Modbus Analog and Digital SNAP Brain

Features

⭷ Controls both analog and digital I/O modules on its rack.

⭷ Works with any Modbus master device.

⭷ Communicates via RS-485 in ASCII and RTU modes.

Description

With the SNAP-B3000-Modbus brain, you can use reliable Opto 22 industrial I/O hardware with your existing Modbus-compatible controller. The SNAP-B3000-Modbus is a high-performance brain designed to remotely control a mix of both analog and digital I/O modules using the SNAP B-series I/O mounting racks. With SNAP B Series racks and any combination of compatible analog and digital SNAP I/O® modules, this brain provides a powerful and sophisticated I/O handling system. The on-board intelligence of the SNAP-B3000-Modbus offers many distributed control functions.

The SNAP-B3000-MODBUS works with any Modbus master device. The SNAP-B3000-Modbus brain communicates to its master
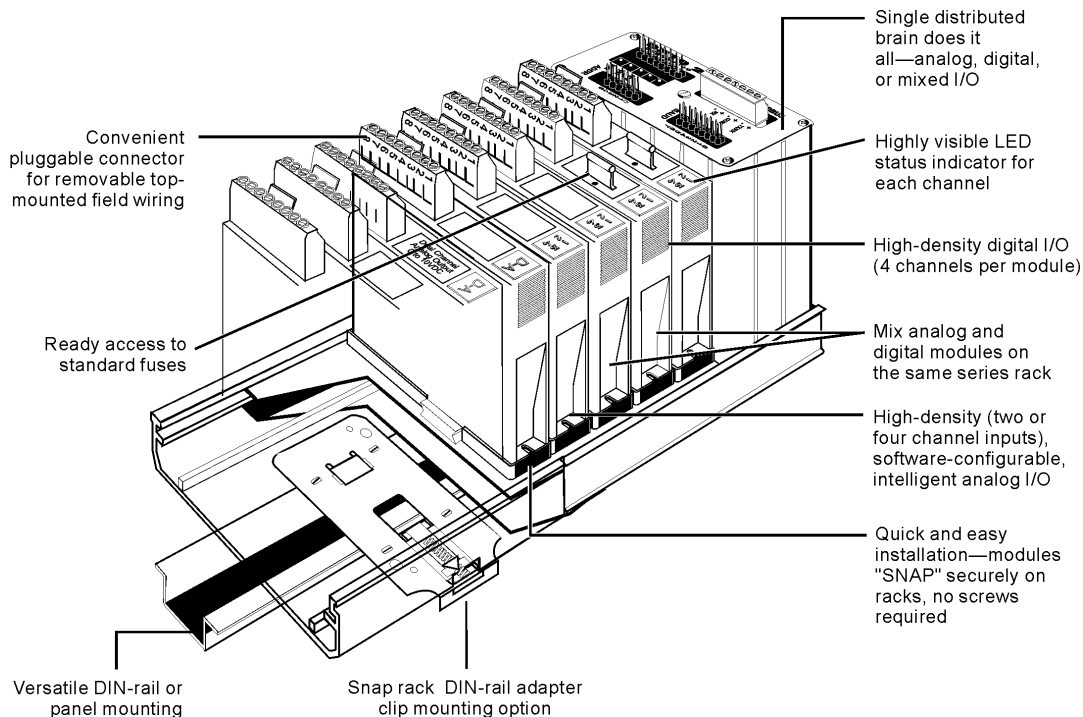
SNAP-B3000-Modbus

controller via RS-485 using the Modbus slave protocol in both ASCII and RTU modes. Serial communication from 300 baud to 115,200 baud is supported.

SNAP-B3000-Modbus functions include the following:

• Digital: Input latching, counting (16-bit), and on/off status

• Analog: Thermocouple linearization (16-bit fixed point for linearized values)

Single distributed brain does it all—analog, digital, or mixed I/O

Highly visible LED status indicator for each channel

High-density digital I/O (4 channels per module)

Mix analog and digital modules on the same series rack

High-density (two or four channel inputs), software-configurable, intelligent analog I/O

Quick and easy installation—modules "SNAP" securely on racks, no screws required

Convenient pluggable connector for removable top-mounted field wiring

Ready access to standard fuses

Versatile DIN-rail or panel mounting

Snap rack DIN-rail adapter clip mounting option

Part Numbers

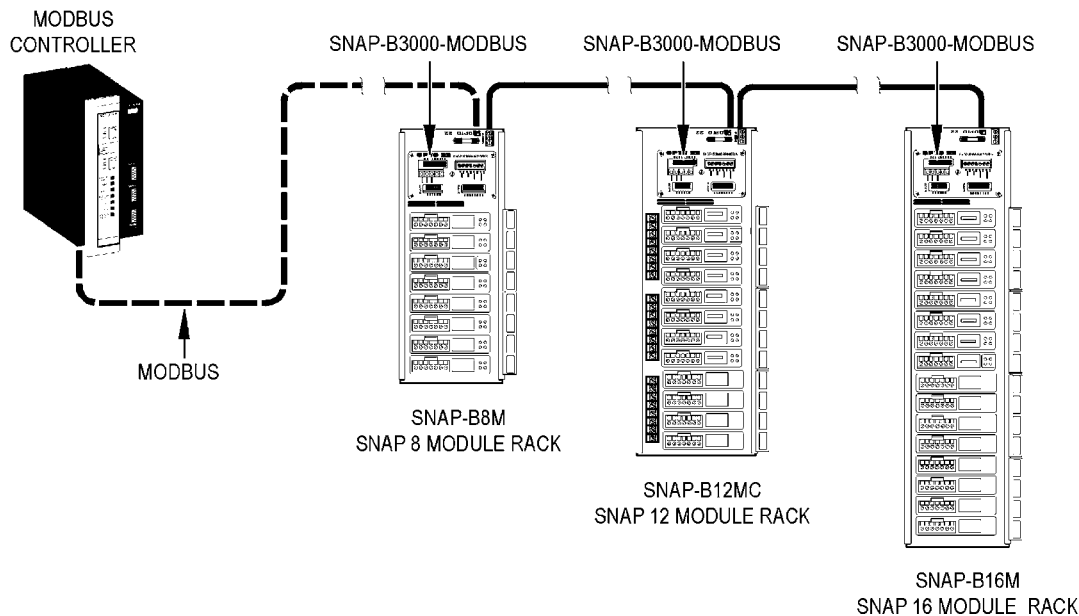| Part	Description
SNAP-B3000-MODBUS	Analog/Digital Modbus Slave Brain

OPTO 22

Modbus Analog and Digital SNAP Brain

Description (continued)

SNAP-B3000-Modbus System Architecture

The SNAP-B3000-Modbus is connected to a SNAP B-series I/O rack, which can hold either 8, 12, or 16 SNAP modules.

