

Basics of Circuit Breakers

SIEMENS

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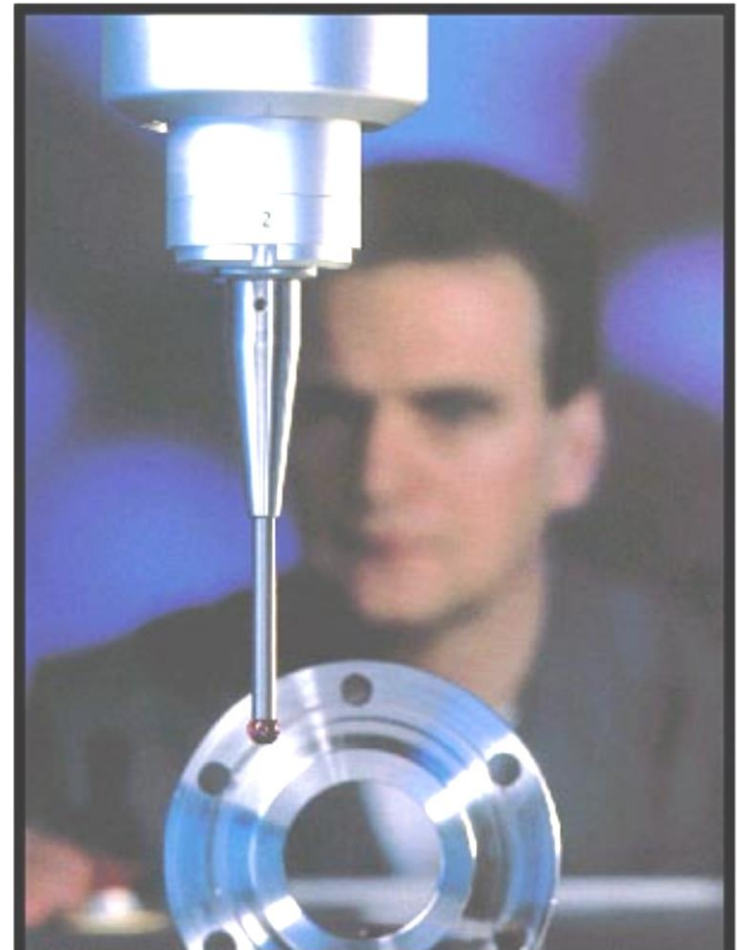


- *Get enough sleep*
- 35.3% adults report <7 hours of sleep during a typical 24-hr period
- Sleep is a vital indicator of overall health and well-being
- Avoid alcohol and caffeine before bedtime and strive for 7+ hours each night

High Voltage Circuit Breaker Type SPS2

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- World leader in development and manufacturing of transmission & distribution equipment
- ISO 9001:2000 registered quality system
- State-of-the-art manufacturing
- Tested to IEEE and IEC standards in the world's largest, privately owned, electrical laboratory



What is a Circuit Breaker ?

A circuit breaker is an apparatus in electrical systems that has the capability to, in the shortest possible time, switch from being an ideal conductor to an ideal insulator and vice versa.

Furthermore, the circuit breaker should be able to fulfill the following requirements:

1. In the stationary closed position, **conduct its rated current** without producing impermissible heat rise in any of its components.
2. In its stationary positions, open as well as closed, the circuit breaker must be able to **withstand any type of overvoltages within its rating**.
3. The circuit breaker shall, at its rated voltage, be **able to make and break any possible current within its rating**, without becoming unsuitable for further operation

Why do we need circuit breakers?

The circuit breaker is a crucial component in the substation, where it is used for coupling of busbar, transformers, transmission lines, etc.

The most important task of a circuit breaker is to interrupt fault currents and thus protect electric and electronic equipment.

The interruption and the subsequent reconnection should be carried out in such a way that normal operation of the network is quickly restored, in order to maintain system stability.

