CIBANO 500 PTM

User Manual

Manual Version: CIBANO500PTM.ENU.2

The product information, specifications, and technical data embodied in this manual represent the technical status at the time of writing and are subject to change without prior notice.

We have done our best to ensure that the information given in this manual is useful, accurate and entirely reliable. However, OMICRON electronics does not assume responsibility for any inaccuracies which may be present.

The user is responsible for every application that makes use of an OMICRON product.

OMICRON electronics translates this manual from the source language English into a number of other languages. Any translation of this manual is done for local requirements, and in the event of a dispute between the English and a non-English version, the English version of this manual shall govern.

Contents

Using This Manual

This User Manual provides information on how to use the *CIBANO 500* test system safely, properly and efficiently. The CIBANO 500 PTM User Manual contains important safety rules for working with *CIBANO 500* and gets you familiar with operating *CIBANO 500*. Following the instructions in this User Manual will help you to prevent danger, repair costs, and avoid possible down time due to incorrect operation.

The CIBANO 500 PTM User Manual always has to be available on the site where *CIBANO 500* is used. The users of *CIBANO 500* must read this manual before operating *CIBANO 500* and observe the safety, installation, and operation instructions therein.

Reading the CIBANO 500 PTM User Manual alone does not release you from the duty to comply with all national and international safety regulations relevant to working on high-voltage equipment.

Operator Qualifications and Safety Standards

Working on high-voltage assets can be extremely dangerous. Consequently, only qualified, skilled and authorized personnel are allowed to work with *CIBANO 500*. Before starting to work, clearly establish the responsibilities.

Personnel receiving training, instructions, directions, or education on *CIBANO 500* must be under constant supervision of an experienced operator while working with the equipment.

Testing with *CIBANO 500* must comply with the internal safety instructions and all additional safety relevant documents.

In addition, observe the following safety standards, if applicable:

- EN 50191 (VDE 0104) "Erection and Operation of Electrical Test Equipment"
- EN 50110-1 (VDE 0105 Part 100) "Operation of Electrical Installations"
- IEEE 510 "IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing"

Symbols Used

In this manual, the following symbols indicate safety instructions for avoiding hazards.

Symbol	Description
	**Caution:** Equipment damage or loss of data possible
	**Warning:** Personal injury or severe damage to objects possible

1 Safety Instructions

Before operating the *CIBANO 500* test system and its accessories, read the following safety instructions carefully. Do not turn on *CIBANO 500* and do not operate *CIBANO 500* without understanding the safety information in this manual. If you do not understand some safety instructions, contact OMICRON before proceeding.

Maintenance and repair of *CIBANO 500* and its accessories is only permitted by qualified experts at OMICRON Service Centers except for hardware update options delivered with the relevant Supplementary Sheet.

1.1 Safety Rules

Always observe the following safety rules:

- Disconnect completely.
- Secure against re-connection.
- Verify that the installation is dead.
- Carry out grounding and short-circuiting.
- Provide protection against adjacent live parts.
- Ground the test object at one or more terminals during connecting, testing and disconnecting.

1.2 Operating the Measurement Setup

When operating the *CIBANO 500* test system and its accessories, observe the following safety instructions:

- Do not modify, extend, or adapt *CIBANO 500* and its accessories.
- Use only the *CIBANO 500* original accessories and cables and only use the OMICRON accessories together with OMICRON devices as described in this manual.
- Use only adequately rated power cords.
- Do not insert objects (for example, screwdrivers) into any input/output socket.
- Do not operate *CIBANO 500* without a solid connection to ground of at least 6 mm^2 cross-section. Ground *CIBANO 500* as close as possible to the operator.
- Supply *CIBANO 500* only from a power outlet with protective earth (PE).
- Position the measurement setup so that you can easily disconnect *CIBANO 500* from mains.
- To run *CIBANO 500* at maximum power level, mains overcurrent protection with a 16 A automatic circuit breaker is recommended.
- Do not use extension cables on a cable reel to prevent overheating of the cord. Instead, run out the extension cord.
- The warning symbol on the side panel of *CIBANO 500* (see 2.2.2 "Side Panel" on page 16) indicates dangerous voltage on one of the *CIBANO 500* sockets, either from an internal source or from an external one, for example, from the station battery. If the green light on the front panel (see Figure 2-1 "Front view of CIBANO 500" on page 15) is on, no external voltage is applied (to be sure, disconnect all cables) and the warning symbol is flashing, *CIBANO 500* is defective. In this case, do not use *CIBANO 500* and contact your regional OMICRON Service Center.

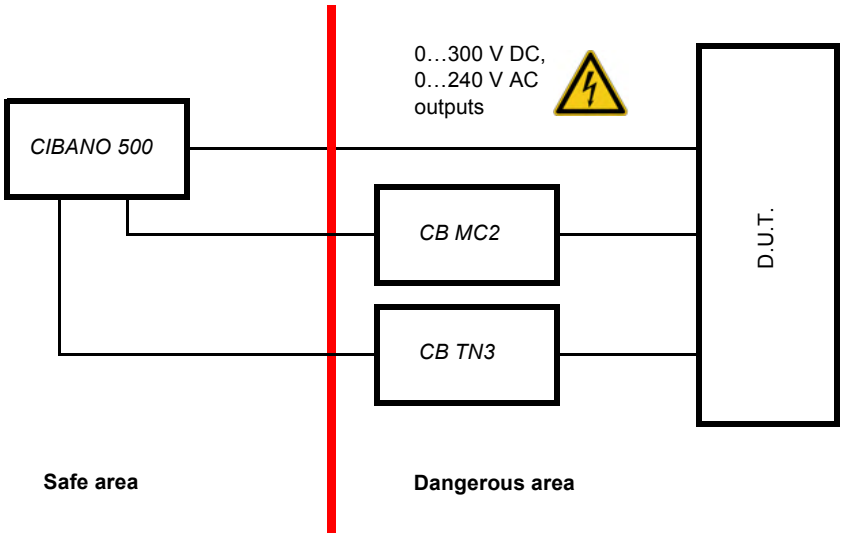


Figure 1-1 Example of the separation of the safe and dangerous areas

- All AC and DC output sockets of *CIBANO 500* can carry life-hazardous voltage potential and provide life-hazardous currents. To avoid personal injury or severe damage to objects:
  - When connecting cables to the input and output sockets, use wires with either 4 mm safety banana connectors fulfilling the requirements of 300 V CAT III or, if applicable, with the especially manufactured counterpart supplied by OMICRON.
  - Do not stand right next to or directly underneath the connection to the test object to avoid personal injury due to falling clamps (physical and electrical hazard).
  - After booting *CIBANO 500* either the red or the green warning light on the front panel should be on. If after booting both warning lights are on or off *CIBANO 500* might be defective. In this case, do not use *CIBANO 500* and contact your regional OMICRON Service Center.
  - Always insert connectors completely.
- Operate *CIBANO 500* and its accessories only under ambient conditions specified in "Technical Data" in the CIBANO 500 User Manual.
- Make sure to position the test equipment on dry, solid ground.
- Do not operate *CIBANO 500* and its accessories in the presence of explosives, gas or vapors.
- If *CIBANO 500* or its accessories do not seem to function properly, stop using them and contact your regional OMICRON Service Center.

1.3 Orderly Measures

The CIBANO 500 PTM User Manual always has to be available on the site where *CIBANO 500* is operated. The users of *CIBANO 500* must read this manual before operating *CIBANO 500* and observe the safety, installation, and operation instructions therein.

Warning: The *CIBANO 500* test system and its accessories may be used only as described in "Application" in the CIBANO 500 User Manual. Any other use is not in accordance with the regulations.

The manufacturer and the distributor are not liable for damage resulting from improper usage. The user alone assumes all responsibility and risk.

Following the instructions provided in this User Manual is also considered part of being in accordance with the regulations.

Breaking the seal to open the *CIBANO 500* housing invalidates all warranty claims.

1.4 Disclaimer

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

2 Introduction

2.1 Designated Use

CIBANO 500, in conjunction with its accessories or as stand-alone unit, is a test system for commissioning and maintenance of circuit breakers. The following tests can be performed using *CIBANO 500* according to IEC and ANSI standards:

- Main contact resistance measurement (μΩ meter)
- Minimum pick-up voltage measurement of trip and close coils
- Main and resistive contact timing measurement
- Sending trip and close commands to perform different operations:
  - Open (O)
  - Close (C)
  - Reclose (OC)
  - Trip-free (CO)
  - Autoreclose (O-CO)
  - CO-CO
  - O-CO-CO
- Main contact dynamic resistance measurement enabling users to perform the operations listed earlier in this section
- Along with timing and dynamic resistance measurements, the following measurements can be included:
  - Trip and close coil current and voltage
  - Motor current and voltage
  - Test of under voltage trip function
  - Main contact travel

CIBANO 500 operates only when connected to an external computer through an Ethernet connection. By using the *Primary Test Manager* software, you can define, parametrize, and execute various, partly automated tests.

2.2 Connections and Operating Controls

CIBANO 500 is available in two interface options:

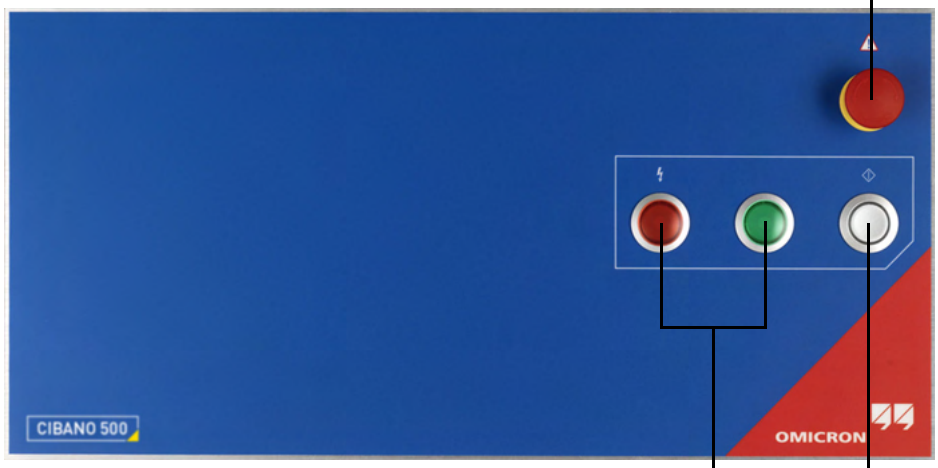
- 4×EtherCAT®[1]
- 1×EtherCAT®, 3×AUX

In this User Manual, both options are referred to as *CIBANO 500* and the different option features are described, if applicable.

The following figures describe the connections and operating controls of *CIBANO 500*.

1. EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

2.2.1 Front Panel



Emergency Stop button
Press the button to *immediately* shut off all current and voltage outputs.
See 2.2.4 "Emergency Stop Button" on page 19

Warning lights indicating safe operation and possible hazardous voltage and/or current levels at the *CIBANO 500* outputs
See Table 2-1 "Warning Lights" on page 18.

Measurement Start/Stop button
Press the button to enable the *CIBANO 500* outputs and start a measurement.
Press the button once more to stop the measurement.

Figure 2-1 Front view of *CIBANO 500*

Warning: Do not cover the warning lights (for example, with a computer). The warning lights indicate possible hazards. Disregarding the warning signals can cause personal injury or death of the operating staff.

2.2.2 Side Panel

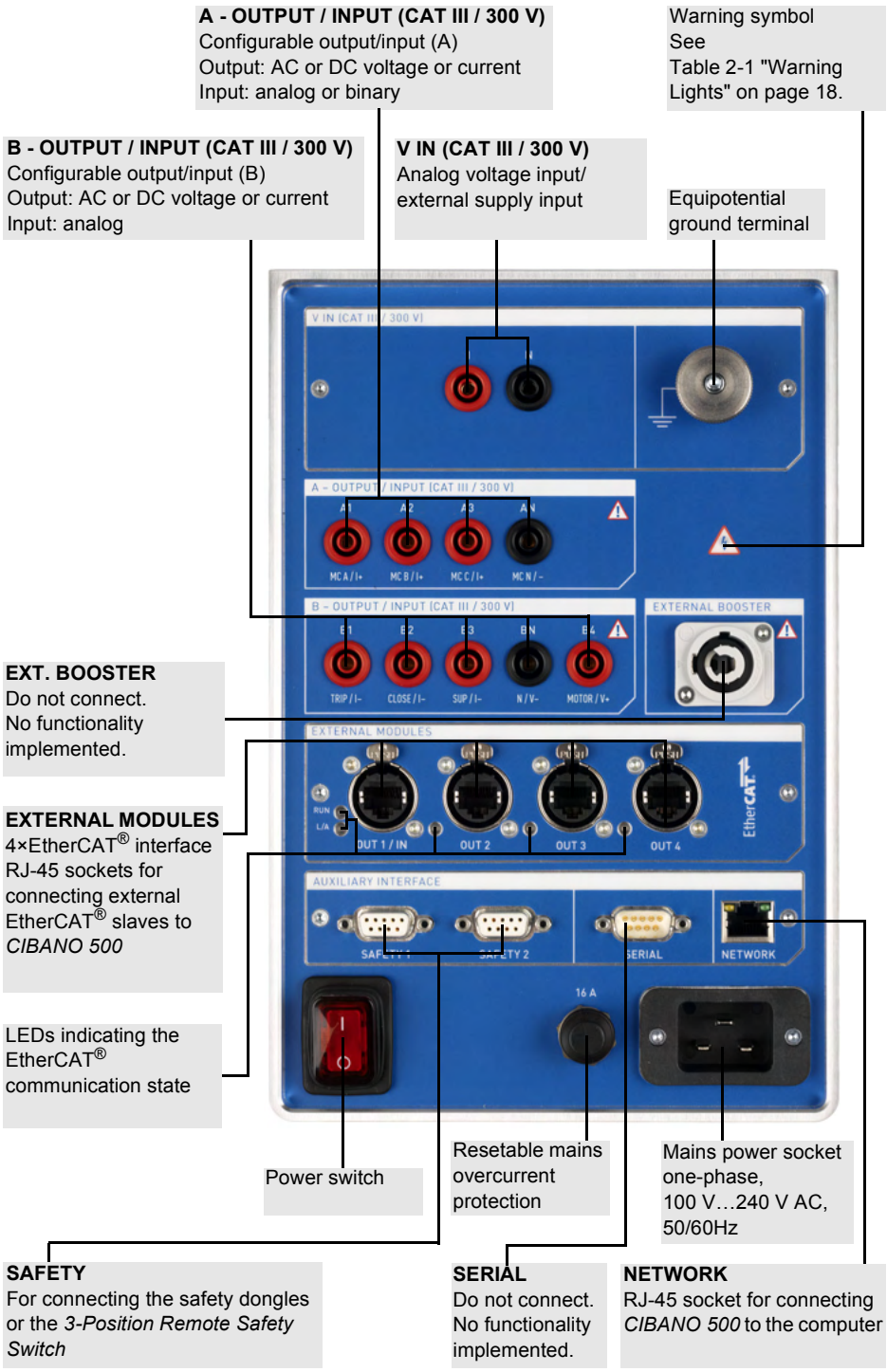


Figure 2-2 Side view of *CIBANO 500* (4×EtherCAT®) option

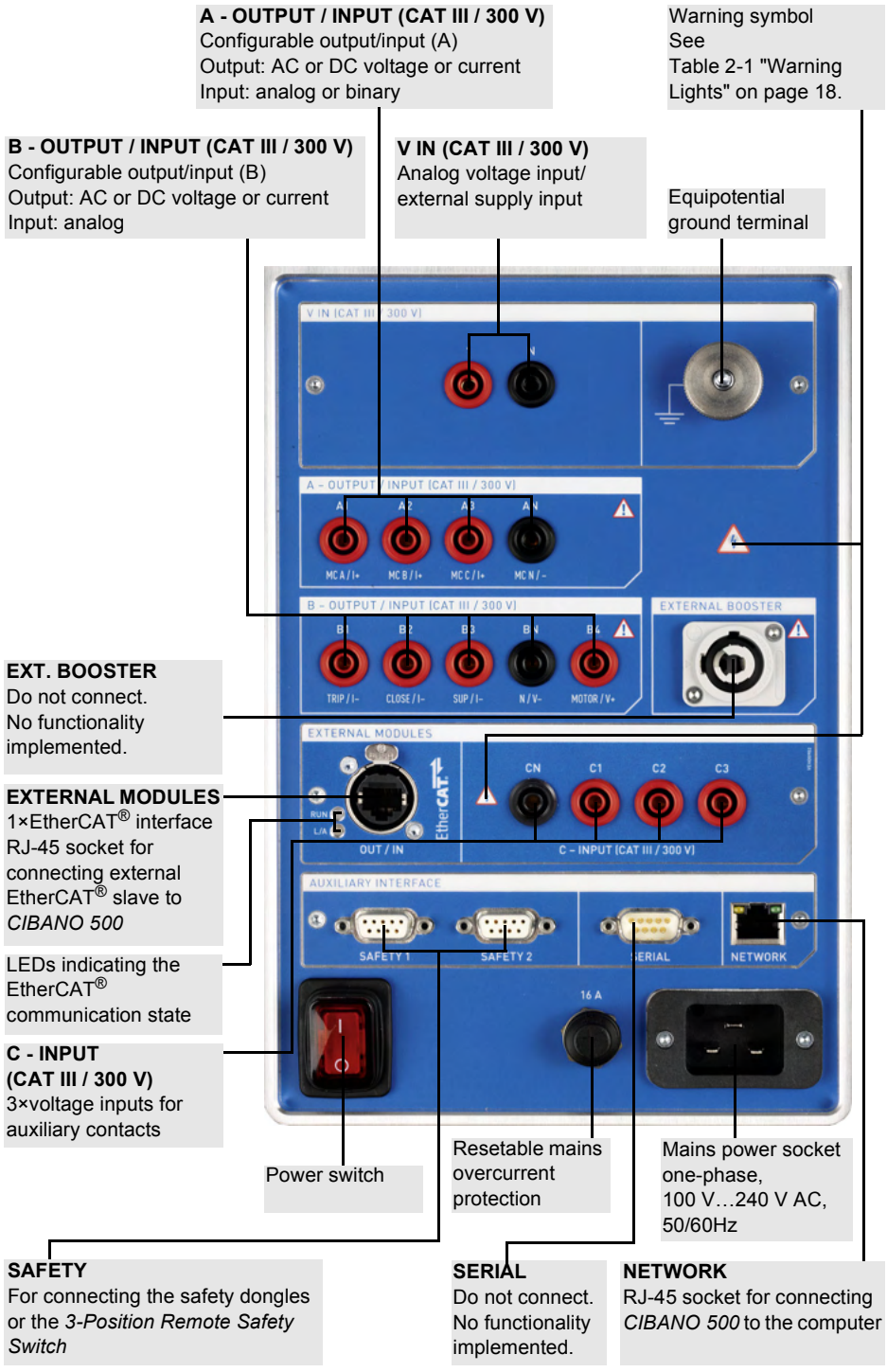


Figure 2-3 Side view of *CIBANO 500* (1×EtherCAT®, 3×AUX) option

2.2.3 Warning Lights

CIBANO 500 provides the following warning lights to indicate safe operation and possible hazards.

Table 2-1 Warning Lights

Warning Light	Description	*CIBANO 500* State	Operating Condition
	Green light on the front panel is on.	*CIBANO 500* is up and running in the stand-by mode.	Safe operating condition as long as no voltage is applied from outside (As long as the warning symbol on the side panel is off.)
	Blue ring on the **Measurement Start/Stop** button is on.	A test is prepared and ready to start.	
	Blue ring on the **Measurement Start/Stop** button is flashing.	A test is running. Possibly there are hazardous voltage and/or current levels at the *CIBANO 500* outputs.	 **Dangerous operating condition**
	Red light on the front panel is flashing.	A test is running. Possibly there are hazardous voltage and/or current levels at the *CIBANO 500* outputs.	 **Dangerous operating condition**
	Warning symbol on the side panel is flashing.	There are hazardous voltage and/or current levels at the *CIBANO 500* inputs/outputs independent of the measurement state.	 **Dangerous operating condition**

2.2.4 Emergency Stop Button

Pressing the **Emergency Stop** button *immediately* shuts off all *CIBANO 500* outputs and stops the running measurement. After pressing the **Emergency Stop** button, *Primary Test Manager* does not allow starting a measurement.

To restart the measurement after the reason for the emergency stop has been resolved, release the **Emergency Stop** button by carefully turning it, click the **Start** button in *Primary Test Manager*, and then press the **Measurement Start/Stop** button.

For information about the *CIBANO 500* accessories, see "Accessories" in the CIBANO 500 User Manual.

2.3 *Primary Test Manager*

Primary Test Manager is a control software for testing circuit breakers with the *CIBANO 500* test system. *Primary Test Manager* provides a computer interface to the test set and assists you with the hardware configuration and test assessment.

With *Primary Test Manager*, you can create new manual tests, open manual tests, and execute the tests. For a specified test, you can make measurements by just pressing the **Measurement Start/Stop** button on the front panel of the *CIBANO 500* test system. After you have performed a test, you can generate exhaustive test reports. *Primary Test Manager* runs on a computer and communicates with the test set through Ethernet interface.

For detailed information about *Primary Test Manager*, see "Using Primary Test Manager" in the CIBANO 500 User Manual.

3 Functional Scheme

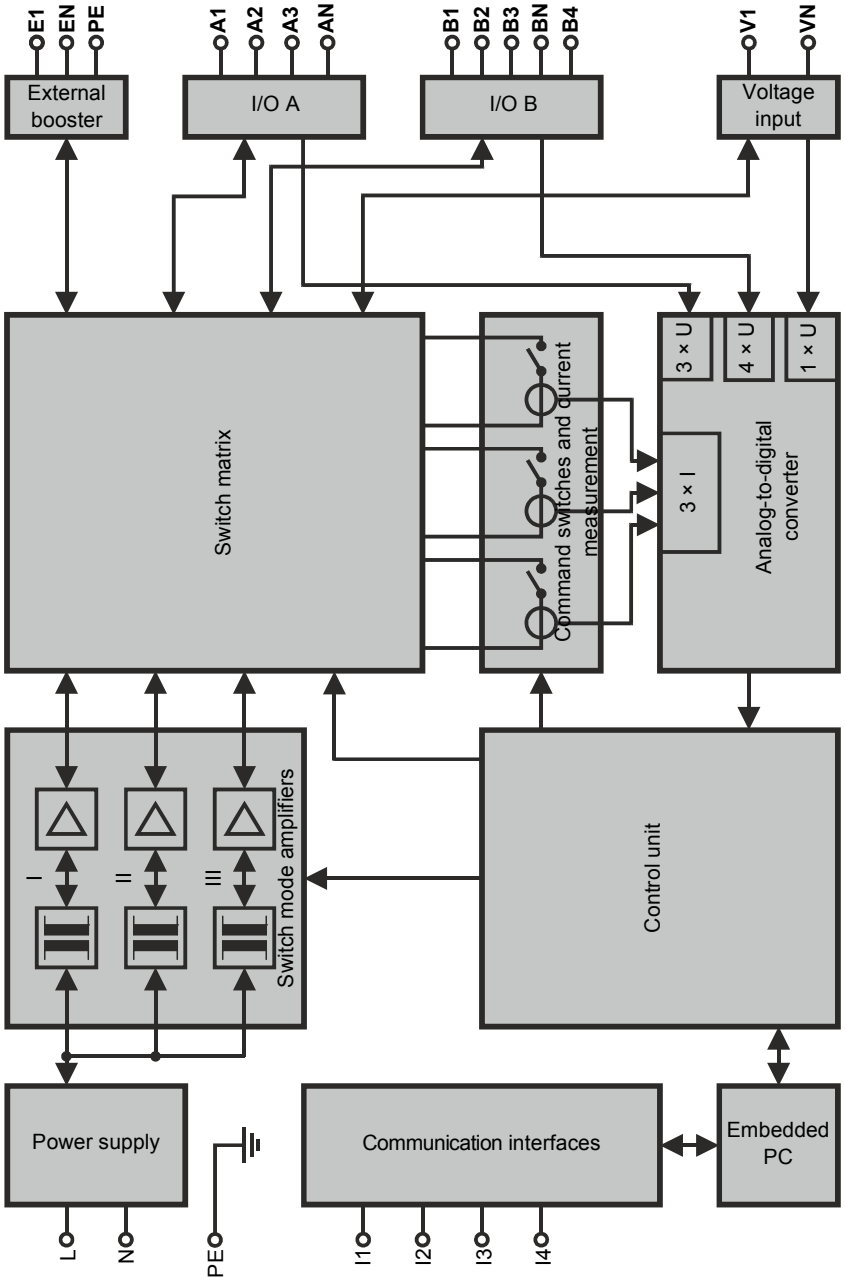


Figure 3-1 *CIBANO 500* (4×EtherCAT®) option

The following table describes the terminals of the functional scheme of *CIBANO 500* (4×EtherCAT®) option.

Table 3-1 Terminals of *CIBANO 500* (4×EtherCAT®) Option

Terminal	Description
Mains interface	
L	Mains phase
N	Mains neutral
PE	Equipotential ground
Communication interfaces	
I1	4 × external EtherCAT® modules
I2	1 × Ethernet
I3	1 × serial
I4	2 × safety
External booster	
E1	External booster phase
EN	External booster neutral
PE	Equipotential ground
I/O A	
A1	Input/output A1
A2	Input/output A2
A3	Input/output A3
AN	Input/output AN
I/O B	
B1	Input/output B1
B2	Input/output B2
B3	Input/output B3
BN	Input/output BN
B4	Input/output B4
Voltage input	
V1	Voltage input 1
VN	Voltage input N

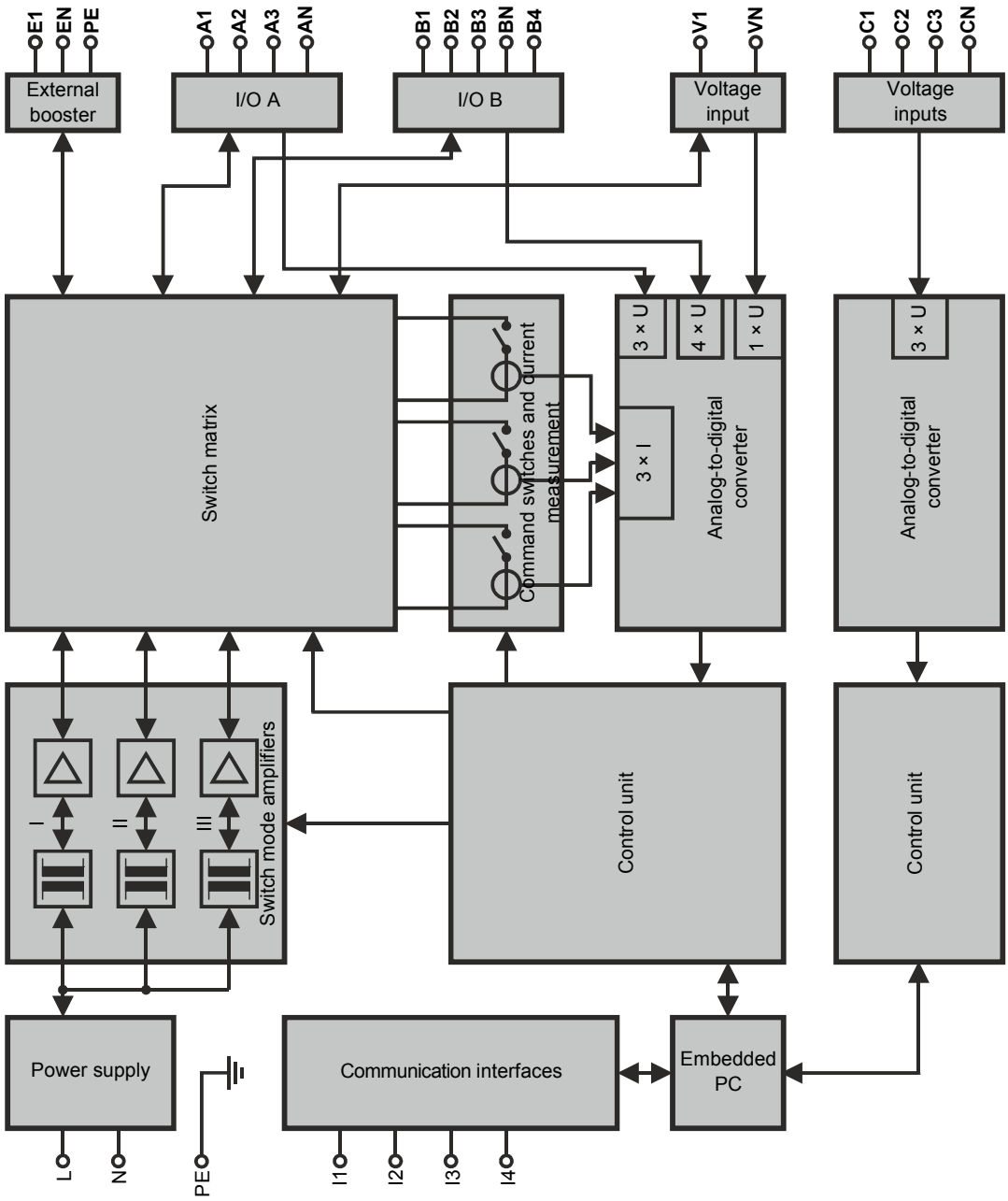


Figure 3-2 *CIBANO 500* (1×EtherCAT®, 3×AUX) option

The following table describes the terminals of the functional scheme of *CIBANO 500* (1×EtherCAT®,3×AUX) option.

Table 3-2 Terminals of *CIBANO 500* (1×EtherCAT®,3×AUX) Option

Terminal	Description
Mains interface	
L	Mains phase
N	Mains neutral
PE	Equipotential ground
Communication interfaces	
I1	1 × external EtherCAT® module
I2	1 × Ethernet
I3	1 × serial
I4	2 × safety
External booster	
E1	External booster phase
EN	External booster neutral
PE	Equipotential ground
I/O A	
A1	Input/output A1
A2	Input/output A2
A3	Input/output A3
AN	Input/output AN
I/O B	
B1	Input/output B1
B2	Input/output B2
B3	Input/output B3
BN	Input/output BN
B4	Input/output B4
Voltage inputs	
C1	Voltage input C1
C2	Voltage input C2
C3	Voltage input C3
CN	Voltage input CN

Table 3-2 Terminals of *CIBANO 500* (1×EtherCAT®,3×AUX) Option

Terminal	Description
Voltage input	
V1	Voltage input 1
VN	Voltage input N

3.1 Voltage Operating Mode

The following figure explains the *CIBANO 500* voltage operating mode.

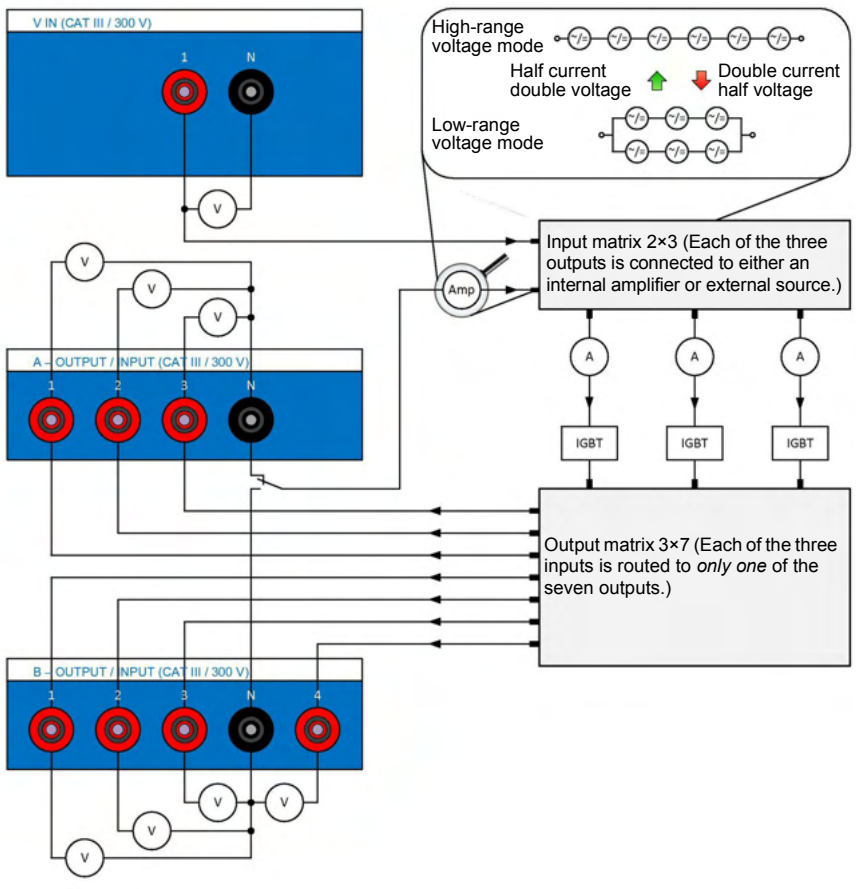


Figure 3-3 The *CIBANO 500* voltage operating mode

Figure 3-3 "The CIBANO 500 voltage operating mode" shows the switching of the internal amplifiers in the voltage operating mode. In this case seven channels are available: **A1**…**A3** and **B1**…**B4**. Three channels of these seven channels can be used synchronously but all either of the section **A** or the section **B**. You cannot use the outputs of both sections at the same time but only sequentially, one after each other.

The driving source of the channel can be either the internal amplifiers or an external source connected to the **V IN** input of *CIBANO 500*. Depending on the settings of the firmware the amplifier matrix in Figure 3-3 connects inputs of the IGBTs (integrated gate bipolar transistors) to either the internal amplifier or the external source. The socket matrix then routes the output of each of the three IGBTs to the seven channels on the *CIBANO 500* side panel. To apply a voltage to a socket the corresponding IGBT is closed.

Note: There is a certain voltage drop across the IGBTs which is not controlled by the source due to the design related issues of the device.

In comparison to the current operating mode (see the next section) in which you can select three individual amplifiers the voltage operating mode provides only one single amplifier composed of six amplifiers. Consequently, you cannot apply two different voltages at the same time but only sequentially. In the voltage operating mode, two modes are available: the high-range voltage mode and the low-range voltage mode. For the output data of the voltage operating mode, see 10.1 "CIBANO 500 Specifications" on page 179.

The current measurement is performed in series to each IGBT. The voltage is measured for each output individually.

3.2 Current Operating Mode

The following figure explains the *CIBANO 500* current operating mode.

