OMICRON

CT SB2

User Manual

Manual Version: CTSB2.AE.2

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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 GmbH 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 GmbH 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

Preface

Using This Manual

This CT SB2 User Manual provides information on how to use the *CT SB2* switch box. The CT SB2 User Manual contains important safety instructions for working with the *CT SB2*, gets you familiar with operating it, and provides typical application examples. Read and observe the safety rules described in "Safety Rules" on page 7 and all relevant instructions for installation and operation. 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 CT SB2 User Manual always has to be available at the site where the *CT SB2* is used. It must be read and observed by all users of the *CT SB2*.

Reading the CT SB2 User Manual alone does not release you from the duty to comply with all relevant national and international safety regulations.

Operator Qualifications and Safety Standards

Working on high-voltage power equipment can be extremely dangerous.

Testing with the *CT Analyzer* and the *CT SB2* switch box should only be carried out by authorized and qualified personnel. Before starting to work, clearly establish the responsibilities.

Personnel receiving training, instruction, direction, or education on the *CT Analyzer* and the *CT SB2* should remain under the constant supervision of an experienced operator while working with the equipment.

The operator is responsible for the observance of all applicable safety requirements during the entire test. When performing tests in high-voltage areas, pay attention to the national and international standards for safe operation of high-voltage test equipment (EN 50191, IEEE 510, and others).

Moreover, observe all applicable regulations for accident prevention in the country and at the site of operation.

Conventions and Symbols Used

In this manual, the following symbols indicate paragraphs with special safety-relevant meaning:

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

Related Documents

The following documents complete the information covered in the CT SB2 User Manual:

Title	Description
CT Analyzer User Manual	Contains information how to use and operate the *CT Analyzer* as well as safety instructions for working with the *CT Analyzer*.
CT Analyzer Reference Manual	Contains detailed information about the *CT Analyzer* as well as theoretical backgrounds and normative definitions.
Help System for *CT Analyzer PC Toolset*	Contains detailed information about the software tools provided with the *CT Analyzer PC Toolset*.

Safety Rules

Before operating the *CT SB2* switch box, read the instructions in this section carefully. If you do not understand some safety rules, contact OMICRON electronics GmbH before proceeding. The *CT SB2* is designated for use with the *CT Analyzer*. Therefore, observe the safety rules both in this User Manual and in the CT Analyzer User Manual when working with the *CT SB2* switch box.

Maintenance and repair is only permitted by qualified experts either at the factory or certified external repair centers.

General

Always observe the five safety rules:

- Disconnect completely
- Secure from reconnection
- Verify that the installation is dead
- Carry out grounding and short-circuiting
- Provide protection against adjacent live parts

Orderly Measures

The CT SB2 User Manual or the e-book version of the manual always has to be available on the site where the *CT SB2* is being used. All users of the *CT SB2* must read and observe the safety rules and all relevant instructions for installation and operation.

The *CT SB2* may be used only as described in this 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.

Full compliance with the regulations also includes following the instructions provided in this User Manual.

Power Supply

Supply the *CT SB2* only from a power outlet that is equipped with protective ground (PE). Instead of supplying the *CT SB2* from phase-neutral, it may also be supplied from phase-phase. However, the voltage must not exceed 240 V AC.

Safe Operation

- Make sure to position the test equipment on dry, solid ground.
- If working in other than laboratory environment only use the *CT SB2* with a solid connection to ground of at least 6 mm^2. Use a ground point as close as possible to the test object.
- Do not open the *CT SB2*. Opening the *CT SB2* invalidates all warranty claims.
- Do not repair, modify, extend, or adapt the *CT SB2* or any accessories.
- Do not operate the *CT SB2* under wet or moist conditions (condensation).
- Do not operate the *CT SB2* when explosive gas or vapors are present.
- Use only original accessories available from OMICRON electronics GmbH.
- Before putting the *CT SB2* into operation, check it for visible damages.
- Use the *CT SB2* only in a technically sound condition and when its use is in accordance with the safety regulations for the specific job site and application.
- Always be aware of the danger of the high voltages and currents associated with this equipment. Pay attention to the information provided in this User Manual.
- When disconnecting cables, always start at the device feeding the power.
- Never connect or disconnect a test object while the outputs of the connected *CT Analyzer* are active.
- If the *CT SB2* seems to be functioning improperly, please call the OMICRON electronics GmbH hotline (refer to chapter "Contact Information / Technical Support" on page 57).
- For protection against parasitic currents or voltages, always connect the equipotential connector on the *CT SB2* to protective ground (PE). Only use the original cable set supplied by OMICRON electronics GmbH.
- Make sure that the terminals of the test object to be connected to the *CT SB2* do not carry any voltage potential. During a test, the *CT Analyzer* (with the *CT SB2* connected) is the only permitted power source for the test object.
- Only use wires with 4 mm safety "banana" connectors and plastic housing for connection to the front panel input/output sockets.

Warning: When measuring the ratio of transformers make sure that the test voltage is connected to the corresponding secondary winding, and the primary winding is connected to the according measurement input. Accidentally mixing up the windings can cause life-threatening voltages within the transformer and/or destroy the connected CT, the *CT SB2* or the *CT Analyzer*!

Disclaimer

The *CT SB2* is intended exclusively for the applications described in chapter 1 on page 11. Any other use is deemed not to be according to the regulations.

If the *CT SB2* is used in a manner not specified by the manufacturer, the protection provided by the *CT SB2* may be impaired.

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

1 Introduction and Designated Use

The *CT SB2* switch box is an accessory for the *CT Analyzer* and therefore exclusively designated for use with the *CT Analyzer*.

The *CT SB2* is intended for the following applications:

- Multi-ratio CT testing

  The *CT SB2* switch box enables automatic testing of multi-ratio CTs with up to 6 tap connections. With this accessory, the *CT Analyzer* is able to measure every tap combination of multi-ratio CTs without any need for wiring changes during the test.

- Burden and primary winding resistance measurement

  Using the *CT SB2* it is also possible to include burden and primary winding resistance measurement to the automatic CT test procedure without rewiring.

- Single-ratio CT testing

  Due to the possibility to include burden and primary winding resistance measurement, the *CT SB2* is not only useful for testing multi-ratio CTs but also for testing single-ratio CTs.

The *CT SB2* is intended exclusively for the applications described above. Any other use is deemed not to be according to the regulations. The manufacturer and the distributor are not liable for damage resulting from improper usage. The user alone assumes all responsibility and risk.

Warning: The *Quick Test* function of the *CT Analyzer* and the *CTA Quick Test* PC tool cannot be used with the *CT SB2* switch box.

