

Application Note

A Guide for Using PTM and The CIBANO 500 to test Circuit Breakers in North America

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CIBANO 500

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Circuit Breaker testing with PTM

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Abstract

This application note is a step-by-step guide for users creating a test plan in the PTM software for testing circuit breakers. Important settings and tips for obtaining a good measurement are highlighted in the guide for each major test associated with the CIBANO 500 (Dead Tank Package).

General information

OMICRON electronics GmbH, including all international branch offices, is henceforth referred to as OMICRON.

The product information, specifications, and technical data embodied in this Application Note 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 Application Note is useful, accurate and entirely reliable. However, OMICRON does not assume responsibility for any inaccuracies which may be present.

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1 Safety instructions

This Application Note may only be used in conjunction with the relevant product manuals which contain all safety instructions. The user is fully responsible for any application that makes use of OMICRON products.

Instructions are always characterized by a ► symbol, even if they are included in a safety instruction.



DANGER

Death or severe injury caused by high voltage or current if the respective protective measures are not complied with.

- Carefully read and understand the content of this Application Note as well as the manuals of the systems involved before taking them into operation.
- Please contact OMICRON support if you have any questions or doubts regarding the safety or operating instructions.
- Follow each instruction listed in the manuals, especially the safety instructions, since this is the only way to avoid the danger that can occur when working on high voltage or high current systems.
- Only use the equipment involved according to its intended purpose to guarantee safe operation.
- Existing national safety standards for accident prevention and environmental protection may supplement the equipment's manual.

Only experienced and competent professionals that are trained for working in high voltage or high current environments may implement this Application Note. Additionally, the following qualifications are required:

- Authorized to work in environments of energy generation, transmission or distribution, and familiar with the approved operating practices in such environments.
- Familiar with the five safety rules.
- Good knowledge/proficient in working with the CIBANO 500 and testing of MV/HV circuit breakers

2 PTM Test Procedure Document: Introduction

The purpose of the following document is to provide the user a step-by-step guide for successfully using PTM. The document closely follows the PTM “workflow” concept. The user will be guided through the following process,

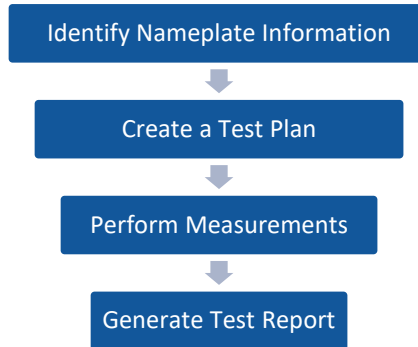


Figure 1: PTM Workflow Concept

In addition to providing a step-by-step guide for using PTM, the intention of this document is to also help the user develop good testing practices, which can help increase the accuracy and quality of the measurements performed, as well as decrease the likelihood of making safety related mistakes.

The home screen of the PTM software is shown in Figure 2, and can be used to complete the following tasks,

- ▶ Connect the OMICRON equipment to the laptop via an Ethernet cable
- ▶ Access the PTM Database via the “Manage” option
- ▶ Create a new test plan

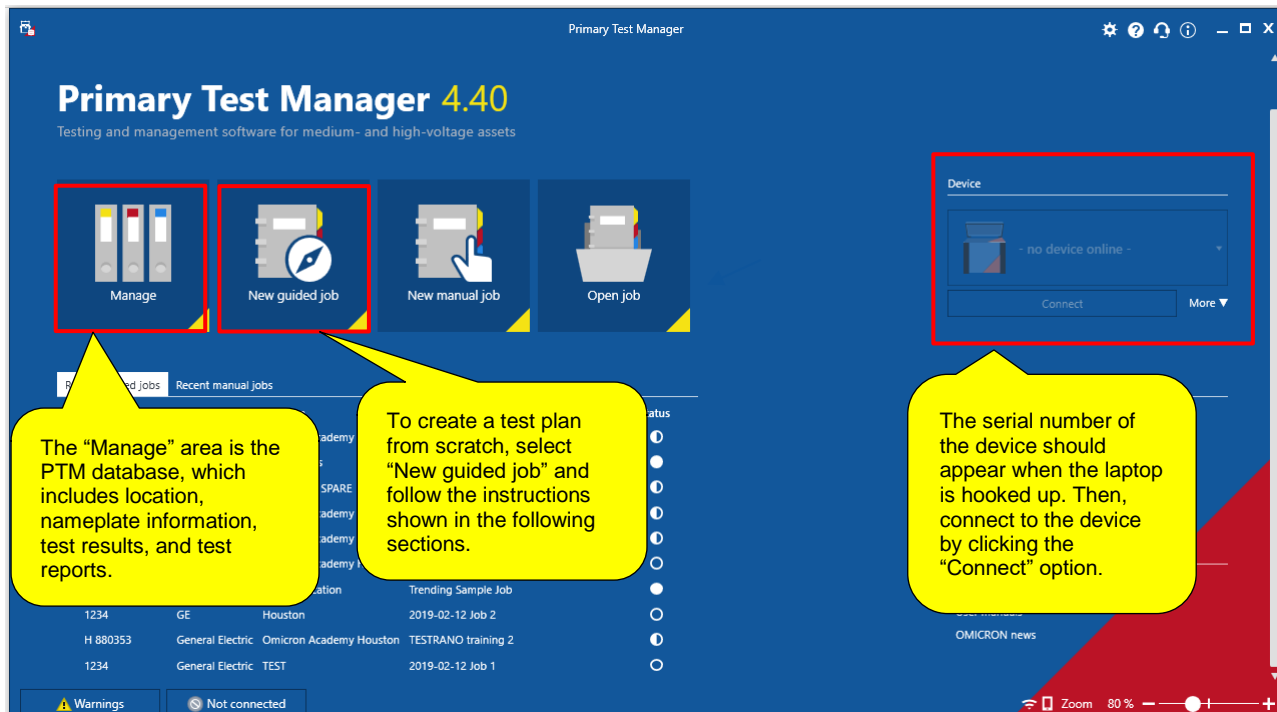


Figure 2: PTM Home Screen

A new test plan can be created either by clicking the “New guided job” or “Manage” button; however, the “New guided job” button is a more direct way of creating a new test plan and allows the user to bypass the data manager. Therefore, to create a new test plan for a circuit breaker, select the “New guided job” button.

Once a new job is created, the user will have access to the five main sections of the PTM software, which include, the “overview”, “location”, “asset”, “tests”, and “report” section. The five sections can be found on the left panel of PTM (see Figure 3). The user should complete these sections from top to bottom, as shown in Figure 3.

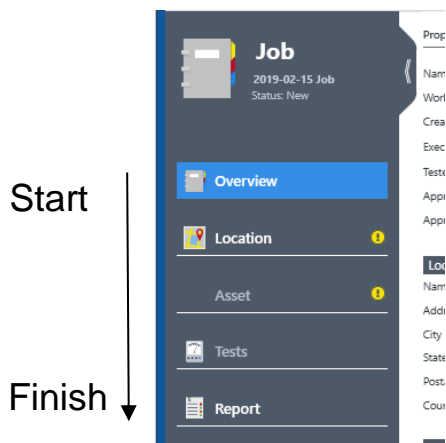


Figure 3: PTM Left Panel-Workflow

3 Overview

Once a new job is created, the first section that will automatically be displayed is the “Overview” section, as shown in Figure 4. Please enter the information outlined in Figure 4.

Primary Test Manager

Home Save Job Export Job Synchronize

Job
2019-02-15 Job
Status: New

Overview

Location

Asset

Tests

Report

Properties

Name 2019-02-15 Job

Work order

Creation date 19-02-15

Execution date 02-15

Tested by

Approved by

Approval date

Summary

Attachments

Field available for additional comments (not required)

Purple balloon: mandatory fields required for performing tests
Blue balloon: recommended fields which support PTM workflow
Gray balloon: non-required fields which contain descriptive information
No balloon: non-required fields for documentation only

Overall Assessment Not assessed

Warnings Not connected Zoom 80%

Figure 4: PTM Overview Section

4 Location

Once the overview section is complete, click on the “Location” tab on the PTM left panel, as shown in Figure 5. The “Location” is the name of the job site, substation, etc... The asset that you will eventually create within this test plan will be stored at this location within the PTM database.

Please enter the information outlined in Figure 5.

Primary Test Manager

Home Save Job Export Job Load existing location Synchronize

Job
2019-02-15 Job
Status: New

Overview

Location

Asset

Tests

Report

Properties

Name Region Division Area Plant Address City State/Province Postal code Country Geo coordinates Location system code

Name Phone no. 1 Phone no. 2 Company Department Address City State/Province Postal code Country Phone no. Fax no. E-mail

Edit coordinates

Additional addresses

+ Add address X Delete

Warnings Not connected Zoom 80 %

Figure 5: Location Section

5 Asset

Once the “Location” section is complete, click on the “Asset” tab on the PTM left panel, as shown in Figure 6. The “Asset” section of the software is where all the nameplate information of the asset under test and its ancillary equipment (e.g. bushings) will be entered.

NOTICE

Complete fields from top-to-bottom

- It is important that the “Asset” section of the software is completed from top-to-bottom. The “Asset” section may change based on a previous selection so it is important to enter the information accurately, and in order.

Please complete the sections outlined in Figure 6.

Home | Save job | Export job | Load existing asset | Load from asset library | Save to asset library

Job
2019-07-10 Job
Status: Prepared

Asset
1111

Tests
Report

Apparatus ID
Feeder

Circuit breaker
<Select asset type>
1111

Comment

If the circuit breaker is already in the PTM database, then select this option to import the asset and all associated nameplate information.

Complete the “Asset” section working from top to bottom. It is recommended that you complete as many fields as possible, unless otherwise noted.

These options are associated with the circuit breaker testing library (CBTL) which requires an individual software license. Selecting “Load from asset library” allows you to upload predefined settings based on the circuit breaker type. Additionally, you can create your own custom library which saves the asset settings for your own defined breaker type by selecting “Save to asset library”

Figure 6: Asset Information

5.1 Asset: Circuit Breaker

After selection of the asset as circuit breaker and asset type, new settings will appear. The “Asset” section will expand into 4 tabs, “Circuit breaker”, “Operating mechanism”, “Bushings”, and “Assessment Limits” (Fig.7).. Complete the settings from top to bottom and left to right, starting with the circuit breaker settings (Fig.8). The data should be available from nameplate and manufacturer data sheets.

1 2 3 4

Circuit breaker Operating mechanism Bushings Assessment limits

Job *
2019-02-18 Job 1
Status: Prepared

Overview

Location
Omicron Academy Houston

Asset

Properties

Asset Circuit breaker

Asset type Dead tank SF6 breaker

Serial no. 123

Manufacturer Siemens

Manufacturer type

Manufacturing year

Asset system code

Apparatus ID

Feeder

Comment

Figure 7: Asset Information Example

Circuit breaker

Number of phases ☐ 1 ☐ 2 ☒ 3

Number of interrupters per phase 1

Pole operation ☐ Independent ☒ Ganged

Pre-insertion resistors (PIR) ☐

PIR value

Grading capacitors ☐

Capacitor value

Interrupting medium SF6

Tank type Live tank

▼ Ratings

▼ Contact system

▼ Others

Note: The default wiring diagrams assume only a single interrupter per phase.

