Joslyn Hi-Voltage® Capacitor Switches

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Joslyn Hi-Voltage® Capacitor Switches

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Overview

Why Use Joslyn Hi-Voltage® Capacitor Switches?

There are four major reasons for using switched power capacitors:

1. To reduce losses caused by reactive load current
2. To reduce kVA demand
3. To improve voltage profile
4. To increase revenue or decrease customer energy consumption

Switched capacitor banks can dramatically reduce losses caused by the reactive component of the load. The resistance of the feeder conductors causes about 60% of a system’s energy loss. Thus, it is important to locate the power capacitors on the feeders as close to the load as practical. Losses can be reduced by 89% by installing one bank that is only two-thirds as large as the peak load kVAR. Typically, the VAR sensing control should be set to switch the bank to close when the load inductive current equals two-thirds of the bank capacitive current. Even though this scheme drives the line leading when the bank is first turned on and before it is turned off, the loss reduction is optimum for a single bank.

The reduction in reactive current caused by a switched power capacitor also reduces the total line current. This reduction in kVA demand during heavy load periods has a number of benefits:

- The peak allowable loading is increased when it is most needed
- The effective ampacity of the lines is increased
- The operating temperatures of the lines and transformers are reduced, increasing equipment life
- The necessity to upgrade lines and transformers may be delayed

The demand capacity of distribution feeders is usually limited by voltage drop along the line. The service entrance voltage of all customers must be kept within certain limits, usually +5 to +10%. “Flattening” the feeder voltage profile offers several benefits:

- The kVA demand can be increased
- The substation voltage can be lowered to reduce peak demand and save energy
- The service entrance voltage can be allowed to increase, resulting in increased revenue

When one bank on a feeder is switched on, the entire feeder voltage, upstream and downstream from the bank, is increased. Additional banks on the line will add to the voltage rise, so that all active capacitors contribute to the shape of the voltage profile along the entire feeder.

Joslyn Hi-Voltage® capacitor and reactor switches, together with Fisher Pierce® capacitor controls, provide a complete solution to optimize losses, voltage, kVA demand and, ultimately, revenue in electrical systems from 15 to 230kV.
Overview

Power & High Voltage — Joslyn Hi-Voltage® Capacitor Switches

Varmaster VBM Switch 15kV–69kV

VerSaVac® Three-Phase Switch 15kV–38kV

Varmaster VBM Switch with VacStar® Vacuum Interrupter Monitor 15kV–69kV

VBU Switch 69kV–230kV
VerSaVac® 15–38kV Capacitor Switches

Solenoid operating mechanism offers the longest life of any distribution capacitor switch — 100,000 maintenance-free operations!

Joslyn Hi-Voltage® VerSaVac® Capacitor Switches

- Synchronized operation from a fast, repeatable solenoid operating mechanism ensures all phases will operate within 1/4 cycle — unlike slow motor-operated devices — reducing recovery voltage when the bank is switched off, which, in turn, reduces electrical stress on capacitor bank insulation
- Optional Zero Voltage Closing (ZVC) Control mitigates transients associated with bringing capacitor banks online, virtually eliminating costly customer equipment damage resulting from voltage spikes created when switching capacitor banks
- Retrofits to existing oil switch power supply transformer impedances and existing 14 AWG oil switch wiring*
- Optional manual trip lever not mechanically connected to operating mechanism to eliminate wear during normal operation
- Vacuum interruption and solid dielectric Joslyte insulation — no oil, no gas, no maintenance
- Long-life solenoid operating mechanism yields 100,000 maintenance-free operations (50,000 open and 50,000 close)
- Models support grounded and ungrounded systems in a variety of applications, 15–38kV, single- or three phase
- Compatible with existing oil switch or vacuum switch installations
- Available with Vacstat® Vacuum Interrupter Monitor that provides local/remote status of vacuum bottle and can block operation if a problem is detected
- Field-proven reliable design — more than 150,000 worldwide installations and more than 20 years of operational experience
- Select porcelain or polymer housing

* See I 750-271 Single-Phase VerSaVac® Switch Installation and Operating Procedure for complete details.

The Joslyn Hi-Voltage® VerSaVac® Capacitor Switch is a completely sealed vacuum switch that provides an operational life of more than 100,000 (50,000 open/50,000 close) maintenance-free operations — greater than other switches used for pole-top capacitor switching. Specifically designed as a replacement for maintenance-intensive oil switches, the VerSaVac® switch can be used as a direct replacement on existing capacitor banks or supplied by capacitor manufacturers on new banks. The VerSaVac® switch not only results in substantial savings from reduced maintenance and maximized capacitor bank uptime, but also improves power quality.
VerSaVac® 15–38kV Capacitor Switches

VerSaVac® Single-Phase Capacitor Switch

No Oil or Gas
Vacuum interruption and solid dielectric Joslyte insulation around vacuum bottle. This material is non-hydroscopic and absorbs stresses from the thermal expansion and shock. Joslyte insulation has been field-proven for more than 40 years.

Synchronized Operation
The fast and repeatable solenoid operating mechanism ensures all phases will operate within 1/4 cycle, unlike slow motor-operated devices, reducing the recovery voltage when the bank is being switched off, which in turn reduces the electrical stress on the insulation of the capacitor bank.

Exceeds electrical requirements of ANSI C37.66

Zero Voltage Closing (ZVC) Control
Optional Zero Voltage Closing control mitigates transients associated with bringing capacitor banks online. It virtually eliminates costly customer equipment damage resulting from voltage spikes created when switching capacitor banks.

Porcelain or Cycloaliphatic Epoxy Housing

Long-Life Solenoid Mechanism
Provides 100,000 operations (50,000 open/50,000 close).

Optional Manual Trip Lever

Position Indicator (Bottom View)
Highly visible reflective lettering indicates switch position.

Bladder completely seals switch system.
VerSaVac® 15–38kV Capacitor Switches

Eliminate costs associated with off-line vacuum interrupter inspections by using the VerSaVac® Single-Phase Capacitor Switch with Vacstat® Vacuum Interrupter Monitor.

- Continuously monitors vacuum interrupter status while the switch is energized and in service
- Reduces operating and maintenance costs by eliminating the need for routine off-line vacuum interrupter inspections
- Blocks switch operation if vacuum loss is detected and protects your equipment and personnel from potential harm
- Provides local and remote indication of vacuum interrupter status — enables operating and maintenance personnel to take corrective action immediately in the event of loss of vacuum, maximizing system reliability
- SCADA notification available

The Vacstat® Vacuum Interrupter Monitor is the only system that can give you real-time status of your vacuum interrupters. This simple device notifies you immediately of a loss of vacuum through a visual indicator located on the switch and via a contact in the VerSaVac® Switch control. The Vacstat monitor will also block further operation of the switch.

Use the Vacstat® Vacuum Interrupter Monitor to:
- Increase reliability
- Reduce maintenance costs
- Reduce the risk of harm to employees and assets

How the Vacstat® Vacuum Interrupter Monitor works.

The Vacstat® sensor is attached to the vacuum interrupter of a VerSaVac® capacitor switch during the manufacturing process. The sensor then continuously monitors the interrupter for the presence of vacuum.

Once the capacitor switch is installed, the sensor generates an optical signal that travels via a pair of fiber optic cables to a control board in the low-voltage section of the switch. As long as vacuum exists, the fiber optic signal has a continuous path, and the Vacstat® indicator remains in the normal (unalarmed) state.

