

CAT II series

Circuit Breaker Analyzers & Timers

- Robust design for field use
- Accurate measurement in high voltage environment
- Timing and motion measurement
- Both Sides Grounded feature
- Built-in micro ohmmeter (up to 500 A)
- Dynamic resistance measurement
- Detailed analysis of test results using DV-Win software



Description

The CAT II series circuit breaker analyzers & timers are stand-alone or a PC-controlled digital instruments for circuit breakers condition assessments. The timing channels record closing and opening of the arcing, resistor and auxiliary contacts. CAT II series records graphs of both, open and close coil currents and displacements of the HV and MV circuit breaker moving parts. The main contact channels can also measure the resistance value of the pre-insertion resistors (if present in the circuit breaker). Test results are printed on the 112 mm (4.4 inch) thermal printer (optional accessory) in tabular and graphical form.

CAT II series provides an easy selection of different operational modes:

- Open (O)
- Close (C)
- Reclose (O-0,3s-C)
- Tripfree (CO)
- O-0,3s-CO
- Open-Close (O-C)
- Close-Open (C-O)
- Open-Close-Open (O-C-O)
- First trip (O)

Multiple operations, such as Open-Close and Open-Close-Open, can be initiated by using a predefined delay time or by sensing a breaker's contact position.

The circuit breaker operation can be initiated in different ways (for instance from a control room, by a local switch or externally by a testing device) depending on a testing condition. The several time measurement triggers are available to record a measurement in a various testing condition:

- external trigger
- analog channels
- auxiliary channels
- coil control channel

The auxiliary inputs are used to monitor dry and wet auxiliary contacts. The external trigger input can be used as the additional auxiliary input.

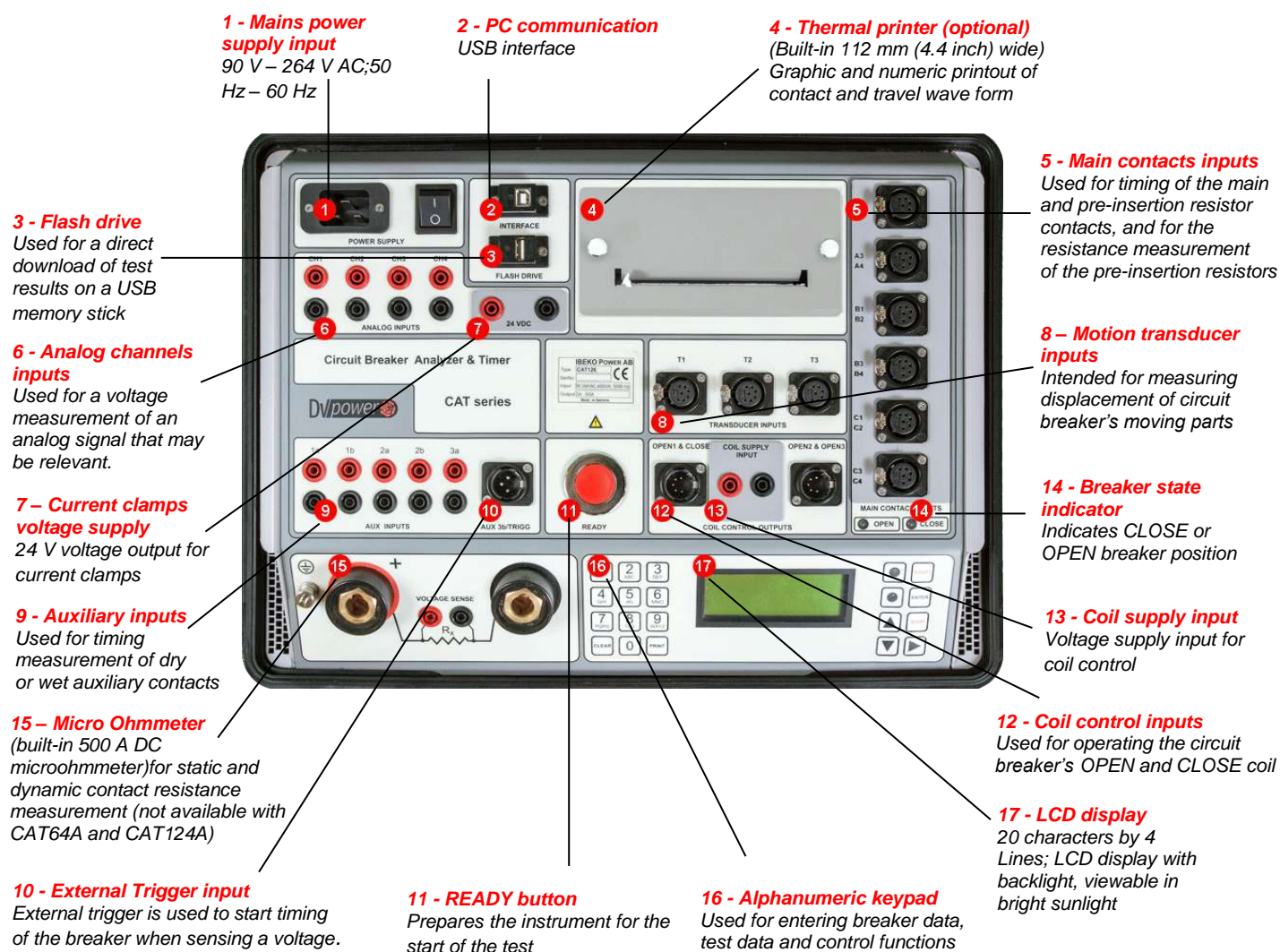
The four coil control analog channels can measure and record coil currents simultaneously (OPEN and CLOSE), up to 35 A AC/DC.

