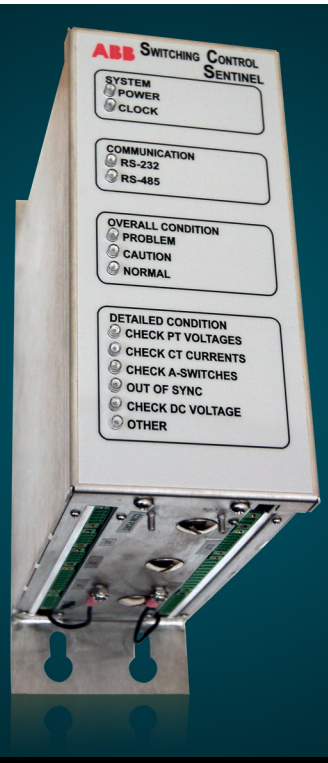


Switching Control Sentinel (SCS)™

For all ABB independent pole operated circuit breakers

Power and productivity
for a better world™

Switching Control Sentinel (SCS)™ for circuit breakers

Voltage and current transients generated during switching of high voltage circuit breakers are of increasing concern for the electric utility industry. These concerns include both power quality issues for voltage-sensitive customer loads, and excessive stresses on power system equipment. Conventional solutions for reducing switching transients include circuit breaker pre-insertion devices such as resistors or inductors and fixed devices such as arresters and current limiting reactors. While these solutions provide some degree of mitigation, they require additional equipment, increase costs and are accompanied by reliability concerns.

A superior method to reduced switching transients is synchronous switching, sometimes referred to as point-on-wave switching. Synchronous switching is performed by the Switching Control Sentinel™, which - upon receiving a close (or trip) command - delays the energization of the circuit breaker control coils by a few milliseconds such that current inception (or contact separation) coincides with a certain point on the AC wave, known to reduce switching transients.

Switching Control Sentinel

The Switching Control Sentinel™ is a microprocessor-based control device, which enables synchronized closing or opening of independent pole operated (IPO) circuit breakers. Housed in a NEMA 1 enclosure, the SCS is installed as a modular component in the control cabinet of the circuit breaker at the factory. Upon request it is also available for control house installation.

Testing and validation

The SCS has been successfully tested for operation under extreme temperature conditions including: low temperature cold-start and operation tests at -40°C and high temperature tests at 70°C. Surge withstand capability tests have been performed on input and output connections to the SCS, in compliance with IEC 61000-4-5 Class 4 for connections to the breaker AC and DC system, and Class 3 for connections to its own sensors. Radio frequency interference tests have been performed per IEC 61000-4-3 to prove that the SCS is immune to radiated interference up to 10 V/m.

Vibration and shock tests to simulate conditions inside the circuit breaker cabinet were performed per IEC 60255-21-1,-2-27 and -2-29.

Models

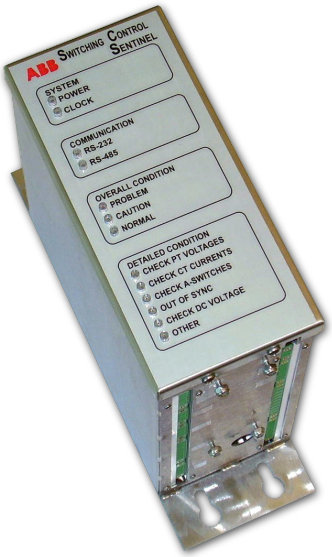
Different models of the SCS are required to accommodate the DC voltages 48V, 125V and 250V. Any model can be used for any of the numerous synchronous closing or opening application by means of configuration and external wiring. A bypass circuit, providing ganged breaker operation in case of loss of DC power or other problems, can be enabled or disabled via an external jumper.

