

CAPACITOR CONTROLS



Fisher Pierce capacitor controls range from solid-state single function controls to state-of-the-art microprocessor based programmable units. Autocap™ Adaptive Capacitor Controllers feature adaptive functions which allow the unit to program itself. Model with two-way communications provides the use of a data radio and cellular technologies.

VERSAVAC DISTRIBUTION CAPACITOR SWITCHES



Joslyn VerSaVac vacuum switches are used for pole top capacitor switching. VerSaVac switches are a direct replacement for oil switches, designed to eliminate costly maintenance and hazards.

AIR SWITCH & INTERRUPTER ATTACHMENTS



Joslyn Air Disconnect Switches provide highly dependable operation for sectionalizing or isolation service. Vertical-Break switches are available in voltage ratings from 15kV to 230kV. Side-Break switches are available in voltage ratings from 15kV through 115kV. Interrupter attachments can be easily mounted to most isolating switches to provide a complete interrupter switch.

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Hi-Voltage

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- Varmaster Switches 15kV - 69kV
- VBU Switches 69kV - 230kV
- Zero Voltage Closing Controls
- Fisher Pierce Capacitor Controls

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FEATURES

- Maintenance-free long life
- Completely sealed construction
- Safe, completely oil free
- Low cost installation
- Quiet operation
- High speed operation
- Easy to test
- Compact and lightweight
- Choice of operating mechanisms
- Wide choice of control options
- Zero voltage closing

Varmaster switching systems use VBM switches that are completely sealed breaker class devices utilizing vacuum as the interrupting dielectric. VBM switches offer high reliability with little or no maintenance. Interruption is safe, with no external arcing, and quiet. VBM Interrupters are manufactured for application at system voltages from 15 to 69 kV. Vacuum interrupters are connected electrically in series to provide the necessary recovery voltage characteristics for the specific application. Vacuum interrupters may also be connected electrically in parallel for high continuous or momentary current requirements.

VBM Switches are lightweight and require no special foundations or supports. VBMs are completely factory assembled, ready for fast, easy installation.

Each vacuum interrupter is enclosed in a shatterproof, high dielectric housing to form a module (Figure 1) designed with all solid insulation. The interrupter is surrounded by "Joslyte™" high-dielectric strength non-hygroscopic solid foam 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.

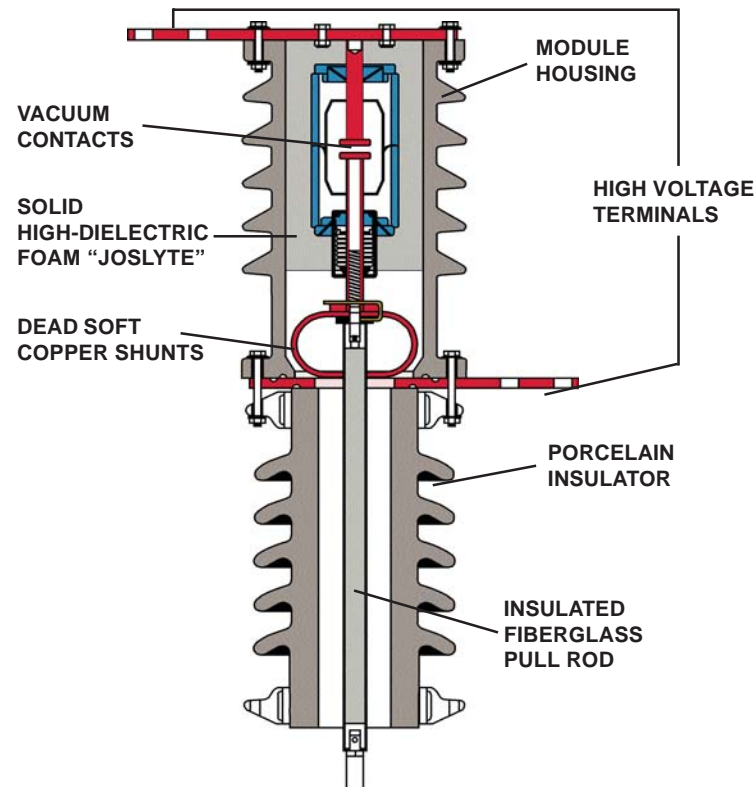


Figure 1- Cutaway of single vacuum module mounted on a 15kV line-to-ground insulator.

