Contents

Metal-Enclosed Switchgear MEB & MSB Medium-Voltage Vacuum Breakers

Drawout-Mounted Breaker (MEB)
- General Description and Seismic Compliance .................................................. 7.1-1
- Construction ...................................................................................................... 7.1-2
- Technical Data ................................................................................................. 7.1-3
- Overcurrent Protection ..................................................................................... 7.1-2
- Assembly Ratings ............................................................................................ 7.1-3
- Breaker Control Ratings .................................................................................. 7.1-3
- Layout Dimensions ........................................................................................... 7.1-4

Switch- and Fixed-Mounted Vacuum Breaker (MSB)
- General Description .......................................................................................... 7.2-1
- Seismic Qualification ......................................................................................... 7.2-2
- Construction ...................................................................................................... 7.2-3
- Technical Data ................................................................................................... 7.2-3
- Overcurrent Protection ..................................................................................... 7.2-4
- Assembly Ratings ............................................................................................ 7.2-4
- Circuit Breaker Ratings .................................................................................... 7.2-5
- Breaker Control Ratings .................................................................................. 7.2-5
- Layout Dimensions ........................................................................................... 7.2-6

Vacuum Breakers
- Application Examples ....................................................................................... 7.3-1
- Low Resistance Ground Schemes .................................................................... 7.3-1
- Single-Ended Substation Designs ..................................................................... 7.3-1
- Optional Accessories (MEB and MSB) ............................................................... 7.3-2
- Surge Arresters ................................................................................................. 7.3-2
- MEB and MSB Switchgear with Automatic Transfer Control ....................... 7.3-3
- Partial Discharge Sensing and Monitoring for Switchgear ............................ 7.3-4

Specifications


CSI Format: ................................. 1995 ................................. 2010

MEB ........................................ Section 16347A ................................. Section 26 13 19.11
MSB ........................................ Section 16347B ................................. Section 26 13 19.16

Metal-Enclosed Switchgear
**MEB Metal-Enclosed Drawout Breaker**

**General Description**

Eaton’s MEB (metal-enclosed breaker) switchgear assembly consists of a single-high drawout vacuum circuit breaker (Type VCP-W) in a metal-enclosed cabinet. This equipment has been designed primarily where metal-clad switchgear is not required and a switch or switch and fuse combination are not suitable. As primary protection for single-ended substations, it can eliminate the need for a secondary main circuit breaker. It can also be applied as the primary main device and integrated with fused or unfused feeder switches in an Eaton Type MVS load interrupter switchgear assembly. Two and three breaker automatic transfer schemes are also available. For drawout vacuum circuit breaker metal-clad switchgear, Eaton Type VacClad-W, see Tab 5.

For drawout vacuum circuit breaker metal-enclosed front access only, Type MEF switchgear, see Tab 6.

A Type MEB switchgear assembly is classified as an overcurrent protective device that provides increased system protection and increased coordination with upstream and downstream devices where these benefits cannot be achieved with a switch and fuse combination. Vacuum circuit breakers provide the following features:

- High interrupting capacity suitable for use with ground fault equipment and differential relay schemes
- High duty cycle
- Adjustable overcurrent protection
- Expanded protective relay functions, such as those provided in the EDR-5000 (refer to Tab 4)
- Three-phase tripping; no single phasing on tripping
- Maintainable
- Long equipment life
- Special applications, such as capacitor switching, are possible with breakers

Type MEB switchgear provides a minimal footprint using vacuum breaker technology. All protective devices and metering are conveniently mounted on the switchgear structure door.

Type VCP-W vacuum circuit breakers have been designed with a V-Flex™ current transfer system that provides a unique non-sliding current transfer arrangement, no maintenance, excellent electrical and thermal transfer, and long vacuum interrupter life.

Both indoor and outdoor non-walk-in enclosures are available. Uses are single or multiple circuits, transformer primaries and mains for MVS applications. Configurations with an automatic transfer control system can be easily accommodated. Drawout vacuum breakers are ideal for high duty cycle, as well as applications requiring rapid return to service after a load fault.

Type MEB switchgear is one product of choice for ground fault interruption when air interrupters alone would be potentially hazardous if called on to operate above their assigned interrupting ratings. Capacitor switching is easily handled by MEB, avoiding the restrike hazard presented by air switches.

Standardized designs cover most common applications, while custom designs are also available for unusual requirements.

Type MEB vacuum switchgear meets or exceeds the following industry standards: ANSI/IEEE® C37.20.3, ANSI/IEEE C37.20.4, ANSI C37.22, ANSI C37.57, ANSI C37.58, NEMA® SG5, NEMA SG6, CSA® 22.2 No. 31-04, EEMAC G8-3.3. It is also CSA listable for Canada and U.S. markets.

MEB circuit breaker sections are easily mixed with MVS fused switch sections in lineups. No bus transitions are required between them except where bus runs from top to bottom locations, such as between main and feeder sections.

**Seismic Qualification**

Refer to Tab 1 for information on seismic qualification for this and other Eaton products.
Construction
Current and voltage transformers associated with protection devices such as the EDR-3000 or EDR-5000 electronic overcurrent relays are applied using the same ratings as drawout metal-clad switchgear. Metering and protective relay devices are mounted on the single front hinged door. The front door may be opened at any time to provide access to low-voltage components and to the front of the circuit breaker without being exposed to high voltage.

The IQ family of electronic meters is normally used when metering functions are required.

The circuit breaker is racked into or out of position, but can easily be drawn out and removed from the enclosure with grounded steel shutters, preventing accidental contact with primary voltage connections. Routine maintenance can be performed on the circuit breaker mechanism in the enclosure.

If ac control power is used, a capacitor trip device is provided as standard. A Digitrip™ 3010 relay with dual source power supply may be used for overcurrent protection, thus eliminating the need for an uninterruptible power source for continuous fault current protection.

