



# Circuit Breaker Sentinel™ (CBS) for SF<sub>6</sub> power circuit breakers

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It is widely recognized that the concept of periodic equipment maintenance is becoming obsolete. A reliability centered program, built around condition monitoring, data analysis and spare parts inventory management, is a more effective methodology for cost effectively managing substation assets.

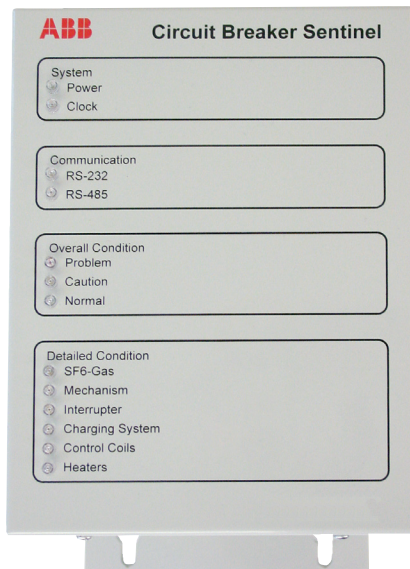
Successful reliability centered maintenance programs require an information system. For power circuit breakers, the network must include condition monitors, circuit breaker engineers, field service and spare parts. ABB has invested in people, material, software and hardware to provide all of these elements.

ABB utilized its breaker design expertise in the development of the most advanced condition monitoring algorithms available in the industry. The ABB Circuit Breaker Sentinel™ (CBS) not only collects and stores data but also employs sophisticated mathematical processing and analysis to provide a complete picture of the breaker condition. The ability to interpret and present this data in a useful way is what sets ABB's monitoring unit apart from the rest.

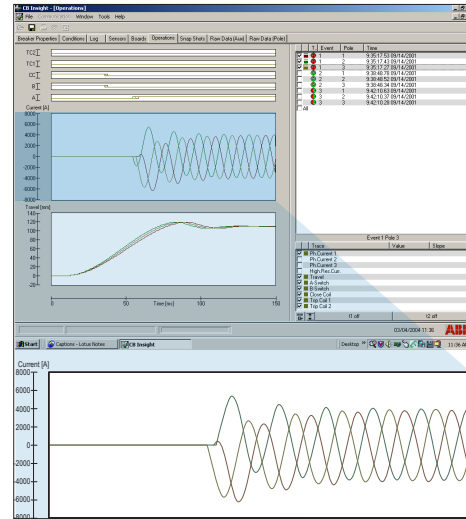
## CB Insight™

CB Insight™ is a user friendly software program used for communication with the CBS via the built-in RS-232 port. CB Insight™ shown below is used to receive data from the CBS and display it in a clear way. Its powerful features allow tabular viewing, plotting, tracking and further analyzing of data received from the CBS. A detailed log displays operations, alarms, sensor input changes and user intervention. Communication can be opened via direct cable connection or via modem. An unlimited number of connections can be configured for efficient dialing and port switching. Data can be saved in archives and later retrieved by browsing through file folders using the handy preview feature.

Front view of the Circuit Breaker Sentinel (IPO version).



Event record screen, showing A/B switch operation, coil energization, phase currents and contact travel.



Condition screen listing all monitored conditions and their present values.

Conditions	Unit	Pole 2
Integrity	%	100.00
C.Coil Monitor	UF	220.00
Pri.TC.Monitor		220.00
Sec.TC.Monitor	uA	220.00
Travel (Close)	mm	110.00
Travel (Open)	mm	110.00
Travel (C/O)	mm	88.00
Closing Speed	m/s	-4.20
Opening Speed	m/s	-4.20
Open.Speed(C/O)	m/s	10.00
React.Time(C)	ms	10.00
React.Time(O)	ms	41.00
Mech.Time(C)	ms	21.00
Mech.Time(O)	ms	21.00

## CBS integration

The standard model CBS communicates with the CB Insight™ software through a serial RS-232 port using its own protocol. The CBS may optionally be furnished with ethernet capability, affording Modbus TCP support for integration with other ABB or third party systems.

Additionally, ABB is available to customize our systems to assure compatibility with a customer's particular substation integration requirements.