If a loss of vacuum occurs, the sensor blocks the optical signal to the control board, and the Vacstat status indicator automatically turns to red to alert the operator to the problem. In addition, the remote status dry contact provides a means to send an alarm signal to a remote location. The Vacstat monitor also blocks further electrical operation of the switch to prevent possible damage to equipment or injury to personnel.
**VerSaVac® 15–38kV Capacitor Switches**

Typical VerSaVac® Single-Phase Installation

![Diagram of VerSaVac® Single-Phase Installation]

- **Power Transformer**
- **Control Power Neutral Lead**
- **Cap Control Power Lead**
- **VSV Switch Junction Box**
- **VSV Switches, 8-Foot 16 AWG Cable**
- **Neutral Lead**
- **Control Power “Hot” Lead**
- **Epoxy Powder Coated Steel Housing**
- **One-Piece Porcelain or Epoxy Interrupter Module Assembly and Line Ground Insulator on ZA12 Zinc Aluminum Alloy Casting**
- **Eyebolt Type Terminals for 8 Solid to 2/0 Copper Cable**
  (Max. Torque on Terminal Studs = 216 in.-lbs. [24.4Nm])
- **Center to Center, Top and Side Terminals**
- **2½” (63.5mm)**
- **2” (50.8mm)**
- **1½” (38.1mm)**
- **1” (25.4mm)**
- **8” (203.2mm)**
- **7½” (190.5mm)**
- **6” (152.4mm)**
- **5¾” (146.1mm)**
- **5¼” (133.4mm)**
- **4½” (114.3mm)**
- **3½” (89.6mm)**
- **3” (76.2mm)**
- **2½” (63.5mm)**
- **2” (50.8mm)**
- **1½” (38.1mm)**
- **1⅞” (47.6mm)**
- **1⅜” (34.9mm)**
- **3/16” (4.8mm)**
- **Center to Center, Top and Side Terminals**
- **Grounding Connection, ½–13UNC Galvanized Steel Bolt, Nut, Flat & Lock Washer**
- **Control Cable Receptacle, MS3102R18, 1⅛ – 18 UNEF Threads**
- **Internal Position Indicator Sight Glass, “Open–Closed” Reflectant Lettering on Green–Red Background**
- **Note:** Non-Trip Handle Switches Can Be Rotated by Loosening the Lug Bolts, and Retightening to 45 in.-lbs. (5.1Nm)

Dimensions and Creepage Distances for Joslyn Hi-Voltage® VerSaVac® Single-Phase Capacitor Switch

<table>
<thead>
<tr>
<th>MAX. VOLTAGE</th>
<th>LINE TO GROUND KV BIL</th>
<th>LINE TO GROUND INSULATION CREEPAGE DISTANCE IN. (MM)</th>
<th>X IN. (MM)</th>
<th>Y IN. (MM)</th>
<th>Z IN. (MM)</th>
<th>WEIGHT LBS. (KG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15kV</td>
<td>95</td>
<td>12.63 (320.7)</td>
<td>14 (355.6)</td>
<td>23.63 (600.1)</td>
<td>7.94 (201.6)</td>
<td>27.5 (12.5)</td>
</tr>
<tr>
<td>15kV</td>
<td>125</td>
<td>17.19 (436.6)</td>
<td>16 (406.4)</td>
<td>25.63 (650.9)</td>
<td>7.94 (201.6)</td>
<td>28.5 (12.9)</td>
</tr>
<tr>
<td>27kV</td>
<td>125</td>
<td>17.19 (436.6)</td>
<td>17 (431.8)</td>
<td>26.63 (676.3)</td>
<td>8.94 (227.0)</td>
<td>30.8 (14.3)</td>
</tr>
<tr>
<td>27kV</td>
<td>150</td>
<td>19.44 (493.7)</td>
<td>18 (457.2)</td>
<td>27.63 (701.7)</td>
<td>8.94 (227.0)</td>
<td>32.8 (14.8)</td>
</tr>
</tbody>
</table>
# VerSaVac® 15–38kV Capacitor Switches

## Ratings

<table>
<thead>
<tr>
<th>Exceeds Electrical Requirements of ANSI C37.66</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Current</td>
</tr>
<tr>
<td>Short-Time Current</td>
</tr>
<tr>
<td>Asymmetrical Momentary/Making Current</td>
</tr>
<tr>
<td>Peak Inrush Current Limit for Parallel or Back-to-Back Switching Applications</td>
</tr>
</tbody>
</table>

| Control Voltages                              | 120VAC, 240VAC (see accessories, p. H-170) |
| Minimum Operating Voltage                     | 80VAC, 160VAC |
| Recommended Control Pulse Time                | 100 msec. |
| Auxiliary Contact Rating                      | 15A @ 120VAC, .5A @ 125VDC |

## Voltage Class (kV)

<table>
<thead>
<tr>
<th>Maximum Voltage</th>
<th>27.5</th>
<th>38</th>
<th>38</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Solid Grounded Applications (kV)</td>
<td>15.5</td>
<td>27.5</td>
<td>N/A</td>
</tr>
<tr>
<td>- Ungrounded Applications (kV)</td>
<td>12.47</td>
<td>22.5</td>
<td>N/A</td>
</tr>
<tr>
<td>- Ungrounded Applications with Manual Trip* (kV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impulse Withstand (kV BIL)</td>
<td>95</td>
<td>125</td>
<td>150</td>
</tr>
<tr>
<td>- Line to Ground</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Open-Gap</td>
<td>95</td>
<td>95/125</td>
<td>125</td>
</tr>
<tr>
<td>Power Frequency AC Withstand Dry/Wet (kV RMS)</td>
<td>36/30</td>
<td>60/50</td>
<td>70/60</td>
</tr>
</tbody>
</table>

* Units equipped with manual trip handle.
VerSaVac® 15–38kV Capacitor Switches

VerSaVac® Three-Phase Capacitor Switch

The VerSaVac® switch is a completely sealed, long-life vacuum switch that provides an operational life of over 100,000 (50,000 open/50,000 close) maintenance-free operations. This results in an operational life greater than other switches used for pole-top capacitor switching. The VerSaVac® switch was specifically designed as a replacement for maintenance-intensive oil switches and can be used as a direct replacement on existing banks or supplied by capacitor manufacturers on new banks. Using the VerSaVac® switch will result in substantial savings from reduced maintenance and maximized bank uptime and will also improve power quality.

No Oil or Gas
Vacuum interruption and solid dielectric Joslyte insulation around vacuum bottle. This material is non-hydroscopic and absorbs stresses from thermal expansion and shock. Joslyte insulation has been field proven for more than 40 years.

Compatibility
VerSaVac® switches are compatible with existing oil switch or vacuum switch installations.

Reliability
Proven design with over 150,000 worldwide installations and over 35 years of operational experience.