NOTE: Only one data link is required.

MODBUS CONTROLLER

SNAP-B3000-MODBUS   SNAP-B3000-MODBUS   SNAP-B3000-MODBUS

MODBUS

SNAP-B8M
SNAP 8 MODULE RACK

SNAP-B12MC
SNAP 12 MODULE RACK

SNAP-B16M
SNAP 16 MODULE RACK

Specifications

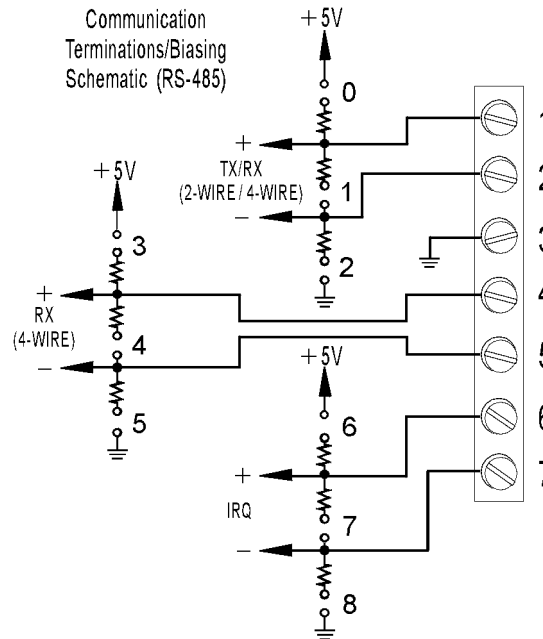|	
Power Requirements	5.0–5.2 VDC at 1.0A max.
Operating Temperature	0 to 70 °C, 95% humidity, non-condensing
Storage Temperature	-40 to 85 °C
CPU	16-bit Intel 80C196 I/O processor
Communications Interface	RS-485/422, 2- or 4-wire, twisted pair(s), with shield
Data Rates	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, and 115200 baud
Range: (Multidrop Mode)	Up to 3,000 feet total length or 32 stations maximum without repeaters
Counter\Frequency Measurement	Maximum Rate: 20 kHz Minimum Pulse Width: 10 msec 16 bit
LED Indicators	RUN (Power On), RCV (Receive), and XMT (Transmit)
Options: Jumper Selectable	Address, Communication baud rate, RTU/ASCII

Modbus Analog and Digital SNAP Brain

Communication Jumpers/Wiring

Top View: SNAP-B3000-Modbus
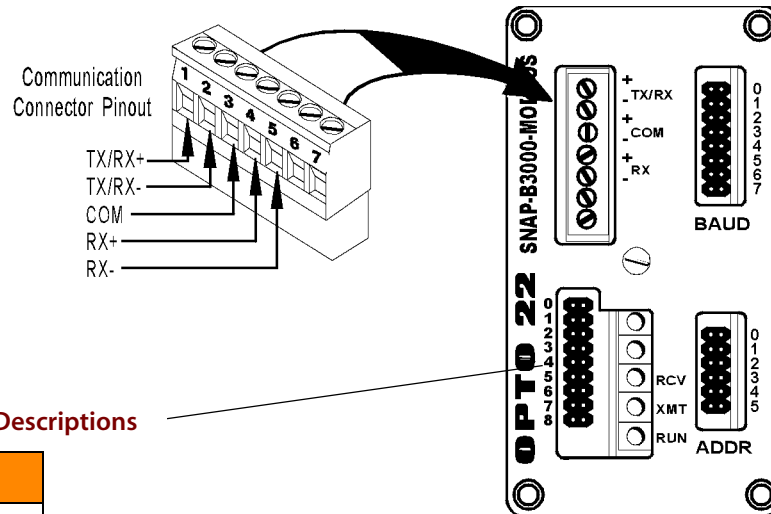
Communication Jumper Descriptions

Jumper	Description
0	Pull-up for TX/RX+
1	Terminator for TX/RX
2	Pull-down for TX/RX-
3	Pull-up for RX
4	Terminator for RX line
5	Pull-down for RX line
6	Pull-up for IRQ+
7	Terminator for IRQ
8	Pull-down for IRQ-

Communication Terminations/Biasing Schematic (RS-485)

DATA SHEET
Form 1051-100304

PAGE
3

Specifications

Communication Jumpers/Wiring (Continued)

STANDARD 2-WIRE CONFIGURATION

NOTE: IN THIS EXAMPLE THE CABLE SHIELD IS <u>NOT</u> ELECTRICALLY CONNECTED TO THE RS-485 COM (COMMON) TERMINALS.
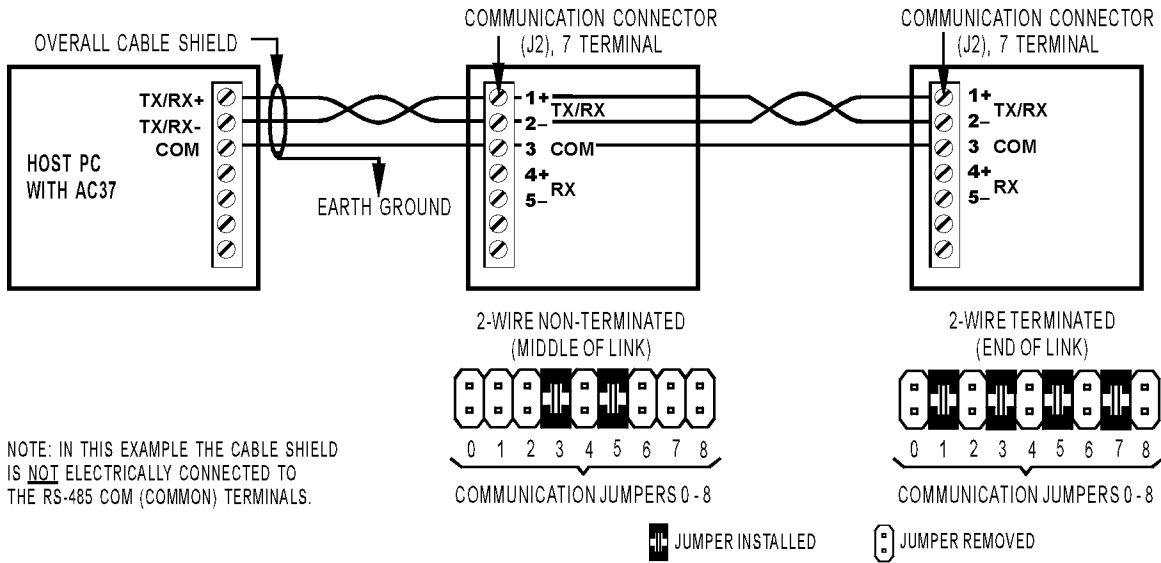
ALTERNATE 2-WIRE CONFIGURATION
(ACCEPTABLE FOR MOST CONDITIONS)

