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The way PC-based instrumentation should be

DI-900MB Series
Modbus/RS485 Network I/O Modules

Model DI-932MB
Dual RTD Input/Digital Ouput

Model DI-934MB
Quad RTD Input/Digital Output

User's Manual

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Warranty and Service Policy

Product Warranty

DATAQ Instruments, Inc., warrants the instruments described in this manual to be free from defects in materials and factory workmanship to the original buyer. This warranty is contingent upon proper use of the equipment, and does not cover equipment that has been modified or has been subjected to abusive physical or electrical stresses. DATAQ Instruments, Inc., agrees to repair or replace, at its sole discretion, any instrument that fails to perform as specified within 18 months after date of the original shipment from the factory, or 12 months after the date of installation, whichever date comes first.

DATAQ Instruments, Inc., reserves the right to make substitutions and modifications in the specifications of equipment that do not materially or adversely affect the performance of the equipment.

New equipment may be returned within 30 days of shipment with prior factory approval and upon the assignment of a Returned Material Authorization number, RMA number, by DATAQ Instruments, Inc. This number must be clearly shown on the return package(s). RMA numbers are valid for 30 days from date of issue. New items in factory sealed containers which are less than thirty days old after shipment may be returned for credit, less a minimum restocking and testing charge of twenty percent of the list price upon factory approval only, provided the customer pays all shipping and handling charges. Specially ordered, or modified goods, or goods which have been used or have been unpacked from the factory-sealed containers, or goods which have been shipped more than thirty days prior are not returnable.

The information contained in this manual is subject to change without notice. DATAQ Instruments, Inc., makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Further, DATAQ Instruments, Inc., assumes no responsibility for any errors that may appear in this manual and makes no commitment to update, or keep current, the information contained in this manual.

Service Policy

Units within the warranty period returned for repair, test, and recalibration are serviced at no charge in accordance with the terms of the warranty policy. The Customer pays all transportation and other charges to the factory.

Units out of warranty returned for repair, test, and/or recalibration are handled on a time and material basis. If requested, or if costs exceed 50% of current list price, DATAQ Instruments, Inc., advises the customer prior to making the repairs. Such repairs are performed at the customer's expense. Typical test, recalibration, and repairs are 25% of the instrument's current list price. Transportation charges both ways are at the customer's expense.

Please be sure all returns are shipped with the following information included:

1. "Returned Material Authorization," RMA number, clearly shown on each package. Please call DATAQ Instruments, Inc., at 330-668-1444 to obtain your RMA number.

2. Your company Name with Billing and Shipping Addresses.

3. A complete description of your problem, or re-calibration data.

4. The contact person at your company, with their telephone and facsimile numbers.

5. Non-Warranty returns additionally need your Purchase Order Number.

Please pack your returned instruments in their original shipping cartons, or in equivalent strong protective shipping cartons.

Service and Repair Assistance

This module contains solid-state components and requires no maintenance, except for periodic cleaning and transmitter configuration parameter (zero, full-scale, setpoint, deadband, etc) verification. Since Surface Mount Technology (SMT) boards are generally difficult to repair, it is highly recommended that a non-functioning module be returned to DATAQ Instruments Inc., for repair. The board can be damaged unless special SMT repair and service tools are used. Further, DATAQ Instruments, Inc., has automated test equipment that thoroughly checks and calibrates the performance of each module. Please contact DATAQ Instruments, Inc., for complete details on how to obtain service parts and repair..

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

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

Safety Summary

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

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 DATAQ Instruments, Inc., that this is the Buyer's responsibility.

Table of Contents

1. Introduction

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

Models Covered in This Manual		
Series/Input Type	-Options/Output/Enclosure/ Approvals[1]	-Factory Configuration[2]
DI-932MB[3]	-0900	-C
DI-934MB[3]	-0900	-C

Notes:

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.

3. The DI-932MB model supports two RTD channels, while the DI-934MB model supports four RTD channels.

Description

The DI-900MB family is a group of process I/O modules and accessories for Modbus/RS485 network I/O applications. The Model DI-932MB will condition up to two RTD inputs, while the DI-934MB will condition up to four RTD inputs. Both models provide an isolated RS485 network I/O path utilizing the industry standard Modbus protocol, and include isolated control outputs for high/low limit alarm support, or for simple ON/OFF control of external devices. These modules contain an advanced technology microcontroller with integrated downloadable flash memory and EEPROM for non-volatile program, configuration, calibration, and parameter data storage. Units are fully reconfigurable via our user-friendly Windows® Configuration Program and the RS485 interface. Once configured, these modules may operate as an active RS485 network slave connected to other modules and a host computer.

These modules provide two (DI-932MB), or four (DI-934MB) inputs for RTD signals, connected in 2-wire or 3-wire format. Sensor excitation, linearization, lead-wire compensation, and upscale/ downscale lead break detection are included. The module uses a high resolution, low noise, Sigma-Delta Analog to Digital Converter (Σ-Δ ADC) to accurately convert the input signals into digitized values. Inputs also include high/low alarm functionality with solid-state relay output switches. These output channels include a yellow LED on the front of the module that provides visual indication of its on/off state and/or alarm condition. Additionally, a green "Run" and yellow "Status" LED provides local feedback of operating mode, system diagnostics, watchdog timeout, and module status.

All DI-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, or from common 24VAC power. Since the input supply is diode-bridge coupled, the unit may be connected to redundant power supplies, or several units may safely share a single DC supply. All Modbus units are DIN-rail mounted and removable terminal blocks facilitate ease of installation and replacement, without having to remove wiring. Transmitter power, network, and relay output wiring are inserted at one side of the unit, while input 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, alarm support, 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 DI-932MB/DI-934MB Module Features:

- **Agency Approvals** - CE, UL, & cUL Listings.

- **Easy Windows® Configuration** - Fully reconfigurable via our user-friendly Windows® Series DI-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** - An advanced technology microcontroller with integrated, non-volatile, downloadable flash memory and EEPROM allows the functionality of this device to be reliably reprogrammed thousands of times.

- **Fully Isolated** - The input, outputs, network, and power are all isolated from each other for safety and increased noise immunity.

- **Flexible Dual or Quad RTD Inputs** - Accepts two or four channels of input for Platinum (Pt), Copper (Cu), and Nickel (Ni) RTD types, or simple resistance. Linearization, excitation, and lead break detection are included.

- **Dual/Quad Discrete SSR or Alarm Outputs** - High voltage, high current, solid-state relays provide for direct control, or alarm control of external devices. Output relays may be activated independently, via watchdog timeout, or under alarm control, in both failsafe and non-failsafe modes.

- **Self-Diagnostics** - Built-in routines operate upon power-up for reliable service, easy maintenance, and convenient troubleshooting. In addition, a hardware watchdog timer is 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.

- **Ratiometric Differential RTD Sampling** - The RTD signal is sampled differentially using a ratiometric conversion method that increases accuracy.

- **Wide-Range DC-Power or 24VAC Power** - This device receives power over a wide supply range and the power terminals are diode-bridge coupled, making this transmitter useful for systems with redundant supplies, and/or battery back-up. Additionally, the power terminals are not polarized.

- **Watchdog Timer** - An I/O watchdog timer function is included and may be configured for timeout periods up to 65534 seconds (18.2 hours). This timer will timeout if a read or write operation to any I/O channel does not occur over the configured time period. Optionally, outputs may be automatically set to user-defined states following timeout. Watchdog control of the output relay has a higher priority than alarm control and direct control.

- **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 installation, removal, and replacement easy.

- **High-Resolution Precise A/D Conversion** - Transmitters include high-resolution, low noise, Sigma-Delta Analog to Digital Converters ($\Sigma\text{-}\Delta$ ADC) for high accuracy & reliability.

- **LED Indicators** - A green LED indicates power. A yellow status LED will turn on if an input signal is out of calibrated range or a lead break has occurred, or will flash if the unit is placed in the default communication mode. It will also flash rapidly upon watchdog timeout. Another yellow output LED indicates the ON/OFF state of the associated output relay.

- **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.

- **Automatic Self-Calibration** - Built-in self-calibration helps correct for temperature drift of the input circuit every 60 seconds.

- **Upscale Or Downscale Break Detection** - Inputs may be configured to go upscale or downscale upon lead breakage.

- **Alarm Functionality** - Alarm limit checking is always active for the module. High and/or low limit levels, plus deadband may be configured at each input. Optionally, failsafe or non-failsafe alarm outputs may be enabled for each limit. Alarm control has priority over direct control of an output relay.

- **Configurable Setpoint With Deadband** - Includes programmable deadband to help eliminate output relay switch "chatter."

2. Specifications

General

The Model DI-932MB and DI-934MB modules are DC-powered or 24VAC powered network transmitters which condition two (DI-932MB) or four (DI-934MB) channels of RTD or resistance input, and provide an isolated RS485/Modbus network interface, plus four solid-state relay outputs. Isolation is supplied between inputs (as a group), the network, power, and the outputs (as a group). Outputs may be operated independently, or as alarm outputs for ON/OFF control of external devices. This network transmitter is DIN-rail mounted.

Units can be easily configured and calibrated with the user-friendly Windows® 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 you to set the module address, baud rate, and parity to Default Mode values if the internal settings are unknown. Non-volatile re-programmable memory in the module stores calibration and configuration information.

Model Number Definition

DI-932MB-0900: Transmits/isolates two RTD or resistance inputs.

DI-934MB-0900: Transmits/isolates four RTD or resistance inputs.

Input transmitters are color coded with a white label. The prefix "9" refers to the Series 900. The "MB" suffix denotes ModBus. The four digit suffix of this model number represents the following options, respectively: 0 = No Options; 9 = Output: RS485/Modbus; 0 = Enclosure: DIN rail mount; 0 = Approvals: CE, UL Listed, and cUL Listed (Pending).

Analog Input Specifications

The unit must be wired and configured for the intended input type and range (see Module Installation for details). The same input type and break detect direction is configured across all input channels. The following paragraphs summarize this model's input types, ranges, and applicable specifications.

RTD: User configured to one of four RTD types, or as a simple resistance input as noted in Table: RTD Types, Ranges, and Accuracy below. The module supports 2 or 3-wire connection types and provides sensor excitation, linearization, lead-wire compensation (3-wire mode), and sensor lead break detection.

Input Reference Test Conditions: Pt RTD 0°C to 100°C, Ni RTD 0°C to 50°C, Cu RTD 0°C to 250°C; Ambient = 25°C; Power Supply = 24V DC.

Input Configuration: Two-wire or three-wire only.

Excitation Current: 1mA DC typical, all types.

Linearization: Better than ±0.25°C, typical.

Lead-Wire Compensation: Applies to 3-wire RTD with lead wires of equal size and length. The maximum possible resistance including lead wires is 506Ω Thus, the maximum lead resistance is approximately 25Ω per lead (Pt), 15Ω per lead (Ni), 10Ω per lead (Cu), 3Ω per lead (500Ω resistance).

Lead Resistance Effect: 3.5°C per Ω of unbalance, typical (Pt), 1.4°C per Ω of unbalance, typical (Ni), 25.5°C per Ω of unbalance, typical (Cu).

Break Detection: Sensor failure (open) or lead breakage can provide upscale or downscale indication for all channels. This applies to each lead individually, or all leads together. Note that this will also trigger an out-of-range indication (module Status LED constant ON).

IMPORTANT (0-500 ohm inputs w/ break detection): The maximum input resistance including lead wires is about 506Ω If break detection is set downscale and your input resistance is greater than 506Ω (saturated), this will trigger break detection and the input reading will be sent downscale for the over-range input resistance without actual lead breakage. Likewise, upscale break is indistinguishable from an over-range input resistance greater than 506Ω

RTD Types, Ranges, and Accuracy

RTD Type	α Alpha	°C Range	Typical Accuracy
Pt 100Ω	1.3850	-200 to +850°C	±0.25°C
Pt 100Ω	1.3911	-200 to +850°C	±0.25°C
Ni 120Ω	1.6720	-80 to +320°C	±0.25°C
Cu 10Ω	1.4272	-200 to +260°C	±1.25°C
Resistance (Linear)	1.000	0 to 500Ω	±0.05Ω

Notes:

1. Alpha (α) is used to identify the particular RTD curve. The value of alpha is derived by dividing the resistance of the sensor at 100°C by the resistance at 0°C ($\alpha = R_{100°C}/R_{0°C}$). For Pt 100Ω this is 138.5Ω/100.0Ω or 1.385 (also shown as 0.00385Ω/Ω/°C).

