

## CAT I series

# Circuit Breaker Analyzers & Timers

- Simple and easy to operate
- Robust design for field use
- Accurate measurement in high voltage environment
- Timing and motion measurement
- Voltage and current measurement
- Detailed analysis of test results using DV-Win software



### Description

The CAT I 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 I series records graphs of both, trip 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 80 mm (3.15 inch) thermal printer (optional accessory) in tabular and graphical form.

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

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

Multiple operations, such as Trip-Close and Trip-Close-Trip, 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.

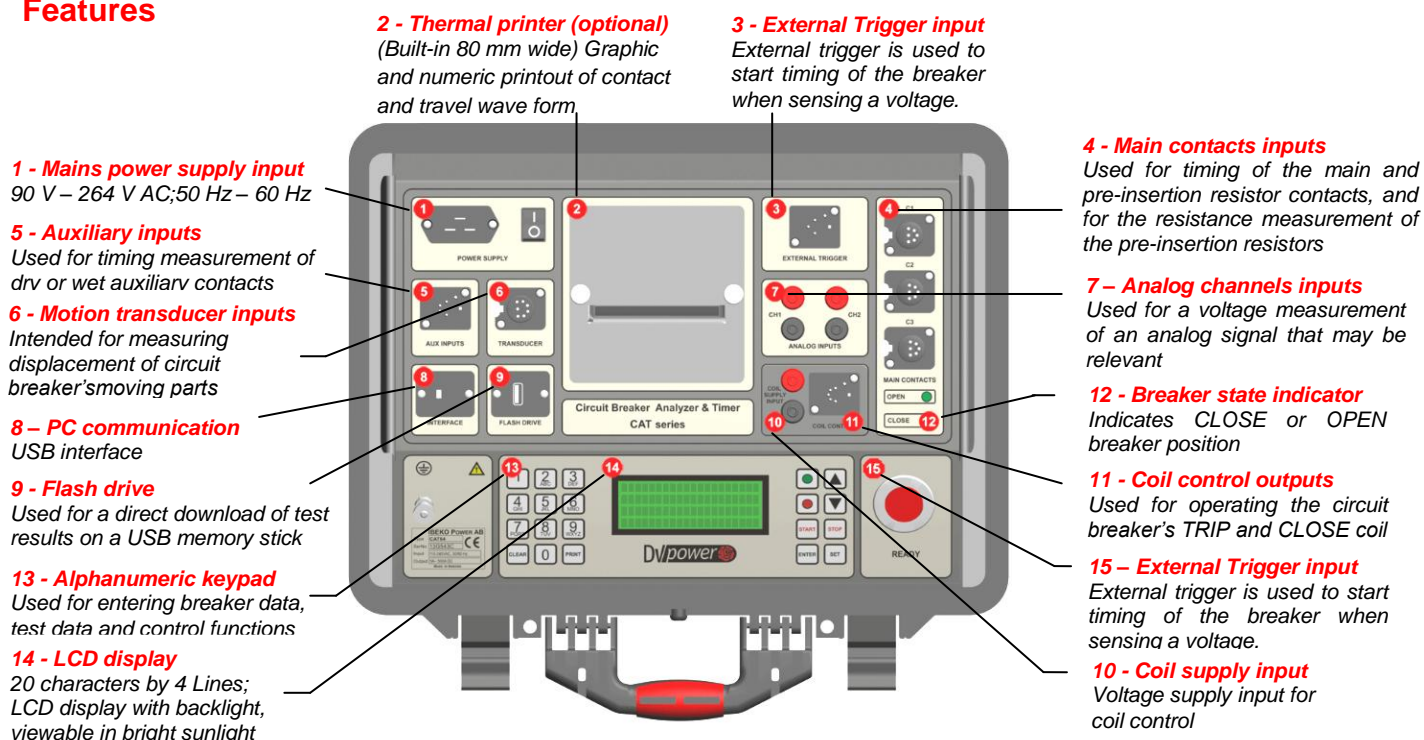
The two coil control analog channels can measure and record the coil currents simultaneously (TRIP and CLOSE), up to 35 A AC/DC.

