

# Circuit Breaker Analyzer & Timer **CAT-H**

- Compact and ergonomic design – only 1,5 kg (3.3 lbs)
- Simple and easy to operate
- Battery operation for up to 8 hours
- Timing and coil current measurement
- Graphical results for quick interpretation
- Touch screen color display 145 mm (5.7 in)
- On-site analysis of test results  
(overlay up to 4 records in graphical form)



## Description

Handheld Circuit Breaker Analyzer & Timer CAT-H is a digital instrument for circuit breakers condition assessment. CAT-H records graphs of both, open and close coil currents, timing of main arcing contacts, DC substation battery voltage. The timing channels record closing and opening of the main contacts and can also measure the resistance value of the pre-insertion resistors (if present in the circuit breaker).

CAT-H provides an easy selection of different operating modes:

- Open (O)
- Close (C)
- Trip free (CO)
- Reclose (O-C)
- Close-Open (C-O)
- Open-Close-Open (O-C-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:

- Coil control channel
- DC current clamp channel
- DC voltage channel

CAT-H is a powerful diagnostic tool for recording and analyzing:

- Main arcing contacts operation
- Trip/Close coils operation
- Auxiliary contact operation
- DC supply voltage
- Integrity of control circuit wiring

CAT-H displays numerical and graphical results (it can overlay up to 4 records in graphical form). This enables quick onsite analysis of potential defects by comparing the obtained test results.

## Features



### 1 - Coil supply input

Voltage supply input for coil control.

### 2 - Coil control outputs

Used for operating the circuit breaker's TRIP and CLOSE coil

### 3 - DC current clamp input

Used for a DC coil current recording and measurement.

### 4 - DC voltage channel input

Used for a voltage measurement of an analog signal.

### 5 - Main contacts input for offline measurement

Used for timing of the main and pre-insertion resistor contacts, and for the resistance measurement of the pre-insertion resistors.

### 6 - Touchscreen display

Touchscreen color display 5.7 in

### 7 - Soft keys

Used for selecting preferred (test) settings (options/menus) as an alternative to touchscreen.

### 8 - Alphanumeric keypad

Used for entering breaker data, test data and control functions.

### 9 - Power ON/OFF indicator

Indicates if the instrument is turned ON/OFF.

### 10 - READY button

Prepares the instrument for the start of the test.

### 11 - Power ON/OFF button

Used for turning ON/OFF the instrument turning.

### 12 - DC power supply

12 V DC, 3 A

DC adapter 85-264 V AC (47-63 Hz) / 12 V DC

### 13 - Flash drive

Used for a direct download of test results on a USB memory stick.

### 14 - PC communication

USB interface for PC.

## Application

The list of the instrument applications includes:

- Timing measurement of up to 3 main contacts (1 break per phase) including pre-insertion resistors (if present in the circuit breaker) and auxiliary contact.
- Resistance measurement of the pre-insertion resistors (if present in the circuit breaker).
- Main contacts bounce time measurement.
- Evaluation of synchronization between the circuit breaker poles.
- A measurement and graphical display of the coil currents.
- Evaluating the state of the substation's battery (or other types of analog signals that may be relevant) by presenting the voltage value numerically and graphically.

## 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 stipulated in IEC 62271-100 and ANSI 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 CAT-H can be used for measurement of the main arcing contact operating times when the circuit breaker is isolated from the power grid or is being tested at another location such as the manufacturer's premises or a maintenance workshop. When making test connections circuit breaker needs to be disconnected or separated from its circuit on both sides of the breaker in accordance with the national safety regulations. The circuit breaker needs to be properly grounded to a protective ground.