One or two vacuum modules are mounted on each line-to-ground insulator and are connected to the operating mechanism by a high strength pull rod. The operating mechanism is completely sealed in a housing, which 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. 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 that can be operated manually or electrically move the contacts at a high speed and are unaffected by control voltage fluctuation or manual operating speed. An operation counter is included with each switch. 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.

1. Select Application

Capacitor Switching, Reactor Switching or Filter Bank Switching

(Certain Filter Banks may require additional vacuum interrupters. Please consult the factory when applying VBM Varmasters or VBU's for Filter Bank Switching.

2. Voltage Rating

VBM Varmaster: 15.5kV, 25kV, 38kV, 48.5kV, or 12.5kV

VBU: 72kV, 121kV, 145kV, 169kV, or 242kV

3. Continuous Current Rating

VBM Varmaster: 200A, 300A, 400A, or 600A

VBU: 600A

4. Control Voltage

120V AC, 48V DC, 125V DC, or 250V DC

5. Operating Mechanism

VBM Varmaster: Solenoid or Motor. Motor operator can only be supplied with a single-mechanism switch, such as a 15kV model.

VBU: Solenoid Only

6. Terminal Pad Orientation

VBM Varmaster Only: Select terminal pad orientation from Diagram 1.

7. Mounting Stand

VBM Varmaster:

Substation Frame-
Height: 8 ft. or 10 ft.
Material: Galvanized Steel or Aluminum

Pole Mounting Frame- For 15.5kV or 38kV single-mechanism VBM Varmasters
Material: Galvanized Steel

VBU:

8 ft. Tubular Galvanized Steel
Substation Frame

8. Options & Accessories

- Capacitor Controls
 - Fisher Pierce: 4400, 4500, AC100
 - Joslyn Capmaster
- Zero Voltage Closing Control
- Current Limiting Reactors

For additional options refer to page 7

****Please consult the factory for standard control configurations available for faster delivery and cost effectiveness.***

Example:

1. Capacitor Switching
2. 34.kV VBM Varmaster
3. 600A Continuous
4. 120V AC Control Voltage

5. Solenoid Operated Mechanism
6. Terminal Pad Orientation- Standard
7. 8 ft. Galvanized Steel Mounting Stand
8. Zero Voltage Closing Control
Fisher Pierce 4400 AutoCap Control