General Input Specifications

Accuracy: Accuracy is better than ±0.05% of span, typical for nominal input ranges (see Table: RTD Types, Ranges, and Accuracy, above). This includes the effects of repeatability, terminal point conformity, and linearization, but does not include sensor error.

Accuracy Versus Temperature: Better than ±0.005% of input span per °C (±50ppm/°C or ±1uV/°C, whichever is greater).

Resolution: 0.005% or 1 part in 20000. See Table below.

Effective Resolution Per Applicable Range

Range	Resolution
10Ω Cu (α=1.4272)	0.2°C (0.36°F)
Pt (α=1.3850)	0.1°C (0.18°F)
Pt (α=1.3911)	0.1°C (0.18°F)
Ni (α=1.6720)	0.1°C (0.18°F)
0 to 500Ω	7.8125mΩ

Input Filter: Normal mode filtering, plus digital filtering, optimized and fixed per input range within the Σ–Δ ADC.

Input Filter Bandwidth: -3dB at 3Hz, typical.

Noise Rejection (Normal Mode): Better than 40dB @ 60Hz, typical with 100Ω input unbalance.

Noise Rejection (Common Mode): Better than 130dB @ 60Hz, typical with 100Ω input unbalance (10Ω unbalance for Cu RTD).

Analog to Digital Converter (A/D): A 16-bit Σ-Δ converter, Analog Devices AD7714AR-5. A/D reference is 1020Ω (1.02V at 1mA excitation). The differential input is sampled ratiometric to the reference.

Input Bias current: 1mA DC excitation current.

Input Conversion Rate: Maximum 1.5625 conversions per channel per second (80ms/sample * 2 samples/ conversion * 4 channels = 640ms per scan).

Digital Output Specifications

Isolated Solid-State Relays (one per input channel) operate as discrete outputs, alarm outputs, or watchdog timeout outputs. Alarm control of the output state has a higher priority than direct control. Watchdog timeout control (timeout state) will have the highest priority when enabled. Disable alarm outputs if direct control is desired. Outputs are turned OFF following a software or power-on reset.

Output Channel: Solid-State Relay (SSR), one Form A switch (SPST-NO) per input channel. Outputs share a common return connection at the RTN terminals. Observe proper polarity. To control higher voltages and/or currents, or for controlling AC, an interposing relay may be used (see Drawing Electrical Connections (4501-895)).

Output "OFF" Voltage Range: 0 to 48V DC.

Output "OFF" Leakage Current: 1uA typical at 48VDC.

Output "ON" Current Range: 0 to 1A DC (up to 40°C) continuous, for each output switch with one RTN termination per each output pair.

Derate "ON" Current Above 40°C: 10mA per °C.

Output "ON" Resistance: 0.4Ω Maximum.

Output "ON" Voltage: 0.4V DC Maximum at 1A DC.

Output Response Time: Digital Outputs: 5ms, typical, measured from receipt of force coil command to switch state transfer. Effective time will vary with output load. Alarm outputs will change states for a step change in the input from one side of the alarm level to the other within 650ms (varies between 180ms and 630ms typical).

Enclosure/Physical Specifications

See Enclosure Dimensions Drawing 4501-897. 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: 1.05 inches wide, 4.68 inches high, 4.35 inches deep (see Drawing Enclosure Dimensions (4501-897)).

DIN Rail Mounting (-xx0x): Type EN50022; "T" rail (35mm).

Connectors: Removable plug-in type terminal blocks rated up to 15A/300V for stranded or solid wire from 12-24 AWG. 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: Agency Approvals - CE, UL Listed, and cUL Listed. UL3121 First Edition, CSA C22.2 No. 1010.1-92, Low Voltage Directive (72/23/EEC), EMC (89/336/EEC) Directives. Product approval is limited to general safety requirements of the above standards.

Warning: Product is NOT approved for hazardous locations.

Environmental Specifications

Operating Temperature: -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: 10V to 36V DC SELV (Safety Extra Low Voltage), or 22-26 VAC. The power terminals are diode-bridge coupled and are not polarized. Current draw is a function of supply voltage (see Supply Current Tables below). Currents shown assume all outputs are ON.

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

DI-932MB Supply Current

Supply	DI-932MB Current Draw
10V	90mA Typical, 105mA Maximum
12V	72mA Typical, 80mA Maximum
15V	58mA Typical, 65mA Maximum
24V	38mA Typical, 42mA Maximum
36V	29mA Typical, 34mA Maximum
24VAC	68mArms Typical, 76mArms Maximum

DI-934MB Supply Current

Supply	DI-934MB Current Draw
10V	120mA Typical, 135mA Maximum
12V	97mA Typical, 110mA Maximum
15V	76mA Typical, 85mA Maximum
24V	50mA Typical, 60mA Maximum
36V	38mA Typical, 42mA Maximum
24VAC	89mArms Typical, 100mArms Maximum

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.

Isolation:	Inputs (as a group), network, power, and digital outputs (as a group) 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. Note that inputs and outputs are not isolated channel-to-channel. However, inputs do provide some common mode noise isolation channel-to-channel for small voltages up to 4V DC.
Installation Category:	Designed to operate in an Installation Category (Overvoltage Category) II environment per IEC 1010-1 (1990).
Electromagnetic Interference Immunity (EMI):	No alarm trips will occur beyond ±0.25% of input span from setpoint, and no output shifts will occur beyond ±0.25% of span, while under the influence of EMI from switching solenoids, commutator motors, and drill motors.
Electromagnetic Compatibility - Immunity Per European Norm EN50082-1	
Electrostatic Discharge (ESD) Immunity:	4KV direct contact and 8KV air discharge to the enclosure port per EN61000-4-2.
Radiated Field Immunity (RFI):	3V/M, 80 to 1000MHz AM and 900MHz keyed carrier, per EN61000-4-3 and ENV50204.
Electrical Fast Transient Immunity (EFT):	0.5KV to power and signal I/O per EN61000-4-4.
Conducted RF Immunity (CRFI):	3Vrms, 150KHz to 80MHz, per EN61000-4-6.
Surge Immunity:	0.5KV per EN61000-4-5.
Emissions Per European Norm EN50081-1	
Radiated Frequency Emissions:	30 to 1000MHz per EN55022 Class B.

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:	Can be programmed for 2400, 4800, 9600 (Default Mode rate), 14400, 19200, 28800, 38400, 57600, 76800, or 115200 bits per second.
Duplex:	Half Duplex only.
Parity:	Odd, Even, or None (Default Mode). The absence of parity is equivalent to 2 stop bits.
Stop Bits:	One for Even or Odd parity, two for 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. As a minimum value, it must be set greater than the inherent delay already present in order to be effective. 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. Try increasing this delay if you experience communication problems.

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 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 a repeater. Distance can be extended with the use of a signal repeater.

Default Communication Mode Parameters: In this mode, the module address is set to 247, the baud rate is set to 9600bps, the parity is set to none (2 stop bits) by pressing the DFT push-button on the front of the module until the yellow Status LED flashes ON/OFF. This allows communication with a module when its internal 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. Note that new communication parameters for module address, baud rate, and parity take effect outside of Default Mode after a software or power-on reset.

Watchdog Timer: A hardware watchdog timer is built into the microcontroller that causes it to self-reset if the controller ever fails to return from an operation or "locks up." Additionally, an I/O watchdog timer function is included that may be set for timeout periods up to 65534 seconds (18.2 hours). The I/O watchdog timer will cause the status LED to blink rapidly, set a bit in the Module Status Register, and optionally program the digital outputs to a pre-defined state upon timeout. The I/O watchdog timer is reinitiated via a read or write to any input/ output channel. Clearing a timeout condition will not automatically restore the outputs to their initial state. Outputs have to be driven manually or under alarm control.

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 are also indicated). Refer to MODULE CONFIGURATION for detailed information on each of these functions:

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

Configuration and Controls

Module Push Button (See Dwg. 4501-897 For Location): Default (DFT) - 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 is applied and unit is operating normally. Flashing ON/OFF indicates unit is performing diagnostics (first two seconds following power-up), or has failed diagnostics (after a few seconds).

Status (Yellow) - Flashing LED indicates the module is in the Default Communication Mode. Rapid flashing LED indicates an I/O watchdog timeout has occurred. A constant ON LED indicates an input is outside of the transmitter's calibrated input range or an input lead is broken (when module is outside of default mode only).

IMPORTANT: Any inputs not terminated or left open will cause the module Status LED to turn ON and signal a lead break (out-of-range) condition. This will mask other (flashing) conditions like default mode and watchdog timeout indication. As such, it is recommended that unused inputs be properly terminated to avoid this condition.

Output (Yellow) - Two or four LED's, one per output. OFF if the output switch is OFF (open), and ON if the output switch is ON (closed).

Software Configuration

The following transmitter attributes and controls are set via the DI-900MB Configuration Software (Model 100969), or any other software that supports the ModBus command/response protocol. You can use the Preset Single/Multiple Register functions to write configuration data to the appropriate register(s) as required by your application (see Register Map).

Slave Communication

Slave - ID: The Report Slave ID command will return the model number, run on/off status, module serial number, and firmware number.

Slave - Reset: This command will 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 (see Memory Map register 40024). The second approach is provided to accomplish reset with Modbus 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 slave address.

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

Slave - Parity: Select Even, Odd, or No Parity (See Parity Checking) error checking. Odd or even parity bit is followed by 1 stop bit. If no parity is selected, 2 stop bits are used. Note that the absence of parity is equivalent to 1 stop bit and some references still refer to this as No Parity with 1 Stop Bit instead of No Parity with 2 Stop Bits.

Slave - Response Delay: Sets the minimum delay a module will wait before it sends a response to a message from the host (set 0-65500 ticks, 1.085us/tick). As a minimum, it must be set greater than the inherent delay already present to be effective. Some signal converters or host/software systems cannot accept a response to a message immediately after sending the message without adding delay.

Slave - Status: The Module Status Register can be used to determine alarm status, I/O watchdog timeout, A/D status, and the internal flash memory checksum error status.

Slave - Watchdog: A watchdog timer may be applied to the I/O 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 I/O watchdog timer. Use the Timeout State Register to define the states that the outputs are to be programmed to upon I/O timeout. The four lower order bits of this register value define the timeout states of each of the four output channels. Watchdog timeout state control takes precedence over alarm and direct control of the output channels. Writing 65535 (FFFFH) to the Timeout States Register will leave the port outputs unchanged upon timeout. A watchdog fault indication flag (bit 0 of the Module Status register) will be set if any of the module output channels have not been written to over the specified time period, or if any of the I/O channels have not been read over the specified time period. In addition, the module status LED will blink rapidly if a watchdog timeout occurs. Note that alarm outputs will not change states if a timeout has occurred until the timeout is cleared.

Analog Input

Input - Type/Range: Select one of four RTD types or resistance input. Refer to Input Specifications for signal ranges. Note that this model uses °C or percent-of-span units.

IMPORTANT: Multiple inputs of module must be configured for the same range/type (same gain).

Input- RTD Wiring: Select a 2-wire or 3-wire configuration.

Input- Break Detect: Select Upscale or Downscale break detection for all inputs.

Input Calibration: The configuration software can be used to calibrate the input conditioning circuit of this module (see 6. Module Software Configuration), or by using the Preset Register Functions to write the appropriate data to the calibration registers (see Register Map).

Digital (SSR) 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 switch is ON (closed), or if the corresponding input is in alarm (but only if output is enabled as an alarm output). The Force Single Coil (05) and Force Multiple Coil (15) commands may be used to directly control the output state via the coil registers. The outputs may also be set under alarm control at the corresponding input channel, or via watchdog timeout control.

