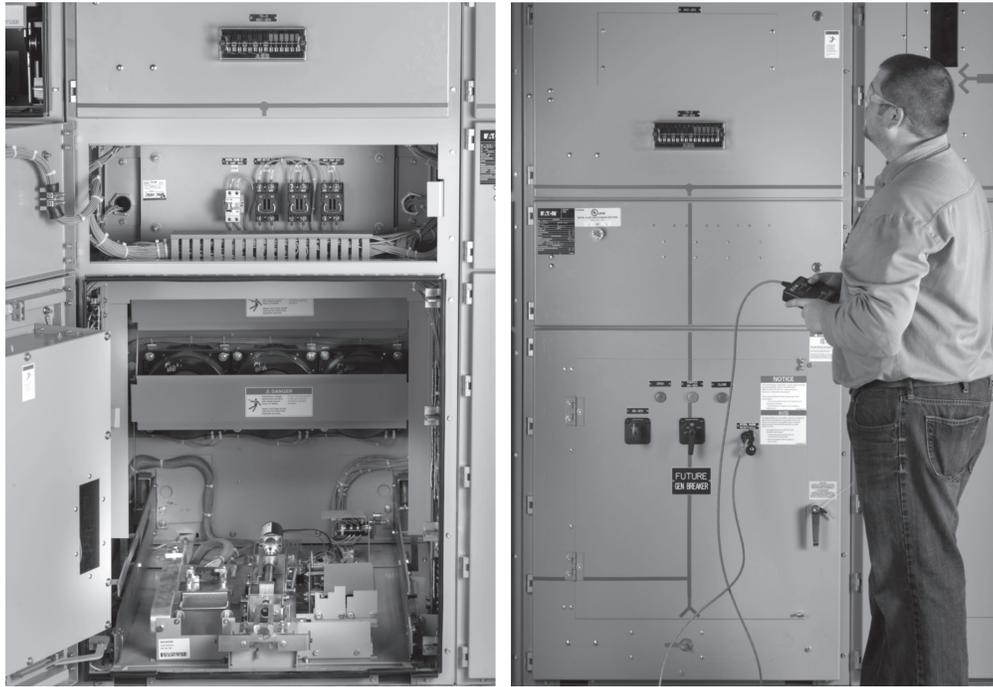


MODBUS interface to VCPW-HD and VCPW-MR2 controllers



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This product is manufactured by Eaton at the Greenwood Assemblies Plant: 2210 Hwy 72/221, Greenwood, SC 29649.

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Introduction

Switchgear with the VC-W MR2 integral racking option allows an operator to remotely rack a VCP-W breaker or auxiliary drawer from a distance of 30 ft. (9.14 m) or greater depending on the communication option installed. The integral racking assembly consists of a controller and a motor mounted in the rear of the breaker or auxiliary pan assembly, as well as safety and component position sensing devices located on the racking mechanism of the breaker and auxiliary pan assembly. The controller accepts 120 Vac and supplies power to the motor based on user input. The position of the VCP-W breaker or auxiliary drawer is detected by two limit switches located on the side of the racking mechanism.

⚠ DANGER

WHEN SWITCHGEAR IS CERTIFIED TO BE ARC-RESISTANT PER ANSI/IEEE® STD. C37.20.7, THE ARC-RESISTANT RATING IS ONLY VALID WHEN ALL DOORS ARE CLOSED AND PROPERLY LATCHED OR BOLTED, AND ALL COMPONENTS ARE INSTALLED AND WORKING PROPERLY. IN ADDITION, REMOVAL OF ANY BREAKER FROM ITS CELL WITHOUT REINSTALLING A BREAKER OR ARC-RESISTANT PROVISION COVER WILL VOID THE ARC-RESISTANT RATING.

Eaton contact information

For additional information about Eaton products please call 1-800-525-2000 or log onto www.eaton.com. Additional Medium Voltage Switchgear information regarding Pricing/Aftermarket, Customer Service, Engineering/Technical Information, or Warranty, can be found by calling 1-800-345-4072.

