

## Interrupter Application Guide

### General

Interrupter Attachments are added to disconnect switches to increase their capability. The capability is added to allow application of these switches for such things as loop sectionalizing, line dropping, load breaking and transformer magnetizing current interruption.

The value of this added capability is gaining operation efficiency and flexibility, as well as reducing number of circuit breaker operations and/or investment. Additionally, devices that provide multiple functions on a single switch, such as the Joslyn Load Sectionalizer Interrupter (LSI), increase personnel safety because they can eliminate switch mis-operations.

### Design

Joslyn interrupters are designed in such a way as to not reduce the rating of the disconnect switch in any way and not to violate the coordinated open gap design of the switch. The interrupters include custom designed mounting brackets and arc horns to ensure the interrupters are properly transitioned into the circuit when the disconnect switch is opened. Moreover, the arc horns are designed to withstand the prestrike that is developed upon closing of the switch. The interrupters are designed for a 30-year life and can be operated 5,000 times without any maintenance.

Products Referred to in this Guide

HVI – Hi-Velocity Interrupter



This device stores energy in the spring rod and in the coil spring inside the aluminum housing. The stored energy in the spring rod is added to the energy stored in the coil spring at the instant the spring rod is separated from the latch. The parting velocity is 22 inches per cycle. This allows the HVI to be the highest rated device in this category. Applications include interruption of line charging current up to 161kV and transformer magnetizing current up to 230kV.

UVI – Universal VacRupter Interrupter



This device uses one vacuum interrupter per phase. The vacuum interrupter is inserted into the circuit when the disconnect switch is opened. Once the switch blade is sufficiently away from the switch jaw, the vacuum contacts will separate and interrupt the circuit. Specially designed arcing horns are designed to handle prestrikes upon closing of the switch. Applications include load breaking up to 34.5kV and parallel switching up to 230kV.

Add the Joslyn Voltage Limiter (V/L) Attachment and add the capability to interrupt line charging current of 15A up to 69kV.

LSI – Load Sectionalizer Interrupter



The LSI combines both the HVI and UVI into one system. The interrupter will automatically determine which device will be providing the interruption with a preset latch/spark gap assembly.

MVI – Modular VacRupter Interrupter



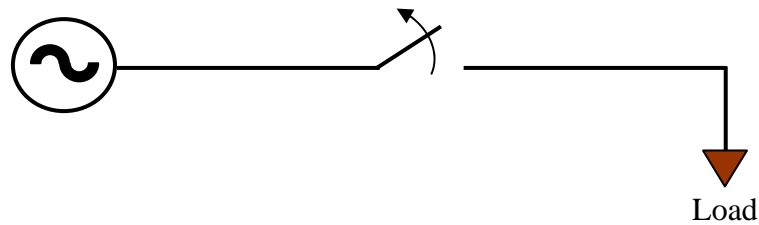
This device uses up to eight vacuum interrupters in series per phase. The vacuum interrupters are inserted into the circuit when the disconnect switch is opened. Once the switch blade is sufficiently away from the switch jaw, the vacuum contacts will separate and interrupt the circuit. Specially designed arcing horns are designed to handle prestrikes upon closing of the switch. Applications include load-breaking, line charging current interruption, and parallel switching up to 230kV.

Applications

*Load Dropping*

Loads are being fed from one source and opening the switch will disconnect the loads from the source. The interrupter needs to be able to interrupt the continuous load current at the system voltage. This is rarely done since customers would be interrupted. Usually specified as a safety measure in case of an emergency.

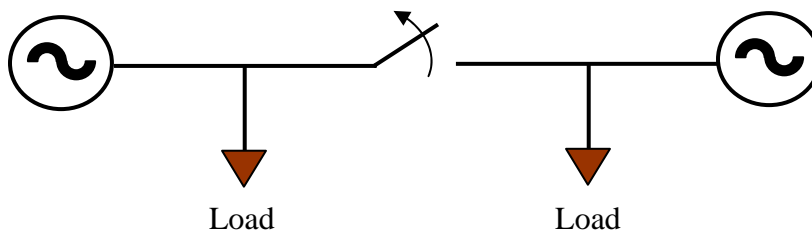
Products used for this application: UVI [34.5kV and below]  
MVI [46kV to 230kV]



*Loop Sectionalizing*

Loads are being fed from multiple sources and a switch in the circuit needs to be opened. The interrupter needs to be able to interrupt the circulating current between the two energized sources. When the switch is open, both sides will still be energized at the system voltage. The recovery voltage is typically low, but currents can be high.

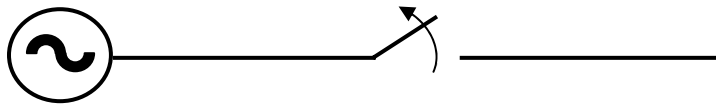
Products used for this application: UVI [230kV and below, unless peak recovery voltage is greater than 30kV]  
MVI [If peak recovery voltage > 30kV]



*Line and Cable Dropping*

When a section of line is energized and there is no load connected, a small amount of charging current is flowing. When the line is de-energized the recovery voltage will be high since the system voltage will be seen on the source side of the switch and there will be a trapped charge on the other side of the switch.