Once the circuit breaker is closed and the closing spring is recharged, the breaker can open, close and open without spring recharge.

The IQ family of electronic meters is normally used when metering functions are required.

The circuit breaker is racked into or out of position, but can easily be drawn out and removed from the enclosure with grounded steel shutters, preventing accidental contact with primary voltage connections. Routine maintenance can be performed on the circuit breaker mechanism in the enclosure.

Overcurrent Protection
Eaton’s MEB breaker can be furnished with an Eaton Type EDR-3000 or EDR-5000 relay to provide overcurrent and fault protection. Optional zero sequence 50/51G ground fault protection is shown below. Refer to Tab 4 for more details.

Table 7.1-1. Protective Relays

<table>
<thead>
<tr>
<th>Relay Type</th>
<th>Protective Relay IEEE Functions</th>
<th>Metering</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDR-3000</td>
<td>50/51; 50/51G</td>
<td>Amperes and ampere demand</td>
</tr>
<tr>
<td>EDR-5000</td>
<td>25, 27, 32, 46, 47, 50N/G, 51N/G, 50N/51N, 51N, 59, 67N, 67</td>
<td>Amps; volts; pf, energy, power; THD; waveform</td>
</tr>
</tbody>
</table>

See Tab 4 for available relays, selection and application details.

Figure 7.1-1. Typical MEB Single-Section One-Line Diagram

Use of EDR-5000 requires VTs.
The switchgear assembly is designed for use with Type VCP-W, VCP-WC and VCP-WG circuit breakers. However, please note that certain VCP-WC circuit breakers may have higher capabilities than required by ANSI standards. In such cases, switchgear assembly ratings as given in this table will apply.

### Assembly Ratings

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Rated Maximum Voltage</th>
<th>Rated Voltage Range Factor</th>
<th>Rated Continuous Current</th>
<th>Rated Short-Circuit Current at Rated Maximum Voltage</th>
<th>Maximum Symmetrical Interrupting Capability</th>
<th>Closing and Latching Capability (Momentary)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V</td>
<td>K</td>
<td>I</td>
<td>K * I</td>
<td>kA rms Symmetrical</td>
<td>kA Peak</td>
</tr>
<tr>
<td></td>
<td>kV rms</td>
<td>kA rms Symmetrical</td>
<td>Amperes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 VCP-W 250</td>
<td>4.76</td>
<td>1.24</td>
<td>1200</td>
<td>1200</td>
<td>36</td>
<td>97</td>
</tr>
<tr>
<td>50 VCP-W 350</td>
<td>4.76</td>
<td>1.19</td>
<td>1200</td>
<td>1200</td>
<td>41</td>
<td>132</td>
</tr>
<tr>
<td>50 VCP-W 500</td>
<td>4.76</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>63</td>
<td>170</td>
</tr>
<tr>
<td>75 VCP-W 500</td>
<td>8.25</td>
<td>1.25</td>
<td>1200</td>
<td>1200</td>
<td>33</td>
<td>111</td>
</tr>
<tr>
<td>150 VCP-W 500</td>
<td>15</td>
<td>1.3</td>
<td>1200</td>
<td>1200</td>
<td>18</td>
<td>62</td>
</tr>
<tr>
<td>150 VCP-W 750</td>
<td>15</td>
<td>1.3</td>
<td>1200</td>
<td>1200</td>
<td>28</td>
<td>36</td>
</tr>
<tr>
<td>150 VCP-W 1000</td>
<td>15</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>37</td>
<td>48</td>
</tr>
<tr>
<td>150 VCP-W 1500</td>
<td>15</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>50 VCP-W 25</td>
<td>4.76</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>25</td>
<td>65</td>
</tr>
<tr>
<td>50 VCP-W 40</td>
<td>4.76</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>40</td>
<td>104</td>
</tr>
<tr>
<td>50 VCP-W 50</td>
<td>4.76</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>50</td>
<td>130</td>
</tr>
<tr>
<td>50 VCP-W 63</td>
<td>4.76</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>63</td>
<td>164</td>
</tr>
<tr>
<td>75 VCP-W 50</td>
<td>8.25</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>50</td>
<td>130</td>
</tr>
<tr>
<td>150 VCP-W 25</td>
<td>15</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>25</td>
<td>65</td>
</tr>
<tr>
<td>150 VCP-W 40</td>
<td>15</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>40</td>
<td>104</td>
</tr>
<tr>
<td>150 VCP-W 50</td>
<td>15</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>50</td>
<td>130</td>
</tr>
<tr>
<td>150 VCP-W 63</td>
<td>15</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>63</td>
<td>164</td>
</tr>
<tr>
<td>50 VCP-WG 50</td>
<td>4.76</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>50</td>
<td>130</td>
</tr>
<tr>
<td>50 VCP-WG 63</td>
<td>4.76</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>63</td>
<td>164</td>
</tr>
<tr>
<td>150 VCP-WG 50</td>
<td>15</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>50</td>
<td>137</td>
</tr>
<tr>
<td>150 VCP-WG 63</td>
<td>15</td>
<td>1.0</td>
<td>1200</td>
<td>1200</td>
<td>63</td>
<td>164</td>
</tr>
</tbody>
</table>

For detailed ratings of Type VCP-W circuit breakers, refer to Table 5.4-1A. For detailed ratings of Type VCP-WC circuit breakers, refer to Table 5.4-2. For detailed ratings of Type VCP-WG circuit breakers, refer to Table 5.4-3 and 5.4-4. Please note certain Eaton breakers may have higher capabilities than required by ANSI standards. When these breakers are applied in an MEB switchgear assembly, the assembly ratings as given in Table 7.1-2 will apply. Close and latch capability shown is 2.7*K*1 for circuit breakers rated on the basis of K=1, and 2.8*K*1 for those rated on the basis of K = 1.

