# GE Zenith Controls

**MX150/MX250** *(MX Version 6.0+ Only)*
**Modbus Network Card** *50P-2035*

**Operation and Maintenance Manual**

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# Disclaimer

# Overview

The Modbus network card is designed for the MX150 and MX250 controllers, version 6.0 program and above. If the controller is ordered with the Modbus option, the Modbus card will reside on the back of the controller board and it will be part of the controller assembly. The purpose of this card is to allow the controller to be available on a Modbus network as a slave device. This allows a master device, such as a programmable logic controller (PLC), to obtain information from the controller and have that information available for control, data acquisition and monitoring.

Every Modbus network consists of one master device and at least one slave device. All devices on the network are daisy-chained using a twisted pair cable (see Appendix E). Each slave device is assigned a unique address from 1-247. Factory default for each Modbus card is Slave Address 1. This address enables the master to distinguish between the various slaves on the network. It also allows the master device to send a query command to the addressed slave. When the addressed slave receives this command it will send back an appropriate response to the master. *Table 1* shows a list of Modbus commands which the Modbus network card supports. Reference Appendix G for a more detailed description of the Modbus commands.

| Modbus Command | Modbus Command Description |
| --- | --- |
| 01 | Read Coil Status |
| 03 | Read Holding Register |
| 05 | Write Single Coil |
| 06 | Write Single Holding Register |
| 15 | Write Multiple Coils |
| 16 | Write Multiple Holding Registers |

**Table 1 – Supported Modbus Commands**

The Modbus commands allow the master device to read data from, and write data to, specific memory locations in the controller. These memory locations, which are listed in Appendix A and B, make up the Modbus network variables. These variables allow the reading of controller status, configuration, etc. The variables which can be written to (reference Appendix B), include timer values, Fail/Restore settings, and control variables.

Both lists contain a parameter name column that displays the name of the memory locations. The non-indented names in that column are 16-bit registers while the indented ones are individual bits, which make up the 16-bit registers. For example, Status 0, a non-indented name, is a 16-bit register that consists of the following bits:

- S1 Available
- S2 Available
- Load, No Load, Fast Load Test Status
- Load Test Running
- Alarm
- ATS Not in Auto Mode
- Automatic Transfer Relay



**Most Significant Byte**     **Least Significant Byte**

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

Normal Source Available
Emergency Source Available
Load, No Load, Fast Load Test Status
Load Test Running
Not Used
Alarm
ATS Not in Auto Mode
Automatic Transfer Relay
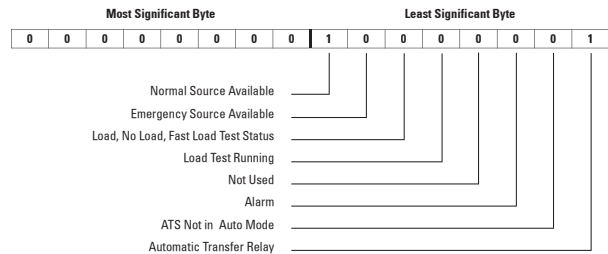
**Figure 1 – Status 0 Register**

These bits make up the least significant byte of the Status 0 register, while the most significant byte of the Status 0 register contains zeros. *Figure 1* shows an example of what the Master device would see if it read back the entire Status 0 register. In this example, the Master device would read back the decimal value of 129 from the Status 0 register. When this value is decoded, the Master finds out that the S1 source is available and the Automatic Transfer Relay input is active. The Master also has the option of reading the individual bits, indented under Status 0. This allows the Master to know the status of each parameter without doing any decoding. The second column contains the actual addresses for the network variables. These addresses are used when the Master is reading a Holding Register (16-bit reg). The third column contains addresses that are used when the Master is reading a Coil (individual bit). The remaining columns show the values and ranges (only in Appendix B) for the network variables.

## LED Indicator

The Modbus card has a 10-segment LED module (Refer to Appendix E for location). These LED's display the slave address of the card as well as transmit and receive status. The first LED from the bottom indicates the receive status, the second LED indicates the transmit status. When a Modbus packet has been successfully transmitted or received, the associated LED will light for 100ms. If another packet is sent or received before the 100ms elapses, the LED on-time will be extended by another 100ms. LED's 3-10 display the slave address of the controller as a binary number with each LED corresponding to a bit. *Figure 2* shows the 10-segment LED module along with LED's 3, 5, and 6 being lit. The lit LED's correspond to slave address 13.



| LED 10 - $2^7$ |
| LED 9 - $2^6$ |
| LED 8 - $2^5$ |
| LED 7 - $2^4$ |
| LED 6 - $2^3$ |
| LED 5 - $2^2$ |
| LED 4 - $2^1$ |
| LED 3 - $2^0$ |
| LED 2 - Transmit |
| LED 1 - Receive |

**Figure 2 – LED Module**

# Installation

## Installation on the Controller

If the Modbus network card is not installed on the controller, do the following to install it:

1. Open the ATS cabinet. If the ATS has power going to it, be EXTREMELY cautious not to touch any energized parts.

2. Remove the two Engine Start wires from the P-Relay(s) if applicable (not applicable in Utility-Utility applications). Use electrical tape to tape over the exposed ends of both wires.

3. Obtain a grounding wrist strap and put the elastic end of the strap on your wrist. Attach the alligator clip end to the controller chassis or an equivalent earth ground.

4. Remove the J5 plug from the controller (located on bottom of board), this will remove power. If controller is equipped for external battery, also remove the J4 connector from the side of the controller. When power is removed from the controller, the ATS will not transfer.

5. Unscrew the black metal cover from the back of the controller. Be sure not to lose any screws.

6. Remove the three screws from the metal standoffs on the controller. Plug the Modbus network card into socket J3 and fasten it to the controller with the three screws (previously removed).

7. Screw the black metal cover back on.

8. Reconnect the J5 plug back into the controller. (If controller is equipped for external battery, also reconnect the J4 connector on the side of the controller.)

9. Connect the two Engine Start wires to the P-Relay(s) if applicable.

10. Once the controller has power, the network option must be enabled by going into the CFG menu for the network option (Reference Appendix H).

11. When the network option is enabled, exit the CFG menu.

## Termination Resistor

Located on the bottom of the Modbus card is jumper J6 (See Appendix C), which enables or disables a termination resistor on the board *(Figure 3)*. Jumper J6 is disabled when it comes from the factory.
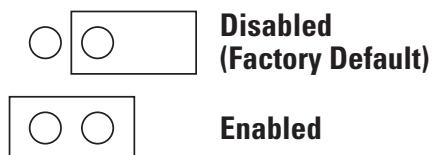

**Disabled
(Factory Default)**

**Enabled**

**Figure 3 – Jumper J6**

The only time that Jumper J6 should be enabled is when its corresponding Modbus card is the last device at the end of the chain.

## Configuring a Modbus Network Card

The Modbus card can be configured in a variety of ways. The configuration of the card includes configuring the slave address, RTU or ASCII mode, baud rate, parity, and stop bits **(the default settings are Slave Address 1, RTU mode, 9600 Baud, No Parity and 2 Stop Bits).** These slave settings will be setup by the user and must match the master device settings for proper communications. The user configures these settings using the Modbus Configuration application (GE Zenith Part # 50P-1111). This application can also read the configuration of the card. The following is a procedure for configuring the Modbus Network card (See Appendix D for wiring connections).

**To change configuration settings:**

1. Disconnect the two Engine Start wires from the P-Relay(s), if applicable. Use electrical tape to tape over the exposed ends of both wires.

2. Obtain a grounding wrist strap and put the elastic end of the strap on your wrist. Attach the alligator clip end to the controller chassis, or an equivalent earth ground.

3. Remove the J5 plug from the controller (located on bottom of board). This will remove power. (If controller is equipped for external battery, also remove the J4 connector from the side of the controller.)

4. Unscrew the black metal cover from the back of the controller.

5. Install the J4 jumper on the back of the Modbus Card (Refer to Appendix C for location).

6. Connect the RS232/485 converter (GE Zenith Part # 50W-1208) to the PC that has the Configuration Application Software Installed.

7. Connect a twisted pair cable between the RS485 connector of the Modbus Card and the RS485 connector of the RS232/485 converter. Verify correct polarity (Refer to Appendix D for connection).

8. Reconnect the J5 plug. This will restore power to the controller.

9. Start up the Configuration Application on the PC.

10. Click on the "READ" button to read the device's current configuration.

11. Click on the "MODIFY" button to enable parameter changing.

12. Make necessary changes to the communication settings.

13. Click on the "WRITE" button to send the new configuration to the Modbus Card.

14. Verify that the configuration was written by clicking the "READ" button, and verify the settings.

15. Remove the J5 plug from the controller.

16. Remove the J4 jumper from the Modbus Card.

17. Screw the black metal cover back on the controller.

18. Reconnect the J5 plug to the controller. (If controller is equipped for external battery, also reconnect the J4 connector on the side of the controller.)

19. Reconnect the two Engine Start wires to the P-Relay(s), if applicable.

## Testing a Modbus Network

The Modbus network can be tested using the components in the Modbus Configuration package (GE Zenith Part # 50P-1124). Reference Appendix D for connections.

1.  If testing a network consisting of more than one card, make sure that all of the cards are daisy chained as shown in Appendix E. Verify that all Modbus cards are in the run mode (jumper J4 on the Modbus card must not be installed). Termination jumper (J6) is only installed on the last card on the network daisy chain.

2.  Connect the RS232/485 converter (GE Zenith Part # 50W-1208) to the PC that contains the Configuration software (GE Zenith Part # 50P-1111). A cable needs to be connected to the RS485 connector of the Modbus card and the RS485 connector of the RS232/485 connector. Check to make sure that the polarity connections are correct. (See Appendix D)

3.  Run the Configuration software on the PC.

4.  Press the TEST button and then verify that the settings in the Communication Settings section match the settings of the Modbus network. If necessary, make changes to the settings and click the NEXT button.

5.  The software will now scan the network and display the serial number of all controllers, which have the Modbus card attached. The user can select any of the listed serial numbers and execute a load test on a controller associated with the selected serial number, but only one controller can be tested at a time.

## CDP Programmable Exercisers

CDP Programmable Exercisers are an option on the MX150 and MX250. They allow the controller to be programmed to automatically test the generator and Automatic Transfer Switch. Up to seven exercisers can be programmed to run on a daily, 7 day, 14 day, or 28 day basis; or up to 24 exercisers can be programmed to run on a yearly basis.

Configuration information regarding CDP Programmable Exercisers is available in the Exerciser Configuration Register (Holding Register 40063):

Bit 0 of the Exerciser Configuration Register (Coil 81) indicates whether the controller is configured for CDT or CDP Programmable Exercisers. A one means the controller is configured for CDP Programmable Exercisers.

