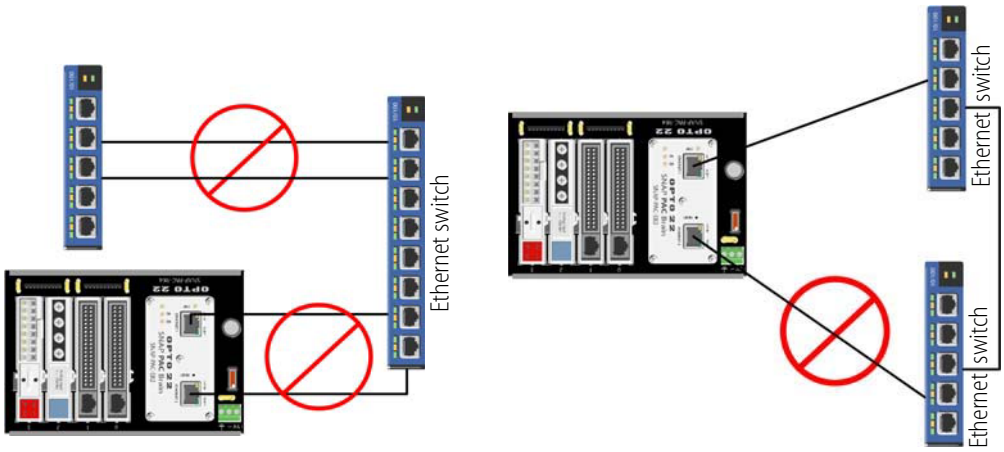
Correct Connections for Daisy-Chaining



Never connect SNAP PAC brains in a loop or ring. For example, do not connect both ends of the chain to the same switch, nor to different switches on the same network. As a rule, do not connect the second Ethernet interface on the last brain in the chain to any other device.

NOTE: There is one exception to this rule: you can connect the network in a loop if at least one switch in the loop supports STP/RSTP (Spanning Tree Protocol/Rapid Spanning Tree Protocol) and has that feature enabled.