In addition to the protective function, the circuit breakers are also applied for intentional switching such as energizing and de-energizing of shunt reactors and capacitor banks. (Independent Pole Operated – IPO breakers)

Recipe to Quench an Arc

- Q: What is the “arc” and how does the breaker extinguish it?
- A: Cool it down
- Recipe....
 1. Wait for current zero. (Arc is extinguished during a zero crossing)
 2. Need to have Gas Flow to the nozzle area to reestablish the Dielectric strength
 - “Fresh” gas is cooler and has better dielectric strength
 - Pushes other materials/molecules out of the area

- **Spring-Spring**
 - - Helical Compression
 - - Torsion

- **Hydraulic**
 - - Pure hydraulic
 - - Spring hydraulic

- **Pneumatic**

What is Opening Time?

- Several factors/steps add up to create the opening time for a CB...
 1. Time for relay to activate trip solenoid and to start the mechanism release
 2. Mechanical time to open (contacts physically separating)
 3. Build SF6 gas pressure in the Arc region/nozzle as quickly as possible
 4. Time for Arc to extinguish at next zero crossing

Key Characteristics of Circuit Breakers

- Voltage Class (e.g. 72kV, 245kV, etc)
- Continuous Current Rating (e.g. 1200A, 2000A, etc.)
- Short Circuit Rating (e.g. 31.5kA, 40kA, 50kA, 63kA)
 - Are TRV Capacitors required?
 - Can you lower the voltage and get more current?
- Opening time (2-cycle, 3-cycle, 5-cycle, etc.)
- Gang-operated OR Independent Pole Operated (IPO)
- Current Transformers (quantity and ratios)
- Insulator Type and Creep (e.g. porcelain, composite)
- Various Control Requirements (e.g. annunciators, trip coil monitors, etc.)

Circuit Breaker Types

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Oil Circuit Breaker (OCB)

- Interrupting Medium:
 - Clean Mineral Oil
- Oil requires regular replacement or filtering
- Dielectric Strength:
Gas > Oil > Vacuum > Air



Vacuum Circuit Breaker (VCB)



- Interrupting Medium:
 - Vacuum
- Mostly Medium Voltage Applications (15kV-35kV)
 - Some 72kV-145kV
- Dielectric Strength:
Gas > Oil > Vacuum > Air



Vacuum Circuit Breaker (VCB)

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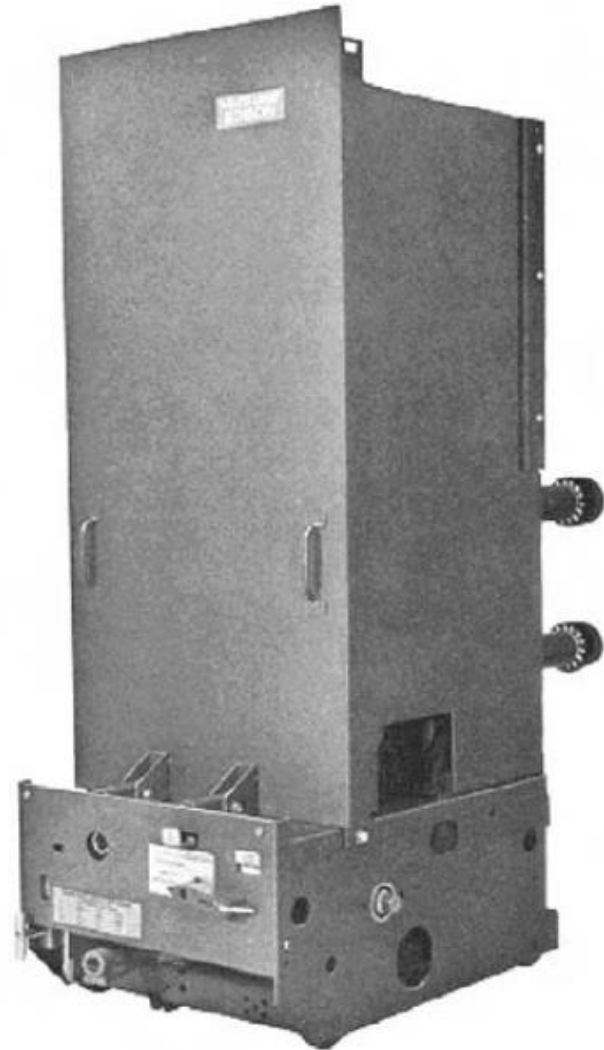
72.5kV VCB – Mitsubishi



