Application Note

Measuring Coil Resistance Using CAT Device

International standard IEC 62271-100 defines a procedure for the coil circuit resistance measurement. The coil circuit resistance values can range from a few tens to several hundred Ω. If a lower than specified resistance encountered, it may indicate a short circuit condition between the coil turns due to damaged or burned insulation. The higher coil circuit resistance value than specified may indicate contact corrosion, loose auxiliary contacts or damaged wire of the coil winding due to overheating.

The CAT (Circuit Breaker Analyzer & Timer) instrument can measure the trip and close coil resistances during timing operations. It can measure resistances of all three opening or closing coils simultaneously (for independent-pole controlled circuit breakers). Measurement procedure is based on the simultaneous measurement of the voltage drop across the coil and the current through the coil during circuit breaker operation. Based on the coil voltage drop and current values, the coil resistance is calculated according to the Ohm's law R=U/I. Coil voltage drop and current values are measured during the time interval when the constant DC current is established through the coil (Figure 1). At that period only the voltage drop on the coil resistance exists, since the voltage drop on the coil inductivity is zero or negligibly low.

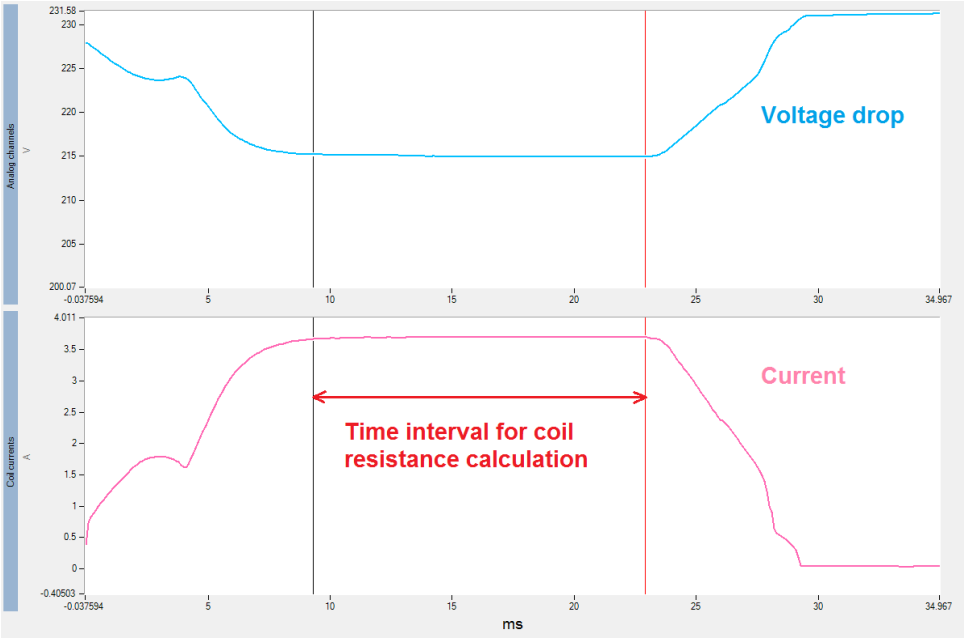

Figure 1. *Time interval for coil resistance calculation shown on the coil voltage drop and coil current waveforms*

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Cables Connection for Coil Resistance Measurement

To perform the trip and close coil resistance measurements, the CAT coil control outputs and analog channels inputs should be connected to coils simultaneously. The coil control cable connection is described in details in the Application Note [1]. In general, a coil resistance can be properly measured only if both, the analog channel input and the coil control output are appropriately connected to the coil. An example of the connection of the Coil control cable and Analog channel cable measuring the resistance of the Opening coil 1 is illustrated in the Figure 2. It is important to notice that for the resistance measurement of Opening coil 1 it is necessary to connect together the Coil control cable labeled “Open 1” and analog channel cable labeled “ACH 1”. Further on, for the resistance measurement of the remaining coils (in case of the independent pole controlled CB) one should combine the coil control cables and the analog channels cables in the following way:

- Closing coil 1: Close 1 - ACH 2
- Opening coil 2: Open 2 – ACH 3
- Closing coil 2: Close 2 - ACH 4
- Opening coil 3: Open 3 – ACH 5
- Closing coil 3: Close 3 – ACH 6.