Bit 2 of the Exerciser Configuration Register (Coil 82) indicates whether or not the CDP Programmable Exercisers can be configured to run under load (transfer the ATS to the generator). A zero indicates that exercisers can only run No-Load. A one indicates that exercisers can be programmed to run Load or No-Load.

Holding Registers 40101 through 40110 are provided to control and report the status of the CDP Exercisers. These registers contain valid data only if the controller is configured for CDP Exercisers. If the controller is configured for CDP Exercisers, then Holding Register 40063, Bit 0 (Coil 81) will be set to 1.

## Reading the CDP Exerciser Holding Registers

The controller may be programmed for multiple exercisers, depending on the status of the Exerciser Schedule Selection. All data relevant to every exerciser is read out through Holding Registers 40101 through 40110. These registers will contain data describing one exerciser at a time. The value of Holding Register 40101, "Exerciser Record Pointer", determines which exerciser is presently being displayed in Holding Registers 40102 through 40109.

To read the contents of a different exerciser, the Exerciser Record Pointer must be written. For example, in order to read data about CDP Exerciser #3, the Exerciser Record Pointer must be set to 3.

The controller will automatically place all exercisers in chronological order.

## CDT Exercisers

CDT Exercisers are a standard feature of the MX150 and MX250 (unless replaced by CDP Programmable Exercisers). They allow the controller to be programmed to automatically test the generator and Automatic Transfer Switch. The exerciser will run at the same time of day on a daily, 7 day, 14 day, or 28 day basis. Programming of the CDT Exerciser can be done only at the HMI on the front panel of the MX150 or MX250.

Configuration information regarding CDT Exercisers is available in the Exerciser Configuration Register (Holding Register 40063):

Bit 0 of the Exerciser Configuration Register (Coil 81) indicates whether the controller is configured for CDT or CDP Programmable Exercisers. A zero means the controller is configured for CDT Exercisers. Conversely, bit 1 implies the controller is configured for the CDP Exerciser.

Bit 1 of the Exerciser Configuration Register (Coil 82) indicates whether or not the CDT is configured for Load Exercises. A one indicates the CDT will run a Load Exercise. A zero indicates the CDT will run a No-Load Exercise.

The upper byte of the Exerciser Configuration Register (bits 15 through 8) indicates the CDT Exerciser Run Duration, in minutes.

## Setting System Time

Holding Registers 40094 through 40099 are provided to control and report the status of the controller's System Time. Reading Holding Register 40094 through 40099 will report the current Hour, Minute, Day, Month, Year, and Day of Week to which controller's internal clock is currently set.

### Writing the System Time Holding Registers

Holding Registers 40094 through 40098 must be written using a Write Multiple Holding Register Command (Function Code 16). This is to ensure that the data contained in these registers is a complete ordered set. Any attempt to write Holding Registers 40094, 40095, 40096, 40097, or 40098 with a Write Single Holding Register Command (Function Code 6), or a Write Multiple Holding Register Command (Function Code 16) that does not include the entire range of 40094 - 40098, will result in an Illegal Data Address exception response from the Modbus Card.

**Note:** Holding Register 40099, "System Time-Day of Week" is Read Only. The value of this register is automatically computed and updated by the controller, based on the calendar date.

## Operation with In-Phase Monitor

Special consideration is required if the controller is configured with the In-Phase Monitor. Most Modbus network data and control are unavailable while the In-Phase Monitor is waiting for phase synchronization. The Modbus Network Card will return a "Slave Device Busy" exception code (06h) to all Modbus queries, except for queries to the System Busy Status Register (Holding Register 40112) or the System Busy Control Register (Holding Register 40113).

If the Modbus Network Card returns a Slave Device Busy exception code, information about the source of the busy condition may be available in the System Busy Status Register (Holding Register 40112). If Bit 0 of the System Busy Status Register (Coil 105) is set to one, the controller is busy waiting for phase synchronization.

If the controller is busy waiting for phase synchronization, the In-Phase Monitor may be bypassed over the Modbus network by performing the following sequence:

**Warning: EXTREME CAUTION** must be used when bypassing the In-Phase Monitor! Transferring between sources that are not in phase synchronization may cause unexpected operation, resulting in damage to plant equipment and personnel.

1. Set Bit 0 of the System Busy Control Register (Coil 113) to one. This is a request by the Modbus user to bypass the In-Phase Monitor.

2. Once an In-Phase Monitor bypass has been requested, and the controller has been waiting for phase synchronization for more than one minute, the controller will request confirmation of the In-Phase Monitor bypass. This request is indicated by a one in Bit 1 of the System Busy Status Register (Coil 106).

3. To confirm the request to bypass, set Bit 1 of the System Busy Control Register (Coil 114) to one. The controller will bypass the In-Phase Monitor.

**Note:** The In-Phase Monitor bypass feature is an interlocked command-and-confirm mechanism. The Modbus Card will not allow the Confirm Bypass control bit (Coil 114) to be set before the controller has set Ready to Confirm Bypass status bit (Coil 106). If a write request is received to set Coil 114 before the controller has set Coil 106, an Illegal Data Value error code will be returned.

## Bypass Pending Exerciser

Bit 0 (Coil 121) is the Bypass Pending Exerciser bit. The MX Platform performs a logic-OR with this bit and the BPASS EXER key on the HMI. A 1 in Bit 0 bypasses the pending exerciser; a 0 does nothing.

## Cancel Bypass

Bit 1 (Coil 122) is the Cancel Bypass bit. The MX Platform performs a logic-OR this bit with the CANCL BPASS key on the HMI. A 1 in Bit 1 cancels the Bypass Pending Exerciser. A 0 in this bit position does nothing.

The Bypass Pending Exerciser Bit works different, between a Timer Exerciser and Clock Exerciser, depending on the state of Exerciser Type (Holding Register 40063, Bit 0, Coil 81). When Coil 81 = 0 (Timer Exerciser), if Coil 121 is set to 1, the Timer Exerciser will be bypassed until the Cancel Bypass Bit (Coil 122) is set to 1. When Coil 81 = 1 (Clock Exerciser), if Coil 121 is set to 1, only the exerciser that is pending at the time gets bypassed, and the exerciser only gets bypassed once. The Controller waits for Coil 121 to reset to a 0 before a subsequent bypass can be performed.

## Operation Under Battery Backup

The controller can be powered from an external 12-volt battery in the event that neither S1 nor S2 are available. While the controller is on external battery backup, data will still be available over the Modbus Network as noted below.

While the controller is running on external battery backup, data regarding ATS position and limit switch inputs may be invalid if both S1 and S2 sources are lost. Therefore, if Bits 6 and 7 of Holding Register 40001, or Coils 7 and 8, are both zero, the following Modbus network data may not be reliable:

- Automatic Transfer Relay – Holding Register 40001, Bit 0 or Coil 1
- SN Limit Switch – Holding Register 40002, Bit 0 or Coil 9
- SE Limit Switch – Holding Register 40002, Bit 1 or Coil 10
- SNO Limit Switch – Holding Register 40002, Bit 2 or Coil 11
- SEO Limit Switch – Holding Register 40002, Bit 3 or Coil 12
- S1 Position Status – Holding Register 40004, Bit 9 or Coil 34
- S2 Position Status – Holding Register 40004, Bit 10 or Coil 35

# Appendix A – Read Only Register List

| Holding Reg. | Bit | Coil | Description | Value |
|---|---|---|---|---|
| 40001 | | | MX Status 0 | |
| | 0 | 1 | Automatic Transfer Relay | 1 = On, 0 = Off |
| | 1 | 2 | ATS Not in Auto Mode | 1 = Not in Auto |
| | 2 | 3 | General Purpose Alarm | 1 = Alarm Active |
| | 3 | 4 | Unused | |
| | 4 | 5 | Load Test or Fast Load Test Running | 1 = Running |
| | 5 | 6 | Load, No Load, Fast Load Test Status | 1 = Running |
| | 6 | 7 | S2 Available | 1 = Available |
| | 7 | 8 | S1 Available | 1 = Available |
| 40002 | | | MX Status 1 | |
| | 0 | 9 | SN Limit Switch | 1 = On, 0 = Off |
| | 1 | 10 | SE Limit Switch | 1 = On, 0 = Off |
| | 2 | 11 | SNO Limit Switch | 1 = On, 0 = Off |
| | 3 | 12 | SEO Limit Switch | 1 = On, 0 = Off |
| | 4 | 13 | S2 Phase Rotation - Valid only if 3ph and S2 Avail | 1 = CW, 0 = CCW |
| | 5 | 14 | S1 Phase Rotation - Valid only if 3ph and S1 Avail | 1 = CW, 0 = CCW |
| | 6 | 15 | Number of Phases on S2 | 1 = Three, 0 = One |
| | 7 | 16 | Number of Phases on S1 | 1 = Three, 0 = One |
| 40003 | | | MX Status 2 | |
| | 0 | 17 | Unused | |
| | 1 | 18 | S5 Active | 1 = On, 0 = Off |
| | 2 | 19 | S12 Active | 1 = On, 0 = Off |
| | 3 | 20 | Load Shed (LS) Active | 1 = On, 0 = Off |
| | 4 | 21 | Q7 Active | 1 = On, 0 = Off |
| | 5 | 22 | Q3 Active | 1 = On, 0 = Off |
| | 6 | 23 | Closed Transfer Relay (CTR) Active | 1 = On, 0 = Off |
| | 7 | 24 | Transfer Mode Select (TMS) Active | 1 = On, 0 = Off |
| 40004 | | | Timer ID 0 | |
| | 0 | 25 | Timer Bit 0 | See Table 1 |
| | 1 | 26 | Timer Bit 1 | See Table 1 |
| | 2 | 27 | Timer Bit 2 | See Table 1 |
| | 3 | 28 | Unused | |
| | 4 | 29 | Unused | |
| | 5 | 30 | Unused | |
| | 6 | 31 | Unused | |
| | 7 | 32 | Unused | |
| | 8 | 33 | Timer Active | 1 = Timer Running |
| | 9 | 34 | S1 Position Status | 1 = S1 Position |
| | 10 | 35 | S2 Position Status | 1 = S2 Position |
| | 11 | 36 | Unused | |
| | 12 | 37 | Unused | |
| | 13 | 38 | Unused | |
| | 14 | 39 | Unused | |
| | 15 | 40 | Unused | |