FEATURES

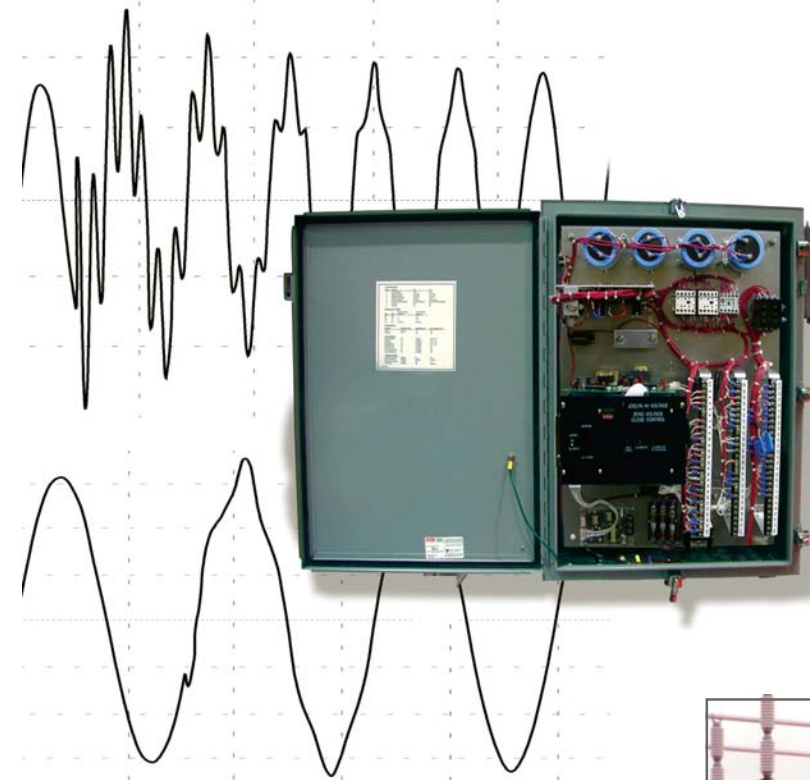
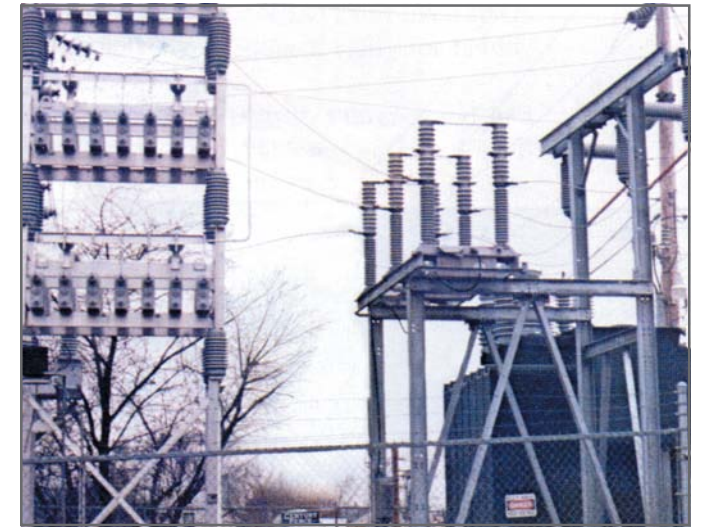
- Eliminates Electronic Adjustable Speed Drive Nuisance Tripping
- Increases Capacitor Life
- Eliminates High Inrush Currents
- Reduces System Overvoltages Normally Associated with Random Capacitor Switching
- Several Hundred Installations Worldwide
- Over Fifteen Years Successful Field Experience
- Available for Voltages from 15 to 230kv
- Now Available for Distribution Capacitor Banks
- Easy Installation Setup
 - a. Select phase rotation
 - b. Select reference phase (and phase shift if necessary)



Standard 15kV VBM Switch and Zero Voltage Closing Control Package

Capacitor Switching

Joslyn VBM Varmaster Switches are ideally suited for repetitive switching of any load, and can carry or switch full continuous current rating regardless of power factor. Maximum load current including harmonics, nameplate-rating tolerances of the load, and system voltages must be considered in selecting the continuous current rating. Switching capacitor banks connected back-to-back may require current limiting reactors, available from Joslyn, to limit high frequency inrush currents.



Zero Voltage Closing (ZVC)

The Joslyn ZVC control can be supplied with the Varmaster switching package to reduce system overvoltages and stress on capacitors due to overvoltages and high inrush currents. Refer to the ZVC section in this brochure for a more detailed description.

Figure 5
Standard Control

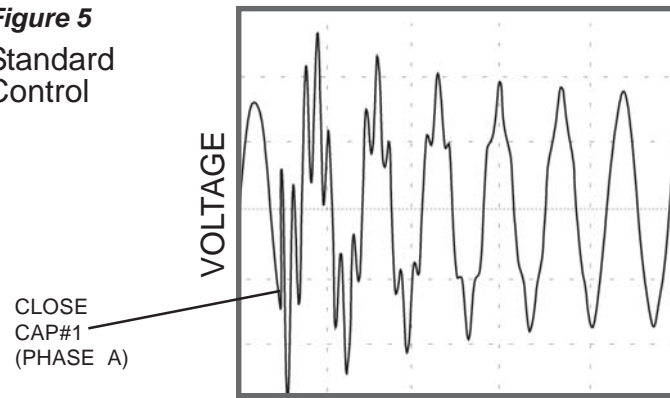
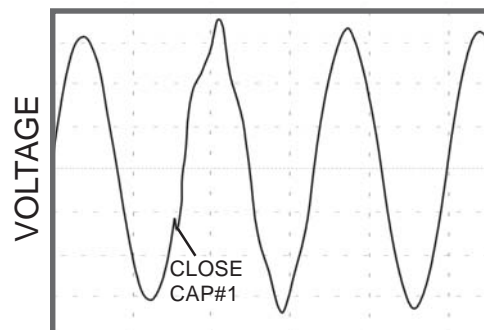