Exceeds Electrical Requirements of ANSI C37.66

*See I 750-272 Three-Phase VerSaVac® Switch Installation and Operating Procedure for complete details
**VerSaVac® 15–38kV Capacitor Switches**

**Typical VerSaVac® Three-Phase Switch Installation**

**Dimensions and Creepage Distances for Joslyn Hi-Voltage® VerSaVac® Three-Phase Capacitor Switch**

<table>
<thead>
<tr>
<th>LINE TO GROUND KV BIL</th>
<th>LINE TO GROUND INSULATION CREEPAGE DISTANCE IN. (MM)</th>
<th>X IN. (MM)</th>
<th>Y IN. (MM)</th>
<th>Z IN. (MM)</th>
<th>H IN. (MM)</th>
<th>WEIGHT LBS. (KG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
<td>12.63 (321)</td>
<td>14 (356)</td>
<td>17.25 (438)</td>
<td>23.63 (600)</td>
<td>7.94 (202)</td>
<td>75 (34.0)</td>
</tr>
<tr>
<td>125</td>
<td>17.19 (437)</td>
<td>16 (406)</td>
<td>19.25 (489)</td>
<td>25.63 (651)</td>
<td>7.94 (202)</td>
<td>78 (35.4)</td>
</tr>
<tr>
<td>150</td>
<td>19.44 (494)</td>
<td>18 (457)</td>
<td>21.25 (540)</td>
<td>27.63 (702)</td>
<td>8.94 (227)</td>
<td>85 (38.6)</td>
</tr>
</tbody>
</table>
VerSaVac® 15–38kV Capacitor Switches

VerSaVac® Single- and Three-Phase Capacitor Switch

To order a basic VerSaVac® Switch, the catalog number would be constructed as follows:

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Phase</th>
<th>Grounded Maximum System Voltage</th>
<th>Ungrounded Max. System Voltage</th>
<th>BIL (L-G/L-L)</th>
<th>Housing Material</th>
<th>Vacstat® Monitor*</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSV</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1-Phase</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3-Phase</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trip Lever</td>
<td>2</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>45 Manual Trip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>180 Manual Trip</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>3-Ph. Trip Lever</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Vacstat® Vacuum Interrupter Monitor available only in single-phase switches.
* For more information on the Vacstat® Vacuum Interrupter Monitor, see page H-156.

Indicates sequential numbers. Sequential numbers are used for controls and other accessories.
Varmaster VBM 15–69kV Capacitor and Reactor Switches

For substation capacitor and reactor switching.

Joslyn Hi-Voltage® Varmaster
VBM Switching Systems

- Vacuum interruption and solid dielectric Joslyte insulation — no oil, no gas, no maintenance
- Depending on operating mechanism and control voltage selection, offers up to 100,000 maintenance-free operations
- 15kV–69kV system range, substation or pole mounted installations
- Available Vacstat® Vacuum Interrupter Monitor provides local/remote status of vacuum bottle and can block operation if a problem is detected
- Available Zero Voltage Closing (ZVC) Control mitigates the system overvoltages and high inrush currents typically associated with bringing capacitor banks online, preventing resulting customer equipment damage and stress on capacitors
- Compact and lightweight, no special foundations or support required
- Completely sealed construction provides safe interruption with no external arcing and quiet yet high-speed operation
- Factory-assembled for fast, easy, low-cost installation
- Solenoid or motor operating mechanism with AC or DC control voltage

Joslyn Hi-Voltage® Varmaster switching systems use VBM switches that are completely sealed, breaker-class devices using a vacuum as the interrupting dielectric. VBM switches offer high reliability with little or no maintenance and quiet, safe interruption with no external arcing. Manufactured for system voltages from 15kV to 69kV, VBM switches are electrically connected in series to provide the necessary recovery voltage characteristics for the specific application. They may also be electrically connected in parallel for high continuous or momentary current requirements. VBM switches ship completely factory-assembled, ready for fast, easy installation requiring no special foundations or supports due to their compact, lightweight design. Each vacuum interrupter is enclosed in a shatterproof, high-dielectric housing to form a module designed with all solid insulation. The interrupter is surrounded by Joslyte high-dielectric, non-hydroscopic solid insulation that does not absorb moisture, eliminates condensation and increases the impulse level on the outside of the vacuum interrupter. No gas, oil or other material is required to maintain electrical properties.

One or two vacuum modules are mounted on each line-to-ground insulator and connected to the operating mechanism by a high-strength pull rod. The operating mechanism is completely sealed in a housing that supports the line-to-ground insulators and the modules. An environmental protection system in the housing, consisting of a breather chamber and desiccant, prevents moisture and contaminated air from entering the switch operator, and an “Open/Closed” position indicator is directly coupled to the mechanism. The entire assembly can withstand a force of several G’s without damage.

Stored-energy operating mechanisms, which can be operated manually or electrically, move the contacts at high speed and are unaffected by control voltage fluctuation or manual operating speed. Each switch features an operation counter. A wide range of AC and DC voltage control package options are available. All electrical control connections to the operating mechanism are made through a single environmental-control cable connector.
Varmaster VBM 15–69kV Capacitor and Reactor Switches

VBM Switch Construction

The VBM switch is manufactured in voltage ratings from 15kV to 69kV with continuous current capabilities from 200A to 600A. The mechanism may be operated manually, or electrically by solenoid or motor operators.

Single Vacuum Module Cutaway

The assembly containing the vacuum interrupter is called a module. Each module has a vacuum interrupter contact sealed in Joslyte solid dielectric insulation, which provides mechanical strength, high dielectric strength and complete moisture sealing. The module housing is cycloaliphatic or EPR rubber bonded to a fiberglass tube. One or two modules are mounted on each insulator and connect to the mechanism by a high-strength pull rod.
Varmaster VBM 15–69kV Capacitor and Reactor Switches

Varmaster VBM Switch with Vacstat® Vacuum Interrupter Monitor alerts you immediately of loss of vacuum!

- Continuously monitors vacuum interrupter status while the switch is energized and in service
- Reduces operating and maintenance costs by eliminating the need for routine off-line vacuum interrupter inspections
- Blocks switch operation if vacuum loss is detected and protects your equipment and personnel from potential harm
- Provides local and remote indication of vacuum interrupter status and enables operating and maintenance personnel to take corrective action immediately in the event of loss of vacuum, maximizing system reliability
- SCADA notification available

The Joslyn Hi-Voltage® Vacstat® Vacuum Interrupter Monitor provides you real-time status monitoring of your vacuum interrupters. This simple device notifies you immediately of a loss of vacuum through a visual indicator located on the switch and via a contact in the switch control. Once the Vacstat® Vacuum Interrupter Monitor senses a loss of vacuum, all switch operations will be blocked until the switch has been serviced.

How the Vacstat® Vacuum Interrupter Monitor works.

The Vacstat® sensor is attached to the vacuum interrupter of a Varmaster VBM Switch during the manufacturing process. The sensor then continuously monitors the interrupter for the presence of vacuum.

Once the capacitor switch is installed, the sensor generates an optical signal that travels via a pair of fiber optic cables to a control board in the low-voltage section of the switch. As long as vacuum exists, the fiber optic signal has a continuous path, and the Vacstat® indicator remains in the normal (unalarmed) state.

If a loss of vacuum occurs, the sensor blocks the optical signal to the control board, and the Vacstat® status indicator automatically turns to red to alert the operator to the problem. In addition, the remote status dry contact provides a means to send an alarm signal to a remote location. The Vacstat® monitor also blocks further electrical operation of the switch to prevent possible damage to equipment or injury to personnel.
Varmaster VBM 15–69kV Capacitor and Reactor Switches

Varmaster VBM Switch Models

Three Phase
15kV/25kV* 400A
15kV/25kV* 600A
* 25kV rating for solidly grounded capacitor bank configurations only.