NOTE: IN THIS EXAMPLE THE CABLE SHIELD IS CONNECTED TO THE RS-485 COM (COMMON) TERMINALS, BUT THE SHIELD IS <u>NOT</u> EARTH GROUNDED.
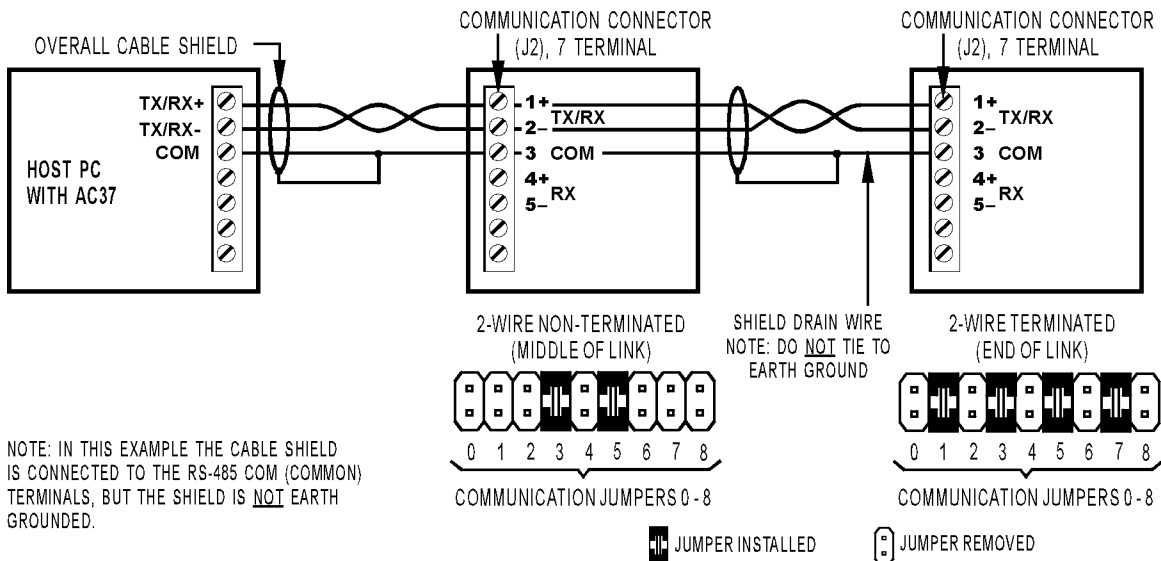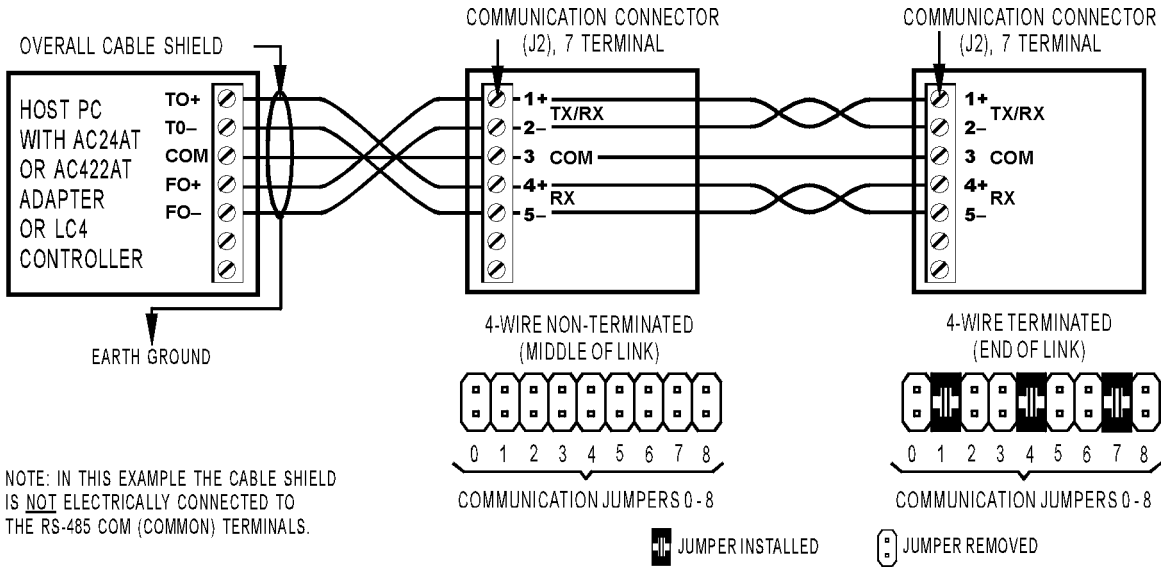
Modbus Analog and Digital SNAP Brain

Specifications

Communication Jumpers/Wiring (Continued)

STANDARD 4-WIRE CONFIGURATION

NOTE: IN THIS EXAMPLE THE CABLE SHIELD IS <u>NOT</u> ELECTRICALLY CONNECTED TO THE RS-485 COM (COMMON) TERMINALS.

