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BusWorks® 900MB Series
Modbus/RS485 Network I/O Modules

Model 917MB-0900 Quad Current Output
Model 918MB-0900 Quad Voltage Output

USER'S MANUAL

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Safety Summary – Symbols on equipment:



Means "Caution, refer to this manual for additional information".

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IMPORTANT SAFETY CONSIDERATIONS

It is very important for the user to consider the possible adverse effects of power, wiring, component, sensor, or software failures in designing any type of control or monitoring system. This is especially important where economic property loss or human life is involved. It is important that the user employ satisfactory overall system design. It is agreed between the Buyer and Acromag, that this is the Buyer's responsibility.

1.0 INTRODUCTION

These instructions cover the hardware functionality of the transmitter models listed in Table 1. Supplementary sheets are attached for units with special options or features.

Table 1: Models Covered in This Manual

Series/ Input/Type	-Options/Output/ Enclosure/Approvals[1]	-Factory Configuration[2]
917MB	-0900	-C
918MB	-0900	-C

Notes (Table 1):
1. Agency approvals include CE, UL Listed, and cUL Listed.
2. Include the "-C" suffix to specify factory configuration option. Otherwise, no suffix is required for standard configuration.

DESCRIPTION

The Acromag 900MB family is a group of process I/O modules and accessories for Modbus/RS485 network I/O applications. The Model 917MB-0900 and 918MB-0900 provide control of four analog output channels, plus four digital output channels, via an isolated RS485 network I/O path utilizing the industry standard Modbus protocol. The Model 917MB drives four channels of process current, while the 918MB drives four channels of voltage output signals. Both models also include four control outputs for simple ON/OFF control of external devices. The 917/918MB modules contain an advanced technology microcontroller with integrated downloadable flash and EEPROM memory for non-volatile program, configuration, calibration, and parameter data storage. Units are fully reconfigurable via our user-friendly Windows 95/98® or NT® Configuration Program and the RS485 interface, or other compatible Modbus software. Once configured, these modules may operate as an active RS485 network slave connected to other modules and a host computer.

Each module provides four isolated analog outputs for DC process current or voltage signals. The module uses four 12-bit DAC's to generate separate channel voltage signals. In addition, four open-drain mosfets provide discrete control of external devices. Outputs may be automatically programmed to user-defined levels or states following a watchdog timer timeout. The open-drain outputs include yellow LED's at the front of the module that provide visual indication of output state. Additionally, a green "Run" and yellow "Status" LED provide local feedback of operating mode, system diagnostics, watchdog status, and module status.

All 900MB modules are designed to withstand harsh industrial environments. They feature RFI, EMI, ESD, EFT, and surge protection, plus low temperature drift, wide ambient temperature operation, and isolation between signal I/O, power, and the network. They also have low radiated emissions per CE requirements.

As wide-range DC-powered devices, these units may be powered from DC power networks incorporating battery backup. Since input power is diode-bridge coupled, the unit may be connected to redundant power supplies, or several units may safely share a single DC supply. The unit may also be powered from common 24VAC power.

Units are DIN-rail mounted and removable terminal blocks facilitate ease of installation and replacement, without having to remove wiring. Transmitter power, network, and digital output wiring are inserted at one side of the unit, while analog output wiring is inserted at the other side. Plug-in connectors are an industry standard screw clamp type that accept a wide range of wire sizes.

Flexible transmitter functionality, network reprogrammability, mixed signal I/O, and a network interface, all combine in a single package to make this instrument extremely powerful and useful over a broad range of applications. Further, the safe, compact, rugged, reconfigurable, and reliable design of this transmitter makes it an ideal choice for control room or field applications. Custom module configurations are also possible (please consult the factory).

Key 918MB Module Features:

- **Agency Approvals** – CE, UL, & cUL Listed.
- **Easy Windows® Configuration** – Fully configurable via our user-friendly Windows 95/98® or NT® 900MB Configuration Program.
- **RS485/Modbus Network Interface** – This proven high speed interface is highly immune to noise, can operate over long distances, and allows a large number of modules to be networked together. The unit communicates using the industry-standard Modbus command/response protocol.
- **Nonvolatile Reprogrammable Memory** – This module has an advanced technology microcontroller with integrated, non-volatile, downloadable flash memory and EEPROM. This allows the functionality of this device to be reliably reprogrammed thousands of times.
- **Fully Isolated** – Output circuitry, network, & power are isolated from each other for safety and noise immunity.
- **Discrete Outputs** – High voltage and current, open-drain mosfets provide direct control of external devices. Outputs may be controlled independently, or via watchdog timeout.
- **Flexible Process Current Output (917MB)** – Generates up to four process current signals in three ranges.
- **Flexible DC Voltage Output (918MB)** – Generates up to four DC voltage signals in three ranges.
- **Watchdog Timer** – An output watchdog timer function is included and may be configured for timeout periods up to 65534 seconds (18.2 hours). Timer will timeout if a read or write operation to any I/O channel does not occur over the configured time period. Outputs may be automatically set to user-defined levels or states following a watchdog timeout..
- **Self-Diagnostics** – Built-in routines operate upon power-up for reliable service, easy maintenance, and troubleshooting. A watchdog timer is also built into the microcontroller that causes it to initiate a self reset if the controller ever "locks up" or fails to return from an operation in a timely manner.
- **High-Speed Data Rates** – Supports RS485 communication rates up to 115K baud.
- **Wide Ambient Operation** – The unit is designed for reliable operation over a wide ambient temperature range.

Key 918MB Module Features…continued:

- **Wide-Range DC-Power or 24VAC Power** – This device receives power over a wide supply range and the power terminals are diode coupled. This makes this transmitter useful for systems with redundant supplies, and/or battery back-up. Additionally, the power terminals are not polarized.
- **Hardened For Harsh Environments** – The unit will operate reliably in harsh industrial environments and includes protection from RFI, EMI, ESD, EFT, and surges, plus low radiated emissions per CE requirements.
- **Convenient Mounting, Removal, & Replacement** – The DIN-rail mount and plug-in type terminal blocks make module removal and replacement easy.
- **High-Resolution Precise D/A Conversion** – Transmitters include high-resolution, low noise, Digital-to-Analog Converters for high accuracy and reliability.
- **LED Indicators** – A green LED indicates power. A yellow status LED will flash if the unit is placed in the default communication mode. It will also flash rapidly upon watchdog timeout. A yellow output LED indicates the ON/OFF state of the associated open-drain output.
- **Default Communication Mode –** A push-button switch is provided to set the module to a default set of communication parameters for baud rate, module address, parity, and number of stop bits. This provides a convenient way of establishing communication with the module when its internal settings are unknown.

ACCESSORY ITEMS

The following accessories are available from Acromag. Acromag also offers other standard and custom transmitter types to serve a wide range of applications (please consult the factory).

900MB Configuration & Control Software (Model 5034-186)

Series 900MB modules are configured with this user-friendly Windows 95/98® or NT® Configuration Program. Optionally, any software that supports the Modbus/RTU protocol may be used to configure and control Series 900MB modules, but the use of this software makes getting started easier. All module functions are programmable and downloadable to the modules via this software. The software also includes on-line help. Non-volatile memory provides program and configuration storage within the module. Note that this software may be optionally downloaded from our website (www.acromag.com) to registered owners of Series 900MB modules.

RS-232 to RS-485 Serial Adapter (Model 5034-214)

This device is a non-isolated, port-powered, signal converter for communication between the RS-232 serial port of a personal computer and the RS-485 network interface of Series 900MB I/O Modules. It is used in conjunction with the Acromag Configuration Software for simple reconfiguration, testing, and troubleshooting of Series 900MB I/O modules. As a port-powered device, it is not intended for driving fully loaded RS-485 networks over long distances, and does not have sufficient power to drive terminated networks. The adapter has DB-9F connectors at both ends and plugs directly into the common DB-9M serial port connector of most personal computers. The module is connected to the RS-485 side of this adapter via a separate interconnecting cable (see Cable 5034-202 described below).

Interface Cable (Model 5034-202)

An 8-foot, 3-wire cable used to connect the RS-485 side of Signal Converter 5034-214 to the RS-485 network terminals of 900MB modules. This cable has a DE-9M connector on one end, with three stripped & tinned wires on the other end, labeled A, B, & C for connection to module D, Dbar, & COM, respectively.

Series 900MB Software Interface Package (Model 900C-SIP)

The 900C-SIP Software Interface Package combines the 900MB Configuration Software (5034-186), RS-232 to RS-485 Serial Converter (5034-214), Interface Cable (5034-202), and Instructions (8500-649), into a complete kit for interfacing with Series 900MB I/O Modules.

2.0 PREPARATION FOR USE

UNPACKING AND INSPECTION

Upon receipt of product, inspect the shipping carton for evidence of mishandling during transit. If shipping carton is badly damaged or water stained, request that the carrier's agent be present when the carton is opened. If the carrier's agent is absent when the carton is opened, and the contents of the carton are damaged, keep the carton and packing material for the agent's inspection. For repairs to a product damaged in shipment, refer to the Acromag Service Policy to obtain return instructions. Salvageable shipping cartons & packing material should be saved for future use if the product must be shipped.



This module is physically protected with packing material and electrically protected with an anti-static bag during shipment. It is recommended the module be visually inspected for evidence of mishandling prior to applying power. This circuit utilizes static sensitive components and should only be handled at a static-safe workstation.

MODULE INSTALLATION

This transmitter utilizes a general purpose plastic enclosure. Use an auxiliary enclosure to protect the unit in unfavorable environments or vulnerable locations, or to maintain conformance to applicable safety standards. Stay within the unit's operating temperature range. As shipped, unit is calibrated for all valid input ranges and has the defaults shown in Table 2 below:

WARNING: Applicable IEC Safety Standards may require that this device be mounted within an approved metal enclosure or sub-system, particularly for applications with exposure to voltages greater than or equal to 75VDC or 50VAC.

Table 2: 918MB Default Factory Configuration

PARAMETER	CONFIGURATION/CALIB
Module Address	247
Baud Rate	9600bps
Parity	None (2 stop bits w/No parity)
Stop Bits	1 or 2 (When Parity=None)
Response Delay	0 (No Delay)
Output Range (Each Out)	0-20mA (917MB); 0-10V (918MB)
Watchdog Time	0 (Timer Disabled)
Analog Timeout Level	0 (Each Output)
Discrete Timeout State	1/ON (Each Output)

Notes (Table 2):

1. Do not confuse the Default Factory Configuration noted above with the Default Communication Mode, which refers to the fixed baud rate, module address, parity, and stop bit settings achieved by pushing the Default Mode button until the yellow status LED flashes ON/OFF. The Default Communication Mode will temporarily over-ride any factory configuration of baud rate, module address, parity, and stop bits with settings of 9600bps, 247, None, and 2, respectively. It is provided as a convenient means of achieving communication with a module when these parameters are unknown.

Your application will typically differ from the default factory configuration and will require that the transmitter be reconfigured to suit your needs. This can be easily accomplished with Acromag's user-friendly Windows 95/98® or NT® 900MB Configuration Program. Configuration is normally done prior to field installation. Refer to MODULE SOFTWARE CONFIGURATION of Section 3.0 for detailed instructions.

Default Mode Switch

A push-button default mode switch (DFT) and status LED are provided at the front of the module as a convenient way of communicating with the module when its baud rate and address settings are unknown. Push and hold this button until the Status LED flashes ON/OFF to indicate the module is in the Default Communication Mode with a fixed module address of 247, baud rate of 9600bps, no parity, and 2 stop bits. It is most convenient to configure a module in this mode, then leave the default mode by pressing this button again until the Status LED stops flashing (constant ON or OFF), or by resetting the module. The Default Mode is disabled following a software or power-on reset. New communication parameters (baud rate, address, & parity) will take effect following a module reset after leaving the Default Mode.

Mounting

Refer to Enclosure Dimensions Drawing 4501-833 for mounting and clearance dimensions.

DIN Rail Mounting: This module can be mounted on "T" type DIN rails. Use suitable fastening hardware to secure the DIN rail to the mounting surface. Units may be mounted side-by-side on 1-inch centers for limited space applications.
"T" Rail (35mm), Type EN50022: To attach, angle the top of the unit towards the rail and locate the top groove of the adapter over the upper lip of the rail. Firmly push the unit towards the rail until it snaps solidly into place. To remove module, first separate the input terminal block(s) from the bottom side of the module to create a clearance to the DIN mount area. Next, insert a screw-driver into the lower arm of the DIN connector and use it as a lever to force the connector down until it disengages from the rail.

Electrical Connections

Analog output, digital output, and network & power terminals can accommodate wire from 12-24 AWG, stranded or solid copper. Strip back wire insulation ¼-inch on each lead before installing into the terminal block. Analog output wiring should be shielded twisted-pair. Since common mode voltages can exist on signal wiring, adequate wire insulation should be used and proper wiring practices followed.

It is recommended that analog output wiring, digital output wiring, network wiring, and power wiring be separated from each other for safety, as well as for low noise pickup. Note that terminal blocks are a plug-in type and can be easily removed to facilitate module removal or replacement, without removing individual wires. Be sure to remove power before unplugging the terminals to uninstall the module, or before attempting service. All connections must be made with power removed.

CAUTION: Risk of Electric Shock – More than one disconnect switch may be required to de-energize the equipment before servicing.

1. **Power:** Refer to Electrical Connections Drawing 4501-831. Variations in power supply voltage within rated limits has negligible effect on module accuracy. For supply connections, use No. 14 AWG wires rated for at least 75°C. The power terminals are diode bridge-coupled and not polarized. The unit is powered from 10-36VDC, or 24VAC.
2. **Analog Outputs:** Connect outputs per Electrical Connections Drawing 4501-831. Observe proper polarity when making connections (see label for output type).
   Note: Analog outputs go to their minimum levels following a software or power-on reset of the module. Outputs may be optionally sent to user-defined levels following a watchdog timer timeout.
3. **Digital Outputs (Coils):** All discrete outputs are the open-drains of n-channel mosfets whose source terminals share return (RTN). Externally wired drain pullups or other load is generally required. All outputs include transient voltage suppressers and integrated snubbers, but may require additional protection when switching inductive loads (see below). Refer to the SPECIFICATIONS section for output specifications and see the module side label for terminal designations. Note that these outputs are for current-sinking (low-side switching) applications only. Digital outputs are turned OFF following a software or power-on reset of the module, but can be optionally programmed to user-defined states following a watchdog timer timeout. Observe proper polarity when making connections. The output circuitry as a group is electrically isolated from the network and power circuits. If necessary, an interposing relay can be used to switch higher currents as illustrated in the Interposing Relay Connection Drawing 4501-832.
   Note: Digital outputs go to their OFF state following a software or power-on reset of the module. Outputs may be optionally sent to user-defined states following a watchdog timer timeout.
   IMPORTANT – Protection With Inductive Loads: The output mosfets have integrated shunt diode clamps connected from drain to source to help protect the output switch from damaging reverse emf voltages that exist when controlling inductive loads. You may need to add external protection local to the inductive load for added protection and to prevent this emf from being distributed across the connection media. For DC inductive loads, place a diode across the load (1N4006 or equivalent) with cathode to (+) and anode to (-).
4. **Network Connections:** Wire network as shown in Network Connections Drawing 4501-805. Network common (COM) should connect to earth ground at one point.
5. **Grounding:** See Electrical Connections Drawing 4501-831. The module housing is plastic and does not require an earth ground connection.

WARNING: For compliance to applicable safety and performance standards, the use of shielded cable is recommended as shown in Drawing 4501-831. Further, the application of earth ground must be in place as shown in Drawing 4501-831. Failure to adhere to sound wiring and grounding practices may compromise safety & performance.