Three Phase
25kV 200A
25kV 300A
25kV 400A

One Pole*
38kV 400A
38kV 600A
48.5kV 200A**
* Three poles required for a three-phase installation.
** Solidly grounded capacitor bank configurations only.

One Pole*
72.5kV 300A
* Three poles required for a three-phase installation.

* Three poles required for a three-phase installation.
Varmaster VBM 15–69kV Capacitor and Reactor Switches

Varmaster VBM Switch Options and Accessories

Operating Mechanisms

A solenoid mechanism has an expected maintenance-free life of 100,000 operations on AC and 15,000 operations on DC. Controls for solenoid operators are mounted in a separate enclosure.

A motor operator is only used on single-mechanism three-phase Varmaster VBM switches, such as 15kV, 400A and 600A models and 34.5kV, 300A models. All controls are located inside the VBM mechanism housing. Inspection after 10,000 operations is recommended.

The completely sealed operating mechanism housing supports line-to-ground insulators and the modules. An expansion bag in the housing prevents the intake of contaminants or moisture and contains a desiccant package to maintain dry air.

All electrical control connections to the mechanism are made through a single environmental control cable connector.

An “open-closed” position indicator is directly coupled to the mechanism. A separate operating crank enables manual operation of the switch. The entire assembly can withstand several G’s without damage. Note that there may be one or more mechanisms for a three-phase Varmaster VBM switch.

Operating Mechanism Options

<table>
<thead>
<tr>
<th>CONTROL VOLTAGE</th>
<th>OPERATING MECHANISM</th>
<th>CONTROL CURRENT PER SWITCH MECHANISM</th>
<th>CLOSE TIME¹</th>
<th>TRIP TIME²</th>
<th>AUXILIARY CONTACTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC 120V</td>
<td>Motor³</td>
<td>5A</td>
<td>3 sec.</td>
<td>2 cycles</td>
<td>2 A and 2 B¹</td>
</tr>
<tr>
<td>AC 120V</td>
<td>Solenoid³</td>
<td>60A¹, ²</td>
<td>6 cycles</td>
<td>6 cycles</td>
<td>4 A and 4 B²</td>
</tr>
<tr>
<td>DC 48V</td>
<td>Motor³</td>
<td>3A</td>
<td>5 sec.</td>
<td>2 cycles</td>
<td>2 A and 2 B²</td>
</tr>
<tr>
<td>DC 48V</td>
<td>Solenoid³</td>
<td>60A¹, ²</td>
<td>6 cycles</td>
<td>6 cycles</td>
<td>4 A and 4 B²</td>
</tr>
<tr>
<td>DC 125V</td>
<td>Motor³</td>
<td>4A</td>
<td>3 sec.</td>
<td>2 cycles</td>
<td>2 A and 2 B²</td>
</tr>
<tr>
<td>DC 125V</td>
<td>Solenoid³</td>
<td>60A¹, ²</td>
<td>6 cycles</td>
<td>6 cycles</td>
<td>4 A and 4 B²</td>
</tr>
<tr>
<td>DC 250V</td>
<td>Solenoid³</td>
<td>60A</td>
<td>6 cycles</td>
<td>6 cycles</td>
<td>4 A and 4 A²</td>
</tr>
</tbody>
</table>

1. Two A and two B mechanically operated contacts are standard. Six A and six B contacts are available as an option. Contacts are rated at 10A, 125VDC or 115VAC.

2. Four A and four B contacts available from auxiliary relay. Eight A and eight B contacts are available as an option. Contacts are rated at 15A, 120VAC and 10A, 125VDC.

3. For capacitor or reactor switching, a low-energy control is available. See Options and Accessories.

4. Close or Trip Times are measured from applying of close or trip signals. Vacuum contact travel time is six milliseconds. All Varmaster VBM switches have built-in anti-pump controls.

5. Motor operating mechanisms are designed for single-mechanism three-phase switches only.

6. Current is 60A peak for one-, two- or three-mechanism switch systems.

7. Current is 120A for the 34.5kV, 300A Varmaster VBM switch.

8. Current for three-mechanism switch systems is approximately 180A peak for three cycles.
Varmaster VBM 15–69kV Capacitor and Reactor Switches

Varmaster VBM Switch Clearance Requirements

For Varmaster VBM switches with multiple vacuum interrupters in series, a 32” (813mm) clearance must be maintained from all switch line parts to adjacent equipment, such as buses, reactors, CTs, transformers or frames. Adjacent equipment also includes high-voltage conductors, which must run horizontally for at least 32” before bending upward.

Failure to meet this clearance requirement will adversely affect the electrical voltage distribution and electromagnetic field within the interrupters during opening and closing operations. This insufficient clearance can prevent proper interruption within the vacuum switch interrupters, resulting in undesirable restrikes during opening operations for some application parameters.

32” Clearance around 38kV Single-Phase Interrupters, Front View

Incorrect — High-Voltage Conductor is within 32-Inch Area

Correct — High-Voltage Conductor is outside 32-Inch Area

Two Interrupters in Series with Bus Bar

32” Clearance around 38kV Single-Phase Interrupters, Side View

32”
Varmaster VBM 15–69kV Capacitor and Reactor Switches

One Interrupter per Phase, 32" (813mm) Clearance Not Required

Two or More Interrupters per Phase, 32" (813mm) Clearance Required

Note: The 32" (813mm) clearance requirement does not apply to Varmaster VBM switches with only one interrupter per phase, as shown above. All other configurations shown must maintain the 32" (813mm) clearance.
Varmaster VBM 15–69kV Capacitor and Reactor Switches

Varmaster VBM Terminal Pad Orientation
Options for Single-Mechanism Switches

High-Voltage Connections

Varmaster VBM switches have terminal pads made of aluminum alloy with standard NEMA two-hole drilling. The electrical connection at the terminal pad must be treated with Alcoa No. 2 joint compound or equivalent. Remove the brown paper from the terminal pad before making electrical connections. Wire brushing through the compound will improve the connection.

Terminal Pad

![Diagram of Varmaster VBM Terminal Pad Orientation](image-url)
Varmaster VBM 15–69kV Capacitor and Reactor Switches

Dimensions for Three-Phase Switch, 15kV/25kV* Grounded 400A, 15kV/25kV* Grounded 600A

Dimensions for Three-Phase Switch, 25kV 200A, 25kV 300A, 25kV 400A

Weight: 148lb. (67kg) maximum.

Weight: 225lb. (102kg) maximum.

* Solid grounded systems and capacitor bank only.
Varmaster VBM 15–69kV Capacitor and Reactor Switches

Dimensions for Three-Phase Switch, 38kV 300A

- Terminal Pads: 67⅜" (1,721mm)
- 61¾" (1,569mm)
- 30⅞" (783mm)
- 44⅞" (1,135mm)
- 22⅝" (568mm)

Front View

Weight: 225lb. (102kg) maximum.

Dimensions for One-Pole* Switch, 38kV 400A, 38kV 600A, 48.5kV 200A**

- Control Cable Socket
- Clear Space Required for Removal of Mechanism Cover

Front View

Weight: 180lb. (82kg) maximum.

* Three poles are required for a three-phase installation.
** Solidly grounded 48kV capacitor bank configuration.

