

FEBRUARY 14, 2017

Joslyn Hi-Voltage[®]

Capacitor switches — customer presentation

Joslyn Hi-Voltage capacitor switches — agenda

Fundamentals

Compelling value

Product line overview

VerSaVac® (VSV)

- Product features and benefits
- Design
- Ratings
- Applications

VBM (Varmaster)

- Product features and benefits
- Design
- Ratings
- Applications

JHV capacitor switches
compelling features

- ZVC

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Joslyn Hi-Voltage capacitor switches

Fundamentals — capacitor banks

Why are they used?

- To improve distribution system efficiency
 - Reduce avoidable losses and penalties
- To improve distribution system voltage profile
- To increase distribution system capacity
 - Reduce kVA demand



Joslyn Hi-Voltage capacitor switches

Fundamentals — capacitor banks/capacitor types

Fixed capacitors



- Power factor compensation
- Need to be precisely located
- Voltage profile improvement

Switched capacitors



- Flexibility of being in service when needed

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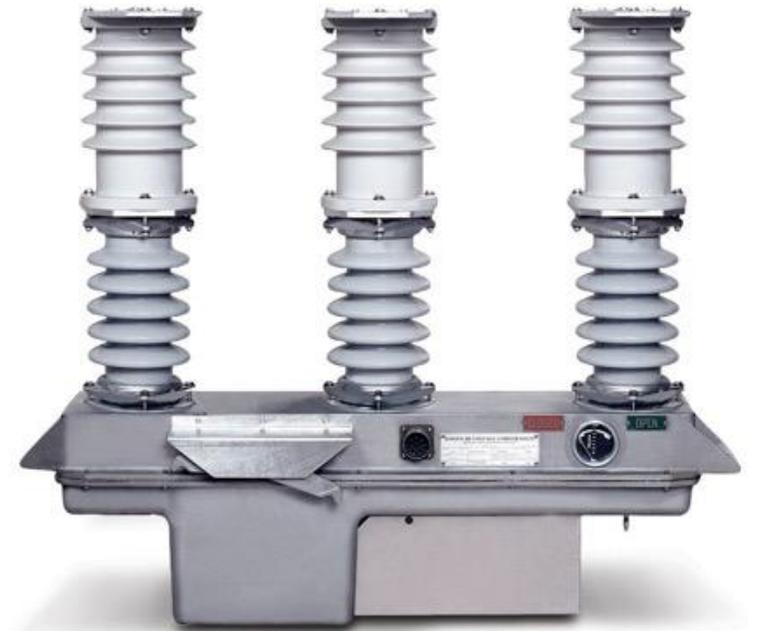
JHV capacitor switches
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Joslyn Hi-Voltage capacitor switches

Compelling value

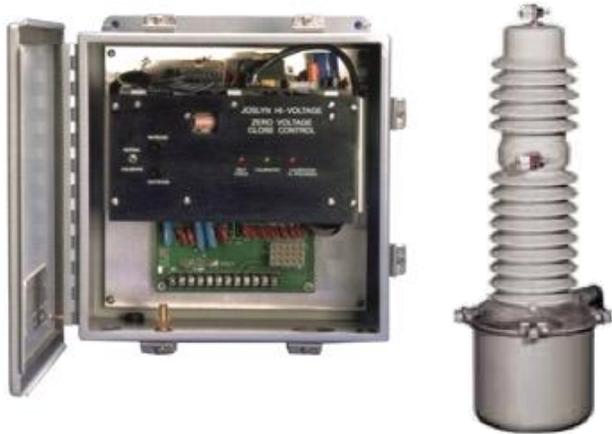
- Efficiency
- Compatibility
- Environmental sustainability
- Lifecycle cost reductions



Joslyn Hi-Voltage capacitor switches

Efficiency — transient mitigation of system over-voltages and inrush current

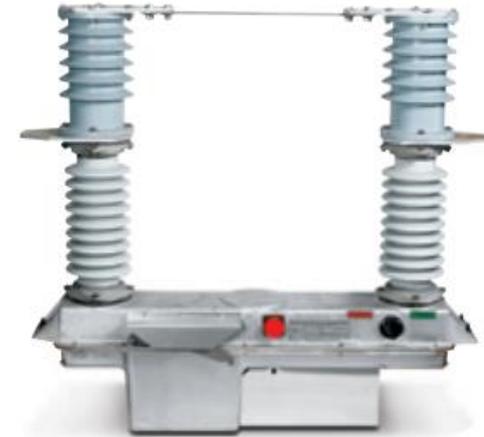
VerSaVac



ZVC control



VBM (Varmaster)



Zero voltage closing control (ZVC)

- Prevents customer equipment damage and stress on capacitors when bringing capacitor banks online
- Synchronous closing of three switch poles independently, with the occurrence of zero voltage in each phase
- Enables volt-VAR optimization (VVO)

Joslyn Hi-Voltage capacitor switches

Compatibility — with various controls platforms

- Can be rack or pole mounted
- Works with all major control platforms (Fisher Pierce, Schweitzer, Beckwith and ABB)



Joslyn Hi-Voltage capacitor switches

Compatibility — complete fixed capacitor bank retrofit

Existing fixed capacitor banks can be converted easily to switched banks.



Joslyn Hi-Voltage capacitor switches

Environmental sustainability — no oil or gases

VBM (Varmaster)



VerSaVac



Uses vacuum interruption and solid dielectric insulation for 15 kV to 72.5 kV applications.

