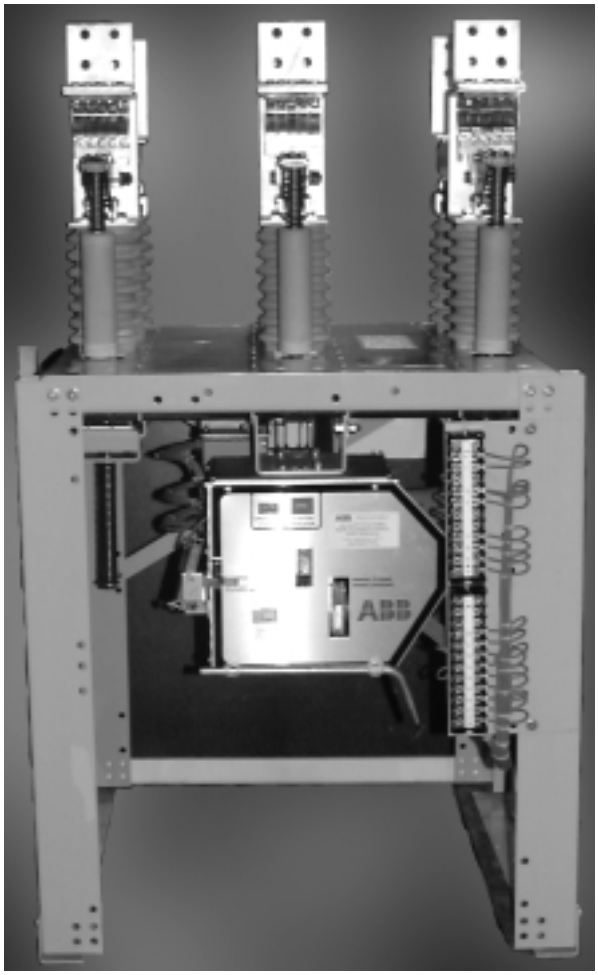
Type R and Type V Vacuum Circuit Breaker Trays

Descriptive Bulletin



Introduction

The Type R and Type V vacuum circuit breaker trays are the industrial application of the Type R and Type V outdoor circuit breakers. Type R is used for applications at 15 kV or 27 kV, and Type V for applications at 38 kV. These designs are to be used for indoor applications. They are primarily used by utilities for updating older indoor oil circuit breakers. They are also used by OEMs as the basic breaker for their equipment or for switching metal-enclosed capacitor banks.

Application

ABB vacuum breaker trays are designed for a wide range of applications, from line switching to fault current interruption. These breakers must be applied within their voltage and current ratings.

The Type R or Type V breaker trays can be applied in capacitor switching applications. ABB offers a capacitor switching solution that significantly reduces system disturbances during closing. The zero voltage closing option achieves this benefit by controlling the initial closing point on the voltage waveform, and controlling the time interval between the closing of individual phases.

Applications involving switching of shunt reactors, arc furnaces, dry transformers, and large motors may require surge capacitors for proper protection. These applications require careful study in order to assure the proper insulation procedures.

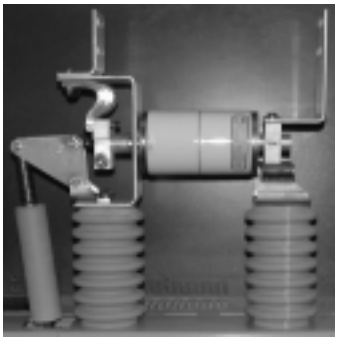
Modernization of older indoor oil breaker switchgear is accomplished by removing the existing oil breaker and installing the ABB vacuum circuit breaker tray in the existing enclosure, with minimum bus, frame and control modifications. Contact PTMV Components Group for retrofit assistance.

General

ABB vacuum circuit breaker trays are self-contained packages. The Type R (15 kV and 27 kV) utilizes three vacuum interrupters. The Type V (38 kV) design features two vacuum interrupters per phase, connected in series. The pair of interrupters is driven by a common push rod, through a unique linkage which ensures simultaneous operation. Each interrupter has an individual contact pressure spring and provisions to measure contact wear. Both types have a stored energy mechanism that has been designed and tested in accordance with the ANSI and NEMA Standards for AC High-Voltage Circuit Breakers rated on a symmetrical current basis.