Note: Other insulation ratings are available for extra creepage.
**Varmaster VBM 15–69kV Capacitor and Reactor Switches**

### Dimensions for One-Pole* Switch, 48.5kV 300A, 48.5kV 400A

- **Front View**
  - 31” (787mm)
  - 36⅞” (926mm)
  - 24⅛” (619mm)
  - 5⅛” (140mm)
  - 48⅛” (1,220mm)
  - 44” (1,118mm)
  - 42” (1,067mm)
  - 24⅜” (622mm)
  - 5⅛” (140mm)

- **Side View**
  - 57⅜” (1,465mm)
  - 6⅜” (165mm)
  - 9⅞” (223mm)

### Dimensions for One-Pole* Switch, 72.5kV 300A

- **Front View**
  - 31” (787mm)
  - 30⅞” (783mm)
  - 25⅛” (641mm)
  - 42” (1,067mm)
  - 39⅞” (994mm)
  - 173⁄16” (44mm)
  - 155⁄16” (39mm)
  - 135⁄16” (34mm)
  - 121⁄2” (32mm)

- **Side View**
  - 55⅛” (1,408mm)
  - 6⅜” (165mm)
  - 8⅛” (223mm)

---

*Weight of one-pole switch: 200lb. (91kg) maximum.

*Three poles are required for a three-phase installation.

---

**Power & High Voltage — Joslyn Hi-Voltage® Capacitor Switches**

**United States**
Tel: 901.252.8000
800.816.7809
Fax: 901.252.1354

**Technical Services**
Tel: 888.862.3289

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**Thomas Betts**
Tel: 901.252.8000
800.816.7809
Fax: 901.252.1354

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**H-172**
Varmaster VBM 15–69kV Capacitor and Reactor Switches

VBM Switch Ratings

<table>
<thead>
<tr>
<th>MAXIMUM VOLTAGE</th>
<th>15.5kV/25kV</th>
<th>25kV</th>
<th>38kV</th>
<th>48.5kV</th>
<th>72.5kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacitor and Load Switching Current (Amps)</td>
<td>400 600</td>
<td>200 300</td>
<td>400</td>
<td>300 400 600</td>
<td>200 300 400 300</td>
</tr>
<tr>
<td>Fault Interrupting Current (kA)</td>
<td>3 4</td>
<td>3 3 3</td>
<td>3 3 4</td>
<td>4 3 3 3</td>
<td></td>
</tr>
<tr>
<td>Momentary Current (kA RMS, Asymmetric)</td>
<td>20 20</td>
<td>15 15 15</td>
<td>15 20 20</td>
<td>20 15 15 15</td>
<td></td>
</tr>
<tr>
<td>Impulse Withstand (KV BIL) Terminal-to-Terminal</td>
<td>110 110</td>
<td>200 200</td>
<td>200 200</td>
<td>200 250 250</td>
<td>250</td>
</tr>
<tr>
<td>Line-to-Ground (KV BIL) (1.2 x 50 Positive Wave)</td>
<td>150 150</td>
<td>150 150</td>
<td>150 200</td>
<td>200 250 250</td>
<td>350 250 250 280</td>
</tr>
</tbody>
</table>

Maximum 60-Cycle Withstand Line-to-Ground (kV)

| One Minute Dry | 101 101 | 101 101 | 101 101 | 138 138 138 | 178 178 178 |
| Two Seconds Wet | 74 74 | 74 74 | 74 74 | 119 119 119 | 176 176 176 176 |
| Maximum Peak Making Current (kA) | 20 20 | 15 15 15 | 15 20 20 | 20 15 15 15 |
| Maximum Peak Back-to-Back Inrush Current (kA) | 8 8 | 8 8 | 8 10 10 | 10 8 8 8 |
| Two-Second Current (Amps) | 12,500 |
| Four-Second Current (Amps) | 9,000 |

Notes:

1. Varmaster VBM switches can switch loads of any power factor up to their continuous current rating. Include effects of voltage variances, harmonic currents and load tolerances in calculating continuous current.
2. Varmaster VBM switches are available with continuous current ratings through 3,000A for non-capacitor bank applications. Consult your T&B representative regarding application of these switches.
3. Grounded systems only at 25kV.
4. In capacitor switching applications, the 48.5kV, 200A Varmaster VBM may be used on solidly grounded systems and grounded capacitor banks with total current less than 200A. For all other loads, this VBM rating is 600A.
5. Interrupter portion of switch does not provide a visible open gap; therefore, it cannot be used to establish a safety clearance for personnel.
6. In back-to-back capacitor bank switching applications, it is recommended that inrush current be limited to the values shown for maximum maintenance-free performance. Current limiting reactors through 60 microhenries/phase are available from Joslyn Hi-Voltage®. Refer to Joslyn Hi-Voltage® bulletin T.D. 750-457.
Varmaster VBM 15–69kV Capacitor and Reactor Switches

Varmaster Three-Phase Capacitor Switch

To order a basic Varmaster Switch, the catalog number would be constructed like this:

VBM 3 15 3 M S N X X X X

Model Number

Number of Poles

1 1 Pole
3 3 Pole

Continuous Current

4 2 200 Amps
3 300 Amps
4 400 Amps
6 600 Amps

Operating Mechanism

5 M Motor
S Solenoid

Terminal Pad Orientation

6 S Standard
A A-Alternate*
B B-Alternate*
C C-Alternate*
D D-Alternate**

VacStat Monitor***

7 N No
Y Yes

Maximum System Voltage

2–3 15 15.5kV
22 22kV
25 25.8kV
38 38kV
48 48.5kV
72 72.5kV

Indicates sequential numbers. Sequential numbers are used for controls and other accessories.

* Apply only to 15kV through 38kV 300A. For more information on Terminal Pad orientation, see page H-169.

** Apply to 38kV and above. For more information on Terminal Pad orientation, see page H-169.

*** VacStat Vacuum Interrupter Monitor available only in 15kV through 38kV 300A three-phase switches. For more information on the VacStat Vacuum Interrupter Monitor, see page H-156.
VBU 69–230kV Capacitor Switches

Ideally suited for capacitor switching on 69kV to 230kV systems.

Joslyn Hi-Voltage® VBU Capacitor Switches

- Vacuum interruption and solid dielectric Joslyte insulation provide completely oil-free operation, and explosive or combustible materials won’t compromise the safety of personnel or equipment
- Modular design — change voltage rating simply by adding or removing vacuum contact modules
- Completely sealed construction for long, virtually maintenance-free service life, with no heaters or routine exercise required
- Wide choice of control options ensures dependable switching of magnetizing current, cable or line charging current or load current of any power factor
- Available Zero Voltage Closing (ZVC) Control closes three switch poles independently, synchronized with the occurrence of zero voltage in each phase, eliminating overvoltage duty on capacitors and system overvoltage disturbances

Joslyn Hi-Voltage® VBU Capacitor Switches are sealed against the environment, immune to ice and contamination and designed to withstand system voltage continuously in the open position. The completely sealed operating mechanism requires neither heaters nor routine exercise.

Suitable for all loads, the reliable vacuum interrupters in the VBU capacitor switches ensure dependable switching of magnetizing current, cable or line charging current or load current of any power factor. VBU capacitor switches are ideally suited for capacitor switching.

VBU capacitor switches can be applied on 69kV to 230kV systems. The flexibility of their modular design makes a change in the voltage rating of VBU capacitor switches as simple as adding or subtracting the appropriate number of vacuum contact modules.