Features

- Same firmware and hardware supports synchronous opening or synchronous closing of grounded/ungrounded capacitor bank energization and other applications.
- Firmware upgrades are possible in the field via serial port. No EPROM changes are required.
- The SCS can be powered down without data loss.
- Both settings and event data are stored in non-volatile Flash memory.
- A real-time clock is powered by a gold capacitor while DC power is off.
- Battery-free design.
- Automatic tracking of the delay between arcing and auxiliary contact operations for synchronous opening (patent pending).
- Detection of wiring errors through phasor calculation (patent pending).
- DNP and Modbus protocol supported.

Benefits

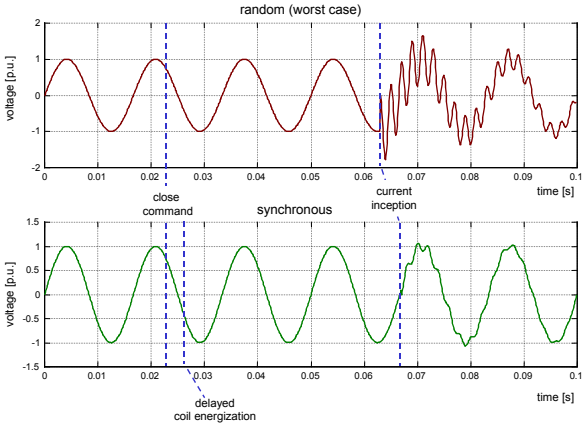
- Controlled point-on-wave switching is a very effective way of reducing switching transients and enhancing circuit breaker performance.
- Synchronized closing reduces transient over-voltages and currents associated with switching operations of shunt capacitor banks, shunt reactors, transformers and transmission lines.
- Synchronized opening allows for optimization of the circuit breaker arcing time. The arcing time may be increased with the purpose of minimizing the probability of re-ignitions.
- Reduced interrupter wear.



Synchronous switching type	Type of load	SCS functions	Benefits
Synchronous opening	- Load switching - Capacitor - Reactor switching - Line dropping	Open with maximum arcing time	- Further reduces already low probabilities of re-strike and re-ignition transients - Added protection for system equipment from severe re-strike and re-ignition transients
Synchronous closing	- Shunt capacitor bank (single or back-to-back) - Transmission line - Transmission cable	Close at voltage zero across the circuit breaker	- Reduction of voltage and current switching transients - Improved power quality - Reduced stress on equipment insulation
	- Shunt reactor - Transformer	Close at voltage zero peak across the circuit breaker	- Reduction of magnitude and distortion of inrush current - Reduced impact of system harmonic resonances - Simplified differential protection

Synchronous switching

In power systems, switching operations are inevitable. Every circuit breaker operation, be it open or close, potentially causes a disturbance of the steady state that the system was in before. These disturbances are called switching transients and last for tens to hundreds of milliseconds. They can affect both voltages and currents and can have magnitudes of several p.u. Switching transients generated in the high voltage system can propagate to a medium voltage system and their relative magnitude in per units may increase substantially.

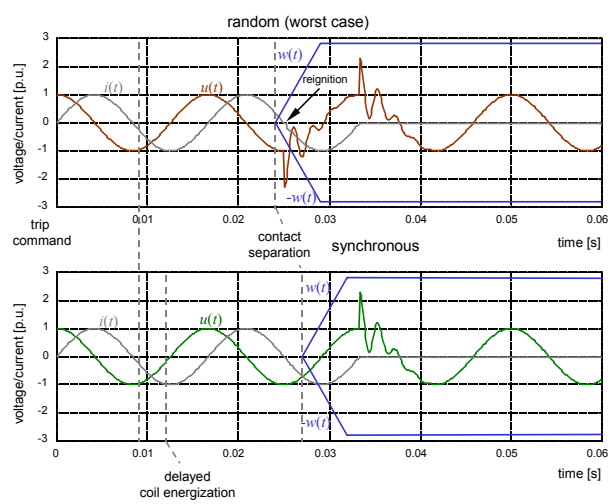


Random and synchronous closing for capacitor banks

Switching transients are a power quality problem at best. At their worst, they can lead to equipment failure and severe damages. Many industrial electricity consumers have sensitive motor drives that are protected by fast acting digital relays. Switching transients cause these relays to trip resulting in expensive outage time for the industrial consumer.