Insulators

The six phase support insulators and the three insulated pull rods are made of polymer concrete. This material has electrical properties equal to electrical grade porcelain, with superior mechanical properties.



15 kV 1200 A Type R Vacuum Circuit Breaker Assembly

User Connections

Six plated copper terminal pads with standard NEMA 4 hole spacing, suitable for copper or aluminum bus, or cable connectors are standard.

A single 16 pole auxiliary switch is standard and is also available with 20 or 32 poles. In all cases, the switches are configured as 50% “A” and 50% “B” contacts. See Table 3 on back page.

Control Voltages

AC: 120 V or 240 V

DC: 48 V, 125 V or 250 V

Trip Voltage

DC trip: 24 V*, 48 V, 125 V, or 250 V

Capacitor trip only for 120 VAC or 240 VAC

*24 VDC on Type R only

Close Voltage

AC: 120 V or 240 V

DC: 125 V or 250 V

Control Wiring

600 Volt, # 14 AWG, type SIS

Operating Mechanisms

The operating mechanisms are the stored energy type, spring close-spring open. A motor driving through a ratchet mechanism is used to charge the main closing springs. Energy is stored in the tripping spring during the closing sequence to ensure adequate tripping energy whenever it is required. The mechanisms are electrically and mechanically trip free.

The operating mechanism drives directly to the main shaft, which connects all three phases. Each phase is operated from this shaft through an independently adjustable linkage.

Configuration

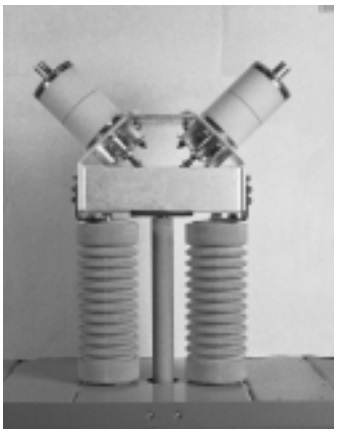
Mechanism Orientation - Type R 15 kV and 27 kV

0° Mechanism mounted on the center of the long side of the tray

90° Mechanism mounted on the end of the tray

Mechanism Orientation - Type V 38 kV

90° Mechanism mounted on the end of the tray only



38 kV 1200 A Type V Vacuum Circuit Breaker Assembly (terminals removed)

Advantages of Vacuum Interruption

Maintenance

The absence of oil as an insulating and interrupting medium minimizes the maintenance and servicing required. The mechanical life is 2,500 operations.

Installation

The forces generated during interruption are only those of the operating mechanism. This greatly simplifies foundation requirements.

Duty Cycle

No derating of interrupting capability is required, regardless of the reclosing duty cycle.

Safety

The use of air as the primary insulation minimizes the hazard from fire or explosion.

Environment

Arc extinction is silent and the sound level of the mechanism is low. Quiet operation is particularly desirable near hospitals, residential areas and shopping centers.

No oil or gas to be handled or disposed.

Advantages of Zero Voltage Closing in Capacitor Switching Applications

It is clear that demands for improved power quality will continue. Synchronized switching of capacitors and a variety of other loads can improve power quality while simultaneously extending circuit breaker life and reducing maintenance costs. A synchronous closing Type R circuit breaker can provide a cost effective solution for these critical applications on distribution systems.

It is well known that routine energization of capacitor banks can cause undesirable voltage and current transients on transmission and distribution systems. The maximum transients occur when the circuit breaker contacts close at the instant of peak voltage between the open contacts, where the difference between the system voltage and the capacitor bank voltage is greatest. In conventional circuit breaker applications, contact closing is random, which means that the transients generated are uncontrolled. Various methods have been implemented to limit the magnitude of the disturbances using pre-insertion resistors and current limiting reactors.

It is generally agreed that transients are reduced to acceptable levels when the contact closing occurs within plus or minus one millisecond of the voltage zero. To accomplish this, beaker performance must be predictable during all of the expected variations in operating conditions. These include ambient temperature, control voltage and mechanism linkage wear.

ABB began the project to develop the Type R vacuum circuit breaker for synchronous closing following a request by a large utility company for a breaker to be used in capacitor switching applications.