VBU capacitor switches are free of explosive or combustible materials and are designed to be virtually maintenance-free. Normal operation inspections should be conducted every 5–10 years or 10,000 operations. Testing, when required, is fast and easy.

VBU capacitor switches ship completely assembled and adjusted. They are lightweight and easy to install, requiring a minimum of structural support and space. Less expensive to purchase and install than circuit breakers, they are often mounted on potential transformer stands and offer quiet yet high-speed operation.
**VBU 69–230kV Capacitor Switches**

**Interrupter Module**

Each vacuum interrupter module contains a vacuum interrupter mounted within an outer housing. Capacitors are connected in parallel with each vacuum interrupter to ensure uniform voltage distribution across all interrupter modules in an interrupter assembly. The space within the outer housing is filled with Joslyte solid dielectric insulation, which provides increased dielectric strength over the exterior of the vacuum interrupter and enables the module assembly to resist physical shock.

The electrical connection between interrupter modules is accomplished through the upper end flange and lower end flange. Current is transferred from the upper end flange to the movable contact end of the vacuum interrupter through laminated shunts. The non-moving end of the vacuum interrupter is connected directly to the lower end flange. The vacuum interrupter contacts are opened and closed by the module drawbar.

A pair of compression springs forces the drawbar upward — which opens the vacuum interrupter — and drawbar stop bolts limit the amount of upward motion of the module drawbar.

The stop bolts determine the separation of the vacuum contacts in the open position. The vacuum interrupter contacts close with a downward motion of the module drawbar. The downward motion also compresses the springs, providing stored energy for the opening operation.

After the module drawbar has been moved downward to the point where the vacuum contacts close, it is moved downward an additional distance. This distance is referred to as overtravel. During overtravel, the vacuum contacts are not moving since they are a butt design and are essentially fully closed once continuity is established. The overtravel of the module drawbar increases the stored energy in the opening springs and compresses the contact pressure spring. The contact pressure spring is preset so the amount of contact pressure is substantially independent of the amount of overtravel.

The module drawbars connect mechanically to each other and to the master drawbar by a pair of pull rods, which pass through each module. The master drawbar connects to the operating mechanism via the master pull rod located within the line-to-ground insulator.

---

**Diagram:**

1. Vacuum Interrupter
2. Outer Housing
3. Capacitors
4. Joslyte Solid Dielectric Insulation
5. Upper End Flange
6. Lower End Flange
7. Movable Contact End
8. Laminated Shunts
9. Module Drawbar
10. Compression Springs
11. Drawbar Stop Bolts
12. Contact Pressure Spring
13. Pull Rods
14. Master Drawbar
15. Master Pull Rod
VBU 69–230kV Capacitor Switches

Position Indicator

A visual position indicator attaches to each mechanism housing. It directly activates by movement of the primary switch mechanism. Auxiliary switch contacts are available in each VBU pole for remote indication of VBU position and interlocking the VBU with other equipment.

Operating Mechanism

Each pole of the VBU contains an operating mechanism; there is no mechanical interphase connection. The vacuum interrupters are held in the open position by the opening springs located in each interrupter module. The operating mechanism utilizes solenoids to impart a downward motion to the master pull rod, which pulls the vacuum interrupters to the closed position. The operating mechanism linkages then lock in an overtoggle position to restrain the contacts in the closed position. When the mechanism reaches the closed overtoggle position, the close solenoids are automatically de-energized. The VBU is opened by energizing a low-energy trip solenoid. The solenoid untoggles the mechanism and removes the restraining force that holds the contacts closed. This action enables the opening springs within the interrupter modules to open the vacuum contacts.
General Description

The major components of a Joslyn Hi-Voltage® VBU Capacitor Switch are the interrupter assembly, the insulator assembly and the operator assembly.

The interrupter assembly is a modular design that connects vacuum interrupter modules electrically in series. The number of vacuum interrupter modules is determined by recovery voltage considerations. The interrupter assembly is connected to the operating mechanism with an insulating operating rod located within the hollow line-to-ground insulator assembly.
VBU 69–230kV Capacitor Switches

Specifications and Ratings

The VBU capacitor switch yields a very long service life with a modular design including vacuum interrupter modules connected electrically in series and mechanically in parallel. The VBU system is supplied with the appropriate number of modules determined by recovery voltage considerations for specific applications (refer to VBU Ratings table). Order by fully describing the application, options and accessories.

- Standard Control Features Include: Electrical Operations Counter, Heater, Anti-Single Phasing Circuit
- Voltage Class: 69kV–230kV
- Continuous Current (Amperes): 600
- Fault Interrupting Current (Amperes, Symmetrical): 4,000
- Momentary Current (Amperes, Asymmetric): 40,000
- Two-Second Current (Amperes): 10,000
- Three-Second Current (Amperes): 8,000
- Four-Second Current (Amperes): 7,000
- Closing Time: 55 milliseconds
- Max. Interrupt Time: 2 cycles
- Control Current Close: 1A peak at 48VDC or 125VDC
- Control Current Trip: 18A at 125VDC; 54A at 48VDC

## VBU Switch Ratings

<table>
<thead>
<tr>
<th>RATED MAXIMUM VOLTAGE (kV)</th>
<th>L-G BIL (kV)</th>
<th>TERM. TO TERM. BIL (kV)</th>
<th>INTERRUPTER MODULES PER PHASE</th>
<th>A</th>
<th>B</th>
<th>WEIGHT PER PHASE (LBS.)</th>
<th>PRIMARY APPLICATION*</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>350</td>
<td>400</td>
<td>4</td>
<td></td>
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<tr>
<td>121</td>
<td>550</td>
<td>550</td>
<td>5</td>
<td>11</td>
<td>1/4</td>
<td>48</td>
<td>T</td>
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<tr>
<td>121</td>
<td>550</td>
<td>750</td>
<td>7</td>
<td>13</td>
<td>1/4</td>
<td>60</td>
<td>G</td>
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<td>145</td>
<td>750</td>
<td>650</td>
<td>6</td>
<td></td>
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<td>750</td>
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<td>1/4</td>
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<td>950</td>
<td>9</td>
<td>17</td>
<td>1/4</td>
<td>1,180</td>
<td>T</td>
</tr>
</tbody>
</table>

* Primary Application Codes:
  - T = Transformer Switching & Fault Protection — Grounded or Ungrounded
  - G = Shunt Capacitor or Reactor Switching — Solidly Grounded Source & Load
  - U = Shunt Capacitor or Reactor Switching — Ungrounded Source or Load

Refer to Joslyn Hi-Voltage Bulletin TD 750-457 for recommended inrush current-limiting reactor size if applied for back-to-back capacitor banks.
VBU 69–230kV Capacitor Switches

Joslyn Hi-Voltage® VBU Switches

Please specify:

1. Application
   - Capacitor Switching, Reactor Switching or Filter Bank Switching
     - **Note**: a) With capacitor bank applications, specify grounded or ungrounded configuration.
     - b) Certain filter banks may require additional vacuum interrupters. Please consult your Thomas & Betts representative when applying VBU switches for filter bank switching.