IMPORTANT: Alarm limits take precedence over direct control and must be disabled if direct control is desired. Watchdog timeout control has highest priority (if enabled).

Channel Alarm Configuration

Channel - Alarm Output State & Output Enable: Use the Alarm Output State and Alarm Output Enable Register to enable the corresponding discrete output as an alarm output and to select failsafe or non-failsafe alarm output activation. A failsafe alarm output will turn OFF in alarm (the same state as the power-down state). A non-failsafe alarm output will turn ON in alarm. Alarm limit checking is always active for the module, but assignment of an alarm output is optional via this control.

Channel - High Limit Value: Use the channel High Limit Value Register to write a high limit value. Limit values use same units as input--°C for RTD inputs or scaled °percent-of-span units for resistance input (±20000 represents ±100%). Limit values must be within the full input range (see Analog Input Specifications). The corresponding digital output will transfer to the alarm state when the high limit value is exceeded and remains at that state until the input signal has retreated below the limit, plus any deadband.

Channel - Low Limit Value: Use the channel Low Limit Value Register to write a low limit value. Limit values use same units as input--°C for RTD inputs or scaled °percent-of-span units for resistance input (±20000 represents ±100%). Limit values must be within the full input range (see Analog Input Specifications). The corresponding digital output transfer to the alarm state when the low limit value is exceeded and remains at that state until the input signal has retreated above the low limit, plus any deadband.

Channel - Deadband Value: Use the channel Deadband Value Register to assign deadband to limit checking. Deadband values use scaled percent-of-span units (±20000 represents ±100%) and must be within the full input range (see Analog Input Specifications). Deadband determines the amount the input signal has to return into the "normal" operating range before the output will turn OFF. Deadband is normally used to eliminate false trips or alarm "chatter" caused by fluctuations in the input near the alarm point.

IMPORTANT: Noise and/or jitter on the input signal has the effect of reducing (narrowing) an instrument's deadband and may produce output chatter. Another long term effect of output chatter is a reduction in the life of any mechanical relay controlled via the output. To reduce this undesired effect, increase the deadband setting.

Visual Alarm Output Indication: A yellow output LED is turned ON when the output is switched ON. This LED can provide visual indication of when the matching input channel is in alarm if the matching output is enabled as an alarm output (ON in alarm for the non-failsafe mode). Alarm control of an output will take precedence over direct control (when enabled), except for input signals in the deadband region. Watchdog timeout control of an output will have the highest priority when enabled.

Software Alarm Indication: The Module Status Register can be used to determine if any of the module's inputs are in alarm. The Channel Status Register can be used determine when a specific input is in alarm.

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 the input signal values and 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 input channel in case of error.

4. Provides controls to reset a module.

5. Reads the contents of the Module Status Register.

6. Allows optional user documentation to be saved to a module file. Information includes tag number, comment, configured by, location, and identification information. This information can also be printed via this software.

7. Allows a module's complete configuration to be printed in an easy to read, one or two page format, including user documentation.

3. Getting Started

Unpacking and Inspection

Upon receipt of this product, inspect the shipping carton for evidence of mishandling during transit. If the 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 Warranty and Service Policy to obtain return instructions. It is suggested that salvageable shipping cartons and packing material be saved for future use in the event the product must be shipped.

This module is physically protected with packing material and electrically protected with an anti-static bag during shipment. However, it is recommended that 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 module is packaged in 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 specified operating temperature range. As shipped from the factory, the unit is calibrated for all valid input ranges and has the default configuration shown in the table 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.

DI-932MB/DI-934MB Default Factory Configuration

Parameter	Configuration/Calibration
Module Address	247
Baud Rate	9600bps
Parity	None
Stop Bits	2 (When Parity=None)
Response Delay	0 (No Delay)
Watchdog Time	0 (Disabled)
Output Timeout States	All ON (Timer Disabled)
Input Range (All Inputs)	Pt 100Ω (α=1.385)
RTD Wiring	3-Wire
Sensor Break (All Inputs)	Upscale Indication
Temperature Units	°C
Limit Configuration (Each Input)	Alarm Outputs Disabled
High Limit Value (Each Input)	100°C (High Endpoint)
Low Limit Value (Each Input)	0°C (Low Endpoint)
Deadband (Each Input)	1°C

Note: 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 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 the user-friendly Windows® DI-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 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, a baud rate of 9600bps, no parity, and 2 stop bits. It is most convenient to first 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 (for baud rate, address, and parity) will take effect following a reset of the module after leaving the Default Mode.

IMPORTANT: The default mode is indicated via a flashing status LED. However, if an input is not terminated or left open, the status LED will turn ON to indicate a signal over-range condition and/or break detect at one or more input channels. This will mask default mode indication or watchdog timeout indication. As such, it is recommended that you not leave unused channels open and properly terminate unused inputs to avoid this condition.

Mounting

Refer to Drawing 4501-897 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 a module to this style of DIN rail, 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 a module, first separate the input terminal block(s) from the bottom side of the module to create a clearance to the DIN mounting area. Next, insert a screwdriver into the lower arm of the DIN rail connector and use it as a lever to force the connector down until the unit disengages from the rail.

Electrical Connections

Digital output, network, power, and input terminals can accommodate wire from 12-24 AWG, stranded or solid copper. Strip back wire insulation 1/4-inch on each lead before installing into the terminal block. Analog input 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 transmitter network, digital output, and power wiring be separated from the input signal wiring for safety, as well as for low noise pickup. Note that input, power, network, and digital output 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 4501-895. 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. Unit is powered from 10-36VDC, or 24VAC only.

2. **Inputs:** Connect inputs per Electrical Connections Drawing 4501-895. Input supports 2-wire or 3-wire RTD configurations only. Observe proper polarity when making input connections (see label for input type) and be sure to include ground at the LRTN terminal.

   Input Grounding: Do not connect earth ground to any of the RTD input leads or input terminals. The input should be earth grounded at the logic return terminal (LRTN, TB3-6) only.

   IMPORTANT: Noise and/or jitter on the input signal has the effect of reducing (narrowing) the instrument's deadband and may produce switch chatter when using the alarm output. The long term effect of chatter will reduce the life of any mechanical relays that may be connected to these outputs. To reduce this undesired effect, you should increase the effective deadband.

3. **Outputs (Coils):** Outputs are solid-state switches that share a common return (RTN) and are intended for DC switching applications only. Observe proper polarity when making connections. Each output includes a transient voltage suppresser, a snubber diode, plus an integrated snubber, but may still require additional protection when switching inductive loads (see below). Refer to the SPECIFICATIONS section for output specifications and the module's side label for terminal designations. The output circuits as a group are electrically isolated. If necessary, an interposing relay can be used to switch higher currents as illustrated in the Interposing Relay Connection Drawing 4501-896.

   Note: The outputs go to their OFF state (open) following a software or power-on reset of the module. Outputs may be optionally sent to a user-defined state following a watchdog timer timeout.

   IMPORTANT - Protection With Inductive Loads: The outputs include reverse-bias shunt diodes connected to help protect the solid-state switch from damage due to reverse emf voltages that are generated in switching inductive loads. However, you should add external protection local to the inductive load 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 4501-895 for application of earth ground. 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 4501-895. Further, the application of earth ground must be in place as shown in Drawing 4501-895. Failure to adhere to sound wiring and grounding practices may compromise safety & performance.

Software Installation

The 900MB Configuration Software is used to configure Series DI-900MB modules and is installed as follows:

1. Insert the DI-900MB Resource CD into your CD-ROM drive.

   IMPORTANT: Before continuing with installation, be sure to exit any other Windows programs that may be running.

2. The Window's AutoRun feature should start the CD and the installation software will run.

3. Select the option "Install DI-900MB Configuration Software" and click on OK.

4. The Welcome Dialog Box appears. Click on Next to continue with the installation or Cancel to abort.

5. Fill out your user information in the appropriate text boxes and click on Next.

6. The Choose Destination dialog box allows you to specify the program files' destination directory. To keep the default (C:\Program Files\Series900MB) click on Next, to change the destination click on the Browse button, select a destination, then click on Next.

7. The Select Program Folder allows you to designate the program folder. To keep the default (Series900MB), click on Next, to choose a different folder, make a selection from the list then click on Next.

8. The Start Copying Files dialog box shows the current settings and allows you to change them by using the Back button. To change settings, click on the Back button until you reach the setting you would like to change, change that setting, and click on the Next button until you get back to the Start Copying Files dialog box. To keep the current settings and install the software, click on the Next button.

9. Setup is complete. Click Finish to exit the DATAQ installation program and return to Windows.

10. To run the configuration software, go to the Start Menu and click on Programs > Series900MB > Series900MB Configuration (this is the default - if you did not keep the default settings choose the program folder and directory you had specified during installation).

4. Module Configuration

This module needs to be configured for your application. Configuration is easily accomplished using the Windows®
Series DI-900MB Configuration Software and an RS232-to-RS485 signal converter. It is not required to use the Configuration software to communicate with the Series DI-900MB, as any software capable of sending Modbus protocol commands over an RS485 interface can be used. However, the Configuration software provides an easy to use 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:

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. 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 module I/O. The following table outlines the register map for both Model DI-932MB and DI-934MB network I/O modules. Some registers are applicable to DI-934MB models only, which include two additional input channels. You will find it helpful to refer to this map as you review the Modbus function descriptions given later.

Ref	Addr.	Description	Data Type/Format
Coil Registers (0x References, Read/Write)			
00001 Thru 00004	0-3 (0000-0003)	Up to Four Discrete Outputs 0-3	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 (closed). A clear bit (0) means the corresponding output is OFF (open). 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.
		Note: After reset, these registers read 0 (outputs OFF) and these registers are not maintained in EEPROM.	Bits 15-4: Not Used. Additionally, unused bits in range 3-0 are set to 0.
			IMPORTANT: Disable the corresponding limits if you wish to control the state of a discrete output directly via these registers, as limit alarm control will take precedence.
Input Registers (3x References, Read-Only)			
30001	0 (0000)	Module Status	Bit 15: Flash Checksum; 1 = Error Flag; 0 = No Flash Error
			Bit 14: A/D Error Flag; 1 = A/D Error; 0 = No A/D Error
			Bit 13: Default Mode Flag; 1 = Default Mode Indication; 0 = Not In Default Mode
			Bits 12-4: Zero
			Bit 3: I/O Watchdog Fault; 1 = Watchdog Timeout; 0 = No Timeout
			Bit 2: Global Limit Exc.; 1 = Global Limit Exceeded; 0 = No Limit Exceeded
			Bit 1: Break Detect Flag; 1 = Upscale Break; 0 = Downscale Break
			Bit 0: Zero
30002	1 (0001)	Current Global Input Configuration Register DI-932MB and DI-934MB Models **Note:** Applies to all inputs together.	Bit 15: Input Wiring; 0 = 2-Wire Mode; 1 = 3-Wire Mode
			Bits 14-4: Reserved
			Bits 3,2,1,0: Input Range
			$0000 = 0 = $ Pt 100Ω, 3-Wire ($\alpha=1.3850$, -200 to 850°C)
			$0001 = 1 = $ Pt 100Ω, 3-Wire ($\alpha=1.3911$, -200 to 850°C)
			$0010 = 2 = $ Ni 120Ω, 3-Wire ($\alpha=1.6720$, - 80 to 320°C)
			$0011 = 3 = $ Cu 10Ω, 3-wire ($\alpha=1.4272$, -200 to 260°C)
			$0100 = 4 = $ Res, 3-wire(Linear 0 to 500Ω, 3-Wire)
			$0101 = 5 = $ Pt 100Ω, 2-Wire ($\alpha=1.3850$, -200 to 850°C)
			$0110 = 6 = $ Pt 100Ω, 2-Wire ($\alpha=1.3911$, -200 to 850°C)
			$0111 = 7 = $ Ni 120Ω, 2-Wire ($\alpha=1.6720$, - 80 to 320°C)
			$1000 = 8 = $ Cu 10Ω, 2-wire ($\alpha=1.4272$, -200 to 260°C)
			$1001 = 9 = $ Res, 2-wire(Linear 0 to 500Ω, 2-Wire)
			1xxx = 10-15 = Reserved
30003	2 (0002)	CH 0 Input Value	Temperature (°C) or Percentage (%)