Joslyn Hi-Voltage capacitor switches

Lifecycle cost reductions — with solenoid operators

Long operational life of 10,000–100,000 open and close operations with no required maintenance*

- Oil and gas interrupting mediums require maintenance and personal protective equipment
- Regulatory requirements call for monitoring and measuring of oil and gas usage/leakage
- Solenoid operating mechanism provides a long life of maintenance-free operations

* **Note:** Because they contain no oil or gas to monitor or maintain, Joslyn Hi-Voltage capacitor switches are considered maintenance-free.

Joslyn Hi-Voltage capacitor switches — agenda

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Joslyn Hi-Voltage capacitor switches

Product types

VerSaVac



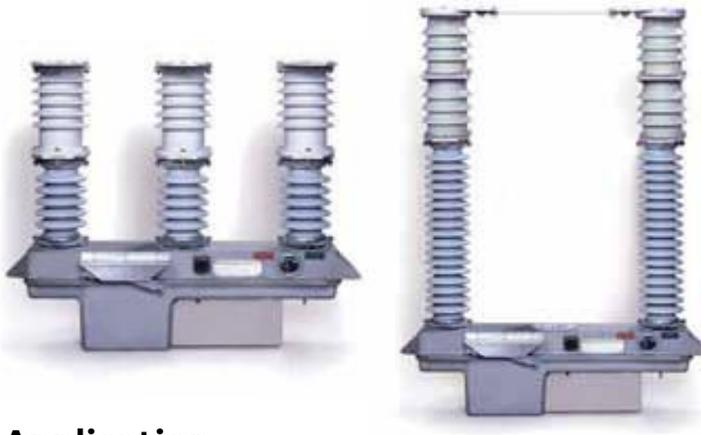
Application

- Distribution capacitor switching

Rating

- 15 kV–38 kV
- 200 amps

VBM (Varmaster)



Application

- Substation capacitor and reactor switching

Rating

- 15 kV–72.5 kV
- 300–600 amps

ZVC control



Application

- Zero voltage closing control (ZVC) Option

Rating

- 15 kV–72.5 kV

Joslyn Hi-Voltage capacitor switches

Agency standards listings

All Joslyn Hi-Voltage capacitor switches exceed the electrical requirements of ANSI C37.66.

Joslyn Hi-Voltage capacitor switches — agenda

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JHV capacitor switches
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Joslyn Hi-Voltage capacitor switches

Features and benefits — VerSaVac single phase



Offers the longest life of any distribution capacitor switch!

Features

Benefits/descriptions

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).

15 kV–38 kV, single- or three-phase

Available in models to support grounded and ungrounded systems in a variety of applications.

Compatibility

Can replace existing oil switch or vacuum switch installations.

Field-proven reliable design

More than 150,000 worldwide installations and more than 20 years of operational experience.

Choice of housing material

Select porcelain or polymer housing.