2 Hardware

2.1 Functional Components of the CT SB2

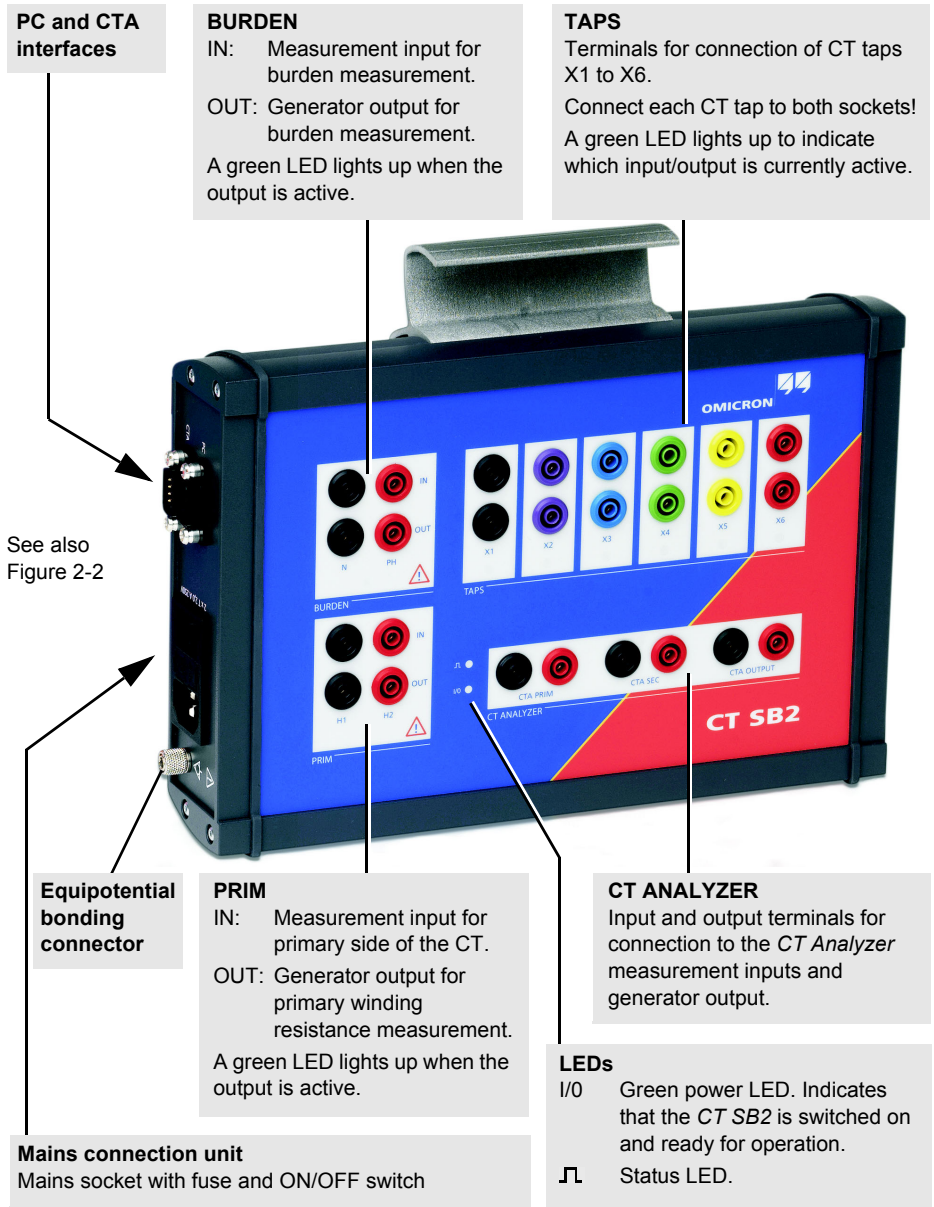


Figure 2-1 *CT SB2* overview

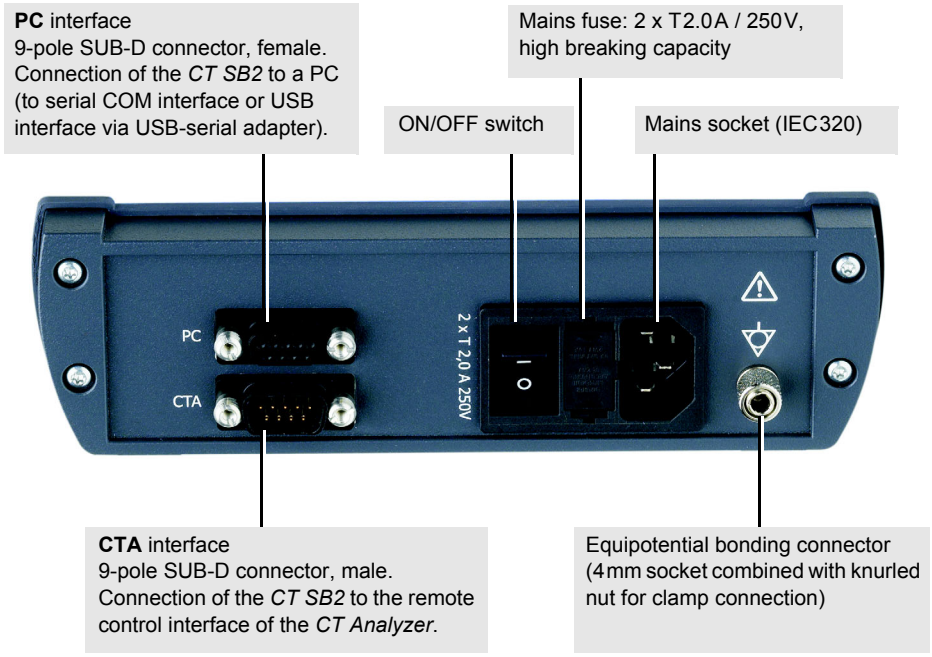


Figure 2-2 Side view to the *CT SB2* with mains connection unit, PC and CTA interfaces, and equipotential bonding connector

2.2 Block Diagram (Simplified)

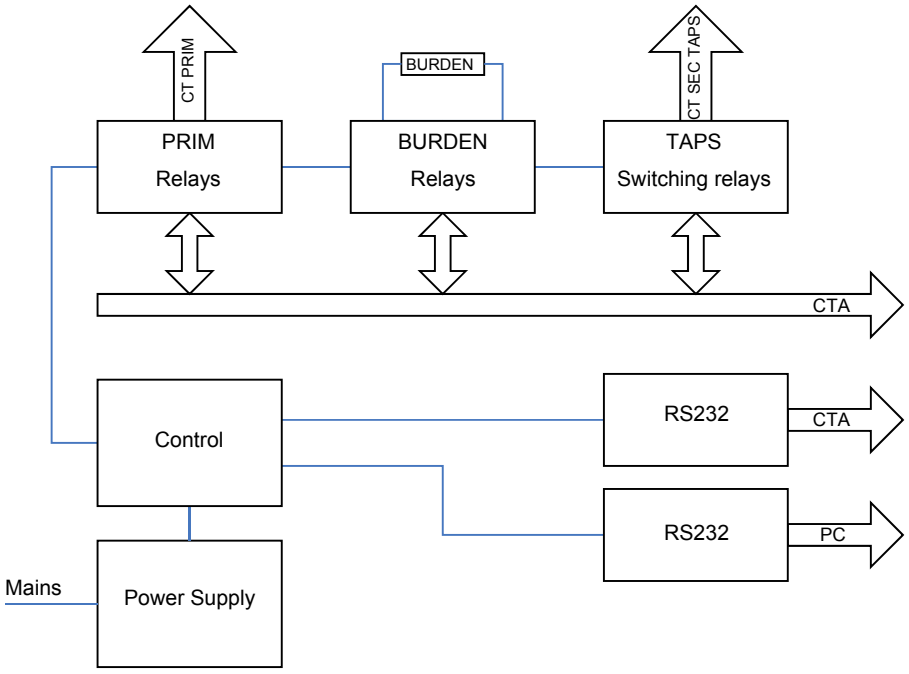


Figure 2-3 Simplified block diagram of the *CT SB2*

2.3 CT SB2 Accessories (Scope of Delivery)

The following accessories are delivered with the *CT SB2* switch box:

Accessories		Description
1 x 6-pole cable		Cable for connecting the *CT SB2* to the *CT Analyzer*
1 x 12-pole cable, 7 m (22 ft)		Test cable for connecting the secondary side of the CT to the *CT SB2*
1 x 4-pole cable, 7 m (22 ft)		Test cable for connecting the burden to the *CT SB2*
1 x 9-pole SUB-D cable, 0.3 m (1 ft)		Data connection cable from the CTA interface on the *CT SB2* to the remote control interface on the *CT Analyzer*
12 x clamp		Clamps in 6 different colors according to the 12-pole test cable for connecting the test cable plugs to the tap connections on the secondary side of the CT
1 x Power cord adapter		Using this adapter, only one power supply cord is required to supply the *CT Analyzer* and the *CT SB2*

Accessories		Description
1 x Cable bag		Bag for cables and accessories

3 Measurement Setup

3.1 General

When connecting the CT to the *CT SB2*, please also observe the wiring hints given in the CT Analyzer User Manual.

Always connect only one CT to the *CT SB2*. Disconnect and remove unused cabling from the *CT SB2* and the CT after testing.

Using the *CT SB2* switch box, CT testing, burden measurement and primary winding resistance measurement can be performed separately (i.e., using separate test procedures) or together in one test sequence. Figure 3-1 and Figure 3-2 show the basic wiring required for CT testing. To measure the burden and the primary winding resistance together with the CT test, the additional wiring shown in Figure 3-3 and Figure 3-4 is necessary.

The advantage of using the *CT SB2* for single-ratio CT testing is the option to include burden and/or primary winding resistance measurement to the test without any need for wiring changes during the test procedure. If you do not want to perform burden or primary winding resistance measurement, you should preferably use the normal single-ratio CT test mode of the *CT Analyzer* without using the *CT SB2*.

If you do not use the *CT SB2* switch box for CT testing with the *CT Analyzer*, disconnect all cabling to the *CT SB2* from the *CT Analyzer* (incl. the data connection cable connected to the remote control interface of the *CT Analyzer*).