The design is based on the following:

1. One mechanism operates all three poles simultaneously. Adjustments for phase timing are made in the mechanical linkage of each phase.
2. The control voltage is 125 VDC or 48 VDC.
3. Standard design vacuum interrupters are used.
4. Control timing is provided by the ABB Switchsync E113 in conjunction with the precision closing board.

The control provides zero voltage detection with an adjustable delay prior to initiating the closing signal. The calculated delay is based on the known closing time of the breaker and is selected so that contact closing will occur at the zero point of the voltage wave.

To compensate for variation in breaker operating time, the control is programmed to adjust the timing of the closing signal by averaging the difference between the timing of the two previous operations. This would adjust for any overall trends in the breaker performance.

Vacuum interrupters are ideal for this application. Prestrike distances are minimal and have little effect on overall timing. Contact wear is also minimal and will produce only minor variations between phases in normal operation. If found necessary, adjustments can be made on individual phases during routine inspection and servicing.

Oscillograms (Figures 1 - 3) show the improvements made by the addition of a synchronous closing scheme to a circuit breaker.

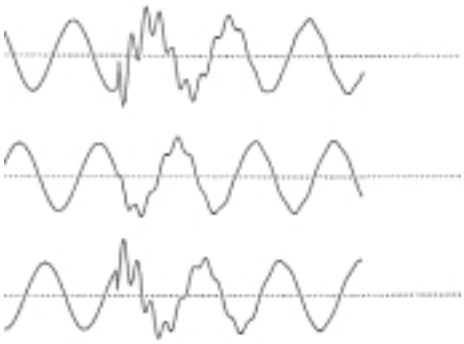


Figure 1: Random Close

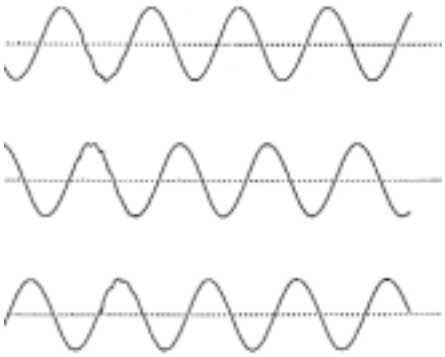


Figure 2: First Synchronized Close

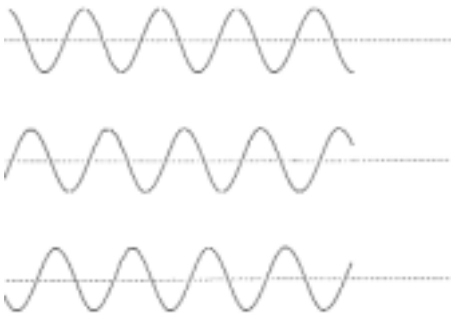


Figure 3: Second Synchronized Close

Table 1: Vacuum Circuit Breaker Trays, Type R & Type V

Ratings comply with ANSI C37.06 - 1997

Voltage Class (kV)	15	15	15	15	27	38
Continuous Current (A)	600	600	1200	2000	1200	1200
Breaker Type	R-1	R-3	R-3	R-3	R-3	V
Rated Max Voltage (kV)	15.5	15.5	15.5	15.5	27.0	38.0
Voltage Range Factor (K)	1.0	1.0	1.0	1.0	1.0	1.0
Frequency (Hz)	60	60	60	60	60	60
Dielectric Strength						
Low Frequency Withstand						
Dry 60 Hz for 1 minute	50	50	50	50	60	80
Wet 60 Hz for 10 seconds	45	45	45	45	50	75
Full Wave Withstand (BIL)	110	110	110	110	125	150
Operating Duty (Standard Duty Cycle)	a	a	a	a	a	a
Interrupting Time (Cycles)	3.0	3.0	3.0	3.0	3.0	3.5
Permissible Tripping Delay Y (Seconds)	2	2	2	2	2	2
Closing Time (Cycles)	6.0	6.0	6.0	6.0	6.0	6.0
Reclosing Time (Seconds)	0.33	0.33	0.33	0.33	0.33	0.33
Short Circuit Interrupting Current (at Contact Part)						
RMS Sym. (kA)	12.0	20.0	20.0	20.0	20.0	31.5
RMS Asym. (kA)	15.0	24.0	24.0	24.0	24.0	37.8
Close & Latch (Initial Current Loop) (kA) RMS Asym.	19.4	31.0	31.0	31.0	31.0	50.4
Close & Latch (kA Peak)	33.8	43.2	54.0	67.5	43.2	82.0
Short Time Current (3 seconds) (kA) RMS Sym.	12.0	20.0	20.0	20.0	20.0	31.5
Transient Recovery Voltage (kV Peak) Time to peak T_2 value at:						
T_2	36 µ s	36 µ s	36 µ s	36 µ s	52 µ s	61 µ s
kV Peak	29	29	29	29	48.5	79.4