Joslyn Hi-Voltage capacitor switches

Features and benefits — VerSaVac three phase

**Mechanically ganged phases
with gang-operated manual handle**



**Three single-phase VSV configuration
for use with junction box**

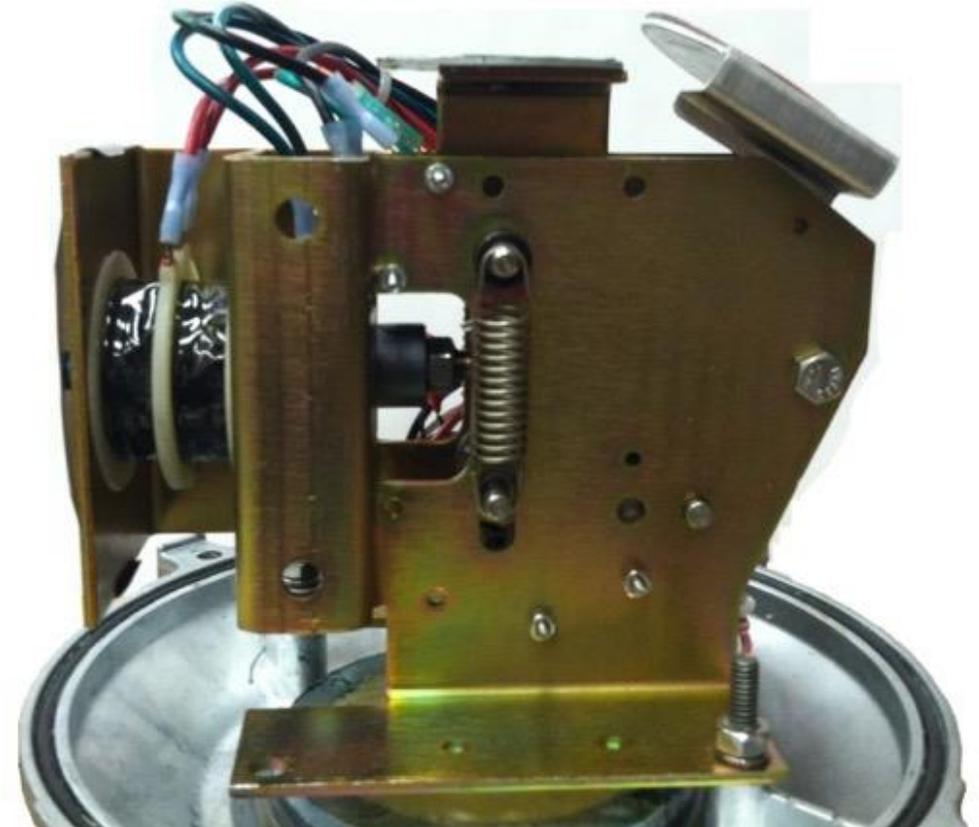


Joslyn Hi-Voltage capacitor switches

VerSaVac — design and mechanism

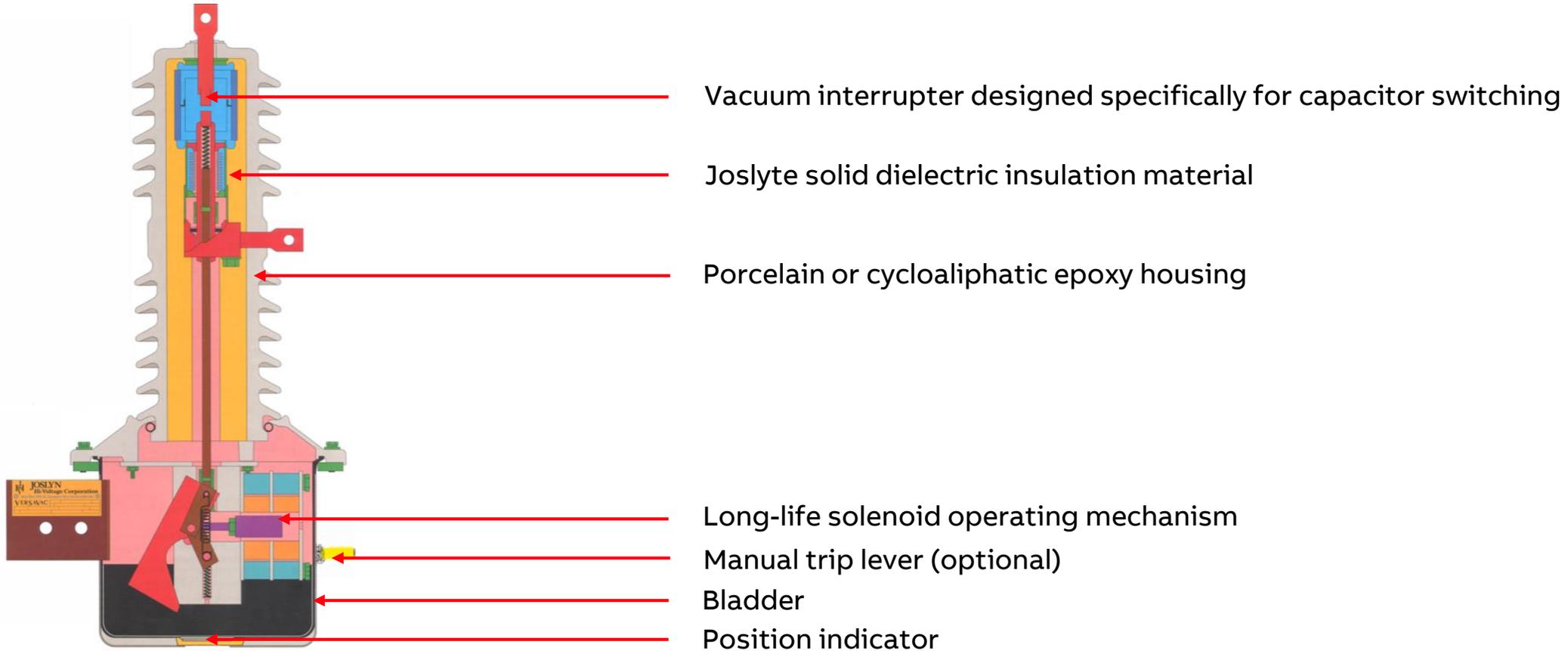
Solenoid operator

- Simple: Few moving parts
- Fast operation: Allows zero voltage closing (ZVC) operation
- Synchronous: Operates less than $\frac{1}{2}$ cycle timing pole-to-pole
- Low-energy operator
- Operates down to 80 VAC @ 120 VAC or 160 VAC @ 240 VAC



Joslyn Hi-Voltage capacitor switches

VerSaVac — design cutaway



Joslyn Hi-Voltage capacitor switches

VerSaVac — ratings and models

Ratings

Exceeds electrical requirements of ANSI C37.66			
Continuous current		200 A	
Short-time current		6 kA (1/2 sec.), 4.5 kA (1 sec.)	
Asymmetrical momentary/making current		9 kA asymmetrical RMS/23 kA peak	
Peak inrush current limit for parallel or back-to-back switching applications		6 kA	
Control voltages		120 VAC, 240 VAC	
Minimum operating voltage		80 VAC, 160 VAC	
Recommended control pulse time		100 msec.	
Auxiliary contact rating		15 A @ 120 VAC, 0.5 A @ 125 VDC	
Operating temperature range		-60 °C to 40 °C	
Voltage class (kV)			
Maximum voltage			
- Solid grounded applications (kV)	15.5	27.5	38
- Ungrounded applications (kV)	15.5	27.5	N/A
- Ungrounded applications with manual trip* (kV)	12.47	22.5	N/A
Impulse withstand (kV BIL)			
- Line to ground	95	125	150
- Open-gap	95	95/125	125
Power frequency AC withstand dry/wet (kV RMS)	36/30	60/50	70/60

* Units equipped with manual trip handle.