### Breaker Control Ratings

<table>
<thead>
<tr>
<th>Rated Control Voltage</th>
<th>Spring Charge Motor Inrush Amperes</th>
<th>Run Amperes</th>
<th>Time Seconds</th>
<th>Close or Trip Amperes</th>
<th>Voltage Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 Vdc</td>
<td>36.0</td>
<td>9.0</td>
<td>6</td>
<td>6</td>
<td>38–56</td>
</tr>
<tr>
<td>125 Vdc</td>
<td>16.0</td>
<td>9.0</td>
<td>6</td>
<td>6</td>
<td>100–140</td>
</tr>
<tr>
<td>250 Vdc</td>
<td>9.2</td>
<td>2.0</td>
<td>6</td>
<td>6</td>
<td>200–280</td>
</tr>
<tr>
<td>120 Vac</td>
<td>16.0</td>
<td>9.0</td>
<td>6</td>
<td>6</td>
<td>104–127</td>
</tr>
<tr>
<td>240 Vac</td>
<td>9.2</td>
<td>2.0</td>
<td>6</td>
<td>6</td>
<td>208–254</td>
</tr>
</tbody>
</table>
Typical Arrangements—5 kV and 15 kV

The sketches in this section represent the most common arrangements. Layouts shown are for rear-accessible equipment. Front-accessible designs are available—refer to Eaton. See Tab 8 for detailed layout information on load interrupter switchgear. Many other configurations and combinations are available. Two voltage transformers (fixed or drawout) for metering or one control transformer for ac breaker control can be mounted in the structures shown. For control power above 1 kVA, additional space is required. Depth of units will vary due to cable entrance and exit requirements, the addition of lightning arrester, instrument transformers, special cable terminators, and so on. Cables are shown out top and bottom for layout only. Top or bottom must be selected for incoming and for outgoing cables. Please note that rear access is required for installation.

Cable sizing is based on two 500 kcmil XLP or EPR insulated cables per phase using preformed slip-on cable termination devices. For unit substation alignment details, see Tabs 13 and 14.

Figure 7.1-2. Layouts and Dimensions in Inches (mm)

Note: PR—Overcurrent protective relay, typical functions—50/51, 50/51N or 50/51G. Eaton EDR-3000 or EDR-5000.
Note: ATC—Automatic Transfer Controller.

Dimensions in inches (mm). Not to be used for construction purposes unless approved.
Figure 7.1-3. 5 and 15 kV MEB with Main Bus, Main Breaker and Fixed Line or Bus VTs

Depth shown is based on the use of (2)-500 kcmil cables per phase. For stand-alone cable in and cable out in the same section, minimum 80.00-inch (2032.0 mm) depth is required.

Note: Drawout VTs are not available in MEB switchgear. Use Type VCP-W or MEF designs.

Table 7.1-5. Approximate Weights in Lb (kg)

<table>
<thead>
<tr>
<th>5 or 15 kV Class</th>
<th>Indoor</th>
<th>Outdoor</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEB section</td>
<td>1600 (726)</td>
<td>1900 (863)</td>
</tr>
<tr>
<td>MVS section (non-fused)</td>
<td>1500 (681)</td>
<td>1800 (817)</td>
</tr>
<tr>
<td>Fuses (three) add</td>
<td>200 (91)</td>
<td>200 (91)</td>
</tr>
<tr>
<td>Transition section</td>
<td>300 (136)</td>
<td>—</td>
</tr>
</tbody>
</table>

Figure 7.1-4. 5 and 15 kV Roof Layouts and Floor Layouts

For cable in and cable out in same section, 80.00-inch (2032.0 mm) depth is required.

Note: A = Power cable to load, B = Power cable from source.
Figure 7.1-5. Typical Anchor Plan for MEB, Indoor or Outdoor

1. Locations for tie-down 0.65 (16.5 mm) diameter holes. Four places. Customer provided bolts for anchoring should be 0.50–13 min. SAE Grade 5, (M12 x 1.75 min. CL 10.9), and tightened to 75 ft-lb (101.7 Nm).

2. Door swing equals unit width at 90°.

3. The standard minimum clearances on side. The authority having jurisdiction may require a larger distance.

4. Clearance required for additional door swing to insert or remove breaker, and for metering/relays on front of door. Left hand side only. The authority having jurisdiction may require a larger distance.

5. Minimum distance in front is 72.00 inches (1828.8 mm) for breaker insertion and removal. The authority having jurisdiction may require a larger distance.

6. The standard minimum recommended distance is 30.00 inches (762.0 mm) for assemblies requiring rear access for installation and maintenance. The authority having jurisdiction may require a larger distance.

7. If optional rear door is supplied, the minimum is the width of the widest vertical section plus 1.00 inch (25.4 mm). The authority having jurisdiction may require a larger distance.

8. Finished foundation's surface shall be level within 0.06-inch (1.5 mm) in 36.00 inches (914.4 mm) left-to-right, front-to-back and diagonally, as measured by a laser level.
MSB Metal-Enclosed Switch and Vacuum Breaker

General Description
Eaton's assembly designated MSB (metal-enclosed switch and breaker) consists of a load interrupter switch (Type MVS) in series with a vacuum circuit breaker (Type VCP-TR for 5–15 kV) in a metal-enclosed cabinet. This combination has been designed primarily where a vacuum circuit breaker is required for its higher interrupting capacity and a switch is required to provide a visible means of disconnect. As primary protection for single-ended substations, it can eliminate the need for a secondary main circuit breaker. It can also be applied as the primary main device and integrated with fused or unfused feeder switches in a lineup of MVS switchgear. Two and three breaker automatic transfer schemes are also available.

For drawout vacuum circuit breaker metal-enclosed switchgear, Type MEB, see Page 7.1-1.