SOFTWARE INSTALLATION – USING SETUP.EXE

The 900MB Configuration Software (Model 900C-SIP) is used to configure Series 900MB modules and is installed as follows:

1. Start Windows 95/98/NT® and insert the 900MB Configuration Software CDROM into your drive D: (E: or M).

   IMPORTANT: Before continuing with the installation sequence, be sure to exit any other Windows programs that may be running.
2. Click on the [START] button in the lower left hand corner of the Windows screen. Then click on the "Run…" icon.
3. In the Run dialogue box, type **d:\setup** (or e:\setup) in the Open field and click on [OK]. The setup program will execute the Installshield Wizard.
   You may need to click on the "Setup.exe" icon of the install shield to proceed. On some machines, the setup.exe program is not started automatically.
4. From the introductory Acromag 900MB Setup Screen, click on [Next>] to proceed.
5. At this point, the 900MB Setup program will prompt you for your "Name" and "Company". Fill in this information, then click on [Next>].
6. Now you will be prompted for a destination directory. You may click on [Browse] to change the default directory, or [Next>] to accept "C:\ProgramFiles\Acromag\900MB" as the default. You may also click on [Back] to return to the prior screen and make any changes.
7. At this point you will be prompted for a program folder name. You may type a new name, use the scroll bar to select an existing program folder, or click on [Next>] to accept the "Acromag 900MB" default folder name.
8. Now you will be presented with your selections and you should verify if they are correct. Press [Next>] to continue and begin copying files, or press [Back] to return to prior screens and make any changes.
9. After the Configuration Program files have been copied to your hard drive, you will be prompted to click on [Finish] to complete the setup.
10. Now click on the [Acromag 900MB] program folder icon at the bottom of your windows screen, then click on the Acromag 900MB program icon to start the Configuration Program (Programs-Acromag 900MB-Acromag 900MB Configuration icon).

3.0 MODULE CONFIGURATION

This module needs to be configured for your application. This is easily accomplished using Acromag's Windows 95/98® or NT® Modbus Configuration Software and an RS232-to-RS485 signal converter. The Acromag software is not required to communicate with the Series 900MB, as any software capable of sending Modbus network protocol commands over an RS485 network can be used. However, this software provides an easy Windows format for communicating with the module that does not require advanced familiarity with the Modbus protocol.

REGISTER MAP

Modbus registers are organized into the following reference types identified by the leading number of the reference address:

Reference	Description
0xxxx	Read/Write Discrete Outputs or Coils. A 0x reference address is used to drive output data to a digital output channel.
1xxxx	Read Discrete Inputs. The ON/OFF status of a 1x reference is controlled by the corresponding digital input channel.
3xxxx	Read Input Registers. A 3x reference register contains a 16-bit number received from an external source—e.g. an analog signal.
4xxxx	Read/Write Output or Holding Registers. A 4x register is used to store 16-bits of numerical data (binary or decimal), or to send the data from the CPU to an output channel.

Notes (Register Map):

1. The "x" following the leading character represents a four-digit address location in user data memory. The leading character is generally implied by the function code and omitted from the address specifier for a given function. The leading character also identifies the I/O data type.
2. The ON/OFF state of discrete inputs and outputs is represented by a 1 or 0 value assigned to an individual bit in a 16-bit data word. This is sixteen 0x or 1x references per data word. With respect to mapping, the LSB of the word maps to the lowest numbered channel of a group and channel numbers increase sequentially as you move towards the MSB. Unused bits are set to zero.

Modbus functions operate on register map registers to configure and control modules. The following table outlines the register map for Model 917MB-0900 and 918MB-0900 network I/O modules. You will find it helpful to review this map as you review the Modbus function descriptions later.

Model 917MB-0900 and 918MB-0900 Register Map

Ref	Addr.	Description	Data Type/Format
Coil Registers (0x References, Read/Write)			
00001 Thru **0**0004	0-3 (0000-0003)	Four Discrete Outputs 0-3, Program States	Discrete Output Value. Addresses a specific bit of a 16-bit word that controls/ monitors the ON/OFF status for the output. A set bit (1) means the corresponding output is ON. A clear bit (0) means the corresponding output is OFF. The bit position corresponds to the output channel number (i.e. output 0 uses bit 0 of the 16-bit word at address 0, output 1 uses bit 1 of the 16-bit word at address 1, etc.) Unused bits of a word are set to 0. Bits 15-4: Not Used. Additionally, unused bits in range 3-0 are set to 0.
Note: This signal corresponds to the gate signal of the n-channel output mosfet. Thus, a read of this register may not reflect the actual output level at the drain of the mosfet if the open-drain is not pulled up or is left floating (no excitation). Excitation must be provided in order to operate the outputs. After reset, these registers read 0 (outputs OFF) and these registers are not maintained in EEPROM.			

Model 917MB-0900 and 918MB-0900 Register Map

Ref	Addr.	Description	Data Type/Format
Input Registers (3x References, Read-Only)			
30001	0 (0000)	Module Status	Bit 15: Flash Checksum 1 = Error Flag 0 = No Flash Error Bit 14: Not Used I Bit 13: Default Mode 1 = Default Mode Indicator 0 = Not In Default Mode Bits 12-1: Zero Bit 0: Watchdog Fault 1 = Watchdog Timeout 0 = Timeout Cleared
30002	1 (0001)	CH 0 Status Value **(917MB)**	Bits 15-2: Zero Bits 1,0: Output Range 00 = 0 = 0-20mA 01 = 1 = 4-20mA 10 = 2 = 0-1mA 11 = 3 = Reserved
30002	1 (0001)	CH0 Status Value **(918MB)**	Bits 15-2: Zero Bits 1,0: V-Output Range 00 = 0 = 0-10V 01 = 1 = 0-5V 10 = 2 = 0-1V 11 = Reserved
30003	2 (0002)	CH 1 Status Value	*Format Is Same As CH 0*
30004	3 (0003)	CH 2 Status Value	*Format Is Same As CH 0*
30005	4 (0004)	CH 3 Status Value	*Format Is Same As CH 0*
30006	5 (0005)	CH0 Raw Count	Raw DAC Count Value (See CALIBRATION)
30007	6 (0006)	CH1 Raw Count	Raw DAC Count Value (See CALIBRATION)
30008	7 (0007)	CH2 Raw Count	Raw DAC Count Value (See CALIBRATION)
30009	8 (0008)	CH3 Raw Count	Raw DAC Count Value (See CALIBRATION)
Holding Registers (4x References, Read/Write)			
40001	0 (0000)	Slave Address **Default=247**	1-247
40002	1 (0001)	Baud Rate **Default=2, 9600bps**	0 = 2400bps 1 = 4800bps 2 = 9600bps (Default) 3 = 14400bps 4 = 19200bps 5 = 28800bps 6 = 38400bps 7 = 57600bps 8 = 76800bps 9 = 115200bps
40003	2 (0002)	Parity **Default= 0, None**	0 = No Parity Check 1 = Odd Parity Checking 2 = Even Parity Checking
40004	3 (0003)	Output Watchdog Time **Default=0, Disabled**	Can be set from 1 to 65534 seconds. Set to 65535 (FFFFH) or 0 (0000H) to disable the watchdog timer.

Model 917MB-0900 and 918MB-0900 Register Map

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40005	4 (0004)	Digital Output Channel Watchdog Timeout States **Default= 65535, Disabled**	The four lower order bits of this 16-bit register define the state output channels will be programmed to following a watchdog timeout. Timeout control of outputs takes precedence over alarm and direct control. Bit 0 corresponds to channel 0, bit 1 to channel 1, bit 2 to channel 2, and bit 3 to channel 4. Write 65535 (FFFFH) to this register to leave the outputs unchanged following a timeout (this is also the default value).
Note: Clearing a timeout via an I/O read or write does not return the output(s) to their initial state or level. They remain at their timeout state or level until otherwise written.			
40006	5 (0005)	Response Delay Time (Turnaround Delay) **Default=0, No Delay**	Can be set from 0 to 65500 ticks (1 tick = 1.085us) and represents the additional delay the module will wait before responding to a message from the host. Increase this value if you have communication trouble with the module or you encounter a high degree of error messages.
40007	6 (0006)	CH 0 Output Value **Default=0**	Percentage (%) - Note 2. After reset, this register reads 0 and this register is not maintained in EEPROM.
40008	7 (0007)	CH 0 Timeout Value **Default=0**	Percentage (%) – Note 2. Write 32767 (7FFFH) to leave output unaffected by a watchdog timeout.
40009	8 (0008)	CH0 Output Configuration **(917MB) Default=0, 0-20mA**	Bits 15-2: Zero Bits 1,0: I-Output Range 00 = 0 = 0-20mA 01 = 1 = 4-20mA 10 = 2 = 0-1mA 11 = Reserved Note that the 0-20mA range may not precisely go to the 0mA endpoint. It will typically approach 0mA within 0.1%.
40009	8 (0008)	CH0 Output Configuration **(918MB) Default=0, 0-10V**	Bits 15-2: Zero Bits 1,0: V-Output Range 00 = 0 = 0-10V 01 = 1 = 0-5V 10 = 2 = 0-1V 11 = Reserved
40010	9 (0009)	CH 1 Output Value **Default=0**	Percentage (%) - Note 2. After reset, this register reads 0 and this register is not maintained in EEPROM.

Model 917MB-0900 and 918MB-0900 Register Map

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40011	10 (000A)	CH 1 Timeout Value **Default=0**	Percentage (%) – Note 2. Write 32767 (7FFFH) to leave output unaffected by a watchdog timeout.
40012	11 (000B)	CH1 Output Configuration **(917MB)** **Default=0, 0-20mA**	Bits 15-2: Zero Bits 1,0: I-Output Range 00 = 0 = 0-20mA 01 = 1 = 4-20mA 10 = 2 = 0-1mA 11 = Reserved Note that the 0-20mA range may not precisely go to the 0mA endpoint. It will typically approach 0mA within 0.1%.
40012	11 (000B)	CH1 Output Configuration **(918MB)** **Default=0, 0-10V**	Bits 15-2: Zero Bits 1,0: V-Output Range 00 = 0 = 0-10V 01 = 1 = 0-5V 10 = 2 = 0-1V 11 = Reserved
40013	12 (000C)	CH 2 Output Value **Default=0**	Percentage (%) - See Note 2.
40014	13 (000D)	CH 2 Timeout Value **Default=0**	Percentage (%) – Note 2. Write 32767 (7FFFH) to leave output unaffected by a watchdog timeout.
40015	14 (000E)	CH2 Output Configuration **(917MB) Default=0, 0-20mA**	Bits 15-2: Zero Bits 1,0: I-Output Range 00 = 0 = 0-20mA 01 = 1 = 4-20mA 10 = 2 = 0-1mA 11 = Reserved Note that the 0-20mA range may not precisely go to the 0mA endpoint. It will typically approach 0mA within 0.1%.
40015	14 (000E)	CH2 Output Configuration **(918MB) Default=0, 0-10V**	Bits 15-2: Zero Bits 1,0: V-Output Range 00 = 0 = 0-10V 01 = 1 = 0-5V 10 = 2 = 0-1V 11 = Reserved
40016	15 (000F)	CH 3 Output Value **Default=0**	Percentage (%) - See Note 2.
40017	16 (0010)	CH 3 Timeout Value **Default=0**	Percentage (%) – Note 2. Write 32767 (7FFFH) to leave output unaffected by a watchdog timeout.
40018	17 (0011)	CH3 Output Configuration **(917MB) Default=0, 0-20mA**	Bits 15-2: Zero Bits 1,0: I-Output Range 00 = 0 = 0-20mA 01 = 1 = 4-20mA 10 = 2 = 0-1mA 11 = Reserved Note that the 0-20mA range may not precisely go to the 0mA endpoint. It will typically approach 0mA within 0.1%.

Model 917MB-0900 and 918MB-0900 Register Map

Ref	Addr.	Description	Data Type/Format
Holding Registers (4x References, Read/Write)			
40018	17 (0011)	CH3 Output Configuration **(918MB) Default=0, 0-10V**	Bits 15-2: Zero Bits 1,0: V-Output Range 00 = 0 = 0-10V 01 = 1 = 0-5V 10 = 2 = 0-1V 11 = Reserved
40019	18 (0012)	Calibration Access And **Alternate Method of Module Reset**	Writing 24106 (5E2AH) here immediately removes write protection from the calibration registers that follow. All other values apply write protection to the calibration registers (except 41429). Writing 41429 (A1D5H) to this register will cause an immediate module reset. This is provided as an alternate method of Reset for software that does not support the Reset Slave (08) command. After a reset, this register reads 0 (write protection enabled and no reset). **This register is not maintained in EEPROM.**
40020	19 (0013)	CH0 Cal High Value	Raw DAC Value Register (See CALIBRATION)
40021	20 (0014)	CH0 Cal Low Value	Raw DAC Value Register (See CALIBRATION)
40022	21 (0015)	CH1 Cal High Value	Raw DAC Value Register (See CALIBRATION)
40023	22 (0016)	CH1 Cal Low Value	Raw DAC Value Register (See CALIBRATION)
40024	23 (0017)	CH2 Cal High Value	Raw DAC Value Register (See CALIBRATION)
40025	24 (0018)	CH2 Cal Low Value	Raw DAC Value Register (See CALIBRATION)
40026	25 (0019)	CH3 Cal High Value	Raw DAC Value Register (See CALIBRATION)
40027	26 (001A)	CH3 Cal Low Value	Raw DAC Value Register (See CALIBRATION)
41001	. . .	This block mirrors 1xxxx registers.	Refer to Note 6. 1xxxx Discrete Input Registers are mapped to the 41xxx Holding Register space using an address offset of 41000.
42001	. . .	This block mirrors 0xxxx registers.	Refer to Note 6. 0xxxx Coil Registers are mapped to the 42xxx Holding Register space using an address offset of 42000.
43001	. . .	This block mirrors 3xxxx registers.	Refer to Note 5. 3xxxx Input registers are mapped to the 43xxx Holding Register space using an address offset of 43000.

Notes (Register Map):

1. Note that the Report Slave ID and Reset Slave functions do not operate on Register Map locations.
2. Output values are indicated in percent-of-span units represented by a 16-bit signed integer value with resolution of 0.005%/lsb. The range is –163.84% (-32768 decimal) to +163.835% (+32767 decimal). For example, -100%, 0% and +100% are represented by the decimal values –20000, 0, and 20000, respectively. Clearing a watchdog timeout does not return an output to its pre-timeout level, it remains at its timeout level until otherwise written.
3. Configuration variables stored in holding registers (4xxxx reference addresses) are maintained in EEPROM, except for the Calibration Access & Reset Register and Output Value Registers. Changes to configuration registers do not take effect until the next software or power-on reset.
4. **WARNING:** Access to shaded register entries is normally not required and writes to these registers should be avoided to prevent module miscalibration.
5. For your convenience, this module mirrors the contents and operation of 3xxxx registers into 43xxx holding register space for systems and controllers that cannot directly access 3xxxx register address space. That is, the 3xxxx registers of this model can be written to, or read from, using either the standard methods described in the Modbus specification, or through mapping (mirroring) to the Holding Register space. The format of the registers are identical and you only need to offset your address by 43000. For example: if you want to read Input Register 1 through the Holding Registers, you would use the "Read Holding Registers" function with an address of 43001.
6. For modules with a firmware revision later than G (as in 9300-037G of 917MB, or 9300-028G of 918MB), the mirroring function as described in Note 5 is augmented as follows (0xxxx also maps to 42xxx space, and 1xxxx also maps to 41xxx space):

   For 1xxxx Input Status Registers (where supported), the return data is reformatted to match the Holding Register format. For example, if you request Input Status for 12 digital inputs, instead of getting 2 bytes returned with the first 12 bits representing 12 digital inputs, you will get 12 separate words (2 bytes) instead, with each set to 0000H (OFF) or FFFFH (ON).

   For 0xxxx Coil Registers (where supported), reads are handled in the same way as noted for 1xxxx Input Status Registers. That is, you may write to the coil registers using the "Preset Single Register" function with an address offset of 42000. Setting the data to 0000H will turn the coil OFF, while setting the data to FF00H will turn the coil ON.

MODULE CALIBRATION

These analog out modules are calibrated using a single base output range with fixed calibration points. Calibration of the sub-ranges are interpolated based on these results. Prior to cal, 917MB units must have the 0-20mA output range selected, and 918MB units must have the 0-10V range selected. Calibration is performed by adjusting the output signal until its measured value precisely matches the low or high cal point. With the output level precisely adjusted to the low or high cal point, the output channel's raw DAC Count is then read from the module (registers 30006-30009 in Memory Map). This same value is then written to the corresponding channel's respective Cal High or Cal Low register (registers 40020-40027 of Memory Map). Note that you will have to write 24106 into the Calibration Access register to be able to modify the Cal High/Low registers. This process is repeated for the opposite calibration point.

After writing the required values to the Cal Low & Cal High registers of the output, new output calibration takes effect immediately following a module reset. For best results, allow some settling time between Low & High calibration and always calibrate the low calibration point first.