Incorrect Network Connections

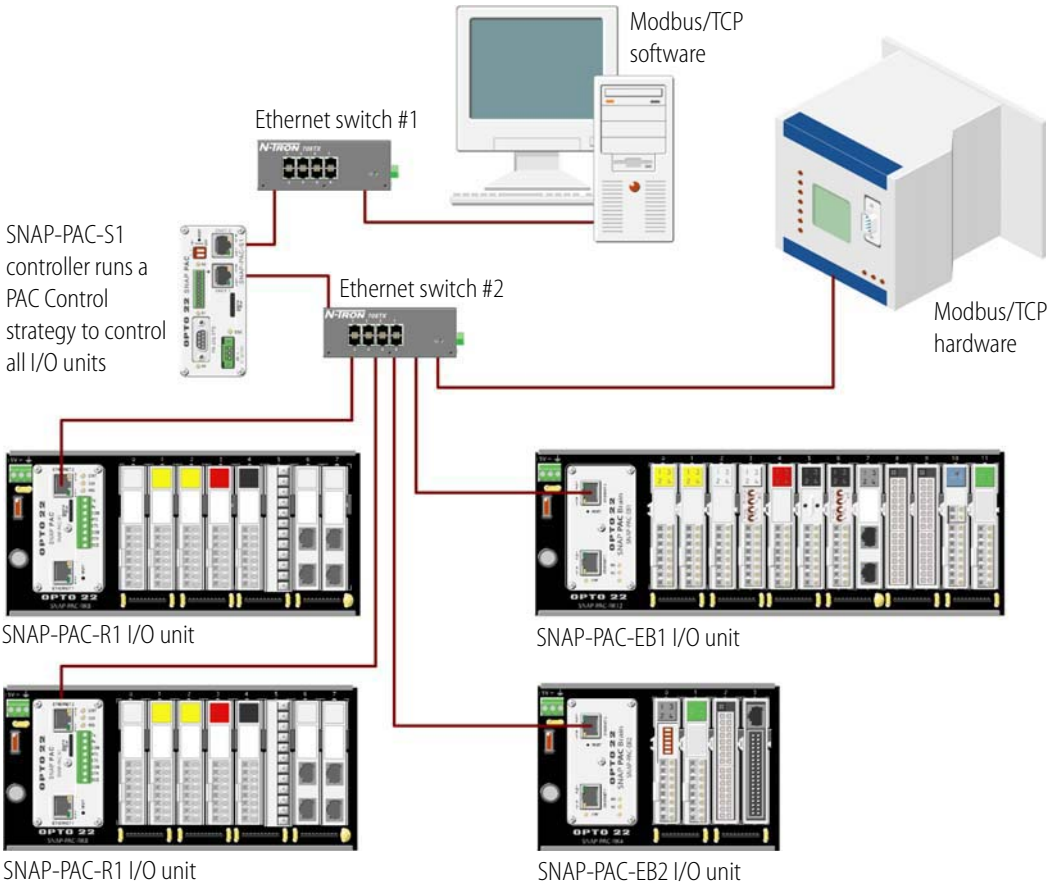


Communicating with Modbus/TCP Systems

All SNAP PAC controllers and brains can communicate natively using Modbus/TCP, a protocol for Modbus hardware and software on an Ethernet network.

The following diagram shows an Opto 22 system communicating with a Modbus system. In this example, the SNAP-PAC-S1 standalone controller runs a PAC Control strategy to monitor and control the I/O. Simultaneously, the Modbus system exchanges data with the Opto 22 system.

This example shows the Opto 22 control network segmented from the computer network: the PC is attached to Ethernet switch #1 and the control network is on Ethernet switch #2. Because the Modbus/TCP hardware is also on switch #2, it can send data to and from every I/O unit shown. The Modbus software running on the PC, attached to switch #1, can access data only from the controller; for instance, it might access data placed in the controller's Scratch Pad by the PAC Control strategy. The Scratch Pad is a large area within the controller's memory that stores binary data, floats, integers, and strings for peer-to-peer data exchange.



This is just one example; many other configurations are possible. If you are not using PAC Control, Modbus/TCP hardware or software on the same network segment as I/O units can provide full control for I/O points.

For details about communicating with Modbus/TCP systems, see Opto 22 form #1678, the *Modbus/TCP Protocol Guide*.

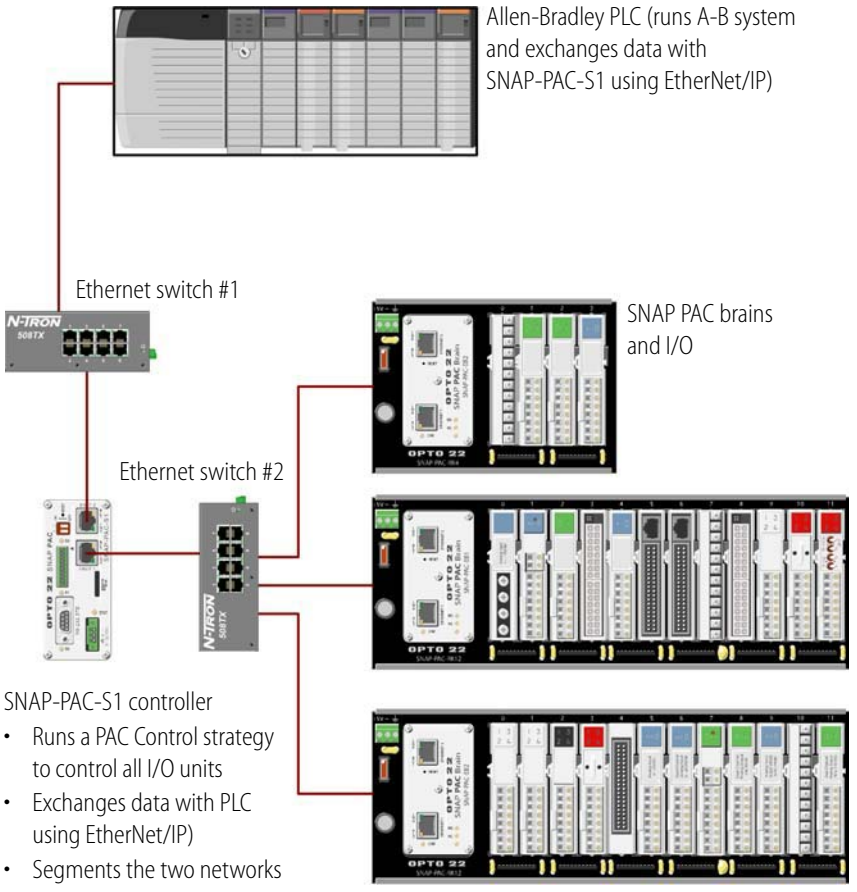
Communicating with Allen-Bradley Logix Systems