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

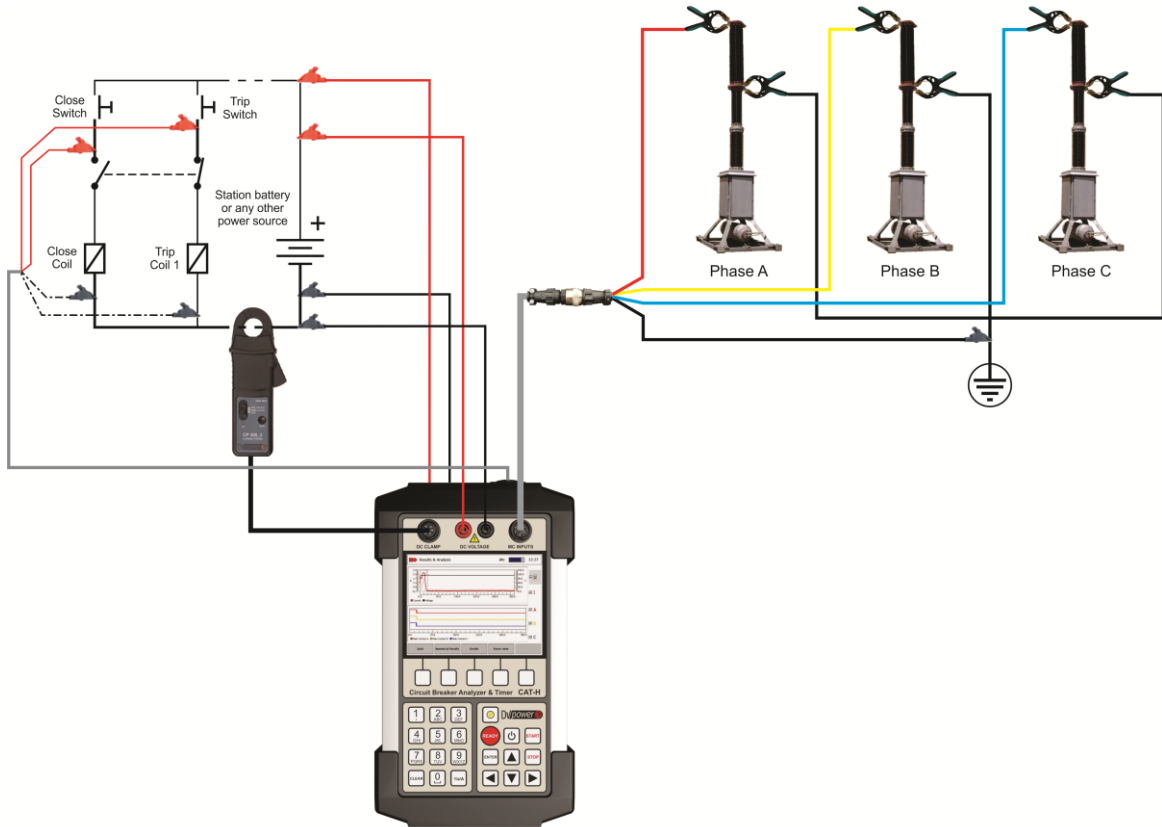


Figure 1. CAT-H connection to live tank circuit breaker with one breaking element per phase

