

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

NOTE: This product is obsolete and no longer available due to the unavailability of essential parts as of 8/16/22. Contact Opto 22 Product Support for current options.

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

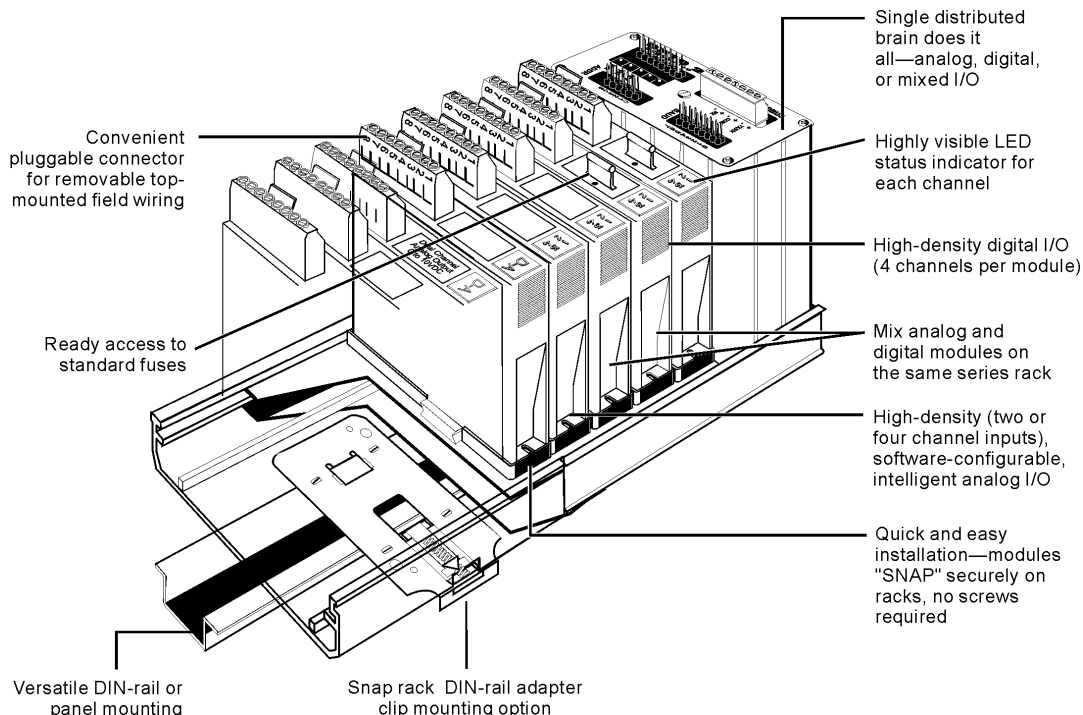
and RTU modes. Serial communication from 300 baud to 115,200 baud is supported.

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)



SNAP-B3000-Modbus



Part Numbers

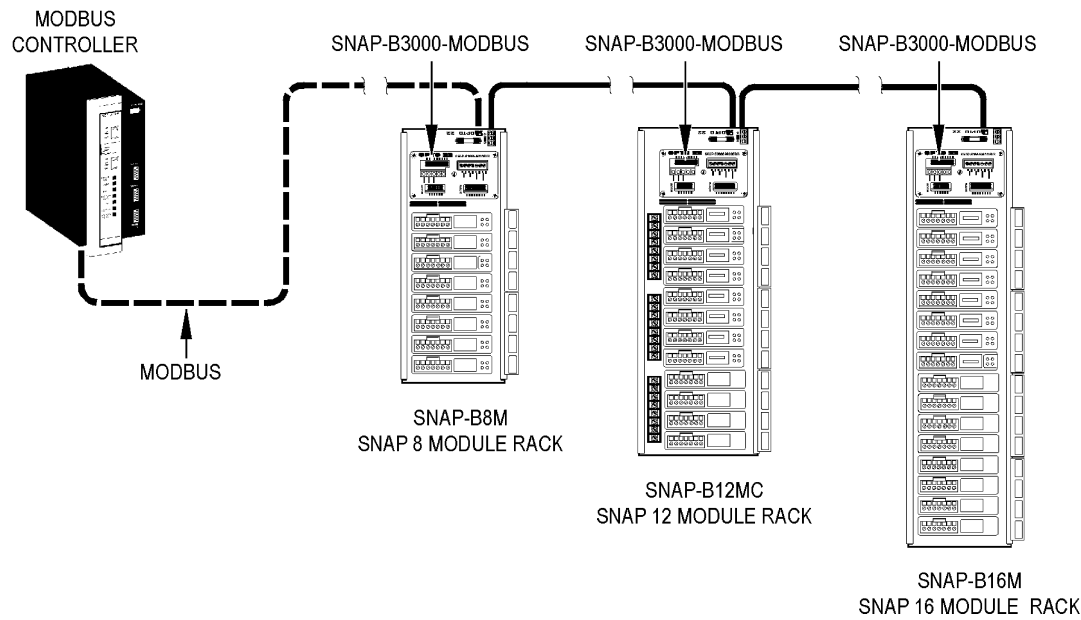
Part	Description
SNAP-B3000-MODBUS (OBSOLETE - 8/16/2022)	Analog/Digital Modbus Slave Brain