SNAP PAC controllers and brains can also communicate natively with Allen-Bradley ControlLogix® and CompactLogix® PLCs and RSLogix software, using their EtherNet/IP® protocol. This means:

- You can extend a PLC system using Opto 22 brains and I/O as intelligent, distributed I/O. In this case the brains provide distributed control, but supervisory control is left up to the PLC. See the white paper, *Expanding Allen-Bradley Systems with Distributed, Intelligent I/O* (form #1785).
- You can exchange data between the SNAP PAC System and an Allen-Bradley Logix system, as shown below. Any SNAP PAC controller running a PAC Control strategy can move variables and values to and from its Scratch Pad, and a Logix system can read from or write to the Scratch Pad using EtherNet/IP. The Scratch Pad is a large area in the controller's memory that stores binary data, floats, integers, and strings for peer-to-peer data exchange.

In this example, the SNAP PAC is segmenting the two networks. Note that the N-TRON switches provide IGMP snooping, which is required for effective network traffic on EtherNet/IP.

Exchanging data between an A-B PLC system and a SNAP PAC System



For detailed information on configuring I/O and communicating with Logix systems, see Opto 22 form #1770, the *EtherNet/IP Protocol Guide*.

Serial Network Options

Although the SNAP PAC System is an Ethernet-based control system, it provides serial network options for connecting to hosts, distributed I/O, and other serial devices.

- You can connect to distributed SNAP PAC Serial Brains and I/O (page 62).
- You can communicate with any RS-232 or RS-485 serial device, such as chart recorders, RFID and barcode readers, printers, and scales (page 62).
- You can exchange data with a Profibus system (page 62).
- You can communicate with a remote host over a modem (see page 63).
- You can connect to legacy Opto 22 serial *mistic* I/O (see page 64).

Using Distributed Serial I/O

If all or a portion of your control system needs to be on a serial link, SNAP PAC **SB** brains provide the distributed serial I/O. Note that SB brains must be used with a SNAP PAC S-series controller, which has RS-485 ports. The SNAP-PAC-S1 and SNAP-PAC-S1-FM each have one RS-485 port; the SNAP-PAC-S2 has four serial ports, any number of which can be software configured for RS-485.

Use either PAC Project Basic or Professional with the S-series controller and SB brains. Configuration and programming are the same as for Ethernet (EB) brains.

Serial communication parameters (baud rate, address, termination) for SB brains are set on the brain's top cover. See "Setting Up Serial Networking" on page 68 for details.

Connecting Directly to Serial Devices

The serial ports on SNAP PAC R-series and S-series controllers can also be used for direct connection to serial devices. For types and number of ports on each controller, see the diagrams starting on page 46.