The four additional analog channels have four selectable voltage ranges available ($\pm 0,5$ V, $\pm 2,5$ V, ± 60 V and ± 300 V AC/DC). They are used to monitor:

- circuit-breaker substation battery voltage,
- connection of the current clamps for “The first trip” monitoring test,
- other types of analog signals that may be relevant.

Three transducer channels provide measuring displacement of the circuit breaker moving parts, contact wipe, over-travel, rebound, damping time and an average velocity. Either an analog or a digital transducer can be connected to these universal channels.

Features



Application

The list of the instrument applications include:

- Simultaneous timing measurement of up to 12 main contacts (4 breaks per phase) including pre-insertion resistors (if present in the circuit breaker) and 6 auxiliary contacts
- Resistance measurement of the pre-insertion resistors (if present in the circuit breaker)
- Evaluation of synchronization between the circuit breaker poles
- Measurement of the coil currents, simultaneously for 4 coils
- Evaluating the state of substation's batteries by graphically showing the voltage value
- Measurement of displacement, contact wipe, over-travel, rebound, damping time and average velocity of the breaker's moving parts
- "First trip" test
- Static resistance measurement
- Dynamic resistance measurement

Timing measurement

Timing measurement of the mechanical operations is one of the most important tests to determine real condition of the circuit breaker. Timing measurement tests fulfill all the requirements defined by IEC 62271-100 and IEEE C37.09.

In three-phase systems, not only the contacts in a single pole have to operate simultaneously, but all poles must also operate at the same time. All contacts must be synchronized, within a certain tolerance limit.

Synchronization between the circuit breaker poles during opening shall not exceed 1/6 of the rated frequency cycle (3,33 ms at 50 Hz; 2,78 ms at 60 Hz) and during closing shall not exceed 1/4 of the rated frequency cycle, as well (5,0 ms at 50 Hz; 4,17 ms at 60 Hz).

Simultaneous measurements within a single phase are important in situations where a number of contacts are connected in series.

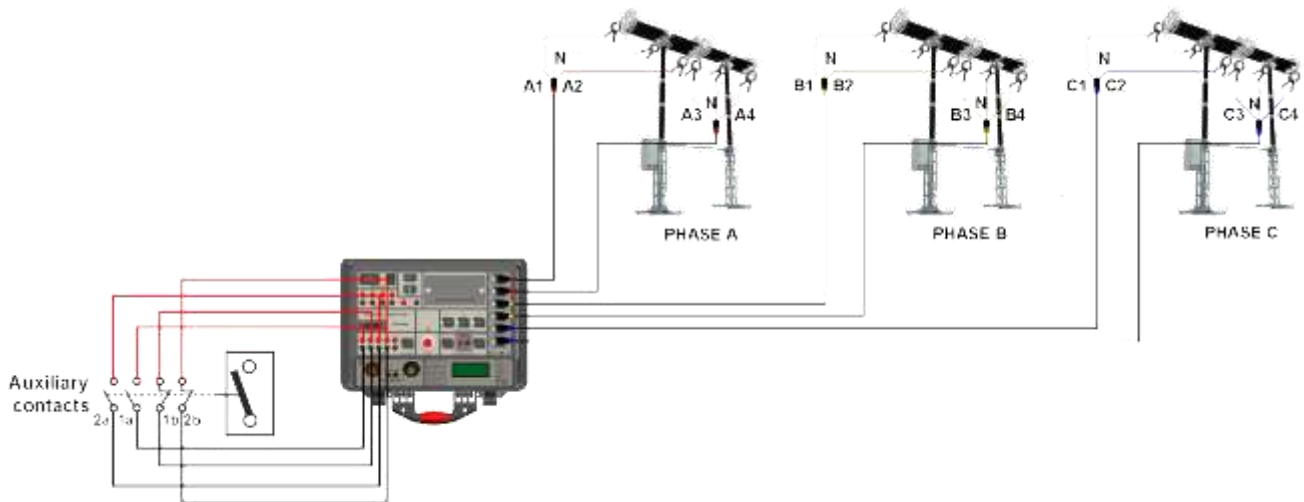
The maximum difference between the instants of contact separation within series connected interrupter units shall not exceed 1/8 of a cycle of rated frequency (2,50 ms at 50 Hz; 2,08 ms at

60 Hz). Maximum difference between the instants of contacts touching within series connected interrupter units shall not exceed a 1/6 of a cycle of rated frequency (3,33 ms at 50 Hz; 2,78 ms at 60 Hz).

Auxiliary contacts are mechanically driven by the operating mechanism and are used for control and indication of main contacts state. There are no general requirements, related to timing measurement of auxiliary contacts, described in IEC® and IEEE® standards. Anyway, in order to assess condition of high-voltage circuit breakers, it is important to check their operation.

Type "a" contact follows circuit breaker main contact position and must close/open ahead of the closing/opening of the main contact. Type "a" contact is connected in series with the open coil and interrupts the open coil circuit when the circuit breaker opens.

The "b" contact must open/close when the operating mechanism has released its stored energy in order to close/open the breaker. Type "b" contact is connected in series with the closing coil, interrupting the closing coil circuit when the circuit breaker closes.