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If further information is desired regarding this particular installation or application information, contact the local Eaton sales office, reference Eaton's Consulting Application Guide, or the appropriate industry standards.

Refer to the following two reference documents for details about implementation of the industry-standard MODBUS protocol.

Both documents can be accessed at www.modbus.org

1. “MODBUS Over Serial Line Specification and Implementation Guide V1.0”

This document explains the Physical and Data Link Layers (OSI model Layers 1 and 2) for sending MODBUS data over a serial data communications line.

2. “MODBUS Application Protocol Specification V1.1b”

This document explains the Application Layer (OSI model Layer 7) for sending MODBUS messages between Master (Client) and Slave (Server) devices.

The above two documents and the specifications contained in this document are all the information that is needed to use MODBUS to communicate with the VCPW-MR2 and VCPW-HD Controllers.

In the VCPW products, MODBUS is used to communicate with the Controller unit in the switchgear. The controller is used to move the breaker to DISCONNECT, TEST and CONNECT or opening and closing the breaker if used. The Controller is always a MODBUS Slave and will respond to commands issued by MODBUS Masters. A MODBUS Master can be a hand-held MR2 Pendant or a PLC-type device.

In this implementation of the MODBUS protocol, only the “Unicast” mode is supported. In Unicast mode, a single Master device communicates with a single Slave device. The “Broadcast” mode is not supported (or necessary).

In the VCPW system, up to 99 different Controller units can be addressed by a single Master. Each Controller (slave) has a unique address which is set by writing the MODBUS address to holding register 0x0000 (see below for details).

The physical layer of this MODBUS implementation uses a passive, 2-wire, half-duplex, RS-485, multi-drop topology. The VCPW System uses Linear Technologies’ LT1785 RS-485 half-duplex drivers. The LT1785 drivers can support up to 128 nodes on an RS-485 network; however, the VCPW system firmware limits the number of RS-485 nodes to 100 (1 Master and up to 99 Controller/Slaves). MODBUS data is transmitted over the 2-wire interface using serial asynchronous characters. Each character is transmitted at 9600 baud with 8 data bits, one stop bit and no parity.

Note: The MODBUS specification specifies EVEN parity as recommended but allows NO parity to be used.

There are two modes of MODBUS data transmission in the MODBUS specification: ASCII and RTU. The VCPW system uses the RTU mode. The RTU mode transmits binary data and requires that each MODBUS message end with a 16-bit CRC word for message validation.

A MODBUS Master device will always be the first device to send a message over the 2-wire bus. All slaves (Controllers) on the bus will be listening and only the addressed slave will respond to a Master’s request.

There are three reasons that a MODBUS Master would want to communicate with an addressed slave (Controller):

Request controller status: the Master requests that the addressed Controller respond with its status (e.g. breaker position, Error conditions, LED indicator states, etc.)

Activate controller: the Master signals the Controller to perform a specific function (e.g. move the breaker to the CONNECT position, DISCONNECT position or TEST position).

Set the controller’s Modbus address: the Master can program the Controller’s MODBUS address by writing the address to holding register 0x0000 using the Write Single Register Function Code.

Request controller status

The Master accesses (retrieves) the Controller status by using the MODBUS “Read Input Registers” function code. This is function code 04 (0x04). Refer to the “MODBUS Application Protocol Specification V1.1b” for details on the Read Input Registers function code. The Controller status is contained in a contiguous block of input registers. The Read Input Registers function code is sent by the Master to the addressed slave (Controller) and the slave (Controller) will respond by sending the status information back to the Master. The Master will specify the starting address of the block of input registers and the number of input registers to read.

Modbus protocol restrictions

To keep the MODBUS interface between the Master and Slave (Controller) simple, the Controller only implements a subset of the full MODBUS protocol definition.