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.

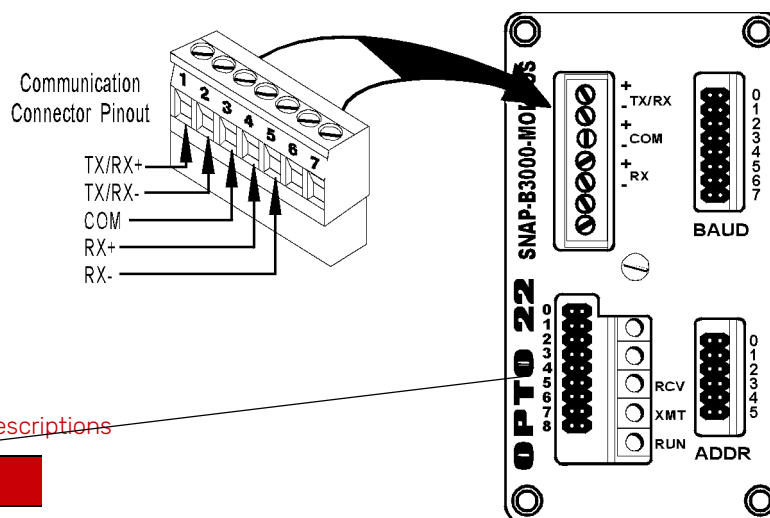


SPECIFICATIONS

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

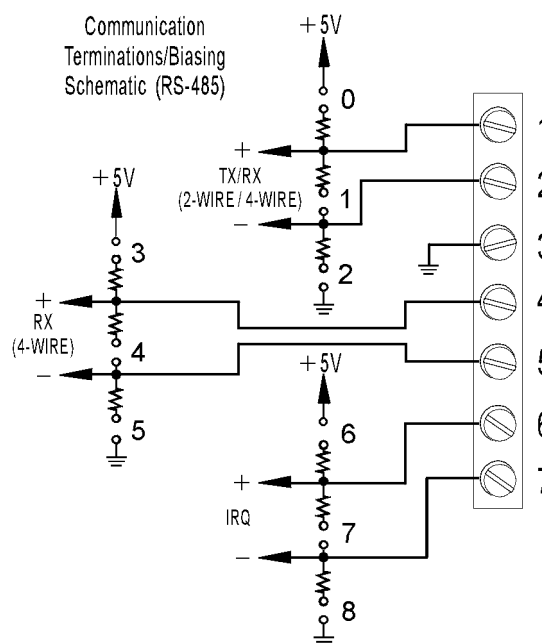
Communication Jumpers/Wiring