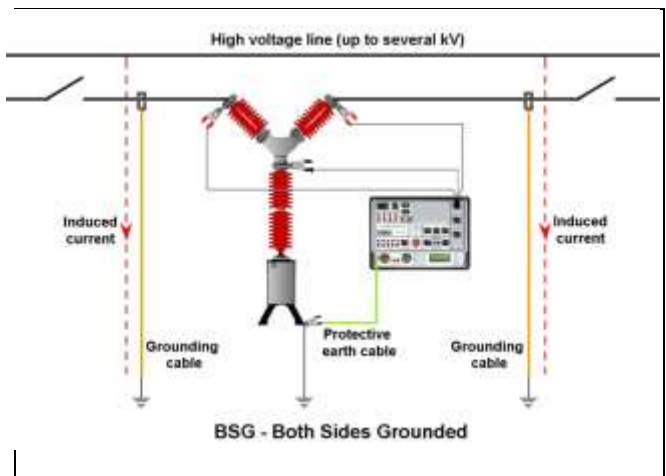
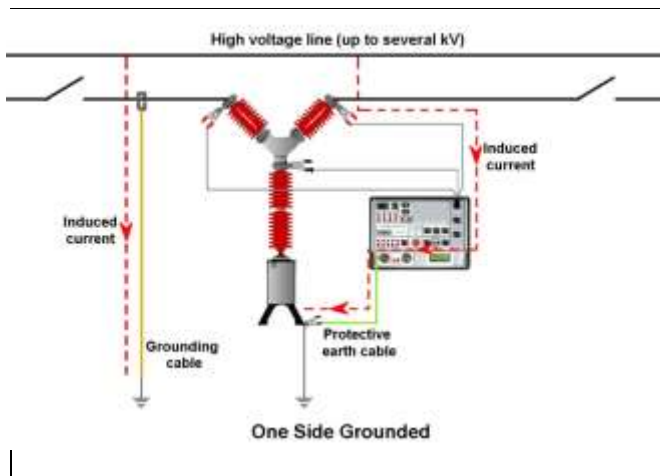


Connecting the main contact timing cables and auxiliary timing cables to a test object

Both Sides Grounded

BSG feature enables safe and fast testing in high voltage substations, without removing the safety ground connections on both sides of the circuit breaker. No additional modules or remote

boxes are required. Each main contacts timing channel is able to detect main contacts state in case when both terminals are grounded.



Motion measurement

Motion measurement of the high voltage circuit breakers' contact system is of crucial importance for assessing a condition of the test object. The three motion transducer channels can acquire data from 3 linear or rotary motion transducers. Each channel can be configured for either an analog or a digital transducer.

Due to universal transducer channels design, a user is able to connect a variety of motion transducers available on the market.

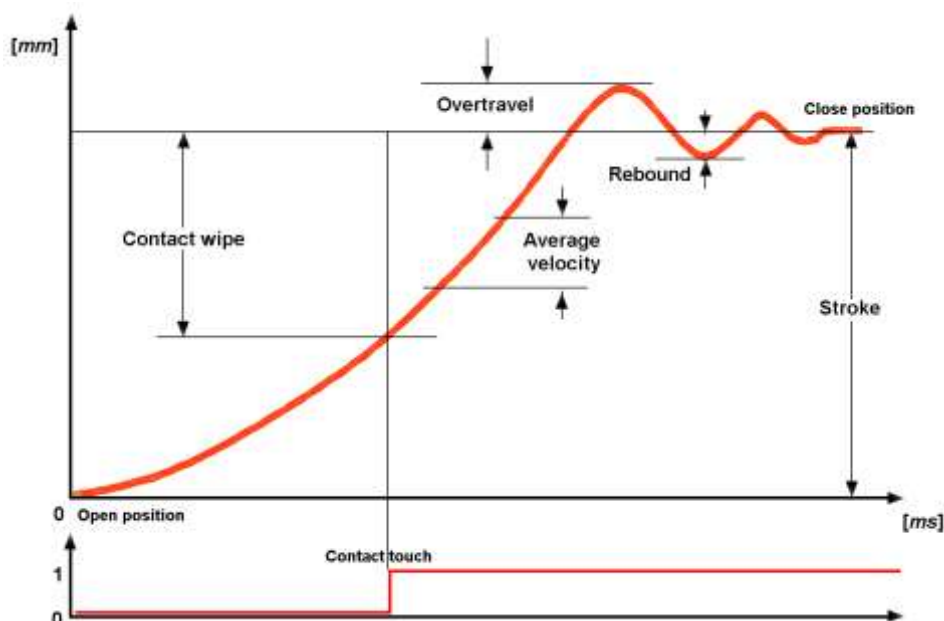
Performance values such as stroke, over-travel, rebound, contact wipe are obtained as a result of the measurement. These values can be compared to the manufacturer's reference data and data acquired from previous measurements. This provides indications about potential wear of the breaker.

Average velocity is calculated between the two points on the motion curve. The upper point is defined as a distance in length or time elapsed from the breaker's closed position, or contact-separation point. The lower point is determined based on the upper point. It can either be a distance below the upper point or a time before the upper point.



Digital rotary transducer mounted on ABB LTB 245 kV SF6 circuit breaker

User is usually allowed to mount transducers on accessible parts of the circuit breaker's mechanical linkage. Beside this, instrument often records rotary motion, even it is known the main contacts motion is linear. As a result, motion results obtained do not represent real movement of the main contacts, but just linear or nonlinear interpretation of the main contacts moving parts displacement. DV-Win software provides transfer function feature which allows user to define linear or non-linear parameters in order to obtain actual displacement values of the main contact moving parts.



