JOSLYN Hi-Voltage

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SINGLE-PHASE VSV SWITCH

INSTALLATION
AND
OPERATING MANUAL

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4000 East 116th Street λ Cleveland, Ohio 44105-4398 USA λ 216-271-6600 λ FAX 216-341-3615
http://www.joslynhivoltage.com

I. GENERAL

The Type VSV (VerSaVac) Switch was redesigned in November 2001 with a Low Energy (LE) operating mechanism. This instruction manual outlines the positive impact of this change in the Specification and Power Input/Design Requirements Sections. All VSVs received under this redesign will be clearly identified with a "LE" stamped/printed on the nameplate. This manual also maintains the necessary power input requirement details for all VSV received from Joslyn before November 2001 in the Appendix A Section.

The VSV continues to be completely factory adjusted and sealed. A cable connector assembly for interconnection wiring to the switch is supplied. Accessories such as a junction box or an electronic switch control can be supplied as optional items.

Equipment Included with Each Switch

Single Phase VSV
Eyebolt Type Terminals
Hardware provision to connect ground

Cable Assembly
Manual Trip Lever
Junction Box
Capacitor Controls
Zero Voltage Closing Control (Special VSV switch part number required)
Extra auxiliary contacts
Animal Protectors
Undervoltage Trip Controls

Optional Accessories (Ordered Separately)

II. SPECIFICATIONS

Control Voltage: 120 Vac VSV: 80 Vac* to 127 Vac
240 Vac VSV: 160 Vac* to 252 Vac

Inrush Current: 120 Vac VSV: 12 Amps per switch for a maximum of 1.5 cycles
240 Vac VSV: 12 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.

III. 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 you 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:

The mounting bracket on the VSV is designed to be directly bolted to a wooden utility pole using 5/8 diameter mounting hardware (not provided). 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.

IMPORTANT

- The Versavac switch is not designed for rigid bus connections that can exert high forces. **If rigid bud is used, flexible connection joints must be used** to prevent any bus forces applied to the Versavac terminals.
- 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. The high voltage cables should be orientated to maintain a minimum distance of 12" from the side of the interrupter housing. Figure 1 is provided to demonstrate proper installation details.

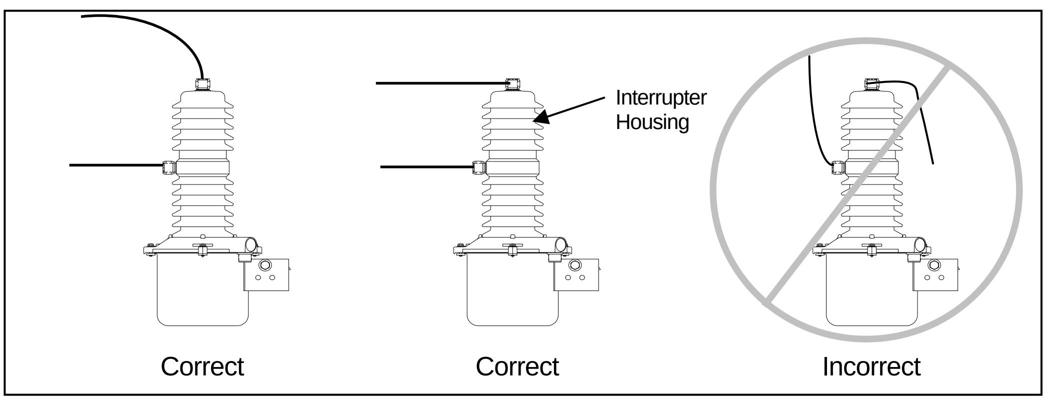


Figure 1: Cable Connections

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^{o}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. Resistance values should be less than 200 micro-ohms. Resistance measurements should be made at a current of 10 Amperes.

IV. MAINTENANCE

No maintenance of the VSV is required.

V. VSV Power Input/Design Requirements

<u>New Standard Low Energy VSV Switch</u>

VSV switches shipped from Joslyn **after November 2001** have been redesigned to operate at a minimum voltage of 80 volts. This is 22 volts lower than the previous 102 volt minimum requirement. For the 240 Vac VSVs, the minimum operating voltage is now 160 volts. Recommended voltages for normal duty must be above these values to insure proper operation with expected power system variations. The new Type VSV switch can be easily identified by a “LE” stamped/printed on the nameplate

Consistent with this redesign, acceptable voltage drop from the control power transformer to the VSV switches during the inrush current flow of 12 amps RMS per switch pole (36 amps total for 3 poles) has been increased to 10%. This is twice the acceptable value contained in the National Electrical Code (NEC). This 10% voltage drop requires a maximum circuit resistance of 0.333 ohms at a nominal voltage of 120 volts. For a 240 volt VSV, 12 amps RMS per switch pole (36 amps total for 3 poles) the maximum allowable circuit resistance is 0.667 ohms. The inrush current level exists for approximately 24 mS (1.5 cycles).