Output Calibration Values For 917MB/918MB

Output Range	Factory Calibration LOW Point		
	Output	Output %	DAC Count
0-20mA	4.000mA	4000	723
0-10V	0.000V	0	50
Output Range	**Factory Calibration HIGH Point**		
	Output	**Output %**	**DAC Count**
0-20mA	20.000mA	20000	3614
0-10V	10.000V	20000	3609

Note that 917MB units have the 0-20mA output range selected during calibration, while 918MB units have the 0-10V output range selected during calibration. The output % value and DAC count of the table are based on "ideal" conditions and will only approximate random selected performance.

IMPORTANT: Because calibration of the module's sub-ranges are interpolated based on the primary range calibration noted above, and because resolution is degraded for the sub-ranges, it is very important that high accuracy be ensured for the primary range calibration when making output adjustments and measuring the output levels. Further, resolution limits of the output sub-ranges may make it difficult to accurately adjust the output level to the ideal range endpoints (especially for 0-1mA and 0-1V output ranges). The inability to precisely attain endpoint values will increase total error at the endpoints.

AN INTRODUCTION TO MODBUS

This section provides a description of the Modbus protocol and the Modbus functions that apply to this model. The Modbus protocol provides an industry standard method Series 900MB modules use for parsing messages. Modbus devices communicate using a master-slave technique in which only one device (the master) can initiate transactions (called queries). The other devices are slaves and respond by supplying the requested data to the master, or by taking the action requested in the query. Series 900MB modules are the slaves, and a typical master is a host computer running appropriate application software. Masters can address individual slaves, or initiate a broadcast message to all slaves. Slaves return a response to all queries addressed to them individually, but no response is returned to broadcast queries from a master device.

Remote Terminal Unit (RTU) Mode

Series 900MB modules use the widely accepted Modbus network protocol in the RTU (Remote Terminal Unit) serial transmission mode. In RTU mode, each 8-bit message byte contains two 4-bit hexadecimal characters, and is transmitted in a continuous stream. The RTU mode byte format is shown below:

RTU Mode Byte Format	
Coding System	8-bit binary, hexadecimal 0-9, A-F, two hexadecimal characters contained in each 8-bit field of the message.
Bits Per Byte	1 start bit + 8 data bits, lsb sent first + 1bit for even/odd parity or no bit for no parity + 1 stop bit if parity is used or 2 stop bits with no parity.
Error Check Field	Cyclical Redundancy Check (CRC)

A master's query is comprised of a slave address (or broadcast), a function code defining the requested action, any data required, and an error checking field. A slave's response is comprised of fields confirming the action taken, any data to be returned, and an error checking field. The query and response both include a device address + function code + data byte(s) + error checking field. If an error occurred in the receipt of the query, or if the slave is unable to perform the requested action, the slave will return an exception message as its response (see Modbus Exceptions). The error check field allows the master to confirm that the message contents are valid.

Modbus Message Framing

A Modbus message is placed in a frame by the transmitting device. A frame is used to mark the beginning and ending point of a message allowing the receiving device to determine which device is being addressed and to know when the message is completed. It also allows partial messages to be detected and errors flagged as a result. RTU mode messages start with a silent interval of at least 3.5 character times implemented as a multiple of character times at the baud rate being used on the network (indicated as t1t2t3t4 below). The first field transmitted is the device address. The allowable characters transmitted for all fields are hexadecimal values 0-9, A-F.

A networked device continuously monitors the network, including the silent intervals, and when the first field is received (the address), the device decodes it to determine if it is the addressed device. Following the last character transmitted, a similar silent interval of 3.5 character times marks the end of the message and a new message can begin after this interval. A typical message frame is shown below.

RTU Message Frame

Start	Addr.	Function	Data	CRC	End
t1t2t3t4	8 bits	8 bits	nx8 bits	16 bits	t1t2t3t4

The entire message must be transmitted as a continuous stream. If a silent interval of more than 1.5 character times occurs before completion of the frame, the receiving device flushes the incomplete message and assumes the next byte will be the address field of a new message.

In similar fashion, if a new message begins earlier than 3.5 character times following a previous message, the receiving device assumes it is a continuation of the previous message. This will generate an error, as the value in the final CRC field will not be valid for the combined messages.

How Characters Are Transmitted Serially

When messages are transmitted on Modbus serial networks, each character or byte is sent in the order of Least Significant Bit (LSB) to Most Significant Bit (MSB) as outlined below (moving left to right). Note that an additional stop bit is transmitted to fill out the character frame for no parity.

RTU Character Framing (No Parity)

Start	0	1	2	3	4	5	6	7	Stop	Stop

RTU Character Framing (With Parity)

Start	0	1	2	3	4	5	6	7	Parity	Stop

Modbus Addresses

The master device addresses a specific slave device by placing the 8-bit slave address in the address field of the message. Valid addresses are from 1-247. When the slave responds, it places its own address in this field of its response to let the master know which slave is responding. Address 0 is reserved for the broadcast address, which all slave devices on a network recognize. A slave does not issue a response to broadcast messages. Further, not all function messages support the broadcast address.

With respect to data addresses, all data addresses in Modbus messages are referenced to 0, with the first occurrence of a data item addressed as item number zero. Further, a function code field already specifies which register group it is to operate on (i.e. 0x, 1x, 3x, or 4x reference addresses). For example, holding register 40001 is addressed as register 0000 in the data address field of the message. The function code that operates on this register specifies a "holding register" operation and the "4xxxx" reference is implied. Holding register 40108 is addressed as register 006BH (107 decimal).

Modbus Functions

The function code field of a message frame contains the 8 bits that tell the slave what kind of action to take. Valid codes are in the range 1-255. Not all codes apply to a module and some codes are reserved for future use. The following table highlights the subset of standard Modbus functions supported by the Model 918MB-0900 module (the reference register addresses that the function operates on are also indicated):

CODE	FUNCTION	REFERENCE
01 (01H)	Read Coil (Output) Status	0xxxx
03 (03H)	Read Holding Registers	4xxxx
04 (04H)	Read Input Registers	3xxxx
05 (05H)	Force Single Coil (Output)	0xxxx
06 (06H)	Preset Single Register	4xxxx
08 (08H)	Reset Slave	*Hidden*
15 (0FH)	Force Multiple Coils (Outputs)	0xxxx
16 (10H)	Preset Multiple Registers	4xxxx
17 (11H)	Report Slave ID	*Hidden*

These functions are used to access the registers outlined in the register map for sending and receiving data and are described in the following paragraphs. Note that the Report Slave ID and Reset Slave commands do not operate on register map registers.

When a slave device responds to the master, it uses the function code field to indicate either a normal response (error-free), or that some kind of error has occurred (an exception response). A normal response echoes the original function code of the query, while an exception response returns a code that is equivalent to the original function code with its most significant bit (msb) set to a logic 1. For example, the Read Holding Registers command has the function code 0000 0011 (03H). If the slave device takes the requested action without error, it returns the same code in its response. However, if an exception occurs, it returns 1000 0011 (83H) in the function code field and also appends a unique code in the data field of the response message that tells the master device what kind of error occurred, or the reason for the exception (See Modbus Exceptions).

The master's application program must handle the exception response. It may choose to post subsequent retries of the original message, it may try sending diagnostic messages to the slave, or it may simply notify the operator an exception error has occurred.

The following paragraphs describe the Modbus functions supported by the Model 918MB-0900. To gain a better understanding of Modbus, please refer to the register map as you review this material.

Read Coil Status (01)

This command will read the ON/OFF status of discrete outputs or coils (0x reference addresses) in the slave. For 918MB models, its response is equivalent to reading the gate signals of the n-channel mosfets that drive the outputs. Broadcast transmission is not supported.

The Read Coil Status query specifies the starting coil (output channel) and quantity of coils to be read. Coils correspond to the discrete open-drain outputs of this transmitter and are addressed starting from 0 (up to 4 coils addressed as 0-3 for this model).

The Read Coil Status in the response message is packed as one coil or channel per bit of the data field. The output status is indicated as 1 for ON (sinking current), and 0 for OFF (not conducting). The LSB of the first data byte corresponds to the status of the coil addressed in the query. The other coils follow sequentially, moving toward the high order end of the byte. Since this model has only 4 outputs, the remaining bits of the data byte will be set to zero toward the unused high order end of the byte.

The following example reads the output channel status of coils 0-3 at slave device 247:

Read Coil Status Example Query

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	1 (01)
Starting Address High Order	0 (00)
Starting Address Low Order	0 (00)
Number Of Points High Order	0 (00)
Number Of Points Low Order	4 (04)
Error Check (CRC)	--

Note that the leading character of the 0x reference address is implied by the function code and omitted from the address specified. In this example, the first address is 00001, referenced via 0000H, and corresponding to coil 0.

Read Coil Status Example Response

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	1 (01)
Byte Count	2 (02)
Data (Coils 3-0)	10 (0A)
Error Check (CRC)	--

To summarize, the status of coils 3-0 is shown as the byte value 0A hex, or 00001010 binary. Coil 3 is the fifth bit from the left of this byte, and coil 0 is the LSB. The four remaining bits (toward the high-order end) are zero. Reading left to right, the output status of coils 3..0 is ON-OFF-ON-OFF. This is summarized as follows:

Bin	0	0	0	0	1	0	1	0
Hex	0				A			
Coil	NA	NA	NA	NA	3	2	1	0

Read Holding Registers (03)

This command will read the binary contents of holding registers (4x reference addresses) in the slave device. Broadcast transmission is not supported.

The Read Holding Registers query specifies the starting register and quantity of registers to be read. Note that registers are addressed starting at 0 (registers 1-16 are addressed as 0-15). The Read Holding Registers response message is packed as two bytes per register, with the binary contents right-justified in each byte. For each register, the first byte contains the high order bits and the second byte the low order bits.

The following example reads holding registers 40007…40009 (channel 0 output value, reset value, and output configuration) at slave device 247:

Read Holding Register Example Query

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	3 (03)
Starting Address High Order	0 (00)
Starting Address Low Order	8 (08)
Number Of Points High Order	0 (00)
Number Of Points Low Order	3 (03)
Error Check (CRC)	--

Read Holding Register Example Response

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	3 (03)
Byte Count	6 (06)
Data High (Register 40007)	(3A)
Data Low (Register 40007)	15000 (98)
Data High (Register 40008)	(27)
Data Low (Register 40008)	10000 (10)
Data High (Register 40009)	(00)
Data Low (Register 40009)	1 (01)
Error Check (CRC)	--

To summarize, the contents of register 40007 (two bytes) is the channel 0 output value of 15000 or 75% (3A98H). The contents of register 40008 (two bytes) is the channel 0 reset value of 10000 or 50% (2710H). The contents of register 40009 is the channel 0 output configuration value (two bytes) of 0-20mAV (0001H).

Note that the analog output value is expressed as a 16-bit signed integer value with resolution of 0.005%/lsb. The range is –163.84% (-32768 decimal) to +163.835% (+32767 decimal). For example, -100%, 0% and +100% are represented by decimal values –20000, 0, and 20000, respectively.

Read Input Registers (04)

This command will read the binary contents of input registers (3x reference addresses) in the slave device. Broadcast transmission is not supported.

The Read Input Registers query specifies the starting register and quantity of registers to be read. Note that registers are addressed starting at 0--registers 1-16 are addressed as 0-15.

The Read Input Registers response message is packed as two bytes per register, with the binary contents right-justified in each byte. For each register, the first byte contains the high order bits and the second byte the low order bits.

The following example reads input register 30001 (module status) at slave device 247:

Read Input Registers Example Query

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	4 (04)
Starting Address High Order	0 (00)
Starting Address Low Order	2 (02)
Number Of Points High Order	0 (00)
Number Of Points Low Order	2 (02)
Error Check (CRC)	--

Read Input Registers Example Response

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	4 (04)
Byte Count	6 (06)
Data High (Register 30003)	0 (00)
Data Low (Register 30003)	80 (50)
Data High (Register 30004)	0 (00)
Data Low (Register 30004)	128 (80)
Error Check (CRC)	--

To summarize, the contents of register 30001 (two bytes) is the status value of zero (0000H)--i.e. no EEPROM or flash checksum errors present.

Force Single Coil (05)

This command will force a single coil/output (0x reference address) ON or OFF. For broadcast transmission, this function forces the same coil in all networked slaves.

The Force Single Coil query specifies the coil reference address to be forced, and the state to force it to. The ON/OFF state is indicated via a constant in the query data field. A value of FF00H forces the coil to be turned ON (i.e. the gate of the corresponding n-channel mosfet is set high), and 0000H forces the coil to be turned OFF (i.e. the gate of the corresponding output mosfet is set low). All other values are illegal and will not affect the coil. Note that coils are referenced starting at 0—up to 4 coils are addressed as 0-3 for this model and this corresponds to the discrete output channel number. The example below forces discrete output 3 ON at slave device 247:

Force Single Coil Example Query

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	5 (05)
Coil Address High Order	0 (00)
Coil Address Low Order	3 (03)
Force Data High Order	255 (FF)
Force Data Low Order	0 (00)
Error Check (CRC)	--

The Force Single Coil response message is an echo of the query as shown below, returned after executing the force coil command. No response is returned to broadcast queries from a master device.

Force Single Coil Example Response

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	5 (05)
Coil Address High Order	0 (00)
Coil Address Low Order	3 (03)
Force Data High Order	255 (FF)
Force Data Low Order	0 (00)
Error Check (CRC)	--

Preset Single Register (06)

This command will preset a single holding register (4x reference addresses) to a specific value. Broadcast transmission is supported by this command and will act to preset the same register in all networked slaves.

The Preset Single Register query specifies the register reference address to be preset, and the preset value. Note that registers are addressed starting at 0--registers 1-16 are addressed as 0-15. The Preset Single Registers response message is an echo of the query, returned after the register contents have been preset. The following example writes a baud rate of 9600bps to holding register 40002 (Baud Rate) at slave device 247:

Preset Holding Register Example Query

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	6 (06)
Register Address High Order	0 (00)
Register Address Low Order	1 (01)
Preset Data High Order	0 (00)
Preset Data Low Order	2 (02)
Error Check (CRC)	--

Preset Holding Register Example Response

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	6 (06)
Register Address High Order	0 (00)
Register Address Low Order	1 (01)
Preset Data High Order	0 (00)
Preset Data Low Order	2 (02)
Error Check (CRC)	--

The response simply echoes the query after the register contents have been preset. No response is returned to broadcast queries from a master device.

Force Multiple Coils (15)

This command will simultaneously force a sequence of coils (0x reference addresses) either ON or OFF. Broadcast transmission is supported by this command and will act to force the same block of coils in all networked slaves.

The Force Multiple Coils query specifies the starting coil reference address to be forced, the number of coils, and the force data to be written in ascending order.

The ON/OFF states are specified by the contents in the query data field. A logic 1 in a bit position of this field requests that the coil turn ON, while a logic 0 requests that the corresponding coil be turned OFF. Unused bits in a data byte should be set to zero. Note that coils are referenced starting at 0—up to 4 coils are addressed as 0-3 for this model and this also corresponds to the discrete output channel number.

The Force Multiple Coils normal response message returns the slave address, function code, starting address, and the number of coils forced, after executing the force instruction. Note that it does not return the byte count or force value. The following example forces outputs 1 & 3 OFF, and 0 & 2 ON for coils 0-3 at slave device 247:

Force Multiple Coils Example Query

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	15 (0F)
Coil Address High Order	0 (00)
Coil Address Low Order	0 (00)
Number Of Coils High Order	0 (00)
Number Of Coils Low Order	4 (04)
Byte Count	01
Force Data High (First Byte)	5 (05)
Error Check (CRC)	--

Note that the leading character of the 0x reference address is implied by the function code and omitted from the address specified. In this example, the first address is 00001 corresponding to coil 0 and referenced via 0000H. Thus, the data byte transmitted will address coils 3...0, with the least significant bit addressing the lowest coil in this set as follows (note that the four unused upper bits of the data byte are set to zero):

Bin	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**
Hex	**0**				**5**			
Coil	**NA**	**NA**	**NA**	**NA**	**3**	**2**	**1**	**0**

Force Multiple Coils Example Response

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	15 (0F)
Coil Address High Order	0 (00)
Coil Address Low Order	0 (00)
Number Of Coils High Order	0 (00)
Number Of Coils Low Order	4 (04)
Error Check (CRC)	--

The normal response returns the slave address, function code, starting coil address, and quantity of coils forced, after executing the force instruction. It does not return the byte count or force data. No response is returned to broadcast queries from a master device.

Preset Multiple Registers (16)

This command will preset a block of holding registers (4x reference addresses) to specific values. Broadcast transmission is supported by this command and will act to preset the same block of registers in all networked slaves.