The two additional analog channels have four selectable voltage ranges available ( $\pm 0,5$  V,  $\pm 2,5$  V,  $\pm 60$  V and  $\pm 300$  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

The transducer channel intended for 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 this universal channel.

## Features



## Application

The list of the instrument applications includes:

- Simultaneous timing measurement of up to 6 main contacts (2 breaks per phase) including pre-insertion resistors (if present in the circuit breaker) and 3 auxiliary contacts,
- Resistance measurement of the pre-insertion resistors (if present in the circuit breaker),
- Evaluation of synchronization between the circuit breaker poles,
- A measurement of the coil currents, simultaneously for 2 coils,
- Evaluating the state of the substation's batteries by graphically showing the voltage value,
- A measurement of displacement, contact wipe, over-travel, rebound, damping time and average velocity of the breaker's moving parts,
- “First trip” test.

## 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.

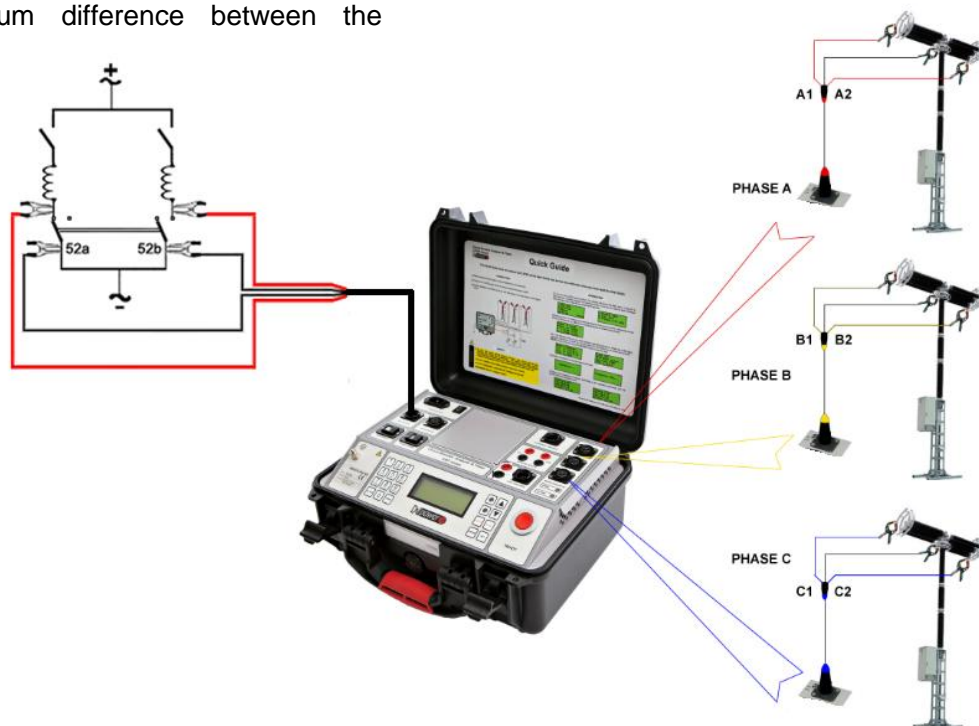
The maximum difference between the instants of contact separation within series connected interrupter units shall not exceed 1/8 of a cycle of rated frequency (2,50 ms at 50 Hz; 2,08 ms at 60 Hz). Maximum difference between the

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 trip coil and interrupts the trip 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.