Joslyn Hi-Voltage capacitor switches

Applications — capacitor switching

Pole-top capacitor banks

- Single or three phase



Joslyn Hi-Voltage capacitor switches

Applications — capacitor switching



Photo: Reuel, Inc

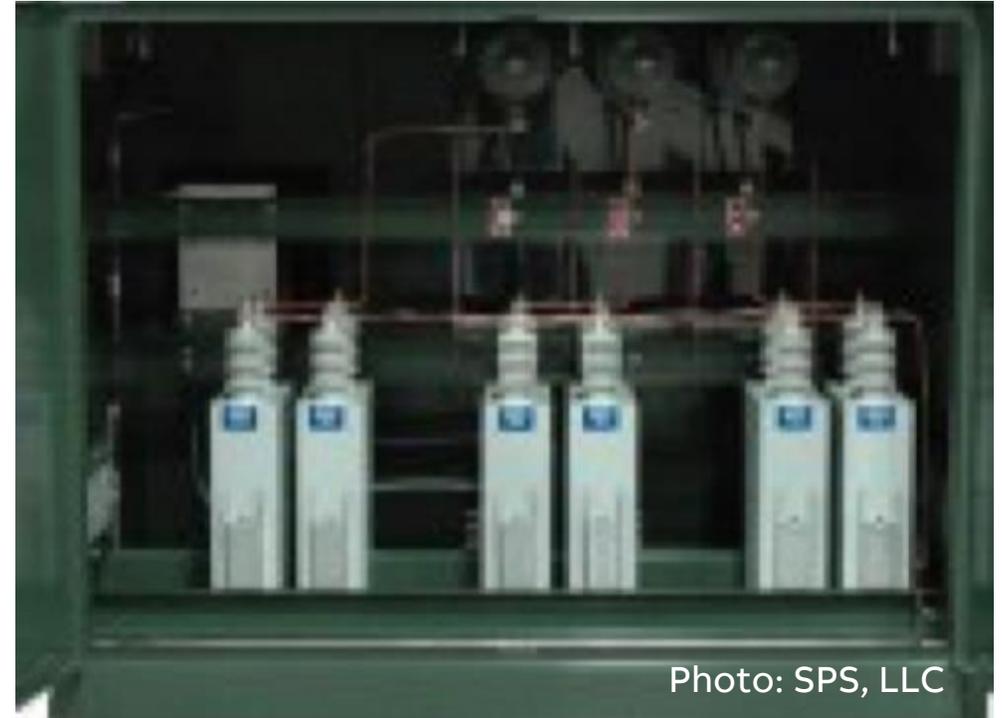


Photo: SPS, LLC

Padmount distribution capacitor banks

Joslyn Hi-Voltage capacitor switches — agenda

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JHV capacitor switches
compelling features

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Joslyn Hi-Voltage capacitor switches

Features and benefits — Varmaster (VBM)



High reliability with quiet and safe interruption.

Features

Benefits/descriptions

Vacuum interruption and solid dielectric Joslyte insulation

No oil, no gas, no maintenance.

Long-life solenoid operating mechanism

Yields up to 100,000 maintenance-free operations (50,000 open and 50,000 close).

15 kV–72.5 kV system range

Substation or pole-mounted installations.

Zero voltage closing (ZVC) control available

Mitigates the system overvoltages and high inrush currents typically associated with bringing capacitor banks online to prevent resulting customer equipment damage and stress on capacitors.

Compact and lightweight

No special foundations or support required.

Completely sealed construction

Safe interruption with no external arcing; quiet yet high-speed operation.

Factory assembled

Fast, easy, low-cost installation.

Choice of operating mechanisms and controls

Solenoid or motor operating mechanism with AC or DC control voltage.

Joslyn Hi-Voltage capacitor switches

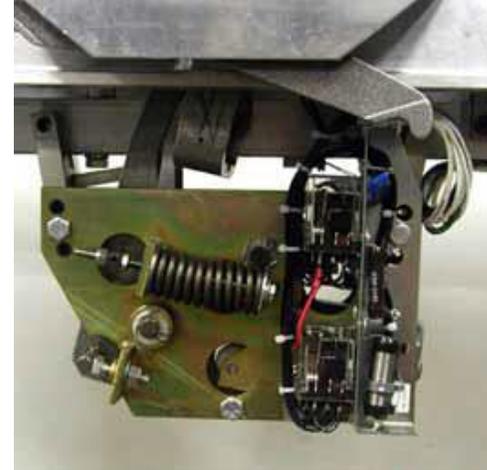
Varmaster — operating mechanisms

Solenoid operating mechanisms



- 100,000 maintenance-free expected operations
- 60 A control inrush per mechanism
- 6-cycle trip and close time
- Normally used in substation applications