Top View: SNAP-B3000-Modbus



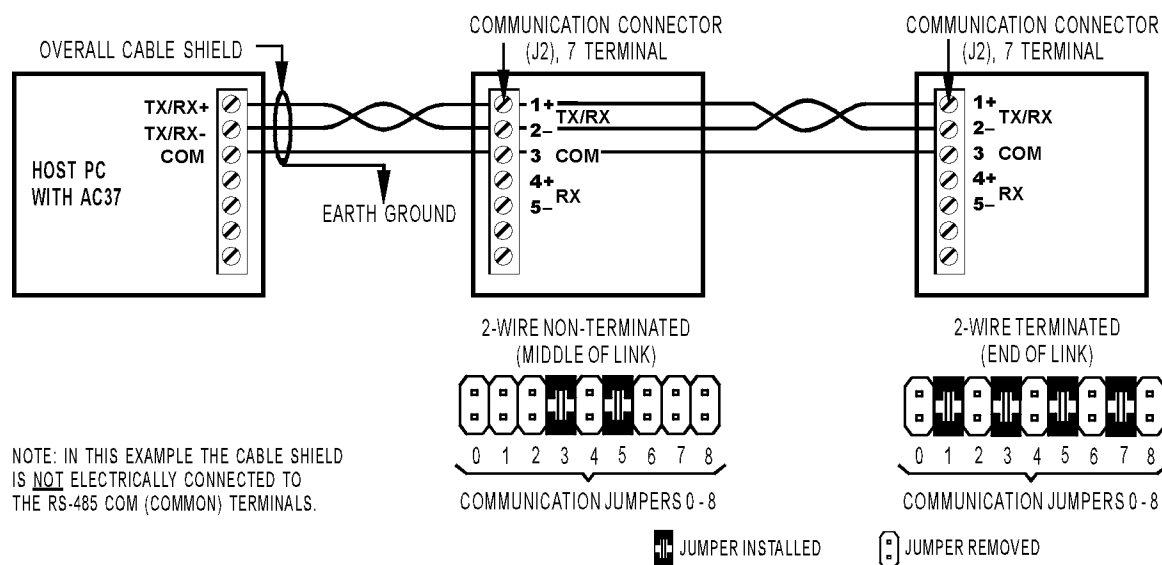
Communication Jumper Descriptions

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-



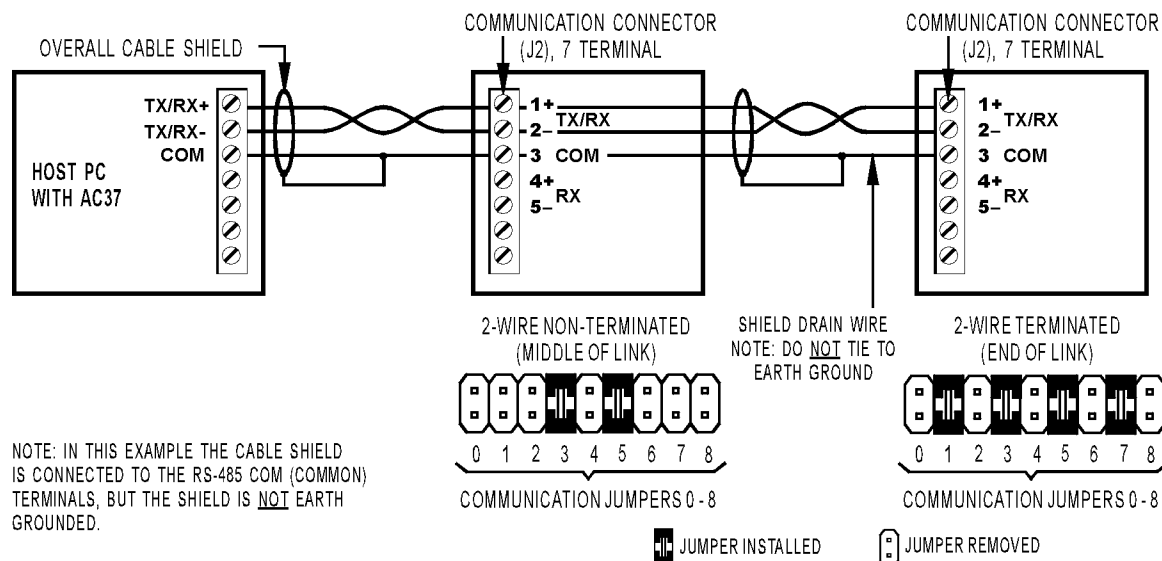
SPECIFICATIONS - COMMUNICATION JUMPERS/WIRING (CONTINUED)

