OMICRON

CT Analyzer

User Manual

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This manual is a publication of OMICRON electronics GmbH.

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 User Manual provides information on how to use the *CT Analyzer*. The CT Analyzer User Manual contains important safety instructions for working with the *CT Analyzer* and gets you familiar with operating the *CT Analyzer*. Read and observe the safety rules described in "Safety Rules" on page 9 and all relevant installation and operation instructions. 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 Analyzer User Manual always has to be available at the site where the *CT Analyzer* is used. It must be read and observed by all users of the *CT Analyzer*. Reading the CT Analyzer 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 the high-voltage power equipment can be extremely dangerous.

Testing with the *CT Analyzer* 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* 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 Analyzer User Manual:

Title	Description
CT Analyzer Reference Manual	Contains detailed information about the *CT Analyzer* as well as theoretical backgrounds and normative definitions.
CT SB2 User Manual	Contains information how to use and operate the optional *CT SB2* switch box for multi-ratio CT measurement with the *CT Analyzer* as well as safety instructions for working with the *CT SB2*.
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 Analyzer*, read the instructions in this section carefully. If you do not understand some safety rules, contact OMICRON electronics GmbH before proceeding. When working with the *CT Analyzer*, observe the following safety rules.

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

Do not touch any terminals without a visible connection to ground.

Make sure to position the test equipment on dry, solid ground.

If working in other than laboratory environment only use the *CT Analyzer* 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 Analyzer*. Opening the *CT Analyzer* invalidates all warranty claims.

Do not repair, modify, extend, or adapt the *CT Analyzer* or any accessories.

Use only original accessories available from OMICRON electronics GmbH.

Use the *CT Analyzer* and its accessories only in a technically sound condition and when its use is in accordance with the safety regulations for the specific job site and application.

Orderly Measures

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

The *CT Analyzer* 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 Analyzer* only from a power outlet that is equipped with protective ground (PE).

Instead of supplying the *CT Analyzer* from phase-neutral (L1-N, A-N), it may also be supplied from phase-phase (e.g. L1-L2, A-B). However, the nominal voltage must not exceed 240 V_{AC}.

If there is a problem with the PE (protective earth) connection or if the mains power supply has no galvanic connection to earth, the *CT Analyzer* displays the error message 901. If you ignore this error message, it is possible to use the device but safety is no longer given!

Warning: When working without a proper PE connection, lethal voltages can occur at the housing and all inputs/outputs.

If you decide to work without proper PE connection you take the risk to become mortally shocked or to destroy the *CT Analyzer* due to high common mode voltages on the mains input. Make sure to connect at least the equipotential terminal of the *CT Analyzer* to PE.

Caution: If the mains supply does not have proper galvanic connection to PE, voltages higher than the *CT Analyzer* is built for can occur between mains and other potential groups of the device. These voltages can possibly destroy the device.

Safe Operation

- 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 are active. Lethal voltages can occur due to the high energy stored in external inductors.

- During the test always connect one terminal of the transformer's primary side to protective earth.
- Do not insert objects (e.g. screwdrivers, etc.) into the ventilation slots or any input/output sockets.
- Before putting the *CT Analyzer* into operation, check the test set for visible damages.
- Do not operate the *CT Analyzer* under wet or moist conditions (condensation).
- Do not operate the *CT Analyzer* when explosive gas or vapors are present.
- When taking the *CT Analyzer* into operation, make sure that the air slots, the power switch and the power supply plug at the test set are not obstructed.
- Voltages of up to 400V can occur inside the *CT Analyzer*! Therefore, only qualified personnel at the manufacturer's facilities is permitted to open the *CT Analyzer*.
- If the *CT Analyzer* seems to be functioning improperly, please call the OMICRON electronics GmbH Hotline (refer to chapter "Contact Information / Technical Support" on page 161).
- For protection against parasitic currents or voltages, always connect the equipotential connector on the *CT Analyzer*'s side panel (see section 3.1.2 on page 18) 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 Analyzer* do not carry any voltage potential. During a test, the *CT Analyzer* is the only permitted power source for the test object.
- Never connect or disconnect a test object while the outputs are active. Even if you switched off the *CT Analyzer*, wait until all LED lights are fully extinguished. As long as an LED lights or the display is on, there may still be voltage and/or current potential on one or more of the *CT Analyzer* outputs.
- Only use wires with 4 mm safety "banana" connectors and plastic housing for connection to the front panel input/output sockets.
- Do not stand right next to or directly underneath a connection point because the clamps may fall off and touch you.
- Flashing lights on the front panel indicate that the *CT Analyzer* output is active and hazardous voltages can be present on the input or output terminals.
- If the *CT Analyzer* or any add-on device or accessory does not seem to function properly, do not use it anymore. Please call the OMICRON electronics GmbH hotline.

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 or the *CT Analyzer*!

Warning: For VT ratio measurement using the *Quick Test* feature, the *CT Analyzer* output has to be connected to the primary side of the VT. Connecting the *CT Analyzer* output to the secondary side of the VT by mistake may cause hazardous voltages on the primary side!

Disclaimer

The *CT Analyzer* is intended exclusively for the applications described in chapter 1 on page 13. Any other use is deemed not to be according to the regulations.

If the *CT Analyzer* is used in a manner not specified by the manufacturer, the protection provided by the *CT Analyzer* 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 Analyzer* is intended to perform automatic testing and calibration of low leakage flux current transformers (i.e., CTs with non-gapped cores) in laboratories as well as on-site in utilities. Testing of CTs with gapped cores is also possible with restricted accuracy. The following tests can be performed using the *CT Analyzer*:

- Burden measurement
- Residual magnetism measurement of CTs
- CT winding resistance measurement
- CT excitation characteristic measurement according to IEC 60044-1, IEC 60044-6 (TPS, TPX, TPY, TPZ) and IEEE C57.13.
- CT ratio measurement with consideration of a connected burden
- CT phase and polarity measurement
- Determination of accuracy limiting factor, instrument security factor, secondary time constant, symmetrical short-circuit current factor, transient dimensioning factor, remanence factor, knee point voltage/current, class, saturated inductance and non-saturated inductance.

Using the *Quick Test* feature it is also possible to use the *CT Analyzer* as a versatile multimeter with included power source, e.g. for:

- Quick and easy resistance measurement, e.g. for wiring checks on the secondary side of CTs.
- Quick voltage ratio checks for VTs.
- Measurement of burden values, e.g. to determine the new burden value after changes of the relay equipment. This allows the re-calculation of the CT test results for the new burden value by the *CT Analyzer* and thus makes it unnecessary to run an additional CT test in order to determine the behavior of the CT with the new burden.

The *CT Analyzer* 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.

2 License-Depending Functional Scope

The functional scope provided by the *CT Analyzer* depends on the licenses actually available on the device.

This User Manual describes the full functional scope provided when the complete set of licenses is available on the *CT Analyzer*. A lack of licenses may primarily result in functional restrictions regarding the selectable standards, classes, core types and frequencies as well as the availability of individual measurement functions and/or test cards.

For up-to-date information about the licenses and packages available for the *CT Analyzer* please refer to the OMICRON electronics GmbH website.

3 Hardware

3.1 Functional Components of the CT Analyzer

3.1.1 Overview

Figure 3-1 provides an overview of the operating and display elements and the connectors of the *CT Analyzer*.