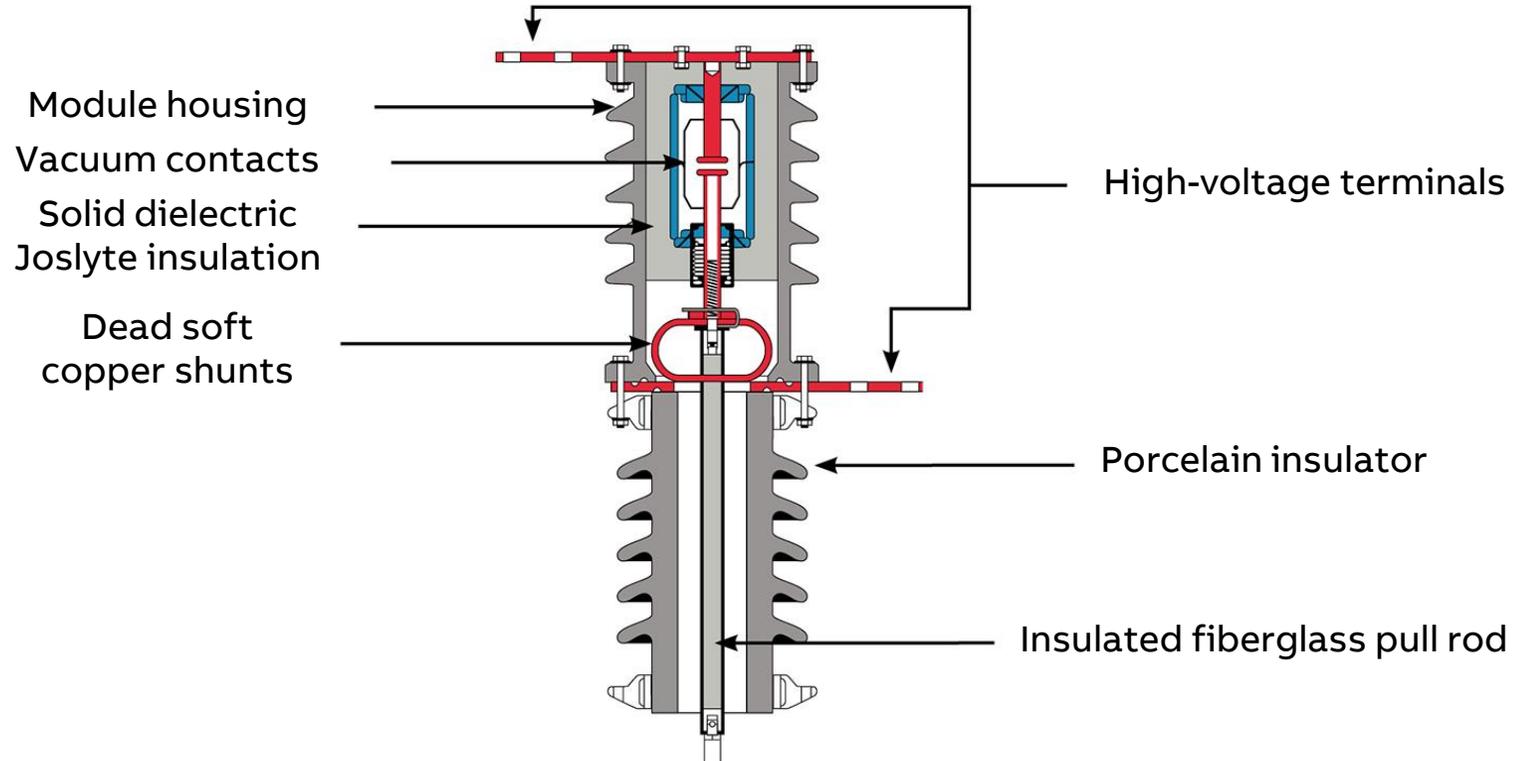
Motor operating mechanisms



- Inspect after 15,000 operations
- Low 3 A control current
 - 5 second close and 2-cycle trip
- Normally used for distribution sectionalizing applications