ALTERNATE 4-WIRE CONFIGURATION
(ACCEPTABLE FOR MOST CONDITIONS)

NOTE: IN THIS EXAMPLE THE CABLE SHIELD IS CONNECTED TO THE RS-485 COM (COMMON) TERMINALS, BUT THE SHIELD IS <u>NOT</u> EARTH GROUNDED.
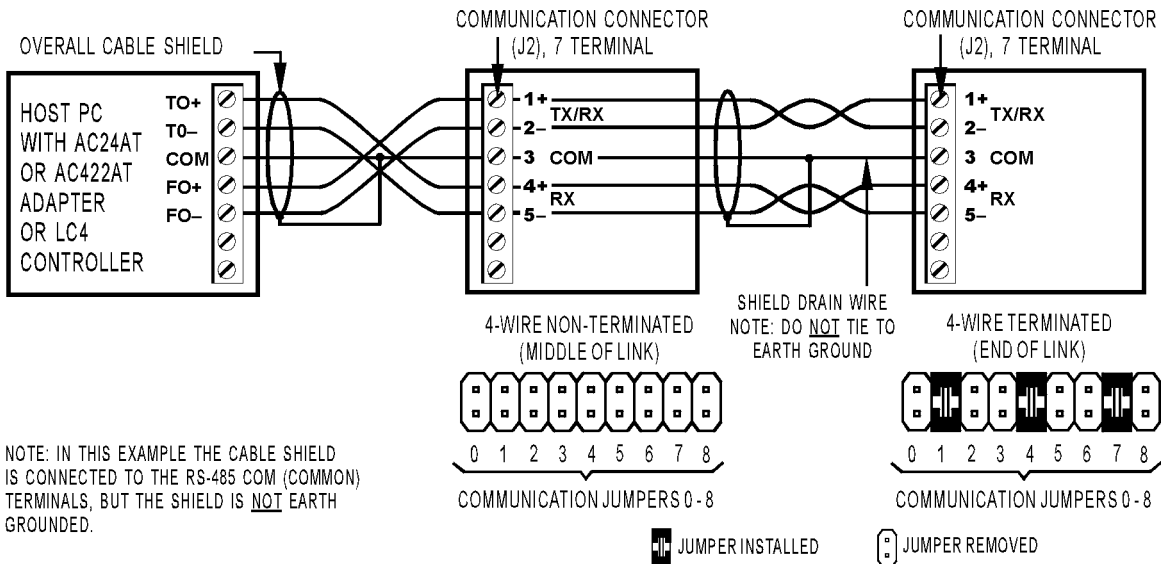
Modbus Analog and Digital SNAP Brain

Specifications

Baud/Address Jumpers, LED Descriptions

SNAP-B3000-Modbus Brain

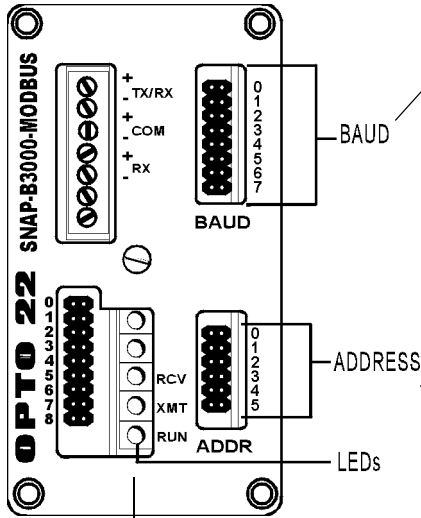SNAP-B3000-MODBUS

OPTO 22

+ TX/RX
+ COM
+ RX

BAUD — BAUD

RCV
XMT
RUN — ADDRESS

ADDR — LEDs

Table 1: Baud Rate Jumpers

JUMPER POSITION
3 2 1 0

BAUD RATE	
115.2 KBaud	
76.8 KBaud	
57.6 KBaud	
38.4 KBaud	
19.2 KBaud	
9600 Baud (factory default setting)	
4800 Baud	
2400 Baud	
1200 Baud	
600 Baud	
300 Baud	

PORT MODES — JUMPER POSITION 4 5 6

ASCII Even Parity	(Default)
ASCII Odd Parity	
RTU Even Parity	
RTU Odd Parity	
RTU No Parity	

Notes: Combinations not shown above are invalid and default to even parity. Baud 7 jumper unused.

■ = JUMPER INSTALLED

ASCII Port Modes:
7 data bits, 1 stop bit, even parity
7 data bits, 1 stop bit, odd parity

RTU Port Modes:
8 data bits, 1 stop bit, even parity
8 data bits, 1 stop bit, odd parity
8 data bits, 1 stop bit, no parity

Table 3. LED Descriptions

LED	Description
RCV	Processor is currently receiving data on communication line.
XMT	Processor is currently transmitting data on communication line.
RUN	Power on processor (at least 4.75 VDC)

Table 2: Address Table

(Address jumper settings 1 through 63, positions 5 4 3 2 1 0)

■ = JUMPER INSTALLED   □ = NO JUMPER

Modbus Analog and Digital SNAP Brain

Modbus Commands

All SNAP digital and analog I/O modules are supported using the Modbus commands listed in the table below.

Modbus Command (Hex)	Definition	Opto 22 Equivalent
01	Read coil status	Read digital output
02	Read input status	Read digital input
03	Read holding registers	Read analog output
04	Read input registers	Read analog input
05	Force single coil	Turn on/off one digital output
06	Preset single register	Write to one analog output
0F	Force multiple coils	Turn on/off multiple digital outputs
10	Preset multiple registers	Write to multiple anlaog outputs

Command 0x11, Report slave ID, returns the following data bytes:
- Byte 1 = Slave ID, in the format 0x22 (for Opto 22 board).
- Byte 2 = RUN indicator; always in the format 0xff. (Since it is a slave, it is always running.)
- Byte 3 = Configured flag, indicating whether the host has written to the configuration area of the controller. If this value is 0, all the analog points are at the default configuration and all digital points are considered inputs. You can look at this value to determine whether the controller has been through a power cycle.
- Bytes 4–8 = Five-character string indicating the version number, for example 3R3.1a.

Exception Errors

The following table shows exception errors that may be returned.