The Preset Multiple Registers query specifies the starting register reference address, the number of registers, and the data to be written in ascending order.

Note that registers are addressed starting at 0--registers 1-16 are addressed as 0-15. The Preset Multiple Registers normal response message returns the slave address, function code, starting register reference, and the number of registers preset, after the register contents have been preset. Note that it does not echo the preset values.

The following example writes a new slave address of 200, a baud rate of 28800bps, and sets parity to even, by writing to holding registers 40001 through 40003 at slave device 247 (changes to slave address, baud rate, and parity will take effect following the next software or power-on reset):

Preset Multiple Registers Example Query

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	16 (10)
Starting Register High Order	0 (00)
Starting Register Low Order	0 (00)
Number Of Registers High Order	0 (00)
Number Of Registers Low Order	3 (03)
Byte Count	6 (06)
Preset Data High (First Register)	0 (00)
Preset Data Low (First Register)	200 (C8)
Preset Data High (Second Reg)	0 (00)
Preset Data Low (Second Reg)	5 (05)
Preset Data High (Third Reg)	0 (00)
Preset Data Low (Third Reg)	2 (02)
Error Check (CRC)	--

Preset Multiple Registers Example Response

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	16 (10)
Starting Register High Order	0 (00)
Starting Register Low Order	0 (00)
Number Of Registers High Order	0 (00)
Number Of Registers Low Order	3 (03)
Error Check (CRC)	--

The response simply echoes the query without returning the preset values after the register contents have been preset. No response is returned to broadcast queries from a master device.

Report Slave ID (17)

This command returns the model number, serial number, and firmware number for the Acromag slave device, the status of the Run indicator, and any other information specific to the device. This command does not address Register Map registers. Broadcast transmission is not supported.

The Report Slave ID query simply sends the slave address and function code with error check (CRC) as follows:

Report Slave ID Example Query

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	17 (11)
Error Check (CRC)	--

Report Slave ID Sample Response

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	17 (11)
Byte Count	26 (1A)
Acromag Slave ID	0 (00H) = 924MB-0900 1 (01H) = 913MB-0900 2 (02H) = 914MB-0900 3 (03H) = 917MB-0900 4 (04H) = 918MB-0900 5 (05H) = 901MB-0900 6 (06H) = 902MB-0900 7 (07H) = 903MB-0900 8 (08H) = 904MB-0900 9 (09H) = 905MB-0900 10 (0AH) = 906MB-0900
Run Indicator Status (ON)	255 (FF)
Firmware Number ASCII Byte String (Additional Data Field)	"ACROMAG, 9300-037A, 917MB-0900," (41 43 52 4F 4D 41 47 2C 39 33 30 30 2D 30 33 37 41 2C 39 31 37 4D 42 2D 30 39 30 30 2CH)
Serial Number ASCII Byte String (Unique Per Module)	Six Numbers + Revision "123456A" (31 32 33 34 35 36 41H)
Error Check (LRC or CRC)	--

Reset Slave (08)

This command is used to trigger a reset of the module and its effect is equivalent to a power-on reset of the module. Note that changes to baud rate, slave address, and parity are initiated following reset. The Reset Slave command uses sub-function 01 (Restart Communications) of the standard Modbus Diagnostics Command (08) to accomplish a module reset. This function does not operate on register map locations. Broadcast transmission is not supported.

The Reset Slave query simply sends the slave address, function code, sub-function code, and data (data is ignored and simply echoed back), with error check (CRC). A Reset Slave response is simply an echoed acknowledge that is returned just before the reset is executed. Allow a few seconds following reset to re-initiate communication with a module.

Reset Slave Example Query

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	08 (08)
Sub-Function High Order Byte	0 (00)
Sub-Function Low Order Byte	1 (01)
Data Field High-Order Byte	0 (00)
Data Field Low Order Byte	0 (00)
Error Check (CRC)	--

Reset Slave Example Response (Sent Prior To Reset)

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	08 (08)
Sub-Function High Order Byte	0 (00)
Sub-Function Low Order Byte	1 (01)
Data Field High-Order Byte	0 (00)
Data Field Low Order Byte	0 (00)
Error Check (CRC)	--

Note that the response simply echoes the query just before the reset is triggered.

For Modbus software that does not support the Reset Slave function, an alternate method of generating a module reset is provided via a write to the Calibration Access & Module Reset Register (See Register 40020 of the Register Map).

Modbus Data Field

The data field of a message frame contains a multiple of 8 bits that provides the slave with any additional information the slave requires to complete the action specified by the function code. The data field typically includes register addresses, count values, and written data. The data field can be nonexistent for some commands (zero length), as not all messages require data.

If no error occurs, the data field of a response from a slave will return the requested data. If an error occurs, the data field returns an exception code (see Modbus Exceptions) that the master application can use to determine the next action to take.

Supported Data Types

All I/O values are accessed via 16-bit Input Registers or 16-bit Holding Registers (see Register Map). Input registers contain information that is read-only. For example, the current input value read from a channel, or the states of a group of digital inputs. Holding registers contain read/write information that may be configuration data or output data. For example, the high limit value of an alarm function operating at an input, or an output value for an output channel. I/O values for this model are represented by the following simple data types for percent-of-span, and discrete on/off.

Summary Of Data Types Used By 900MB Modules

Data Types	Description
Count Value	A 16-bit signed integer value representing an A/D count, a DAC count, or a time value with a range of –32768 to +32767.
Percentage	A 16-bit signed integer value with resolution of 0.005%/lsb. ±20000 is used to represent ±100%. For example, -100%, 0% and +100% are represented by decimal values –20000, 0, and 20000, respectively. The full range is –163.84% (-32768 decimal) to +163.835% (+32767 decimal).
Temperature	A 16-bit signed integer value with resolution of 0.1°C/lsb. For example, a value of 12059 is equivalent to 1205.9°C, a value of –187 equals –18.7°C. The maximum possible temperature range is –3276.8°C to +3276.7°C.
Discrete	A discrete value is generally indicated by a single bit of a 16-bit word. The bit number/position typically corresponds to the discrete channel number for this model. Unless otherwise defined for outputs, a 1 bit means the corresponding output is closed or ON, a 0 bit means the output is open or OFF. For inputs, a value of 1 means the input is in its high state (usually >> 0V), while a value of 0 specifies the input is in its low state (near 0V).

Modbus Error Checking Fields

Modbus networks employ two methods of error checking: parity checking (even or odd parity, or none), and frame checking (Cyclical Redundancy Check).

Parity Checking

A Modbus device can be configured for Even or Odd parity checking, or for no parity checking, and this determines how the parity bit of the data frame is set.

If even or odd parity checking is selected, the number of 1 bits in the data portion of each character frame is counted. Each character in RTU mode contains 8 bits. The parity bit will then be set to a 0 or a 1, to result in an even (Even parity), or odd (Odd parity) total number of 1 bits.

For example, if an RTU character frame contains the following eight data bits: 1100 0011, then since the total number of 1 bits is 4 (already an even number), the frame's parity bit will be 0 if even parity is selected. If odd parity is used, then the parity bit will be set to 1, making the total number of one bits an odd number (five).

When a message is transmitted, the parity bit is calculated and applied to the frame of each character transmitted. The receiving device counts the quantity of 1 bits in the data portion of the frame and sets an error flag if the count differs from that sent. As such, parity checking can only detect an error if an odd number of bits are picked up or dropped off from a character frame during transmission. For example, if odd parity is employed and two 1 bits are dropped from a character, the result is still an odd count of 1 bits. Note that all devices on a Modbus network must use the same parity.

If no parity checking is selected, then no parity bit is transmitted and no parity check is made. An additional stop bit is transmitted to fill out the character frame for the no parity selection. The Acromag device will actually work with 1 or 2 stop bits with no parity selected.

CRC Error Checking

RTU Mode message frames include an error checking method that is based on a Cyclical Redundancy Check (CRC). The error checking field of a frame contains a 16-bit value (two 8-bit bytes) that contain the result of a Cyclical Redundancy Check (CRC) calculation performed on the message contents.

The CRC value is calculated by the transmitting device and is appended to the message as the last field in a message—the low order byte is appended first, followed by the high-order byte. Thus, the CRC high-order byte is the last byte to be sent in a message. The receiving device calculates a CRC during receipt of a message and compares the calculated value to that received in the CRC field. If the two values differ, an error results.

The CRC is started by first preloading the 16-bit CRC register to all 1's. Successive 8-bit bytes of the message (only the 8-data bits in each character--no start, stop, or parity bits) are applied to the current contents of the register, and each 8-bit character is exclusive OR'ed with the register contents.

The exclusive OR result is shifted in the direction of the least significant bit (lsb) of the CRC, with a zero placed into the most significant bit (msb). The lsb is then extracted and examined, if the lsb is a 1, the register is exclusive OR'ed with a preset fixed value. If the lsb is a 0, no exclusive OR takes place. This process is repeated until 8 shifts have been performed. After the last (eighth) shift, the next 8-bit byte is exclusive OR'ed with the register's current contents, and the process repeats itself for 8 more shifts as described above. The final contents of the CRC register after all the message bytes have been applied is the CRC value.

Modbus Exceptions

If an unsupported function code is sent to a module, then the exception code 01 (Illegal Function) will be returned in the data field of the response message. If a holding register is written with an invalid value, then exception code 03 (Illegal Data Value) will be returned in the response message. The following table lists the possible exception codes:

Modbus Exception Codes

Code	Exception	Description
01	Illegal Function	The function code received in the query is not allowed or invalid.
02	Illegal Data Address	The data address received in the query is not an allowable address for the slave or is invalid.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for the slave or is invalid.
04	Slave Device Failure	An unrecoverable error occurred while the slave was attempting to perform the requested action.
05	Acknowledge	The slave has accepted the request and is processing it, but a long time is required to do so. This response is used to prevent a timeout error from occurring in the master.
06	Slave Device Busy	The slave is engaged in processing a long-duration program command. The master should retransmit the message later when the slave is free.
08	Memory Parity Error	The slave attempted to read extended memory, but detected a parity error in memory. The master can retry the request, but service may be required at the slave device.
07	Negative Acknowledge	The slave cannot perform the function received in the query. This code is returned for an unsuccessful programming request using function code 13 or 14 (codes not supported by this model). The master should request diagnostic info from the slave.

In a normal response, the slave echoes the function code of the original query in the function field of the response. All function codes have their most-significant bit (msb) set to 0 (their values are below 80H).

In an exception response, the slave sets the msb of the function code to 1 in the returned response (i.e. exactly 80H higher than normal) and returns the exception code in the data field. This is used by the master's application to recognize an exception response and direct an examination of the data field for the applicable exception code.

MODULE SOFTWARE CONFIGURATION

As shipped from the factory, each module has a default configuration as detailed in the INSTALLATION section of this manual. Your application will likely differ from the default configuration and the module will need to be reconfigured. Series 900MB modules may be easily configured and calibrated by simply issuing the appropriate Modbus functions to the Register Map registers, as required to configure the unit. However, it is much simpler to use the controls of the 900MB Configuration Software to program and control the Model 918MB-0900 transmitter parameters and operating modes. This software is generally easy to use and self explanatory. Complete configuration only takes a few minutes. On-line help is also built-in and includes context sensitive help. As such, a comprehensive guide to the use of this program is not necessary. However, to begin configuration, you should already be familiar with Windows operation and have a basic understanding of transmitter terminology as it relates to this model.

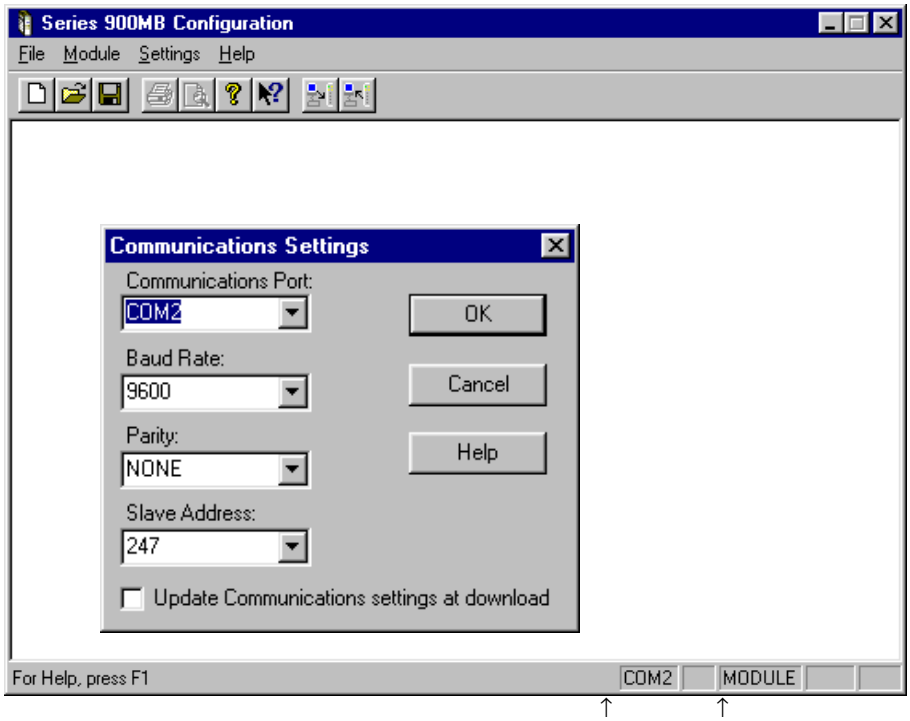
Before You Begin

1. Have you installed the 900MB Configuration Program? You should complete the MODULE INSTALLATION section (Section 2.0) of this manual before proceeding.
2. Check that all necessary electrical connections have been made and that power is applied (module's green LED ON).
3. Have you set the correct baud rate at the RS485 converter (or repeater if used)?
4. Have you tried communicating using the Default Communication Mode? Press the "DFT" push-button of the 918MB module until the yellow status LED is flashing. This sets the module's communication parameters to 9600 baud, a slave address of 247, no parity, and two stop bits. Be sure to also set the baud rate of the RS485 converter or network repeater to 9600 baud.
5. If you fail to communicate with the module or have a high degree of communication errors, try increasing the response delay time (See Response Delay Register 40010). Some network converters or host/software systems cannot accept an immediate response from a slave device without additional delay.

The following sections guide you through the 900MB Configuration Program property sheets used to configure the 918MB Transmitter. These sheets vary slightly between models, but the general approach is the similar. Refer to on-line Help if you have trouble understanding parameters unique to your module.

Starting The Program

After clicking on the Series 900MB program icon to boot the Configuration Program, a screen similar to the one at right will be displayed. To begin, click the "Settings-Serial Communications…" pull-down menu (or press Ctrl-E) to set the COM port, baud rate, parity, and slave address that the host computer will use to communicate with the module (as shown at right). Optionally, you can check the "Update Communications settings at download" box to automatically change the host settings to match the module if new settings are later downloaded to the module (recommended to conveniently maintain communication with a module following reconfiguration).



Available menu selections are listed below.

↑ COM Port ↑ MODULE

Note that the host COM port selected is indicated in the first box of the lower right-hand corner. MODULE is indicated in the third box if a connected module is detected by the software. The fourth and fifth boxes indicate NUM lock and CAP's lock, respectively.

File
- New…
- Open…
- Save
- Save As…
- Print…
- Print Preview
- Print Setup…
- *Recent File Indicated*
- Exit

Use **File-New** to create a new configuration file. You will be prompted to select a model number. Use **File-Open** to open an existing configuration file.

Use **File-Save** to save the current configuration file to disk. Use **File-Save As** to save the current configuration file to a new file name.
Use **File-Print** to get a printout of the currently loaded configuration file.

Use **File-Print Preview** to view the current configuration or preview the print documentation. Use **File-Print Setup** to select a printer and font style.

Module
- Upload Configuration
- Download Configuration

Use **Module-Upload Configuration** to upload the module's current configuration and calibration.

Use **Module-Download Configuration** to write the currently loaded configuration to the module.

Settings-
Serial Communications…
- Communications Port
- Host Baud Rate
- Host Parity
- Slave Address

Use the **Communications Port** scroll window to select the host COM port the module is connected to (COM1-COM4), or type in a COM port as required, from COM1 to COM99. The selected COM port is indicated in the lower right hand corner of the screen.

Use the **Baud Rate** scroll window to select the baud rate to be used by the host in communicating with the module.

Use the **Parity** scroll window to select Odd, Even, or No Parity checking by the software for data transfer.