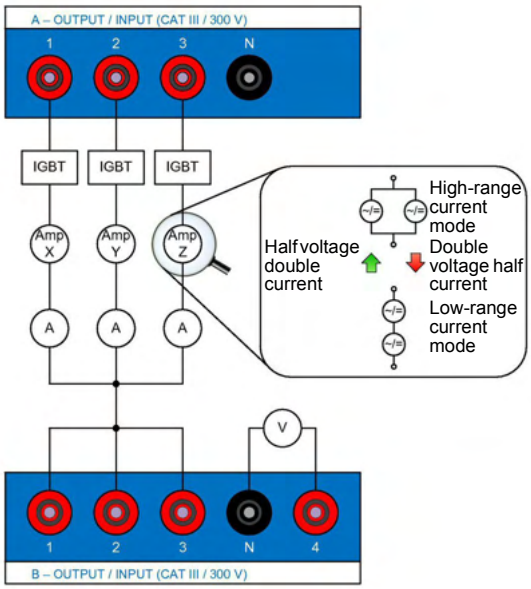


Figure 3-4 The *CIBANO 500* current operating mode

Figure 3-4 "The CIBANO 500 current operating mode" shows the switching of the internal amplifiers in the current operating mode. In this case three independent current channels are available: **A1**, **A2** and **A3**. These channels are driven by the amplifiers Amp X, Amp Y and Amp Z. The sockets **B1**, **B2** and **B3** are connected to the same potential, in this case to the neutral potential of the channels **A1**, **A2** and **A3**.

In the current operating mode, two modes are available: the high-range current mode and the low-range current mode. Each channel is equipped with two amplifiers giving a total of six amplifiers which can either be switched in parallel (high-current mode) or in series (low-current mode). For the output data of the current operating mode, see 10.1 "CIBANO 500 Specifications" on page 179.

4 Installation

This section describes how to put the *CIBANO 500* test system into operation. The *CIBANO 500* operation is controlled by the *Primary Test Manager* software. Consequently, before operating *CIBANO 500*, you must install *Primary Test Manager* and connect *CIBANO 500* to a computer.

4.1 Connect *CIBANO 500* to the Computer

CIBANO 500 communicates with the computer through Ethernet interface. To connect *CIBANO 500* to the computer:

1. Connect the delivered Ethernet cable to the **NETWORK** socket on the *CIBANO 500* side panel.
2. Connect the other end of the Ethernet cable to the Ethernet connector of your computer.
3. Check whether the safety dongels shipped with *CIBANO 500* are plugged in and locked in the **SAFETY** connectors on the side panel (see 2.2.2 "Side Panel" on page 16).

4.2 Power Up *CIBANO 500*

To power up *CIBANO 500*:

1. Connect the equipotential ground terminal of *CIBANO 500* (see 2.2.2 "Side Panel" on page 16) to ground as close as possible to the operator.
2. Plug the power cable into the power socket on the *CIBANO 500* side panel.
3. Plug the mains plug of the power cable into the power outlet.
4. Press the power switch on the *CIBANO 500* side panel.

4.3 Install *Primary Test Manager*

For the minimum requirements your computer needs to run the *Primary Test Manager* software, see "Technical Data" in the CIBANO 500 User Manual.

To install the *Primary Test Manager* software, put the delivered *Primary Test Manager* DVD in the DVD drive of your computer and follow the instructions on the screen.

4.4 Start *Primary Test Manager* and Connect to *CIBANO 500*

To start *Primary Test Manager*, click **Start** on the task bar, and then click **OMICRON Primary Test Manager**, or double-click the **OMICRON Primary Test Manager** icon on the desktop.

To connect to *CIBANO 500*, select the device in the list, and then click **Connect**.

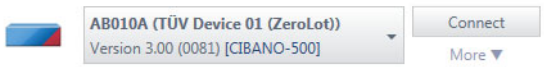


Figure 4-1 Connecting to *CIBANO 500*

If you could not connect to your *CIBANO 500* device and the green light is permanently on, wait a few seconds, and then do one of the following:

- Click **More** beneath the **Connect** button, and then click **Refresh**.
- Press F5.

If the *CIBANO 500* device to which you want to connect is not displayed in the list of available devices, proceed as described in "Troubleshooting" in the CIBANO 500 User Manual.

Alternatively, you can manage the connection to *CIBANO 500* in the *Primary Test Manager* status bar (see "Status Bar" in the CIBANO 500 User Manual).

For information about the upgrading the *CIBANO 500* embedded software and firmware, see "Maintenance" in the CIBANO 500 User Manual.

4.5 Connect *CIBANO 500* to the Test Object

Warning: Working on the high-voltage equipment can be extremely dangerous. Before connecting *CIBANO 500* to a test object, observe the safety rules (see1.1 "Safety Rules" on page 9) and all additional relevant laws and internal safety standards.

You can connect *CIBANO 500* to the test object without disconnecting other parts of the station or with complete disconnection from the station as shown in the following figure.

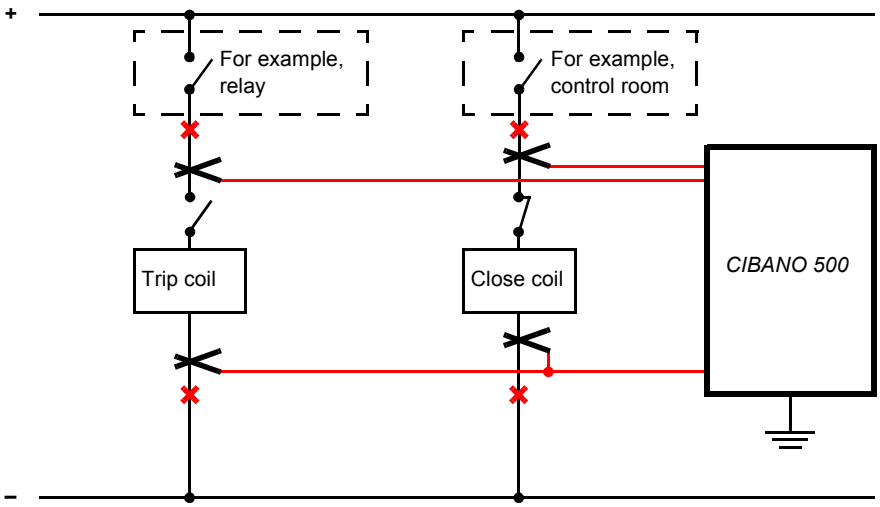


Figure 4-2 Principal connection of *CIBANO 500* to the test object

To connect *CIBANO 500* to the test object:

1. Connect the equipotential ground terminal of *CIBANO 500* (see 2.2.2 "Side Panel" on page 16) to ground as close as possible to the operator.

2. Do one of the following:
   - Assure that the points of connection carry no voltage. Voltage on the connection points can impact the safety of the operator but implies no danger to the test set. Clamp *CIBANO 500* to the circuit breaker's trip and close coils without disconnecting other parts of the station. The advantage of this method is that you do not need to modify the wiring of the circuit breaker to the station. The disadvantage is that it is difficult to ensure that there is no voltage on the points of connection. Connecting *CIBANO 500* while voltage is present on the connection point requires special safety precautions depending on the company and national standards and is explicitly not recommended by OMICRON.
   - Disconnect the circuit breaker at the points marked by the red crosses completely from the substations. Then clamp *CIBANO 500* to the circuit breaker's trip and close coils. You can often do it easily on medium-voltage breakers by removing a single plug and therefore recommended for maximum safety.

The following figures show typical *CIBANO 500* measurement setups for testing medium-voltage and high-voltage circuit breakers. Depending on the *Primary Test Manager* settings, many other configurations are possible.

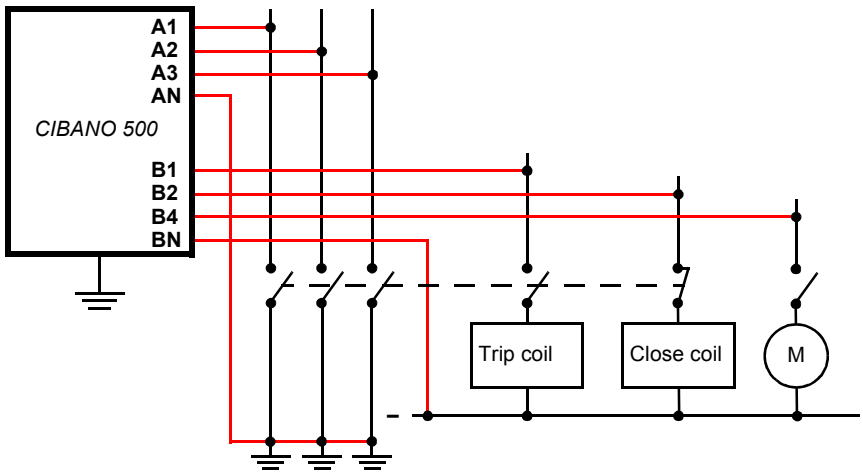


Figure 4-3 Typical measurement setup for the Timing test on medium-voltage circuit breakers with complete disconnection from the station

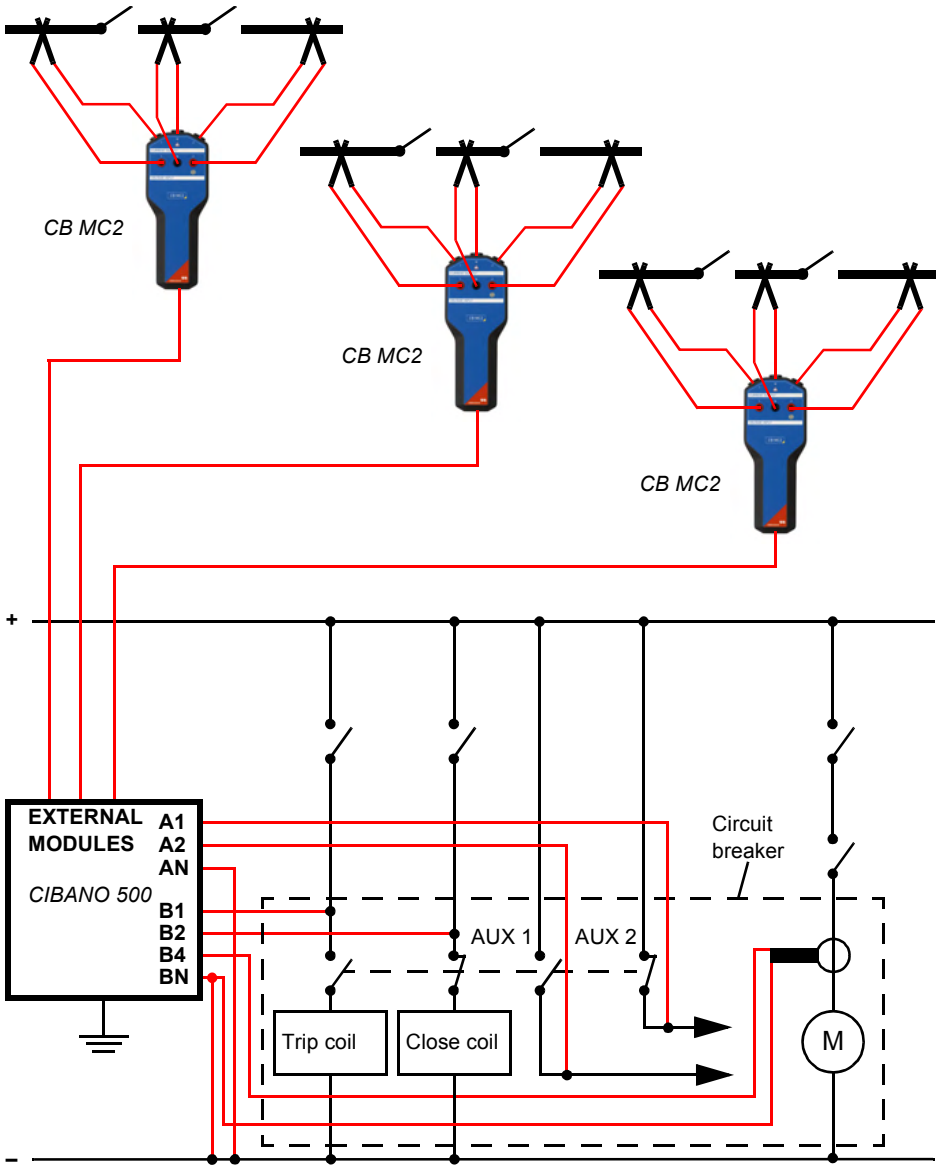


Figure 4-4 Typical measurement setup for testing high-voltage circuit breakers

5 Using *Primary Test Manager*

After starting *Primary Test Manager* for the first time on your computer, the following dialog box appears.

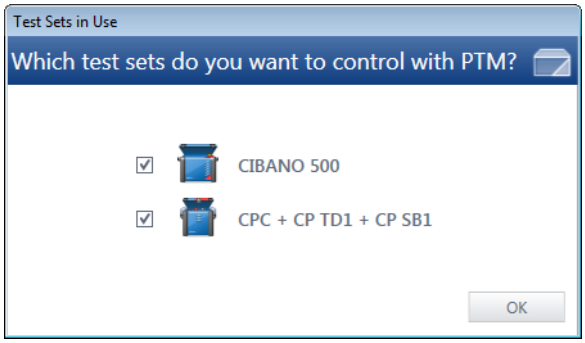


Figure 5-1 Selecting the test system

In the **Test Sets in Use** dialog box, select the test systems available for your test. *Primary Test Manager* generates lists of supported tests for the selected test systems.

After starting *Primary Test Manager*, the home view opens. In the home view, you can select different user tasks designed to support you during diagnostic testing and management of test objects and test data.

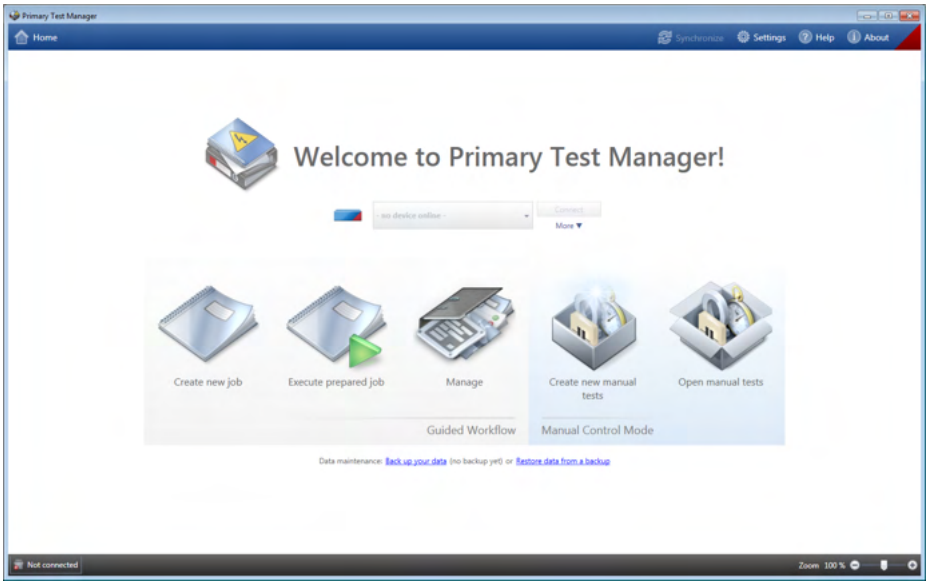


Figure 5-2 *Primary Test Manager* home view

Primary Test Manager currently supports testing with *CIBANO 500* in the manual control mode including the following user tasks.

Table 5-1 Selecting the User Tasks

Button	Description	Action
	Create new manual tests	Click the **Create new manual tests** button to create a manual test (see 5.3 "Create New Manual Tests" on page 45).
	Open manual tests	Click the **Open manual tests** button to open a manual test (see 5.4 "Open Manual Tests" on page 54).

5.1 Title Bar

Note: The title bar is displayed in any *Primary Test Manager* view.

The following table describes the title bar commands.

Table 5-2 Title Bar Commands

Command	Action
Home	Click **Home** to move from any view to the home view.
Settings	Click **Settings** to open the **Settings** dialog box (see 5.1.1 "Settings" on page 37).
Help	Click **Help** to open the CIBANO 500 PTM User Manual (see 5.1.2 "Help" on page 41).
About	Click **About** to open the **About** dialog box (see 5.1.3 "About" on page 42).

5.1.1 Settings

In the **Settings** dialog box, you can make a number of *Primary Test Manager* settings to match your regional conventions. To open the **Settings** dialog box, click **Settings** in the title bar.

Caution: Changing the settings in the **Settings** dialog box affects all data in *Primary Test Manager*.

Note: After changing a setting, you must restart *Primary Test Manager* for the setting to take effect.

The **Settings** dialog box displays the general, global settings, transformer, circuit breaker, and current transformer areas.

General area

In the general area of the **Settings** dialog box, you can set the *Primary Test Manager* language, the profiles for naming conventions, and the test systems available for the test.

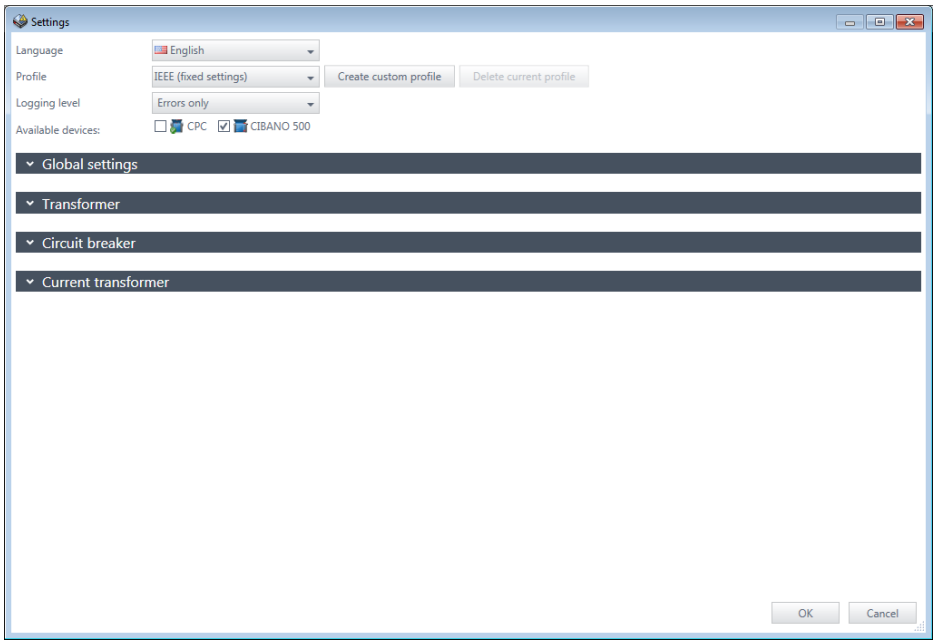


Figure 5-3 **Settings** dialog box: general area

To set the *Primary Test Manager* language, select your preferred language in the **Language** list.

With *Primary Test Manager*, you can use predefined profiles and create your own profiles for naming conventions.

Note: *Primary Test Manager* sets the default profile according to the regional settings of your computer.

To set a profile, select the profile you want to use in the **Profiles** list.

To create your own profile:

1. Click **Create custom profile**.
2. In the **Create custom profile** dialog box, type the profile name.
3. In the global settings area, set the global options (see "Global settings area" later in this section).

4. In the circuit breaker area, set the circuit breaker naming conventions (see "Circuit breaker area" later in this section).
5. Click **OK** to close the **Settings** dialog box.

To delete your own profile, select the profile in the **Profiles** list, and then click **Delete current profile**.

Under **Available devices**, select the test systems available for your test. *Primary Test Manager* generates lists of supported tests for the selected test systems.

Global settings area

In the global settings area of the **Settings** dialog box, you can set the default rated frequency, the loss index, and the units of your own profiles.

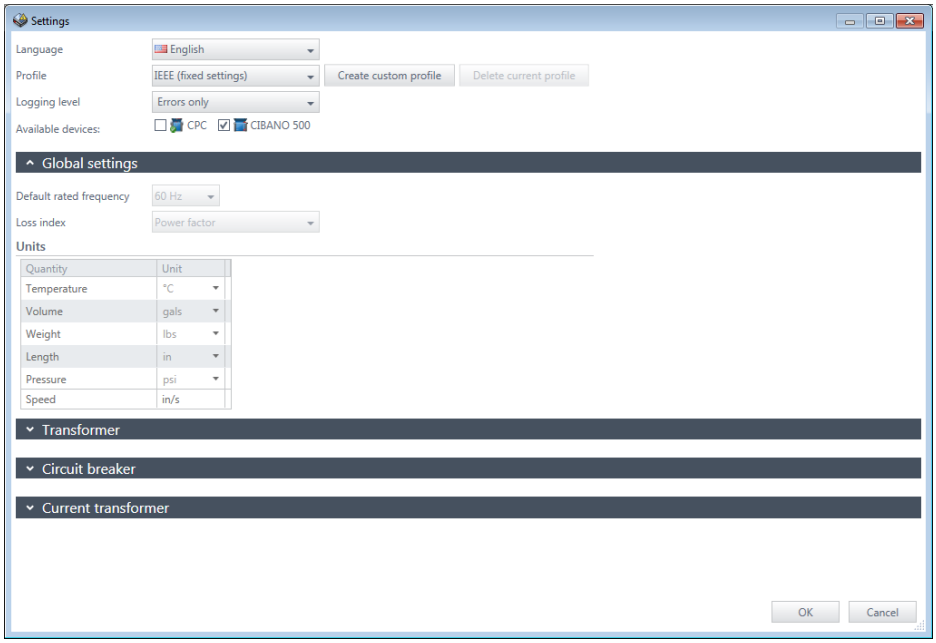


Figure 5-4 **Settings** dialog box: global settings area

Circuit breaker area

In the circuit breaker area of the **Settings** dialog box, you can set the circuit breaker terminal name schemes.

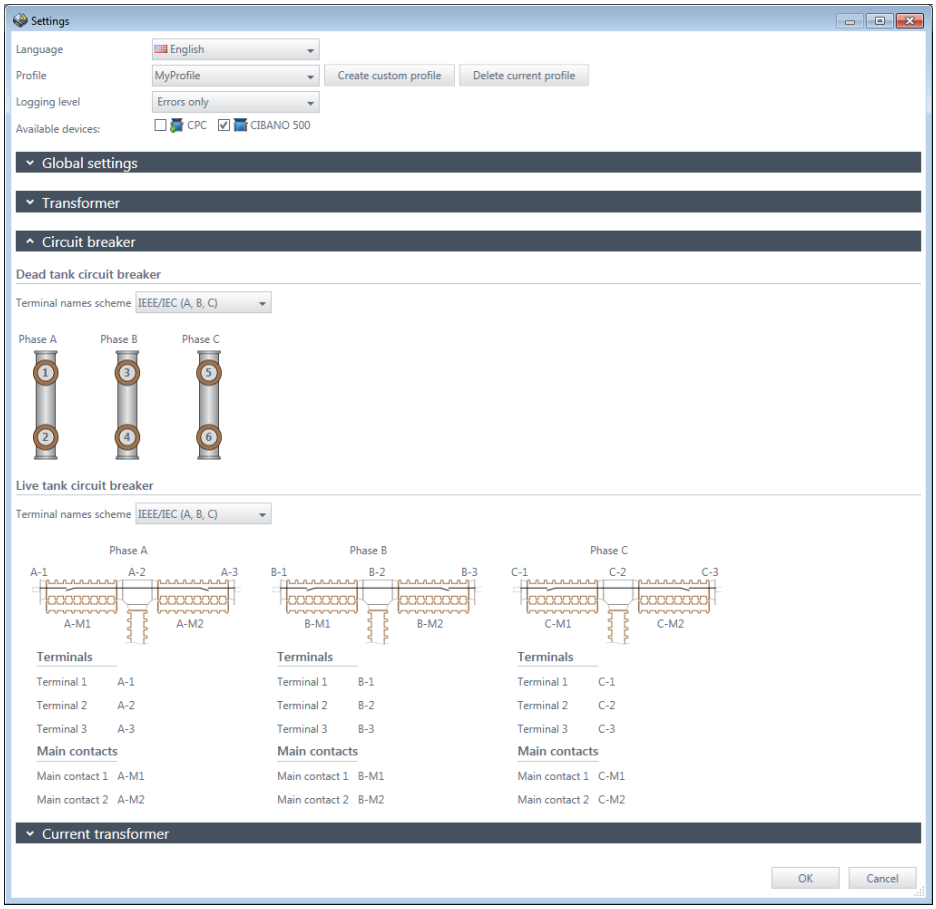


Figure 5-5 **Settings** dialog box: circuit breaker area

Note: Some of these settings have no effect on the *Primary Test Manager* in the current version but it is recommended to do the settings correctly because they are relevant to future software versions.

5.1.2 Help

In the **Help** dialog box, you can open the *Primary Test Manager* technical documentation and send data to OMICRON Technical Support. To open the **Help** dialog box, click **Help** in the title bar.

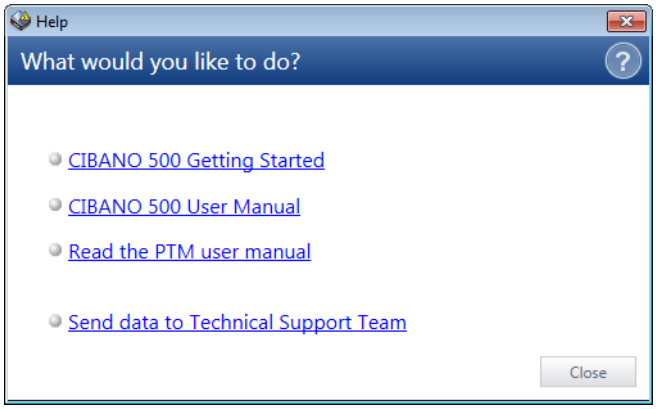


Figure 5-6 **Help** dialog box

5.1.3 About

In the **About Primary Test Manager** dialog box, you can enter a license key to upgrade your *Primary Test Manager* and enhance its functionality by installing additional features. To open the **About Primary Test Manager** dialog box, click **About** in the title bar.

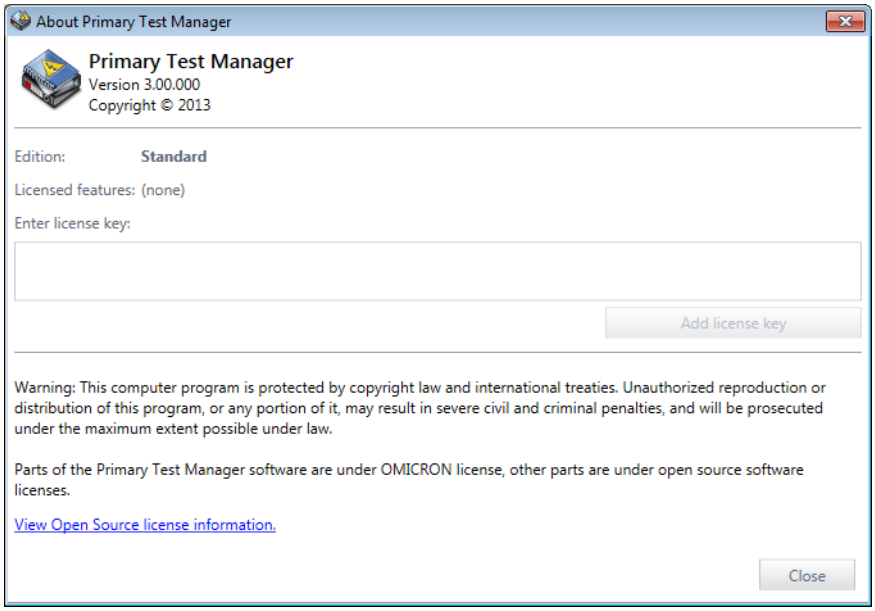


Figure 5-7 **About Primary Test Manager** dialog box

To activate a license, enter the license key in the **About Primary Test Manager** dialog box. For detailed information about the *Primary Test Manager* licensing, contact your OMICRON local sales representative or distributor.

5.2 Status Bar

Note: The status bar is displayed in any *Primary Test Manager* view.

The status bar displays information about the status of the test system and provides access to the zoom function.

The following table describes the statuses of the test system.

Table 5-3 Test System Statuses

Symbol	Status
	*CIBANO 500* is connected.
	*CIBANO 500* is not connected.

In the status bar, you can connect to and disconnect from a test system, and show and refresh the test set information.

To connect to a test system:

1. Right-click the *CIBANO 500* symbol in the status bar, and then click **Connect**.

Figure 5-8 **Connect to device** dialog box

2. In the **Connect to device** dialog box, select the test system in the list, and then click **Connect**.

If you could not connect to your *CIBANO 500* device and the green light is permanently on, wait a few seconds, and then proceed as follows:

1. Click **More** beneath the **Connect** button.
2. Click **Refresh**.

After you have connected to the test system, the following dialog box appears.

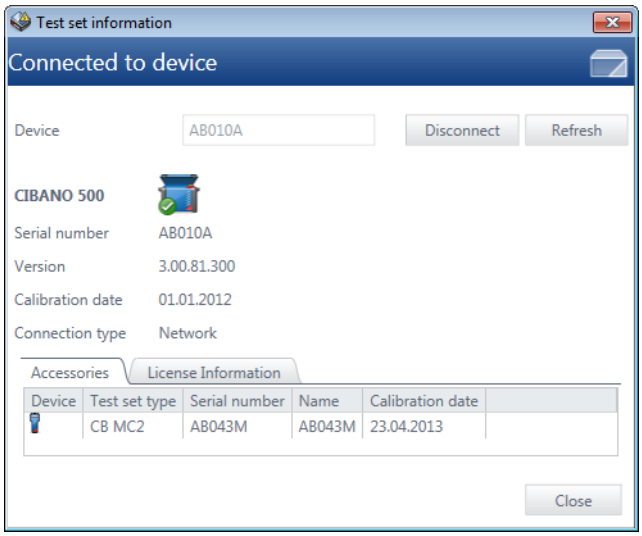


Figure 5-9 **Connected to device** dialog box

Note: For connecting to a test system not included in the list, see 9.1 "Connecting to CIBANO 500" on page 175.

Right-click the *CIBANO 500* symbol in the status bar, and then do one of the following:

- To disconnect from a test system, click **Disconnect**.
- To display information about the connected test system, click **Show test set information**.
- To update the test set information, click **Refresh test set information**.

Note: You can open the **Connect to device** and the **Connected to device** dialog boxes also by double-clicking the *CIBANO 500* symbol.

5.3 Create New Manual Tests

Primary Test Manager assists you to create new manual tests. To open the Create new manual tests view, click the **Create new manual tests** button in the home view.

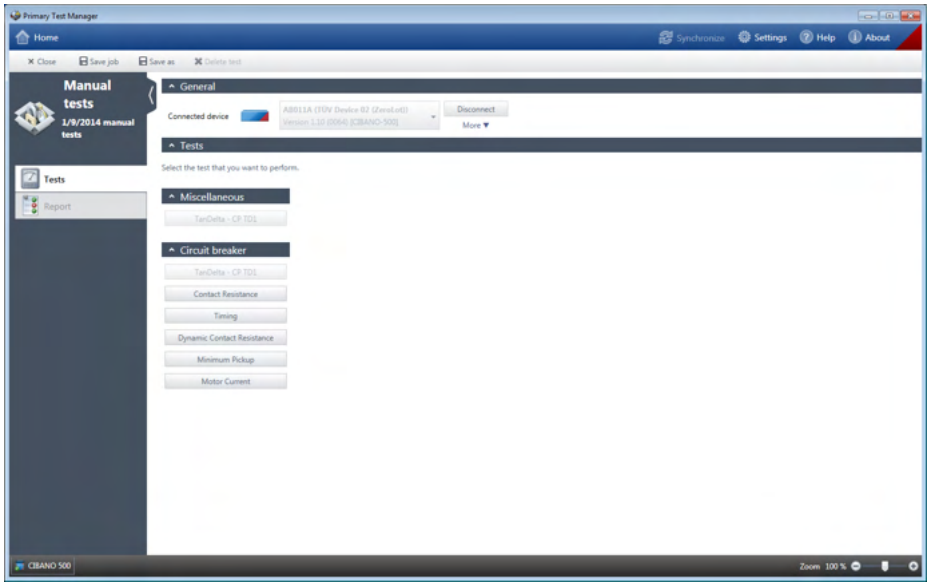


Figure 5-10 Create new manual tests view

The workspace of the Create new manual tests view depends on the selected button in the left pane (see Figure 5-11 "Left-pane buttons" on page 46). Initially, the workspace is divided into the General pane and the Tests pane.

In the General pane, you can manage the connection to the test system as described in 4.4 "Start Primary Test Manager and Connect to CIBANO 500" on page 30.

The Tests pane displays all manual tests supported by *Primary Test Manager*. Only the tests that are available on the connected test system are active and can be selected as described in 5.3.1 "Select Tests" on page 46. After you selected a test, the workspace is split into the Hardware configuration pane, the Settings and conditions pane and the Measurements pane (see Figure 5-12 "Contact Resistance test" on page 47.)

If you click the **Tests** button, the workspace displays the General pane and the Tests pane again.

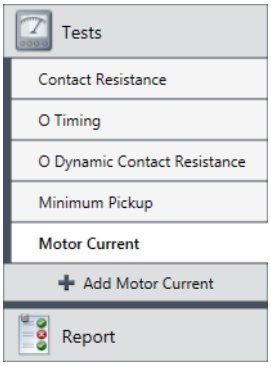


Figure 5-11 Left-pane buttons

Note: You can change the default test names. To rename a test, click the corresponding button in the left pane, and then click the test name.

5.3.1 Select Tests

To select a test, click the test in the Tests pane. The selected test opens in the workspace and a button with the test name appears in the left pane.

To select a next test, do one of the following:

- Click the **+Add *Test Name*** button in the left pane to select the same test.

  Note: Some settings of the previously selected test are copied to the added test.

- Click the **Tests** button in the left pane, and then select the next test you want to perform in the tests area.

Note: You can anytime open a selected test by clicking the corresponding button in the left pane.

If a test is open, the workspace is divided into the following panes:

- Hardware configuration
  Displays the test-specific controls of the test set. For information on the hardware configuration options, see 6 "Application" on page 57.
- Settings and conditions
  Displays the test settings. For the test settings description, see 6 "Application" on page 57.
- Measurements
  Displays the measurement data graphically or numerically in table form. For more information, see 5.3.4 "Display Measurement Results" on page 49.

As an example, the following figure shows the Create new manual tests view when the Contact Resistance test is open.

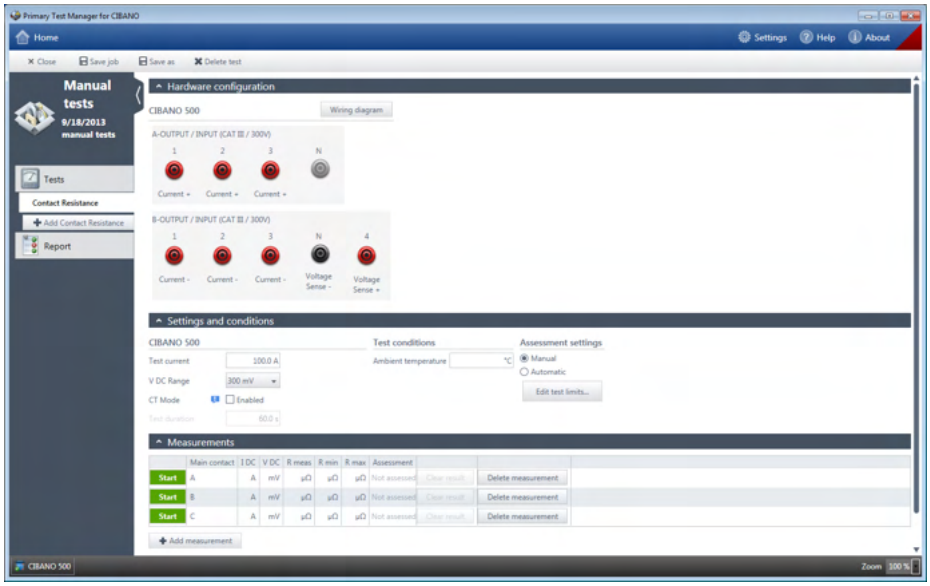


Figure 5-12 Contact Resistance test

5.3.2 Process Tests

By using the commands on the menu bar, you can process the selected tests. The following table describes the commands on the menu bar.

