Medium-voltage power distribution and control systems > Switchgear >

Metal-enclosed switchgear
5/15 kV MEF front-accessible
medium-voltage drawout vacuum breakers

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General Description

MEF Switchgear

Eaton’s MEF metal-enclosed front-accessible switchgear with VCP-T/VCP-TL drawout vacuum circuit breakers provide centralized control and protection of medium-voltage power equipment and circuits in industrial and commercial installations involving:

- Transformer primary switching
- Transformer secondary main
- General purpose feeder circuit
- Bus tie circuit
- Generator main
- Across-the-line starting of medium-voltage motors
- Automatic transfer switching using main-main or main-tie-main configurations
- Harmonic filter bank switching
- Any combination of above applications

MEF metal-enclosed switchgear is designed for applications up to 15 kV. It is a modularized design that can be assembled in various combinations to satisfy user application requirements. The switchgear can be supplied with one-high or two-high breaker arrangements. MEF switchgear is a front-accessible design, suitable for installation against the wall.

Standards

MEF metal-enclosed switchgear is designed to meet requirements of C37.20.3, IEEE® standard for metal-enclosed switchgear. Drawout circuit breakers and auxiliary drawers are designed to meet requirements of C37.20.2, IEEE standard for metal-clad switchgear.

MEF also meets Canadian Standard, CSA® C22.2 No. 31-04.

VCP-T/VCP-TL vacuum circuit breakers used in MEF switchgear meet or exceed ANSI and IEEE standards applicable to ac high-voltage circuit breakers rated on symmetrical current basis; C37.04, C37.06, C37.09.

Third-Party Certifications

- UL®
- CSA

Ratings

- Rated maximum voltage: 4.76 kV, 15 kV
- Rated main bus continuous current: 1200, 2000 A
- Circuit breaker ratings: continuous current 600, 1200, 2000 A
- Rated short-circuit current: 16, 20, 25, 32 and 40 kA
- Refer to Table 6.1-1 and Table 6.1-2 for more details

Advantages

- Reduced footprint
- Front-access design
- Maintenance-free bus joints
- Full benefits of switching and interrupting capabilities of vacuum breakers
- Integral relaying and metering optional breaker allows full short-circuit and overload coordination with upstream devices
- External control power is not required when using integral protection
- Optional external relays and meters
- MEF fills the application gap between metal-enclosed fusible load interrupter and metal-clad breaker switchgear designs
- Breakers shipped installed in the switchgear; no mismatch or misplaced circuit breakers at site and reduced installation cost
MEF Switchgear Assembly Features

MEF is metal-enclosed front-accessible switchgear with many metal-clad features.

- Drawout circuit breaker and auxiliary (VT, CPT) compartments with automatic shutters to prevent accidental contact with high-voltage circuits when breaker/auxiliary is removed.
- No high-voltage connections or circuits are exposed by opening of circuit breaker, VT or CPT compartment door.
- All drawout elements are provided with mechanical interlocks for proper operating sequence under normal operating conditions as described in IEEE C37.20.2.
- All low-voltage control wiring, devices and control compartments are isolated from high-voltage circuits.

MEF Switchgear is Compact

- Breaker and auxiliary cells are 26.00-inch wide, 61.50-inch deep, 92.00-inch tall (660.6 mm wide, 1562.1 mm deep, 2336.8 mm tall).
- Cable pull sections are 19.00 inches wide, 61.50 inches deep, 92.00 inches tall (482.6 mm wide, 1562.1 mm deep, 2336.8 mm tall).
- Reduced front aisle space for breaker withdrawal saves overall floor space.
- Shipping groups can be moved in place by forklift, or overhead lifting means.

MEF Switchgear is Modular

Available configurations include:

- Breaker over auxiliary
- Breaker over breaker
- Auxiliary over auxiliary
- Pull sections with various cable entry combinations

MEF Switchgear is Front Accessible

- Allows primary cable connections from the front of the switchgear.
- All drawout elements (breaker, VT, CPT) are front accessible after opening their compartment door.
- All field connections required at shipping splits are accessible and made from the front.
- No rear access space is required. The switchgear can be installed against the wall.
- All non-accessible primary bus joints and connections are maintenance-free—do not require inspection or re-torque.
VCP-T/VCP-TL Vacuum Circuit Breaker Features

- Vacuum circuit breakers provide high duty cycle, fast interruption, reduced maintenance, and are environmentally friendly.
- Very compact and lightweight circuit breaker rated to 15 kV; weighs only 250–440 lb (114–200 kg).
- Fully horizontal drawout feature with connect, test and disconnect positions provides ease of operation and interchangeability. Levering-in (racking) system is an integral part of the breaker.
- All circuit breaker functions, indicators and controls are grouped on an easily accessible panel on front of the circuit breaker.
- Levering interlock prevents the breaker from being racked out when in connected position and closed.
- Trip-free interlock prevents breaker from closing, manually or electrically, while it is being levered or when in an intermediate position.
- Secondary control connector interlock prevents breaker being moved into the connected position if the breaker control wiring connector is not correctly engaged with its compartment control wiring connector. Interlocking also prevents disconnection of circuit breaker control wiring connector, manually or automatically, while the circuit breaker is in the connected position and in any position between the connected and the test/disconnected.
- Breaker frame remains grounded throughout its travel and in the connected position.

- Choice of manually or electrically operated circuit breakers.
- Integral spring charging handle.
- Choice of breaker mounted protection for automatic short-circuit and overload protection without a need for external control power.
- Can also be used with external relays when equipped with optional shunt trip and external control power.
- Easy-to-see contact erosion indicator is provided on the moving stem of the breaker. Only visual inspection is required to verify that the contacts have not worn out.
- Easy-to-see contact wipe indicator is provided for verification by simple visual inspection that the loading springs are applying proper pressure to the contacts when the circuit breaker is closed.
- One auxiliary switch (5a, 5b) included as standard on all breakers for breaker contact status.
- Quality Assurance Certificate is included with each circuit breaker.

VCP-T/VCP-TL Circuit Breaker Fully Withdrawn on Extension Pan
Circuit Breaker Compartment

- Each circuit breaker compartment is provided with steel shutters (breaker driven) that automatically rotate into position to cover stationary cell studs to prevent contact with high-voltage circuit when the breaker is moved from connected to disconnected position. Provisions for padlocking the shutters open or closed is included as standard.

- Rejection interlock pins prevent insertion of the circuit breaker if the circuit breaker and structure ratings are not compatible.

- A silver-plated copper ground bus keeps the breaker grounded throughout its travel and in its connected position.

![Circuit Breaker Compartment — Breaker in Connected Position](image1)

![Circuit Breaker in Connected Position Indicator](image2)

![VCP-T Circuit Breaker Compartment](image3)

![Panel Space for LV Control Devices](image4)

![Cell Stabs](image5)

![Provision for Padlock Shutters](image6)
Auxiliary Compartments
MEF switchgear permits use of up to four auxiliary drawers in one vertical unit. Those drawers can be used for installation of voltage or control power transformers.

- Each drawer can be fully withdrawn on extension rails, thus allowing easy access to VT, CPT and their primary fuses
- Safety shutter protects against accidental contact with primary stabs when the drawer is withdrawn
- A VT drawer can accommodate two VTs, each connected line-to-line (open delta), or three VTs, each connected line-to-ground
- A CPT drawer can accommodate a maximum of single-phase, 5 kVA CPT
- Mechanical interlock is included on CPT drawer that requires CPT secondary breaker to be opened prior to withdrawing the drawer to ensure that the primary circuit can only be disconnected under no-load
- Primary fuses are automatically grounded as the drawer is withdrawn from connected to disconnected position
Cable pull sections are included as required to allow top or bottom primary cable terminations from the front of the switchgear. Current sensors for use with breaker mounted integral protective relay, or current transformers for use with door mounted external relays are mounted in the primary circuits in the pull sections. Pull sections are also used as needed for bus transition and bus connections to other equipment. Pull section is metal-enclosed.
Bus Compartments

MEF switchgear is completely front accessible, designed to be installed against a wall. Access necessary for customer’s primary cable terminations, joining of bus joints (main bus and ground bus) at shipping splits, and terminations of customer’s control wires are provided from the front of the switchgear. Main bus is accessible from the top front of the switchgear. All bus bars are insulated throughout by epoxy coating using Eaton’s fluidized bed process, and covered with PVC boots at joints. All joints are silver-plated. All bus joints that are not accessible are bolted with special hardware to eliminate need for future inspection or re-torque. Minimum 24.00-inch (609.6 mm) clearance to ceiling is recommended for main bus access.