Products used for this application: UVI [34.5kV and below, up to 69kV with V/L]  
 HVI [69kV to 161kV]  
 MVI [230kV and below]



Typical Conductor and Cable Charging Currents

Overhead Conductor

System Voltage (kV)	Typical Charging Current per Mile (A)
69	.226
115	.377
138	.440
161	.502
230	.737

Transmission & Distribution – Westinghouse Electric Corp Fifth Edition, 1964

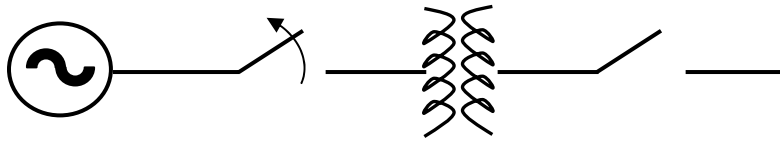
Underground Cable

Many factors determine the amount of cable charging current such as the cable insulation material and geometry of the conductors. A common guideline for determining the charging current is to use 1.5A per 1000 feet of cable; however, it is always recommended to contact the cable manufacture to obtain the exact cable charging currents for a particular cable.

*Transformer Magnetizing Current*

When a transformer is energized and there is no load connected to it there is a small amount of current flowing. This current is called transformer magnetizing current. When the transformer is de-energized the recovery voltage will be high since the system voltage will be seen on the source side of the switch and there will be a trapped charge on the other side of the switch.

Products used for this application: UVI [34.5kV and below, up to 69kV with V/L]  
HVI [69kV to 230kV]



System Voltage (kV)	Transformer MVA	Magnetizing Current per Phase	% Full Load Current
69	10	2.6	3.1
	25	5.0	2.4
138	10	0.98	2.4
	25	3.2	3.1
	50	6.5	3.1
161	25	3.5	3.9
	50	7.0	3.9
230	25	2.2	3.5
	50	3.5	2.8

Transmission & Distribution – Westinghouse Electric Corp Fifth Edition, 1964

*Load Sectionalizer Interrupter (LSI) Application*

A typical application for the LSI is when a particular section of a circuit needs to be de-energized for maintenance. Loop sectionalizing is the first step in this process. At the other end of the line, a device will have to de-energize the line by interrupting the line charging current.

The LSI combines the functions of both low charging current interruption and higher current loop sectionalizing. To accomplish this, the LSI consists of two complementary devices connected in parallel:

- Universal VacRupter Interrupter (UVI)
- Hi-Velocity Interrupter (HVI)

The UVI interrupts the high current associated with loop sectionalizing and the HVI interrupts the line charging current. During an opening operation, the two interrupters are mechanically controlled so that the vacuum contact opens prior to the separation of the HVI. If the recovery voltage is within the capability of the UVI, the UVI interrupts the circuit. If the recovery voltage exceeds the capability of the UVI a spark gap will ignite and instantly place the HVI in the circuit. The HVI will then interrupt the circuit. The mechanical operation of the LSI is the same every time it is operated. The determining factor as to which interrupter is being used is by the magnitude of the recovery voltage.

In the figure below LSIs are installed on both switches. When Switch 1 is opened while Switch 2 is closed, loop sectionalizing will be performed. The loop current is interrupted by the UVI since the recovery voltage is low. When Switch 2 is subsequently opened the higher recovery voltage associated with line dropping will result in the HVI being inserted into the circuit. The HVI will then interrupt the line charging current.

The significant advantage of the LSI is that the switches can be opened in any sequence since this device automatically inserts the correct interrupter in the circuit. This provides operational flexibility and is inherently safer than specific function devices. Some advantages are:

- Reduced switching time
- Reduced mis-operation
- Increased personnel safety
- Reduced breaker operations



Application Table

System Voltage (kV)	Load Dropping	Loop Sectionalizing <sup>1</sup>	Line Dropping	Magnetizing Current
15.5	UVI	UVI	UVI	UVI
25	UVI	UVI	UVI	UVI
34.5	UVI	UVI	UVI V/L	UVI
46	MVI	UVI	UVI V/L	UVI V/L
69	MVI	UVI UVI V/L LSI	HVI UVI V/L LSI	HVI UVI V/L LSI
115	MVI	UVI LSI MVI V/L	HVI LSI MVI V/L	HVI LSI MVI V/L
138	MVI	UVI LSI MVI V/L	HVI LSI MVI V/L	HVI LSI MVI V/L
161	MVI	UVI LSI MVI V/L	HVI LSI MVI V/L	HVI LSI MVI V/L
230	MVI	UVI LSI MVI V/L	MVI	HVI LSI MVI V/L

<sup>1</sup> UVI and LSI can be applied where the peak recovery voltage is less than 30kV.

V/L = Joslyn Voltage Limiter Attachment