## 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.

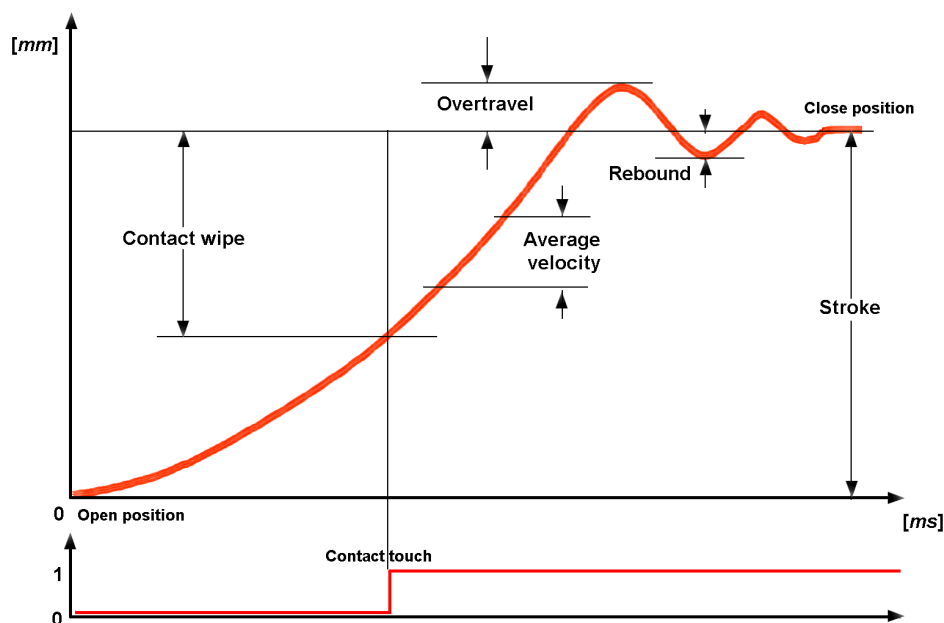
Performance values such as stroke, over-travel, rebound, contact wipe are obtained as a result of the measurement. These values can be compared to the manufacturer's reference data and data acquired from previous measurements. This provides indications about potential wear of the breaker.

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.



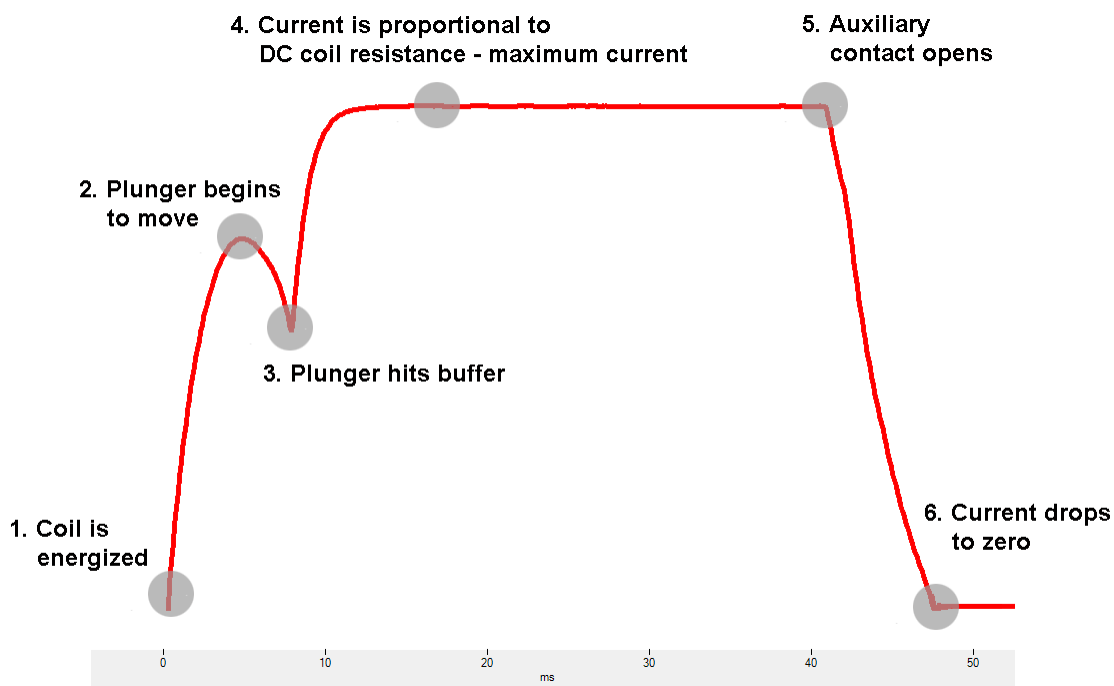
## Coil current measurement

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 2-3) 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.