Joslyn Hi-Voltage capacitor switches

Varmaster — design cutaway



Cutaway of single-vacuum module mounted on 15 kV line-to-ground insulator

Joslyn Hi-Voltage capacitor switches

Varmaster — construction types

Three phase



- 15 kV/25 kV 400 A
- 15 kV/25 kV 600 A

Three phase



- 25 kV 200 A
- 25 kV 300 A
- 25 kV 400 A

Three phase



- 34.5 kV 300 A

One pole



- 34.5 kV 400 A
- 34.5 kV 600 A

One pole



- 46 kV 300 A

One pole



- 72.5 kV 300 A

Joslyn Hi-Voltage capacitor switches

Varmaster — design enhancements

Changed from 300 A vacuum interrupters to 600 A vacuum interrupters

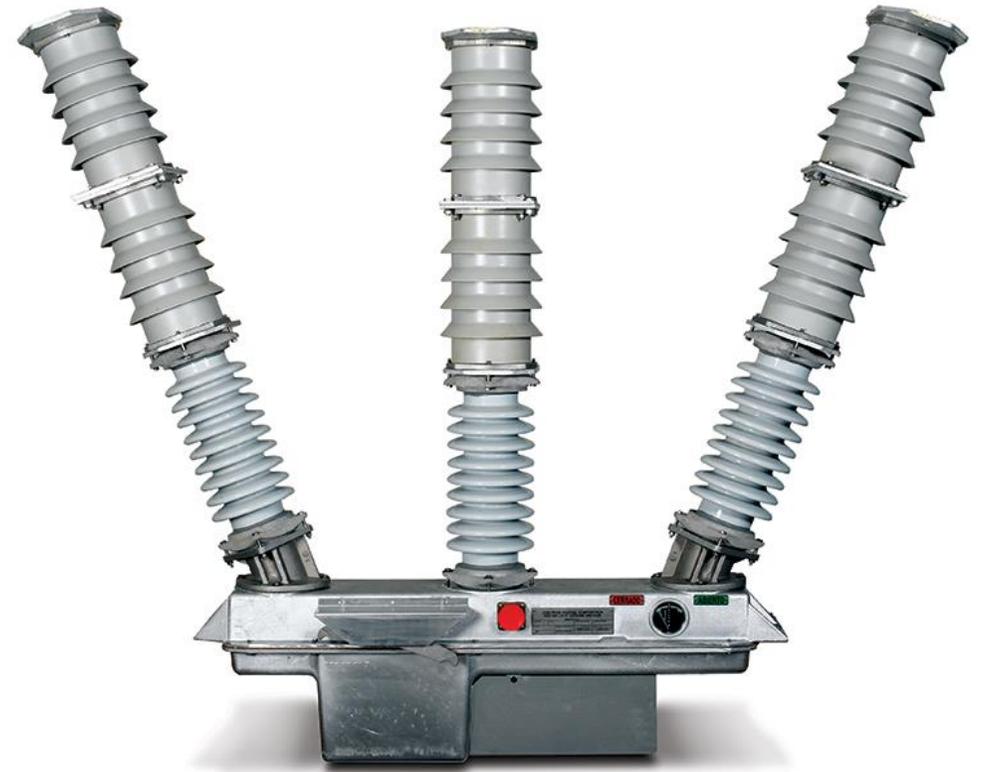
- Standardized to the 600 A-rated vacuum interrupter, which increased vacuum space by 35%.

Electropolish contacts and interrupter stems

- The addition of this process eliminates all rough surfaces and any small imperfections that could potentially cause partial discharge and could temporarily impact an electrical interruption performance. This process allows for higher voltage conditioning.

Voltage conditioning

- This testing procedure is performed by reducing the size of the open gap of the contacts and increasing the conditioning voltage in order to better “clean” the contact surfaces and “burn-off” any microscopic particles initially present during the interrupter manufacturing process. This resulted in an AC withstand test rating of 70 kV for 1 minute with 0 breakdowns.



Joslyn Hi-Voltage capacitor switches

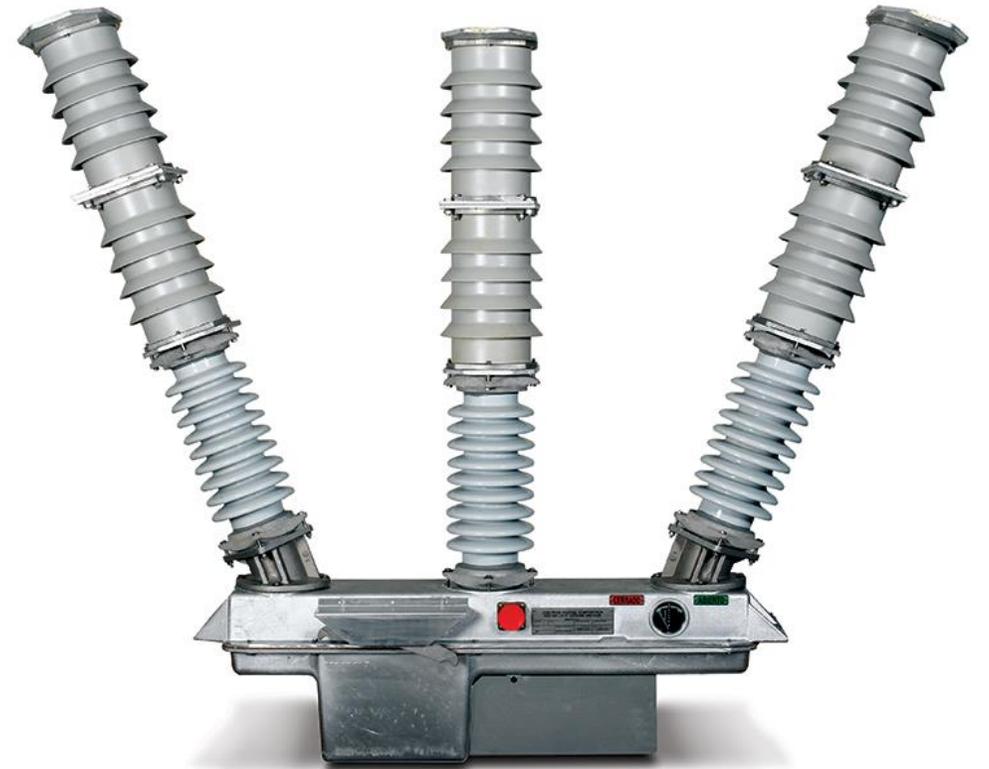
Varmaster — design enhancements

Added non-evaporable getters

- Absorbs gases to maintain constant vacuum integrity and performance.

Retested 38 kV Joslyn VBM — Certified Class C2

- According to IEEE C.37.66, 2005, the Class 2 certification is the lowest restrike rating and is defined as 0.2% probability of restrike after 1200 test operations.
- During the testing performed by T&B at the certified third-party test lab, 0 restrikes were observed in the 1200-operation test.