Ref	Addr.	Description	Data Type/Format
30004	3 (0003)	CH 0 Status Value	Bits 15-4: Zero Bit 3: High Limit Flag; 1 = High Limit Exceeded; 0 = Below High Limit Bit 2: Low Limit Flag; 1 = Low Limit Exceeded; 0 = Above Low Limit Bits 1,0: Under/Over Range 00 = In Range; 01 = Overrange; 10 = Under Range; 11 = Not Defined
30005	4 (0004)	CH 1 Input Value	Temperature (°C) or Percentage (%)
30006	5 (0005)	CH 1 Status Value	Format Is Same As CH 0
30007	6 (0006)	CH 2 Input Value	Temperature (°C) or Percentage (%)
30008	7 (0007)	CH 2 Status Value	Format Is Same As CH 0
30009	8 (0008)	CH 3 Input Value	Temperature (°C) orPercentage (%)
30010	9 (0009)	CH 3 Status Value	Format Is Same As CH 0
30011	10 (000A)	CH 0 Raw Count	Raw A/D Count Value[3]
30012	11 (000B)	CH 1 Raw Count	Raw A/D Count Value[3]
30013	12 (000C)	CH 2 Raw Count	Raw A/D Count Value[3]
30014	13 (000D)	CH 3 Raw Count	Raw A/D Count Value[3]
Holding Registers (4x References, Read/Write)			
Note: Changes to Holding Registers take effect following the next software or power-on reset of the module, except where noted otherwise.			
40001	0 (0000)	Slave AddressDefault=247	1 through 247 (Default)
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 = None (2 stop bits) 1 = Odd Parity Checking (1 stop bit) 2 = Even Parity Checking (1 stop bit)
40004	3 (0003)	I/O 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 (0000H/disabled is the default value).
40005	4 (0004)	Output Channel Timeout States Default=65535, Disabled	The four lower order bits of this 16-bit register value define the state the output channels will be programmed to following a watchdog timeout. 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 that watchdog timeout control takes precedence over alarm and direct control of the output relay.

Ref	Addr.	Description	Data Type/Format
40006	5 (0005)	Response Delay Time (Turn-around Delay) Default=0, No Delay	Can be set from 0 to 65535 ticks (1 tick = 1.085us). This is the additional delay the module will wait before responding to a host message. The default value is 0 (no delay). Increase this value if you are having communication problems or you encounter a high degree of error messages.
40007	6 (0006)	Break Detect (applies to all inputs)[6] Default=0, Upscale	Bit 15-2: 0 (Not Used) Bit 1: RTD Break Status; 1 = Upscale Break; 0 = Downscale Break[6] Bit 0: 0 (Not Used)
40008	7 (0007)	DI-932/DI-934MB Global Input Configuration (applies to all inputs) Default=0, Pt 100Ω (α=1.385)	Bit 15: Input Wiring; 0 = 2-Wire Mode; 1 = 3-Wire Mode Bits 14-4: Reserved Bits 3,2,1,0: Input Range 0000 = 0 =Pt 100Ω 3-Wire (α=1.3850, -200 to 850°C) 0001 = 1 =Pt 100Ω 3-Wire (α=1.3911, -200 to 850°C) 0010 = 2 =Ni 120Ω 3-Wire (α=1.6720, - 80 to 320°C) 0011 = 3 =Cu 10Ω 3-wire (α=1.4272, -200 to 260°C) 0100 = 4 =Res,[6] 3-Wire,(Linear 0 to 500Ω 3-Wire) 0101 = 5 =Pt 100Ω 2-Wire (α=1.3850, -200 to 850°C) 0110 = 6 =Pt 100Ω 2-Wire (α=1.3911, -200 to 850°C) 0111 = 7 =Ni 120Ω 2-Wire (α=1.6720, - 80 to 320°C) 1000 = 8 =Cu 10Ω 2-wire (α=1.4272, -200 to 260°C) 1001 = 9 =Res,[6] 2-Wire(Linear 0 to 500Ω 2-Wire) 1xxx = 10-15 = Reserved
40009	8 (0008)	CH0 High Limit Default=850°(Pt), 320°(Ni), 260°(Cu), or 100%(Res.)	Temperature (°C) or Percentage (%)[5]
40010	9 (0009)	CH0 Low Limit Default=-200°(Pt/Cu), -80° (Ni), or 0%(Resistance)	Temperature (°C) or Percentage (%)[5]
40011	10 (000A)	CH0 Deadband Default=1°C, 1% (Res.)	Temperature (°C) or Percentage (%)[5]
40012	11 (000B)	CH0 Alarm Output State & Alarm Output Enable Default=0, Disabled	Bits 15-3: Zero Bit 2: Alarm Out State; 0 = Failsafe (OFF); 1 = Non-Failsafe (ON) Bit 1: High Limit; 1 = Hi Output Enabled; 0 = Hi Output Disabled Bit 0: Low Limit; 1 = Lo Output Enabled; 0 = Lo Output Disabled
40013	12 (000C)	CH1 High Limit Default=850°(Pt), 320°(Ni), 260°(Cu), or 100%(Res.)	Temperature (°C) or Percentage (%)[5]
40014	13 (000D)	CH1 Low Limit Default=-200°(Pt/Cu), -80° (Ni), or 0% (Resistance)	Temperature (°C) or Percentage (%)[5]
40015	14 (000E)	CH1 Deadband Default=1°C, 1% (Res.)	Temperature (°C) or Percentage (%)[5]

Ref	Addr.	Description	Data Type/Format
40016	15 (000F)	CH1 Alarm Output State & Alarm Output Enable Default=0, Disabled	Bits 15-3: Zero Bit 2: Alarm Out State; 0 = Failsafe (OFF); 1 = Non-Failsafe (ON) Bit 1: High Limit; 1 = Hi Output Enabled; 0 = Hi Output Disabled Bit 0: Low Limit; 1 = Lo Output Enabled; 0 = Lo Output Disabled
40017	16 (0010)	CH2 High Limit Default=850°(Pt), 320°(Ni), 260°(Cu), or 100%(Res.)	Temperature (°C) or Percentage (%)[5]
40018	17 (0011)	CH2 Low Limit Default=-200°(Pt/Cu), -80° (Ni), or 0%(Res.)	Temperature (°C) or Percentage (%)[5]
40019	18 (0012)	CH2 Deadband Default=1°C, 1% (Res.)	Temperature (°C) or Percentage (%)[5]
40020	19 (0013)	CH2 Alarm Output State & Alarm Output Enable Default=0, Disabled	Bits 15-3: Zero Bit 2: Alarm Out State; 0 = Failsafe (OFF); 1 = Non-Failsafe (ON) Bit 1: High Limit; 1 = Hi Output Enabled; 0 = Hi Output Disabled Bit 0: Low Limit; 1 = Lo Output Enabled; 0 = Lo Output Disabled
40021	20 (0014)	CH3 High Limit Default=850°(Pt), 320°(Ni), 260°(Cu), or 100%(Res.)	Temperature (°C) or Percentage (%)[5]
40022	21 (0015)	CH3 Low Limit Default=-200°(Pt/Cu), -80° (Ni), or 0%(Res.)	Temperature (°C) or Percentage (%)[5]
40023	22 (0016)	CH3 Deadband Default=1°C, 1%(Res.)	Temperature (°C) or Percentage (%)[5]
40024	23 (0017)	CH3 Alarm Output State & Alarm Output Enable Default=0, Disabled	Bits 15-3: Zero Bit 2: Alarm Out State; 0 = Failsafe (OFF); 1 = Non-Failsafe (ON) Bit 1: High Limit; 1 = Hi Output Enabled; 0 = Hi Output Disabled Bit 0: Low Limit; 1 = Lo Output Enabled; 0 = Lo Output Disabled
40025	24 (0018)	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.**
IMPORTANT: *Access to calibration registers 40026 through 40115 is not normally required and writes to these registers should be avoided to prevent module miscalibration. Registers 40066-40105 are applicable to Model DI-934MB only, which has two additional channels.*			
40026	25 (0019)	CH0 Pt385 3W Cal High Value	Raw A/D Count Value[3]
40027	26 (001A)	CH0 Pt385 3W Cal Low Value	Raw A/D Count Value[3]
40028	27 (001B)	CH0 Pt391 3W Cal High Value	Raw A/D Count Value[3]

Ref	Addr.	Description	Data Type/Format
40029	28 (001C)	CH0 Pt391 3W Cal Low Value	Raw A/D Count Value[3]
40030	29 (001D)	CH0 Ni 3W Cal High Value	Raw A/D Count Value[3]
40031	30 (001E)	CH0 Ni 3W Cal Low Value	Raw A/D Count Value[3]
40032	31 (001F)	CH0 Cu 3W Cal High Value	Raw A/D Count Value[3]
40033	32 (0020)	CH0 Cu 3W Cal Low Value	Raw A/D Count Value[3]
40034	33 (0021)	CH0 0-500Ω 3W Resistance Cal HI Value	Raw A/D Count Value[3]
40035	34 (0022)	CH0 0-500Ω 3W Resistance Cal LO Value	Raw A/D Count Value[3]
40036	35 (0023)	CH0 Pt385 2W Cal High Value	Raw A/D Count Value[3]
40037	36 (0024)	CH0 Pt385 2W Cal Low Value	Raw A/D Count Value[3]
40038	37 (0025)	CH0 Pt391 2W Cal High Value	Raw A/D Count Value[3]
40039	38 (0026)	CH0 Pt391 2W Cal Low Value	Raw A/D Count Value[3]
40040	39 (0027)	CH0 Ni 2W Cal High Value	Raw A/D Count Value[3]
40041	40 (0028)	CH0 Ni 2W Cal Low Value	Raw A/D Count Value[3]
40042	41 (0029)	CH0 Cu 2W Cal High Value	Raw A/D Count Value[3]
40043	42 (002A)	CH0 Cu 2W Cal Low Value	Raw A/D Count Value[3]
40044	43 (002B)	CH0 0-500Ω 2W Resistance Cal HI Value	Raw A/D Count Value[3]
40045	44 (002C)	CH0 0-500Ω 2W Resistance Cal LO Value	Raw A/D Count Value[3]
40046	45 (002D)	CH1 Pt385 3W Cal High Value	Raw A/D Count Value[3]
40047	46 (002E)	CH1 Pt385 3W Cal Low Value	Raw A/D Count Value[3]
40048	47 (002F)	CH1 Pt391 3W Cal High Value	Raw A/D Count Value[3]
40049	48 (0030)	CH1 Pt391 3W Cal Low Value	Raw A/D Count Value[3]
40050	49 (0031)	CH1 Ni 3W Cal High Value	Raw A/D Count Value[3]
40051	50 (0032)	CH1 Ni 3W Cal Low Value	Raw A/D Count Value[3]
40052	51 (0033)	CH1 Cu 3W Cal High Value	Raw A/D Count Value[3]
40053	52 (0034)	CH1 Cu 3W Cal Low Value	Raw A/D Count Value[3]
40054	53 (0035)	CH1 0-500Ω Resistance 3W Cal HI Value	Raw A/D Count Value[3]
40055	54 (0036)	CH1 0-500Ω Resistance 3W Cal LO Value	Raw A/D Count Value[3]
40056	55 (0037)	CH1 Pt385 2W Cal High Value	Raw A/D Count Value[3]
40057	56 (0038)	CH1 Pt385 2W Cal Low Value	Raw A/D Count Value[3]
40058	57 (0039)	CH1 Pt391 2W Cal High Value	Raw A/D Count Value[3]
40059	58 (003A)	CH1 Pt391 2W Cal Low Value	Raw A/D Count Value[3]
40060	59 (003B)	CH1 Ni 2W Cal High Value	Raw A/D Count Value[3]
40061	60 (003C)	CH1 Ni 2W Cal Low Value	Raw A/D Count Value[3]
40062	61 (003D)	CH1 Cu 2W Cal High Value	Raw A/D Count Value[3]
40063	62 (003E)	CH1 Cu 2W Cal Low Value	Raw A/D Count Value[3]