3.2 Basic Measurement Setup for Multi-Ratio CT Testing

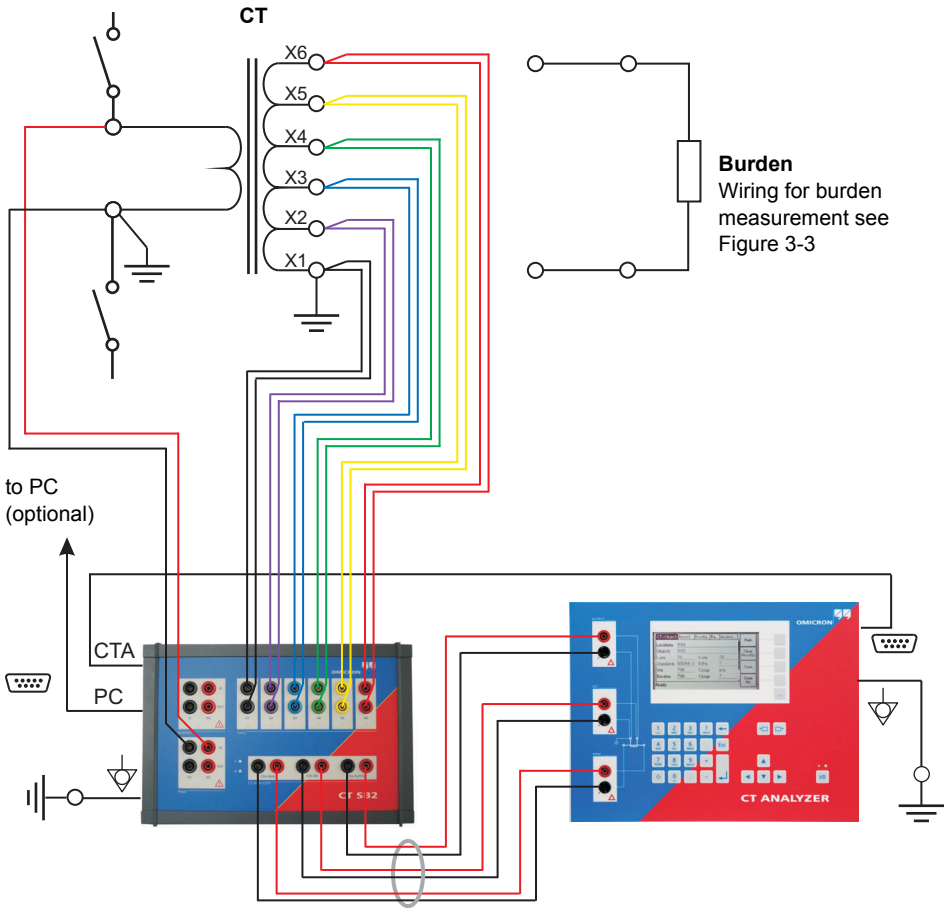


Figure 3-1 Basic measurement setup for multi-ratio CT testing (6 tap CT, no burden measurement, no primary winding resistance measurement)

3.3 Basic Measurement Setup for Single-Ratio CT Testing

Note: If you do not want to perform burden or primary winding resistance measurement, you should preferably use the normal single-ratio CT test mode of the *CT Analyzer* without using the *CT SB2*. Remove the data connection cable from the remote control interface of the *CT Analyzer* if you do not use the *CT SB2* for CT testing with the *CT Analyzer*.

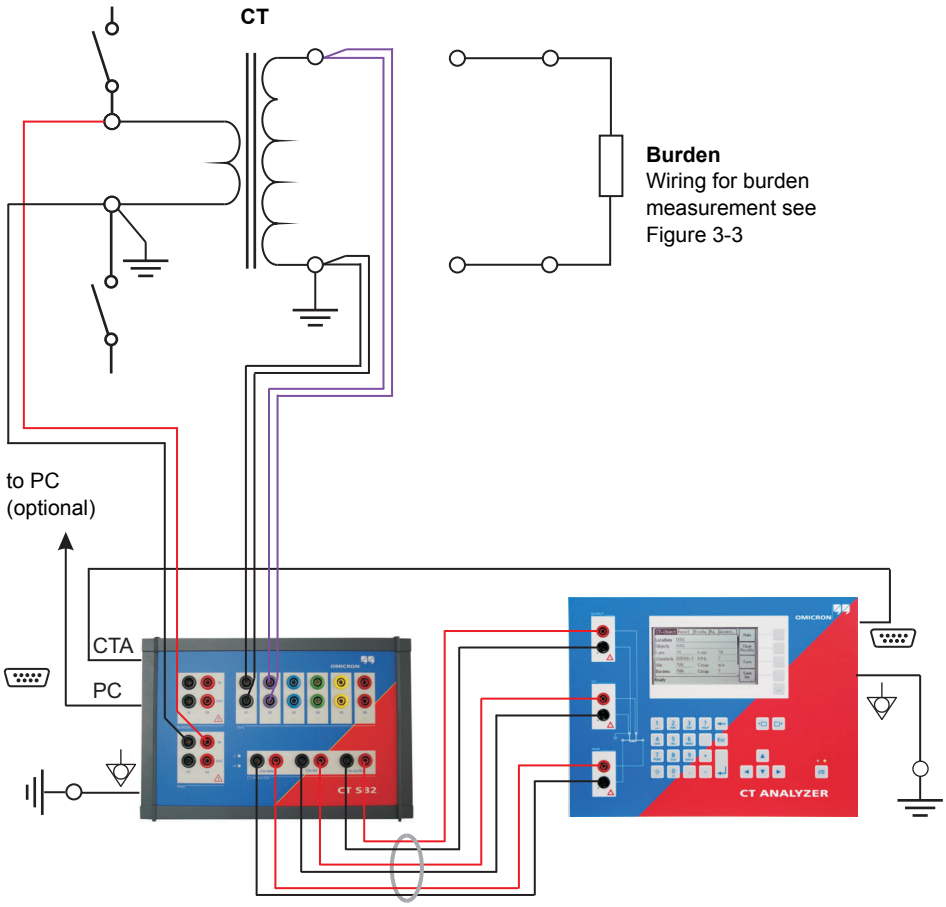


Figure 3-2 Basic measurement setup for single-ratio CT testing (no burden measurement, no primary winding resistance measurement)

3.4 Additional Wiring for Burden Measurement

Burden measurement may be performed separately or in conjunction with CT testing and/or primary winding resistance measurement.

The following wiring is required for burden measurement (in addition to the basic measurement setup shown in Figure 3-1 and Figure 3-2 and/or the additional wiring for primary winding resistance measurement shown in Figure 3-4, as required).

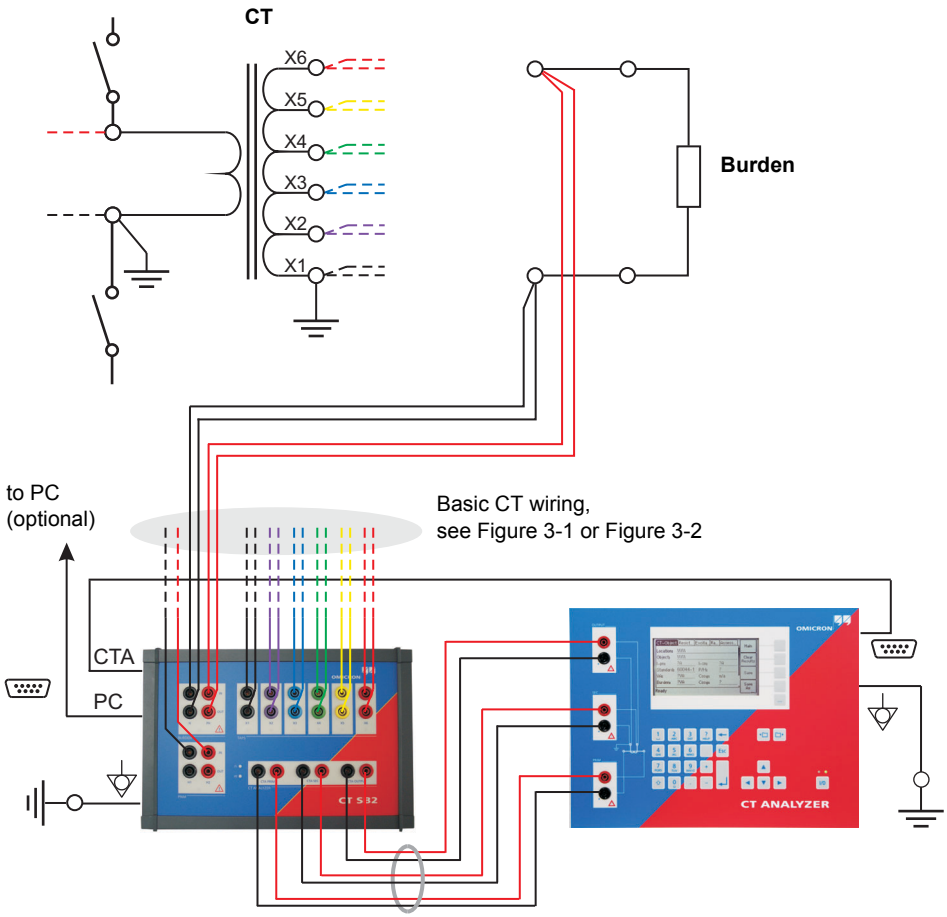


Figure 3-3 Additional wiring required for burden measurement

3.5 Additional Wiring for Primary Winding Resistance Measurement

Primary winding resistance measurement may be performed separately or in conjunction with CT testing and/or burden measurement.

