Type R and Type V Vacuum Circuit Breaker Trays

Descriptive Bulletin
Introduction
The Type R and Type V vacuum circuit breaker trays are the industrial application of the Type R and Type V outdoor circuit breakers. Type R is used for applications at 15 kV or 27 kV, and Type V for applications at 38 kV. These designs are to be used for indoor applications. They are primarily used by utilities for updating older indoor oil circuit breakers. They are also used by OEMs as the basic breaker for their equipment or for switching metal-enclosed capacitor banks.

Application
ABB vacuum breaker trays are designed for a wide range of applications, from line switching to fault current interruption. These breakers must be applied within their voltage and current ratings. The Type R or Type V breaker trays can be applied in capacitor switching applications. ABB offers a capacitor switching solution that significantly reduces system disturbances during closing. The zero voltage closing option achieves this benefit by controlling the initial closing point on the voltage waveform, and controlling the time interval between the closing of individual phases.

Applications involving switching of shunt reactors, arc furnaces, dry transformers, and large motors may require surge capacitors for proper protection. These applications require careful study in order to assure the proper insulation procedures.

Modernization of older indoor oil breaker switchgear is accomplished by removing the existing oil breaker and installing the ABB vacuum circuit breaker tray in the existing enclosure, with minimum bus, frame and control modifications. Contact PTMV Components Group for retrofit assistance.

General
ABB vacuum circuit breaker trays are self-contained packages. The Type R (15 kV and 27 kV) utilizes three vacuum interrupters. The Type V (38 kV) design features two vacuum interrupters per phase, connected in series. The pair of interrupters is driven by a common push rod, through a unique linkage which ensures simultaneous operation. Each interrupter has an individual contact pressure spring and provisions to measure contact wear. Both types have a stored energy mechanism that has been designed and tested in accordance with the ANSI and NEMA Standards for AC High-Voltage Circuit Breakers rated on a symmetrical current basis.

Insulators
The six phase support insulators and the three insulated pull rods are made of polymer concrete. This material has electrical properties equal to electrical grade porcelain, with superior mechanical properties.

User Connections
Six plated copper terminal pads with standard NEMA 4 hole spacing, suitable for copper or aluminum bus, or cable connectors are standard.

A single 16 pole auxiliary switch is standard and is also available with 20 or 32 poles. In all cases, the switches are configured as 50% “A” and 50% “B” contacts. See Table 3 on back page.

Control Voltages
AC: 120 V or 240 V
DC: 48 V, 125 V or 250 V

Trip Voltage
DC trip: 24 V*, 48 V, 125 V, or 250 V
Capacitor trip only for 120 VAC or 240 VAC

*24 VDC on Type R only

Close Voltage
AC: 120 V or 240 V
DC: 125 V or 250 V

Control Wiring
600 Volt, # 14 AWG, type SIS

Operating Mechanisms
The operating mechanisms are the stored energy type, spring close-spring open. A motor driving through a ratchet mechanism is used to charge the main closing springs. Energy is stored in the tripping spring during the closing sequence to ensure adequate tripping energy whenever it is required. The mechanisms are electrically and mechanically trip free.

The operating mechanism drives directly to the main shaft, which connects all three phases. Each phase is operated from this shaft through an independently adjustable linkage.

Configuration
Mechanism Orientation - Type R 15 kV and 27 kV

- 0˚ Mechanism mounted on the center of the long side of the tray
- 90˚ Mechanism mounted on the end of the tray

Mechanism Orientation - Type V 38 kV

- 90˚ Mechanism mounted on the end of the tray only
It is clear that demands for improved power quality will continue. Synchronized switching of capacitors and a variety of other loads can improve power quality while simultaneously extending circuit breaker life and reducing maintenance costs. A synchronous closing Type R circuit breaker can provide a cost effective solution for these critical applications on distribution systems.

It is well known that routine energization of capacitor banks can cause undesirable voltage and current transients on transmission and distribution systems. The maximum transients occur when the circuit breaker contacts close at the instant of peak voltage between the open contacts, where the difference between the system voltage and the capacitor bank voltage is greatest. In conventional circuit breaker applications, contact closing is random, which means that the transients generated are uncontrolled. Various methods have been implemented to limit the magnitude of the disturbances using pre-insertion resistors and current limiting reactors.