Example:

1. Capacitor Switching — Ungrounded

2. Voltage Rating
   - 72kV, 121kV, 145kV, 169kV or 242kV

3. Continuous Current Rating
   - 600A

4. Control Voltage
   - 120VAC, 220/240VAC, 48VDC, 110VDC, 125VDC or 250VDC

5. Operating Mechanism
   - Solenoid only

6. Cable Length
   - Solenoid: 17' 6" or 26'

7. Mounting Stand
   - Substation Frame — Height: 8 ft.; Material: Galvanized Steel

8. Options & Accessories
   - Capacitor Controls: Fisher Pierce® 4400, 4500, AC100 AutoCap® Control
   - Zero Voltage Closing (ZVC) Control
   - Current Limiting Reactors

**Note**: For standard control configurations and faster delivery, call Customer Service.

For more information on capacitor controls, see pages H-272–H-292.

Example:

1. Capacitor Switching — Ungrounded

2. 169kV VBU Switch

3. 600A Continuous

4. 120VAC Control Voltage

5. Solenoid-Operated Mechanism

6. 17’ 6” Cable

7. 8-ft. Galvanized Steel Substation Frame

8. Zero Voltage Closing Control, Fisher Pierce® Series 4400 AutoCap® Capacitor Control
Zero Voltage Closing Control

Eliminates overvoltage disturbances.

Joslyn Hi-Voltage® Zero Voltage Closing (ZVC) Control

- Works with new or existing capacitor controllers and Joslyn Hi-Voltage® VerSaVac® Capacitor Switches, Varmaster VBM Switches and VBU Capacitor Switches
- Mitigates system overvoltage disturbances and eliminates electronic adjustable-speed drive nuisance tripping
- Eliminates high inrush currents, increasing capacitor and related high-voltage equipment life
- Installations worldwide — more than 15 years successful field experience
- Available for 15kV to 230kV voltages
- Supports a variety of systems and applications; available for pole-top distribution capacitor banks
- Easy installation and setup: Simply select phase rotation, reference phase, voltage sensing and bank configuration (grounded or ungrounded)

The Joslyn Hi-Voltage® Zero Voltage Closing (ZVC) Control is a cutting-edge microprocessor-based capacitor control. When an external close command is received, the ZVC virtually eliminates capacitor energization transients by closing three switch poles independently, synchronized with the occurrence of zero voltage in each phase. The closing sequence of the poles minimizes the time from the first pole closure to the last pole closure.

A selected reference phase of the system voltage is used for determining the zero voltage crossing information, and an internal calibration process is used for determining accurate closing time requirements. With this information, the microprocessor sets the individual close command delays required to ensure pole closures at points corresponding to the system zero voltage crossing.

The expected benefits include:
- Increased power quality by utilizing capacitor switching, significantly reducing voltage spikes that are a nuisance to sensitive equipment like computers and adjustable-speed drives
- Increased capacitor and switch life
- A reduction of induced voltages into the low-voltage control wiring
- A reduction of station ground transients and distribution ground transients

* Only one phase shown for clarity.
Zero Voltage Closing Control

The ZVC is designed to automatically close Joslyn Hi-Voltage® VerSaVac® Capacitor Switches, Varmaster VBM Switches and VBU Capacitor Switches at strategic points that correspond to the zero voltage crossing and the bank's configuration. For a grounded bank configuration, the capacitor phases energize .3 milliseconds after each respective phase zero voltage crossing point. For an ungrounded capacitor bank configuration, the ZVC initiates the first pole to close .3 milliseconds after the zero voltage crossing reference point. The second pole automatically closes .3 milliseconds after the voltage difference between the first and second phases is zero (which occurs 30 electrical degrees after the first pole’s zero voltage crossing point). The third pole is closed at .3 milliseconds after the zero voltage crossing reference point associated with that phase. The microprocessor control circuitry is intentionally designed to energize at these timing points to allow for any switch variations to have minimal effect on the intended transient reduction results.

A timing accuracy of ±.89 milliseconds, with respect to the zero voltage crossing target point, should be maintained after initial set-up of the ZVC. With this level of accuracy and control, overvoltages can be reduced from a theoretical maximum of 2 per-unit voltage to .1 per-unit voltage. Also, overcurrents can be reduced to less than .2 per-unit current of the maximum theoretical inrush currents that ranged from 40 to 100 per-unit current for back-to-back capacitor bank switching and 5 to 20 per-unit current for single-bank switching.

The ZVC Control works with any manufacturer’s new or existing capacitor controllers and offers:

- Zero voltage closing
- Low close energy
- Automatic calibration
- Calibration data storage (non-volatile memory)
- Voltage zero synchronization
- Improper sequence trip monitoring
- Flashing self-check LED
- Error-indication LED
- Error-reset push buttons

Provided Standard Features

- Automatic improper sequence trip
- Extra switch auxiliary contacts (4-A and 4-B)
- Control alarm output contact (form C)
- Control cabinet heater
- Calibration cable (either 18.5- or 27-ft. length)

Additional Available Options

- Two-pole control for ungrounded capacitor bank applications
- Capacitor-operated low-energy trip
- Undervoltage trip
- Aluminum cabinet
- Bypass ZVC mode switch — enables emergency close operations without using the ZVC control logic

**Specifications**

- **Timing Accuracy:** ±.89ms @ 3 sigma with respect to designated zero voltage crossing target point
- **Close Response Time:** 5–7 cycles after receiving external close command
- **Open Response Time:** 3–5 cycles after receiving external open command
- **Temperature Range:** -22 to +158° F (-30 to +70° C)*
- **Control Voltage:** 120VAC nominal, ±10%

* Control is designed for operation through this range; however, timing variances greater than .89ms could be encountered at temperatures colder than -4° F (-18° C) and warmer than 140° F (60° C). These variances are expected to remain within 1ms of the zero voltage crossing reference point.

Specifications can change without notice.
Zero Voltage Closing Control

ZVC Control and VerSaVac® switches

A typical layout of system and control using both the ZVC and a VerSaVac® switch is shown below. As a customer-ordered option, the ZVC Control can be mounted directly on the capacitor rack assembly. This application will eliminate the need for the junction box assembly.

For greater control, opt for the Joslyn Hi-Voltage® ZVC Control System with VerSaVac switches. It consists of the following components:

- ZVC Control
- Three VerSaVac switches
- Junction box assembly that includes three separate VerSaVac cables and one main control cable

General Equipment Layout
Zero Voltage Closing Control

ZVC Control and the junction box assembly

Additional details on the junction box assembly are shown in the diagram below. The individual switches are connected to the junction box using cables with threaded pin connectors. Also, a keyed pin connector is provided for an easy and secure connection of the main control cable to the ZVC Control. The main control cable runs from the junction box to the control. All necessary connections into the junction box for the individual VerSaVac switch cables and the main control cable are made at the factory.

Junction Box Assembly

ZVC Control and Varmaster VBM switches

A typical layout of system and control using both the ZVC and Varmaster VBM switches is shown below. The individual poles are connected to the ZVC Control using cables with keyed pin connectors on the switch end. For greater control, opt for the Joslyn Hi-Voltage® ZVC Control System with Varmaster VBM switches. It consists of the following components:

- ZVC Control cabinet
- Three Varmaster VBM switches (poles)
- Three Varmaster VBM pole cables (either standard 17.5- or maximum 26-ft. lengths)

Notes: Connection of the individual cables to the correct system phase designation is critical to proper operation.

Notes: The cables can be shortened as required in the field, but it is recommended that all three cables be the same length. Connection of the individual cables to the correct system phase designation is critical to proper operation.