Select the checkbox, if the circuit breaker has a PIR, to measure the PIR timing during timing tests.

Select the checkbox if the circuit breaker contains grading capacitors. Only typical for circuit breakers with more than 1 interrupting unit.

Figure 8: Circuit Breaker Settings

5.2 Operating mechanisms

Once the “Circuit Breaker” settings have been completed, we can proceed to the “Operating mechanism” tab. After selecting the “Asset type”, additional settings will appear in the “Operating mechanism” tab (Fig.9)

Component	Rated voltage	Rated current	DC	AC	Frequency
Trip coil 1	V	A	<input checked="" type="radio"/>	<input type="radio"/>	
Close coil 1	V	A	<input checked="" type="radio"/>	<input type="radio"/>	
Auxiliary circuits	V	A	<input checked="" type="radio"/>	<input type="radio"/>	
Motor	V	A	<input checked="" type="radio"/>	<input type="radio"/>	

Figure 9: Operating Mechanism Settings

5.3 Bushings

If the circuit breaker has bushings that you would like to test, please click the “Bushings” tab (highlighted in Figure 10) to begin populating the nameplate information of the bushings. Otherwise, proceed to the next section. Note, the CIBANO 500 does not currently support testing of bushings.

Scroll to the top of the Asset page, and select the “Bushings” tab.

Note, it is only necessary to complete the “Bushings” section if the user would like to perform a power factor test on the bushings. Otherwise, entering the bushing nameplate information is for documentation purposes only.

Figure 10: Asset- Four Main Tabs

Transformer / **Bushings** / Tap changers / Surge arresters / DGA Trending

Copy bushing data

From: H1 To: H2

Primary bushings

Pos.	Asset type	Serial no.	Manufacturer	Manufacturer type	Manufacturing year
H1	<Select asset type>				
H2	<Select asset type>				
H3	<Select asset type>				
H0	<Select asset type>				

Secondary bushings

Pos.	Asset type	Serial no.	Manufacturer	Manufacturer type	Manufacturing year
X1	<Select asset type>				
X2	<Select asset type>				
X3	<Select asset type>				
X0	<Select asset type>				

The "Asset type" field is critical. The software will only allow the user to perform a bushing power factor C1 and C2 test, if the user specifies that the bushing has a test or potential tap. If the asset type is not selected, the only bushing test that is available to the user is an Energized Collar test.

Note, the serial no., manufacturer are required for using the trending feature for the bushing power factor tests. The manufacturer type, and manufacturer year fields are recommended, but not required.

Note, for the "Asset type", selecting the "With test tap" option will set the output voltage to 500V for a C2 power factor test for that bushing. If the "With potential tap" option is selected, the output voltage for the C2 power factor test will be 2000V.

Figure 11: Bushing Nameplate- Part 1

Next, scroll to the right to view more bushing nameplate fields, as shown in Figure 12.

Bushings rated > 350kV BIL typically have potential taps
Bushings rated ≤ 350kV BIL typically have test taps

Insul. level LL (BIL)	Voltage L-ground	Max. system voltage	Rated current
kV	kV	kV	A
kV	kV	kV	A
kV	kV	kV	A

Insul. level LL (BIL)	Voltage L-ground	Max. system voltage	Rated current
kV	kV	kV	A
kV	kV	kV	A
kV	kV	kV	A
kV	kV	kV	A

The Voltage L-ground field is critical. It will determine the maximum output voltage for the bushing C1 power factor test. All other fields shown in Fig.12 are recommended, but not required.

Figure 12: Bushing Nameplate- Part 2

Finally, scroll to the right to view the remaining bushing nameplate fields, as shown in Figure 13.

Max. system voltage	Rated current	PF (C1)	Cap. (C1)	PF (C2)	Cap. (C2)	Insulation type	
kV	A	%	pF	%	pF	Select insulation type ▼	Show details
kV	A	%	pF	%	pF	Select insulation type ▼	Show details
kV	A	%	pF	%	pF	Select insulation type ▼	Show details
		PF (C1)	Cap. (C1)	PF (C2)	Cap. (C2)		
	A	%	pF	%			
	A	%	pF	%			
	A	%	pF	%	pF	Select insulation type ▼	Show details
kV	A	%	pF	%	pF	Select insulation type ▼	Show details

Enter the nameplate power factor and capacitance values if available. This allows the PTM software to perform an automatic assessment of the test results by comparing the measured C1 and C2 values to the nameplate values.

To perform an auto-assessment for the bushing power factor results, the insulation type must be selected.

Figure 13: Bushing Nameplate- Part 3

5.4 Assessment Limits

The assessment limits (Fig.14) define the pass/fail criteria for the circuit breaker tests. This should be taken from the manufacturer specifications. If no limits are entered then PTM cannot assess a test as pass or fail. These values are transferred automatically to the individual tests, and can also be edited in the individual test tabs. Editing in the individual test tabs does not affect the values entered in the “Asset settings” section.

Circuit breaker
Operating mechanism
Bushings
Assessment limits

☒ Absolute limits
☐ Relative limits

^ Contact resistance

	R min	R max
Contact resistance	$\mu\Omega$	$\mu\Omega$

^ Operating times

	t min	t max
Opening time	0.00 ms	32.00 ms
Opening sync. (contacts within a phase)	ms	ms
Opening sync. (between breaker phases)	ms	ms
Closing time	90.00 ms	100.00 ms
Closing sync. (contacts within a phase)	ms	ms
Closing sync. (between breaker phases)	ms	ms
Reclosing time	0.00 ms	270.00 ms
Close-Open time	ms	ms
Open-Close time	ms	ms

^ Contact travel

	d min	d max
Total travel, TT	in	in
Over-travel (Trip), OT	0.00 in	0.10 in
Over-travel (Close), OT	in	in
Rebound (Trip), RB	0.00 in	0.50 in
Rebound (Close), RB	in	in
Contact wipe (Trip), CW	in	in
Contact wipe (Close), CW	in	in
Damping distance	in	in

[More information](#)

+ Add velocity zone

Operation	Definition	v min	v max
Trip	Initial contact position + 1.00 in --> Initial contact position + 4.00 in	1.20 in/s	1.35 in/s ✕

^ Auxiliary contacts

^ Miscellaneous

^ Coil characteristics

	Minimum	Maximum
Peak close coil current	A	A
Peak trip coil current	A	A
Average close coil current	A	A
Average trip coil current	A	A
Average close coil voltage	V	V
Average trip coil voltage	V	V
Close coil resistance	Ω	Ω
Trip coil resistance	Ω	Ω

^ Pickup voltage

	V min	V max
Minimum pickup voltage (close)	V	V
Minimum pickup voltage (trip)	V	V

^ Motor characteristics

	Minimum	Maximum
Inrush current	A	A
Charging time	s	s
Charging current	A	A
Minimum voltage	V	V

Figure 14: Assessment limits

6 Test Plan Creation

Once all the information has been entered, click the “Tests” tab located on the left panel of the PTM software. Once the “Tests” tab is selected, the PTM software will automatically generate the “recommended” test plan, based on the nameplate information that was entered in the “Asset” section. Please populate the test plan by following the guidelines provided in Figure 15.

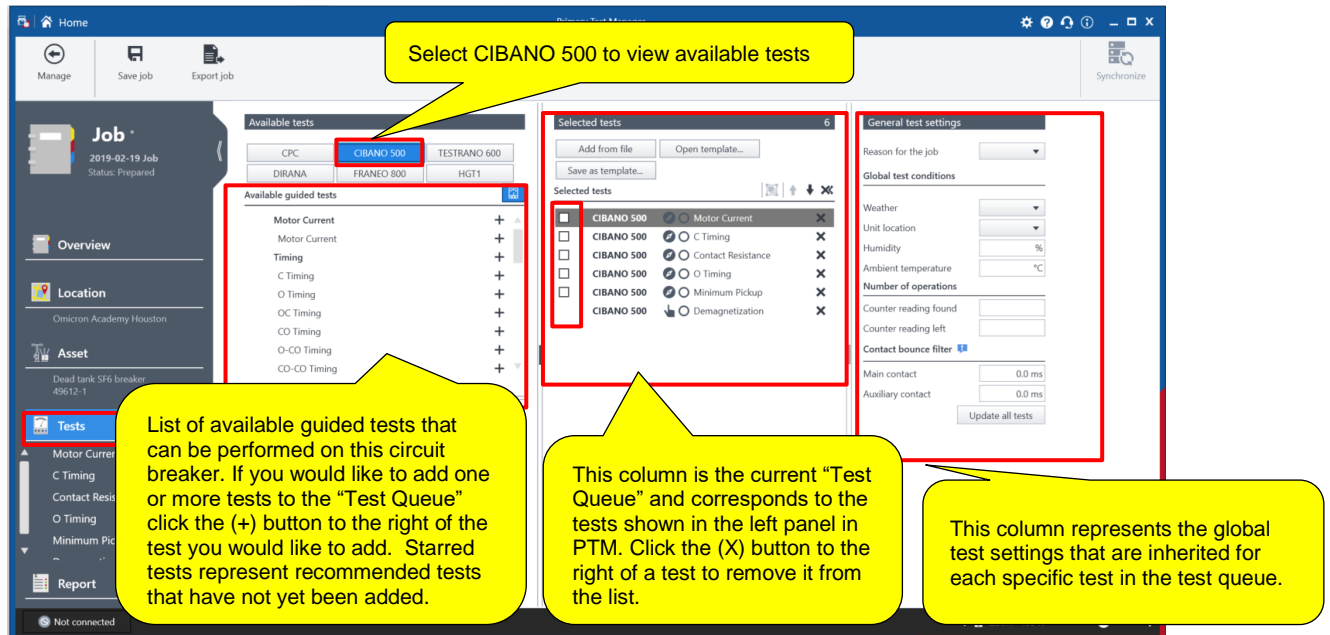


Figure 15: Test Section

Once the test plan has been created, we can begin testing. The following test settings assume the tests are individually run and not grouped together. Use the left panel of PTM to select which test you would like to perform first. Note, the tests can be performed in any order you would like. In addition, you can add more tests to the “Test Queue” at any time by clicking on the “Tests” tab and populating the desired tests.

7 Control Circuit Wiring Examples for Timing, Travel, and Minimum Pickup Tests

The timing/travel and minimum pickup tests require access to the control circuit of the circuit breaker with the CIBANO 500. Control circuit schemes can vary depending on the manufacturer. The following examples show to connect the CIBANO 500 to the control devices for a particular circuit breaker control panel when using the CIBANO 500 as the power source for all components. Note, an external source can be used (battery supply) but this is not covered in this guide.