Standard Switchgear Assembly Ratings

Table 6.1-1. MEF Switchgear Assembly Rated Per ANSI Standards

<table>
<thead>
<tr>
<th>Rated Maximum Voltage</th>
<th>Insulation Level</th>
<th>Rated Main Bus Continuous Current</th>
<th>Rated Short-Time Short-Circuit Current Withstand (2-Second)</th>
<th>Rated Momentary Short-Circuit Current Withstand (10 Cycle)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>I</td>
<td>2.6 * I</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Amperes</td>
<td>kA rms Symmetrical</td>
</tr>
<tr>
<td>4.76</td>
<td>19</td>
<td>60</td>
<td>1200</td>
<td>25</td>
</tr>
<tr>
<td>4.76</td>
<td>19</td>
<td>60</td>
<td>2000</td>
<td>25</td>
</tr>
<tr>
<td>4.76</td>
<td>19</td>
<td>60</td>
<td>1200</td>
<td>40</td>
</tr>
<tr>
<td>15</td>
<td>36</td>
<td>95</td>
<td>1200</td>
<td>25</td>
</tr>
<tr>
<td>15</td>
<td>36</td>
<td>95</td>
<td>2000</td>
<td>25</td>
</tr>
<tr>
<td>15</td>
<td>36</td>
<td>95</td>
<td>1200</td>
<td>40</td>
</tr>
<tr>
<td>15</td>
<td>36</td>
<td>95</td>
<td>2000</td>
<td>40</td>
</tr>
</tbody>
</table>
Circuit Breakers

VCP-T Breaker

- ANSI rated—drawout
- Equipped with stored energy spring operating mechanism
- 5/15 kV, 600/1200/2000 A
- 25 kA and 40 kA rms symmetrical
- K = 1
- Rated interrupting time = 3 cycle
- Operating mechanism = 10,000 operations
- Vacuum interrupters = 30,000 operations

VCP-TL Breaker

- ANSI rated—drawout
- Equipped with linear magnetic actuator operating mechanism
- 5/15 kV, 600/1200 A
- 25 kA rms symmetrical
- K = 1
- Rated interrupting time = 3 cycle
- Operating mechanism = 100,000 operations
- Vacuum interrupters = 30,000 operations

Note: VCP-TL breakers are designed such that in event of control power loss, internal capacitors provide sufficient energy to perform an electrical open operation up to 48 hours after the loss of control power.

Secondary Wiring
Through-the-Window Accessory
Electric Charging Motor
Manual Charging Handle
Contact Status (Open-Close)
Spring Status (Charged-Discharged)
Manual "OFF" Pushbutton
Manual "ON" Pushbutton
Operations Counter

5A/5B Auxiliary Switch
Opening Spring
OFF Key Lock Location
Motor Cutoff Switch
Integral Protective Relay (Optional)
Cradle with Levering Mechanism
Shock Bolt Handle
Shock Bolt
Packing Screw Lock Plate
Levering Drive Nut
Push/Pull Handle

Magnetic Actuator
Capacitor
Controller
Power Supply
<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Rated Maximum Voltage (kV)</th>
<th>Insulation Level (kV rms)</th>
<th>Rated Continuous Current (A)</th>
<th>Rated Short-Circuit Current at Rated Voltage (kA rms)</th>
<th>Maximum Symmetrical Interrupting &amp; 2-Second Short-Time Current Carrying Capability (kA rms)</th>
<th>Closering and Latching Capability (Momentary)</th>
<th>Cable Charging Breaking Current (kA rms)</th>
<th>Three-Phase MVA at Rated Voltage (for Reference Only)</th>
<th>Mechanical Endurance No Load C-O Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>V C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kV ms</td>
<td>kV Peak</td>
<td>Amperes</td>
<td>kA ms Symmetrical</td>
<td>kA Crest</td>
<td>2.6 * K * I</td>
<td>Amperes</td>
<td>1.732 * V * I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50VCP-T16</td>
<td>4.76</td>
<td>19</td>
<td>60</td>
<td>600</td>
<td>16</td>
<td>1.6</td>
<td>42</td>
<td>10</td>
<td>130</td>
</tr>
<tr>
<td>50VCP-T16</td>
<td>4.76</td>
<td>19</td>
<td>60</td>
<td>1200</td>
<td>16, 20</td>
<td>16</td>
<td>42</td>
<td>10</td>
<td>130</td>
</tr>
<tr>
<td>50VCP-T20</td>
<td>4.76</td>
<td>19</td>
<td>60</td>
<td>600, 1200</td>
<td>25, 31.5</td>
<td>25</td>
<td>52</td>
<td>10</td>
<td>105</td>
</tr>
<tr>
<td>50VCP-T25</td>
<td>4.76</td>
<td>19</td>
<td>60</td>
<td>600, 1200, 2000</td>
<td>25, 31.5</td>
<td>25</td>
<td>52</td>
<td>10</td>
<td>105</td>
</tr>
<tr>
<td>50VCP-T32</td>
<td>4.76</td>
<td>19</td>
<td>60</td>
<td>600, 1200, 2000</td>
<td>40</td>
<td>40</td>
<td>104</td>
<td>10</td>
<td>105</td>
</tr>
<tr>
<td>50VCP-T40</td>
<td>4.76</td>
<td>19</td>
<td>60</td>
<td>600, 1200, 2000</td>
<td>40</td>
<td>40</td>
<td>104</td>
<td>10</td>
<td>105</td>
</tr>
<tr>
<td>150VCP-T16</td>
<td>4.76</td>
<td>15</td>
<td>36</td>
<td>95</td>
<td>16</td>
<td>1.6</td>
<td>42</td>
<td>25</td>
<td>420</td>
</tr>
<tr>
<td>150VCP-T20</td>
<td>4.76</td>
<td>15</td>
<td>36</td>
<td>95</td>
<td>20</td>
<td>1.6</td>
<td>42</td>
<td>25</td>
<td>420</td>
</tr>
<tr>
<td>150VCP-T25</td>
<td>4.76</td>
<td>15</td>
<td>36</td>
<td>95</td>
<td>25</td>
<td>1.6</td>
<td>42</td>
<td>25</td>
<td>420</td>
</tr>
<tr>
<td>150VCP-T32</td>
<td>4.76</td>
<td>15</td>
<td>36</td>
<td>95</td>
<td>31.5</td>
<td>1.6</td>
<td>82</td>
<td>25</td>
<td>830</td>
</tr>
<tr>
<td>150VCP-T40</td>
<td>4.76</td>
<td>15</td>
<td>36</td>
<td>95</td>
<td>40</td>
<td>31.5</td>
<td>82</td>
<td>25</td>
<td>830</td>
</tr>
</tbody>
</table>

Note: VCP-T breakers shown in the table above are considered definite purpose breakers per ANSI C37.04.

Table 6.1-3. Capacitor Switching Capability of VCP-T Circuit Breakers

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Rated Continuous Current</th>
<th>Cable Charging Current</th>
<th>Isolated Shunt Bank Current</th>
<th>Back-to-Back Capacitor Switching</th>
<th>kA peak</th>
<th>kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>50VCP-T25</td>
<td>2000</td>
<td>10</td>
<td>75–1000</td>
<td>75–1000</td>
<td>18</td>
<td>2.4</td>
</tr>
<tr>
<td>50VCP-T32</td>
<td>1200</td>
<td>10</td>
<td>75–630</td>
<td>75–1000</td>
<td>18</td>
<td>2.4</td>
</tr>
<tr>
<td>50VCP-T40</td>
<td>1200</td>
<td>10</td>
<td>75–630</td>
<td>75–1000</td>
<td>18</td>
<td>2.4</td>
</tr>
<tr>
<td>150VCP-T25</td>
<td>2000</td>
<td>25</td>
<td>75–1000</td>
<td>75–1000</td>
<td>18</td>
<td>2.4</td>
</tr>
<tr>
<td>150VCP-T32</td>
<td>1200</td>
<td>25</td>
<td>75–630</td>
<td>75–1000</td>
<td>18</td>
<td>2.4</td>
</tr>
<tr>
<td>150VCP-T40</td>
<td>1200</td>
<td>25</td>
<td>75–630</td>
<td>75–1000</td>
<td>18</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Note: VCP-T breakers shown in the table above are considered definite purpose breakers per ANSI C37.04.
Table 6.1-4. Available VCP-TL Vacuum Circuit Breakers Rated Per ANSI Standards (C37.04, C37.09)