Use the **Slave Address** scroll window to tell the software which module to address.

If you wish to maintain communications with a module following download, you should check the **"Update Communications settings at download"** box of the Settings window to keep the host in synch with a module if the module settings are changed.

If the module is in the Default Mode (indicated via a flashing status LED), the baud rate, address, and parity assumed by the module are fixed at 9600bps, 247, and No Parity. You must use the same settings as the connected module.

Help
- Configuration Help Topics
- *Your Model* Help Topics
- About Modbus Configuration
- About *Your Model*

Use **Help** to obtain information about using this software or configuring transmitters. Note that context sensitive help (↑?) is also available for help on a specific field or topic. Simply click on the [↑?] button, then click on the field or topic of interest to obtain help on that subject. You may also click the right mouse button to copy or print the help screen while it is being displayed.

The following sections review the configuration of a Model 918MB-0900 transmitter module. Configuration of your model will be similar.

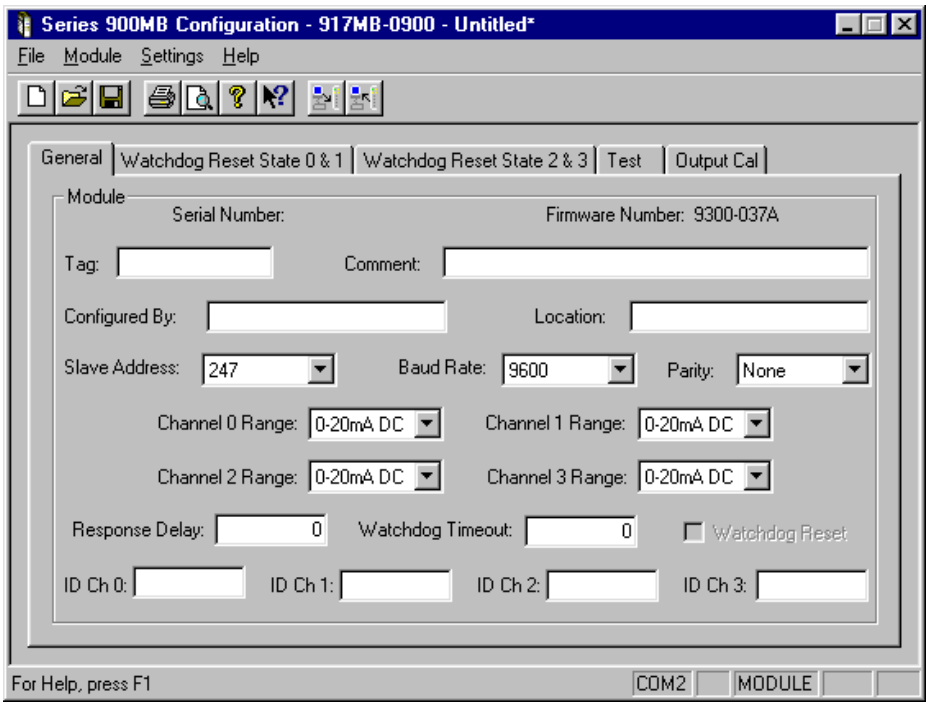
Creating A Configuration File

You may use **File-New** to create a new configuration file, or **File-Open** to open an existing configuration file. You may also use **Module-Upload Configuration** to retrieve the current active configuration from the module connected (recommended).

Uploading first is recommended as it will automatically detect the correct model connected and load the property sheets for that model.

Once you create, open, or upload a configuration file, a screen similar to the one shown at right will be displayed. The model number is indicated at the top of the screen along with the current file name. The Model 917MB-0900 Configuration screen is shown here. Your screen will vary according to your model number.

Note that 3 property sheets define this transmitter's configuration: General, Test, and Output Calibration.



Module

The Serial and Firmware numbers indicated at the top of the General screen cannot be modified.

For "Tag:", enter up to 15 alphanumeric characters (optional).

For "Comment:", enter up to 31 alphanumeric characters (optional).

For "Configured By:", enter your name up to 15 alphanumeric characters (optional).

You can also add a "Location:" note of up to 25 alphanumeric characters (optional).

For "Channel ID:", enter up to 15 alphanumeric characters of identification information relative to the output channel (optional).

Use the **"Slave Address"** scroll bar to select a new module address that will take effect following download. Select from 1 to 247. Address 247 is reserved for Default Mode.

Use the **"Baud Rate"** scroll bar to select a new baud rate to be used by the module following download. Select 2400, 4800, 9600 (Default Mode), 14400, 19200, 28800, 38400, 57600, 76800, or 115200 bits per second.

Use the **"Parity"** scroll bar to select Odd, Even, or No Parity (Default Mode) error checking by the module.

Use the **"Response Delay"** field to specify a delay from 0 to 65500 ticks with 1 tick equal to 1.085 micro-seconds. Response delay is the additional turnaround delay applied between message receipt by the module and its response to the host. A fixed amount of delay is already present and varies with the model. Thus, you will have to specify a comparable amount of response delay to measure any affect. Some host software or signal converters require additional delay to work properly.

Note that slave address, baud rate, and parity selections take effect following a configuration download and do not alter the settings used by the host software (which are configured separately via the **Settings** menu).

If you checked the "Update Communications Settings at Download" box of the Settings pull-down menu, this software will change the host settings to match the module settings that take effect following a download in an effort to maintain communication with the module. Otherwise, you must change the host Settings separately after downloading to match the new module settings.

If the module is in Default Mode (indicated via a flashing status LED), the baud rate, address, and parity of the module are fixed at 9600bps, 247, and No Parity.

Output (All Channels)

Use the **"Range:"** scroll bar to pick one of the following ranges according to your model:

917MB:	**918MB:**
0-20mA	0-10V DC
4-20mA	0-5V DC
0-1mA	0-1V DC

The analog output utilizes percent-of-span units with ±20000 representing ±100%. That is, for the 4-20mA range, a 0% indication (0) represents 4mA and 100% (20000) represents 20mA.

Available ranges will vary according to your model number. All output ranges have been factory calibrated. To begin configuring your module, start by selecting an output range as required.

Use the **"Watchdog Time:"** field to specify a watchdog period up to 65534 seconds (18.2 hours). 0 or 65535 will disable the watchdog function.

Check the **"Watchdog Reset"** box to optionally set the output channels to specific states or levels following a watchdog timeout (see following page).

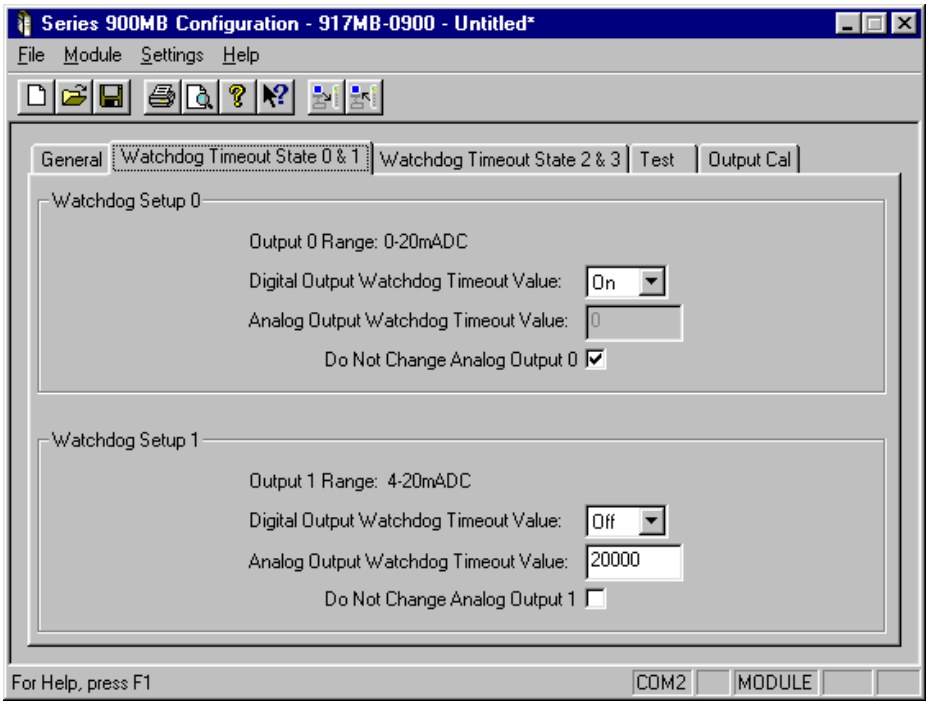
The next section covers Watchdog Timeout Value Configuration for the output channels of this model. Note that you can only make changes to the parameters of the following page if you have configured a Watchdog Timeout delay and checked the Watchdog Reset box as described above.

Watchdog Timeout States/Values

Click on the "Watchdog Timeout State 0 & 1", or "Watchdog Timeout State 2 & 3" property sheet tabs and a screen similar to the one at right will be displayed. The Model 917MB-0900 watchdog screen is shown here (Model 918MB-0900 screen is similar).

If you checked the "Watchdog Reset" box of the General property sheet described on the previous page, you will be allowed to make changes to the parameters of this page.

Use this page to configure the watchdog timeout output states and levels for the corresponding digital and analog outputs. Timeout states and levels may be set for each of the four analog and digital outputs of this model. A watchdog timeout will automatically drive the outputs to the states/levels defined here when enabled.



A watchdog timer may be applied to the output channels of this module and the timeout delay is set via the General property sheet (described on the previous page). A watchdog timeout will occur if no channel I/O has occurred over the specified timeout period. For example, if communication with the unit is lost. Optionally, you can use the parameters of this property sheet to define the states that the digital outputs are to be programmed to upon output timeout. You can also define the timeout levels that the analog outputs will be programmed to upon timeout. Watchdog timeout state or level control takes precedence over direct control of the output channels. A watchdog timeout is cleared and the timer reinitiated via a read or write to any output channel, or by resetting the module. Note that clearing a timeout does not set the outputs to their pre-timeout state--they remain in their timeout state until otherwise written.

Before you can make changes to output timeout states or levels, you must have already configured a watchdog timeout value and have checked the "Watchdog Reset" box of the General property sheet as described on the previous page.

Use the **"Digital Output Watchdog Timeout Value"** scroll bar to select On or Off for the corresponding digital output channel. This defines the state the corresponding output will be programmed to following a watchdog timeout. After a timeout is cleared, the output remains in its current state until otherwise written.

Note that the digital output channels of this module are open-drain mosfet (low-side) switches. On refers to an output that is sinking current. Off refers to a switch that is not conducting.

Use the channel **"Analog Output Watchdog Timeout Value"** field to define the level the analog output is to assume following a watchdog timeout. If you check the "No Change" check box just below this field, the analog output will not be affected by a watchdog timeout. Note that after a timeout is cleared, the output remains at the current level until otherwise written.

Note that the analog output channels utilize percent-of-span units with ±20000 representing ±100%. That is, for the 4-20mA range, a 0% indication (0) represents 4mA (or 0mA for 0-20mA range), and 100% (20000) represents 20mA. You can enter a value from 0 to 20500 for the Model 917MB.

The "Watchdog Timeout State 2 & 3" property sheet is configured in the same fashion, but applied to outputs 2 and 3.

The next section covers testing of your module. Use the Test page to check output operation and/or monitor output states and levels.

Testing Your Configuration

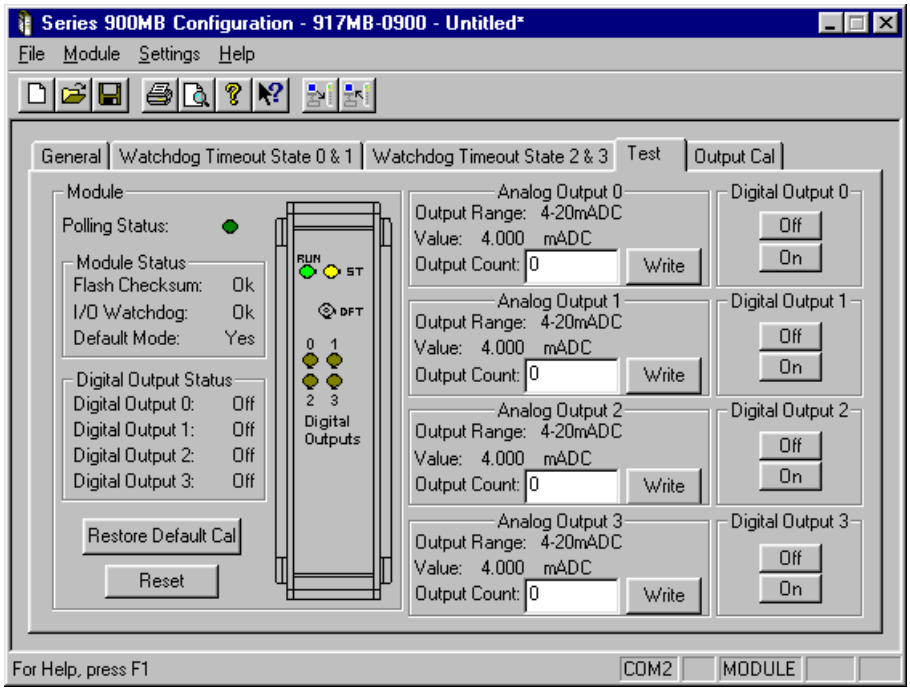
The "Test" portion of this program allows you to monitor polling, monitor module status flags, restore factory calibration, reset the module, monitor output ranges and values, and control or monitor output levels and states.

Test Operation

Click on the "Test" property sheet tab to test the configuration just written to your module and a screen similar to the one at the right will be displayed (Model 917MB-0900 Test screen shown).

The flashing green Status lamp next to "Polling Status" indicates the software is communicating with the module and polling its I/O. Polling is automatic when this screen is displayed and turns off if another screen is selected.

The graphic simulation of the module LED's reflects the current LED status of the module.



You can reset the module by clicking the "Reset" button (same effect as power-on reset). Note that a module will exit the Default Mode following a reset. New address, baud rate, and parity settings will take effect immediately following a reset—to continue communications following reset, be sure to make host software adjustments accordingly via the Settings pull-down menu.

For each analog output, the current selected output range and output value ("Value:") are indicated. A type field and Write button are provided for writing the output count. The count value is written in percent-of-span units with ±20000 representing ±100%. You can write any value from 0 to 20500 for the Model 917MB-0900. That is, for the 4-20mA output range selection, enter 0 for a 0% (4mA) output value, or 20000 for a 100% (20mA) output value.

NOTE: The module always uses percent-of-span units as described above. Translation to milliamp (mA) indication in the "Value:" field is done via this software. Keep this in mind when using other software packages to read or write values to a module. Note also that "Value:" is computed via this software and may not represent the actual output reading (it is not a read value).

If polling is OFF, then the last transmitted values are indicated. If the module is not connected or powered, then an "Unable to communicate with module" message is displayed.

You can write a value to the output by typing a percent-of-span value into the corresponding field box and then clicking on the adjacent "Write" button.

Click buttons are also provided for each digital output. Click the "On" button to turn the output ON (sinking current), or click the "Off" button to turn it OFF (open). The actual state of the output is indicated in the Digital Output States section on the left side of the screen. The current state is also indicated via the yellow Digital Output LED's of the module graphics.

If you miscalibrate a module, or your calibration appears in error, you can use the "Restore Default Calibration" button to restore a module's original factory output calibration (all outputs are restored together).

Print Your Configuration

If you wish to document your transmitter configuration, then select **File-Print** to get a two page printout of all of your selected configuration parameters.

Saving Your Configuration

You should select **File-Save As** to save your configuration file to disk and give it a new file name.

Use File-Save to save the current file without renaming it.

Note that the currently loaded configuration file name is indicated at the top of the screen to the right of the model number.

In the event that you lose a configuration file, you can always upload it from the module via Module-Upload Configuration.

Note that the configuration process may vary slightly for other model types.

Now wasn't that easy! That's all there is to using the configuration software to configure your module. The module is now ready for installation in the field.

The next section covers output calibration of your module. Note that calibration has already been done at the factory and readjustment is not generally required. However, periodic recalibration may be performed to correct for component aging, or as part of your company's maintenance requirements.