NOTICE

Safety Practice

- ▶ Prior to connecting the CIBANO 500 test leads to the control circuit, open the knife switches that power the positive and negative rails of the control circuit. This ensures there is no potential at the terminals the user will connect leads to.
- ▶ Once the CIBANO 500 test leads are “landed”, the user can attempt to test/operate the breaker with the knife switches open.
- ▶ The knife switches can be closed after the CIBANO 500 leads have been removed from the control circuit.
- ▶ **Note**, some cases require the knife switches to be closed to power other components in the circuit for circuit breaker operation. If the circuit breaker does not operate for this reason, the knife switches may need to be closed and the test performed again. Study the connection plan well to ensure this is possible. Once the testing is complete and before the test leads are removed from the control circuit, open the knife switches that power the positive and negative rails of the control circuit. This ensures there is no potential at the terminals the user will remove the leads from.

NOTICE

Common Practice

- ▶ For many circuit breaker schemes, the Trip lead (B1) is connected to terminal 9, the Close lead to terminal 7, and the Neutral lead (BN) to the negative rail of the control circuit.
- ▶ Note, sometimes the negative rail of the Trip Coil and the negative rail of the Close Coil must be manually short-circuited together. The same may apply to the motor circuit. Study the connection plan and make sure this is possible, otherwise connect to each component separately to perform the individual tests.

Close Coil Example

Connecting to the close coil in the control circuit will allow us to power the close coil via the CIBANO 500 and remotely operate the circuit breaker for all the applicable tests.

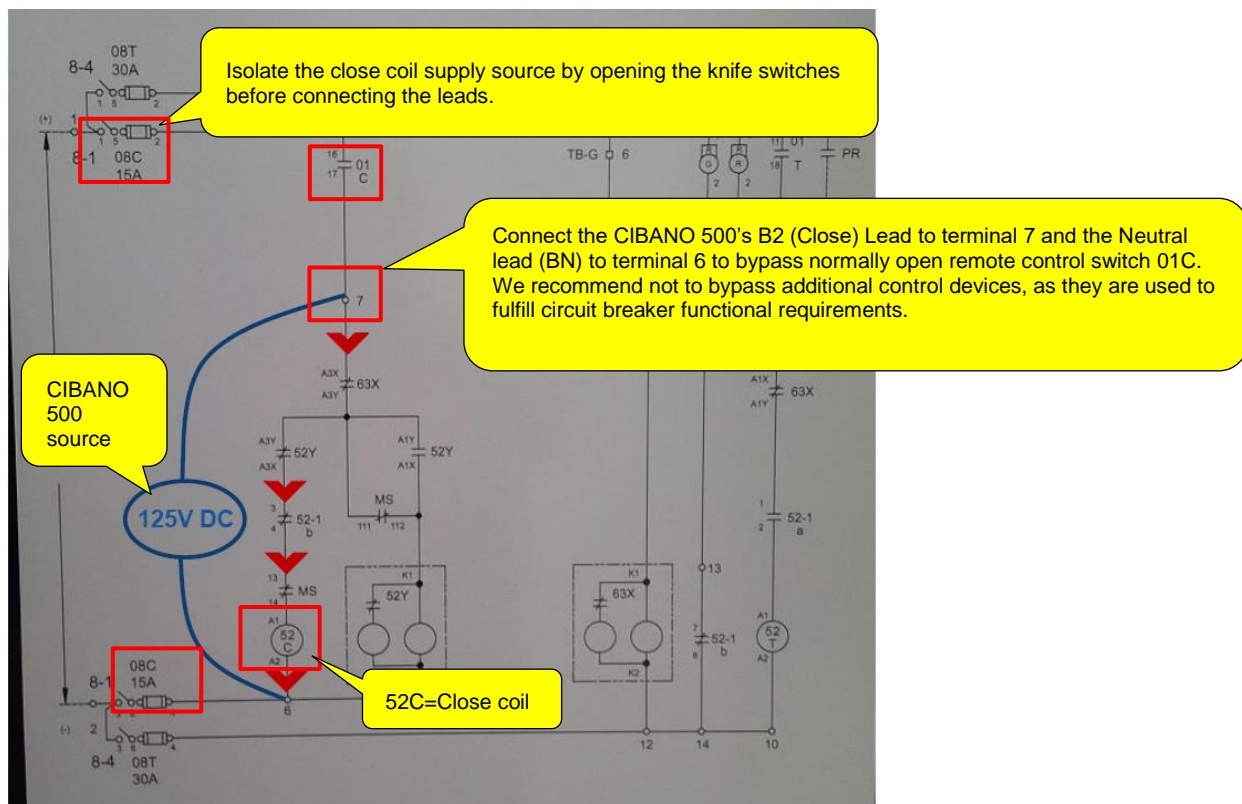
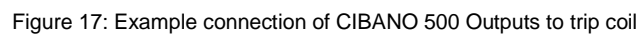


Figure 16: Example connection of CIBANO 500 outputs to Close coil

Connecting to the trip coil in the control circuit will allow us to power the trip coil via the CIBANO 500 and remotely operate the circuit breaker for all the applicable tests.



Motor Example

Connecting to the motor in the control circuit will allow us to power the motor via the CIBANO 500 and measure the current for the motor current test.

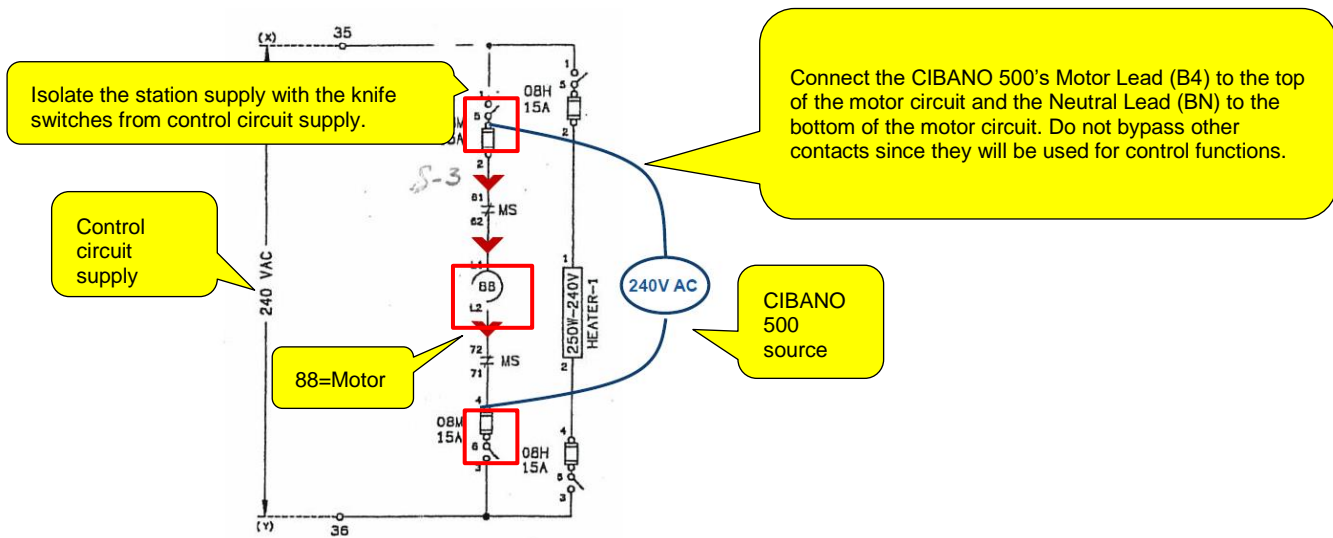


Figure 18: Example connection to motor

Auxiliary Contacts Example

The auxiliary contacts protect the command coils from being energized too long by blocking the command signal. The 52a auxiliary contact is in series with trip coil and follows the state of the main circuit breaker contacts while the 52b is in series with the close coil and follows the opposite state of main contacts.

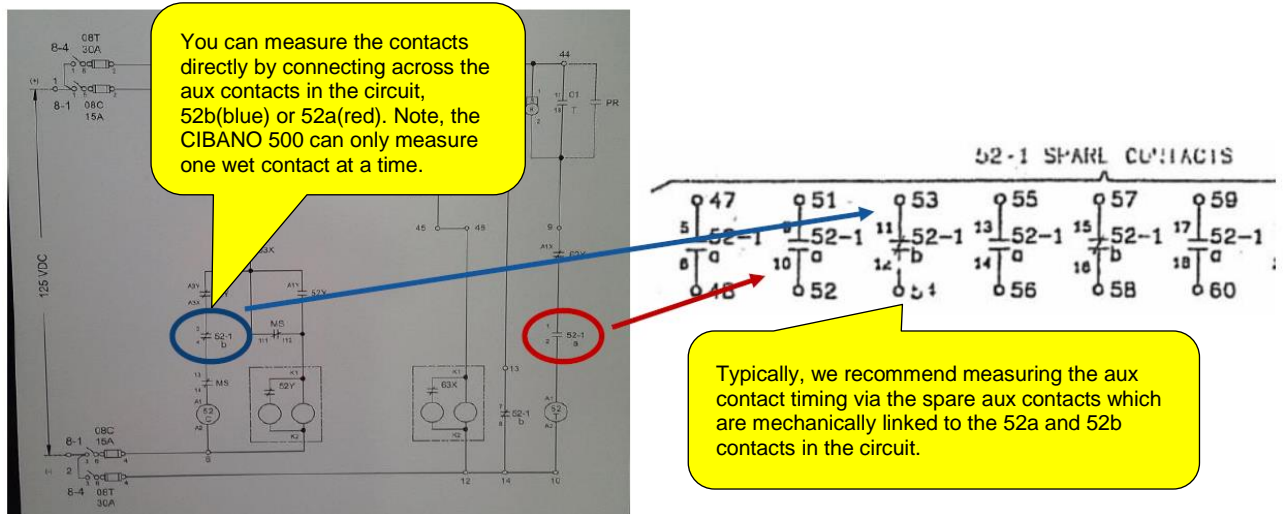


Figure 19: Example Connection of CIBANO 500 Outputs to Auxiliary contacts

8 Tests

8.1 Motor Current

The motor current test verifies the performance of the charging motor which makes up the operating mechanism. Mechanical issues such as lubrication can be identified.

Test Preparation

- Note, the following setup assumes the CIBANO will be used as the supply source and the default hardware configuration and wiring will be used.
- Please consider the wiring examples and safety precautions in Section 7: “Control Circuit Wiring for Timing, Travel, and Minimum Pickup Tests” when connecting the CIBANO leads to the control circuit.

