CIRCUIT BREAKER ANALYZER & TIMER

CAT3x and CAT6x Advanced series
(models: CAT35, CAT36, CAT64A, CAT65 & CAT66)

Manual

Manual Version: M-CA6XAD-114-EN
This Manual refers to the firmware version:
5.xx – without BSG (Both Sides Grounded) feature on AIS (Air Insulated Switchgear) Live Tank
6.xx – with BSG (Both Sides Grounded) feature on AIS (Air Insulated Switchgear) Live Tank
This Manual refers to CAT35, CAT36, CAT64A, CAT65 and CAT66 models
Publishing date: 2022-04-18

Contents

1. Introduction

The purpose of this Manual is to provide helpful instructions on how to use the CAT Advanced series instrument (CAT) safely, properly and efficiently.

The following instructions will help the user avoid dangerous situations, reduce maintenance costs and will ensure the reliability and durability of the CAT instrument.

The CAT must be used in accordance with all existing safety requirements and regulations based on national/local standards for accident prevention and environmental protection. In addition, the relevant international standards are listed in the “Technical Data” section of this document.

1.1. Safety Instructions

Safety is the responsibility of the user. Before operating the CAT, please read the following safety instructions carefully.

It is not recommended to operate CAT instrument (or even turn it on) without careful observation of the instructions listed in this Manual. The CAT should only be operated by trained and authorized personnel.

1.1.1. Safety Terms and Symbols

Terms in this Manual

These terms may appear in the Manual:

WARNING: Warning statements identify conditions or practices that could result in injury or loss of life.

CAUTION: Caution statements identify conditions or practices that could result in damage to this product or to other property.

Terms on the Device

The following warning terms used in this document may appear on the device:

WARNING- indicates that potential hazard may occur.

CAUTION- indicates that potential damage may occur to the instrument or to the test object connected to the instrument.

Symbols on the Device

The following symbols may appear on the device:

Refer to Manual

Protective Earth Terminal

1.1.2. Terms of Use

- The CAT shall be used only if it is in good technical condition. Its use shall be in accordance with local safety and industrial regulations. Adequate precautions must be taken to avoid any risks related to high voltages associated with this equipment and nearby objects.
- The CAT shall be used only for the application purposes described in the ”Intended Use” section. The manufacturer and distributors are not liable for damage resulting from wrong usage. The user bears responsibility for not following the instructions defined in this document.
- Do not remove the protective casing of the CAT.
- All service and maintenance work must be performed by qualified personnel only.

1.1.3. Orderly Practices and Procedures

- The Manual shall always be available on the site where the CAT is used.
- Before using the CAT, all personnel (even personnel who only occasionally, or less frequently, work with the CAT) assigned to operate the CAT should read the operations Manual.
- Do not make any modifications, extensions or adaptations to the CAT.
- Use the CAT only with the original accessories provided by the manufacturer.
- Use the CAT and its original accessories for the device’s intended use only.

1.1.4. Instrument Maintenance

The device should be kept clean in order to prevent excessive cases of dust or other contaminants from affecting its operation. It should be cleaned with water/isopropyl alcohol after any dirt/contaminants are noticed on its surfaces.

1.1.5. Operator Qualifications

- Testing with the CAT should only be carried out by authorized and qualified personnel.
- Personnel receiving training, instruction or education on the CAT should remain under the constant supervision of an experienced operator while working with the test set and the test object.

1.1.6. Safe Operating Procedures

- Hazardous voltages of up to 400 V can occur inside the CAT. Therefore, it is not permitted to remove the protective casing of the CAT.
- Before putting the CAT into operation, check the test set for any visible damage.
- Do not operate the CAT in wet or moist conditions (condensation).
- Do not operate the CAT if explosive gas or vapors are present.

- Only those external devices which meet the requirements for SELV equipment according to EN 60950 or IEC 60950 should be connected to the CAT through the serial interface.
- Removing the CAT protective casing will void the warranty. Any work inside the instrument without prior authorization from DV Power will also void the warranty.
- If the CAT seems to be malfunctioning, please contact the DV Power Support Team (refer to the “Manufacturer Contact Information” section) after previously checking the “Error Messages” section.
- If CAT accessories do not seem to function properly, stop using them and contact the DV Power Support Team (refer to the “Manufacturer Contact Information” section)
- Prior to connecting the CAT, ensure that the circuit breaker (object) to be tested is completely isolated from both the line and the load. Every terminal should be checked and verified before connecting the CAT.
- Do not use the CAT without the extra protective ground cables supplied with the device. It must never be operated in a non-grounded configuration as this may result in an electrical shock to the user or damage to the CAT. Always establish this connection first before establishing any other connections and remove this connection as the very last one.
- Cables between the CAT and any other equipment should be connected and disconnected from the CAT only while the instrument is switched off.

1.1.7. Disposal

DV Power instruments and its accessories are intended for professional use and are not intended for household use. As such they should not be disposed of with waste that was intended for household use.

For customers inside of the EU/EEA member states area

DV Power instruments and accessories are subject to the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE). When disposing DV Power instruments and accessories please use your local WEEE collection systems. Instruments and accessories can be returned to DV Power for disposition and treatment of WEEE.

For customers outside of the EU/EEA member states area

It is important to follow guidelines that are prescribed for disposal of WEEE in the according country. Dispose of DV Power instruments and accessories according to local legal requirements.

1.2. Power Supply

- Supply the CAT only from a power outlet equipped with the protective ground.
- Besides being supplied from phase – neutral (L1-N, A-N), the CAT may also be supplied from phase to phase (e.g., L1-L2; A-B). However, the voltage must not exceed 264 V AC. Please refer to the “Technical Data” section of this document.
- Take care to position the CAT in such a way that it is possible to safely disconnect it from the power supply at any moment.

WARNING / AVERTISSEMENT

This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Il s'agit d'un produit de classe A. Dans un environnement domestique, ce produit peut provoquer des interférences radio, auquel cas l'utilisateur peut être amené à prendre des mesures adéquates.

1.3. Measurement Category

The CAT is intended to be used for measurements in Measurement Category I (CAT I) for voltages up to 300V on analog inputs. The device is also designed to withstand occasional transient overvoltage up to 1000Vpk.

WARNING / AVERTISSEMENT

This equipment is classified as measurement category I and must not be used within measurement category II, III and IV.

Cet équipement est classée dans la I catégorie de mesure, et ne doit pas être utilisé pendant les catégories de mesure II ,III et IV.

1.4. Intended Use

The CAT is designed for condition assessment of HV/MV circuit breakers in electric utilities and industrial facilities.

Typical applications are:

- Simultaneous measurement of up to 6 Main contacts (2 breaks per a phase) including pre-insertion resistors (if present in the circuit breaker) and 6 auxiliary contacts,
- A resistance measurement of the pre-insertion resistors (if present in the circuit breaker)
- An evaluation of synchronization between the circuit breaker poles
- Measurement of the coil currents, voltages and resistance simultaneously for 6 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
- Anti-Pumping relay test
- "First trip" test
- Static resistance measurement
- Dynamic resistance measurement
- Minimum operating voltage test (when used as CAT & SAT test system)
- Measurement of spring-charging motor time, current and voltage (both DC and AC power supply voltage, when used as CAT & SAT test system)

CAUTION: Any use of the CAT other than mentioned above is being considered improper and will void the warranty and exempt the manufacturer from its liability for repair or exchange.

2. Description

2.1. CAT3x and CAT6x Advanced series instruments

CAT3x Advanced series includes: CAT35 and CAT36 instruments.
CAT6x Advanced series includes: CAT64A, CAT65 and CAT66 instruments.

CAT64A:

- 6 Timing channels (3×2) for main and pre-insertion resistor contacts
- 6 Timing channels for auxiliary contacts
- 3 Universal (analog and digital) input channels for motion transducers
- 6 Coil control drivers (3 Open and 3 Close)
- 4 Time measurement trigger sources (Ext trigger, Analog channels, Coil currents and Aux channels)
- 6 additional analog input channels

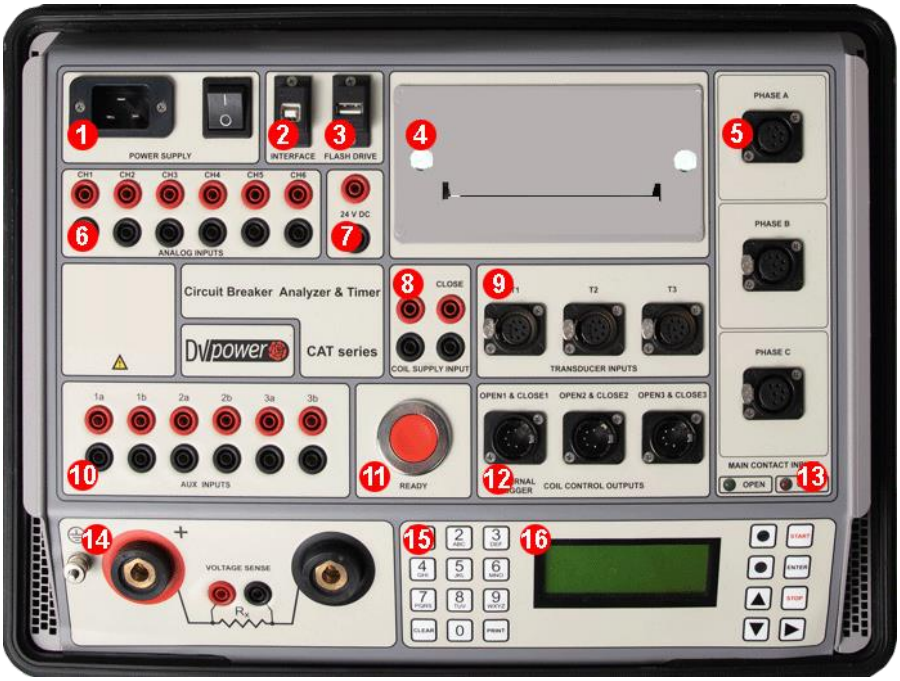
CAT35, CAT65:

- 3 (CAT35) and 6 (CAT65) timing channels for main and pre-insertion resistor contacts
- 6 Timing channels for auxiliary contacts
- 3 Universal (analog and digital) input channels for motion transducers
- 6 Coil control drivers (3 Open and 3 Close)
- 4 Time measurement trigger sources (Ext trigger, Analog channels, Coil currents and Aux channels)
- 6 additional analog input channels
- Built-in Micro Ohmmeter 200A
- Dynamic and static resistance measurement

CAT36, CAT66:

- 3 (CAT36) and 6 (CAT66) timing channels for main and pre-insertion resistor contacts
- 6 Timing channels for auxiliary contacts
- 3 Universal (analog and digital) input channels for motion transducers
- 3 Coil control drivers (3 Open and 3 Close)
- 4 Time measurement trigger sources (Ext trigger, Analog channels, Coil currents and Aux channels)
- 6 additional analog input channels
- Built-in Micro Ohmmeter 500A
- Dynamic and static resistance measurement

2.2. Front Panel Components



1 - Mains power supply input
90 – 264 V AC;50 Hz – 60 Hz

2 - PC communication
USB interface

3 - Flash drive
Used for a direct download of test results on a USB memory stick

4 - Thermal printer (optional)
(Built-in 112 mm (4.4 inch) wide) Graphic and numeric printout of contact and travel wave form

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

6 - Analog channels inputs
Used for a voltage measurement of an analog signal that may be relevant.

7 - Current clamps voltage supply
24 V voltage output for current clamps

8 - Coil supply input
Separated voltage supply inputs for open and close coil control

9 - Motion transducer inputs
Intended for measuring displacement of circuit breaker's moving parts

10 - Auxiliary inputs
Used for timing measurement of dry or wet auxiliary contacts

11 - READY button
Prepares the instrument for the start of the test

12 - Coil control outputs & external trigger input
Used for operating the circuit breaker OPEN and CLOSE coil or external trigger feature

13 - Breaker state indicator
Indicates CLOSE or OPEN breaker position

14 - Micro Ohmmeter
(built-in micro ohmmeter – up to 500 A DC) for static and dynamic contact resistance measurement (not available with CAT64A)

15 - Alphanumeric keypad
Used for entering breaker data, test data and control functions

16 - LCD display
20 characters by 4 Lines; LCD display with backlight, viewable in bright sunlight

Alphanumeric Keypad

Allows users to make menu selections, enter alphanumeric data for breaker data, test data, define the timing test, initial setup, value of memory location, select and confirm operating sequences etc.

CLEAR button

Press to delete the selected memory location.

PRINT button

Test results can be printed using the ***PRINT*** button.

UP/DOWN/RIGHT buttons

Press the ***UP/DOWN/RIGHT*** buttons to navigate through the active menu and set test parameters.

STOP button

Press the ***STOP*** button to stop a test, stop the alarm buzzer, or return to the previous menu.

START button

Press the ***START*** button to start a test

Test parameters must be selected beforehand. To start a test the ***START*** must be pressed simultaneously with the ***READY*** button.

ENTER button

Use the ***ENTER*** button to confirm the edited values for the breaker data, test data, timing test parameters, time and date, time base, or to view the memory location.

READY button

Press and hold the ***READY*** button and then press ***START*** to start a test.
This is an additional safety feature.

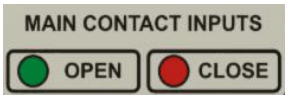
Green LED

Lights continuously when the CAT is turned on.

Red LED

Lights continuously in case of an operational error. Flashes when the test is started.

Breaker State Indicator LEDs

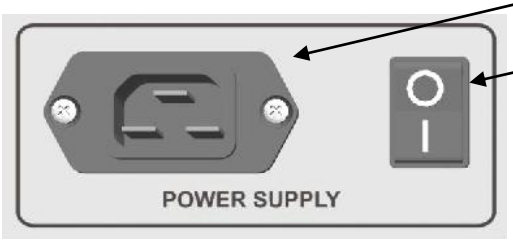


Green LED is continuously ON to indicate the OPEN state of the circuit breaker.

Red LED is continuously ON to indicate the CLOSE state of the circuit breaker.

Both Green and Red LED are ON continuously when the CAT cannot determine the state of the breaker.

Mains Power and Connectors



Connector for the mains power supply

Power switch

0 In this position, the CAT is separated from the mains power supply with both poles.

I In this position, the CAT is connected to the mains power supply.

Figure 2-1: Mains power and connectors

Earth/ground connector

For protection against parasitic currents or voltages, always connect the CAT earth/ground connector to protective ground (Protective Earth - PE). Use only the original cable.

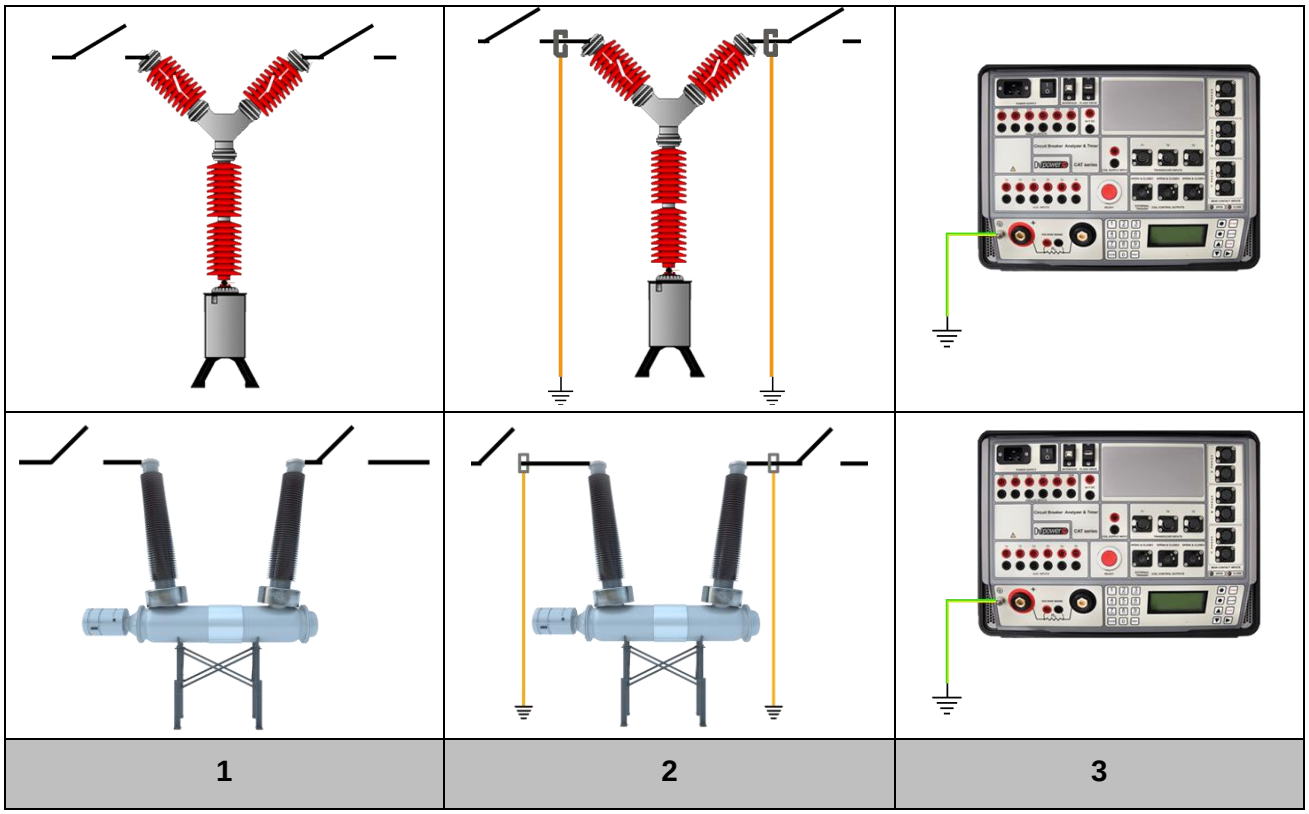
WARNING: For safety reasons, always establish earth/ground connection as the first step before establishing any other connections and disconnect it as the very last one.

3. Getting Started

3.1 Connecting the CAT to a Test Object

Before connecting the CAT to a circuit breaker, make sure that:

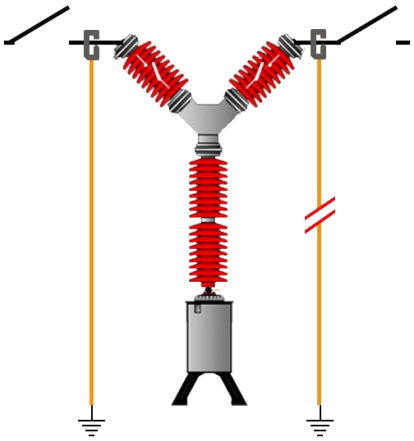
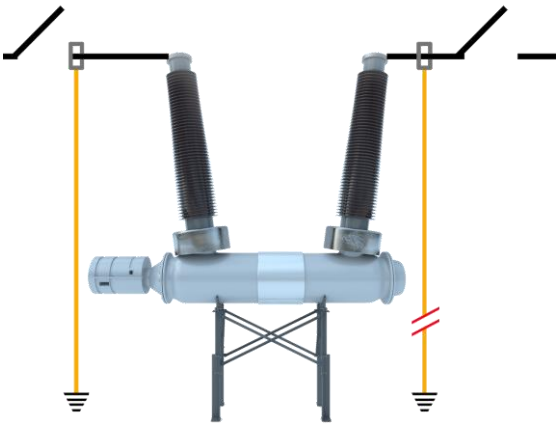
1) The circuit breaker is disconnected or separated from its circuit on both sides of the breaker in accordance with the national safety regulations; **always comply with local safety regulations when using the CAT**. (Not applicable to First Trip tests.)
2) The circuit breaker is properly grounded to a protective ground (PE),
3) CAT itself is properly grounded. To do this, connect the grounding screw of the CAT to a Protecting Earth using only the originally provided grounding cable.



1	2	3

Note: If BSG timing measurement feature is not available, conventional method for ground connection (figures below) must be applied:

- Circuit breaker must be grounded on both sides when the measuring leads are being attached.
- The ground must be removed on one side of the breaker for the test.
- The ground connection should always remain in place on the side on which there is the greatest danger of capacitive or inductively coupled voltages.

	
Live Tank circuit breaker	**Dead Tank circuit breaker**

With the CAT turned off, connect it to the circuit breaker with its appropriate cables.

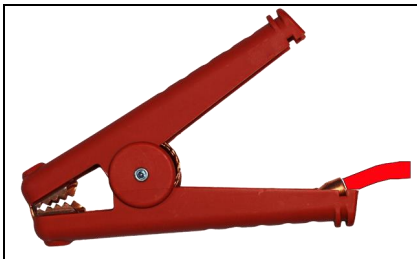
CAUTION: ***Cables between the CAT and other equipment should be connected and removed ONLY when the CAT is switched off.***

WARNING: ***Always connect the measuring cables to the CAT first and then to the test object; and when disconnecting always disconnect the cables from the test object first and after that from the CAT. The grounding wire PE should be disconnected last. Failure to do this may result in serious injury or even loss of life.***

3.1.1 Main Contacts Cable Connections

To simplify on-site hookup of the main contact timing cables, the CAT series instrument comes with a convenient cable set. Cable set for two breaks per phase is described first. This cable set comes with **CAT64A**, **CAT65** and **CAT66** devices.

	Cable set for the Phase A is labeled with a red colored connector mark (red ring over the connector). Cables are equipped with specially designed SCT clamps. Cable set is intended for timing measurement of two breaks per phase. Phase connecting cables of the cable set ends with clamps having red (**A1**), blue (**A2**) and black (**N**) mark over the cable.
	Cable set for the Phase B is labeled with a yellow colored connector mark (yellow ring over the connector). Cables are equipped with specially designed SCT clamps. Cable set is intended for timing measurement of two breaks per phase. Phase connecting cables of the cable set ends with clamps having red (**B1**), blue (**B2**) and black (**N**) mark over the cable.
	Cable set for the Phase C is labeled with a blue colored mark (blue ring over the connector). Cables are equipped with specially designed SCT clamps. Cable set is intended for timing measurement of two breaks per phase. Phase connecting cables of the cable set ends with clamps having red (**C1**), blue (**C2**) and black (**N**) mark over the cable.

		
Red clamp	**Blue clamp**	**Black clamp**

Same color code for phases A, B and C is used for the extension cables:

		
Phase A	**Phase B**	**Phase C**

The typical cable connection to a circuit breaker with two breaking elements per phase is shown in the Figure 3-1a.

The main contact cable's red (A1, B1 & C1) and blue (A2, B2, & C2) clamps are connected to the circuit breaker end terminals of the A, B and C phase, respectively. The black clamps are connected to the middle terminal.

The CAT measures timing for both, the main arcing contacts and pre-insertion resistor arcing contacts using the same channel.