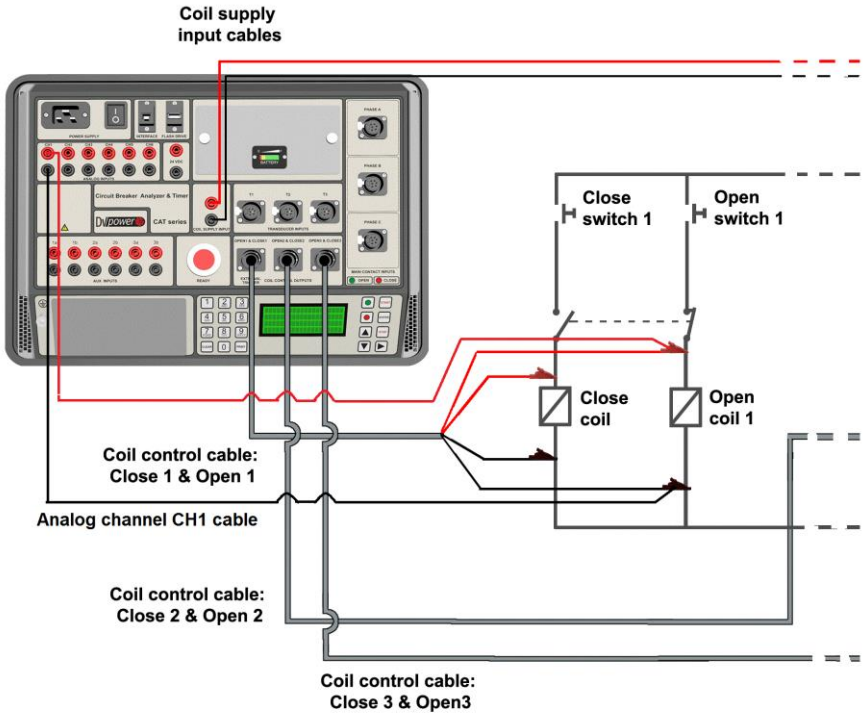

Figure 2. *Coil control cable and analog channel cable connection for resistance measurement*

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For the CAT instrument with four analog channels and four coil control channels, the connection of the cable pairs are the following:

- Opening coil 1: Open 1 - ACH 1
- Closing coil 1: Close 1 - ACH 2
- Opening coil 2: Open 2 – ACH 3
- Opening coil 3: Open 3 - ACH 4

Coil Resistance Measurement Configuratrion in DV-Win Software

The coil resistance measurement option is available only when using the DV-Win software to control and operate the CAT device. To activate the coil resistance measurement option in the software, the checkbox "*Use analog channels for coil resistance measurement"* in the tab "*Aux and Analog channels"* should be enabled (Figure 3).