| Holding Reg. | Bit | Coil | Description | Value |
|---|---|---|---|---|
| 40005 | | | Timer Countdown Value | Seconds |
| 40006 | | | S1 Voltage (Phase A-B) | Volts |
| 40007 | | | S1 Voltage (Phase B-C) | Volts |
| 40008 | | | S1 Voltage (Phase C-A) | Volts |
| 40009 | | | S2 Voltage (Phase A-B) | Volts |
| 40010 | | | S2 Voltage (Phase B-C) | Volts |
| 40011 | | | S2 Voltage (Phase C-A) | Volts |
| 40012 | | | Unused | |
| 40013 | | | S1 Frequency | Freq Value = scaled value/10 |
| 40014 | | | Unused | |
| 40015 | | | S2 Frequency | Freq Value = scaled value/10 |
| 40016 | | | Unused | |
| 40017 | | | Total Transfers to S1 | |
| 40018 | | | Unused | |
| 40019 | | | Serial Number (MSR) | |
| 40020 | | | Serial Number (LSR) | |
| 40021 | | | Nominal Full-Scale Voltage | |
| 40022 | | | MX Network Configuration 0 | |
| | 0 | 41 | Unused | |
| | 1 | 42 | Unused | |
| | 2 | 43 | Unused | |
| | 3 | 44 | Unused | |
| | 4 | 45 | Unused | |
| | 5 | 46 | Closed Transition Configured | 1 = Configured |
| | 6 | 47 | In-Phase Monitor Configured | 1 = Configured |
| | 7 | 48 | ATS Type | 1 = Delay, 0 = Standard |
| 40023 | | | MX Network Configuration 1 | |
| | 0 | 49 | S12 Auto/Manual Option | 1 = Configured |
| | 1 | 50 | S5 Auto/Manual Bypass Option | 1 = Configured |
| | 2 | 51 | Phase Sequence Check Option | 1 = Configured |
| | 3 | 52 | S2 Overfrequency Option | 1 = Configured |
| | 4 | 53 | S2 Overvoltage Option | 1 = Configured |
| | 5 | 54 | S1 Overfrequency Option | 1 = Configured |
| | 6 | 55 | S1 Underfrequency Option | 1 = Configured |
| | 7 | 56 | S1 Overvoltage Option | 1 = Configured |
| 40024 | | | MX Network Configuration 2 | |
| | 0 | 57 | Phase Imbalance Configured | 1 = Configured |
| | 1 | 58 | Unused | |
| | 2 | 59 | Closed Transition Configured | 1 = Configured |
| | 3 | 60 | Pre-Load Disconnect | 1 = Configured |
| | 4 | 61 | Post-Load Disconnect | 1 = Configured |
| | 5 | 62 | Open Loop Transfer Option | 1 = Configured |
| | 6 | 63 | Unused | |
| | 7 | 64 | Controller Type | 1 = MX150/250, 0 = MX200 |

| Holding Reg. | Bit | Coil | Description | Value |
|---|---|---|---|---|
| 40025 | | | S1 Voltage (Phase A-B), Raw A/D | Raw A/D Value - See Note 1 |
| 40026 | | | S1 Voltage (Phase B-C), Raw A/D | Raw A/D Value - See Note 1 |
| 40027 | | | S1 Voltage (Phase C-A), Raw A/D | Raw A/D Value - See Note 1 |
| 40028 | | | S2 Voltage (Phase A-B), Raw A/D | Raw A/D Value - See Note 1 |
| 40029 | | | S2 Voltage (Phase B-C), Raw A/D | Raw A/D Value - See Note 1 |
| 40030 | | | S2 Voltage (Phase C-A), Raw A/D | Raw A/D Value - See Note 1 |
| 40031 | | | S1 Period Count | Raw Value - See Note 2 |
| 40032 | | | S2 Period Count | Raw Value - See Note 2 |
| 40049 | | | Total S1 Fails | |
| 40050 | | | Total Transfers to S2 | |
| 40051 | | | Days Powered Up | |
| 40052 | | | Time S1 Available (MSR) | Hours |
| 40053 | | | Time S1 Available (LSR) | Hours |
| 40054 | | | Time S2 Available (MSR) | Hours |
| 40055 | | | Time S2 Available (LSR) | Hours |
| 40056 | | | Unused | |
| 40057 | | | Unused | |
| 40058 | | | Unused | |
| 40059 | | | Unused | |
| 40060 | | | Unused | |
| 40061 | | | Unused | |
| 40062 | | | Unused | |
| 40063 | | | Exerciser Schedule Status | |
| | 0 | 81 | Exerciser Type | 1 = Clock, 0 = Timer |
| | 1 | 82 | Load/No Load Exerciser (Timer Exerciser Only) | 1 = Load |
| | 2 | 83 | User can set load exercises (Clock Exerciser Only) | 1 = Yes |
| | 3 | 84 | Unused | |
| | 4 | 85 | Unused | |
| | 5 | 86 | Unused | |
| | 6 | 87 | Unused | |
| | 7 | 88 | Unused | |
| | [15:8] | | Timer Exerciser Run Duration | Minutes |
| 40064 | | | MX Status 3 | |
| | 0 | 89 | Exerciser Pending | 1 = Exerciser Pending |
| | 1 | 90 | Exerciser Bypassed | 1 = Exerciser Bypassed |
| | 2 | 91 | Unused | |
| | 3 | 92 | Unused | |
| | 4 | 93 | Unused | |
| | 5 | 94 | Unused | |
| | 6 | 95 | Unused | |
| | 7 | 96 | Unused | |
| 40065 | | | Unused | |
| 40066 | | | Unused | |
| 40067 | | | Unused | |

| Holding Reg. | Bit | Coil | Description | Value |
|---|---|---|---|---|
| 40068 | | | Timer ID 1 | |
| | 0 | 97 | Unused | |
| | 1 | 98 | Unused | |
| | 2 | 99 | A6/A62 Timer Running | 1 = Running |
| | 3 | 100 | T Timer Running | 1 = Running |
| | 4 | 101 | DT Timer Running | 1 = Running |
| | 5 | 102 | T3/W3 Timer Running | 1 = Running |
| | 6 | 103 | W Timer Running | 1 = Running |
| | 7 | 104 | DW Timer Running | 1 = Running |
| 40069 | | | T or W Timer Countdown Value | Seconds |
| 40070 | | | T3/W3 Timer Countdown Value | Seconds |
| 40071 | | | A6/A62 Timer Countdown Value | Seconds |
| 40072 | | | MX Firmware Revision | Ver = Value/10 |
| 40073 | | | Modbus Card Firmware Revision | Ver = Value/100 |
| 40074 | | | Unused | |
| 40075 | | | Unused | |
| 40076 | | | Unused | |
| 40077 | | | Most Recent Event Pointer | |
| 40082 | | | Unused | |
| 40083 | | | Unused | |
| 40099 | | | System Time – Day of Week | |

| Holding Reg. | Bit | Coil | Description | Range | Notes |
|---|---|---|---|---|---|
| 40102 | | | Exerciser Record – Hour | 0 - 23 | |
| 40103 | | | Exerciser Record – Minute | 0 - 59 | |
| 40104 | | | Exerciser Record – Month | 1 - 12 | Not writeable for Daily or Weekly Exercisers |
| 40105 | | | Exerciser Record – Day of Month | 1 - 31 | Max val. depends on month, year Not writeable for Daily or Weekly Exercisers |
| 40106 | | | Exerciser Record – Day of Week | 1 = Sun., 7 = Sat. | Writeable for Weekly Exercisers Only |
| 40107 | | | Exerciser Record – Ex. Duration | 0 - 600 minutes | |
| 40108 | | | Exerciser Record – Load/No Load | 1 = Load, 0 = No Load | Writeable ONLY if Factory Configured for Load Exercisers |
| 40109 | | | Unused | | |
| 40110 | | | Exerciser Schedule Selection | 0 = Off | |
| | | | | 1 = Daily (1 Day) | |
| | | | | 2 = Weekly (7 Day) | |
| | | | | 3 = Bi-Weekly (14 Day) | |
| | | | | 4 = 4 Week (28 Day) | |
| | | | | 5 = Calendar (365 Day) | |

# Appendix A *(cont'd)* Read Only Register List

| Holding Reg. | Bit | Coil | Description | Value |
|---|---|---|---|---|
| 40111 | | | System Busy Status | |
| | 0 | 105 | System Busy due to R50 | 1 = System Busy |
| | 1 | 106 | Ready to Confirm Bypass R50 | 1 = Ready to Confirm Bypass |
| | 2 | 107 | Unused | |
| | 3 | 108 | Unused | |
| | 4 | 109 | Unused | |
| | 5 | 110 | Unused | |
| | 6 | 111 | Unused | |
| | 7 | 112 | Unused | |
| 40113 | | | Unused | |
| 40114 | | | Unused | |
| 40115 | | | Unused | |
| 40116 | | | Unused | |
| 40117 | | | Unused | |
| 40118 | | | Unused | |
| 40119 | | | Unused | |
| 40120 | | | Unused | |
| 40121 | | | Reason for Event 0 | See Table 2 |
| 40122 | | | Event 0 | Second |
| 40123 | | | Event 0 | Hour |
| 40124 | | | Event 0 | Minute |
| 40125 | | | Event 0 | Month |
| 40126 | | | Event 0 | Day of Month |
| 40127 | | | Event 0 | Year |
| 40128 | | | Reason for Event 1 | See Table 2 |
| 40129 | | | Event 1 | Second |
| 40130 | | | Event 1 | Hour |
| 40131 | | | Event 1 | Minute |
| 40132 | | | Event 1 | Month |
| 40133 | | | Event 1 | Day of Month |
| 40134 | | | Event 1 | Year |
| 40135 | | | Reason for Event 2 | See Table 2 |
| 40136 | | | Event 2 | Second |
| 40137 | | | Event 2 | Hour |
| 40138 | | | Event 2 | Minute |
| 40139 | | | Event 2 | Month |
| 40140 | | | Event 2 | Day of Month |
| 40141 | | | Event 2 | Year |
| 40142 | | | Reason for Event 3 | See Table 2 |
| 40143 | | | Event 3 | Second |
| 40144 | | | Event 3 | Hour |
| 40145 | | | Event 3 | Minute |
| 40146 | | | Event 3 | Month |
| 40147 | | | Event 3 | Day of Month |
| 40148 | | | Event 3 | Year |