40.5kV VCB – ABB

Air Circuit Breaker (ACB)

- Interrupting Medium:
 - Air
- Low Voltage Applications <12kV
- Dielectric Strength:
Gas > Oil > Vacuum > Air



SF6 Gas Circuit Breaker (GCB)

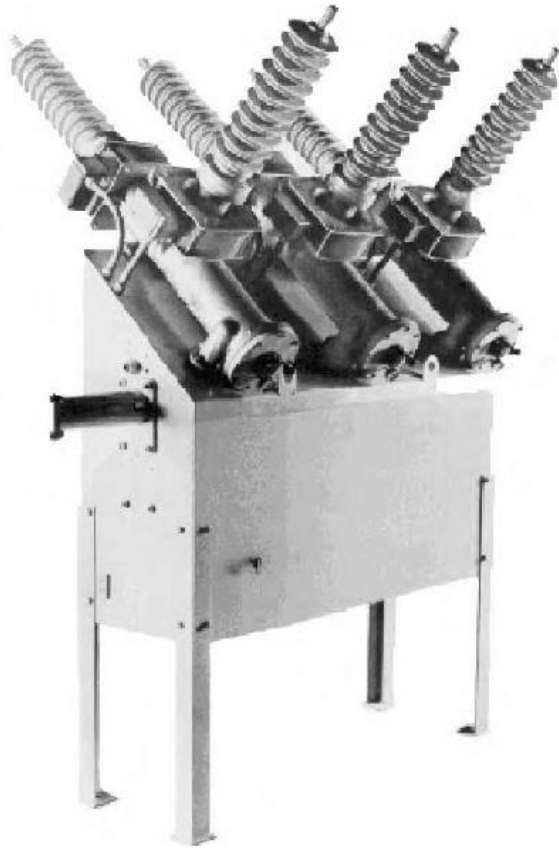
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- Interrupting Medium:
 - Sulfurhexaflouride (SF6)
- SF6 does not require replacement, does have temperature limitations
- Dielectric Strength:
Gas > Oil > Vacuum > Air



SF6 Gas Circuit Breaker (GCB)

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161kV GCB – Courtesy Alliant Energy



362kV GCB – Siemens

Live-Tank Circuit Breakers

Type CPV2 Circuit Switchers/Breakers



Operation of the CPV2 is controlled by a FA spring-spring operator which is the same as the operating mechanism used in the Siemens SPS2 SF6 circuit breakers worldwide.



This unit offers the following advantages:

- 40 kA fault operation
- 12 / 25 year maintenance cycle
- FA spring-spring, no maintenance drive mechanism
- Capable of OCO-15sec-CO operation duty
- Same 3AP interrupter used in Siemens dead tank HV Circuit Breakers
- Available 72.5 kV thru 245 kV