Figure 6
With Zero Voltage Closing Control



Interfaces with new or existing Capacitor Controllers and Joslyn Vacuum Switch

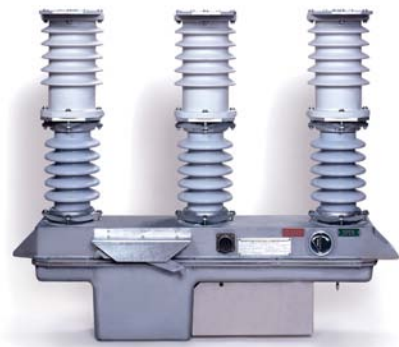
Joslyn's commitment to the demanding duty of capacitor switching is further demonstrated by the development of an optional control package to close three switch poles independently, synchronized with the occurrence of zero voltage in each phase.

The mechanical simplicity, high-speed operation and response repeatability of the Joslyn vacuum switches make this application feasible. The result is elimination of overvoltage duty on the capacitors and system overvoltage disturbances which were once tolerated as an inherent negative aspect of energizing a capacitor bank, and the significant reduction of inrush current duty on the capacitors as illustrated in the difference between . The control can be also interfaced with any manufacturer capacitor controller.

Reactor Switching

The Joslyn VBM Varmaster reactor switch can reliably switch shunt reactors. The "low" 4.1-ampere mean chop current of these switches eliminates overvoltage concerns. Continuous current ratings through 3000 amperes are available.