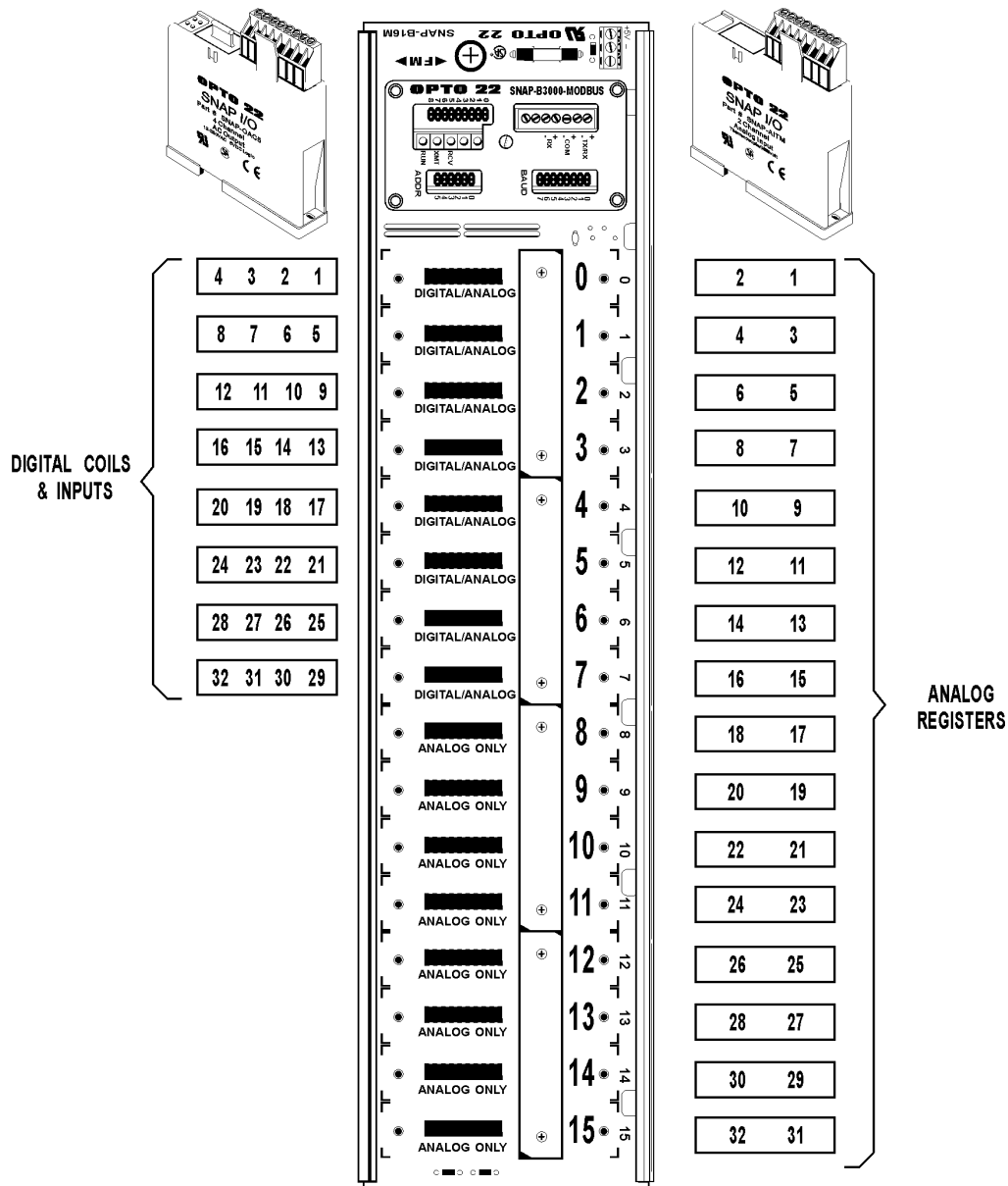| Error	Name	Description
1	ILLEGAL_FUNCTION	The function code is not implemented in this device.
2	ILLEGAL_DATA_ADDRESS	The coil, input, or register specified is not valid for this device.
3	ILLEGAL_DATA_VALUE	The data value specified is out of range for the specified function code.
4	SLAVE_DEVICE_FAILURE	Failure erasing/writing flash memory. (This error is returned after three tries to erase or write.)
6	SLAVE_DEVICE_BUSY	Trying to rewrite to flash memory in less than 10 seconds. (See Holding Register 65. You should store to flash only when the system configuration changes. Make sure you don't put store/clear configuration in a loop, or you'll wear out your flash memory.)

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SALES 800-321-6786 • 951-695-3000 • FAX 951-695-3095 • sales@opto22.com • SUPPORT 800-835-6786 • 951-695-3080 • FAX 951-695-3017 • support@opto22.com

SNAP-B3000-Modbus I/O Mapping

The largest SNAP B Series I/O rack can contain a maximum of 16 modules. As shown below, the first eight modules can be either digital or analog. The last eight modules can be analog only. Because of the rack's flexibility in handling both digital and analog inputs and outputs in many of the same module positions, you can choose where to install modules and how to use the points.

Since each digital module contains four points, up to 32 digital I/O points can be installed in the first eight module positions.

Analog input modules contain two points, but analog output modules can have either one or two points, depending on the module. Using all module positions, up to 32 analog I/O points can be installed in the rack.

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SALES 800-321-6786 • 951-695-3000 • FAX 951-695-3095 • sales@opto22.com • **SUPPORT** 800-835-6786 • 951-695-3080 • FAX 951-695-3017 • support@opto22.com
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SNAP-B3000-Modbus I/O Mapping (Continued)

The table below shows the possible uses for all points on the relay rack. Coils and Inputs are bit masks and contain 0 or 1 only. Since digital counters and module configuration require more than one bit, they are handled in Input and Holding Registers, which are 16-bit registers.

Note that you address the same point using different sets of 32 numbers for different purposes.

For example, suppose you have a digital module in position 0 with four points of I/O.

- Coil 4 gives the status of the output at point 4.

- Coil 36 clears an on-latch for the output at point 4.

- Coil 68 clears an off-latch for the output at point 4.

Or suppose you have a digital input module in position 1 with four points of I/O.

- Input 6 gives the status of the input at point 6.

- Coil 134 activates the counter for the input at point 6.