It is generally agreed that transients are reduced to acceptable levels when the contact closing occurs within plus or minus one millisecond of the voltage zero. To accomplish this, breaker performance must be predictable during all of the expected variations in operating conditions. These include ambient temperature, control voltage and mechanism linkage wear.

ABB began the project to develop the Type R vacuum circuit breaker for synchronous closing following a request by a large utility company for a breaker to be used in capacitor switching applications.

**Advantages of Vacuum Interruption**

**Maintenance**
The absence of oil as an insulating and interrupting medium minimizes the maintenance and servicing required. The mechanical life is 2,500 operations.

**Installation**
The forces generated during interruption are only those of the operating mechanism. This greatly simplifies foundation requirements.

**Duty Cycle**
No derating of interrupting capability is required, regardless of the reclosing duty cycle.

**Advantages of Zero Voltage Closing in Capacitor Switching Applications**

It is clear that demands for improved power quality will continue. Synchronized switching of capacitors and a variety of other loads can improve power quality while simultaneously extending circuit breaker life and reducing maintenance costs. A synchronous closing Type R circuit breaker can provide a cost effective solution for these critical applications on distribution systems.

The design is based on the following:
1. One mechanism operates all three poles simultaneously. Adjustments for phase timing are made in the mechanical linkage of each phase.
2. The control voltage is 125 VDC or 48 VDC.
3. Standard design vacuum interrupters are used.
4. Control timing is provided by the ABB Switchsync E113 in conjunction with the precision closing board.

The control provides zero voltage detection with an adjustable delay prior to initiating the closing signal. The calculated delay is based on the known closing time of the breaker and is selected so that contact closing will occur at the zero point of the voltage wave.

To compensate for variation in breaker operating time, the control is programmed to adjust the timing of the closing signal by averaging the difference between the timing of the two previous operations. This would adjust for any overall trends in the breaker performance.

Vacuum interrupters are ideal for this application. Prestrike distances are minimal and have little effect on overall timing. Contact wear is also minimal and will produce only minor variations between phases in normal operation. If found necessary, adjustments can be made on individual phases during routine inspection and servicing.

Oscillograms (Figures 1 - 3) show the improvements made by the addition of a synchronous closing scheme to a circuit breaker.

**Advantages of Zero Voltage Closing in Capacitor Switching Applications**

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The absence of oil as an insulating and interrupting medium minimizes the maintenance and servicing required. The mechanical life is 2,500 operations.

**Installation**
The forces generated during interruption are only those of the operating mechanism. This greatly simplifies foundation requirements.

**Duty Cycle**
No derating of interrupting capability is required, regardless of the reclosing duty cycle.

**Safety**
The use of air as the primary insulation minimizes the hazard from fire or explosion.

**Environment**
Arc extinction is silent and the sound level of the mechanism is low. Quiet operation is particularly desirable near hospitals, residential areas and shopping centers. No oil or gas to be handled or disposed.

**Advantages of Zero Voltage Closing in Capacitor Switching Applications**

It is clear that demands for improved power quality will continue. Synchronized switching of capacitors and a variety of other loads can improve power quality while simultaneously extending circuit breaker life and reducing maintenance costs. A synchronous closing Type R circuit breaker can provide a cost effective solution for these critical applications on distribution systems.

