Mechanically Switched Capacitors (MSC) or Mechanically Switched Capacitors with Damping Network (MSCDN) are widely deployed by Power Utilities, large energy consumers and energy specialists for reactive power compensation, voltage control and power factor improvement.

They are commonly used in transmission substations, industrial substations and SVC (Static Var Compensator) installations.

Equipment for MSC and MSCDN relies on HV/MV circuit breakers to energize or de-energize capacitor banks. However, an uncontrolled or random switching of capacitor banks causes voltage disturbances and inrush currents, which may damage HV/MV circuit breaker & equipment within substations, alter the power quality for customers and may lead to equipment failures or blackouts (Figure 1: Inrush currents during capacitor bank energization).

Developed by VIZIMAX, SynchroTeq Plus – Controlled Switching Device (CSD) – addresses these issues by operating circuit breakers at the optimal moment to prevent inrush currents and voltage disturbances when switching capacitor banks. As a result, SynchroTeq Plus reduces equipment failures, improves stability and reliability of power networks, and thanks to advanced monitoring features, allows for optimized maintenance costs of HV/MV equipment.

Designed as a manufacturer agnostic solution, SynchroTeq Plus can be used with HV/MV circuit breakers from any vendor and technology and is successfully deployed worldwide on new and existing C/Bs.

Benefits:

- Field proven by Power Utilities, IPPs, C/B specialists and industries since 1991
- Smart upgrade for existing C/Bs, with controlled switching & monitoring features
- Monitors C/B degradation to prevent mechanical/electrical failure.
- Manages future maintenance and repair based on live acquisition, SER and alarms.
- Fast response time allowing for MSC in SVC & FACTS applications.
- Dependable and cost effective alternative to pre-insertion resistors.
- Improves the stability and reliability of power networks and HV/MV assets.
- Modular platform also suitable for advanced switching in TFO, MSR, FLT, Line projects.
Eliminate inrush currents during capacitor bank energization

To eliminate inrush currents, the optimal strategy to energize capacitor banks is to establish electrical conduction in the circuit breaker when the network’s voltage equals the capacitor bank’s voltage.

To achieve this goal, SynchroTeq Plus takes into account the effect of variable fluctuations and past operation history (adaptive control) to adjust and predict the operation time of circuit breakers thus ensuring optimal performances over a wide range of conditions.

SynchroTeq Plus calculates the synchronization delay, the operation time and the most appropriate phase angle in order to reduce inrush currents and disturbances while closing the circuit breaker. It accommodates applications on discharged and partially discharged capacitor banks.
Advanced real-time monitoring of HV/MV assets

Thanks to its secure web-based operation interface, SynchroTeq Plus allows real-time monitoring and visualization of event journal (SER), digital statuses, values and fluctuations of critical parameters including network voltages, currents, C/B operation timings and parameters, ambient temperature, C/B’s idle time and drive mechanism pressure.

To help a utility plan for maintenance and repair operations, the SynchroTeq Plus web-based operation interface includes the following key functions:

- C/B and SynchroTeq Plus digital and analog statuses
- Statuses and values of current and voltage sensors
- User notification through a detailed event journal (SER)
- Alarms (restrike, overcurrent, no flow) to monitor the degradation of C/B performance and prevent mechanical or electrical failure
- Access to recorded digital signals and analog values for each switching operation
- Support for local and remote data export in COMTRADE format
- Communication with control systems using IEC 61850, DNP3, Modbus and IEC 60870

Sequence-of-Events Recorder - SER

SynchroTeq Plus generates events and alarms related to all switching operations. Up to 2,000 events are stored in non-volatile memory, time-stamped (native NTP & PTP/IEEE1588 time synchronization support) and flagged according to their link with the following five categories:

- SynchroTeq Plus internal alarms (i.e. self-diagnostic)
- Sensor alarms (i.e. temperature, pressure, bushing sensor)
- C/B interface alarms (i.e. opened C/B coil circuit, low auxiliary voltage)
- C/B operation timing alarms (i.e. restrike, overcurrent)
- Residual flux and synchronization alarms
Integrated waveform recorder

For each C/B’s opening and closing operation, (whether random, i.e. uncontrolled switching, or controlled switching with SynchroTeq Plus), or through external switching, (protection trip or power outage), SynchroTeq Plus captures, records, and analyzes the following waveforms:

- Network voltage
- Voltages and currents at the load (i.e. capacitor bank, shunt reactor, power transformer)
- Residual flux for each transformer phase when applicable
- Digital signals (i.e. control opening / closing, 52a, 52b)

![Figure 5: Capacitor bank – Current per phase during circuit breaker opening](image)

VIZIMAX solution

**STP 030000**: SynchroTeq Plus base unit compatible with either rackmount or standalone mounting, -40°C to +75°C (-40°F to +165°F)