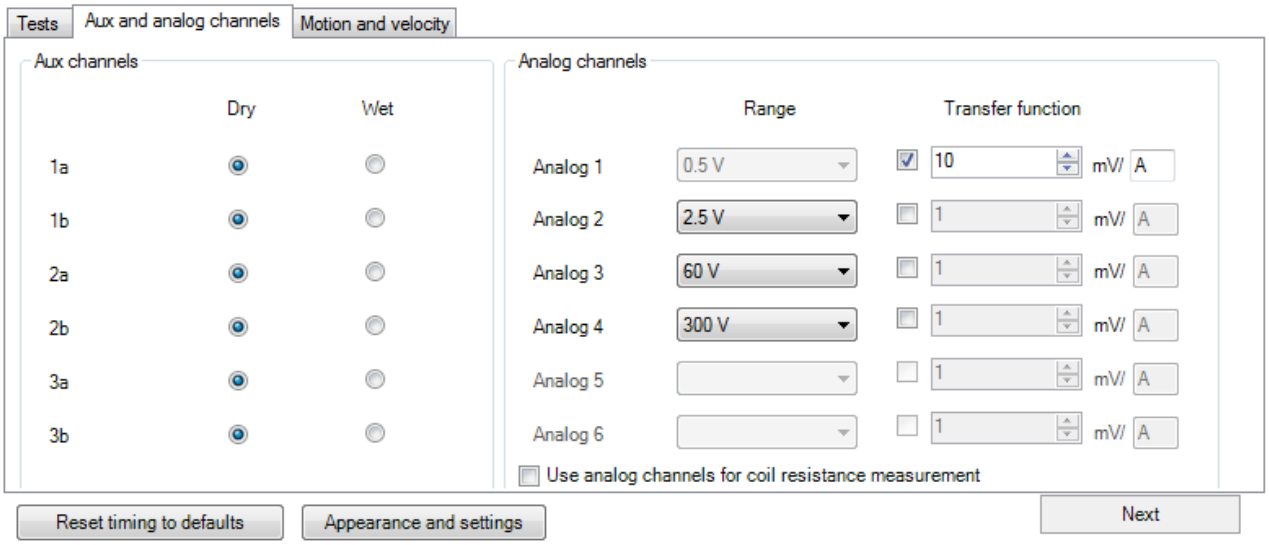

Figure 3. *Aux and analog tab settings*

Certain pairs of analog channel – coil control channel are coupled by the software application, forming the virtual channel for the coil resistances calculation. These are the following pairs:

- Opening coil 1: Open 1 - Analog 1
- Closing coil 1: Close 1 - Analog 2
- Opening coil 2: Open 2 – Analog 3
- Closing coil 2: Close 2 - Analog 4
- Opening coil 3: Open 3 – Analog 5
- Closing coil 3: Close 3 – Analog 6.

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For the CAT having four analog channels and four coil control channels, the pairs are the following:

- Opening coil 1: Open 1 - Analog 1
- Closing coil 1: Close 1 - Analog 2
- Opening coil 2: Open 2 – Analog 3
- Opening coil 3: Open 3 - Analog 4

To prepare Coil resistance measurement, the first step is to select the Coil control channels to be enabled for initiation of coil activation and coil current measurement (menu in the Figure 4). If "*1 – Single pole"* control is selected in the "*Control type"* menu, all six (or four) coil control channels will be automatically enabled. In that case, selecting the checkbox *"Use analog channels for coil resistance measurement"*, all six analog channels will be used for the coil voltage measurement (300 V range will be automatically set). If "*2-Three-pole"* is selected in the "*Control type"* menu, one pair Open-Close coil control channel has to be selected. In case of CAT devices having four coil control channels, one Open channel has to be selected, while common Closing coil channel is enabled always.