Table 5-4 Menu Bar Commands

Command	Action
Close	Closes all selected tests and guides you to the home view. Before closing the tests, you can save the changes, if any.
Save job	Saves all selected tests in the original directory. When saving for the first time, you must specify the directory.
Save as	Saves all selected tests in the specified directory.
Delete test	Deletes the currently open test.

Note: Clicking **Home** in the title bar and **Close** in the menu bar have the same functionality.

5.3.3 Control Tests

In the Measurements pane of *Primary Test Manager*, you can control the test execution. The following table describes the available commands.

Table 5-5 Test Control Commands

Command	Action
Start	Starts the selected measurement of the currently open test.
Start all	Starts all measurements of the currently open test.
Stop	Stops the running measurement.
Stop all	Stops all running measurements.
Clear all	Deletes all measurement results of the currently open test.
Open breaker	Opens the circuit breaker’s main contacts.
Close breaker	Closes the circuit breaker’s main contacts.

Table 5-5 Test Control Commands (continued)

Command	Action
Supply motor	Starts the circuit breaker's motor. To stop the circuit breaker's motor, click **Stop**.
Clear result	Deletes the results of the selected measurement.
Delete measurement	Deletes the selected measurement row.
Add measurement	Adds a new measurement row to the currently open test.

Note: Not all test control commands are available for all tests.

5.3.4 Display Measurement Results

For some tests, *Primary Test Manager* provides graphical display of measurement results. To display the measurement results graphically, click the **Plot** tab in the measurements area, if available. The graphical display of the measurement results consists of the following parts: cursors, binary traces, and analog traces. *Primary Test Manager* displays the analog traces in the oscilloscope view.

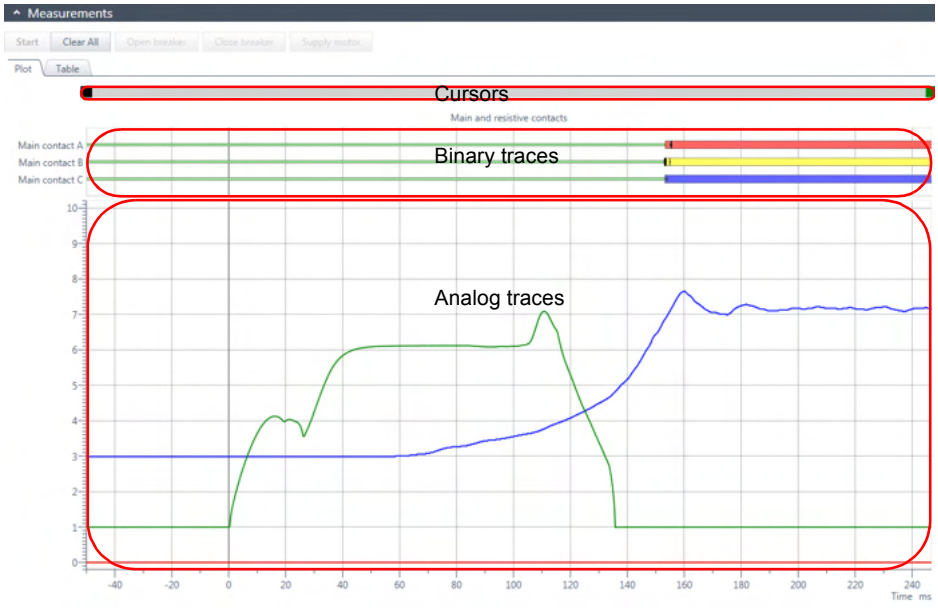


Figure 5-13 Example of the graphical display of measurement data

By clicking the arrow next to **Cursors & Settings** in the upper-right corner of the window, you can open a workspace for setting the cursors and graphical options.

Cursors tab

The graphical display provides two cursors for measuring the analog traces data. To measure the data at any time in the graph, move the cursors in the cursor part of the graphical display. On the **Cursors** tab, you can view the measurement results marked by cursor 1 (C1), the measurement results marked by cursor 2 (C2), and the difference between the two values (C2–C1). The **Cursors** tab displays the measured analog traces selected on the **Settings** tab (for more information, see "Settings tab" later in this section).

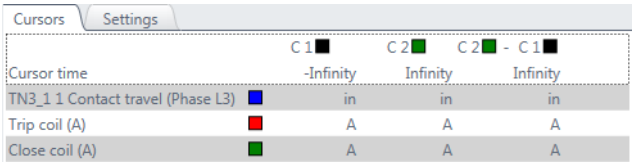


Figure 5-14 Cursors & settings workspace: **Cursors** tab

Settings tab

To set your preferred display options for the analog traces, click the **Settings** tab.

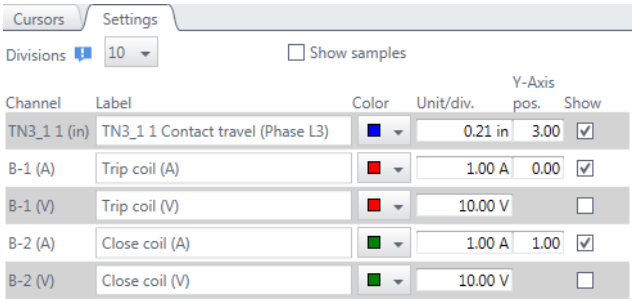


Figure 5-15 Cursors & settings workspace: **Settings** tab

Because the graphical display may contain curves with different units, for example, Volts, Amperes or Ohms, the scale on the Y-axis has no units but a unitless numbers called division (div). On the **Settings** tab, you can set how many, for example, Amperes shows the graphical display per division. As an example, the B-2 (A) channel in Figure 5-13 "Example of the graphical display of measurement data" on page 49 has its highest peak at the seventh division. As the offset on the Y-axis is 1 division and the magnitude is 1 A/div (see Figure 5-15), the peak close coil current is approx. (7–1)×1 = 6 A.

On the **Settings** tab, you can do the following settings.

Table 5-6 Graphical Display Settings

Setting	Description
Divisions	Number of the graphical display divisions according to the ruler on the Y-axis
Show samples	Select the **Show samples** check box to display only the measured values.
Channel	Channels of *CIBANO 500* and the connected external modules
Label	Editable label of the analog trace
Color	Color of the analog trace
Unit/div.	Number of units per division
Y-axis position	Number of units (offset) the analog trace is displaced from 0
Show	Select the **Show** check box to display the analog trace.

Note: You can save all changes made to the display options on the **Settings** tab. To save the changes you have done, click **Save** on the menu bar. The changed settings are reflected also in the test reports.

To display the measurement data numerically, click the **Table** tab in the measurements area. For the measurement data description, see "Measurement Data" of the relevant test in 6 "Application" on page 57.

5.3.5 Generate Test Reports

With *Primary Test Manager*, you can generate and configure test reports. To generate a test report, click the **Report** button  in the left pane.

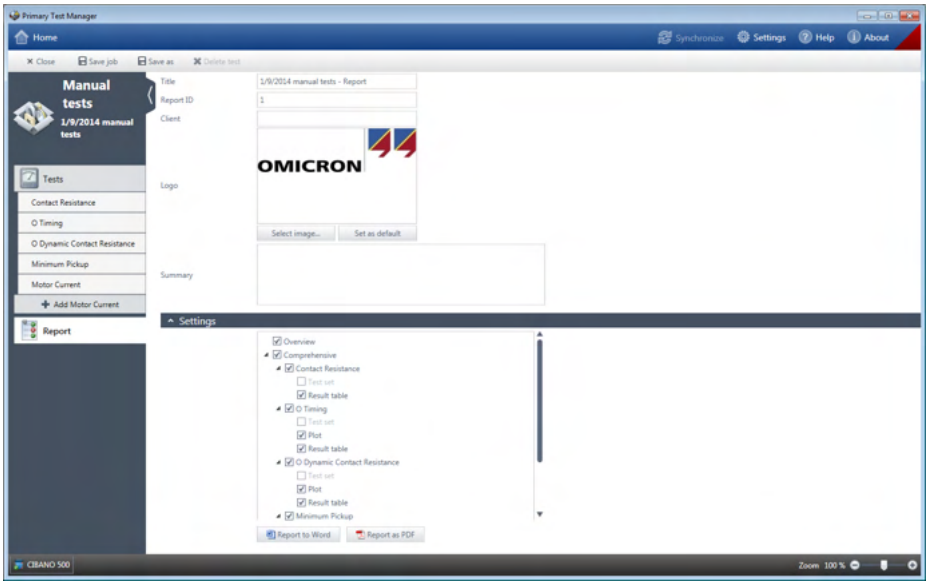


Figure 5-16 Generating a test report

The following table describes the report data.

Table 5-7 Report Data

Data	Description
Title	Title of the report. Appears as the report header.
Report ID[1]	Identifier of the report
Client	Customer for which the report is designated
Logo	Logo to appear in the report To insert your own logo, click **Select image**, and in the **Open image file** dialog box, browse to the file you want to insert in the report. To set your own logo as default, click **Set as default**.
Summary	Text field to summarize the content of the test report in own words.

1. By default generated by *Primary Test Manager*.

Under **Settings**, you can configure the test report to be generated by selecting the respective check boxes.

You can generate test reports as Microsoft Word documents or in PDF format. To generate a test report in your preferred format, click **Report to Word** or **Report as PDF**.

5.4 Open Manual Tests

With *Primary Test Manager*, you can open existing manual tests. To open a manual test:

1. In the home view (see Figure 5-2 "Primary Test Manager home view" on page 36), click the **Open manual tests** button.

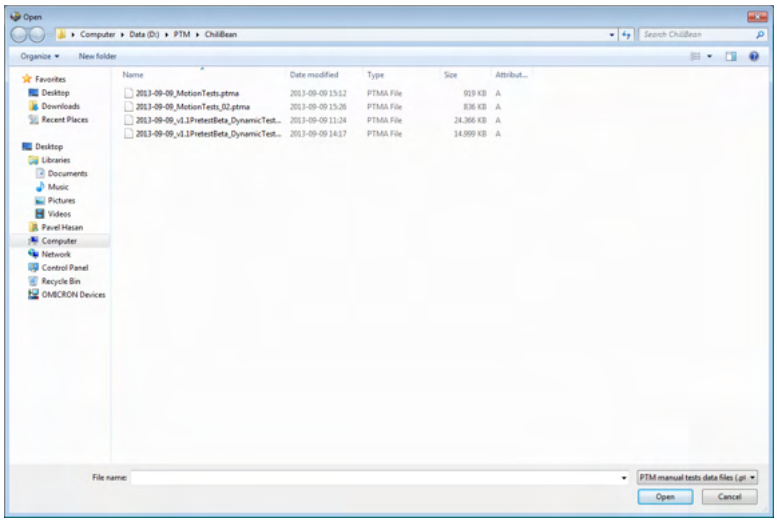


Figure 5-17 **Open** dialog box

2. In the **Open** dialog box, browse to the file you want to open.

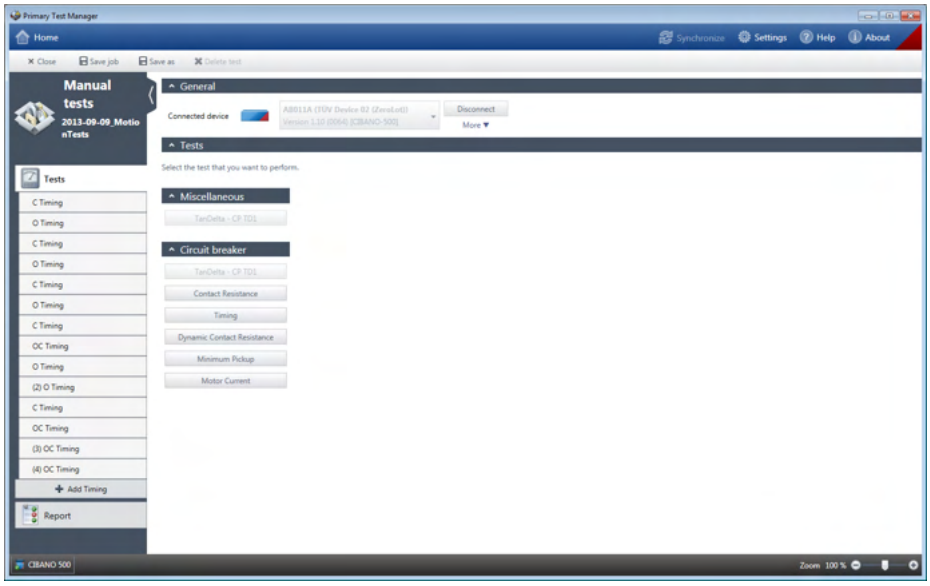


Figure 5-18 Open manual tests view

The Open manual tests view displays the open tests in the left pane. To view the test results, click the corresponding button. You can add new tests and generate test reports as described in 5.3 "Create New Manual Tests" on page 45.

6 Application

6.1 Testing Medium-Voltage Circuit Breakers

The medium-voltage (MV) circuit breakers are typically tested with *CIBANO 500* only (without the *CB MC2* modules). If you want to test the MV circuit breakers with the *CB MC2* modules, see 6.2 "Testing High-Voltage Circuit Breakers" on page 100.

6.1.1 Safety Precautions in the Substation

Always observe the following safety rules:

- Disconnect completely.
- Secure against re-connection.
- Verify that the installation is dead.
- Carry out grounding and short-circuiting.
- Provide protection against adjacent live parts.
- Ground the test object at one or more terminals during connecting, testing and disconnecting.

Separate your working area as shown in Figure 1-1 "Example of the separation of the safe and dangerous areas" on page 11 into a safe area and a dangerous area when test is running.

Warning: Never use the *CIBANO 500* test set without a solid connection to ground with at least 6 mm^2 cross-section. Use a ground point as close as possible to the operator.

Typical MV circuit breakers are opened and then removed from the rack according to the specifications of the circuit breaker manufacturer and the substation regulations. OMICRON recommends to completely disconnect the circuit breaker from the station, including the secondary connections, and to ground the circuit breaker on one side. Because you can use *CIBANO 500* to supply the circuit breaker during the test, in this way the maximum safety is guaranteed.

6.1.2 Test Set and Software Start-Up

To put *CIBANO 500* into operation and start *Primary Test Manager*:

1. Connect properly the *CIBANO 500* grounding terminals to the substation ground.
2. Connect *CIBANO 500* to a computer with the delivered Ethernet cable and switch the computer on.
3. Connect *CIBANO 500* to the mains power supply by using the delivered power cord.

4. Switch *CIBANO 500* on by pressing the mains power on/off switch on the side panel. The green warning light on the *CIBANO 500* front panel (see Figure 2-1 "Front view of CIBANO 500" on page 15) flashes for a short time and then extinguishes for approximately one minute. After it lights up, the *CIBANO 500* outputs carry no dangerous voltage or current.
5. Start *Primary Test Manager* and connect to *CIBANO 500* as described in 4.4 "Start Primary Test Manager and Connect to CIBANO 500" on page 30.

If you could not connect to your *CIBANO 500* device and the green light is permanently on, wait a few seconds, and then do one of the following:

- Click **More** beneath the **Connect** button, and then click **Refresh**.
- Press F5.

Figure 6-1 Connecting to *CIBANO 500*

If the *CIBANO 500* device to which you want to connect is not displayed in the list of available devices, proceed as described in 9.1 "Connecting to CIBANO 500" on page 175.

6.1.3 Contact Resistance Test

The Contact Resistance test measures the static resistance of the circuit breaker's main contacts.

A typical MV circuit breaker has manual operation buttons at its front plate to control the circuit breaker's spring. If the spring is not charged, first charge the spring as described in 6.1.8 "Motor Current Test" on page 94, and then close the breaker. Do not open the circuit breaker again now.

Connection

Warning: During the test, *CIBANO 500* must be the only power source for the circuit breaker's main contacts.

To connect the test object to *CIBANO 500*:

1. In *Primary Test Manager*, select the Contact Resistance test.
2. In *Primary Test Manager*, set the hardware configuration.

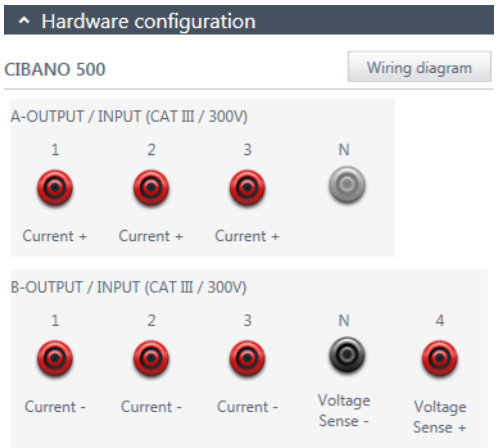


Figure 6-2 Hardware configuration of the Contact Resistance test

Table 6-1 Hardware Configuration Options of *CIBANO 500*

CIBANO 500	Option
A-OUTPUT / INPUT (CAT III / 300 V)	
1	Current +
2	Current +
3	Current +
N	Not connected in this test
B-OUTPUT / INPUT (CAT III / 300 V)	
1	Current –
2	Current –
3	Current –
N	Voltage Sense –
4	Voltage Sense +

3. Make sure that all cable connectors are clean and dry before being tightly connected.
4. Connect *CIBANO 500* to the main contact of the circuit breaker for one phase according to the wiring diagram displayed in *Primary Test Manager*.

Tips & Tricks: For easy connection use the delivered summary cables and connect the end with the short wires to the *CIBANO 500* sockets according to the short wire labels. Connect the cable end with the long wires according to the wiring diagram to the corresponding Kelvin clamp. The black **AN** cable is not needed for this test and remains unconnected.

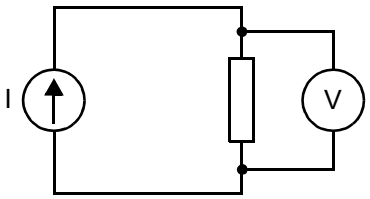


Figure 6-3 Principal scheme of the contact resistance test

Tips & Tricks: The delivered Kelvin clamp is the perfect solution for connecting to a massive conductor like a copper busbar or similar. It is recommended to use only the red connectors of the Kelvin clamps (which is the current path) when connecting to the contact fingers of a MV circuit breaker. Use a separate clamp for the voltage sense cables (**BN** and **B4**) which can be mounted closer to the MV circuit breaker contact. If the connection is set up properly the resistance decreases when the voltage sense clamps are connected closer to the circuit breaker contact. The polarity of connection does not matter for this test.

Measurement

To perform a measurement:

1. In *Primary Test Manager*, enter the settings of the Contact Resistance test.

Table 6-2 Contact Resistance Test Settings

Setting	Description
CIBANO 500	
Test current[1]	Current of the test (typically 100 A)
V DC range[2]	DC voltage measurement range
CT mode	Select the **Enabled** check box to enable CT mode for measuring circuit breakers with current transformers (CT).
Test duration	Duration of the test
Test conditions	
Ambient temperature[3]	Ambient temperature
Assessment settings	
Manual	Click **Manual** to select the manual assessment settings.
Automatic	Click **Automatic** to select the automatic assessment settings. Click **Edit test limits** to adjust the assessment limits (see Figure 6-4 "Edit automatic assessment limits dialog box" on page 62).

1. For normal circuit breakers always use 100 A.
2. For normal circuit breakers the lowest range in recommended. Only if the result is “infinite” select a higher range.
3. Only for reference in the report, the result is not temperature compensated.

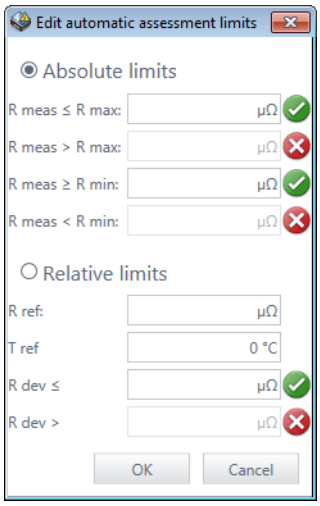


Figure 6-4 **Edit automatic assessment limits** dialog box

Table 6-3 Automatic Assessment Limits

Setting	Description
Absolute limits	
R meas ≤ R max	Maximum limit of the resistance value
R meas ≥ R min	Minimum limit of the resistance value
Relative limits	
R ref	Reference resistance value
T ref	Reference temperature
R dev ≤	Allowed deviation from the reference resistance value

2. In the measurements area, select the measurement you want to perform, and then click **Start**.
   The blue ring on the **Measurement Start/Stop** button is on.

Warning: Stay in the safe area during the test. Any component of the circuit breaker can carry dangerous voltages.

3. Start the measurement by pressing the **Measurement Start/Stop** button. The blue ring on the **Measurement Start/Stop** button flashes for approx. 3 seconds, and the lightning symbol in *Primary Test Manager* and the red warning light on the front panel are flashing.

   Note: You can suspend the measurement anytime manually by pressing the **Emergency Stop** button or the **Measurement Start/Stop** button on the *CIBANO 500* front panel.

4. After the measurement has finished, the lightning symbol in *Primary Test Manager* stops flashing, the green warning light is on, and *Primary Test Manager* displays the measurement results.

Table 6-4 Contact Resistance Measurement Data

Data	Description
Main contact	Main contact of the circuit breaker under test
I DC	DC test current
V DC	Measured voltage
R meas	Measured resistance
R min/R ref[1]	Minimum assessment limit/ Reference resistance value
R max/R dev[1]	Maximum assessment limit/ Allowed deviation from the reference resistance value
Assessment	Measurement assessment

1. Depending on whether the absolute or relative assessment limits are selected.

5. Connect *CIBANO 500* to the main contact of the circuit breaker for the next phase according to the wiring diagram provided by *Primary Test Manager*. To display the wiring diagram, click the **Wiring diagram** button. Click in the diagram to close it.
6. Repeat steps 1 to 5 for other two phases.

Disconnection

Do not disconnect the circuit breaker but leave it connected for performing the next test. For disconnecting the circuit breaker, see "Disconnection" on page 99.

6.1.4 Timing Test with *CIBANO 500* (4×EtherCAT®) Option

The Timing test measures the contact timing of the circuit breaker. Depending on the selected sequence all relevant timing values are automatically calculated.

Connection

To connect the test object to *CIBANO 500*:

1. In *Primary Test Manager*, select the Timing test.
2. In *Primary Test Manager*, set the hardware configuration.

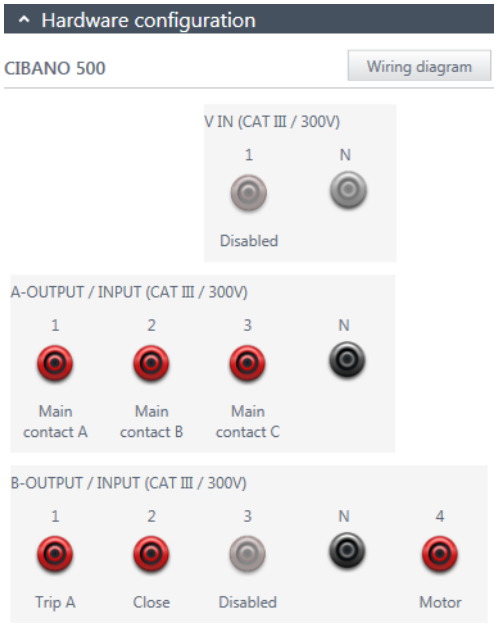


Figure 6-5 Hardware configuration of the Timing test

Table 6-5 Hardware Configuration Options of *CIBANO 500*

CIBANO 500	Option
V IN (CAT III / 300 V)	
1	External source or disabled
N	Neutral connection of **V IN**
A-OUTPUT / INPUT (CAT III / 300 V)	
1	Main contact A (preferred), close A, motor A, or disabled
2	Main contact B (preferred), close B, motor B, or disabled
3	Main contact C (preferred), close C, motor C, or disabled
N	Common neutral connection for outputs/inputs in group **A**
B-OUTPUT / INPUT (CAT III / 300 V)	
1	Trip A (preferred), I clamp 1, or disabled
2	Trip B, I clamp 2, close (preferred), or disabled
3	Trip C, I clamp 3, supply, or disabled (preferred)
N	Neutral connection of outputs in group **B**
4	Motor (preferred), I clamp 4, or disabled

3. Make sure that all cable connectors are clean and dry before being tightly connected.

4. Connect *CIBANO 500* to the trip and close coils of the circuit breaker for all phases according to the wiring diagram displayed in *Primary Test Manager* and the following figure.

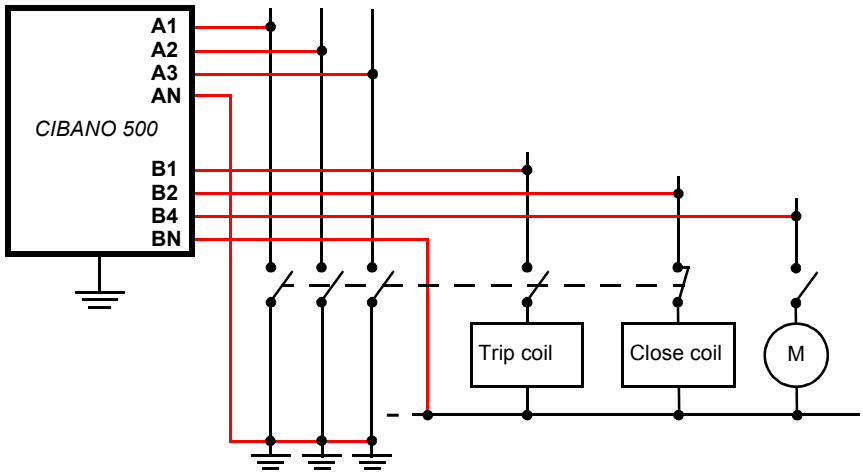


Figure 6-6 Connecting *CIBANO 500* to the circuit breaker for the Timing test

Caution: Never connect *CIBANO 500* between the respective AUX contact of the trip and close coils and the coils themselves. These contacts assure that the voltage is not applied too long to the coils. Otherwise, the coils might be damaged.

Caution: Ensure that the DC coils are connected with the right polarity. Most coils have free running diodes that will be damaged if the voltage polarity is reversed.

5. Depending on the test requirements, connect *CIBANO 500* to the motor of the circuit breaker.
6. In a typical test of a MV circuit breaker the motor is supplied from *CIBANO 500*. To do so, click the **B4** socket in the hardware configuration, and then click **Motor**. After that connect the **B4** socket on the side panel of *CIBANO 500* to "+" or phase contact of the motor and the **BN** socket to "–" or neutral contact of the motor.

Measurement

To perform a measurement:

1. In *Primary Test Manager*, enter the settings of the Timing test.

Table 6-6 Timing Test Settings

Setting	Description
CIBANO 500	
Coil supply with	Click **CIBANO 500** to supply the coil with *CIBANO 500*. Click **External source** to supply coils with the source connected to **V IN**.
Coil supply voltage[1]	Voltage of the coil power supply Click **AC** or **DC** for AC or DC coil supply voltage respectively.
Test frequency	Frequency of the AC coil power supply
Supply during test[2]	
Enable	Select the **Enable** check box to supply voltage on the **B3** socket during test execution.[3]
Supply voltage	Voltage supplied on the **B3** socket (same as the coil supply voltage)
Supply before test	Time interval within which the voltage is supplied before the test starts
Other	
Sample rate	Measurement sample rate
Assessment settings	
Manual	Click **Manual** to select the manual assessment settings.
Automatic	Click **Automatic** to select the automatic assessment settings. Click **Edit test limits** to adjust the assessment limits. In the **Edit automatic assessment limits** dialog box, click **Absolute limits** (see Figure 6-7 "Edit automatic assessment limits dialog box: absolute limits" on page 69) or **Relative limits** (see Figure 6-8 "Edit automatic assessment limits dialog box: relative limits" on page 70) to select absolute or relative limits respectively.

Table 6-6 Timing Test Settings (continued)

Setting	Description
Motor supply	
Motor supply with	Click **CIBANO 500** to supply the motor with *CIBANO 500*. Click **External source** if the motor is supplied from the station supply or battery without any connection to *CIBANO 500* or if the station battery is connected to the **V IN** section and supplied, for example, via the **B4** socket.
Motor supply voltage[1]	Voltage of the motor power supply Click **AC** or **DC** for AC or DC motor supply voltage respectively.
Test frequency	Frequency of the AC motor power supply
Sequence	
O	Perform an open sequence
C	Perform a close sequence
OC[4]	Perform a reclose sequence
CO[4]	Perform a trip-free sequence
O-CO[4]	Perform an autoreclose sequence
CO-CO[5]	Perform a CO-CO sequence
O-CO-CO[5]	Perform an O-CO-CO sequence

1. Only available if *CIBANO 500* is selected as source
2. Only available if the internal amplifier is used.
3. The **B3** socket must be configured as **Supply** and the coil supply voltage must be specified.
4. See Table 6-9 "Timing Test Sequences" on page 71.
5. Not recommended for MV circuit breakers

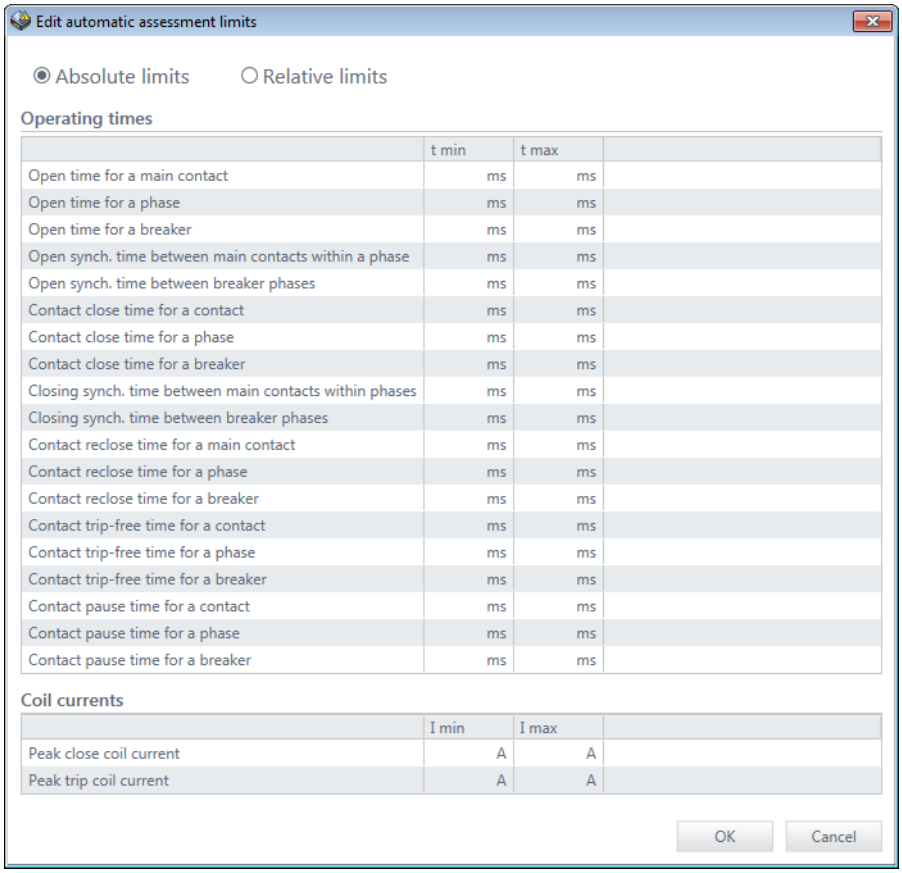


Figure 6-7 **Edit automatic assessment limits** dialog box: absolute limits

Table 6-7 Absolute Assessment Limits

Setting	Description
Operating times	
t min	Minimum operating time limit
t max	Maximum operating time limit
Coil currents	
I min	Minimum coil current limit
I max	Maximum coil current limit

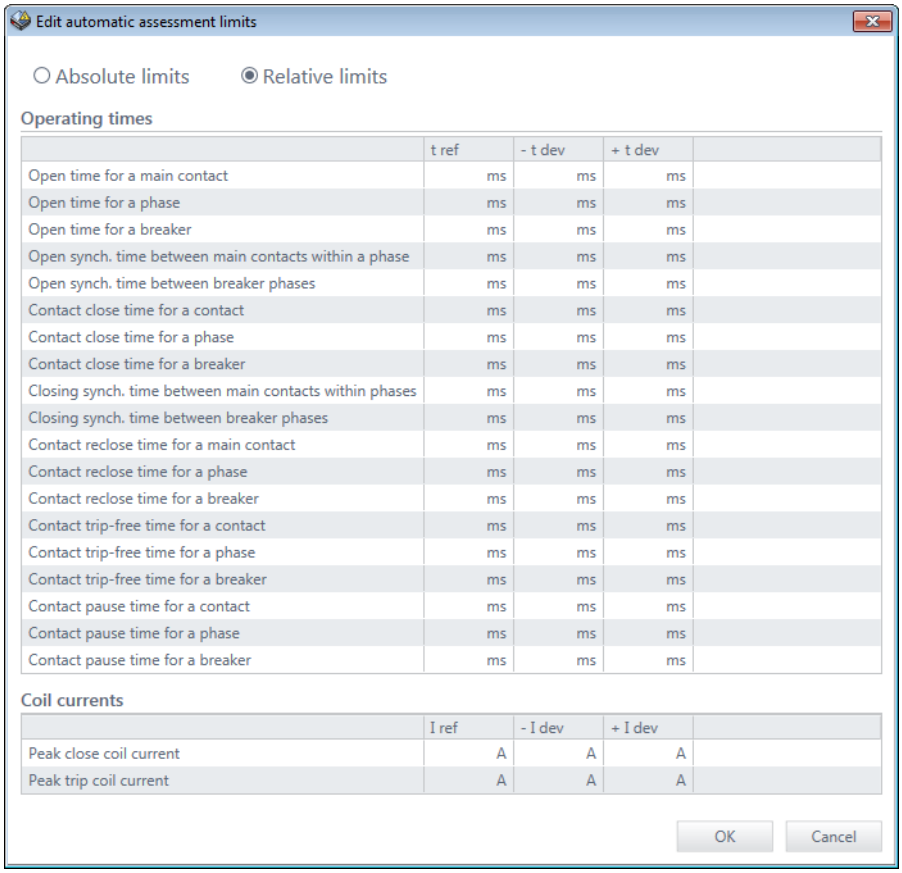


Figure 6-8 **Edit automatic assessment limits** dialog box: relative limits

Table 6-8 Relative Assessment Limits

Setting	Description
Operating times	
t ref	Operating time reference value
–t dev	Allowed negative deviation
+t dev	Allowed positive deviation
Coil currents	
I ref	Coil current reference value
–I dev	Allowed negative deviation
+I dev	Allowed positive deviation

The following table explains the sequences of the Timing test.