To request the Controller status, the Master MUST issue the MODBUS function code 0x04 (Read Input Registers). The Controller DOES NOT SUPPORT the MODBUS function codes 0x01 (Read Coils), 0x02 (Read Discrete Inputs), or 0x03 (Read Holding Registers). If any of these three “Read commands” are received from the Master a MODBUS error response will be issued by the Controller. The ONLY valid MODBUS command to read data from the Controller is the 0x04 (Read Input Registers) command. In addition, the MODBUS fields for “starting address” and “quantity of input registers” MUST be set as follows:

- Starting Address MUST be 0x0000
- Quantity of Input Registers MUST be 0x0008

This information is important when configuring a MODBUS Master that will be polling the Controller.

The following MODBUS input registers contain the status of the Controller.

Note: Per the MODBUS specification, input registers are READ ONLY:

INPUT REGISTER: GEARTYPE REGISTER.

Address = 300001. MODBUS address 0x00000

The values returned to the Master by the Slave when the Master reads the Gear Type register will depend on the PRODUCT GROUP field in the FIRMWARE VERSION REGISTER. Each PRODUCT GROUP will have its own values for the GEAR TYPE register. So it is necessary to examine the PRODUCT GROUP field in order to determine the GEAR TYPE.

If the PRODUCT GROUP field in the FIRMWARE VERSION REGISTER is 0x00 (GREENWOOD GROUP), the following GEAR TYPES will apply:

bit # -->	15	14	13	12	11	10	9	8	
0x00000	TEST	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	(High Byte)
	POS	15	14	13	12	11	10	9	
	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	TYPE	
	8	7	6	5	4	3	2	1	(Low Byte)
	7	6	5	4	3	2	1	0	<--- bit #

Bit 15 = 1 if installation has a TEST position

TEST POS = 0 if installation does not have a TEST position

Note: Determined by setting of SW2 on PC board)

Note: ONLY 1 OF BITS 14..0 WILL BE SET = 1 TO INDICATE THE GEAR TYPE:

Bit 14 = 1 for Gear Type 15:

Bit 13 = 1 for Gear Type 14:

Bit 12 = 1 for Gear Type 13:

Bit 11 = 1 for Gear Type 12:

Bit 10 = 1 for Gear Type 11:

Bit 9 = 1 for Gear Type 10:

Bit 8 = 1 for Gear Type 9:

Bit 7 = 1 for Gear Type 8:

Bit 6 = 1 for Gear Type 7:

Bit 5 = 1 for Gear Type 6:

Bit 4 = 1 for Gear Type 5:

Bit 3 = 1 for Gear Type 4:

Bit 2 = 1 for Gear Type 3:

Bit 1 = 1 for Gear Type 2:

Bit 0 = 1 for Gear Type 1:

INPUT REGISTER: FIRMWARE VERSION REGISTER.

Address = 300002. MODBUS address 0x00001

bit # -->	15	14	13	12	11	10	9	8	
0x00001	PRODUCT GROUP (0-255)								(High Byte)
	FIRMWARE VERSION (0-255)								(Low Byte)
	7	6	5	4	3	2	1	0	<--- bit #

The high byte of the word contains the PRODUCT GROUP.
e.g. 0x23 = 35 decimal

The low byte of the word contains the FIRMWARE VERSION.
e.g. 0x23 = 35 decimal

INPUT REGISTER: BREAKER STATUS REGISTER. Address = 300003. MODBUS address 0x00002

bit # -->	15	14	13	12	11	10	9	8		
0x00002	MOT RUN	MOT DIR	DEST CONN	DEST TEST	DEST DISC	AT DISC	AT TEST	OVER TEST	(High Byte)	
	AT CONN	BETW CONN TEST	BETW TEST DISC	BETW CONN DISC	BRK OPEN	N/A	N/A	N/A	N/A	(Low Byte)
	7	6	5	4	3	2	1	0	<---bit#	