Joslyn Hi-Voltage capacitor switches

Varmaster — ratings

VBM switch ratings

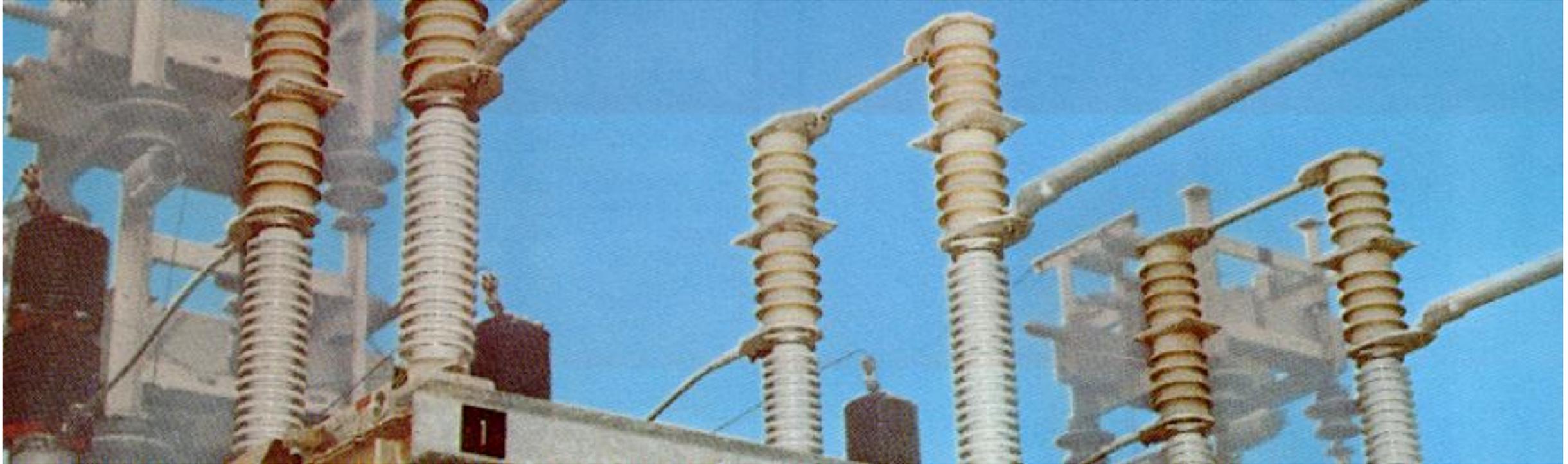
Maximum voltage	15.5 kV/25 kV ³		25 kV			38 kV			48.5 kV			72.5 kV
Capacitor and load switching current ^{1,2} (amps)	400	600	200	300	400	300	400	600	200 ⁴	300	400	300
Fault interrupting current (kA)	3	4	3	3	3	3	3	4	4	3	3	3
Momentary current (kA RMS, asymmetric)	20	20	15	15	15	15	20	20	20	15	15	15
Impulse withstand (kV BIL) terminal-to-terminal ⁵	110	110	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	200	200	200	250	250	250	350
Maximum 60-cycle withstand line-to-ground (kV)												
One minute dry	101	101	101	101	101	138	138	138	178	178	178	178
Two seconds wet	74	74	74	74	74	119	119	119	176	176	176	176
Maximum peak making current (kA) ⁶	20	20	15	15	15	15	20	20	20	15	15	15
Maximum peak back-to-back inrush current (kA)	10	10	8	8	8	8	10	10	10	8	8	8
Two-second current (amps)												12,500
Four-second current (amps)												9,000

Notes:

- 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.
- Varmaster VBM switches are available with continuous current ratings through 3,000 A for non-capacitor bank applications. Consult your T&B representative regarding application of these switches.
- Grounded systems only at 25 kV.
- In capacitor switching applications, the 48.5 kV, 200 A Varmaster VBM may be used on solidly grounded systems and grounded capacitor banks with total current less than 200 A. For all other loads, this VBM rating is 600 A.
- Interrupter portion of switch does not provided a visible open gap; therefore, it cannot be used to establish a safety clearance for personnel.
- 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.

Joslyn Hi-Voltage capacitor switches

Applications — capacitor switching — substations



Open-air type

Joslyn Hi-Voltage capacitor switches — agenda

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**JHV capacitor switches
compelling features**

– ZVC

Joslyn Hi-Voltage capacitor switches

Compelling feature — Zero voltage closing (ZVC) control



Eliminates overvoltage disturbances.

Features

Benefits/descriptions

Interfaces with a variety of equipment

Works with new or existing capacitor controllers and with Joslyn Hi-Voltage VerSaVac capacitor switches and Varmaster VBM switches.

Mitigates system overvoltage disturbances

Eliminates electronic adjustable speed drive nuisance tripping.

Eliminates high inrush currents

Increases capacitor and related high-voltage equipment life.

Field-proven design

Installations worldwide — more than 15 years successful field experience.

Available for 15 kV to 72.5 k 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).