The following wiring is required for primary winding resistance measurement (in addition to the basic measurement setup shown in Figure 3-1 and Figure 3-2 and/or the additional wiring for burden measurement shown in Figure 3-3, as required).

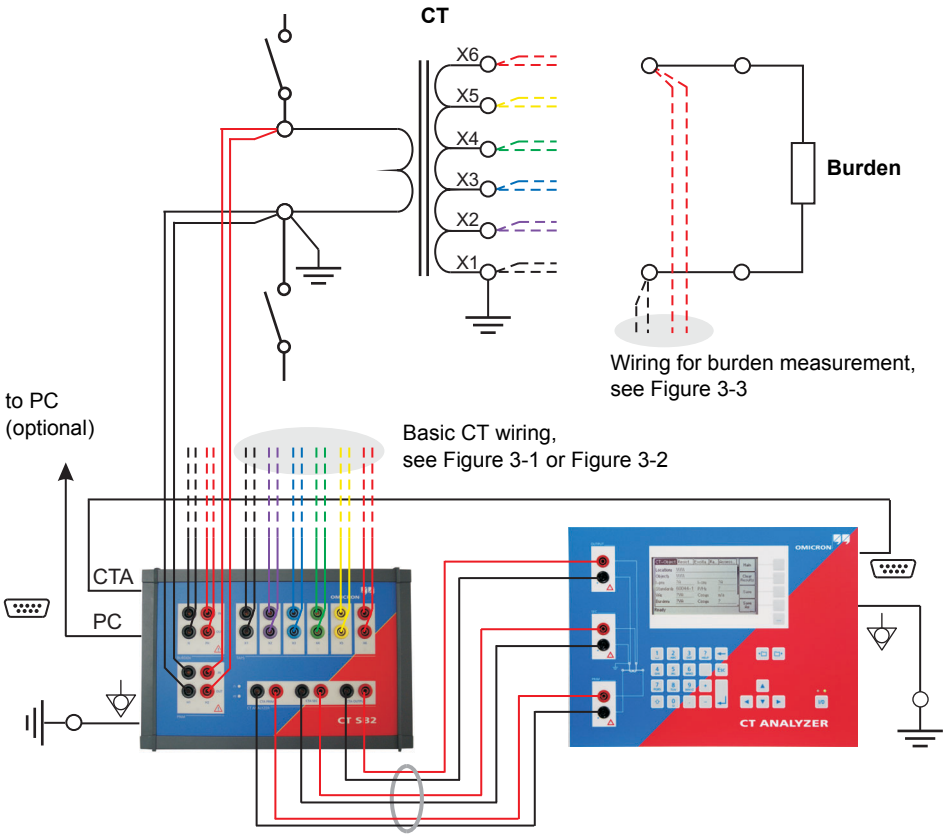


Figure 3-4 Additional wiring required for primary winding resistance measurement

4 Short Guide for Multi-Ratio CT Testing Using the CT SB2

Note: For detailed instructions regarding the operation of the *CT Analyzer*, please refer to the CT Analyzer User Manual.

The test procedure described below shows an example for a multi-ratio CT test without using the guesser function of the *CT Analyzer*. For a more detailed description of the guesser function, please refer to the CT Analyzer User Manual.

For reasons of simplicity, the test described below does not use the the burden measurement and the primary winding resistance measurement.

4.1 Preparing the Test

1. Connect the *CT SB2*, the *CT Analyzer* and the CT under test as described in section 3.1 on page 19 and Figure 3-1 on page 20.
2. Switch the *CT SB2* and the *CT Analyzer* on.
3. On the *CT Analyzer*, select "New MR-Test" from the **main menu** and press the **OK** soft key to initialize a new multi-ratio CT test.

4.2 Configuring and Starting the Test

After initializing a new multi-ratio CT test, the default **CT-Object** card is displayed on the *CT Analyzer*.

How to get there:

Press the **...** key in the **CT-Object** card

Press the **Select Cards** soft key

In the **Select Cards** page, use the **Add** or **Remove** soft key to select or deselect a test card

1. Press the **Select Cards** soft key in the **CT-Object** card to open the **Select Cards** page. Check, and if necessary make the following test card selection. When finished, press the **Back** soft key to return to the **CT-Object** card.

Test cards required (add if necessary)	**Test cards not required (remove if necessary)**
CT-Object Secondary Winding Resistance Excitation Ratio Assessment	Burden Residual Magnetism Primary Winding Resistance

2. In the **CT-Object** card, specify the CT data according to the CT's name plate. Specify the data in the order of the following table.

   For more detailed information, please refer to section 6.1 on page 36.

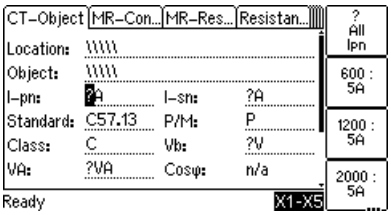


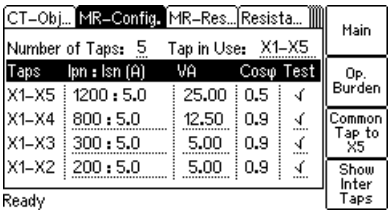
Figure 4-1 **CT-Object** card with soft keys for predefined CT ratios if the number of taps is set to 5

Standard	Standard to be used for the CT test and the test assessment.
P/M	CT type. Set "P" for a protection CT or "M" for a metering CT.
I-pn I-sn	Rated primary current **for the full tap combination** of the CT and rated secondary current of the CT. **Note:** The CT data for the full tap combination can only be set in the **CT-Object** card. If the selected standard is IEEE C57.13 and the "Number of Taps" is set to 5 or 3 in the **MR-Config.** card, the *CT Analyzer* offers soft keys with predefined ratios when the "I-pn" field is selected with the cursor (see Figure 4-1). If you select one of these predefined multi-ratio schemes, the *CT Analyzer* automatically specifies the ratios for all tap combinations in the **MR-Config.** card. **Note:** The default number of taps can be set in the device settings of the *CT Analyzer*, see chapter 5 on page 33. If the selected standard is not IEEE C57.13, enter the values for I_{pn} and I_{sn} manually.
Class	Rated accuracy class of the CT. This field becomes available after selecting the CT type (protection or metering CT).
VA (or Vb) cos φ	Nominal burden **for the full tap combination** of the CT. For protection CTs of the IEEE C57.13 classes C, K and T, enter the rated secondary terminal voltage V_b instead of VA. The *CT Analyzer* then automatically calculates the value for VA. The cos φ for the nominal burden is automatically selected according to the standard.

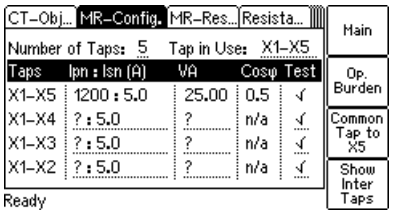
Burden cos φ	Operating burden and cos φ of the **tap in use**. If the value of the connected operating burden is available, enter the values to these fields. If you measure the burden during the CT test using the burden measurement function of the *CT Analyzer*, these fields are filled automatically. If you do not set any value in these fields, the *CT Analyzer* automatically uses the same values as for the nominal burden.

3. Display the **MR-Config.** card (see Figure 4-2) and configure the multi-ratio CT test according to your CT under test.

   For a detailed description of this card, please refer to section 6.2 on page 38.



MR-Config. card for a new multi-ratio CT test after selecting a predefined multi-ratio scheme for I_{pn} in the **CT-Object** card.



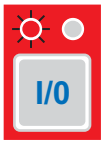
MR-Config. card for a new multi-ratio CT test after specifying the values for I_{pn} and I_{sn} manually in the **CT-Object** card.

Figure 4-2 **MR-Config.** card for a new multi-ratio CT test

Number of Taps	Select the overall number of tap connections available on the multi-ratio CT using the soft keys. If the number of taps selected is 5 or 3, the *CT Analyzer* offers soft keys with predefined CT ratios when the "I-pn" field is selected in the **CT-Object** card. **Note:** The default number of taps can be set in the device settings of the *CT Analyzer*, see chapter 5 on page 33.