STANDARD 2-WIRE CONFIGURATION



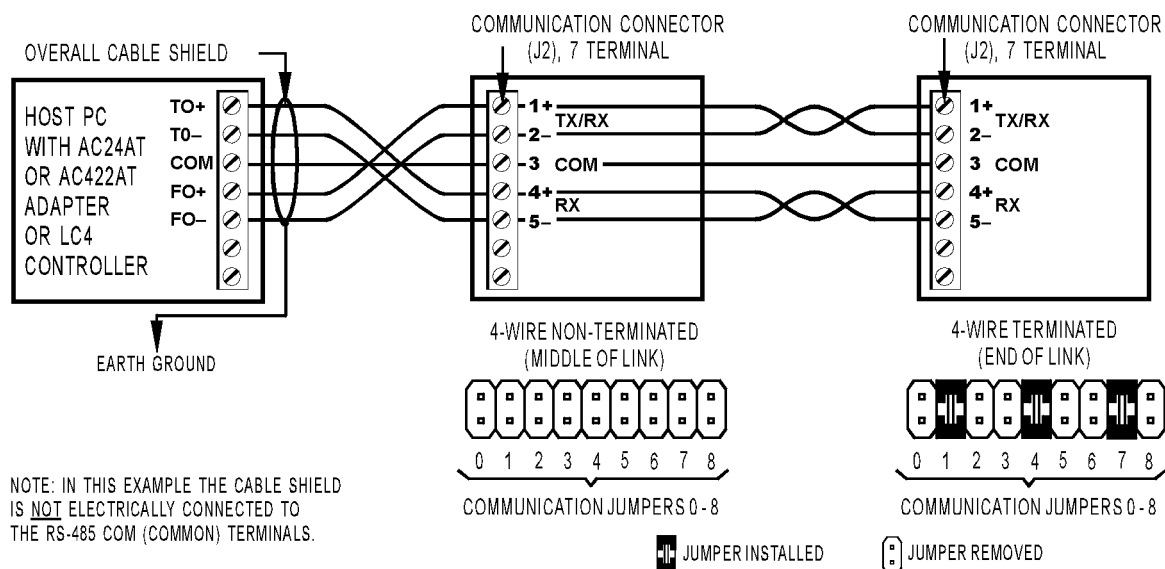
ALTERNATE 2-WIRE CONFIGURATION

(ACCEPTABLE FOR MOST CONDITIONS)



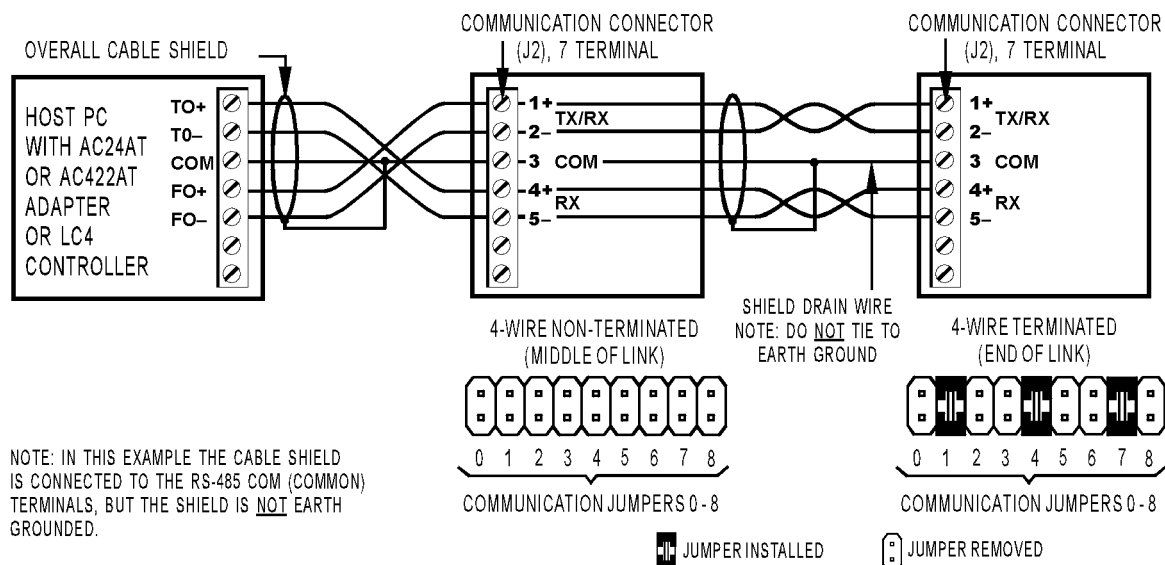
SPECIFICATIONS - COMMUNICATION JUMPERS/WIRING (CONTINUED)