## Functions

The CBS is a diagnostic and monitoring system for single pressure SF<sub>6</sub> power circuit breakers rated 38 kV and above. The CBS monitors interrupter wear, integrity of the SF<sub>6</sub> gas system, the circuit breaker mechanical system, the electrical control system and auxiliaries. It consists of a modular microprocessor unit and sensors. The unit is housed in a NEMA-1 enclosure, which is installed inside the circuit breaker control cabinet or in an additional enclosure mounted on the side of the control cabinet. The following conditions are monitored by the CBS:

- Coil continuity
- Total travel
- Contact velocity
- Reaction time
- Coil energization time
- Contact wear
- Auxiliary nozzle wear
- Main nozzle wear
- Trip count
- RMS current
- Tank/gas temperature
- Mechanical/cabinet temperature
- Leak rate (5 time spans)
- Heater off at low temperature
- Heater on at high temperature
- Heater off (heater w/o thermostat)
- Pump starts w/o operation
- Pump starts with operation

The user interface software, CB Insight™, allows the user to access and download information, upgrade software and change the set point values.

## Benefits

- Monitors circuit breaker parameters necessary to assess the availability of this equipment to perform its switching functions.
- Advises users when to maintain their circuit breakers based on switching history, duty and number of operations.
- Reduces the probability of performing unnecessary dismantling of the circuit breaker, which often occurs when maintenance practices are based solely on fixed time intervals or when they are based on incomplete information of its switching history.
- Alerts to conditions that may compromise correct operation of the circuit breaker before a failure can occur.
- Optimizes service and outage time by identifying parameters that have changed beyond established limits.
- Reduces costs associated with downtime and maintenance. Users maintain or repair only items that require it.
- Provides local and remote access to information of key parameters related to circuit breaker performance, eliminating the need for substation visits to check circuit breaker condition.
- Saves in travel time and personnel expense.
- Records and displays, in the user interface program, CB Insight™, the timing values and travel curves for each circuit breaker operation.

## CBS sensors

A series of external sensors provide the CBS with information on key parameters necessary to assess the condition of the circuit breaker. Each diagnostic feature offered by the CBS requires information on several parameters, as shown in the table below.

Diagnostic features	Monitored parameters
Interrupter wear	<ul style="list-style-type: none"><li>- Phase currents</li><li>- Arching time</li><li>- Contact travel</li></ul>
SF <sub>6</sub> gas system integrity and leakage rate	<ul style="list-style-type: none"><li>- SF<sub>6</sub> gas density</li><li>- Temperature</li></ul>
Mechanical integrity of the circuit breaker	<ul style="list-style-type: none"><li>- Position versus time, travel characteristics</li><li>- Operating times</li><li>- Supply voltage to the charging motor</li><li>- Coil energization time</li><li>- Auxiliary contact position</li></ul>
Trip / close coil condition	<ul style="list-style-type: none"><li>- Coil impedance</li><li>- Circuit continuity</li></ul>
Mechanism charging system condition	<ul style="list-style-type: none"><li>- Motor supply voltage</li><li>- Number of motor starts</li><li>- Charging time</li></ul>
Control cabinet heater system	<ul style="list-style-type: none"><li>- Heater current</li><li>- Heater continuity</li></ul>