Ref	Addr.	Description	Data Type/Format
40064	63 (003F)	CH1 0-500Ω Resistance 2W Cal HI Value	Raw A/D Count Value[3]
40065	64 (0040)	CH1 0-500Ω Resistance 2W Cal LO Value	Raw A/D Count Value[3]
40066	65 (0041)	CH2 Pt385 3W Cal High Value	Raw A/D Count Value[3]
40067	66 (0042)	CH2 Pt385 3W Cal Low Value	Raw A/D Count Value[3]
40068	67 (0043)	CH2 Pt391 3W Cal High Value	Raw A/D Count Value[3]
40069	68 (0044)	CH2 Pt391 3W Cal Low Value	Raw A/D Count Value[3]
40070	69 (0045)	CH2 Ni 3W Cal High Value	Raw A/D Count Value[3]
40071	70 (0046)	CH2 Ni 3W Cal Low Value	Raw A/D Count Value[3]
40072	71 (0047)	CH2 Cu 3W Cal High Value	Raw A/D Count Value[3]
40073	72 (0048)	CH2 Cu 3W Cal Low Value	Raw A/D Count Value[3]
40074	73 (0049)	CH2 0-500Ω 3W Resistance Cal HI Value	Raw A/D Count Value[3]
40075	74 (004A)	CH2 0-500Ω 3W Resistance Cal LO Value	Raw A/D Count Value[3]
40076	75 (004B)	CH2 Pt385 2W Cal High Value	Raw A/D Count Value[3]
40077	76 (004C)	CH2 Pt385 2W Cal Low Value	Raw A/D Count Value[3]
40078	77 (004D)	CH2 Pt391 2W Cal High Value	Raw A/D Count Value[3]
40079	78 (004E)	CH2 Pt391 2W Cal Low Value	Raw A/D Count Value[3]
40080	79 (004F)	CH2 Ni Cal 2W High Value	Raw A/D Count Value[3]
40081	80 (0050)	CH2 Ni Cal 2W Low Value	Raw A/D Count Value[3]
40082	81 (0051)	CH2 Cu Cal 2W High Value	Raw A/D Count Value[3]
40083	82 (0052)	CH2 Cu Cal 2W Low Value	Raw A/D Count Value[3]
40084	83 (0053)	CH2 0-500Ω Resistance 2W Cal HI Value	Raw A/D Count Value[3]
40085	84 (0054)	CH2 0-500Ω Resistance 2W Cal LO Value	Raw A/D Count Value[3]
40086	85 (0055)	CH3 Pt385 3W Cal High Value	Raw A/D Count Value[3]
40087	86 (0056)	CH3 Pt385 3W Cal Low Value	Raw A/D Count Value[3]
40088	87 (0057)	CH3 Pt391 3W Cal High Value	Raw A/D Count Value[3]
40089	88 (0058)	CH3 Pt391 3W Cal Low Value	Raw A/D Count Value[3]
40090	89 (0059)	CH3 Ni Cal 3W High Value	Raw A/D Count Value[3]
40091	90 (005A)	CH3 Ni Cal 3W Low Value	Raw A/D Count Value[3]
40092	91 (005B)	CH3 Cu Cal 3W High Value	Raw A/D Count Value[3]
40093	92 (005C)	CH3 Cu Cal 3W Low Value	Raw A/D Count Value[3]
40094	93 (005D)	CH3 0-500Ω 3W Resistance Cal HI Value	Raw A/D Count Value[3]
40095	94 (005E)	CH3 0-500Ω 3W Resistance Cal LO Value	Raw A/D Count Value[3]
40096	95 (005F)	CH3 Pt385 2W Cal High Value	Raw A/D Count Value[3]
40097	96 (0060)	CH3 Pt385 2W Cal Low Value	Raw A/D Count Value[3]

Ref	Addr.	Description	Data Type/Format
40098	97 (0061)	CH3 Pt391 2W Cal High Value	Raw A/D Count Value[3]
40099	98 (0062)	CH3 Pt391 2W Cal Low Value	Raw A/D Count Value[3]
40100	99 (0063)	CH3 Ni 2W Cal High Value	Raw A/D Count Value[3]
40101	100 (0064)	CH3 Ni 2W Cal Low Value	Raw A/D Count Value[3]
40102	101 (0065)	CH3 Cu 2W Cal High Value	Raw A/D Count Value[3]
40103	102 (0066)	CH3 Cu 2W Cal Low Value	Raw A/D Count Value[3]
40104	103 (0067)	CH3 0-500Ω 2W Resistance Cal HI Value	Raw A/D Count Value[3]
40105	104 (0068)	CH3 0-500Ω 2W Resistance Cal LO Value	Raw A/D Count Value[3]
40106	105 (0069)	Pt385 Input Range High	Ideal A/D Count Value[3]
40107	106 (006A)	Pt385 Input Range Low	Ideal A/D Count Value[3]
40108	107 (006B)	Pt391 Input Range High	Ideal A/D Count Value[3]
40109	108 (006C)	Pt391 Input Range Low	Ideal A/D Count Value[3]
40110	109 (006D)	Ni Input Range High	Ideal A/D Count Value[3]
40111	110 (006E)	Ni Input Range Low	Ideal A/D Count Value[3]
40112	111 (006F)	Cu Input Range High	Ideal A/D Count Value[3]
40113	112 (0070)	Cu Input Range Low	Ideal A/D Count Value[3]
40114	113 (0071)	0-500Ω Input Range High	Ideal A/D Count Value[3]
40115	114 (0072)	0-500Ω Input Range Low	Ideal A/D Count Value[3]

Notes (Register Map):

1. Note that the Report Slave ID and Reset Slave functions do not operate on Register Map locations. An alternate method of accomplishing reset is provided if your software does not support the Reset Slave function (see Register 40025).

2. Configuration variables stored in holding registers (4xxxx reference addresses) are maintained in EEPROM. Changes to these registers do not take effect until the next software or power-on reset of the module, except for the Calibration Access & Reset Register which takes effect immediately.

3. The DI-932MB/DI-934MB A/D Count value is calculated via the expression: count = (32768*Vin*Gain/Vref)+32768, where Vref=1.020V (1020Ω*0.001mA). Gain is 2 (Pt), 2 (Ni), 8 (Cu), and 2 (0-500Ω).

4. **WARNING:** Access to shaded calibration registers 40026 through 40115 is not normally required and writes to these registers should be avoided to prevent miscalibration.

5. RTD input values are represented via 16-bit signed integer values with a resolution of 0.1°C/lsb and a possible range of -3276.8°C to +3276.7°C. Default limit values are set to the RTD input range endpoints: -200°C (Pt/Cu) or -80°C (Ni) for the Low Limit, and +850°C (Pt), +320°C (Ni), or +260°C (Cu) for the High Limit. Default deadband is set to 1.0°C. The 0-500Ω input range values are represented via 16-bit signed integers representing percent with a resolution of 0.005%/lsb. The full range is -163.84% (-32768 decimal) to +163.835% (+32767 decimal). That is, ±20000 is used to represent ±100% (a span of -20000 to +20000). For example, 0% and 100% are represented by decimal values 0 and 20000, respectively. Default limit values are set to the input range endpoints: 0% (Low Limit, 0 count at 0Ω) and +100% (High Limit, +20000 count at 500Ω). Default deadband is set to 1% of span (a count of 200). Limit checking is always active.

6. **IMPORTANT** - Break detection with 0-500 ohm inputs: The maximum input resistance including lead wires is approximately 506Ω. If break detection is set to downscale and your input resistance is greater than 505Ω (saturated), this will trigger break detection and the input reading will be sent downscale for the over-range input resistance without actual lead breakage. Likewise, upscale break detect is not distinguishable from an input resistance greater than 505Ω.

5. An Introduction to Modbus

The Modbus protocol provides an industry standard method that Series DI-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 (slaves) respond by supplying the requested data to the master, or by taking the action requested in the query. DI-900MB modules are slaves, while a typical master device is a host computer running appropriate application software. Masters can address individual slaves, or can initiate a broadcast message to all slaves. Slaves return a response to all queries that are addressed to them individually, but no response is returned to broadcast queries from a master device.

Remote Terminal Unit (RTU) Mode

Series DI-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 the message is transmitted in a continuous stream. The format for each byte in RTU mode is outlined 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 address), a function code defining the requested action, any required data, 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 DI-932MB/DI-934MB 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 presented in the prior section for sending and receiving data. Note that the Report Slave ID and Reset Slave commands do not operate on register map registers.

When the slave device responds to the master, it uses the function code field to indicate either a normal (error-free) response, or that some kind of error has occurred (an exception response). A normal response simply 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 this model. 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 DI-932MB/DI-934MB models, its response is equivalent to reading the on/off status of the solid-state output relays. 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 solid-state relays 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 (conducting 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 (LRC or CRC)	--

Read Coil Status Example Response

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

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 40006…40008 (Channel 0 high limit value, low limit value, deadband value) 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	5 (05)
Number Of Points High Order	0 (00)
Number Of Points Low Order	3 (03)
Error Check (LRC or 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 40006)	(3A)
Data Low (Register 40006)	75%=15000 (98)
Data High (Register 40007)	(13)
Data Low (Register 40007)	25%=5000 (88)
Data High (Register 40008)	(00)
Data Low (Register 40008)	1%=200 (C8)
Error Check (LRC or CRC)	--

To summarize, the contents of register 40006 (two bytes) is the channel 0 high limit of 75% (15000=3A98H). The contents of register 40007 (two bytes) is the channel 0 low limit of 25% (5000=1388H). The contents of register 40008 is the channel 0 deadband value (two bytes) of 1% (200=00C8H).

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 registers 30003 & 30004 (Channel 0 input value and status) at slave device 247:

Read Input Register 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 (LRC or CRC)	--

Read Input Register Example Response

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	4 (04)
Byte Count	4 (04)
Data High (Register 30003)	(3E)
Data Low (Register 30003)	80%=16000 (80)
Data High (Register 30004)	(00)
Data Low (Register 30004)	136 (88)
Error Check (LRC or CRC)	--

To summarize, the contents of register 30003 (two bytes) is the channel 1 input value of 80% (16000=3E80H). The contents of register 30004 (two bytes) is the channel 0 status flags of 136 (0088H)-i.e. flagging high limit exceeded.

Force Single Coil (05)

This command will force a single coil/output (ox 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 corresponding solid-state relay is turned ON or closed), and 0000H forces the coil to be turned OFF (i.e. the solid-state output relay is turned OFF or opened). 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 following example 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 (LRC or CRC)	--

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 (LRC or CRC)	--

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

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 (LRC or 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 (LRC or 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 (LRC or 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 (LRC or 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)
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 (LRC or 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 (LRC or 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 a 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 (LRC or CRC)	--

Report Slave ID Example Response

Field Name	Example Value (Hex)
Slave Address	247 (F7)
Function Code	17 (11)
Byte Count	26 (1A)
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 11 (0BH) = 932MB-0900 12 (0CH) = 934MB-0900 13 (0DH) = 942MB-0900
Run Indicator Status (ON)	255 (FF)

Firmware Number ASCII Byte String (Additional Data Field)	"ACROMAG, 9300-041A, 934MB-0900,"(41 43 52 4F 4D 41 47 2C 39 33 30 30 2D 30 34 31 41 2C 39 33 34 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)	--

The Report Slave ID response message returns the slave model ID and firmware number string as shown above.

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 (LRC or 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 (LRC or CRC)	--

Note that the response simply echoes the query just <u>before</u> 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 40011 of 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 temperature, percentage, and discrete on/off.

Summary Of Data Types Used By DI-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 $\gg 0V$), 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 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.

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 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 duration of time is required to do so. This response is returned 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.
07	Negative Acknowledge	The slave cannot perform the program 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 information from the slave.
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.

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 to direct an examination of the data field for the applicable exception code.

6. Module Software Configuration

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

Before You Begin

1. Have you installed the DI-900MB Configuration Program? You should complete the Module Installation section 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. Is baud set correctly at the RS485 converter/repeater??