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Insulation Level</th>
<th>Rated Maximum Voltage</th>
<th>Rated Continuous Current</th>
<th>Rated Short-Circuit Current at Rated Maximum Voltage</th>
<th>Maximum Symmetrical Interrupting &amp; 2-Second Short-Time Current Carrying Capability</th>
<th>Closing and Latching Capability (Momemtary)</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>Rated Power Frequency Withstand Voltage 60 Hz, 1 Minute</td>
<td>Impulse Withstand Voltage (BIL) 1.2 x 50 microsec</td>
<td></td>
<td></td>
<td>Rated Voltage Range Factor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kV rms</td>
<td>kV rms</td>
<td>kV Peak</td>
<td>Amperes</td>
<td>kA rms</td>
<td>kA Crest</td>
<td>kA rms</td>
<td>Symmetrical</td>
<td>kA Crest</td>
<td>MVA</td>
</tr>
<tr>
<td>50VCP-TL16</td>
<td>4.76</td>
<td>19</td>
<td>60</td>
<td>600, 1200</td>
<td>16</td>
<td>1</td>
<td>16</td>
<td>42</td>
<td>10</td>
</tr>
<tr>
<td>50VCP-TL20</td>
<td>4.76</td>
<td>19</td>
<td>60</td>
<td>600, 1200</td>
<td>20</td>
<td>1</td>
<td>20</td>
<td>52</td>
<td>10</td>
</tr>
<tr>
<td>50VCP-TL25</td>
<td>4.76</td>
<td>19</td>
<td>60</td>
<td>600, 1200</td>
<td>25</td>
<td>1</td>
<td>25</td>
<td>65</td>
<td>10</td>
</tr>
<tr>
<td>150VCP-TL16</td>
<td>15</td>
<td>36</td>
<td>95</td>
<td>600, 1200</td>
<td>16</td>
<td>1</td>
<td>16</td>
<td>42</td>
<td>25</td>
</tr>
<tr>
<td>150VCP-TL20</td>
<td>15</td>
<td>36</td>
<td>95</td>
<td>600, 1200</td>
<td>20</td>
<td>1</td>
<td>20</td>
<td>52</td>
<td>25</td>
</tr>
<tr>
<td>150VCP-TL25</td>
<td>15</td>
<td>36</td>
<td>95</td>
<td>600, 1200</td>
<td>25</td>
<td>1</td>
<td>25</td>
<td>65</td>
<td>25</td>
</tr>
</tbody>
</table>

1. Rated interrupting time for all VCP-TL circuit breakers is 3 Cycle (50 ms).
2. Operating duty for all VCP-TL circuit breakers is O-0.3sec-CO-3min-CO.
3. Tested for capacitor switching capabilities. “General Purpose” to ANSI C37: Cable charging = 25 A. “Definite Purpose” to ANSI C37: Back-to-back equals 250 and 1000 A. Ratings of 250 and 1000 A cover capacitor bank applications from 75 to 1000 A. Inrush current and frequency rating = 18 kA/pk at 2.4 kHz.

Table 6.1-5. Capacitor Switching Capability of VCP-TL Circuit Breakers

<table>
<thead>
<tr>
<th>Cable Charging</th>
<th>Grounded Capacitor Banks</th>
<th>Single Bank</th>
<th>Back-to-Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 A</td>
<td>250 and 630 A</td>
<td>250 A with inrush current 15 kA/pk at 5 kHz and 630 A with inrush current 15 kA/pk at 1.5 kHz</td>
<td></td>
</tr>
</tbody>
</table>

Note: Ratings of 250 and 630 A cover capacitor bank applications from 75 to 630 A. VCP-TL breakers are considered definite purpose breakers per ANSI C37.04.
VCP-T Circuit Breaker Operating Times

The closing time (initiation of close signal to contact make) and opening time (initiation of the trip signal to contact break) are shown in Table 6.1-6. Figure 6.1-1 below shows the sequence of events in the course of circuit interruption, along with applicable VCP-T circuit breaker timings.

Table 6.1-6. Closing and Opening Times for Electrically Operated VCP-T Breakers, at Rated Control Voltage

<table>
<thead>
<tr>
<th>Rated Control Voltage</th>
<th>Breaker Rating</th>
<th>Closing Time Milliseconds</th>
<th>Opening Time Milliseconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>48 V, 125 V, 250 Vdc</td>
<td>All</td>
<td>28–40</td>
<td>17–27</td>
</tr>
<tr>
<td>120 V, 240 Vac</td>
<td>All</td>
<td>28–40</td>
<td>—</td>
</tr>
<tr>
<td>120 V or 240 Vac capacitor trip</td>
<td>All</td>
<td>—</td>
<td>17–27</td>
</tr>
<tr>
<td>Optional—undervoltage trip release 48 V, 125 V, 250 Vdc</td>
<td>All</td>
<td>—</td>
<td>40–60</td>
</tr>
</tbody>
</table>

For manually operated breakers with integral protective relay, refer to applicable relay time-current curves for clearing time.

Figure 6.1-1. Sequence of Events for VCP-T Circuit Breakers with Shunt Trip

Figure 6.1-2. Typical Transfer Times—Fast Sequential Transfer—VCP-T Circuit Breakers

For manually operated breakers with integral protective relay, refer to applicable relay time-current curves for clearing time.
VCP-TL Circuit Breaker Operating Times

The closing time (initiation of close signal to contact make) and opening time (initiation of the trip signal to contact break) are shown in Table 6.1-7. Figure 6.1-3 below shows the sequence of events in the course of circuit interruption, along with applicable VCP-TL circuit breaker timings.

Table 6.1-7. Closing and Opening Times for Electrically Operated VCP-TL Breakers, at Rated Control Voltage, Typical

<table>
<thead>
<tr>
<th>Rated Control Voltage</th>
<th>Breaker Rating</th>
<th>Closing Time Milliseconds</th>
<th>Opening Time Milliseconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>36–60 Vac, 36–72 Vdc</td>
<td>All</td>
<td>60</td>
<td>25–33</td>
</tr>
<tr>
<td>100–240 Vac, 100–353 Vdc</td>
<td>All</td>
<td>60</td>
<td>25–33</td>
</tr>
</tbody>
</table>

For manually operated breakers with integral protective relay, refer to applicable relay time-current curves for clearing time.

Figure 6.1-3. Sequence of Events for VCP-TL Circuit Breakers with Shunt Trip

For manually operated breakers with integral protective relay, refer to applicable relay time-current curves for clearing time.

Figure 6.1-4. Typical Transfer Times—Fast Sequential Transfer—VCP-TL Circuit Breakers
Data provided are for charging of internal capacitors from a fully discharged state. In normal operation, the capacitors recharge in about 15 seconds after each closing operation.

### Table 6.1-8. Shunt Coil Ratings, VCP-T Breakers

<table>
<thead>
<tr>
<th>Rated Control Voltage</th>
<th>Operational Voltage Range</th>
<th>Inrush Power Consumption at Rated Voltage</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Vdc</td>
<td>14–28</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>48 Vdc</td>
<td>28–56</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>110 Vdc</td>
<td>77–121</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>125 Vdc</td>
<td>70–140</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>220 Vdc</td>
<td>154–242</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>250 Vdc</td>
<td>140–280</td>
<td>450</td>
<td></td>
</tr>
<tr>
<td>110 Vac</td>
<td>77–121</td>
<td>450</td>
<td>Capacitor Trip</td>
</tr>
<tr>
<td>120 Vac</td>
<td>104–127</td>
<td>450</td>
<td>Capacitor Trip</td>
</tr>
<tr>
<td>220 Vac</td>
<td>154–242</td>
<td>450</td>
<td>Capacitor Trip</td>
</tr>
<tr>
<td>240 Vac</td>
<td>208–254</td>
<td>450</td>
<td>Capacitor Trip</td>
</tr>
</tbody>
</table>

* These electrical accessories are optional for VCP-T circuit breaker, and require external control power. Please specify each of these accessories as required for the application.

### Table 6.1-9. Spring Release Coil (Closing Coil) Ratings, VCP-T Breakers

<table>
<thead>
<tr>
<th>Rated Control Voltage</th>
<th>Operational Voltage Range</th>
<th>Inrush Power Consumption at Rated Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Vdc</td>
<td>20–27</td>
<td>250</td>
</tr>
<tr>
<td>48 Vdc</td>
<td>38–56</td>
<td>250</td>
</tr>
<tr>
<td>110 Vdc</td>
<td>94–121</td>
<td>450</td>
</tr>
<tr>
<td>125 Vdc</td>
<td>100–140</td>
<td>450</td>
</tr>
<tr>
<td>220 Vdc</td>
<td>187–242</td>
<td>450</td>
</tr>
<tr>
<td>250 Vdc</td>
<td>200–280</td>
<td>450</td>
</tr>
<tr>
<td>110 Vac</td>
<td>94–121</td>
<td>450</td>
</tr>
<tr>
<td>120 Vac</td>
<td>104–127</td>
<td>450</td>
</tr>
<tr>
<td>220 Vac</td>
<td>187–242</td>
<td>450</td>
</tr>
<tr>
<td>240 Vac</td>
<td>208–254</td>
<td>450</td>
</tr>
</tbody>
</table>

* These electrical accessories are optional for VCP-T circuit breaker, and require external control power. Please specify each of these accessories as required for the application.