Also, readily available control power transformers with standard impedance can now be utilized in all installations. The need to locate and purchase new "special" impedance transformers has been eliminated.

Low Energy VSV Installation Example (120 VAC Application)

(See Table 1 for Wire Resistance)

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.

1.) In Figure 2 the power transformer is 100 feet from the junction box or the capacitor controller. Since #8 AWG is run between the transformer and the junction box or the controller there is a total of 200 feet (hot and neutral) of #8 AWG wire. Using Table 1, this run has a resistance of .1256 ohms and a voltage drop of 4.52 volts (36 X .1256).

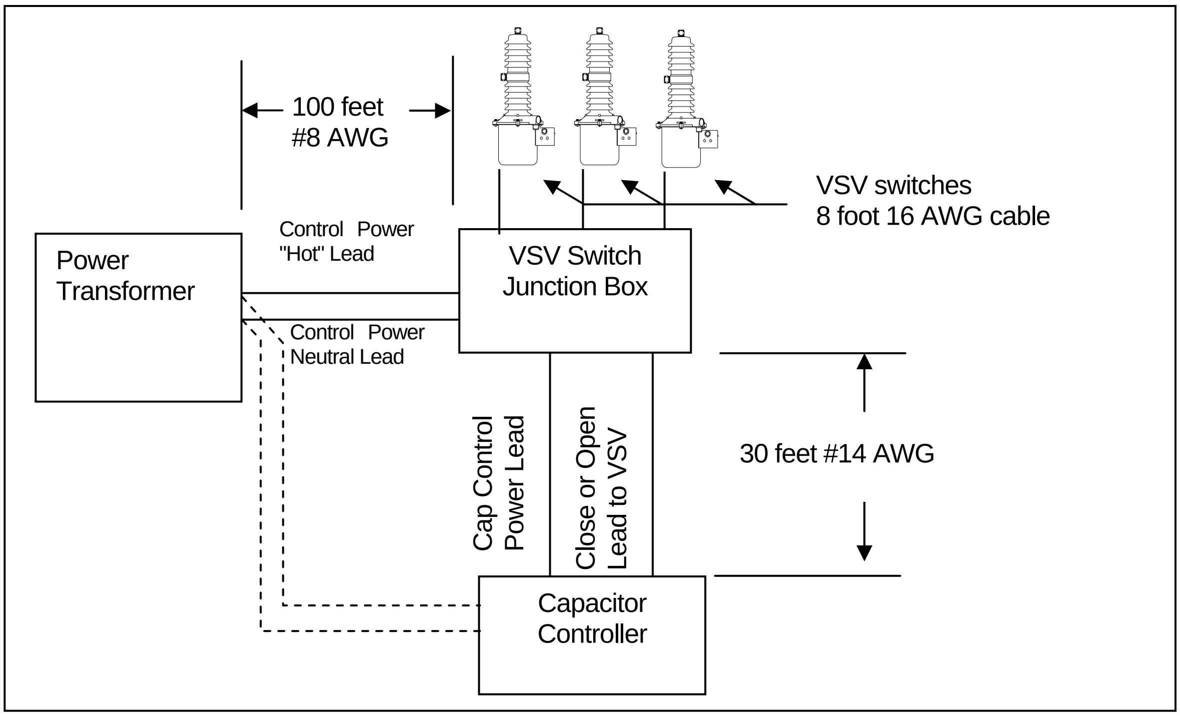


Figure 2: VSV LE Example Installation

2.) 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.

3.) The VSV junction box is 30 feet from the capacitor controller. The total run is 60 feet of #14 AWG, which includes the return path, gives a circuit resistance of 0.1515 ohms and a voltage drop of 5.45 volts.

4.) 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 x 0.06406 = 0.77V)

5.) The total voltage drop of the cabling is 4.52 + 0.46 + 5.45 + 0.77 volts for a total drop of 11.2 volts, which is acceptable, because it is less than 12.0 volts at 120 Vac, or the 10% acceptable voltage drop limit.

FORMULA FOR VOLTAGE DROP

	FT x Resistance (from Table 1)	= Wire Resistance	x Switch Current	= Voltage Drop
Transformer to Junction Box:	200 feet of 8 AWG = 200 x (0.000628)	™ 0.1256 Ohms	x 36 amps	= 4.52 Volts
Controller Internal Wiring:	2 feet of 18 AWG = 2 x (0.006374)	™ 0.0128 Ohms	x 36 amps	= 0.46 Volts
Controller to Junction Box:	60 feet of 14 AWG = 60 x (0.002525)	™ 0.1515 Ohms	x 36 amps	= 5.45 Volts
Junction Box to Switch:	16 feet of 16 AWG = 16 x (0.004020)	™ 0.06406 Ohms	x 12 amps	= 0.77 Volts
			Total Voltage Drop	= 11.2 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 60 amps at 240 VAC. The transformer does need to have the capability to supply the momentary current requirement without an excessive voltage drop.

