

Instructions for installation, operation, and maintenance of medium voltage VC-W MR2 (integral racking)



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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.

Eaton Electrical Services and Systems (EESS) can be reached at 1-800-498-2678.

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.

Pan configurations

Integrated racking is available for all voltage ratings. For 5/15 kV and 27 kV switchgear, there is an optional "Test" position available. The "Test" position is a physically different position in this assembly, and the breaker can be racked from "Disconnect" to "Test," "Test to Connect," or in any other order selected by the operator. See below for what positions are available for each voltage rating.

Voltage class (kV)	Breaker cell width in inches	Breaker positions available	Auxiliary positions available
5/15	36.00	Disconnect and Connect	Disconnect and Connect
5/15 ①	36.00	Disconnect, Test, and Connect	Disconnect and Connect
5	26.00	Disconnect and Connect	N/A
27	36.00	Disconnect and Connect	N/A
27 ②	36.00	Disconnect, Test, and Connect	N/A
38	42.00	Disconnect and Connect	N/A

① Optional "Test" position with Breaker Position Indication (BPI) pan only.

② Optional "Test" position available with non-arc gear equipped with BPI pan only.

Permissive interlocks

Operational interlock features

There are multiple permissive interlocks features built into the controller programming, and error codes are displayed on the pendant. There are three standard permissive interlocks wired for every breaker cell with integrated racking and one for every auxiliary cell with integrated racking.

Breaker cell specific interlocks:

- Normally closed mechanism-operated compartment (MOC) contact wired into the controller programming permissive circuit (breaker cell only). Part of the E5 error code circuit (see Figure 1).
 - If the MV circuit breaker is closed, this circuit will open and the motor will not run.
 - This permissive uses only the controller programming to stop the motor from being powered on.
- Normally closed MOC contact wired in series with the black motor lead (breaker cell only). Part of the E2 error code circuit (see Figure 1).
 - This works the same as the first MOC permissive.
 - Used as a redundant interlock in case the first MOC permissive fails.
 - This contact breaks the power to the motor for a more hardwired permissive.

Breaker cell and auxiliary cell interlocks:

- Normally closed manual crank permissive switch located on the right side of the Lev-in assembly (breaker and auxiliary cell) (see Figure 15 and 16). Part of the E5 error code circuit (see Figure 1).
 - This permissive is opened if an operator inserts a tool into the manual crank of the Lev-in assembly.
 - This prevents someone from operating the motor while a person is manually racking the MV circuit breaker or auxiliary.

In addition to the permissive contacts mentioned above, the controller will accept as many normally closed permissive contacts wired in series with permissive #1 and #3 as specified (see Figure 1- circuit board wiring points).