Tap in Use	Select the tap combination actually used during operation of the CT (e.g. X1-X5) using the soft keys. By default, the "Tap in Use" field is set to the full tap combination. For the tap combination selected here, the *CT Analyzer* displays the detailed test results in the **Resistance**, **Excitation** and **Ratio** cards. The automatic test assessment in the **Assessment** card is however always done for the full tap combination given by the **Number of Taps** (e.g. for X1-X5 if number of taps = 5).
Taps	This column lists all possible tap combinations of the CT (e.g. X1-X5, X1-X4, X1-X3, ...). The number of available tap combinations depends on the number of taps specified in the "Number of Taps" field. **Note:** When the **MR-Config.** card's tab is highlighted you can select whether X1 or the highest available tap is used as the common tap. The default common tap can be selected in the device settings of the *CT Analyzer*, see chapter 5 on page 33. Using the **Show Inter Taps** soft key you can display the intertap combinations instead of the tap combinations. If the intertap combinations are displayed, the soft key changes to **Show Taps**.
Ipn : Isn (A)	Enter the nominal ratio for each single tap combination. If you selected a predefined multi-ratio scheme for IEEE C57.13 in the **CT-Object** card, this column is automatically filled with predefined ratios for all tap combinations. If you entered I_{pn} and I_{sn} manually in the **CT-Object** card, you have to specify the I_{pn} for each tap combination in this column. I_{sn} is always taken from the **CT-Object** card. **Note:** The *CT Analyzer* automatically performs a plausibility check for the ratios entered by the user. For example, an error message is displayed if the I_{pn} entered for X1-X3 is higher than the I_{pn} specified for X1-X4. **Note:** The data for the full tap combination can only be set in the **CT-Object** card.

VA cos φ or Burden cos φ	Nominal burden for each tap combination. To obtain correct measurement results, the nominal burdens for the inner tap combinations (e.g. X1-X2 etc.) should be smaller than the nominal burden for the full tap combination according to the winding ratios of the tap combinations (e.g. 25 VA for X1-X5, 12.5 VA for X1-X4 etc.). The *CT Analyzer* supports this with an automatic function. As soon as the primary current I_{pn} is specified for a tap combination, the *CT Analyzer* automatically calculates and sets the corresponding nominal burden and cos φ for this tap combination. The nominal burden (VA) automatically assigned by the *CT Analyzer* can be changed manually by the user for all tap and intertap combinations except the full tap combination. **Note:** The "VA" column is displayed by default when opening the **MR-Config.** card the first time after initializing a new multi-ratio test. Using the **Op. Burden** soft key you can display the "Burden" column instead. Operating burden and cos φ for each tap combination. This column displays for each tap combination the operating burden and cos φ specified in the **CT-Object** card. The values cannot be changed by the user. **Note:** The "Burden" column is displayed if you selected to display the operating burden using the **Op. Burden** soft key.
Test	In this column, select the tap combinations you actually want to measure during the CT test. You can enable or disable each single tap combination individually (disabling the full tap combination is not possible). Disabling unused tap combinations reduces the test duration.



4. Start the multi-ratio CT test by pressing the I/0 key on the *CT Analyzer*. The red LED on the *CT Analyzer* flashes to indicate that the CT test is running.

4.3 Automatic Test Execution

After starting the multi-ratio CT test, the *CT Analyzer* first checks the communication with the *CT SB2* via the serial interface. The *CT Analyzer* then checks the input/output wiring between the *CT Analyzer* and the *CT SB2* and, prior to each measurement, the corresponding wiring from the *CT SB2* to the test object required for this particular measurement. If the *CT Analyzer* detects any missing or faulty connections, a corresponding error message is displayed.

The currently active input/output of the *CT SB2* switch box is indicated by a green LED on the *CT SB2* front panel.

1. The *CT Analyzer* measures the secondary winding resistance of the CT for each tap combination.
2. The *CT Analyzer* measures the excitation curve and determines the knee point and other important CT data for each tap combination.
3. The *CT Analyzer* measures the actual current ratio, the winding ratio, the ratio error and the phase error for each tap combination.

4. When the test is over, the red LED stops flashing and the green LED is on.

   The *CT Analyzer* displays a "Test finished" message showing the status of the test execution and the overall test assessment. Press any key on the keyboard to close this message.

4.4 After the Test is Finished

After the test is finished, the **CT-Object** card is displayed, showing the CT data (see Figure 4-3).

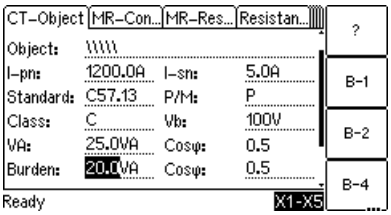


Figure 4-3 **CT-Object** card after the test is finished

The **MR-Config.** card displays the test configuration defined prior to the test.

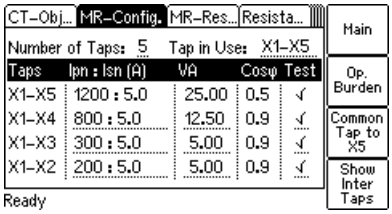


Figure 4-4 **MR-Config.** card

The **MR-Results** card displays detailed data for the individual tap combinations of the multi-ratio CT. You can switch this card to display the ratio results (e.g. winding ratio, ratio and phase error, etc.) or the excitation results (e.g. V_{kn}, I_{kn}, etc.).

For a detailed description of this card, please refer to section 6.3 on page 44.

The *CT Analyzer* calculates the results for the operating burden (parameter "Burden" in the **CT-Object** card) and for the nominal burden (parameter "VA" in the **CT-Object** card). Depending on the burden selected, the **MR-Results** card shows the results calculated with the nominal burden or calculated with the operating burden.

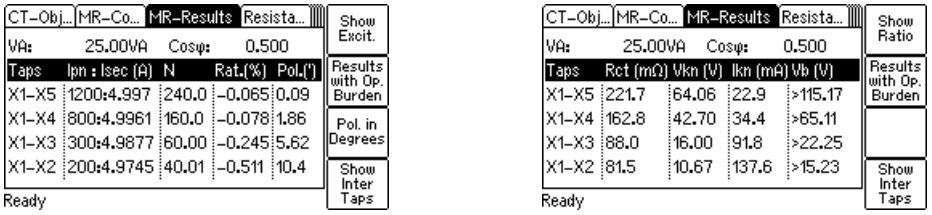


Figure 4-5 **MR-Results** card showing ratio results (left) and excitation results (right)

Hint: It is possible to simulate the performance of the CT for other burden values than the nominal burden by changing the "Burden" value in the **CT-Object** card. The *CT Analyzer* then automatically performs a recalculation of the results displayed in the **MR-Results** card for the new operating burden.

In the **CT-Object** card, enter the "Location" and "Object" details and save the test (use the cursor keys to scroll within the card and select the edit fields).

The assessment of the measurement results **for the full tap combination** can be viewed on the **Assessment** card.

If desired, you can view the measurement results **for the tap in use** selected in the **MR-Config.** card by viewing the **Resistance** card, the **Excitation** card and the **Ratio** card.

5 Default Settings on the CT Analyzer for Multi-Ratio CT Testing

How to get there:

Press the **Main** soft key in any test card on the *CT Analyzer*

Main Menu:
- Settings

Select soft key

Setting Menu:
- Select Startup Mode

Select soft key

-> **Set Startup Mode** page

The *CT Analyzer* allows customization of the default settings for multi-ratio CT testing using the *CT SB2*. These settings are defined using the **Select Startup Mode** option in the **Setting Menu** of the *CT Analyzer*.

Open the **Set Startup Mode** page and press the **Multi-Ratio** soft key. The **Set Startup Mode** page then looks as shown in Figure 5-1.

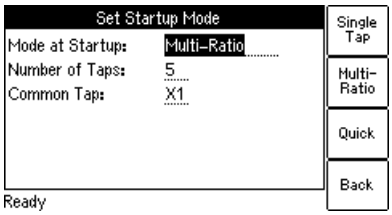


Figure 5-1 **Set Startup Mode** page with **Multi-Ratio** startup mode selected

Modify the default settings according to your needs and press the **Back** soft key to apply your default settings.

Mode at Startup	According to the mode selected, the *CT Analyzer* automatically initializes a single tap CT test, a multi-ratio CT test or a QuickTest measurement after startup. Select the mode using the soft keys **Single Tap**, **Multi-Ratio** or **Quick**. If the **Multi-Ratio** mode is selected, the CT test initialized after switching on the *CT Analyzer* contains the additional test cards **MR-Config.** and **MR-Results** for multi-ratio CT testing.
Number of Taps	The number of taps is the overall number of tap connections available on the multi-ratio CT. Select the default number of taps using the soft keys **No. of Taps 2** to **No. of Taps 6**. The default number of taps defined here is used each time a new multi-ratio CT test is initialized by selecting "New MR-Test" from the main menu of the *CT Analyzer*.