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		

MANUAL REVISION NOTES

Date	Page	Scope
May 2006	2	Add note – special Versavac switch part number required for ZVC
	3	Add IMPORTANT note regarding rigid bus connections
March 2006	3, 4, 7, 8	Added a clearance reference of 12” in second bullet of Item C point 2. In-rush rating for 240 VAC VerSaVac corrected from 60A to 36A. Corrected to 240 VAC resistance from 0.4 to .667 ohms in 2nd paragraph of Section V. Revised 2nd paragraph of Section VI (Appendix A) for clarification.
March 2002	2 & 4	In-rush rating for 240 VAC VerSaVac corrected from 20A to 12A.
November 2001	Rework Manual	VerSaVac II LE version.

Application Details for VSV Switches before November 2001 only

VI. APPENDIX A

This information/example is supplied only as a reference for VSV switches previously purchased and/or received **before November 2001** and are currently in-service. The details outlined below are consistent with the February 2000 revision of this Instruction Manual, I. 750-271.

VSV switches produced between January 1, 2000 and November 1, 2001 were improved to require a minimum operating voltage of only 102 volts (Prior to January 1, 2000, the minimum voltage requirement was 107V). For the 240 volt VSVs, the minimum operating voltage was also reduced to 204 volts. Recommended voltages for normal duty must be above these values to insure proper operation with expected power system variations.

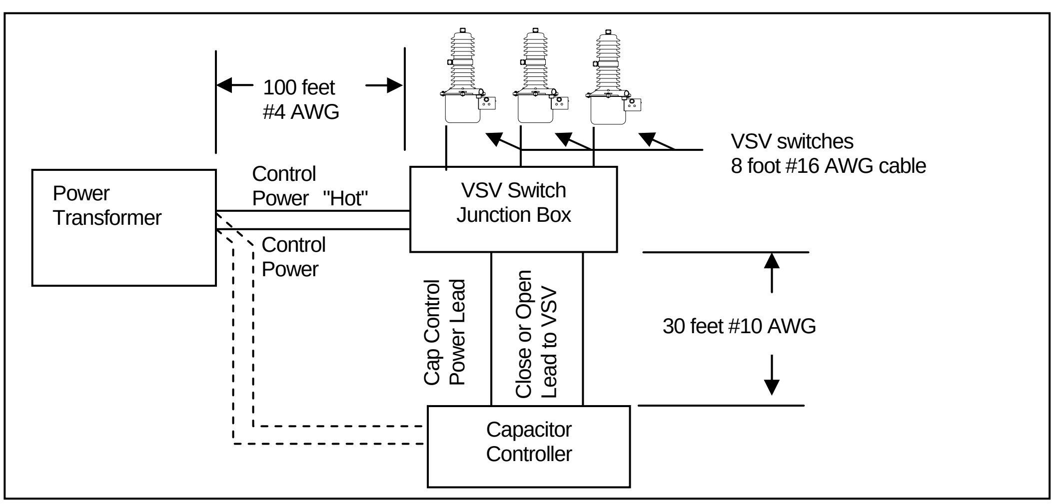
Consistent with the National Electrical Code (NEC), the cabling from the control power transformer to the VSV switches must be sized to allow no more than a 5% drop during the inrush current flow of 12 amps RMS per switch pole (36 amps total for 3 poles). This 5% voltage drop requires a maximum circuit resistance of 0.166 ohms at a nominal voltage of 120 volts. For a 240 volt VSV, 20 amps RMS per switch pole (60 amps total for 3 poles) the maximum allowable circuit resistance is 0.200ohms. 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.**

<u>Example Installation Calculation (120 VAC Application)</u>
(See Table 1 for Wire Resistance)

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.

1.) 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 X .0497).



<u>Figure 3: Example Installation</u>

2.) 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.

3.) 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.

4.) 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 x 0.06406 = 0.77V)

5.) 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 x Resistance (from Table 1)	= Wire Resistance	x Switch Current	= Voltage Drop
Transformer to Junction Box:	200 feet of 4 AWG = 200 x (0.0002485)	™ 0.0497 Ohms	x 36 amps	= 1.79 Volts
Controller Internal Wiring:	2 feet of 18 AWG = 2 x (0.006374)	™ 0.0128 Ohms	x 36 amps	= 0.46 Volts
Controller to Junction Box:	60 feet of 10 AWG = 60 x (0.0009989)	™ 0.060 Ohms	x 36 amps	= 2.16 Volts
Junction Box to Switch:	16 feet of 16 AWG = 16 x (0.004020)	™ 0.06406 Ohms	x 12 amps	= 0.77 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 60 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 2: Maximum Transformer Impedance **

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

**** NOTE:** Tables 2 and 3 only apply to VSV switches received **before November 2001**.