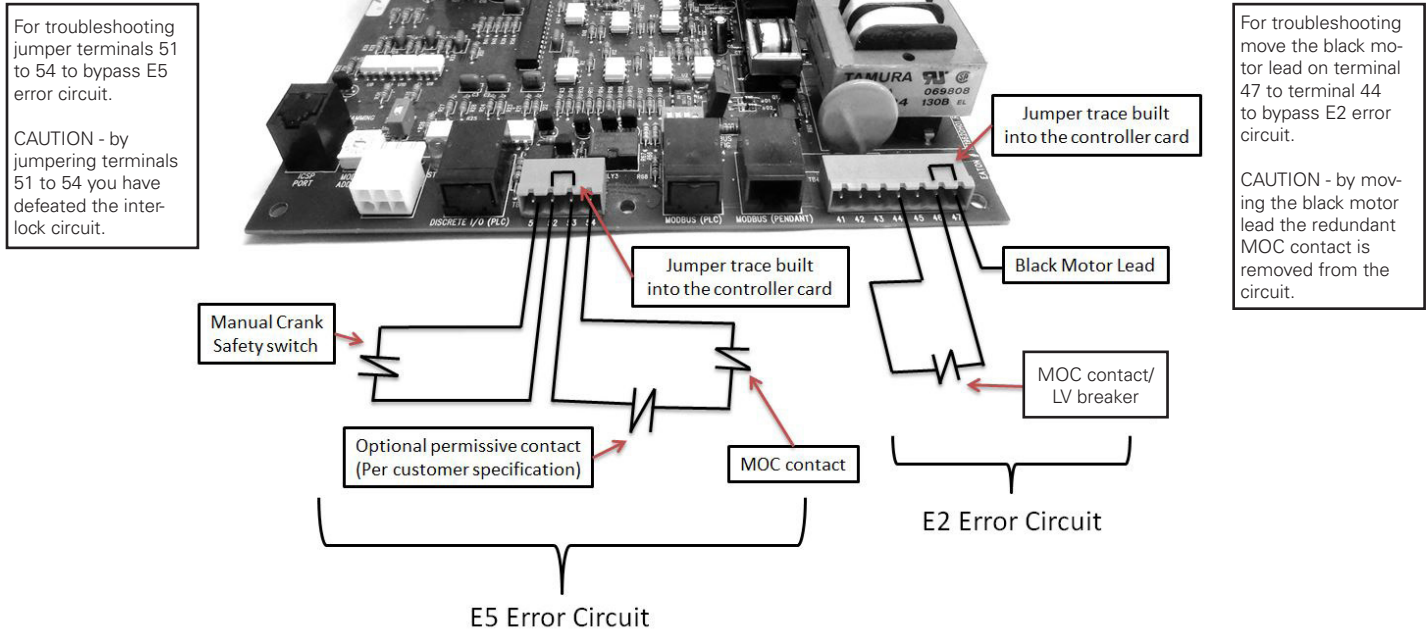


Figure 1. Permissive wiring diagram for MR2.

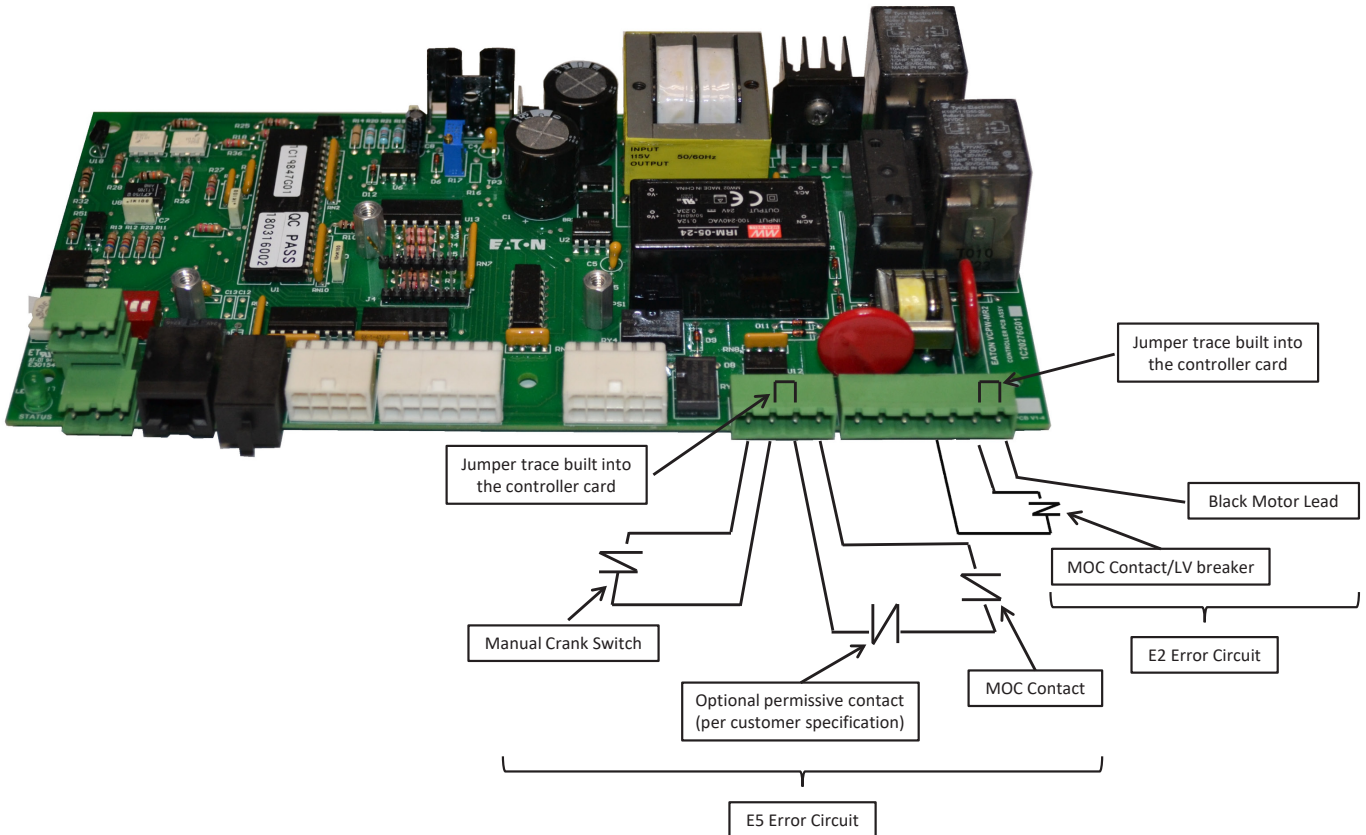


Figure 2. Permissive wiring diagram for MR2 O/C.

Lockout-tagout

With the electrical racking feature MR2 option, there are now two methods of racking a MV circuit breaker or drawout auxiliary, requiring a lockout-tagout (LOTO) method for both options. The first is the standard positional interlock located at the front right of the breaker pan assembly (see Figure 3) or front right of the auxiliary pan assembly. This lock prohibits an operator from manually inserting a crank into the Lev-in assembly and manually racking the breaker or auxiliary device as specified in the switchgear instruction book. Once a lock option is installed, the (MR2) will be disabled via the LOTO/padlock permissive switch for the breaker pan assembly (see Figure 4) and the auxiliary pan assembly (see Figure 5).