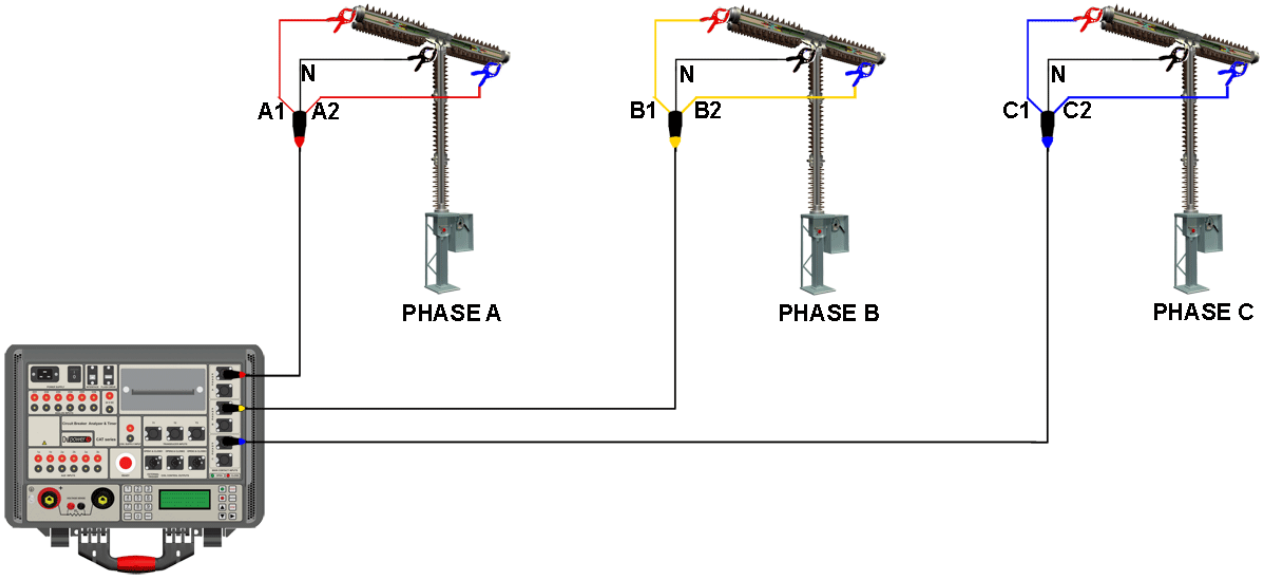
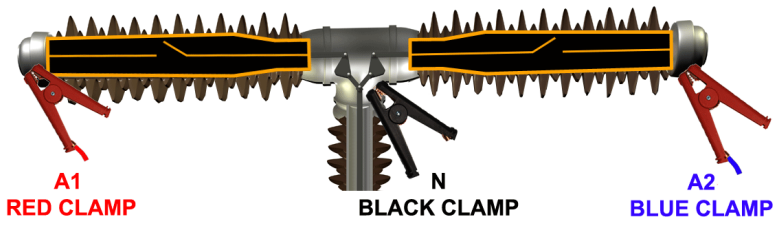
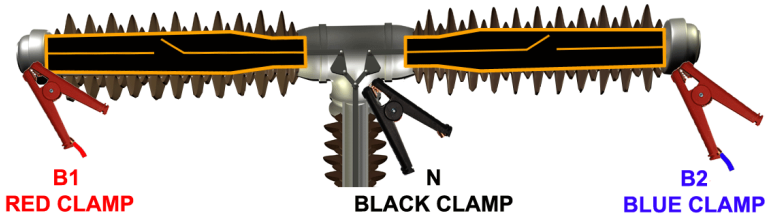


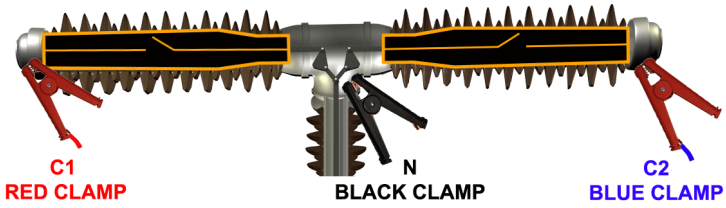
Figure 3-1a: Connecting main contact timing cables to live tank circuit breaker with two breaking elements per phase (CAT64A, CAT65 and CAT66)



PHASE A



PHASE B



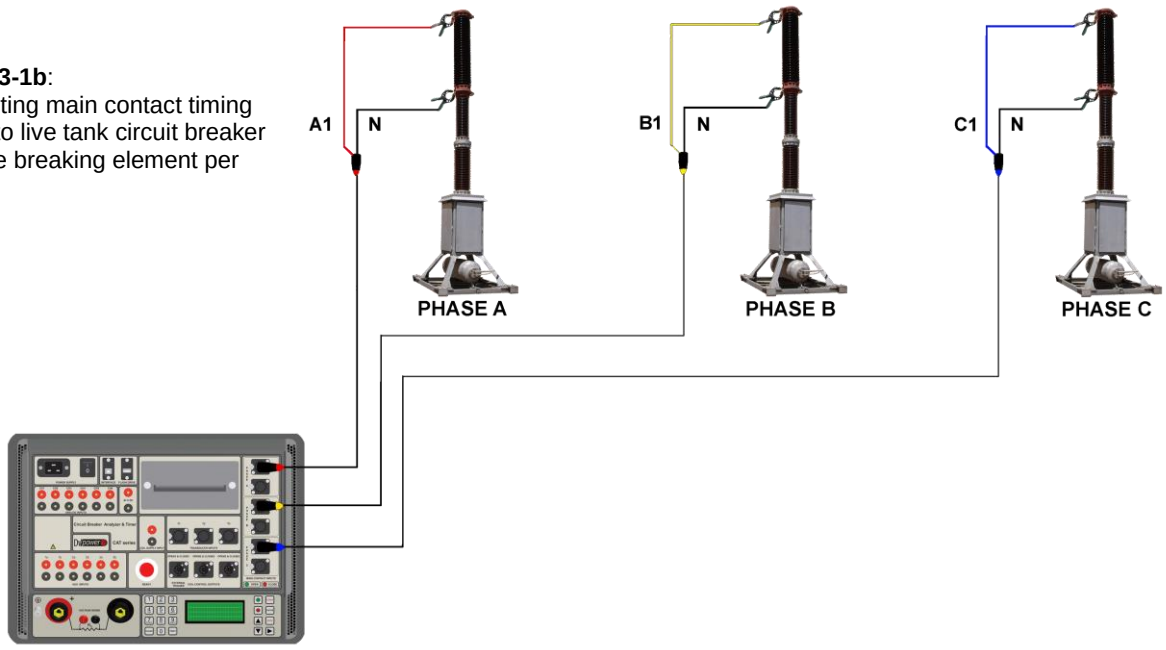
PHASE C

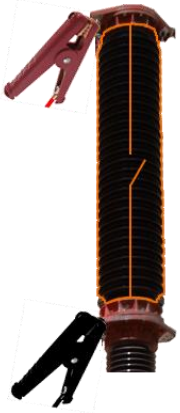
The typical cable connection to a live tank circuit breaker with one breaking element per phase is shown in the **Figure 3-1b**.

The main contact cable's red (A1, B1 & C1) clamps are connected to the circuit breaker terminals of the A, B and C phase, respectively. The black clamps are connected to the ground or to the common side of the terminal. The CAT measures timing for both, the main arcing contacts and pre-insertion resistor arcing contacts using the same channel.

Note: While performing measurements on a circuit breaker with one breaking element per phase, only the main contact timing channels A1, B1 and C1 are active.

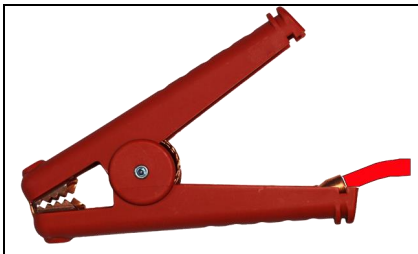
Figure 3-1b:
Connecting main contact timing cables to live tank circuit breaker with one breaking element per phase



A1 RED CLAMP  N BLACK CLAMP	B1 RED CLAMP  N BLACK CLAMP	C1 RED CLAMP  N BLACK CLAMP
PHASE A	PHASE B	PHASE C

Cable set for one break per phase is described below. This cable set comes with **CAT35** and **CAT36** device. Color code for the extension cables is same like for cable set for two breaks per phase.

	Cable set for the Phase A is labeled with a red colored connector mark (red ring over the connector). Cables are equipped with specially designed SCT clamps. Cable set is intended for timing measurement of one break per phase. Phase connecting cables of the cable set ends with clamps having red (**A)** and black (**N**) marks over the cable.
	Cable set for the Phase B is labeled with a yellow colored connector mark (yellow ring over the connector). Cables are equipped with specially designed SCT clamps. Cable set is intended for timing measurement of one break per phase. Phase connecting cables of the cable set ends with clamps having red (**B)** and black (**N**) marks over the cable.
	Cable set for the Phase C is labeled with a blue colored mark (blue ring over the connector). Cables are equipped with specially designed SCT clamps. Cable set is intended for timing measurement of one break per phase. Phase connecting cables of the cable set ends with clamps having red (**C)** and black (**N**) marks over the cable.

	
Red clamp	**Black clamp**

The typical cable connection of the cable set for CAT35 to a circuit breaker with one breaking element per phase is shown in the Figure 3-2.

The main contact cable's red (A, B & C) clamps are connected to the ungrounded circuit breaker terminals of the A, B and C phase, respectively. The black clamps are connected to the ground (if second side terminals are grounded) or to the common side of the terminal.

The CAT measures timing for both, the main arcing contacts and pre-insertion resistor arcing contacts using the same channel.

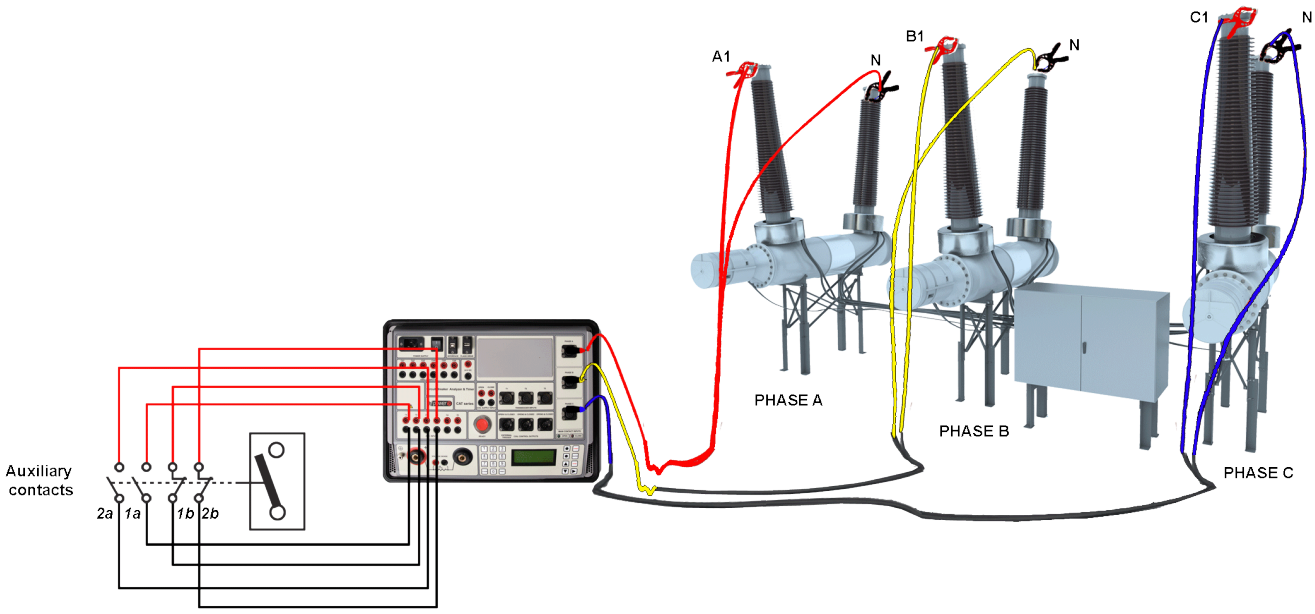
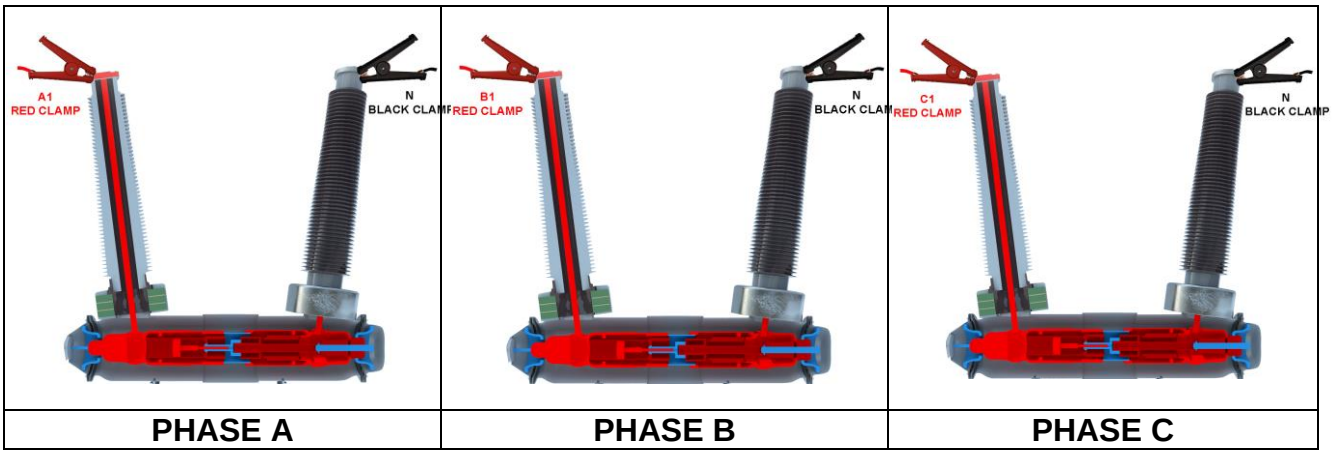


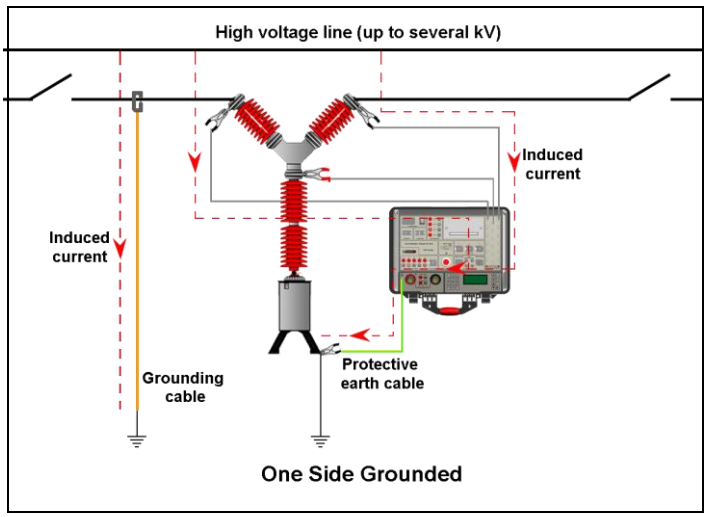
Figure 3-2: Connecting main contact timing cables to dead tank circuit breaker (CAT35 or CAT36)

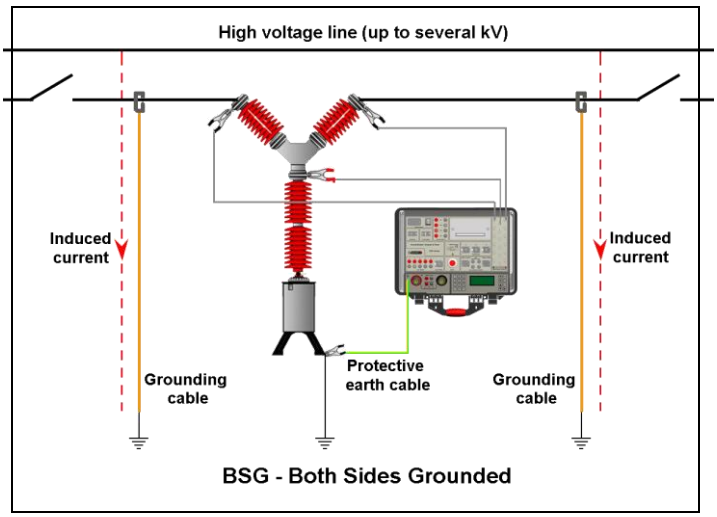


PHASE A	PHASE B	PHASE C

BSG (Both sides grounded) feature for **Live Tank Air Insulated Switchgear** enables safe and fast testing in high voltage substations, without removing the safety ground connections on both sides of the circuit breaker. Each main contacts timing channel is able to detect change of the main contact state in a case when both terminals are grounded (figure below), under conditions that resistance of the grounding loop is not less than 10 mΩ.

For more details about BSG feature for Live Tank Air Insulated Switchgear test setup can be found in Chapter 3.3.5 (page 63)





Both Sides Grounded (BSG) of **GIS (Gas Insulated Substation)** and feature enables timing measurement of GIS contact time without having to remove detachable shunts for grounding of GIS circuit breaker terminals (**Figure 3-2a**). The same method is used for timing measurement of **Dead Tank AIS (Air Insulated Switchgear)** contact time with any type of grounding system being applied to both sides of the bushings (**Figure 3-2b**).

Method is based on the DC current generation through the main circuit and measurement voltage or current response on the CT secondary during CB operation.
Built-in micro ohmmeter (up to 500 A) is used as a DC current source. A connection from a current source to circuit breaker terminals is performed with current cables which further branch each in three cables, providing in that way the equal current distribution through all three main contacts.

The AC transformer based current probes are connected to accessible CT secondary terminals. The current AC probes, which outputs are connected to analog channels inputs, will detect a changes in the response signals when the circuit breaker contact is opened or closed.

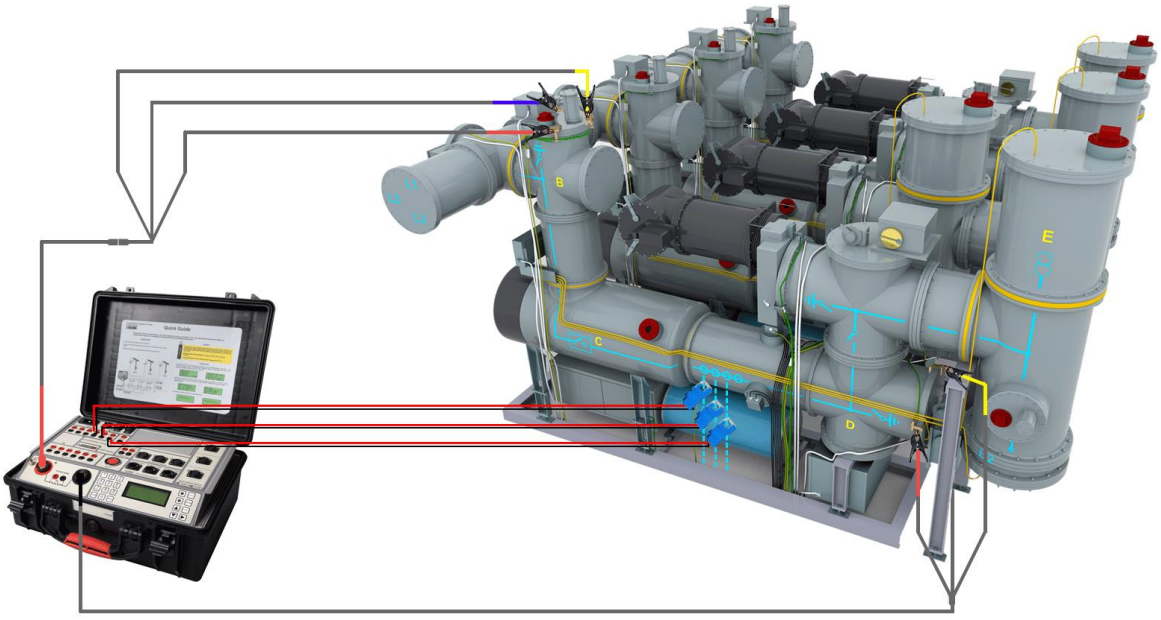


Figure 3-2a: Timing measurements on Gas Insulated Switchgear (GIS) with grounding on both sides

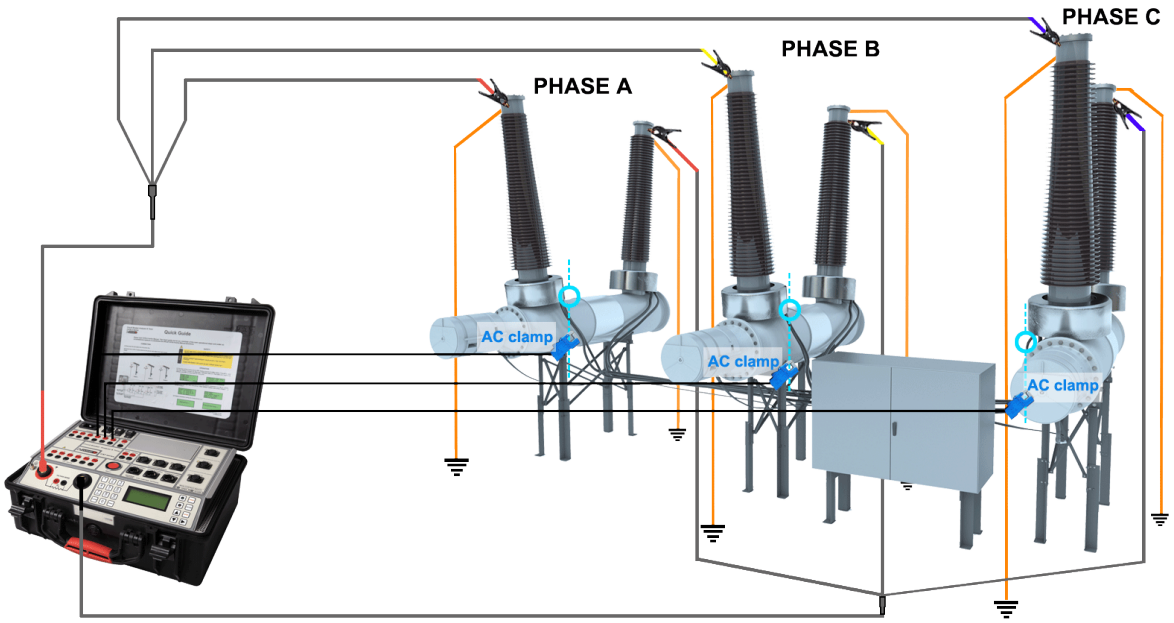


Figure 3-2b: Timing measurements on Dead Tank circuit breaker with grounding on both sides

3.1.2 Coil Control Cable Connections

The CAT coil control circuit can actuate any AC or DC open or close coil. The internal electronic driver can control any voltage ranging from 10 V to 300 V DC (250 V AC).

Depending on circuit breaker design (three pole operated circuit breakers or single pole (independent) operated circuit breakers), coil control cable connection can be:

- **three-pole control**
- **single pole control**.

Coil control cable set for **three-pole control** consists of one cable (see figure below)

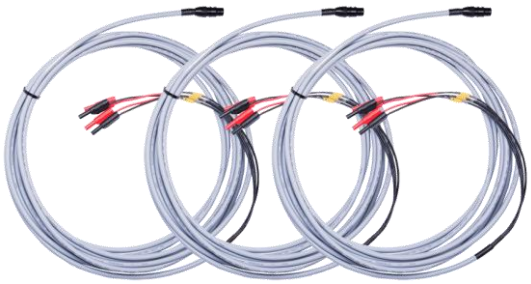
(*for more information about available length and options, please contact DV Power or visit our official website www.dv-power.com*).
Two pairs of wires (each pair has one red and one black wire) are used for closing and opening coil and are labeled as CLOSE and OPEN, respectively. Coil control cable set for **three-pole control** can be connected to any of front panel coil control connectors (Open 1 & Close 1, Open 2 & Close 2, Open 3 & Close 3).

Coil control cable set for **single-pole control** consists of three cables:

- The first cable is used for the first closing and first opening coil with two pairs of wires (each pair has one red and one black wire) labeled as CLOSE1 and OPEN1, respectively. Labels correspond to front panel coil control connectors.
- The second cable is used for the second closing and second opening coil on the single-pole operated circuit breakers. Red and black wires are labeled as CLOSE2 and OPEN2 corresponding to front panel coil control connectors.
- The third cable is used for the third closing and third opening coil on the single-pole operated circuit breakers. Red and black wires are labeled as CLOSE3 and OPEN3 corresponding to front panel coil control connectors.

Coil supply input cables is consisted of two pairs of red and black cables used for separated voltage supply inputs for open and close coil control

(*for more information about available length and options, please contact DV Power or visit our official website www.dv-power.com*).