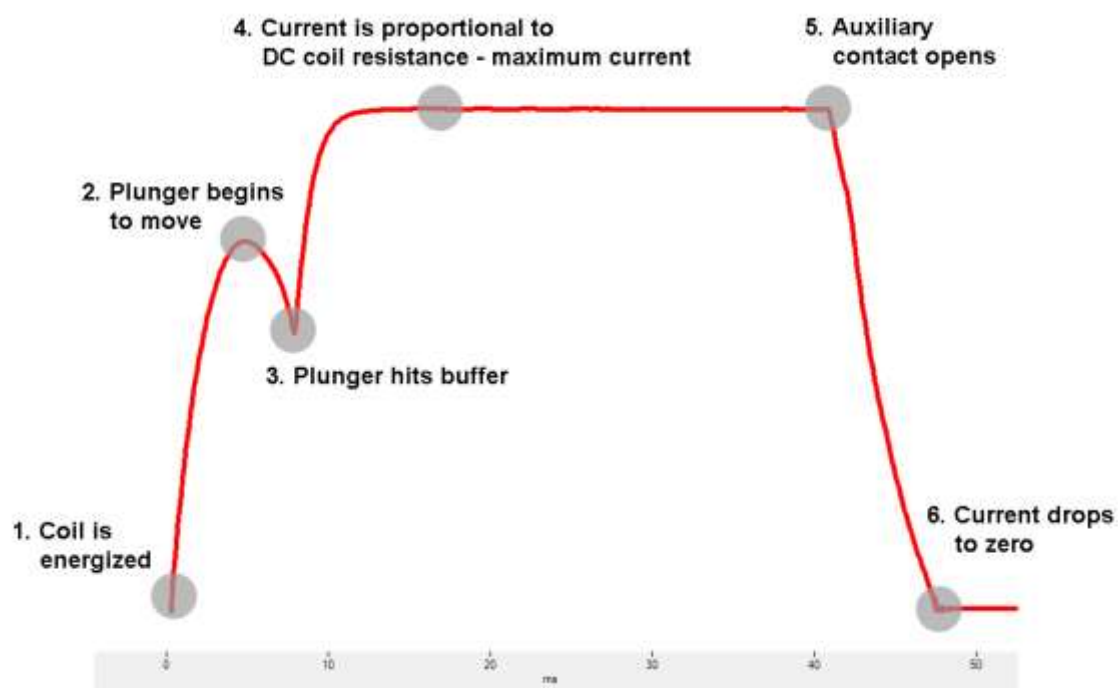
Coil current measurement

The IEC 62271-100 standard states that it is desirable to record the coil currents waveform, since it provides information about coils' condition (e.g. increased friction of the plungers, burned insulation, short-circuited part of the winding), the latch for release of the operating mechanism (e.g. increased friction) and the operating mechanism (e.g. if there is reduced operating mechanism speed that can be seen based on the opening time of auxiliary contacts).

When the opening or closing command is initiated, the coil is energized (point 1) and the current rises causing a magnetic field to apply a force on the iron plunger. When the force on the plunger exceeds the retaining force the plunger begins to move (point 2). The motion of the iron plunger induces an *EMF* in the coil, effectively reducing the current.

The combined mass of the plunger and the latch continue to move at a reduced velocity causing a further reduction in the coil current (points 2 to

3) until it hits a buffer bringing it to a rest (point 3). If the current values at points 2 and 3 are higher than specified and the time at point 3 is longer than specified, it may indicate a friction of the plunger and latch. With the plunger at rest, the current increases to the saturation level (DC current which is proportional to the coil resistance, point 4). If the current value from point 4 to point 5 deviates from specific it may indicate a burned insulation or short-circuited part of the winding of coil. Meanwhile, the latch unlocks operating mechanism, releasing the stored energy to open the main breaker contacts. Typically, after a short delay the auxiliary contacts open, disconnecting the opening coil from the control voltage (point 5). As the coil is de-energized the current drops quickly to zero in accordance with the coil inductance (point 6). Longer time than specified at points 5 and 6 may indicate auxiliary contact malfunction or insufficient driving energy of the operating mechanism.

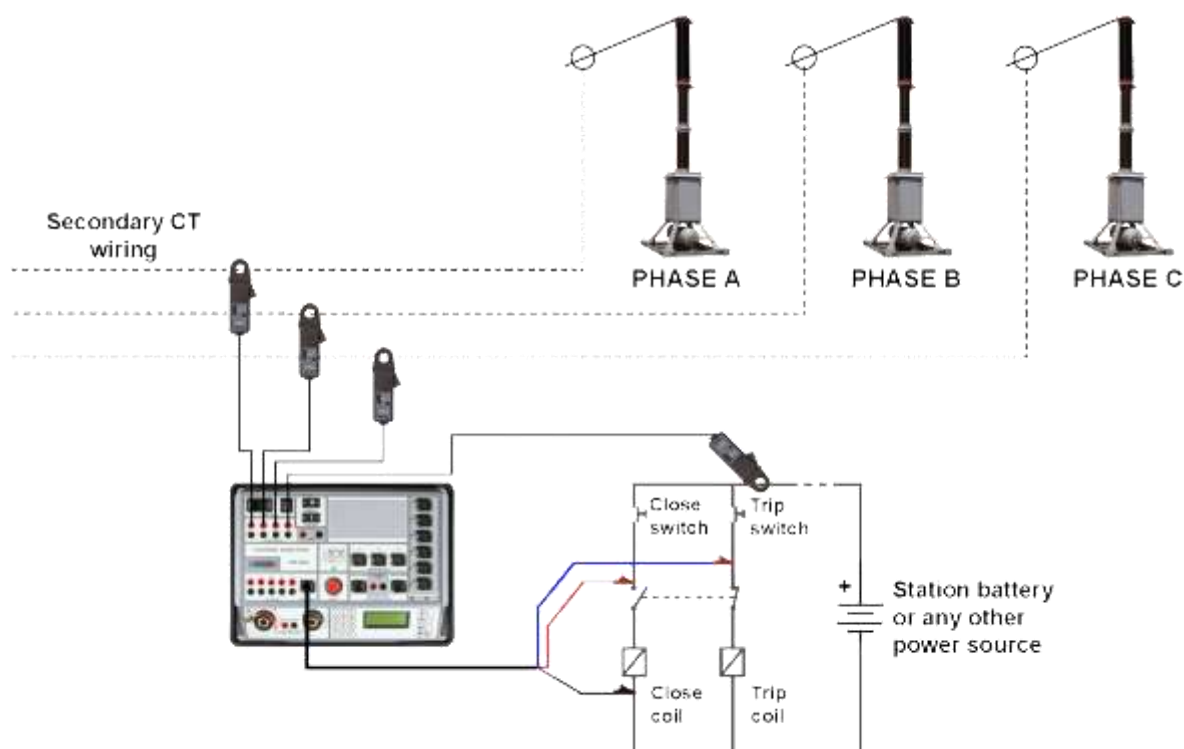


First trip test

“First trip” analysis is important to determine a condition of the coil operating mechanism. Circuit breaker spends most of its lifetime conducting a current without any operation. Once the protective relay detects a problem, the circuit breaker, that was idle for maybe a year or longer, has to operate as fast as possible. However, if the circuit breaker has not been operated for a long time, the friction of the trip latch release mechanism may increase. Information about the latch friction, open circuit contacts, insufficient spring tension, can be

learned from the coil current waveform recorded during the “**First trip**” test.