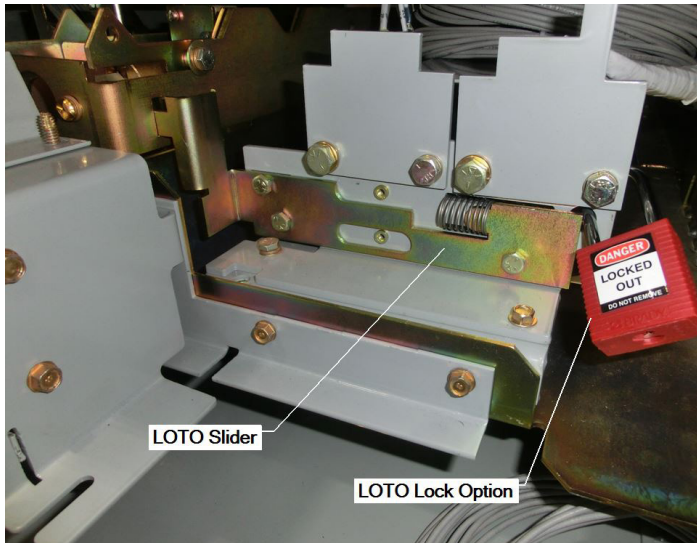


Figure 3. Positional interlock for circuit breaker pan assembly (5-27 kV).

Refer to equipment instruction booklet for acceptable LOTO options.

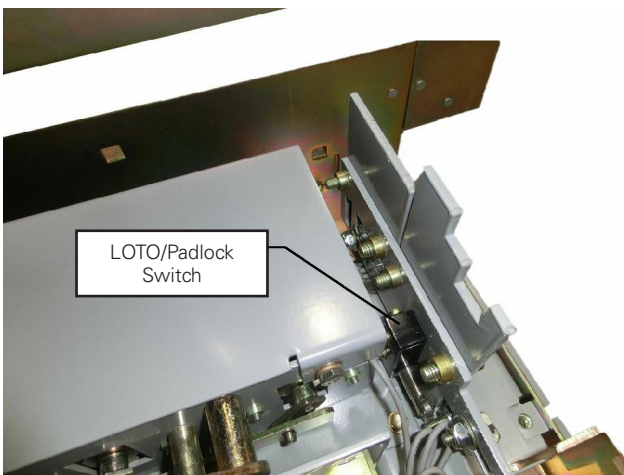


Figure 4. LOTO/padlock switch for typical circuit breaker and arc auxiliary circuit breaker pan assembly.

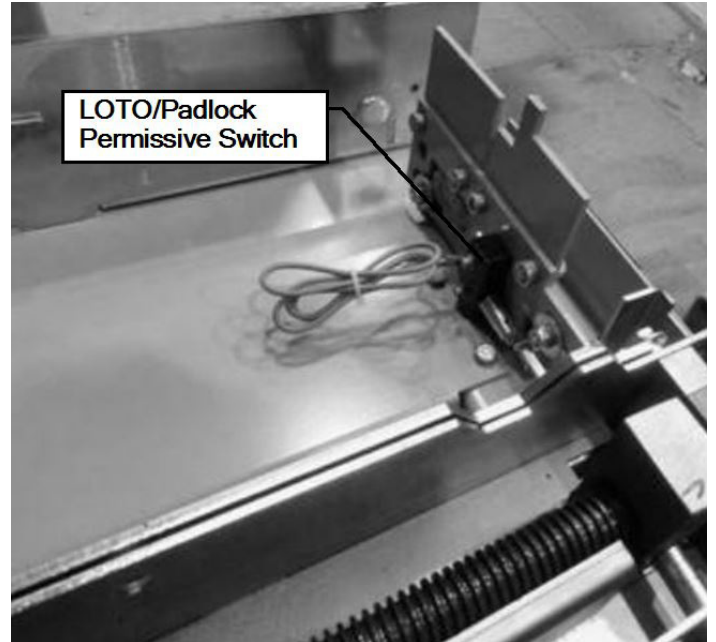


Figure 5. LOTO/Padlock Switch Arc Auxiliary Pan Assembly.

Diagnostics/troubleshooting

The integrated racking controller programming has built-in diagnostics and error detection. If an error occurs, “E1” to “E9” will appear on the pendant display (see Figure 6). On the back of the pendant there is a label that explains what the error is and what to do if the error occurs (see Figure 9).



Figure 6. MR2 Error code display.



Figure 7. MR2 O/C error code display.



Figure 8. MR2 O/C error code display with out connect/disconnect.



Figure 9. MR2 error code display.



Figure 10. MR2 O/C error code display.