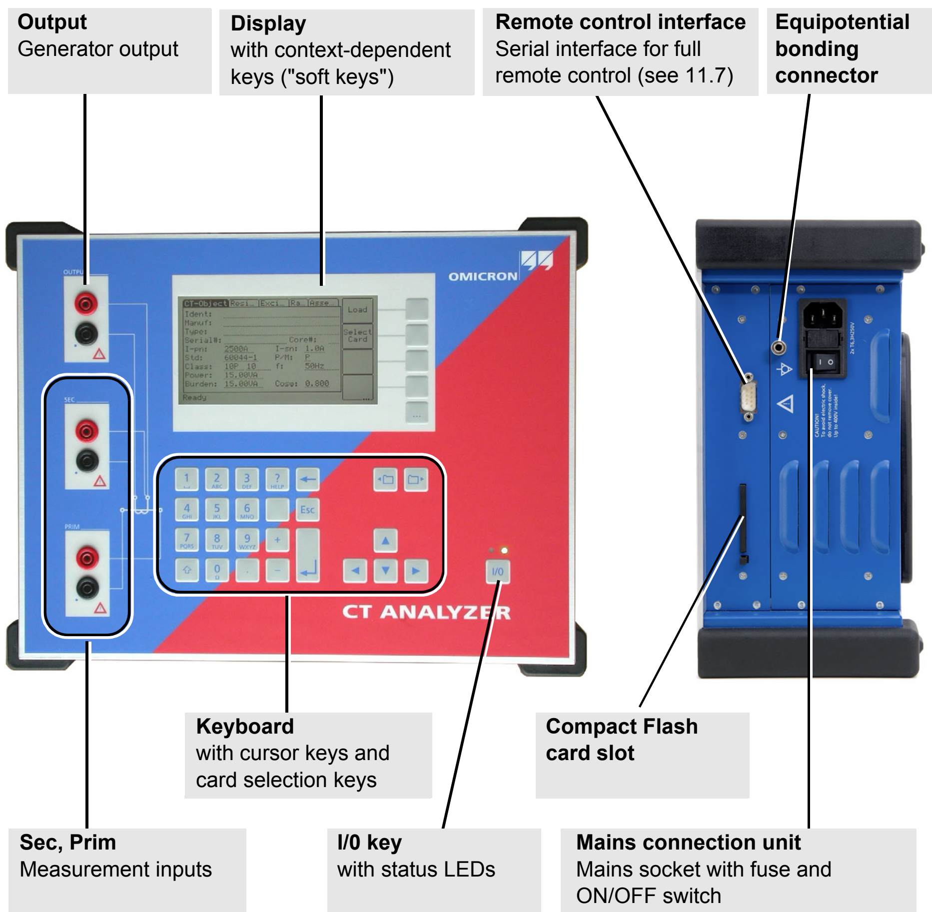


Figure 3-1 *CT Analyzer* overview

3.1.2 Mains Connection Unit and Grounding

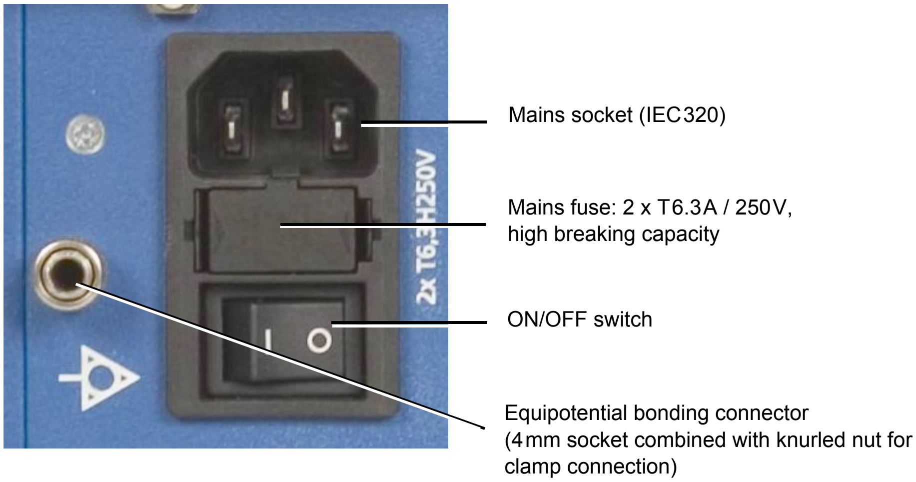


Figure 3-2 Mains connection unit and equipotential bonding connector

3.1.3 Compact Flash Card Slot

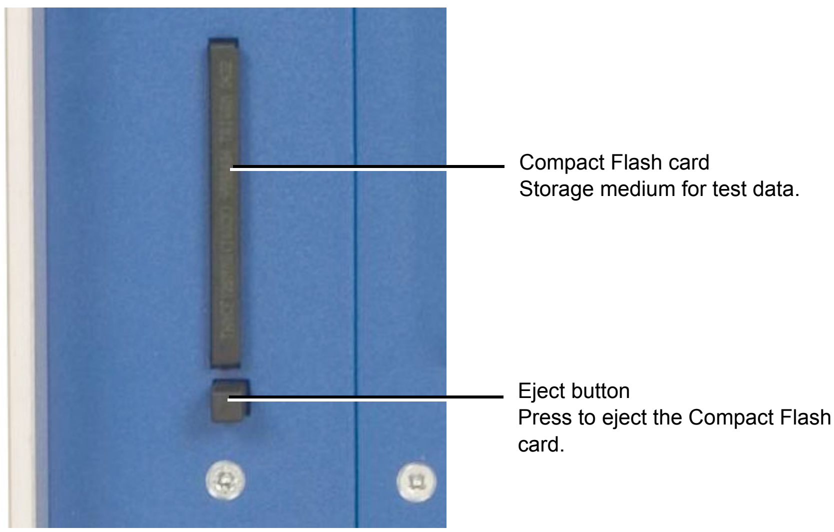
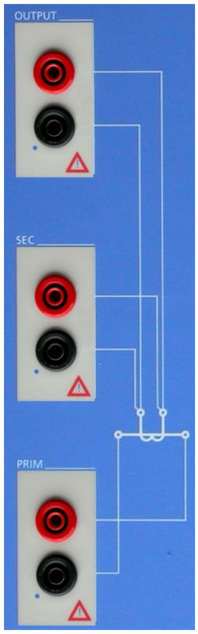


Figure 3-3 Compact Flash card slot

3.1.4 Inputs and Outputs

Warning: While the red LED of the I/0 key is flashing, voltage is applied at the output and the measurement inputs.



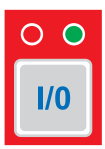
Output
Generator output, $120V_{AC}$, $15A_{DC}$

Sec
Measurement input for secondary side of CT,
$150V_{AC}$ max., 500 kΩ input impedance

Prim
Measurement input for primary side of CT,
$30V_{AC}$ max., 150 kΩ input impedance

Figure 3-4 Inputs and outputs of the *CT Analyzer*

3.1.5 I/0 Key with Status LEDs



Red LED on the left, green LED on the right.

I/0 key to start the test.

During the boot process after switching the *CT Analyzer* on, both LEDs are on. The red LED is switched off when the boot process is finished and the *CT Analyzer* is ready for operation.

Green LED on:	The *CT Analyzer* is switched on and ready for operation.
Red LED flashing:	Test is running. **Warning:** While the red LED is flashing, voltage is applied at the output and the measurement inputs.
Red LED steadily on:	Device error.

3.1.6 Display with Soft Keys

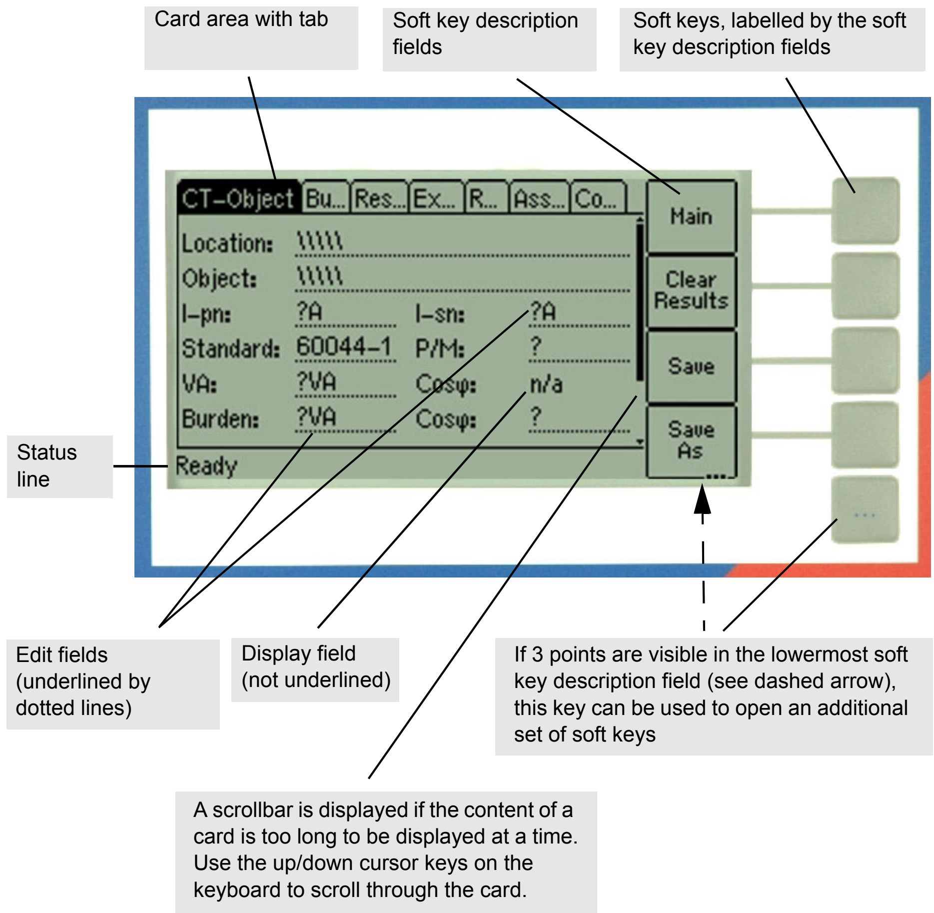
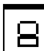


Figure 3-5 Display with context-dependent soft keys

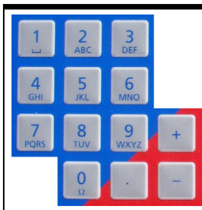
The following icons may be displayed in the status line:

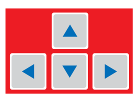
	Remote control. The *CT Analyzer* is connected to a computer and a software tool of the *CT Analyzer PC Toolset* (e.g. the *CTA Remote Excel File Loader*) running on that computer has established connection to the *CT Analyzer*.
	The keyboard on the *CT Analyzer* is locked until the running test is finished.

	Security key. The data measured with the *CT Analyzer* can be stored in XML files. Stored files are protected by a security checksum to prevent the data within these files from being edited. If the *CT Analyzer* displays the data of a previously stored test, and the data in this file are valid, a key is shown in the status line. If the file data are invalid since someone tried to edit them later, a broken key is displayed. **Note:** When loading older files containing no security checksum, no security information is shown.
OVL	Overload indication. The *CT Analyzer* could not output the required test current or take all necessary measurement points due to an overload.
X1-X4	Multi-ratio CT measurement. Indicates that a multi-ratio CT test using the optional *CT SB2* switch box has been initialized on the *CT Analyzer* (here: full tap combination X1-X4).

3.1.7 Keyboard

Figure 3-6 Keyboard

	Numeric / character keys for entering values and text. After pressing a key, the status line displays the character set available for the key. Press the key as often as required to scroll through the displayed character set. After 1 second or after pressing another key, the character selected in the status line is entered into the edit field in the display. **Note:** To quickly change between letters and numerics, hold the button pressed for a second.

	Press this key to enter capital letters.
	Press this key to display the context-sensitive help system (see section 6.2 on page 65).
	Press this key to delete the character left of the cursor position.
	Press this key to leave an edit field without applying a change or to leave the edit mode of a card or to go one level back in the user interface level. The **CT-Object** card is the top user interface level. Pressing this key several times will always bring you back to the **CT-Object** card.
	Press this key to apply a change for an edit field. When working in the *CT Analyzer* file system, use this key to open a selected folder or to confirm to move back to the next higher level in the file structure.
	Use the card selector keys to display a specific card.
	Use the cursor keys to select an edit field in the user interface or to move the cursor within an edit field. Use the  cursor key to enter the edit mode of a displayed card.

4 Connecting the CT Analyzer

4.1 Basic Wiring for a CT Test

This section shows the basic wiring of the *CT Analyzer* for a CT test. For a detailed description how to connect the *CT Analyzer* for specific applications, please refer to the separate Application Notes.