Typical serial devices you might connect to include printers, scales, chart recorders, and RFID and barcode systems. Using the controller's ports, you can control, monitor, and collect data from these types of devices using the PAC Control strategy (either Basic or Professional).

For locations away from the controller, you can use SNAP serial communication modules on distributed I/O. Serial modules snap on a mounting rack alongside analog and digital modules to provide the serial connections needed at distributed locations. RS-232 modules include RTS/CTS. RS-485 modules offer either 2-wire or 4-wire mode. Each module offers two serial ports (one port if you use an RS-485 in 4-wire mode). Up to eight serial modules can be placed on a single rack.

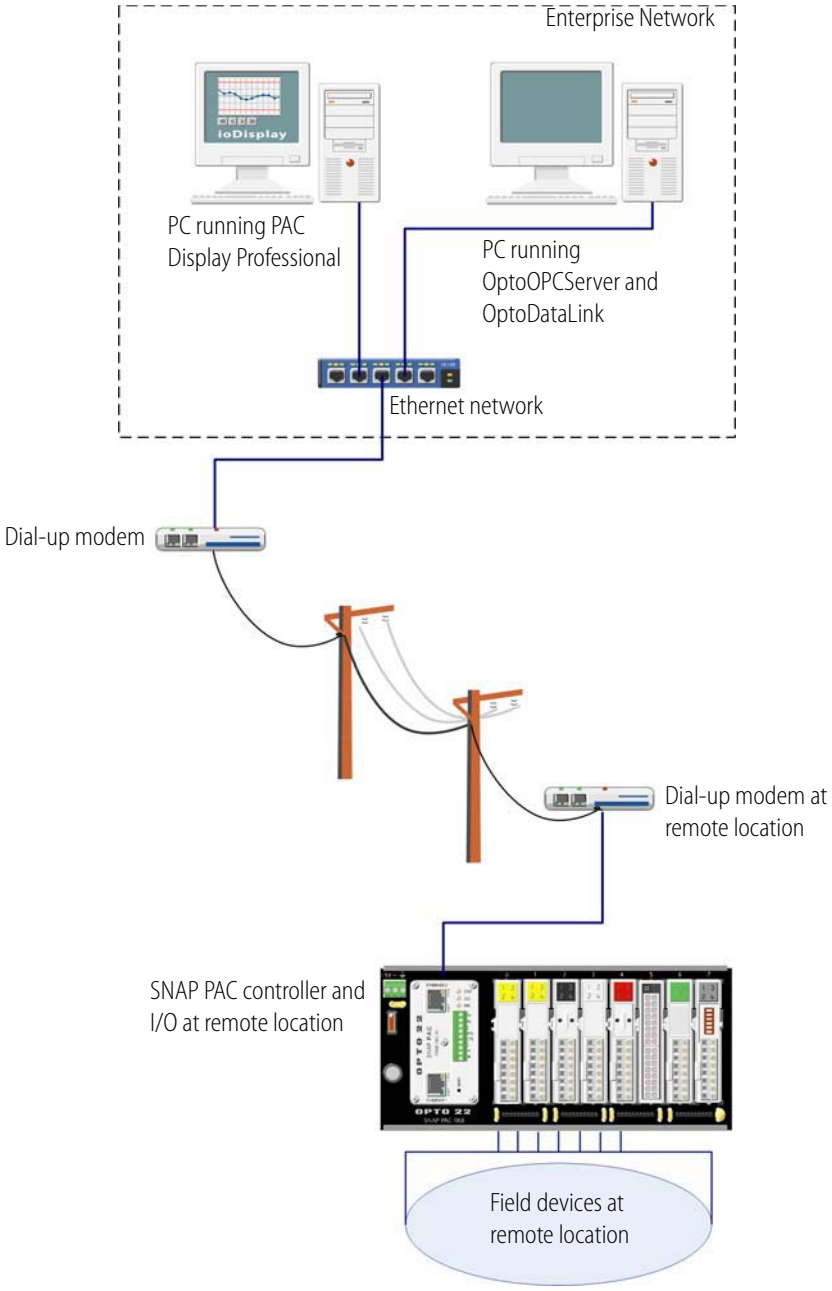
Communicating with Profibus Systems

The SNAP PAC System can communicate with Profibus® systems through a serial-based Profibus module, part number SNAP-SCM-PROFI. The Profibus module plugs into the mounting rack

alongside other modules to provide a standard electrical interface between the SNAP PAC System and PROFIBUS DP® networks.

