



**JOSLYN HI-VOLTAGE TYPE THREE-PHASE VSV SWITCH
INSTALLATION AND OPERATING PROCEDURE**

GENERAL

The Type VSV (VerSaVac) Switch is supplied completely factory adjusted and sealed. Accessories such as a junction box, or an electronic switch control can be supplied as optional items.

Equipment Included with Each Switch

Three Phase VSV
Eyebolt Type Terminals
Hardware provision to connect ground

Optional Accessories (Ordered Separately)

Cable Assembly
Manual Trip Lever
Junction Box
Capacitor Controls
Extra auxiliary contacts
Animal Protectors
Undervoltage Trip Control
Wood Pole Mounting Bracket

Specifications

Control Voltage: 120 Vac VSV: 102 Vac* to 127 Vac
240 Vac VSV: 204 Vac* to 252 Vac

Inrush Current: 120 Vac VSV: 42 Amps per switch for a maximum of 1.5 cycles
240 Vac VSV: 18 Amps per switch for a maximum of 1.5 cycles

Open and Close Operating Time: 11 milliseconds

Recommended Control Pulse Time: 100 milliseconds

* Minimum voltage that must be maintained at the pins of the switch control cable connector during the operating inrush current transient.

INSTALLATION

A. Inspection:

1. Uncrate and visually inspect for shipping damage or missing items.
2. If any damage occurred, immediately file a claim with the shipping carrier and then contact your local Joslyn Hi-Voltage Representative.
3. The VSV is shipped from the factory in the CLOSED position to eliminate any potential damage to the vacuum contact due to possible excessive vibration during the shipping process. The VSV MUST always be in the CLOSED position whenever the switch is being transported to prevent the possibility of contact damage.

B. Mount the VSV:

Mounting hardware shall be compatible with the galvanized coating of the VSV bracket such that it does not reduce the corrosion resistance level of the coating or the mounting hardware. Refer to the specific switch outline drawing for further mounting and dimensional details.

The VSV shall be mounted in a manner such that it does not reduce the required insulation levels of the VSV or any other nearby device.

C. Connecting to the VSV

1. Grounding: A ½-13UNC galvanized steel bolt, nut, flat and lockwasher are provided for grounding. The User is responsible for solidly grounding the mechanism housing to all applicable standards to ensure proper and safe operations.
2. High Power Connections: Eyebolt Type Terminal are provided for #8 Solid to 2/0 copper cable connections. Maximum Torque on Terminal Stud is 216 in-lbs. The following installation details are important to assure proper switch performance.
 - When tightening the terminals to the 216 in-lbs., the proper work practice of holding the connector bolt and then tightening the connector nut must be utilized to eliminate any induced rotational or twisting torque on the terminal. Excessive rotational torque or stress on the switches' stationary terminals could result in damage of the terminal connection integrity.
 - The actual connection of the high voltage cables are required to be orientated to avoid close proximity of the switch module to assure proper interrupting performance. Figure 1 is provided to demonstrate proper installation details.

D. Mounting Control Cabinets or Junction boxes

A control cabinet or junction box is not a standard accessory. User should consult manufacturer of controls or junction boxes for installation recommendations of such devices. If a control or junction box is purchase as an optional accessory, refer to the provided wiring and interconnection drawings for specific installation details.

E. Operational Checks

After setting up the VSV and control, operate the VSV from the control cabinet to close and open observing the position indicator for agreement with control indication if applicable. If the manual trip lever is supplied, close the VSV and strike the trip handle observing that the switch has opened.

F. High Potential Testing

High potential testing is used to check the integrity of the vacuum inside the vacuum interrupter. Loss of vacuum results in complete breakdown across open vacuum contacts at voltages below 30kV RMS. Only AC high potential testing is meaningful. DC testing cannot be used. With the VSV in the open position, apply 30kV RMS across each individual contact for 15 seconds. To avoid possible generation of x-rays, do not apply more than 30kV RMS.

During the high potential testing, self-extinguishing, momentary breakdowns lasting only a few seconds may occur. These "breakdowns" are not significant but can result in false indication of vacuum loss if the test set utilizes a high-speed overload relay or breaker.