Caution: The grounded terminal on the secondary side of the CT always has to be connected to the black sockets of input "Sec" and the "Output" of the *CT Analyzer*. Connecting the red sockets of the *CT Analyzer* to PE can result in incorrect measurement and/or cause an automatic abortion of the measurement with an error message.

Caution: If it is necessary to use clamps for the connection of the measurement leads to the secondary side of the test object, always use the 4-wire connection technique as described in section 4.4 on page 27 in order to avoid measurement errors.

For a CT test, connect the *CT Analyzer* as shown in Figure 4-1.

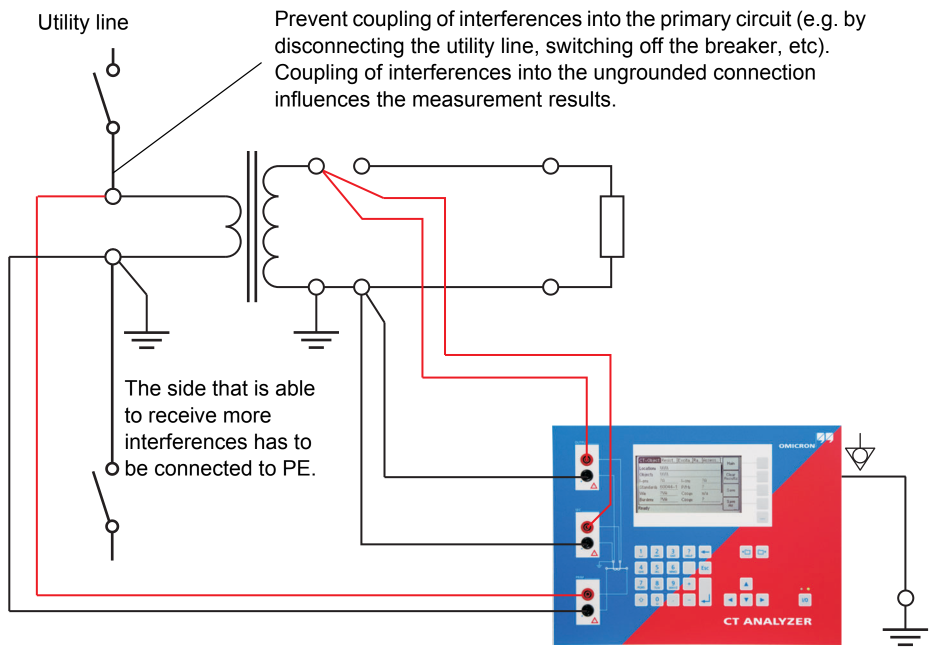


Figure 4-1 Basic wiring for a CT test

1. Connect the *CT Analyzer*'s equipotential terminal to protective earth (PE).
2. Make sure that the primary side of the CT is connected to PE on one side and open on the other side.

Caution: It is absolutely important to avoid coupling of interferences into the primary circuit during measurement. Therefore, connect the side of the primary circuit that is able to receive more interferences to PE (e.g. the side with the longer line length). The ungrounded side should be the side that receives less interferences (refer to Figure 4-1).

3. Disconnect the hot side of all secondary windings of the CT in order to remove any load from the CT. Every kind of load remaining on the secondary side of the CT during measurement leads to incorrect measurement results or error messages.
4. Connect the black socket of *CT Analyzer* input "Prim" to the grounded side of the CT's primary circuit and the red socket of this input to the open (ungrounded) side.
5. Connect the black "Output" socket and the black socket of input "Sec" of the *CT Analyzer* to that terminal on the secondary side of the CT that is connected to PE.
6. Connect the red "Output" socket and the red socket of input "Sec" of the *CT Analyzer* to the other (ungrounded) terminal on the secondary side of the CT.

4.2 Basic Wiring for a Burden Test

For a burden test, connect the *CT Analyzer* as shown in Figure 4-2.

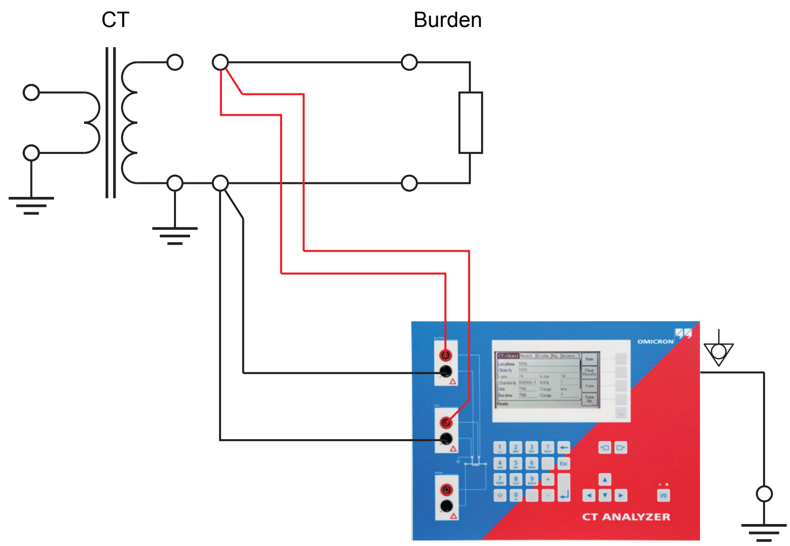


Figure 4-2 Basic wiring for a burden test

1. Connect the *CT Analyzer*'s equipotential terminal to protective earth (PE).
2. Open the connection line to the ungrounded side of the CT (refer to Figure 4-2). Otherwise, the *CT Analyzer* measures the parallel impedance of the burden and the CT winding instead of the burden itself.
3. Connect the black "Output" socket and the black socket of input "Sec" of the *CT Analyzer* to that side of the burden that is connected to PE.
4. Connect the red "Output" socket and the red socket of input "Sec" of the *CT Analyzer* to the other (ungrounded) side of the burden.

Caution: If you do not disconnect the CT for the burden test, the *CT Analyzer* measures the parallel impedance of the burden and the CT winding. Although in many cases the impedance of the CT is many times higher than the burden impedance, this will cause a measuring error.

The *CT Analyzer* does not perform demagnetization after burden measurement. Therefore, CT saturation could occur if you do not disconnect the CT prior to the burden test.

4.3 Basic Wiring for Primary Resistance Measurement

For the primary winding resistance test, connect the *CT Analyzer* as shown in Figure 4-3.

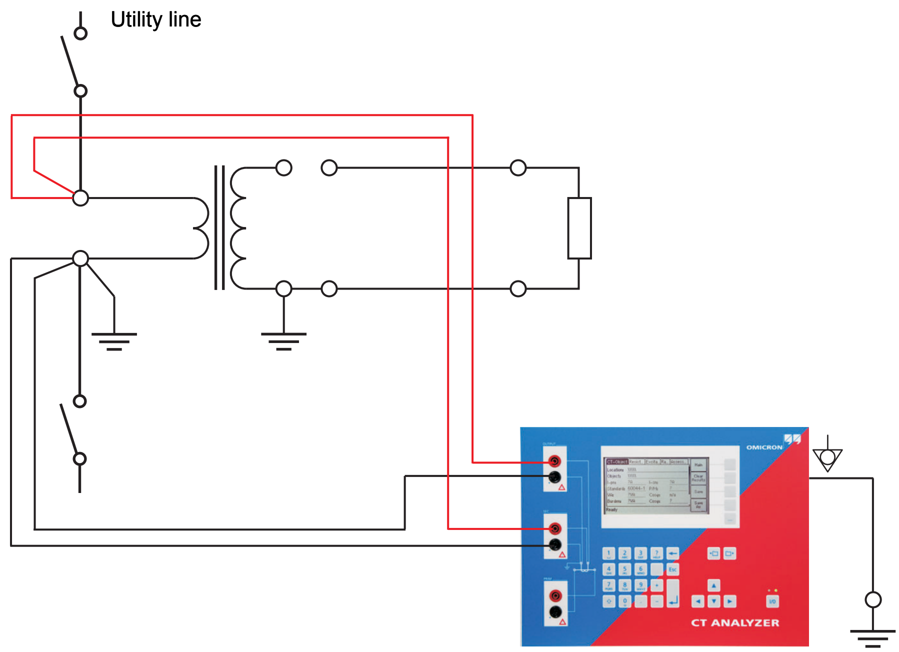


Figure 4-3 Basic wiring for primary winding resistance measurement

1. Connect the *CT Analyzer*'s equipotential terminal to protective earth (PE).
2. Make sure that the primary side of the CT is connected to PE on one side and open on the other side.
3. Disconnect the hot side of all secondary windings of the CT in order to remove any load from the CT. Every kind of load remaining on the secondary side of the CT during measurement leads to incorrect measurement results or error messages.
4. Connect the black socket of *CT Analyzer* input "Prim" to the grounded side of the CT's primary circuit and the red socket of this input to the open (ungrounded) side.
5. Connect the black "Output" socket of the *CT Analyzer* to that terminal on the secondary side of the CT that is connected to PE.
6. Connect the red "Output" socket of the *CT Analyzer* to the other (ungrounded) terminal on the secondary side of the CT.

4.4 4-Wire Measurement vs. 2-Wire Measurement

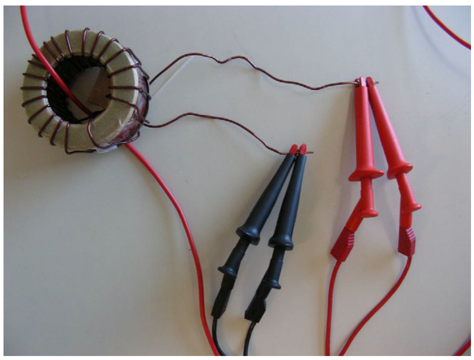
If the secondary side of the test object does not provide screw terminals for connecting the delivered terminal adapters or banana sockets to insert the measurement leads directly, and it is therefore necessary to use clamps (e.g. crocodile clamps or Kelvin clamps) for the connection of the measurement leads, always use the 4-wire connection technique as described below.

Otherwise, the possibly existing contact resistance of the clamps could affect the measurement results, i.e., the *CT Analyzer* possibly delivers incorrect measurement results.