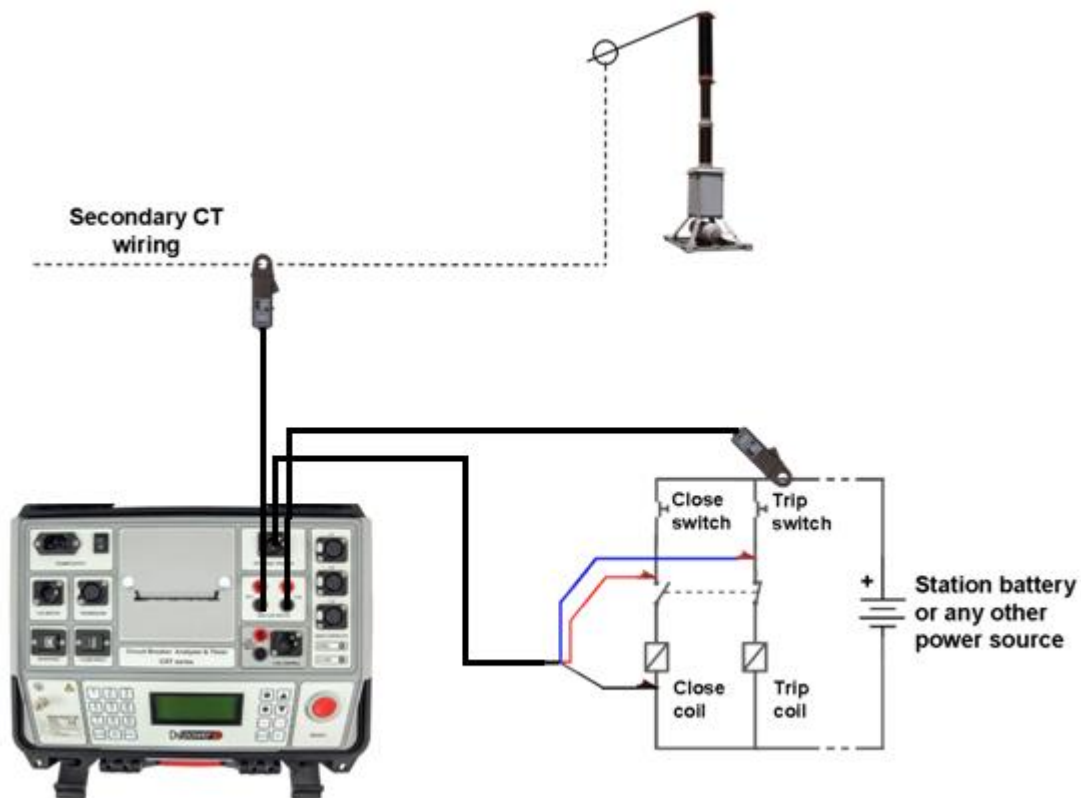


## First Trip Test

“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, trip circuit contacts, insufficient spring tension, can be

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

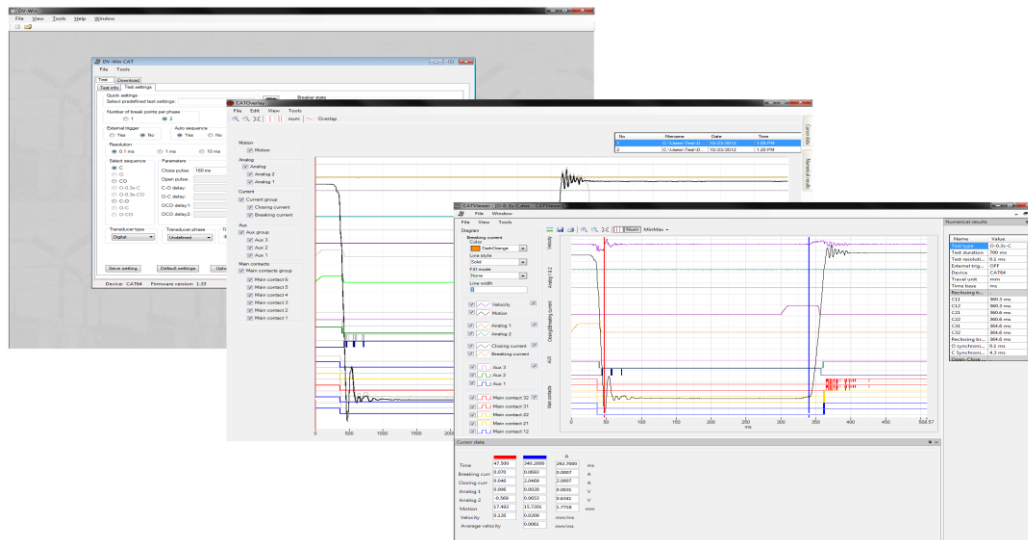
Since the breaker is in service, the conventional way of off-line timing measurement with timing cables across the interrupter cannot be used. Instead of main contact timing cables, three current probes are used. These current probes show current flowing through the secondary side of the current transformer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