### Table 6.1-10. Undervoltage Release Coil Ratings, VCP-T Breakers

<table>
<thead>
<tr>
<th>Rated Control Voltage</th>
<th>Operational Voltage Range (35–80%)</th>
<th>Inrush Power Consumption</th>
<th>Continuous Power Consumption at Rated Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Vdc</td>
<td>10–14</td>
<td>250</td>
<td>18</td>
</tr>
<tr>
<td>48 Vdc</td>
<td>17–29</td>
<td>275</td>
<td>18</td>
</tr>
<tr>
<td>110 Vdc</td>
<td>39–66</td>
<td>450</td>
<td>10</td>
</tr>
<tr>
<td>125 Vdc</td>
<td>44–75</td>
<td>450</td>
<td>10</td>
</tr>
<tr>
<td>220 Vdc</td>
<td>77–132</td>
<td>450</td>
<td>10</td>
</tr>
<tr>
<td>250 Vdc</td>
<td>88–150</td>
<td>450</td>
<td>10</td>
</tr>
<tr>
<td>110 Vac</td>
<td>94–121</td>
<td>450</td>
<td>10</td>
</tr>
<tr>
<td>120 Vac</td>
<td>102–132</td>
<td>450</td>
<td>10</td>
</tr>
<tr>
<td>220 Vac</td>
<td>187–242</td>
<td>400</td>
<td>10</td>
</tr>
<tr>
<td>240 Vac</td>
<td>204–264</td>
<td>400</td>
<td>10</td>
</tr>
</tbody>
</table>

* These electrical accessories are optional for VCP-T circuit breaker, and require external control power. Please specify each of these accessories as required for the application.

### Table 6.1-11. Spring Charging Motor Ratings, VCP-T Breakers

<table>
<thead>
<tr>
<th>Rated Control Voltage</th>
<th>Operational Voltage Range</th>
<th>Running Current</th>
<th>Inrush Current</th>
<th>Power Consumption at Rated Voltage</th>
<th>Spring Charging Time</th>
<th>Close Contact</th>
<th>Carry Current</th>
<th>Trip Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 Vdc</td>
<td>20–27</td>
<td>8</td>
<td>32</td>
<td>250</td>
<td>5</td>
<td>11 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
</tr>
<tr>
<td>48 Vdc</td>
<td>36–56</td>
<td>4</td>
<td>16</td>
<td>250</td>
<td>5</td>
<td>11 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
</tr>
<tr>
<td>110 Vdc</td>
<td>94–121</td>
<td>3</td>
<td>12</td>
<td>250</td>
<td>5</td>
<td>11 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
</tr>
<tr>
<td>125 Vdc</td>
<td>100–140</td>
<td>3</td>
<td>12</td>
<td>250</td>
<td>5</td>
<td>11 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
</tr>
<tr>
<td>220 Vdc</td>
<td>187–242</td>
<td>2</td>
<td>8</td>
<td>250</td>
<td>5</td>
<td>11 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
</tr>
<tr>
<td>250 Vdc</td>
<td>200–280</td>
<td>2</td>
<td>8</td>
<td>250</td>
<td>5</td>
<td>11 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
</tr>
<tr>
<td>110 Vac</td>
<td>94–121</td>
<td>3</td>
<td>12</td>
<td>250</td>
<td>5</td>
<td>11 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
</tr>
<tr>
<td>120 Vac</td>
<td>104–127</td>
<td>3</td>
<td>12</td>
<td>250</td>
<td>5</td>
<td>11 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
</tr>
<tr>
<td>220 Vac</td>
<td>187–242</td>
<td>2</td>
<td>8</td>
<td>250</td>
<td>5</td>
<td>11 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
</tr>
<tr>
<td>240 Vac</td>
<td>208–254</td>
<td>2</td>
<td>8</td>
<td>250</td>
<td>5</td>
<td>11 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
<td>4 mA at 96 Vdc</td>
</tr>
</tbody>
</table>

* These electrical accessories are optional for VCP-T circuit breaker, and require external control power. Please specify each of these accessories as required for the application.

### Table 6.1-12. VCP-TL Circuit Breaker Control Power Requirements

<table>
<thead>
<tr>
<th>Rated Control Voltage</th>
<th>Electro-Magnetic Controller Internal Capacitors Charging</th>
<th>Minimum Close, Carry and Interrupting Current Ratings Needed for External Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maximum Inrush Peak</td>
<td>Inrush Duration</td>
</tr>
<tr>
<td>A</td>
<td>ms</td>
<td>A</td>
</tr>
<tr>
<td>48 Vdc</td>
<td>0.52</td>
<td>3.5</td>
</tr>
<tr>
<td>125 Vdc</td>
<td>14</td>
<td>3.5</td>
</tr>
<tr>
<td>250 Vdc</td>
<td>22</td>
<td>3.5</td>
</tr>
<tr>
<td>120 Vac</td>
<td>17</td>
<td>3.5</td>
</tr>
<tr>
<td>240 Vac</td>
<td>22</td>
<td>3.5</td>
</tr>
</tbody>
</table>

* Data provided are for charging of internal capacitors from a fully discharged state. In normal operation, the capacitors recharge in about 15 seconds after each closing operation.
Breaker Auxiliary Switch

All VCP-T/VCP-TL circuit breakers are supplied with an auxiliary switch with 5NO and 5NC contacts. On Manually Operated breakers, all 5NO and 5NC contacts are available for customer’s use. On Electrically Operated circuit breakers, 1NO and 1NC contacts are used for breaker status indicating lights (red and green lights) and remaining 4NO and 4NC contacts are generally available for other control functions or customer’s use.

The auxiliary switch is a heavy-duty, double-break type switch with wipe type contacts. The switch contact ratings and operating times are given in Table 6.1-13 and Figure 6.1-5.

MOC Switch

The mechanism operated cell (MOC) switch is not available in MEF switchgear. When number of NO and NC contacts available from the Breaker Auxiliary Switch are not sufficient for controls or customer’s use, an auxiliary relay energized by one of the available NO or NC contacts must be used as needed. The use of auxiliary relay requires external control power.

TOC Switch

The optional truck operated cell (TOC) switch operates when the circuit breaker is levered into or out of the operating (connected) position. In MEF TOC option includes two micro switches, one for connected position, and one for test/disconnected position, each with 1 Form C contact. If additional contacts are required, auxiliary relay must be used. The use of auxiliary relay requires external control power. The TOC switch contact ratings are given in Table 6.1-14.

---

**Table 6.1-13. Breaker Auxiliary Switch Contact Ratings**

<table>
<thead>
<tr>
<th>Continuous Current in Amperes</th>
<th>Control Circuit Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>120Vac</td>
</tr>
<tr>
<td>Non-Inductive Circuit Interrupting Capacity in Amperes</td>
<td>20</td>
</tr>
<tr>
<td>Inductive Circuit Interrupting Capacity in Amperes</td>
<td>20</td>
</tr>
</tbody>
</table>

**Table 6.1-14. TOC Switch Contact Ratings**

<table>
<thead>
<tr>
<th>Continuous Current in Amperes</th>
<th>Control Circuit Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>120Vac</td>
</tr>
<tr>
<td>Non-Inductive Circuit Interrupting Capacity in Amperes</td>
<td>20</td>
</tr>
<tr>
<td>Inductive Circuit Interrupting Capacity in Amperes</td>
<td>20</td>
</tr>
</tbody>
</table>
Protection and Metering
MEF switchgear with VCP-T/VCP-TL circuit breakers can be supplied with integral breaker mounted protective relays for overload and short-circuit protection and metering. The integral relays are self-powered from specially designed and tested current sensors. MEF switchgear can be supplied with external relays and meters connected to current transformers and powered from an external auxiliary power.

Integral Protection and Metering
- VCP-T/VCP-TL circuit breakers can be equipped with Eaton’s Digitrip 520MCV or Digitrip 1150V protection relays
- The Digitrip 520MCV is used for basic overcurrent protection
- The Digitrip 520MCV relay includes an Arcflash Reduction Maintenance System™ (ARMS) feature that may be activated at the breaker or from remote. When activated, the ARMS feature lowers the available arc flash energy at the connected downstream device by faster clearing of the downstream fault
- The Digitrip 1150V is used for advanced current and voltage protections, and metering and communication functions. ARMS feature is included on 1150V relay as standard
- The 520MCV and 1150V relays are designed and tested to work with Eaton’s Type V current sensors only.

The power required to operate the protective relay's basic overcurrent protection functions is provided by secondary output from the current sensors once the three-phase primary current through the circuit breaker exceeds approximately 10 to 12% of the current sensor rating or single-phase primary current exceeds approximately 30% of the current sensor rating.

The relay continuously analyzes secondary current signals from the current sensors and when preset current levels and time delay settings are exceeded, sends a trip signal to the trip actuator of the circuit breaker. The trip actuator causes tripping of the circuit breaker by providing the required mechanical force for tripping. The trip actuator is automatically reset each time the circuit breaker opens.