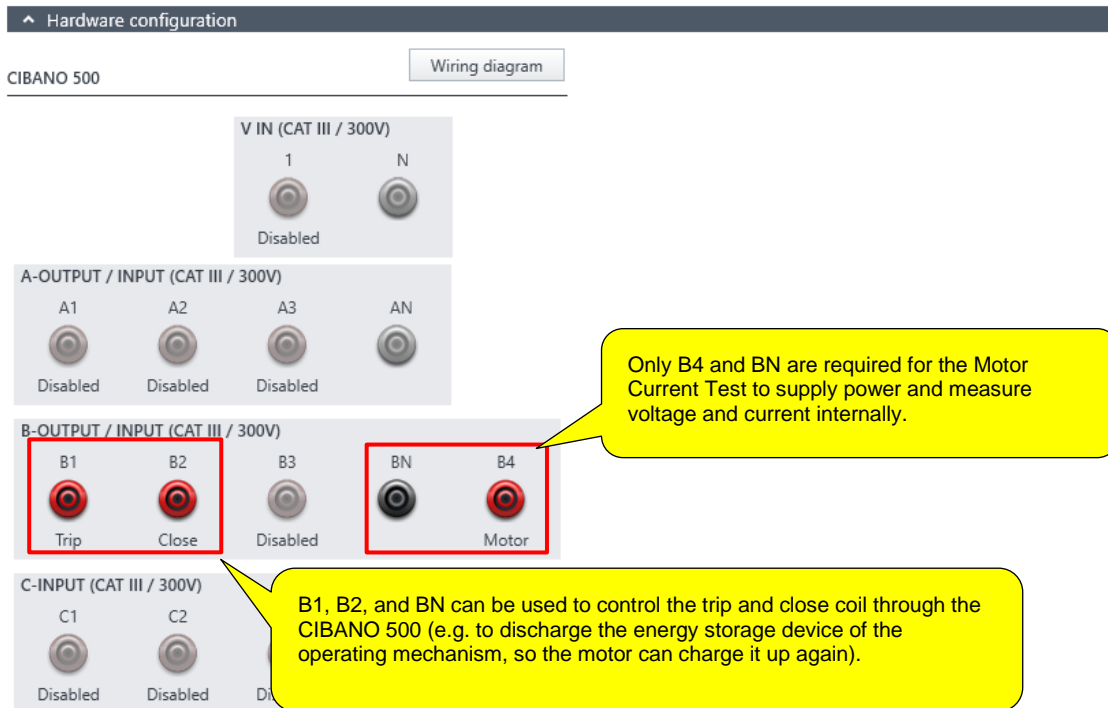


Figure 20: Default Hardware configuration for single motor

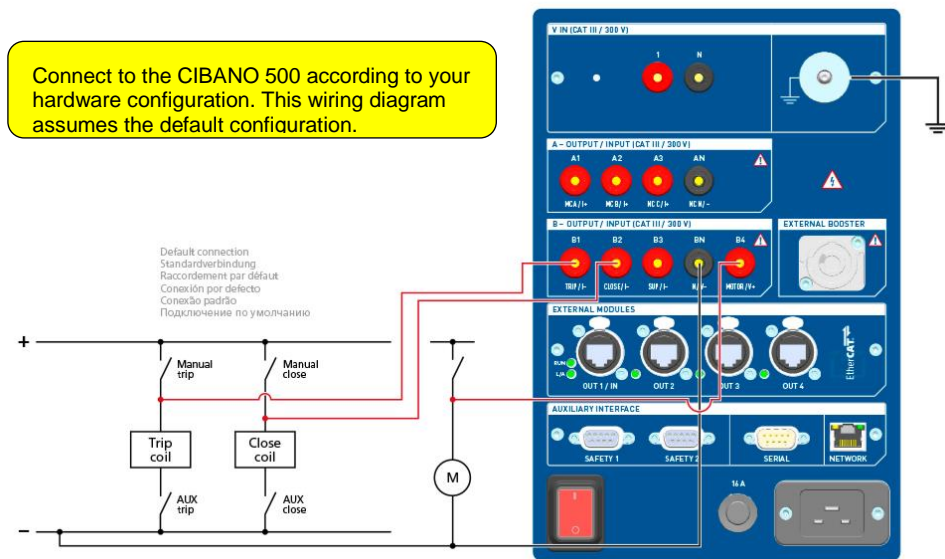


Figure 21: Wiring Diagram of Motor Current Test

Settings and conditions

Motor supply (B4)

Supply source: ☒ CIBANO 500 ☐ External source

Supply settings: Motor (240.0 V, AC, 60.00 Hz)

Max. supply duration: 30.0 s

Coil supply (B1, B2)

Supply source: ☒ CIBANO 500 ☐ External source

Supply settings: Trip coil 1 (125.0 V, DC)

The supply settings are automatically populated using the values entered in the "Asset section" if using the CIBANO 500 as the source. Custom values can also be entered. Ensure the correct motor voltage before proceeding.

To obtain an assessment, the motor must fully charge. Ensure the supply duration is long enough to fully charge the motor. Motor will stop charging automatically when fully charged. 30s is the default charging time.

Figure 22: Settings and Conditions Section - Motor Current Test

NOTICE

Enabling Assessments

- If the assessment section is completed, PTM can assess the measurement as pass or fail according to the motor characteristics (fig.23)

Assessment

Motor characteristics

	Minimum	Maximum
Inrush current	A	A
Charging time	s	s
Charging current		A
Minimum voltage		V

Edit configuration...

This section is automatically populated from the relevant data previously entered in the "Asset" settings.

The motor characteristics for the assessment can also be edited in this window. This does not change the settings in the "Asset Section".

Figure 23: Assessment Section - Motor Current Test

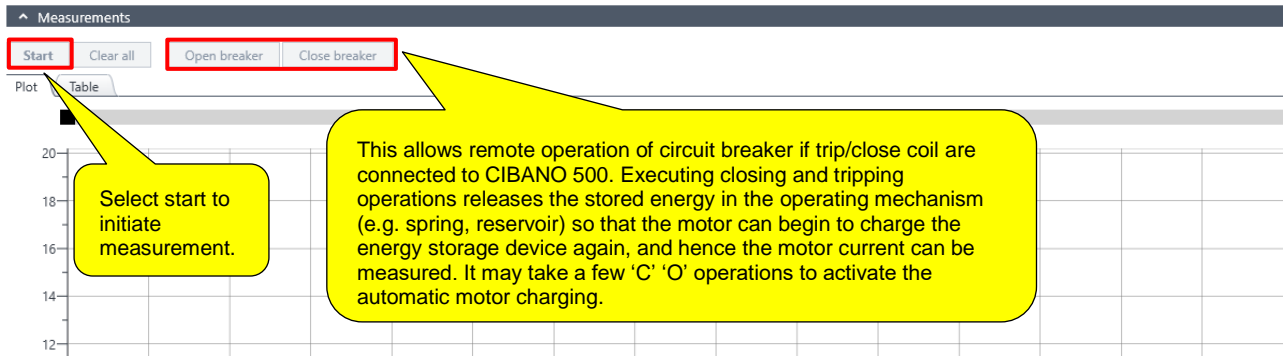


Figure 24: Measurement Section - Motor Current Test

Once the motor automatically stops charging, numerical results along with a plot of the motor current and voltage will be available (Fig. 25 & 26). The plot pattern of the motor current varies depending on the driving mechanism that charges the stored energy device. If the test is stopped prematurely, numerical results and assessment shown in Fig.25 and 26 will not be available. In the measurement section, we can visually assess the motor current by comparing the shape to a previous measurement.

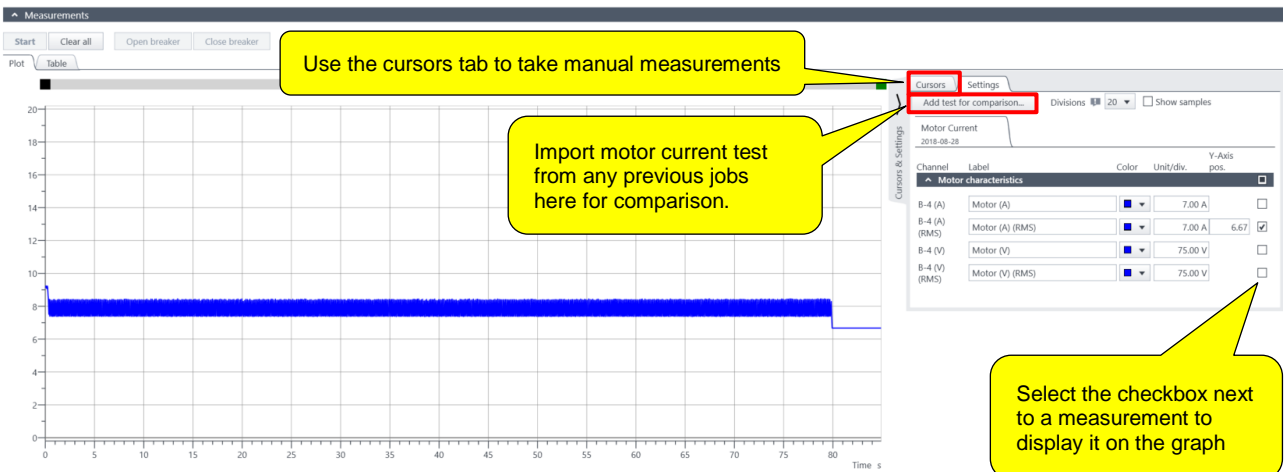


Figure 25: Measurements Results - Motor Current Test

The pass/fail assessment on motor current is based on the limits entered in the assesment section which is populated automatically by the data entered in the “Asset” settings.

Motor characteristics

	Inrush current	Charging time	Charging current	Minimum voltage	Assessment
Motor	22.77 A	79.90 s	7.67 A (RMS)	154.67 V (RMS)	✓ Pass

Figure 26: Measurements Table - Motor Current Test

8.2 Timing Tests

The timing tests help assess the integrity of the kinematic chain. Recording main contact and auxiliary contact state, command coil currents, and travel distance of circuit breaker contacts can help in assessing all circuit breaker components which are mechanically linked together.

Test Preparation

- ▶ Note, the following setup assumes the CIBANO will be used as the supply source and the default hardware configuration and wiring will be used.
- ▶ Please consider the wiring examples and safety precautions in Section 7: “Control Circuit Wiring for Timing, Travel, and Minimum Pickup Tests” when connecting the CIBANO leads to the control circuit.