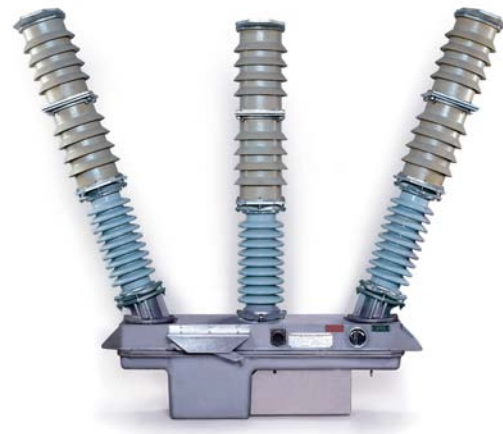




THREE PHASE
15kV/25kV¹ 400A
15kV/25kV¹ 600A

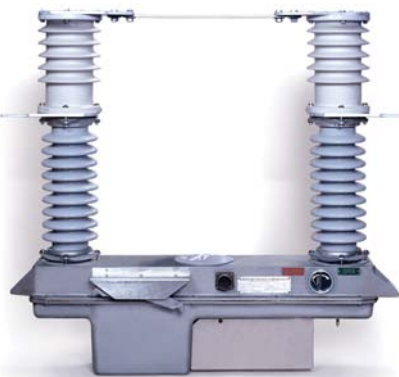


THREE PHASE
25kV 200A
25kV 300A
25kV 400A

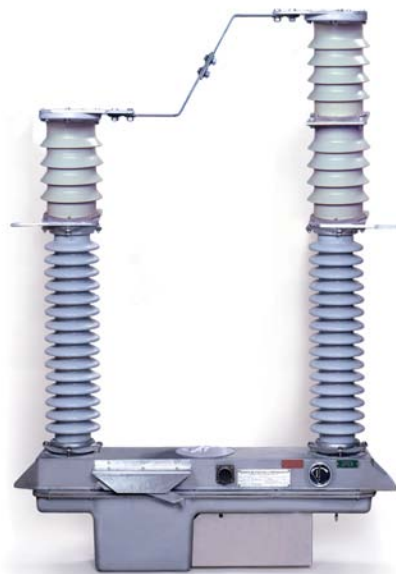


THREE PHASE
34.5kV 300A

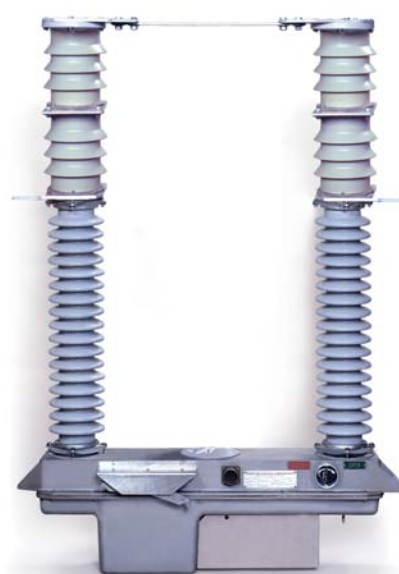
¹Solid grounded system and capacitor banks only.



ONE POLE ²
34.5kV 400A
34.5kV 600A



ONE POLE ²
46kV 300A



ONE POLE ²
69kV 300A

²Three poles required for a 3-Phase installation

Figure 2

The VBU yields a very long life switch by utilizing a modular design concept which connects vacuum interrupter modules electrically in series and mechanically in parallel. The VBU is supplied with the appropriate number of modules determined by recovery voltage considerations for specific applications. (Refer to table 4) Order by fully describing the application, options and accessories.

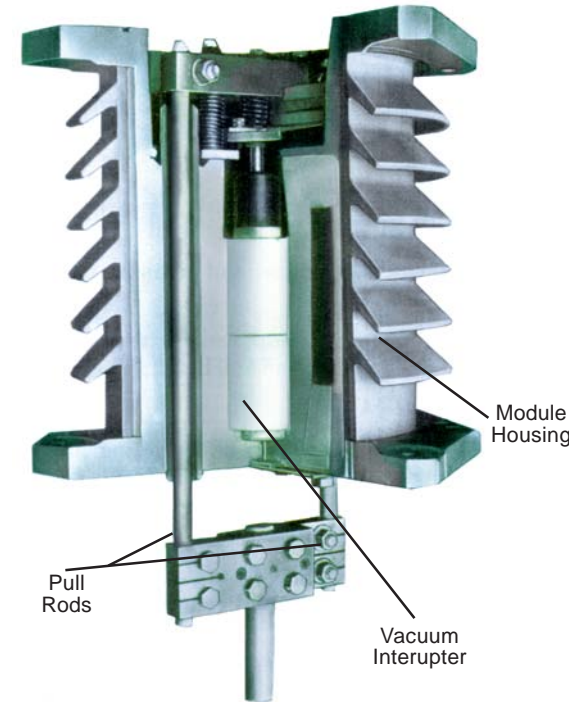


Figure 4

Standard Control Features Include:

Electrical Operations Counter, Heater, Anti-Single Phasing Circuit

Control Current Close:

1 ampere peak at 48 V.D.C. or 125 V.D.C.

Trip:

18 amperes at 125 V.D.C.; 54 amperes at 48 V.D. C.

Table 3 VBU Ratings**

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
Maximum Interrupt Time	2 cycles

Table 4 VBU Ratings

Rated Maximum Voltage kV	L-G Bil kV	Term-Term Bil kV	Interrupter Modules per Phase	A	B	Weight per Phase Lbs.	Primary Application*
72	350	400	4	8' 7 1/4"	30"	710	T G U
121	550	550	5	11' 1 1/4"	48"	860	T G
121	550	750	7	13' 1 1/4"	48"	940	U
145	750	650	6	13' 1 1/4"	60"	950	T
145	750	750	7	14' 1 1/4"	60"	990	G
145	750	850	8	15' 1 1/4"	60"	1030	U
169	750	750	7	14' 1 1/4"	60"	990	T
169	750	850	8	15' 1 1/4"	60"	1030	G
169	750	950	9	16' 1 1/4"	60"	1070	U
242	900	950	9	17' 7 1/4"	78"	1180	T G

*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 Bulletin TD 750-457 for recommended inrush current limiting reactor size if applied for back to back capacitor banks.

VBU OPTIONS & ACCESSORIES

Refer to page 7.

FEATURES

- Maintenance-free long life
- Completely sealed construction
- Safe, completely oil free
- Low cost installation
- Quiet operation
- High speed operations
- Easy to test
- Wide choice of control options
- Zero voltage closing

The VBU Switching System is completely sealed against the environment. They are immune to ice and to the effects of contamination. The mechanism is completely sealed so no heaters are required. Routine "exercise" is not required. The VBU is designed to withstand system voltage continuously in the open position.