- Input Register 38 returns the value of the counter for the input at point 6.

- Coil 102 clears the counter for the input at point 6.

Mapping Information

Coils (0x)		
1–32	Digital outputs	1 bits = on; 0 bits = off
33–64	Clear on-latch	1 bits clear on-latches
65–96	Clear off-latch	1 bits clear off-latches
97–128	Counter clear	1 bits clear counters
129–160	Counter state	1 bits activate counters
Inputs (1x)		
1–32	Digital inputs	1 bits = on; 0 bits = off
33–64	State of on-latches	1 bits = on; 0 bits = off
65–96	State of off-latches	1 bits = on; 0 bits = off
Input Registers (3x)		
1–32	Analog inputs	Input values only (Outputs will return 0.)
33–64	Digital counters	If counters are enabled, digital counter values are returned here.
Holding Registers (4x)		
1–32	Analog outputs	(Reading inputs here will return 0.)
33–48	Module configuration	16 module positions (See "SNAP-B3000-Modbus I/O Configuration" on page 10.)
65	Store/clear configuration	1 stores configuration values in flash memory; 0 clears flash.

Latch bits are cleared automatically when the I/O unit clears the physical latch.

You must enable or disable digital counters here. Digital counter values are returned under Input Registers.

If you are using dual-channel analog outputs, you can read or write all registers to get all the data. But if you are using single-channel analog outputs, you must skip the odd-numbered registers and read or write to even-numbered registers only.

Use Holding Register 65 to copy the current configuration to flash memory. When a power cycle occurs on the relay rack, modules will be reconfigured with the values from the flash memory. Store the configuration in flash only when it changes. Make sure you don't put store/clear in a loop, or you'll wear out flash memory.
NOTE: For brain firmware earlier than R 1.19 (dated 6-8-01), you must use the Preset Single Register Modbus command (06), not the Preset Multiple Registers Modbus command (10 hex), to copy to flash. For later firmware, use either command.

SNAP-B3000-Modbus I/O Configuration

Tables of Configuration Types, Values, Scaling

These tables show the values for Holding Registers 33–48 in the Mapping Information table on the previous page. Part numbers are shown for analog inputs and outputs. Both points on a module must be configured the same. All temperatures are in degrees C.

Analog points also show the scaling used for the I/O type and the default for this type. Scaling allows a floating point to be returned as an integer. To find the actual value, divide by the scaling number. For example, if a value of 4,128 is returned for a single-channel 4–20mA analog output, divide 4,128 by 1,000 to obtain the actual value, which is 4.128.

Digital Points	Decimal Value	Hex Value
Input	256	100
Output	384	180

Analog Points - Output Points				
Module	Decimal Value	Hex Value	Scaling	Default
SNAP-AOA-3				
Raw counts	128	80	1	
Single-channel 4 to 20 mA	131	83	1000	x
SNAP-AOA-23				
Raw counts	128	80	1	
Dual-channel 4 to 20 mA	163	A3	1000	x
SNAP-AOV-5				
Raw counts	128	80	1	
Single-channel 0 to 10 VDC	133	85	1000	x
SNAP-AOV-25				
Raw counts	128	80	1	
Dual-channel 0 to 10 VDC	165	A5	1000	x
SNAP-AOV-7				
Raw counts	128	80	1	
Single-channel -10 to +10 VDC	135	87	1000	x
SNAP-AOV-27				
Raw counts	128	80	1	
Dual-channel -10 to +10 VDC	167	A7	1000	x
SNAP-AOA-28				
Raw counts	128	80	1	
Dual-channel 0 to 20 mA	168	A8	1000	x

Analog Points - Input Points				
Module	Decimal Value	Hex Value	Scaling	Default
SNAP-AICTD				
Raw counts	0	0	1	
Temperature input - ICTD	4	4	100	x
SNAP-AITM and SNAP-AITM-i				
Raw counts	0	0	1	
Type J Thermocouple	5	5	10	x
Type K Thermocouple	8	8	10	
Type E Thermocouple	19	13	10	
-75 to +75 mV	68	44	100	
-150 to +150 mV	66	42	100	x
SNAP-AITM-2 and SNAP-AITM-2i				
Raw counts	0	0	1	
-25 to +25 mV	67	43	1000	
-50 to +50 mV	9	9	100	x
Type B Thermocouple	24	18	10	
Type C Thermocouple	32	20	10	
Type D Thermocouple	33	21	10	
Type G Thermocouple	31	1F	10	
Type N Thermocouple	30	1E	10	
Type R Thermocouple	17	11	10	
Type S Thermocouple	23	17	10	
Type T Thermocouple	18	12	10	
SNAP-AIRTD				
Raw counts	0	0	1	
100 ohms platinum RTD	10	A	10	x
SNAP-AIV and SNAP-AIV-i				
Raw counts	0	0	1	
-5 to +5 VDC	11	B	1000	
-10 to +10 VDC	12	C	1000	x
SNAP-AIMA, SNAP-AIMA-i, SNAP-AIMA-iSRC				
Raw counts	0	0	1	
-20 to +20 mA	64	40	1000	x

SNAP-B3000-Modbus I/O Configuration (Continued)

Tables of Configuration Types, Values, and Scaling (Continued)

Analog Points - Two-channel Input Points				
Module	Decimal Value	Hex Value	Scaling	Default
SNAP-AIMA2-i				
Raw counts	0	0	1	
−1 to +1 mA	85	55	1000	x
SNAP-AIRATE				
Raw counts	0	0	1	
0 to 25,000 kHz	69	45	1	x

Analog Points - Two-channel Input Points				
Module	Decimal Value	Hex Value	Scaling	Default
SNAP-AIVRMS				
Raw counts	0	0	1	
0 to 250 V RMS	70	46	100	x
SNAP-AIARMS				
Raw counts	0	0	1	
0 to 10 A RMS	71	47	1000	x

Steps for Using SNAP-B3000-MODBUS

1. Configure the modules by writing the appropriate module configuration codes to Holding Registers 33 through 48 (decimal).