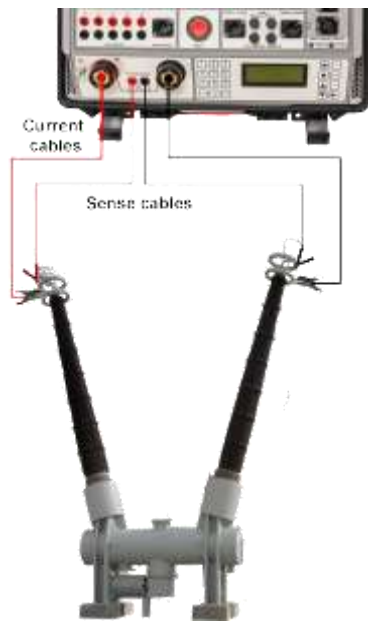
Since the breaker is in service, the conventional way of off-line timing measurement with timing cables across the interrupter cannot be used. Instead of main contact timing cables, three current probes are used. These current probes show current flowing through the secondary side of the current transformer for each phase. The instant when the current stops flowing, reveals the breaker open time.



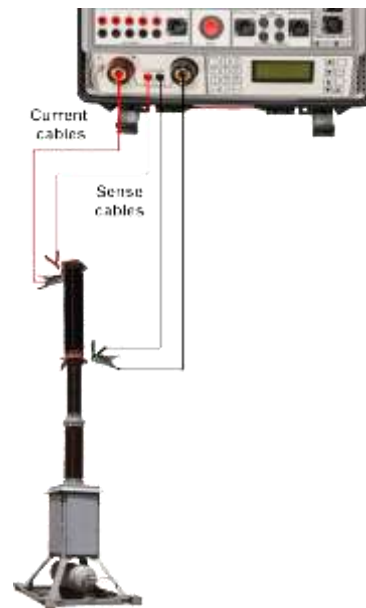
Static resistance measurement

The 500 A built-in micro ohmmeter generates a true DC ripple free current with an automatically regulated test ramps. The resistance measurement is using the well known Kelvin's four point's method.

The DC current is generated through the closed circuit breaker contacts. Voltage drop is measured between terminals of the circuit breakers. The resistance is calculated using the Ohm's law $R=U/I$.



Micro Ohmmeter cable connection on dead tank circuit breaker



Micro Ohmmeter cable connection on live tank circuit breaker

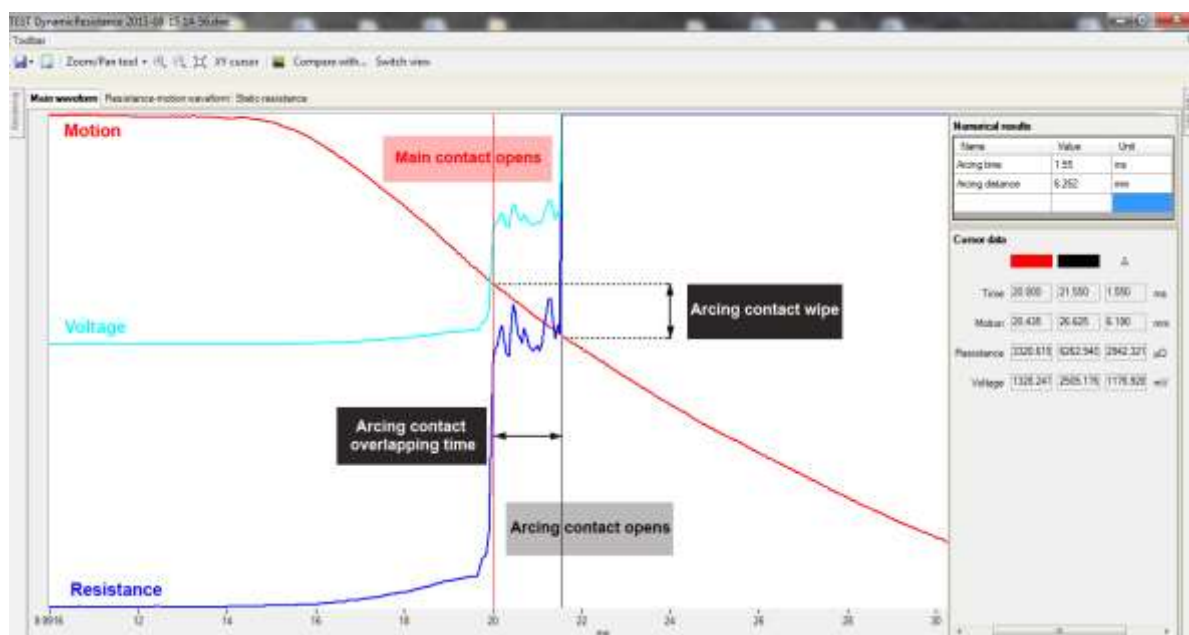
DRM (Dynamic Resistance Measurement)

The built-in micro ohmmeter can also be used for the DRM. DRM test is performed by injecting a current through the breaker contact and simultaneously monitoring the voltage drop across the breaker contact as well as the current flow during the breaker operation. The DRM test requires the circuit breaker analyzer with a high resolution measurement.