| Holding Reg. | Bit | Coil | Description | Value |
|---|---|---|---|---|
| 40149 | | | Reason for Event 4 | See Table 2 |
| 40150 | | | Event 4 | Second |
| 40151 | | | Event 4 | Hour |
| 40152 | | | Event 4 | Minute |
| 40153 | | | Event 4 | Month |
| 40154 | | | Event 4 | Day of Month |
| 40155 | | | Event 4 | Year |
| 40156 | | | Reason for Event 5 | See Table 2 |
| 40157 | | | Event 5 | Second |
| 40158 | | | Event 5 | Hour |
| 40159 | | | Event 5 | Minute |
| 40160 | | | Event 5 | Month |
| 40161 | | | Event 5 | Day of Month |
| 40162 | | | Event 5 | Year |
| 40163 | | | Reason for Event 6 | See Table 2 |
| 40164 | | | Event 6 | Second |
| 40165 | | | Event 6 | Hour |
| 40166 | | | Event 6 | Minute |
| 40167 | | | Event 6 | Month |
| 40168 | | | Event 6 | Day of Month |
| 40169 | | | Event 6 | Year |
| 40170 | | | Reason for Event 7 | See Table 2 |
| 40171 | | | Event 7 | Second |
| 40172 | | | Event 7 | Hour |
| 40173 | | | Event 7 | Minute |
| 40174 | | | Event 7 | Month |
| 40175 | | | Event 7 | Day of Month |
| 40176 | | | Event 7 | Year |
| 40177 | | | Reason for Event 8 | See Table 2 |
| 40178 | | | Event 8 | Second |
| 40179 | | | Event 8 | Hour |
| 40180 | | | Event 8 | Minute |
| 40181 | | | Event 8 | Month |
| 40182 | | | Event 8 | Day of Month |
| 40183 | | | Event 8 | Year |
| 40184 | | | Reason for Event 9 | See Table 2 |
| 40185 | | | Event 9 | Second |
| 40186 | | | Event 9 | Hour |
| 40187 | | | Event 9 | Minute |
| 40188 | | | Event 9 | Month |
| 40189 | | | Event 9 | Day of Month |
| 40190 | | | Event 9 | Year |
| 40191 | | | Reason for Event 10 | See Table 2 |
| 40192 | | | Event 10 | Second |
| 40193 | | | Event 10 | Hour |
| 40194 | | | Event 10 | Minute |
| 40195 | | | Event 10 | Month |
| 40196 | | | Event 10 | Day of Month |
| 40197 | | | Event 10 | Year |

| Holding Reg. | Bit | Coil | Description | Value |
|---|---|---|---|---|
| 40198 | | | Reason for Event 11 | See Table 2 |
| 40199 | | | Event 11 | Second |
| 40200 | | | Event 11 | Hour |
| 40201 | | | Event 11 | Minute |
| 40202 | | | Event 11 | Month |
| 40203 | | | Event 11 | Day of Month |
| 40204 | | | Event 11 | Year |
| 40205 | | | Reason for Event 12 | See Table 2 |
| 40206 | | | Event 12 | Second |
| 40207 | | | Event 12 | Hour |
| 40208 | | | Event 12 | Minute |
| 40209 | | | Event 12 | Month |
| 40210 | | | Event 12 | Day of Month |
| 40211 | | | Event 12 | Year |
| 40212 | | | Reason for Event 13 | See Table 2 |
| 40213 | | | Event 13 | Second |
| 40214 | | | Event 13 | Hour |
| 40215 | | | Event 13 | Minute |
| 40216 | | | Event 13 | Month |
| 40217 | | | Event 13 | Day of Month |
| 40218 | | | Event 13 | Year |
| 40219 | | | Reason for Event 14 | See Table 2 |
| 40210 | | | Event 14 | Second |
| 40221 | | | Event 14 | Hour |
| 40222 | | | Event 14 | Minute |
| 40223 | | | Event 14 | Month |
| 40224 | | | Event 14 | Day of Month |
| 40225 | | | Event 14 | Year |
| 40226 | | | Reason for Event 15 | See Table 2 |
| 40227 | | | Event 15 | Second |
| 40228 | | | Event 15 | Hour |
| 40229 | | | Event 15 | Minute |
| 40230 | | | Event 15 | Month |
| 40231 | | | Event 15 | Day of Month |
| 40232 | | | Event 15 | Year |

# Appendix A *(cont'd)* Read Only Register List

## Notes:

1. Registers 40025 - 40030 contain unscaled voltage values In order to obtain a full-scale voltage value, use the following formula:

   Voltage = (A/D Raw Value / 192) x Full Scale Voltage (Register 40021)

2. Registers 40031 and 40032 contain unscaled frequency values. In order to obtain a full-scale frequency value, use the following formula:

   Scales Frequency + (20,000,000 / Period Count)

| Timer | Value |
|---|---|
| P | 111b |
| W-W3, Unbypassed | 110b |
| W-W3, YE bypassed | 101b |
| T-T3, Unbypassed | 011b |
| Y-T3, YN bypassed | 010b |
| U | 000b |

| Reason Code | Description |
|---|---|
| 0 | S1 Fail |
| 1 | S2 Fail |
| 2 | S1 Phase Imbalance |
| 3 | S2 Phase Imbalance |
| 4 | S2 Start |
| 5 | S2 Stop |
| 6 | Sync Fail |
| 7 | Load Shed |
| 8 | ATS Inhibit |
| 9 | Phase Rotation |
| 10 | Remove Test |
| 11 | Local Test |
| 12 | S1-S2 Volt. Imbalance |
| 13 | S1-S2 Freq. Imbalance |
| 14 | CT Xfr S1>S2 |
| 15 | CT Xfr S2>S1 |
| 16 | Xfr S1>S2 |
| 17 | Xfr S2>S1 |
| 18 | |
| 19 | |
| 20 | No Xfr |
| 21 | OLC |
| 22 | STE |
| 23 | S1 UV Fail |
| 24 | S1 OV Fail |
| 25 | S1 UF Fail |
| 26 | S1 OF Fail |
| 27 | S2 UV Fail |
| 28 | S2 OV Fail |
| 29 | S2 UF Fail |
| 30 | S2 OF Fail |
| 31 | S1 Restore |
| 32 | S2 to Open |
| 33 | Exerciser |
| 34 | Remote Test Network |
| 35 | Remote Inhibit |
| 36 | Local Inhibit |
| 37 | S2 Avail |
| 38 | S2 Off |

# Appendix B - Read/Write Register List

| Holding Reg. | Bit | Coil | Description | Range | Notes |
|---|---|---|---|---|---|
| 40033 | | | P Timer Setting | 0 - 1000 1/100 of a second | |
| 40034 | | | W Timer Setting | 0 - 300 seconds | |
| 40035 | | | T3/W3 Timer Setting (Mirror of 40038) | 0 - 60 seconds | |
| 40036 | | | DW Timer Setting | 0 - 600 seconds | |
| 40037 | | | T Timer Setting | 0 - 3600 seconds | |
| 40038 | | | T3/W3 Timer Setting (Mirror of 40035) | 0 - 60 seconds | |
| 40039 | | | DT Timer Setting | 0 - 600 seconds | |
| 40040 | | | U Timer Setting | 0 - 3600 seconds | |
| 40041 | | | S1 Undervolt Restore | 85 - 100 percent | Must be at least 2 > S1 UV Fail |
| 40042 | | | S1 Undervolt Fail | 75 - 98 percent | Must be at least 2 < S1 UV Restore |
| 40043 | | | S2 Undervolt Restore | 85 - 100 percent | Must be at least 2 > S2 UV Fail |
| 40044 | | | S2 Undervolt Fail | 75 - 98 percent | Must be at least 2 < S2 UV Restore |
| 40045 | | | S1 Underfreq Restore | 90 - 100 percent | Must be at least 2 > S1 UF Fail |
| 40046 | | | S2 Underfreq Restore | 90 - 100 percent | Must be at least 2 > S2 UF Fail |
| 40047 | | | Net Control 0 | | |
| | 0 | 65 | Reset Time S2 Available | 1 = Reset | |
| | 1 | 66 | Alarm Silence | 1 = Silence Alarm | |
| | 2 | 67 | Unused | | |
| | 3 | 68 | YE Control | 1 = Bypass to S2 | |
| | 4 | 69 | YN Control | 1 = Bypass to S1 | |
| | 5 | 70 | No Load Test Control | 1 = Start Test | |
| | 6 | 71 | Load Test Control | 1 = Start Test | |
| | 7 | 72 | Fast Load Test Control | 1 = Start Test | |
| 40048 | | | Net Control 1 | | |
| | 0 | 73 | Unused | | |
| | 1 | 74 | S5 Control | 1 = On, 0 = Off | |
| | 2 | 75 | S12 Control | 1 = On, 0 = Off | |
| | 3 | 76 | LS Control | 1 = On, 0 = Off | |
| | 4 | 77 | Q7 Control | 1 = On, 0 = Off | |
| | 5 | 78 | Q3 Control | 1 = On, 0 = Off | |
| | 6 | 79 | Aux 2 Control | 1 = On, 0 = Off | |
| | 7 | 80 | TMS Control | 1 = On, 0 = Off | |
| 40078 | | | UMD Timer Setting | 0 - 300 seconds | |
| 40079 | | | Phase Imbalance Timer Setting | 10 - 30 seconds | |
| 40080 | | | Phase Imbalance Fail Setting | 5 - 20 percent | |
| 40081 | | | Phase Imbalance Restore Setting | 3 - 18 percent | |
| 40084 | | | S1 Overvolt Fail | 105 - 110 percent | Must be at least 2 > S1 OV Restore |
| 40085 | | | S1 Overvolt Restore | 103 - 108 percent | Must be at least 2 < S1 OV Fail |
| 40086 | | | S2 Overvolt Fail | 105 - 110 percent | Must be at least 2 > S2 OV Restore |
| 40087 | | | S2 Overvolt Restore | 103 - 108 percent | Must be at least 2 < S2 OV Fail |
| 40088 | | | S1 Underfreq Fail | 88 - 98 percent | Must be at least 2 < S1 UF Restore |
| 40089 | | | S1 Overfreq Fail | 103 - 105 percent | Must be at least 1 > S1 OF Restore |
| 40090 | | | S1 Overfreq Restore | 102 - 104 percent | Must be at least 1 < S1 OF Fail |
| 40091 | | | S2 Underfreq Fail | 88 - 98 percent | Must be at least 2 < S2 UF Restore |
| 40092 | | | S2 Overfreq Fail | 103 - 105 percent | Must be at least 1 > S2 OF Restore |
| 40093 | | | S2 Overfreq Restore | 102 - 104 percent | Must be at least 1 < S2 OF Fail |