		
Coil control cable with banana plugs (Three-pole control - 2 coil channels)	**Coil control cable set with banana plugs (Single-pole control - 6 coil channels)**	**Coil supply input cables**

Two pairs of wires (each pair has one red and one black wire) labeled as CLOSE and OPEN

Three-pole operated circuit breaker

For a three-pole operated circuit breaker Coil control cable with 2 coil channels (open and close) is used. One pair of wires (red and black), labeled with OPEN, is used for open coil. Second pair of wires (red and black), labeled with CLOSE, is used for close coil (**Figure 3-3**).

CAT has separated voltage supply inputs for open and close coil control. In case when both coils (open and close) use equal voltage value, coil supply inputs should be shorted (**Figure 3-3**).

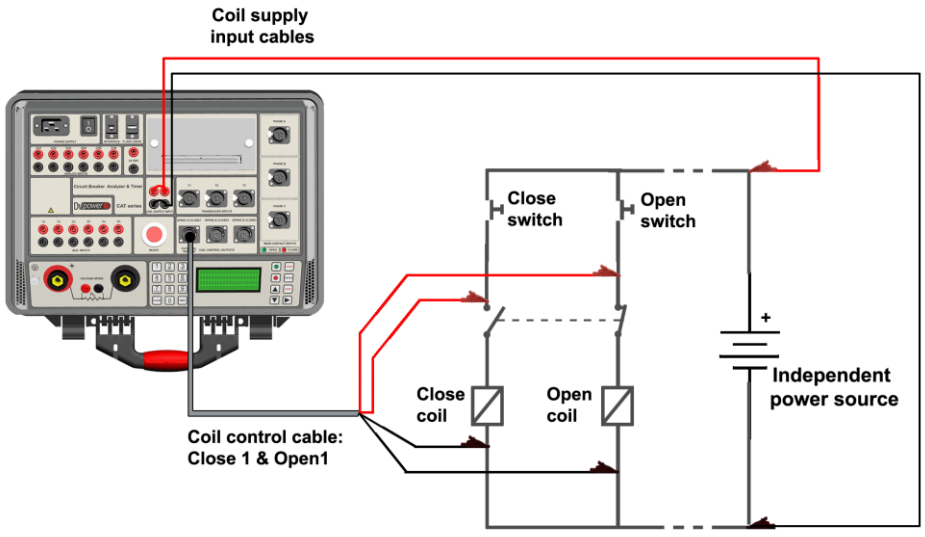


Figure 3-3: Connection diagram of the coil control cables for three-pole operated circuit breakers with independent power voltage supply used as a power source

In case when open and close are supplied from voltage sources with different voltage value, **coil supply inputs** should be connected to separate power voltage sources (**Figure 3-4**).

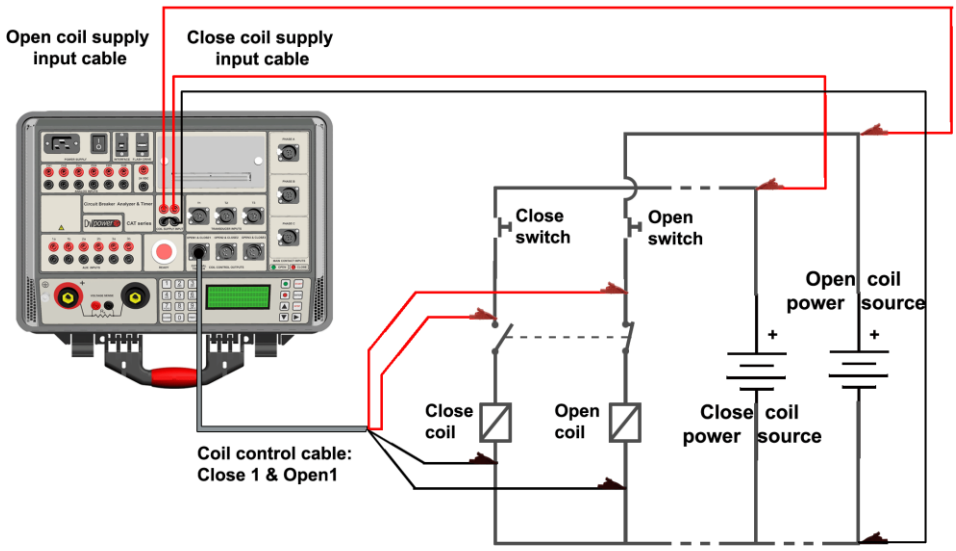


Figure 3-4: Connection diagram of the coil control cables for three-pole operated circuit breakers with separated independent power voltage supply for close and open coil

When connecting to three-pole operated circuit breaker, where a substation power voltage supply is used as a power source, minus line is in the most cases common for both coils as well as for substation battery. In this case, there is no need to connect black wire of Coil control cable to corresponding open and close coils. Also, it is not necessary to connect black (minus) coil supply input from substation voltage supply source (**Figure 3-5**)

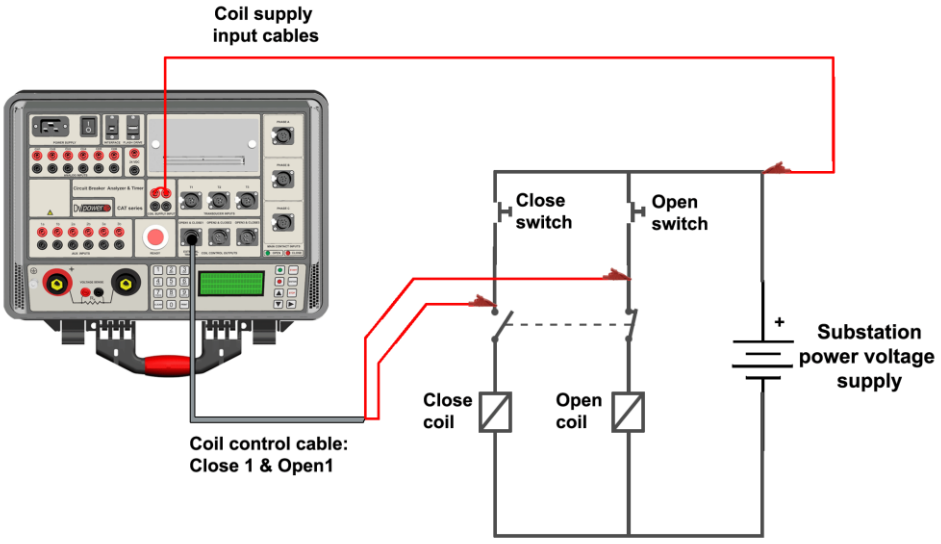


Figure 3-5: Connection diagram of the coil control cables for three-pole operated circuit breakers with substation power voltage supply used as a power source

For some substations, the plus of the power supply is common for both coils as well as for substation battery. In that case, it is necessary to connect the minus of the substation power supply to red connectors of the Coil supply input and red wires of the Coil control cable to minuses of coils (**Figure 3-6**). As in the previous case, it is no need to connect black wires of the Coil control and Coil supply input cables.

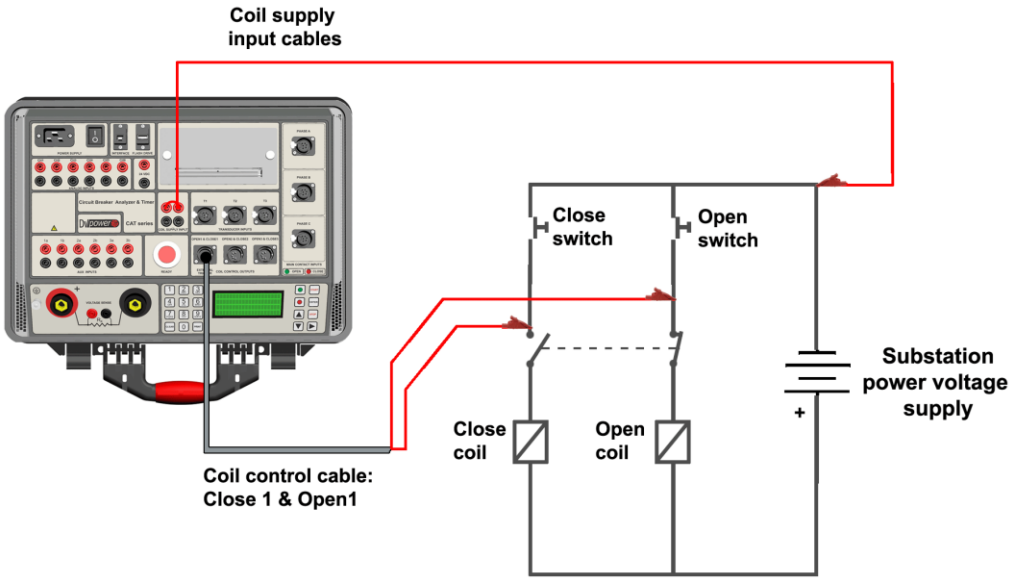


Figure 3-6: Connection diagram of the coil control cables for three-pole operated circuit breakers with substation power voltage supply used as a power source and common plus line

Single-pole operated circuit breaker

For a single-pole operated circuit breaker coil control cable set of three cables with 6 coil channels is used (**Figure 3-7**).

Cable with pair of wires labeled as CLOSE1 and OPEN1, is used for the first closing and first opening coil.

Cable with pair of wires labeled as CLOSE2 and OPEN2, is used for the second closing and second opening coil.

Cable with pair of wires labeled as CLOSE3 and OPEN3, is used for the third closing and third opening coil.

CAT has separated voltage supply inputs for open and close coil control.

In case when open and close are supplied from voltage sources with different voltage value, **coil supply inputs** should be connected to separate power voltage sources (as described in **Figures 3-7** and **3-8**).

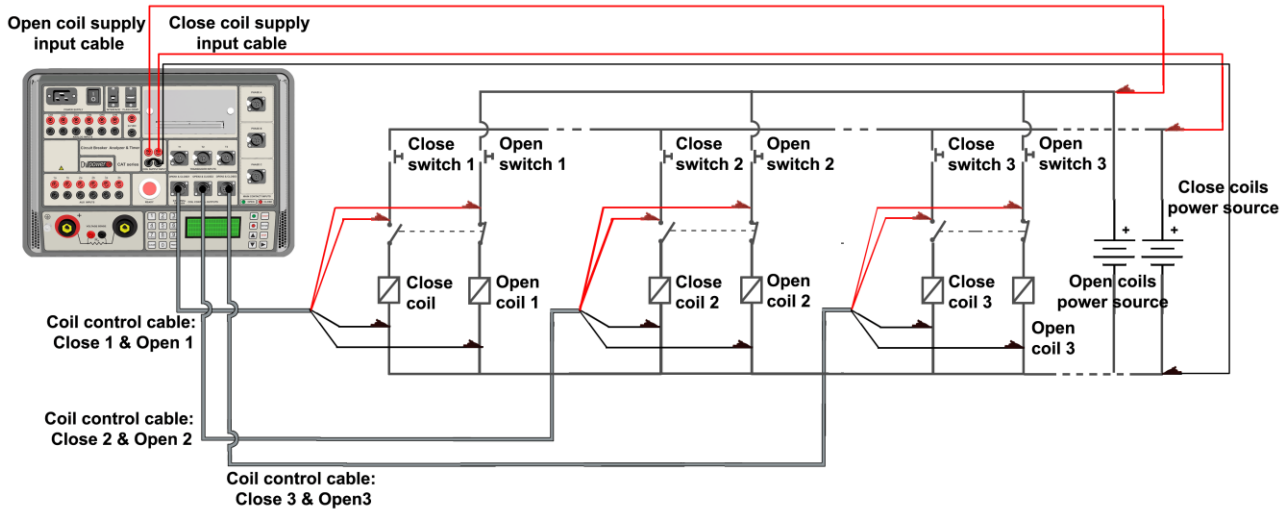


Figure 3-7: Connection diagram of the coil control cables for single-pole operated circuit breakers with separated independent power voltage supply for close and open coil

When connecting to single-pole operated circuit breaker, where a substation power voltage supply is used as a power source, minus line is common for all coils as well as for substation voltage supply. In this case, there is no need to connect black wire of Coil control cable to corresponding open and close coils. Also, it is not necessary to connect black (minus) coil supply input from substation voltage supply source (**Figure 3-8**)

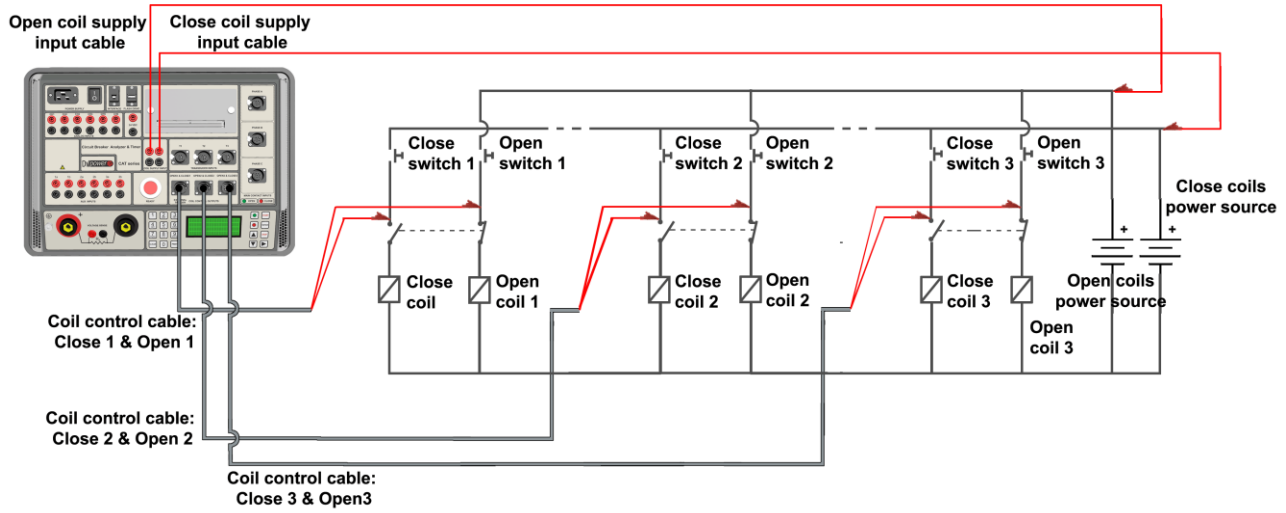


Figure 3-8: Connection diagram of the coil control cables for single-pole operated circuit breakers with substation power voltage supply used as a power source

3.1.1 Cables Connection for External Trigger

The External trigger feature enables a start of data recording as soon as the CAT series instrument senses a voltage in the range between 10 V and 300 V AC/DC on the Coil control Open1 & Close1 input. The Coil control cable is connected to the breaker coils using the voltage drop across the circuit breaker coils as a trigger signal.

External trigger mode can be used to start timing of the breaker operation when the user opens or closes the circuit breaker by the local switch or remotely from a control room. External trigger feature also provides some online measurements, like the “First trip” test. To start the test in the External trigger mode the Coil control cable with labels OPEN1 and CLOSE1 should be connected as shown in the Figure 3-9.

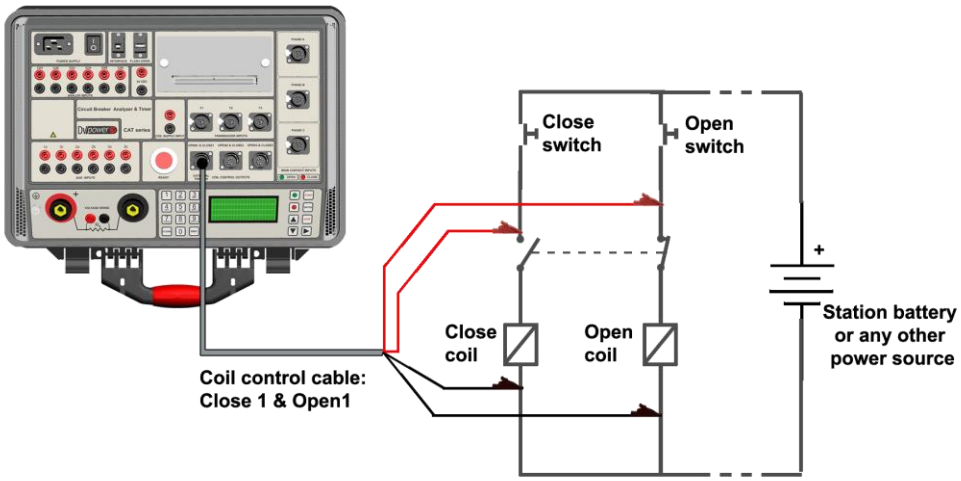
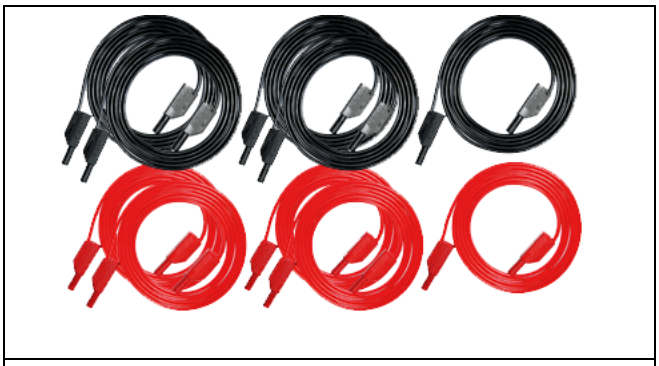


Figure 3-9: Connecting the Coil control cable to circuit breaker coils during external trigger mode of testing

3.1.2 Auxiliary Contacts Cable Connection

There are six separate timing channels for the auxiliary contacts measurement (Figure 3-10). Six auxiliary timing inputs are designated with 1a, 1b, 2a, 2b, 3a and 3b. Auxiliary inputs are used to monitor auxiliary (52a and 52b) contacts.



Auxiliary contacts cable set

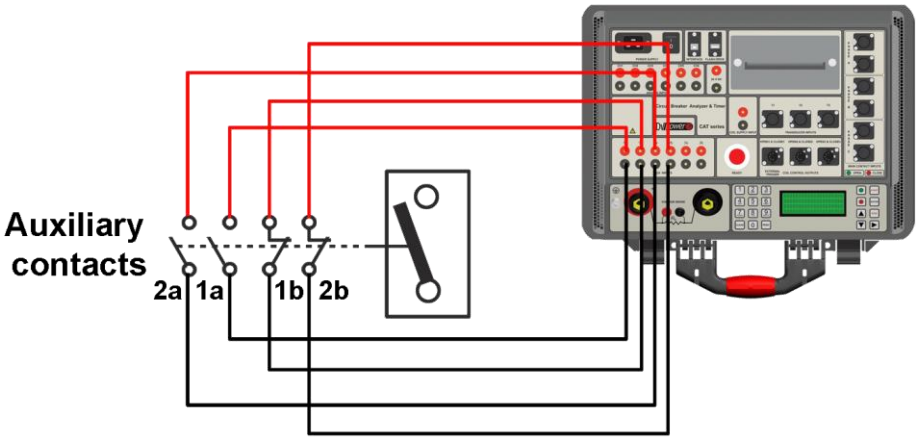


Figure 3-10: Connecting auxiliary cable to circuit breaker AUX contacts

3.1.3 Analog Channels Cable Connection

The six analog channels have four selectable voltage ranges available (±1 V, ±5 V, ±60 V and ±300 V AC/DC). They are used for monitoring of:

- circuit-breaker substation battery voltage,
- trip coil current during the “First trip” test, using the current clamps,
- current flowing through the secondary side of the current transformer for each phase during the “first trip” test, using the current clamps,
- other types of analog signals that may be relevant.

The analog inputs are isolated with respect to all other circuits.

Analog channels cable set

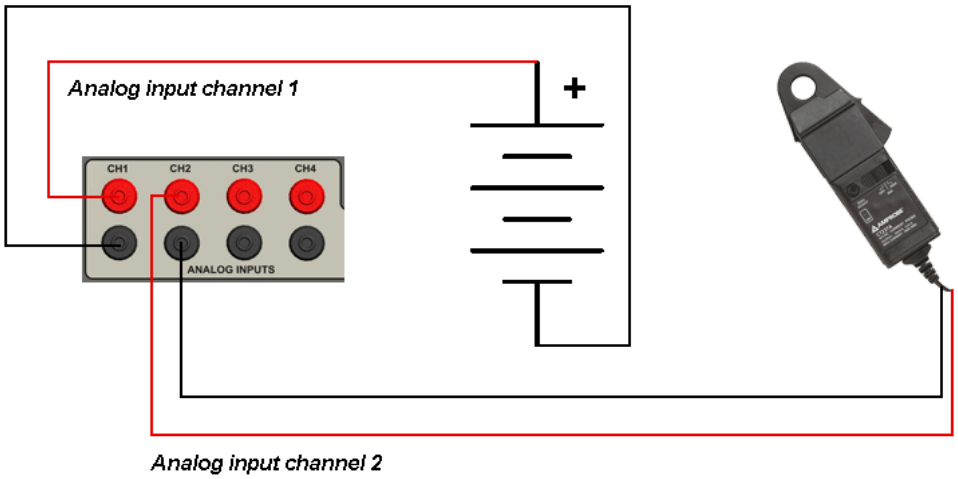


Figure 3-11: Connecting the analog input channel cables to a battery and a current probe

3.1.6. Transducer Connection

The three transducer channels are 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 these universal transducer channels.

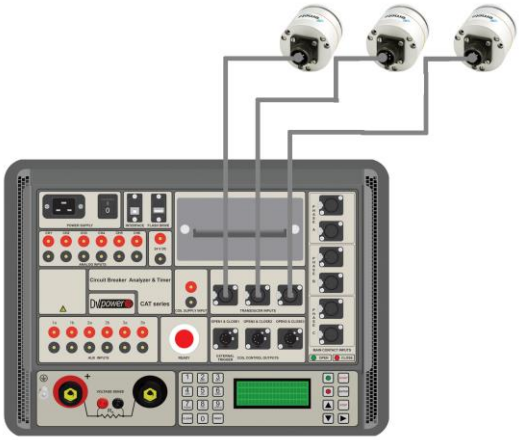


Figure 3-12:
Connecting rotary digital transducers to CAT

Figure 3-13:
Digital rotary transducer mounted on ABB LTB 245 kV SF6 circuit breaker

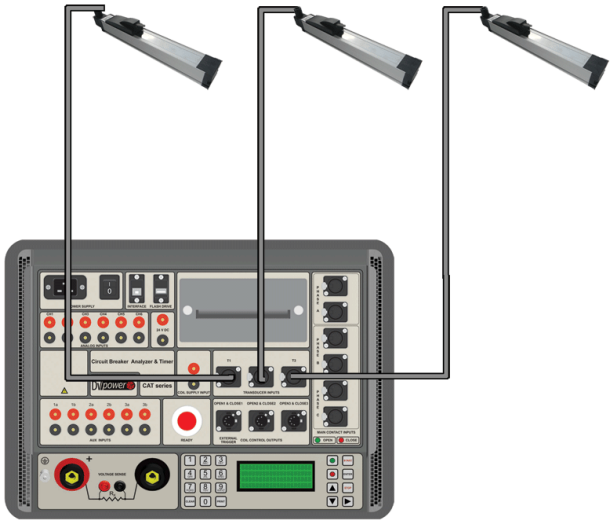


Figure 3-14:
Connecting linear analog transducers to CAT

Figure 3-15:
Analog linear transducer mounted on Mitsubishi SF6 138 kV 120-SFMP-40HE

3.1.7. Micro Ohmmeter Cables Connection

The built-in micro ohmmeter generates a true DC ripple free current with an automatically regulated test ramps. For a resistance measurement the well-known Kelvin's four point's method is being used. The DC current is generated through the closed circuit breaker contacts. The voltage drop is measured between the terminals of the circuit breakers (Figures 3-16 and 3-17). The resistance is calculated using the Ohm's law R=U/I.

Micro ohmmeter is available on the CAT35, CAT36, CAT65 and CAT66 instruments.