STANDARD 4-WIRE CONFIGURATION



ALTERNATE 4-WIRE CONFIGURATION

(ACCEPTABLE FOR MOST CONDITIONS)



SPECIFICATIONS

Baud/Address Jumpers, LED Descriptions

SNAP-B3000-Modbus Brain

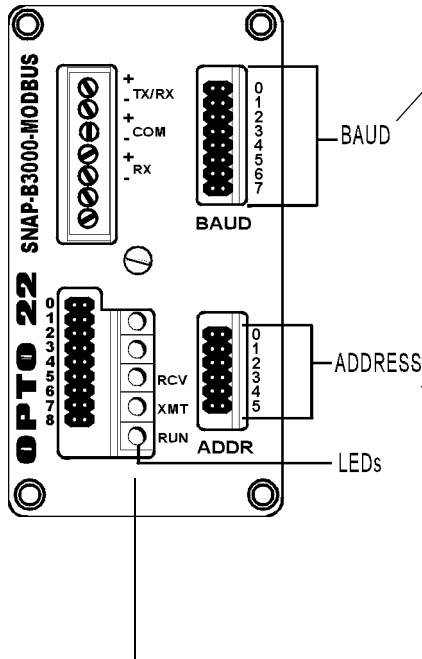


Table 1: Baud Rate Jumpers

BAUD RATE	JUMPER POSITION			
	3	2	1	0
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	□	■	□	□

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

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

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

543210		16	543210		32	543210		48	543210	
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

■ = JUMPER INSTALLED

□ = NO JUMPER

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 analog 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.