| Holding Reg. | Bit | Coil | Description | Range | Notes |
|---|---|---|---|---|---|
| HR 40094 - 40098 MUST ALL be written with a Write Multiple Holding Register Command | | | | | |
| 40094 | | | System Time – Hour | 0 - 23 | |
| 40095 | | | System Time – Minute | 0 - 59 | |
| 40096 | | | System Time – Day | 1 - 31 | Max val. depends on month, year |
| 40097 | | | System Time – Month | 1 - 12 | |
| 40098 | | | System Time – Year | 0 - 255, 0 = Year 2000 | |
| 40100 | | | Daylight Savings Time | 1 = ATS follows DST | |
| | | | | | |
| HR 40101 - 40109 MUST ALL be written with a Write Multiple Holding Register Command | | | | | |
| HR's listed as "Not Writeable" under certain conditions must be written as zeros | | | | | |
| HR40101-40110 are for CDP Programmable Exercisers Only | | | | | |
| 40112 | | | System Busy Control | | |
| | 0 | 113 | Command to Bypass In-Phase Monitor | 1 = Bypass In-Phase Monitor | |
| | 1 | 114 | Confirm Bypass In-Phase Monitor | 1 = Confirm | |
| | 2 | 115 | Unused | | |
| | 3 | 116 | Unused | | |
| | 4 | 117 | Unused | | |
| | 5 | 118 | Unused | | |
| | 6 | 119 | Unused | | |
| | 7 | 120 | Unused | | |
| 40113 | | | Net Control 2 | | |
| | 0 | 121 | Bypass Pending Exerciser | 1 = Bypass | |
| | 1 | 122 | Cancel Exerciser Bypass | 1 = Cancel Bypass | |
| | 2 | 123 | Unused | | |
| | 3 | 124 | Unused | | |
| | 4 | 125 | Unused | | |
| | 6 | 127 | Unused | | |
| | 7 | 128 | Unused | | |
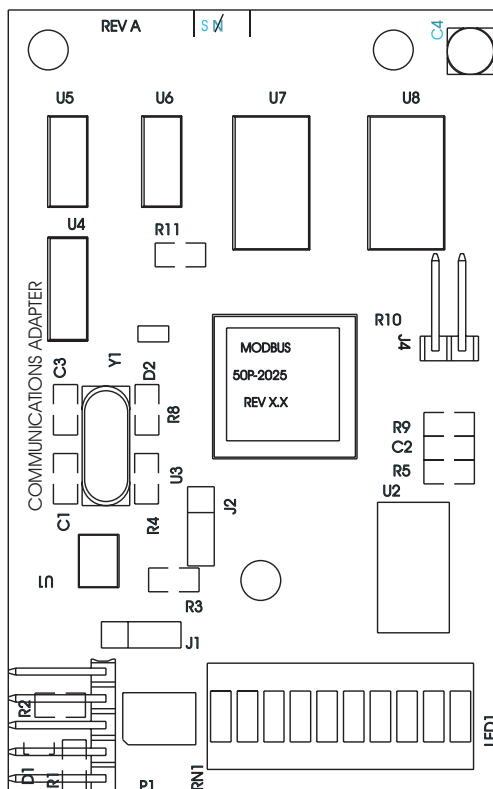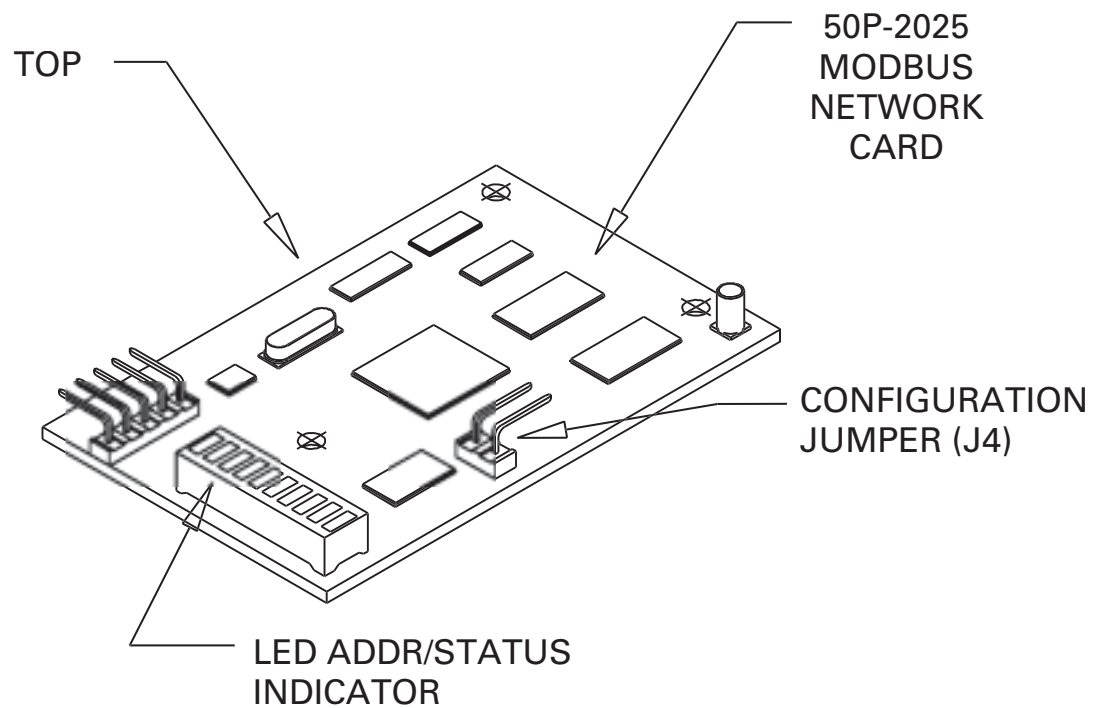
TOP

50P-2025
MODBUS
NETWORK
CARD

CONFIGURATION
JUMPER (J4)

LED ADDR/STATUS
INDICATOR

REV A    S M    C4

U5    U6    U7    U8

U4    R11

COMMUNICATIONS ADAPTER

C3    Y1    D2

MODBUS
50P-2025
REV X.X

R10
J4

R8

R9
C2
R5
U2

R4    J2

C1    U3

U1

R3

J1

R2

D1    R1

P1    RN1    LED1

**TOP OF MODBUS CARD**

J3

R12

C8    C7    C6    C5

C10    C9

C11

C12

R13    J5

TERMINATION
JUMPER (J6)    J6    R15    R14

R16    C13    R17
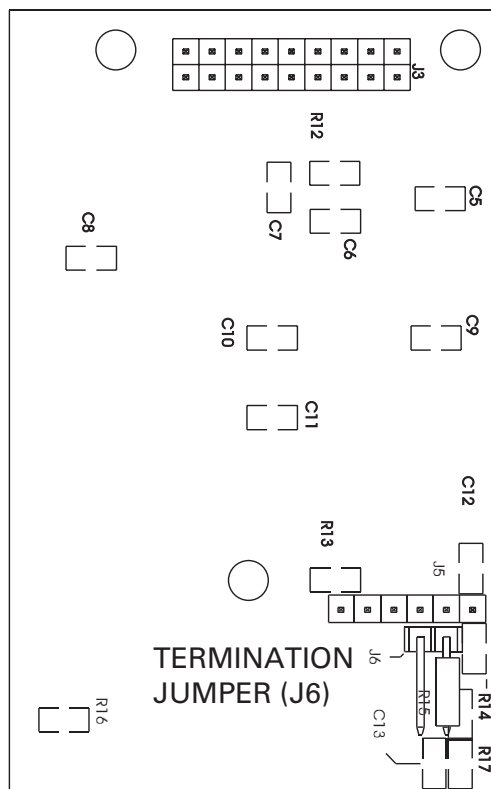
**BOTTOM OF MODBUS CARD**

**MODBUS NETWORK CARD DEFAULT SETTINGS**

SLAVE ADDRESS 1
RTU MODE
8 DATA BITS, 9600 BAUD, NO PARITY, 2 STOP BITS.

50P-2035
MODBUS
NETWORK CARD
ASSEMBLY

PS-5140
NETWORK PLUG
CONNECTOR
VERIFY POLARITY
CONNECTIONS

A

B

SEE NOTE 1

CONFIGURATION JUMPER (J4)
(NOTE 2)

ADDRESS/STATUS INDICATOR LEDs
(REF. PG.1, FIG. 2)