# Circuit Breaker Sentinel™ (CBS) technical data

<b>General</b>	
DC voltage in control cubicle	125 V nominal (70 V to 140 V)
AC voltage in control cubicle	110 V <sub>rms</sub> (max 140 V <sub>rms</sub> )
Ambient temperature range	-40 °C to 70 °C
Power consumption	0.05 A @ 125 V per main board
<b>Enclosure</b>	
Protection level	NEMA-1
Approx. dimensions w/o mounting flanges (inch)	(1) 8.5 x 8.5 x 3.75; (2) 8.5 x 8.5 x 6.25
Panel footprint (inch)	(1) 11.5 x 3.75; (2) 11.5 x 6.25
<b>Electromagnetic compatibility</b>	
Electrostatic discharge immunity	IEC 61000-4-2 Level 4
Electrical fast transient/burst immunity	IEC 61000-4-4 Level 4
Surge immunity	IEC 61000-4-5 (1) Level 4 for all AC and DC connections (2) Level 3 for connections between CBS and its own sensors
<b>Panel controls and indicators</b>	
LED's	13 (power, clock, RS 232, RS 485, problem, caution, normal, SF <sub>6</sub> -gas, mechanism, interrupter, charging system, control coils, heaters)
Alarm relays	2 (problem and caution)
<b>Connectors for wires connected to cubicle or control house</b>	
Spacing	3.81 mm
Rated voltage	250 V
Rated surge voltage	2.5 kV
Nominal current	8 A
<b>Connectors for wires between to CBS modules/sensors</b>	
Spacing	0.1"
Rated voltage	250 V
Rated current	3 A
<b>Connector usage</b>	
Power supply	5 pin (DC+, N/C, GND, 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: N/C, common, NO-problem alarm N/C, common, NO-problem alarm N/C, common, NO)
Controls	11 pin (A switch, common, B switch, N/C, N/C, secondary trip coil +, secondary trip coil -, primary trip coil +, primary trip coil -, close coil +, close coil -)
Currents	6 pin (current channel 1 signal, current channel 1 reference, current channel 2 signal, current channel 2 reference, current channel 3 signal, current channel 3 reference)
Auxiliaries	16 pin (heaters common, heater 7, heater 6, heater 5, heater 4, heaters common, heater 3, heater 2, heater 1, N/C, motor reference, N/C, motor voltage, temperature probe common, mechanism temperature probe, tank temperature probe)
Travel	6 pin (quadrature channel 1 negative, channel 1 positive channel, 2 negative channel, 2 positive +24 V, ground)
Pressure sensor	4 pin (+12 V, positive input, negative input, ground)
Signal levels	+/- 7.5 V to 8 V
Bit-rate	19200 baud
<b>RS-485 (CBS use only)</b>	
Signal levels	0 V to 5 V
Bit-rate	19200 baud

<b>Alarm contacts</b>	
Rating	2 A @ 30 VDC; 1 A @ 120 VDC
Dielectric strength	1000 V <sub>rms</sub> across contacts; 1500 V <sub>rms</sub> across contacts and coil
<b>Coil connections</b>	
Threshold for coil energization detection	115 V standard; 40 V via jumper selection
Maximum voltage	See maximum DC voltage
Coil monitor pulse output	12 V
<b>Auxiliary switch inputs</b>	
Output voltage	24 V
<b>Phase current inputs (via clamp-on current transformers)</b>	
Nominal value	2.0 A or 5.0 A
Range	Up to 20 x nominal
Accuracy	1% of nominal
<b>Travel sensor interface</b>	
Range	0 mm to 200 mm
Resolution	1.2 mm; 0.6 mm
<b>Heater current inputs</b>	
Input range	0 mA to 300 mA (cut-off at upper limit)
<b>Temperature inputs</b>	
Input range	-40 °C to 100 °C
Accuracy	0.5 °C
<b>Motor voltage input</b>	
Input range	0 V <sub>rms</sub> to 110 V <sub>rms</sub>
<b>Pressure input</b>	
Input range	0 psig to 150 psig
Accuracy	0.5 psi
<b>CBS Ethernet master (optional)</b>	
Ethernet type	IEEE 802.3
Protocol	(1) Modbus; (2) Modbus TCP
Supported modbus function codes	20 – read general reference; 21 – write general reference
- RS-485	
Signal levels	0 V to 5 V
Bit-rate	19200 baud
- Connectors (Ethernet 10Base-T)	
RJ-45	1st plug (to network); 2nd plug (input to fiber optic bridge)
- Connectors (Ethernet 10Base-FL)	
ST	2 pieces (transmit and receive)
Fiber	62.5 μ/125 multimode, 850 nm
- Connectors (RS-485)	
Number of connectors	2
Minimum pitch	3.81 mm
Rated voltage	250 V
Rated surge voltage	2.5 V
Nominal current	8 A
Pins	3 pin (Bus-, Bus+, GND, N/C)
- Functions	
Communicate with CBS main boards via internal RS-485 bus	
Route messages to and from external RS-485 bus	
Route messages to and from Ethernet port	To/from RJ-45; To/from optical fibers

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