Both connection techniques are shown in the following figure.

OK

4-wire connection

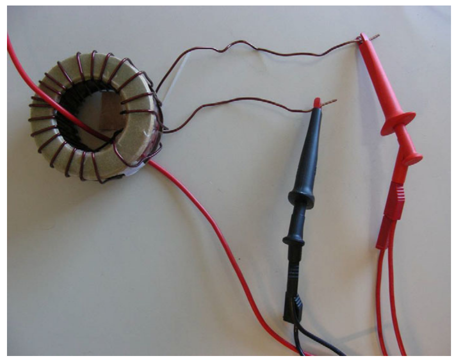


The measurement leads from the "Output" sockets and input "Sec" of the *CT Analyzer* are connected to the test object via separate clamps.

One clamp is used for each measurement lead! **Correct!**

Do not use!

2-wire connection



Separate measurement leads are used for the "Output" sockets and input "Sec" of the *CT Analyzer*, but the measurement leads are connected to the test object via a common clamp.

Two measurement leads use one single clamp! **Do not use!**

Figure 4-4 Demonstration of 2-wire and 4-wire connection technique

4.5 Noise Reduction Techniques

For proper test results it is important to consider the following:

- Connect the *CT Analyzer*'s equipotential terminal to protective earth (PE).
- If possible, disconnect both primary terminals of the CT from the utility lines.
- Only use the original coax measurement cables delivered by OMICRON electronics GmbH or twisted-pair lines. If it is necessary to use loose single-wire measurement cables, twist the wires to a twisted-pair line. Avoid open loops consisting of individual single-wire measurement cables in order to prevent interference voltages caused by magnetic fields.
- Connect one terminal of the CT's primary side to protective earth. If it is not possible to disconnect the utility lines from both primary terminals, connect that side of the primary circuit that is able to receive more interferences to PE (the primary side that is still connected to the utility lines or the side with the longer line length, respectively). The ungrounded side should be the side that receives less interferences.
- When testing a CT in a utility, take care that one side of the CT is connected to PE and at least the ungrounded terminal is disconnected from all utility lines.

Refer to Figure 4-5.

Caution: Do **not** connect both primary terminals to PE! This would cause incorrect measurement results. Connecting both primary terminals to PE has the same effect as a short-circuit in the CT.

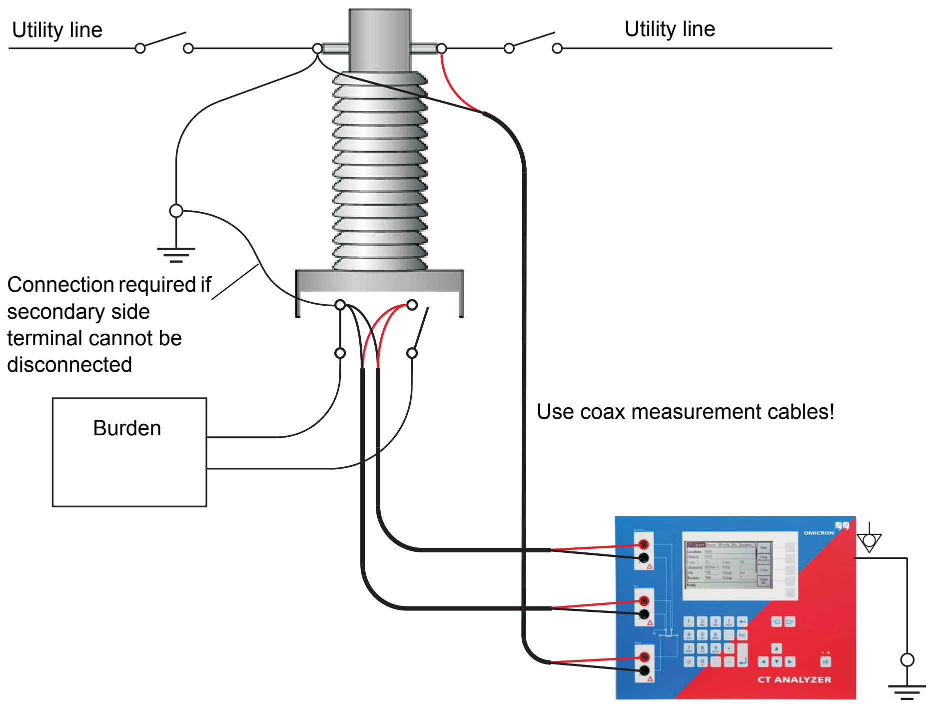


Figure 4-5 Noise reduction for CT measurement

4.6 Measurement on a Gapped Core

For gapped cores, the position of the primary wire inside the core has a large influence on the ratio measurement results.

Therefore, in order to obtain correct measurement results, it is very important to arrange the primary wire during measurement to the same position inside the core as it is during real operation. Depending on the position of the primary wire inside the core, the measured ratio can differ by up to 20%.

The figure below shows how the ratio error can differ depending on the position of the primary wire inside the core.

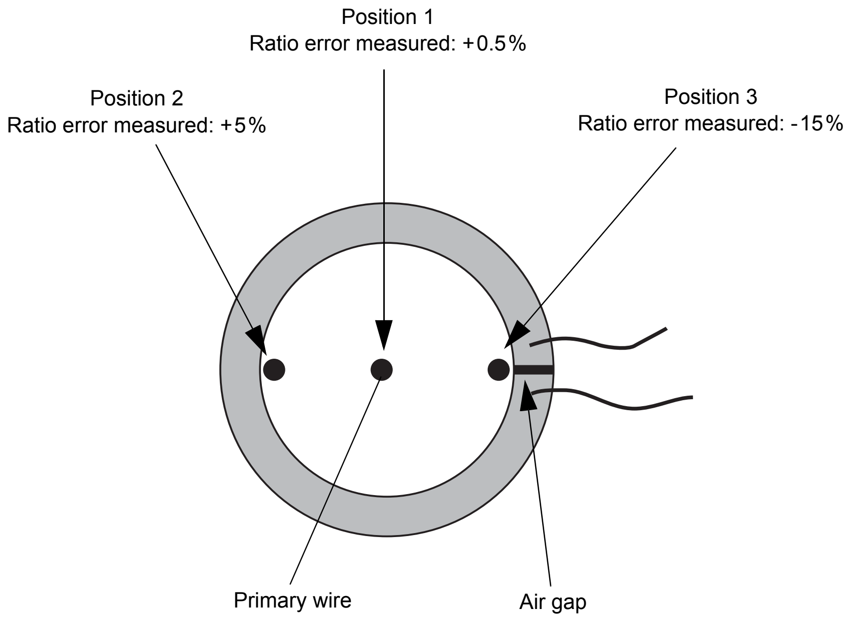


Figure 4-6 Ratio error depending on the position of the primary wire inside the gapped core

As shown in Figure 4-6, the measured ratio error may differ considerably depending on the position of the primary wire. Best measurement results are obtained if the primary wire is positioned exactly in the center of the core. As an alternative, a copper foil formed to a ring and placed to the inner side of the core can be used as shown in Figure 4-7.

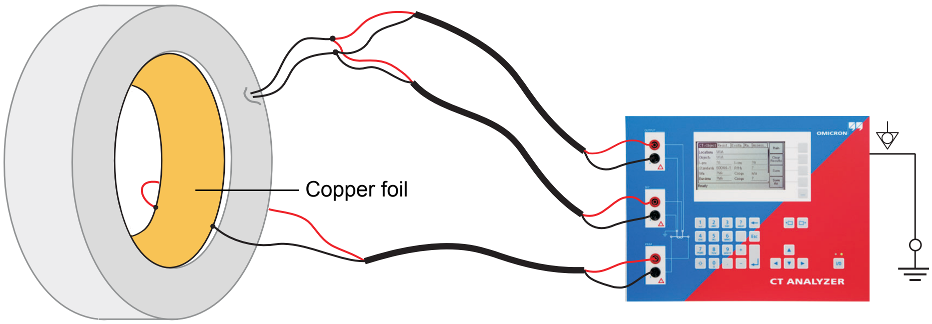


Figure 4-7 Using a copper foil formed to a ring as primary wire

Note: Exact measurement results are only possible if the if the primary wire is positioned exactly in the center of the core.

The *CT Analyzer* does not consider leakage inductances. The leakage inductances are neglected instead. This way, the *CT Analyzer* is able to reach a measurement error of approx. 0.1 % for class PR and class TPY CTs and approx. 0.8 % for class TPZ CTs.

4.7 Excitation Curve Measurement for an Unwound Iron Core

Using the *CT Analyzer* it is possible to measure the magnetic properties of an empty, unwound iron core. For this purpose, it is necessary to apply an "auxiliary winding" of at least 20 turns to the core.

For this purpose, OMICRON electronics GmbH offers a special cable with 23 turns (VEHK0658) and a special Microsoft Excel template for the required calculations.

Proceed as follows to perform the measurement (refer to Figure 4-8 and Figure 4-9):

1. Connect the *CT Analyzer*'s equipotential terminal to protective earth (PE).
2. Apply the "auxiliary winding" cable to the unwound core.
3. Connect the "Output" sockets and input "Sec" of the *CT Analyzer* to the cable as shown in Figure 4-8. For cores that require high currents to reach the knee point, several cables can be cascaded to increase the number of turns, see Figure 4-9.
4. Start the *CTA Remote Excel File Loader* with the special Excel template mentioned above.
5. Enter the iron parameters to the template.
6. Start the measurement from the *CTA Remote Excel File Loader*.