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

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

The VBU is safe even when exposed to fault currents that exceed the equipment rating. They are free of explosive or combustible materials.

VBUs are virtually maintenance-free. All that is needed is a normal operation inspection every five years or 10,000 operations.

VBUs are easily installed. They are shipped completely assembled and adjusted. They are lightweight. Field installation is quickly and easily accomplished. Often they are mounted on potential transformer stands.

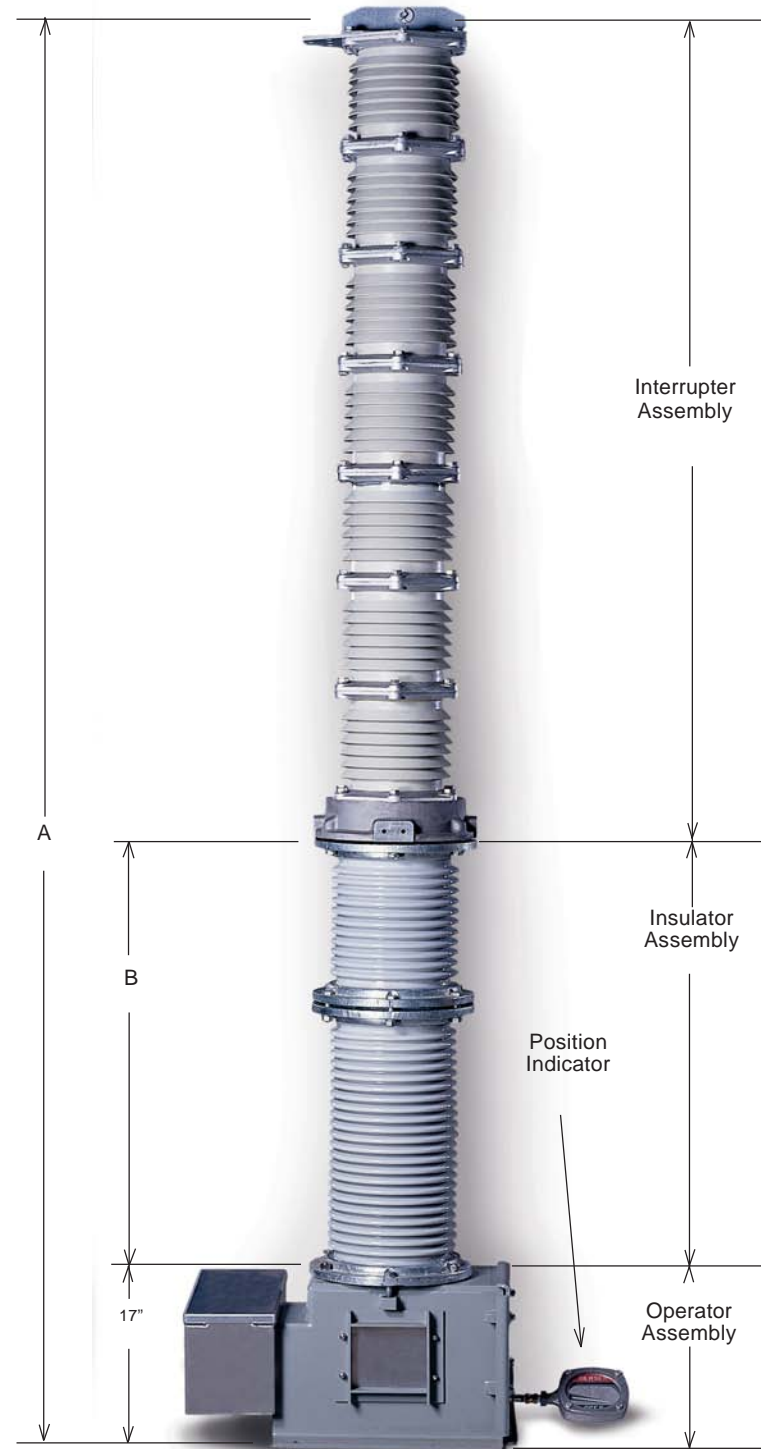


Figure 3

The VBU System is economical. They are less expensive to purchase than circuit breakers and less expensive to install. They are free of routine maintenance, and require a minimum of structural support and space.