Table 6-9 Timing Test Sequences

Sequence	Action
O	With this sequence, the opening time of the circuit breaker is measured. Only for the O and C sequence it is recommended to perform the test twice, once with nominal voltage and once with 20 % undervoltage to assure the functionality of the circuit breaker for a weak station battery.
C	This is the sequence to measure the closing time of the circuit breaker.
OC	With this sequence, a closing operation after the circuit breaker has tripped to clear a fault is simulated. Initially, the circuit breaker must be in the closed position. A trip command initiates the sequence, followed by a dead time to clear the fault; and finally a close command must close the circuit breaker. This sequence is also known as reclosing time. To find out the shortest reclosing time the circuit breaker can provide, the close command is already applied while the breaker is still opening. The circuit breaker then will close after opening as fast as possible.

Table 6-9 Timing Test Sequences (continued)

Sequence	Action
CO	With this sequence, a tripping operation after the circuit breaker has been closed under a fault condition (trip-free) or the verification of the correct operation of the anti-pumping system is simulated. To test the trip-free time the circuit breaker must be in the open position before the test is started. The circuit breaker is closed and then during the close operation is still in progress an open command is sent. The circuit breaker then opens as fast as possible. To test the anti-pumping function of the circuit breaker, the circuit breaker must be in closed position before the test is started. For this test the open time is set shorter (typically 200 ms) than the closing time (typically 400 ms). Ensure that the end time is increased so that the test sequence covers the whole close command duration (typically at least 190 ms). When the close command is sent the breaker is already closed which initiates the anti-pumping function. Then an open command is sent and the circuit breaker trips. The closing command is still on when the trip command ends, but the circuit breaker should not "pump", so that it should not close again.
O-CO	With this sequence, a reclose sequence (OC) under a fault condition is simulated. If the fault is not released, the circuit breaker must open (O) immediately and remain in this position. Initially, the circuit breaker must be in the closed position. The sequence begins with a trip command, after a dead time the close and trip commands (CO) must be applied at the same time (delay time typically 300 ms).

2. By using the **Open breaker**, **Close breaker** and **Supply motor** buttons in the measurements area of *Primary Test Manager* you can check whether all cables are correctly connected and bring the circuit breaker to the proper state. For example, to test an O sequence, the circuit breaker must be closed and the spring charged.

3. In the measurements area, click **Start**.
   The blue ring on the **Measurement Start/Stop** button is on.

Warning: Stay in the safe area during the test. Any component of the circuit breaker can carry dangerous voltages.

4. Start the measurement by pressing the **Measurement Start/Stop** button. The blue ring on the **Measurement Start/Stop** button flashes for approx. 3 seconds, and the lightning symbol in *Primary Test Manager* and the red warning light on the front panel are flashing.

   Note: You can suspend the measurement anytime manually by pressing the **Emergency Stop** button or the **Measurement Start/Stop** button on the *CIBANO 500* front panel.

5. After the measurement has finished, the lightning symbol in *Primary Test Manager* stops flashing, the green warning light is on, and *Primary Test Manager* displays the measurement results.
   The Timing measurement data depends on the sequence of the trip and close commands. The following table describes the data for all measurement sequences.

Table 6-10 Timing Measurement Data

Data	Description
Operating times for breaker	
Open time	Contact open time[1]
Open synch.	Open synchronization time[1]
Close time	Contact close time[1]
Close synch.	Closing synchronization time[1]
Reclose time	Contact reclose time of OC operation[1]
Trip-free time	Contact trip-free time of CO and O-CO operation[1]
Trip-free time 2	Second contact trip-free time of CO-CO and O-CO-CO operation[1]
Pause time	Contact pause time of O-CO, CO-CO, and O-CO-CO operation[1]
t min/t ref[2]	Minimum operating time limit/ Operating time reference value
t max/t dev[2]	Maximum operating time limit/ Operating time deviation
Assessment	Assessment of operating times
Coil characteristics	
Peak current	Peak current value through a trip or close coil
Assessment	Assessment of coil characteristics

1. The operating times are calculated per contact, phase or circuit breaker.
2. Depends on the absolute or relative assessment limits selected.

Disconnection

Do not disconnect the circuit breaker but leave it connected for performing the next test. For disconnecting the circuit breaker, see "Disconnection" on page 99.

6.1.5 Timing Test with *CIBANO 500* (1×EtherCAT®, 3×AUX) Option

The Timing test measures the contact timing of the circuit breaker. Depending on the selected sequence all relevant timing values are automatically calculated.

Connection

To connect the test object to *CIBANO 500*:

1. In *Primary Test Manager*, select the Timing test.
2. In *Primary Test Manager*, set the hardware configuration.

Figure 6-9 Hardware configuration of the Timing test

Table 6-11 Hardware Configuration Options of *CIBANO 500*

CIBANO 500	Option
V IN (CAT III / 300 V)	
1	External source or disabled
N	Neutral connection of **V IN**
A-OUTPUT / INPUT (CAT III / 300 V)	
1	Main contact A (preferred), close A, motor A, or disabled
2	Main contact B (preferred), close B, motor B, or disabled
3	Main contact C (preferred), close C, motor C, or disabled
N	Common neutral connection for outputs/inputs in group **A**
B-OUTPUT / INPUT (CAT III / 300 V)	
1	Trip A (preferred), I clamp 1, or disabled
2	Trip B, I clamp 2, close (preferred), or disabled
3	Trip C, I clamp 3, supply, or disabled (preferred)
N	Neutral connection of outputs in group **B**
4	Motor (preferred), I clamp 4, or disabled
C-INPUT (CAT III / 300 V)	
1	AUX 1 or disabled
2	AUX 2 or disabled
3	AUX 3 or disabled
N	Neutral connection of inputs in group **C**

3. Make sure that all cable connectors are clean and dry before being tightly connected.

4. Connect *CIBANO 500* to the trip and close coils of the circuit breaker for all phases according to the wiring diagram displayed in *Primary Test Manager* and the following figure.

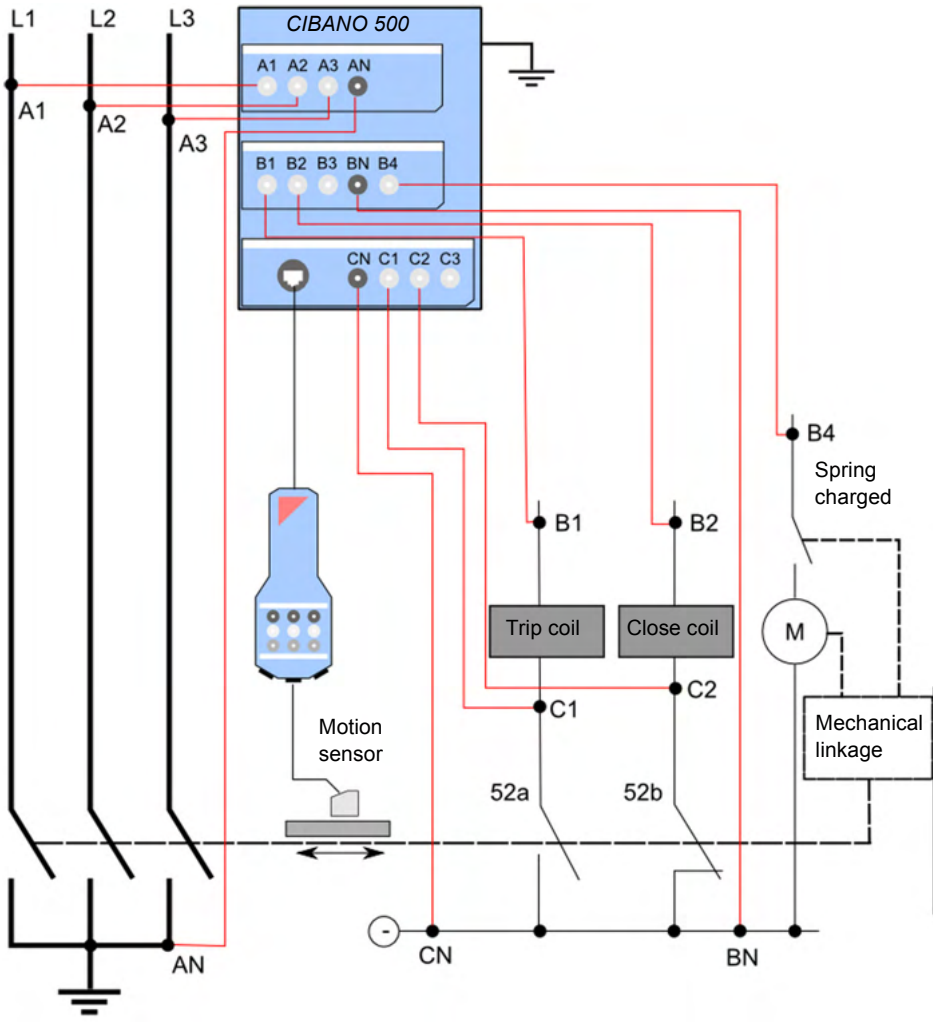


Figure 6-10 Connecting *CIBANO 500* to the circuit breaker for the Timing test

Caution: Never connect *CIBANO 500* between the respective AUX contact of the trip and close coils and the coils themselves. These contacts assure that the voltage is not applied too long to the coils. Otherwise, the coils might be damaged.

Caution: Ensure that the DC coils are connected with the right polarity. Most coils have free running diodes that will be damaged if the voltage polarity is reversed.

5. Depending on the test requirements, connect *CIBANO 500* to the motor of the circuit breaker.
6. In a typical test of a MV circuit breaker the motor is supplied from *CIBANO 500*. To do so, click the **B4** socket in the hardware configuration, and then click **Motor**. After that connect the **B4** socket on the side panel of *CIBANO 500* to "+" or phase contact of the motor and the **BN** socket to "–" or neutral contact of the motor.

Measurement

To perform a measurement:

1. In *Primary Test Manager*, enter the settings of the Timing test.

Table 6-12 Timing Test Settings

Setting	Description
CIBANO 500	
Coil supply with	Click **CIBANO 500** to supply the coil with *CIBANO 500*. Click **External source** to supply coils with the source connected to **V IN**.
Coil supply voltage[1]	Voltage of the coil power supply Click **AC** or **DC** for AC or DC coil supply voltage respectively.
Test frequency	Frequency of the AC coil power supply
Supply during test[2]	
Enable	Select the **Enable** check box to supply voltage on the **B3** socket during test execution.[3]
Supply voltage	Voltage supplied on the **B3** socket (same as the coil supply voltage)
Supply before test	Time interval within which the voltage is supplied before the test starts
Other	
Sample rate	Measurement sample rate
Assessment settings	
Manual	Click **Manual** to select the manual assessment settings.
Automatic	Click **Automatic** to select the automatic assessment settings. Click **Edit test limits** to adjust the assessment limits. In the **Edit automatic assessment limits** dialog box, click **Absolute limits** (see Figure 6-7 "Edit automatic assessment limits dialog box: absolute limits" on page 69) or **Relative limits** (see Figure 6-8 "Edit automatic assessment limits dialog box: relative limits" on page 70) to select absolute or relative limits respectively.

Table 6-12 Timing Test Settings (continued)

Setting	Description
Motor supply	
Motor supply with	Click **CIBANO 500** to supply the motor with *CIBANO 500*. Click **External source** if the motor is supplied from the station supply or battery without any connection to *CIBANO 500* or if the station battery is connected to the **V IN** section and supplied, for example, via the **B4** socket.
Motor supply voltage[1]	Voltage of the motor power supply Click **AC** or **DC** for AC or DC motor supply voltage respectively.
Test frequency	Frequency of the AC motor power supply
Sequence	
O	Perform an open sequence
C	Perform a close sequence
OC[4]	Perform a reclose sequence
CO[4]	Perform a trip-free sequence
O-CO[4]	Perform an autoreclose sequence
CO-CO[5]	Perform a CO-CO sequence
O-CO-CO[5]	Perform an O-CO-CO sequence

1. Only available if *CIBANO 500* is selected as source
2. Only available if the internal amplifier is used.
3. The **B3** socket must be configured as **Supply** and the coil supply voltage must be specified.
4. See Table 6-9 "Timing Test Sequences" on page 71.
5. Not recommended for MV circuit breakers

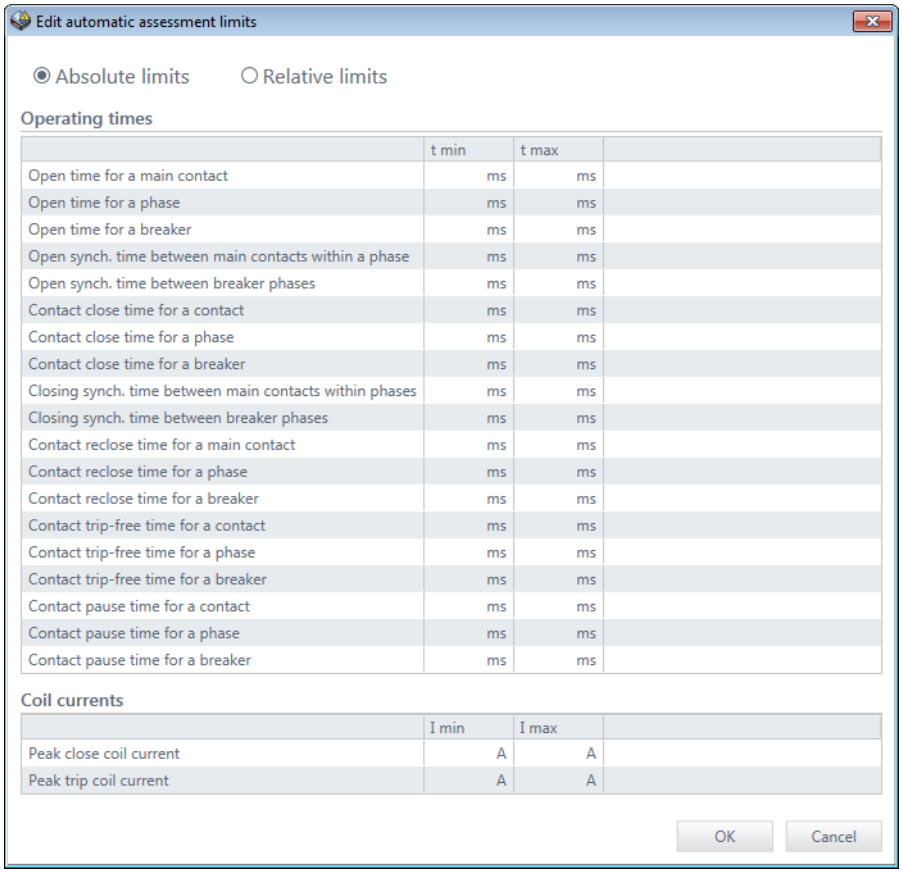


Figure 6-11 **Edit automatic assessment limits** dialog box: absolute limits

Table 6-13 Absolute Assessment Limits

Setting	Description
Operating times	
t min	Minimum operating time limit
t max	Maximum operating time limit
Coil currents	
I min	Minimum coil current limit
I max	Maximum coil current limit

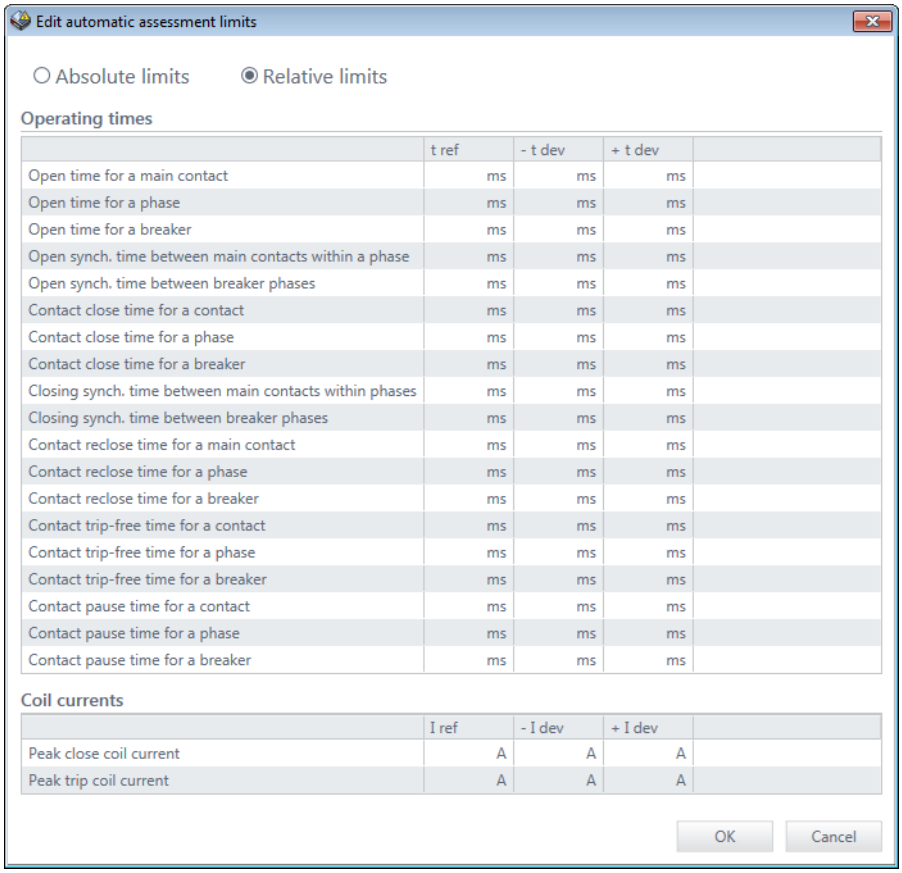


Figure 6-12 **Edit automatic assessment limits** dialog box: relative limits

Table 6-14 Relative Assessment Limits

Setting	Description
Operating times	
t ref	Operating time reference value
–t dev	Allowed negative deviation
+t dev	Allowed positive deviation
Coil currents	
I ref	Coil current reference value
–I dev	Allowed negative deviation
+I dev	Allowed positive deviation

The following table explains the sequences of the Timing test.

Table 6-15 Timing Test Sequences

Sequence	Action
O	With this sequence, the opening time of the circuit breaker is measured. Only for the O and C sequence it is recommended to perform the test twice, once with nominal voltage and once with 20 % undervoltage to assure the functionality of the circuit breaker for a weak station battery.
C	This is the sequence to measure the closing time of the circuit breaker.
OC	With this sequence, a closing operation after the circuit breaker has tripped to clear a fault is simulated. Initially, the circuit breaker must be in the closed position. A trip command initiates the sequence, followed by a dead time to clear the fault; and finally a close command must close the circuit breaker. This sequence is also known as reclosing time. To find out the shortest reclosing time the circuit breaker can provide, the close command is already applied while the breaker is still opening. The circuit breaker then will close after opening as fast as possible.

Table 6-15 Timing Test Sequences (continued)

Sequence	Action
CO	With this sequence, a tripping operation after the circuit breaker has been closed under a fault condition (trip-free) or the verification of the correct operation of the anti-pumping system is simulated. To test the trip-free time the circuit breaker must be in the open position before the test is started. The circuit breaker is closed and then during the close operation is still in progress an open command is sent. The circuit breaker then opens as fast as possible. To test the anti-pumping function of the circuit breaker, the circuit breaker must be in closed position before the test is started. For this test the open time is set shorter (typically 200 ms) than the closing time (typically 400 ms). Ensure that the end time is increased so that the test sequence covers the whole close command duration (typically at least 190 ms). When the close command is sent the breaker is already closed which initiates the anti-pumping function. Then an open command is sent and the circuit breaker trips. The closing command is still on when the trip command ends, but the circuit breaker should not "pump", so that it should not close again.
O-CO	With this sequence, a reclose sequence (OC) under a fault condition is simulated. If the fault is not released, the circuit breaker must open (O) immediately and remain in this position. Initially, the circuit breaker must be in the closed position. The sequence begins with a trip command, after a dead time the close and trip commands (CO) must be applied at the same time (delay time typically 300 ms).

2. By using the **Open breaker**, **Close breaker** and **Supply motor** buttons in the measurements area of *Primary Test Manager* you can check whether all cables are correctly connected and bring the circuit breaker to the proper state. For example, to test an O sequence, the circuit breaker must be closed and the spring charged.

3. In the measurements area, click **Start**.
   The blue ring on the **Measurement Start/Stop** button is on.

Warning: Stay in the safe area during the test. Any component of the circuit breaker can carry dangerous voltages.

4. Start the measurement by pressing the **Measurement Start/Stop** button. The blue ring on the **Measurement Start/Stop** button flashes for approx. 3 seconds, and the lightning symbol in *Primary Test Manager* and the red warning light on the front panel are flashing.

   Note: You can suspend the measurement anytime manually by pressing the **Emergency Stop** button or the **Measurement Start/Stop** button on the *CIBANO 500* front panel.

5. After the measurement has finished, the lightning symbol in *Primary Test Manager* stops flashing, the green warning light is on, and *Primary Test Manager* displays the measurement results.
   The Timing measurement data depends on the sequence of the trip and close commands. The following table describes the data for all measurement sequences.

Table 6-16 Timing Measurement Data

Data	Description
Operating times for breaker	
Open time	Contact open time[1]
Open synch.	Open synchronization time[1]
Close time	Contact close time[1]
Close synch.	Closing synchronization time[1]
Reclose time	Contact reclose time of OC operation[1]
Trip-free time	Contact trip-free time of CO and O-CO operation[1]
Trip-free time 2	Second contact trip-free time of CO-CO and O-CO-CO operation[1]
Pause time	Contact pause time of O-CO, CO-CO, and O-CO-CO operation[1]
t min/t ref[2]	Minimum operating time limit/ Operating time reference value
t max/t dev[2]	Maximum operating time limit/ Operating time deviation
Assessment	Assessment of operating times
Coil characteristics	
Peak current	Peak current value through a trip or close coil
Assessment	Assessment of coil characteristics

1. The operating times are calculated per contact, phase or circuit breaker.
2. Depends on the absolute or relative assessment limits selected.

Disconnection

Do not disconnect the circuit breaker but leave it connected for performing the next test. For disconnecting the circuit breaker, see "Disconnection" on page 99.

6.1.6 Dynamic Contact Resistance Test

The Dynamic Contact Resistance test is typically not done on MV circuit breakers and can be performed only with the *CB MC2* modules in connection with *CIBANO 500*. For more information, see 6.2.6 "Dynamic Contact Resistance Test" on page 126.

6.1.7 Minimum Pickup Test

The Minimum Pickup test determines the minimum voltage required to trip or close the circuit breaker. By using the internal power source of *CIBANO 500*, the coil supply voltage is increased step by step through an automated test sequence until the circuit breaker operates.

Note: To execute the Minimum Pickup test, you need a license. Without the license, you can configure the test but after pressing the **Start** button *Primary Test Manager* stops running and a missing license message appears.

For getting the license, contact your regional OMICRON Service Center.

Connection

To connect the test object to *CIBANO 500*:

1. In *Primary Test Manager*, select the Minimum Pickup test.
2. In *Primary Test Manager*, set the hardware configuration.
   Often you can leave the cables as already connected in the previous test.
   Unused sockets can remain connected.

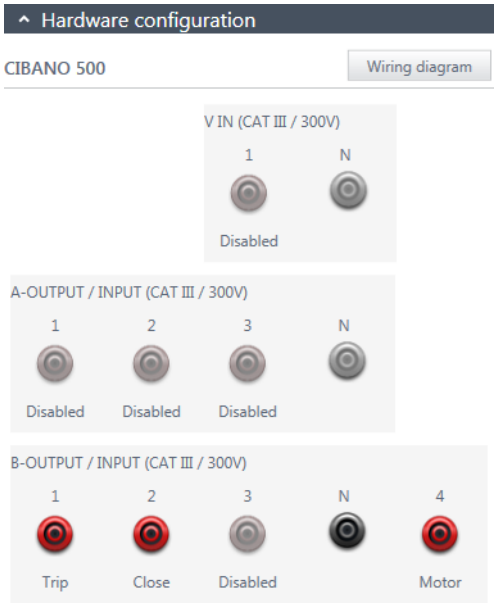


Figure 6-13 Hardware configuration of the Minimum Pickup test

Table 6-17 Hardware Configuration Options of *CIBANO 500*

CIBANO 500	Option
V IN (CAT III / 300 V)[1]	
1	External source or disabled
N	Neutral connection of **V IN**
A-OUTPUT / INPUT (CAT III / 300 V)	
1	Motor A or disabled (preferred)
2	Motor B or disabled (preferred)
3	Motor C or disabled (preferred)
N	Common neutral connection for outputs/inputs in group **A**
B-OUTPUT / INPUT (CAT III / 300 V)	
1	Trip or disabled
2	Close or disabled
3	Supply or disabled
N	Common neutral connection for outputs/inputs in group **B**
4	Motor (preferred) or disabled

1. Cannot be used to supply the trip or close coil because a variable voltage is needed, however it can be used to supply the motor.

3. Make sure that all cable connectors are clean and dry before being tightly connected.
4. Connect *CIBANO 500* to the trip and close coils of the circuit breaker according to the wiring diagram displayed in *Primary Test Manager* and Figure 6-6 "Connecting CIBANO 500 to the circuit breaker for the Timing test" on page 66.

Measurement

To perform a measurement:

1. In *Primary Test Manager*, enter the settings of the Minimum Pickup test.

Table 6-18 Minimum Pickup Test Settings

Setting	Description
CIBANO 500	
Rated coil supply voltage	Rated voltage of the coil power supply Click **AC** or **DC** for AC or DC coil supply voltage respectively.
Test frequency	Frequency of the AC coil power supply
Supply during test	
Enable	Select the **Enable** check box to supply voltage on the **B3** socket during test execution.[1]
Supply voltage	Voltage supplied on the **B3** socket (same as the coil supply voltage)
Supply before test	Time interval within which the voltage is supplied before the test starts
Test sequence	
Coil supply voltage start	Start voltage of the automated test sequence to determine the minimum pickup voltage
Coil supply voltage end	End voltage of the automated test sequence to determine the minimum pickup voltage
Coil supply voltage step	Stepwise voltage increase of the automated test sequence
Command impulse duration	Duration of the command pulse of the automated test sequence
Pause between impulses	Time interval between impulses of the automated test sequence

Table 6-18 Minimum Pickup Test Settings (continued)

Setting	Description
Assessment settings	
Manual	Click **Manual** to select the manual assessment settings.
Automatic	Click **Automatic** to select the automatic assessment settings. Click **Edit test limits** to adjust the assessment limits (see Figure 6-14 "Edit automatic assessment limits dialog box" on page 92).
Motor supply	
Motor supply with	Click **CIBANO 500** to supply the motor with *CIBANO 500*. Click **External source** to supply the motor externally.
Motor supply voltage[2]	Voltage of the motor power supply Click **AC** or **DC** for AC or DC motor supply voltage respectively.
Test frequency	Frequency of the AC motor power supply

1. The **B3** socket must be configured as **Supply** and the coil supply voltage must be specified.
2. Only available if *CIBANO 500* is selected as source

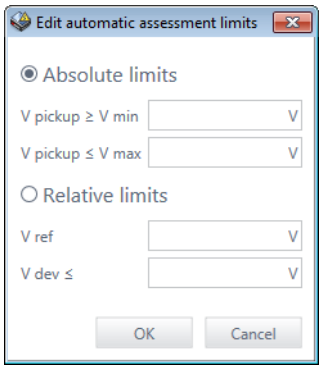


Figure 6-14 **Edit automatic assessment limits** dialog box

Table 6-19 Automatic Assessment Limits

Setting	Description
Absolute limits	
V pickup ≥ V min	Minimum value of the pickup voltage
V pickup ≤ V max	Maximum limit of the pickup voltage
Relative limits	
V ref	Reference pickup voltage
V dev ≤	Allowed deviation from the reference pickup voltage

2. By using the **Open breaker**, **Close breaker** and **Supply motor** buttons in the measurements area of *Primary Test Manager* check whether all cables are correctly connected and bring the circuit breaker to the proper state. For testing the minimum pickup by the open sequence the circuit breaker must be closed and vice versa.

3. In the measurements area, select the measurement you want to perform, and then click **Start**.
   The blue ring on the **Measurement Start/Stop** button is on.

Warning: Stay in the safe area during the test. Any component of the circuit breaker can carry dangerous voltages.

4. Start the measurement by pressing the **Measurement Start/Stop** button. The blue ring on the **Measurement Start/Stop** button flashes for approx. 3 seconds, and the lightning symbol in *Primary Test Manager* and the red warning light on the front panel are flashing.

   Note: You can suspend the measurement anytime manually by pressing the **Emergency Stop** button or the **Measurement Start/Stop** button on the *CIBANO 500* front panel.

   Note: If you connect, for example, three coils of three phases in parallel not all might operate at the same voltage. In this case the test will run until the last phase has operated and the highest voltage (worst case) will be shown.

5. After the measurement has finished, the lightning symbol in *Primary Test Manager* stops flashing, the green warning light is on, and *Primary Test Manager* displays the measurement results.

Table 6-20 Minimum Pickup Measurement Data

Data	Description
No.	Number of the measurement
Operation	Trip or close
V pickup	Pickup voltage of the circuit breaker under test
V min/V ref[1]	Assessment limit
V max/V dev[1]	Assessment limit
Assessment	Measurement assessment

1. Depends on the absolute or relative assessment limits selected.

Disconnection

Do not disconnect the circuit breaker but leave it connected for performing the next test. For disconnecting the circuit breaker, see "Disconnection" on page 99.

6.1.8 Motor Current Test

The Motor Current test records the supply voltages and currents of the circuit breaker's charging motor(s).

Note: To execute the Motor Current test, you need a license. Without the license, you can configure the test but after pressing the **Start** button *Primary Test Manager* stops running and a missing license message appears.

For getting the license, contact your regional OMICRON Service Center.

Connection

To connect the test object to *CIBANO 500*:

1. In *Primary Test Manager*, select the Motor Current test.
2. In *Primary Test Manager*, set the hardware configuration.
3. If not already set in the Timing test, click the **A1** socket in the hardware configuration, and then click **Disabled**. After that, click the **B4** socket, and then click **Motor**. After you set the hardware configuration, connect the **B4** socket on the side panel of *CIBANO 500* to "+" or phase contact of the motor and the **BN** socket to "–" or neutral contact of the motor.

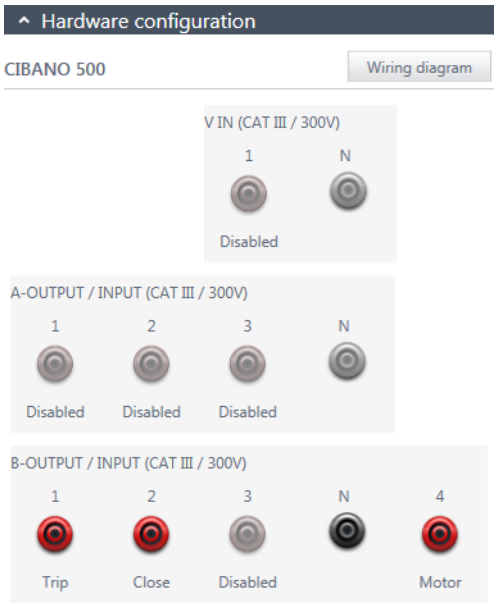


Figure 6-15 Hardware configuration of the Motor Current test

Note: You can control three circuit breaker's motors simultaneously. In this case connect the phase contact of the motor 1 to the **A1** socket, the phase contact of the motor 2 to the **A2** socket, the phase contact of the motor 3 to the **A3** socket, and the neutral motor contacts to the **AN** socket.

Table 6-21 Hardware Configuration Options of *CIBANO 500*

CIBANO 500	**Option**
V IN (CAT III / 300 V)	
1	External source or disabled
N	Neutral connection of **V IN**
A-OUTPUT / INPUT (CAT III / 300 V)	
1	Motor A or disabled
2	Motor B or disabled
3	Motor C or disabled
N	Common neutral connection for outputs/inputs in group **A**

Table 6-21 Hardware Configuration Options of *CIBANO 500* (continued)

CIBANO 500	Option
B-OUTPUT / INPUT (CAT III / 300 V)	
1	Trip or disabled
2	Close or disabled
3	Supply or disabled
N	Neutral connection of outputs in group **B**
4	Motor or disabled

4. Make sure that all cable connectors are clean and dry before being tightly connected.
5. Connect *CIBANO 500* to the motor of the circuit breaker according to the wiring diagram displayed in *Primary Test Manager* and the following figure.

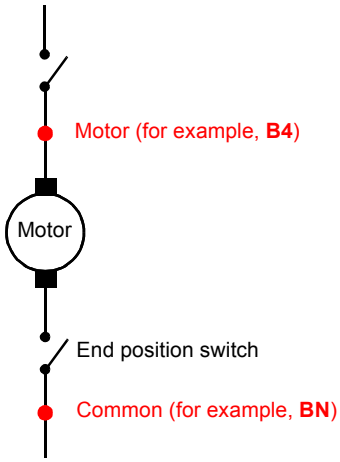


Figure 6-16 Connecting *CIBANO 500* to the circuit breaker for the Motor Current test (The end position switch opens when the spring is charged.)

Measurement

To perform a measurement:

1. In *Primary Test Manager*, enter the settings of the Motor Current test.

Table 6-22 Motor Current Test Settings

Setting	Description
Motor supply	
Motor supply with	Click **CIBANO 500** to supply the motor with *CIBANO 500*. Click **External source** to supply the motor externally.
Motor supply voltage[1]	Voltage of the motor power supply Click **AC** or **DC** for AC or DC motor supply voltage respectively.
Test frequency	Frequency of the AC motor power supply
Coil supply	
Coil supply with	Click **CIBANO 500** to supply the coil with *CIBANO 500*. Click **External source** to supply the coil externally.
Coil supply voltage[1]	Voltage of the coil power supply Click **AC** or **DC** for AC or DC coil supply voltage respectively.
Test frequency	Frequency of the AC coil power supply
Other	
Sample rate	Measurement sample rate
Supply during test	
Enable	Select the **Enable** check box to supply voltage on the **B3** socket during test execution.[2]
Supply voltage	Voltage supplied on the **B3** socket (same as the coil supply voltage)
Supply before test	Time interval within which the voltage is supplied before the test starts

1. Only available if *CIBANO 500* is selected as source
2. The **B3** socket must be configured as **Supply** and the coil supply voltage must be specified.

2. In the measurements area, click **Start**.
   The blue ring on the **Measurement Start/Stop** button is on.

Warning: Stay in the safe area during the test. Any component of the circuit breaker can carry dangerous voltages.

3. Start the measurement by pressing the **Measurement Start/Stop** button.
   The blue ring on the **Measurement Start/Stop** button flashes for approx. 3 seconds, and the lightning symbol in *Primary Test Manager* and the red warning light on the front panel are flashing.