## DV-Win

DV-Win software provides acquisition and analysis of the test results, as well as control of all the CAT I 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:  
3 (3 x 1), 1 per phase (CAT03, CAT31, CAT34)  
6 (3 x 2), 2 per phase (CAT61, CAT64)
  - Each channel detects Main and pre-insertion resistor contacts.
    - Closed  $\leq 10 \Omega$
    - Resistor contacts range  $10 \Omega$  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: 3, galvanically isolated (external trigger input can be used as a third 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, 250V AC  
Low activation mode  $\pm 5\text{V}$   
High activation mode  $\pm 10\text{V}$
- Overcurrent and overvoltage protection

### 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

The user can select any desired test sequence

### Coil driver

- Number of channels: 2 (Trip and Close coil)
- Two separate outputs for coil triggering
- Driver characteristics: 300 V DC max, 35 A DC max
- Electronic drivers provide superior timing control
- Overcurrent and overvoltage protection
- Coil supply input: 300 V DC max, 35 A DC max

### Current measurement

- Current measurement for Trip and Close coil, 2 channels, Hall-Effect sensor
- Range  $\pm 35 \text{ A DC}$  to 5 kHz
- Accuracy  $\pm (0,5 \% \text{ rdg} + 0,1 \% \text{ FS})$
- Graphic presentation: currents waveform is displayed with a resolution of 0,1 ms

### Analog inputs

- 2 channels – Coil current measurement
- 2 Voltage channels, each channel has four measurement ranges:  $\pm 0,5 \text{ V}$ ,  $\pm 2,5 \text{ V}$ ,  $\pm 60 \text{ V}$  and  $\pm 300 \text{ V AC/DC}$

The analog inputs are isolated with respect to all other circuits

### Printer (optional)

- Thermal printer
- Graphic and numeric printout
- Paper width 80 mm (3.15 in)

**Transducer input**

- Digital transducer inputs: 1
- Analogue transducer inputs: 1

**Time measurement triggers**

- External trigger: 2 channels (trigger input voltage: 10 V – 300 V AC/DC)
- Coil currents: threshold level user selectable
- Auxiliary inputs (change of contacts state)

**Dimensions and weight**

- Dimensions (W x H x D):  
405 mm x 170 mm x 335 mm  
15.9 in x 6.7 in x 13.1 in
- Weight: 5,5 - 7 kg / 11.4 - 15.4 lb

**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: 250 VA
- Fuse 2 A / 250 V, Fast blow, not user Replaceable

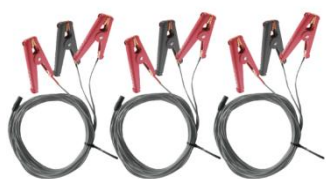
**Applicable standards**

- Installation/overvoltage: category II
- Pollution: degree 2
- Safety: LVD 2006/95/EC (CE Conform) 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 to + 55 °C / 14 °F to +131 °F
- Storage & transportation:  
-40 °C to + 70°C / -40 °F to +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.*



Main contacts cables 5 m (16.4 ft) with SCT clamps\*



Main contacts extensions cables 5 m (16.4 ft)\*



Coil control cable 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 4 x 5 m (16.4 ft) with banana plugs\*