In EHV systems, switching surges can be expected to be even more severe than those caused by lighting strike. Therefore, transient mitigation methods are imperative. Traditional transient mitigation methods include pre-insertion resistors or inductors and surge arresters. Synchronous switching is a method of reducing switching transients by controlling the exact timing to either make or break a circuit, and thereby prevent the generation of switching transients in the first place.

Not all synchronous switching applications require closing on zero crossings. Some target voltage peaks instead or any other points on the voltage wave. Synchronous switching is also called point-on-wave switching. The Switching Control Sentinel continuously acquires the phase voltage waveforms. When a trip command is received, the unit determines at what point in time the contacts would open if the trip coils were immediately energized. Next it calculates the time from this point until the target point, for instance a certain time after a zero crossing. This is the delay time that has to be inserted to make the contacts separate at the target time. The Switching Control Sentinel then delays the trip command by exactly that time and then energizes the trip coil. If the opening time was calculated correctly, the contacts will open on target.



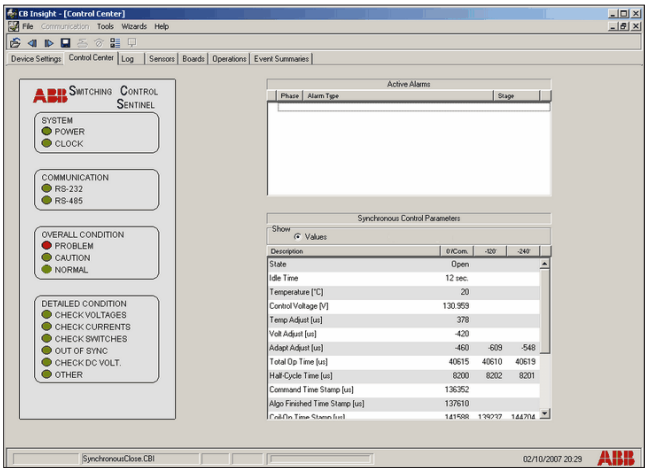
Random and synchronous opening for reactors

CB Insight™

CB Insight™ is a user-friendly software program used to receive data from the SCS™ or to configure it. The program utilizes "wizards" to simplify tasks such as commissioning or data downloads. The wizards are of a "non-blocking" kind for which ABB has a patent pending. "Non-blocking" means that the wizard window does not obstruct the main window and that many functions remain available to the user while the wizard is executing. CB Insight™ provides remote communication through dial-up or TCP/IP and can be used to view captured waveforms as well as statistical data pertaining to the synchronous performance (patent pending).

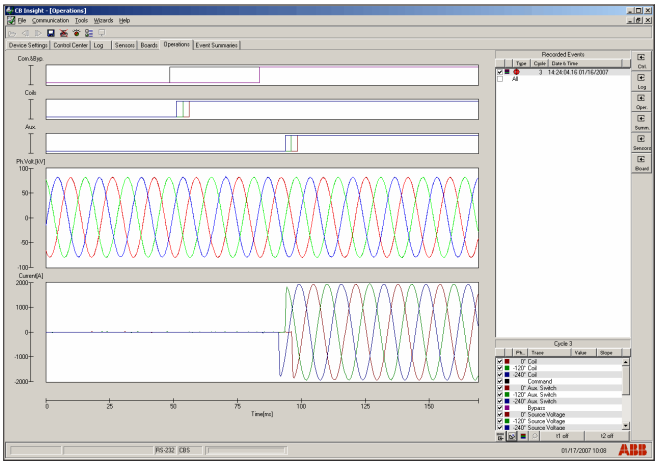
The wizard window appears at the bottom of the screen in a shape that allows viewing as much as possible of the main window. Wizards are available for data download and commissioning. This reduces the learning curve significantly, because the user needs very little prior knowledge and can rely on the wizard to be guided through the process in a step by step manner. All tasks can be completed using the controls of the wizard only; however, some controls of the main menu remain enabled during wizard execution, allowing the advanced user to stray from the predetermined path.