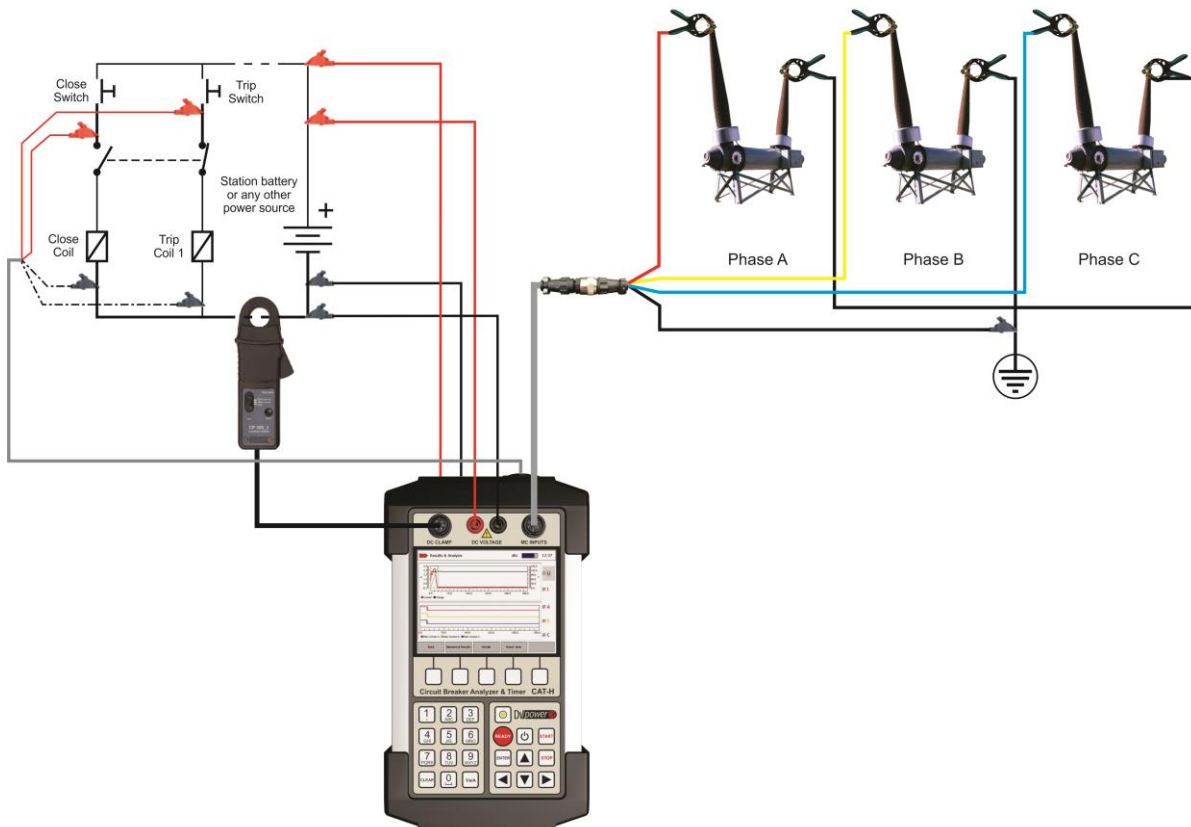


Figure 2. CAT-H connection to dead tank circuit breaker with one breaking element per phase