Coil supply cable set 2 x 5 m (16.4 ft) 2,5 mm<sup>2</sup> (13 AWG) with banana plugs



Current clamp 30/300 A



Digital rotary transducer with 5 m (16.4 ft) connection cable



Linear analog transducer with 5 m (16.4 ft) connection cable\*\*



Linear to rotary converter



Cable plastic case - large size



Cable bag



Transport case



Universal transducer mounting kit



Universal transducer mounting kit (extended version) + digital rotary transducer with accessories

\*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 I series - models

CAT03



### Main contact inputs

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

CAT31



### Main contact inputs

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

CAT34



### Main contact inputs

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

CAT61



### Main contact inputs

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

CAT64



### Main contact inputs

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

## Order info

Instrument	Article No
Circuit Breaker Analyzer & Timer CAT03	CAT0300-N-00
Circuit Breaker Analyzer & Timer CAT31	CAT3100-N-00
Circuit Breaker Analyzer & Timer CAT34	CAT3400-N-00
Circuit Breaker Analyzer & Timer CAT61	CAT6100-N-00
Circuit Breaker Analyzer & Timer CAT64	CAT6400-N-00

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

Recommended accessories	Article No
Main contact cables 5 m (16.4 ft) with SCT clamps ( <i>for CAT03, CAT31, CAT34</i> )	CM-05-34MXST
Main contact cables 5 m (16.4 ft) with SCT clamps ( <i>for CAT61, CAT64</i> )	CM-05-65MXST
Main contact cables extension 5 m (16.4 ft) ( <i>for CAT61, CAT64</i> )	E3-05-65MXFX
Coil control cable 5 m (16.4 ft) with banana plugs ( <i>for CAT31, CAT34, CAT61, CAT64</i> )	CO-05-00C5B1
Coil supply cable set 2 x 5 m 2,5 mm <sup>2</sup> (16.4 ft, 13 AWG) with banana plugs ( <i>for CAT31, CAT34, CAT61, CAT64</i> )	C2-05-02BPBP
Auxiliary contact cable 5 m (16.4 ft) with banana plugs ( <i>for CAT31, CAT34, CAT61, CAT64</i> )	CA-05-00C4B1
External trigger cable 5 m (16.4 ft) with banana plugs	CE-05-00C4B1
Analog channels cable set 4 x 5 m (16.4 ft) with banana plugs ( <i>for CAT34, CAT64</i> )	C4-05-02BPBP
Cable bag ( <i>for CAT03, CAT31, CAT61</i> )	CABLE-BAG-00
Cable bag (x2) ( <i>for CAT34, CAT64</i> )	CABLE-BAG-00
Transport case ( <i>for CAT31, CAT34, CAT61, CAT64</i> )	HARD-CASE-SC

Optional accessories	Article No
Main contact cables 3 m (9.8 ft) with SCT clamps ( <i>for CAT03, CAT31, CAT34</i> )	CM-03-34MXST
Main contact cables 3 m (9.8 ft) with SCT clamps ( <i>for CAT61, CAT64</i> )	CM-03-65MXST
Main contact cables 3 m (9.8 ft) with alligator clamps (A1) ( <i>for CAT03, CAT31, CAT34</i> )	CM-03-34MXA1
Main contact cables 3 m (9.8 ft) with alligator clamps (A1) ( <i>for CAT61, CAT64</i> )	CM-03-65MXA1
Main contact cables 3 m (9.8 ft) with alligator clamps (A2) ( <i>for CAT03, CAT31, CAT34</i> )	CM-03-34MXA2
Main contact cables 3 m (9.8 ft) with alligator clamps (A2) ( <i>for CAT61, CAT64</i> )	CM-03-65MXA2
Main contact cables 5 m (16.4 ft) with alligator clamps (A1) ( <i>for CAT03, CAT31, CAT34</i> )	CM-05-34MXA1
Main contact cables 5 m (16.4 ft) with alligator clamps (A1) ( <i>for CAT61, CAT64</i> )	CM-05-65MXA1
Main contact cables 5 m (16.4 ft) with alligator clamps (A2) ( <i>for CAT03, CAT31, CAT34</i> )	CM-05-34MXA2
Main contact cables 5 m (16.4 ft) with alligator clamps (A2) ( <i>for CAT61, CAT64</i> )	CM-05-65MXA2
Main contact cables extension 7 m (23 ft)	E3-07-65MXFX
Main contact cables extension 10 m (32.8 ft)	E3-10-65MXFX
Main contact cables extension 12 m (39.4 ft)	E3-12-65MXFX
Main contact cables extension 15 m (49.2 ft)	E3-15-65MXFX
Main contact cables extension 17 m (55.8 ft)	E3-17-65MXFX