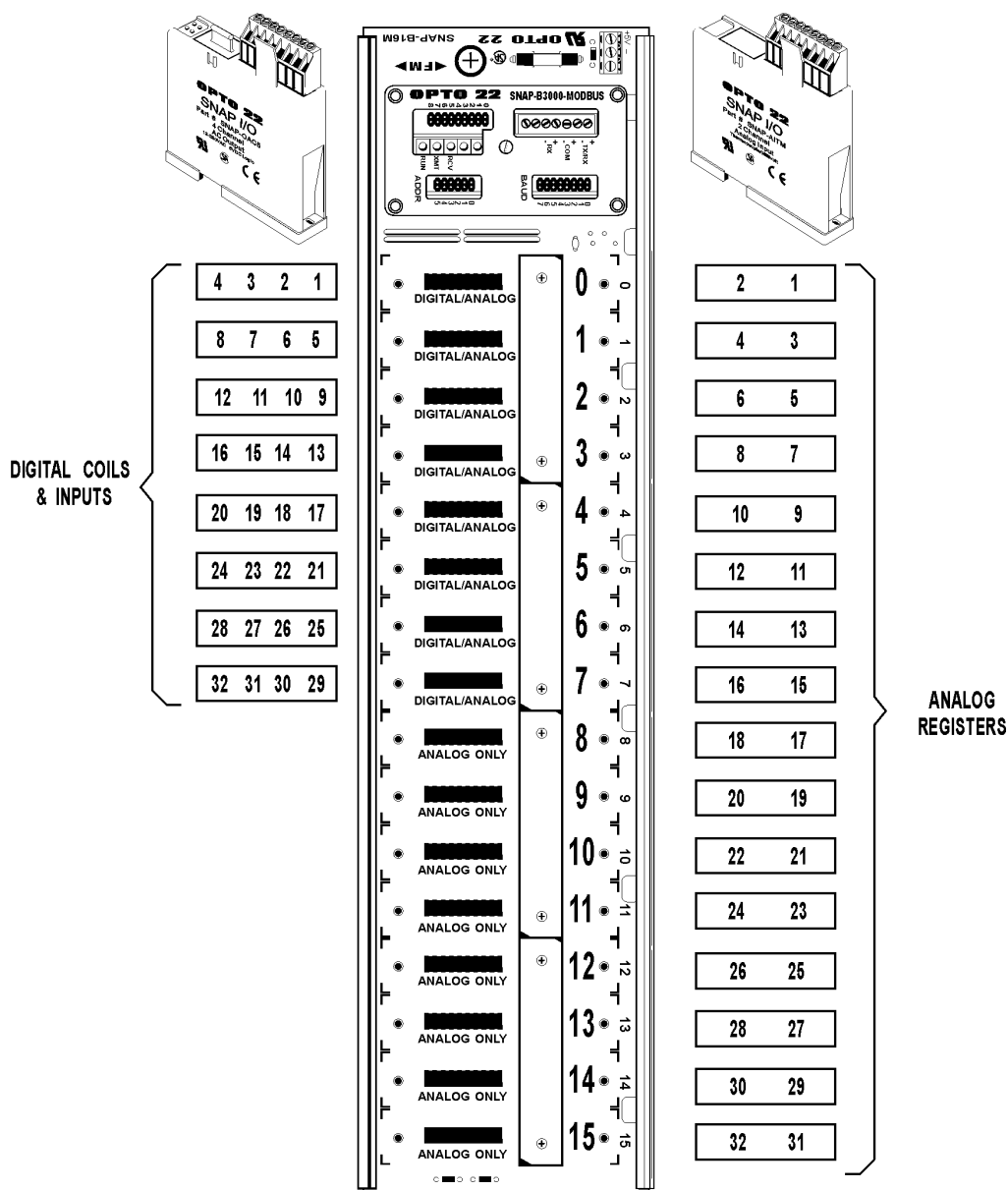
Error	Name	Description
1	ILLEGAL_FUNCTION	The function code is not implemented in this device.
2	ILLEGAL_DATA_ADDRESS	The coil, input, or register specified is not valid for this device.
3	ILLEGAL_DATA_VALUE	The data value specified is out of range for the specified function code.
4	SLAVE_DEVICE_FAILURE	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.)

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.



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

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,

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		
Analog Modules only	7	Digital Input	40	256		
	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.

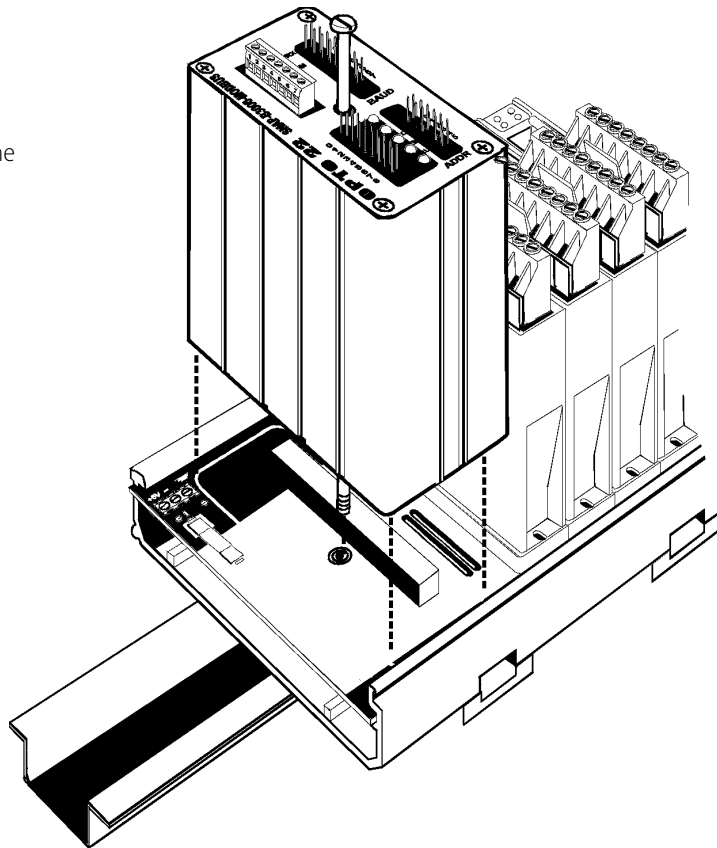
BRAIN ASSEMBLY

To install the brain onto a B Series rack:

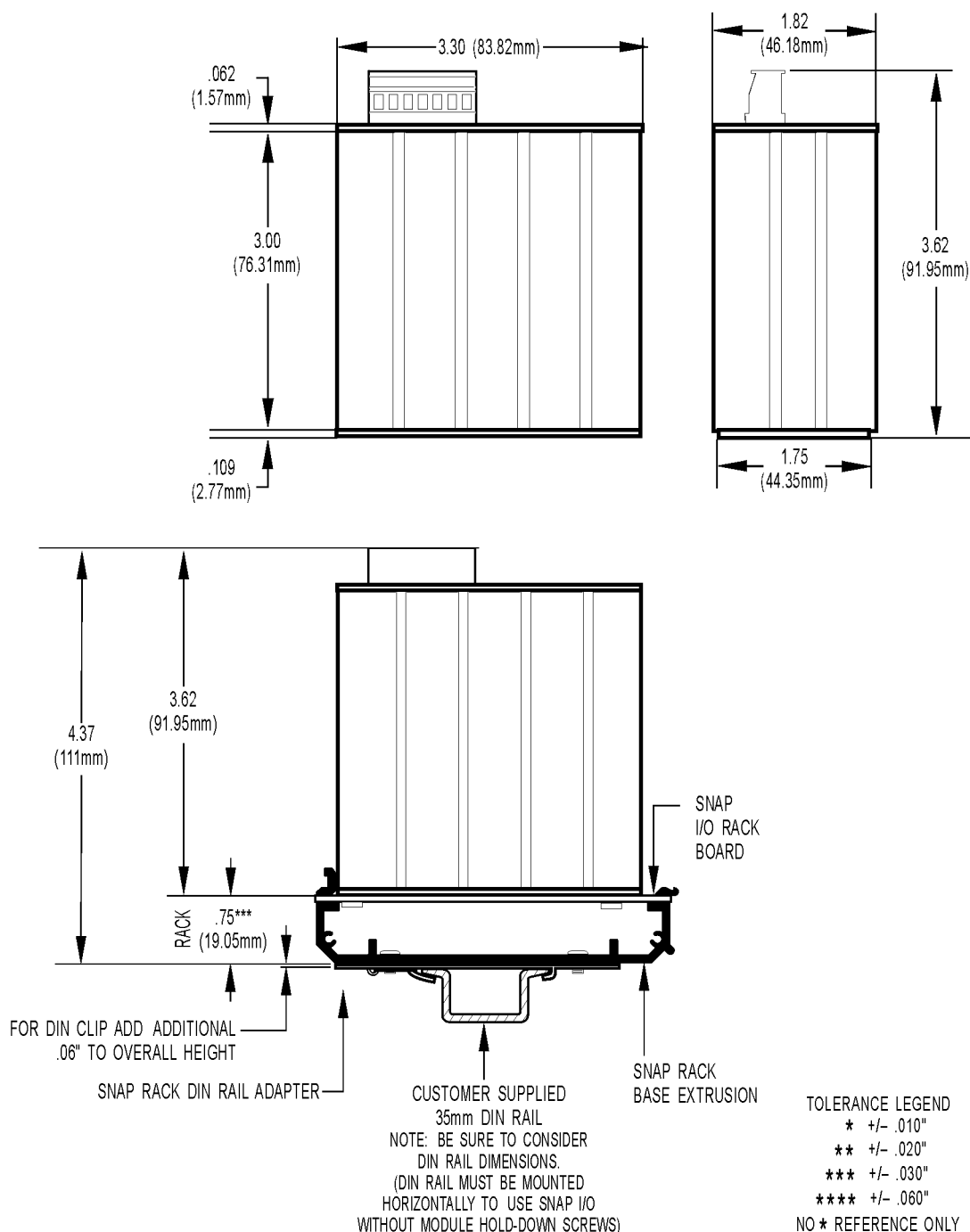
1. Turn off power to the rack assembly.
2. Align the brain connector with the mating connector on the mounting rack.
3. Seat the brain onto the connector.
4. Use the integral hold-down screw to secure the brain in position.
5. DO NOT OVERTIGHTEN!