E1: Motor overcurrent

Condition when motor current is in excess of allowed value. Multiple causes could create this condition. E1 error codes may occur if system is operated on temporary generator power. Operator should shut off power to the VC-W MR2 controller by tripping the 15 A circuit breaker (see Figure 11) in the LV compartment and manually rack out the MV device. The operator should inspect the MV device, levering system subassembly, and controller card for obvious damage or abnormal conditions. If no obvious issues are found, reinstall the MV device .

E2: Open motor circuit

Can occur when the motor thermal switch opens, possibly caused by an excessive duty cycle (more than 10 consecutive operations in quick succession without stopping). Once the thermal switch closes (motor cools down), the controller can be reset by pressing the disconnect switch.

An open motor circuit as shown (Figure 1 and 2) will also cause this error. Use troubleshooting as shown with Figure 1 and 2.

E3: Motor timed out

Condition when motor continues to run in excess of 45 seconds during racking process. This error state condition can be caused from a broken motor shaft, coupling, or a damaged gear box. Operator should shut off power to the VC-W MR2 controller by tripping the 15 A circuit breaker (see Figure 11) in the LV compartment and manually rack out the MV device. Once the MV device is removed from the compartment, the operator can replace the damaged devices.

E4: MV device position “unknown”

Controller does not know the location of the MV device in the breaker or auxiliary compartment. The operator must press the “Disconnect” button on the pendant as the other buttons will not function. Once the breaker has reached the disconnect position, the “Disconnect” LED will illuminate and the operator can start the MV device racking process over by pressing the “Connect” button.

E5: Open permissive

This state is due to a permissive contact being open. It could be a standard permissive such as the circuit breaker being closed or the slider bracket being pushed in. In this case, press the “Disconnect” button to reset the controller. Once the permissive switch is closed, any operation will work. Use troubleshooting guide as shown with Figure 1 and 2.

E6: Communication error

This state results from damaged communication cable or wiring. Check all areas of communication wiring (e.g., discrete, CAT5, TB wiring, or Modbus controller wiring). If disconnect and connect positional circuits are closed, the board enters programming mode causing a communication error.

E7: No MV device

This state occurs when the Lev-in assembly racks in and the “Connect” limit switch is depressed; however, no increase in motor current is detected. See below table for normal operating current values.

Device type	Racking in/out current (amperes)	Racking on/off current (amperes)
Breaker	2–3	10
5/15 kV Arc Auxiliary	—	—
5/15 kV Non-arc Auxiliary	—	—

E8: Firmware compatibility error

This state results from the pendant and controller card not having compatible firmware. Contact your Eaton representative to have the firmware updated.

E9: No test (MR2 open/close only)

This state occurs when the test button is pressed and the control board does not have test activated. See Figure 2. There is not a test position available for the MV device.

Controller diagnostic display

This feature can be used for diagnostic and troubleshooting purposes. The operator will press and hold down the enable button while pressing and holding down the unused button under the “Intermediate” label on the pendant for 3 seconds. The Gear type, controller firmware version, pendant firmware version, rack-in count, rack-out count, overcurrent count and “test” or “No Test” verification will scroll across the display.

Ex. of entire sequence:

PG ##	GR ##	CF ##	PF ##	RI ###	RO ###	OC ###	NT or T	AD ##
1	2	3	4	5	6	7	8	9

1. Product Group
2. Gear type
3. Controller Firmware version
4. Pendant Firmware version
5. Rack-in count
6. Rack-out count
7. Overcurrent count
8. “No Test” or “Test”
9. MODBUS Address (01 to 99)



Each new version of the firmware will be an increased revision of that firmware in our system. There will be no rev 2.1 then rev 2.2, it will go from rev 2 to 3 to 4 and so on for any change made to the firmware.

Setting gear type

⚠ CAUTION

SETTING THE WRONG GEAR TYPE CAN CAUSE THE BREAKER TO NOT FULLY RACK IN. GEAR TYPE IS CELL SPECIFIC, IF A CONTROL BOARD IS MOVED TO A NEW CELL ONE MUST VERIFY GEAR TYPE USING CONTROLLER DIAGNOSTIC DISPLAY.

Setting the gear type

All gear types are imbedded in one controller firmware version. The gear type is set with defined inputs on power up. Gear Type may be set by one of the two methods shown below. If Method 1 is used it will override any Gear Type set using Method 2.

Gear types	
01	5/15kV 1200, 38kV 25kA *
02	5/15kV 3000A
03	5kV narrow design
04	27kV
05	5/15kV 2000A, 38kV 40kA
06	Arc aux (ignores E7)
07	¼ high aux (ignores E7)
15	Demo (ignores E7)

* 5/15 kV 2000A switchgear cells built prior to 2019 used Gear Type 01.

Method 1, applies to pendant with enable button.

The gear type is set by turning the Gear Type Dial to correct gear type shown in the table in the previous section (Note: Gear Type 15 is position F on the dial). The gear type can then be verified with the diagnostic display.