The current sensors, protective relay and circuit breaker are fully tested as a system for time-overcurrent response over the entire current range up to the interrupting rating of the circuit breaker.

An optional OvercurrentTrip Switch (OTS) with one latching type Form C contact can be provided to indicate tripping of the circuit breaker by the action of an integral protective relay.

Rating Plug
A rating plug matched to phase current sensor rating is installed on all integral protective relays. The rating plug and phase current sensors define maximum continuous current rating (In) of the circuit breaker. The rating plug and phase current sensors also determine the maximum instantaneous setting.

If the rating plug is removed from the protective relay, the circuit breaker will trip if it is carrying current. See Page 6.1-21 for available phase current sensors and rating plugs.

External Protection and Metering
MEF switchgear with VCP-T circuit breakers can be supplied with external relays, such as Eaton’s EDR-3000, EDR-5000 and EMR-3000, and meters such as Eaton’s Power Xpert Meter family. The external relays and meters are typically installed on the circuit breaker or control compartment doors and connected into the secondary circuits of conventional CTs and VTs. External control power may be required for correct operation of the external relays depending on the type of relays used.

Eaton’s EDR-3000 is a microprocessor-based multifunction overcurrent protection relay designed to provide the following ANSI protection functions:


The EDR-5000 can be zone interlocked for faster selective tripping. It can also be used for automatic open or closed transition transfer of three breaker main-tie-main systems.

Eaton’s EMR-3000 is a microprocessor-based motor protection relay designed to provide the following ANSI protection functions:

- 49, 50, 51, 46, 50G, 51G, 37, 38, 66, 2/19, 74, 86.

Eaton’s Power Xpert and IQ microprocessor-based metering and communication devices can be provided in MEF for use with conventional CTs and VTs.

Communication Systems
Eaton’s power management products provide hardware and software solutions that allow customers to interface with their switchgear at varying levels of sophistication. Power Xpert and IQ Meters monitor common electrical parameters and communicate the data via standard industry protocols and optional Web interfaces. Power Xpert Gateways consolidate devices into a single Web browser interface and provide Ethernet connectivity. Eaton’s Power Xpert Insight® and Foreseer Web-based software systems display, analyze and store data from multiple devices across the facility to enable management of the customer’s power system.
Protection Relays and Metering

Digitrip 520MCV Integral
Protective Relay

The Digitrip 520MCV integral protective relay is used when basic three-phase (50/51) and ground (50/51N or 50/51G) overcurrent protection is required. The relay is a microprocessor-based device that operates from secondary output of current sensors and provides true rms sensing of each phase and ground, and is suitable for application at either 50 or 60 Hz systems. The sensing current for ground protection can be derived from residual connections of the phase sensors or from an optional Type-V zero sequence current sensor. The relay does not require external control power for its protection functions and can be applied with Manually or Electrically Operated circuit breakers.

The 520MCV relay provides a number of time-overcurrent response curves and settings for phase, as well as ground protection and coordination with upstream or downstream devices. It can also be zone interlocked with other upstream or downstream relays for faster selective tripping.

The 520MCV includes an Arcflash Reduction Maintenance System (ARMS) feature when enabled, it reduces arc flash incident energy during equipment maintenance.

Table 6.1-15. Digitrip 520MCV Protection and Coordination

<table>
<thead>
<tr>
<th>IEEE Device Number</th>
<th>Protection Function</th>
<th>Available Settings (50 or 60 Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase Long Delay</td>
<td>S1</td>
<td>Pickup setting (Ir)</td>
</tr>
<tr>
<td></td>
<td>S0T</td>
<td>Pickup setting (Ir)</td>
</tr>
<tr>
<td>Phase Short Delay</td>
<td>S0</td>
<td>Pickup setting (Ir)</td>
</tr>
<tr>
<td>Phase Instantaneous</td>
<td>S0/50G</td>
<td>Pickup setting (Ir)</td>
</tr>
<tr>
<td>Ground Fault</td>
<td>S1/50G</td>
<td>Pickup setting (Ir)</td>
</tr>
<tr>
<td>Zone Selective Interlocking</td>
<td>—</td>
<td>Phase short delay and ground fault</td>
</tr>
<tr>
<td>ARMS Mode Settings</td>
<td></td>
<td>Settings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1</td>
</tr>
</tbody>
</table>

\[ I_{r} = \text{Current Sensor/Rating Plug rating in amperes.} \]
\[ M1 = \text{Maximum Setting based on } I_{r} = (12 \times I_{r}) \text{ for } I_{r} = 1600 \text{ and } 2000 \text{ A}; (14 \times I_{r}) \text{ for all other values of } I_{r}. \]
\[ st1 \text{ and } st2 \text{ settings are based on } I_{r} = \text{Instat}12 \\
\hspace{1cm} 200-400 A \text{ 0.5 sec} \hspace{1cm} 1.0 sec \\
\hspace{1cm} 600-2000 A \text{ 1.0 sec} \hspace{1cm} 2.0 sec \]

\[ I_{r} \text{ response is applicable to currents less than } (8 \times I_{r}). \]
For currents greater than (8 x Ir), the Ir response reverts to FLAT response.

\[ M1 = \text{Maximum Setting based on } I_{r} = (12 \times I_{r}) \text{ for } I_{r} = 1600 \text{ and } 2000 \text{ A}; (14 \times I_{r}) \text{ for all other values of } I_{r}. \]

\[ I_{r} \text{ response is applicable to currents less than } (0.625 \times I_{r}). \]
For currents greater than (0.625 x Ir), the Ir response reverts to FLAT response.
Digitrip 1150V Integral Protective Relay

The Digitrip 1150V integral protective relay is used for advanced current and voltage protection, and metering and communication.

The Arcflash Reduction Maintenance System (ARMS) feature is included on 1150V units as standard. When enabled, it reduces arc flash incident energy during equipment maintenance.

The relay is a microprocessor-based device that operates from secondary output of current sensors and external voltage transformers, provides true rms sensing of each phase and ground, and is suitable for application at either 50 or 60 Hz systems. The sensing current for ground protection can be derived from residual connections of the phase sensors or from an optional Type-V zero sequence current sensor.

The basic overcurrent protection functions of this relay are self-powered from the current flowing in the secondary of the current sensors. It does require external auxiliary power for its voltage and frequency related protection and alarm functions, and metering displays. The relay can be applied with manually or electrically operated circuit breakers.

The 1150V relay provides following ANSI/IEEE protection functions:

\[
\begin{align*}
51/50, 51/50N \text{ or } 51/50G, 37, 46, 27, 59, 81U, 81O, 47 \text{ and } 32.
\end{align*}
\]

The 1150V relay provides a number of time-overcurrent response curves and settings for phase, as well as ground protection and coordination with upstream or downstream devices. It can also be zone interlocked with other upstream or downstream relays for faster and selective tripping.

In addition to display of metering values as noted in Figure 6.1-7 above, the relay provides data through its front panel display to help plan inspection and maintenance schedules of the circuit breaker and the circuit it is protecting. Those data include:

- Total number of Close Operations by circuit breaker since last reset
- The last time the circuit breaker was operated (Opened or Closed or Tripped) with time and date
- Total number of instantaneous and short delay trip operations by the circuit breaker since last reset
- Total number of overloads (long delay trips) and ground fault trips since last reset

The 1150V relay is also suitable for communication using the INCOM communications system. All monitored values, trip/alarm events, and captured waveforms can be displayed on a remote computer. Breakers can also be opened/closed remotely with password protection. Peripheral translator/gateway devices are available to convert INCOM to other protocols, such as Modbus RTU, ModbusTCP, etc.

The relay has a built-in 24-character alphanumeric LED display to allow programming and viewing of settings, menus, trip and alarm logs, and real time metering data. Because the relay is installed on the circuit breaker, the breaker compartment door must be opened for viewing or programming of the relay functions. An optional Breaker Interface Module can be used for monitoring, viewing and programming of multiple relays from an alternate location, eliminating the need to open circuit breaker compartment door. Also available is wireless transceiver for short-range infrared wireless communication between a hand-held Palm™ personal data assistant (PDA) and the Digitrip 1150V relays with compartment doors closed.
I2t response is applicable to currents less than (0.625 x In). For currents greater than (0.625 x In), the I2t response reverts to FLAT response.

When using phase residual connection scheme, In is current sensor/rating plug rating in amperes. When using zero sequence connection scheme, In is zero sequence current sensor rating in amperes.

I2t response curve for phase short delay is only available when phase long delay response selected is I2t. The I2t response reverts to FLAT response.

For currents greater than (8 x Ir), the I2t response reverts to FLAT response.

Maximum Setting is based on In:

- For In = Current Sensor/Rating Plug rating in amperes.
- For In = (12 x Ir) for 100 A sensor/rating plug, 200 A sensor/rating plug, and 400 A sensor/rating plug.
- For In = (14 x Ir) for all other values of Ir.