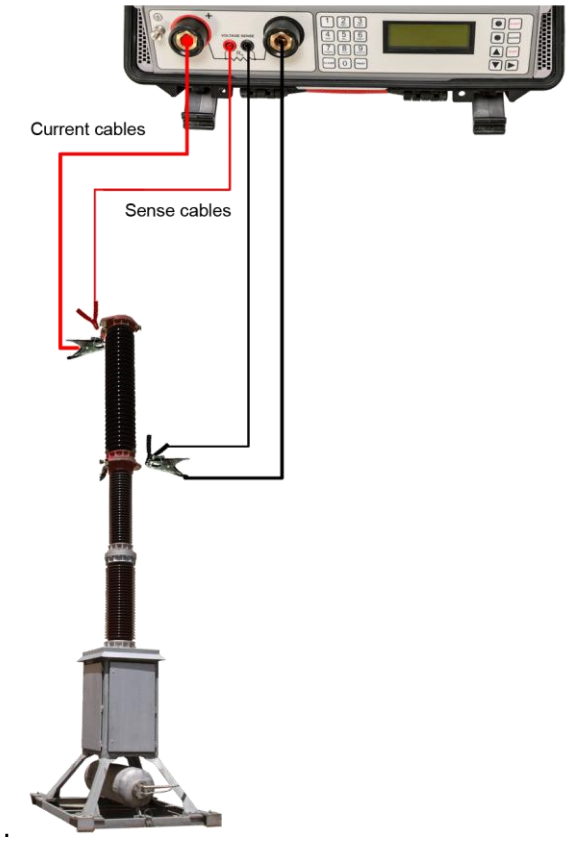


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Figure 3-16: Micro Ohmmeter cable connection on live tank circuit breaker

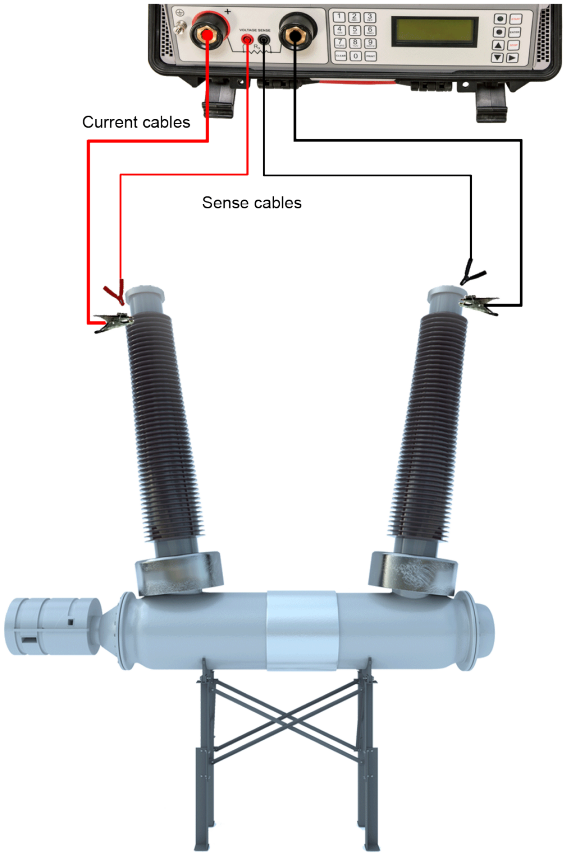


Figure 3-17: Micro Ohmmeter cable connection on dead tank circuit breaker

Current and sense cables are also available in several lengths and terminations.

(*for more information about available length and options, please contact DV Power or visit our official website www.dv-power.com*.)

3.1.8 Cables connection for Dynamic Resistance Measurement (DRM) test

For performing the basic DRM test it is necessary to connect the coil control cable and Micro Ohmmeter cables (current and voltage sense cables) simultaneously, as shown in the **Figure 3-18**. Since DRM is single phase test, for the independent pole operated circuit breakers it should be taken into account that coil control cable is connected to the auxiliary circuit of the pole on which DRM test is performed.

For extended DRM test, beside above stated connections, it is also necessary to perform the motion measurement which requires motion transducer mounting to the appropriate place in the circuit breaker mechanism. Cables connection for extended DRM test is shown in the Figure 3-18 (for the live tank type of circuit breaker) and the **Figure 3-19** (for the dead tank type of circuit breaker).

Since DRM test is performed during opening operation it is only obligatory to connect coil control cable to opening coil, but it is also recommended to connect coil control cable to the closing coil which will provide the closing operation initiation from CAT device.

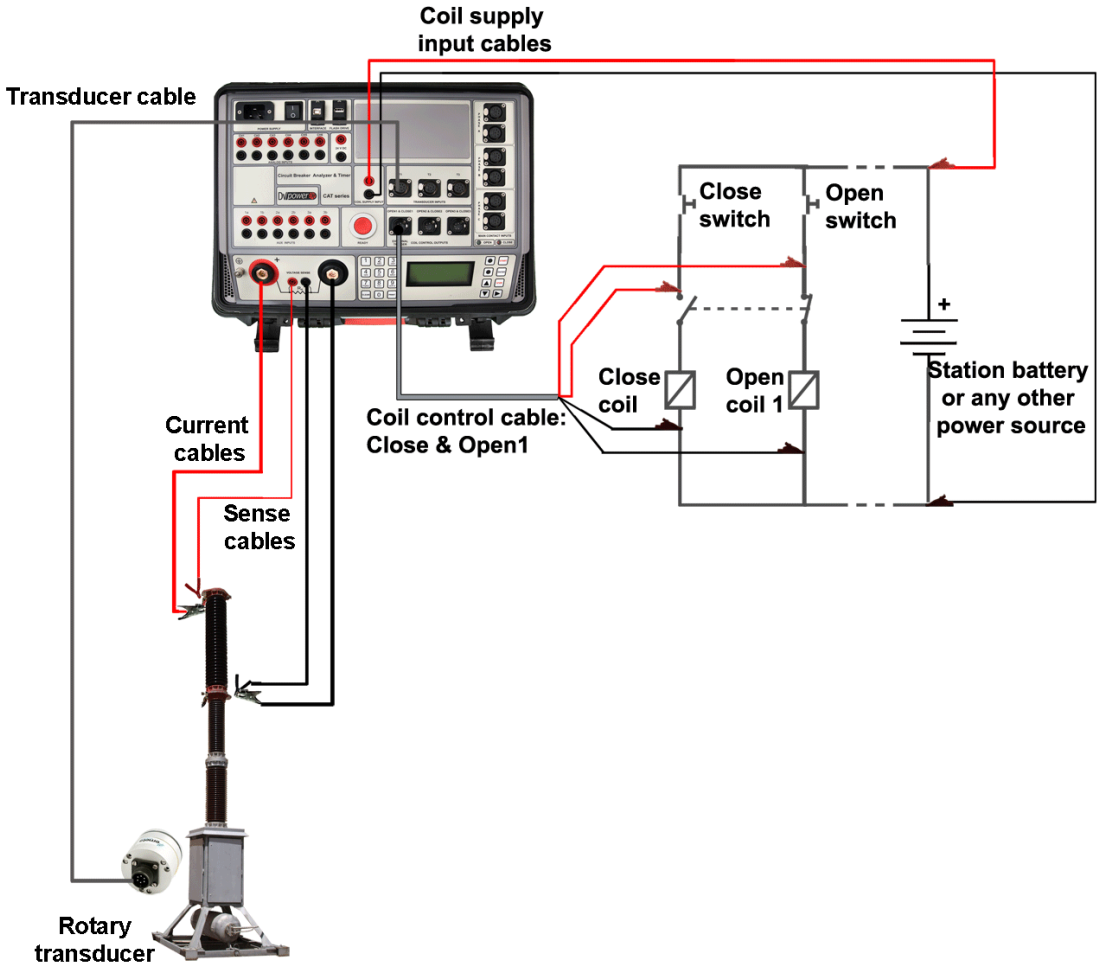


Figure 3-18: DRM cables connection for live tank type of circuit breaker

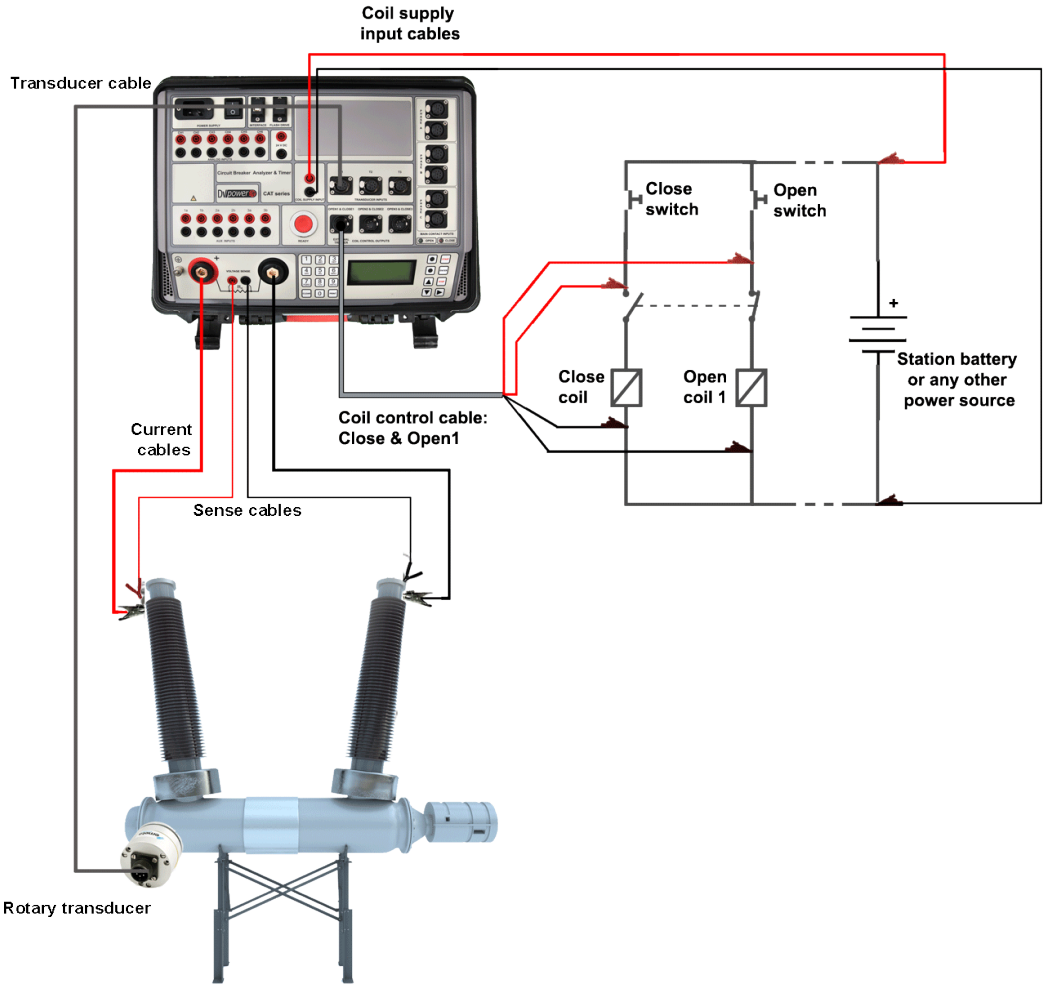


Figure 3-19: DRM cables connection for dead tank type of circuit breaker

Note: During the DRM test, the Main contact cables for timing measurements should be disconnected from the circuit breaker pole under DRM test.

3.2 Settings menu

To define initial settings, timing test parameters, transducer settings, analog channels and auxiliary timing channels parameters use the **Settings** menu. Turn the CAT power switch on. The display shows the **Main** menu (Figure 3-20). Press ***#2*** and CAT will enter in the **Settings** menu (Figure 3-21).

Figure 3-20: The **Main** menu

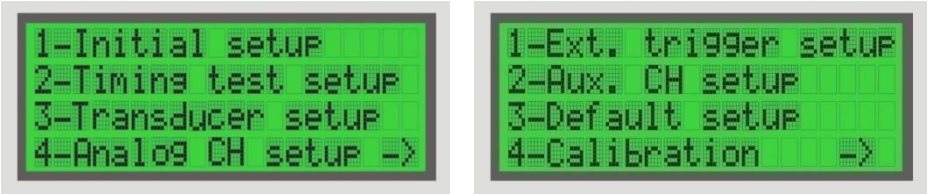


Figure 3-21: The Settings menu (page 1 and page 2)

Press ***1, 2, 3*** or ***4*** to enter desired setup menu or press ► to go to a next page of the **Settings** menu.

3.2.1. Initial Setup

Initial setup menu enables to define a language, internal time and date, time base, operating frequency, activation open coil, number of timing channels (depending on a breaker design) and location for the test results storage. Initial setup menu is also used to activate Auto sequence.

Select **#1** in the Settings menu to enter **Initial setup** menu. It brings the language selection display (see the figure below).

Selecting **#1** defines English language to be used. Pressing ***STOP*** always cancels a selection and returns operation to the previous screen at any test stage. After choosing the language, in the following screen internal time and date can be defined (see the figure below).

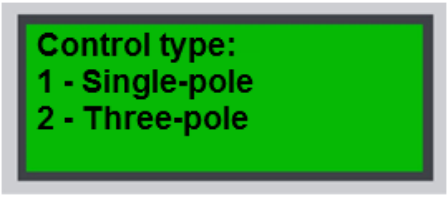
Pressing ***ENTER*** the CAT goes to the next page of the **Initial setup** menu.

In the following screen the measurement time base unit is defined. User is allowed to select among milliseconds, seconds or cycles (1 cy = 20 ms at 50 Hz and 16,67 ms at 60 Hz) (see the picture below).

Press ***#1***, ***#2*** or ***#3*** to select the time unit (milliseconds, seconds of cycles) for the measurement. After this selection the CAT offers the following **Initial setup** menu screen to select frequency (50 Hz or 60 Hz).

Press either ***#1*** (*50 Hz*) or ***#2*** (*60 Hz*) to set the frequency to the corresponding value.

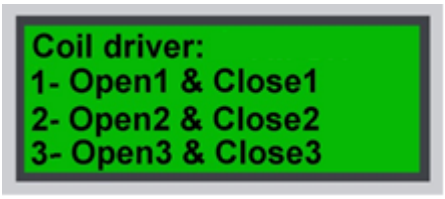
In the following screen of the **Initial setup** menu, control type of coil drivers can be selected.



If single-pole operation is selected, each individual pole of the circuit breaker is operated by its own operating mechanism. Press #**1** to activate all six coil drivers for independent (single) pole operation. This makes single-phase as well as three-phase auto-reclosing possible.

For a three-pole operation, (ganged operation) all three poles are operated by a common operating mechanism. The three poles are mechanically linked together for three-phase auto-reclosing.

Press ***#2***, to select Three-pole control type. If three-pole control type is selected, the following screen will appear:



Press ***#1***, ***#2*** or ***#3*** to select the corresponding pair of coil drivers (Open 1 & Close 1; Open 2 & Close 2 or Open 3 & Close 3) for the three-pole (ganged) operation.

Auto Sequence feature can be activated in the following screen of the **Initial setup** menu.

Press ***#1*** or ***#2*** to activate or deactivate Auto Sequence function. When activated, the Auto sequence function will attempt to detect the state of the breaker and indicate it by the main contacts LEDs - the appropriate red (CLOSE) or green (OPEN) LED will be lit on. If the state is detected, user is allowed to select a possible breaker operation in the **Sequence** menu (e.g. if the breaker is in OPEN state, available operations are C, CO (trip free) and C-O).

In the following screen of the **Initial setup** menu a **number of breaking elements per phase** of the test object can be defined (for CAT64A, CAT65 and CAT66). The number of the breaking elements per phase depends on the breaker design (Figures 3-1a, 3-1b).

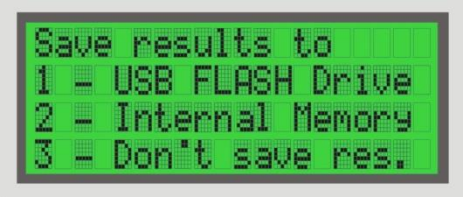
Press **#1** or **#2** to define the number of breaking elements per phase depending on a design of the circuit breaker to be tested.

Note: The format of the test results will automatically be adjusted change depending on the number of existing breaking elements per phase.

If #1 is selected (one break per phase), only A1, B1 and C1 timing channels will be activated.

If #2 is selected (two breaks per phase), all main contact timing channels will be activated (A1, A2, B1, B2, C1 and C2).

The following screen provides a selection of the test results storage location. User is allowed to select between USB Flash Drive and internal memory of the CAT instrument itself.



If one does not want to save test results, **#3** should be selected.

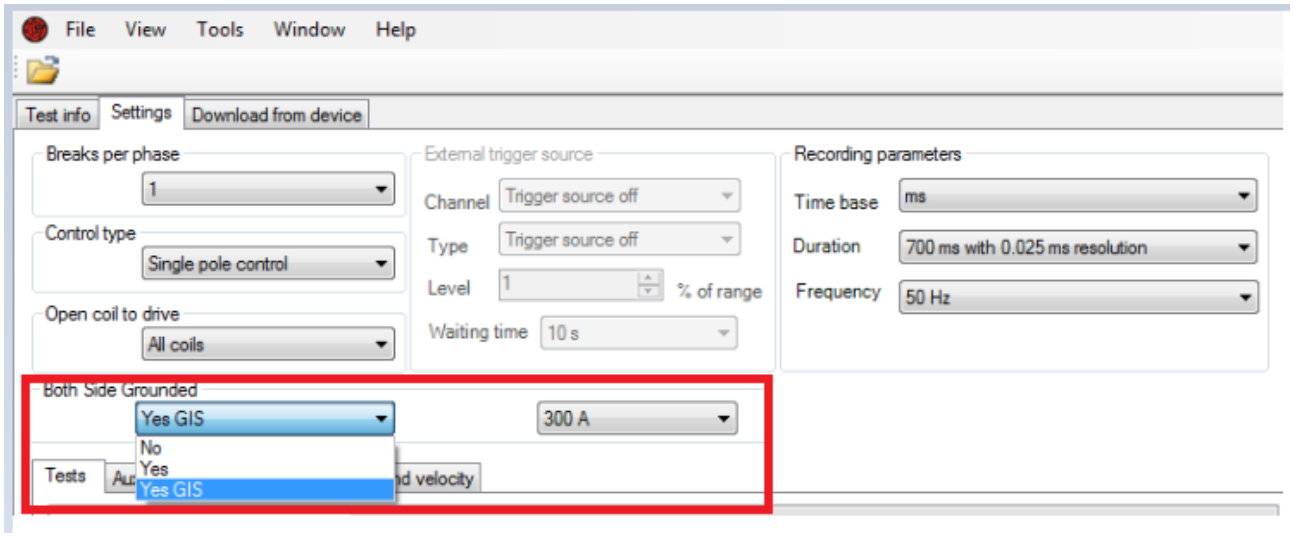
Once the Initial setup is completed, defined settings are stored in the CAT internal memory. The user will be returned to the **Settings** menu.

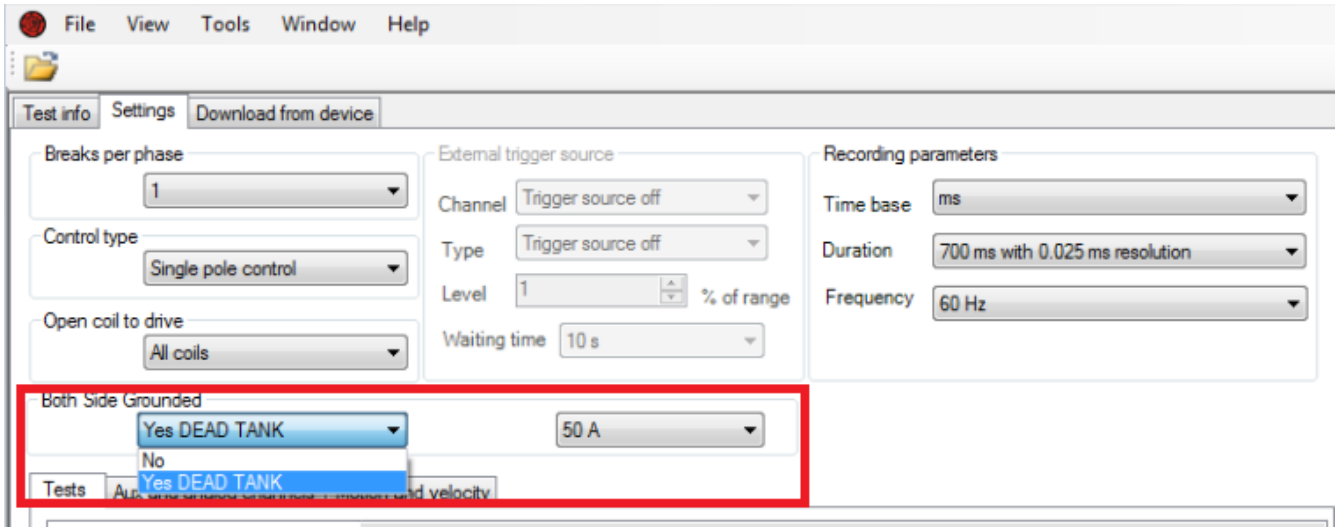
Note: If the timing test is performed on a circuit breaker with both terminals grounded, depending on your instrument configuration, Both Sides Grounded (BSG) feature should be activated.

BSG feature is available only within DV-Win software and therefore to activate this feature CAT device should be controlled via DV-Win software.

In the DV-Win software in **Settings** tab, depending on the type of circuit breaker to be tested, user should select one of the following options in **Both Sides Grounded** section (figure below):

- **Yes** for BSG on AIS (Air Insulated Switchgear – Live Tank)
- **Yes GIS** for BSG on GIS (Gas Insulated Switchgear), along with the test current which will be used for this test
- **Yes Dead Tank**, for BSG on Dead Tank circuit breaker, along with the test current which will be used for this test





3.2.2 Default setup

User is allowed to load Default values for Initial and Time test settings as shown below:

Press either ***#1****or* ***#2*** to select Default setup for 50 Hz or 60 Hz. Press **#3** to go back to **Settings** menu.

Default values for Initial and Timing Test settings are listed below:

Initial settings	
Language:	**English**
Time base:	**ms**
Frequency	**50 Hz**
Open coil to drive	**Single pole control**
Autosequence	**No**
Both sides grounded	**No**
Number of breaking units per phase	**2**
Save results to:	**Internal memory**

Timing test settings	
Measuring resolution	**0,1 ms**
Measuring time	**700 ms**
Close pulse length	**160 ms**
Open pulse length	**80 ms**
C-O delay	**10 ms**
O-C delay	**300 ms**
O-C-O: O-C delay: C-O delay	 **300 ms** **10 ms**

3.3. Running the Test

Turn the CAT power switch ON. The CAT displays a notification that memory card initialization has started.

After the memory card initialization is completed, the display will show the **Main** menu (**Figure 3-22**); The Green LED is ON.

Figure 3-22: **Main** menu

Select ***#1*** on the keypad to start a new test. The display shows the **New test** menu (**Figure 3-23**).

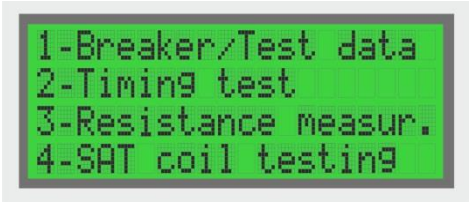


Figure 3-23: **New test** menu

Press #***1*** to edit "**Breaker** and **Test data**" details (*Breaker ID, Station name, Department, Manufacturer, Serial number, Breaker type, Type of a test, Company name, Operator*). Edit the required details using the alphanumeric keypad. Press ***ENTER*** to confirm.

Note: Typing is similar to that using a mobile phone keypad. Each number, beginning with 2, has a set of letters underneath. Hit the button with the letter you would like to type several times until the letter you want appears. For example, if you would like to type the letter "B" press the button "2" three times (2 – A – B; numbers appear before letters). Wait until the cursor moves to next position to type a new letter.

If *Breaker data* and *Test data* do not need to be defined, press ***#2*** to proceed with **"Timing test".**

Figures 3-24 and **3-25** illustrate a selection of the breaker operating sequence.