Method 2, applies to pendant without enable button.

On power up if both connect and disconnect positional limit switches are closed then the controller will look to see what series of I/O controls are closed. The gear type is then set depending on what pushbuttons are closed. The gear type can then be verified with the diagnostic display. Below are the sequences of closed contacts to set each gear type.

Closed contacts upon power-up

Gear type	Positional limit switches (ref Figure 15)	I/O Controls jumper
01	"Disc" & "Conn"	Pin 8 to pin 1
02	"Disc" & "Conn"	Pin 8 to pin 2
03	"Disc" & "Conn"	Pin 8 to pin 3
04	"Disc" & "Conn"	Pin 8 to pin 1 and 2
05	"Disc" & "Conn"	Pin 8 to pin 2 and 3
06	"Disc" & "Conn"	Pin 8 to pin 1, 2 and 3"
07	"Disc" & "Conn"	None
15	"Disc" & "Conn"	Pin 8 to pin 1 and 3

Procedure:

Step 1. - Using an Ethernet cable and a RJ485 to 8 pin terminal block adapter. Connect one end of the Ethernet cable to the discrete I/O control connection shown on Figure 12. Connect the other end of the Ethernet cable to the RJ485 connection shown on Figure 12.

Setting the Modbus address

If the enable button is present (Figure 7 and 8) the enable button must be held to operate the pendant. The Modbus address of a controller board is set using the pendant. The available MODBUS addresses are 01 to 99 for one RS485 network.



To set the MODBUS address, follow the steps below:

1. Connect pendant to the cell to be programmed.
2. Hold down the "Intermediate" button and within 3 seconds press and hold the "Connect" button until the 2-digit LED display begins to flash "##", at the same time the "Connect" LED will begin to flash.
3. Now the "Test" and "Disconnect" buttons can be used to scroll up and down (01 to 99) until the desired address number is reached. While scrolling, the "Connect" LED will continue to flash to let the user know that the address is not set.
4. Once the desired address number is reached, press the "Connect" button to connect to the Modbus address displayed.
5. Press "Disconnect" to return to operation mode.
6. At this time the address can be verified using the controller diagnostic display described above.

The MODBUS address can be modified after being set using the same sequence.

Note: See Instruction Booklet IB022022EN for information on the MODBUS interface to VCPW-MR2 and VCPW-HD controllers.

Manual racking

Follow the steps listed below to manually rack the MV device in the case of a motor/controller failure or loss of control power.

1. Turn "Off" the 15 A two-pole LV circuit breaker mounted in the LV compartment (see Figure 11).
 - a. This action does two things:
 1. It ensures that the motor will not turn on during manual racking.
 2. It prevents the motor from back feeding voltage and causing the user to apply excessive torque to the lead screw.
2. Once the LV circuit breaker is turned "Off," the operator can insert the standard racking tool (for 5/15 kV 1/4 high auxiliary drawers, use a standard 1/2" socket) and rack the MV device to the connected or disconnected position.
 - a. This will require slightly more torque than normal because it will be driving through the motor gearbox.

In the case that the motor is jammed and the lead screw does not turn freely or with less than 35 ft-lbs (47.45 N-m) of torque, the operator can apply approximately 70 ft-lbs (94.91 N-m) of torque and the lead screw will break away from the motor. Once the lead screw has broken free from the motor, the MV device can be racked manually. The unit should then be inspected and a new lead screw installed.



Figure 11. 15 A circuit breaker.

Terminals 1 and 2 are the 120 VAC power supply. Terminals 3 and 4 are the 140 VDC motor circuit.

Control options

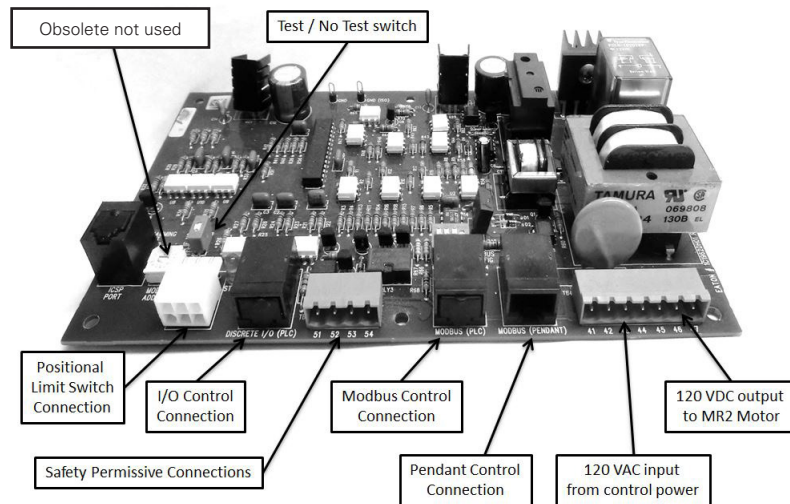


Figure 12. MR2 controller.