Live-Tank Breaker v. Circuit Switcher



Circuit Switcher

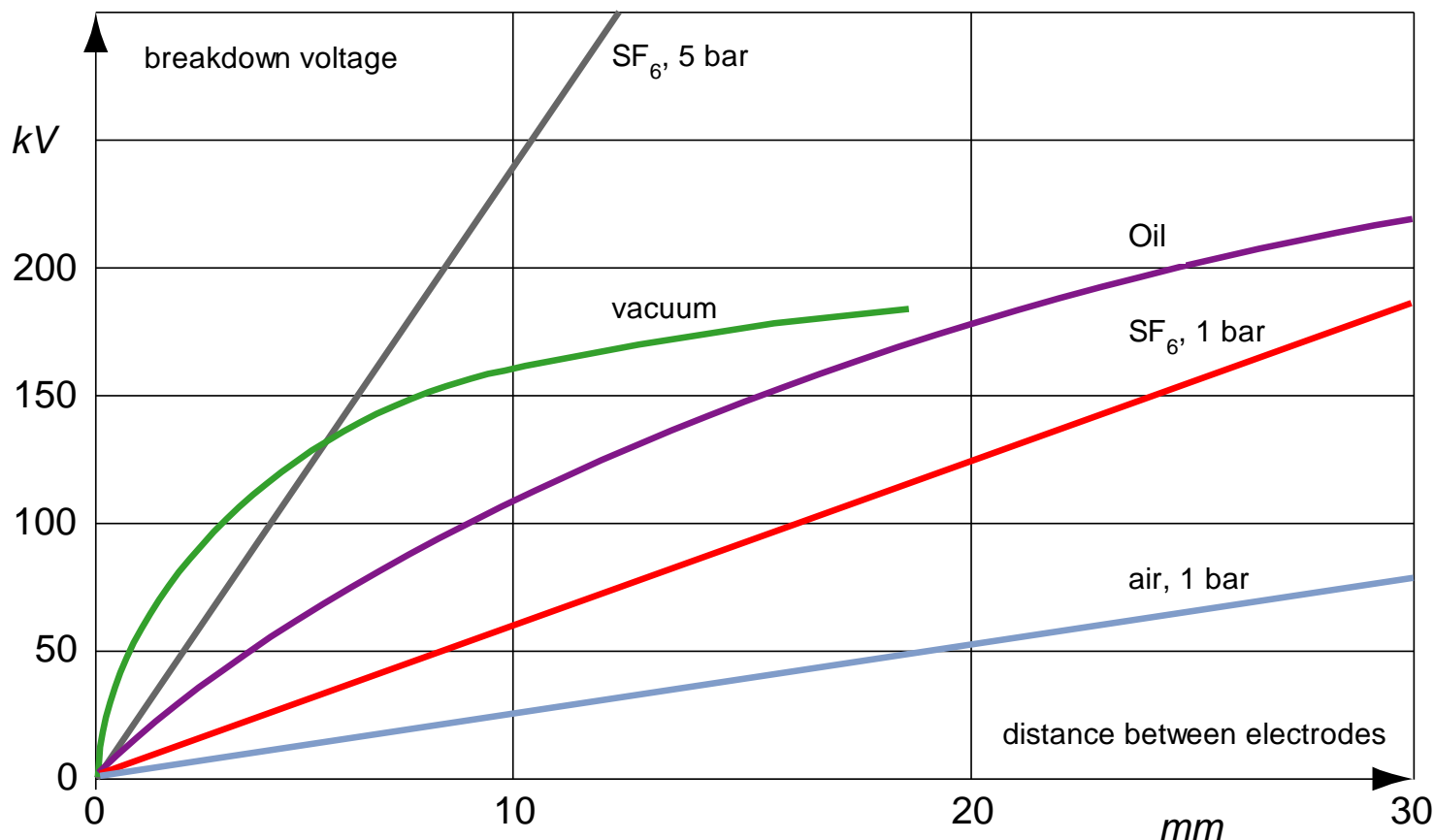
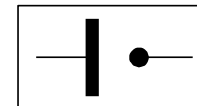
- Interrupting Time:
 - 5 cycles
- De-rated reclose interrupting capability:
 - Initial: 40kA
 - Second: 31.5kA
- IEEE C37.016

Live-Tank Breaker

- Interrupting Time:
 - 3 cycles (72-245kV)
 - 2 cycles (362-550kV)
- Full interrupting capability during reclose
- IEEE C37.06