For drawout vacuum circuit breaker metal-clad switchgear, Type VacClad-W, see Tab 5.

For drawout vacuum circuit breaker metal-enclosed front access only, Type MEF switchgear, see Tab 6.

With the vacuum circuit breaker, Type MSB switchgear is classified as an overcurrent protective device that provides increased system protection and increased coordination with upstream and downstream devices where these benefits cannot be achieved with a switch and fuse combination. Vacuum circuit breakers provide the following features:

- High interrupting capacity suitable for use with ground fault equipment and differential relay schemes
- Load Break Switch providing visible means of disconnect without opening the door
- High duty cycle
- Adjustable overcurrent protection
- Expanded protective relay functions, such as those provided in the EDR-5000 (refer to Tab 4)
- Three-phase tripping; no single phasing on tripping
- Maintainable
- Long equipment life
- Special applications, such as capacitor switching, are possible with breakers

Eaton Type MSB switchgear provides a small footprint using vacuum breaker technology where the breaker rating does not exceed 1200A continuous and the interrupting ratings shown. All protective devices and metering are conveniently mounted on the switchgear structure door.

The VCP-TR vacuum breaker is a fully rated two-step stored energy circuit breaker with an “open-close-open” duty cycle. It is rated for 25 or 40 kA interrupting ratings at alls from 4.76 to 15 kV and has a front access mechanism. Type VCP-TR circuit breakers can be supplied with integral trip unit for phase and ground overcurrent protection.

The vacuum circuit breakers have been designed with a flex current transfer system that provides a unique non-sliding current transfer arrangement, no maintenance, excellent electrical and thermal transfer, and long vacuum interrupter life.

Visible disconnect means is ensured by the load break air interrupter switch and viewing window. Both indoor and outdoor non-walk-in enclosures are available. Applications are single units, lineups and transformer primary applications. Configurations with an automatic transfer control system can be easily accommodated. Fixed vacuum breakers are ideal for high duty cycle, as well as applications requiring rapid return to service after a load fault.

Type MSB switchgear is the product of choice for ground fault interruption when air interrupters alone would be potentially hazardous if called on to operate above their assigned ratings. Capacitor switching is easily handled by MSB avoiding the restrike hazard presented by air switches.

Standardized designs cover most common applications while custom designs are also available for unusual requirements.

Type MSB vacuum switchgear meets or exceeds the following industry standards:
- ANSI/IEEE C37.20.3
- ANSI/IEEE C37.20.4
- ANSI C37.22
- ANSI C37.57
- ANSI C37.58
- NEMA SG5
- NEMA SG6
- CSA 22.2 No. 31
- EEMAC G8-3.3
- CSA listable for Canada and U.S. markets

Refer to MVS Tab 8. MVS switch sections are easily mixed with MSB sections in lineups. No bus transitions are required between them except where bus runs from top to bottom locations, such as between main and feeder sections.
Seismic Qualification

Refer to Tab 1 for information on seismic qualification for this and other Eaton products.
Construction

Eaton’s Type MSB switchgear uses the same proven enclosure and air switch mechanism as MVS switchgear. It differs in the addition of the fixed-mounted Eaton VCP-TR (5–15 kV) vacuum breaker in place of fuses. Current and transformers associated with protection devices such as the EDR-3000 or EDR-5000 electronic protective relays are applied using the same ratings as drawout metal-clad switchgear. Integral overcurrent protective devices with the Arcflash Reduction Maintenance System™ mode switch, such as DT 520MCV and DT-1150V, are also available. Devices are mounted on the single front-hinged door. The front door may be opened at any time to provide access to low-voltage components and the front of the circuit breaker without being exposed to high.

Eaton’s IQ family of electronic meters is normally used when metering functions are required.

The circuit breaker is bolted into position, but can be unbolted and removed from the enclosure. Routine maintenance can be performed on the circuit breaker mechanism in the enclosure.

Standard switch insulators are NEMA rated glass polyester or optional epoxy. Control power will be required as detailed below. The ac can be supplied integrally if specified. The dc control power, if required, must be furnished by others.

If ac control power is used, a capacitor trip device is provided.

Once the circuit breaker is closed and the closing spring is recharged, the breaker can open, close and open without spring recharge.
Overcurrent Protection

Eaton’s MSB breaker can be furnished with an Eaton Type EDR-3000 or EDR-5000 relay to provide overcurrent and fault protection. Optional zero sequence 50/51G ground fault protection is shown below. Refer to Tab 4 for more details.

Figure 7.2-1. Typical MSB Single-Section One-Line Diagram

3 Use of EDR-5000 requires VTs.

Figure 7.2-2. Typical MSB One-Line Diagram with DT 520MCV

Assembly Ratings

Table 7.2-3. MSB Switchgear Assembly Ratings

Table 7.2-1. Integral Protective Relays

<table>
<thead>
<tr>
<th>Relay Type</th>
<th>Protective Relay IEEE Functions</th>
<th>Metering</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT 520MCV</td>
<td>50, 50T, 51, 50G, 51G</td>
<td>Amperes</td>
</tr>
<tr>
<td>DT-1150V</td>
<td>50, 50T, 51, 51G, 50G, 37, 46,</td>
<td>Amperes, VA, VAR, Watt, Wh, VAh, THD</td>
</tr>
<tr>
<td></td>
<td>27, 59, 32, 47, 74, 81U, 81-0</td>
<td></td>
</tr>
</tbody>
</table>

See Tab 6, Pages 6.0-10, 6.0-11 and 6.0-12 for details.

Table 7.2-2. Protective Relays

<table>
<thead>
<tr>
<th>Relay Type</th>
<th>Protective Relay IEEE Functions</th>
<th>Metering</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDR-3000</td>
<td>50/51</td>
<td>Ampere and ampered demand</td>
</tr>
<tr>
<td>EDR-5000</td>
<td>25, 27, 32, 46, 47, 50N/G, 51N/G, 50/51, 50BF, 51VR, 59, 67N, 67</td>
<td>Amps; volts; pf, energy, power; THD; waveform</td>
</tr>
</tbody>
</table>

See Tab 4 available relays selection and application details.