Table 1 VBM Varmaster Ratings

Maximum Voltage	15.5kV/25kV ³			25kV			38kV				48.5kV			72.5kV
Capacitor and Load Switching Current ^{1,2} (Amperes)	400	600	600	200	300	400	300	400	600	600	200 ⁴	300	400	300
Fault Interrupting Current (Amperes)	3kA	4kA	8kA	3kA	3kA	3kA	3kA	3kA	4kA	8kA	4kA	3kA	3kA	3kA
Momentary Current (RMS Amperes, Asymmetric)	20kA	20kA	20kA	15kA	15kA	15kA	15kA	20kA	20kA	20kA	20kA	15kA	15kA	15kA
Impulse Withstand (kV BIL) Terminal-to-Terminal ⁵	110	110	110	200	200	200	200	200	200	200	200	250	250	280
Line-to-Ground (kV BIL) (1.2 x 50 Positive Wave)	150	150	150	150	150	150	200	200	200	200	250	250	250	350
Maximum 60-Cycle Withstand Line-to-Ground (kV): One Minute Dry	101	101	101	101	101	101	138	138	138	138	178	178	178	178
	74	74	74	74	74	74	119	119	119	119	176	176	176	176
Two Seconds Wet	74	74	74	74	74	74	119	119	119	119	176	176	176	176
Maximum Peak Making Current (kA)	20	20	20	15	15	15	15	20	20	20	20	15	15	15
Maximum Peak Back-to-Back Inrush Current (kA) ⁶	10	10	10	8	8	8	8	10	10	10	10	8	8	8
Two-second Current	12,500 Amperes													
Four-second Current	9,000 Amperes													

¹VBM Varmasters 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.

²VBM Varmasters are available with continuous current ratings through 3000 amperes. Consult factory regarding application of these switches.

³Grounded systems only at 25kV

⁴In capacitor switching applications the 48.5kV, 200 ampere VBM may be used on solidly grounded systems and grounded capacitor banks with total current less than 200 amperes. For all other loads, this VBM rating is 600 amperes.

⁵Interrupter portion of switch does not provide a visible open gap; therefore it cannot be used to establish a safety clearance for personnel.

⁶In 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 bulletin T.D. 750-457

VARMASTER OPERATING MECHANISMS

1. Solenoid Mechanism

Solenoid operators have 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.

2. Motor Mechanism

Motor operators are primarily used on single mechanism VBM's such as 15kV, 400A and 600A switches and 34.5kV, 300A switches. All controls are located inside the VBM mechanism housing. Inspection after 10,000 operations is recommended.

Table 2 Operating Mechanisms Options

	Control Voltage	Operating Mechanism	Control Current Per Switch Mechanism	Close Time ⁴	Trip Time ⁴	Auxilliary Contacts
AC	120 V	Motor ⁵ Solenoid ³	5 amps 60 amps ^{7,8}	3 sec 6 cycles	2 cycles 6 cycles	2"a" and 2"b" ¹ 4"a" and 4"b" ²
	48 V	Motor ⁵ Solenoid ^{3,8}	3 amps 60 amps ⁶	5 sec 6 cycles	2 cycles 6 cycles	2"a" and 2"b" ¹ 4"a" and 4"b" ²
DC	125 V	Motor ⁵ Solenoid ³	4 amps 60 amps ^{7,8}	3 sec 6 cycles	2 cycles 6 cycles	2"a" and 2"b" ¹ 4"a" and 4"b" ²
	250 V	Solenoid ^{3,8}	60 amps	6 cycles	6 cycles	4"a" and 4"b" ²

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

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

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

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

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

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

⁷Current is 120 amperes for 34.5kV 300A VBM.

⁸Current for three mechanism switch systems is approximately 180 amperes peak for 3 cycles.