   Note: The measurement does not stop automatically. In emergency cases, you can suspend the measurement anytime manually by pressing the **Emergency Stop** button on the *CIBANO 500* front panel.

4. After the charging process finished (indicated by stopping the circuit breaker's motor), press the **Start Stop** button on the *CIBANO 500* front panel to stop the measurement.
   The lightning symbol in *Primary Test Manager* stops flashing, the green warning light is on, and *Primary Test Manager* displays the measurement results.
   Primary Test Manager displays the measurement results of the Motor Current test only graphically. The following figure shows an example of the Motor Current test results.

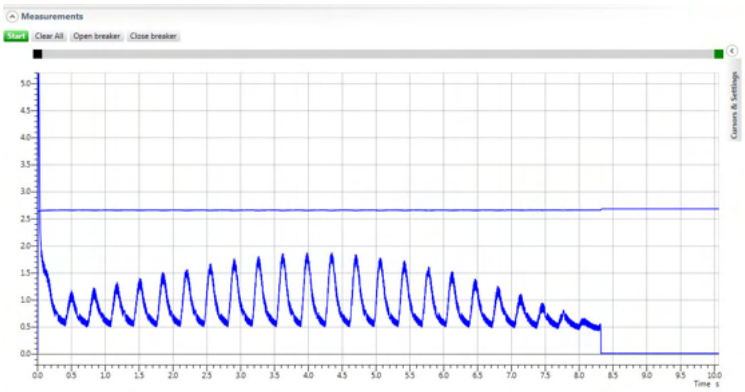


Figure 6-17 Example of the Motor Current test results

Disconnection

Note: Do not disconnect the test object from *CIBANO 500* if you intend to make further measurements.

To disconnect the test object from *CIBANO 500*:

1. Press the **Emergency Stop** button on the *CIBANO 500* front panel.
2. Disconnect all cables from the circuit breaker.
3. Disconnect all cables from *CIBANO 500*.
4. Switch *CIBANO 500* off by pressing the mains power on/off switch on the *CIBANO 500* side panel.
5. Disconnect the mains power cord.
6. Remove the equipotential ground as the last connection that is removed first on the substation side and then from *CIBANO 500*.

Warning: After you have completely disconnected *CIBANO 500* from the circuit breaker, operate the circuit breaker manually by using the circuit breaker's operation buttons until the spring(s) are discharged.

6.2 Testing High-Voltage Circuit Breakers

The high-voltage (HV) circuit breakers are typically tested with the *CB MC2* and *CB TN3* modules in connection with *CIBANO 500*. If you want to test the HV circuit breakers without the *CB MC2* modules, see 6.1 "Testing Medium-Voltage Circuit Breakers" on page 57. In this case read both sections carefully and use *Primary Test Manager* as described in 6.1 "Testing Medium-Voltage Circuit Breakers" on page 57 but observe also the safety rules and tips and tricks relevant for testing the HV circuit breakers.

6.2.1 Safety Precautions in the Substation

Warning: A lightning discharge to the test object can cause injury or possibly death of the operating staff. Do not connect the test set to the test object if there is a possibility of a thunderstorm over any part of the system to be tested.

Always observe the following safety rules:

- Disconnect completely.
- Secure against re-connection.
- Verify that the installation is dead.
- Carry out grounding and short-circuiting.
- Provide protection against adjacent live parts.
- Ground the test object at one or more terminals during connecting, testing and disconnecting.

Warning: Ensure that the circuit breaker to be tested is grounded on both ends on all phases before carrying out any of the following steps. Ensure that the circuit breaker is closed to have proper grounding between the interrupters.

Separate your working area as shown in Figure 1-1 "Example of the separation of the safe and dangerous areas" on page 11 into a safe area and a dangerous area when test is running.

Protect others from accessing the dangerous area and accidentally touching live parts by setting up a suitable barrier and, if applicable, warning lights.

If there is a longer distance between the location of *CIBANO 500* and the dangerous area (that is, the test object), a second person with an additional **Emergency Stop** button is required.

Warning: Never use the *CIBANO 500* test set without a solid connection to ground with at least 6 mm^2 cross-section. Use a ground point as close as possible to the operator.

6.2.2 Test Set and Software Start-Up

To put *CIBANO 500* into operation and start *Primary Test Manager*:

1. Connect properly the *CIBANO 500* grounding terminals to the substation ground.
2. Connect *CIBANO 500* to a computer with the delivered Ethernet cable and switch the computer on.
3. Connect *CIBANO 500* to the mains power supply by using the delivered power cord.

4. Switch *CIBANO 500* on by pressing the mains power on/off switch on the side panel. The green warning light on the *CIBANO 500* front panel (see Figure 2-1 "Front view of CIBANO 500" on page 15) flashes for a short time and then extinguishes for approx. one minute. After it lights up, the *CIBANO 500* outputs carry no dangerous voltage or current.
5. Start *Primary Test Manager* and connect to *CIBANO 500* as described in 4.4 "Start Primary Test Manager and Connect to CIBANO 500" on page 30.

If you could not connect to your *CIBANO 500* device and the green light is permanently on, wait a few seconds, and then do one of the following:

- Click **More** beneath the **Connect** button, and then click **Refresh**.
- Press F5.

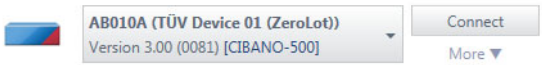


Figure 6-18 Connecting to *CIBANO 500*

If the *CIBANO 500* device to which you want to connect is not displayed in the list of available devices, proceed as described in 9.1 "Connecting to CIBANO 500" on page 175.

6.2.3 Testing Circuit Breakers with *CIBANO 500* and the *CB MC2* Modules

One or two interrupters per phase

This section describes testing circuit breakers with three *CB MC2* modules. For testing with less *CB MC2* modules, see "Three to six interrupters per phase" later in this chapter.

When testing circuit breakers with one or two interrupters per phase you can hook up the *CB MC2* modules to all interrupters at the same time, without reconnecting them during any of the following tests. In some of the following sections we recommend to rewire to the control cabinet depending on the circuit breaker type but you do not have to rewire anything in the high-voltage section of the circuit breaker.

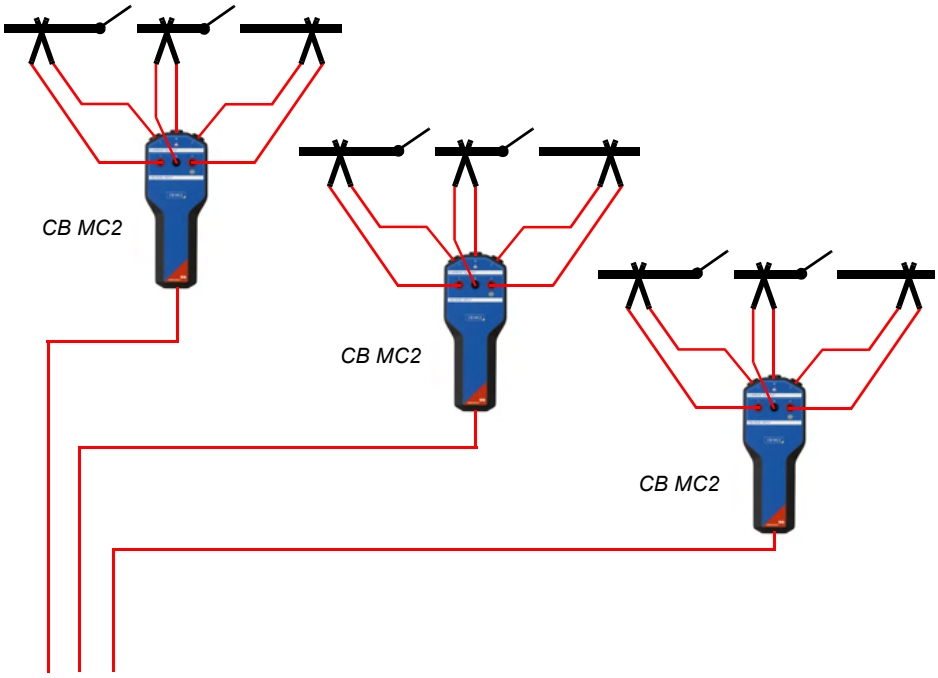


Figure 6-19 High-voltage section of a circuit breaker with two interrupters per phase with connected *CB MC2* modules

Three to six interrupters per phase

If you do not need to measure the static resistance and timing of the individual interrupters you can proceed as described in "One or two interrupters per phase" earlier in this chapter but by bridging more than one interrupter at the same time. However, we strongly recommend to proceed as described in this section.

With three *CB MC2* modules you can test circuit breakers with more than two interrupters per phase simultaneously phase by phase. Connect two or three *CB MC2* modules so that each *CB MC2* module covers two interrupters as shown in the following figure.

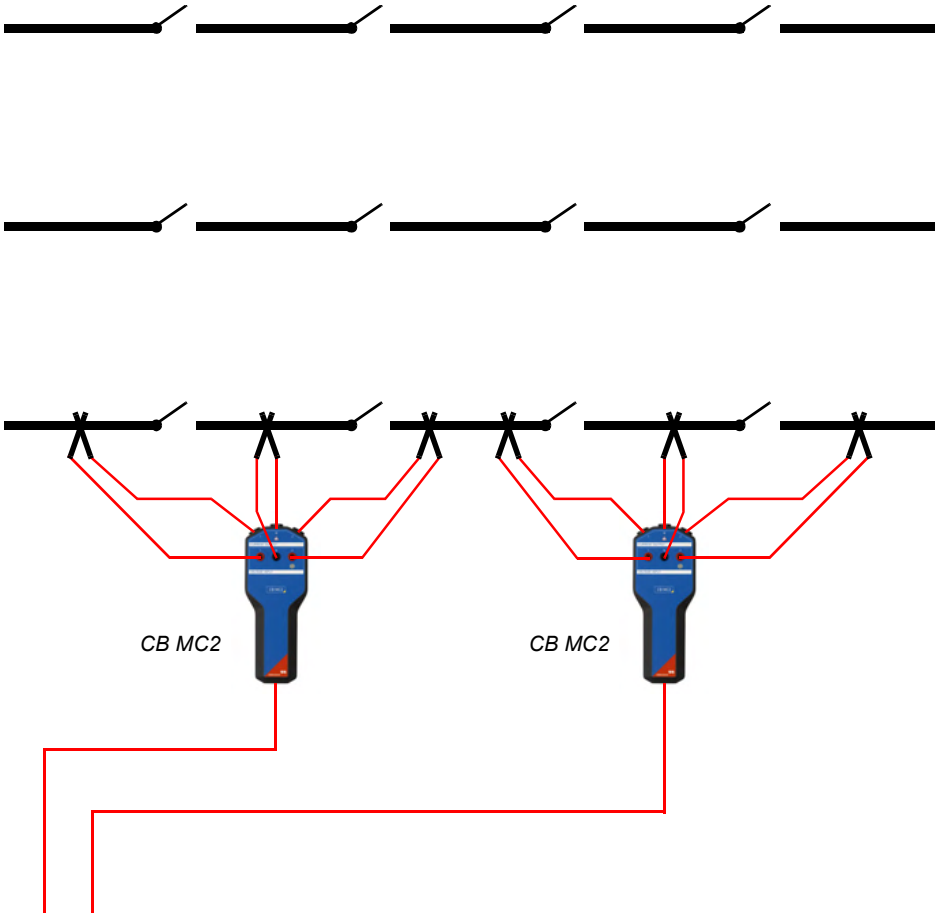


Figure 6-20 Example of the connection to the first phase of a circuit breaker with four interrupters per phase

If the circuit breaker has three separate drives it makes also sense to connect to one drive after the other. If the circuit breaker has only one central drive or all drives are interconnected, all phases are operated together but phase by phase is measured.

The tests described in the following sections are carried out for the first phase, and then for the other phases subsequently. If the circuit breaker has one common drive you do not have to repeat the Minimum Pickup and Motor Current tests.

You do not need to additionally test the synchronicity between the phases, however, if requested you can do it by connecting one *CB MC2* module to each phase as a last test and by bridging more interrupters with one channel of the *CB MC2* module.

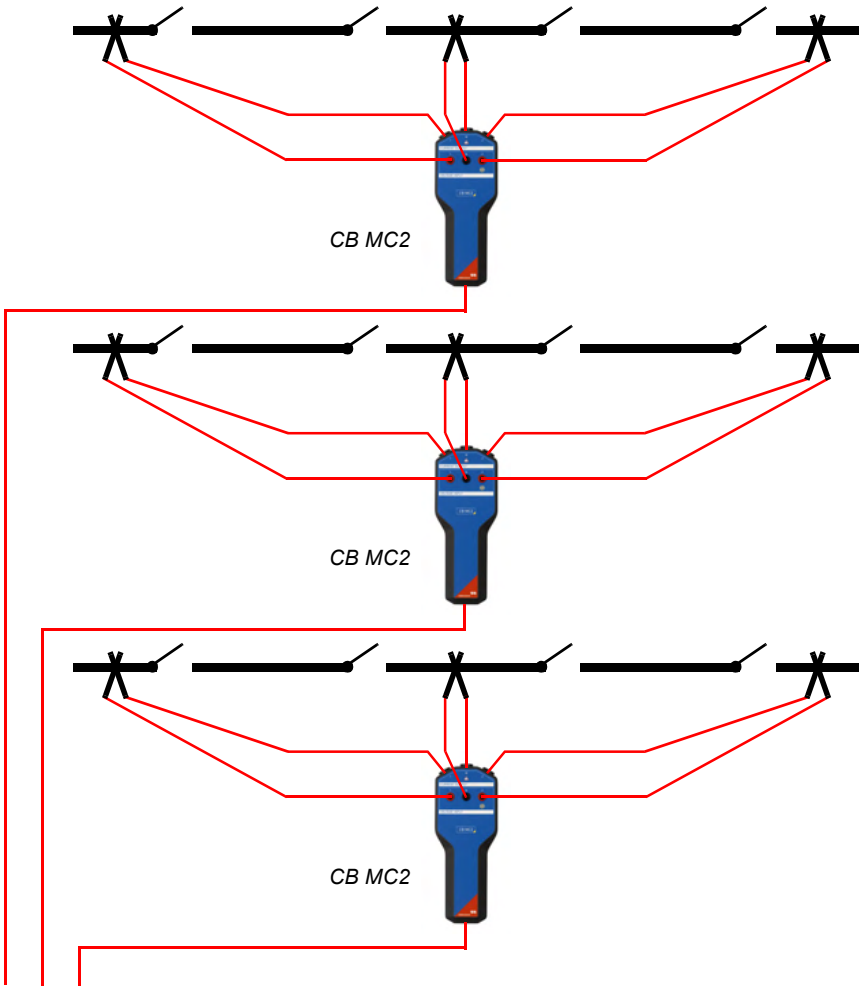


Figure 6-21 Testing the phase synchronicity of the previous example

More than six interrupters per phase

To test circuit breakers with more than six interrupters per phase, split the tests described earlier in this chapter in two tests to cover all interrupters individually.

6.2.4 Contact Resistance Test

The Contact Resistance test measures the static resistance of the circuit breaker's main contacts.

Connection

Warning: During the test, the *CB MC2* must be the only power source for the circuit breaker's main contacts.

Warning: Before connecting anything to the circuit breaker ensure that it is grounded on both ends on all phases and it is closed to have proper grounding between the interrupters.

To connect the test object to *CIBANO 500*:

Warning: Connect the EtherCAT® cables first to *CIBANO 500* and then to the *CB MC2* module.

1. Make sure that all cable connectors are clean and dry before being tightly connected.
2. Connect the *CB MC2* to *CIBANO 500* with the EtherCAT® cable.
3. Hook up the *CB MC2* to the first or the first two interrupter(s) of the circuit breaker.
4. Connect the *CB MC2* to the main contact of the circuit breaker with the delivered cables and clamps.

Tips & Tricks: The delivered Kelvin clamp is the perfect solution for connecting to a massive conductor like a copper busbar or similar. If you cannot connect in this way, use the Kelvin clamp as a normal current clamp only for current injection (6 mm connector) and use a separate crocodile clamp for voltage sensing. Then connect the voltage sense closer to the circuit breaker contact than the current clamp.
Because sometimes it is difficult to connect to the center point between two interrupters by using the Kelvin clamp, one pair of Y-clamps is shipped with each *CB MC2* module. With the Y-clamps you can connect alternatively, even cutting through paint with the clamp. In this case connect the voltage sense clamp on the other side of the central housing opposite to the current injection clamp.

5. Repeat steps 2 to 4 for all interrupters you want to test.
6. In *Primary Test Manager*, select the Contact Resistance test.
7. In *Primary Test Manager*, set the hardware configuration and check whether *Primary Test Manager* recognized all connected *CB MC2* modules.

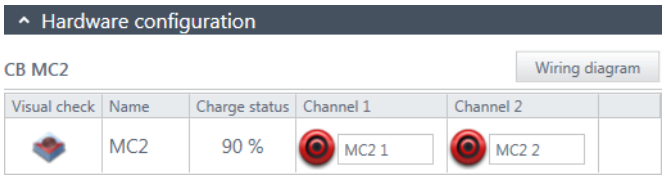


Figure 6-22 Hardware configuration of the Contact Resistance test

Table 6-23 Hardware Configuration Options of the *CB MC2* Module

CB MC2	Option
Visual check	Click the LED symbol to identify the connected *CB MC2* module by flashing LED.
Name[1]	Editable name of the *CB MC2* module
Charge status	Indicates the charge status of the *CB MC2* module.
Channel 1[1]	Editable name of the *CB MC2* channel 1. Click the socket symbol to activate or deactivate the channels depending on the connections made.
Channel 2[1]	Editable name of the *CB MC2* channel 2. Click the socket symbol to activate or deactivate the channels depending on the connections made.

1. This name is permanently stored in the *CB MC2* memory. You can, for example, mark your *CB MC2* modules with the colored stickers and name them according to the colors. You can also rename the *CB MC2* modules depending on the connection point.

For the basic connection diagram, see Figure 6-3 "Principal scheme of the contact resistance test" on page 60 and 6.2.3 "Testing Circuit Breakers with CIBANO 500 and the CB MC2 Modules" on page 102.

Measurement

To perform a measurement:

1. In *Primary Test Manager*, enter the settings of the Contact Resistance test.

Table 6-24 Contact Resistance Test Settings

Setting	Description
CB MC2	
Test current	Current of the test[1] (typically 100 A)
V DC range	DC voltage measurement range[2]
CT Mode	Select the **Enabled** check box to enable CT mode for measuring circuit breakers with current transformers (CT).
Test duration	Duration of the test
Test conditions	
Ambient temperature	Ambient temperature[3]
Assessment settings	
Manual	Click **Manual** to select the manual assessment settings.
Automatic	Click **Automatic** to select the automatic assessment settings. Click **Edit test limits** to adjust the assessment limits (see Figure 6-23 "Edit automatic assessment limits dialog box" on page 109).

1. Generally the maximum current of 100 A is recommended for maximum accuracy. If during a test the time the breaker is closed should be longer than 1.5 s you might necessarily reduce the test current to drive the current for the whole test duration. Normally, times of 1.5 seconds are however unproblematic.
2. The lower the range, the higher is the accuracy.
3. Only for reference in the report, the results are not temperature compensated.

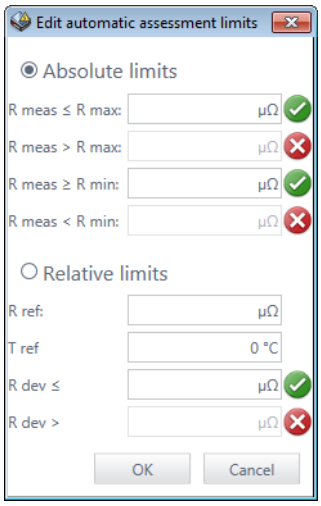


Figure 6-23 **Edit automatic assessment limits** dialog box

Table 6-25 Automatic Assessment Limits

Setting	Description
Absolute limits	
R meas ≤ R max	Maximum limit of the resistance value
R meas ≥ R min	Minimum limit of the resistance value
Relative limits	
R ref	Reference resistance value
T ref	Reference temperature
R dev ≤	Allowed deviation from the reference resistance value

2. In the measurements area, click **Start all**.
   The blue ring on the **Measurement Start/Stop** button is on.

3. Start the measurement by pressing the **Measurement Start/Stop** button.
   The blue ring on the **Measurement Start/Stop** button flashes for approx. 3 seconds, and the lightning symbol in *Primary Test Manager* and the red warning light on the front panel are flashing.

   Note: You can suspend the measurement anytime manually by pressing the **Emergency Stop** button or the **Measurement Start/Stop** button on the *CIBANO 500* front panel.

4. After the measurements have finished, the lightning symbol in *Primary Test Manager* stops flashing, the green warning light is on, and *Primary Test Manager* displays the measurement results.

Table 6-26 Contact Resistance Measurement Data

Data	Description
Channel	Channel of the *CB MC2* module
I DC	Measured test current
V DC	Measured voltage
R meas	Measured resistance
R min/R ref[1]	Minimum assessment limit/ Reference resistance value
R max/R dev[1]	Maximum assessment limit/ Allowed deviation from the reference resistance value
Assessment	Measurement assessment

1. Depending on whether the absolute or relative assessment limits are selected.

In case of one interrupter per phase, the groundings on both sides create a current path in parallel to the main contact, and the resistance of this path results in a measurement error. By measuring twice, once with the breaker open and once with the breaker closed, you can compensate the error perfectly by calculating
$R_{CB} = (R_{BsgCbOpen} \times R_{BsgCbClosed})/(R_{BsgCbOpen} - R_{BsgCbClosed})$,
where R_{CB} is the calculated real value of the circuit breaker's static contact resistance,
$R_{BsgCbOpen}$ is the measured value when the circuit breaker is open and both sides are grounded, and
$R_{BsgCbClosed}$ is the measured value when the circuit breaker is closed and both sides are grounded.

If the circuit breaker has an even number of interrupters per phase, the test is typically performed with the circuit breaker grounded on both ends. In this case no compensation is needed because the voltages of the two channels of each *CB MC2* module cancel out each other which results in no current through the ground loop. If only one side of a *CB MC2* module is connected, it is a similar case to the circuit breakers with one interrupter per phase described earlier in this section.

Tips & Tricks: The connection to the center point between two circuit breaker's interrupters can be tricky.If you are not sure whether the connection you have made is good, you can verify the connection as follows. Perform a measurement with only channel 1, then a measurement with channel 2, and finally a measurement with both channels. If the results match you have a perfect center point connection. If the results do not match you either have a bad center connection or the effect of the ground loop, that affects the result only when measuring asymmetrically, is too big.

Disconnection

Do not disconnect the circuit breaker but leave it connected for performing the next test. For disconnecting the circuit breaker, see "Disconnection" on page 153.

6.2.5 Timing Test

The Timing test measures the contact timing of the circuit breaker. Depending on the selected sequence the open time, close time, trip-free time, and so on are automatically calculated. With the *CB TN3* modules, you can also measure the displacement of the circuit breaker's main contacts during operation.

If you have the software license to perform the Dynamic Contact Resistance test proceed with that test as described in 6.2.6 "Dynamic Contact Resistance Test" on page 126. The Timing test requires the same amount of work but gives less information.

Connection

Warning: Before connecting anything to the circuit breaker ensure that it is grounded on both ends on all phases and it is closed to have proper grounding between the interrupters.

To connect the test object to *CIBANO 500*:

Warning: Connect the EtherCAT® cables first to *CIBANO 500* and then to the *CB MC2* modules.

1. Make sure that all cable connectors are clean and dry before being tightly connected.
2. Connect the *CB MC2* to *CIBANO 500* with the EtherCAT® cable.
3. If the *CB MC2* modules are not connected from the last test, hook up the *CB MC2* to the first or the first two interrupter(s) of the circuit breaker.
4. Connect the *CB MC2* to the main contact of the circuit breaker with the delivered cables and clamps.
5. Repeat steps 2 to 4 for all interrupters you want to test.
6. In *Primary Test Manager*, select the Timing test.

7. In *Primary Test Manager*, set the hardware configuration and check whether *Primary Test Manager* recognized all connected *CB MC2* modules.

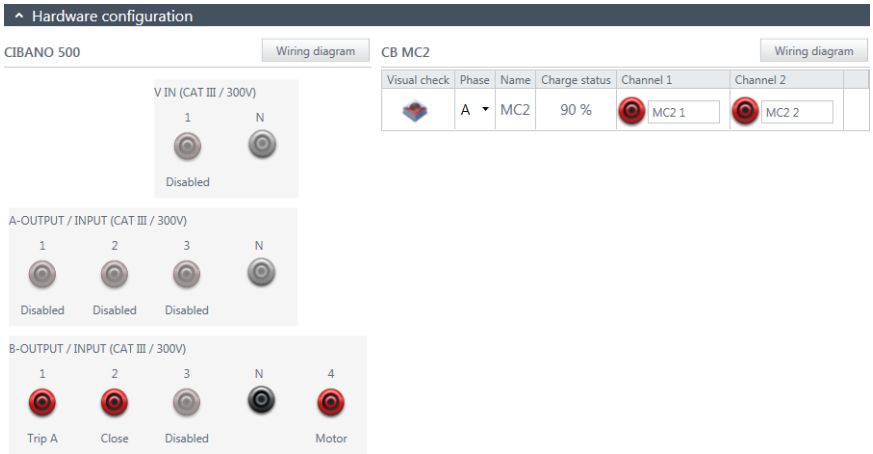


Figure 6-24 Hardware configuration of the Timing test

Table 6-27 Hardware Configuration Options of *CIBANO 500*

CIBANO 500	Option
V IN (CAT III / 300 V)	
1	External source or disabled
N	Neutral connection of **V IN**
A-OUTPUT / INPUT (CAT III / 300 V)	
1	AUX 1, close A, motor A, or disabled
2	AUX 2, close B, motor B, or disabled
3	AUX 3, close C, motor C, or disabled
N	Common neutral connection for outputs/inputs in group **A**
B-OUTPUT / INPUT (CAT III / 300 V)	
1	Trip A, I clamp 1, or disabled
2	Trip B, I clamp 2, close, or disabled
3	Trip C, I clamp 3, supply, or disabled
N	Neutral connection of outputs in group **B**
4	Motor, I clamp 4, or disabled

V IN (CAT III / 300 V)

These inputs can be configured to connect an external source such as a station battery or an external power supply. Generally the input is not used but if you need to test the behavior (voltage) of the station battery under real load conditions this option is available.

Note: The coils or the motor can be configured to be supplied from **V IN** (external source). When activated the respective output of *CIBANO 500* is supplied from the socket **1** of the **V IN** section via the internal command switch. This command switch can also disrupt the current in case of a short circuit. Input **N** of the **V IN** section is for voltage reference measurement only.

A-OUTPUT / INPUT (CAT III / 300 V)

For the most tests the **A** group is used as auxiliary inputs on HV circuit breakers. The contacts can be "wet" or "dry". The dry contacts are floating contacts without any reference to ground. The wet contacts are contacts that carry voltage when closed. In this case the common pole of the battery (minus in most cases) is connected to **AN** and the auxiliary contacts are connected to the respective inputs of group **A**.

If you want to record the supply current for three close coils or three motors simultaneously you can configure the sockets by clicking them.

Note: *CIBANO 500* has only three command switches. Consequently, three trip *or* three close coils can be operated simultaneously but not all six coils at the same time. To record currents for three trip coils and three close coils separately, connect three close coils to **A1** to **A3**, three trip coils to **B1** to **B3**, and then perform an O and a C Timing test. The other tests like CO or OC with the trip and close signals applied simultaneously are then performed with different wiring.

B-OUTPUT / INPUT (CAT III / 300 V)

The **B** group is generally used as follows. **B1** is used for the trip command, **B2** is used for the closed command, and **B3** is not used. **B4** is used to supply the motor or the measure the motor current by using a current clamp.

Table 6-28 Hardware Configuration Options of the *CB MC2* Module

CB MC2	Option
Visual check	Click the LED symbol to identify the connected *CB MC2* module by flashing LED.
Phase	Phase to which the *CB MC2* module is connected
Name[1]	Editable name of the *CB MC2* module
Charge status	Indicates the charge status of the *CB MC2* module.
Channel 1[1]	Editable name of the *CB MC2* channel 1. Click the socket symbol to activate or deactivate the channel depending on the connections made.
Channel 2[1]	Editable name of the *CB MC2* channel 2. Click the socket symbol to activate or deactivate the channel depending on the connections made.

1. This name is permanently stored in the *CB MC2* memory. You can, for example, mark your *CB MC2* modules with the colored stickers and name them according to the colors. You can also rename the *CB MC2* modules depending on the connection point.

8. Connect *CIBANO 500* to the trip and close coils of the circuit breaker for all phases according to the wiring diagram displayed in *Primary Test Manager* and the following figure.

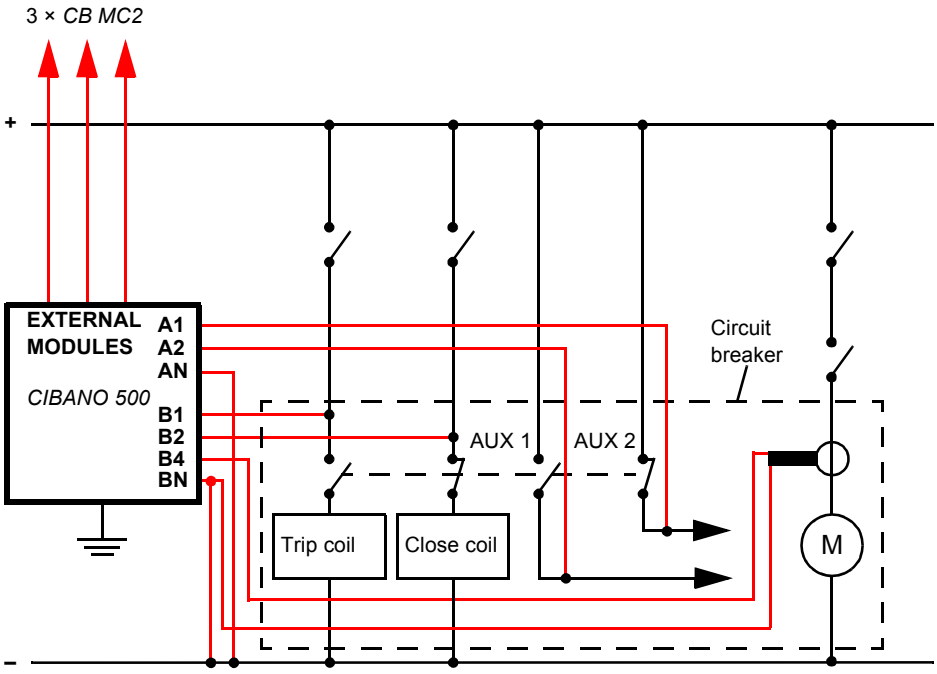


Figure 6-25 Typical measurement setup for the Timing test

For circuit breakers with one drive for all three phases connect the trip coil to **B1**, the close coil to **B2**, and the common connection of the trip and close coils (typically the battery minus) to **BN**. Generally, the motor of the HV circuit breakers remains connected to the station battery throughout the test and a current clamp connected to **BN** and **B4** is used to record the motor current.

Note: Connect the current clamp neutral directly to *CIBANO 500* and not to the other end of the neutral cable to avoid measurement errors due to the voltage drop on the cable. Alternatively you can supply the motor from *CIBANO 500* if you want or no station battery is available.

Circuit breakers with three drives are either tested phase by phase (see 6.2.3 "Testing Circuit Breakers with CIBANO 500 and the CB MC2 Modules" on page 102) or you can connect the three trip and close signals together. If you want to record the supply current for three coils simultaneously you can configure the sockets by clicking them.

Warning: If you use the station battery to supply the motor or the coils via *CIBANO 500*, it is safer to connect the cables first to grounded *CIBANO 500* and then to the station battery.

Measurement

To perform a measurement:

1. In *Primary Test Manager*, enter the settings of the Timing test.

Table 6-29 Timing Test Settings: *CIBANO 500*

Setting	Description
CIBANO 500	
Coil supply with	Click **CIBANO 500** to supply the coil with *CIBANO 500*. Click **External source** to supply coils with the source connected to **V IN**.
Coil supply voltage[1]	Voltage of the coil power supply. Click **AC** or **DC** for AC or DC coil supply voltage respectively. **Note:** To perform the undervoltage trip and undervoltage close tests set the coil supply voltage lower than the nominal voltage.
Test frequency	Frequency of the AC coil power supply
Supply during test	
Enable	Select the **Enable** check box to supply voltage on the **B3** socket during test execution.[2]
Supply voltage	Voltage supplied on the **B3** socket (same as the coil supply voltage)
Supply before test	Time interval within which the voltage is supplied before the test starts
Other	
Sample rate	Measurement sample rate[3]
Assessment settings	

Table 6-29 Timing Test Settings: *CIBANO 500* (continued)

Setting	Description
Manual	Click **Manual** to select the manual assessment settings.
Automatic	Click **Automatic** to select the automatic assessment settings. Click **Edit test limits** to adjust the assessment limits. In the **Edit automatic assessment limits** dialog box, click **Absolute limits** (see Figure 6-30 "Edit automatic assessment limits dialog box: absolute limits" on page 136) or **Relative limits** (see Figure 6-31 "Edit automatic assessment limits dialog box: relative limits" on page 137) to select absolute or relative limits respectively.
Motor supply	
Motor supply with	Click **CIBANO 500** to supply the motor with *CIBANO 500*. Click **External source** if the motor is supplied from the station supply or battery without any connection to *CIBANO 500* or if the station battery is connected to the **V IN** section and supplied, for example, via the **B4** socket. **Note:** We do not recommend to supply the motor with undervoltage. Doing so does not provide any additional useful information and can cause degradation of the motor operation over time.
Motor supply voltage[1]	Voltage of the motor power supply Click **AC** or **DC** for AC or DC motor supply voltage respectively.
Test frequency	Frequency of the AC motor power supply
Sequence	
O	Perform an open sequence
C	Perform a close sequence
OC[4]	Perform a reclose sequence

Table 6-29 Timing Test Settings: *CIBANO 500* (continued)

Setting	Description
CO[4]	Perform a trip-free sequence
O-CO[4]	Perform an O-CO sequence
CO-CO	Perform a CO-CO sequence
O-CO-CO	Perform an O-CO-CO sequence

1. Only available if *CIBANO 500* is selected as source
2. The **B3** socket must be configured as **Supply** and the coil supply voltage must be specified.
3. 10 kHz is recommended to constrain the amount of created data. Higher sample rates are needed for special tests only.
4. See Table 6-33 "Timing Test Sequences" on page 122.