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.



DIMENSIONS—SNAP-B3000-MODBUS BRAIN



PRODUCTS

Opto 22 develops and manufactures reliable, easy-to-use, open standards-based hardware and software products. Industrial automation, process control, remote monitoring, data acquisition, and industrial internet of things (IIoT) applications worldwide all rely on Opto 22.

groov RIO®

groov RIO edge I/O offers a single, compact, PoE-powered industrial package with web-based configuration and IIoT software built in, support for multiple OT and IT protocols, and security features like a device firewall, data encryption, and user account control.

Standing alone, *groov RIO* connects to sensors, equipment, and legacy systems, collecting and securely publishing data from field to cloud. Choose a universal I/O model with thousands of possible field I/O configurations, with or without Ignition from Inductive Automation®, or a *RIO EMU energy monitoring unit* that reports 64 energy data values from 3-phase loads up to 600 VAC, Delta or Wye.

You can also use *groov RIO* with a Modbus/TCP master or as remote I/O for a *groov EPIC* system.

groov EPIC® System

Opto 22's *groov Edge Programmable Industrial Controller (EPIC) system* gives you industrially hardened control with a flexible Linux®-based processor with gateway functions, guaranteed-for-life I/O, and software for your automation and IIoT applications.

groov EPIC Processor

The heart of the system is the *groov EPIC* processor. It handles a wide range of digital, analog, and serial functions for data collection, remote monitoring, process control, and discrete and hybrid manufacturing.

In addition, the EPIC provides secure data communications among physical assets, control systems, software applications, and online services, both on premises and in the cloud. No industrial PC needed.

Configuring and troubleshooting I/O and networking is easier with the EPIC's integrated high-resolution color touchscreen. Authorized users can manage the system locally on the touchscreen, on a monitor connected via the HDMI or USB ports, or on a PC or mobile device with a web browser.

groov EPIC I/O

groov I/O connects locally to sensors and equipment. Modules have a spring-clamp terminal strip, integrated wireway, swing-away cover, and LEDs indicating module health and discrete channel status. *groov I/O* is hot swappable, UL Hazardous Locations approved, and ATEX compliant.

groov EPIC Software

The *groov EPIC* processor comes ready to run the software you need:

- Programming: Choose flowchart-based PAC Control, CODESYS Development System for IEC61131-3 compliant programs, or secure shell access (SSH) to the Linux OS for custom applications
- Node-RED for creating simple IIoT logic flows from pre-built nodes
- Efficient MQTT data communications with string or Sparkplug data formats
- Multiple OPC UA server options
- HMI: *groov View* to build your own HMI viewable on touchscreen, PCs, and mobile devices; PAC Display for a

Windows HMI; Node-RED dashboard UI

- Ignition or Ignition Edge® from Inductive Automation (requires license purchase) with OPC-UA drivers to Allen-Bradley®, Siemens®, and other control systems, and MQTT communications

Older products

From solid state relays, to world-famous G4 and SNAP I/O, to SNAP PAC controllers, older Opto 22 products are still supported and working hard at thousands of installations worldwide. You can count on us for the reliability and service you expect, now and in the future.

QUALITY

Founded in 1974, 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 test each product twice before it leaves our factory rather than testing a sample of each batch, we can afford to guarantee most solid-state relays and optically isolated I/O modules for life.

FREE PRODUCT SUPPORT

Opto 22's California-based Product Support Group offers free technical support for Opto 22 products from engineers with decades of training and experience. Support is available in English and Spanish by phone or email, Monday–Friday, 7 a.m. to 5 p.m. PST.

Support is always available on our website, including [free online training](#) at OptoU, how-to [videos](#), [user's guides](#), the Opto 22 KnowledgeBase, and [OptoForums](#).

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** (toll-free in the U.S. and Canada) or **+1-951-695-3000**, or visit our website at www.opto22.com.