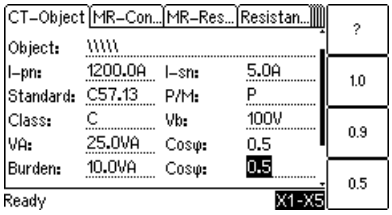
Common Tap	The common tap is the tap that is used as reference for all tap combinations (e.g. X1-X2, X1-X3, X1-X4, etc. if common tap is X1). Select the default common tap using the soft keys **X1** and **X#**, where # is the highest tap number available depending on the selected number of taps. The common tap defined here is used each time a new multi-ratio test is initialized by selecting "New MR-Test" from the main menu of the *CT Analyzer*.

6 CT Analyzer Test Cards for Multi-Ratio CT Testing

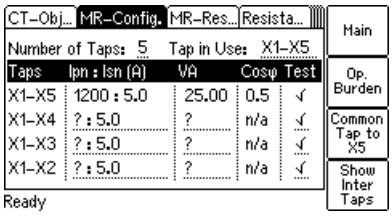
For multi-ratio CT testing using the *CT SB2* switch box, the *CT Analyzer* provides two additional test cards: **MR-Config.** and **MR-Results**.

These cards are only available if a multi-ratio CT test has been initialized by selecting "New MR-Test" from the main menu of the *CT Analyzer*.

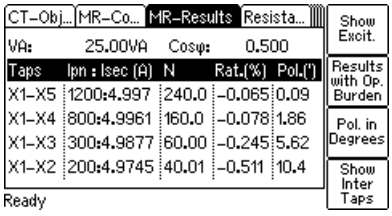
Depending on the selected standard, the behavior of the **CT-Object** card may differ slightly from the normal single-ratio CT test mode without using the *CT SB2*.



See section 6.1 on page 36.



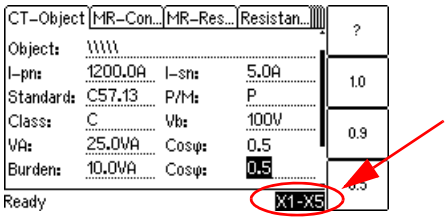
See section 6.2 on page 38.



See section 6.3 on page 44.

6.1 CT-Object Card for Multi-Ratio CT Testing

Use the **CT-Object** card to specify the CT data according to the CT's name plate. Specify the data in the order of the following table.



Fields underlined by dotted lines can be edited.

In multi-ratio test mode, the status line displays the full tap combination of the CT.

Figure 6-1 **CT-Object** card with name plate data entered

Standard	Standard to be used for the CT test and the test assessment.
P/M	CT type. Set "P" for a protection CT or "M" for a metering CT.
I-pn I-sn	Rated primary current **for the full tap combination** of the CT and rated secondary current of the CT. These values specify the full tap ratio displayed in the **MR-Config.** card. The full tap ratio of the CT can only be specified and/or changed here. For IEEE C57.13 only: If the selected standard is IEEE C57.13 and the "Number of Taps" is set to 3 or 5 in the **MR-Config.** card, the *CT Analyzer* offers soft keys with predefined ratios for 3-tap or 5-tap CTs when the "I-pn" field is selected with the cursor (see Figure 6-2). If you select one of these predefined multi-ratio schemes, the *CT Analyzer* automatically specifies the ratios for all tap combinations in the **MR-Config.** card. For example, selecting the **1200 : 5 A** soft key will result in nominal ratios of 1200 : 5, 800 : 5, 300 : 5 and 200 : 5 (see Figure 6-3 on page 38). **Note:** Selecting a predefined multi-ratio scheme overwrites possibly existing settings for I_{pn} and I_{sn} in the **CT-Object** card and the ratios in the **MR-Config.** card.
Class	Rated accuracy class of the CT. This field becomes available after selecting the CT type (protection CT or metering CT).

VA (or Vb) cos φ	Nominal burden **for the full tap combination** of the CT. For protection CTs of the IEEE C57.13 classes C, K and T, enter the rated secondary terminal voltage V_b instead of VA. The *CT Analyzer* then automatically calculates the value for VA. The cos φ for the nominal burden is automatically selected according to the standard. **Note:** The *CT Analyzer* automatically scales down the nominal burden specified here for the individual tap combinations available in the **MR-Config.** card according to their ratios (see ”VA” on page 42).
Burden cos φ	Operating burden and cos φ of the **tap in use**. Enter the burden manually or measure the burden using the **Burden** card. **Note:** The operating burden specified here is used for all tap combinations specified in the **MR-Config.** card. In contrast to the nominal burden (VA), the operating burden is not scaled down according to the ratios (see ”Burden” on page 42). You could use these fields for example to simulate the CT behavior at different load conditions after the test. Enter the value of your choice and view the measurement results of the multi-ratio CT test for the new operating burden in the **MR-Results** card (see section 6.3.2 on page 45).

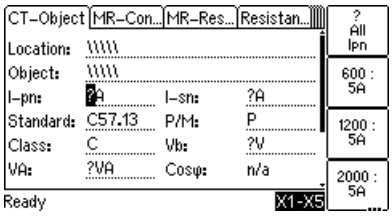


Figure 6-2 **CT-Object** card with soft keys for predefined CT ratios if the number of taps is 5

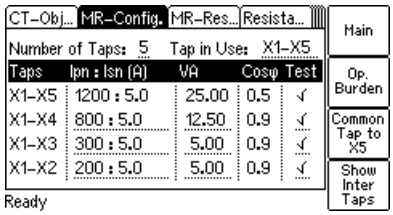
6.2 MR-Config. Card

Use the **MR-Config.** card to configure the multi-ratio CT test. In this card, set

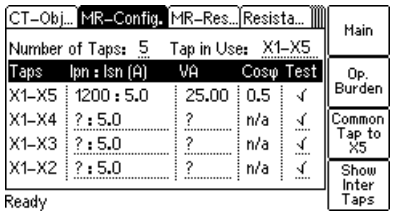
- the number of taps available on the CT,
- the "tap in use", i.e., the tap combination (ratio) which is actually used and connected to the operating burden during operation of the CT,
- the nominal CT ratios for the tap combinations,
- the nominal burden for each tap combination,
- and select the tap combinations you want to test during the multi-ratio CT test.

If necessary, use the ▲ ▼ cursor keys to scroll the table.

The current ratio I_{pn}/I_{sn} and the nominal burden for the full tap combination as well as the operating burden have to be specified in the **CT-Object** card, see section 6.1 on page 36.



MR-Config. card for a new multi-ratio CT test after selecting a predefined multi-ratio scheme for I_{pn} in the **CT-Object** card.



MR-Config. card for a new multi-ratio CT test after specifying the values for I_{pn}, I_{sn} and VA manually in the **CT-Object** card.

Fields underlined by dotted lines can be edited.

Figure 6-3 **MR-Config.** card

The **MR-Config.** card can be switched to display

- the tap combinations or intertap combinations of the CT with
- the nominal burden values or the operating burden.

Refer to sections 6.2.1 and 6.2.2 on the following pages for more information.

6.2.1 Available Soft Keys

The following soft keys are available if the **MR-Config.** card is selected but not in edit mode (the card's tab is highlighted as shown in Figure 6-3):

Op. Burden Nom. Burden	By default, the table in the **MR-Config.** card displays the nominal burden values. Use the **Op. Burden** soft key to display this table with the operating burden instead. The soft key then changes to **Nom. Burden** to switch the table back to the nominal burden values. For the nominal burden values the column header is "VA", for the operating burden values the column header is "Burden". See "VA" and "Burden" on page 42 for more detailed information.
Common Tap to X5 Common Tap to X1	Using the **Common Tap to X#** soft key you can select the common tap (e.g. tap X5 instead of default tap X1). The common tap is the tap that is used as reference for all tap combinations (e.g. X1-X2, X1-X3, X1-X4 etc. if the common tap is X1). If the highest tap (e.g. X5) is selected as common tap, the soft key changes to **Common Tap to X1**. The default common tap can be selected using the **Select Startup Mode** option in the **Setting Menu**, see chapter 5 on page 33.
Show Inter Taps Show Taps	Use the **Show Inter Taps** soft key to display the intertap combinations instead of the tap combinations. If the intertap combinations are displayed, the soft key is labeled **Show Taps**. Examples of tap combinations: X1-X2, X1-X3, X1-X4, etc. Examples of intertap combinations: X2-X3, X2-X4, X3-X4, etc.