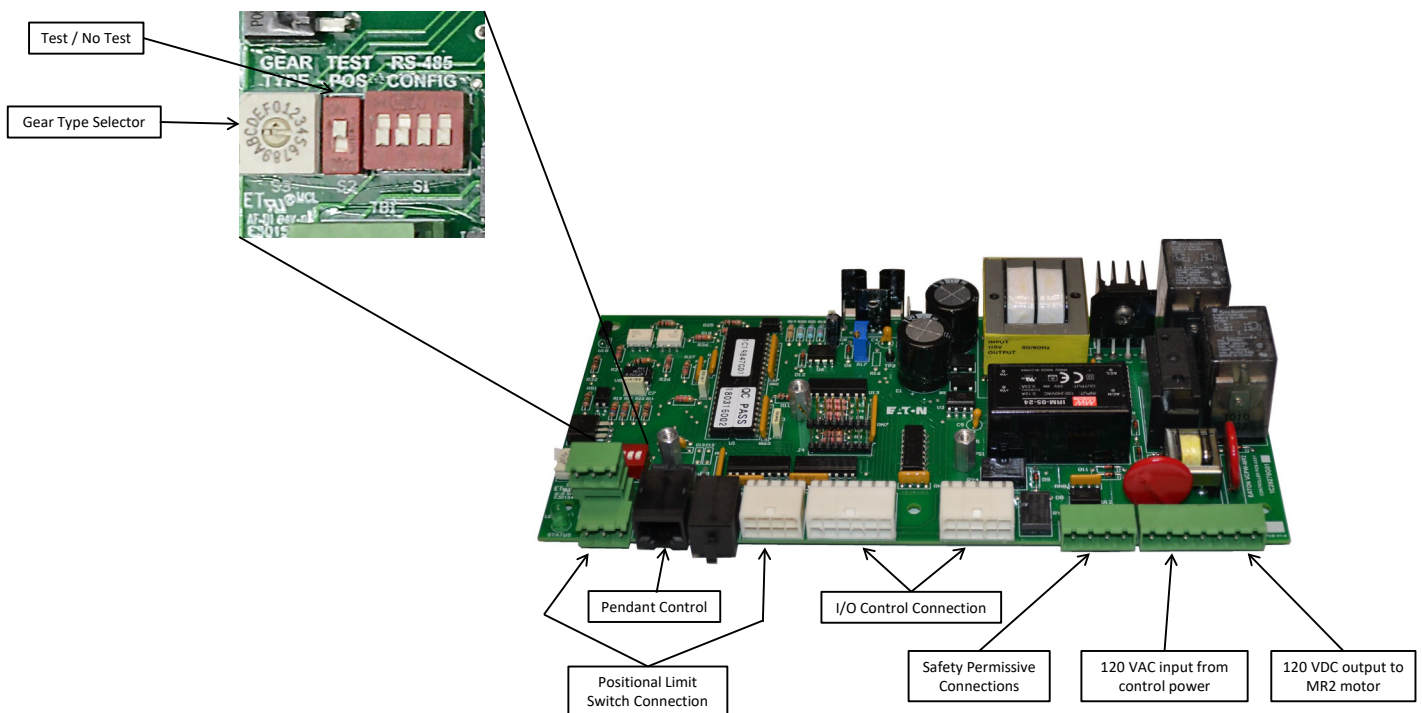


Figure 13. MR2 O/C controller.

There are three modes of operations available to communicate with the integrated racking controller:

1. Handheld pendant (see Figure 6 and 9);
2. Discrete I/O;
3. Modbus communication.

Option 1

The handheld pendant can operate the integral racking device from a distance of up to 30 ft. (9.14 m) from the equipment with a Cat 5 cable (typically there will be an RJ-45 jack located on the front panel of the switchgear - see Figure 14). The MV device can be racked to the connect, test(BPI pan only), or disconnect positions

by pressing the desired button on the pendant. MV device position and error codes are indicated on the pendant. **With the pendant plugged in, Discrete I/O and Modbus control are disabled.** This is a feature that does not allow someone to operate the system remotely while an operator is in close proximity of the switchgear.

CAUTION

THERE ARE NO SERVICEABLE PARTS INSIDE THE CASE OF THE PENDANT. ATTEMPTING A MODIFICATION OR REPAIR OTHER THAN THOSE EXPLAINED IN THIS SECTION COULD EXPOSE PERSONNEL TO SHOCK HAZARD FROM INTERNAL CAPACITORS. OPENING THE CASE OF THE PENDANT TO ATTEMPT A REPAIR WILL VOID THE WARRANTY.

Option 2

Discrete I/O control allows the user to operate the integral racking device via pushbuttons or PLC. These systems can be wired to a central control room or to a remote panel located a safe distance away from the switchgear equipment. If an error occurs while under I/O control, all I/O breaker position indication lights will flash. The pendant can then be plugged into the RJ-45 jack located on the front panel of the switchgear - (see Figure 14) to read the error code. Once the pendant is plugged in, I/O control is disabled until the pendant is unplugged.