Both points on a module must be configured the same. The following table shows a sample system:

	Module Position (See page 8)	Module Part Numbers (See page 10)	Holding Registers (See page 9)	Holding Register Data (See page 10)	Module Data	Signal Type
Digital or Analog Modules	0	Digital Input	33	256		
	1	Digital Output	34	384		
	2	SNAP-AOA-23	35	128	Raw Counts	4 to 20 mA
	3	SNAP-AOA-23	36	131	(1000) x (mA signal)	4 to 20 mA
	4	SNAP-AICTD	37	4	(100) x (Degrees C)	ICTD Sensor
	5	Digital Output	38	384		
	6	Digital Output	39	384		
	7	Digital Input	40	256		
Analog Modules only	8	SNAP-AOV-27	41	128	Raw counts	-10 to +10 VDC
	9	SNAP-AOV-27	42	167	(1000) x (voltage signal)	-10 to +10 VDC
	10	SNAP-AITM	43	5	(10) x (Degrees C)	Type J Thermocouple
	11	SNAP-AITM	44	8	(10) x (Degrees C)	Type K Thermocouple
	12	SNAP-AITM	45	19	(10) x (Degrees C)	Type E Thermocouple
	13	SNAP-AITM	46	68	(1000) x (mV signal)	-75 to +75 mV
	14	SNAP-AITM	47	66	(1000) x (mV signal)	-150 to +150 mV
	15	SNAP-AIV	48	11	(1000) x (V signal)	-5 TO +5 VDC

2. Store the module configuration to flash by writing the value 1 to Holding Register 65 (decimal).

3. Cycle power to the brain so that it will boot up with the values stored to flash.

4. Read the module configuration values from Holding Registers 33 through 48 (decimal) to confirm that the values were stored to flash.
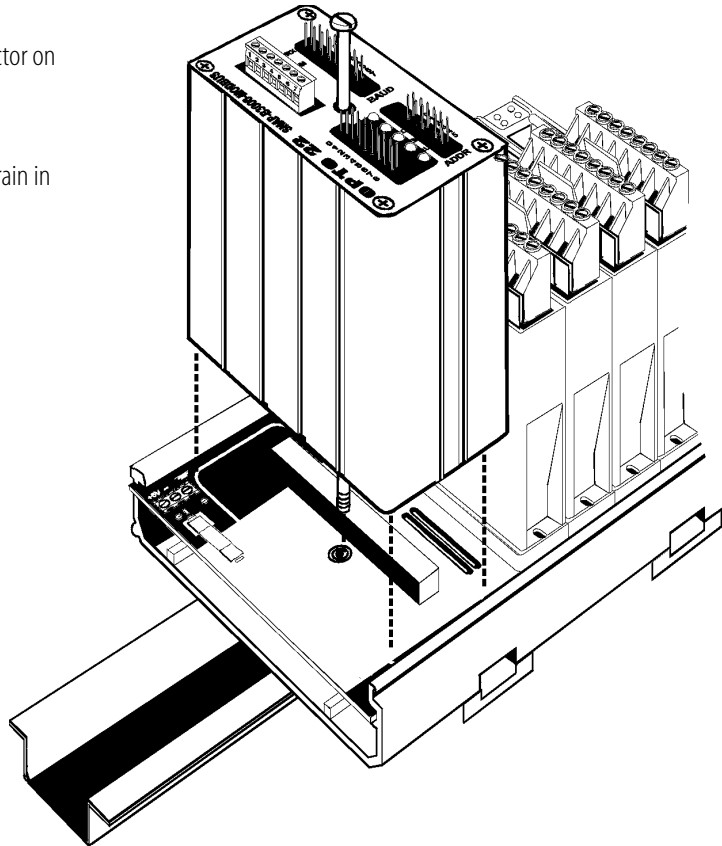
Brain Assembly

To install the brain onto a B Series rack:

1. Turn off power to the rack assembly.
2. Align the brain connector with the mating connector on the mounting rack.
3. Seat the brain onto the connector.
4. Use the integral hold-down screw to secure the brain in position.
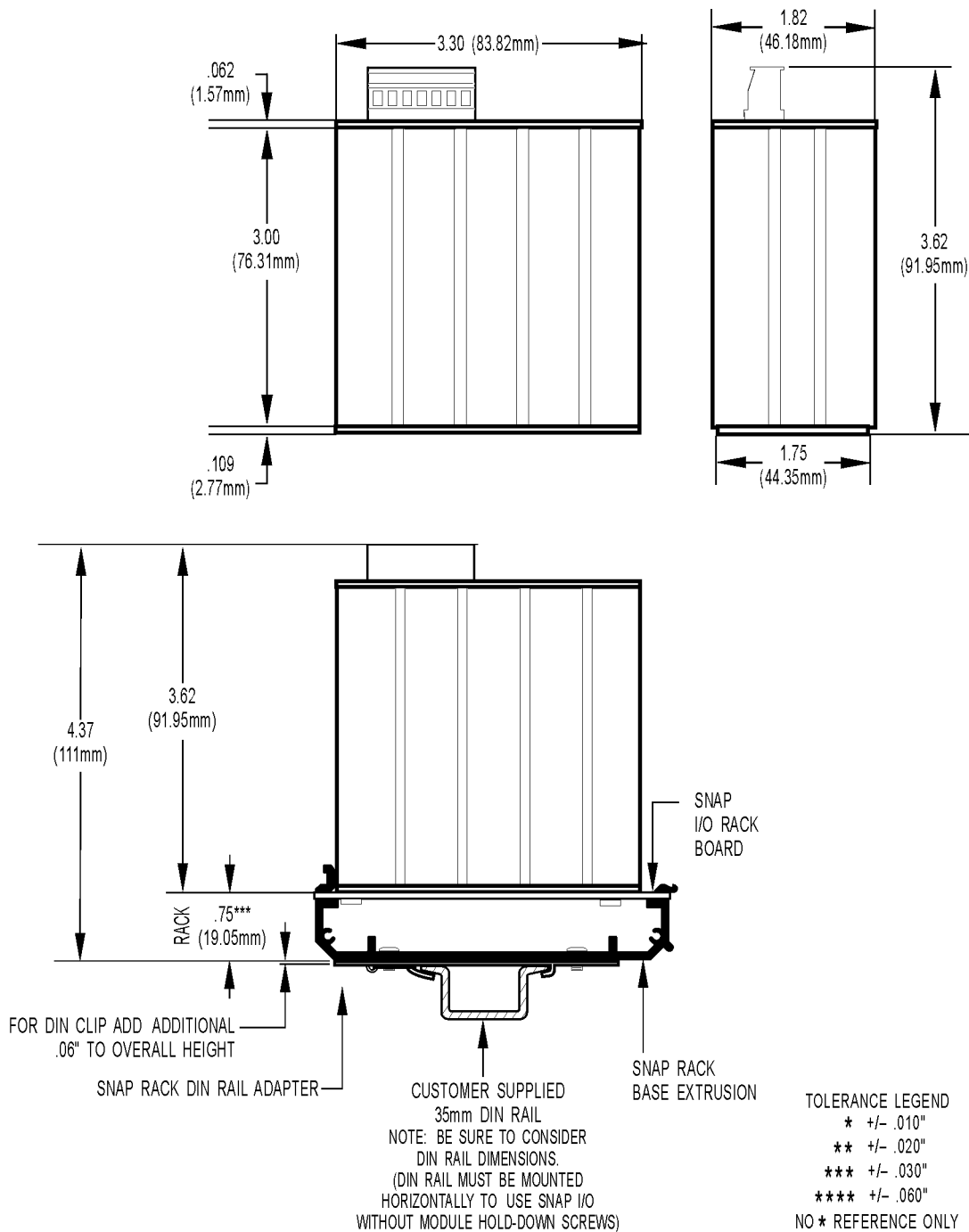5. DO NOT OVERTIGHTEN!