Upper limit of this setting is 0.5 for 100 A sensor/rating plug, 1.0 for 200 to 400 A sensor/rating plug, and 2.0 for sensors/rating plugs rated above 600 A.

I2t response is applicable to currents less than (0.625 x In) for currents greater than (0.625 x In), the I2t response reverts to FLAT response.

ARMS Mode Available Trip Current Settings
The 1150V unit provides the following pick-up settings:

- 2.5 x rating plug amperes
- 4.0 x rating plug amperes
- 6.0 x rating plug amperes
- 8.0 x rating plug amperes
- 10.0 x rating plug amperes

Metering, Power Quality and Other Features

- Individual phase and ground currents in rms amperes, real time
- Individual phase and ground currents in rms amperes, 5-minute average
- Individual phase and ground currents, maximum and minimum since last reset
- Line-to-line voltages
- Forward/reverse kW, kW demand and maximum kW demand
- kVA, kVA demand and maximum kVA demand
- Watt and VA demand, maximum W and VA demand
- Forward/reverse kWh
- kVAh
- kVAh and kWh pulse initiate
- Total harmonic distortion for each phase current
- Individual harmonic currents up through 27th harmonic for each phase
- Power factor, minimum and maximum
- Frequency
- Circuit breaker operations count
- Programmable alarms
- Programmable output contacts (breaker close, alarm, trip)

Metering Accuracy

- ±1% of full-scale (Iph) for currents in the range of 5–100% of (Iph)
- ±3% of full-scale for voltages (full scale is equal to phase-to-phase voltage)
- ±4% of full-scale for power and energy readings
**Instrument Transformers**

**Phase Current Sensors**

Eaton Type-V phase current sensors are specifically designed and tested to function with Eaton’s 520V and 1150V integral protective relays and the VCP/T/VCP-TL circuit breaker. The phase current sensors are installed in the primary circuit, external to the circuit breaker, over a set of specially designed insulated bushings. The bushings and current sensors are tested as an assembly for the same impulse withstand (BIL) rating as that of the switchgear in which they are installed.

The power required to operate the relay’s basic overcurrent protection functions is provided by secondary output from the current sensors once the three-phase primary current through the circuit breaker exceeds approximately 10 to 12% of the current sensor rating or single-phase primary current exceeds approximately 30% of the current sensor rating.

The current sensors are designed to supply sensing and operating power to Eaton’s 520V and 1150V integral protective relays. They are not suitable for use with any other relays or meters.

Primary current rating of the current sensors defines maximum continuous current rating (I_{p}) of the primary circuit in which they are installed, regardless of the circuit breaker frame rating. For example, an 800 A current sensor installed in a primary circuit controlled by 1200 A rated circuit breaker, defines 800 A as the maximum continuous current that can be carried through that circuit. The current sensors also determine the maximum instantaneous setting that can be set on the relays.

**Phase Current Sensors and Rating Plugs—Available Ratings**

- 100, 200, 250, 300, 400, 600, 630, 800, 1000, 1200, 1250, 1600 and 2000

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**Zero Sequence Current Sensors**

Eaton Type-V zero sequence current sensors are specifically designed and tested to function with Eaton’s 520V and 1150V integral protective relays and VCP/T/VCP-TL circuit breaker. The zero sequence current sensor, as its name implies, measures zero sequence current (vector summation of phase currents) and provides sensitive method for ground fault sensing. Refer to Table 6.1-17 for available zero sequence sensors.

**Phase and Zero Sequence Current Transformers**

Conventional current transformers with 5A secondary are used when using external relays. CTs used for phase protection and metering are installed over the specially designed insulated bushings in the primary circuit. Maximum of two sets of CTs, or one set of CT and one set of current sensor can be installed over those insulated bushings. Ground fault sensing, when used, can be accomplished by residual sensing of phase currents, or by using an optional zero sequence current transformer. Refer to Table 6.1-18 for the available current transformers and their ratings and accuracies.

**Voltage Transformers**

Voltage transformers supply voltage signal proportional to primary circuit voltage for relaying and metering. Refer to Table 6.1-19 for available VT ratings and accuracies.

When two VTs are used, they are typically connected L-G, and provide phase-to-phase voltages, \( V_{ab} \), \( V_{bc} \), \( V_{ca} \) for metering and relaying.

When three VTs are used, they are connected line-to-ground, and provide phase-to-phase voltages, \( V_{a} \), \( V_{b} \), \( V_{c} \) as well as phase-to-ground, \( V_{ab}, V_{bc}, V_{ca} \) voltages for metering and relaying.

If metering or relaying application requires phase-to-ground voltages, use three VTs, each connected L-G. If not, use of two VTs connected LL is sufficient.

For ground detection, three VTs connected in line-to-ground/broken-delta are used.

A single VT, when used, can be connected line-to-line (it will provide line-to-line output, for example \( V_{ab} \) or \( V_{bc} \) or \( V_{ca} \)), line-to-ground (it will provide line-to-ground output, for example \( V_{a} \) or \( V_{b} \) or \( V_{c} \)). Generally, a single VT is used to derive voltage signal for synchronizing or Over Voltage/Under Voltage function.
For ac control, a capacitor trip device is used with each circuit breaker shunt trip to ensure energy is available for tripping during fault conditions. When ac control power is derived from within the switchgear, CPT should be connected on line side of the main breaker. For main-tie-main lineups, CPT connected on source side of each main with automatic transfer control device on the secondary should be used.

VCP-TL Circuit Breakers

All VCP-TL circuit breakers are equipped with linear actuator mechanism, comprising of: the linear actuator, electro-magnetic controller (EM controller), three closing capacitors, and internal power supply modules for the EM controller. An ac or dc control supply (selected by breaker style number) is required to operate the linear actuator mechanism. Internal power supply modules convert input control voltage and supplies 96 Vdc for operation of the EM controller and charging of capacitors. The linear actuator mechanism is designed for OCO duty cycle with control power on. Initial charging of capacitors (from fully discharged state) takes about 30 seconds. In normal operation with control power connected, the capacitors recharge in about 15 seconds after each closing operation. All circuit breakers include a standard anti-pump feature.

Once the capacitors are charged, circuit breaker can be closed and opened through: the use of manual ON and OFF pushbuttons mounted on the breaker itself, control switch mounted on the breaker compartment door, or any external dry contacts. In the event that control power is lost, the circuit breaker is capable of performing a manual or electrical OPEN operation up to 48 hours after the loss of control power. If the control power loss lasts longer than 48 hours, the circuit breaker can be opened using the integral EMERGENCY OPEN hand located on the front of the circuit breaker, by grasping the handle firmly and then pulling down.

Control Power Transformers

Control power transformer is used for auxiliary power for space heaters, light, receptacle and control of electrically operated breakers when external auxiliary power source is not available. Control power transformer when used for control of electrically operated breakers should be connected on source side of the main breaker so that the control power is available to close the main breaker. Refer to Table 6.1-20 for available control power transformer ratings in MEF switchgear.

Surge Protection

Surge arresters and or surge capacitors can be provided in MEF switchgear.
Ohmic Voltage Sensing (OVS)

Eaton’s Ohmic Voltage Sensing (OVS) is an alternative to traditional VTs in medium voltage. While traditional VTs are susceptible to transients and Ferro-resonance, the OVS system is not. The OVS sensor consists of four non-inductive resistors (two medium-voltage resistors in series and two low-voltage resistors in parallel) that serve as a voltage divider; a low-voltage signal from the sensor is sent to the R2m adapter that is connected to the CAPDIS device. The CAPDIS device then sends 120 V signals to the relays and meters in the system (see Figure 6.1-8). The system is designed to be agnostic when meter and relay devices are being selected for use in a protection and controls scheme.

The OVS system is rated for applications 2.4 to 36 kV as a replacement for VTs. The selection of sensors and R2m adapter for the system is dependent on the nominal voltage being applied to the switchgear. The OVS systems must be applied with three sensors installed line to ground; the low-voltage control circuit can be configured to provide a line-to-line or a line-to-ground output dependent upon the wiring to the relay or meter. Relays and meters installed in the protection and controls scheme would process the signal from the OVS system in the same manner it would a VT. The sensors are traditionally mounted in the rear switchgear compartment (see Figure 6.1-9). However, if an existing installation requires the OVS system, it can be retrofitted into the existing VT drawer.

OVS is not to be used to provide any control power to devices in the switchgear, or to be used for utility metering applications.

The OVS system has been tested to IEEE C37.20.2.2015 Annex D.

Technical Data

- 24 to 230 Vac or Vdc control power for CAPDIS
- Voltage system accuracy better than 2%
- Phase angle accuracy of better than 0.1% over frequency range of 2 kHz
- Burden 0.78 VA L-L, 0.45 VA L-N
Accessories

Standard Accessories

Levering Crank
Used for moving the breaker between the disconnected/test and connected position.