MR2 5 VDC	20 mA
MR2 O/C 24 VDC	20 mA
include typical schematics	

Option 3

Modbus communication control allows the user to operate the integral racking device via a SCADA system or multiple Modbus interface communication systems. These systems can be wired to a central control room or to a remote panel located a safe distance away from the equipment. Error codes can be read with the Modbus communication system. Eaton can supply an installed Modbus system or the Modbus addresses to the customer for their personalized Modbus system and programming (for Modbus Interface details, refer to "1C19667 MODBUS interface .txt").



Figure 14. RJ-45 pendant jack.

Callout descriptions

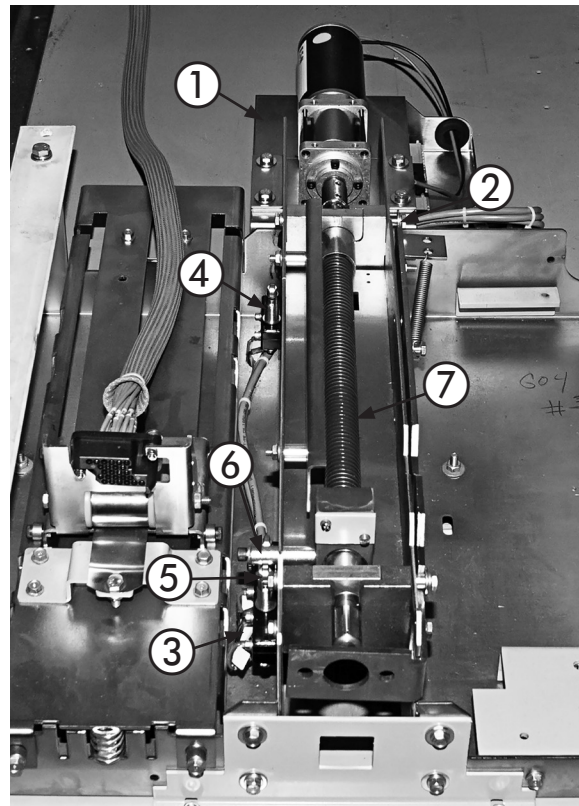


Figure 15. Typical MR2 – standard breaker pan assembly.

1. VC-W MR2 motor/controller assembly.
2. Manual crank safety permissive switch: disables the motor if an operator were to insert a manual tool to rack the circuit breaker.
3. "Disconnect" positional limit switch: activated when the circuit breaker is in the disconnected position.
4. "Connect" positional limit switch: activated when the circuit breaker is in the connected position.
5. "Test" positional limit switch: activated when the circuit breaker is in the "Test" position.
6. Limit switch actuator.
7. Lev-in lead screw.

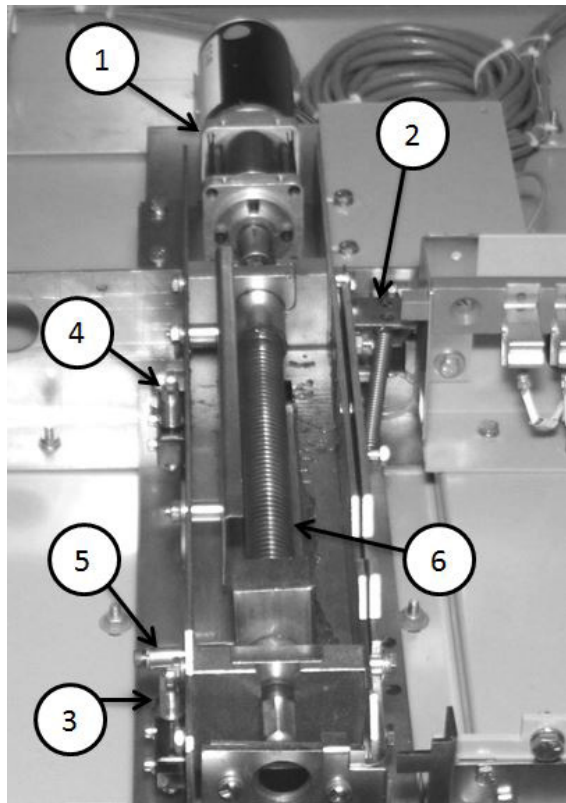


Figure 16. MR2 – arc auxiliary pan assembly.

1. VC-W MR2 motor/controller assembly.
2. Manual crank safety permissive switch: disables the motor if an operator were to insert a manual tool to rack the circuit breaker.
3. “Disconnect” limit switch: activated when the auxiliary drawer is in the disconnected position.
4. “Connect” limit switch: activated when the auxiliary drawer is in the connected position.
5. Limit switch actuator.
6. Lev-in lead screw.