Coil control cable 10 m (32.8 ft) with banana plugs (for CAT31, CAT34, CAT61, CAT64)	CO-10-00C5B1
Coil control cable 15 m (49.2 ft) with banana plugs (for CAT31, CAT34, CAT61, CAT64)	CO-10-00C5B1
Coil supply cable set 2 x 10 m (32.8 ft) 2,5 mm <sup>2</sup> (13 AWG) with banana plugs (for CAT31, CAT34, CAT61, CAT64)	C2-10-02BPBP
Analog channels cable set 4 x 5 m with alligator clamps (A1) (for CAT34, CAT64)	S4-05-02BPA1
Analog channels cable set 4 x 5 m with alligator clamps (A2) (for CAT34, CAT64)	S4-05-02BPA2
Auxiliary contact cable 10 m (32.8 ft) with banana plugs (for CAT31, CAT34, CAT61, CAT64)	CA-10-00C4B1
External trigger cable 10 m (32.8 ft) with banana plugs	CE-10-00C4B1
Current clamp 30/300 A with internal battery supply and extension 5 m (for CAT34, CAT64)	CACL-0300-08
Digital rotary transducer 5 m (16.4 ft) with accessories (for CAT34, CAT64)	DRT-SET-0005
Digital rotary transducer 10 m (32.8 ft) with accessories (for CAT34, CAT64)	DRT-SET-0010
Linear analog transducer 150 mm (5,9 in) with 5 m (16.4 ft) connection cable (for CAT34, CAT64)	LAT-150-C305
Linear analog transducer 225 mm (8,9 in) with 5 m (16.4 ft) connection cable (for CAT34, CAT64)	LAT-225-C305
Linear analog transducer 300 mm (11.8 in) with 5 m (16.4 ft) connection cable (for CAT34, CAT64)	LAT-300-C305
Linear analog transducer 500 mm (19.7 in) with 5 m (16.4 ft) connection cable (for CAT34, CAT64)	LAT-500-C305
Current clamp 30/300 A with internal battery supply and extension 5 m (16.4 ft) (for CAT34, CAT64)	CACL-0300-08
Thermal printer 80 mm (3.15 in) (built-in)	PRINT-080-00
Thermal paper roll 80 mm (3.15 in)	PRINT-080-RC
Cable plastic case - small size	CABLE-CAS-01
Cable plastic case - medium size	CABLE-CAS-02
Cable plastic case - large size	CABLE-CAS-03
Cable plastic case with wheels - medium size	CABLE-CAS-W2
Cable plastic case with wheels - large size	CABLE-CAS-W3
Universal transducer mounting kit (for CAT34, CAT64)	UTM-KIT-0000
Universal transducer mounting kit - extended version (for CAT34, CAT64)	UTM-KIT-0001
Linear to rotary convertor (for CAT34, CAT64)	LTR-CON-0000
Doble transducer adapter (for CAT34, CAT64)	DTA-BOX-C002
Bluetooth communication module	BLUET-MOD-00
Test probe with grip jaws (black)	TESTPR-GJ-B0
Test probe with grip jaws (red)	TESTPR-GJ-R0
Test probe with split test clamps (black)	TESTPR-SC-B0
Test probe with split test clamps (red)	TESTPR-SC-R0
Dolphin clip (black)	DOLPIN-CL-B0
Dolphin clip (red)	DOLPIN-CL-R0

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