Breaker Extension Pan
Used for installing/removing the breaker to/from its compartment.

Breaker Lifting Yoke
Used with the breaker for installation/removal of the breaker onto/from the breaker extension pan using optional breaker lifter or other overhead lifting means.

Test Jumper
Allows connection of breaker secondary controls disconnect to cell disconnect when the breaker is outside its compartment.

VT/CPT Drawer Extension Rails
Allows withdrawal of VT/CPT auxiliary drawer for inspection and access to primary fuses and VT/CPT.

Optional Accessories

Breaker Lifting Device
Used for installing/removing the breaker onto/from the Breaker Extension Pan.

Manual Ground and Test Device
The ground and test device is a drawout element that may be inserted into a breaker compartment in place of a circuit breaker to provide access to the primary circuits to permit the temporary connections of grounds or testing equipment to the high-voltage circuits.

The device includes six terminals for connections to primary circuits. Selection of upper or lower terminals for grounding is accomplished manually by cable connections before the device is inserted into the desired breaker compartment. The circuit selected for grounding using this device must be checked by some other means, prior to insertion of the device into the compartment, to be sure it is de-energized.

High potential testing of cable or phase checking of circuits are typical tests that may be performed. The device is insulated to suit voltage rating of the switchgear and will carry required levels of short-circuit current, but it is not rated for any current interruption.

Before using a ground and test device, it is recommended that each user develop detailed operating procedure consistent with safe operating practices. Only qualified personnel should be authorized to use the dummy element.

Functional Test Kit (for Testing of Digitrip 520V and 1150V Relays)
Functional Test Kit is a hand-held battery powered tester capable of testing trip elements of 520V and 1150V protective relays. The test kit allows testing of: Relay Power Up, Instantaneous Trip, Short Delay Trip, Long Delay Pickup and Trip, and Ground Fault Trip, when applicable.

Dummy Element
Dummy element is a drawout element with primary disconnects similar to a drawout circuit breaker, but consists of solid copper conductors in place of vacuum interrupters, and is designed for manual racking. It is typically used as drawout disconnect link in the primary system for circuit isolation or bypass. The device is insulated to suit the voltage rating of the switchgear and will carry required levels of short-circuit current, but it is not rated for any current interruption. It must be key interlocked with all source devices such that it can only be inserted into or removed from its connected position only after the primary circuit that it is to be applied is completely de-energized.

Before using a dummy element, it is recommended that each user develop detailed operating procedure consistent with safe operating practices. Only qualified personnel should be authorized to use the dummy element.
Partial Discharge Sensing and Monitoring for Switchgear

Partial Discharge in Switchgear

Partial discharge 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 discharges are essentially small arcs occurring in or on the surface of the insulation system when voltage 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 the insulation becomes deteriorated. Examples of partial discharges 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 activity is not detected and corrected, it can develop into a full-scale insulation failure followed by an electrical fault. Most switchgear flashover and bus failures are a result of insulation degradation caused by various forms of partial discharges.

Sensing and Monitoring

Eaton’s MEF 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 voltages 4000 V and above. MEF switchgear can be equipped with factory-installed partial discharge sensors and a 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 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, that 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 MEF switchgear compartments are detected by the installation of a small donut type radio frequency current transformer (RFCT) sensors over floating stress shields of the specially designed CT/sensor primary bushings. Partial discharges in power cables (external discharges) are detected by the installation of the RFCT around ground shields of the incoming or outgoing power cable terminations.

Output signals from sensors (RFCTs) 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, including 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 by Eaton engineers can also be provided by remote communication with the InsulGard relay.

The sensors and InsulGard relay are optional in MEF switchgear.

In 5/15 kV MEF switchgear (refer to Figure 6.1-11), primary epoxy bushings with stress shield and RFCT sensors for measurement of internal, as well as external partial discharges are all optional. The InsulGard relay is also optional. When specified, one set of CT/sensor primary bushings is provided on the line side) with stress shield and associated RFCT sensor is provided in every incoming and outgoing primary circuit. An additional RFCT sensor for each incoming and outgoing power cable can be provided as required. The RFCT output signals can be connected directly to an InsulGard relay for continuous monitoring of partial discharges or can be used for periodic field measurements.

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**Figure 6.1-10. InsulGard Relay System**

- **Temp Sensor**
- **Humidity Sensor**
- **Input Terminal Block**
- **InsulGard Relay**
- **Optional Modem**
- **120 Vac Auxiliary Power**
- **Output Alarm Status**
- **Signals (up to 15 Total) from PD Sensors (Coupling Capacitors, RFCT Sensor, RTD Input, etc.)**
RFCT #1 detects partial discharges internal to switchgear compartment.
RFCT #2 detects partial discharges in customer’s cables up to 100 ft from switchgear.

Figure 6.1-11. Typical Partial Discharge Sensor Connections in MEF Switchgear (5–15 kV)

Note: Use one set of CT/sensor bushings for all incoming and outgoing primary circuits.
MEF Switchgear with Automatic Transfer Control (ATC)

Application
Eaton’s MEF switchgear with an automatic transfer control system is an integrated assembly of drawout VCP-T/VCP-TL breakers, sensing devices and control components available in 5 through 15 kV classes.

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

MEF 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.

ATC Controller
Eaton’s ATC-900 controller is equipped to display history information either via the front panel or through a monitoring system. The ATC-900 controller stores 320 time stamped events. Oscillographic data for the last 10 events can be downloaded via a USB port or displayed in the controller’s display window. The controller allows communications via RS-232 or Modbus through an RS-458 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 on
- Interlocking to prevent paralleling of sources via software
- Control power for the automatic transfer control system is derived from the sensing voltage 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
When three breaker transfer systems are required, a PLC transfer system is provided. 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 correct voltages. 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 voltage 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. An interlocking is provided to prevent closing all three breakers simultaneously in manual mode.

Typical Two-Breaker Automatic Transfer Control Using ATC Controller
Eaton’s ATC controller continuously monitors all three phases on both sources for correct voltages. Should the voltage of the normal source be lost while the voltage of the alternate source remains normal, the voltage sensing function in the ATC controller will change state starting the time delay function. If the voltage of 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.
MEF Switchgear Available Configurations with Metering Compartment

- Available MEF configurations are shown in Figure 6.1-12. For other configurations, contact Eaton.
- If utility metering compartment is required, use MVS or VCP-W (rear-access) switchgear.
- Shipping group maximum length = 104.00 inches (2642.0 mm).
- All units are 92.00 inches (2367.0 mm) tall, 61.50 inches (1562.0 mm) deep.
- Main bus—1200 or 2000 A.
- 2000 A breakers—1-high (one breaker/vertical section) only, except as noted in Figure 6.1-12.
- 600 and 1200 A breakers can be stacked 2-high (breaker/breaker).
- Auxiliary shown can be either VTs (two or three) or single-phase 5 kVA CPT.
- CTs or current sensors cannot be placed on main-bus side of the breaker.
- CTs shown can be either one or two sets; or one set of CT and one set of current sensors.
- Zero sequence CT shown can be replaced with Zero sequence current sensor.
- Zero sequence CT and surge arresters shown are optional.
- Maximum number of cables per phase is limited as shown in Table 6.1-21.

### Table 6.1-21. Maximum Number of Cables per Phase

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Cable Entry Direction</th>
<th>Number of Power Cables/Phase ⑤</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.00-Inch (660.4 mm) Wide Cell</td>
<td>Adjacent 19.00-Inch (482.6 mm) Wide Pull Section</td>
<td>When Using Zero Sequence CT ⑥ Without Zero Sequence CT or Sensor</td>
</tr>
<tr>
<td>Breaker/blank</td>
<td>None</td>
<td>Bottom</td>
</tr>
<tr>
<td>Breaker/auxiliary</td>
<td>Yes</td>
<td>Bottom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Top</td>
</tr>
<tr>
<td>Breaker/breaker</td>
<td>Yes</td>
<td>Top/top</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bottom/bottom</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Top/bottom</td>
</tr>
</tbody>
</table>

⑤ Multiple cables per phase are based on the use of a maximum wire size of 500 kcmil for each cable. One cable per phase is based on the use of maximum wire size of 1000 kcmil.

⑥ When using a zero sequence sensor (for use with an integral protective relay), the number of cables is limited to one per phase with a maximum wire size of 750 kcmil.

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Figure 6.1-12. MEF Switchgear—Available Configurations

Note: ▲ = No shipping split here.
MEF Switchgear Available Configurations

Note: Refer to Page 6.1-27 for notes.

Figure 6.1-12. MEF Switchgear—Available Configurations (Continued)

Note: ▲ = No shipping split here.
MEF Switchgear Available Configurations

Note: Refer to Page 6.1-27 for notes.