4. Have you tried communicating using the Default Mode? Press the "DFT" push-button of the 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.

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 40006). Some network converters or host/software systems cannot accept an immediate response from a slave without added delay.

The following sections guide you through the Configuration Program property sheets used to configure a DI-932MB or DI-934MB Transmitter. These models share identical circuits and only differ in the number of input channels. Property sheets will vary from model to model, but the general approach is the same.

Starting The Program

After clicking on the Series DI-900MB program icon to boot the Configuration Program, a screen will be displayed similar to that shown at right.

To begin, click on 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).
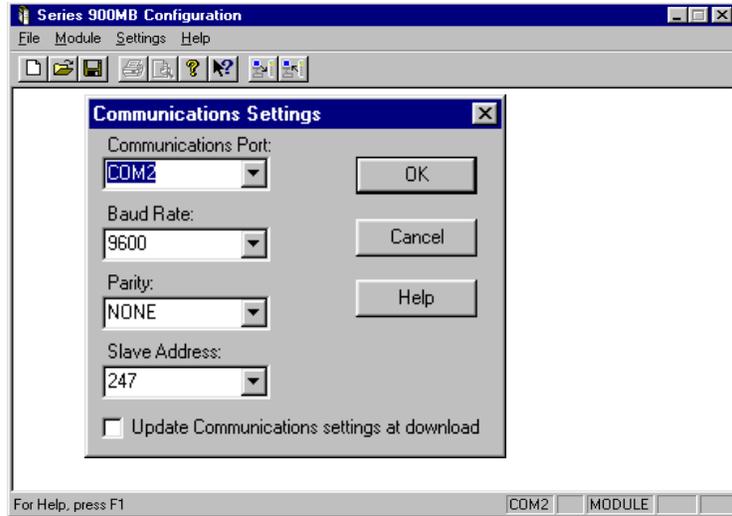
Note that the host COM port selected is indicated in the first box of the lower right-hand corner. MODULE is indicated in the third box if a connected module is detected by the software. The fourth and fifth boxes indicate NUM for Num lock and CAP for Caps lock, respectively. Available menu selections are listed below.

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 <u>H</u>elp Topics
 Your Model Help Topics
 <u>A</u>bout Modbus Configuration
 About *Your Model*

Use **<u>H</u>elp** 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 DI-934MB transmitter. The Model DI-932MB is configured in the same manner, but has two less input channels.

Creating A Configuration File

You may use **<u>F</u>ile-<u>N</u>ew** to create a new configuration file, or **<u>F</u>ile-<u>O</u>pen** to open an existing configuration file. However, It is recommended that you first use **Module-<u>U</u>pload Configuration** to retrieve the current active configuration from the connected module. This will automatically detect the correct model number 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. Your screen will vary according to your model number. The model number is indicated at the top of the screen along with the current file name. The Model DI-934MB General screen is shown here.
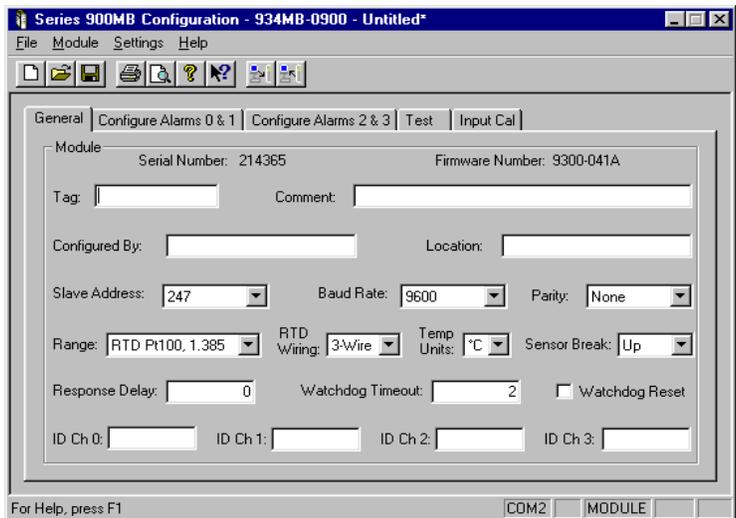
Note that 5 property sheets define this transmitter's configuration: General, Configure Alarms 0 & 1, Configure Alarms 2 & 3, Test, and Input Calibration.

Module

The Serial and Firmware numbers are indicated at the top of the General screen and 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:" (bottom), 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.

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 (configured separately via the **Settings** menu).

If you checked the "Update Communications settings at download" box of the Settings pull-down menu, the host software will change its own 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, & parity of the module are fixed at 9600bps, 247, and No Parity.

Use the **"Range:"** scroll bar to pick one of the following ranges according to your model (Model DI-924MB ranges shown):

Pt 100Ω (1.3850) -200 to 850°C
Pt 100Ω (1.3911) -200 to 850°C
Ni 120Ω (1.6720) - 80 to 320°C
Cu 10Ω (1.4272) -200 to 260°C
Resistance 0-500Ω (% of span)

Note that RTD inputs return units of °C, while resistance inputs returns units of percent-of-span. For the 0-500Ω range, a 0% indication represents 0W, and 100% represents 500Ω Scaling of ±20000 to ±100% is done for convenience of display in this software.

Your software may rescale these values as required for your application. Keep this in mind when using other software to communicate with the module.

Multiple inputs of the same module must have same input type. All input ranges have already been factory calibrated.

To begin configuring your module, start by selecting an input range as required.

Click on **"RTD Wiring"** to select a 2-Wire or 3-Wire configuration (RTD only).

Click on **"Temp Units"** to select °C, °F, or K (Kelvin) units of measure for the input signal (RTD inputs only).

IMPORTANT: The module returns units in °C only. The selection of °F or K only applies to their use within this software.

Changing units will cause alarm levels already set to revert to their range endpoints.

For **"Sensor Break,"** select Upscale or Downscale break detection for all inputs. Break detect will result in an upscale or downscale range endpoint reading and the module's ST LED to turn ON.

Use the **"Response Delay"** field to specify a delay from 0 to 65500 ticks with 1 tick equal to 1.085 microseconds. Response delay is the added 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 comparably greater amount of response delay to measure any affect. Some host software or signal converters require added delay to work properly.

If you wish to enable the I/O Watchdog Timer, specify a **"Watchdog Timeout"** delay from 1 to 65534 seconds (0 will disable timer). A watchdog timeout will occur if no I/O has occurred within this time period.

You may click the **"Watchdog Reset"** check box to also send the outputs to their reset states upon watchdog timeout (Reset States are set via the Configure Alarms screens).

The next section covers optional alarm configuration.

Alarm Configuration

Clicking the Configure Alarms property sheet tab(s) will display a screen similar to the one at right. A second Configure Alarms 2 & 3 screen is included for four channel DI-934MB models. Your screen may vary slightly according to your model and selected input range.

IMPORTANT: Limit checking is always active, while alarm outputs are enabled selectively. Default limit values are the input range endpoints.

The default High and/or Low Limit values can be changed. You can enable the corresponding output as an alarm output via the High/ Low Alarm Output Enable boxes. You can also specify failsafe or non-failsafe alarm outputs. Optionally, deadband may be applied to a limit. Refer to the limit alarm configuration field descriptions below to complete this information for Limit Alarms 0 & 1, and 2 & 3 (DI-934MB).
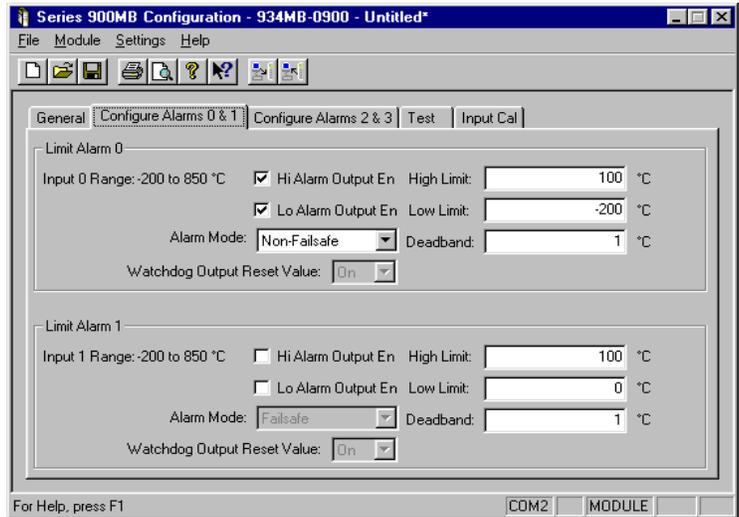
Alarm Config Field Descriptions

Limit Alarm (Each Input)
Hi/Lo Alarm Output En (Each Input): Enable High and/or Low Limit alarm output control for each input. Limit alarm control of the corresponding output takes priority over direct control when enabled.

High Limit (Each Input): The high limit level is programmable over the entire input range and entered in the same engineering units as the input. The corresponding alarm output will go to its alarm state for an increasing input signal that equals or exceeds the high limit value (if enabled).

Low Limit (Each Input): The low limit level is programmable over the entire input range and entered in the same engineering units as the input. The corresponding alarm output will go to its alarm state for a decreasing input signal that equals or goes below the low limit value (if enabled).

Deadband (Each Input): Deadband may be applied to both limit levels and is programmable over the entire input range. Deadband is entered in the same units as the input and determines the amount the input signal has to return into the "normal" operating range before the corresponding alarm relay will transfer out of the "alarm" state. Deadband is normally used to eliminate false trips or switch "chatter" caused by fluctuations of the input near the limit.

Alarm Mode (Each Input): This field allows you to select failsafe or non-failsafe alarm output activation. Alarm outputs must be separately enabled. A failsafe alarm output will turn OFF in alarm (the same state as the power-down state). A non-failsafe alarm output will turn ON in alarm.

Alarm control of the output will take precedence over direct control when the High/Low Alarm Output Enable box is checked. Keep this in mind if you attempt to control the state of an alarm output directly, as the module will seek to maintain the correct output state relative to the alarm condition and alarm mode, each time it scans the input. How-

ever, this does not apply for input signals within the deadband region. If the input is within the deadband region, the discrete output state can be controlled directly, but direct control of an alarm output is not recommended.

There are three methods of detecting an alarm: the output status LED can be used to indicate a transfer to the alarm state, a global limit exceeded flag will be set in the Module Status Register, and a high and/or low limit flag will be set in the Channel Status Register. The Test Page of this software program will also report the alarm status for the module and an input channel.

Watchdog Output Reset Value: This selection determines the state the output will be automatically toggled to following a watchdog timeout. Select "On" or "Off" as required. Watchdog timer control of an output will take precedence over alarm and direct control.

Writing Your Configuration

After making your General and Alarm Configuration selections, you must download the new settings as follows:

Select **Module-Download Configuration** to write your configuration to the module.

Module
  Upload Configuration
  Download Configuration

Note that you can select Module-Upload Configuration to retrieve the module's current alarm configuration and calibration, or to review and verify its configuration. Configuration data is stored in non-volatile memory within the DI-900MB module.

The next section covers testing of your configuration. If you have made changes to any of the module configuration screens, be sure to down-load your changes to the module prior to invoking any of the test or calibration pages.

Testing Your Configuration

The "Test" portion of this program allows you to monitor polling, module status flags, read input values, reset the module, and control or monitor outputs.