Table 6-30 Timing Test Settings: *CB MC2*

Setting	Description
CB MC2	
Test current	Current of the test[1]
V DC range	DC voltage measurement range[2]
PIR	Select the **Measure PIR** check box to measure timing of the pre-insertion resistors.
C-O threshold	Resistance threshold to detect whether the main contact is open or closed. *Primary Test Manager* interprets the contact as open if the contact resistance is over the C-O threshold and vice versa.
Current clamp settings[3]	
Channel	**B** group I/O socket
Ratio	Current clamp ratio
I max	Maximum current of the selected probe range

1. For the Timing test 10 A is mostly sufficient.
2. The lower the range the more accurate is the result. Use a higher range only if you expect a voltage higher than the set range.
3. Only available if a current clamp is configured. The channel value displayed refers to the **B** group of the I/O sockets on the *CIBANO 500* side panel. The **B1**…**B4** sockets can be configured as **I clamp 1**…**I clamp 4** respectively.

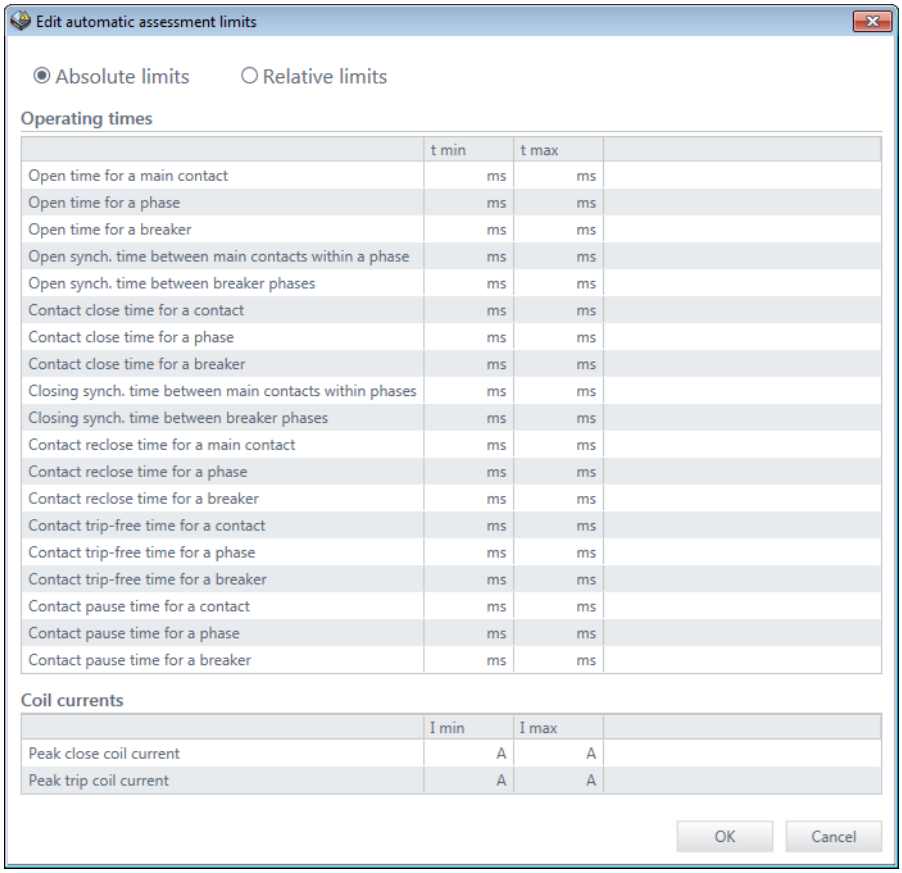


Figure 6-26 **Edit automatic assessment limits** dialog box: absolute limits

Table 6-31 Absolute Assessment Limits

Setting	Description
Operating times	
t min	Minimum operating time limit
t max	Maximum operating time limit
Coil currents	
I min	Minimum coil current limit
I max	Maximum coil current limit

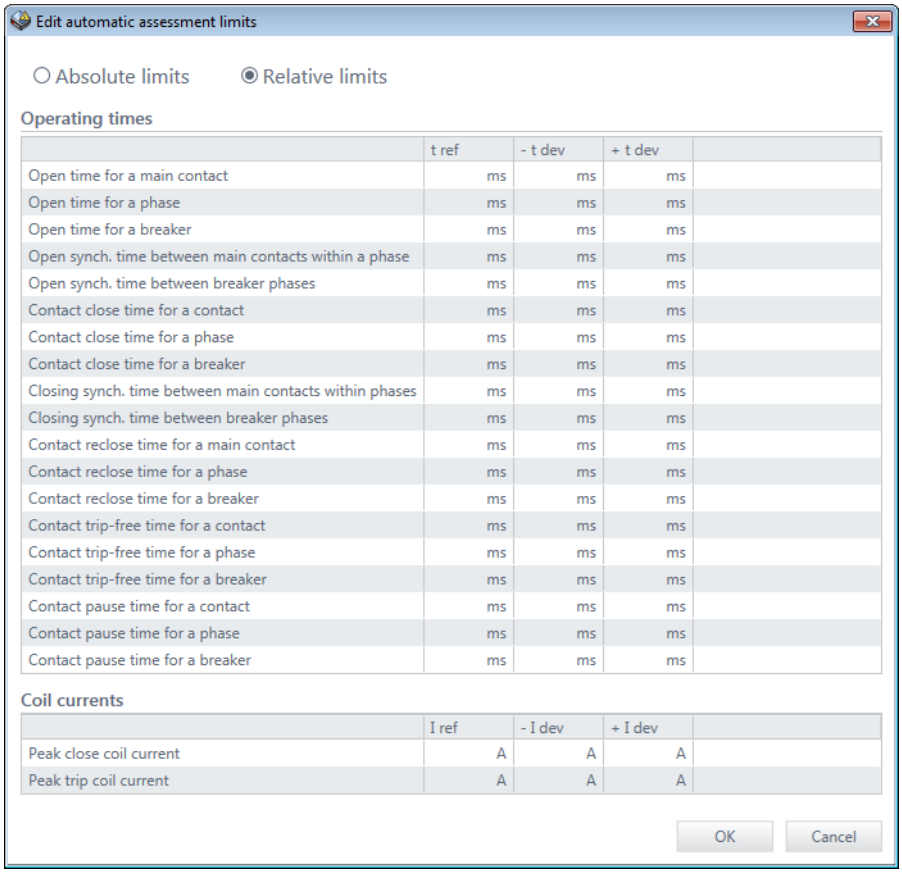


Figure 6-27 **Edit automatic assessment limits** dialog box: relative limits

Table 6-32 Relative Assessment Limits

Setting	Description
Operating times	
t ref	Operating time reference value
–t dev	Allowed negative deviation
+t dev	Allowed positive deviation
Coil currents	
I ref	Coil current reference value
–I dev	Allowed negative deviation
+I dev	Allowed positive deviation

The following table explains the sequences of the Timing test.

Table 6-33 Timing Test Sequences

Sequence	Action
O	With this sequence, the opening time of the circuit breaker is measured. Only for the O and C sequence it is recommended to perform the test twice, once with nominal voltage and once with 20 % undervoltage to assure the functionality of the circuit breaker for a weak station battery.
C	This is the sequence to measure the closing time of the circuit breaker.
OC	With this sequence, a closing operation after the circuit breaker has tripped to clear a fault is simulated. Initially, the circuit breaker must be in the closed position. A trip command initiates the sequence, followed by a dead time to clear the fault; and finally a close command must close the circuit breaker. This sequence is also known as reclosing time. To find out the shortest reclosing time the circuit breaker can provide, the close command is already applied while the breaker is still opening. The circuit breaker then will close after opening as fast as possible.
CO	With this sequence, a tripping operation after the circuit breaker has been closed under a fault condition (trip-free) or the verification of the correct operation of the anti-pumping system is simulated. To test the trip-free time the circuit breaker must be in the open position before the test is started. The circuit breaker is closed and then during the close operation is still in progress an open command is sent. The circuit breaker then opens as fast as possible. To test the anti-pumping function of the circuit breaker, the circuit breaker must be in closed position before the test is started. For this test the open time is set shorter (typically 200 ms) than the closing time (typically 400 ms). Ensure that the end time is increased so that the test sequence covers the whole close command duration (typically at least 190 ms). When the close command is sent the breaker is already closed which initiates the anti-pumping function. Then an open command is sent and the circuit breaker trips. The closing command is still on when the trip command ends, but the circuit breaker should not "pump", so that it should not close again.

Table 6-33 Timing Test Sequences (continued)

Sequence	Action
O-CO	With this sequence, a reclose sequence (OC) under a fault condition is simulated. If the fault is not released, the circuit breaker must open (O) immediately and remain in this position. Initially, the circuit breaker must be in the closed position. The sequence begins with a trip command, after a dead time the close and trip commands (CO) must be applied at the same time (delay time typically 300 ms).
CO-CO	Some circuit breakers have a different specification for the pause time between the CO and CO for CO-CO and O-CO-CO sequences. Therefore both sequences are available for testing. The time between the two CO subsequences shall be set according to the technical data of the circuit breaker (typically 15000 ms).
O-CO-CO	Some circuit breakers have a different specification for the pause time between the CO and CO for CO-CO and O-CO-CO sequences. Therefore both sequences are available for testing. The time between the two CO subsequences shall be set according to the technical data of the circuit breaker (typically 15000 ms).

2. By using the **Open breaker**, **Close breaker** and **Supply motor** buttons in the measurements area of *Primary Test Manager* you can check whether all cables are correctly connected and bring the circuit breaker to the proper state. For example, to test a C sequence, the circuit breaker must be open and the spring charged.

3. In the measurements area, click **Start**.
The blue ring on the **Measurement Start/Stop** button is on.

Warning: Stay in the safe area during the test. Any component of the circuit breaker can carry dangerous voltages.

4. Start the measurement by pressing the **Measurement Start/Stop** button. The blue ring on the **Measurement Start/Stop** button flashes for approx. 3 seconds, and the lightning symbol in *Primary Test Manager* and the red warning light on the front panel are flashing.

5. After the measurement has finished, the lightning symbol in *Primary Test Manager* stops flashing, the green warning light is on, and *Primary Test Manager* displays the measurement results.
   The Timing measurement data depends on the sequence of the trip and close commands. The following table describes the data for all measurement sequences.

Table 6-34 Timing Measurement Data

Data	Description
Operating times for breaker	
Open time	Contact open time[1]
Open synch.	Open synchronization time[1]
Close time	Contact close time[1]
Close synch.	Closing synchronization time[1]
Reclose time	Contact reclose time of OC operation[1]
Trip-free time	Contact trip-free time of CO and O-CO operation[1]
Trip-free time 2	Second contact trip-free time of CO-CO and O-CO-CO operation[1]
Pause time	Contact pause time of O-CO, CO-CO, and O-CO-CO operation[1]
t min/t ref[2]	Minimum operating time limit/ Operating time reference value
t max/t dev[2]	Maximum operating time limit/ Operating time deviation
Assessment	Assessment of operating times
Contact travel characteristics	
Module	Name of the *CB TN3* module set in the hardware configuration
Channel/command	Channel of the *CB TN3* module/ command of the test sequence
Av. speed	Average speed of the contact travel. The row labeled with the *CB TN3* channel displays the minimum of all measurement results for this channel.

Table 6-34 Timing Measurement Data (continued)

Data	Description
Total travel	Total distance travelled by the contact during operation (excluding possible overshoot). The row labeled with the *CB TN3* channel displays the maximum of all measurement results for this channel.
Stroke	Total distance travelled by the contact during operation (including possible overshoot). The row labeled with the *CB TN3* channel displays the maximum of all measurement results for this channel.
Coil characteristics	
Peak current	Peak current value through a trip or close coil
Assessment	Assessment of coil characteristics

1. The operating times are calculated per contact, phase or circuit breaker.
2. Depends on the absolute or relative assessment limits selected.

Disconnection

Do not disconnect the circuit breaker but leave it connected for performing the next test. For disconnecting the circuit breaker, see "Disconnection" on page 153.

6.2.6 Dynamic Contact Resistance Test

The Dynamic Contact Resistance test measures the resistance of the circuit breaker's main contacts during opening or closing. With the *CB TN3* modules, you can also measure the displacement of the circuit breaker's main contacts during operation.

Note: To execute the Dynamic Contact Resistance test, you need a license. Without the license, you can configure the test but after pressing the **Start** button *Primary Test Manager* stops running and a missing license message appears.

For getting the license, contact your regional OMICRON Service Center.

Connection

Warning: Before connecting anything to the circuit breaker ensure that it is grounded on both ends on all phases and it is closed to have proper grounding between the interrupters.

To connect the test object to *CIBANO 500*:

Warning: Connect the EtherCAT® cables first to *CIBANO 500* and then to the *CB MC2* modules.

1. Connect the *CB MC2* to *CIBANO 500* with the EtherCAT® cable.
2. If the *CB MC2* modules are not connected from the last test, hook up the *CB MC2* to the first or the first two interrupter(s) of the circuit breaker.
3. Connect the *CB MC2* to the main contact of the circuit breaker with the delivered cables and clamps.
4. Repeat steps 1 to 3 for all interrupters you want to test.
5. Make sure that all cable connectors are clean and dry before being tightly connected.
6. In *Primary Test Manager*, select the Dynamic Contact Resistance test.

7. In *Primary Test Manager*, set the hardware configuration and check whether *Primary Test Manager* recognized all connected *CB MC2* modules.

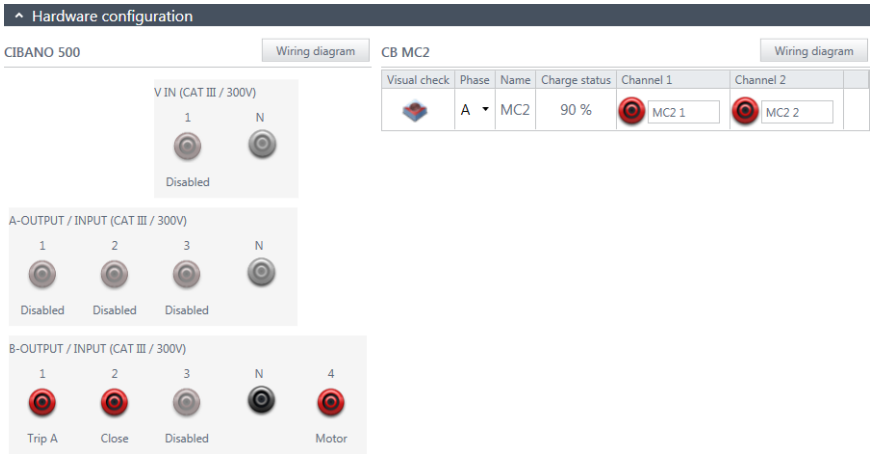


Figure 6-28 Hardware configuration of the Dynamic Contact Resistance test

Table 6-35 Hardware Configuration Options of *CIBANO 500*

CIBANO 500	Option
V IN (CAT III / 300 V)	
1	External source or disabled
N	Neutral connection of **V IN**
A-OUTPUT / INPUT (CAT III / 300 V)	
1	AUX 1, close A, motor A, or disabled
2	AUX 2, close B, motor B, or disabled
3	AUX 3, close C, motor C, or disabled
N	Common neutral connection for outputs/inputs in group **A**
B-OUTPUT / INPUT (CAT III / 300 V)	
1	Trip A, I clamp 1, or disabled
2	Trip B, I clamp 2, close, or disabled
3	Trip C, I clamp 3, supply, or disabled
N	Neutral connection of outputs in group **B**
4	Motor, I clamp 4, or disabled

V IN (CAT III / 300 V)

These inputs can be configured to connect an external source such as a station battery or an external power supply. Generally the input is not used but if you need to test the behavior (voltage) of the station battery under real load conditions this option is available.

Note: The coils or the motor can be configured to be supplied from **V IN** (external source). When activated the respective output of *CIBANO 500* is supplied from the socket **1** of the **V IN** section via the internal command switch. This command switch can also disrupt the current in case of a short circuit. Input **N** of the **V IN** section is for voltage reference measurement only.

A-OUTPUT / INPUT (CAT III / 300 V)

For the most tests the **A** group is used as auxiliary inputs on HV circuit breakers. The contacts can be "wet" or "dry". The dry contacts are floating contacts without any reference to ground. The wet contacts are contacts that carry voltage when closed. In this case the common pole of the battery (minus in most cases) is connected to **AN** and the auxiliary contacts are connected to the respective inputs of the group **A**.

If you want to record the supply current for three close coils or three motors simultaneously you can configure the sockets by clicking them.

Note: *CIBANO 500* has only three command switches. Consequently, three trip *or* three close coils can be operated simultaneously but not all six coils at the same time. To record currents for three trip coils and three close coils separately, connect three close coils to **A1** to **A3**, three trip coils to **B1** to **B3**, and then perform an O and a C Dynamic Contact Resistance test. The other tests like CO or OC with the trip and close signal applied simultaneously are then performed with different wiring.

B-OUTPUT / INPUT (CAT III / 300 V)

The **B** group is generally used as follows. **B1** is used for the trip command, **B2** is used for the closed command, and **B3** is not used. **B4** is used to supply the motor or the measure the motor current by using a current clamp.

Table 6-36 Hardware Configuration Options of the *CB MC2* Module

CB MC2	Option
Visual check	Click the LED symbol to identify the connected *CB MC2* module by flashing LED.
Phase	Phase to which the *CB MC2* module is connected
Name[1]	Editable name of the *CB MC2* module
Charge status	Indicates the charge status of the *CB MC2* module.
Channel 1[1]	Editable name of the *CB MC2* channel 1. Click the socket symbol to activate or deactivate the channel depending on the connections made.
Channel 2[1]	Editable name of the *CB MC2* channel 2. Click the socket symbol to activate or deactivate the channel depending on the connections made.

1. This name is permanently stored in the *CB MC2* memory. You can, for example, mark your *CB MC2* modules with the colored stickers and name them according to the colors. You can also rename the *CB MC2* modules depending on the connection point.

8. Connect *CIBANO 500* to the trip and close coils of the circuit breaker for all phases according to the wiring diagram displayed in *Primary Test Manager* and the following figure.

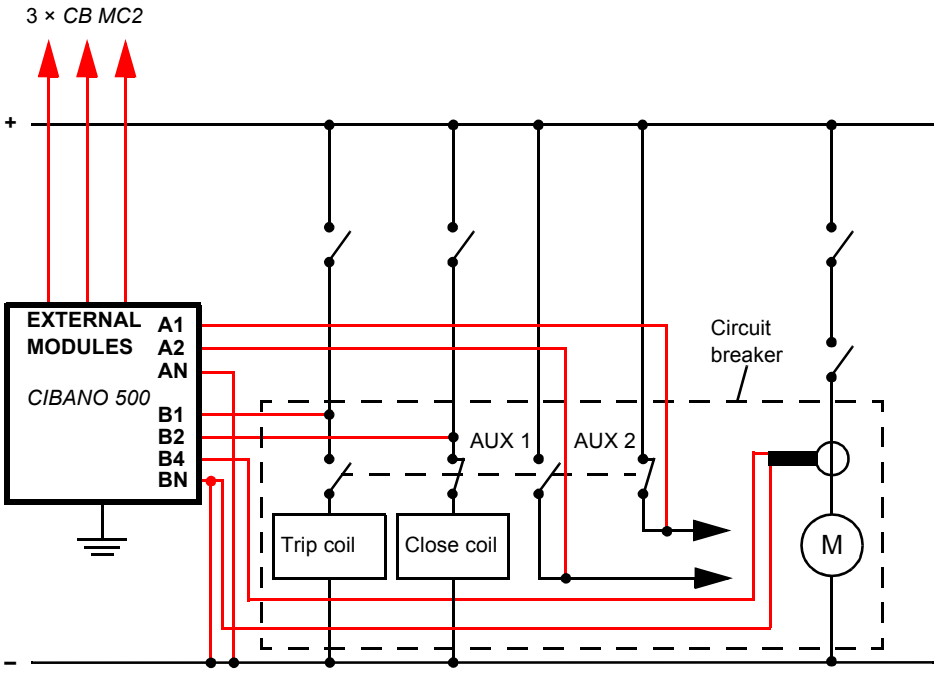


Figure 6-29 Typical measurement setup for the Dynamic Contact Resistance test

For circuit breakers with one drive for all three phases connect the trip coil to **B1**, the close coil to **B2**, and the common connection of the trip and close coils (typically the battery minus) to **BN**. The HV circuit breaker's motor remains generally connected to the station battery throughout the test and a current clamp connected to **BN** and **B4** is used to record the motor current.

Note: Connect the current clamp neutral directly to *CIBANO 500* and not to the other end of the neutral cable to avoid measurement errors due to the voltage drop on the cable. Alternatively you can supply the motor from *CIBANO 500* if you want or no station battery is available.

Circuit breakers with three drives are either tested phase by phase (see 6.2.3 "Testing Circuit Breakers with CIBANO 500 and the CB MC2 Modules" on page 102) or you can connect the three trip and close signals together. If you want to record the supply current for three coils simultaneously you can configure the sockets by clicking them.

Warning: If you use the station battery to supply the motor or the coils via *CIBANO 500*, it is safer to connect the cables first to grounded *CIBANO 500* and then to the station battery.

Measurement

To perform a measurement:

1. In *Primary Test Manager*, enter the settings of the Dynamic Contact Resistance test.

Table 6-37 Dynamic Contact Resistance Test Settings: *CIBANO 500*

Setting	Description
CIBANO 500	
Coil supply with	Click **CIBANO 500** to supply the coil with *CIBANO 500*. Click **External source** to supply coils with the source connected to **V IN**.
Coil supply voltage[1]	Voltage of the coil power supply. Click **AC** or **DC** for AC or DC coil supply voltage respectively. **Note:** To perform the undervoltage trip and undervoltage close tests set the coil supply voltage lower than the nominal voltage.
Test frequency	Frequency of the AC coil power supply
Supply during test	
Enable	Select the **Enable** check box to supply voltage on the **B3** socket during test execution.[2]
Supply voltage	Voltage supplied on the **B3** socket (same as the coil supply voltage)
Supply before test	Time interval within which the voltage is supplied before the test starts
Other	
Sample rate	Measurement sample rate[3]
Assessment settings	
Manual	Click **Manual** to select the manual assessment settings.

Table 6-37 Dynamic Contact Resistance Test Settings: *CIBANO 500*

Setting	Description
Automatic	Click **Automatic** to select the automatic assessment settings. Click **Edit test limits** to adjust the assessment limits. In the **Edit automatic assessment limits** dialog box, click **Absolute limits** (see Figure 6-30 "Edit automatic assessment limits dialog box: absolute limits" on page 136) or **Relative limits** (see Figure 6-31 "Edit automatic assessment limits dialog box: relative limits" on page 137) to select absolute or relative limits respectively.
Current clamp settings[4]	
Channel	**B** group I/O socket
Ratio	Current clamp ratio
I max	Maximum current of the selected probe range
Motor supply	
Motor supply with	Click **CIBANO 500** to supply the motor with *CIBANO 500*. Click **External source** if the motor is supplied from the station supply or battery without any connection to *CIBANO 500* or if the station battery is connected to the **V IN** section and supplied, for example, via the **B4** socket. **Note:** We do not recommend to supply the motor with undervoltage. Doing so does not provide any additional useful information and can cause degradation of the motor operation over time.
Motor supply voltage[1]	Voltage of the motor power supply Click **AC** or **DC** for AC or DC motor supply voltage respectively.
Test frequency	Frequency of the AC motor power supply
Sequence	
O	Perform an open sequence
C	Perform a close sequence
OC[5]	Perform a reclose sequence

Table 6-37 Dynamic Contact Resistance Test Settings: *CIBANO 500*

Setting	Description
CO[5]	Perform a trip-free sequence
O-CO[5]	Perform an O-CO sequence
CO-CO	Perform a CO-CO sequence
O-CO-CO	Perform an O-CO-CO sequence

1. Only available if *CIBANO 500* is selected as source
2. The **B3** socket must be configured as **Supply** and the coil supply voltage must be specified.
3. 10 kHz is recommended to constrain the amount of created data. Higher sample rates are needed for special tests only.
4. Only available if a current clamp is configured. The channel value displayed refers to the **B** group of the I/O sockets on the *CIBANO 500* side panel. The **B1**…**B4** sockets can be configured as **I clamp 1**…**I clamp 4** respectively.
5. See Table 6-41 "Dynamic Contact Resistance Test Sequences" on page 138.

Table 6-38 Dynamic Contact Resistance Test Settings: *CB MC2*

Setting	Description
CB MC2	
Test current	Current of the test[1]
V DC range	DC voltage measurement range[2]
PIR	Select the **Measure PIR** check box to measure timing of the pre-insertion resistors.
C-O threshold	Resistance threshold to detect whether the main contact is open or closed. *Primary Test Manager* interprets the contact as open if the contact resistance is over the C-O threshold and vice versa.
Current clamp settings[3]	
Channel	**B** group I/O socket
Ratio	Current clamp ratio
I max	Maximum current of the selected probe range

1. For the Timing test 10 A is mostly sufficient.
2. The lower the range the more accurate is the result. Use a higher range only if you expect a voltage higher than the minimum range.
3. Only available if a current clamp is configured. The channel value displayed refers to the **B** group of the I/O sockets on the *CIBANO 500* side panel. The **B1**…**B4** sockets can be configured as **I clamp 1**…**I clamp 4** respectively.

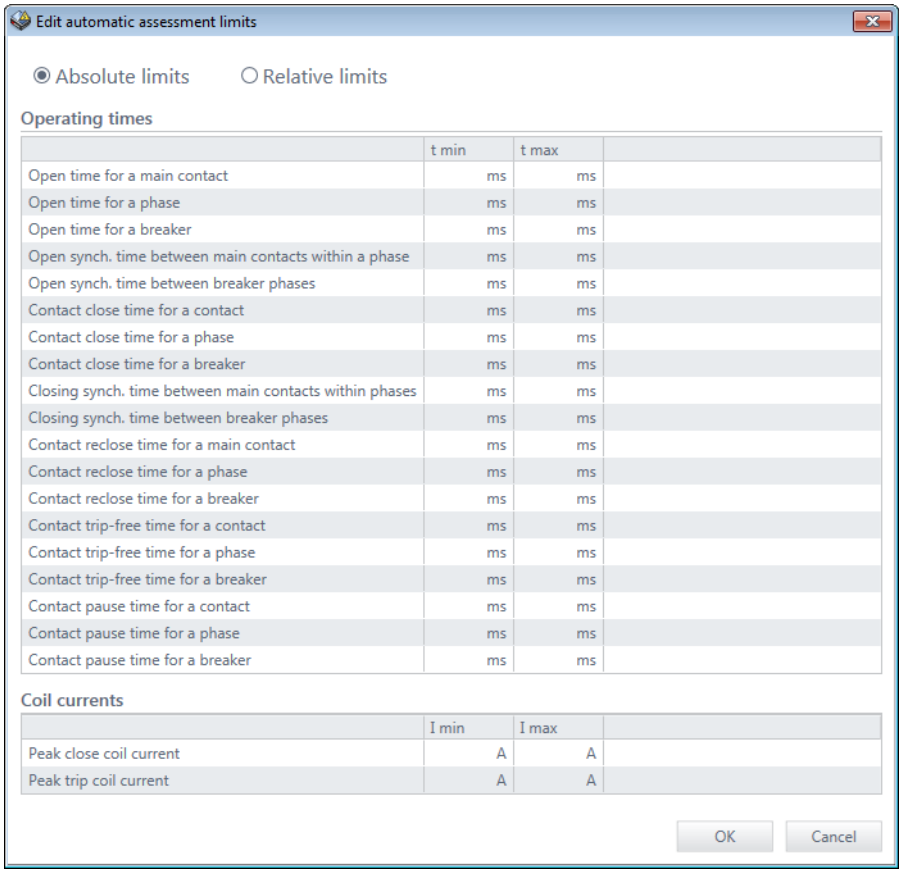


Figure 6-30 **Edit automatic assessment limits** dialog box: absolute limits

Table 6-39 Absolute Assessment Limits

Setting	Description
Operating times	
t min	Minimum operating time limit
t max	Maximum operating time limit
Coil currents	
I min	Minimum coil current limit
I max	Maximum coil current limit

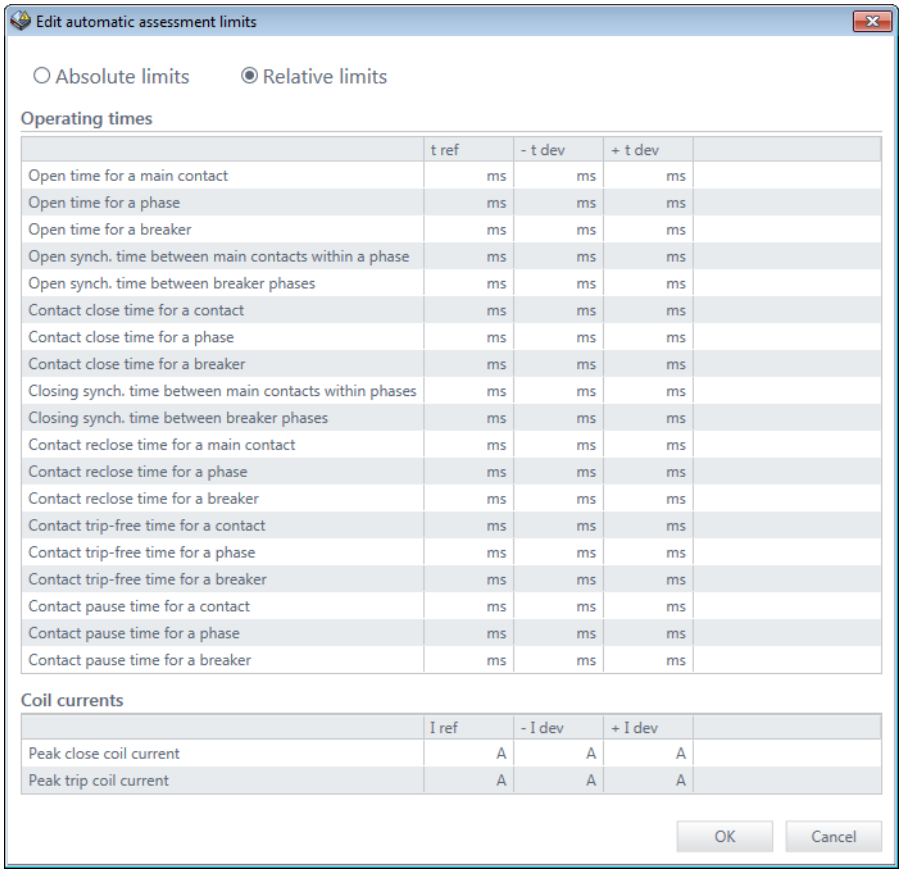


Figure 6-31 **Edit automatic assessment limits** dialog box: relative limits

Table 6-40 Relative Assessment Limits

Setting	Description
Operating times	
t ref	Operating time reference value
–t dev	Allowed negative deviation
+t dev	Allowed positive deviation
Coil currents	
I ref	Coil current reference value
–I dev	Allowed negative deviation
+I dev	Allowed positive deviation

The following table explains the sequences of the Dynamic Contact Resistance test.

Table 6-41 Dynamic Contact Resistance Test Sequences

Sequence	Action
O	With this sequence, the opening time of the circuit breaker is measured. Only for the O and C sequence it is recommended to perform the test twice, once with nominal voltage and once with 20 % undervoltage to assure the functionality of the circuit breaker for a weak station battery.
C	This is the sequence to measure the closing time of the circuit breaker.
OC	With this sequence, a closing operation after the circuit breaker has tripped to clear a fault is simulated. Initially, the circuit breaker must be in the closed position. A trip command initiates the sequence, followed by a dead time to clear the fault; and finally a close command must close the circuit breaker. This sequence is also known as reclosing time. To find out the shortest reclosing time the circuit breaker can provide, the close command is already applied while the breaker is still opening. The circuit breaker then will close after opening as fast as possible.

Table 6-41 Dynamic Contact Resistance Test Sequences (continued)

Sequence	Action
CO	With this sequence, a tripping operation after the circuit breaker has been closed under a fault condition (trip-free) or the verification of the correct operation of the anti-pumping system is simulated. To test the trip-free time the circuit breaker must be in the open position before the test is started. The circuit breaker is closed and then during the close operation is still in progress an open command is sent. The circuit breaker then opens as fast as possible. To test the anti-pumping function of the circuit breaker, the circuit breaker must be in closed position before the test is started. For this test the open time is set shorter (typically 200 ms) than the closing time (typically 400 ms). Ensure that the end time is increased so that the test sequence covers the whole close command duration (typically at least 190 ms). When the close command is sent the breaker is already closed which initiates the anti-pumping function. Then an open command is sent and the circuit breaker trips. The closing command is still on when the trip command ends, but the circuit breaker should not "pump", so that it should not close again.
O-CO	With this sequence, a reclose sequence (OC) under a fault condition is simulated. If the fault is not released, the circuit breaker must open (O) immediately and remain in this position. Initially, the circuit breaker must be in the closed position. The sequence begins with a trip command, after a dead time the close and trip commands (CO) must be applied at the same time (delay time typically 300 ms).
CO-CO	Some circuit breakers have a different specification for the pause time between the CO and CO for CO-CO and O-CO-CO sequences. Therefore both sequences are available for testing. The time between the two CO subsequences shall be set according to the technical data of the circuit breaker (typically 15000 ms).
O-CO-CO	Some circuit breakers have a different specification for the pause time between the CO and CO for CO-CO and O-CO-CO sequences. Therefore both sequences are available for testing. The time between the two CO subsequences shall be set according to the technical data of the circuit breaker (typically 15000 ms).

2. By using the **Open breaker**, **Close breaker** and **Supply motor** buttons in the measurements area of *Primary Test Manager* you can check whether all cables are correctly connected and bring the circuit breaker to the proper state. For example, to test a C sequence, the circuit breaker must be open and the spring charged.

3. In the measurements area, click **Start**.
   The blue ring on the **Measurement Start/Stop** button is on.

Warning: Stay in the safe area during the test. Any component of the circuit breaker can carry dangerous voltages.

4. Start the measurement by pressing the **Measurement Start/Stop** button.
   The blue ring on the **Measurement Start/Stop** button flashes for approx. 3 seconds, and the lightning symbol in *Primary Test Manager* and the red warning light on the front panel are flashing.

5. After the measurement has finished, the lightning symbol in *Primary Test Manager* stops flashing, the green warning light is on, and *Primary Test Manager* displays the measurement results.
   The Dynamic Contact Resistance measurement data depends on the sequence of the trip and close commands. The following table describes the data for all measurement sequences.