Figure 6.1-12. MEF Switchgear—Available Configurations (Continued)

Note: ▲ = No shipping split here.
MEF Switchgear Available Configurations

Note: Refer to Page 6.1-27 for notes.

Figure 6.1-12. MEF Switchgear—Available Configurations (Continued)

Note: ▲ = No shipping split here.
Front and Sectional Views

Figure 6.1-13. Typical 1-High Breaker Unit, Cables Out the Bottom

Figure 6.1-14. Typical Breaker/Auxiliary Unit and Pull Section, Cables Out Top or Bottom
Front and Side Views

Figure 6.1-15. Typical Breaker/Breaker Unit and Pull Section, Cables Out the Bottom

Figure 6.1-16. Typical Breaker/Breaker Unit and Pull Section, Cables Out the Top
Front and Side Views

Figure 6.1-17. Typical Bus Tie Breaker Unit and Bus Transition Section
MEF 26.00-Inch (660.4 mm) Wide Unit

- Suggested locations for 0.50 inch bolts or welding.
- Secondary control wiring conduit openings (top or bottom) conduit projection must not exceed 3.00 inches (76.2 mm).
- Minimum front clearance when using portable lifter. Local jurisdictions may require a larger distance.
- Minimum clearance for door opening: door hinged on left A = 15, B = 6.
- Primary cable entrance space, available only with 1-high breaker with cables from below. Primary conduit projection must not exceed 3.00 inches (76.2 mm). See shop order base plan for conduit location.
- Minimum rear clearance, local jurisdictions may require a larger distance.
- Finished foundations 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.
- Location of station grounding lug.
- Minimum clearance recommended on top of the switchgear for main bus access is 24.00 inches (609.6 mm).

Figure 6.1-18. MEF 26.00-Inch (660.4 mm) Wide Unit Floor Plan
MEF 19.00-Inch (482.6 mm) Wide Pull Section

Figure 6.1-19. MEF 19.00-Inch (482.6 mm) Wide Pull Section Floor Plan

1. Suggested locations for 0.50 inch bolts or welding.
2. Secondary control wiring conduit openings (top or bottom) conduit projection must not exceed 3.00 inches (76.2 mm).
3. Minimum front clearance when using portable lifter. Local jurisdictions may require a larger distance.
5. Minimum rear clearance, local jurisdictions may require a larger distance.
6. Finished foundations 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.
7. Location of station grounding lug.
8. Primary cable entrance space (top or bottom entry). Primary conduit projection must not exceed 3.00 inches (76.2 mm).
9. See shop order base plan for conduit location.
10. Minimum clearance recommended on top of the switchgear for main bus access is 24.00 inches (609.6 mm).
# Weights

## Table 6.1-22. MEF Switchgear Units Less Circuit Breakers—Approximate Weights

<table>
<thead>
<tr>
<th>Type of Structure</th>
<th>Structure Width Inches (mm)</th>
<th>Structure Weight in Lb (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25 kA Switchgear</td>
<td>40 kA Switchgear</td>
</tr>
<tr>
<td></td>
<td>Main Bus Rating</td>
<td>Main Bus Rating</td>
</tr>
<tr>
<td></td>
<td>1200 A</td>
<td>2000 A</td>
</tr>
<tr>
<td>600–1200 A Breaker over cable entry</td>
<td>26.00 (660.4)</td>
<td>1350 (614)</td>
</tr>
<tr>
<td>600–1200 A Breaker over 600–1200 A breaker, with an adjacent pull section</td>
<td>45.00 (1143.0)</td>
<td>2000 (909)</td>
</tr>
<tr>
<td>600–1200 A Breaker over blank, with an adjacent pull section</td>
<td>1700 (773)</td>
<td>1785 (811)</td>
</tr>
<tr>
<td>600–1200 A Breaker over auxiliary, with an adjacent pull section</td>
<td>26.00 (660.4)</td>
<td>2000 (909)</td>
</tr>
<tr>
<td>2000 A Breaker over blank, with an adjacent pull section</td>
<td>45.00 (1143.0)</td>
<td>—</td>
</tr>
<tr>
<td>2000 A Breaker over auxiliary, with an adjacent pull section</td>
<td>45.00 (1143.0)</td>
<td>—</td>
</tr>
<tr>
<td>1200 A Stand-alone breaker, cable-in/cable-out, with an adjacent pull section</td>
<td>26.00 (660.4)</td>
<td>2000 (909)</td>
</tr>
<tr>
<td>2000 A Stand-alone breaker, cable-in/cable-out, with an adjacent pull section</td>
<td>45.00 (1143.0)</td>
<td>—</td>
</tr>
<tr>
<td>Auxiliary over blank or blank over auxiliary</td>
<td>1600 (727)</td>
<td>1500 (682)</td>
</tr>
<tr>
<td>Auxiliary over auxiliary</td>
<td>26.00 (660.4)</td>
<td>1900 (864)</td>
</tr>
<tr>
<td>Blank structure (with main bus only)</td>
<td>26.00 (660.4)</td>
<td>1000 (455)</td>
</tr>
<tr>
<td>Transition section (for close coupling to MCC, liquid or dry transformer)</td>
<td>19.00 (482.6)</td>
<td>800 (364)</td>
</tr>
<tr>
<td>Blank pull section (with main bus only)</td>
<td>19.00 (482.6)</td>
<td>550 (250)</td>
</tr>
</tbody>
</table>

## Table 6.1-23. VCP-T/VCP-TL Circuit Breakers—Approximate Weights

<table>
<thead>
<tr>
<th>Circuit Breaker Type</th>
<th>Continuous Current Rating Amperes</th>
<th>Static Weight in Lb (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 VCP-T16, 50 VCP-T20, 50 VCP-T25</td>
<td>1200</td>
<td>250 (114)</td>
</tr>
<tr>
<td>50 VCP-T32, 50 VCP-T40</td>
<td>2000</td>
<td>440 (200)</td>
</tr>
<tr>
<td>150 VCP-T16, 150 VCP-T20, 150 VCP-T25</td>
<td>1200</td>
<td>250 (114)</td>
</tr>
<tr>
<td>150 VCP-T32, 150 VCP-T40</td>
<td>2000</td>
<td>440 (200)</td>
</tr>
<tr>
<td>50 VCP-TL16, 50 VCP-TL20, 50 VCP-TL25</td>
<td>600</td>
<td>232 (105)</td>
</tr>
<tr>
<td>150 VCP-TL16, 150 VCP-TL20, VCP-TL25</td>
<td>1200</td>
<td>234 (106)</td>
</tr>
<tr>
<td>600</td>
<td>232 (105)</td>
<td></td>
</tr>
<tr>
<td>2200</td>
<td>232 (105)</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Breaker impact weight = 1.5 x static weight.

## Heat Loss

### Switchgear Heat Loss

The heat-loss data for circuit breakers given in Table 6.1-24 includes portion of main bus conductors and load runbacks. Please note that the estimated wattage given for each component is at its full rating. For example, the chart shows 600 W for 1200 A breaker. It simply means an estimated 600 W loss in breaker in a 1200 A, 5/15 kV compartment when the circuit breaker is carrying full 1200 A. The actual loss, of course, will depend on the actual current being carried by the breaker. If the full load current of the load connected to that 1200 A breaker, for example, is only 200 A, the heat-loss in that compartment will be much less. By simple “I x I x R” calculations, one can easily calculate actual loss at 200 A as = 600 x (200/1200) x (200/1200) = 16.67 W. Also, in case of lineup consisting of many feeders, all feeders might not be carrying or supplying loads at all times. If that is the case, then one can further reduce total watt loss for the lineup by applying a utilization factor.

### Table 6.1-24. MEF Equipment Losses

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Watts Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium-Voltage Switchgear (Indoor, 5 and 15 kV)</td>
<td></td>
</tr>
<tr>
<td>600 A breaker</td>
<td>400</td>
</tr>
<tr>
<td>1200 A breaker</td>
<td>600</td>
</tr>
<tr>
<td>2000 A breaker</td>
<td>1400</td>
</tr>
</tbody>
</table>
Typical Schematics

Electrically Operated Breakers—Control Schemes

Figure 6.1-20. Typical ac Control Circuit—VCP-T Breaker

Figure 6.1-21. Typical dc Control Circuit—VCP-T Breaker
Electrically Operated Breakers—Control Schemes

Figure 6.1-22. VCP-TL Circuit Breaker—Typical Control Circuit
Typical Three-Line Diagrams

Integral Protection

Figure 6.1-23. Typical MEF Switchgear with Digitrip 520MCV Integral Protective Relay

Figure 6.1-24. Typical MEF Switchgear with Digitrip 1150V Integral Protective Relay
External Protection

Figure 6.1-25. Typical MEF Switchgear with EDR-3000 Overcurrent Protective Relay

Figure 6.1-26. Typical MEF Switchgear with EDR-5000 Multi-Function Protective Relay