Figure 3-24: **Select sequence** menu - page 1

Press **#6** to go to the next page and select other operating sequences. Select **#5** to go back to the previous page.

Figure 3-25: **Select sequence** menu - page 2

The CAT can initiate any of the following breaker operating sequences:

C – Close

O – Open

CO - Trip free

O-0,3s-C – Reclose

O-0,3s-CO

C-O

O-C

O-C-O

Note: In case the Auto Sequence function has been activated, the CAT will automatically detect the state of the breaker (e.g. if the breaker is in OPEN state the green LED is ON) and offer the adequate operating sequences (e.g. if the breaker is in OPEN state, the available operations are C, CO (trip free) and C-O).

3.3.1. CLOSE test

Make sure the breaker is in an open position. Press **#1** on the keypad to select the "Close" operation. The following notification will appear:

Press and hold the ***READY*** button and then press ***START*** to start the test.

The CAT will initiate the Close pulse. The default value for the Close pulse length is **160 ms** (50 Hz). The Close pulse length can be changed to a desired value.

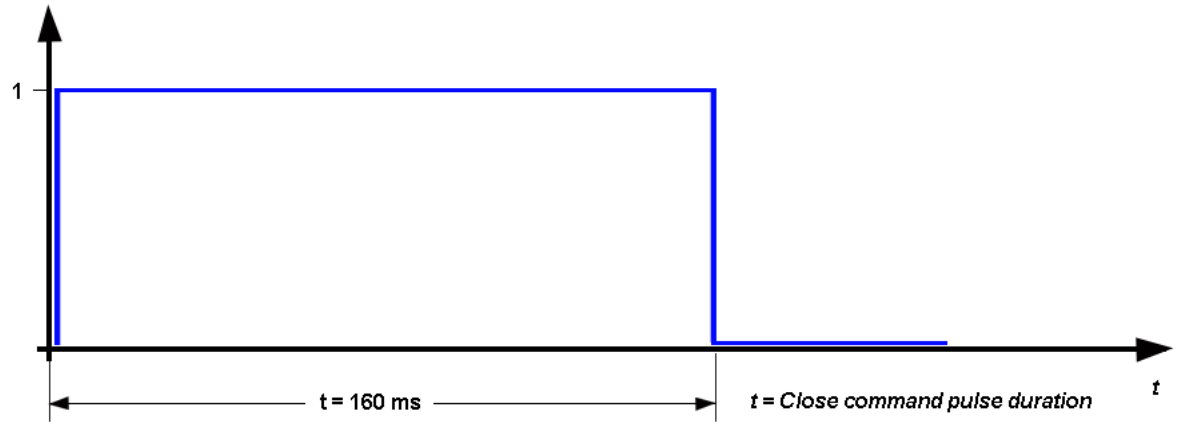
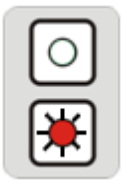


Figure 3-26: CLOSE command pulse

During the operating process, the following message appears on the display window and the Red LED blinks:



After the operating process is completed, the CAT starts processing data.

After data processing completion, the CAT will display ***Results*** menu for the CLOSE test. Results are classified in sub-menus, as illustrated below.

3.3.1.1 Timing Channels Results

Press **#1** in the ***Results*** menu to see Closing time results. CAT calculates the Closing time on up to 6 main contact timing channels (3x2) (see the figures on the left side of the table below and the Figure 3-27).

Use ▲▼buttons to navigate between the screens.

Phase A

A1 and **A2** are closing times of the main contacts in the phase A.

Phase A Closing time is the interval of time between the initiation of the closing operation and a moment when metallic continuity is established in the phase A.

Phase A Synchronization is the time difference between the first and the last main contacts to close in the phase A during a CLOSE operation.

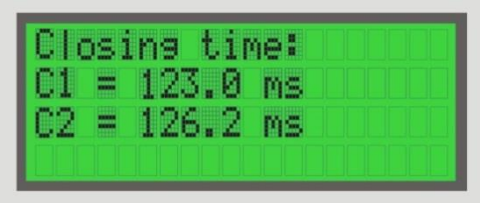
Phase B

B1 and **B2** are closing times of the main contacts in the phase B.

hase B Closing time is the interval of time between the initiation of closing operation and a moment when metallic continuity is established in the phase B.

Phase B Synchronization is the time difference between the first and the last main contacts to close in the phase B during a CLOSE operation.

Phase C

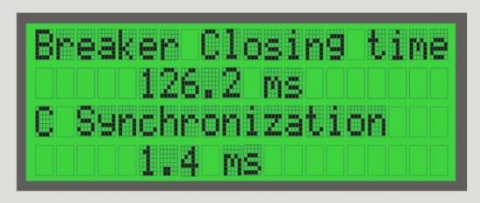


C1 and **C2** are closing times of the main contacts in the phase C.

Phase C Closing time is the interval of time between the initiation of the closing operation and a moment when metallic continuity is established in the phase C.

Phase C Synchronization is the time difference between the first and the last main contacts to close in the phase C during a CLOSE operation.

Breaker Closing Time & Close Synchronization:



Breaker Closing time is the interval of time between the initiation of the closing operation and a moment when metallic continuity is established in all poles.

Close synchronization is the time difference between the first and the last contacts touching during a CLOSE operation (see the figure on the left and Figure 3-27).

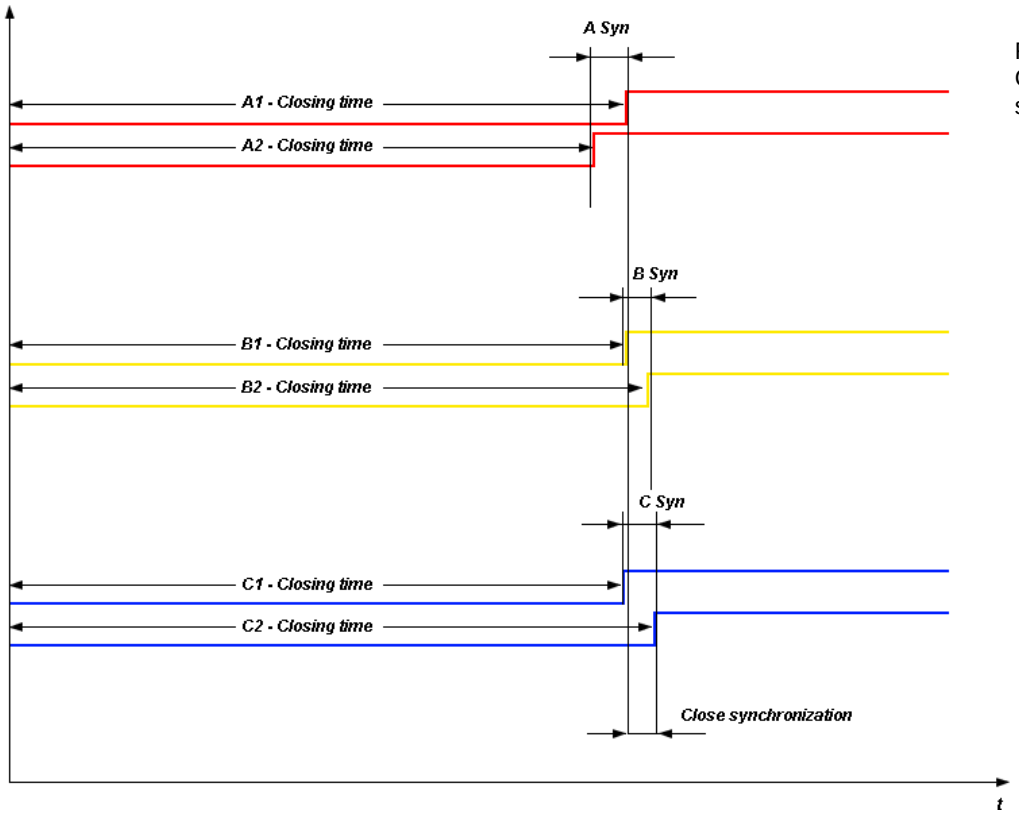


Figure 3-27:
Closing time & Close synchronization

AUX contacts closing time:

The time interval between a moment the actuating quantity of the release circuit reaches the operating value and a moment in time the state of the auxiliary contacts (52a and 52b) changes during a CLOSE operation.

Press the ***STOP*** to go back to the **Results** menu.

3.3.1.2 Closing Coil Current

Press #**2** in the ***Results*** menu to display closing coil current results. Depending on the control type selected, the device calculates and displays the peak value of the closing coil current for all three close coil channels or only one (in this case displayed results is for *Three pole control* type; measured value: 2,086 A) and the time interval when it was reached (15,9 ms) (see the figure below).

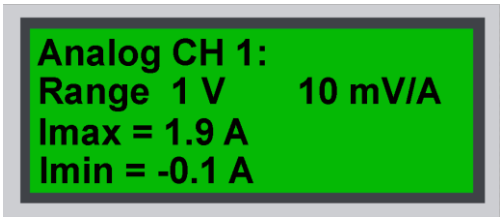
Press the ***STOP*** to go back to the **Results** menu.

3.3.1.3 Analog Channels Results

Press **#3** in the ***Results*** menu to see results obtained with analog channels. Use ▲▼buttons to navigate between the screens.

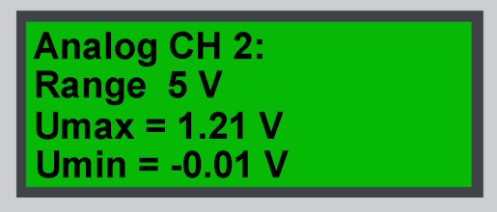
Note: ***Each analog channel has 4 selectable ranges ±1 V, ±5V, ±60V and ±300V AC/DC.***

Analog Channel 1:



Analog channel 1 (range selected 0.5 V; Current clamps output 10 mV/A) indicates the maximum and minimum current detected on the current clamps during a CLOSE operation.

Analog Channel 2:



Analog channel 2 (range selected 2.5 V) indicates the maximum and minimum voltage detected during a CLOSE operation.

Analog Channel 3:

Analog channel 3 (range selected 300 V) indicates the maximum and minimum voltage detected during a CLOSE operation.

Analog Channel 4:

Analog channel 4 (range selected 60 V) indicates the maximum and minimum voltage detected during a CLOSE operation.

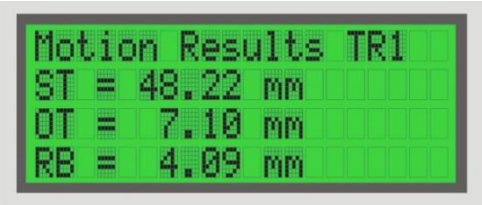
Similar information will be displayed for other analog channels (**Analog channels 5** and **6**), depending on the voltage level range selected.

Press the ***STOP*** to go back to the **Results** menu.

3.3.1.4 Motion results

Press **#4** in the ***Results*** menu to see measurement results obtained with transducer channels. Use ▲▼buttons to navigate between the screens.

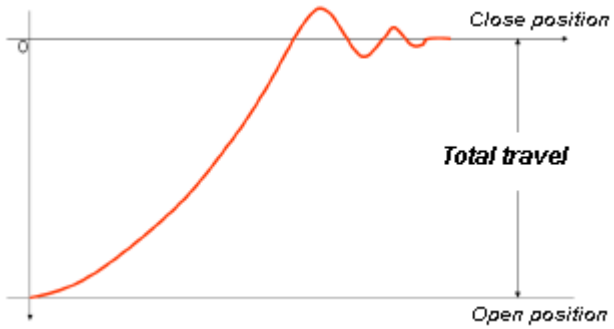
Transducer channel 1 (phase A)



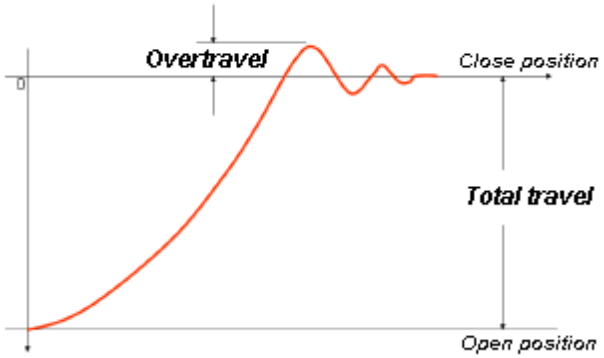
ST - Stroke

OT - Over travel

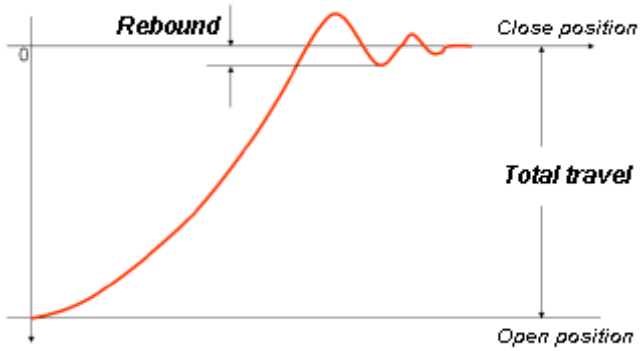
RB – Rebound



STROKE (during a CLOSE operation) is the distance between the open position of the circuit breaker and the final close position.

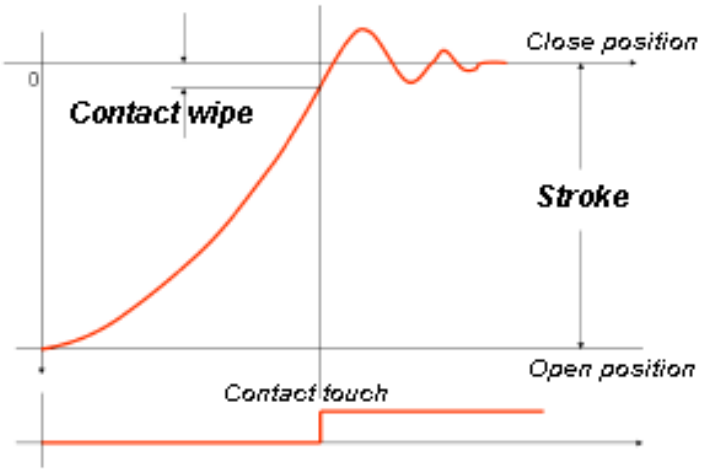


OVETRAVEL (during a CLOSE operation) is the distance between the maximum temporary displacement of the circuit breaker main contacts beyond the final close position.



REBOUND (during a CLOSE operation) is the distance between the lowest measured position that occurs directly after the overtravel and the breaker's final close position.

Contact wipe on phase A:

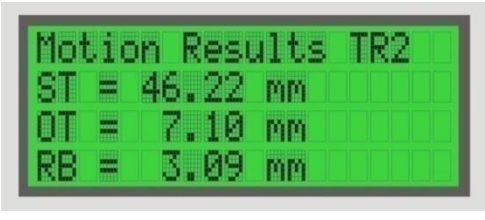


Contact wipe is the distance measured from the contacts touching position to the final close position during a CLOSE operation.

Note: If only one transducer is used and the circuit breaker is a single-pole (independent pole) controlled, the contact wipe is calculated only for the phase where the transducer is installed.

If the circuit breaker is a three-pole controlled, the contact wipe is calculated for all phases based on the transducer on the mounted phase.

Transducer channel 2 (phase B)



ST - Stroke
OT - Over travel
RB – Rebound

Contact wipe on phase B:

Transducer channel 3 (phase C)

ST - Stroke
OT - Over travel
RB – Rebound

Contact wipe on phase C:

Press the ***PRINT*** button to print test results on the (optional) built-in printer.
Press the ***STOP*** to go back to the **Results** menu.

3.3.1.5 Preinsertion resistors results

Press **#5** in the ***Results*** menu to see measurement results of the circuit breaker moving parts displacement. Use ▲▼buttons to navigate between the screens.

Preinsertion resistor closing time is the time interval between the initiation of the CLOSE operation and the instant when the preinsertion resistor contact closes in each phase.

The CAT calculates the preinsertion resistor closing time on 6 main contact timing channels (3x2) (see the figures below and the **Figure 3-28**).

Preinsertion resistor closing time (phase A)

Preinsertion resistor closing time (phase B)

Preinsertion resistor closing time (phase C)

Preinsertion resistor arcing contacts synchronization

The time difference between the first and the last preinsertion resistor contacts touching during a CLOSE operation (see the figure on the left and **Figure 3-28**).

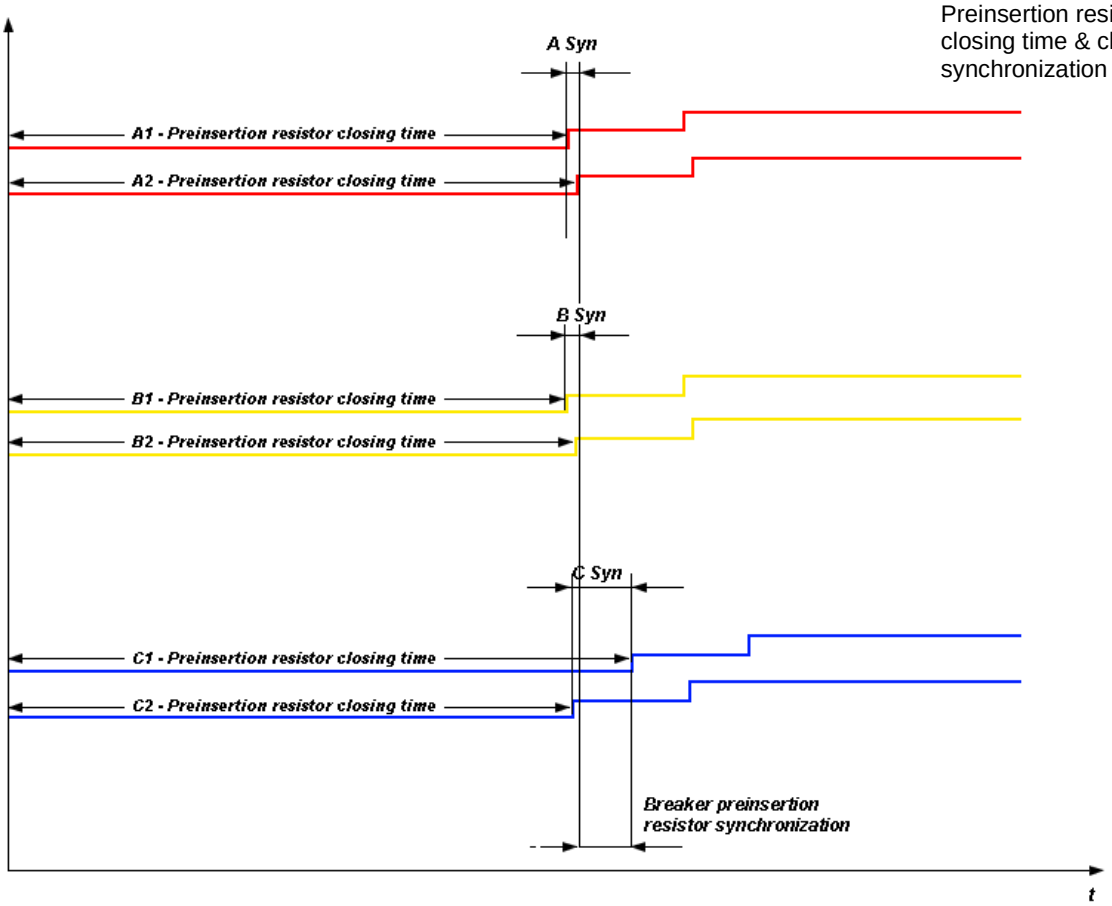
A Syn - Preinsertion resistor synchronization time in the phase A

B Syn - Preinsertion resistor synchronization time in the phase B

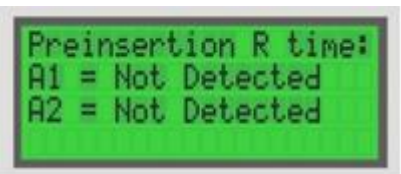
C Syn - Preinsertion resistor synchronization time in the phase C

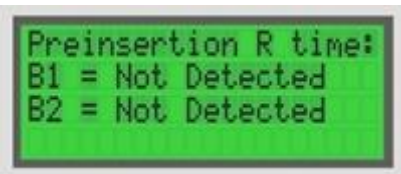
Preinsertion resistor synchronization time for the breaker.

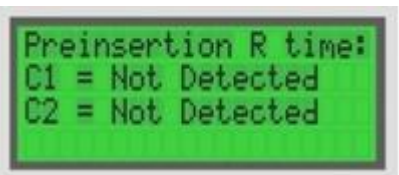
Figure 3-28: Preinsertion resistors closing time & close synchronization



Note: If no preinsertion resistors are present, the CAT will indicate the preinsertion resistor is not detected:

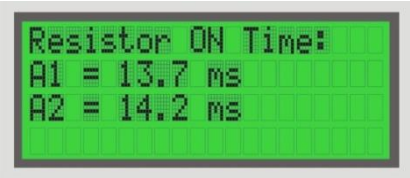


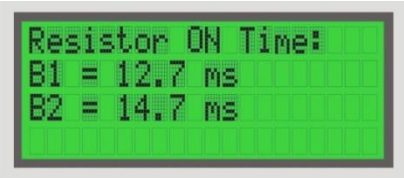


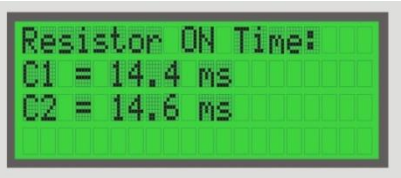


Preinsertion resistor ON time:

The time interval between the instant when the preinsertion resistor contact is activated and the instant the contacts touch during a CLOSE operation (see the figures below and the Figure 3-29).





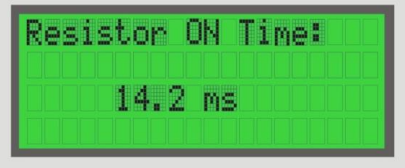


Phase resistor ON time:

The interval of time between the instant when the first preinsertion resistor contact is activated and the instant of the last contact touch in each phase during a CLOSE operation (see the figure on the left and the Figure 3-29).

Total breaker preinsertion resistor ON time:

The time interval between the instant when the first preinsertion resistor contact is activated in any phase and the instant of time the last contact touch during a CLOSE operation (see the display screen below and the Figure 3-28).