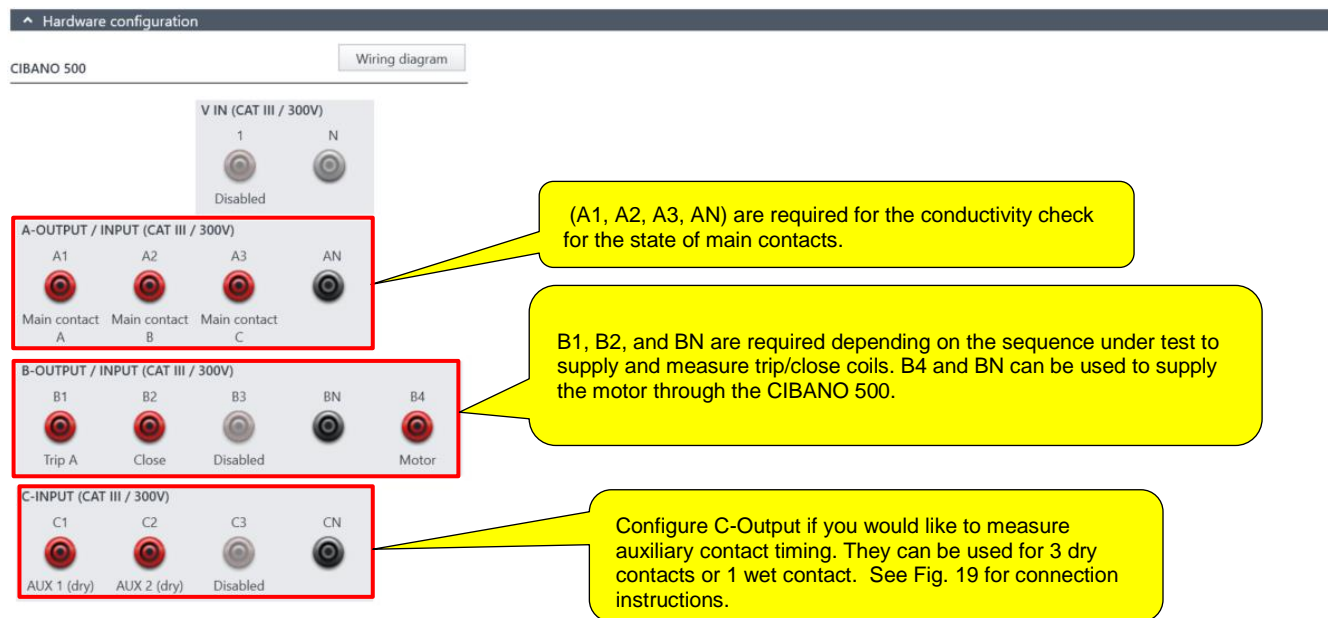


Figure 27: Default Hardware Configuration – Timing Test

If you are also interested in travel measurements, see pg. 30 for the additional configuration and settings required.

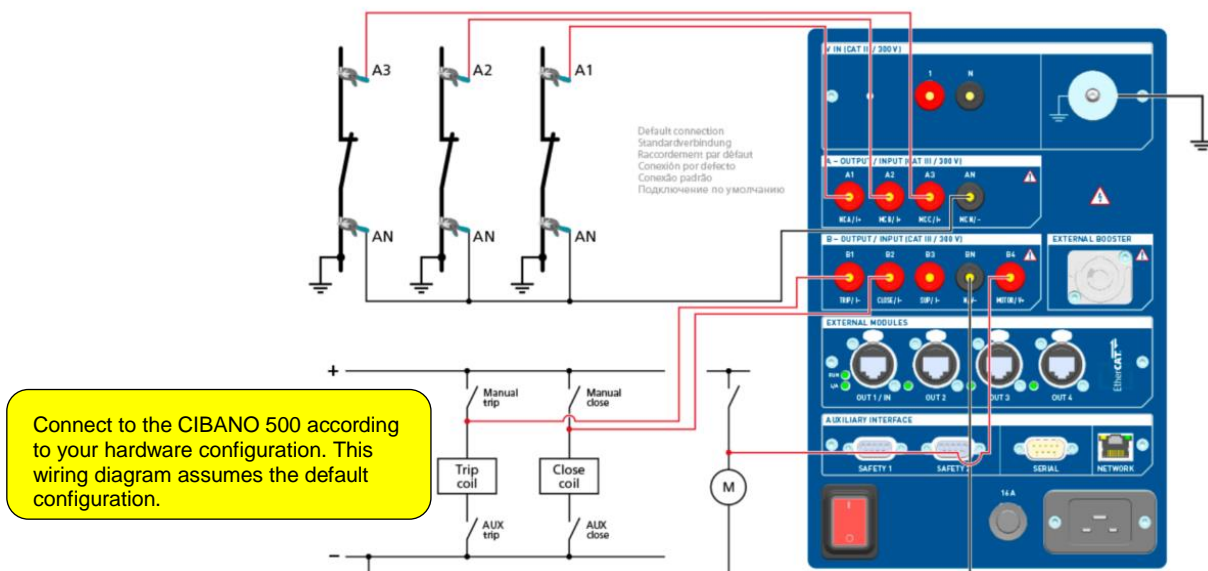


Figure 28: Timing Wiring Diagram

Settings

Coil supply

Supply source ☒ CIBANO 500 ☐ Control board

Supply settings **Close coil 1 (125.0 V, DC)**

Other

Grounding ☐ Single side grounded ☒ Both sides grounded

Sequence

Test sequence **C**

The supply settings are automatically populated using the values entered in the "Asset section" when using the CIBANO 500 as the source. Select the appropriate settings according to the test being executed.

Supply source ☒ CIBANO 500 ☐ External source

Supply settings **Motor (240.0 V, AC, 60.00 Hz)**

Max. supply duration **30.0 s**

This limits the time of supply to the motor. A longer charging time may be required.

Select single side grounded. The CIBANO 500 can only perform timing tests with both sides grounded when used in combination with the MC2s.

Figure 29: Settings and Conditions – Timing Test

In the "Advanced settings", the test sequences can be edited (Fig.30). The typical timing command signals are shown in figures 31-34. Select the appropriate sequence depending on the test to be executed.

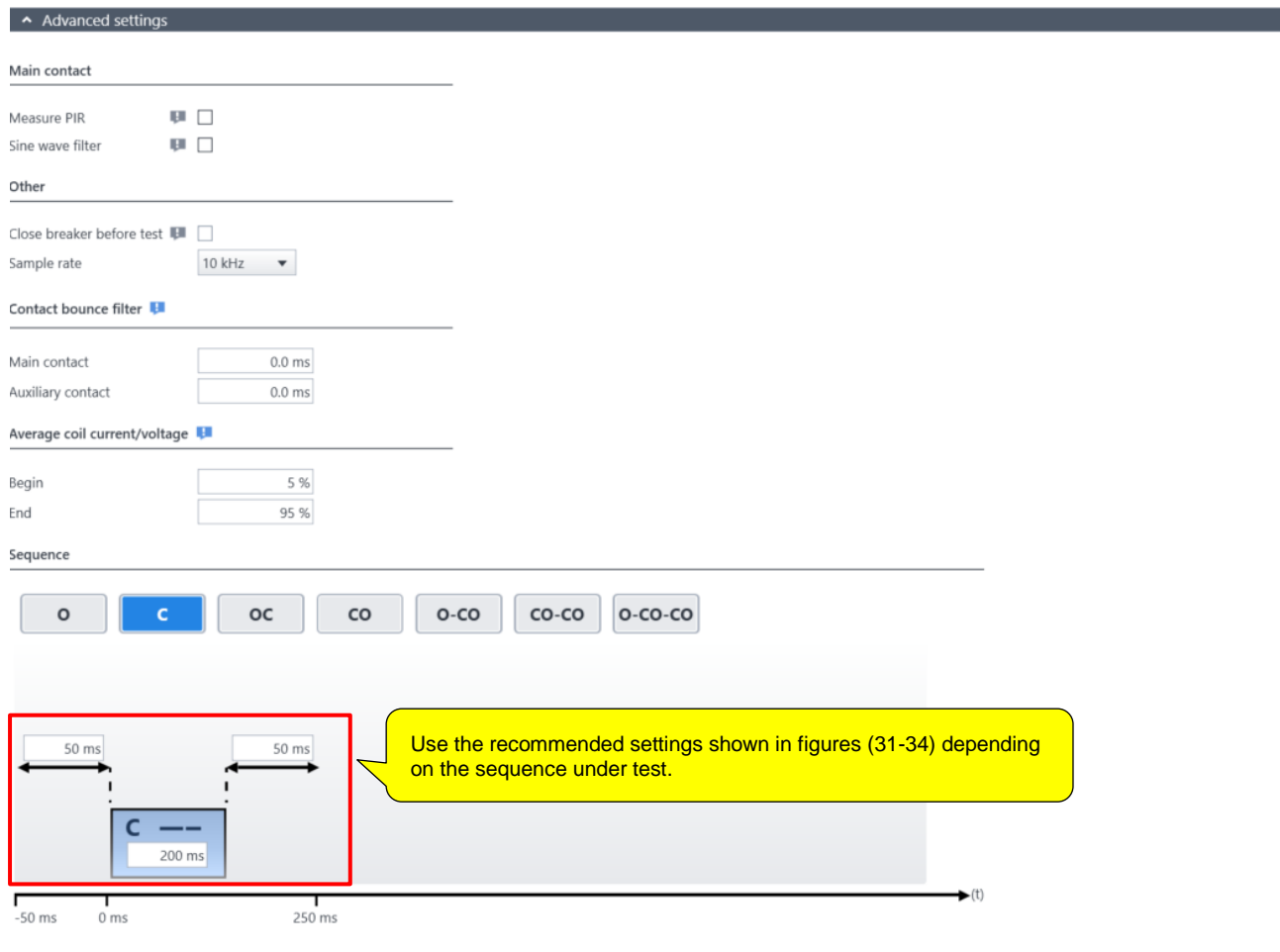


Figure 30: Advanced Settings – Timing Test

The recommended settings for the sequences are depicted below. These are typical control signal timing values used in performing the timing test.