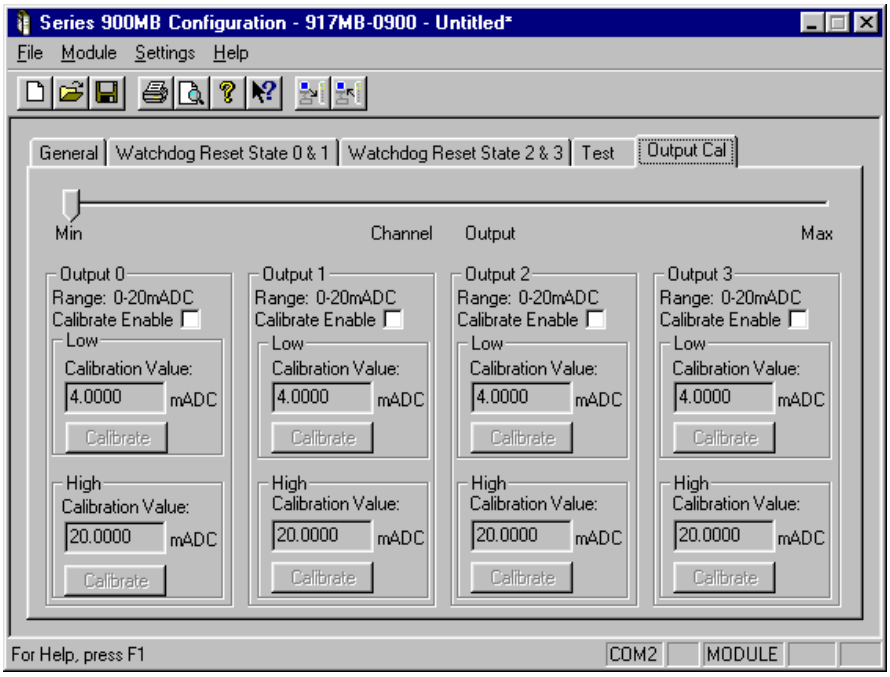
OUTPUT CALIBRATION

Selecting the **Output Cal** property sheet will display a screen similar to the one shown at right.

Note: Calibration of the analog output has already been done on your module at the factory. Recalibration is normally not required, except as necessary to correct for long term component aging, or to satisfy your company's maintenance requirements.

To begin calibration, you must first check the Calibrate Enable box of the output channel you wish to calibrate. This will cause the output controls (slide control and the right & left arrow keyboard keys) to control only the output channel of interest.

If you miscalibrate a module, or your calibration appears in error, you can use the "Restore Default Calibration" button of the Test page to restore a module's original factory output calibration.



IMPORTANT: Checking the Calibration Enable box will automatically set the 917MB output range to 0-20mA, as all channels are calibrated using the 0-20mA output range, a low calibration value of 4mA, and a high calibration value of 20mA. On 918MB units, the output range is set to 0-10V, the low calibration value is 0V, and the high calibration value is 10V. The calibration of other output ranges is calculated internally and based on these endpoints. As such, if you are using any other output range, you will need to reselect it from the General Page, then download your configuration again, after calibrating the outputs via this software.

The slide control at the top of the screen is used to adjust the output signal of the Calibrate-Enabled output channel. Simply drag the Min/Max slide control with your mouse until the output signal is equivalent to the Calibration Value indicated. Use the right and left arrow keys of your keyboard to make fine adjustments and increment or decrement the output signal as required. Click on the corresponding Low or High "Calibrate" button to set the respective endpoint (a reset will occur).

For best results, you must measure the output signal via an external current or volt meter that is at least as accurate as the module itself.

There are four output channels on this module. You may follow this procedure to select, measure, and calibrate each output channel separately.

Output Calibration Procedure

1. Prior to attempting calibration, be sure to upload the module's current configuration via **Module-Upload Configuration.** This will help to prevent miscalibration by recalling the module's current calibration.

2. Click on the **Output Cal** property sheet tab to display the screen shown above. Click on the Calibrate Enable check box of the output channel to calibrate.

3. Connect a meter to measure the output signal as required. For current outputs, you can place an ammeter in series with your load or a voltmeter across a precision load resistor to monitor voltage. Observe proper polarity. Be sure to use a meter of greater accuracy than the module itself.

4. Use the slide control by clicking and dragging it with your mouse until the output signal is equivalent to the Low Calibration Value. Use the right or left arrow keys to increment or decrement the output signal until the output is precisely equivalent to the Low Calibration Value within 1 DAC step.

   Does the measured value match the Low Calibration Value within 0.1% of output span? If not, then continue to tap the arrow keys slowly, until it is within the acceptable error band. Then click on the Low **"Calibrate"** button to set the Low Calibration endpoint.

5. As in Step 4, use the slide control and right/left arrow keys to adjust the output to the High Calibration Value. Make adjustments until the output is precisely equal to the High Calibration Value within 1 step.

   Does the measured value match the High Calibration Value within 0.1% of output span? If not, then continue to tap the arrow keys slowly, until it is within the acceptable error band. Click on the High **"Calibrate"** button to set the High Calibration endpoint.

6. **IMPORTANT:** On 917MB models, all ranges are calibrated with the 0-20mA input range selected via Calibrate Enable (or 0-10V on 918MB units). If you are using any other input range, you will need to reselect it from the General Page, then download your configuration again after calibrating the outputs via this software.

For best results, you should always calibrate the low value before the high value, and allow the module to warmup a few minutes prior to calibration.

The 0-20mA and 0-1mA output ranges (917MB only) may not go to precisely 0mA. The 0-20mA range will typically approach 0mA to within 20uA. As such, it is necessary to use a non-zero low calibration value instead of 0mA for these ranges. In addition, the 0-1mA range resolution is poor. Keep this in mind if you are using some other software to accomplish calibration.

4.0 THEORY OF OPERATION

Refer to Simplified Schematic 4501-828 and Functional Block Diagram 4501-829 to gain a better understanding of the circuit. Note that this transmitter will drive up to four analog current, plus four open-drain digital outputs, and provides network commands to configure the module, plus monitor and control the outputs. The microcontroller parses I/O commands and sends output values to 12-bit Digital-to-Analog Converters at each output. A corresponding DAC output voltage is sent to a voltage-to-current converter circuit. I/O lines of the microcontroller also switch discrete outputs ON/OFF, as required. The UART of the microcontroller sends/receives its I/O signals to the network via an optically isolated RS485 transceiver. Embedded configuration and calibration parameters are stored in non-volatile memory integrated within the micro-controller. Only the functions required by an application are actually stored in memory—new functionality can be downloaded via the host running the Modbus Configuration Software, or other compatible Modbus software along the network. A wide input switching regulator (isolated flyback mode) provides isolated power to the various I/O circuits. Refer to Functional Block Diagram 4501-829 for an overview of how the software configuration variables are arranged.

5.0 SERVICE AND REPAIR

CAUTION: Risk of Electric Shock - More than one disconnect switch may be required to de-energize the equipment before servicing.

SERVICE AND REPAIR ASSISTANCE

This module contains solid-state components and requires no maintenance, except for periodic cleaning and transmitter configuration parameter verification. Since Surface Mounted Technology (SMT) boards are generally difficult to repair, it is highly recommended that a non-functioning module be returned to Acromag for repair. The board can be damaged unless special SMT repair and service tools are used. Further, Acromag has automated test equipment that thoroughly checks and calibrates the performance of each module. Please refer to Acromag's Service Policy Bulletin or contact Acromag for complete details on how to obtain service parts and repair.

PRELIMINARY SERVICE PROCEDURE

Before beginning repair, be sure that all installation and configuration procedures have been followed. Make sure that the correct baud rate is selected for the RS232-to-RS485 converter employed. The unit routinely performs internal diagnostics following power-up or reset. During this period the green "Run" LED flashes. If the diagnostics complete successfully, the "Run" LED will stop flashing after two seconds and remain ON. This indicates that the unit is operating normally. If the "Run" LED continues to flash, then this is indicative of a problem. In this case, use the Acromag Modbus Configuration Software to reconfigure the module and this will usually cure the problem. If the diagnostics continue to indicate a problem (a continuously flashing green LED), or if other evidence points to a problem with the unit, an effective and convenient fault diagnosis method is to exchange the questionable module with a known good unit.

Acromag's Application Engineers can provide further technical assistance if required. When needed, complete repair services are available from Acromag.

TROUBLESHOOTING

If you fail to communicate with the Model 917MB or 918MB…

1. Is power ON at the module (Green power LED ON) AND the RS485 signal converter?
2. Have you set the correct baud rate at the RS485 converter (or repeater if used)? Have you set the correct baud rate and parity at the host? Are you using the correct slave address?
3. Have you tried communicating using the Default Communication Mode? Press the "DEF" push-button of the 918MB module until the yellow status LED is flashing. This sets the module's communication parameters to 9600 baud, a slave address of 247, no parity, and two stop bits. Additionally, be sure to set the baud rate of the RS485 converter or repeater to 9600 baud.
4. Has the module been reset? The module will automatically leave the Default Communication Mode following a software or power-on reset and new settings for address, baud rate, and parity will take effect following reset. Be sure to make host/software adjustments to these parameters following a reset of the module, as required to maintain communication.
5. If you fail to communicate with the module or have a high degree of communication errors, try increasing the response delay time (See Response Delay Time Register 40006). Some network converters or host/software systems cannot accept an immediate response from a slave device without additional delay.

6.0 SPECIFICATIONS

General: The Model 917MB-0900 & 918MB-0900 are DC-powered or 24VAC powered network transmitters which drive up to four analog output signals (current or voltage), plus four open-drain output switches, and provide an isolated RS485/Modbus network interface. Isolation is supplied between the output circuit (as a group), the network, and power. The outputs may operate as discrete on/off controls for external devices. This transmitter is DIN-rail mounted.

The unit is configured and calibrated with our user-friendly Windows 95/98® or NT® 900MB Configuration Program. Optionally, you may use your own software as long as you adhere to the Modbus command/response format for supported commands. A push button on the module allows communication with a module when its address, baud rate, and parity settings are unknown. Non-volatile reprogrammable memory in the module stores calibration and configuration information.

MODEL NUMBER DEFINITION

Transmitters are color coded with a white label. The prefix "9" denotes the Series 900, while the "MB" suffix specifies that this device is primarily a process transmitter for Modbus networks.

917MB: Transmits up to four DC current output channels, plus four digital outputs.
918MB: Transmits up to four DC voltage output channels, plus four digital outputs.

-0900: The four digits of this model suffix represent the following options, respectively:
0 = No Options;
9 = Output: RS485/Modbus;
0 = Enclosure: DIN rail mount;
0 = Approvals: CE, UL Listed, and cUL Listed.

ANALOG OUTPUT SPECIFICATIONS

Each output channel of these models includes a 12-bit DAC (Digital-to-Analog Converter) that drives a voltage to current converter (917MB model), or voltage amplifier (918MB model). The unit must be wired and configured for the intended output type and range (see Installation Section for details). The unit can be easily reconfigured to accept any one of the output ranges described below using the Modbus Configuration Program. Analog outputs go to their minimum levels following a software or power-on reset of the module, but may be optionally sent to user-defined levels following a watchdog timer timeout. The following paragraphs summarize this model's output ranges and applicable specifications.

Current Output Specifications (917MB Only):

Output Ranges: Select 0-20mA DC, 4-20mA DC, or 0-1mA DC. Ranges are sub-ranges of nominal 0-22.67mA design limit (includes approximately 12.5% of over-range).
Note: The 0-20mA & 0-1mA output ranges may not precisely go to the 0mA endpoint. The 0-20mA range will typically approach 0mA within 0.1% of span.
Output Maximum Current: 22.67mA typical.
Output Accuracy: See Table 3.
Output Compliance: 12V Minimum, 13V Typical.
Output Load Resistance Range: 0 to 625Ω, typical.
Response Time: 11ms typical into 500Ω, for measurement to reach 98% of the final value in response to a step command. Actual response time will vary with load.
Output Resolution: 12 bits, or 1 part in 4096 based 22.67mA full-scale. This is 5.535uA/bit (22.67mA/4096bits). See below for effective resolution calculations.
DAC Count (Current): The internal DAC count can be calculated by multiplying the output current by 180680. The resultant value (rounded) can be used to calculate the effective resolution and to approximate the required output register program value (see below).

Internal DAC Count Versus Current Output Range

Range	DAC 0%	DAC 100%	DAC Span
0-1mA	0	181	181
4-20mA	723	3614	2891
0-20mA	0	3614	3614

Note that the effective resolution is 1 part in the DAC Span.

Register Program Value: Output values use integers with ±20000 representing ±100%. The required output register program value can be approximated using the DAC values shown above via the formula:

Register Value = 20000 * (DAC Count – DAC 0%)/DAC Span

Current Output Register Program Value

	Output Current				
Range	0mA	1mA	4mA	12mA	20mA
0-1mA	0	20000	---	---	---
4-20mA	---	---	0	10000	20000
0-20mA	0	1000	4000	12000	20000

Voltage Output Specifications (918MB Only):

Output Range: 0-10V DC, 0-5V DC, or 0-1V DC. Ranges are sub-ranges of nominal 0-11.3V design limit (includes approximately 13% of over-range).
Output Maximum Voltage: 11.3V, typical.
Output Accuracy: See Table 3.
Output Current: 0-10mA DC maximum.
Output Impedance: 1Ω.
Output Short Circuit Protection: Included
Response Time: 110us rise time typical, 150us fall time typical, unloaded, for output to reach 98% of the final value in response to a step command. Actual response time will vary with load.
Output Resolution: 1 part in 4046 based on 11.368V full-scale, or 2.81mV/bit (11.368V/4046bits).
DAC Count (Voltage): The internal DAC count can be calculated by multiplying 355.96 by the sum of the output voltage and 0.1393. The resultant value (rounded) can be used to calculate the effective resolution and to approximate the required output register program value (see below).

Internal DAC Count Versus Voltage Output Range

Range	DAC 0%	DAC 100%	DAC Span
0-1V	50	406	356
0-5V	50	1829	1779
0-10V	50	3609	3559

Note that the effective resolution is 1 part in the DAC Span.

Register Program Value: Output values use integers with ±20000 representing ±100%. The required output register program value can be approximated using the DAC values shown above via the following formula:

Register Value = 20000 * (DAC Count – DAC 0%)/DAC Span

Voltage Output Register Program Value

	Output Voltage				
Range	0V	1V	2.5V	5V	10V
0-1V	0	20000	---	---	---
0-5V	0	4000	10000	20000	---
0-10V	0	2000	5000	10000	20000

General Output Specifications

Accuracy: Accuracy is better than ±0.1% of span, typical, for 4-20mA, 0-20mA, 0-10V, and 0-5V ranges (see Table 3). This includes the effects of repeatability, terminal point conformity, and linearization.
Resolution: See Table 3.
Ambient Temperature Effect: Better than ±.01% of output span per °C (±100ppm/°C), or ±1.0uV/°C, whichever is greater.
Digital-to-Analog Converter: Burr-Brown DAC7615, 12-bit. Monotonic to 12 bits.
Integral Non-Linearity: ±0.1% of span or ±2LSB typical, whichever is larger, for spans equal to or greater than 16mA (917MB) or 5V (918MB).

Table 3: Analog Output Range Resolution & Accuracy

Calibrated Out Range	Effective Resolution	Accuracy Percent-of-Span
Model 917MB-0900		
0 to 20mA DC	.028%, 1/3614	±0.1% span (±0.02mA)
4 to 20mA DC	.035%, 1/2891	±0.1% span (±0.02mA)
0 to 1mA DC	.552%, 1/181	±1.6% span (±0.002mA)
Model 918MB-0900		
0-10V DC	.028%, 1/3559	±0.1% span (±10mV)
0-5V DC	.056%, 1/1779	±0.1% span (±5mV)
0-1V DC	.281%, 1/356	±0.8% span (±8mV)

DIGITAL OUTPUT SPECIFICATIONS

Four open-drain outputs are installed in this module and operate as discrete outputs (coils) for control of external devices. Digital outputs go to their OFF state following a software or power-on reset of the module, but may be optionally sent to user-defined states following a watchdog timer timeout.
Note: To control a higher amperage device, such as a pump, an interposing relay may be used (see Drawing 4501-832).
Note: When the outputs are used to control interposing relays to switch AC and DC devices of higher voltage/current, the coil ratings for the interposing relay shall not exceed 24V DC, 100mA.