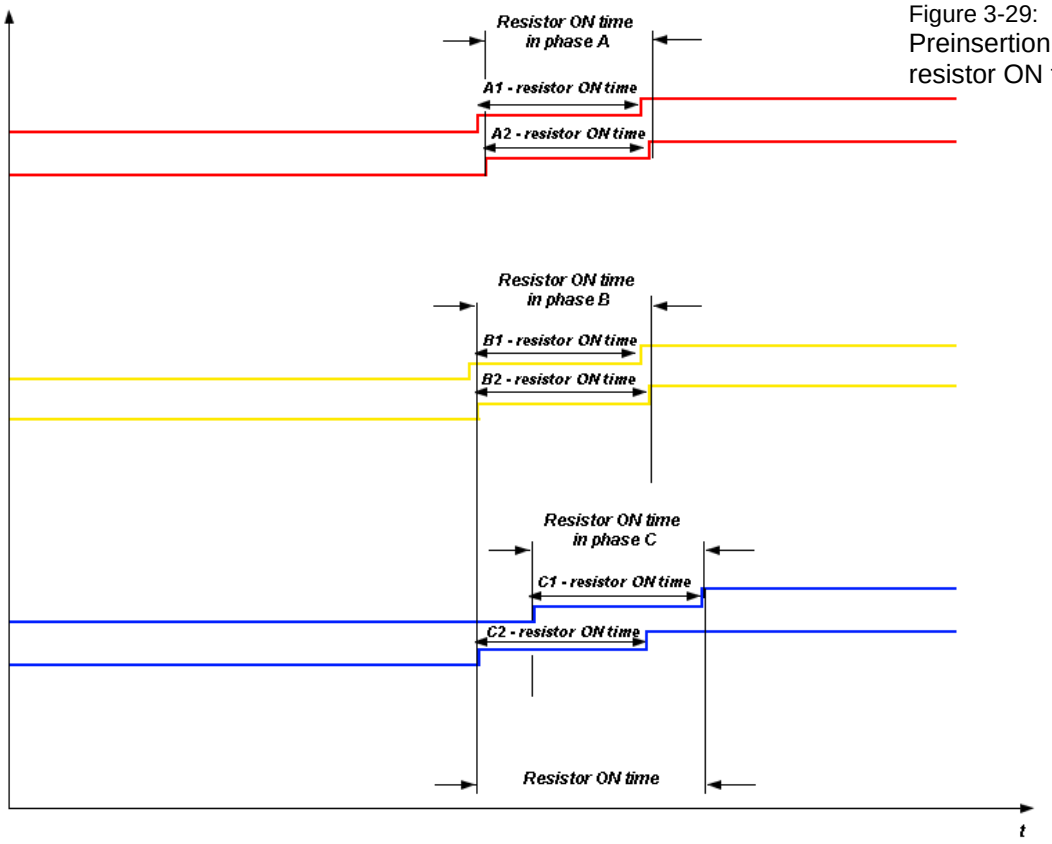
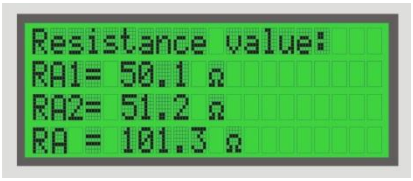


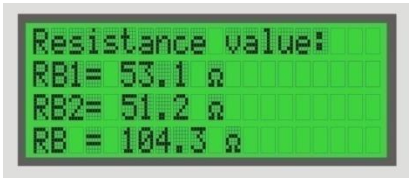
Figure 3-29: Preinsertion resistor ON time

Resistance value

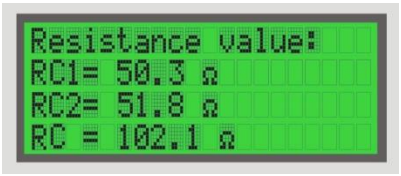
CAT measures the resistance of the preinsertion resistor contacts in each phase.



RA = RA1+RA2



RB=RB1+RB2



RC=RC1+RC2

3.3.2. External trigger

The External trigger feature enables a start of data recording as soon as the CAT series instrument senses a voltage in the range between 10 V and 300 V AC/DC on the External trigger input. The Coil control cables OPEN1 & CLOSE1 are connected to the breaker coils using the voltage drop across the circuit breaker coils as a trigger signal.

External trigger mode can be used to start timing of the breaker operation when the user opens or closes the circuit breaker by the local switch or remotely from a control room. External trigger feature also provides some online measurements, like the “First trip” test.

3.3.2.1 External trigger setup

Select the **Settings** menu in the **Main** menu (Figure 3-20). Press #***2*** and the CAT will enter in the **Settings** menu (Figure 3-20). Press ► to go to the second page of the **Settings** menu.

Press #***1*** to select the External trigger setup.

External trigger setup menu is used to activate the trigger source measurement mode (see the figure below) and to define trigger source.

Press ***#1*** or ***#2*** to activate or deactivate the External trigger mode.

If **#1** is selected, a pre-trigger time out has to be defined (see the figure below).

Press ***#1***, ***#2*** or **#3** to select between **10 s**, **20 s** or **unlimited** pre-trigger time out.

After the external trigger mode is activated, a trigger source type needs to be defined. Beside the External trigger, the **Figure 3-30**, illustrates, several other measurement triggers available to record a measurement in a various testing conditions: analog channels, auxiliary channels and coil currents.

Figure 3-30: **Trigger Source** menu

Press ***#1***, ***#2, #3*** *or* ***#4*** to select a corresponding trigger source.

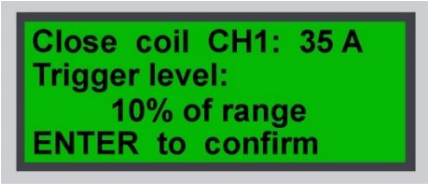
External Trigger Mode

Press #***1*** to select External Trigger mode. External trigger enables start of recording when the CAT senses a voltage on Coil control cable OPEN1 & CLOSE 1 inputs. Trigger input voltage range: 10 V – 300 V AC/DC.

Coil current trigger mode

Press #***2*** in Trigger Source menu (Figure 3-29) to select Coil current trigger mode. The following screen will be displayed:

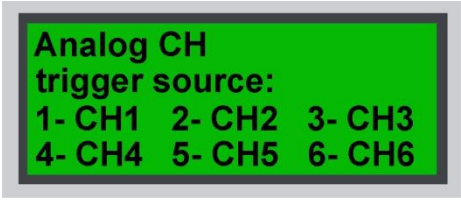
Press ***#1***, ***#2, #3, #4, #5*** *or* ***#6*** to select corresponding coil current channel as a trigger source. Threshold level is a user selectable. Default threshold level is 10% of the coil current maximum range (35 A).



Press ***ENTER*** to confirm.

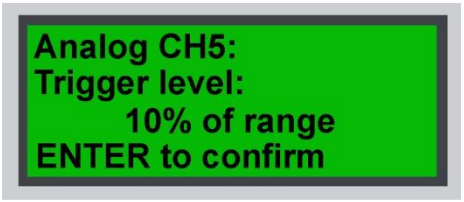
Analog input trigger mode

Press #**3** in the Trigger Source menu (Figure 3-30) to select analog channel as a trigger input. The following screen will be displayed:

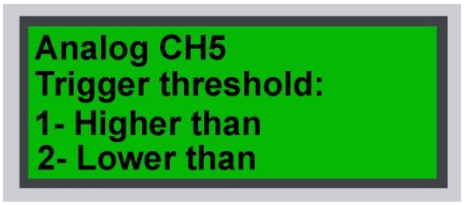


Press ***#1***, ***#2, #3*** *or* ***#4*** to select a corresponding analog channel as a trigger source.

Threshold level is a user selectable. Default threshold level is 10% of the previously selected measurement range for analog channel (e.g. Analog channel 5).



Press ***ENTER*** to confirm. The following screen will be displayed:



User is allowed to select between “Higher than” or “Lower than” threshold level. Press either ***#1****or* ***#2*** to select corresponding option.

3.3.2.2 External trigger – Running the Test

Select one of the breaker operating sequences (Figure 3-31).

Figure 3-31: The **Select sequence** - **External trigger** menu

The CAT measures timing for the following operating sequences in the External trigger mode:

1 - OPEN

2 - CLOSE

3 - C-O

4 - O-C

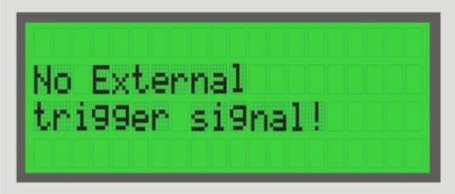
5 - O-C-O

For example, if one selects **#1** and selects the CLOSE operation, the following notification will appear:

Hold the **READY** button and then press **START** to start the test.

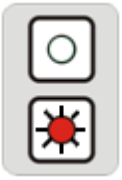
The CAT will start waiting for the external trigger voltage and the following notification will appear:

The external trigger voltage needs to be detected by the CAT within 10 seconds (pre-trigger time out can be set to 20 s or unlimited time value - please refer to the page 13) after the sequence initiation has begun. The CAT will display the following notification if no voltage is detected:



Note: Trigger input voltage is in the range from 10 V to 300 V AC/DC.

After the external trigger voltage is detected, the CAT will start operating process and the following messages will appear on the display window and the red LED blinks:



After the operating process is finished, the CAT starts processing data.

CAT will display CLOSE test result after processing of data is completed.

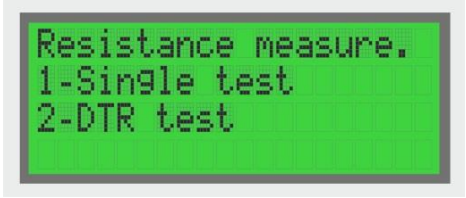
The same procedure is used for all other sequences.

3.3.3. Contact Resistance Measurement (available with the CAT35, CAT36, CAT65 & CAT66)

Note:	Disconnect the main contact timing cables while performing the contact (static) resistance measurement. Otherwise accuracy of the measurement can be affected.

Press ***#3*** in the **New test** menu (Figure below) to select resistance measurement test.

The CAT will change into **Resistance Measurement** menu. Press ***#1*** or ***#2*** to select between **Single** or Dead Tank Resistance test (**DTR test**), respectively.



If ***#1*** is selected, CAT will change into **Single** menu. Before a test can be started, both test current and memory location need to be defined.

Before a test can be started, the following parameters need to be defined in the **Single** menu:

- Test current; the following values can be selected:

  5 A, 10 A, 20 A, 50 A, 100 A, 200 A, 300 A, 400 A and 500 A;

- Memory position, 000-499.

Use ***UP/DOWN*** buttons to set test current value (here **100A**). Once these parameters are defined, press ***ENTER*** to change to the **Ready** state.

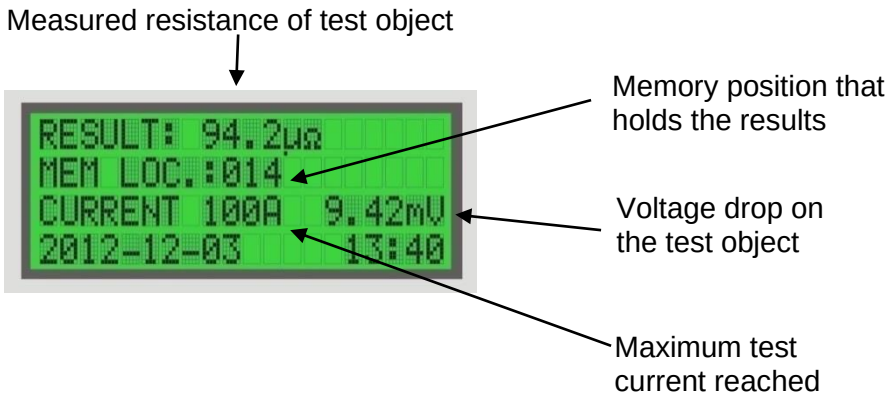
The **Ready** state displays the test current and memory position defined. If one of these values has to be changed, press ***STOP*** to return to the **Single** menu.

The flashing green LED indicates that CAT is now ready to start the test. Press the START button to run a test. At a start of the test, the internal cable connection safety check is done automatically by the device itself. In case of e.g. a disconnection, an alarm is activated and the error message is shown on the display.

During the test, both the green and the red LEDs flash alternately. The display shows a graphical representation of the output current that ramps from 0 A to the defined maximum value (here 100A).

CAT generates a filtered (true) DC current in a form of automatically regulated current ramp. The current increases with a constant slope from zero up to a preset maximum value. When the current has reached its maximum, it is kept constant for 1 s and CAT measures the resistance of the test object within this interval. After the test, the output current ramps back down to zero with a constant slope. By sloping the current up and down, magnetic transients are virtually eliminated.

After the test, CAT will display test results.



Maximum current that can be generated during resistance measurement is 200 A with CAT35 and CAT65, while 500 A is available with CAT36 and CAT66.

The contact resistance measurement of Dead Tank circuit breakers requires a different approach comparing to the live tank circuit breakers due to their design. A DC current used for this measurement flows directly through the current transformers mounted on the bushings. Presence of current transformers (CT) on this type of circuit breakers may introduce errors during a test due to CT magnetizing process.

It is necessary to saturate a CT prior to measurement. This can be achieved in DTR test menu, specially designed for dead tank circuit breakers.

The same procedure for test parameters setup used for ***Single*** test, can be applied to ***Dead Tank Resistance (DTR)*** test.

Use ***UP/DOWN*** buttons to set test current value (here **200A**). Once these parameters are defined, press ***ENTER*** to change to the **Ready** state.

Note: Maximum test current for CAT66 is **300 A** in the DTR test menu.
Maximum test current for CAT35 and CAT65 is **200 A** in the DTR test menu.

The **Ready** state displays the test current and memory position defined. If one of these values has to be changed, press ***STOP*** to return to the **DTR test** menu.

The device generates continuous DC current through the contacts and current transformers for certain period of time, required to saturate current transformers. The result is displayed after the CTs are saturated and result becomes stable.

The table below provides CAT35, CAT36, CAT65 & CAT66 models accuracy parameters under the maximal test current per the range being used.

Range	Recommended Test Current	Nominal Resistance	Full Range Display	Resolution	Typical accuracy
1	100 A - *I_{max}	1 mΩ	999,9 µΩ	0,1 µΩ	± 0,1 % rdg ± 0,1 % FS
2	100 A - 200 A	10 mΩ	9999 µΩ	1 µΩ	± 0,1 % rdg ± 0,1 % FS
3	50 A - 100 A	20 mΩ	20,00 mΩ	10 µΩ	± 0,1 % rdg ± 0,1 % FS
4	20 A - 50 A	50 mΩ	50,00 mΩ	10 µΩ	± 0,1 % rdg ± 0,1 % FS
5	10 A - 20 A	100 mΩ	99,99 mΩ	10 µΩ	± 0,1 % rdg ± 0,1 % FS
6	10 A	500 mΩ	500,0 mΩ	0,1 mΩ	± 0,1 % rdg ± 0,1 % FS
7	5 A	1 Ω	999,9 mΩ	0,1 mΩ	± 0,1 % rdg ± 0,1 % FS

**** I_{max} – maximal test current for appropriate model (e.g. 500 A for CAT66 model)***

3.3.4. Dynamic Resistance Measurement (available with the CAT35, CAT36, CAT65 & CAT66)

Note:	While performing the DRM test, please disconnect the main contact timing cables since the measurement accuracy can be affected.

The DRM test can be performed only if DV-Win application software is being used.

Connect the USB port of the CAT and the PC, using a serial cable. Turn the CAT on. Start DV-Win:

- Click on ”Start”,
- Click on ”Programs”,
- Click on ''DV-Win'',

or double click at icon on the desktop. The Introduction screen will appear as in the **Figure 3-32**.

By pressing “Start new test” on the *Introduction screen* one can start a new test with the detected device (in this case DV-Win will detect the CAT35, CAT36, CAT65 or CAT66).

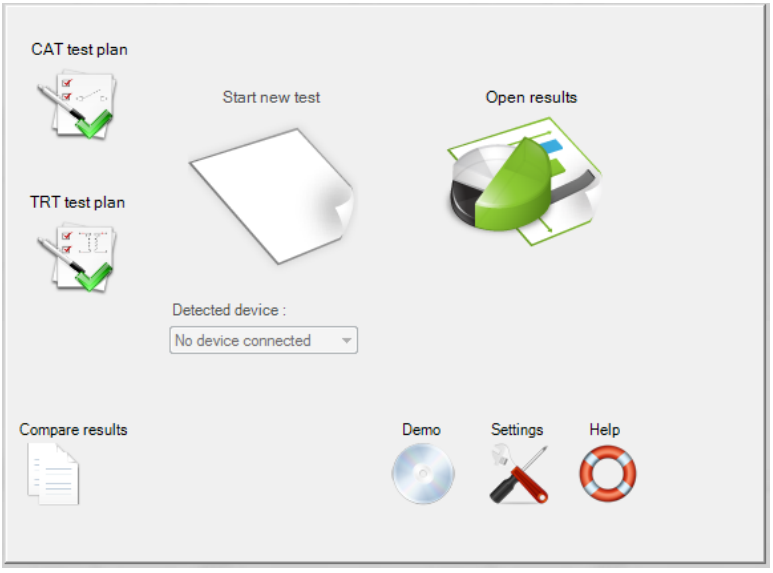


Figure 3-32: Introduction screen

After starting the New test, select Settings tab, as shown in the **Figure 3-33**. All test parameters are contained in this tab. The common test parameters for all tests are placed in the upper part of the window. Other test settings are contained in three tabs: *Tests*, *Aux and analog channels*, and *Motion and velocity*.

Tests tab (**Figure 3-33**) provides access to all available tests and their settings parameters. All tests are divided into three sections: *Sequence*, *Static resistance measurement* and *Dynamic resistance measurement.*

Specific settings for a Dynamic resistance measurement (DRM) test are shown in the bottom part of the window in **Figure 3-33**. Test current can be selected up to 200 A for CAT35 and CAT65 and up to 500 A for CAT36 and CAT66.

DRM test is available for all sequences. Particular sequence pulse duration is configurable.

	Please pay attention that circuit breaker is in a **CLOSE** position prior to initiating any of DRM test sequences.
Note:	Even for DRM for Close or CO sequence, circuit breaker should be in a **CLOSE** position, since instrument will firstly initiate Open sequence and perform DRM for C or CO test afterwards.

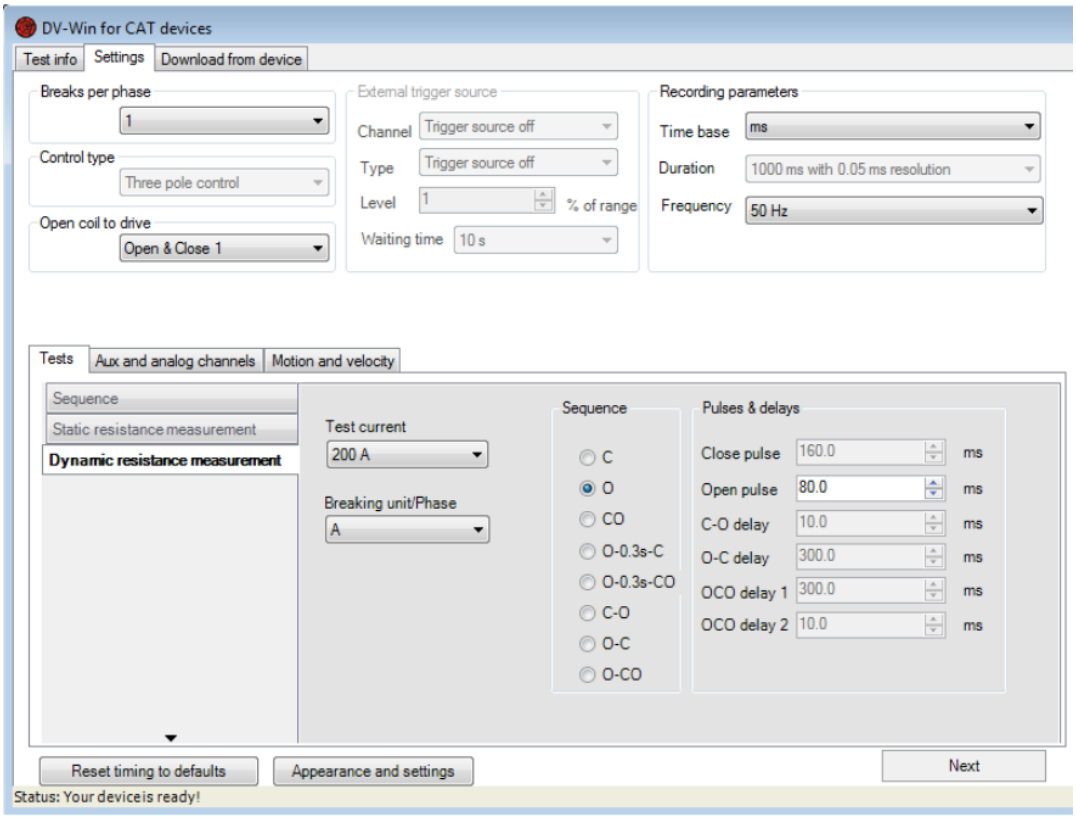


Figure 3-33. *Settings for DRM test*

To obtain the complete DRM test result, it is required to record the contact motion curve in addition to voltage/resistance graph. An accurate measurement of the contact motion needs set up of the parameters in the *Motion and velocity* tab (Figure 3-34). Enable only the motion channels that have linear/rotary transducers connected. Select either linear or rotary transducer. Since rotary transducer can be installed directly on a mechanism or using linear to rotary converter, it is needed to select the appropriate installation method.

In many circuit breakers, it is not possible to attach a transducer connecting rod to a part of the circuit breaker mechanism that moves directly with the main contacts. However, it should be possible to connect the transducer connecting rod to another location in the mechanism that moves in a secondary relationship to the main contacts. Under these circumstances, the displacement measured at the transducer may be different than the actual displacement at the contacts. Therefore, transducer scaling may be applied to the measured displacement to properly relate it to the actual displacement. For example, 2 deg of the rotation measured at the transducer

may correspond to 1 mm of the movement at the contacts. In order to correlate the rod travel to the main contact travel, *Transducer transfer function* needs to be used (**Figure 3-34**).

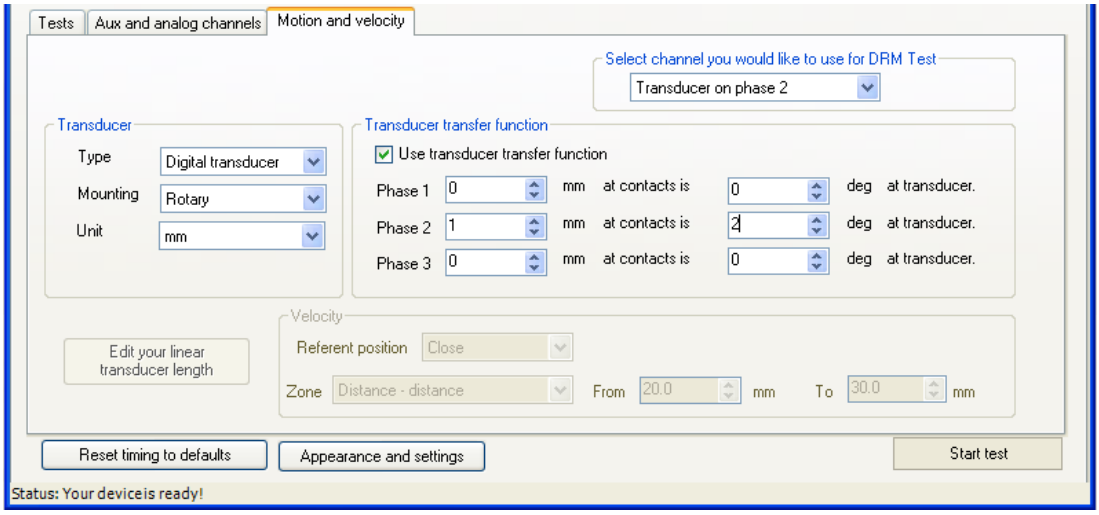


Figure 3-34. *Motion and velocity tab*

Click on the *START* button to start the test (lower right corner of the working area). If all data fields in the *Test info* tab are not filled, the warning message will appear. In the next step, *Test preview* window with parameter values will be provided as shown in the Figure 3-35. Click *START* to proceed with the test.

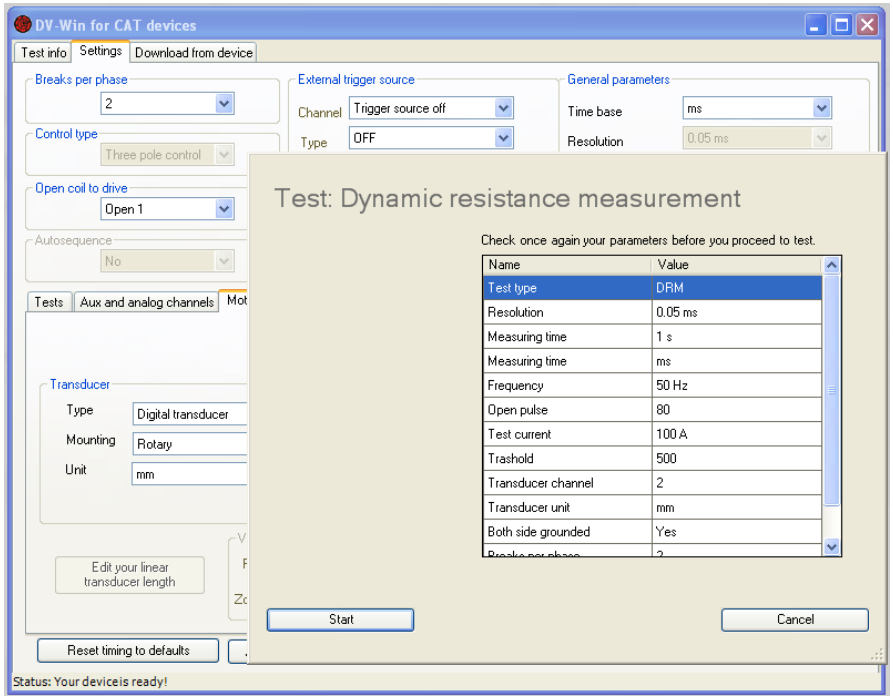


Figure 3-35. *Test parameters preview*

Once a test is started, both, Static and Dynamic resistance measurements will be performed. Process status during the test is illustrated in the Figure 3-36.