6.2.2 Parameters and Settings Used or Determined During the Test

Parameter	Description
Number of Taps	Overall number of tap connections available on the multi-ratio CT. Possible values: Soft keys **No. Taps 2**, **No. Taps 3**, **No. Taps 4**, **No. Taps 5** or **No. Taps 6**. If the number of taps selected is 5 or 3, the *CT Analyzer* offers soft keys with predefined CT ratios when the "I-pn" field is selected in the **CT-Object** card (see ”I-pn” on page 36). The default number of taps can be selected using the **Select Startup Mode** option in the **Setting Menu**, see chapter 5 on page 33. **Note:** When testing a single-ratio CT using the *CT SB2* switch box, select **No. Taps 2**. However, single-ratio CT testing should preferably be performed using the normal single-ratio CT test mode of the *CT Analyzer* without using the *CT SB2*.
Tap in Use	The tap combination actually used during operation of the CT (e.g. X1-X4). Select the tap combination using the soft keys (for example **X1-X5**, **X1-X4**). To select an intertap combination for the tap in use, press the **Show Inter Taps** soft key. The **MR-Config.** card then offers soft keys for the intertap combinations (for example **X2-X4**, **X3-X4**). For the tap combination selected here, the *CT Analyzer* displays the detailed test results in the **Resistance**, **Excitation** and **Ratio** cards. The automatic test assessment in the **Assessment** card is however always done for the full tap combination given by the **Number of Taps** (e.g. for X1-X5 if number of taps = 5). See sections 6.4 and 6.5 on page 47. **Note:** By default, the "Tap in Use" is set to the full tap combination given by the "Number of Taps".

Parameter	Description
Taps	This column lists all possible tap combinations of the CT (e.g. X1-X5, X1-X4, X1-X3, ...). The number of available tap combinations depends on the number of taps specified in the "Number of Taps" field. When the **MR-Config.** card is displayed but not in edit mode (i.e., the card's tab is highlighted as shown in Figure 6-3 on page 38) you can switch the common tap. Example: X1 is assumed as the default common tap, X5 as the highest available tap: Press the **Common Tap to X5** soft key to use X5 as common tap instead of X1. The soft key then changes to **Common Tap to X1**. Using the **Show Inter Taps** soft key you can display the intertap combinations instead of the tap combinations. If the intertap combinations are displayed, the soft key changes to **Show Taps**. Examples of intertap combinations: X2-X3, X2-X4, X3-X4.
Ipn : Isn (A)	Use this column to set the nominal current ratio I_{pn} / I_{sn} for each tap combination. The nominal ratio for the full tap combination (e.g. X1-X5 for a 5-tap CT) is automatically taken from the **CT-Object** card and cannot be changed in the **MR-Config.** card. For all other tap combinations, I_{pn} can be changed or entered by the user. I_{sn} is always taken from the **CT-Object** card. **Note:** The *CT Analyzer* automatically performs a plausibility check for the ratios entered by the user. For example, an error message is displayed if the I_{pn} entered for X1-X3 is higher than the I_{pn} specified for X1-X4. If a predefined multi-ratio scheme has been selected in the **CT-Object** card using the soft keys (see "I-pn" on page 36), the *CT Analyzer* automatically enters the nominal CT ratios for all tap combinations according to this scheme. The ratios of the intertap combinations (e.g. X2-X4) are calculated from the tap combinations and cannot be changed by the user.

Parameter	Description
VA cos φ	Use this column to set the nominal burden for each tap combination. To obtain correct measurement results, the nominal burdens for the inner tap combinations (e.g. X1-X2 etc.) should be smaller than the nominal burden for the full tap combination according to the winding ratios of the tap combinations (e.g. 25 VA for X1-X5, 12.5 VA for X1-X4 etc.). The *CT Analyzer* supports this with an automatic function. As soon as the primary current I_{pn} is specified for a tap combination, the *CT Analyzer* automatically calculates and sets the corresponding nominal burden and cos φ for this tap combination. For this, the *CT Analyzer* automatically scales down the nominal burden for the full tap combination according to the ratio of the specific tap combination and rounds it to the next value stated in the standard (see Figure 6-3 on page 38). The nominal burden (VA) automatically assigned by the *CT Analyzer* can be changed manually by the user for all tap and intertap combinations except the full tap combination. The cos φ cannot be changed by the user. **Note:** The "VA" column is displayed by default when opening the **MR-Config.** card the first time after initializing a new multi-ratio test. If the "Burden" column is displayed instead, use the **Nom. Burden** soft key to display the "VA" column with the nominal burdens again.
Burden cos φ	The "Burden" column is displayed if you selected to display the operating burden in the **MR-Config.** card using the **Op. Burden** soft key. This column displays the operating burden for the tap combination. The operating burden is taken from the **CT-Object** card and cannot be changed in the **MR-Config.** card. The same value is used for all tap combinations to test the behavior of the CT with the connected burden.

Parameter	Description
Test	In this column, select the tap combinations you actually want to measure during the multi-ratio CT test. Select or deselect each single tap combination individually using the **Enable** and **Disable** soft keys. It is not possible to disable the full tap combination. Disabling unused tap combinations reduces the test duration. Disabled taps are not measured. Therefore, no test results are available for disabled tap combinations. Disabling a tap combination also disables the corresponding intertap combinations. It is not possible to disable a specific intertap combination.

6.3 MR-Results Card

After the multi-ratio CT test is finished, the **MR-Results** card shows the measurement results for each enabled tap combination and/or intertap combination.

If necessary, use the ▲ ▼ cursor keys to scroll the display.

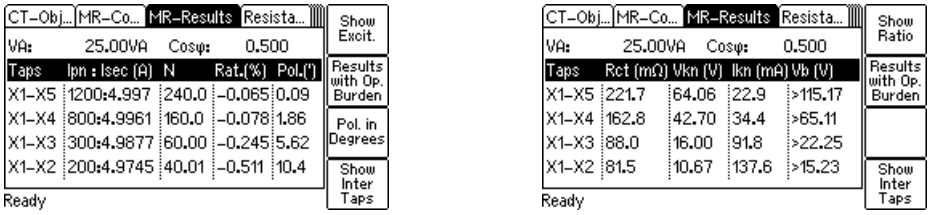


Figure 6-4 **MR-Results** card with measurement results: Page for **ratio** results (left) and page for **excitation** results (right)

The **MR-Results** card can be switched to display

- the ratio results or the excitation results (see ”Ratio results or excitation results” on page 46),
- the results for the tap combinations or the intertap combinations of the CT (see **Show Inter Taps** and **Show Taps** on page 45), and
- the results with the nominal burdens or the operating burden (see section 6.3.2 on page 45).

6.3.1 Available Soft Keys

The following soft keys are available in the **MR-Results** card.

Show Excit. Show Ratio	Use this soft key to switch between the ratio results and the excitation results. If the ratio results are displayed, the soft key is labeled **Show Excit.** to display the excitation results. If the excitation results are displayed, the soft key is labeled **Show Ratio** to display the ratio results.

Results with Op. Burden Results with Nom Burden	By default, the results are displayed for the nominal burden values. Use the **Results with Op. Burden** soft key to display the results for the operating burden instead. The operating burden is the same for all tap combinations. If the results are displayed for the operating burden, the soft key changes to **Results with Nom. Burden** to toggle back to the results with nominal burden. See section 6.3.2 below.
Pol. in Degrees Pol. in min.	Using this soft key you can switch the unit for the phase error ("Pol. (')" column) between minutes and degrees. If the phase error is displayed in minutes, the soft key is labeled **Pol. in Degrees**. If the phase error is displayed in degrees, the soft key is labeled **Pol. in Min.**.
Show Inter Taps Show Taps	Using this soft key you can display the intertap combinations instead of the tap combinations. If the tap combinations are displayed, the soft key is labeled **Show Inter Taps**. If the intertap combinations are displayed, the soft key is labeled **Show Taps**.

6.3.2 Test Results

Results with nominal burden or with operating burden

The measured or calculated results in the **MR-Results** card can be displayed for the nominal burden or for the operating burden. Select the burden to be used using the corresponding soft key **Results with Op. Burden** or **Results with Nom. Burden**.

- When the results are displayed for the nominal burden, the "VA" and "cos φ" fields on the top of the page show for each tap or intertap combination selected with the cursor in the "Taps" column the assigned nominal burden and cos φ used for the measurement (e.g. 25VA for X1-X5, 12.5VA for X1-X4 etc., as assigned in the **MR-Config.** card).

  Using the **Show Inter Taps** soft key you can display the intertap combinations instead of the tap combinations.

- When the results are displayed for the operating burden, the "Burden" and "cos φ" fields on the top of the page display the operating burden specified on the **CT-Object** card. The operating burden is the same for all tap or intertap combinations.