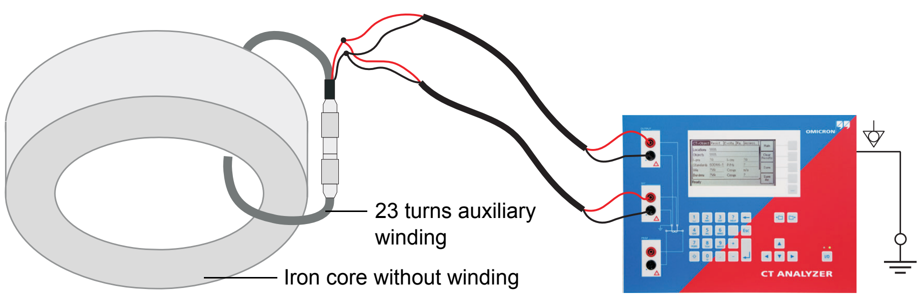


Figure 4-8 Excitation curve measurement using one "auxiliary winding" cable

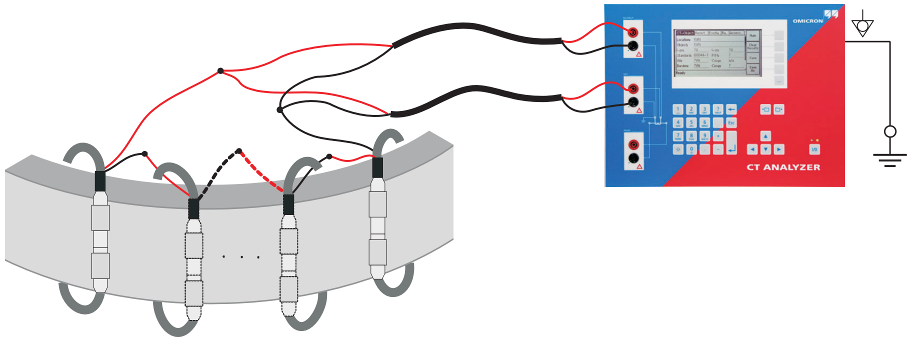


Figure 4-9 Excitation curve measurement using several cascaded "auxiliary winding" cables

4.8 VT Ratio Measurement Using QuickTest

To measure the ratio of VTs using the *CT Analyzer*, you can either use the *Quick Test* function of the *CT Analyzer* (see chapter 9 on page 115) or the *CTA QuickTest* PC tool which is part of the *CT Analyzer PC Toolset*.

Warning: For VT ratio measurement using the *Quick Test* feature, the *CT Analyzer* output has to be connected to the **primary side** of the VT. Connecting the *CT Analyzer* output to the secondary side of the VT by mistake may cause hazardous voltages on the primary side!

For VT ratio measurements using *Quick Test*, connect the *CT Analyzer* as shown in Figure 4-10. For a detailed description on how to perform such measurements, please refer to section 9.6 on page 125.

Connect the "Output" sockets and input "Sec" of the *CT Analyzer* to the primary side of the VT, and input "Prim" of the *CT Analyzer* to the secondary winding of the VT.

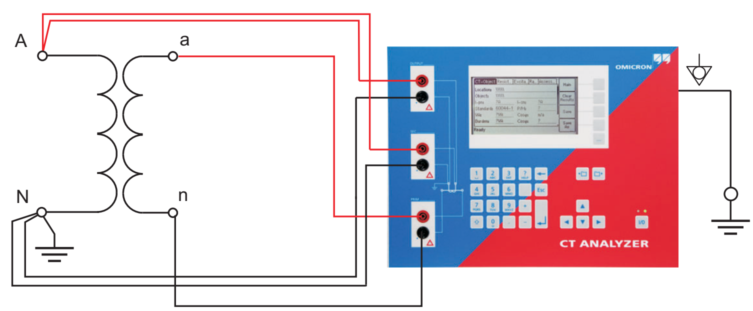


Figure 4-10 Connecting the VT for ratio measurement using the *CT Analyzer*

4.9 VT Winding Resistance Measurement Using QuickTest

To measure the winding resistance of VTs using the *CT Analyzer*, you can either use the *Quick Test* function of the *CT Analyzer* (see chapter 9 on page 115) or the *CTA QuickTest* PC tool which is part of the *CT Analyzer PC Toolset*.

For VT winding resistance measurements using *Quick Test*, connect the *CT Analyzer* as shown in Figure 4-11. For a detailed description on how to perform such measurements, please refer to section 9.7 on page 128.

Connect the "Output" sockets and input "Sec" of the *CT Analyzer* to the winding to be measured.

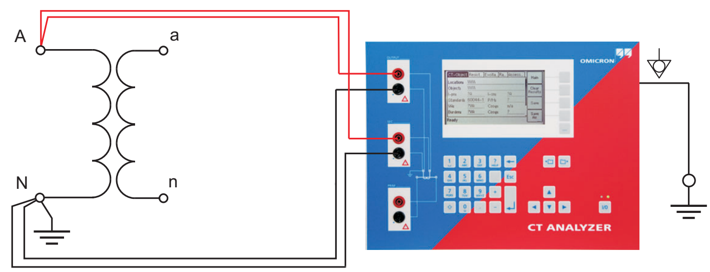


Figure 4-11 Connecting the VT for winding resistance measurement using the *CT Analyzer*

4.10 Measurement on a GIS (SF6) Switch Gear

Proceed as follows to perform measurements on a GIS (SF6) switch gear (refer to Figure 4-12):

1. Connect the *CT Analyzer*'s equipotential terminal to protective earth (PE).
2. Disconnect all utility lines.
3. Open all circuit breakers to the bus bars.
4. Close the earthing switch.
5. Connect one secondary side terminal of the CT to protective earth.
6. Connect the secondary side of the CT to the "Output" sockets and input "Sec" of the *CT Analyzer*:
   - Connect that side of the CT that is connected to PE to the black sockets of the *CT Analyzer*.
   - Connect that side of the CT that is open to the red sockets of the *CT Analyzer*.
7. Connect the primary side of the CT to *CT Analyzer* input "Prim". Make sure that the polarity is correct (same colors on same polarity).
8. Start the test.

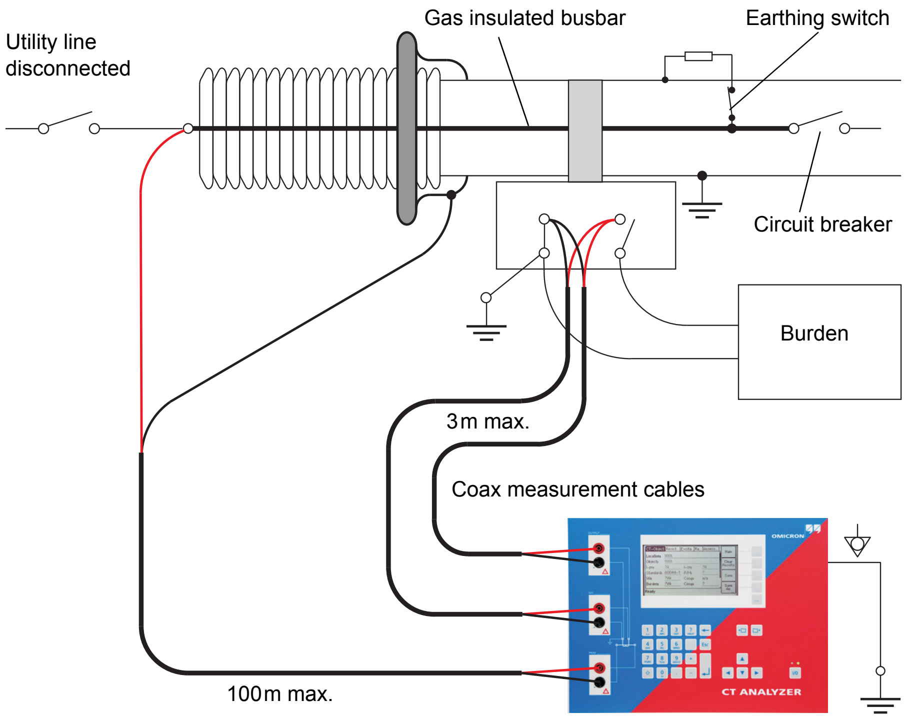


Figure 4-12 Measurement on a GIS (SF6) switch gear

4.11 Measurement on Bushing-Type CTs

4.11.1 Measurement on a Bushing-Type CT

Proceed as follows to perform measurements on a bushing-type CT (refer to Figure 4-13):

1. Connect the *CT Analyzer*'s equipotential terminal to protective earth (PE).
2. Disconnect all utility lines from the transformer (i.e., isolate the transformer from the energized power system).
3. Connect all transformer terminals that are not used for measurement (in this example H2 and H3) to protective earth (PE) in order to minimize the external disturbances. External disturbances can influence the measurement results because the bushings are acting as an antenna.
4. Connect terminal H0 to protective earth.
5. Connect one secondary side terminal of the CT to protective earth.
6. Connect the secondary side of the CT to the "Output" sockets and the "Sec" sockets of the *CT Analyzer*:
   - Connect that side of the CT that is connected to PE to the black sockets of the *CT Analyzer*.
   - Connect that side of the CT that is open to the red sockets of the *CT Analyzer*.
7. Connect the primary side of the CT to *CT Analyzer* input "Prim". Make sure that the polarity is correct (same colors on same polarity).
8. Short-circuit and ground the free winding on the measured transformer leg to reduce the impedance of the winding that is connected in series to the primary side of the CT. The input impedance of *CT Analyzer* input "PRIM" is only approx. 330 kΩ and can thus influence the measurement results, if no winding of that leg is short-circuited.
9. If the transformer has a tap changer installed, the position of the tap changer should be changed to a position where the regulation winding is completely bridged in order to ensure that the regulation winding cannot act as a voltage divider together with the main winding of the transformer.
10. Start the test.