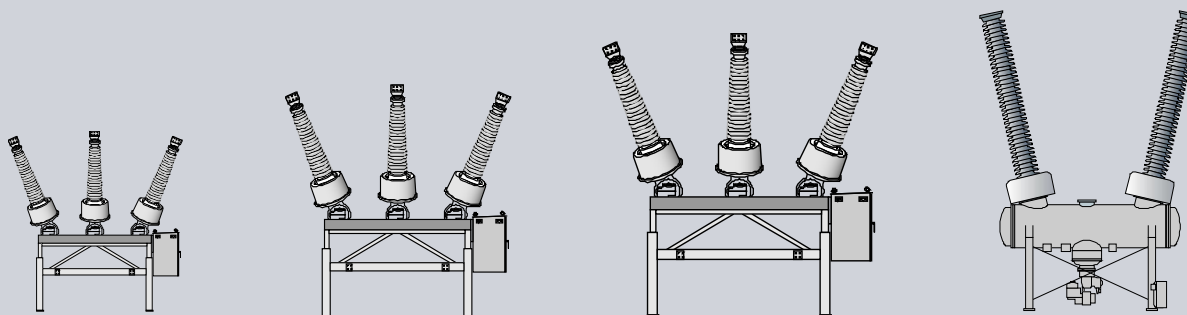
Electrical properties

- 50 Hz breakdown voltage of SF_6 in a homogeneous field as a function of the distance between electrodes (1 bar = 14.5 psi)



HVCB (High Voltage Circuit Breaker)

Type SPS2 72.5- 550 kV



Type	SPS2					
Rated voltage [kV]	72.5	123	145/170	245	362	550
Interrupting Time [cycle]	3	3	3	2 or 3	2	2
Power frequency withstand voltage [kV]	140	230	275	460	555	860
Lightning Impulse withstand voltage [kV]	350	550	650/750	900/1050	1300	1800
Switching impulse withstand voltage [kV]	-	-	-	-	900*	1350*
Rated current, up to [A]	1200/3500	1200/4000	1200/4000	1200/4000	4000/5000	4000/5000
Rated breaking current, up to [kA]	40	40/63	40/63/80/90	63/80/90	63/80	63

*Switching impulse only required for EHV
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 Power Transmission and Distribution / High Voltage

High Voltage Circuit Breaker Type SPS2

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- 15.5 kV through 245kV



High Voltage Circuit Breaker Type SPS2

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■ Circuit Breaker Highlight 15.5kV through 245kV

■ Standard

- Ambient Temperature -30°C to 50°C
- Rated Current 3,150A
- Interrupting Time 3 cycle
- Rated Breaking Current 40kA/50kA
- Drive Spring-Spring
- Extinguishing Principal Arc Assist
- High Voltage Bushings Porcelain

■ Options

- Ambient Temperature -40°C to 50°C with heating blanket
- Rated Current 4000A
- Rated Breaking Current 63kA without capacitors
- High Voltage Bushings Composite



High Voltage Circuit Breaker Type SPS2



- Control Cabinet Construction
 - NEMA 3R
 - Galvanized
 - Two Doors
 - Adjacent to Phase 1
- Control Cabinet Contains
 - Control Voltage 125V DC or 120V AC
 - External pull to trip handle
 - Local/remote switch
 - Breaker Drive FA2/4
 - SF6 Density Switch
 - SF6 Manifold with Pressure Gauge
 - Heaters 240V total 750W
 - Auxiliary Switches
 - 14 gauge wires with ring tongue
 - 12 gauge CT wire
 - Terminal EB-25 and EB-27 for CTs
 - 120V AC receptacle



High Voltage Circuit Breaker Type SPS2

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■ A Better Circuit Breaker

- Longer Operating Life
- Quick and Easy Installation
- No Adjustment
- No Maintenance
- Low Ownership Cost



Thank You for Your Time!!