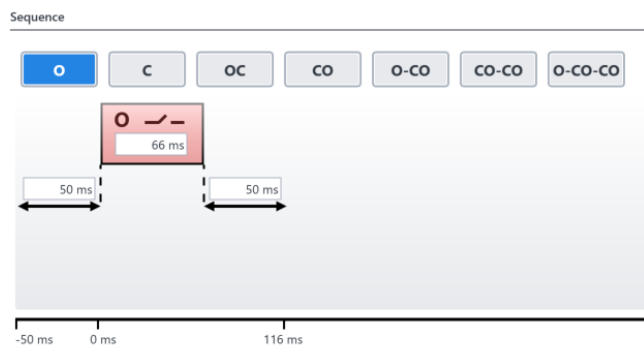


Figure 31: Open Test (O) Sequence Setting

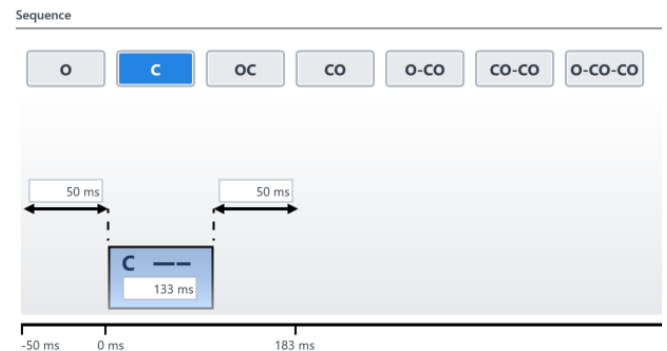


Figure 32: Close Test (C) Sequence Setting

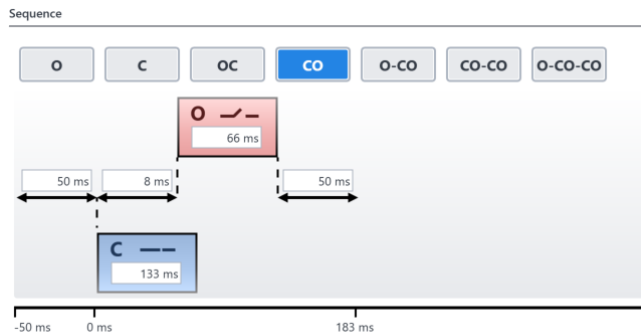


Figure 33: Trip Free (CO) test Sequence Setting

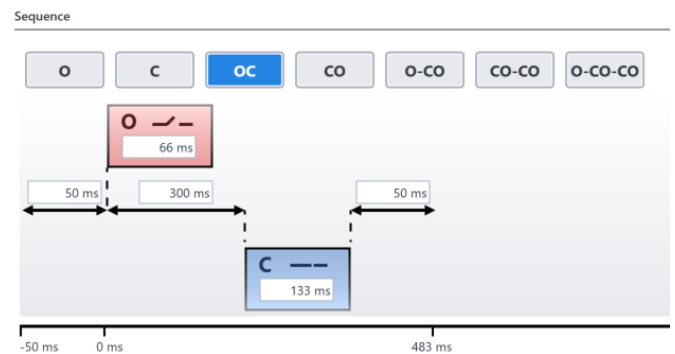


Figure 34: Reclose (OC) Test sequence Setting

NOTICE

Verifying the Anti-Pump circuit

- The CO sequence can be used to not only test the trip-free functionality (circuit breaker tripping after closed under a fault condition) but also to verify the anti-pump system. To test the anti-pump the circuit breaker must first be open before the test is started. The close command is then sent, and during the close operation an open command is sent opening the circuit breaker as fast as possible (fig.33). Due to the open time being shorter than the closing time, the close command will still be on after the open command ends, but the circuit breaker should not “pump”, or close again for a successful test.

If the assessment section (Fig.35) is completed, PTM can assess the measurements.

^ Assessment

Operating times	
Closing time	<div> t min t max </div> <div> 90.00 ms 100.00 ms </div>

This section automatically populates the relevant data previously entered in the "Asset" settings. The timing characteristics can also be edited in this window.

Figure 35: Assessment Section – Timing Test

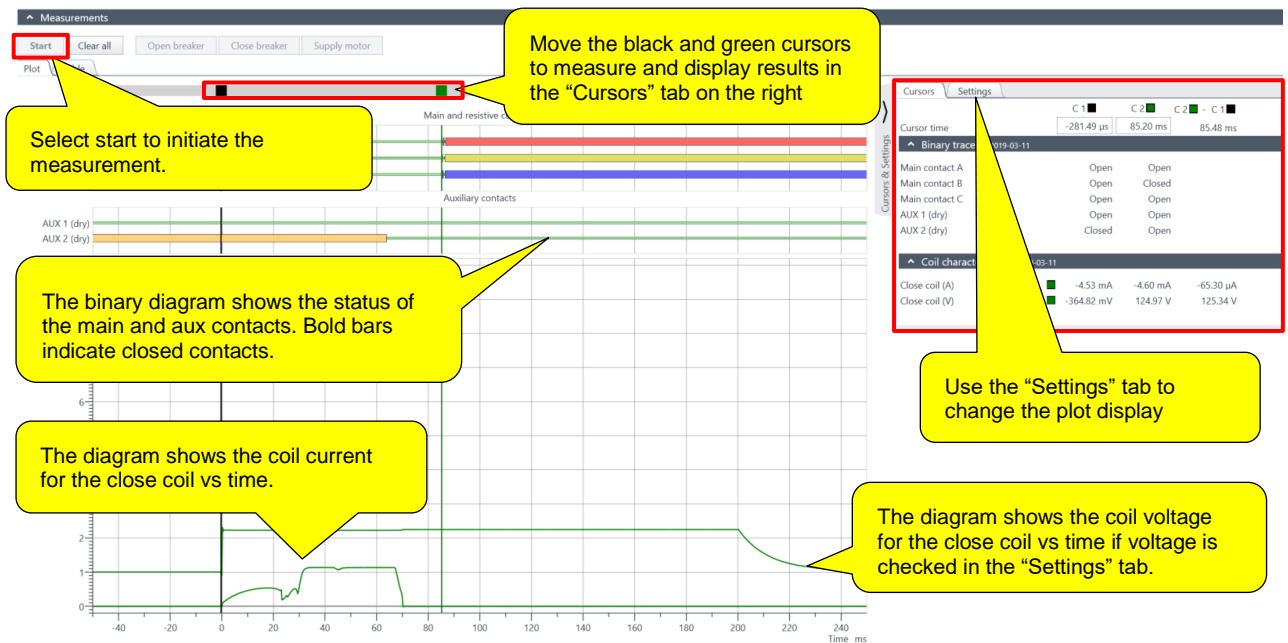


Figure 36: Measurement Section C-Timing Example

The pass/fail assessment (Fig. 37) of the timing values and coil characteristics are based on the limits entered in the assessment section which are populated automatically by the data entered in the "Asset" settings.

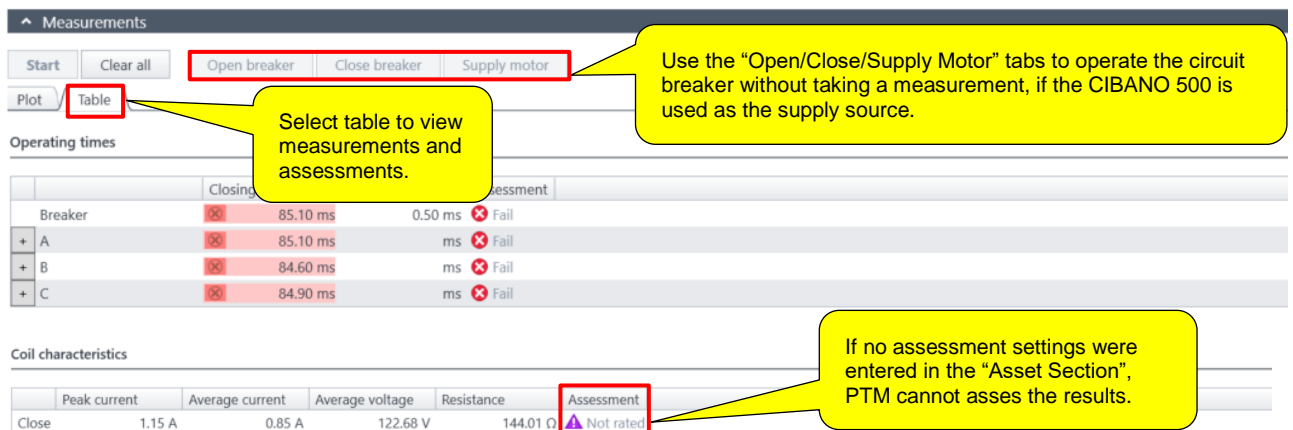


Figure 37: Measurement Table C-Timing Example

Coil Current

The coil current allows us to test the performance of the control circuit. It helps identify insufficient lubrication (e.g. sticky plunger), assess command coil performance, auxiliary contacts, and latch operation. We can use the plot to visually assess the "Coil Signature" by comparing to a previous measurement as shown below and trending any change over time (Fig.38).

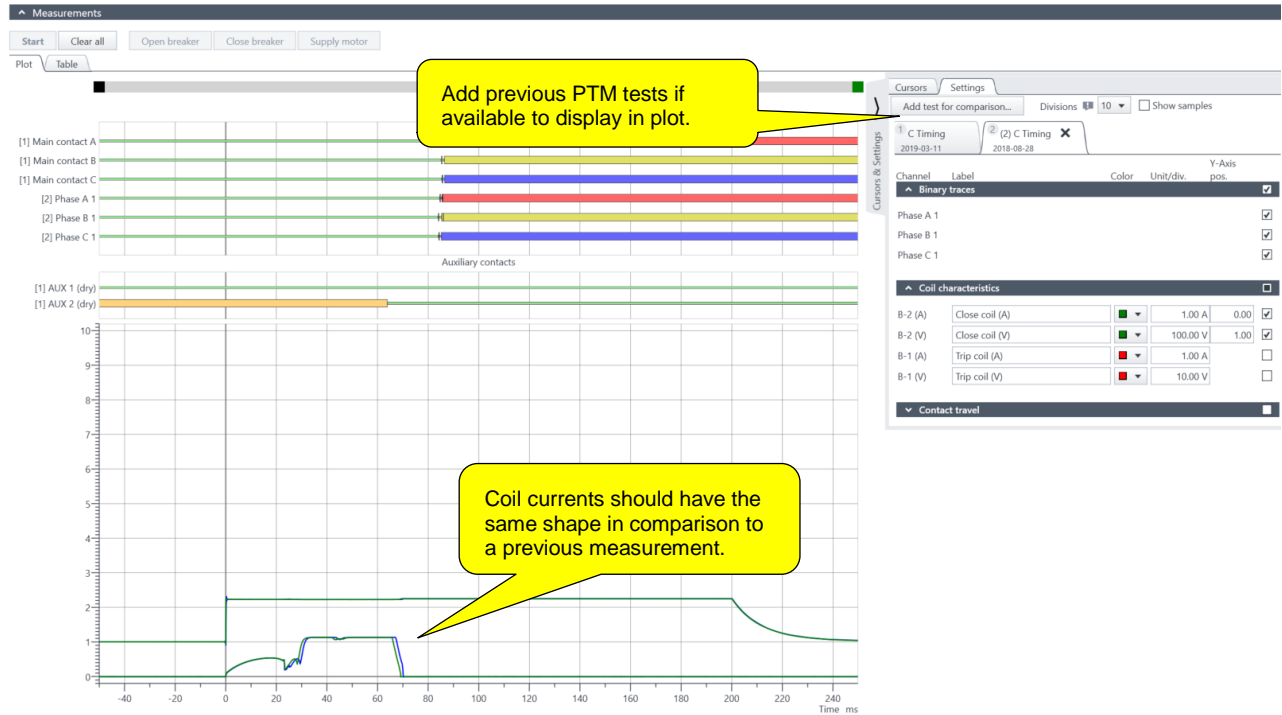


Figure 38: Measurement Section C-Timing Comparison Example

Under-voltage

The under-voltage test, allows us to test the performance of the control circuit. The timing tests should pass at the minimum voltage designated in the operating voltage range of the trip or close coil (see circuit breaker nameplate for voltage range). To perform this test, repeat the (O) or (C) timing tests at a reduced voltage to check the timing performance with under-voltage. For a visual comparison you can import the previous test using the comparison tool as shown in (Fig.38). An example of the results at different voltages is shown in Fig.39.