Figure 7.2-3. Typical MSB One-Line Diagram with DT-1150V

Figure 7.2-4. Transformer Primary Breaker with Secondary Bus Overcurrent Protection

Surge protection device, such as RC snubber, EH2 or Protec Z is highly recommended for transformer protection. Refer to Tab 5, Page 5.4-17 to Page 5.4-20 for Eaton’s recommendations for surge protection.
## Metal-Enclosed Switchgear—MEB & MSB Medium-Voltage Switch and Fixed Mounted Vacuum Breakers (MSB)

### Technical Data

#### Circuit Breaker Ratings

Type MSB assemblies can be supplied with Type VCP-TR (stored energy operator) or with Type VCP-TRL (electromagnetic linear actuator operator) circuit breakers. Refer to Table 7.2-5 for additional capacitor switching capability of the VCP-TR and VCP-TRL circuit breakers.

**Table 7.2-4. Available Type VCP-TR and VCP-TRL Vacuum Circuit Breakers Rated per ANSI Standards (C37.04, C37.06, C37.09)**

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Rated Maximum Voltage</th>
<th>Power Frequency Withstand Voltage 60 Hz, 1 Minute</th>
<th>Insulation Level</th>
<th>Rated Continuous Current</th>
<th>Rated Short-Circuit at Rated Maximum Voltage</th>
<th>Rated Voltage Range Factor</th>
<th>Maximum Symmetrical Interrupting &amp; 2-Second Short-Time Current Carrying Capability</th>
<th>Closing and Latching Capability (Momentary)</th>
<th>Cable Charging Breaking Current</th>
<th>Three-Phase MVA at Rated Maximum Voltage (for Reference Only)</th>
<th>Mechanical Endurance No Load C-O Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>i</td>
<td>k</td>
<td>I k</td>
<td>v</td>
<td>I k</td>
<td>v</td>
<td>k</td>
<td>v</td>
<td>v</td>
<td>v</td>
<td>v</td>
</tr>
<tr>
<td>kV rms</td>
<td>kV Peak</td>
<td>kV Peak</td>
<td>Amperes</td>
<td>kA rms sym</td>
<td>kA rms sym</td>
<td>kA Crest</td>
<td>Amperes</td>
<td>MVA</td>
<td>MVA</td>
<td>MVA</td>
<td>MVA</td>
</tr>
<tr>
<td>50 VCP-TR 25</td>
<td>4.76</td>
<td>6.6</td>
<td>60</td>
<td>600, 1200</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>50 VCP-TR 26</td>
<td>4.76</td>
<td>6.6</td>
<td>60</td>
<td>600, 1200</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>50 VCP-TR 40</td>
<td>4.76</td>
<td>6.6</td>
<td>60</td>
<td>600, 1200</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>150 VCP-TR 26</td>
<td>15</td>
<td>9.5</td>
<td>95</td>
<td>600, 1200</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>150 VCP-TR 40</td>
<td>15</td>
<td>9.5</td>
<td>95</td>
<td>600, 1200</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
</tbody>
</table>

1. Rated interrupting time for all VCP-T circuit breakers is 3 cycle (50 ms).
2. Operating duty for all VCP-T circuit breakers is O-0.3sec-CO-3min-CO.

#### Breaker Control Ratings

**Table 7.2-5. Capacitor Switching Capability of Type VCP-TR and VCP-TRL Circuit Breakers**

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Rated Continuous Current</th>
<th>Cable Charging Current</th>
<th>Isolated Shunt Capacitor Bank Current</th>
<th>Back to Back Capacitor Switching</th>
<th>Inrush Current</th>
<th>Inrush Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>kA peak</td>
<td>kHz</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 VCP-TR 25</td>
<td>600, 1200</td>
<td>10</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>50 VCP-TR 26</td>
<td>600, 1200</td>
<td>10</td>
<td>250 and 630</td>
<td>250 and 630</td>
<td>15</td>
<td>1.5</td>
</tr>
<tr>
<td>50 VCP-TR 40</td>
<td>600, 1200</td>
<td>10</td>
<td>75–400</td>
<td>75–400</td>
<td>18</td>
<td>2.4</td>
</tr>
<tr>
<td>150 VCP-TR 25</td>
<td>600, 1200</td>
<td>25</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>150 VCP-TR 26</td>
<td>600, 1200</td>
<td>25</td>
<td>250 and 630</td>
<td>250 and 630</td>
<td>15</td>
<td>1.5</td>
</tr>
<tr>
<td>150 VCP-TR 40</td>
<td>600, 1200</td>
<td>25</td>
<td>75–400</td>
<td>75–400</td>
<td>18</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Note: Type VCP-TRL 25 and VCP-TRL 40 circuit breakers shown in this table are considered definite-purpose breakers per ANSI C37.04.