50W-1208
RS232/485
CONVERTER

SEE NOTE 6
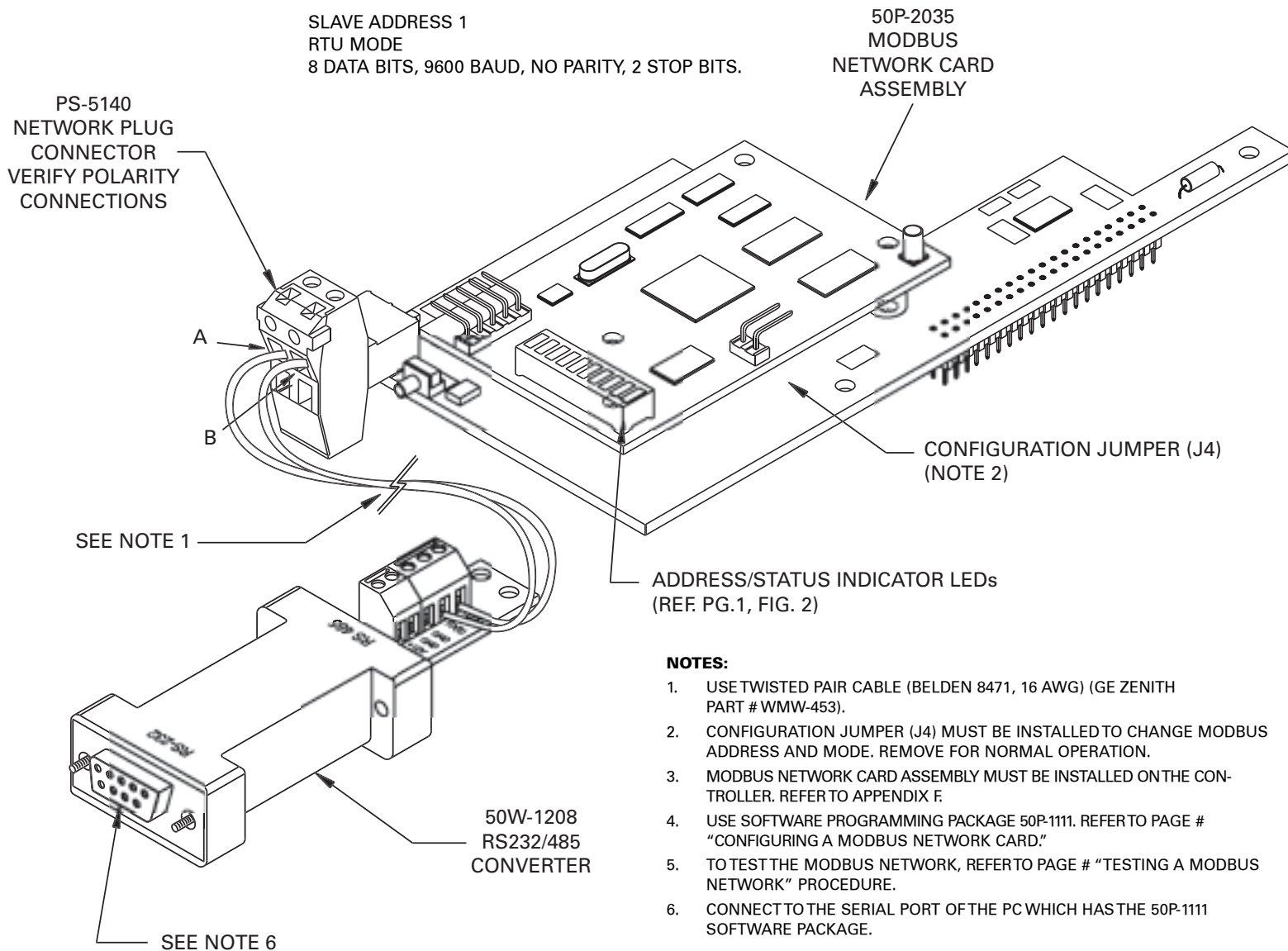
**NOTES:**

1.  USE TWISTED PAIR CABLE (BELDEN 8471, 16 AWG) (GE ZENITH
    PART # WMW-453).

2.  CONFIGURATION JUMPER (J4) MUST BE INSTALLED TO CHANGE MODBUS
    ADDRESS AND MODE. REMOVE FOR NORMAL OPERATION.

3.  MODBUS NETWORK CARD ASSEMBLY MUST BE INSTALLED ON THE CON-
    TROLLER. REFER TO APPENDIX F.

4.  USE SOFTWARE PROGRAMMING PACKAGE 50P-1111. REFER TO PAGE #
    "CONFIGURING A MODBUS NETWORK CARD."

5.  TO TEST THE MODBUS NETWORK, REFER TO PAGE # "TESTING A MODBUS
    NETWORK" PROCEDURE.

6.  CONNECT TO THE SERIAL PORT OF THE PC WHICH HAS THE 50P-1111
    SOFTWARE PACKAGE.

# Appendix E

## RS485 Multi-Drop Connection
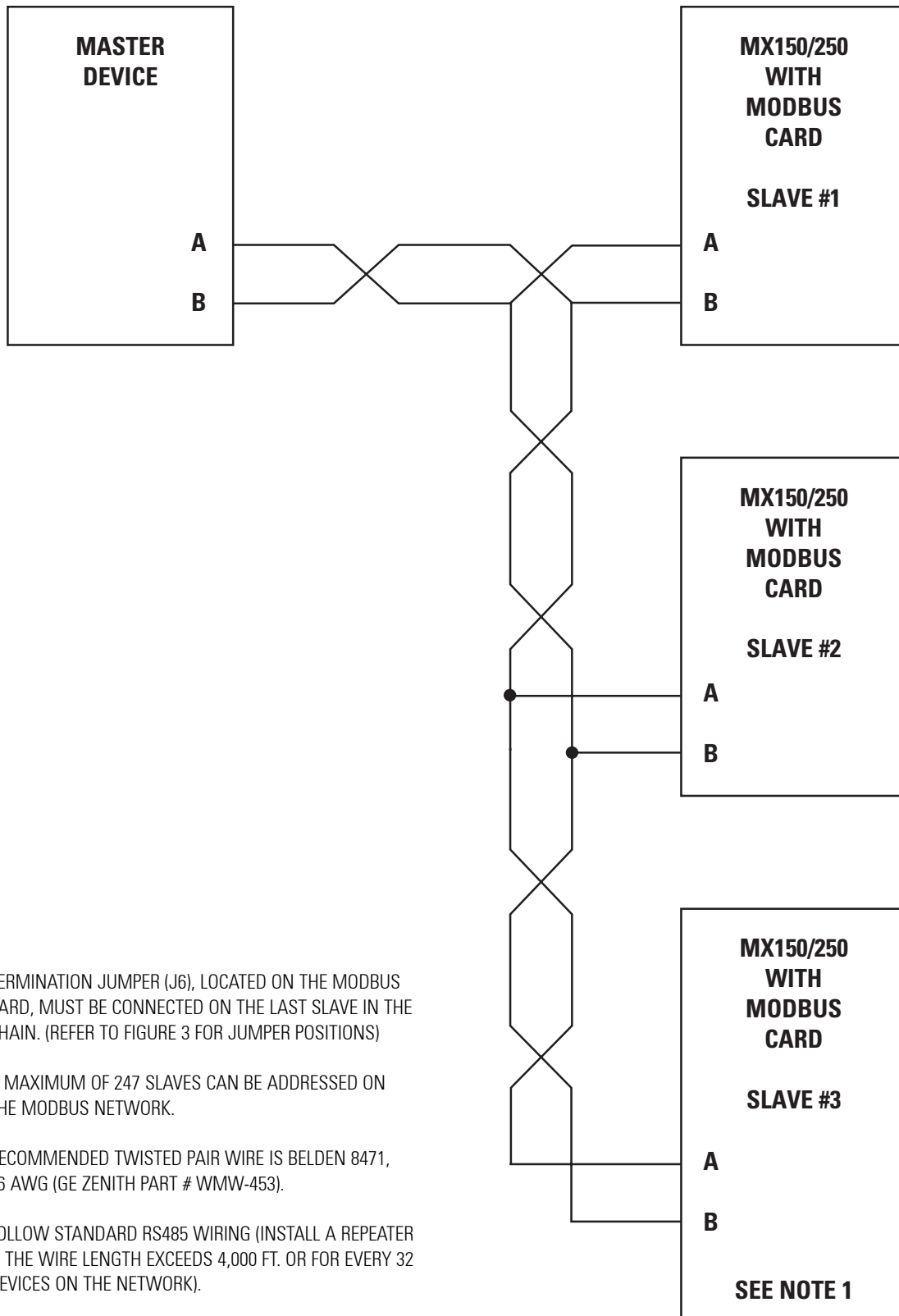
```
MASTER                                    MX150/250
DEVICE                                      WITH
                                           MODBUS
                                            CARD

                                          SLAVE #1

     A                                      A
     B                                      B


                                          MX150/250
                                            WITH
                                           MODBUS
                                            CARD

                                          SLAVE #2

                                            A
                                            B


NOTE:
                                          MX150/250
                                            WITH
1.  TERMINATION JUMPER (J6), LOCATED ON THE MODBUS     MODBUS
    CARD, MUST BE CONNECTED ON THE LAST SLAVE IN THE    CARD
    CHAIN. (REFER TO FIGURE 3 FOR JUMPER POSITIONS)
                                          SLAVE #3
2.  A MAXIMUM OF 247 SLAVES CAN BE ADDRESSED ON
    THE MODBUS NETWORK.
                                            A
3.  RECOMMENDED TWISTED PAIR WIRE IS BELDEN 8471,       B
    16 AWG (GE ZENITH PART # WMW-453).

4.  FOLLOW STANDARD RS485 WIRING (INSTALL A REPEATER
    IF THE WIRE LENGTH EXCEEDS 4,000 FT. OR FOR EVERY 32   SEE NOTE 1
    DEVICES ON THE NETWORK).
```
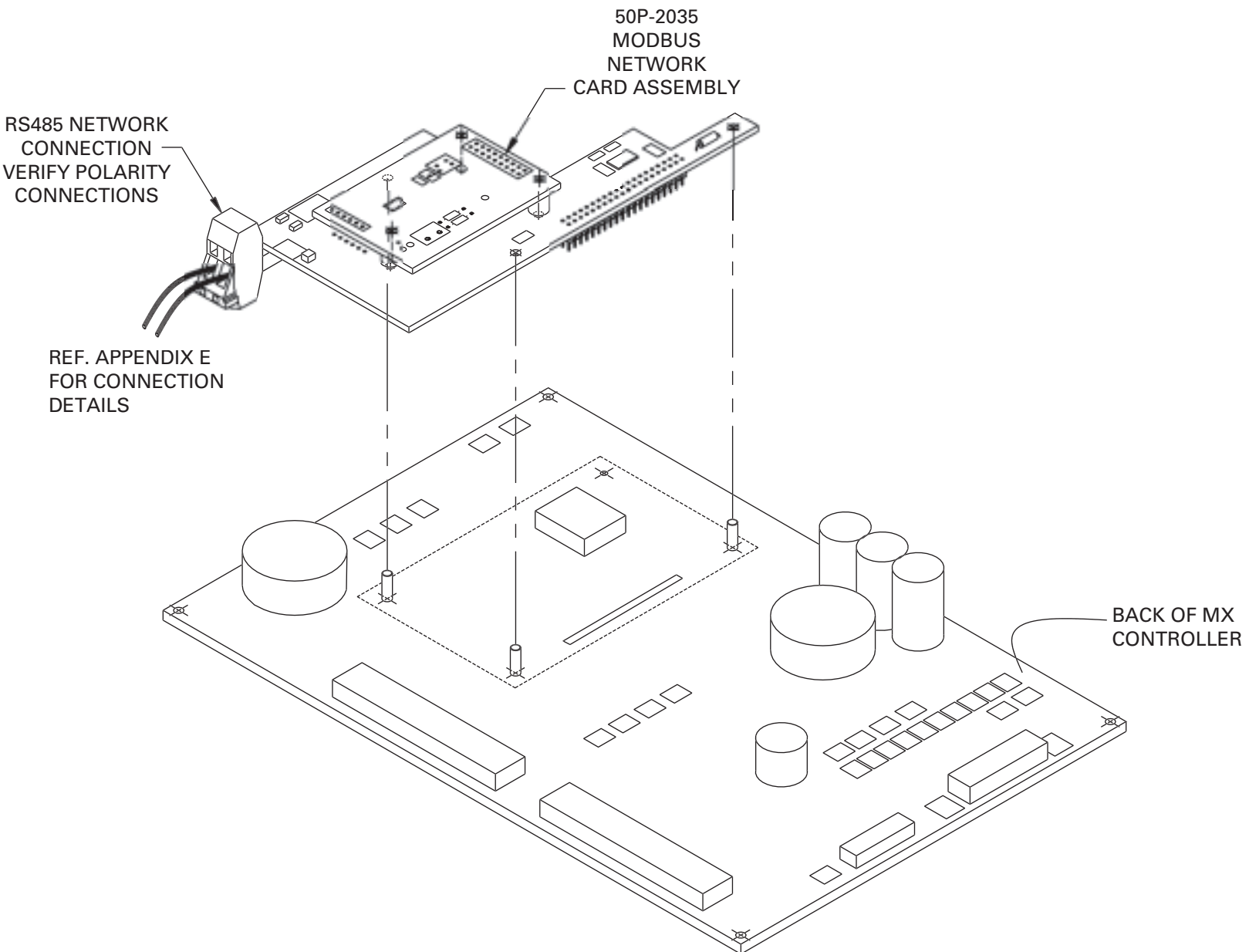
**Appendix F**

**Installation of Modbus Card on MX Controller**

50P-2035
MODBUS
NETWORK
CARD ASSEMBLY

RS485 NETWORK
CONNECTION
VERIFY POLARITY
CONNECTIONS

REF. APPENDIX E
FOR CONNECTION
DETAILS

BACK OF MX
CONTROLLER

# Appendix G

## Modbus Protocol Illustration

For a detailed specification of the Modbus protocol, reference the Modicon website address **www.modbus.org**.