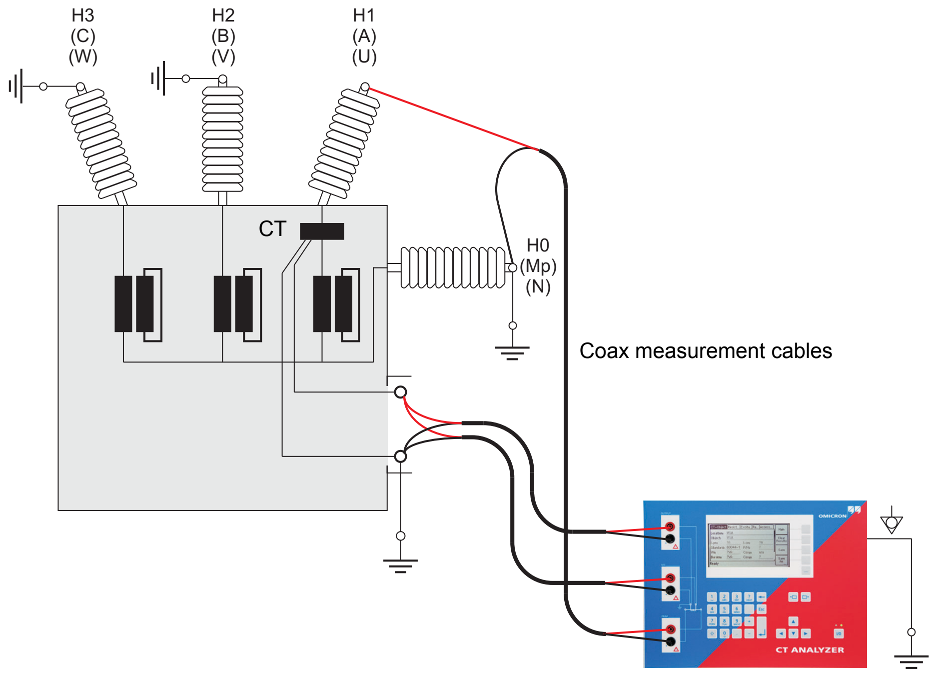


Figure 4-13 Measurement on a bushing-type CT

Note: Primary terminal H1 must be open. Otherwise the primary side is shorted and the *CT Analyzer* cannot obtain proper results.

4.11.2 Measurement on a Y (Wye) Winding Transformer

For measurements on current transformers in Y-connected transformer windings it has to be assured that the main impedance of the transformer does not influence the measurement results.

The *CT Analyzer* has an input impedance of approx. 330 kΩ. This measurement impedance can be low enough to influence the measurement results. In order to prevent any influence of the *CT Analyzer*'s input impedance to the measurement results, the transformer winding at the same leg should be short-circuited. Short-circuiting the windings on all legs of the transformer is even better.

Furthermore, all bushing terminals that are not connected to the *CT Analyzer* should be connected to protective earth in order to prevent influence of external disturbances (see Figure 4-14).

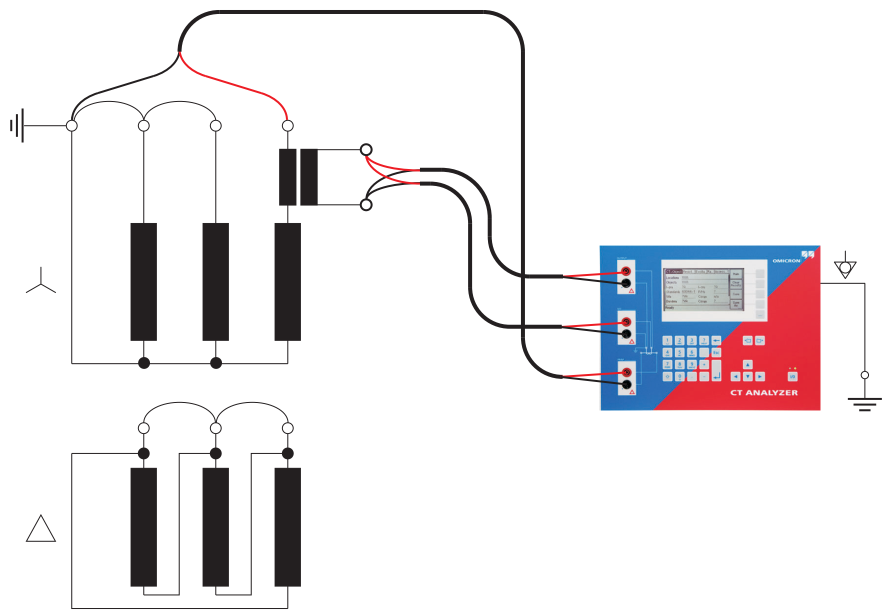


Figure 4-14 Measurement on a Y winding transformer

4.11.3 Measurement on a ∆ (Delta) Winding Transformer

CTs outside the delta winding

For CTs that are located in the bushing outside of the delta winding (Figure 4-15), no delta compensation is needed.

In this case, only two parallel transformer windings are connected in series to the CT. This connection method provides least possible influence to the measurement result for the winding resistance of the CT.

The Y winding and the remaining windings of the power transformer's delta winding are short-circuited to avoid influence of the induced flux of the power transformer's core to the measurement.

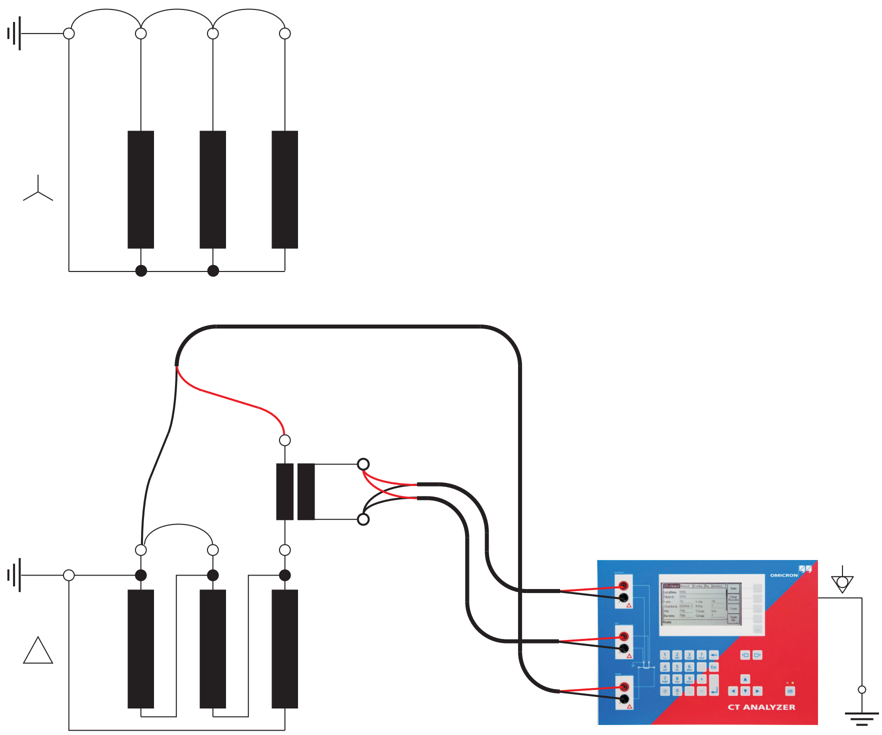


Figure 4-15 Bushing-type CT outside the delta winding power transformer

CTs inside the delta winding

For CT's that are integrated in the delta winding of the transformer, it is not possible to read the CT ratio directly since the delta winding acts as a voltage divider. In order to obtain the correct CT ratio, the ratio value determined by the *CT Analyzer* has to be corrected.

For this purpose, the *CT Analyzer* provides a "Delta Compensation" field on the **CT- Object** card where you can select the delta compensation factor depending on the bushing terminals that are used for primary signal measurement.

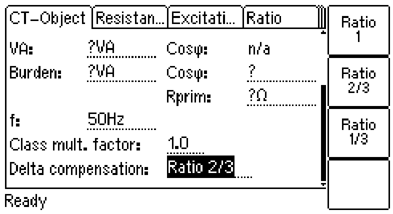


Figure 4-16 Setting the delta compensation on the **CT-Object** card

If it is possible to short-circuit the transformer winding at the same leg as the primary measurement is done (see Figure 4-18), the measurement should be performed with the winding short-circuited. In this case, no delta compensation is required since the voltage induced on the transformer's secondary winding is zero and thus the voltage induced on the primary side of the transformer is also zero.

For the measurement setup shown in Figure 4-17, the delta compensation factor on the **CT-Object** card has to be set to "Ratio 2/3" (see Figure 4-16).

If input "PRIM" is connected between L1 and L2, the delta compensation has to be set to "Ratio 1/3".

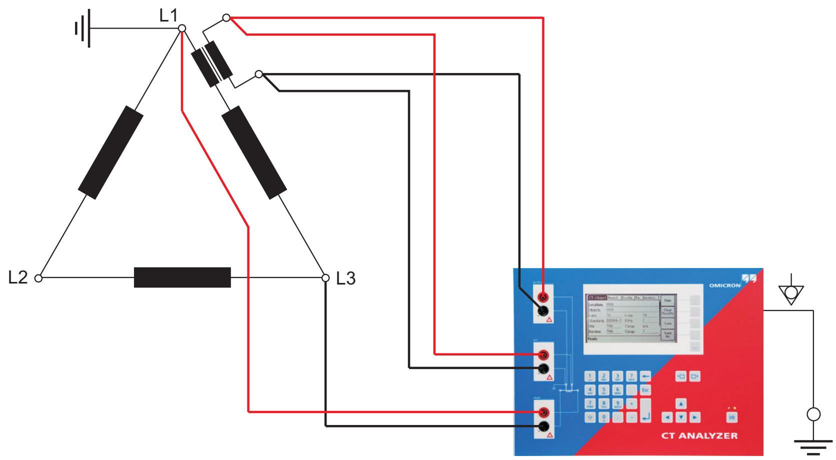


Figure 4-17 Measurement setup for delta compensation "Ratio 2/3"

In the configuration shown in Figure 4-18, no delta compensation is required since the main winding of the power transformer is short-circuited on the other side. This avoids the induction of flux in the main winding of the power transformer that could influence the measurement results.