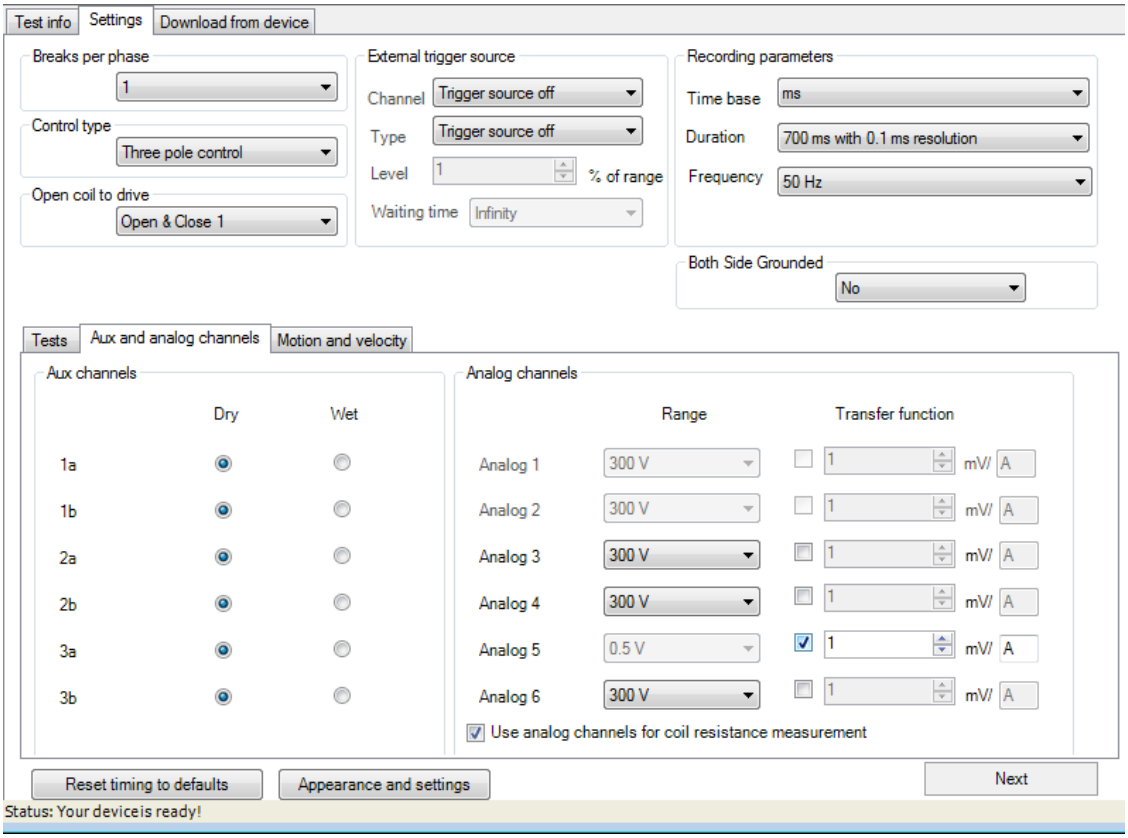

Figure 4. Configuring coil resistance measurement in the tab Aux and Analog channels

When the option "*Use analog channels for coil resistance measurement"* is enabled, with previously selected coil control channels, the appropriate analog channels will be reserved

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for the coil voltage measurement and disabled for other purposes. For example, if Open & Close 1 coil control channels are selected, the analog channels Analog 1 and Analog 2 are used for the coil voltage measurement and disabled for other purposes, as can be seen in the Figure 4. The rest of the channels can be used for other purposes and measurements.

Note: ***Analog channels can be used and set for the coil resistance measurement during timing operations C and O only.***

Coil Resistance Results View

After performing a timing test and downloading results, the window with graphical and numerical results will appear as shown in the Figure 5. If the option for coil resistance measurement was enabled during the measurement, the section “Coil resistance” will be shown within “Numercial results” tab (framed red in the Figure 5).

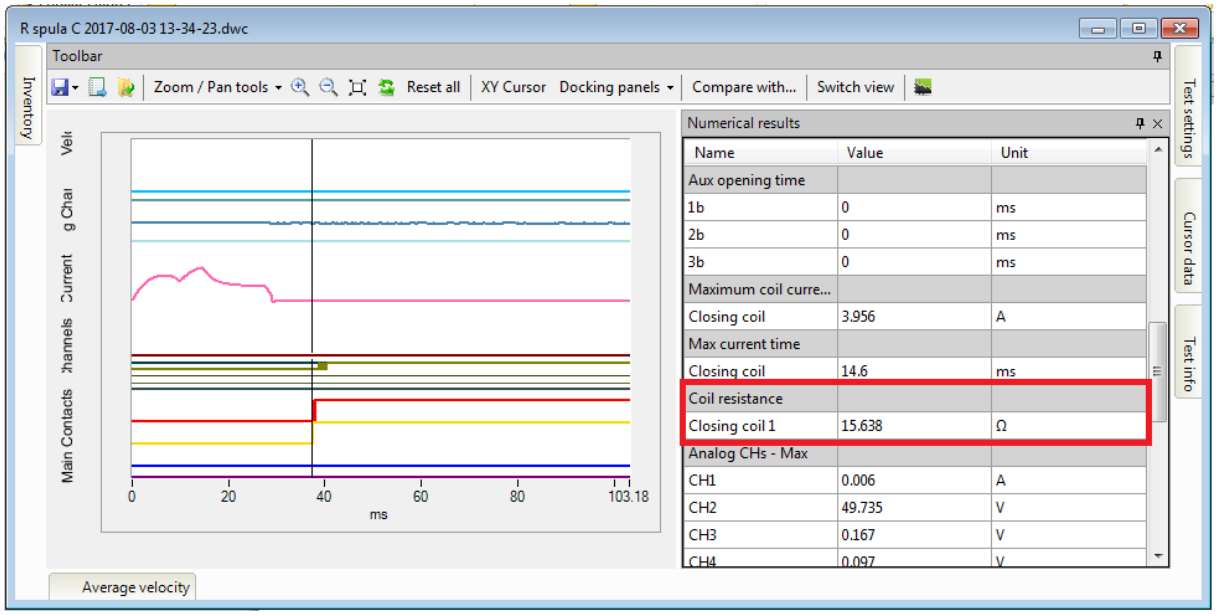

Figure 5. Closing coil resistance result within Numerical results tab

REFERENCES

[1] How to connect Coil Control cable to CB coils, DV Power, Stockholm 2014

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