The Modbus protocol provides the internal standard for parsing messages. During communications on a Modbus network, the protocol determines how each slave will know its device address, recognize a message addressed to it, determine the kind of action to be taken, and extract any data or other information contained in the message. If a reply is required, the slave will construct the reply message and send it using Modbus protocol.

The following is a brief description of the Modbus commands supported by the Modbus Network Card. Each command consists of the following:
- a sample query message that is sent out by the master device to the designated slave
- the slave's reply message to the master device

The query and reply messages show how the information is packeted and sent out using the Modbus Protocol.

Each query message consists of the following:
- *Slave Address* – address of the slave you wish to establish communications with.
- *Function Code* – code that lets the slave know what command is being requested, e.g. read coil, write single coil.
- *Starting Address High/Low Order* – high and low byte of the address the master reads from or writes to. Coils and Registers are addressed starting at 0. For instance Coil 1 is address 0 and Register 40001 is address 0.
- *Error Check Field* – contains either a CRC (RTU mode) or LRC (ASCII mode) error check value.

The query message for specific functions requires some of the following information:
- *Number of Data Points High/Low Order* – high and low byte of the number of addresses the master wants to read.
- *Data High/Low Order* – high and low byte of the data that will be written to the slave device.
- *Number of Coils High/Low Order* – high and low byte for the number of coils to force ON or OFF.
- *Number of Regs High/Low Order* – high and low byte for the number of registers to preset.
- *Byte Count* – is the number of data bytes which are sent to the slave.

These query and reply messages are for both RTU and ASCII modes depending on whether the Error Check Field contains a CRC or LRC respectively. Each value in the query message is a hexadecimal value.

### Read Coil Status (Function Code 01)

#### Query

This function allows the master device to obtain the ON/OFF bit status of various coils from the addressed slave.

*Figure G1* is a sample read coil status request to read coils 9-24 (MX150/250 status bits) from slave device 5.

| Slave Address | Function Code | Starting Address *High* Order | Starting Address *Low* Order | No. of Data Points *High* Order | No. of Data Points *Low* Order | Error Check Field (LRC or CRC) |
|---|---|---|---|---|---|---|
| 05h | 01h | 00h | 08h | 00h | 10h | — |

**Figure G1 – Read Coil Status Query Message**

#### Response

An example response to the Read Coil Status is shown in *Figure G2*. The response includes the slave address, function code, number of data bytes sent, the data, and error checking.

| Slave Address | Function Code | Byte Count | Data Coil Status 9-16 | Data Coil Status 17-24 | Error Check Field (LRC or CRC) |
|---|---|---|---|---|---|
| 05h | 01h | 02h | C1h | A2h | — |

**Figure G2 – Read Coil Status Response Message**

The data consists of one bit per coil (1=ON, 0=OFF). The status of coils 9-16 is C1 (hex) or 1100 0001 (binary). Reading left to right, coils 16, 15, and 9 are ON and the remainder is OFF. The other data byte is decoded similarly.

### Read Holding Register (Function Code 03)
Read holding registers allows the master device to obtain the binary contents of holding registers 4xxxx in the addressed slave.

#### Query

*Figure G3* is an example that reads registers 40006-40007 from slave 8.

| Slave Address | Function Code | Starting Address *High* Order | Starting Address *Low* Order | No. of Data Points *High* Order | No. of Data Points *Low* Order | Error Check Field (LRC or CRC) |
|---|---|---|---|---|---|---|
| 08h | 03h | 00h | 05h | 00h | 02h | — |

**Figure G3 – Read Holding Register Query Message**

## Modbus Protocol Illustration *(cont'd)*

**Response**

The slave responds with its address, function code, number of data bytes, and the data. The contents of the registers requested (data) are two bytes each. The first byte includes the high order bits and the second, the low order bits.

| Slave Address | Function Code | Byte Count | High Order Data | Low Order Data | High Order Data | Low Order Data | Error Check Field (LRC or CRC) |
|---|---|---|---|---|---|---|---|
| 08h | 03h | 04h | 00h | 76h | 00h | 78h | — |

**Figure G4 – Read Holding Register Response Message**

Register 40006 , Normal Voltage Ph1-Ph2, has a value of 118 (76 hex) and register 40007, Normal Voltage Ph2-Ph3 has a value of 120 (78 hex).

### Write Single Coil (Function Code 05)
This function forces a single coil either ON or OFF. A value of 65,280 (FF00 Hex) will set the coil ON and the value zero will turn it OFF; all other values are illegal and will not affect that coil.

### Query

*Figure G5* is an example of a request to slave number 3 to turn ON coil 71.

| Slave Address | Function Code | Starting Address *High* Order | Starting Address *Low* Order | Data *High* Order | Data *Low* Order | Error Check Field (LRC or CRC) |
|---|---|---|---|---|---|---|
| 03h | 05h | 00h | 46h | FFh | 00h | — |

**Figure G5 – Write Single Coil Query Message**

**Response**

The slave's normal response to the Write Single Coil query is to return the original message after the coil state has been altered.

| Slave Address | Function Code | Starting Address *High* Order | Starting Address *Low* Order | Data *High* Order | Data *Low* Order | Error Check Field (LRC or CRC) |
|---|---|---|---|---|---|---|
| 03h | 05h | 00h | 46h | FFh | 00h | — |

**Figure G6 – Write Single Coil Response Message**

### Write Single Holding Register (Function Code 06)
This function allows the master to modify the contents of one holding register.

### Query

*Figure G7* is an example of a request to preset register 40041 (Normal Pickup Voltage) to 92 (00 5C hex) in slave device 17.

| Slave Address | Function Code | Starting Address *High* Order | Starting Address *Low* Order | Data *High* Order | Data *Low* Order | Error Check Field (LRC or CRC) |
|---|---|---|---|---|---|---|
| 11h | 06h | 00h | 28h | 00h | 5Ch | — |

**Figure G7 – Write Single Holding Register Query Message**

**Response**

The slave's response to the Write Single Holding Register query is to return the original message after the registers have been altered.

| Slave Address | Function Code | Starting Address *High* Order | Starting Address *Low* Order | Data *High* Order | Data *Low* Order | Error Check Field (LRC or CRC) |
|---|---|---|---|---|---|---|
| 11h | 06h | 00h | 28h | 00h | 5Ch | — |

**Figure G8 – Write Single Holding Register Response Message**

### Write Multiple Coils (Function Code 15)
Forces each coil in a sequence of coils to either ON or OFF. The requested ON/OFF states are specified by contents of the query data field. A logical '1' in a bit position of the field requests the corresponding coil to be ON and a logical '0' requests it to be OFF. Coils are addressed starting at 0. For examples coil 1 is addressed as 0.

### Query

The following example is a request to force a series of sixteen coils starting at coil 41 (addressed as 40, or 28 hex) in slave device 9.

The query data contents consist of two bytes: 3C 9B hex (0011 1100 1001 1011 binary). The binary bits correspond to the coils in the following way:

| Bit: | 0 0 1 1 1 1 0 0 | 1 0 0 1 1 0 1 1 |
|---|---|---|
| Coil: | 48 47 46 45 44 43 42 41 | 56 55 54 53 52 51 50 49 |

The first byte sent (3C hex) addresses coils 41-48, with the least significant bit addressing coil 41. The second byte sent (9B hex) addresses coils 49-56, with the least significant bit addressing coil 49.

| Slave Address | Function Code | Starting Address *High* Order | Starting Address *Low* Order | Number of Coils *High* Order | Number of Coils *Low* Order | Byte Count | Data *High* Order | Data *Low* Order | Error Check Field (LRC or RC) |
|---|---|---|---|---|---|---|---|---|---|
| 09h | 0Fh | 00h | 28h | 00h | 10h | 02h | 3Ch | 9Bh | — |

**Figure G9 – Write Multiple Coils Query Message**

## Modbus Protocol Illustration *(cont'd)*

**Response**

The response from the slave is an echo of the slave address, function code, starting address and number of coils forced.

| Slave Address | Function Code | Starting Address *High* Order | Starting Address *Low* Order | Number of Coils *High* Order | Number of Coils *Low* Order | Error Check Field (LRC or CRC) |
|---|---|---|---|---|---|---|
| 09h | 0Fh | 00h | 28h | 00h | 10h | — |