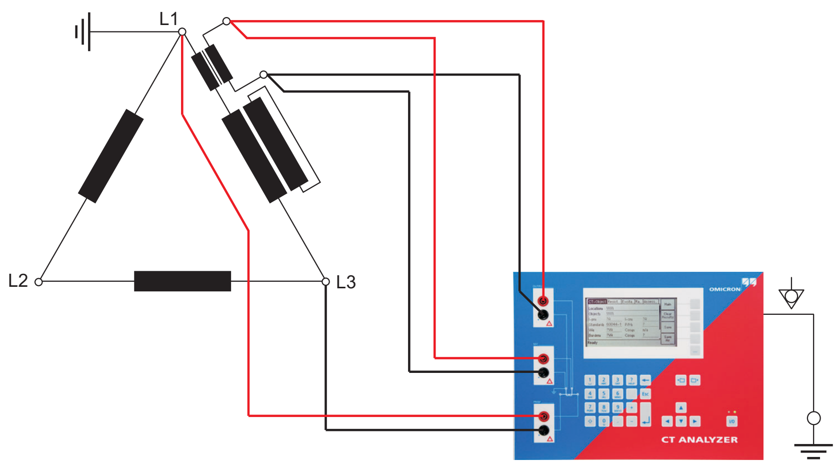


Figure 4-18 Measurement setup for delta compensation "Ratio 1"

5 Short Guide for CT Testing

5.1 Note Regarding the Guesser Function of the CT Analyzer

The guesser function of the *CT Analyzer* is intended as an aid for the user to find out single unknown name plate data of a CT, for example if parts of the CT's name plate are unreadable. If sufficient other name plate data of the CT are available and specified by the user, this function is often able to reliably determine single missing CT data, for example I_{prim}, I_{sec}, class or ratio.

The guesser function cannot release the user from specifying the CT's name plate data prior to testing. Always specify as many CT data as possible to increase the reliability of the values guessed by the *CT Analyzer*!

Caution: The data and values determined by the *CT Analyzer* using the guesser function are not guaranteed and have to be verified by the user.

The example CT test described below does not use the guesser function. For detailed information on how to run a test using the guesser function, please refer to chapter 8 on page 113.

5.2 Connecting the CT

Connect the CT to the *CT Analyzer* as shown on the front panel. Be sure that the polarity of all wires is correct.

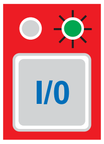
1. Secondary side of the CT to input "Sec" and "Output" of the *CT Analyzer*.
2. Primary side of the CT to *CT Analyzer* input "Prim".

5.3 Preparing the Test

Proceed as follows to display the **CT-Object** card with a new CT test.

If the *CT Analyzer* is already switched on:

1. If necessary, display the **CT-Object** card and then press the **Main** soft key to display the main menu.
2. In the main menu, select "New CT Test" and press the **OK** soft key to initialize a new CT test.
3. The display shows the **CT-Object** card, ready to start a test.



If the *CT Analyzer* is switched off:

1. Switch the *CT Analyzer* on.
2. After the boot process is finished, the green LED is on and the red LED is off.
3. The display shows the **CT-Object** card, ready to start a test.

5.4 Configuring and Starting the Test

After switching the *CT Analyzer* on or after initializing a new test from the main menu, the default **CT-Object** card is displayed.

1. For reasons of simplicity, we do not want to perform a burden measurement or a primary winding resistance measurement in our example CT test described below. Therefore, 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 (see Figure 5-1):

   The following test cards are required: **CT-Object**, **Secondary Winding Resistance**, **Excitation**, **Ratio** and **Assessment**.

   The following test cards are not required. Deselect them if necessary: **Burden**, **Residual Magnetism** and **Primary Winding Resistance**.

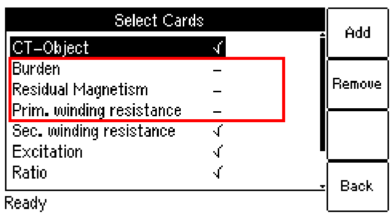
   

   Figure 5-1 **Select Cards** page

   When finished, press the **Back** soft key to return to the **CT-Object** card.

2. Enter the CT name plate data listed in the table below to the **CT-Object** card (see Figure 5-2).

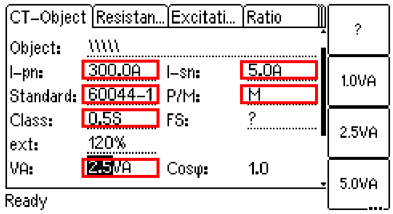
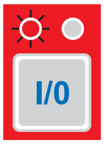


Figure 5-2 **CT-Object** card with name plate data entered

I-pn	Rated primary current of the CT.
I-sn	Rated secondary current of the CT.
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.
Class	Rated accuracy class of the CT. This field becomes available after selecting the CT type (protection CT or metering CT).
VA	Rated power of the CT. **Note:** 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 (see also parameter "VA" on page 72).



3. Start the test by pressing the I/0 key. The red LED flashes to indicate that the CT test is running.

5.5 Automatic Test Execution

Automatic test step 1: CT resistance measurement

The *CT Analyzer* measures the secondary winding resistance of the CT.

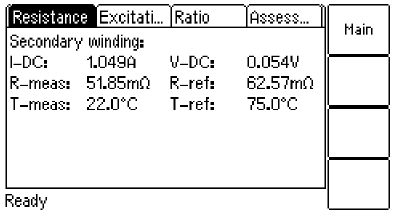


Figure 5-3 **Resistance** card with measurement results **after the test is finished**

Automatic test step 2: Determination of the excitation characteristic

The *CT Analyzer* measures the excitation curve and determines the knee point and other important CT data.

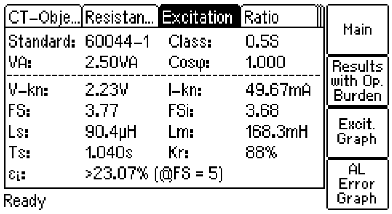


Figure 5-4 **Excitation** card with measurement results **after the test is finished**

Automatic test step 3: Ratio measurement

The *CT Analyzer* then measures the current ratio error, the phase error, the composite error and the polarity. The *CT Analyzer* calculates the ratio error for the operating burden (parameter "Burden" in the **CT-Object** card) and the nominal burden (parameter "VA" in the **CT-Object** card).

To view the measurement results based on the operating burden after the test is finished, open the **Ratio** card using the card selection keys.

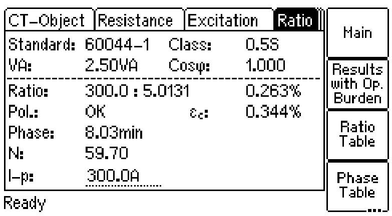
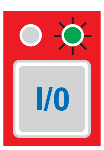


Figure 5-5 Ratio error and phase displacement at operating burden **after the test is finished**

"Test finished" message



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 (see Figure 5-6). Press any key on the keyboard to close this message.

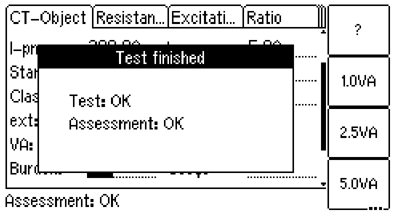


Figure 5-6 **Test finished** message when the test is over

5.6 After the Test is Finished

After the test is finished, the **CT-Object** card displays the CT data determined during the test (refer to Figure 5-7).

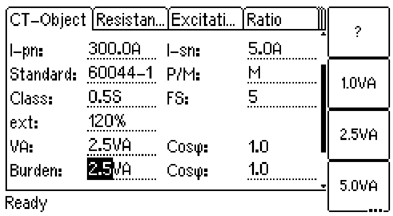


Figure 5-7 **CT-Object** card after the test is finished

Now, you can enter the "Location" and "Object" details and save the test (use the cursor keys to scroll within the card and select edit fields).

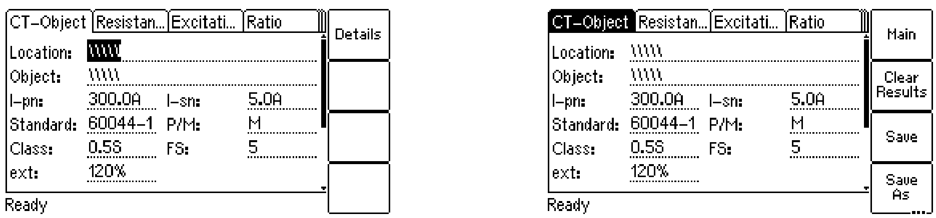


Figure 5-8 **CT-Object** card after the test, ready to enter location details (left) and ready to save the test (right)

The assessment of the individual parameters can be viewed on the **Assessment** card (Figure 5-9).

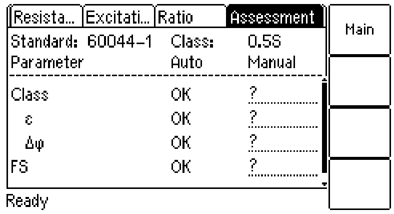


Figure 5-9 **Assessment** card after the test is finished

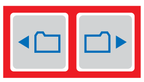
If desired, you can view the individual measurement results acquired during the test by viewing the **Resistance** card, the **Excitation** card and the **Ratio** card, as shown in the figures 5-3 to 5-5 above.

6 Operating the CT Analyzer

6.1 General Operation

6.1.1 Working in the User Interface

Displaying a specific card



To display a specific card, select the card by pressing the card selection keys. The card's tab showing the name of the selected card is then highlighted (see Figure 6-1).

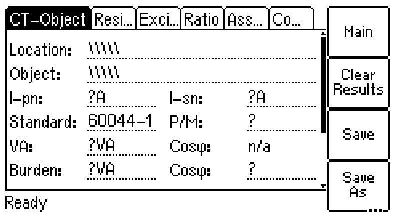


Figure 6-1 **CT-Object** card selected

Using the soft keys

Using the soft keys you can operate the *CT Analyzer* and change the user interface level of the software.

The functionality of the soft keys is context-dependent, i.e., the software offers different functions or selectable sets of parameters depending on the focus (i.e., depending on which card or field is highlighted or selected in the user interface).

If the lowermost soft key description field contains 3 points (see **Save As** in Figure 6-1), additional soft key functions are available. Then you can switch the set of displayed soft keys using the  key located below the soft keys (see Figure 6-2).