- 15 MOT RUN = 1 if motor is running; = 0 if motor is stopped
- 14 MOT DIR = 1 if motor is racking IN; = 0 if motor is racking OUT
- 13 DEST CONN = 1 if the breaker destination is the CONNECT position; = 0 otherwise
- 12 DEST TEST = 1 if the breaker destination is the TEST position; = 0 otherwise
- 11 DEST DISC = 1 if the breaker destination is the DISCONNECT position; = 0 otherwise
- 0 AT DISC = 1 if the breaker is stopped at the DISCONNECT position; = 0 otherwise
- 9 AT TEST = 1 if the breaker is stopped at the TEST position; = 0 otherwise
- 8 OVER TEST = 1 if the breaker is moving over the TEST position; = 0 otherwise
- 7 AT CONN = 1 if the breaker is stopped at the CONNECT position; = 0 otherwise
- 6 BETW CONN EST = 1 if the breaker is moving and is between the CONNECT and TEST positions; = 0 otherwise
- 5 BETW TEST DISC = 1 if the breaker is moving and is between the TEST and DISCONNECT positions; = 0 otherwise
- 4 BETW CONN DISC = 1 if the breaker is moving and is between the CONNECT and DISCONNECT positions; = 0 otherwise
- 3 BRK OPEN = 1 if breaker is OPEN; = 0 if breaker is CLOSED
- 2 N/A Not used; reserved for future expansion
- 1 N/A Not used; reserved for future expansion
- 0 N/A Not used; reserved for future expansion

INPUT REGISTER: ERROR CODE REGISTER.
Address = 300004. MODBUS address 0x00003

bit # --->	15	14	13	12	11	10	9	8	
0x00003	0	0	0	0	0	0	0	0	(High Byte)
	ERROR CODE								(Low Byte)
	7	6	5	4	3	2	1	0	<--- bit #

- = 0 for NO ERROR
- = 32 (decimal) ERROR code for motor overcurrent detected (E1)
- = 33 (decimal) ERROR code for motor inoperative error (E2)
- = 34 (decimal) ERROR code for breaker timeout error (E3)
- = 35 (decimal) ERROR code for breaker position unknown (E4)
- = 36 (decimal) ERROR code for open permissive circuit (E5)
- = 37 (decimal) ERROR code for Contoller MODBUS communications error (E6)
- = 38 (decimal) ERROR code for no breaker installed (E7)
- = 39 (decimal) ERROR code for no test position (E9)
- = 40 (decimal) ERROR code for limit switch error (E8)
- = 41..255 Codes reserved for future expansion

INPUT REGISTER: LED STATUS REGISTER.
Address = 300005. MODBUS address 0x00004

bit # --->	15	14	13	12	11	10	9	8	
0x00004			BCS	BOS	DS	TS	IS	CS	(High Byte)
			BCF	BOF	DF	TF	IF	CF	(Low Byte)
	7	6	5	4	3	2	1	0	<---bit#

- BCS = 1 if the BREAKER CLOSED LED is ON SOLID (i.e. not flashing)
= 0 if the BREAKER CLOSED LED is OFF
- BOS = 1 if the BREAKER OPEN LED is ON SOLID (i.e. not flashing)
= 0 if the BREAKER OPEN LED is OFF
- DS = 1 if the DISCONNECT LED is ON SOLID (i.e. not flashing)
= 0 if the DISCONNECT LED is OFF
- TS = 1 if the TEST LED is ON SOLID (i.e. not flashing)
= 0 if the TEST LED is OFF
- IS = 1 if the INTERMEDIATE LED is ON SOLID (i.e. not flashing)
= 0 if the INTERMEDIATE LED is OFF
- CS = 1 if the CONNECT LED is ON SOLID (i.e. not flashing)
= 0 if the CONNECT LED is OFF
- BCF = 1 if the BREAKER CLOSED LED is flashing
= 0 if the BREAKER CLOSED LED is not flashing
- BOF = 1 if the BREAKER OPEN LED is flashing
= 0 if the BREAKER OPEN LED is not flashing
- DF = 1 if the DISCONNECT LED is flashing
= 0 if the DISCONNECT LED is not flashing
- TF = 1 if the TEST LED is flashing
= 0 if the TEST LED is not flashing
- IF = 1 if the INTERMEDIATE LED is flashing
= 0 if the INTERMEDIATE LED is not flashing
- CF = 1 if the CONNECT LED is flashing
= 0 if the CONNECT LED is not flashing