#### Breaker Control Ratings

**Table 7.2-6. Breaker Stored Energy Mechanism Control Power Requirements**

<table>
<thead>
<tr>
<th>Rated Control Voltage</th>
<th>Spring Charge Motor</th>
<th>Close or Trip</th>
<th>Voltage Range</th>
<th>Close</th>
<th>Trip</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Run</td>
<td>Time</td>
<td>Amperes</td>
<td>Seconds</td>
<td></td>
</tr>
<tr>
<td>48 Vdc</td>
<td>4.0</td>
<td>5</td>
<td>5.2</td>
<td>1.8</td>
<td>28–56</td>
</tr>
<tr>
<td>125 Vdc</td>
<td>3.0</td>
<td>5</td>
<td>3.6</td>
<td>1.8</td>
<td>100–140</td>
</tr>
<tr>
<td>250 Vdc</td>
<td>2.0</td>
<td>5</td>
<td>3.6</td>
<td>1.8</td>
<td>200–280</td>
</tr>
<tr>
<td>120 Vac</td>
<td>3.0</td>
<td>5</td>
<td>3.6</td>
<td>1.8</td>
<td>104–127</td>
</tr>
<tr>
<td>240 Vac</td>
<td>2.0</td>
<td>5</td>
<td>3.6</td>
<td>1.8</td>
<td>208–254</td>
</tr>
</tbody>
</table>

* Inrush current is 4 times running amperes.
Typical Arrangements—5 kV and 15 kV

The sketches in this section represent the most common switch arrangements. Many other configurations and combinations are available. Layouts shown are for rear-accessible equipment. Front-accessible designs are available—refer to Eaton.

Depth of units will vary due to cable entrance and exit requirements, the addition of lightning arresters, instrument transformers, special cable terminators, and so on. Cables are shown out top and bottom for layout only. Top or bottom must be selected for incoming and for outgoing cables. Cable sizing is based on two 500 kcmil XLP or EPR insulated cables per phase using preformed slip-on cable termination devices. Rear access is required for installation. For unit substation alignment details, see Tabs 13 and 14.

Figure 7.2-5. Layouts and Dimensions in Inches (mm)

Arrangement 1
Single Unit, Cable In and Out

Arrangement 2
Primary for Dry-Type Transformer

Arrangement 3
Primary for Liquid Filled Transformer

Arrangement 5
Main Device with Feeders; Metering Section (Optional) ①

Arrangement 6
Main Lugs with Feeders; Metering Section (Optional) ①

Arrangement 7
Two Breaker Auto Transfer—Single Load

Arrangement 8
Three Breaker Auto Transfer—Main-Tie-Main with Feeders

Note:
- PR—Overcurrent protective relay, typical functions—50/51, 50/51N or 50/51G. Eaton’s EDR-3000 or EDR-5000.

Dimensions in inches (mm). Not to be used for construction purposes unless approved.
Figure 7.2-6. 5, 15 kV MSB with Main Bus

- Minimum depth 70.00 inches (1778.0 mm) if two sets of CTs are required.

Figure 7.2-7. 5, 15 kV MSB without Main Bus

- Minimum depth 80.00 inches (2032.0 mm) if two sets of CTs are required.

Figure 7.2-8. 5 kV and 15 kV Roof Layouts and Floor Layouts

- Cable location B not available with main bus.

Note: A = Power cable to load, B = Power cable from source.

Note: For D dimension, refer to Page 7.1-4.

Dimensions in inches (mm).

Not to be used for construction purposes unless approved.
Figure 7.2-9. Typical Anchor Plan for MSB, Indoor or Outdoor

Table 7.2-7. Approximate Weights in Lb (kg)

<table>
<thead>
<tr>
<th>5 or 15 kV Class</th>
<th>Indoor</th>
<th>Outdoor</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSB section</td>
<td>1700 (773)</td>
<td>2000 (909)</td>
</tr>
<tr>
<td>MVS section (non-fused)</td>
<td>1500 (681)</td>
<td>1800 (817)</td>
</tr>
<tr>
<td>Fuses (three) add</td>
<td>200 (91)</td>
<td>200 (91)</td>
</tr>
<tr>
<td>Transition section</td>
<td>300 (136)</td>
<td>—</td>
</tr>
</tbody>
</table>

1. Locations for tie-down 0.65 inches (16.5 mm) diameter holes for four places. Customer provided bolts for anchoring should be 0.50–13 min. (M12 x 1.75 min. CL 10.9) and tightened to 75 ft-lb (101.7 Nm).
2. Door swing equals unit width at 90°.
3. The standard minimum clearances on side. The authority having jurisdiction may require a larger distance.
4. Minimum clearance in front is the width of the widest vertical section plus 1.00 inch (25.4 mm). The authority having jurisdiction may require a larger distance.
5. The standard minimum recommended distance is 30.00 inches (762.0 mm) for assemblies requiring rear access for installation and maintenance. The authority having jurisdiction may require a larger distance.
6. For MVS only. If the application is specifically provided by contract as not requiring rear access as stated in 5, then the minimum recommended distance is 6.00 inches (152.4 mm).
7. If optional rear door is supplied, the minimum is the width of the widest vertical section plus 1.00 inch (25.4 mm). The authority having jurisdiction may require a larger distance.
8. Finished foundation’s surface shall be level within 0.06-inch (1.5 mm) in 36.00 inches (914.4 mm) left-to-right, front-to-back and diagonally, as measured by a laser level.

Dimensions in inches (mm).
Not to be used for construction purposes unless approved.
Application Examples

Low Resistance Ground Schemes

Medium-voltage low-resistance ground schemes are typically used for medium 5 kV class systems feeding 5 kV class motor loads. The resistor affords both full selectivity in tripping on ground faults, while limiting ground fault magnitudes to low values (typically 50–400 A). Reducing the current levels to a faulted motor greatly reduces the damage to the motor and subsequent rewind and repair costs.

System tripping during a ground fault on the line side of the secondary main breaker must be cleared by sending a trip signal to the transformer primary side protective device. Fusible switches on the primary side of the step-down transformer (typically rated 5–15 kV) may not be used for this purpose. Any ground fault sensed may escalate as the switch is being signaled to trip thereby exceeding its typical 600 A maximum current breaking capacity.

Eaton’s MEB and MSB breaker, being a fully rated interrupting device, may be tripped regardless of fault level up to its interrupting rating (for example, 28 kA). Only this type of overcurrent device or a metal-clad switchgear drawout breaker may be safely used.