Via the "Control Center" window, the user has access to alarm information, phasor diagrams, front panel indications and details from the latest synchronous switching operation. Alarms can be cleared and certain parameters, such as the cycle count or the adaptation adjustments can be edited. The "Immediate Adjustment" feature which brings the SCS "in-sync" faster can also be invoked from the "Control Center" window.



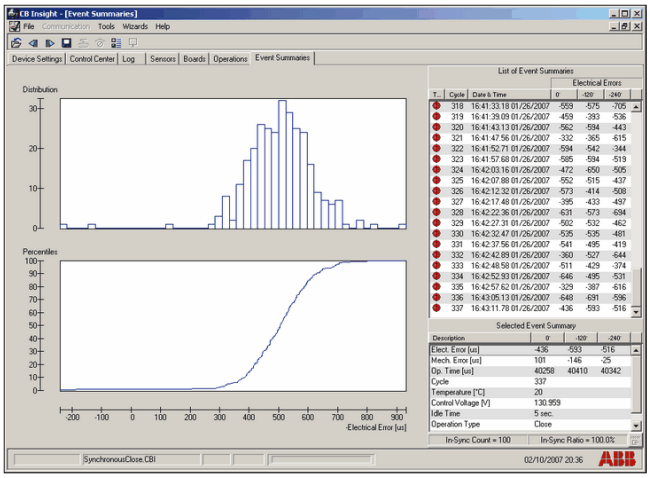
The analog and digital waveforms recorded by the SCS can be reviewed in the "Operations" window. The waveforms of multiple operations can be selected for plotting and overlaid, if desired.

Markers can be set to display momentary values, determine time differences or define a window to zoom in. Individual traces can be hidden to give more emphasis and plotting space to others. In the auto-refresh mode, new operations are automatically loaded and displayed as they occur.



The "Event Summary" window lists the timing information of up to 100 recent operations. This includes electrical error values, time stamps, temperature and control voltage at the time of the operation. The synchronous performance becomes very clear with one look at the electrical error histogram or the percentile plot.

ABB honors customers' requests that the electrical error be measured from the zero crossing (for capacitive loads) as opposed to a vendor-defined target. The electrical error as measured from the voltage zero crossing is the only value that is directly linked to the reduction of transients during capacitive load switching.



Technical data

General	
DC voltage options	48 V, 125 V, 250 V
Ambient temperature range	-40° to 70° C
Power consumption	0.050 A @ 125 V 0.065 A @ 125 V (Ethernet Version)
Enclosure	
Protection level	NEMA-1, IP20
Approx. dimensions w/o mounting flanges (inch)	8.5 x 8.5 x 3.75 8.5 x 8.5 x 5.0 (Ethernet Version)
Panel footprint (inch)	11.5 x 3.75 11.5 x 5.0 (Ethernet Version)
Electromagnetic compatibility	
Power frequency magnetic field, IEC 61000-4-8	100 A / 1000 A
Radiated RF electromagnetic field, 61000-4-3	10 V/m
Electrostatic discharge immunity, IEC 61000-4-2	8 kV / 15 kV
Damped oscillatory wave, IEC 61000-4-12	1 kV / 2.5 kV
Electrical fast transient / burst immunity, IEC 61000-4-4	4 kV
Surge immunity, IEC 61000-4-5	4 kV mains, 2 kV data
Conducted disturbances, induced by RF fields, IEC 61000-4-6	10 V
Ripple on DC power supply, IEC 61000-4-17	10%
Voltage dips, IEC 61000-4-29	30% / 60%, 1 s
Voltage interruptions, IEC 61000-4-29	100%, 0.05 s
Environmental compatibility	
Cold, IEC 60068-2-1, Ad	-40° C
Dry heat, IEC 60068-2-2, Ba	+70° C
Damp heat, steady state, IEC 60068-2-78	+40° C, 93% rh
Damp heat, cyclic, IEC 60068-2-30	+25° C...+40° C, 95% rh
Vibration response, IEC 60255-21-1	0.075 mm, 1.0 g
Shock, IEC 60068-2-27	15 g, 3 each dir.
Bump, IEC 60068-2-29	10 g, 100 pulses
Panel indicators	
LEDs	13 (power, clock, RS 232, RS 485, problem, caution, normal, check PT voltages, check CT currents, check A-switches, out-of-sync, check DC voltages, other)
Alarm relays	2 (problem, caution)
Connectors (auxiliary switches)	
Spacing	0.254 mm
Maximum current	3 A
Maximum voltage	250 V
Dielectric withstanding voltage (1 min)	1500 VAC
Connectors (DC controls)	
Spacing	5.08 mm
Nominal current	8 A
Rated voltage (III/2)	320 V
Rated voltage (II/2)	400 V
Rated surge voltage	4 kV
Connectors (except DC controls and auxiliary switches)	
Spacing	3.81 mm
Nominal current	8 A
Rated voltage (III/2)	160 V
Rated voltage (II/2)	250 V
Rated surge voltage	2.5 kV