Varmaster Terminal Pad Orientation Options

(for single mechanism switches)

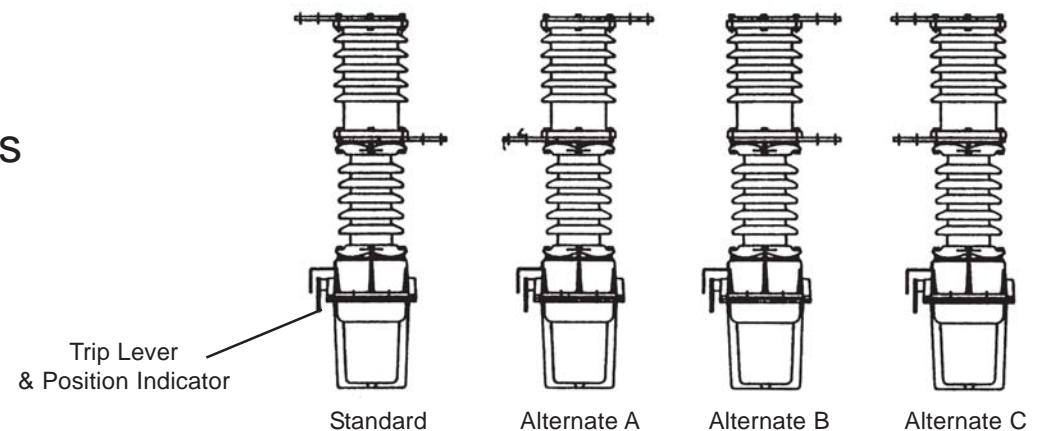


Diagram 1

Fisher Pierce Brand Capacitor Controls



Series AC100 Programmable Capacitor Control Provides voltage, time, or temperature primary control with programmable override. Controller can be set up through easy to program front panel or through USB connection. Low profile enclosure comes integrated with meter socket base.

Series 4400 AutoCap™ Adaptive Capacitor Controller and Recorder Microprocessor based control featuring one-to-four programming adapts itself to the installation. The controller automatically corrects for installation errors. Programmable control modes include Var, current, voltage, time and temperature, as well as override and protective functions. Windows based application software is included.



Series 4500 AutoCap™ Adaptive Capacitor Controller with Two-Way Communications Microprocessor based control including all features of the Series 4400 with data radios for two-way communications. A dedicated communications microprocessor and flash memory allow the use of data radios cellular, and modem communication technologies. The result is a powerful tool for discrete feeder management, data gathering, trouble shooting, system evaluation analysis.

PowerFlex® Two and Three Step Capacitor Switching Controllers Multi-step controllers are intended for use with multiple capacitor racks found in substation applications. The controls can be purchased in Var, voltage or line current configurations. The control operates the first step which activates the following steps after a fixed time delay. Proper sequencing on capacitors is ensured.

Zero Voltage, Independent Pole Closing Control for Capacitor Switching

Closes the three poles independently synchronized with zero voltage in each phase to eliminate overvoltages and reduce inrush current. See page 10 for more information.

Undervoltage Trip Option

The undervoltage trip accessory causes the switch to open within three cycles of loss of control power.

Low Energy, Capacitor Discharge Option

This control package enables use of solenoid operated switches in locations where control power is limited. The main application for this system is in switching substation capacitor banks and reactors, which are located at long distances from the source of power. Current drain is 5 amperes peak and less than 30 milliamperes average.

Current Limiting Reactors

For back-to-back capacitor switching applications, reactors with wide range of inductance are available for all system voltages. Refer to Joslyn bulletin TD 750-457.

Overcurrent Relay Packages

Complete relay packages are available for fault interruption applications.

Junction Box Accessory (Motor Operated VBM's only)

A weatherproof junction box can be mounted on the VBM mechanism housing containing terminal strips for customer connections to the internal switch control circuits. This can be supplied instead of the control cable.

Time Delay Relay

A 5-minute time delay can be included in the controls to prevent closing into a charged capacitor bank.

Heater For Control Enclosures

(No heater is required for the VBM or VBU switch).

Electrical Operations Counter

This counter is mounted in the control cabinet. (A mechanical counter is always provided on the VBM switch.)

Upright Stands and Pole Mounting Frames

Special Controls

Joslyn can design special controls for particular