Single-Ended Substation Designs

In this configuration, the MEB or MSB serves as both primary and secondary protection for the transformer. Savings in both floor space and cost result, due to elimination of the secondary main device. This scheme is only recommended where cost and space prevent the use of secondary main device.

Note: Two sets of current transformers are used to protect against secondary ground faults, overloads and short circuits, as well as primary winding faults.

Figure 7.3-1. Low Resistance Ground Scheme (Phase and Primary Ground Fault Protection not Shown)

Figure 7.3-2. Single-Ended Unit Substations Using Primary Breaker Protection (MEB)

Figure 7.3-3. Single-Ended Unit Substations Using Primary Breaker Protection (MSB)
Surge Arresters

IEEE Standard C62.11 for metal-oxide surge arresters lists the maximum rated ambient temperature as 40 °C. The ambient temperature inside an MEB and MSB switchgear vertical section may exceed this temperature, especially in outdoor applications where solar radiation may produce a significant contribution to the temperature. Table 7.3-1 lists the recommended minimum duty cycle rating for various system grounding methods based on switchgear temperatures not exceeding 55 °C.

Table 7.3-1. Suggested Minimum Ratings (kV) for Metal-Oxide Surge Arresters Located in Metal-Enclosed Switchgear

<table>
<thead>
<tr>
<th>Service Voltage Line-to-Line kV</th>
<th>Distribution Class Arresters</th>
<th>Station Class Arresters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrester Ratings kV Nominal MCOV</td>
<td>Solidly Grounded System Low Resistance Grounded System High Resistance or Ungrounded System</td>
<td>Solidly Grounded System Low Resistance Grounded System High Resistance or Ungrounded System</td>
</tr>
<tr>
<td>2.30 3 2.55 3 2.55 3 2.55 3 2.55 3 2.55 3 2.55 3 2.55 3</td>
<td>2.55</td>
<td>2.55</td>
</tr>
<tr>
<td>2.40 3 2.55 3 2.55 3 2.55 3 2.55 3 2.55 3 2.55 3 2.55 3</td>
<td>2.55</td>
<td>2.55</td>
</tr>
<tr>
<td>3.30 3 2.55 3 2.55 3 2.55 3 2.55 3 2.55 3 2.55 3 2.55 3</td>
<td>2.55</td>
<td>2.55</td>
</tr>
<tr>
<td>4.00 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6</td>
<td>5.10</td>
<td></td>
</tr>
<tr>
<td>4.16 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6</td>
<td>5.10</td>
<td></td>
</tr>
<tr>
<td>4.76 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6</td>
<td>5.10</td>
<td></td>
</tr>
<tr>
<td>6.80 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6</td>
<td>5.10</td>
<td></td>
</tr>
<tr>
<td>6.90 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6</td>
<td>5.10</td>
<td></td>
</tr>
<tr>
<td>7.20 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6</td>
<td>5.10</td>
<td></td>
</tr>
<tr>
<td>7.40 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6</td>
<td>5.10</td>
<td></td>
</tr>
<tr>
<td>8.00 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6</td>
<td>5.10</td>
<td></td>
</tr>
<tr>
<td>8.12 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6</td>
<td>5.10</td>
<td></td>
</tr>
<tr>
<td>8.32 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6</td>
<td>5.10</td>
<td></td>
</tr>
<tr>
<td>8.40 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6 5.10 6</td>
<td>5.10</td>
<td></td>
</tr>
<tr>
<td>11.00 9 7.65 9 7.65 9 7.65 9 7.65 9 7.65 9 7.65 9 7.65 9</td>
<td>7.65</td>
<td></td>
</tr>
<tr>
<td>11.50 9 7.65 9 7.65 9 7.65 9 7.65 9 7.65 9 7.65 9 7.65 9</td>
<td>7.65</td>
<td></td>
</tr>
<tr>
<td>12.00 9 7.65 9 7.65 9 7.65 9 7.65 9 7.65 9 7.65 9 7.65 9</td>
<td>7.65</td>
<td></td>
</tr>
<tr>
<td>12.47 10 8.40 12 10.20 18 15.30 10 8.40 12 10.20 18 15.30 10 8.40 12</td>
<td>10.20</td>
<td></td>
</tr>
<tr>
<td>13.20 10 8.40 12 10.20 18 15.30 10 8.40 12 10.20 18 15.30 10 8.40 12</td>
<td>10.20</td>
<td></td>
</tr>
<tr>
<td>13.80 10 8.40 12 10.20 18 15.30 10 8.40 12 10.20 18 15.30 10 8.40 12</td>
<td>10.20</td>
<td></td>
</tr>
<tr>
<td>14.40 12 10.20 12 10.20 21 17.00 12 10.20 15 12.70 21 17.00 12 10.20 15</td>
<td>12.70</td>
<td></td>
</tr>
</tbody>
</table>

Note: MCOV = Maximum Continuous Operating Voltage.
MEB and MSB Switchgear with Automatic Transfer Control

Application

Eaton’s MEB and MSB switchgear with an automatic transfer control system is an integrated assembly of drawout VCP-W breakers, sensing devices and control components. Available in 5–15 kV classes.

It is typically applied where the continuity of service for critical loads from two power sources in either a two-breaker (one load) or three-breaker (two loads) configuration is desired.

MEB and MSB switchgear with an automatic transfer control system can meet most automatic throwover requirements as it has a wide variety of operational sequences embodied in one standard automatic transfer control system.

Typical Two-Breaker Automatic Transfer Using ATC Controller

Eaton’s ATC-900 controller continuously monitors all three phases on both sources for corrects. Should the normal source be lost while the alternate source remains normal, the sensing function in the ATC controller will change state starting the time delay function. If the normal source is not restored by the end of the time delay interval, the normal breaker will open and the alternate source breaker will close, restoring power to the load.