CAUTION: If you have made changes to module configuration data screens but have not already downloaded those changes to the module, then selecting this page may change some of your software selections to match those obtained from polling the module. Always download your changes to the module before invoking the Test or Cal pages.
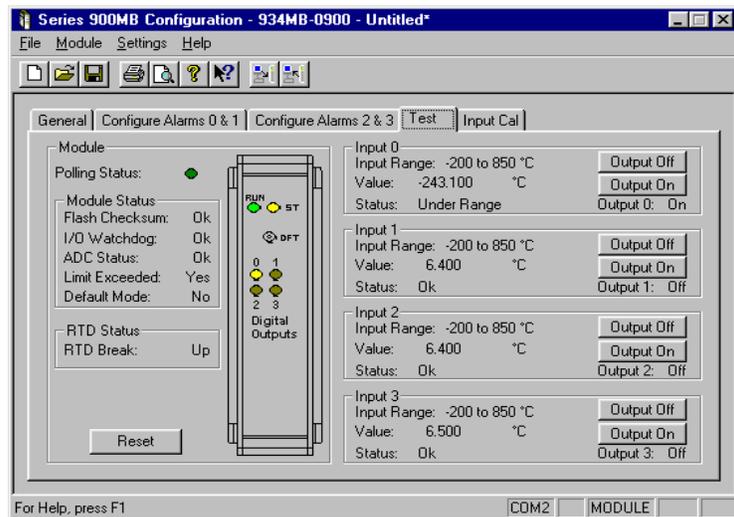
Test Operation

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 (A Model DI-934MB Test screen is 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. Note that a watchdog timeout will never occur if you are viewing this screen as it continuously polls the I/O.

The graphic simulation of the module LED's reflect 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, make host software adjustments accordingly via the Settings pull-down menu.

For each input, the current selected input range, input value ("Value:"), and input status is indicated (under-range, OK, limit exceeded, or over range). The output states are also indicated. You may also turn the outputs On/Off by clicking on the Output On or Output Off buttons (assuming outputs are not already enabled as alarm outputs). Keep in mind that alarm control of an output has priority over direct control (if enabled) and will seek to maintain the correct output state relative to the input level each time the input is scanned.

Clearing a watchdog timeout by initiating I/O with a module that has timed out will not automatically return the digital outputs to their pre-timeout state. It simply returns control of the output state to the alarms, or to the operator via manual control. Watchdog timeout control of the output has the highest priority (if enabled), followed by alarms (if enabled), with manual control of the outputs having the lowest priority.

If an output is already enabled as an alarm output, then alarm control of the output state will over-ride manual control of the output state.

NOTE: The resistance input will always return its measurements in scaled percent-of-span units with ±20000 representing ±100%. Scaling to input signal engineering units is done via this software for the convenience of display. Likewise, RTD inputs always return their measurements in °C, with translation to °F or K done for convenience via this software. Keep this in mind when using other software packages to interrogate a module.

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.

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.

Note that the configuration process will vary slightly for other model types. The next section covers calibration of your inputs. Note that calibration has already been done at the factory and adjustment is not generally required. However, periodic recalibration may be performed to correct for component aging, or as part of your company's maintenance requirements.

Module Calibration

Calibration of a module is much simpler using the controls of the Modbus Configuration Software as described here.

CAUTION: If you have made changes to module configuration data screens but have not already downloaded those changes to the module, then selecting this page may change your software selections to match those obtained from polling the module. Always download accumulated changes to a module before invoking the Test or Input Cal pages to prevent data loss.
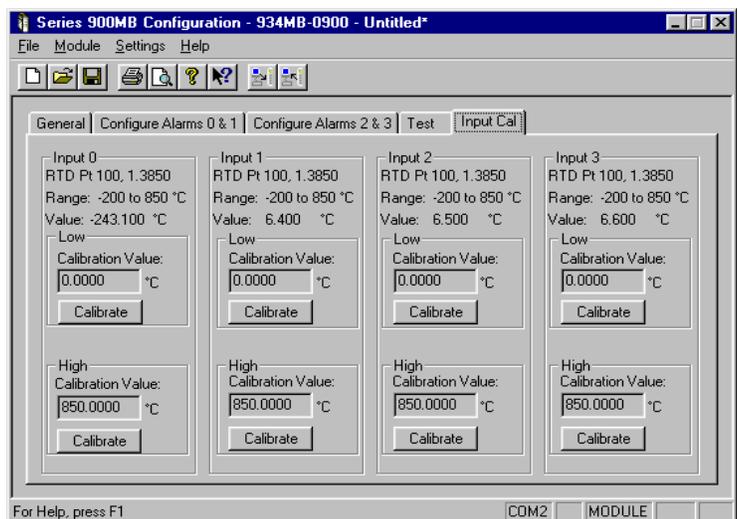
Note: Calibration of all supported input ranges has already been done on your module at the factory. Recalibration is normally not required, except as necessary to correct for long term component aging or to satisfy your company's maintenance requirements.

This portion of the program will allow you to calibrate the nominal input ranges of your module.

WARNING: Miscalibration may render an input channel unstable or inoperable. Try recalibrating an input if it appears unstable.

For best results, you will need a precision input resistance source capable of reproducing nominal RTD input range endpoint signals, at least as accurate as the module itself. You will also need an RTD table that relates RTD resistance to temperature.

Prior to calibration, configure the RTD wiring as desired in your final application (2-Wire or 3-Wire) and allow the module to warmup a few minutes.

Module Input Calibration

1. Click on the Input Calibration property sheet tab to display the screen shown at right (your screen may be slightly different according to your model and selected input range).

   Note that Module-Upload Configuration will recall the module's current calibration for review or to make minor adjustments.

   After upload, the current Low and High calibration values will be indicated in the Calibration Value fields. These correspond to the nominal input range endpoint signals of the selected input range. Uploading first will help prevent miscalibration if the input range set at the module is different than that selected via this software.

2. Adjust your input resistance to precisely match that of the Low Calibration Value field entry.

3. If the current input value indicated in the "Value:" field does not precisely match the low input signal value, and the externally applied low endpoint signal level, press the Low "Calibrate" button to set the Low Calibration Value. After a moment, the value indicated should match the Low Calibration Value.

4. Next, adjust your input resistance to precisely match the High Calibration Value field entry. Observe proper polarity.

5. If the current input value indicated in the "Value:" field does not precisely match the high input signal value and the externally applied high endpoint signal level, press the High "Calibrate" button to reset the High Calibration Value. After a moment, the value indicated should match the High Calibration Value.

6. Repeat steps 1-5 for each of the other input channels, as required.

Please Note:

Calibration points are restricted to the current selected input range endpoint values. Be sure to precisely match these levels via your resistance source. Failure to use calibration points other than the current input range endpoints will result in measurement error.

For best results, wire the RTD as required by the final application (2-wire or 3-wire connection) and allow the module to warmup a few minutes prior to calibration. In addition, you should always calibrate the low value first before the high value.

Resistance input always returns measurements in scaled percent-of-span units with ±20000 representing ±100%. Scaling to input signal engineering units is done via this software for the convenience of display. Likewise, RTD inputs always return measurements in °C. Translation to °F or K is done for convenience via this software. Keep this in mind when using other software packages to interrogate a module.

Refer to Drawing 4501-895 at the back of this manual for example input connections.

7. Block Diagrams and Schematics

Theory of Operation

Refer to Simplified Schematic 4501-893 and Functional Block Diagram 4501-894 to gain a better understanding of the circuit. Note that these transmitters will process up to two or four RTD input signals, and provide network commands to configure the module, monitor the inputs, and control the outputs. An integrated multiplexer and analog switch are used to connect each of two input channels to an A/D converter. The A/D converter then applies appropriate gain to the signal, performs analog-to-digital conversion, and digitally filters the signal. The digitized A/D signal is then transmitted to a microcontroller. The microcontroller completes the transfer function according to the input type and its embedded program. The microcontroller also compares the signal value to the limit value if the alarm function is used and completes all necessary alarm functionality per its embedded program. I/O lines of the microcontroller also switch the solid-state relays 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. New module 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 4501-894 for an overview of how the software configuration variables are arranged.

Simplified Schematic (4501-893)
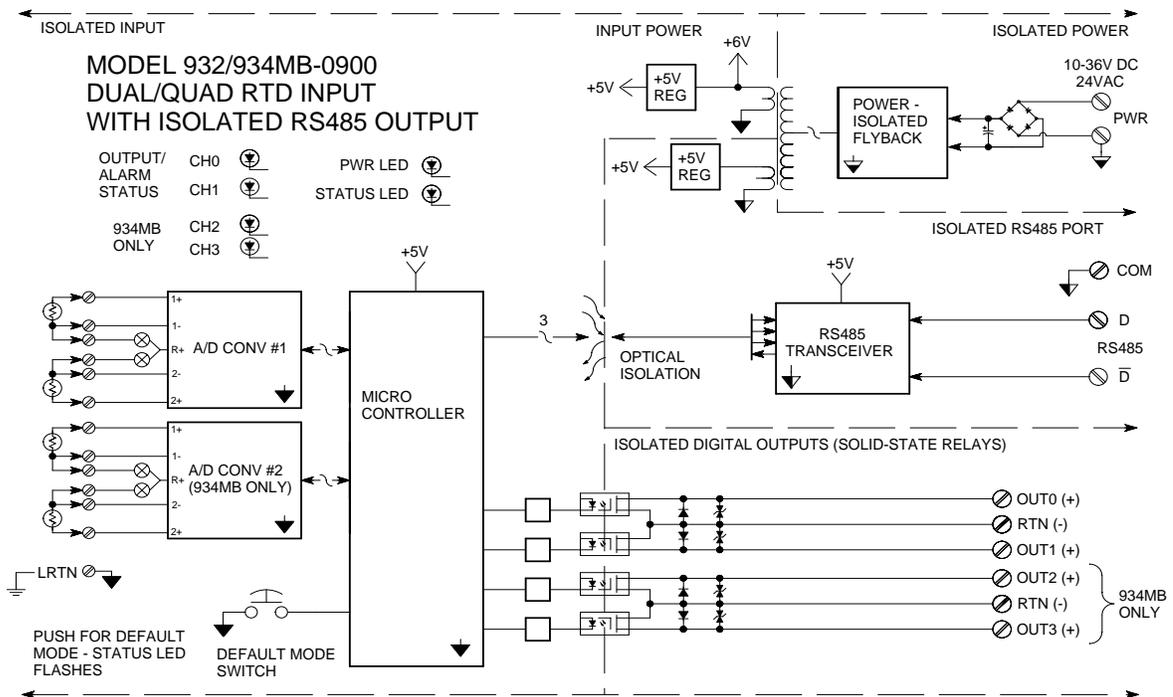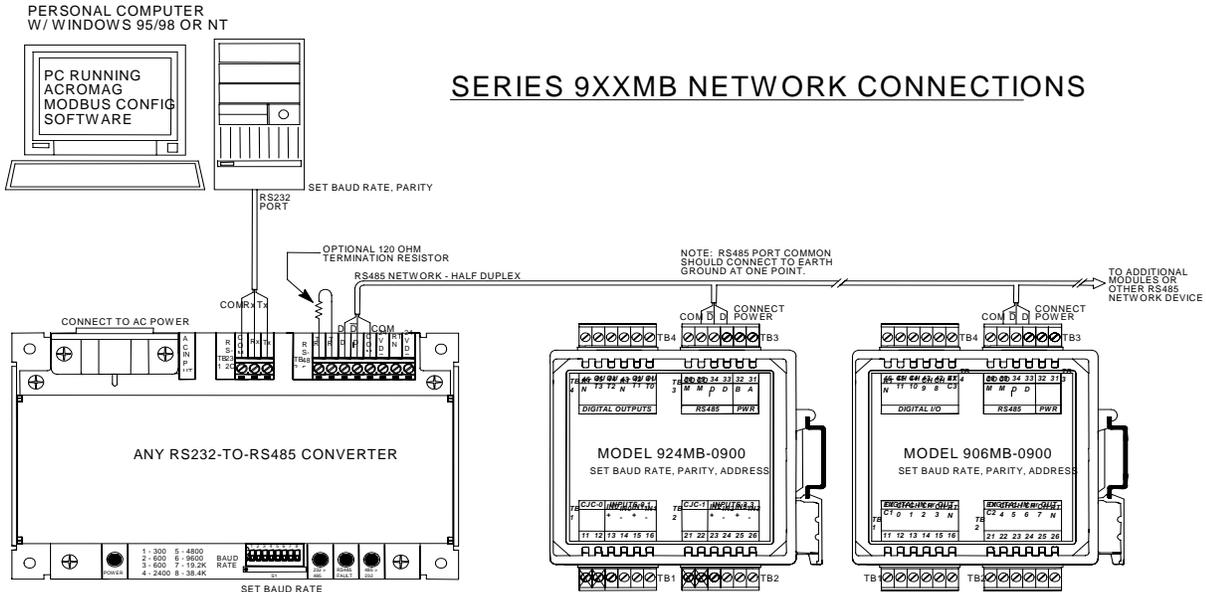