Joslyn Hi-Voltage capacitor switches

Compelling feature — ZVC control distribution to substation applications



VerSaVac

15–38 kV; 200 A



Varmaster

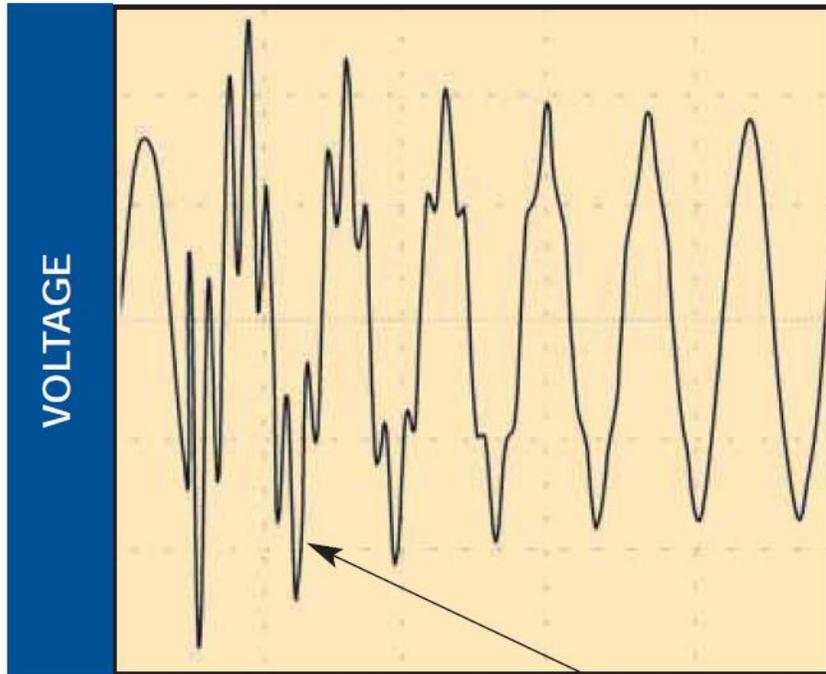
15–72.5 kV; 400 A, 600 A



Joslyn Hi-Voltage capacitor switches

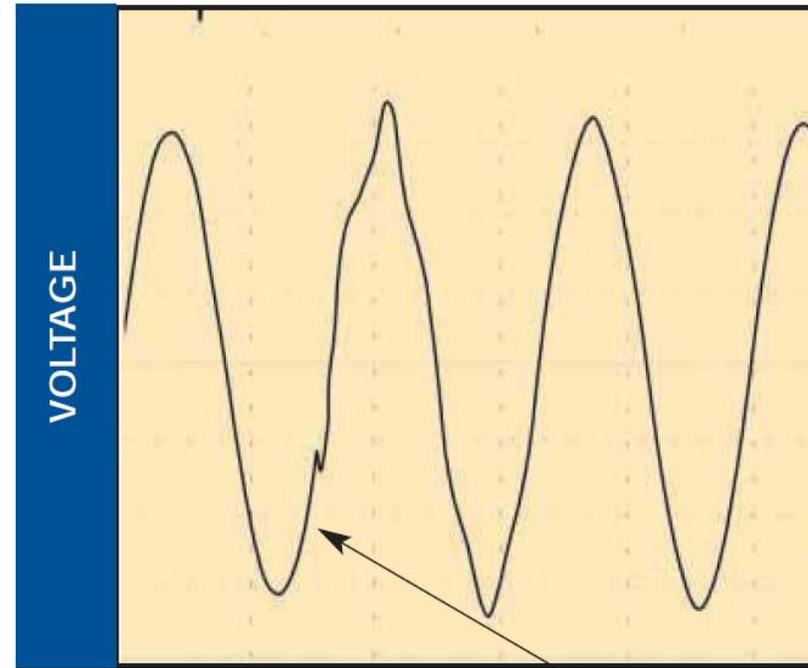
Compelling feature — performance improvement

Standard control



Close cap #1

With ZVC control

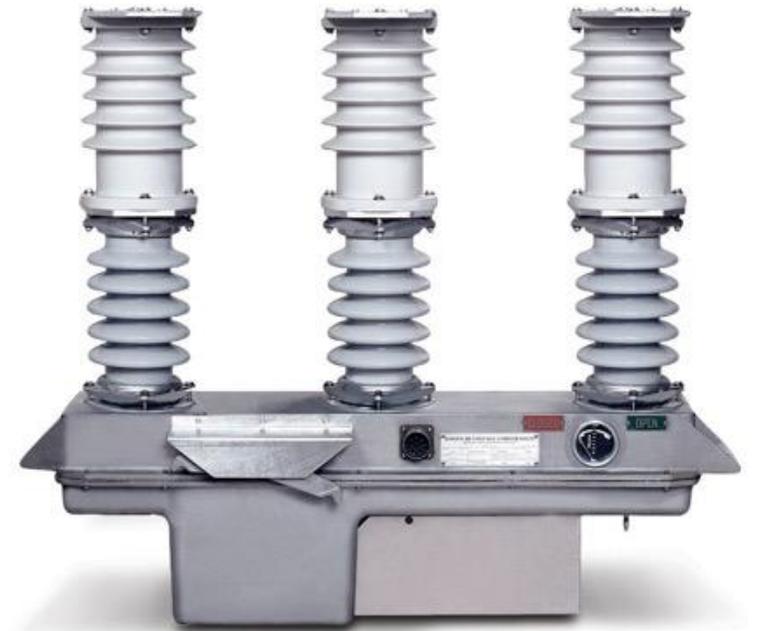


Close cap #1

Joslyn Hi-Voltage capacitor switches

Compelling value

- Efficiency
- Compatibility
- Environmental sustainability
- Lifecycle cost reductions





ABB