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3. Standard design vacuum interrupters are used.
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Oscillograms (Figures 1 - 3) show the improvements made by the addition of a synchronous closing scheme to a circuit breaker.
# Ratings comply with ANSI C37.06 - 1997

### Table 1: Vacuum Circuit Breaker Trays, Type R & Type V

<table>
<thead>
<tr>
<th>Voltage Class (kV)</th>
<th>15</th>
<th>15</th>
<th>15</th>
<th>15</th>
<th>27</th>
<th>38</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Current (A)</td>
<td>600</td>
<td>600</td>
<td>1200</td>
<td>2000</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>Breaker Type</td>
<td>R-1</td>
<td>R-3</td>
<td>R-3</td>
<td>R-3</td>
<td>R-3</td>
<td>V</td>
</tr>
<tr>
<td>Rated Max Voltage (kV)</td>
<td>15.5</td>
<td>15.5</td>
<td>15.5</td>
<td>15.5</td>
<td>27.0</td>
<td>38.0</td>
</tr>
<tr>
<td>Voltage Range Factor (K)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Frequency (Hz)</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

### Table 2: Stored Energy Mechanism Control Power Requirements, Type R & Type V

<table>
<thead>
<tr>
<th>Rated Spring Charge Voltage (A)</th>
<th>Control Run Motor or Trip Time Sec. (A)</th>
<th>Close Trip Time (Cycles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 VDC</td>
<td>8/-</td>
<td>14-28/-</td>
</tr>
<tr>
<td>48 VDC</td>
<td>9.9/9.0</td>
<td>16/16</td>
</tr>
<tr>
<td>27/36 VDC</td>
<td>36/36/36</td>
<td>28/28/28/28/28</td>
</tr>
<tr>
<td>125 VDC</td>
<td>5.0/5.0</td>
<td>37/37</td>
</tr>
<tr>
<td>140/190 VDC</td>
<td>90/90/90/90/90/90</td>
<td>70/70/70/70/70/70</td>
</tr>
<tr>
<td>250 VDC</td>
<td>5.0/3.0</td>
<td>5/5</td>
</tr>
<tr>
<td>180/280 VDC</td>
<td>180/180/280/280/280</td>
<td>140/140/140/140/140/140</td>
</tr>
<tr>
<td>120 VAC</td>
<td>5.0/5.0</td>
<td>104/104/104/104/104/104</td>
</tr>
<tr>
<td>208/254/280/280/280/280 a cap</td>
<td>104/104/104/104/104/104/104/104/104/104</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3: Available Contacts, Type R & Type V CB Trays

<table>
<thead>
<tr>
<th>Trip</th>
<th>Close</th>
<th>Motor</th>
<th>Available Contacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>cap trip</td>
<td>AC</td>
<td>AC</td>
<td>6a 6b</td>
</tr>
<tr>
<td>DC</td>
<td>AC</td>
<td>AC</td>
<td>6a 5b</td>
</tr>
<tr>
<td>DC</td>
<td>DC</td>
<td>AC or DC</td>
<td>5a 5b</td>
</tr>
</tbody>
</table>

The above table illustrates the number and type of contacts available for customer use when a single 16 pole switch is used in the above control combinations.

### Table 4: Interrupting Capacity of Auxiliary Switch Contacts, Type R & Type V CB Trays

<table>
<thead>
<tr>
<th>Volts</th>
<th>Non-Inductive Circuit</th>
<th>Inductive Circuit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single Contacts</td>
<td>Two Contacts in Series</td>
</tr>
<tr>
<td>24/48 VDC</td>
<td>40 A</td>
<td>40 A</td>
</tr>
<tr>
<td>125 VDC</td>
<td>11 A</td>
<td>25 A</td>
</tr>
<tr>
<td>250 VDC</td>
<td>2 A</td>
<td>5.5 A</td>
</tr>
<tr>
<td>115 VAC</td>
<td>75 A</td>
<td>75 A</td>
</tr>
<tr>
<td>230 VAC</td>
<td>40 A</td>
<td>70 A</td>
</tr>
</tbody>
</table>

Contacts will carry 15 A continuously or 250 A for 3 secs

### Table 5: Overall Dimensions

<table>
<thead>
<tr>
<th>kV</th>
<th>Height</th>
<th>Width</th>
<th>Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>40.0</td>
<td>31.0</td>
<td>29.0</td>
</tr>
<tr>
<td>27</td>
<td>43.0</td>
<td>37.0</td>
<td>29.0</td>
</tr>
<tr>
<td>38</td>
<td>64.0</td>
<td>53.0</td>
<td>31.0</td>
</tr>
</tbody>
</table>

Dimensions are in inches.