To remove the brain from a B Series rack:

1. Turn off power to the rack assembly.
2. Loosen the brain's integral hold-down screw.
3. Pull up on the brain to remove it.

Modbus Analog and Digital SNAP Brain

Dimensions—SNAP-B3000-Modbus Brain

3.30 (83.82mm)

.062 (1.57mm)

3.00 (76.31mm)

.109 (2.77mm)

1.82 (46.18mm)

3.62 (91.95mm)

1.75 (44.35mm)

4.37 (111mm)

3.62 (91.95mm)

RACK .75*** (19.05mm)

SNAP I/O RACK BOARD

FOR DIN CLIP ADD ADDITIONAL .06" TO OVERALL HEIGHT

SNAP RACK DIN RAIL ADAPTER

CUSTOMER SUPPLIED 35mm DIN RAIL
NOTE: BE SURE TO CONSIDER DIN RAIL DIMENSIONS.
(DIN RAIL MUST BE MOUNTED HORIZONTALLY TO USE SNAP I/O WITHOUT MODULE HOLD-DOWN SCREWS)

SNAP RACK BASE EXTRUSION

TOLERANCE LEGEND
* +/– .010"
** +/– .020"
*** +/– .030"
**** +/– .060"
NO * REFERENCE ONLY

More About Opto 22

Products

Opto 22 develops and manufactures reliable, flexible, easy-to-use hardware and software products for industrial automation, remote monitoring, and data acquisition applications.

SNAP PAC System

Designed to simplify the typically complex process of understanding, selecting, buying, and applying an automation system, the SNAP PAC System consists of four integrated components:

- SNAP PAC controllers
- PAC Project™ Software Suite
- SNAP PAC brains
- SNAP I/O™

SNAP PAC Controllers

Programmable automation controllers (PACs) are multifunctional, multidomain, modular controllers based on open standards and providing an integrated development environment.

Opto 22 has been manufacturing PACs for many years. The latest models include the standalone SNAP PAC S-series and the rack-mounted SNAP PAC R-series. Both handle a wide range of digital, analog, and serial functions and are equally suited to data collection, remote monitoring, process control, and discrete and hybrid manufacturing.

SNAP PACs are based on open Ethernet and Internet Protocol (IP) standards, so you can build or extend a system without the expense and limitations of proprietary networks and protocols.

PAC Project Software Suite

Opto 22's PAC Project Software Suite provides full-featured and cost-effective control programming, HMI (human machine interface) development and runtime, OPC server, and database connectivity software to power your SNAP PAC System.

These fully integrated software applications share a single tagname database, so the data points you configure in PAC Control™ are immediately available for use in PAC Display™, OptoOPCServer™, and OptoDataLink™. Commands are in plain English; variables and I/O point names are fully descriptive.

PAC Project Basic offers control and HMI tools and is free for download on our website, www.opto22.com. PAC Project Professional, available for separate purchase, adds OptoOPCServer, OptoDataLink, options for Ethernet link redundancy or segmented networking, and support for legacy Opto 22 serial *mistic*™ I/O units.

SNAP PAC Brains

While SNAP PAC controllers provide central control and data distribution, SNAP PAC brains provide distributed intelligence for I/O processing and communications. Brains offer analog, digital, and serial functions, including thermocouple linearization; PID loop control; and optional high-speed digital counting (up to 20 kHz), quadrature counting, TPO, and pulse generation and measurement.

SNAP I/O

I/O provides the local connection to sensors and equipment. Opto 22 SNAP I/O offers 1 to 32 points of reliable I/O per module, depending on the type of module and your needs. Analog, digital, serial, and special-purpose modules are all mixed on the same mounting rack and controlled by the same processor (SNAP PAC brain or rack-mounted controller).

Quality

Founded in 1974 and with over 85 million devices sold, Opto 22 has established a worldwide reputation for high-quality products. All are made in the U.S.A. at our manufacturing facility in Temecula, California. Because we do no statistical testing and each part is tested twice before leaving our factory, we can guarantee most solid-state relays and optically isolated I/O modules for life.

Free Product Support

Opto 22's Product Support Group offers free, comprehensive technical support for Opto 22 products. Our staff of support engineers represents decades of training and experience. Product support is available in English and Spanish, by phone or email, Monday through Friday, 7 a.m. to 5 p.m. PST.

Free Customer Training

Hands-on training classes for the SNAP PAC System are offered at our headquarters in Temecula, California. Each student has his or her own learning station; classes are limited to nine students. Registration for the free training class is on a first-come, first-served basis. See our website, www.opto22.com, for more information or email training@opto22.com.

Purchasing Opto 22 Products

Opto 22 products are sold directly and through a worldwide network of distributors, partners, and system integrators. For more information, contact Opto 22 headquarters at 800-321-6786 or 951-695-3000, or visit our website at www.opto22.com.

www.opto22.com