Sequence of operations

Below is the basic sequence of operations to use the integrated racking system. The operation steps are the same for each of the control options (Pendant, I/O, and Modbus).

If the enable button is present (Figure 7 and Figure 8) the enable button must be held to operate the pendant.

For breaker pan assemblies WITHOUT test position

1. Insert the breaker into the breaker cell.
 - a. The breaker is now in the disconnect position.
 - b. The solid green disconnect LED will be illuminated.
2. The operator should then manually pull the secondary plug to apply control power to breaker.
 - a. At this time the breaker open and close operations can be tested electrically.
 - b. To proceed further and rack the breaker to the connected position, the breaker must be open.
 1. Arc gear – the compartment door must be closed and latched.
 2. Non-arc gear – it is recommended to close the door but not mandatory if door safety switch is not included.
3. Press the connect button.
4. The green disconnect LED will turn off and the intermediate LED will flash as the breaker is in motion.
5. Once the breaker reaches the connect position, the solid red connect LED will illuminate.
 - a. The breaker is now in the connect position and can be energized.
6. To rack the breaker out, the breaker must be open.
 - a. If the breaker is not open and the operator tries to press the disconnect button, the operator will receive an open permissive error “E5”.
 - b. The operator should then open the breaker.
 - c. After the breaker is open, the error can be cleared by pressing the disconnect button.
7. Once the error is cleared, the disconnect button can be pressed.
 - a. It is not necessary to hold the button down.
8. The red connect LED will turn off and the intermediate LED will flash as the breaker is in motion.
9. Once the breaker reaches the disconnect position, the solid green disconnect LED will illuminate.
10. At this time the secondary plugs will be disconnected and there will not be any power on the breaker.

For breaker pan assemblies WITH test position

1. Insert the breaker into the breaker cell.
 - a. The breaker is now in the disconnect position.
 - b. The solid green disconnect LED will be illuminated.
 - c. To proceed further and rack the breaker to the connected position, the breaker must be open.
 1. Arc gear – the compartment door must be closed and latched.
 2. Non-arc gear – it is recommended to close the door but not mandatory if door safety switch is not included.
2. Press the test button.
 - a. It is not necessary to hold the button down.
 - b. The breaker will then move to the test position.
3. The green disconnect LED will turn off and the yellow test LED will be illuminated.
 - a. The secondary plugs will mate and the breaker will now have control power.
 - b. At this time the breaker open and close operations can be electrically tested.
 - c. To proceed further and rack the breaker to the connected position, the breaker must be open.
 1. Arc gear – the compartment door must be closed and latched.
 2. Non-arc gear – it is recommended to close the door but not mandatory if door safety switch is not included.
4. Press the connect button.
5. The yellow test LED will turn off and the intermediate LED will flash as the breaker is in motion.
6. Once the breaker reaches the connect position, the solid red connect LED will illuminate.
 - a. The breaker is now in the connect position and can be energized.
7. To rack the breaker out, the breaker must be open.
 - a. If the breaker is not open and the operator tries to press the disconnect button, the operator will receive an open permissive error "E5".
 - b. The operator should then open the breaker.
 - c. After the breaker is open, the error can be cleared by pressing the disconnect button.
8. Once the error is cleared, the operator can rack the breaker to the test or disconnect position.
 - a. It is not necessary to hold the button down.
9. The red connect LED will turn off and the intermediate LED will flash as the breaker is in motion.
10. Once the breaker reaches the test or disconnect position, the solid yellow test LED or a solid green disconnect LED will illuminate.
 - a. If the breaker is in the test position, there is still control power on the breaker and the open and close operations can be electrically tested.
 - b. If the breaker is at the disconnect position, the secondary plugs will be disconnected and there will not be any power on the breaker.

For Auxiliary pan assemblies

1. Insert the auxiliary device into the auxiliary cell.
 - a. The auxiliary device is now in the disconnect position.
 - b. The solid green disconnect LED will be illuminated.
2. To proceed further and rack the auxiliary to the connected position.
 - a. Arc gear – the compartment door must be closed and latched.
 - b. Non-arc gear – it is recommended to close the door but not mandatory unless the door safety switch is included.
3. Press and the connect button.
4. The green disconnect LED will turn off and the intermediate LED will flash as the auxiliary device is in motion.
5. Once the auxiliary device reaches the connect position, the solid red connect LED will illuminate.
 - a. The auxiliary device is now in the connect position.
6. Press the disconnect button.
 - a. It is not necessary to hold the button down.
 - b. If the "Test" button is pressed an "E9" error will be displayed (auxiliaries do not have a test position). Press the disconnect button to clear the error.
7. The red connect LED will turn off and the intermediate LED will flash as the auxiliary is in motion.
8. Once the auxiliary reaches the disconnect position, the solid green disconnect LED will illuminate.

Notes:

Instructional Booklet IB022010EN

Effective July 2019

Revision #4

Instructions for installation, operation,
and maintenance of medium voltage
VC-W MR2 (integral racking)

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