During normal operation with the VSV in service, loss of vacuum or a defective interrupter may be indicated by excessive AM radio noise with the VSV open, or by measuring a difference in surface temperatures (a differential of more than 5°C temperature rise above normal ambient) between switches on the same capacitor bank. A vacuum interrupter that has experienced a loss of vacuum will typically have an increased contact resistance. A module which has a higher than normal resistance will operate at a higher temperature than other VSVs.

G. Resistance Testing:

With the VSV in the closed position, measure the resistance across the VSV terminals of each phase of the switch. Resistance values should be less than 200 micro-ohms. Resistance measurements should be made at a current of 10 Amperes.

MAINTENANCE

No maintenance of the VSV is required.

VSV SWITCH POWER INPUT/DESIGN REQUIREMENTS

The Joslyn Model VSV switch is designed for long-life, maintenance-free operation. To assure this trouble-free long life operation, the control power requirements of the switch must be insured during installation.

VSV switches produced after January 1, 2000 have been improved to provide a minimum operating voltage of 102 volts. That is 5 volts lower than the previous 107 volt minimum requirement. For the 240 volt VSVs, the minimum operating voltage is now 204 volts. Recommended voltages for normal duty must be above these values to insure proper operation with expected power system variations.

Consistent with the National Electrical Code (NEC), the cabling from the control power transformer to the VSV switches must be sized to allow no more than a 5% drop during the inrush current flow of 42 amps RMS per switch. This 5% voltage drop requires a maximum circuit resistance of 0.166 ohms at a nominal voltage of 120 volts. For a 240 volt VSV, 18 amps RMS per switch, the maximum allowable circuit resistance is 0.667ohms. The inrush current level exists for approximately 24 mS (1.5 cycles).

In addition to the requirement of no more than a 5% voltage drop, the voltage at the cable connector pins of the switches must be at least 102 volts [204 volts for 240 volt VSV switch] during the switch operating current transient. **Note: 102V and 204V are design calculation values, and can only be accurately measured with an oscilloscope and when the solenoids are energized at peak voltage to determine worst case.**

Example Calculation for a 120 VAC Installation (See Table 1 for Wire Resistances)

Calculation of the voltage drop must include the supply and return paths for the power to the switches. The voltage drop calculation must include the run from the transformer to the controller, controller to junction box, the junction box to each pole and any small gauge wire within the controller. This small gauge wire introduces a large drop even though the length of wire is not long.

- A. In Figure 2 the power transformer is 100 feet from the junction box or the capacitor controller. Since #4 AWG is run between the transformer and the junction box or the controller there is a total of 200 feet (hot and neutral) of #4 AWG wire. Using Table 3, this run has a resistance of .0497 ohms and a voltage drop of 1.79 volts ($36 \times .0497$).