The resistance curve, as a function of a contact

travel can be used to reveal potential problems related to the arcing contact condition. The injected current value should be as high as possible but no less than 100 A, to provide a reliable voltage drop reading, thus allowing an easier detection of the arcing contact.

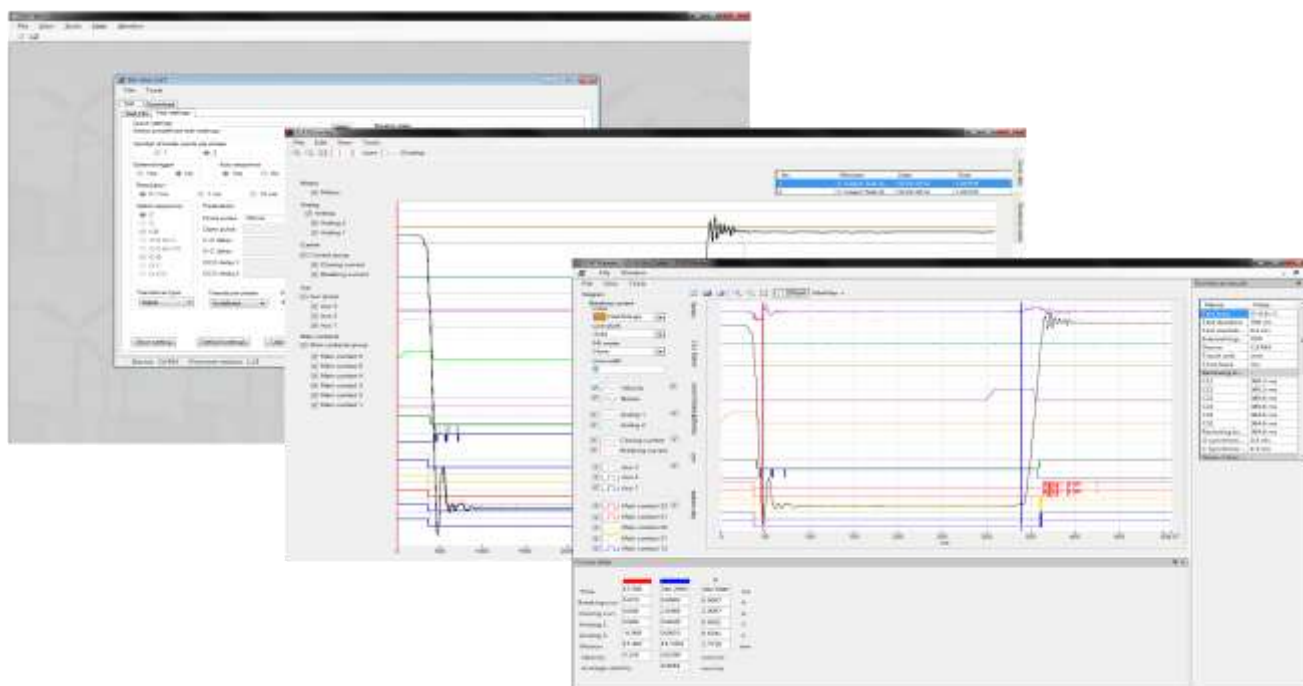
CAT66 and CAT126 models incorporate the most powerful micro ohmmeter generating up to 500 A.



DV-Win software

DV-Win software provides acquisition and analysis of the test results, as well as control of all the CAT II series functions from a PC. Graphical presentation of a variety of measurements and timing test results uses cursors and powerful zoom functions for detailed

analysis. Colors, grids, scales and positioning of the test data are all controlled by the user. DV-Win supports automatic unit conversion (e.g.: cycles to seconds or mm to inches). The test records can be exported in **.dwc** file format for further analysis.



- Full control of the CAT functions from a PC
- Downloading the test results from the instrument
- Acquisition and analysis of the test results
- The test results can be viewed, edited, saved, printed and exported
- Viewing and overlaying several graphs, for an easy test result comparison
- Selecting the measurement points and intervals using the two cursors
- Zoom and pan graph feature
- Specific test sequence setup
- Customized configuration of the test result graphs
- Creation of predefined test plans for an easy and quick field testing

Technical data

Main contact inputs

- Number of contact inputs: up to 12 (3 x 4), 4 per phase, depending on the model
- Each channel detects main and pre-insertion resistor contacts.
 - Closed $\leq 10 \Omega$,
 - Resistor contacts range 10Ω to $5 \text{ k}\Omega$,
 - Open $\geq 5 \text{ k}\Omega$

Open circuit voltage: 20 V DC
Short circuit current 50 mA
- Each channel measures resistance of pre-insertion resistors

Auxiliary inputs

- Number of channels: 6, galvanically isolated (external trigger input can be used as a sixth auxiliary input)
- User selectable: dry or wet
- Contact sensing (dry):

Open circuit voltage 24 V DC,
Short circuit current 5 mA
- Voltage sensing (wet):

Working voltage 300 V DC, 250 V AC
Low activation mode $\pm 5 \text{ V}$
High activation mode $\pm 10 \text{ V}$
- Overcurrent and overvoltage protection

Coil driver

- Number of channels: 4 (3 open and 1 close coil)
- Four separate outputs for coil triggering
- Driver characteristics: 300 V DC max, 35 A DC max
- Electronic drivers: it provides superior timing control

- Overcurrent and overvoltage protection
- Coil supply input: 300 V DC max, 35 A DC max

Time measurement

Time measurement resolution:

- 0,1 ms for 2 s test duration (sampling rate 10 kHz)
- 1 ms for 20 s test duration (sampling rate 1 kHz)
- 10 ms for 200 s test duration (sampling rate 100 Hz)