Load Current Switching Capability (A)	600	600	1200	2000	1200	1200
Capacitance Current Switching						
Open Wire Line Charging System Current (A)	b	b	b	b	b	b
Isolated Cable Charging Current (A)	b	b	b	b	b	b
Isolated Capacitor Bank Switching Current (A) RMS	600	600	600	600	600	1200
Back-to-Back Shunt Capacitor Bank Switching Current (A) RMS	600	600	600	600	600	1200
Transient Overvoltage Factor	2.5	2.5	2.5	2.5	2.5	2.5
Transient Inrush Current (kA Peak)	40	40	40	40	20	50
Transient Inrush Frequency (Hz)	2000	2000	2000	2000	4240	6800
Interrupting Time (Cycles)	3.0	3.0	3.0	3.0	3.0	3.5
Capacitor Current Switching Life (Operations)	1500	1500	1500	1500	1500	1500
Grounding of System & Capacitor Bank System	c	c	c	c	c	d
Capacitor Bank	c	c	c	c	c	c
Contact Resistance (µ ohms)	<350	<350	<350	<350	<350	<350

Other ratings available - for detailed application information and dimensions consult the factory

a - 0-0.3 Sec. CO
15 Sec. CO
15 Sec. CO
b - up to 600 A RMS
c-grounded or ungrounded
d - grounded only

** Breaker can be applied on all voltages up to & including the rated maximum voltages*

Table 2: Stored Energy Mechanism Control Power Requirements, Type R & Type V

Rated Control Voltage	*Spring Run (A)*	*Charge Motor Time Sec.*	*Close* or Trip (A)*	*Voltage Range Close*	*Trip*
24 VDC			8/-		14-28/-
48 VDC	9.0/9.0	6/6	16/16	36-56/36-56	28-56/28-56
125 VDC	5.0/5.0	6/6	3/7	90-140/90-140	70-140/70-140
250 VDC	5.0/3.0	6/6	5/4	180-280/180-280	140-280/140-280
120 VAC	5.0/5.0	6/6	40**/6	104-127/104-127	cap trip/cap trip
240 VAC	5.0/3.0	6/6	29**/3	208-254/208-254	cap trip/cap trip

**These are the "worst case" inrush values for sizing protection or batteries only. Opening time is .0415 secs from the time the opening coil is energized until main contact break. Closing time is .0996 secs from the time the the close coil is energized until main contact make.*
***Closing current only. AC voltage tripping is not available. Stored energy capacitor trip devices are used with AC control voltage.*

Table 3: Available Contacts, Type R & Type V CB Trays

Trip	*Close*	*Motor*	*Available Contacts*
cap trip	AC	AC	6a 6b
DC	AC	AC	6a 5b
DC	DC	AC or DC	5a 5b

The above table illustrates the number and type of contacts available for customer use when a single 16 pole switch is used in the above control combinations.

Table 4: Interrupting Capacity of Auxiliary Switch Contacts, Type R & Type V CB Trays

Volts	*Non-Inductive Circuit*		*Inductive Circuit*	
	Single Contacts	*Two Contacts in Series*	*Single Contact*	*Two Contacts in Series*
24/48 VDC	40 A	40 A	20 A	40 A
125 VDC	11 A	25 A	6.25 A	12.5 A
250 VDC	2 A	5.5 A	1.75 A	3.5 A
115 VAC	75 A	75 A	15 A	22 A
230 VAC	40 A	70 A	8.5 A	15 A

Contacts will carry 15 A continuously or 250 A for 3 secs

Table 5: Overall Dimensions

kV	*Height*	*Width*	*Depth*
15	40.0	31.0	29.0
27	43.0	37.0	29.0
38	64.0	53.0	31.0

Dimensions are in inches.

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