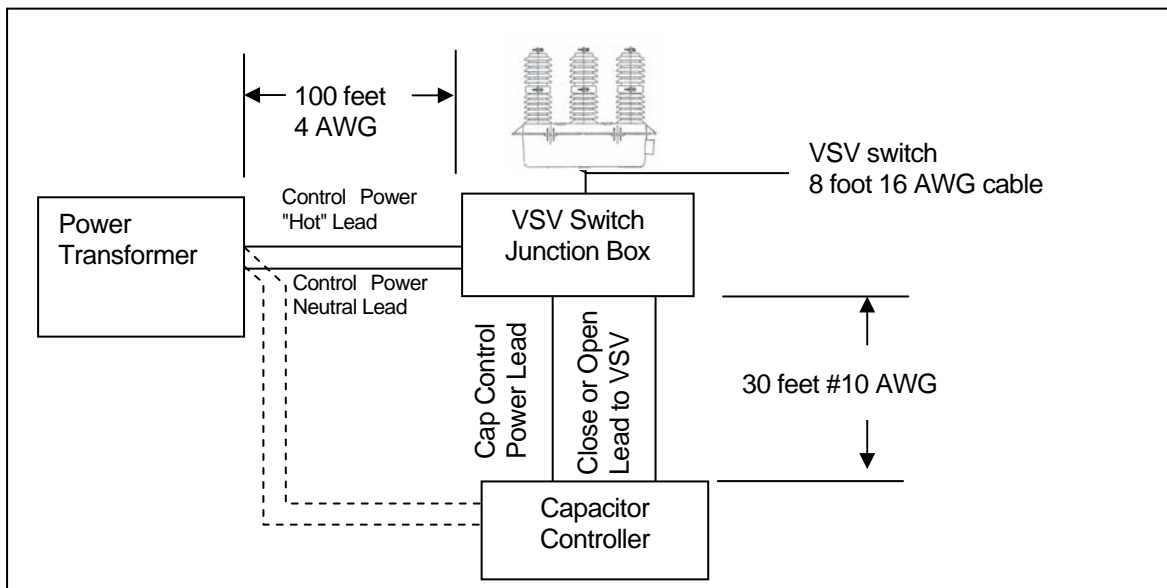


Figure 2: Example Installation

- B. The capacitor controller has 2 feet total of #18 AWG internal wiring. The resistance of this run is .0128 ohms which has a voltage drop of 0.46 volts.
- C. The VSV junction box is 30 feet from the capacitor controller. The total run is 60 feet of #10 AWG, which includes the return path, gives a circuit resistance of .06 ohms and a voltage drop of 2.16 volts.

- D. The individual cable for each pole from the junction box to the VSV Switch is 8 foot, 16 AWG cable and has a total resistance of 0.06406 ohms and a voltage drop of 0.77 volts ($12 \times 0.06406 = 0.77V$)
- E. The total voltage drop of the cabling is $1.79 + 0.46 + 2.16 + 0.77$ volts for a total drop of 5.2 volts, which is acceptable, because it is less than 6.0 volts at 120 Vac, or the 5% acceptable voltage drop limit.

FORMULA FOR VOLTAGE DROP

	$FT \times \text{Resistance (from Table 1)} = \text{Wire Resistance} \times \text{Switch Current} = \text{Voltage Drop}$
Transformer to Junction Box:	$200 \text{ feet of 4 AWG} = 200 \times (0.0002485)^{TM} \times 0.0497 \text{ Ohms} \times 36 \text{ amps} = 1.79 \text{ Volts}$
Controller Internal Wiring:	$2 \text{ feet of 18 AWG} = 2 \times (0.006374)^{TM} \times 0.0128 \text{ Ohms} \times 36 \text{ amps} = 0.46 \text{ Volts}$
Controller to Junction Box:	$60 \text{ feet of 10 AWG} = 60 \times (0.0009989)^{TM} \times 0.060 \text{ Ohms} \times 36 \text{ amps} = 2.16 \text{ Volts}$
Junction Box to Switch:	$16 \text{ feet of 16 AWG} = 16 \times (0.004020)^{TM} \times 0.06406 \text{ Ohms} \times 12 \text{ amps} = \underline{0.77 \text{ Volts}}$
	Total Voltage Drop = 5.18 Volts

Since the current flow to the switches is transient, the control power transformer does not have to be continuously rated for 36 amps at 120 VAC or 18 amps at 240 VAC. The transformer does need to have the capability to supply the momentary current requirement without excessive voltage drop. The kVA rating of the transformer is not sufficient information to determine the voltage drop during the momentary current requirements of the switches. The percent impedance rating of the transformer, along with the kVA nameplate, gives a good indication of this capability. It is important, however, to verify that for the 1.5 cycle operating current that excessive voltage drop does not occur. Table 2 lists various kVA sizes of transformers and the maximum percent impedance allowable for proper operation. Table 3 is a listing of transformers that have been utilized in VSV installations at 120 VAC. Table 3 is not intended to be a comprehensive list but is intended as a list of qualified transformers for users who do not wish to verify the percent impedance requirements of the control power transformer utilized.

Table 1 - Wire Resistance Reference

AWG	OHMS/FT	AWG	OHMS/FT
#2	.0001563	#12	.001588
#4	.0002485	#14	.002525
#6	.0003951	#16	.004004
#8	.0006282	#18	.006374
#10	.0009989		

Table 2: Maximum Transformer Impedances

kVA Rating	Maximum % Impedance (120VAC)	Maximum % Impedance (240VAC)
0.5 kVA	0.5%	1.0%
1.0 kVA	1.2%	2.4%
3.0 kVA	2.5%	5.0%

Table 3: 120 VAC Transformers and Suppliers

Manufacturer	Phone Number	Type
Eastern Electric	(602) 252-2326	CBT .5 kVA or 1kVA
Mid Central	(608) 835-3513	SS-72-120SP, SP indicates cap switch
Instrument Transformer, Inc. (ITI)	(727) 442-0414	PT5-110-722F, CPT5-95-5