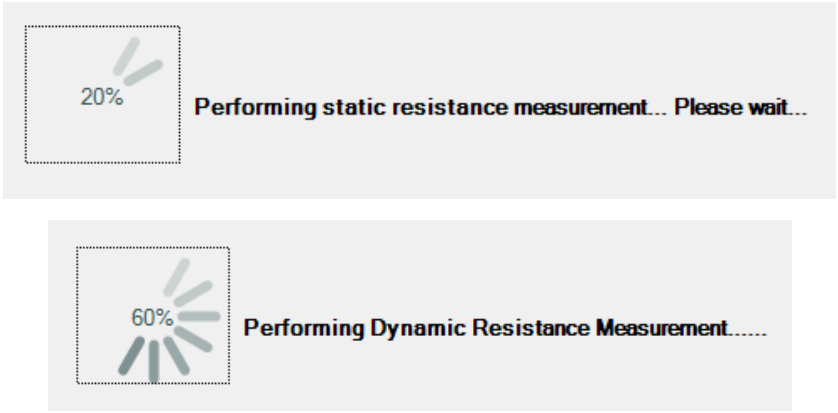


Figure 3-36. *Process status during DRM test*

After the test is performed, the graphic results are shown in the *CAT Viewer* window (Figure 3-37.). Graphic results contain contact voltage drop (turquoise), contact resistance (blue) and motion (red) curves recorded. Two cursors (red and black vertical line shown in the Figure 3-37) are used to provide detailed analysis of the graphical results. Cursor data values are shown in the right hand section of the window. By moving the cursors along x axis, current values for active signals can be read. Moving the cursors along the x axis, a time interval between two moments in time as defined by the selected positions of the cursors can be measured. Using the cursors, it is possible to determine parameters (extracted in the Figure 3-38) needed for the assessment of the arcing contacts condition.

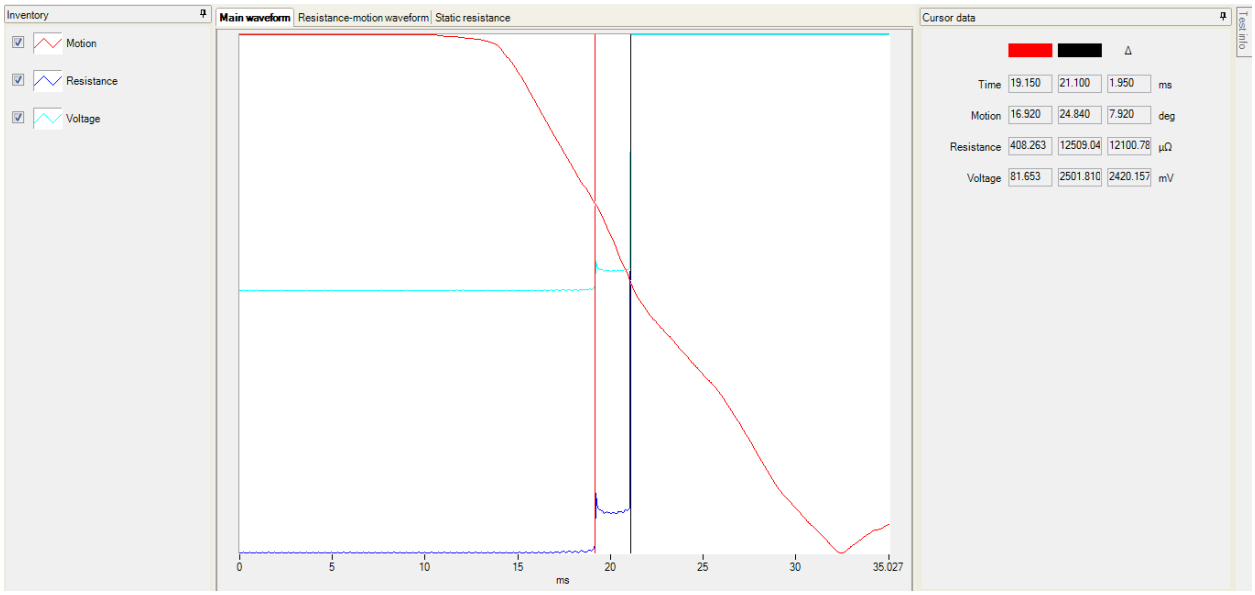


Figure 3-37: *DRM graphic results and cursor data*

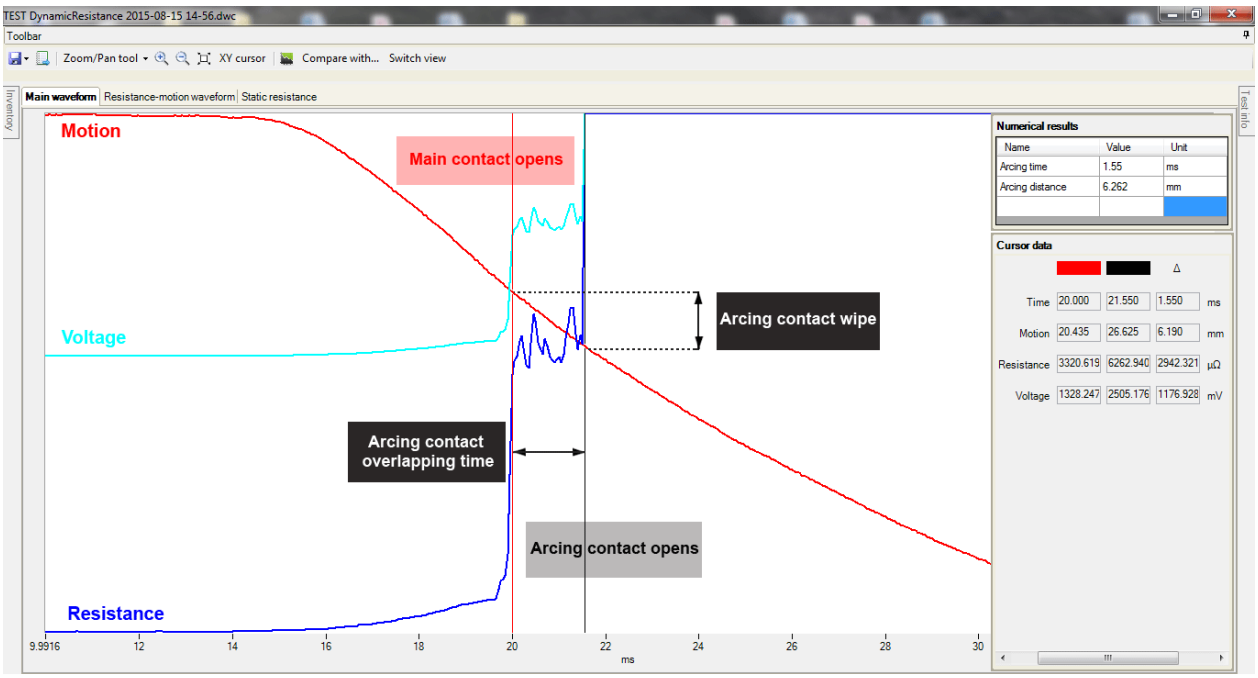
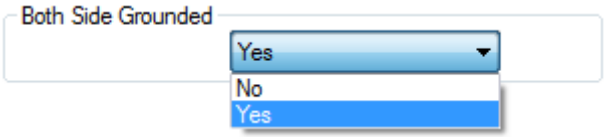


Figure 3-38. *Extracted parameters from DRM graph*

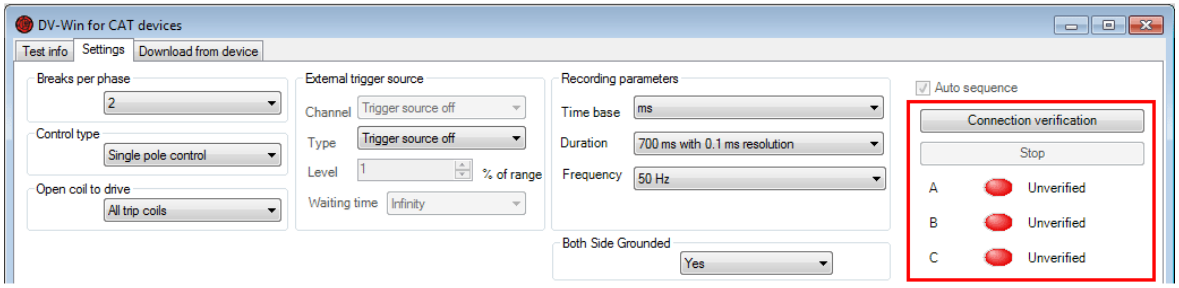
3.3.5. Test in Both Sides Grounded conditions for AIS (Live Tank)

If the timing test is performed on a circuit breaker with both terminals grounded, then Both Sides Grounded **for Air Insulated Live Tank Circuit Breakers** (**BSG**) feature (available with the firmware versions 6.xx) should be activated. The BSG feature is available only with use of DV-Win software application. In the DV-Win software in **Settings** tab, in **Both Sides Grounded** section select option **Yes.**

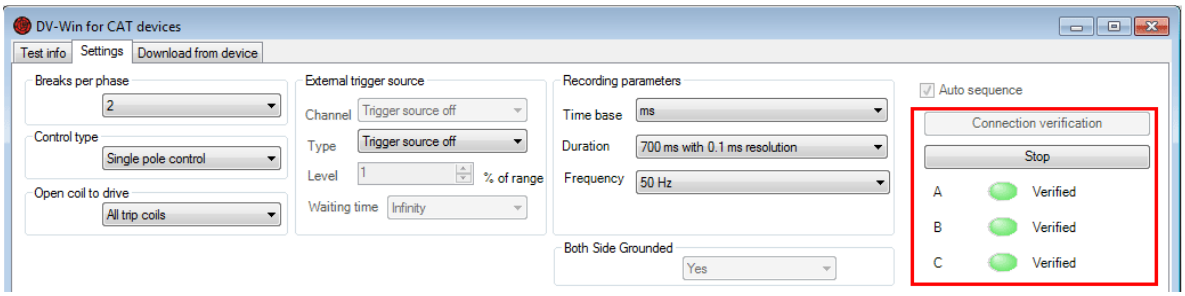


For proper and reliable test in the BSG (Both Sides Grounded) condition, it is very important to establish good contact between the Main contact clamps and the circuit breaker terminals surface. Accordingly, before running the test, it is necessary to check the contact quality. Contact quality check can be performed by following procedure:

- Close the circuit breaker,
- Click on the option **Check connection** (window in the figure below),
- Monitor the indication for phases A, B and C (window in the figure below).



If the indication switches from “Unverified” to “Verified” (as shown in the figure below) a few seconds after running the checking, contact quality is good.



If the indication stays on “Unverified” for some phase (or phases) to the end of checking process (in duration of 30 s), contact quality for that phase (or phases) is bad and clamps should be better connected and circuit breaker terminal surface cleaned. During checking process test can not be started. Checking process can be interrupted by clicking the **Stop** button. If the contact quality is good, test running can be continued.

Note: Auto sequence and **External trigger** options are not available with use of **BSG** option.

3.4. Saving test results to USB Flash Drive

The test results from actual reading can be saved directly to a USB memory device. This feature can be activated in **Initial setup** menu. After data processing is finished and CAT displayed the test results, pressing the STOP button will initiate connection with the USB memory device.

To save the results, please plug in the USB memory device and press **ENTER**. Press **STOP** to exit and CAT will go back to **Main Menu**.

In this example, the actual test results are for CLOSE operation. If **ENTER** is selected, the CAT will proceed with saving the test results.

After the **ENTER** button is pressed, the CAT will start saving the test results. The progress bar indicates process of transferring data from the CAT to a memory device.

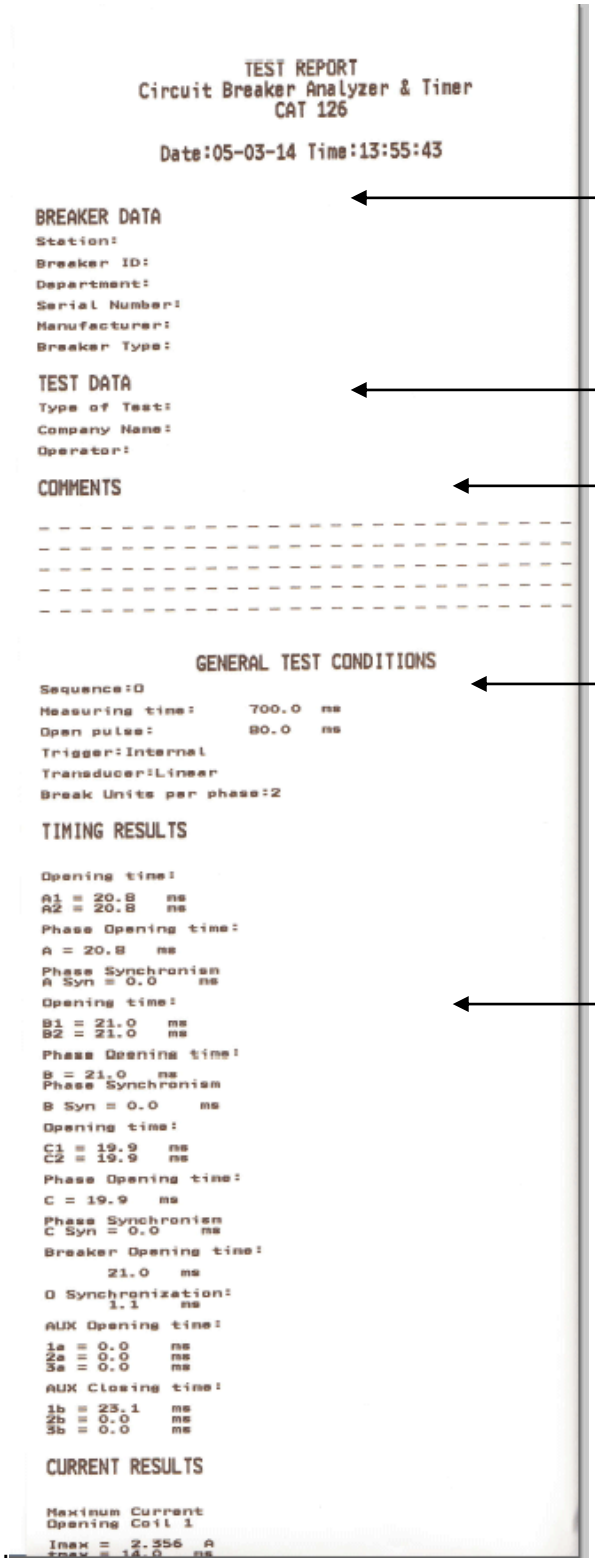
When the test results (for CLOSE test in this case) are saved, the CAT will display the following notification:

The CAT saves the results in the **DVData** folder **on the** USB memory device.

If the USB Memory device is not connected to the Flash Drive connector, CAT will display the following message:

3.5 Printing the Test Results

The results can be printed using the ***PRINT*** button. The measurement results can be printed from the **Memory** menu or from the **Result** menu immediately after the test has been completed.



TEST REPORT
Circuit Breaker Analyzer & Timer
CAT 126

Date:05-03-14 Time:13:55:43

BREAKER DATA
Station:
Breaker ID:
Department:
Serial Number:
Manufacturer:
Breaker Type:

TEST DATA
Type of Test:
Company Name:
Operator:

COMMENTS

GENERAL TEST CONDITIONS
Sequence:0
Measuring time: 700.0 ms
Open pulse: 80.0 ms
Trigger:Internal
Transducer:Linear
Break Units per phase:2

TIMING RESULTS

Opening time:
A1 = 20.8 ms
A2 = 20.8 ms
Phase Opening time:
A = 20.8 ms
Phase Synchronism
A Syn = 0.0 ms
Opening time:
B1 = 21.0 ms
B2 = 21.0 ms
Phase Opening time:
B = 21.0 ms
Phase Synchronism
B Syn = 0.0 ms
Opening time:
C1 = 19.9 ms
C2 = 19.9 ms
Phase Opening time:
C = 19.9 ms
Phase Synchronism
C Syn = 0.0 ms
Breaker Opening time:
21.0 ms
O Synchronization:
1.1 ms
AUX Opening time:
1a = 0.0 ms
2a = 0.0 ms
3a = 0.0 ms
AUX Closing time:
1b = 23.1 ms
2b = 0.0 ms
3b = 0.0 ms

CURRENT RESULTS

Maximum Current
Opening Coil 1
Imax = 2.356 A
tmax = 14.0 ms

Space for your Breaker data

Space for your Test data

Space for your Comments

General test conditions:
Type of Sequence
Measuring time
Length of pulses

Timing results O test

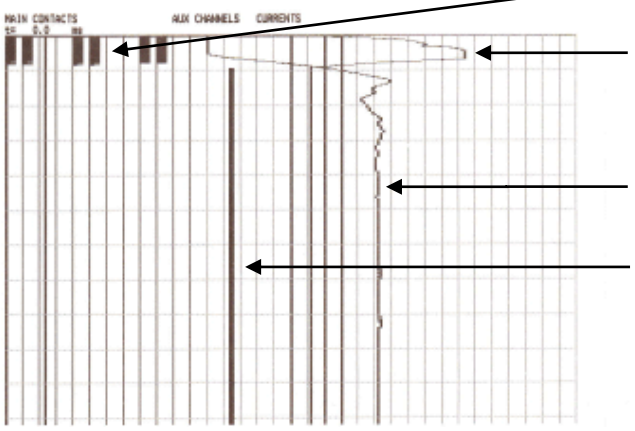
```
AUX Opening time:

1a = 0.0     ms
2a = 0.0     ms
3a = 0.0     ms

AUX Closing time:

1b = 23.1    ms
2b = 0.0     ms
3b = 0.0     ms

CURRENT RESULTS

Maximum Current
Opening Coil 1

Imax =  2.356  A
tmax = 14.0    ms

Maximum Current
Opening Coil 2

Imax =  0.000  A
tmax = 0.0     ms

Maximum Current
Opening Coil 3

Imax =  0.000  A
tmax = 0.0     ms

ANALOG CH. RESULTS

Analog CH 1   10
Range 0.5 V   mV/A

Imax = 2.99 A
Imin = -0.74 A

Analog CH 2
Range 300 V

Umax = 0.19 V
Umin = 0.00 V

Analog CH 3
Range 300 V

Umax = 0.19 V
Umin = 0.09 V

Analog CH 4
Range 300 V

Umax = 0.18 V
Umin = 0.08 V

TRANSDUCER RESULTS

Motion Results TR2

ST:55.918 mm
OT: 3.842 mm
RB: 5.600 mm

Contact Wipe:

A1 =29.77 mm
A2 =29.77 mm
B1 =50.44 mm
B2 =50.44 mm
C1 =26.47 mm
C2 =26.47 mm

GRAPH

Horizontal Scale:
     25.0   ms/div
Vertical Scale:
Closing Coil Current:1.00 A/div

Opening Coil 1 Current:0.25 A/div
Opening Coil 2 Current:1.00 A/div
Opening Coil 3 Current:1.00 A/div

Transducer 1: 5.44 mm/div
Transducer 2: 5.44 mm/div
Transducer 3: 5.44 mm/div
```

Current results - O test

Analog channels results - O test

Transducer results - O test

Graphical printout



Main contacts

Opening coil current

Motion graph

Auxiliary contacts

Note: The print density is guaranteed within range: 5°C to 40°C, 20 to 85% RH No condensation.

The printer can operate from 0°C to 50°C.

4. Memory Menu

Up to 499 test results can be stored in the CAT's internal memory. The Memory menu allows a user to manage test results. Press ***#3*** while in the **Main** menu (Figure 3-16) to enter the **Memory** menu. Memory menu displays the first free memory location (in this case, the first free memory location is 001).

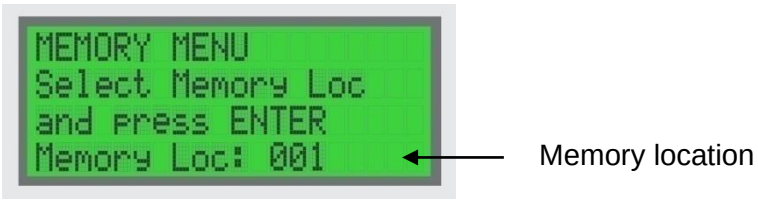


Figure 4-1: The **Memory** menu

User is allowed to navigate between different memory locations by using alphanumeric keypad. If a test result exists on the selected memory location, the CAT will indicate a type of the test.

Press ***ENTER*** to view test results for a selected memory location. **Result** menu will be displayed (here **Close** test). If no test result exists on the selected memory location, the CAT will indicate the message: ***No results!***

In order to delete the selected memory location press ***CLEAR***. The following screen will be displayed:

Figure 4-2: *The **Memory** menu showing an option to delete all saved measurements from the memory positions*

Press ***#1*** to delete test results on the selected memory location, or press **#2** if needed to keep test results.

Press **#3** to delete all test results from the memory.

5. Error Messages

Any operational error is indicated by a continual light on the Red LED followed by a buzzing sound alarm. Furthermore, the display shows an error status message.

To stop the alarm buzzer, remove the status message on the display, and return to the **Main** menu, press the ***STOP*** button.

5.1. Error MOD: 05

This message is displayed in case of a mod 05 (Main contacts CH1) malfunction. It usually indicates power loss at the specified mode or a communication malfunction.

- Mod 01 – Closing current measurement channel
- Mod 02 – Breaking current measurement channel
- Mod 03 – Digital transducer channel
- Mod 04 – Analog channels
- Mod 05 – Main contacts channel 1
- Mod 06 – Main contacts channel 2
- Mod 07 – Main contacts channel 3

5.2. Error Message “ERROR GIB: 011”

This message is displayed in case of a communication error inside the device. The GIB error indicates an unsuccessful command reception.

5.3. Error Message “PRINTER ERROR”

This message occurs in case of problems with the printing process on the thermal printer (optional accessory).

5.4. Error Message “MEMORY CARD ERROR”

This message occurs in case of problems with saving the results onto the memory card.

5.5. Error Message “OPERATING ERROR”

This message is displayed in case of communication problems while running the test.

5.6. Error Message “OPERATING ERROR – COIL OVERCURRENT”

This message appears when the current through coil control circuitry exceeded 35 A. The CAT coil control circuit is protected for IGBT drivers to prevent their damage caused by an overcurrent. To solve the problem, check the Coil control cable connections to the circuit breaker coils. Connections should be established as described in the Figure 3-3, 3-4 and 3-5.

6. Troubleshooting Guide

If experiencing problems with the Circuit Breaker Analyzer and Timer it is recommended to reset the device to default settings (**Settings** -> **Default setup**) and choose the appropriate frequency (50 Hz or 60 Hz).

6.1. Main contacts test

I. Connect all Main Contact cables to the device, short circuiting clamps, as shown in the Figure 6-1.

II. Set time settings (**Settings** -> **Timing test setup**): set *Measuring Resolution* to **1ms** and *Measuring Time* to **20s**.

III. Return to the **Main** menu, choose ***New test*** (**New test** -> **Timing test**). At this point of the test, red LED should be light ON and green LED OFF. Select Open test ***(O)*** and press the ***READY*** and ***START*** buttons at the same time. After starting the test disconnect all the red, yellow and blue clamps from the black clamps. After the test is finished (after 20s) the "opening" times corresponding to the timing of disconnecting clamps should be shown on the device display.