Table 6-42 Dynamic Contact Resistance Measurement Data

Data	Description
Operating times for breaker	
Open time	Contact open time[1]
Open synch.	Open synchronization time[1]
Close time	Contact close time[1]
Close synch.	Closing synchronization time[1]
Reclose time	Contact reclose time of OC operation[1]
Trip-free time	Contact trip-free time of CO and O-CO operation[1]
Trip-free time 2	Second contact trip-free time of CO-CO and O-CO-CO operation[1]
Pause time	Contact pause time of O-CO, CO-CO, and O-CO-CO operation[1]
t min/t ref[2]	Minimum operating time limit/ Operating time reference value

Table 6-42 Dynamic Contact Resistance Measurement Data (continued)

Data	Description
t max/t dev[2]	Maximum operating time limit/ Operating time deviation
Assessment	Assessment of operating times
Contact travel characteristics	
Module	Name of the *CB TN3* module set in the hardware configuration
Channel/command	Channel of the *CB TN3* module/ command of the test sequence
Av. speed	Average speed of the contact travel. The row labeled with the *CB TN3* channel displays the minimum of all measurement results for this channel.
Total travel	Total distance travelled by the contact during operation (excluding possible overshoot). The row labeled with the *CB TN3* channel displays the maximum of all measurement results for this channel.
Stroke	Total distance travelled by the contact during operation (including possible overshoot). The row labeled with the *CB TN3* channel displays the maximum of all measurement results for this channel.
Coil characteristics	
Peak current	Peak current value through a trip or close coil
Assessment	Assessment of coil characteristics

1. The operating times are calculated per contact, phase or circuit breaker.
2. Depends on the absolute or relative assessment limits selected.

Disconnection

Do not disconnect the circuit breaker but leave it connected for performing the next test. For disconnecting the circuit breaker, see "Disconnection" on page 153.

6.2.7 Minimum Pickup Test

The Minimum Pickup test determines the minimum voltage required to trip or close the circuit breaker. By using the internal power source of *CIBANO 500*, the coil supply voltage is increased step by step through an automated test sequence until the circuit breaker operates.

Note: To execute the Minimum Pickup test, you need a license. Without the license, you can configure the test but after pressing the **Start** button *Primary Test Manager* stops running and a missing license message appears.

For getting the license, contact your regional OMICRON Service Center.

Connection

Warning: Before connecting anything to the circuit breaker ensure that it is grounded on both ends on all phases and it is closed to have proper grounding between the interrupters.

To connect the test object to *CIBANO 500*:

1. In *Primary Test Manager*, select the Minimum Pickup test.
2. In *Primary Test Manager*, set the hardware configuration.
   Often you can leave the cables as already connected in the previous test.
   Unused sockets can remain connected.

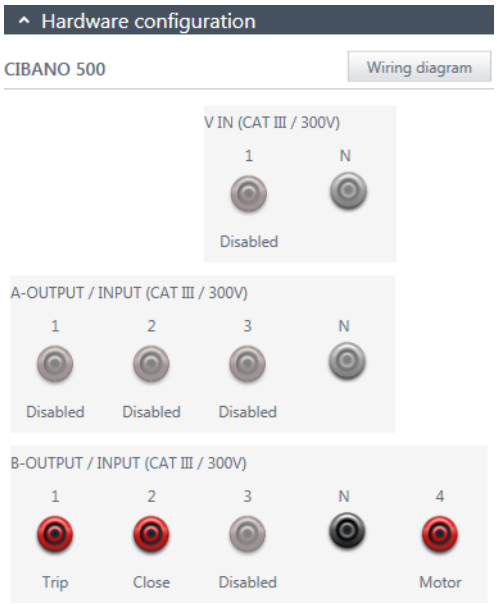


Figure 6-32 Hardware configuration of the Minimum Pickup test

Table 6-43 Hardware Configuration Options of *CIBANO 500*

CIBANO 500	Option
V IN (CAT III / 300 V)[1]	
1	External source or disabled
N	Neutral connection of **V IN**
A-OUTPUT / INPUT (CAT III / 300 V)	
1	Motor A or disabled (preferred)
2	Motor B or disabled (preferred)
3	Motor C or disabled (preferred)
N	Common neutral connection for outputs/inputs in group **A**

Table 6-43 Hardware Configuration Options of *CIBANO 500* (continued)

CIBANO 500	Option
B-OUTPUT / INPUT (CAT III / 300 V)	
1	Trip or disabled
2	Close or disabled
3	Supply or disabled
N	Common neutral connection for outputs/inputs in group **B**
4	Motor (preferred) or disabled

1. Cannot be used to supply the trip or close coil because a variable voltage is needed, however it can be used to supply the motor.

3. Make sure that all cable connectors are clean and dry before being tightly connected.
4. Connect *CIBANO 500* to the trip and close coils of the circuit breaker according to the wiring diagram displayed in *Primary Test Manager*.

Measurement

To perform a measurement:

1. In *Primary Test Manager*, enter the settings of the Minimum Pickup test.

Table 6-44 Minimum Pickup Test Settings

Setting	Description
CIBANO 500	
Rated coil supply voltage	Rated voltage of the coil power supply Click **AC** or **DC** for AC or DC coil supply voltage respectively.
Test frequency	Frequency of the AC coil power supply
Supply during test	
Enable	Select the **Enable** check box to supply voltage on the **B3** socket during test execution.[1]
Supply voltage	Voltage supplied on the **B3** socket (same as the coil supply voltage)
Supply before test	Time interval within which the voltage is supplied before the test starts
Test sequence	
Coil supply voltage start	Start voltage of the automated test sequence to determine the minimum pickup voltage
Coil supply voltage end	End voltage of the automated test sequence to determine the minimum pickup voltage
Coil supply voltage step	Stepwise voltage increase of the automated test sequence
Command impulse duration	Duration of the command pulse of the automated test sequence
Pause between impulses	Time interval between impulses of the automated test sequence
Assessment settings	
Manual	Click **Manual** to select the manual assessment settings.
Automatic	Click **Automatic** to select the automatic assessment settings. Click **Edit test limits** to adjust the assessment limits (see Figure 6-33 "Edit automatic assessment limits dialog box" on page 146).

Table 6-44 Minimum Pickup Test Settings (continued)

Setting	Description
Motor supply	
Motor supply with	Click **CIBANO 500** to supply the motor with *CIBANO 500*. Click **External source** to supply the motor externally.
Motor supply voltage[2]	Voltage of the motor power supply Click **AC** or **DC** for AC or DC motor supply voltage respectively.
Test frequency	Frequency of the AC motor power supply

1. The **B3** socket must be configured as **Supply** and the coil supply voltage must be specified.
2. Only available if *CIBANO 500* is selected as source

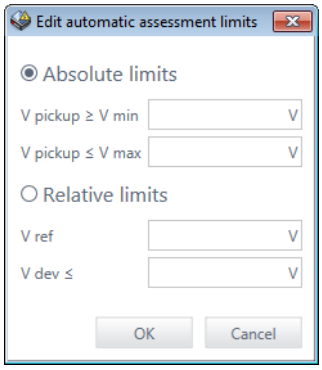


Figure 6-33 **Edit automatic assessment limits** dialog box

Table 6-45 Automatic Assessment Limits

Setting	Description
Absolute limits	
V pickup ≥ V min	Minimum value of the pickup voltage
V pickup ≤ V max	Maximum limit of the pickup voltage
Relative limits	
V ref	Reference pickup voltage
V dev ≤	Allowed deviation from the reference pickup voltage

2. By using the **Open breaker**, **Close breaker** and **Supply motor** buttons in the measurements area of *Primary Test Manager* you can check whether all cables are correctly connected and bring the circuit breaker to the proper state. For testing the minimum pickup by the open sequence the circuit breaker must be closed and vice versa.

3. In the measurements area, select the measurement you want to perform, and then click **Start**.
   The blue ring on the **Measurement Start/Stop** button is on.

Warning: Stay in the safe area during the test. Any component of the circuit breaker can carry dangerous voltages.

4. Start the measurement by pressing the **Measurement Start/Stop** button. The blue ring on the **Measurement Start/Stop** button flashes for approx. 3 seconds, and the lightning symbol in *Primary Test Manager* and the red warning light on the front panel are flashing.

   Note: You can suspend the measurement anytime manually by pressing the **Emergency Stop** button or the **Measurement Start/Stop** button on the *CIBANO 500* front panel.

   Note: If you connect, for example, three coils of three phases in parallel not all might operate at the same voltage. In this case the test will run until the last phase has operated and the highest voltage (worst case) will be shown.

5. After the measurement has finished, the lightning symbol in *Primary Test Manager* stops flashing, the green warning light is on, and *Primary Test Manager* displays the measurement results.

Table 6-46 Minimum Pickup Measurement Data

Data	Description
No.	Number of the measurement
Operation	Trip or close
V pickup	Pickup voltage of the circuit breaker under test
V min/V ref[1]	Assessment limit
V max/V dev[1]	Assessment limit
Assessment	Measurement assessment

1. Depends on the absolute or relative assessment limits selected.

In case of three different trip coils, the trip coils can trip at different voltages. After the last pole has tripped the test will stop and show the worst case result.

Note: If there is an active discordance protection in place you must deactivate it for this test to avoid tripping of the other phases due to the discordance protection instead of the minimum pickup test.

Disconnection

Do not disconnect the circuit breaker but leave it connected for performing the next test. For disconnecting the circuit breaker, see "Disconnection" on page 153.

6.2.8 Motor Current Test

The Motor Current test records the supply voltages and currents of the circuit breaker's charging motor(s).

Note: To execute the Motor Current test, you need a license. Without the license, you can configure the test but after pressing the **Start** button *Primary Test Manager* stops running and a missing license message appears.

For getting the license, contact your regional OMICRON Service Center.

Connection

Warning: Before connecting anything to the circuit breaker ensure that it is grounded on both ends on all phases and it is closed to have proper grounding between the interrupters.

To connect the test object to *CIBANO 500*:

1. In *Primary Test Manager*, select the Motor Current test.
2. In *Primary Test Manager*, set the hardware configuration.
3. If not already set in the Timing test, click the **A1** socket in the hardware configuration, and then click **Disabled**. After that, click the **B4** socket, and then click **Motor**. After that connect the **B4** socket on the side panel of *CIBANO 500* to "+" or phase contact of the motor and the **BN** socket to "–" or neutral contact of the motor.

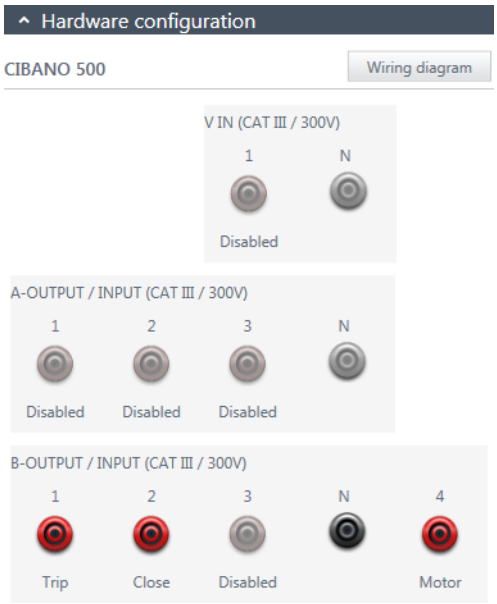


Figure 6-34 Hardware configuration of the Motor Current test

Note: You can control three circuit breaker's motors simultaneously. In this case connect the phase contact of the motor 1 to the **A1** socket, the phase contact of the motor 2 to the **A2** socket, the phase contact of the motor 3 to the **A3** socket, and the neutral motor contacts to the **AN** socket.

Table 6-47 Hardware Configuration Options of *CIBANO 500*

CIBANO 500	Option
V IN (CAT III / 300 V)	
1	External source or disabled
N	Neutral connection of **V IN**
A-OUTPUT / INPUT (CAT III / 300 V)	
1	Motor A or disabled
2	Motor B or disabled
3	Motor C or disabled
N	Common neutral connection for outputs/inputs in group **A**

Table 6-47 Hardware Configuration Options of *CIBANO 500* (continued)

CIBANO 500	Option
B-OUTPUT / INPUT (CAT III / 300 V)	
1	Trip or disabled
2	Close or disabled
3	Supply or disabled
N	Neutral connection of outputs in group **B**
4	Motor or disabled

4. Make sure that all cable connectors are clean and dry before being tightly connected.
5. Connect *CIBANO 500* to the motor of the circuit breaker according to the wiring diagram displayed in *Primary Test Manager* and the following figure.

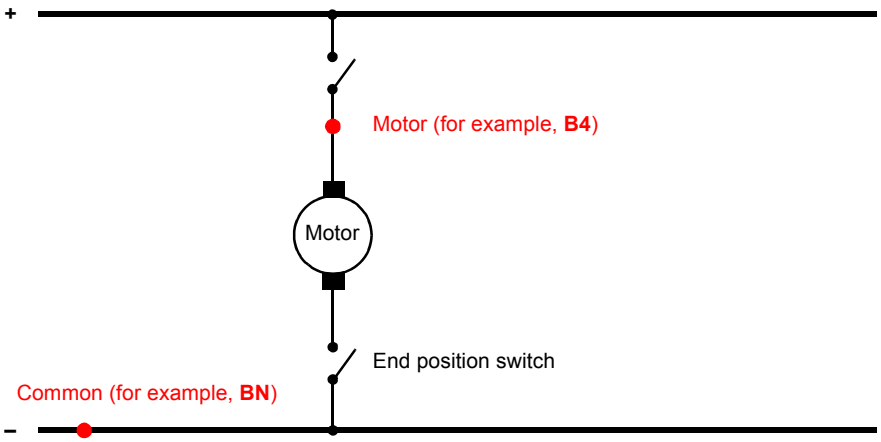


Figure 6-35 Connecting *CIBANO 500* to the circuit breaker for the Motor Current test (The end position switch opens when the spring is charged.)

Measurement

To perform a measurement:

1. In *Primary Test Manager*, enter the settings of the Motor Current test.

Table 6-48 Motor Current Test Settings

Setting	Description
Motor supply	
Motor supply with	Click **CIBANO 500** to supply the motor with *CIBANO 500*. Click **External source** to supply the motor externally.
Motor supply voltage[1]	Voltage of the motor power supply Click **AC** or **DC** for AC or DC motor supply voltage respectively.
Test frequency	Frequency of the AC motor power supply
Coil supply	
Coil supply with	Click **CIBANO 500** to supply the coil with *CIBANO 500*. Click **External source** to supply the coil externally.
Coil supply voltage[1]	Voltage of the coil power supply Click **AC** or **DC** for AC or DC coil supply voltage respectively.
Test frequency	Frequency of the AC coil power supply
Other	
Sample rate	Measurement sample rate
Supply during test[2]	
Enable	Select the **Enable** check box to supply voltage on the **B3** socket during test execution.[3]
Supply voltage	Voltage supplied on the **B3** socket (same as the coil supply voltage)
Supply before test	Time interval within which the voltage is supplied before the test starts

1. Only available if *CIBANO 500* is selected as source
2. Only available if the internal amplifier is used.
3. The **B3** socket must be configured as **Supply** and the coil supply voltage must be specified.

2. In the measurements area, click **Start**.
   The blue ring on the **Measurement Start/Stop** button is on.

Warning: Stay in the safe area during the test. Any component of the circuit breaker can carry dangerous voltages.

3. Start the measurement by pressing the **Measurement Start/Stop** button.
   The blue ring on the **Measurement Start/Stop** button flashes for approx. 3 seconds, and the lightning symbol in *Primary Test Manager* and the red warning light on the front panel are flashing.

   Note: The measurement does not stop automatically. In emergency cases, you can suspend the measurement anytime manually by pressing the **Emergency Stop** button on the *CIBANO 500* front panel.

4. After the charging process finished (indicated by stopping the circuit breaker's motor), press the **Start Stop** button on the *CIBANO 500* front panel to stop the measurement.
   The lightning symbol in *Primary Test Manager* stops flashing, the green warning light is on, and *Primary Test Manager* displays the measurement results.
   Primary Test Manager displays the measurement results of the Motor Current test only graphically. The following figure shows an example of the Motor Current test results.

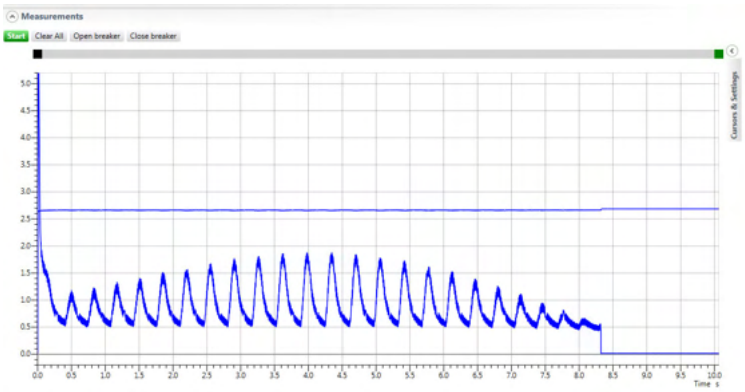


Figure 6-36 Example of the Motor Current test results

Disconnection

Note: Do not disconnect the test object from *CIBANO 500* if you intend to make further measurements.

To disconnect the test object from *CIBANO 500*:

1. Press the **Emergency Stop** button on the *CIBANO 500* front panel.
2. Disconnect the cables from the station battery, if connected.
3. Disconnect the cables from the circuit breaker's motor, if connected.
4. Disconnect the cables from the circuit breaker's trip and close coils.
5. Disconnect all *CB TN3* modules first from *CIBANO 500* and then from the transducers.
6. Disconnect one *CB MC2* module from *CIBANO 500*.

Warning: Ground the test object's terminals by using a grounding set.

7. Disconnect the *CB MC2* from the main contact of the circuit breaker.
8. Unhook the *CB MC2* from one phase of the circuit breaker.
9. Repeat steps 6 to 8 for all phases tested.

Switch *CIBANO 500* off by pressing the mains power on/off switch on the *CIBANO 500* side panel.

Warning: After you have completely disconnected *CIBANO 500* from the circuit breaker, operate the circuit breaker manually by using the circuit breaker's operation buttons until the spring(s) are discharged.

6.3 Testing Circuit Breakers with *CIBANO 500* and the *CB TN3* Modules

Within the scope of the Timing and Dynamic Contact Resistance tests, you can also measure the displacement of the circuit breaker's main contacts during operation by using the *CB TN3* modules. The following procedures apply both to *CIBANO 500* (4×EtherCAT®) and *CIBANO 500* (1×EtherCAT®, 3×AUX) options.

6.3.1 Timing Test

Connection

Warning: Before connecting anything to the circuit breaker ensure that it is grounded on both ends on all phases and it is closed to have proper grounding between the interrupters.

To connect the test object to *CIBANO 500*:

Warning: Connect the EtherCAT® cables first to *CIBANO 500* and then to the *CB TN3* modules.

1. Make sure that all cable connectors are clean and dry before being tightly connected.
2. Connect the *CB TN3* to *CIBANO 500* with the EtherCAT® cable.
3. Hang up the *CB TN3* close to the circuit breaker's mechanical moving part.
4. Connect the transducer to the *CB TN3* with the delivered cable.
5. Attach the transducer to the circuit breaker. For detailed information, see 7 "Transducer Installation" on page 165.
6. Repeat steps 2 to 5 for all *CB TN3* modules you want to connect.
7. In *Primary Test Manager*, select the Timing test.

8. In *Primary Test Manager*, set the hardware configuration and check whether *Primary Test Manager* recognized all connected *CB TN3* modules.
   The following figure shows the hardware configuration of the *CIBANO 500* (1×EtherCAT®, 3×AUX) option with one *CB TN3* module connected. For the hardware configuration options of *CIBANO 500*, see Table 6-11 "Hardware Configuration Options of CIBANO 500" on page 76.

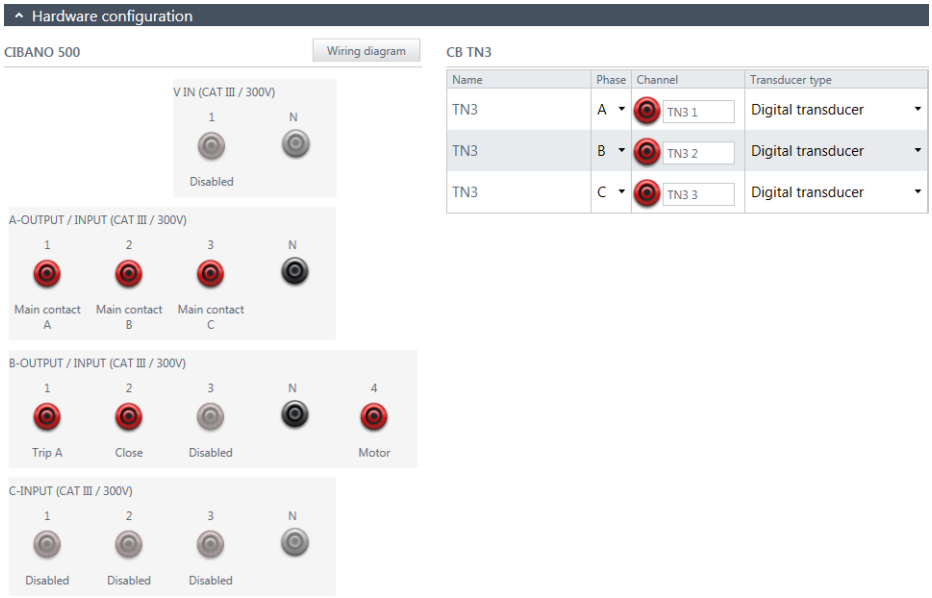


Figure 6-37 Example of the hardware configuration of the Timing test for measuring the main contact travel during operation

Table 6-49 Hardware Configuration Options of the *CB TN3* Module

CB TN3	Option
Name[1]	Editable name of the *CB TN3* module
Phase	Phase to which the *CB TN3* module is connected
Channel[1]	Editable name of the *CB TN3* channel. Click the socket symbol to activate or deactivate the channel depending on the connections made.
Transducer type	Type of the connected transducer: digital or analog

1. This name is permanently stored in the *CB TN3* memory. You can, for example, rename the *CB TN3* modules depending on the connection point.

Measurement

To perform a measurement:

1. In *Primary Test Manager*, enter the transducer settings. For the *CIBANO 500* settings, see Table 6-12 "Timing Test Settings" on page 79.

Table 6-50 Transducer Settings[1]

Setting	Description
Digital transducer settings	
Module	Name of the *CB TN3* module set in the hardware configuration
Channel	Channel name set in the *CB TN3* hardware configuration
Type	Transducer type: linear or angular
Supply	Transducer supply voltage
Resolution	Transducer travel per 1 pulse
Contact factor	Transfer factor from transducer movement to main contact movement.
Analog transducer settings	
Module	Name of the *CB TN3* module set in the hardware configuration
Channel	Channel name set in the *CB TN3* hardware configuration
Type	Transducer type: linear or angular
Supply	Transducer supply voltage
Resolution	Transducer travel per 1 V
Contact factor	Transfer factor from transducer movement to main contact movement.
Calibrate	Click **Calibrate** to calculate the transducer resolution (see "Calibration" later in this section).

1. Only available if the *CB TN3* module is connected

2. In the measurements area, click **Start**.
   The blue ring on the **Measurement Start/Stop** button is on.

Warning: Stay in the safe area during the test. Any component of the circuit breaker can carry dangerous voltages.

3. Start the measurement by pressing the **Measurement Start/Stop** button. The blue ring on the **Measurement Start/Stop** button flashes for approx. 3 seconds, and the lightning symbol in *Primary Test Manager* and the red warning light on the front panel are flashing.
4. After the measurement has finished, the lightning symbol in *Primary Test Manager* stops flashing, the green warning light is on, and *Primary Test Manager* displays the measurement results.

Table 6-51 Travel Measurement Data

Data	Description
Contact travel characteristics	
Module	Name of the *CB TN3* module set in the hardware configuration
Channel/command	Channel of the *CB TN3* module/ command of the test sequence
Av. speed	Average speed of the contact travel. The row labeled with the *CB TN3* channel displays the minimum of all measurement results for this channel.
Total travel	Total distance travelled by the contact during operation (excluding possible overshoot). The row labeled with the *CB TN3* channel displays the maximum of all measurement results for this channel.
Stroke	Total distance travelled by the contact during operation (including possible overshoot). The row labeled with the *CB TN3* channel displays the maximum of all measurement results for this channel.

Calibration

With *Primary Test Manager*, you can calibrate analog transducers when using them. To calibrate an analog transducer:

1. In the Hardware configuration pane, select the analog transducer type.
2. In the Settings and conditions pane, click **Calibrate**.
3. In the **Transducer calibration** dialog box, enter the maximum stroke of the transducer, and then click **Start**.
4. Press the **Measurement Start/Stop** button on the *CIBANO 500* front panel.
5. During the calibration time (10 seconds), move the transducer manually from the minimum to maximum position.
6. After the calibration process has finished, the calculated transcducer resolution appears in the Settings and conditions pane.

Disconnection

Do not disconnect the circuit breaker but leave it connected for performing the next test. For disconnecting the circuit breaker, see "Disconnection" on page 153.

6.3.2 Dynamic Contact Resistance Test

Connection

Warning: Before connecting anything to the circuit breaker ensure that it is grounded on both ends on all phases and it is closed to have proper grounding between the interrupters.

To connect the test object to *CIBANO 500*:

Warning: Connect the EtherCAT® cables first to *CIBANO 500* and then to the *CB TN3* modules.

1. Make sure that all cable connectors are clean and dry before being tightly connected.
2. Connect the *CB TN3* to *CIBANO 500* with the EtherCAT® cable.
3. If the *CB TN3* modules are not connected from the last test, hang up the *CB TN3* close to the circuit breaker's mechanical moving part.
4. Connect the transducer to the *CB TN3* with the delivered cable.
5. Attach the transducer to the circuit breaker. For detailed information, see 7 "Transducer Installation" on page 165.
6. Repeat steps 2 to 5 for all *CB TN3* modules you want to connect.
7. In *Primary Test Manager*, select the Dynamic Contact Resistance test.

8. In *Primary Test Manager*, set the hardware configuration and check whether *Primary Test Manager* recognized all connected *CB TN3* modules.
   The following figure shows the hardware configuration of the *CIBANO 500* (4×EtherCAT®) option with one *CB MC2* and one *CB TN3* module connected. For the hardware configuration options of *CIBANO 500* and the *CB MC2* module, see Table 6-35 "Hardware Configuration Options of CIBANO 500" on page 127 and Table 6-36 "Hardware Configuration Options of the CB MC2 Module" on page 129.

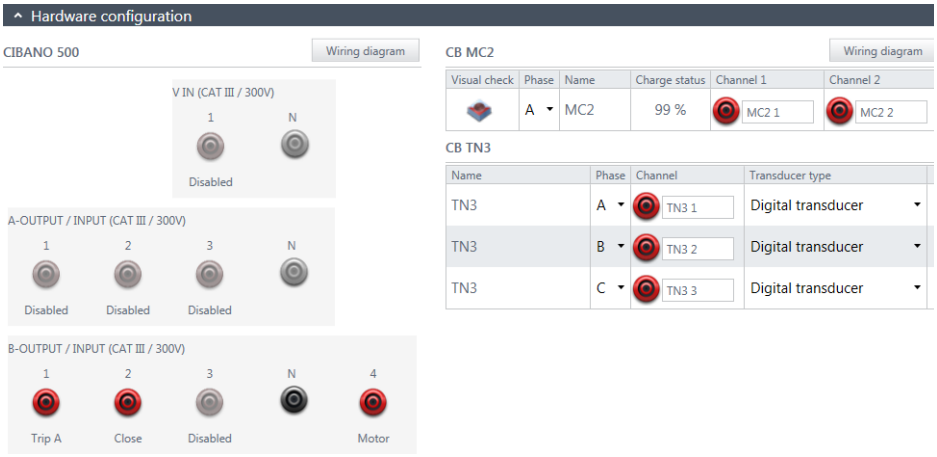


Figure 6-38 Example of the hardware configuration of the Dynamic Contact Resistance test for measuring the main contact travel during operation

Table 6-52 Hardware Configuration Options of the *CB TN3* Module

CB TN3	Option
Name[1]	Editable name of the *CB TN3* module
Phase	Phase to which the *CB TN3* module is connected
Channel[1]	Editable name of the *CB TN3* channel. Click the socket symbol to activate or deactivate the channel depending on the connections made.
Transducer type	Type of the connected transducer: digital or analog

1. This name is permanently stored in the *CB TN3* memory. You can, for example, mark your *CB TN3* modules with the colored stickers and name them according to the colors. You can also rename the *CB TN3* modules depending on the connection point.

Measurement

To perform a measurement:

1. In *Primary Test Manager*, enter the transducer settings. For the *CIBANO 500* and the *CB MC2* settings, see Table 6-37 "Dynamic Contact Resistance Test Settings: CIBANO 500" on page 132 and Table 6-38 "Dynamic Contact Resistance Test Settings: CB MC2" on page 135.

Table 6-53 Transducer Settings[1]

Setting	Description
Digital transducer settings	
Module	Name of the *CB TN3* module set in the hardware configuration
Channel	Channel name set in the *CB TN3* hardware configuration
Type	Transducer type: linear or angular
Supply	Transducer supply voltage
Resolution	Transducer travel per 1 pulse
Contact factor	Transfer factor from transducer movement to main contact movement.
Analog transducer settings	
Module	Name of the *CB TN3* module set in the hardware configuration
Channel	Channel name set in the *CB TN3* hardware configuration
Type	Transducer type: linear or angular
Supply	Transducer supply voltage
Resolution	Transducer travel per 1 V
Contact factor	Transfer factor from transducer movement to main contact movement.
Calibrate	Click **Calibrate** to calculate the transducer resolution (see "Calibration" later in this section).

1. Only available if the *CB TN3* module is connected

2. In the measurements area, click **Start**.
   The blue ring on the **Measurement Start/Stop** button is on.

Warning: Stay in the safe area during the test. Any component of the circuit breaker can carry dangerous voltages.

3. Start the measurement by pressing the **Measurement Start/Stop** button.
   The blue ring on the **Measurement Start/Stop** button flashes for approx. 3 seconds, and the lightning symbol in *Primary Test Manager* and the red warning light on the front panel are flashing.
4. After the measurement has finished, the lightning symbol in *Primary Test Manager* stops flashing, the green warning light is on, and *Primary Test Manager* displays the measurement results.

Table 6-54 Travel Measurement Data

Data	Description
Contact travel characteristics	
Module	Name of the *CB TN3* module set in the hardware configuration
Channel/command	Channel of the *CB TN3* module/ command of the test sequence
Av. speed	Average speed of the contact travel. The row labeled with the *CB TN3* channel displays the minimum of all measurement results for this channel.
Total travel	Total distance travelled by the contact during operation (excluding possible overshoot). The row labeled with the *CB TN3* channel displays the maximum of all measurement results for this channel.
Stroke	Total distance travelled by the contact during operation (including possible overshoot). The row labeled with the *CB TN3* channel displays the maximum of all measurement results for this channel.

Calibration

With *Primary Test Manager*, you can calibrate analog transducers when using them. To calibrate an analog transducer:

1. In the Hardware configuration pane, select the analog transducer type.
2. In the Settings and conditions pane, click **Calibrate**.
3. In the **Transducer calibration** dialog box, enter the maximum stroke of the transducer, and then click **Start**.
4. Press the **Measurement Start/Stop** button on the *CIBANO 500* front panel.
5. During the calibration time (10 seconds), move the transducer manually from the minimum to maximum position.
6. After the calibration process has finished, the calculated transcducer resolution appears in the Settings and conditions pane.

Disconnection

Do not disconnect the circuit breaker but leave it connected for performing the next test. For disconnecting the circuit breaker, see "Disconnection" on page 153.

7 Transducer Installation

This section describes how to use the transducers for measuring the circuit breaker's contact travel with *CIBANO 500* and the related issues. The emphasis is on the attachment of the transducers to the circuit breaker.

7.1 Angular Transducers

The angular transducers are used to derive motion curves from a rotating part of the circuit breaker. There is a mechanical coupling between the transducer and the circuit breaker.

7.1.1 Components

The following components are typically required to perform measurements by using the angular transducer.

Transducer and adapter

The angular transducer comes with an adapter which facilitates attaching the transducer to the articulating arm described later in this section. The adapter has five threaded holes (M8) for mounting flexibility. To enhance the number of options for fixing the transducer, three additional holes with a diameter of 8.2 mm are available.

Figure 7-1 Angular transducer

Articulating arm and screw clamp

The articulating arm consists of two levers coupled by a ball joint. On the ends of the levers, the ball joints hold a threaded stub for interfacing with other mechanical components. All three joints can be fixed with a single set screw. The articulating arm is connected on one side to the screw clamp and on the other side, it holds the transducer.

Figure 7-2 Articulating arm

The screw clamp is attached directly to the circuit breaker. It has a ball joint for connecting the articulating arm or the mechanical extensions described later in this section. The ball joint can be fixed by bringing the lever in the corresponding position.

Figure 7-3 Screw clamp

Extensions

Two types of extensions of length 100 mm and 50 mm are available to increase the range of the articulating arm. The extensions can be inserted at either end of the articulating arm.

Figure 7-4 Articulating arm extensions

Couplings

Two types of couplings are available for the angular transducers: a flexible coupling and a coupling using a drill chuck. The couplings are used to connect the shaft of the angular transducer to a rotating part of the circuit breaker. The diameter of the hole of the flexible coupling is 10 mm, the drill chuck accepts shafts with diameters between 0.8 mm and 10 mm.

Figure 7-5 Couplings

7.1.2 Installation and Measurement Setup

The angular transducer has to be installed directly in front of the rotating shaft (axial alignment) of the circuit breaker. Before installing the transducer, check that there is enough space for mounting the screw clamp and the articulating arm.

To install the angular transducer:

1. Attach the flexible coupling and the drill chuck, if necessary, to the rotating shaft of the circuit breaker.
2. Mount the screw clamp and the articulating arm holding the transducer in the optimal position in front of the rotating shaft on the circuit breaker.
3. Fit the shaft of the transducer into the hole of the flexible coupling and tighten the screws.
4. Fix the articulating arm by using the set screw and the joint of the screw clamp by switching the lever to the corresponding position.
5. Optionally, if you have another (supporting) articulating arm, attach the supporting articulating arm to the circuit breaker as described in 2 and 4. Clip the hook to the lever of the articulating arm holding the transducer. Ensure that the hook is as close to the transducer as possible.
6. Connect the cable of the transducer to one digital interface of the *CB TN3* module.
7. Configure the *CB TN3* digital interface in *Primary Test Manager*.

7.2 Linear Transducers

The linear transducers are used to derive motion curves from a linearly moving part of the circuit breaker. Alternatively, the linear transducers can translate the rotation of a shaft into a motion curve if the diameter of the shaft is large enough. There is no mechanical connection between the circuit breaker and the transducer.

7.2.1 Components

The following components are typically required to perform measurements by using the linear transducer.

Transducer and adapter

The linear transducer comes with an adapter which facilitates the transducer to the articulating arm described earlier in this chapter.

Figure 7-6 Linear transducer

Magnetic tape

The magnetic tape is the “scale” for the linear transducer. It is either fixed onto the flat surface of a moving part of the circuit breaker or wrapped around a rotating shaft. Usually, a double-sided adhesive tape is used for the mechanical bond between the tape and the circuit breaker.