For ordering information for ZVC Control, see pages H-174 and H-180.
Transmaster® VBT Electric Furnace Switches

Longest life product for electric furnaces!

Joslyn Hi-Voltage® Transmaster® Electric Furnace Switch

- Long, maintenance-free life under demanding conditions, designed for 100,000 operations
- No oil or gas used for interruption or insulation
- Safe — no visible or hazardous arcing and no hot exhaust or ionized gas dissemination
- Vacuum interrupter condition can be determined by a high-potential withstand test quickly
- Lightweight modular design — no special foundations or costly support required

The operation of electric furnaces requires large amounts of power to be under constant control. The Transmaster™ switch is rugged and can withstand this kind of duty. Joslyn Hi-Voltage® VBT and VBU-T switches operate uniformly on all power factors and are available for system voltages from 15kV up to 230kV.

If the primary circuit breaker is used as a switching device for control of transformer magnetizing, load and secondary fault currents, this will result in the circuit breaker being opened and closed more than 100 times per day.

This wear and tear causes even the most durable breakers to require frequent maintenance, which is costly.

Joslyn Hi-Voltage® engineers worked closely with electric furnace manufacturers to develop the Transmaster® Electric Furnace Switch, a heavy-duty vacuum switch designed to deliver maintenance-free switching of electric furnaces.

Since 1962, over 3500 field installations worldwide have proven the capability and reliability of the Transmaster® Electric Furnace Switch.

Ideal Furnace System

<table>
<thead>
<tr>
<th>Fault Protection</th>
<th>Visible Isolation</th>
<th>Primary Interrupter</th>
<th>Loss of Vacuum Detector</th>
<th>Overvoltage Protection</th>
<th>Furnace Transformer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit Breaker</td>
<td>Motorized Air Switch Equipped with Vac-Rupter Interrupter</td>
<td>Transmaster® VBT or VBU-T</td>
<td>Vacstat® or Power Circuit Monitor</td>
<td>Station Class Arresters RC Network</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remote Position Indicator pages H-220–H-223</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Motor Operator</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Options</td>
<td>Extra auxiliary contacts, stainless steel enclosure, local/remote switch, heater, pushbuttons, Point On Wave Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Transmaster® VBT Electric Furnace Switches

Monitor alerts you immediately of loss of vacuum when you use the Transmaster® VBT Switch with Vacstat® Vacuum Interrupter Monitor!

- Continuously monitors vacuum interrupter status while the switch is energized and in service
- Reduces operating and maintenance costs by eliminating the need for routine off-line vacuum interrupter inspections
- Blocks switch operation if vacuum loss is detected, protecting your equipment and personnel from potential harm
- Provides local and remote indication of vacuum interrupter status, enabling operating and maintenance personnel to take corrective action immediately in the event of loss of vacuum
- SCADA notification available

The Joslyn Hi-Voltage® Vacstat® Vacuum Interrupter Monitor provides you with real-time status monitoring of your vacuum interrupters. This simple device notifies you immediately of a loss of vacuum through a visual indicator located on the Transmaster® VBT Switch and via a contact in the switch control. Once the Vacstat® Vacuum Interrupter Monitor senses a loss of vacuum, all switch operations will be blocked until the switch has been serviced.

How the Vacstat® Vacuum Interrupter Monitor works.

The Vacstat® sensor is attached to the vacuum interrupter of a Transmaster® VBT Switch during the manufacturing process. The sensor then continuously monitors the interrupter for the presence of vacuum.

Once the capacitor switch is installed, the sensor generates an optical signal that travels via a pair of fiber optic cables to a control board in the low-voltage section of the switch. As long as vacuum exists, the fiber optic signal has a continuous path, and the Vacstat® indicator remains in the normal (unalarmed) state.

If a loss of vacuum occurs, the sensor blocks the optical signal to the control board, and the Vacstat® status indicator automatically turns to red to alert the operator to the problem. In addition, the remote status dry contact provides a means to send an alarm signal to a remote location. The Vacstat® monitor also blocks further electrical operation of the switch to prevent possible damage to equipment or injury to personnel.
### VBT Ratings

**VBT 15kV–69kV Maximum Voltage**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>15.5kV</th>
<th>38kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Current (Amps)</td>
<td>600</td>
<td>1000</td>
</tr>
<tr>
<td>Momentary Current (RMS Amps, Asymmetrical) (kA)</td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>Impulse Withstand Open-Gap (kV BIL)</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>Impulse Withstand Line-to-Ground (kV BIL)</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Maximum 60 Cycle Withstand Line-to-Ground Dry (One Minute) (kV)</td>
<td>112</td>
<td>112</td>
</tr>
<tr>
<td>Maximum 60 Cycle Withstand Line-to-Ground Wet (Ten Seconds) (kV)</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td>Fault Interrupting Rating (Amps, Symmetric) (kA)</td>
<td>4</td>
<td>4</td>
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</tbody>
</table>

### VBU-T Ratings

**VBU-T 72kV–242kV Maximum Voltage**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>72kV</th>
<th>121kV</th>
<th>145kV</th>
<th>161kV</th>
<th>242kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Current (Amps)</td>
<td>600</td>
<td>1000</td>
<td>1500</td>
<td>2000</td>
<td>2500</td>
</tr>
<tr>
<td>Momentary Current (RMS Amps, Asymmetrical) (kA)</td>
<td>40</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Impulse Withstand Open-Gap (kV BIL)</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>550</td>
<td>550</td>
</tr>
<tr>
<td>Impulse Withstand Line-to-Ground (kV BIL)</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>550</td>
<td>550</td>
</tr>
<tr>
<td>Maximum 60 Cycle Withstand Line-to-Ground Dry (One Minute) (kV)</td>
<td>175</td>
<td>175</td>
<td>175</td>
<td>293</td>
<td>293</td>
</tr>
<tr>
<td>Maximum 60 Cycle Withstand Line-to-Ground Wet (Ten Seconds) (kV)</td>
<td>175</td>
<td>175</td>
<td>175</td>
<td>281</td>
<td>281</td>
</tr>
<tr>
<td>Fault Interrupting Rating (Amps, Symmetric) (kA)</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
**Transmaster® VBT Electric Furnace Switches**

**Point on Wave Control**

The purpose of the independent pole, point on wave, synchronous close system is to reduce transformer energization transients by being able to close each pole at the natural current zero point. The expected benefits include significantly reduced inrush currents, reduced electromechanical stress on transformer bushings and windings and reduced stress on all equipment associated with the closing circuit of the transformer.

**Application**

When an electric furnace switch is called on to close, a “random closing” occurs, which can energize the transformer at any point on the voltage waveform. This produces high-magnitude transient inrush currents rated 1000% of full load current. The Point on Wave Control is designed to energize the transformer at the optimal point on the voltage waveform which provides these benefits:

- **Longer Equipment Life**  
  Reduces mechanical forces on the transformer bushings and windings, resulting in lower total ownership cost

- **Increased Safety**  
  Less electrical stress on transformer interwinding insulation

- **Reduced Maintenance Costs**  
  Minimal wear on components decreases maintenance requirements

- **Increased Reliability**  
  Reduces stress on all other components of the furnace

**Note:** To order Joslyn Hi-Voltage® Transmaster® VBT and VBU-T Switching Systems, contact your Thomas & Betts representative.