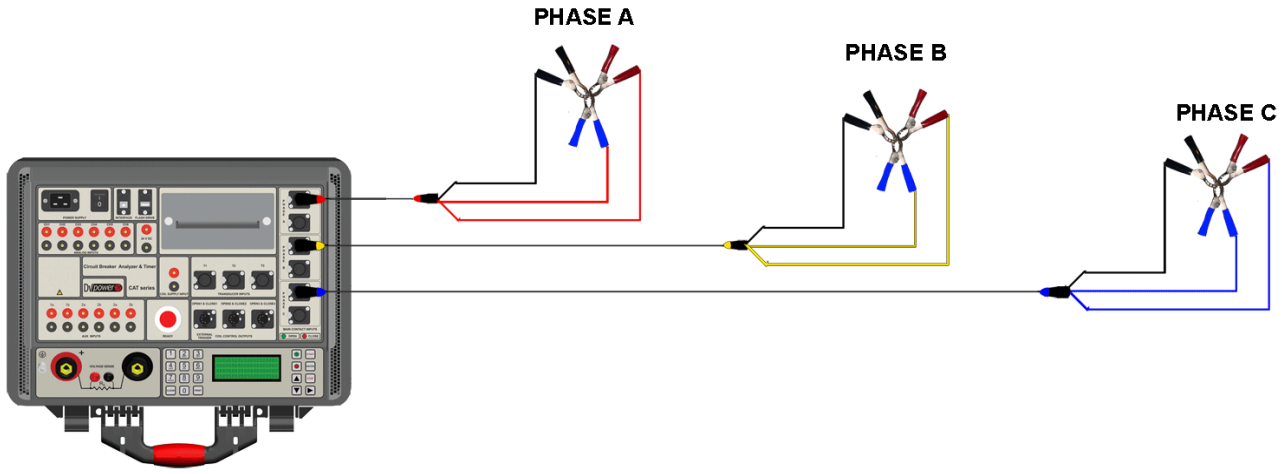


Figure 6-1: Main Contacts test (two break points per phase)

Note:	In the Figure 6-1 the two break points per phase test is selected as an example

6.2. Coil control test

Coil Control test can be performed in two ways, with and without the use of DV Win software:

6.2.1. Coil control test without using DV Win software

I. Connect Coil Control cable to the CAT device and switch ON the device.

II. Check the resistance between the red and black wires of Coil Control cable – CLOSE pair, OPEN1 pair, OPEN2 pair and OPEN3 pair, respectively. If there is no short circuit between these wires please continue to the next step. Otherwise, if there is a short circuit between these wires, please contact the DV Power Support Team.

III. Connect an external voltage source to the Coil supply input as shown in the Figure 6-2. Connect the Coil Control cable – CLOSE pair to the resistor as shown in the Figure 6-2. The resistance R of resistor used and voltage V should be chosen so the current in the circuit is limited within the range 1A - 10A.

IV. After turning ON the device, set time settings (**Settings** -> **Timing test setup**): set *Measuring Resolution* to **0,1ms** and *Measuring Time* to **700ms**.

V. Return to the **Main** menu, select *New test* (**New test** -> **Timing test**). Select Close test ***(C)*** and press ***READY*** and ***START*** buttons at the same time. Read the maximal current value from the CAT display. Measured current should be proportional to the used resistance and voltage: $I = \frac{V}{R}$

VI. Repeat steps 3-5 using the Coil Control Cable – OPEN1, OPEN2 and OPEN3 pairs, individually and selecting the *OPEN test (O)* when performing procedure described in the step 5.

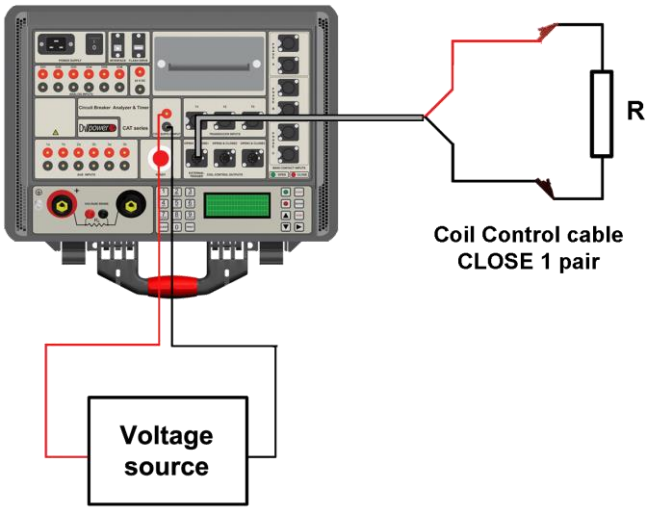


Figure 6-2: Coil Control test – Close pair of Coil Control Cable

6.2.2. Coil Control test using the DV Win software

I. Connect the CAT device to the PC. Connect the Main Contact cables and the Coil Control cable – CLOSE pair, as shown in the Figure 6-3. Connect jumper to the Coil supply input (Figure 6-3).

II. After starting the new test in the DV Win software, please select the *Test Settings* tab and define parameters for the *CLOSE* test. It is recommended to define the *Close pulse length* of 160 ms.

III. Start the test by pressing the *START* button and confirming the defined parameters.

IV. When the test is finished, *CAT Viewer* window should appear with test results for active signals, as shown in the Figure 6-4. In the numerical results table, Closing time should be 160 ms.

Repeat steps 1 - 4 using the Coil Control cable – OPEN1, OPEN2 and OPEN3 pair and defining the parameters for *OPEN* test in step 2. It is recommended to define *Open pulse length* of 80 ms.

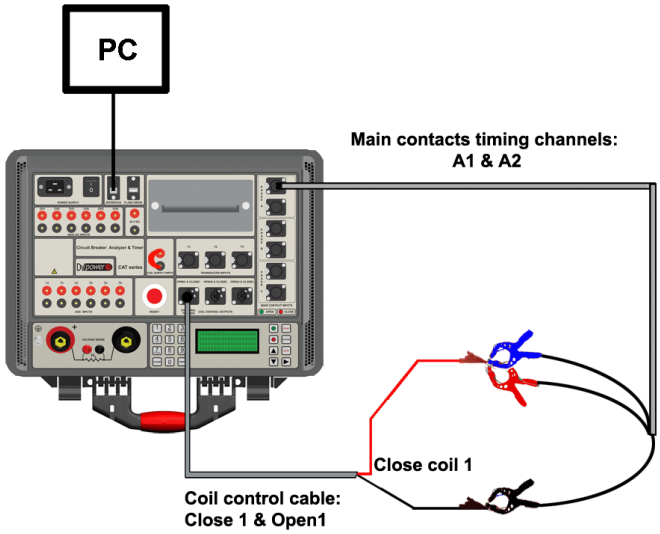


Figure 6-3: Coil Control test – connection

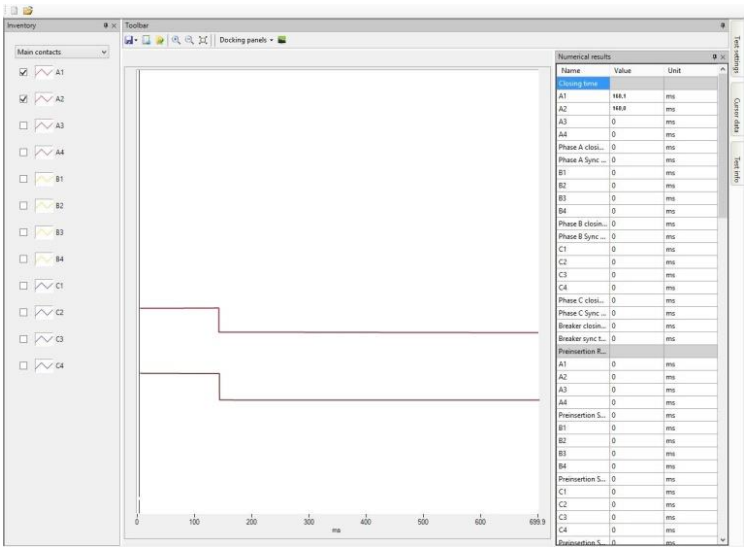


Figure 6-4: Coil control test – DV Win test results

7. Technical Data

Main contact inputs

- Number of contact inputs:
  - 6 (3 x 2), 2 per phase (CAT64A, CAT65, CAT66)
  - 3 (3 x 1), 1 per phase (CAT35, CAT36)
- Each channel detects main and pre-insertion resistor contacts.
  - Closed ≤ 10 Ω,
  - Resistor contacts range 10 Ω to 5 kΩ,
  - Open ≥ 5 kΩ

  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
- User selectable: dry or wet
- Contact sensing (dry):
  Open circuit voltage *20 V DC ± 20%*
  Short circuit current 25 mA ± 20%
  Closed threshold <600 Ω ± 30%.
  Open threshold> 600 Ω ± 30%.
- Voltage sensing (wet):
  Working voltage up to 300 V DC, 250 V AC
  Open state threshold <8 V, insensitive to polarity.
  Closed state threshold> 13 V, insensitive to polarity.
- Overcurrent and overvoltage protection

Coil driver

- Number of channels: 6 (3 open and 3 close coil)
- 6 separate outputs for coil triggering
- Driver characteristics: 300 V DC/AC_{max}, 35 A DC/AC_{max}
- Electronic drivers: it provides superior timing control
- Overcurrent and overvoltage protection
- Coil supply inputs for open and close coil: 300 V DC/AC_{max}, 35 A DC/AC_{max}

Coil resistance measurement

- 3 coils simultaneously (Open or Close)
- Measuring range / Resolution
  1 Ω - 99,9 Ω / 0,1 Ω
  100 Ω – 999 Ω / 1 Ω
- Typical accuracy ± (0,5 % rdg + 0,5 % FS)

Time measurement

Time measurement resolution:

- 0,025 ms for 1 s test duration (sampling rate 40 kHz)
- 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 rate100 Hz)

Time accuracy ±0,05% of the reading ± 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, 6 channels, Hall-Effect sensor
- Range ±35 A AC/DC to 5 kHz
- Resolution: 25 mA
- Accuracy ± (0,5 % rdg + 0,1 % 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 (Open 1 & Close 1), input voltage: 10 V – 300 V AC/DC
- Coil currents: threshold level user selectable
- Auxiliary inputs
- Analog inputs: threshold level user selectable

Analog inputs

- 6 channels – Coil current measurement
- 6 Voltage channels, each channel has four measurement ranges: ±1 V, ±5 V, ±60 V and ±300 V AC/DC
- Typical accuracy:
  ± (0,1% rdg + 0,05% FS) up to 10 V AC /DC
  ± (0,5% rdg + 0,1% FS) up to 300 V AC/DC

The analog inputs are isolated with respect to all other circuits

DC output

- 24 V voltage supply for current clamps

Printer (optional)

- Thermal printer
- Graphic and numeric printout
- Paper width 112 mm / 4.4 in

The print density is guaranteed within range: 5°C to 40°C, 20 to 85% relative humidity, non-condensing

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 µΩ - 999,9 mΩ
- Resolution 0,1 µΩ
- Accuracy ± (0,1 % rdg + 0,1 % FS)

Dynamic resistance measurement

- Voltage and current measuring channels
- DRM sampling rate 40 kHz (0,025 ms time resolution)
- Resolution 16 bit
- Breaker operations available for DRM test:
  - Open (O)
  - Close (C)
  - O – C (auto reclose)
  - C – O (make brake)

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:
  from 10,7 kg (23.5 lbs) up to 13.2 kg (29.1 lbs) depending on the model and built-in features

Internal Memory

- Store up to 500 test records (including numerical and graphical results)

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 (without use of Micro Ohmmeter)
  - 1900 VA (with use of Micro Ohmmeter 200 A)
  - 3900 VA (with use of Micro Ohmmeter 500 A)

Applicable Standards

- Installation/overvoltage: category II
- Pollution: degree 2
- Safety: LVD 2014/35/EU (CE Conform)
  Standard EN 61010-1
- EMC: Directive 2014/30/EU (CE Conform)
  Standard EN 61326-1:2006
- CAN/CSA-C22.2 No. 61010-1

Environmental conditions

- Operating temperature:
  -20 ºC - + 55 ºC / -4 ºF - +131 ºF
- Storage & transportation:
  -40 ºC - + 70ºC / -40 ºF - +158 ºF
- Humidity 0 % - 95 % relative humidity, non-condensing

Warranty

- 3 years' warranty + additional 1 (one) year upon registration on DV Power official website (www.dv-power.com).

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

8. The Instrument & Accessories

CAT35

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

Auxiliary contact inputs: 6
Analog contact inputs: 6
Coil control outputs: 6
Transducer inputs: 3

Static resistance measurement:
Built-in Micro Ohmmeter 200 A

Optional:
High precision module (built-in)
BSG on Live Tank AIS
BSG on Dead Tank AIS

CAT36

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

Auxiliary contact inputs: 6
Analog contact inputs: 6
Coil control outputs: 6
Transducer inputs: 3

Static resistance measurement:
Built-in Micro Ohmmeter 500 A

Optional:

High precision module (built-in)
BSG on Live Tank AIS
BSG on Dead Tank AIS
BSG on GIS

CAT64A

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

Auxiliary contact inputs: 6
Analog contact inputs: 6
Coil control outputs: 6
Transducer inputs: 3

Static resistance measurement: Not available

Optional:
BSG on Live Tank AIS

CAT65

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

Auxiliary contact inputs: 6
Analog contact inputs: 6
Coil control outputs: 6
Transducer inputs: 3

Static resistance measurement:
Built-in Micro Ohmmeter 200 A

Optional:
High precision module (built-in)
BSG on Live Tank AIS
BSG on Dead Tank AIS

CAT66

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

Auxiliary contact inputs: 6
Analog contact inputs: 6
Coil control outputs: 6
Transducer inputs: 3

Static resistance measurement
Built-in Micro Ohmmeter 500 A

Optional:
High precision module (built-in)
BSG on Live Tank AIS
BSG on Dead Tank AIS
BSG on GIS

Instrument with included accessories	Article No
Circuit Breaker Analyzer & Timer CAT35	CAT3500-N-01
Circuit Breaker Analyzer & Timer CAT36	CAT3600-N-01
Circuit Breaker Analyzer & Timer CAT64A	CAT64A0-N-01
Circuit Breaker Analyzer & Timer CAT65	CAT6500-N-01
Circuit Breaker Analyzer & Timer CAT66	CAT6600-N-01
USB memory stick	
DV-Win software	
USB cable	
Mains power cable	
Ground (PE) cable	
Transport case	

Standard accessories	Article No
Main contact cables 5 m (16.4 ft) with SCT clamps*	CM-05-65MXST
Main contact cables 5 m with SCT clamps**	CM-05-34MXST
Main contact cables extension 10 m (32.8 ft)	E3-10-65MXFX
Main contact cables extension 5 m (16.4 ft)	E3-05-65MXFX
Coil control cable set 5 m (16.4 ft) with banana plugs (Single-pole control - 6 coil channels)	CO-05-6BC5B1
Coil supply cable set 4 x 5 m 2,5 mm^2 (16.4 ft, 13 AWG) with banana plugs	CS-05-02BPBP
Auxiliary contacts cable set 10 x 5 m (16.4 ft) with banana plugs	AX-05-02BPBP
Analog channels cable set 8 x 5 m (16.4 ft) with banana plugs	AN-05-02BPBP
Current cables 2 x 10 m 25 mm^2 (32.8 ft, 3 AWG) with battery clamps***	C2-10-25VMB1
Current cables 2 x 10 m 50 mm^2 (32.8 ft, 0 AWG) with battery clamps****	C2-10-50VMB3
Sense cables 2 x 10 m (32.8 ft) with alligator clamps	S2-10-02BPA1
Cable plastic case - large size (x 2)	CABLE-CAS-03

* Standard accessories for CAT64A, CAT65 and CAT66
** Standard accessories for CAT35 and CAT36
*** Standard accessories for CAT35 and CAT65
**** Standard accessories for CAT36 and CAT66

Optional accessories and features	Article No
Both Sides Grounded (BSG) of AIS (Air Insulated Substation) Live Tank Circuit Breaker for CAT3x Advanced series (3 channels - one break per phase) (available with CAT35 and CAT36)	BSG-CATII-00
Both Sides Grounded (BSG) of AIS (Air Insulated Substation) Live Tank Circuit Breaker for CAT6x and CAT12x Advanced series (6 channels - two breaks per phase) (available with CAT65, CAT66)	BSG-CATII-01
Both Sides Grounded (BSG) of AIS (Air Insulated Substation) Dead Tank Circuit Breaker for CAT Advanced series (available with CAT35, CAT36, CAT65, CAT66)	BSG-CATDTB-0
BSG on GIS feature for CAT Advanced series (available with CAT36 and CAT66)	BSG-CATGIS-0
Current cables with branch connectors 2 x (3 x 5 m, 16 mm2) with SCT clamps	C6BC-05-16GMST
Extension cables 2 x 5 m 50 mm2	E2-05-50VMVF
AC Current clamp 1 A / 1 V and cable 5 m with banana plugs	CACL-ACBP-05
Built-in high precision measurement module (available with CAT35, CAT36, CAT65 and CAT66)	RMO-HPMM-DG0
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
Cable plastic case with wheels - large size	CABLE-CAS-W3

Control cabinet cables	
Coil control cable set 10 m with banana plugs (Single-pole control -6 coil channels)	CO-10-6BC5B1
Coil control cable set 15 m with banana plugs (Single-pole control -6 coil channels)	CO-15-6BC5B1
Coil control cable 5 m with banana plugs (Three-pole control - 2 coil channels)	CO-05-00C5B1
Coil control cable 10 m with banana plugs (Three-pole control - 2 coil channels)	CO-10-00C5B1
Coil control cable 15 m with banana plugs (Three-pole control - 2 coil channels)	CO-15-00C5B1
Jumper cable 1 x 15 cm 2,5 mm2 with banana plugs (black)	JCB-15-2BPBP
Jumper cable 1 x 15 cm 2,5 mm2 with banana plugs (red)	JCR-15-2BPBP
Auxiliary contacts cable set 12 x 5 m with banana plugs	AX-05-02BPBP
Auxiliary contacts cable set 12 x 10 m with banana plugs	AX-10-02BPBP
Auxiliary contacts cable set 12 x 15 m with banana plugs	AX-15-02BPBP
Analog channels cable set 12 x 5 m with banana plugs	AN-05-02BPBP
Analog channels cable set 12 x 10 m with banana plugs	AN-10-02BPBP
Analog channels cable set 12 x 15 m with banana plugs	AN-15-02BPBP
Main contact cables	
Main contact cables 3 m (9.8 ft) with SCT clamps (for CAT35, CAT36)	CM-03-34MXST
Main contact cables 3 m (9.8 ft) with SCT clamps (for CAT64A, CAT65, CAT66)	CM-03-65MXST
Main contact cables 3 m (9.8 ft) with alligator clamps (for CAT35, CAT36)	CM-03-34MXA2
Main contact cables 5 m (16.4 ft)with alligator clamps (for CAT35, CAT36)	CM-05-34MXA2
Main contact cables 3 m (9.8 ft) with alligator clamps (for CAT64A, CAT65, CAT66)	CM-03-65MXA2
Main contact cables 5 m (16.4 ft) with alligator clamps (for CAT64A, CAT65, CAT66)	CM-05-65MXA2

Main contact cables extension	
Main contact cables Extension 5 m (16.4 ft) (for CAT35, CAT36, CAT64A, CAT65, CAT66)	E3-05-65MXFX
Main contact cables Extension 15 m (49.2 ft) (for CAT35, CAT64A, CAT65, CAT66)	E3-15-65MXFX
Current cables	
Current cables 2 x 5 m 50 mm^2 (32.8 ft, 0 AWG) with battery clamps (for CAT36 and CAT66)	C2-05-50VMB3
Current cables 2 x 15 m 70 mm^2 (49.2 ft, 00 AWG) with battery clamps (for CAT36 and CAT66)	C2-15-70VMB3
Current cables 2 x 5 m 25 mm^2 (32.8 ft, 3 AWG) with battery clamps (for CAT35, CAT65 and CAT125)	C2-05-25VMB1
Current cables 2 x 15 m 35 mm^2 (49.2 ft, 2 AWG) with battery clamps (for CAT35, CAT65 and CAT125)	C2-15-35VMB1
Sense cables	
Sense cables 2 x 5 m (32.8 ft) with alligator clamps A2	S2-05-02BPA2
Sense cables 2 x 15 m (49.2 ft) with alligator clamps A2	S2-15-02BPA2
Transducers	
Digital rotary transducer with 5 m (16.4 ft) connection cable	DRT-250-C605
Digital rotary transducer with 10 m (32.8 ft) connection cable	DRT-250-C610
Digital rotary transducer with 5 m (16.4 ft) connection cable with accessories	DRT-SET-0005
Digital rotary transducer with 10 m (32.8 ft) connection cable with accessories	DRT-SET-0010
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
Three phase digital rotary transducer kit (with 5 m connection cable)	TPH-DRTS-005
Online first trip test kit - Three-pole control for CAT Advanced series	ONFTT-KIT-01
Online first trip test kit - Single-pole control for CAT Advanced series	ONFTT-KIT-00
Transducer mounting kits	
Universal transducer mounting kit	UTM-KIT-0000
Universal transducer mounting kit - extended version	UTM-KIT-0001
Doble transducer adapter	DTA-BOX-C002

9. Members Area

DV Power customer can create account to get access to **DV Power Members Area**. By creating an account with DV Power you get access to:

- Application Notes
- Published Articles

To create an account please visit DV Power register on page: **dv-power.com/register/**.
If you register a valid DV Power instrument you will get access to:

- DV-Win Software
- Manuals
- Troubleshooting Guides

To register an instrument please log in and visit **dv-power.com/register-new-product/**. Your access will be granted after a verification process for which is normally one working day required.

If you require additional help during the process of registration, please contact us via e-mail support@dv-power.com.

10. Customer Service

Before calling or sending an e-mail to the DV Power Customer Service for assistance, please perform the following steps:

- Check all cable connections.
- If possible, try testing on another instrument of the same type
- Perform the troubleshoot procedure as described above in the Section “Troubleshooting Guide”.
- Provide following information: instrument serial number, instrument's installed software revision number, details about a PC configuration used and operating system installed.
- As comprehensive as possible description of the problem, including DUT (Device under Test), error messages and the sequence of events before the problem appeared.

The DV Power Customer Service can be reached at:

Local support (Sweden): +46 8 731 78 24

International support: +46 70 0925 000

North America support: +1 800 599 8113 (available until 16:00 EDT)

E-mail: support@dv-power.com

Note: **The preferred contact is via e-mail. In this way the case is documented and traceable. Also time zone problems and busy telephone lines do not delay the response.**

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11. Packing the Instrument for Shipment

Prior to sending the instrument to DV Power for servicing, please contact the DV Power Customer Service at:

Local support (Sweden): +46 8 731 78 24

International support: +46 70 0925 000

E-mail: support@dv-power.com

for the return instructions.

CAUTION: **DV Power is not responsible for any damage during shipping. Please carefully protect each instrument from shipping and handling hazards. Ensure the protective covers are securely in place.**
Instrument has to be sent to DV Power as freight pre-paid, unless other arrangements have been authorized in advance by the DV Power Customer Service.

To prepare the instrument for shipment:

1. Disconnect and remove all external cables. Do not include manuals, cables, and transducer connecting rods unless recommended by the DV Power Customer Service.

2. Reuse the original packing material if it is available.

If it is not available:

Pack the instrument following a practice used for fragile electronic equipment. It has to include a 2-wall minimum corrugated cardboard box with minimum 5 cm (2 inch) thick poly foam padding, or a wooden crate with minimum of 5 cm (2 inch) thick poly foam pads wrapping the instrument completely.

IBEKO Power AB 2022

Manufacturer contact information

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