Time accuracy 0,05% of the reading \pm resolution

Breaker operation

- Close (C)
- Open (O)
- Close-Open (C-O)
- Open-Close (O-C)
- Open-Close-Open (O-C-O)
- First trip test

User can select any desired test sequence

Current measurement

- Current measurement for Open and Close coil, 4 channels, Hall-Effect sensor
- Range $\pm 35 \text{ A AC/DC}$ to 5 kHz
- Accuracy $\pm (0,5 \% \text{ rdg} + 0,1 \% \text{ FS})$
- Graphic presentation: currents waveform is displayed with resolution of 0,1ms

Universal transducer inputs

- 3 digital travel transducer channels
Digital rotary transducers: 2500ppr
- 3 analog travel transducer channels
- Analog transducer input measurement resolution: 16 bit.
- Internal supply for linear transducer: 5 V DC

Time measurement triggers

- External trigger: 2 channels, input voltage: 10 V – 300 V AC/DC
- Coil currents: threshold level user selectable
- Auxiliary inputs
- Analog inputs: threshold level user selectable, positive or negative

Analog inputs

- 4 channels – Coil current measurement
- 4 Voltage channels, each channel has four measurement ranges: ± 0.5 V, ± 2.5 V, ± 60 V and ± 300 V AC/DC

The analog inputs are isolated with respect to all other circuits

DC output

- 24 V voltage supply for current clamps

Static resistance measurement

- Built-in Micro Ohmmeter with up to 500 A, depending on the model
- Current range 5 A - 500 A
- Max. load voltage 6,2 V
- Resistance range 0,1 $\mu\Omega$ - 999,9 m Ω
- Resolution 0,1 $\mu\Omega$
- Accuracy $\pm (0,1 \% \text{ rdg} + 0,1 \% \text{ FS})$

Dynamic resistance measurement

- Voltage and current measuring channels
- DRM sampling rate 20 kHz (0,05 ms time resolution)
- Resolution 16 bit
- Breaker operations available for DRM test: Open (O)

Printer (optional)

- Thermal printer
- Graphic and numeric printout

- Paper width 112 mm / 4.4 in

Warranty

- 3 years

Dimensions and weight

- Dimensions (W x H x D):
480 mm x 197 mm x 395 mm
18.89 in x 7.75 in x 15.55 in
- Weight: 12,9 kg / 28.4 lbs

Mains power supply

- Connection according to IEC/EN60320-1; UL498, CSA 22.2
- Mains supply: 90 V - 264 V AC
- Frequency: 50/60 Hz
- Input power: 3900 VA
- Fuse 15 A / 250 V, Fast blow, but not user replaceable

Applicable Standards

- Installation/overvoltage: category II
- Pollution: degree 2
- Safety: LVD 2006/95/EC (CE Conform)
Standard EN 61010-1
- EMC: Directive 2004/108/EC (CE Conform)
Standard EN 61326-1:2006
- CAN/CSA-C22.2 No. 61010-1, 2nd edition, including Amendment1

Environmental conditions

- Operating temperature:
-10 °C - + 55 °C / 14 °F - +131 °F
- Storage & transportation:
-40 °C - + 70°C / -40 °F - +158 °F
- Humidity 5 % - 95 % relative humidity, non condensing

*All specifications herein are valid at ambient temperature of + 25 °C and recommended accessories.
Specifications are subject to change without notice.*

Accessories

			
Main contacts cables 5 m (16.4 ft) with SCT clamps*	Main contacts extensions cables 10 m (32.8 ft)*	Coil control cable set 5 m (16.4 ft) with banana plugs*	Auxiliary contacts cable set 5 m (16.4 ft) with banana plugs*
			
External trigger cable 5 m (16.4 ft) with banana plugs*	Analog channels cable set 8 x 5 m (16.4 ft) with banana plugs*	Coil supply cable set 2 x 5 m 2,5 mm² (16.4 ft, 13 AWG) with banana plugs	Current clamp 30/300 A
			
Current cables 2 x 10 m 50 mm² (32.8 ft, 0 AWG) with battery clamps	Current cables 2 x 10 m 25 mm² (32.8 ft, 3 AWG) with battery clamps	Sense cables 2 x 10 (32.8 ft) m with alligator clamps	Transport case
			
Cable bag	Cable plastic case with wheels - large size	Universal transducer mounting kit (extended version)	Digital rotary transducer with accessories
			
Digital rotary transducer with 5 m (16.4 ft) connection cable	Linear analog transducer with 5 m (16.4 ft) connection cable**	Doble transducer adapter	Linear to rotary converter

*The above cables are also available in several lengths and terminations.

**The above linear analog transducers are available in several lengths.
Please contact DV Power for more information

CAT II series - models

CAT35



Main contact inputs

Number of contact inputs: 3 (3 x 1), 1 per phase

Static resistance measurement

Built-in Micro Ohmmeter 200 A

CAT64A



Main contact inputs

Number of contact inputs: 6 (3 x 2), 2 per phase

CAT65



Main contact inputs

Number of contact inputs: 6 (3 x 2), 2 per phase

Static resistance measurement

Built-in Micro Ohmmeter 200 A

CAT66



Main contact inputs

Number of contact inputs: 6 (3 x 2), 2 per phase

Static resistance measurement

Built-in Micro Ohmmeter 500 A

CAT124A



Main contact inputs

Number of contact inputs: 12 (3 x 4), 4 per phase

CAT125



Main contact inputs

Number of contact inputs: 12 (3 x 4), 4 per phase

Static resistance measurement

Built-in Micro Ohmmeter 200 A

CAT126



Main contact inputs

Number of contact inputs: 12 (3 x 4), 4 per phase

Static resistance measurement

Built-in Micro Ohmmeter 500 A

Order info

Instrument	Article No
Circuit Breaker Analyzer & Timer CAT35	CAT3500-N-00
Circuit Breaker Analyzer & Timer CAT64A	CAT64A0-N-00
Circuit Breaker Analyzer & Timer CAT65	CAT6500-N-00
Circuit Breaker Analyzer & Timer CAT66	CAT6600-N-00
Circuit Breaker Analyzer & Timer CAT124A	CAT124A-N-00
Circuit Breaker Analyzer & Timer CAT125	CAT1250-N-00
Circuit Breaker Analyzer & Timer CAT126	CAT1260-N-00