INPUT REGISTER: OVER CURRENT COUNT REGISTER.
Address = 300006. MODBUS address 0x00005

bit # --->	15	14	13	12	11	10	9	8	
0x00005	BCD DIGIT (MS)				BCD DIGIT				(High Byte)
	BCD DIGIT				BCD DIGIT (LS)				(Low Byte)
	7	6	5	4	3	2	1	0	<--- bit #

This register holds the 4-digit count of the number of times that the breaker has experienced an "over current" condition. The 4-digit number is stored in MODBUS register 300006 as 4 BCD digits.

For example, if the OVER CURRENT COUNT is 9,423 the MODBUS OVER CURRENT COUNT REGISTER would contain:

- 0x94 (High Byte)
- 0x23 (Low Byte)

INPUT REGISTER: RACK-IN COUNT REGISTER.
Address = 300007. MODBUS address 0x00006

bit # --->	15	14	13	12	11	10	9	8	
0x00006	BCD DIGIT (MS)				BCD DIGIT				(High Byte)
	BCD DIGIT				BCD DIGIT (LS)				(Low Byte)
	7	6	5	4	3	2	1	0	<--- bit #

This register holds the 4-digit count of the number of times that the breaker has been "racked in" to the CONNECT position. The 4-digit number is stored in MODBUS register 300007 as 4 BCD digits.

For example, if the RACK-IN COUNT is 9,423 the MODBUS RACK-IN COUNT REGISTER would contain:

- 0x94 (High Byte)
- 0x23 (Low Byte)

INPUT REGISTER: RACK-OUT COUNT REGISTER.
Address = 300008. MODBUS address 0x00007

bit # --->	15	14	13	12	11	10	9	8	
0x00007	BCD DIGIT (MS)				BCD DIGIT				(High Byte)
	BCD DIGIT				BCD DIGIT (LS)				(Low Byte)
	7	6	5	4	3	2	1	0	<--- bit #

This register holds the 4-digit count of the number of times that the breaker has been "racked out" to the DISCONNECT position. The 4-digit number is stored in MODBUS register 300008 as 4 BCD digits.

For example, if the RACK-OUT COUNT is 9,423 the MODBUS RACK-OUT COUNT REGISTER would contain:

- 0x94 (High Byte)
- 0x23 (Low Byte)

INPUT REGISTER: RESERVED REGISTER.

Address = 300009. MODBUS address 0x00008

bit # -->	15	14	13	12	11	10	9	8	
0x00008									(High Byte)
									(Low Byte)
	7	6	5	4	3	2	1	0	<--- bit #

This register is used for communication with the hand-held Pendant. DO NOT READ THIS REGISTER. READING THIS REGISTER TRIGGERS FUNCTIONS THAT ARE ONLY APPLICABLE IF A HAND-HELD PENDANT IS CONNECTED. ONLY THE HAND-HELD PENDANT SHOULD READ THIS REGISTER.

The following MODBUS holding registers can be written to using the "Write Single Register" Function Code (MODBUS function code 0x06):

HOLDING REGISTER: CONTROLLER MODBUS ADDRESS REGISTER. Address = 300001. MODBUS address 0x00000

bit # -->	15	14	13	12	11	10	9	8	
0x00000	0	0	0	0	0	0	0	0	(High Byte)
	CONTROLLER MODBUS ADDRESS								(Low Byte)
	7	6	5	4	3	2	1	0	<--- bit #

CONTROLLER MODBUS ADDRESS = A binary number from 1..99

This register contains the Controller's MODBUS address. This is a number from 1 to 99. The Master can set the Controller's MODBUS address by writing to this register using the MODBUS Function Code 0x06. For example to set the Controller's MODBUS address to decimal 27, the Master would write the 16-bit value 0x001B to MODBUS address 0x0000. Note that once the Controller receives and processes this write command, the Controller will change its MODBUS address to the "new" address specified in the Function Code. The Controller will only respond to Function Codes (commands) that are addressed to this "new" address.