ATC Controller

Eaton’s ATC-900 controller is equipped to display history information either via the front panel or over the PowerNet power monitoring system. ATC-900 controller stores 320 time stamped events. Oscillographic data for last 10 events can be downloaded via USB port or displayed in the controller’s display window. Controller allows communications via RS-232 or Modbus through RS-485 port, Ethernet or via USB interface.

Standard Features

- Voltage sensing on both sources is provided by the ATC controller
- Lights to indicate status of switches, sources, and so forth
- Interlocking to prevent paralleling of sources via software
- Control power for the automatic transfer control system is derived from the sensing transformers
- Manual override operation
- Selectable closed with sync check or open transition on return to normal
- Programmable time delays on both sources, “OFF DELAY” and “ON DELAY”
- Four programmable digital inputs and outputs
- Single-source responsibility; all basic components are manufactured by Eaton

Optional Features

- Lockout on phase and/or ground overcurrents and/or internal bus faults
- Load current, power and PF metering with optional DCT module
- 24 Vdc control power input
- Up to four additional I/O modules each with four programmable digital inputs and digital outputs

Typical Three-Breaker (Two Mains and Normally Open Tie) Automatic Transfer Control

The automatic transfer switchgear assembly includes two main breakers and one tie breaker, and an integrated automatic transfer control system containing sensing devices, low-voltage logic control and auxiliary equipment. The transfer control system monitors both sources for corrects. An automatic-manual transfer selector switch is provided for selection of manual or automatic operating mode. In manual mode, all three breakers can be manually operated. Interlocking is provided in manual mode of operation to prevent closing all three breakers at the same time. In the automatic mode, the basic sequence of operation based upon two normally energized sources is carried out as follows. Normal operation is with the main breakers closed and the tie breaker open. Upon detection of an undervoltage(s) to the line side of a main breaker, and after a field-adjustable time delay, that main breaker opens and after an additional field-adjustable time delay, the tie breaker closes to restore power to the affected portion of the facility. Upon restoration of to the line side of the main breaker, and after a field-adjustable time delay, the tie breaker opens and after a field-adjustable time delay, the opened main breaker closes. Interlocking is provided to prevent closing all three breakers simultaneously in manual mode.
Partial Discharge Sensing and Monitoring for Switchgear

Partial Discharge in Switchgear

Partial discharge (PD) is a common name for various forms of electrical discharges such as corona, surface tracking and discharges internal to the insulation. It partially bridges the insulation between the conductors. These high-frequency discharges are essentially small arcs occurring in or on the surface of the insulation system when stress exceeds a critical value. With time, airborne particles, contaminants and humidity lead to conditions that result in partial discharges. Partial discharges start at a low level and increase as more insulation becomes deteriorated. Examples of partial discharge in switchgear are surface tracking across bus insulation, or discharges in the air gap between the bus and a support, such as where a bus passes through an insulating window between the sections of the switchgear. If partial discharge process is not detected and corrected, it can develop into a full-scale insulation failure followed by an electrical fault. Most switchgear flash-over and bus failures are a result of insulation degradation caused by various forms of partial discharges.

Sensing and Monitoring

Eaton’s Type MEB and MSB metal-enclosed switchgear (2.4–15 kV) is corona-free by design. By making switchgear assemblies corona-free, Eaton has made its standard switchgear more reliable. However, as indicated above, with time, airborne particles, contaminants and humidity lead to conditions that cause partial discharges to develop in switchgear operating at 4000V and above. Type MEB and MSB switchgear can be equipped with factory-installed partial discharge sensors and partial discharge sensing relay for continuous monitoring of the partial discharges under normal operation. Timely detection of insulation degradation through increasing partial discharges can identify potential problems so that corrective actions can be planned and implemented long before permanent deterioration develops. Partial discharge detection can be the foundation of an effective predictive maintenance program. Trending of partial discharge data over time allows prediction of failures, which can be corrected before catastrophic failure occurs.

The PD sensing and monitoring system consists of Eaton’s InsulGard™ relay and PD sensors specifically developed for application in the switchgear to work with the relay. Partial discharges within the MEB switchgear compartment are detected by the installation of a small donut type radio frequency current transformer (RFCT) sensor over floating stress shields of the specially designed bus or line side primary bushings. Partial discharge in the customer’s power cables (external discharges) are detected by the installation of the RFCT around ground shields of the incoming or outgoing power cables termination. Partial discharges within the MSB switchgear compartment are detected by installation of coupling capacitor type sensor connected to the main bus or on the load side of the feeder breakers. Partial discharges in the customer’s power cables (external discharges) are detected by the installation of the RFCT around ground shields of the incoming or outgoing power cables termination.

Output signals from sensors (coupling capacitor and RFCT) are wired out to terminal blocks for future or field use, or connected to the InsulGard relay. One InsulGard relay can monitor up to 15 output signals, and temperature and humidity. The temperature and humidity sensors are included with each InsulGard relay system. The “relay continuously monitors the switchgear primary system for partial discharges and provides an alarm signal (contact closure) when high PD level is detected. Data analysis and diagnostics performed by Eaton engineers can also be provided by remote communication with the InsulGard relay.

The sensors and InsulGard relay are optional in MEB and MSB switchgear.

![InsulGard Relay System](image)

Figure 7.3-4. InsulGard Relay System
Partial Discharge Sensors and Monitoring for Switchgear

Figure 7.3-5. Typical Partial Discharge Sensor Connections in MEB Switchgear (5–15 kV)

Note: Use one set of epoxy bottles with ground stress shield on bus side (either in the top or bottom compartment) at every two vertical sections. Use standard bottles at all other locations.

Figure 7.3-6. Typical Partial Discharge Sensor Connections in MSB Switchgear (5–15 kV)

Note: Use one set of PD sensing capacitors at every two vertical sections, or portion thereof. Use one RFCT at each incoming/outgoing cable circuit.
This page intentionally left blank.