Included accessories
Windows based DV-Win PC software including USB cable
Mains power cable
Ground (PE) cable

Recommended accessories	Article No
Transport case	HARD-CASE-LC
Main contact cables	
Main contact cables 5 m (16.4 ft) with SCT clamps (<i>for CAT35</i>)	CM-05-34MXST
Main contact cables 5 m (16.4 ft) with SCT clamps (<i>for CAT64A, CAT65, CAT66</i>)	CM-05-65MXST
Main contact cables 5 m (16.4 ft) with SCT clamps (<i>for CAT124A, CAT125, CAT126</i>)	CM-05-12MXST
Main contact cables extension	
Main contact cables extension 10 m (32.8 ft) (<i>for CAT35, CAT64A, CAT65, CAT66</i>)	E3-10-65MXFX
Main contact cables extension 10 m (32.8 ft) (<i>for CAT124A, CAT125, CAT126</i>)	E6-10-12MXFX
Coil control cable set 5 m (16.4 ft) with banana plugs	CO-05-12C5B1
Coil supply cable set 2 x 5 m 2,5 mm ² (16.4 ft, 13 AWG) with banana plugs	C2-05-02BPBP
Auxiliary contacts cable set 10 x 5 m (16.4 ft) with banana plugs	CA-05-02BPBP
External trigger cable 5 m (16.4 ft) with banana plugs	CE-05-00C4B1
Analog channels cable set 8 x 5 m (16.4 ft) with banana plugs	C8-05-02BPBP
Current cables	
Current cables 2 x 10 m 50 mm ² (32.8 ft, 0 AWG) with battery clamps (<i>for CAT66 and CAT126</i>)	C2-10-50VMB3
Current cables 2 x 10 m 25 mm ² (32.8 ft, 3 AWG) with battery clamps (<i>for CAT35, CAT65 and CAT125</i>)	C2-10-25LMB1
Sense cables	
Sense cables 2 x 10 m (32.8 ft) with alligator clamps (<i>for CAT35, CAT65, CAT66, CAT125 and CAT126</i>)	S2-10-02BPA1
Cable plastic case - large size (x 2)	CABLE-CAS-03

Optional accessories	Article No
BSG feature for CAT35 (one break per phase)	BSG-CATII-00
BSG feature for CAT6x and CAT12x II series (two breaks per phase)	BSG-CATII-01
Current clamp 30/300 A power supplied from the instrument with adapter 5 m (16.4 ft)	CACL-0300-07
Current clamp 30/300 A with internal battery supply and extension 5 m (16.4 ft)	CACL-0300-08
Thermal printer 112 mm (4.4 inch) (built-in)	PRINT-112-00
Thermal paper roll	PRINT-112-RO
Main contact cables Extension 5 m (16.4 ft) (<i>for CAT35, CAT64A, CAT65, CAT66</i>)	E3-05-65MXFX
Main contact cables Extension 5 m (16.4 ft) (<i>for CAT124A, CAT125, CAT126</i>)	E6-05-12MXFX
Main contact cables Extension 15 m (49.2 ft) (<i>for CAT35, CAT64A, CAT65, CAT66</i>)	E3-15-65MXFX
Main contact cables Extension 15 m (49.2 ft) (<i>for CAT124A, CAT125, CAT126</i>)	E6-15-12MXFX
Current cables 2 x 5 m 50 mm ² (32.8 ft, 0 AWG) with battery clamps (<i>for CAT66 and CAT126</i>)	C2-05-50VMB3
Current cables 2 x 15 m 70 mm ² (49.2 ft, 00 AWG) with battery clamps (<i>for CAT66 and CAT126</i>)	C2-15-70VMB3
Current cables 2 x 5 m 25 mm ² (32.8 ft, 3 AWG) with battery clamps (<i>for CAT35, CAT65 and CAT125</i>)	C2-05-25LMB1
Current cables 2 x 15 m 35 mm ² (49.2 ft, 2 AWG) with battery clamps (<i>for CAT35, CAT65 and CAT125</i>)	C2-15-35LMB1
Sense cables 2 x 5 m (32.8 ft) with alligator clamps (<i>for CAT35, CAT65, CAT66, CAT125 and CAT126</i>)	S2-05-02BPA1

Sense cables 2 x 15 m (49.2 ft) with alligator clamps (for CAT35, CAT65, CAT66, CAT125 and CAT126)	S2-15-02BPA1
Cable plastic case with wheels - large size	CABLE-CAS-W3
Digital rotary transducer with 5 m (16.4 ft) connection cable	DRT-250-C605
Linear analog transducer 150 mm (5.9 in) with 5 m (16.4 ft) connection cable	LAT-150-C305
Linear analog transducer 225 mm (8.85 in) with 5 m (16.4 ft) connection cable	LAT-225-C305
Linear analog transducer 300 mm (11.8 in) with 5 m (16.4 ft) connection cable	LAT-300-C305
Linear analog transducer 500 mm (19.68 in) with 5 m (16.4 ft) connection cable	LAT-500-C305
Universal transducer mounting kit	UTM-KIT-0000
Universal transducer mounting kit - extended version	UTM-KIT-0001
Doble transducer adapter	DTA-BOX-C002
Linear to rotary convertor	LTR-CON-0000

IBEKO Power AB

Stockholmsvägen 18
181 50 Lidingö, Sweden

Contact

Phone: +46 70 0925 000
E-mail: sales@dv-power.com