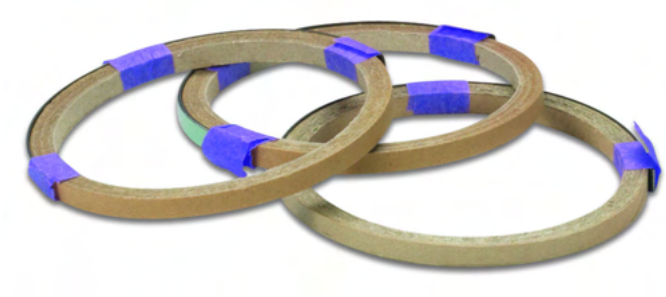


Figure 7-7 Magnetic tapes

Adhesive tapes

Adhesive tapes are used to fix the magnetic tapes to the circuit breaker. The double-sided adhesive tape can be used for flat mounting surfaces. Both double-sided and standard adhesive tapes support mounting of the magnetic tape on the perimeter of a shaft (“wrapping the magnetic tape around a shaft”).

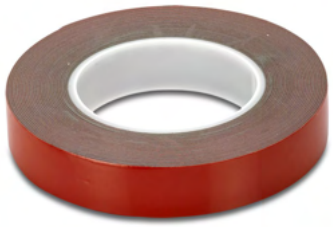


Figure 7-8 Double-sided adhesive tape

Articulating arm and screw clamp

For information about the articulating arm and the screw clamp, see "Articulating arm and screw clamp" on page 166.

Extensions

For information about the extensions, see "Extensions" on page 167.

7.2.2 Installation and Measurement Setup

Before installing the linear transducer, evaluate the options of attaching the magnetic tape on a part of the circuit breaker that undergoes a linear or a nearly linear motion during switching operation. Alternatively, evaluate the options of attaching the magnetic tape to a rotating shaft of the circuit breaker. The minimum diameter of the shaft is 20 mm. Below this diameter the accuracy specifications are no longer guaranteed.

To install the linear transducer:

1. Place the transducer such that the gap between the magnetic tape and the read head is between 0.1 mm and 3 mm. Evaluate the options of connecting the screw clamp in conjunction with the articulating arm such that the transducer can be held in the desired position.
2. Mount the screw clamp and the articulating arm holding the transducer in the optimal position.
3. Adjust the articulating arm such that the transducer is properly aligned to the magnetic tape and the gap between the transducer and the magnetic tape is between 0.1 mm and 3 mm during the whole measurement.
4. Fix the articulating arm by using the set screw and the joint of the screw clamp by switching the lever to the corresponding position.
5. Optionally, if you have another (supporting) articulating arm, attach the supporting articulating arm to the circuit breaker as described in 1 and 4. Clip the hook to the lever of the articulating arm holding the transducer. Ensure that the hook is as close to the transducer as possible.
6. Optionally, remove the installation aid.
7. Connect the cable of the transducer to one digital interface of the *CB TN3* module.
8. Configure the *CB TN3* digital interface in *Primary Test Manager*.

8 Maintenance

Note: There is embedded software and firmware in *CIBANO 500* and firmware in each of the *CB MC2* and *CB TN3* modules. The embedded software upgrade requires a special procedure, all other upgrades can be done during normal operation.

8.1 Upgrading the *CIBANO 500* Embedded Software

The *CIBANO 500* embedded software must be compatible with the *Primary Test Manager* software. To upgrade the *CIBANO 500* embedded software:

1. Exit *Primary Test Manager* if it is running.
2. Double-click the **OMICRON Devices** icon on the desktop.
3. In the **OMICRON Devices** window, right-click the *CIBANO 500* device you want to upgrade, and then choose **Upgrade device** to open the *CIBANO 500* device website in your default web browser.
   In the default web browser, a website with the IP address of the *CIBANO 500* device opens.
4. On the navigation bar, click the flag representing the language you want to use.
5. On the navigation bar, click **Upgrade**, and then click **Select file**.

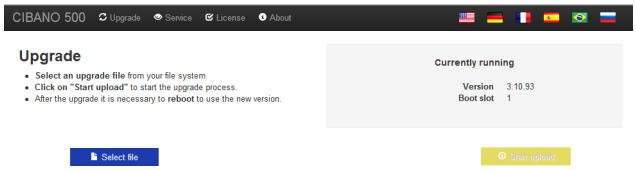


Figure 8-1 Upgrading the *CIBANO 500* embedded software

6. In the **Choose File to Upload** window, browse to the file you want to upload.
7. On the device website, click **Start upload**.
8. After the upload has finished, *CIBANO 500* reboots automatically.

   Note: Depending on the browser you are using you may wait up to 30 seconds for a response after you pressed **Start upload**. Sometimes a message may appear that the server does not respond. Ignore this message, after a while the upload will start automatically.
9. Restart *Primary Test Manager* after the upgrade procedure has finished.

8.2 Upgrading the *CIBANO 500* Firmware

After upgrading the *CIBANO 500* embedded software, you might need to upgrade also the firmware of *CIBANO 500* or the firmware of the *CB MC2* and *CB TN3* modules. If a firmware upgrade is necessary, the following message appears after you selected a test.

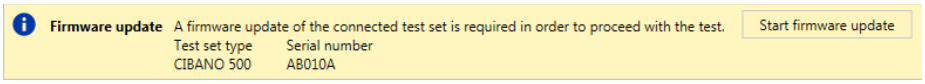


Figure 8-2 Upgrading the *CIBANO 500* and the *CB MC2* and *CB TN3* firmware

To upgrade the firmware, click **Start firmware update**.

8.3 Cleaning

Warning: Before cleaning *CIBANO 500* and its accessories, always disconnect the devices.

To clean *CIBANO 500* and its accessories, use a cloth dampened with isopropanol alcohol.

9 Troubleshooting

9.1 Connecting to *CIBANO 500*

If you encounter any problems when connecting to *CIBANO 500* we recommend to turn off any wireless adapter and VPN software on your computer.

If the *CIBANO 500* device to which you want to connect is not displayed in the list of available devices, proceed as follows:

1. Click the **Start OMICRON Device Browser** button .
2. In the **OMICRON Device Browser** window, look for the device you want to connect to and read its IP address.
3. In the home view, click **More** beneath the **Connect** button, and then click **Add device manually**.

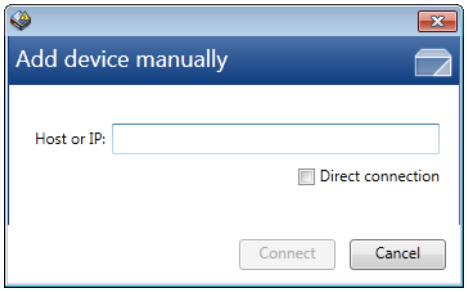


Figure 9-1 **Add device manually** dialog box

4. In the **Add device manually** dialog box, type the IP address of the device you want to connect to.
5. Click **Connect**.

If you assigned a static IP address to the device, you can try to connect as follows:

1. In the **Add device manually** dialog box, select the **Direct connection** check box.
2. In the **Host or IP** box, type cb://*a.b.c.d*, where *a.b.c.d* is the static IP address of the device.

9.2 *CIBANO 500* Does Not Start

A positive temperature coefficient (PTC) protection protects *CIBANO 500* against accidental connection to too high voltages at the mains input. The PTC protection heats up and shuts down the *CIBANO 500* power supply. The red lamp on the power switch remains on but *CIBANO 500* stays off for more than two minutes.

In this case switch *CIBANO 500* off and wait at least five minutes before powering *CIBANO 500* up again. If the PTC protection was accidentally activated *CIBANO 500* will boot normally now.

9.3 Changing the Hardware Configuration

When you open a prepared test, *Primary Test Manager* automatically checks the hardware configuration of your test setup and restores the previously saved configuration. Notification messages inform you about the restore process.

9.3.1 Connecting External Modules

When *Primary Test Manager* automatically restores previously saved hardware configurations of the *CB MC2* modules, the following notification reminds you to verify the current *CB MC2* phase assignment.

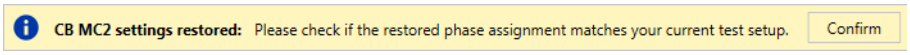


Figure 9-2 *CB MC2* settings restored

When *Primary Test Manager* automatically restores previously saved hardware configurations of the *CB TN3* modules, the following notification reminds you to verify the current transducer settings.

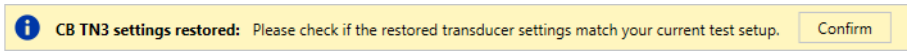


Figure 9-3 *CB TN3* settings restored

Click **Confirm** to hide the notifications.

9.3.2 Disconnecting External Modules

If the previously stored hardware configuration could not be restored with the currently connected test set, *Primary Test Manager* resets the hardware configuration to default. A notification in the Measurements pane informs you about the reset.

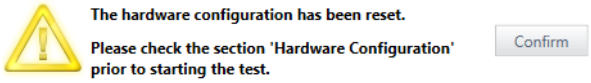


Figure 9-4 Reset notification

Click **Confirm** to hide the notifications.

10 Technical Data

10.1 *CIBANO 500* Specifications

All input/output values are guaranteed for one year within an ambient temperature of 23 ºC ± 5 ºC/73 ºF ± 10 ºF, a warm-up time longer than 25 min. and in a frequency range of 45 Hz to 65 Hz or DC. Accuracy values indicate that the error is smaller than ± (value read × reading error [rd] + full scale of the range × full scale error [fs]). For mains voltages below 190 V AC the system is subject to power restrictions. Technical data is subject to change without notice.

The following technical data apply to both *CIBANO 500* options, if not mentioned explicitly.

Table 10-1 General Output Specifications

Characteristic	**Rating**		
Frequency	DC/15 Hz…400 Hz		
Power	**Vmains**	**$P_{30\ s}$**	**$P_{2\ h}$**
	> 100 V	1500 W	1000 W
	> 190 V	3200 W	2400 W

Table 10-2 Voltage Source (A & B)

Source	**Range**	**$I_{max,\ 30\ s}$**[1]	**$I_{max,\ 2\ h}$**[1]
DC high range	0…±300 V	27.5 A	12 A
DC low range	0…±150 V	55 A	24 A
AC high range	0…240 V	20 A	12 A
AC low range	0…120 V	40 A	24 A

1. Within the power limits specified in Table 10-1 "General Output Specifications"

Table 10-3 Current Source (A & B)

Source	Range	$V_{max, 5\ min}$[1]	$V_{max, 15\ min}$[1]
DC source	3 × 0…±33.3 A	50 V	n/a
DC source	3 × 0…±24 A	n/a	50 V

1. Within the above specified power limit

For *CIBANO 500* CAT I to CAT III is required depending on the application. All inputs are CAT III for the sea levels below 2000 m, there are some limitations between 2000 m and 5000 m sea level.

CAT I is required when the measured voltage is generated by the test set itself. No voltages from other sources are measured. When measuring on circuit breakers that are fully disconnected from the substation installation CAT I would be sufficient.

CAT II is required when measuring within electrical devices or between mains supply and devices.

CAT III is required when measuring in electrical installations such as control cubicles that are still connected to the station battery or mains.

The following figures display the output characteristics of *CIBANO 500*.

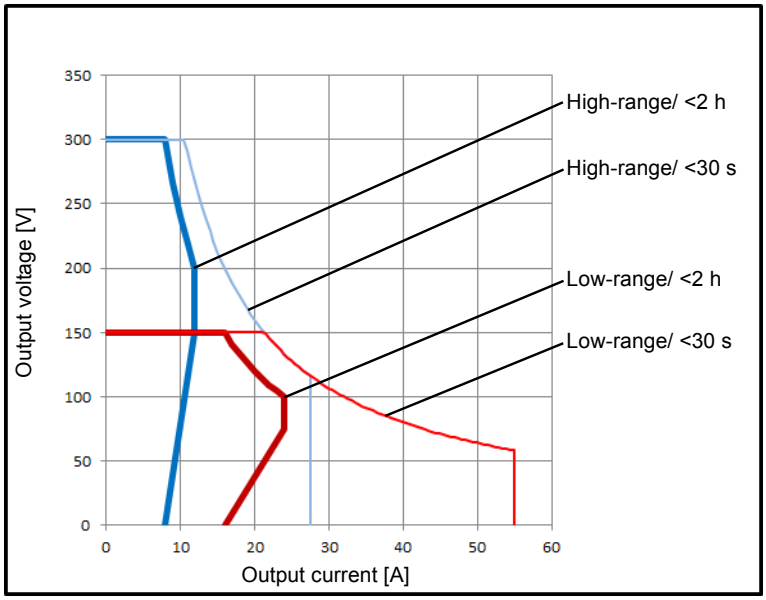


Figure 10-1 DC output characteristics

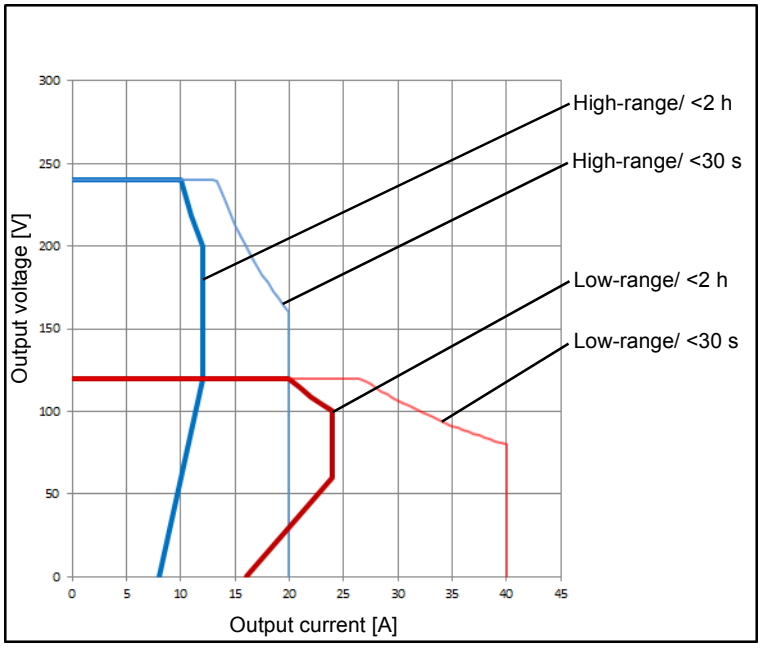


Figure 10-2 AC output characteristics

Table 10-4 Internal Measurement of Outputs (A) CAT III[1]

Range name	Range value	Accuracy
300 V	0…300 V	DC: 0.1% rd + 0.05% fs AC: 0.03% rd + 0.01% fs

1. From 2 000 m to 5 000 m altitude only CAT II compliance or CAT III compliance with half voltage

Table 10-5 Internal Measurement of Outputs (B) CAT III[1]

Range name	Range value	Accuracy
300 V	0…300 V	DC: 0.1% rd + 0.05% fs AC: 0.03% rd + 0.01% fs
3 V	0…3 V	DC: 0.1% rd + 0.05% fs
300 mV	0…300 mV	DC: 0.1% rd + 0.1% fs
30 mV	0…30 mV	DC: 0.1% rd + 0.1% fs

1. From 2 000 m to 5 000 m altitude only CAT II compliance or CAT III compliance with half voltage

Table 10-6 Internal Measurement of Outputs

Range name	Range value	Accuracy
55 A	0…55 A	DC: 0.1% rd + 0.2% fs
40 A	0…40 A	AC: 0.1% rd + 0.1% fs

Table 10-7 Resistance Measurement

Range name	Range value	Meas. current	Accuracy
30 mV	0.1 µΩ…300 µΩ	100 A	0.2% rd + 0.1 µΩ
300 mV	0.5 µΩ…3000 µΩ	100 A	0.2% rd + 0.5 µΩ
3 V	5 µΩ…30 mΩ	100 A	0.2% rd + 5 µΩ
3 V	50 µΩ…300 mΩ	10 A	0.2% rd + 50 µΩ

Table 10-8 Command Switches

Three channels, such as trip, close or motor (command switches can be routed to any socket in section A or B). Typical voltage drop = 3 V.	
Current per channel[1]	**Duty cycle**
6 A_{RMS} AC or DC	Continuous
15 A_{RMS} AC or DC	20 s on, 80 s off
30 A_{RMS} AC or DC	10 s on,190 s off

1. Valid while using one channel. Thermal derating when 2 or 3 channels are used in parallel.

Table 10-9 Voltage Input (V IN) CAT III[1]

Input	Range	Accuracy[2]
DC input	0…420 V	0.5% rd +0.5% fs
AC input	0…300 V	0.5% rd +0.5% fs

1. From 2000 m to 5000 m altitude CAT III compliance only with half voltage
2. Means “typical accuracy”; 98% of all units have an accuracy which is better than specified.

Table 10-10 Binary Input (A) CAT III[1]

Characteristic	Rating
Binary input type	Toggling with potential-free (dry) contacts or voltages (wet) up to 300 V DC
Maximum sample rate	40 kHz
Minimum resolution	25 µs

1. From 2 000 m to 5 000 m altitude only CAT II compliance or CAT III compliance with half voltage

Table 10-11 Interfaces

Interface	Rating
Digital	2 × Safety, 1 × Serial, 1 × Ethernet Optional: 4 × EtherCAT®, 1× EtherCAT®
Analog	1 × analog input (V IN) 3 × analog input/analog output/binary input (A) 4 × analog input/analog output (B) Optional: 3 × binary intput

10.1.1 AUX Board (Optional)

Table 10-12 Voltage Input AUX Board CAT III[1]

Input	Range	Accuracy[2]
DC input	0…420 V	0.5% rd +0.1% fs
AC input	0…300 V	0.5% rd +0.1% fs

1. From 2000 m to 5000 m altitude CAT III compliance only with half voltage
2. Means “typical accuracy”; 98% of all units have an accuracy which is better than specified.

Table 10-13 Binary Input (C) CAT III[1]

Characteristic	Rating
Binary input type	Toggling with potential-free (dry) contacts or voltages (wet) up to 300 V DC
Maximum sample rate	40 kHz
Minimum resolution	25 µs

1. From 2 000 m to 5 000 m altitude only CAT II compliance or CAT III compliance with half voltage

Table 10-14 Interfaces

Interface	Rating
Digital	1 × EtherCAT®
Analog	3 × analog input/analog output/binary input (C)

10.2 Power Specifications

Table 10-15 Power Specifications

Characteristic		Rating
Voltage	Nominal	100 V…240 V AC
	Permitted	85 V…264 V AC
Current	Nominal	16 A
Frequency	Nominal	50 Hz/60 Hz
	Permitted	45 Hz…65 Hz
Power fuse		Automatic circuit breaker with magnetic overcurrent tripping at I > 16 A
Power consumption	Continuous	<3.5 kW
	Peak	<5.0 kW
Connector		IEC320/C20, 1 phase

10.3 Environmental Conditions

Table 10-16 Environmental Conditions

Characteristic		Rating
Temperature	Operating	–10 ºC…+55 ºC/+14 ºF…+131 ºF
	Storage	–30 ºC…+70 ºC/–22 ºF…+158 ºF
Relative humidity		5%…95%, non-condensing
Maximum altitude	Operating	2000 m/6550 ft, up to 5000 m/16400 ft (with limited specifications, see footnotes to tables on page 183 to 183)
	Storage	12 000 m/40 000 ft

10.4 Mechanical Data

Table 10-17 Mechanical Data

Characteristic	Rating
Dimensions (W × H× D)	580 × 386 × 229 mm/ 22.9 × 15.2 × 9.0 inch (W = 464 mm/18.3 inch without handles)
Weight	20 kg/44.1 lb

10.5 Equipment Reliability

Table 10-18 Equipment Reliability

Characteristic	Standard	Rating
Shock	IEC/EN 60068-2-27	15 g/11 ms, half-sinusoid, each axis
Vibration	IEC/EN 60068-2-6	Frequency range 10 Hz…150 Hz, continuous acceleration 2 g (20 m/s^2/65 ft/s^2), 10 cycles per axis

10.6 Standards Conformity

Table 10-19 CE Conformity, EMC, and Safety Standards

CE Conformity	
The product adheres to the specifications of the guidelines of the Council of the European Community for meeting the requirements of the member states regarding the electromagnetic compatibility (EMC) Directive 2004/108/EC and the low-voltage Directive 2006/95/EC.	
EMC	
Emission	
Europe International USA	EN 61326-1 Class A IEC 61326-1 Class A FCC Subpart B of Part 15 Class A
Immunity	
Europe International	EN 61326-1 IEC 61326-1
Certified Safety Standards	
Europe International USA	EN 61010-1 IEC 61010-1 UL 61010-1
Europe International USA	EN 61010-2-30 IEC 61010-2-30 UL 61010-2-30

10.7 System Requirements

Table 10-20 System Requirements

Characteristic	Requirement (*recommended)
Operating system	**Windows 8.1 64-bit***, **Windows 8 64-bit***, **Windows 7 64-bit*** and 32-bit, Windows XP with SP3 and later[1]
CPU	**Multicore system with 2 GHz or faster***, single-core system with 2 GHz or faster
RAM	min. 2 GB (**4 GB***)
Hard disk	min. 4 GB of available space
Storage device	DVD-ROM drive
Graphics adapter	Super VGA (1280×768) or higher-resolution video adapter and monitor[2]
Interface	Ethernet NIC[3]
Installed software required for the optional Microsoft Office interface functions	**Microsoft Office 2013*, Office 2010*, Office 2007***, or Office 2003

1. As Microsoft stops technical assistance for Windows XP after April 8, 2014, Windows XP will no longer be supported by any *Primary Test Manager* release after December 31, 2014.
2. Graphics adapter supporting Microsoft DirectX 9.0 or later is recommended.
3. Ethernet Network Interface Card. *CIBANO 500* can be connected with RJ-45 connectors either directly to the computer or to the local network, for example by using an Ethernet hub.

11 Accessories

11.1 *CB MC2* Module

11.1.1 Designated Use

The *CB MC2* module is a probe for timing, static and dynamic resistance measurements on the circuit breaker's main contacts. It facilitates measurements where current is injected over the circuit breaker interrupter while the circuit breaker is operated (tripped or closed).

Figure 11-1 Front view of the *CB MC2* module

Two green LEDs for indicating the EtherCAT® state.
RUN: Signals the state of the EtherCAT® subordinate machine.
L/A: Signals the state of the physical link and activity on this link.
LEDs with the same functionality are also on the side panel of *CIBANO 500* (see 2.2.2 "Side Panel" on page 16.

EtherCAT® connector for connecting the *CB MC2* to *CIBANO 500*

Figure 11-2 Bottom view of the *CB MC2* module

11.1.2 Technical Data

Table 11-1 *CB MC2* Specifications

Characteristic	Rating
Current output	
Channels	2
Current source	0…100 A DC
Maximum output current duration when circuit breaker is closed with 100 % charged capacitor	2×100 A @ 10 mΩ > typical 1.5 sec 2×10 A @ 10 mΩ > typical 15 sec
Maximum output voltage	2.6 V DC
Static contact resistance measurement	
Range	0.1 µΩ…1000 µΩ
Accuracy[1]	0.2% rd + 0.1 µΩ
Measuring current	100 A
Dynamic contact resistance measurement[2]	
Range	10 µΩ…200 mΩ
Accuracy[1]	0.2% rd + 10 µΩ
Settling time	40 µs
Maximum sample rate	40 kHz
Minimum resolution	25 µs
Pre-insertion resistance (PIR) measurement	
Range	0…10 kΩ
Accuracy (<500 Ω)[1]	0.5% rd + 10 mΩ
Accuracy (500 Ω…10 kΩ)[1]	3% rd
Timing measurement	
Maximum sample rate	40 kHz
Minimum resolution	25 µs
Interface	
Interface type	EtherCAT® to *CIBANO 500*

1. Means “typical accuracy”; 98% of all units have an accuracy which is better than specified.
2. Valid for test currents ≥10 A

Table 11-2 Environmental Conditions

Characteristic		Rating
Temperature	Operating	–30 ºC…+70 ºC/ –22 ºF…+158 ºF
	Storage	–30 ºC…+70 ºC/ –22 ºF…+158 ºF
Relative humidity		5%…95%, non-condensing
Maximum altitude	Operating	5 000 m/16 400 ft
	Storage	12 000 m/40 000 ft

Table 11-3 Mechanical Data

Characteristic	Rating
Dimensions (W × H× D)	109 × 272 × 63 mm/ 4.3 × 10.7 × 2.5 inch
Weight	1.2 kg/2.6 lb

Table 11-4 Shock, Vibration, and Protection Class

Characteristic	Standard	Rating
Shock	IEC/EN 60068-2-27	15 g/11 ms, half-sinusoid, each axis
Vibration	IEC/EN 60068-2-6	Frequency range 10 Hz…150 Hz, continuous acceleration 2 g (20 m/s^2/65 ft/s^2), 10 cycles per axis
Protection class	IEC/EN 60529	IP 42 (only in the pendent position)

Table 11-5 CE Conformity, EMC, and Safety Standards

CE Conformity	
The product adheres to the specifications of the guidelines of the Council of the European Community for meeting the requirements of the member states regarding the electromagnetic compatibility (EMC) Directive 2004/108/EC and the low-voltage Directive 2006/95/EC.	
EMC	
Emission	
Europe International USA	EN 61326-1 Class A IEC 61326-1 Class A FCC Subpart B of Part 15 Class A
Immunity	
Europe International	EN 61326-1 IEC 61326-1
Certified Safety Standards	
Europe International USA	EN 61010-1 IEC 61010-1 UL 61010-1

11.2 *CB TN3* Module

11.2.1 Designated Use

The *CB TN3* module is used to evaluate the displacement of the circuit breaker's main contacts during operation. The contact travel is measured by transducers connected to the *CB TN3* module. The *CB TN3* module supports digital transducers, providing three interfaces according to the EIA-422 standard.

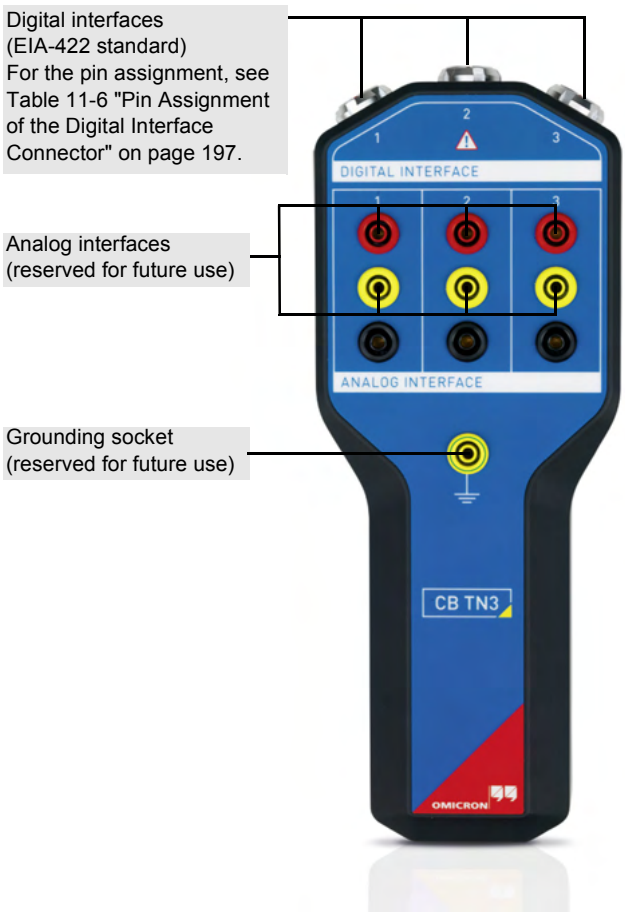


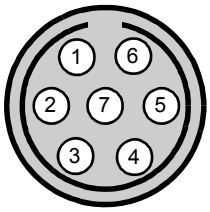
Figure 11-3 Front view of the *CB TN3* module

Two green LEDs for indicating the EtherCAT® state.
RUN: Signals the state of the EtherCAT® subordinate machine.
L/A: Signals the state of the physical link and activity on this link.
LEDs with the same functionality are also on the side panel of *CIBANO 500* (see 2.2.2 "Side Panel" on page 16.

EtherCAT® connector for connecting the *CB TN3* to *CIBANO 500*

Figure 11-4 Bottom view of the *CB TN3* module

Table 11-6 Pin Assignment of the Digital Interface Connector

Layout	Pin	Description
	**Differential signals**	
	1	A
	2	!A[1]
	3	B
	4	!B[1]
	Supply voltage	
	5 (reserved for future use)	+5 V
	6	+5 V…+30 V (set by the user in *Primary Test Manager*)
	Grounding	
	7	GND

1. Inverted signal

11.2.2 Technical Data

Table 11-7 *CB TN3* Specifications

Characteristic	Rating
Analog interface	
Output	
Channels	3
Voltage	5 V…30 V DC
Current	10 mA…50 mA
Voltage input	
Channels	3
Range	30 V
Accuracy[1]	0.1% rd + 20 mV
Maximum sample rate	40 kHz
Minimum resolution	25 µs
Current input	
Channels	3
Range	50 mA
Accuracy[1]	0.1% rd + 20 µA
Maximum sample rate	40 kHz
Minimum resolution	25 µs

Table 11-7 *CB TN3* Specifications (continued)

Characteristic	Rating
Digital interface	
Output	
Channels	3
Voltage	5 V…30 V DC
Current	10 mA…200 mA
Max. power per channel	5 W
Input	
Input signal	2 square-wave signals according to EIA-422/485 standard
Max. input frequency	10 MHz
Maximum sample rate	40 kHz
Minimum resolution	25 µs
Interface	
Interface type	EtherCAT® to *CIBANO 500*

1. Means “typical accuracy”; 98% of all units have an accuracy which is better than specified.

Table 11-8 Environmental Conditions

Characteristic		Rating
Temperature	Operating	–30 ºC…+70 ºC/ –22 ºF…+158 ºF
	Storage	–30 ºC…+70 ºC/ –22 ºF…+158 ºF
Relative humidity		5%…95%, non-condensing
Maximum altitude	Operating	5 000 m/16 400 ft
	Storage	12 000 m/40 000 ft

Table 11-9 Mechanical Data

Characteristic	Rating
Dimensions (W × H× D)	109 × 272 × 63 mm/ 4.3 × 10.7 × 2.5 inch
Weight	0.76 kg/1.7 lb

Table 11-10 Shock, Vibration, and Protection Class

Characteristic	Standard	Rating
Shock	IEC/EN 60068-2-27	15 g/11 ms, half-sinusoid, each axis
Vibration	IEC/EN 60068-2-6	Frequency range 10 Hz…150 Hz, continuous acceleration 2 g (20 m/s^2/65 ft/s^2), 10 cycles per axis
Protection class	IEC/EN 60529	IP 42 (only in the pendent position)

Table 11-11 CE Conformity, EMC, and Safety Standards

CE Conformity	
The product adheres to the specifications of the guidelines of the Council of the European Community for meeting the requirements of the member states regarding the electromagnetic compatibility (EMC) Directive 2004/108/EC and the low-voltage Directive 2006/95/EC.	
EMC	
Emission	
Europe International USA	EN 61326-1 Class A IEC 61326-1 Class A FCC Subpart B of Part 15 Class A
Immunity	
Europe International	EN 61326-1 IEC 61326-1
Certified Safety Standards	
Europe International USA	EN 61010-1 IEC 61010-1 UL 61010-1

11.3 *3-Position Remote Safety Switch*

11.3.1 Designated Use

The *3-Position Remote Safety Switch* is an emergency switch for use with the *CIBANO 500* and *CPC 100* OMICRON test systems. The *3-Position Remote Safety Switch* triggers the emergency stop of the test system.

Figure 11-5 *3-Position Remote Safety Switch*

11.3.2 Specific Safety Instructions

When handling and operating the *3-Position Remote Safety Switch*, observe the safety instructions in1 "Safety Instructions" on page 9 and the following additional safety instructions:

- Do not drop the *3-Position Remote Safety Switch*. Dropping the switch may impair its operation, and the test system controlled by the switch might continue to operate, possibly causing injury or death of the operating staff.
- Do not use the *3-Position Remote Safety Switch* submerged in oil or water or in locations continuously subject to splashes of oil or water.

- Always test the *3-Position Remote Safety Switch* under actual conditions before using it.
- Test the function of the switch before any use in all three positions as described later in this chapter and put the damaged devices or devices not working properly out of service immediately.

11.3.3 Operation

The *3-Position Remote Safety Switch* has three operating positions shown in the following figure.

Figure 11-6 Operating positions of the *3-Position Remote Safety Switch*

Table 11-12 *3-Position Remote Safety Switch* operating positions

Operating Position	Action	Description
I	Do not press the switch.	The test system is off.
II	Press the switch into the middle position.	The test system is on.
III	Press the switch all the way.	The test system is off.

11.3.4 Connection

To connect the *3-Position Remote Safety Switch* to the test system:

1. Remove the safety dongle and store it carefully for later use.
2. Plug in the serial interface connector of the switch into the **SAFETY 1** or **SAFETY 2** socket of the test system as shown in the following figure.

Note: Tighten the screws of the serial interface connector firmly to ensure stable contact of the *3-Position Remote Safety Switch* to the test system.

Figure 11-7 Connecting the *3-Position Remote Safety Switch* to the test system

11.3.5 Technical Data

Table 11-13 *3-Position Remote Safety Switch* Specifications

Characteristic	Rating
Operating voltage	12 V DC
Interface	9-pin D-SUB connector with locking screws
Cable	
Length	15 m/49.2 ft

Table 11-14 Mechanical Durability

Characteristic	Rating
OFF-ON-OFF (direct opening)	100,000 operations min.
OFF-ON	1,000,000 operations min.

Table 11-15 Environmental Conditions

Characteristic		Rating
Temperature	Operating	–10 ºC…+55 ºC/ +14 ºF…+131 ºF
	Storage	–30 ºC…+70 ºC/ –22 ºF…+158 ºF
Relative humidity		5%…95%, non-condensing
Maximum altitude	Operating	5000 m/16404 ft
	Storage	12000 m/39370 ft

Table 11-16 Mechanical Data

Characteristic	Rating
Dimensions (w × h × d)	174 × 61× 44 mm/ 6.9 × 2.4 × 1.7 inch
Weight	1.38 kg/3.0 lb (with cable)

Table 11-17 Shock, Vibration, and Protection Class

Characteristic	Standard	Rating
Shock	IEC/EN 60068-2-27	15 g/11 ms, half-sinusoid, each axis
Vibration	IEC/EN 60068-2-6	Frequency range 10 Hz…150 Hz Acceleration 2 g continuous (20 m/s^2), 10 cycles per axis
Protection class[1]	IEC/EN 60529	IP 66

1. Does not apply to the 9-pin D-SUB connector.

Table 11-18 CE Conformity, EMC, and Safety Standards

CE Conformity	
The product adheres to the specifications of the guidelines of the Council of the European Community for meeting the requirements of the member states regarding the electromagnetic compatibility (EMC) Directive 2004/108/EC and the low-voltage Directive 2006/95/EC.	
EMC	
Emission	
Europe International USA	EN 61326-1 Class A IEC 61326-1 Class A FCC Subpart B of Part 15 Class A
Immunity	
Europe International	EN 61326-1 IEC 61326-1
Certified Safety Standards	
Europe International USA	EN 61010-1 IEC 61010-1 UL 61010-1

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OMICRON electronics GmbH, Oberes Ried 1, 6833 Klaus, Austria, +43 59495

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