Connector usage	
Power supply	5-pin: DC+, N/C, Ground, N/C, DC-
RS-232	5-pin: CTS, RTS, GND, TxD, RxD
RS-485	4-pin: Bus-, Bus+, GND, N/C
Alarms	9-pin: caution alarm: NC, common, NO-problem alarm NC, Common, NO-problem alarm NC, common, NO
Phase voltage inputs (J11)	9-pin: V1 (0º), V1 (-120º), V1 (-240º), V1 Ref, V2 (0º), V2 (-120º), V2 (-240º), V2 Ref, Protective Earth (PE)
DC controls (J12)	10-pin: Coil (0º) Negative, N/C, Coil (-120º) Negative, N/C, Coil (-240º) Negative, N/C, DC Negative, Close/Trip Command, Bypass Circuit, DC Positive (analog voltage measurement
Current inputs (J13)	7-pin: I (0º), I (0º) Return, I (-120º), I (-120º) Return, I (-240º), I (-240º) Return, Shield
Temperature input (J14)	2-pin: RTD measurement current out, RTD measurement current return
Auxiliary switch inputs (J15)	6-pin: +24 V Out, Aux (0º) Return, Aux (-120º) Return, Aux (-240º) Return, N/C, Shield
Phase voltage inputs	
Voltage range	0 to 250 Vrms (±350 V peak)
Burden	150 kΩ
RS232	
Signal levels	+/- 7.5...8 V
Bitrate	57600 baud
RS485 (SCS use only)	
Signal levels	0...5 V
Bitrate	57600 buad
Alarm contacts	
Operational characteristics	Class 3 per Table 16 of IEC 60694
Rated load	2 A @ 30 VDC 1 A @ 120 VDC
Dielectric strength	1000 Vrms across contacts 1500 Vrms across contacts and coil
DC controls	
Maximum voltage	280 V d.c.
Maximum current	15.0 A for 0.1 sec
Current inputs	
Burden, R_B seen at connector	5 kΩ
Ratio of auxiliary CT's, N	5000
Burden seen at customer connections	$R_B \times N^2$
Current measurement range seen at connector, I_{Rb}	± 10 V peak / R_B
Current measurement range seen at customer connections	± 10 A peak
Resolution	10 bit
Temperature input (resistance measurement)	
Output current, I_{RTD}	0.8 mA
Temperature range in combination with standard RTD (100Ω + 0.385Ω/ºC)	-40°C...70°C
Auxiliary switches	
Output voltage	24 V,
Output current	2.0 mA to 3.0 mA
Nominal current	8 A

Notes

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