Activate controller

The Master activates the controller to perform a specific function by using the MODBUS "Write Single Coil" function code. This is function code 05 (0x05). Refer to the "MODBUS Application Protocol Specification V1.1b" for details on the Write Single Coil function code.

There are six (6) specific coils that the Master can write that will cause the slave (Controller) to perform a specific function:

Coil address 000001 (0x00000): Activate the CONNECT function. This is equivalent to pressing the CONNECT button on the hand-held MR2 Pendant;

Coil address 000002 (0x00001): Activate the DISCONNECT function. This is equivalent to pressing the DISCONNECT button on the hand-held MR2 Pendant;

Coil address 000003 (0x00002): Activate the TEST function. This is equivalent to pressing the TEST button on the hand-held MR2 Pendant;

Coil address 000004 (0x00003): Activate the INTERMEDIATE INPUT function.

Coil address 000005 (0x00004): Activate the OPEN BREAKER function.

Coil address 000006 (0x00005): Activate the CLOSE BREAKER function.

RS-485 line configuration: DIP SWITCH S1 on the controller PC board

On the controller PC board, DIP SWITCH S1 is a four (4) position switch used to configure the 2-wire RS-485 electrical interface in accordance with the EIA/TIA-485 standard. For complete details, refer to the public document "MODBUS Over Serial Line Specification and Implementation Guide V1.02". Figure 20 in that document shows details of a 2-wire RS-485 electrical interface.

The settings of the RS-485 MODBUS DIP switches depend on the actual network implementation and wiring. The system engineer responsible for setting up the network will determine these switch settings based on the network specifics (how many nodes, distance between nodes, master biasing).

DIP Switch S1 positions 1 and 2 are used to implement RS-485 biasing. S1-1 and S1-2 are used to connect bias resistors to the 2-wire network. Biasing should be done at only one point on a network; it is best to have the single master on the 2-wire network provide these bias resistors. If the network master (HMI) does not provide line bias, one of the controllers (slaves) on the 2-wire network will need to have its S1-1 and S1-2 switches ON. If the master (HMI) does provide biasing, then all controllers (slaves) on the network should have S1-1 and S1-2 in the OFF position.