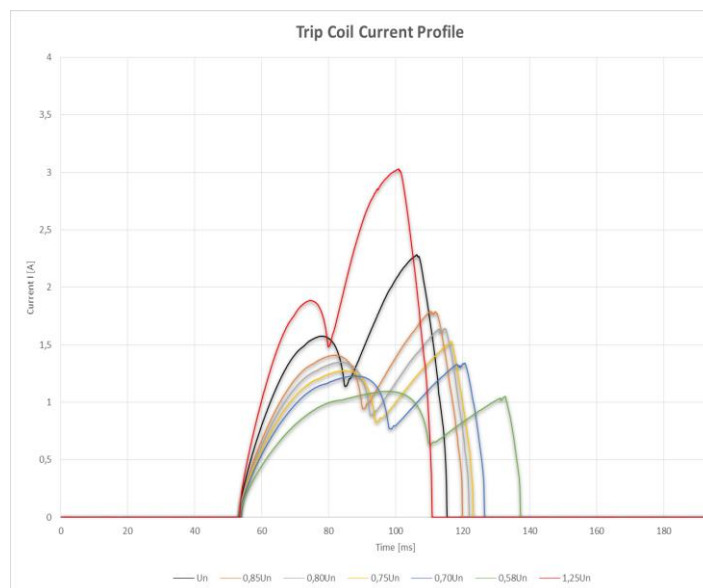


Figure 39: Example of results of under voltage test for Trip Coil

Travel

The travel measurement helps assess the integrity of the components which are mechanically linked together including the operating mechanism, main contacts, and damping system. The travel measurement is done as part of the timing test but requires the TN3 accessory in addition the CIBANO 500. The TN3 connects to different transducer types mounted on the circuit breaker and interprets/transfers the data to the CIBANO 500. To complete this test, we have to configure the hardware again as shown in fig. 40 for the timing test and connect the TN3 according to the user manual.

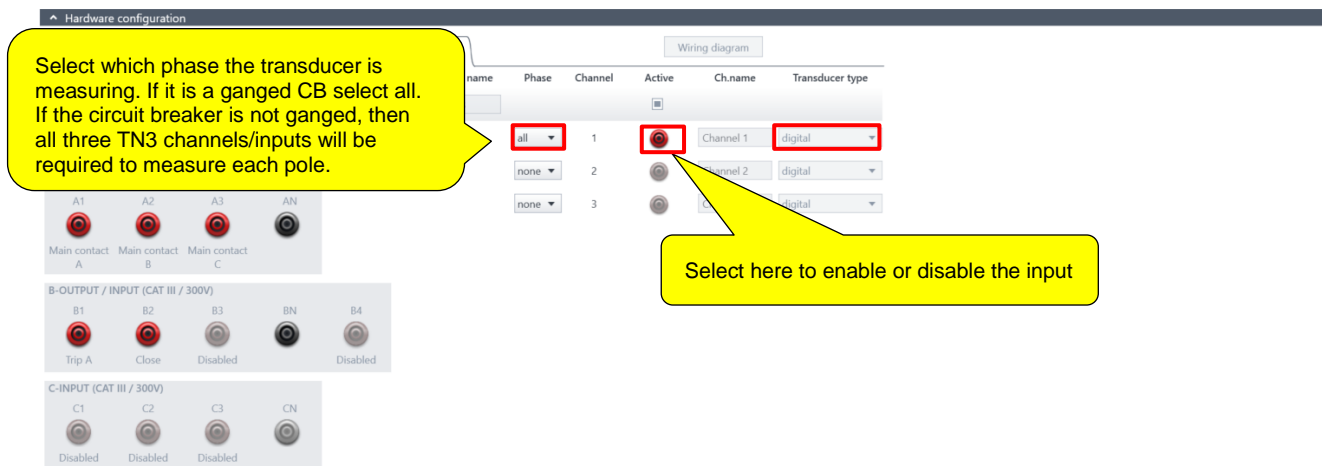


Figure 40: Default CIBANO 500 Hardware Configuration + Example TN3 hardware configuration

In addition, complete additional settings in the “Advanced settings” section.

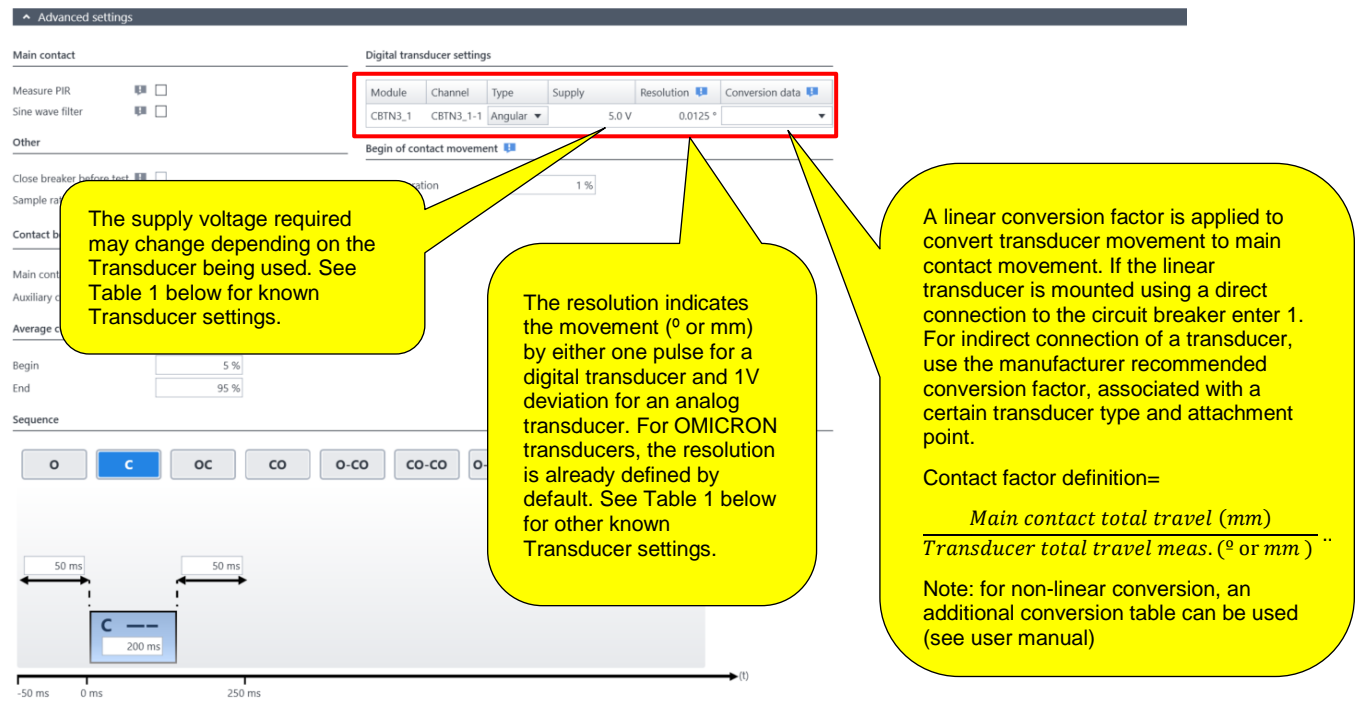


Figure 41: Advanced Settings for Travel Measurement

Table 1: Motion Transducer Settings by Product and Type

		Angular	Linear
	Supply	Rotary (°) (Resolution for angular resolution setting)	Linear (mil) (Resolution when PTM settings are in inches) Linear (um) (Resolution when PTM settings are in mm)
OMICRON Rotary Transducer	5 V _{DC}	0.025 (3600)	-
OMICRON Digital Linear Dead Tank Transducer 300 mm	5 V _{DC}	-	1.9223 48.8281
Doble	5 V _{DC}	0.1 (4000)	1.25 31.75
Vanguard	15 V _{DC}	0.06 (6000)	1.25 31.75

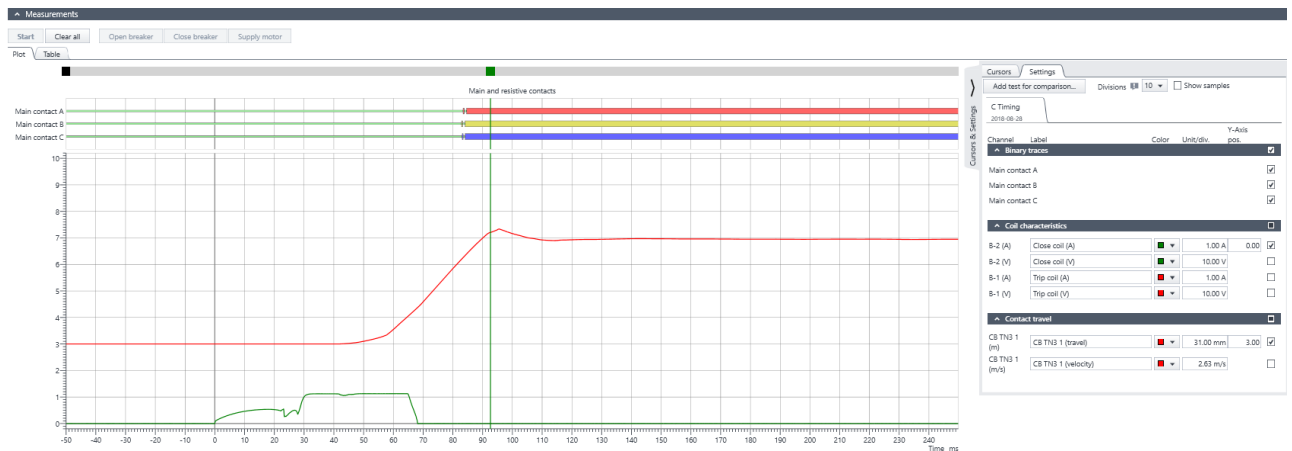


Figure 42: Results with travel measurement

In addition to the timing measurements shown in fig.36, the travel measurements shown in fig.42 will be available. The software automatically calculates the travel characteristics and assesses them if assessment

limits were available. (Fig. 43). Note the velocity is only calculated if a “velocity zone” is define in the assessment limits.

The travel characteristics (in mm) are affected by the conversion factor (fig.41) and can only be assessed correctly if the appropriate conversion factor is entered.

Contact travel characteristics					
Module	Channel	Total travel	Over-travel	Rebound	Assessment
CB TN3	CB TN3 1	122.43 mm	11.95 mm	1.61 mm	⚠ Not rated

Main contact characteristics					
Test data	Contact wipe	Reaction time	Bounce time	Bounce count	Assessment
Main contact A CB TN3 1	21.53 mm	46.60 ms	1.20 ms	1	⚠ Not rated
Main contact B CB TN3 1	23.38 mm	46.60 ms	1.20 ms	1	⚠ Not rated
Main contact C CB TN3 1	22.64 mm	46.60 ms	1.00 ms	1	⚠ Not rated

Figure 43: Measurement table C-timing example with travel measurement

8.3 Minimum Pick-up

The minimum pick-up test is used to test the performance of the control circuit and can help identify insufficient lubrication (sticky plunger), assess electrical command coil performance, and latch/valve operation.