Output Channel Configuration: Four open-drain mosfet switches which share a common return (source) connection at the RTN terminal. For DC voltage and current sinking applications only--observe proper polarity. To control higher voltage and/or current, or for controlling AC, an interposing relay may be used (see Connections Drawing 4501-831).
Output "OFF" Voltage Range: 0-35V DC continuous, 47Vpk.
Output "OFF" Leakage Current: 0.1uA typical, 50uA maximum (25°C, 40VDC).
Output "ON" Current Range: 0 to +1A DC, continuous, for each output switch (group one RTN per each group of 2 outputs). No deration required at elevated temperatures.
Output R_{ds} ON Resistance: 0.15Ω Maximum (25°C, 1A).
Output Response Time: Outputs will switch within 5ms typical, upon receiving a control command.
Output Over-Temperature Protection: Outputs will turn-off if the junction temperature of the device exceeds 165°C. Cycling the output off/on will restart the output.
Output Over-Current Protection: Outputs will turn-off if the drain current reaches 5A. Cycling the output off/on will restart the output.

ENCLOSURE/PHYSICAL SPECIFICATIONS

See Enclosure Dimensions Drawing 4501-833. Units are packaged in a general purpose plastic enclosure that is DIN rail mountable for flexible, high density (approximately 1" wide per unit) mounting.

Dimensions: Width = 1.05 inches, Height = 4.68 inches, Depth = 4.35 inches (see Drawing 4501-833).
DIN Rail Mounting (-xx0x): DIN rail mount, Type EN50022; "T" rail (35mm).
Connectors: Removable plug-in type terminal blocks; Current/Voltage Ratings: 15A/300V; Wire Range: AWG #12-24, stranded or solid copper; separate terminal blocks are provided for analog outputs, discrete outputs, and power & network. For supply connections, use No. 14 AWG copper wires rated for at least 75°C.
Case Material: Self-extinguishing NYLON type 6.6 polyamide thermoplastic UL94 V-2, color beige; general purpose NEMA Type 1 enclosure.
Printed Circuit Boards: Military grade FR-4 epoxy glass.
Shipping Weight: 1 pound (0.45 Kg) packed.

APPROVALS (-xxx0)

0: CE marked, per EMC Directive 2004/108/EC. UL Listed (USA & Canada). Hazardous Locations – Class I, Division 2, Groups A, B, C, D. Consult Factory.

ENVIRONMENTAL SPECIFICATIONS

Operating Temperature: 917MB: -25°C to +60°C (-13°F to +140°F), limit 917MB ambient to 50°C maximum for supply voltages less than 15V; 918MB; -25°C to +70°C (-13°F to +158°F).
Storage Temperature: -40°C to +85°C (-40°F to +185°F).
Relative Humidity: 5 to 95% non-condensing.
Power Requirements: Non-polarized 10-36V DC SELV (Safety Extra Low Voltage), or 22-26 VAC. Current draw is a function of supply voltage and model number (see Tables 8A, 8B). Current shown below assumes that all outputs are ON (LED's ON), the module is connected to the network, and module is in the default mode. The power terminals are diode coupled and are not polarized.

CAUTION: Do not exceed 36VDC peak, to avoid damage to the module.

The 917MB current in Table 8A assumes that all four current outputs are delivering 20mA. Note the 917MB maximum ambient is derated to 50°C for supply voltages less than 15V.

Table 8A: 917MB Supply Current

Supply	917MB-0900
10V	Not Recommended
12V	256mA Typical, 275mA Maximum
15V	183mA Typical, 200mA Maximum
24V	108mA Typical, 120mA Maximum
36V	75mA Typical, 80mA Maximum
24VAC	190mA rms Typical, 210mA rms Maximum

The 918MB current in Table 8B assumes that all four voltage outputs are driving 10V into 10KΩ.

Table 8B: 918MB Supply Current

Supply	918MB-0900
10V	125mA Typical, 140mA Maximum
12V	100mA Typical, 115mA Maximum
15V	80mA Typical, 90mA Maximum
24V	52mA Typical, 60mA Maximum
36V	40mA Typical, 45mA Maximum
24VAC	96mA rms Typical, 105mA rms Maximum

IMPORTANT - External Fuse: If unit is powered from a supply capable of delivering more than 1A to the unit, it is recommended that this current be limited via a high surge tolerant fuse rated for a maximum current of 1A or less (for example, see Bel Fuse MJS1).

Power Supply Effect:
Volts: Less than ±0.001% of output span change per volt for rated power supply variations.
60/120 Hz Ripple: Less than 0.01% of output span per volt peak-to-peak of power supply ripple.

Installation Category: Design to operate in an Installation in a Pollution Degree 2 environment with an installation category (Over-Voltage Category) II rating.

Isolation: Output, network, and power circuits are isolated from each other for common-mode voltages up to 250VAC, or 354V DC off DC power ground, on a continuous basis (will withstand 1500VAC dielectric strength test for one minute without breakdown). This complies with test requirements of ANSI/ISA-82.01-1988 for the voltage rating specified.

Radiated Field Immunity (RFI): Designed to comply with IEC1000-4-3 Level 3 (10V/M, 80 to 1000MHz AM & 900MHz keyed) and European Norm EN50082-1.

Electromagnetic Interference Immunity (EMI): No output shifts beyond ±0.25% of span under the influence of EMI from switching solenoids, commutator motors, and drill motors.

Immunity per BS EN 61000-6-1:

1) Electrostatic Discharge Immunity (ESD), per IEC 61000-4-2.
2) Radiated Field Immunity (RFI), per IEC 61000-4-3.
3) Electrical Fast Transient Immunity (EFT), per IEC 61000-4-4.
4) Surge Immunity, per IEC 61000-4-5.
5) Conducted RF Immunity (CRFI), per IEC 61000-4-6.

Emissions per BS EN 61000-6-3:

1) Enclosure Port, per CISPR 16.
2) Low Voltage AC Mains Port, per CISPR 14, 16.
3) DC Power Port, per CISPR 16.
4) Telecom / Network Port, per CISPR 22.

Note: This is a Class B product.

IMPORTANT: Power, input, and output (I/O) wiring must be in accordance with Class I, Division 2 wiring methods of Article 501-4(b) of the National Electrical Code, NFPA 70 for installations in the US, or as specified in section 18-1J2 of the Canadian Electrical Code for installations within Canada and in accordance with the authority having jurisdiction.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D, or non-hazardous locations only.

WARNING – EXPLOSION HAZARD – Substitution of components may impair suitability for Class I, Division 2.

WARNING – EXPLOSION HAZARD – Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

COMMUNICATION INTERFACE SPECIFICATIONS

These units contain an isolated RS485 communication port for the transmission of data.

Interface Standard: RS-485. Communication with this module is made over a 3-wire cable (D, D-bar, and Common).

Command/Response Protocol: Standard Modbus RTU protocol implemented as defined under "Modicon Modbus Reference Guide" PI-MBUS-300 Rev J (reference www.public.modicon.com, search keyword PI-MBUS-300 to obtain technical publication). See MODULE CONFIGURATION for a review of Modbus & commands.

Baud Rate: Programmable to 2400, 4800, 9600 (Default Mode), 14400, 19200, 28800, 38400, 57600, 76800, or 115200 bits per second.

Duplex: Half Duplex only.

Parity: Odd, Even, or None (Default Mode).

Stop Bits: 1 stop bit for even/odd parity, 1 or 2 stop bits w/no parity.

Response Delay: The minimum communication turnaround delay that a module will wait before it sends its response to a message from the host. It is applied in addition to the inherent delay already present which varies between models. It can be set from 0-65500 ticks, with 1 tick equivalent to 1.085us. Some signal converters or host/software systems cannot accept an immediate response from the slave without additional delay. Note that you may have to specify an amount of delay that is comparable to the inherent delay already present before an effect can be measured.

Module Address: Can be set from 0-247 (01H-F7H). The Default Mode address is 247 (F7H).

Network Capacity: The Module has multi-drop capability for up to 31 modules, plus host, without the use of an RS485 repeater. If a signal repeater is used for every 31 nodes, up to 247 modules may be networked, plus a host computer.

Communication Distance: Up to 4000 feet without use of a repeater. Distance can be extended with a signal repeater.

Default Communication Mode Parameters: In this mode, the module address is 247, the baud rate is 9600bps, the parity is none, and the number of stop bits is set to 2 by pressing the DFT push-button on the front of the module until the yellow Status LED flashes ON/OFF. This is provided as a means to communicate with a module when its internal address, baud rate, parity, and stop bit settings are unknown. Exit the Default Mode by pressing this button until the Status LED is NOT flashing (constant ON or OFF), or by issuing a software or power-on reset. New parameters for module address, baud rate, and parity do not take effect outside of Default Mode until after a software or power-on reset.

Watchdog Timer: A hardware watchdog timer is built into the microcontroller that causes it to initiate a self reset if the controller ever fails to return from an operation in a timely manner or "locks up". Additionally, an output watchdog timer function is implemented that may be configured for timeout periods up to 65534 seconds (18.2 hours). The output watchdog timer will cause the status LED to blink rapidly, set a bit in the Module Status Register, and optionally program the outputs to a pre-defined state or level upon watchdog timeout. The output watchdog timer is reinitiated via a read or write to any output channel.

Supported Modbus Commands: The command & response protocol for communicating with this module adheres to the Modbus/RTU standard for the following Modbus Functions. The register reference addresses that the function operates on is also indicated (see MODULE CONFIGURATION).

Code	Function	Reference
01 (01H)	Read Coil (Output) Status	0xxxx
03 (03H)	Read Holding Registers	4xxxx
04 (04H)	Read Input Registers	3xxxx
05 (05H)	Force Single Coil (Output)	0xxxx
06 (06H)	Preset Single Register	4xxxx
15 (0FH)	Force Multiple Coils (Outputs)	0xxxx
16 (10H)	Preset Multiple Registers	4xxxx
17 (11H)	Report Slave ID	*Hidden*
08 (08H)	Reset Slave	*Hidden*

CONFIGURATION AND CONTROLS

Module Push Button (See Dwg. 4501-833 For Location):

Default (DEF) - Push to engage or disengage the default communication mode with baud rate set to 9600bps, module address set to 247, and no parity selected. The Status LED will flash ON/OFF when the module is in the default mode. A module will leave the default mode following a software or power-on reset (Status LED will be OFF or constant ON).

LED Indicators:

Run (Green) - Constant ON indicates power applied and unit is operating normally. Flashing ON/OFF indicates unit is performing diagnostics (first second following power-up), or has failed diagnostics (after a few seconds).

Status (Yellow) - Flashing ON/OFF indicates module is in the default Communication Mode. Upon watchdog timer timeout, this LED will flash rapidly and may temporarily mask default mode indication.

Output (Yellow) - One per open-drain output. OFF if output is OFF (open), ON if output is ON (sinking current).

SOFTWARE CONFIGURATION

Units are fully reprogrammable via our user-friendly Windows 95/98® or NT® 900MB Configuration Program (Model 900C-SIP). See Network Connection Drawing 4501-805. The following transmitter attributes are configurable via the Configuration Software. Optionally, any software that supports the Modbus command/response protocol may be used. Use the Preset Single/Multiple Register functions to write configuration data to the appropriate registers as required by your application (see REGISTER MAP).

Slave Communication

Slave – ID: Report Slave ID command returns the model, run on/off status, module serial number, and firmware number.

Slave – Reset: This command is used to trigger a reset of the module and its effect is equivalent to a power-on reset. An alternate method of resetting a module can be accomplished via a write to the Calibration Access & Reset Register. This is provided to accomplish reset with software that does not support the Reset Slave command.

Slave – Address: Select valid slave addresses in the range of 1-247 (01H-F7H). Address 247 is the default mode address.

Slave – Baud Rate: Select 2400, 4800, 9600 (default), 14400, 19200, 28800, 38400, 57600, 76800, or 115200 bits/second.

Slave – Parity: Select Even, Odd, or No Parity (See Parity Checking) checking. Odd/even parity bit is followed by 1 stop bit. One or two stop bits are used if no parity is selected.

Slave - Response Delay: Can be set from 0-65500 ticks (1 tick = 1.085us) and refers to the additional delay a module will wait before it sends its response to a message from the host. Some signal converters or host/software systems cannot accept a response to a message immediately after sending the message without additional delay.

Slave – Status: The Module Status Register can be used to determine internal flash or EEPROM checksum error status.

Slave – Watchdog: A watchdog timer may be applied to the output channels of this module. Use the Watchdog Time Register to select a timeout period from 1 to 65534 seconds (18.2 hours). A time of 65535 (FFFFH) or 0 (0000H) will disable the watchdog timer. Use the Timeout States Register to define the states the outputs of the port are to be sent to upon output timeout (the four lower order bits of this register value define the timeout states of each of the channels). Writing 65535 (FFFFH) to the output channel Timeout States register will leave the port outputs unchanged upon timeout. Use the Timeout Value registers to set a level that the corresponding analog output is to be programmed to following a watchdog timeout. Write 65535 (FFFFH) to this register to leave the analog outputs unchanged following a timeout. Watchdog timeout state or level control takes precedence over direct control of the output channels of this model. The output watchdog timer is reinitiated via a read or write to any output channel.

Analog Output

Output – Range/Type:

917MB: Select DC current output ranges 4-20mA, 0-20mA, or 0-1mA.

918MB: Select DC voltage output ranges 0-10V, 0-5V, or 0-1V DC.

Outputs use percent of span units with ±20000 representing ±100% (see Units below).

Output – Timeout Value: The value that the corresponding analog output will be automatically programmed to following a watchdog timer timeout. This value must be within the programmed output range. Write 32767 (7FFFH) to leave the output unchanged following a watchdog timeout.

Output Calibration: The configuration software can be used to calibrate the output circuit of this module (see CALIBRATION/CONFIGURATION), or by using the Preset Register Functions to write the appropriate data to the calibration registers (see REGISTER MAP).

Output Units: Analog output values are expressed as a 16-bit signed integer value representing percent-of-span (resolution of 0.005%/lsb). The range is –163.84% (-32768 decimal) to +163.835% (+32767 decimal). For example, -100%, 0% and +100% are represented by decimal values –20000, 0, and 20000, respectively.

Digital Outputs

Output – State: The coil registers (0x references) may be read via the Read Coil (01) command to determine the current state of the outputs. The current output state is also indicated by a yellow status LED at the front of the module which lights when the corresponding output is sinking current. The Force Single Coil (05) and Force Multiple Coil (15) commands may be used to directly control the output state via the coil registers.

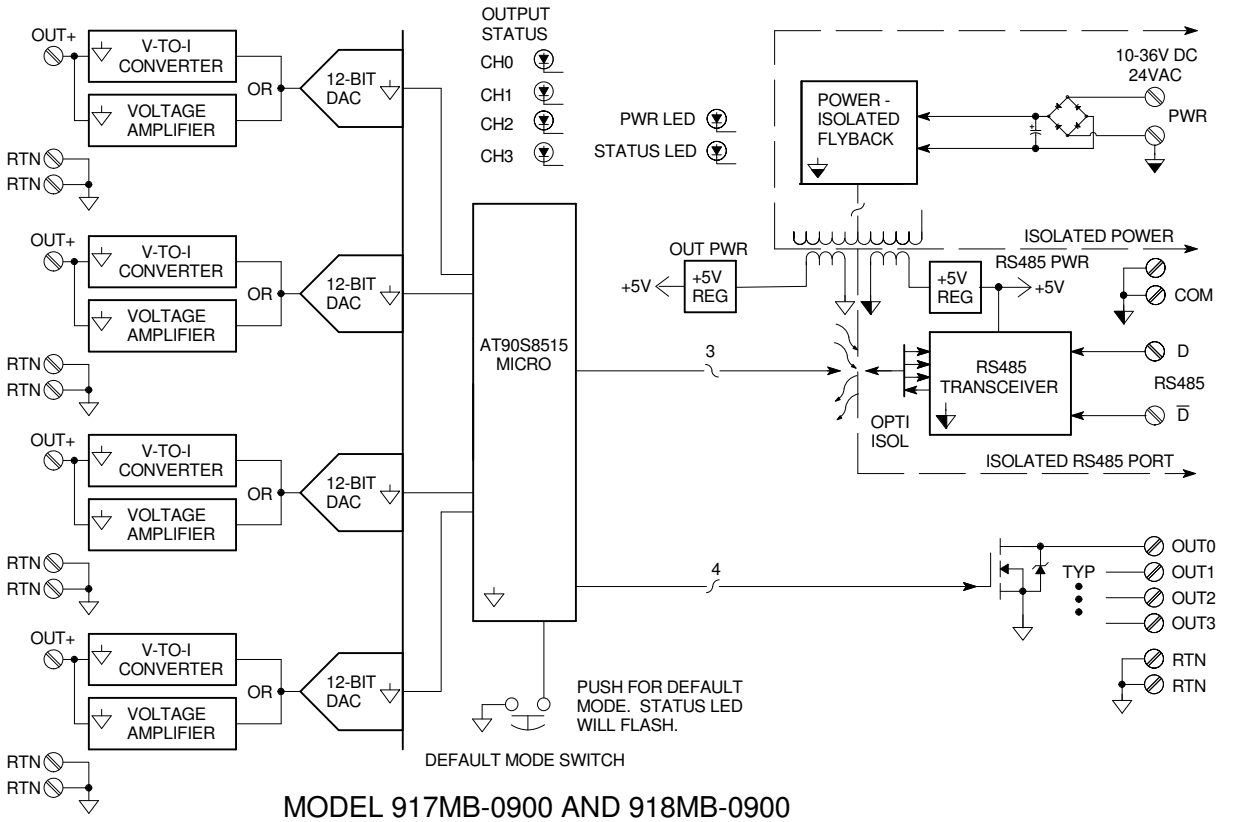
Output – Timeout State: The state that the corresponding discrete output will be automatically programmed to following a watchdog timeout.