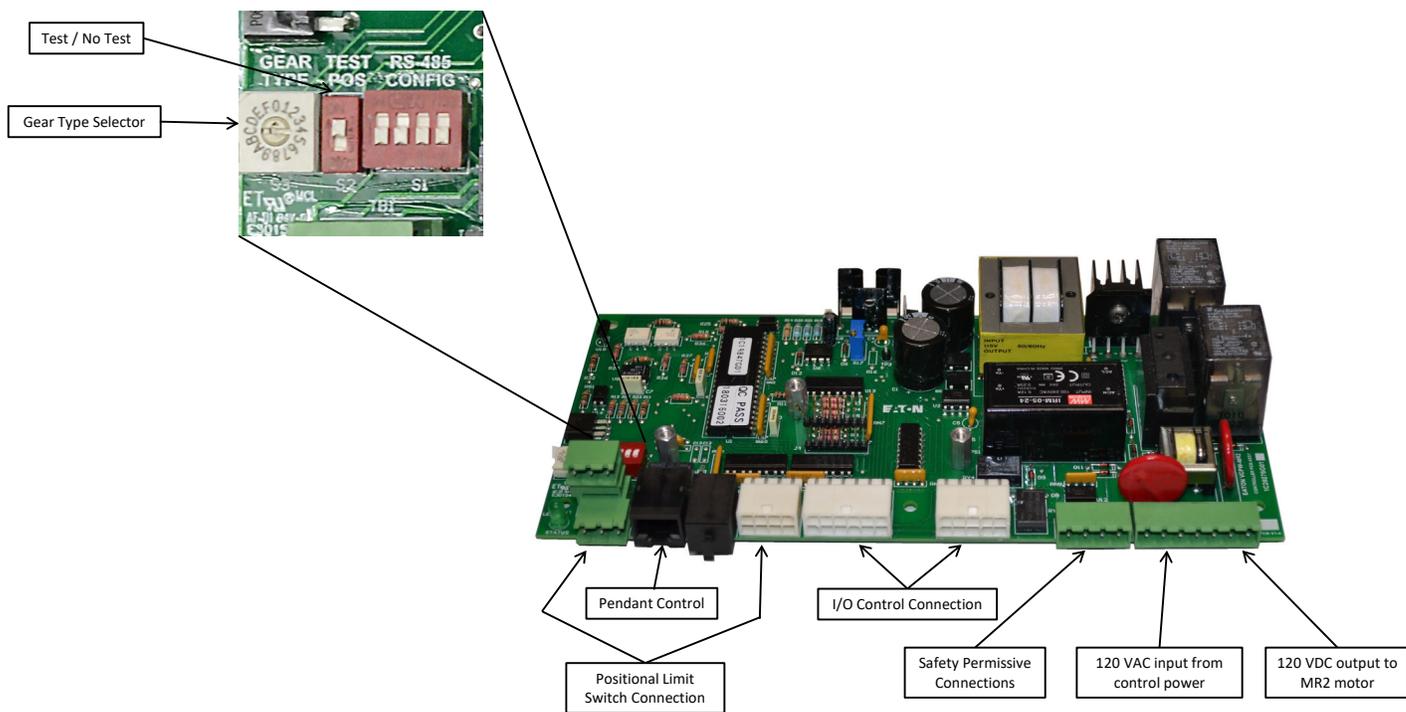
DIP Switch S1 Position 1 is used to connect a 620-ohm pull-down resistor to the RS-485 "A" line. When S1-1 is in the ON position, a 620-ohm resistor is connected between the "A" line and the Ground line (i.e. the "A" line is pulled down to ground through a 620-ohm resistor.) When S1-1 is in the OFF position, the 620-ohm resistor is not connected.

DIP Switch S1 Position 2 is used to connect a 620-ohm pull-up resistor to the RS-485 "B" line. When S1-2 is in the ON position, a 620-ohm resistor is connected between the "B" line and +5V. (i.e. the "B" line is pulled up to +5V through a 620-ohm resistor.) When S1-1 is in the OFF position, the 620-ohm resistor is not connected.

DIP Switch S1 position 3 is used to connect a 120-ohm line termination resistor across the RS-485 "A" and "B" lines. When S1-3 is ON, the 120-ohm line termination resistor is connected across the "A" and "B" lines. When S1-3 is OFF, the 120-ohm line termination resistor is not connected. For "long" transmission lines, there should be a 120-ohm resistor installed at the 2 controllers that are at the ends of the transmission lines. For "short" lines, these resistors are not usually used.

DIP Switch S1 position 4 is used to enable/disable a 100-ohm resistor that is in series with the RS-485 driver/receiver signal ground and the earth/chassis ground. When S1-4 is OFF, a 100-ohm resistor is connected in series between the driver/receiver signal ground and the earth/chassis ground. When S1-4 is ON, the driver/receiver signal ground is connected directly to the earth/chassis ground. During transient events a high voltage potential may exist between the remote grounds. Only the impedance of the wire connecting the grounds limits the current that results from this voltage potential. The RS-485 specifications recommends using 100 ohm resistors in series with the signal ground path in order to limit ground currents (S1-4 OFF).

Note: See Instruction Booklet IB022010EN, Figure 13 for a detailed view of the controller PC board.



MR2 O/C controller.

Note: For complete instructions for installation, operation and maintenance of medium voltage VC-W MR2 (integral racking) refer to Instruction Booklet IB022010EN

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

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