Communicating with a Remote Host Using a Modem

For remote monitoring and control, you can use an RS-232 serial port on a SNAP PAC R-series or S-series controller to connect to a remote host such as a PC using a dial-up link. Like a remote telemetry unit (RTU), the controller communicates over a modem, as shown on the following page, using the Point-to-Point Protocol (PPP).

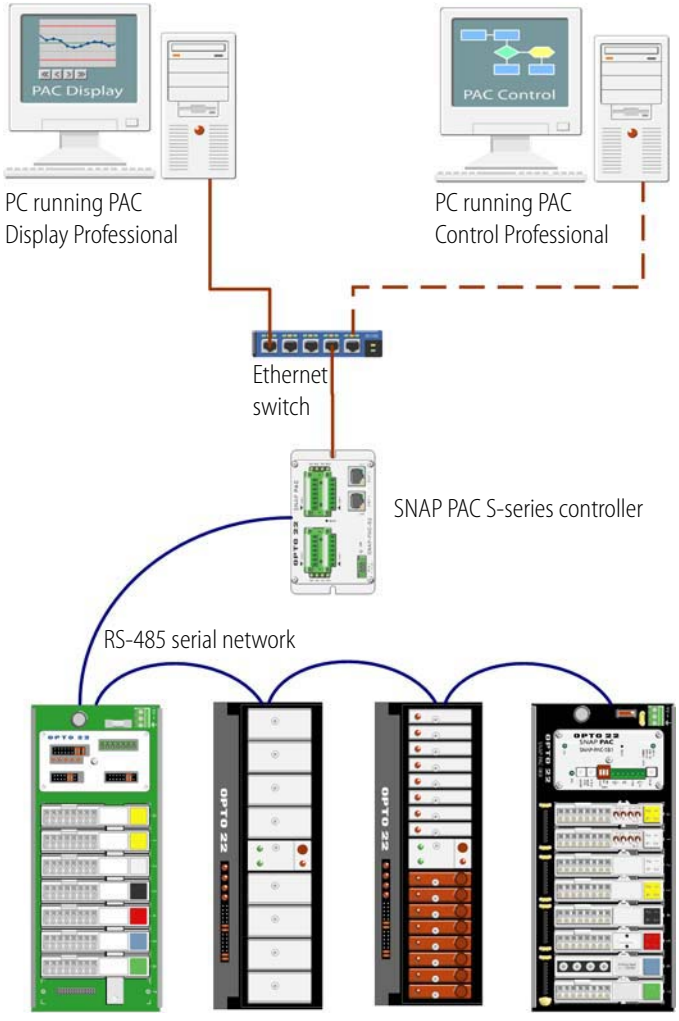


Communicating with Legacy Serial *mistic* I/O Units

Using a SNAP PAC S-series controller and PAC Project Professional, you can incorporate older serial *mistic* systems into the SNAP PAC System, simultaneously communicating with legacy serial I/O units (such as serial B3000 brains and *mistic* bricks), as well as serial and Ethernet SNAP PAC I/O units.

For large numbers of serial I/O, use a SNAP-PAC-S2 controller, which has four serial ports that are all software configurable for RS-485.

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



I/O units are connected via a 2-wire RS-485 serial network. The first three on the serial link are running the *mistic* protocol. The last one is a SNAP PAC SB I/O unit running the OptoMMP protocol.

All I/O units are controlled by the SNAP PAC S-series controller.