4501-893A

Functional Block Diagram (4501-894)

MODEL: 932MB-0900 & 934MB-0900
RTD TO MODBUS TRANSMITTER
FUNCTIONAL BLOCK DIAGRAM
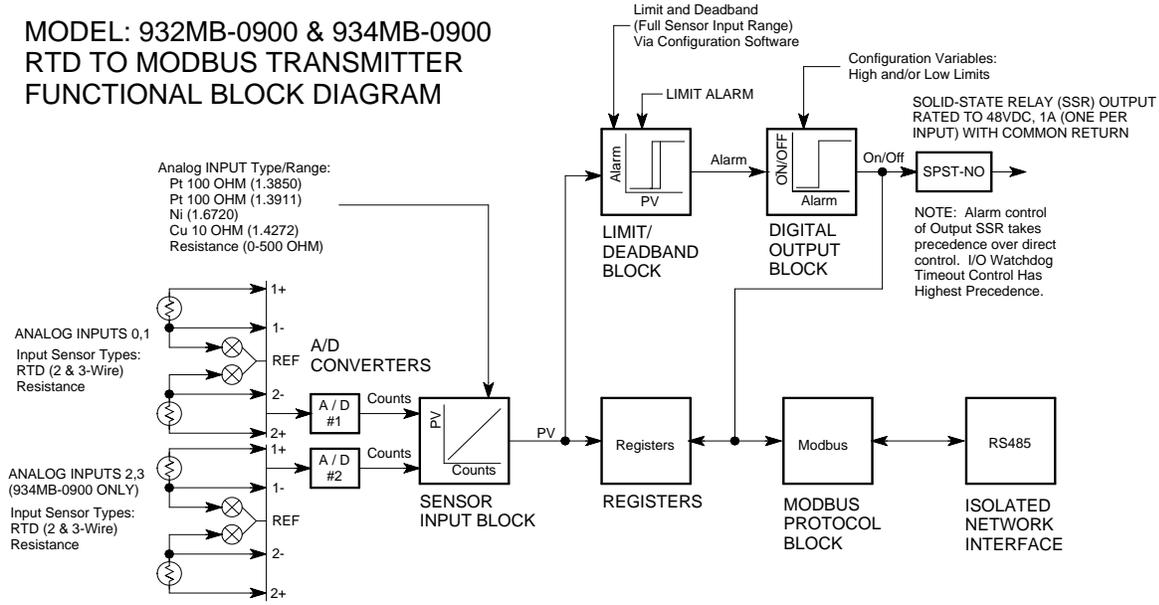
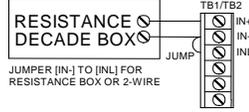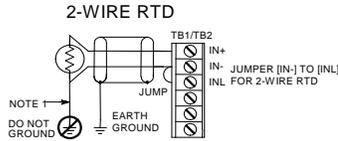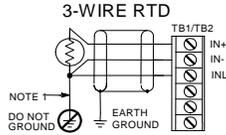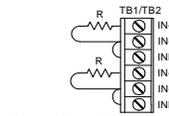

4501-894A

Network Connections (4501-805)

SERIES 9XXMB NETWORK CONNECTIONS

4501-805A

Electrical Connections (4501-895)

ELECTRICAL CONNECTIONS
MODEL 932MB-0900 AND 934MB-0900
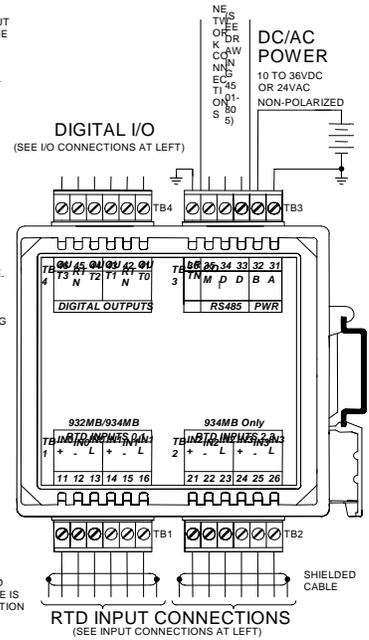
4501-895A

Interposing Relay Conn. & Contact Pro. (4501-896)

INTERPOSING RELAY CONNECTIONS
MODEL 932MB-0900 AND 934MB-0900
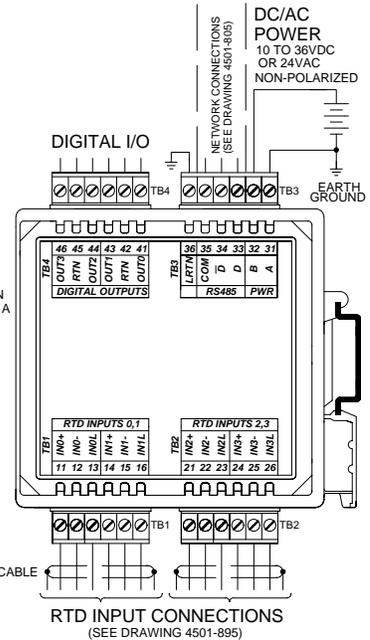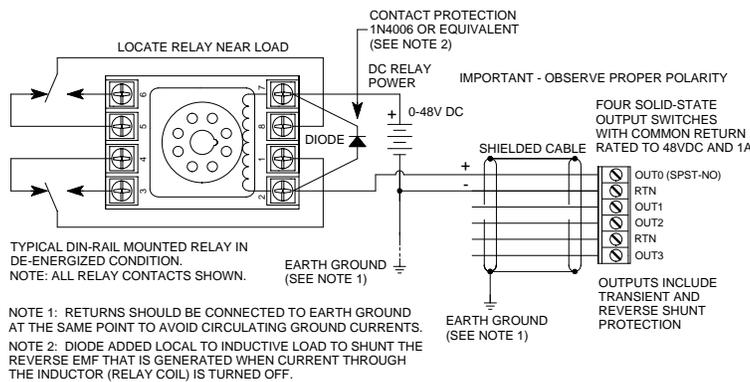
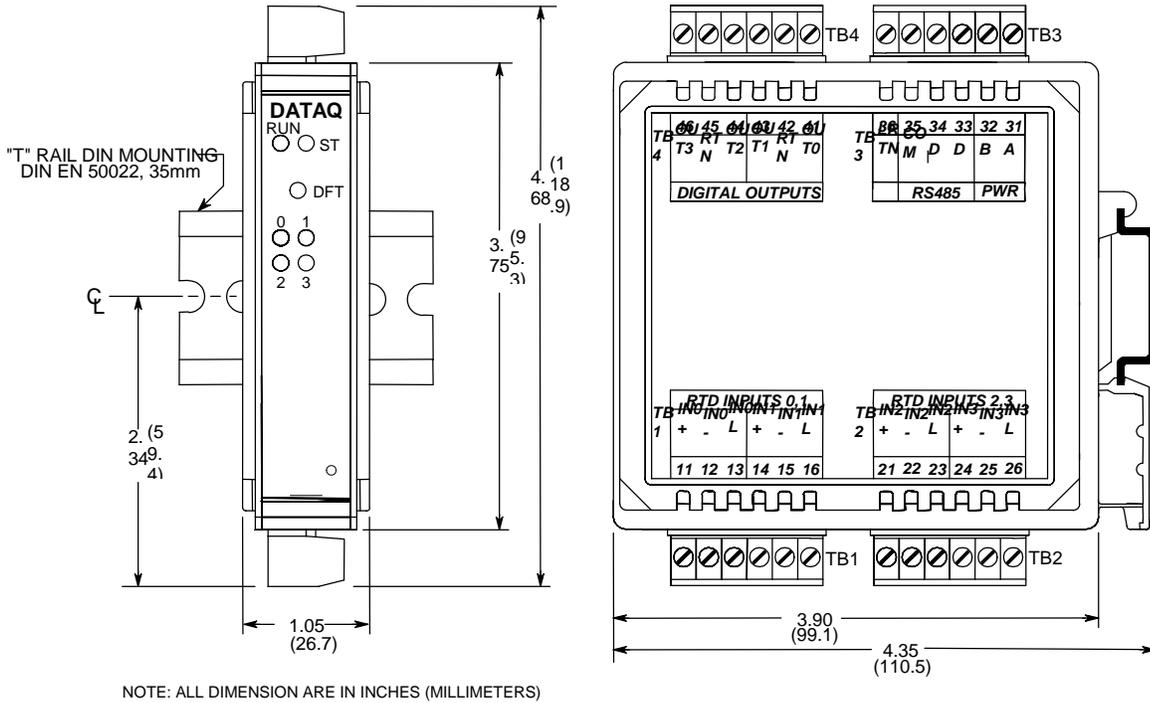4501-896A

Enclosure Dimensions (4501-897)

"T" RAIL DIN MOUNTING
DIN EN 50022, 35mm

DATAQ
RUN
ST
DFT
0 1
2 3

4.68 (118.9)
3.75 (95.3)
2.34 (59.4)

1.05
(26.7)

NOTE: ALL DIMENSION ARE IN INCHES (MILLIMETERS)

TB4   TB3
TB1   TB2

DIGITAL OUTPUTS
T3 RT N T2 T1 RT N T0
46 45 44 43 42 41

RS485   PWR
M D D B A
36 35 34 33 32 31
TN CO

RTD INPUTS 0,1
IN0 IN0 IN0 IN1 IN1 IN1
+ - L + - L
11 12 13 14 15 16

RTD INPUTS 2,3
IN2 IN2 IN2 IN3 IN3 IN3
+ - L + - L
21 22 23 24 25 26

TB4
TB3
TB1
TB2

3.90
(99.1)
4.35
(110.5)

SERIES 934MB ENCLOSURE DIMENSIONS

4501-897A

8. Accessories

Series DI-900MB Software Interface Package (Model 100969)

The Software Interface Package combines the DI-900MB Configuration Software, RS-232 to RS-485 Serial Converter, Interface Cable, and Instructions, into a complete kit for interfacing with Series DI-900MB I/O Modules.

DI-900MB Configuration & Control Software

Series DI-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 DI-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.

RS-232 to RS-485 Serial Adapter

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 DI-900MB I/O Modules. It is used in conjunction with the DI-900MB Configuration Software for simple reconfiguration, testing, and troubleshooting of Series DI-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 Interface Cable described below).

Interface Cable

This 3-wire cable is used to connect the RS-485 side of the Serial Adapter to the RS-485 network terminals of Series DI-900MB modules. This cable is 8 feet long and has a DE-9M connector on one end, and three stripped and tinned wires on the other end. The wires are labeled A, B, and C for connection to the module D, Dbar, and COM terminals, respectively.

Isolated Signal Converter (Models 100974 and 100975)

This unit provides an isolated interface between the host PC's RS-232 port and RS-485 Modbus network devices. Signal conversion is bidirectional with operation that is transparent to all devices. The RS-485 network supports up to 32 devices (including the Signal Converter) across 4000 foot distances. Installation of additional network devices or extending the distance requires the Network Repeater described below. Optional 115V AC Power (Model 100974) or 230V AC Power (Model 100975). Power cord included. The Model Number 100976 connects the PC's RS-232 port to the Isolated Signal Converter.

Isolated Network Repeater (Models 100977 and 100978)

This unit isolates and boosts RS-485 signals to extend communication distances or increase the number of devices on the network. Each Repeater permits the addition of a network branch with up to 32 devices (including the Network Repeater) and will transmit RS-485 signals another 4000 feet. Operation is transparent to all devices and no handshaking is required. Two terminal blocks are provided for 120 ohm resistors to terminate both ends of the network branch. Optional 115V AC Power (Model 100977) or 230V AC Power (Model 100978).

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Data Acquisition | Data Logger | Chart Recorder | Thermocouple | Oscilloscope