## 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.

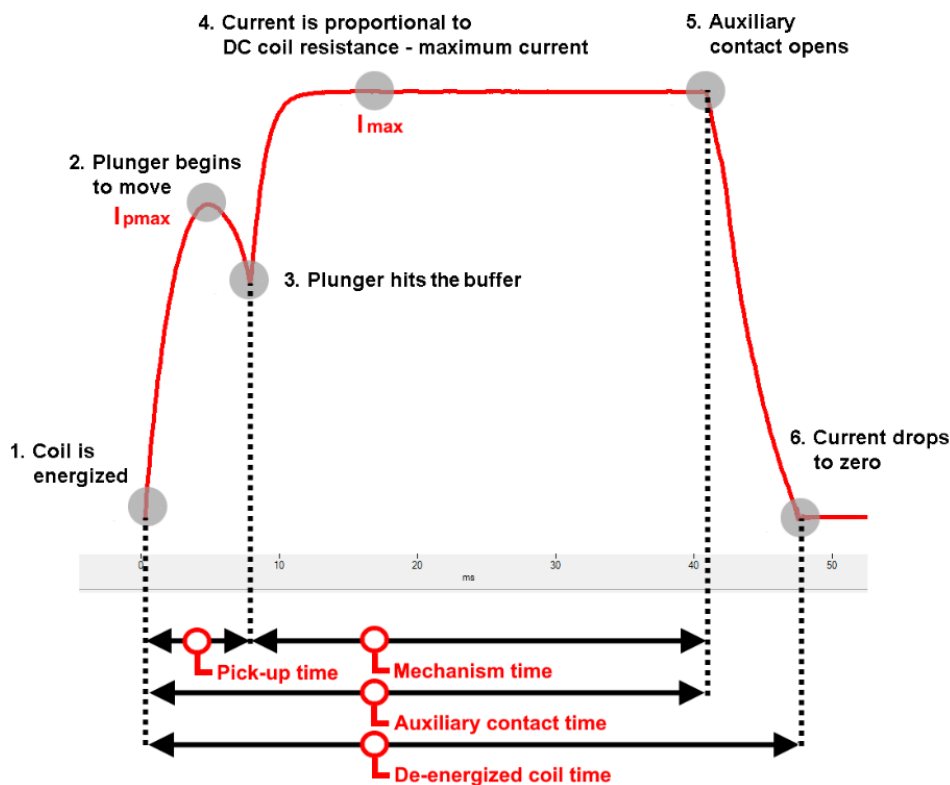
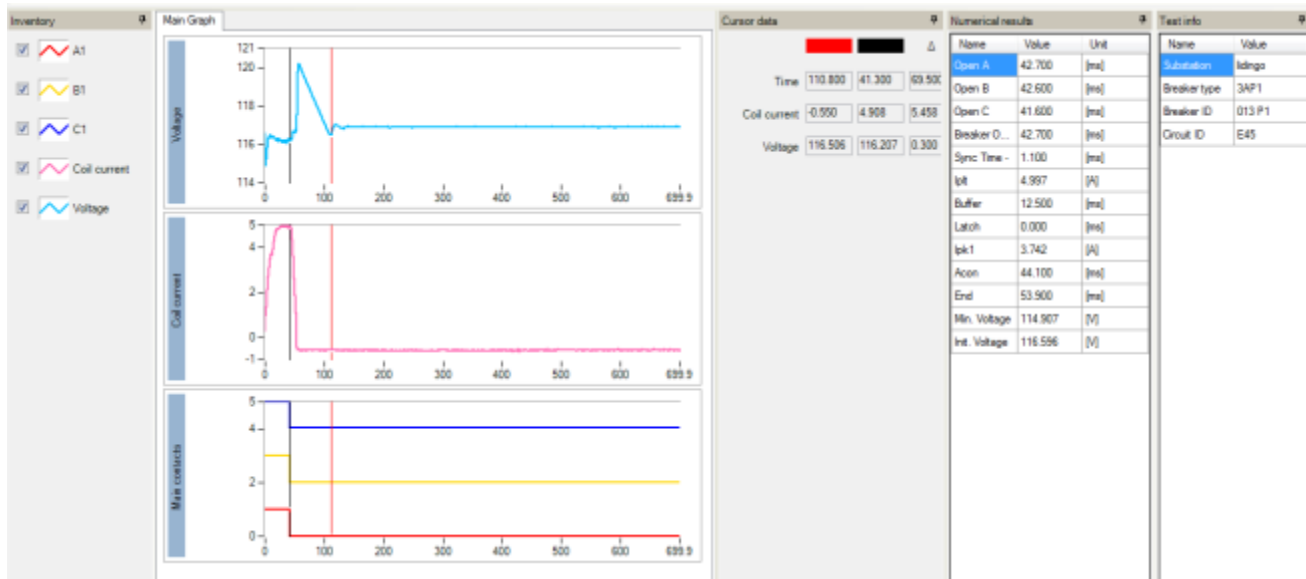


Figure 3. Coil current specific points and measurement parameters

## DV-Win software

DV-Win software provides acquisition and analysis of the test results. 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 an automatic unit conversion (e.g. cycles to seconds or mm to inches). The test records can be exported in .cath file format for further analysis.



- Downloading the test results from the CAT-H to PC
- 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
- Customized configuration of the test result graphs



## Technical data

### Main contact inputs

- Number of contact inputs: 3 (3 x 1), 1 per phase
- Each channel detects Main 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  $\pm 20\%$
- Short circuit current 50 mA

### Time measurement

Time measurement resolution:

- 0,05 ms to 10 ms depending on test duration (sampling rate up to 20 kHz)

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

### Breaker operation

- Close (C)
- Open (O)
- Close-Trip (C-O)
- Trip-Close (O-C)
- Trip-Close-Trip (O-C-O)

### DC Current Clamps

- Nominal current: 300 A<sub>RMS</sub> or 450 A DC<sub>PK</sub>
- Measuring ranges: 30/300 A
- Frequency range: DC to 20 kHz (-3 dB)

### DC Voltage Measurement

- Range:  $\pm 300 \text{ V}$
- Typical accuracy:  $\pm 0,5\% \text{ RDG} \pm 0,5\% \text{ FS}$
- Guaranteed accuracy:  $\pm 1\% \text{ RDG} \pm 1\% \text{ FS}$

### Coil driver

- Number of channels: 2 (Trip and Close coil)
- 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