Test Preparation

- Note, the following test setup assumes the CIBANO will be used as the supply source and the default hardware configuration and wiring will be used.
- Please consider the wiring examples and safety precautions in Section 7: “Control Circuit Wiring for Timing, Travel, and Minimum Pickup Tests” when connecting the CIBANO leads to the control circuit.

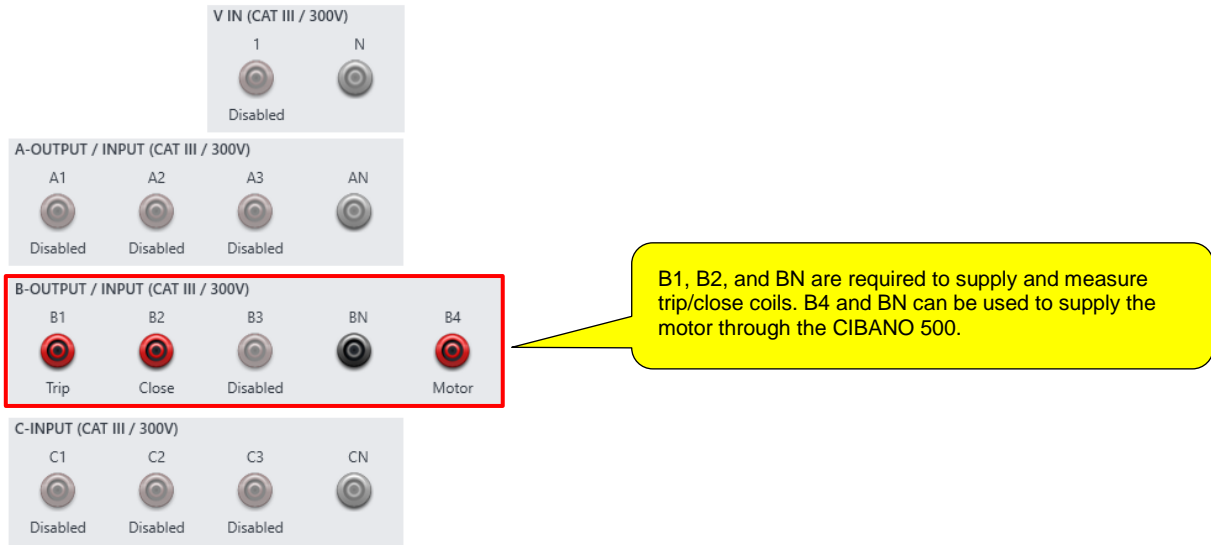


Figure 44: Default Hardware configuration – Minimum Pick-Up Test

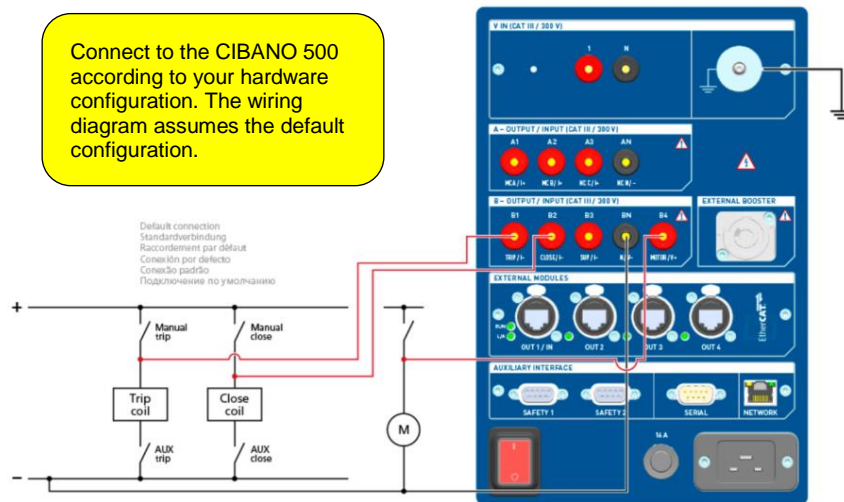


Figure 45: Wiring Diagram – Minimum Pick-Up Test

Define the test sequence. Ensure the start voltage is well below the operating voltage of the coil and the end voltage is at the minimum operating voltage of the coil. The coils may still operate at <50% of its rated voltage. For more accurate test, the voltage step value can be decreased.

Settings and conditions

Coil supply (B1, B2)

Supply settings: Trip coil 1 (125.0 V, DC)

Test sequence

Coil supply voltage start	30.0 V
Coil supply voltage end	125.0 V
Coil supply voltage step	5.0 V

Motor supply (B4)

Supply source: ☒ CIBANO 500 ☐ External source

Supply settings: Motor (240.0 V, AC, 60.00 Hz)

Max. supply duration: 30.0 s

Figure 46: Settings and Conditions – Minimum Pick-Up Test

Assessment

This section automatically populates the relevant data previously entered in the "Asset" settings.

Minimum pickup voltage

	V min	V max
Minimum pickup voltage (close)	V	V
Minimum pickup voltage (trip)	V	V

Edit configuration...

Automatic assessment ☒

Figure 47: Assessment – Minimum Pick-Up Test

Select "edit configuration" to change assessment limits. This does not change the "Asset" section.

The trip and close operation are run independently in the Measurement section. In addition to the assessment (fig.47), these measurements should be documented and trended over time to identify any abnormal change in voltage.

Measurements

Open breaker

After ensuring the right supply settings, select start to run the test.

	No.	Operation	V pickup	Assessment		
Start	1	Trip	V	Not assessed	Clear result	Delete measurement
Start	2	Close	V	Not assessed	Clear result	Delete measurement

+ Add measurement

Figure 48: Measurement – Minimum Pick-Up Test

8.4 Static Contact Resistance

The contact resistance test identifies issues with the main contacts of the circuit breaker. Failure could indicate improper alignment of contacts, improper pressure on contacts, damaged contact surfaces, or poor bushing connections.

Test Preparation

- Verify that circuit breaker is closed

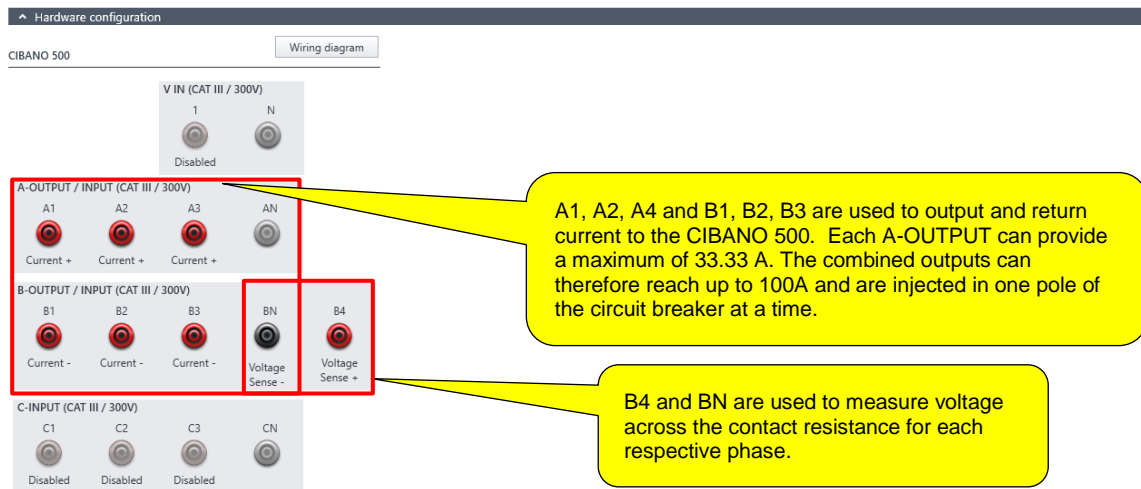


Figure 49: Required Hardware Configuration- Contact Resistance

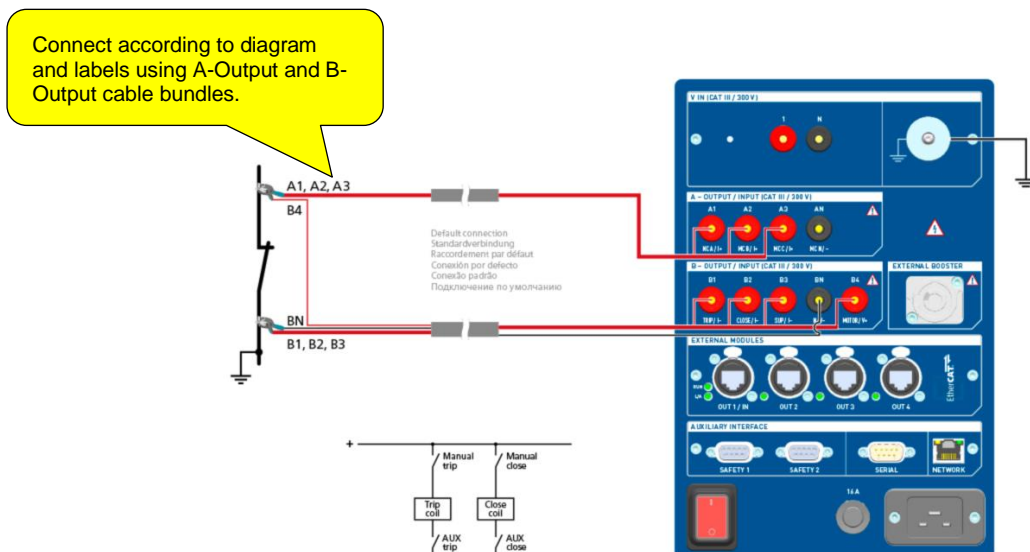


Figure 50: Contact Resistance Wiring

Advanced settings

Test conditions	Main contact
Ambient temperature <input type="text"/> °C	V DC Range <input type="text" value="30 mV"/>
	CT Mode <input checked="" type="checkbox"/>
	Test duration <input type="text" value="60.0 s"/>

CT mode is assumed for Dead Tank breakers. The checkbox is not editable.

Select the DC voltage range. The lowest voltage range that fits the measurement is recommended due to its higher accuracy.

If no CTs, select 2s. The time duration can range anywhere from 2-120s. Input a higher value to saturate larger CTs before measuring the resistance.

Figure 51: Settings - Contact Resistance

Assessment

This section automatically populates the relevant data previously entered in the "Asset" settings.

Contact Resistance

Contact resistance R max

Edit configuration... Select "edit configuration" to change assessment limits. This does not change the "Asset" section.

Automatic assessment ☒

Figure 52: Assessment - Contact Resistance

From the voltage and current measurements, we can calculate the contact resistance. The test will stop automatically after finishing the test. Once the measurement of one pole is completed, move clamps to the next pole and click start in the measurement section until all measurements are complete.

Measurements

Select start to initiate the measurement.

	Main contact	V DC	R meas	Assessment		
Start	A	A	mV	μΩ	Not assessed	Clear result Delete measurement
Start	B	A	mV	μΩ	Not assessed	Clear result Delete measurement
Start	C	A	mV	μΩ	Not assessed	Clear result Delete measurement

+ Add measurement

Figure 53: Measurements - Contact Resistance

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