**Figure G10 – Write Multiple Coils Response Message**

### Write Multiple Holding Registers (Function Code 16)
Presets values into a sequence of holding registers.
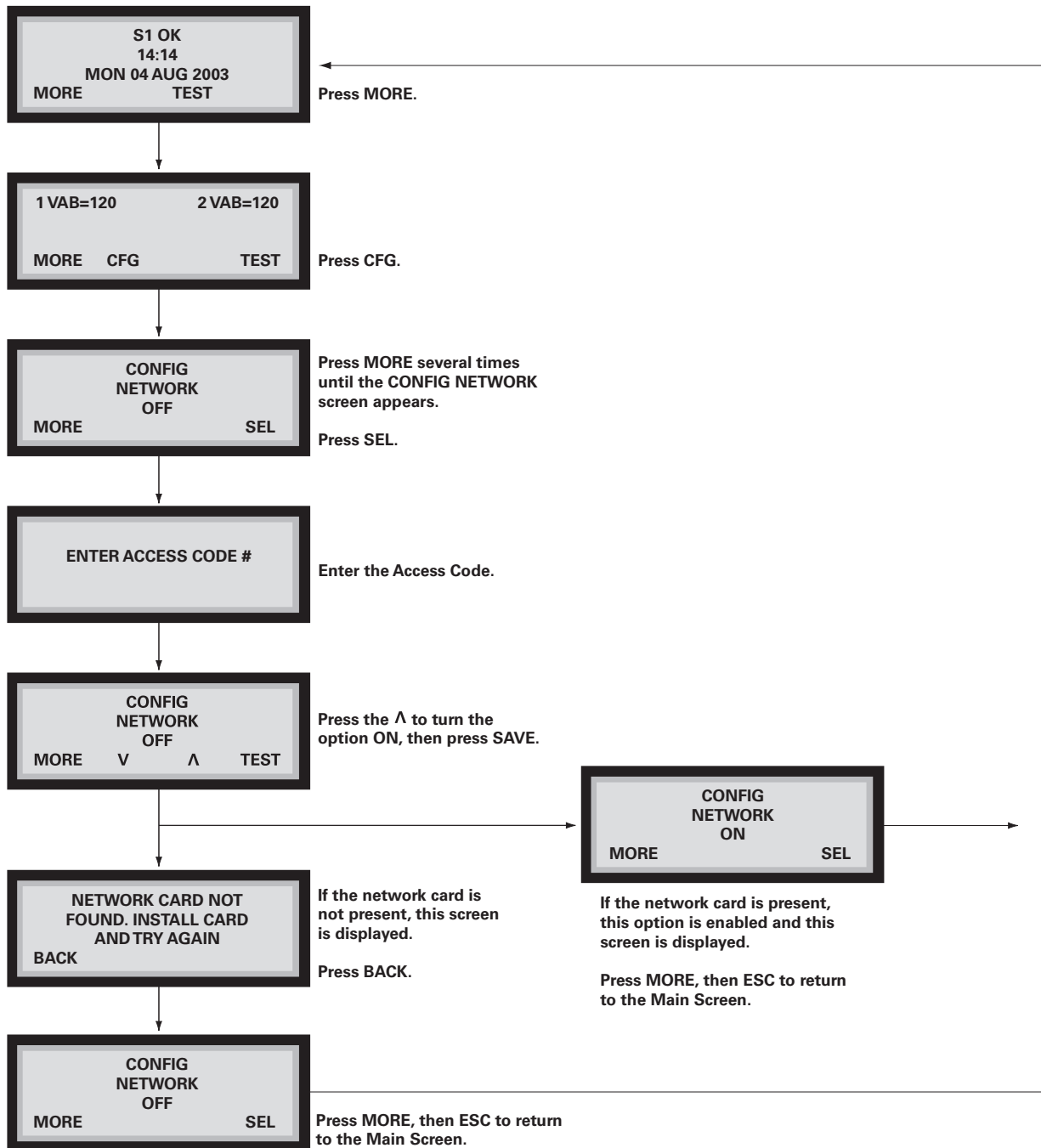
**Query**

The following is an example to preset two registers starting at 40034 (W-Time) to 9 hex (9 seconds) and 40035 (W3-time) to 32 hex (50 seconds), in slave device 17.

| Slave Address | Function Code | Starting Address *High* Order | Starting Address *Low* Order | Number of Regs *High* Order | Number of Regs *Low* Order | Byte Count | Data *High* Order | Data *Low* Order | Data *High* Order | Data *Low* Order | Error Check Field (LRC or CRC) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 11h | 10h | 00h | 21h | 00h | 02h | 04h | 00h | 09h | 00h | 32h | — |

**Figure G11 – Write Multiple Registers Query Message**

**Response**

The response from the slave is an echo of the slave address, function code, starting address and number of registers to be loaded.

| Slave Address | Function Code | Starting Address *High* Order | Starting Address *Low* Order | Number of Regs *High* Order | Number of Regs *Low* Order | Error Check Field (LRC or CRC) |
|---|---|---|---|---|---|---|
| 11h | 10h | 00h | 21h | 00h | 02h | — |

**Figure G12 – Write Multiple Registers Response Message**

# Appendix H

## Configuring Controller for Modbus MX150/250

```
        S1 OK
        14:14
     MON 04 AUG 2003
MORE              TEST
```
Press MORE.

```
 1 VAB=120         2 VAB=120


 MORE   CFG            TEST
```
Press CFG.

```
       CONFIG
       NETWORK
        OFF
MORE               SEL
```
Press MORE several times
until the CONFIG NETWORK
screen appears.

Press SEL.

```
   ENTER ACCESS CODE #


```
Enter the Access Code.

```
       CONFIG
       NETWORK
        OFF
MORE    V    Λ    TEST
```
Press the Λ to turn the
option ON, then press SAVE.

```
       CONFIG
       NETWORK
        ON
MORE               SEL
```
If the network card is present,
this option is enabled and this
screen is displayed.

Press MORE, then ESC to return
to the Main Screen.

```
  NETWORK CARD NOT
  FOUND. INSTALL CARD
    AND TRY AGAIN
BACK
```
If the network card is
not present, this screen
is displayed.

Press BACK.

```
       CONFIG
       NETWORK
        OFF
MORE               SEL
```
Press MORE, then ESC to return
to the Main Screen.

# Bill of Materials

## Components for the Modbus Option (MX150/250 V 6.0+)

| | Part Description | GE Zenith Part Number | Quantity |
|---|---|---|---|
| **Assembly** | Modbus Network Card Assembly | 50P-2035 | 1 |
| **Individual Replacement Components** | Modbus Network Card | 50P-2025 | 1 |
| | MX150/250 Network Adapter Card | 50P-1048 | 1 |
| | Network Plug Connector | PS-5140 | 1 |
| | Miniature Support Post | PS-7363 | 3 |
| | Operations and Maintenance Manual | 71R-2200 | 1 |

## Components for the Modbus Card Configuration

| | Part Description | GE Zenith Part Number | Quantity |
|---|---|---|---|
| **Assembly** | Modbus Card Configuration Assembly | 50P-1124 | 1 |
| **Individual Replacement Components** | RS232/485 Converter | 50W-1208 | 1 |
| | Belden 8471 Twisted Pair Cable | WMW-453 | 6 Feet |
| | Network Plug Connector | PS-5140 | 1 |
| | Configuration Software for Modbus Communications Card | 50P-1111 | 1 |
| | Operations and Maintenance Manual | 71R-2200 | 1 |

# Troubleshooting

| Problem | Possible Cause | Corrective Action |
|---|---|---|
| Trouble configuring the Modbus card | Modbus card is not installed on the controller. | Install the Modbus card on the controller. |
| | Controller does not have power. | Apply power to controller. |
| | Configuration jumper, J4, is not installed. | Install the configuration jumper J4. |
| | Wire between the RS232/485 converter and Modbus card is not connected. | See **Appendix D** for the proper connections. Connect the twisted pair wire between the converter and the Modbus card. |
| | Polarity connections are incorrect. | Make sure that A & B on the Modbus card are connected to A & B on the converter, respectively. |
| | Wrong com port or baud rate. | Select the correct com port and baud rate. (Refer to Appendix D) |
| | RS232/485 converter is not connected to the PC. | Connect the RS232/485 converter to the PC's serial port. |
| | Attempting to configure the Modbus Card to ASCII Mode, No Parity, and 1 Stop Bit. | The combination of ASCII Mode, No Parity, and 1 Stop Bit is not supported. Select another communication setting. |
| No communications between the Modbus card and the Master device | Controller does not have power. | Power up the controller. |
| | Communicating with the wrong addressed slave. | Verify that the address on the Modbus card matches the address you are communicating with. See Figure 2 for reference. |
| | Network wire connection from the Master to the Modbus card is broken or the wire is not connected to the Modbus card. | Check the wire connection from the Master to the Modbus card. Connect the wire to the Network card if necessary. |
| | Not using twisted pair wire to make the network connection. | Make sure interconnect cable is a twisted pair wire (Belden 8471, 16 AWG) (GE Zenith Part # WMW-453). |
| | Configuration jumper, J4, is still installed. | Remove the J4 configuration jumper. |
| | Proper polarity markings are not being followed. | Make sure that A & B on the Modbus card are connected to A & B on the converter, respectively. |
| | Termination jumper, J6, is not installed on the last slave in the chain. | Install termination jumper, J6, on the last slave in the chain. Make sure no other devices have jumper J6 installed. |
| | Modbus card communication configuration does not match the Master's. | Verify that the Master and Modbus card have the same baud rate, data bits, parity, stop bits with ASCII or RTU protocol selected. |
| | Twisted pair wire length exceeds 4,000 ft. | Install repeater if wire length exceeds 4,000 ft. |
| | RS485 multi-drop has more than 32 devices. | Install one repeater for every 32 devices on the network. |
| | Controller network option not enabled. | Refer to **Appendix H.** |
| All LED's on the LED module are off. | Modbus card is not installed on controller. | Install the Modbus card on controller. |
| | Controller does not have power. | Power up the controller. |
| | The Modbus card is damaged. | Call **GE Zenith Controls** Technical Support. |
| Illegal Data Address exception response to a write query | Holding Register or Coil address is beyond the legal range. There are no Holding Registers above address 40232 and no Coils above address 128. | Make sure the correct address is being sent |
| | Holding Register or Coil is Read Only. | Select a Holding Register or Coil that can be written. |
| | Write Multiple Holding Register or Coil range includes Read-Only registers. | Break up the write request into sections that contain only Read/Write registers. |
| | The feature associated with the register being programmed is not enabled. | Enable the feature in the User Configuration Menu on the controller HMI (if applicable), or call GE Zenith Controls Technical Support. |
| | Writing non-zero data to nonprogrammable date registers for CDP Exercisers. | Refer to the "Exerciser Time and Date Format" section of "Clock Exercisers" for more information. |
| | Writing CDP Exerciser registers with Write Single Holding Register command, or Write Multiple Holding Register command with invalid range. | Refer to the "Writing the Clock Exerciser Holding Registers" section for more operation information. |
| | Writing System Time registers with Write Single Holding Register command, or Write Multiple Holding Register command with invalid range. | Refer to the "Writing the System Time Holding Registers" section of "System Time" for more information. |
| Illegal Data Value exception response to a write query | Data value being written is too high or too low. | Refer to **Appendix B** for maximum/minimum data ranges. |
| | Data value would violate a minimum offset with respect to another register. | Refer to **Appendix B** for minimum data offsets. |
| Slave Device Busy exception response to Modbus query | Controller has recently restarted after a power failure and has not initialized the Modbus Card with new data yet. | Wait a few seconds for the controller to initialize the Modbus Card with new data. |
| | Controller is waiting for the In-Phase Monitor to detect phase synchronization. | Refer to the "Operation with In-Phase Monitor" section of this manual for more information. |

**GE Zenith Controls**