Note: Notice that the nominal burdens assigned to the tap combinations are scaled down from the nominal burden for the full tap combination according to the ratios! The **MR-Results** card will therefore show different results for the tap combinations when switching between the **results display with nominal burdens** and the **results display with operating burden**, even if identical values are specified for **VA** and **Burden** in the **CT-Object** card.

Hint:
Once the test is finished, it is possible to simulate the performance of the CT for other burden values than the nominal burden by changing the "Burden" value in the **CT-Object** card. The *CT Analyzer* then automatically performs a recalculation of the results for the new operating burden. Such simulations can be done at any time after the test is finished if the corresponding test file containing the measurement results of the CT is loaded in the *CT Analyzer*.

Ratio results or excitation results

The measurement results are displayed on two different pages (see Figure 6-4 on page 44). You can toggle these pages using the **Show Excit.** or **Show Ratio** soft key.

The following table lists the **ratio results** displayed in the **MR-Results** card.

Parameter	Description
Ipn : Isec (A)	This column shows for each tap combination the measured current ratio I_{pn} / I_{sec}.
N	This column shows for each tap combination the measured winding ratio.
Rat. (%)	This column shows for each tap combination the measured ratio error in %.
Pol. (') Pol. (°)	This column shows for each tap combination the measured phase error (polarity) in minutes or degrees. Switch the unit using the **Pol. in Degrees** or **Pol. in Min.** soft key.

The following table lists the **excitation results** displayed in the **MR-Results** card.

Parameter	Description
Rct (mΩ)	Secondary winding resistance.
Vkn (V)	Knee point voltage.
Ikn (mA)	Knee point current.

Parameter	Description
Vb (V) TCF ALF FS Kssc	The result displayed in this column depends on the standard selected in the **CT-Object** card and the type of CT. **V_b** (IEEE C57.13, protection CTs only): Rated secondary terminal voltage for protection CTs. **TCF** (IEEE C57.13, metering CTs only): Transformer correction factor for metering CTs. **ALF** (IEC 60044-1, protection CTs only): Accuracy limiting factor for protection CTs. **FS** (IEC 60044-1, metering CTs only): Instrument security factor for metering CTs. **K_{ssc}** (IEC 60044-6 only): Rated symmetrical short-circuit current factor.

6.4 Resistance, Excitation and Ratio Card for Multi-Ratio CT Testing

The **Resistance** card, the **Excitation** card and the **Ratio** card display the detailed test results for the tap combination specified as "Tap in Use" in the **MR-Config.** card.

6.5 Test Assessment for Multi-Ratio CT Testing

The automatic test assessment in the **Assessment** card is always performed for the full tap combination given by the **Number of Taps** (e.g. for X1-X5 if number of taps = 5).

7 Technical Data

7.1 Specifications

Specifications	
Mains connection	Connector according to IEC 60320
Mains voltage	100 - 240 V_{AC} / 50/60 Hz / 0.2 A
Mains fuses	2 x T2.0 AH 250 V, (high-breaking capacity wire fuse 5 x 20 mm)
Output voltage	0 - 120 V

7.2 PC and CTA Interfaces

The **PC** interface of the *CT SB2* switch box is exclusively intended to connect the *CT SB2* to a computer (e.g. running the *CT Analyzer PC Toolset* software).

The **CTA** interface of the *CT SB2* switch box is exclusively intended to connect the *CT SB2* to a *CT Analyzer*.

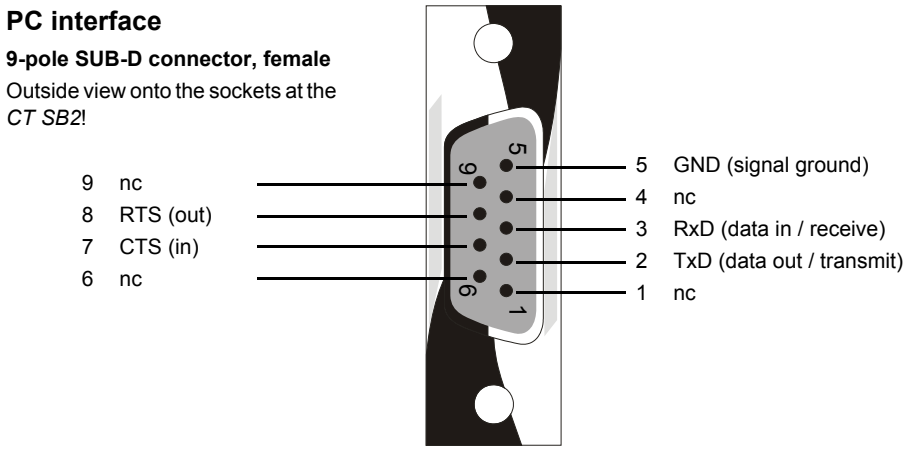


Figure 7-1 PC interface on the *CT SB2*

CTA interface

9-pole SUB-D connector, male

Outside view onto the pins at the *CT SB2*!

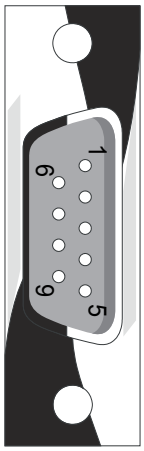


Figure 7-2 CTA interface on the *CT SB2*

9-pole (DB9) null modem or crossover cable, 2 x female

Connections required:

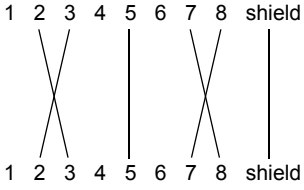


Figure 7-3 Connection cable *CT SB2* to *CT Analyzer*

7.3 Environmental Conditions

7.3.1 Climate

Climate	
Operating temperature	–10 … +50 °C (14 … 122 °F)
Storage and transportation	–20 … +70 °C (–4 … 158 °F)
Max. altitude	2000 m
Humidity	5 … 95% relative humidity, non-condensing Tested acc. to IEC 60068-2-78, Cab, Damp Heat: Temp. 40 °C, duration 48 h, rel. humidity 95%

7.3.2 Shock and Vibration

Dynamics	
Vibration	Tested according to IEC 60068-2-6; frequency range 10 … 150 Hz; acceleration 2 g continuous (20 m/s^2); 20 cycles per axis
Shock	Tested according to IEC 60068-2-27 (operating mode); 15 g / 11 ms, half-sinusoid, 3 shocks in each axis

7.3.3 Mechanical Data

Weight, Dimensions and Protection	
Weight	2.6 kg (5.7 lbs) without accessories
Dimensions W x H x D	285 x 68 x 225 mm (11.2 x 2.7 x 8.9")
Degree of protection	IP20 according to EN 60529

7.3.4 Safety Standards, Electromagnetic Compatibility (EMC)

CE Conformity, Requirements	
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

8 User Maintenance

8.1 Care and Cleaning

The *CT SB2* does not require any special maintenance or care. Clean the device from time to time or as necessary using a cloth dampened with water or isopropanol alcohol. Always disconnect the *CT SB2* prior to cleaning!

8.2 Replacing Fuses

1. Turn off the *CT SB2* and unplug the power cord.
2. Ground the test object, and disconnect it from the *CT SB2*. By disconnecting it you prevent a possibly faulty test object from feeding power back into the *CT SB2*.
3. Disconnect the *CT SB2* from the *CT Analyzer* and, if applicable, from the computer.
4. Locate the blown fuse on the side panel of the *CT SB2* and replace it by an identical fuse type: T2.0A H 250V (2.0 Amps slow-acting high breaking capacity wire fuse 5 x 20mm). The *CT SB2* has two fuses of the same type.

9 Error and Warning Messages for the CT SB2

The *CT SB2*-specific error and warning messages of the *CT Analyzer* are listed in chapter "Error and Warning Messages" in the CT Analyzer User Manual.

Contact Information / Technical Support

Americas

OMICRON electronics Corp. USA
12 Greenway Plaza, Suite 1510
Houston, TX 77046, USA
Phone: +1 713 830-4660
1 800-OMICRON
Fax: +1 713 830-4661
techsupport@omicronusa.com
www.omicronusa.com

Asia – Pacific

OMICRON electronics Asia Ltd.
Suite 2006, 20/F, Tower 2
The Gateway, Harbour City
Kowloon, Hong Kong S.A.R.
Telefon: +852 3767 5500
Fax: +852 3767 5400
support@asia.omicron.at
www.omicron.at

Europe, Middle East, Africa

OMICRON electronics GmbH
Oberes Ried 1
A-6833 Klaus, Austria
Phone: +43 5523 507-333
Fax: +43 5523 507-999
support@omicron.at
www.omicron.at

For addresses of OMICRON electronics offices with customer service centers, regional sales offices or offices for training, consulting and commissioning please visit our Web site.

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