### Handset and inline power supply

- 12 V DC, 3 A
- Input: 90 – 264 V AC, 50/60 Hz

### Internal battery supply

- 2 x 3,7 V, 2900 mAh rechargeable Li-ion battery
- 8 hours under normal usage

### Display

- Touch screen color display 145 mm (5.7 in)

### Applicable standards

- Safety:
  - Low Voltage Directive: Directive 2014/35/EU (CE conform)
  - Applicable standards, for a class I instrument, pollution degree 2, Installation category II: IEC EN 61010-1
- Electromagnetic Compatibility:
  - Directive 2014/30/EU (CE conform)
  - Applicable standard: EN 61326-1
- CAN/CSA-C22.2 No. 61010-1

### 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

### Dimensions and weight

- Dimensions (L x W x H):
  - 310 x 170 x 58 mm / 12.21 x 6.69 x 2.28 in
- Weight:
  - 1,5 kg / 3.3 lbs

### Warranty

- 3 years

## Accessories



**Main Contact Cables 8 m (26.3 ft) with alligator clamps (A1)\***



**Main contacts connection 3 x 1 m (3.3 ft) and ground 2 m (6.6 ft) cable with alligator clamps (A1)**



**Voltage sense 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 power supplied from the instrument with extension 5 m (16.4 ft)**



**Coil control cable set 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**



**Test probe with grip jaws (red, black)**



**Dolphin clip (red, black)**



**Plastic transport case for CAT-H**



**Cable bag**



**Power supply adapter**



**Resistive touch pen**

\* The cables are also available in several lengths and terminations. Please contact DV Power for more information.



## Order info

Instrument with included accessories	Article No
Handheld Circuit Breaker Analyzer & Timer CAT-H with DV-Win software including USB stick and mini USB cable, Resistive touch pen and Plastic transport case	CATH000-N-00
Power supply adapter	
<b>Recommended accessories</b>	
Main contacts cable set 8 m with alligator clamps (A1)	CMP-08-SETA1
Main contacts connection 3 x 1 m and ground 2 m cable with alligator clamps (A1)	MC-CG-0302A1
Coil control cable 5 m with banana plugs	CO-05-00C5B1
Test probe with grip jaws (black) (x 2)	TESTPR-GJ-B0
Test probe with grip jaws (red) (x 2)	TESTPR-GJ-R0
Coil supply cable set 2 x 5 m 2,5 mm <sup>2</sup> with banana plugs	C2-05-02BPBP
Dolphin clip (black)	DOLPIN-CL-B0
Dolphin clip (red)	DOLPIN-CL-R0
<b>Optional accessories</b>	
Main contacts cable set 10 m with alligator clamps (A1)	CMP-10-SETA1
Main contacts cable set 8 m with alligator clamps (A2)	CMP-08-SETA2
Main contacts cable set 10 m with alligator clamps (A2)	CMP-10-SETA2
Main contacts cable set 8 m with SCT clamps	CMP-08-SETST
Main contacts cable set 10 m with SCT clamps	CMP-10-SETST
Current clamp 30/300 A power supplied from the instrument with extension 5 m	CACL-0300-09
Voltage sense cable set 2 x 2 m 2,5 mm <sup>2</sup> with banana plugs	S2-02-02BPBP
Voltage sense cable set 2 x 5 m 2,5 mm <sup>2</sup> with banana plugs	S2-05-02BPBP
Voltage sense cable set 2 x 10 m 2,5 mm <sup>2</sup> with banana plugs	S2-10-02BPBP
Coil control cable 10 m with banana plugs	CO-10-00C5B1
Coil supply cable set 2 x 10 m 2,5 mm <sup>2</sup> with banana plugs	C2-10-02BPBP
Test probe with split test clamps (black)	TESTPR-SC-B0
Test probe with split test clamps (red)	TESTPR-SC-R0
Resistive touch pen	RSTCH-PEN-00
Plastic transport case for CAT-H	HARD-CASE-HH
Cable bag	CABLE-BAG-00
Power supply adapter EU 3 A	PWR-ADP3A-EU
Power supply adapter NA 3 A	PWR-ADP3A-NA
Power supply adapter UK 3 A	PWR-ADP3A-UK
Power supply adapter AU 3 A	PWR-ADP3A-AU

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