Output Visual Indication: Yellow output LED's provide visual status indication of the current state of the corresponding output channel (LED is ON when switch is ON and sinking current).

Other Modbus Configuration Software Capabilities

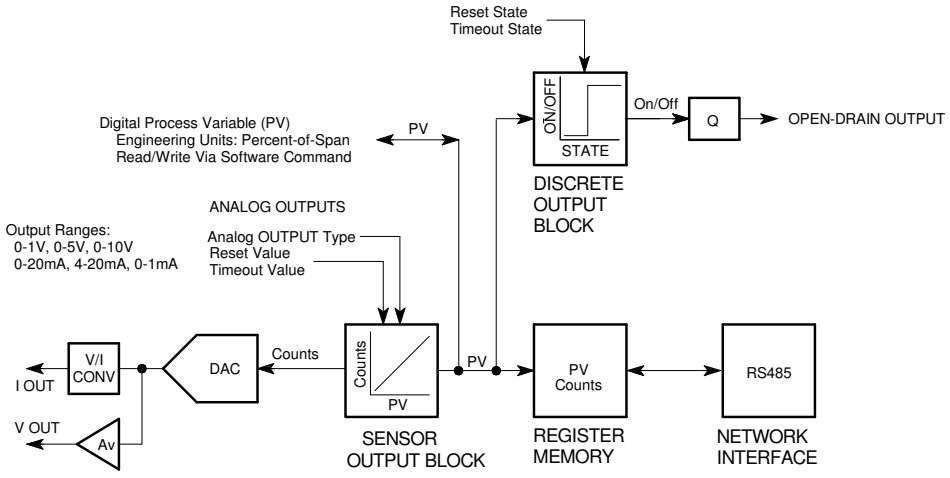
In addition to configuring all features of the module described above, the Modbus Configuration Software includes additional capabilities for testing and control of this module as follows:

1. Monitors and controls analog output signal values and the discrete output signal states. It also allows polling to be turned on or off.
2. Allows a configuration to be uploaded or downloaded to/from the module via the RS485 interface.
3. Provides controls to separately calibrate each output.
4. Provides control to reset a module.
5. Provides control to restore a module's original default factory output calibration in case of miscalibration.
6. Reads the contents of the Module Status Register.
7. Allows optional user documentation to be assigned to a module. Documentation fields are provided for tag number, comment, configured by, location, and identification information. This information can also be uploaded from the module and printed via this software.
8. Allows a module's complete configuration to be printed in an easy to read, one-page format, including user documentation.



MODEL 917MB-0900 AND 918MB-0900
QUAD ANALOG AND DIGITAL OUTPUT
MODULES WITH ISOLATED RS485

4501-828A



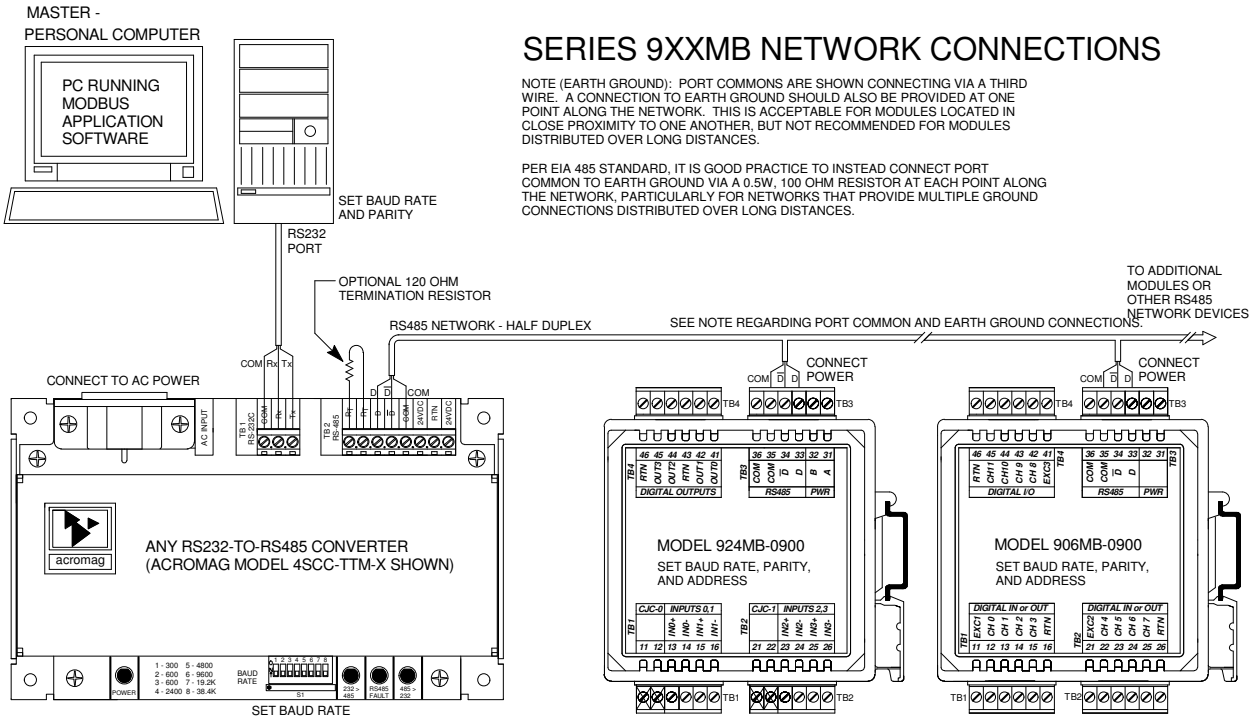
MODEL: 917MB-0900 & 918MB-0900
TRANSMITTER FUNCTIONAL
BLOCK DIAGRAM.

4501-829A

SERIES 9XXMB NETWORK CONNECTIONS

NOTE (EARTH GROUND): PORT COMMONS ARE SHOWN CONNECTING VIA A THIRD WIRE. A CONNECTION TO EARTH GROUND SHOULD ALSO BE PROVIDED AT ONE POINT ALONG THE NETWORK. THIS IS ACCEPTABLE FOR MODULES LOCATED IN CLOSE PROXIMITY TO ONE ANOTHER, BUT NOT RECOMMENDED FOR MODULES DISTRIBUTED OVER LONG DISTANCES.

PER EIA 485 STANDARD, IT IS GOOD PRACTICE TO INSTEAD CONNECT PORT COMMON TO EARTH GROUND VIA A 0.5W, 100 OHM RESISTOR AT EACH POINT ALONG THE NETWORK, PARTICULARLY FOR NETWORKS THAT PROVIDE MULTIPLE GROUND CONNECTIONS DISTRIBUTED OVER LONG DISTANCES.



4501-805B

ELECTRICAL CONNECTIONS
MODEL 917MB-0900 AND 918MB-0900

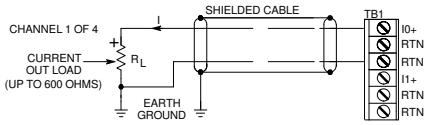
NOTE 1: THIS GROUND CONNECTION IS RECOMMENDED FOR BEST RESULTS. IF SENSORS ARE INHERENTLY CONNECTED TO GROUND, USE CAUTION AND AVOID MAKING ADDITIONAL GROUND CONNECTIONS WHICH COULD GENERATE GROUND LOOPS AND MEASUREMENT ERROR.

NOTE 2: RETURNS SHOULD BE CONNECTED TO EARTH GROUND AT THE SAME POINT TO AVOID CIRCULATING GROUND CURRENTS.

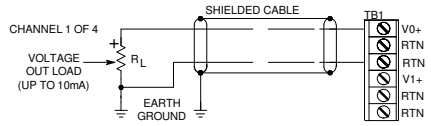
NOTE 3: EXTERNAL PULLUP RESISTOR (USER SUPPLIED).

NOTE 4: RS485 PORT COMMON SHOULD CONNECT TO EARTH GROUND AT ONE POINT.

CURRENT OUTPUT CONNECTIONS (917MB)

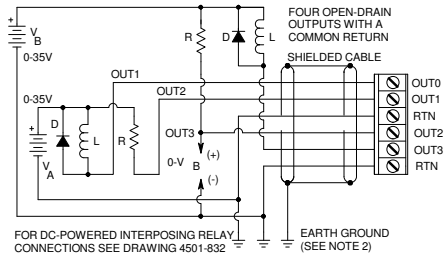


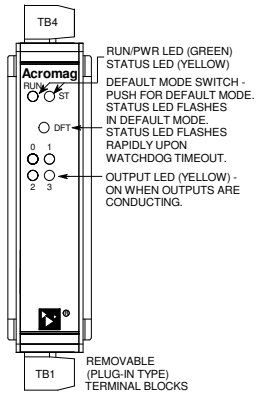
VOLTAGE OUTPUT CONNECTIONS (918MB)

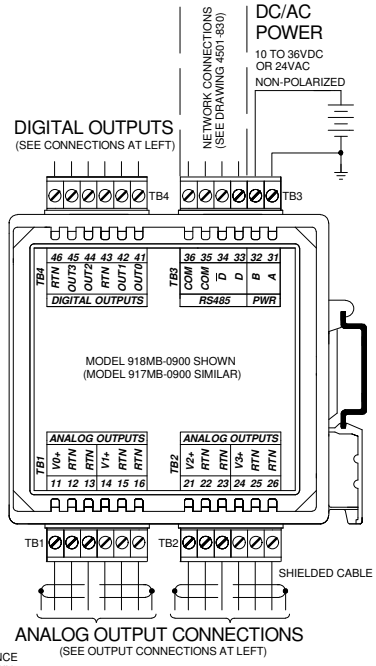


DIGITAL OUTPUT CONNECTIONS

POSSIBLE VARIATIONS - CURRENT SINKING DC APPLICATIONS ONLY





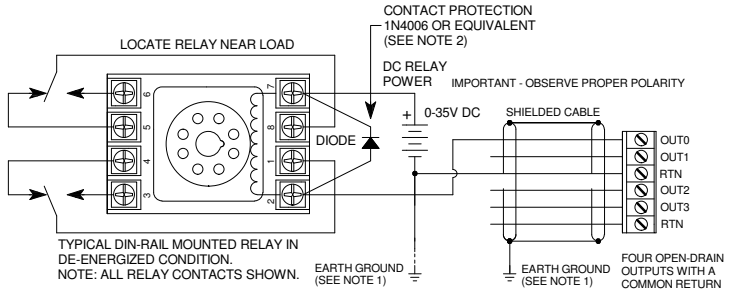


WARNING: FOR COMPLIANCE TO APPLICABLE SAFETY AND PERFORMANCE STANDARDS, THE USE OF SHIELDED CABLE IS RECOMMENDED AS SHOWN. ADDITIONALLY, THE APPLICATION OF EART GROUND MUST BE IN PLACE AS SHOWN IN THIS DRAWING. FAILURE TO ADHERE TO SOUND WIRING AND GROUNDING PRACTICES MAY COMPROMISE SAFETY AND PERFORMANCE.

SAFETY GUIDELINES MAY REQUIRE THAT THIS DEVICE BE HOUSED IN AN APPROVED METAL ENCLOSURE OR SUB-SYSTEM, PARTICULARLY FOR APPLICATIONS WITH VOLTAGES GREATER THAN OR EQUAL TO 75VDC/50VAC.

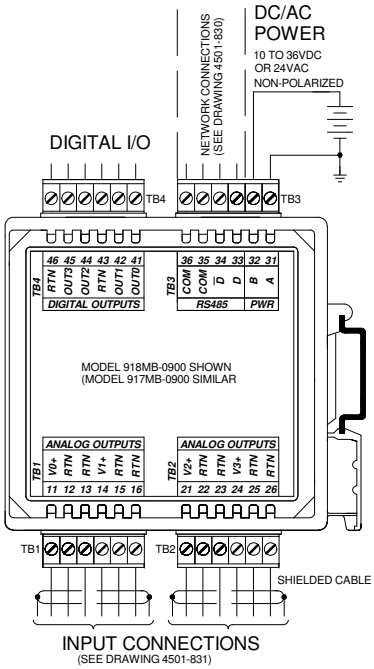
4501-831A

INTERPOSING RELAY CONNECTIONS
MODEL 917MB-0900 AND 918MB-0900

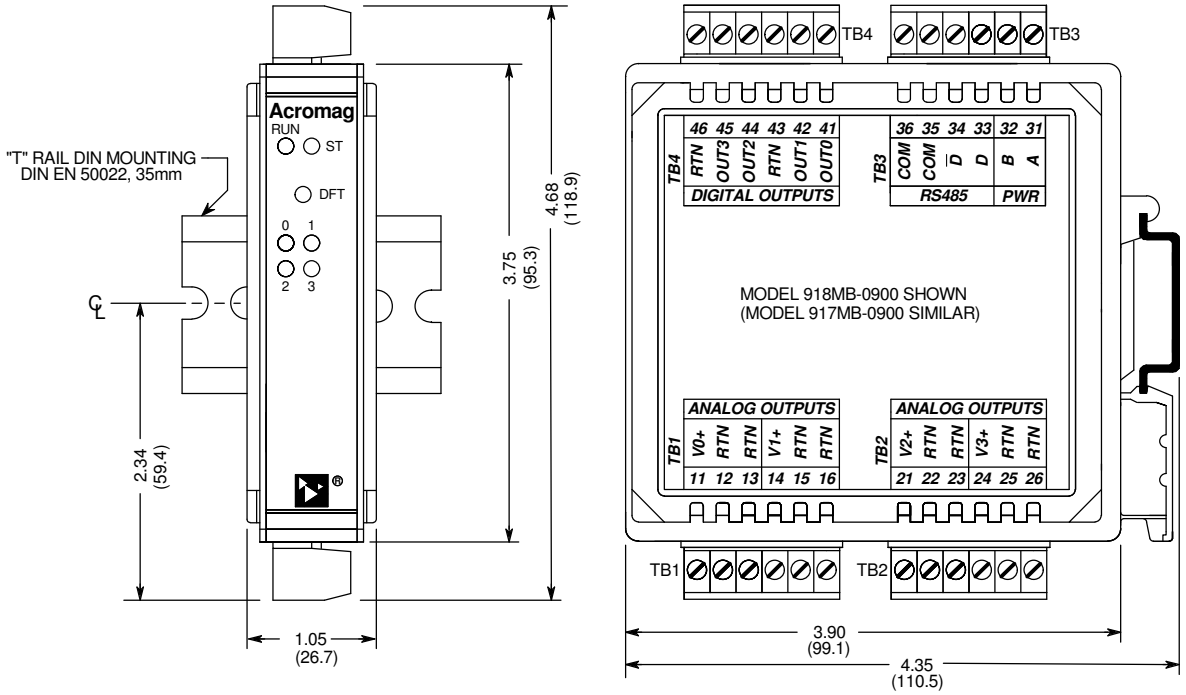


NOTE 1: RETURNS SHOULD BE CONNECTED TO EARTH GROUND AT THE SAME POINT TO AVOID CIRCULATING GROUND CURRENTS.

NOTE 2: DIODE ADDED LOCAL TO INDUCTIVE LOAD TO SHUNT THE REVERSE EMF THAT IS GENERATED WHEN CURRENT THROUGH THE INDUCTOR (RELAY COIL) IS TURNED OFF.



4501-832A



NOTE: ALL DIMENSION ARE IN INCHES (MILLIMETERS)

SERIES 917MB/918MB ENCLOSURE DIMENSIONS

4501-833A

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