1st set of soft keys 2nd set of soft keys

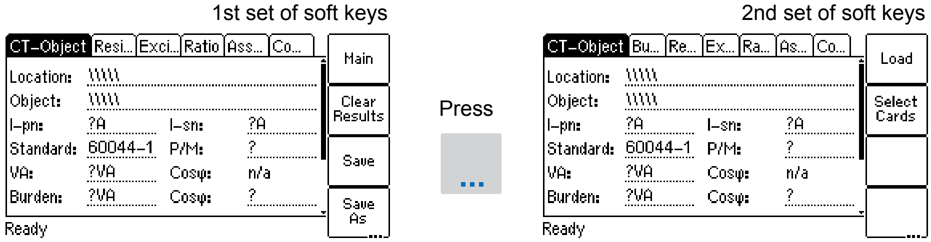
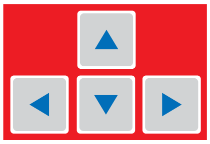


Figure 6-2 Switching the set of soft keys in the **CT-Object** card



Editing a card

To open the edit mode for a displayed card, press the ▼ cursor key. The card's tab is then no longer highlighted (see Figure 6-3).

Use the cursor keys to move the cursor and to select the desired edit field. Some edit fields have soft keys assigned. The soft keys available for an edit field are displayed if the field is selected.

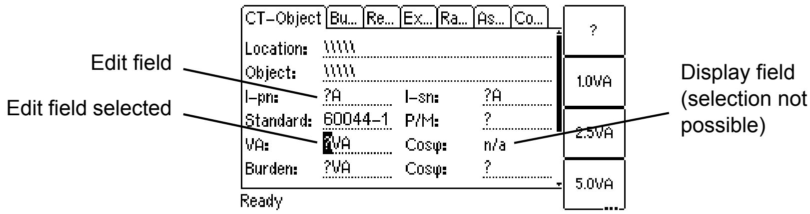


Figure 6-3 Edit field selected in the **CT-Object** card

Proceed as follows to edit a card:

1. Select the edit field using the cursor keys.
2. Enter or edit the value or text:
   – Select an entry offered by the soft keys (if available)
   – or enter the value or text using the keyboard and then press the ↵ key to confirm your input or use the ESC key to leave an edit field without applying and saving the entry.
3. Leave the edit mode either by moving the cursor to the card's tab using the ▲ cursor key or by pressing the ESC key. The focus is then set to the card's tab again (tab highlighted).

6.1.2 The Main Menu

How to get there:

Press the **Main** soft key in any test card

-> **Main Menu**

The Main Menu can be opened from any test card by pressing the **Main** soft key.

The items in the list can be selected using the ▲ ▼ cursor keys. When an item is selected (highlighted), the soft keys are labeled with the functions available for this specific item.

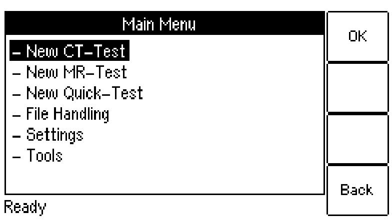


Figure 6-4 **Main Menu** page

6.1.3 New CT-Test

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- New CT-Test

OK soft key

-> **CT-Object** card

By selecting "New CT-Test" in the main menu and then pressing the **OK** soft key, a new CT test with the default parameter settings is loaded and displayed in the **CT-Object** card. Some of the default values can be defined in the default test settings (see section 6.1.7 on page 57).

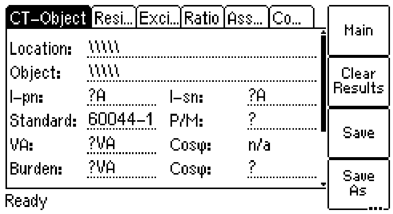


Figure 6-5 **CT-Object** card with default test settings after initializing a new CT test

Note: For more detailed information about the parameters and fields in the **CT-Object** card, please refer to section 7.2 on page 68.

6.1.4 New MR-Test

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- New MR-Test

OK soft key

-> **CT-Object** card

Using the "New MR-Test" option in the main menu you can initialize a new multi-ratio CT test using the optional *CT SB2* switch box.

This option is only available if you have purchased a corresponding license. For more detailed information about multi-ratio CT testing using the *CT SB2*, please refer to the CT SB2 User Manual.

6.1.5 New Quick-Test

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- New Quick-Test

OK soft key

-> **CT-Object** card

Using the "New Quick-Test" option in the main menu you can open the optional *QuickTest* feature. With this feature you can use the *CT Analyzer* as a multimeter.

This option is only available if you have purchased a corresponding license. For more detailed information about *QuickTest*, please refer to chapter 9 on page 115.

6.1.6 File Handling

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- File Handling

Select soft key

-> **File Menu** page

In the **File Menu** page you can access all available file operation functions by selecting the entry using the ▲ ▼ cursor keys and then pressing the **Select** soft key.

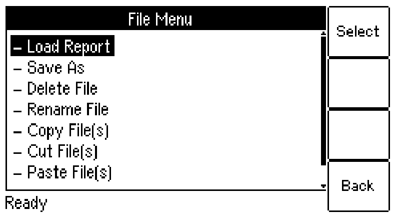


Figure 6-6 **File Menu** page

Available functions

Load Report	Loading an existing report or settings file from the Compact Flash card. You can also load a file by pressing the **Load** soft key in the **CT-Object** card.
Save As	Saving the current file to the Compact Flash card. Saving a file is described in detail on page 56.
Delete File	Deleting a selected file or folder from the Compact Flash card. Only empty folders can be deleted. If you try to delete a folder still containing files or subfolders, an error message is displayed. To select several neighboring files at a time, keep the ⇧ key pressed while selecting the files or folders using the ▲ ▼ cursor keys.
Rename File	Renaming a selected file on the Compact Flash card. Only files can be renamed. Renaming of folders is not possible on the *CT Analyzer*.
Copy / Cut / Paste File(s)	Copying or cutting a file on the Compact Flash card and pasting it at another location on the Compact Flash card. Copying/cutting and pasting a file is described in detail on page 56.
Format CF card	Formatting the Compact Flash card. All data on the Compact Flash card will be lost!

Note: In the *CT Analyzer* file system, the root directory can contain a maximum of 240 files and the file name length (incl. the path) is limited to 240 characters.

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- **File Handling**

Select soft key

File Menu:
- **Load Report** or
- **Save As** or
- **Delete File** or
- **Rename File** or
- **Copy File(s)** or
- **Cut File(s)** or
- **Paste File(s)**

Working in the file system

After selecting one of the available file operation functions in the **File Menu**, the file system card is displayed showing the current path in its title bar and the file system elements in the card area (refer to Figure 6-7).

Navigating in the file system

- To open a folder, select its entry (see Figure 6-7, left) using the ▲ ▼ cursor keys and then press the ↵ key.
- To go one level higher in the directory structure, select the "one level higher" entry ↑.. and then press the ↵ key.

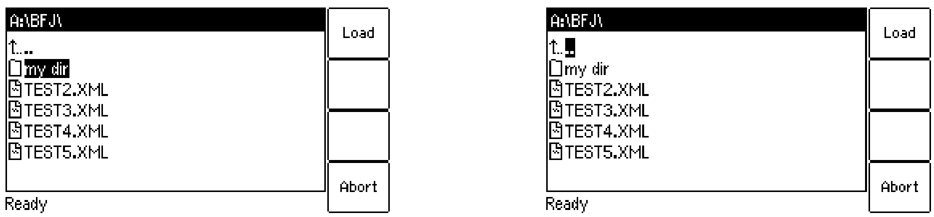


Figure 6-7 File system card for loading a report

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- **File Handling**

Select soft key

File Menu:
- **Save As** or
- **Paste File(s)**

Creating a new folder

Creating a new folder is only possible for the functions **Save As** and **Paste File(s)** of the **File Menu**.

To create a new folder in the file system, select **Save As** or **Paste Files(s)** in the file menu and then navigate to the desired location in the file system where you want to create the new folder. Then press the **New Dir** soft key. A new folder with an empty name is created. Enter a name for the folder and press the ↵ key.

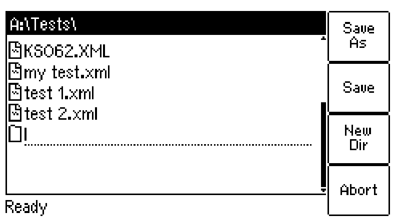


Figure 6-8 File system card after creating a new folder

Note: In the *CT Analyzer* file system, a directory can contain a maximum of 240 files and the maximum file name length is 240 characters. Renaming of folders is not supported by the *CT Analyzer*.

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- File Handling

Select soft key

File Menu:
- Save As

Saving a file

1. Open the file menu and select **Save As**.

   Note: You can also save a file by pressing the **Save** or the **Save As** soft key in the **CT-Object** card.

2. Navigate to the desired folder in the file system where you want to save the file:
   - If you like to save the file with the same name, press the **Save** soft key. A warning will pop up asking whether the existing file should be overwritten or not.
   - If you want to use a similar file name as an existing one in the selected folder, select this file using the ▲ ▼ cursor keys and press the **Save As** soft key or the ↵ key. A new `*.xml` file entry with the selected file name is added. Edit this file name and then press again **Save**, **Save As** or the ↵ key.

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- File Handling

Select soft key

File Menu:
- Copy File(s) or
- Cut File(s)

Copying / cutting and pasting a file on the Compact Flash card

Note: Copying / cutting and pasting folders is not possible with the *CT Analyzer*.

1. Open the file menu and select **Copy File(s)** or **Cut File(s)**.
2. The file system card appears. Navigate to the desired file you want to copy or cut.
3. Highlight the file and then press the **Copy** (or **Cut**) soft key.

   To go back to the main menu without copying or cutting a file, press **Abort**.

   Note: To select several neighboring files at a time, keep the ⇧ key pressed while selecting the files using the ▲ ▼ cursor keys.

4. The file system card is closed and the file menu is displayed. Select **Paste File(s)**.
5. The file system card appears again. Navigate to the desired location in the file system where you want to paste the file.
6. Press the **Paste** soft key to paste the file.

   In case of a cut/paste action, the file is not deleted from its old location until it has been pasted at its new location.

6.1.7 Settings

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- Settings

Select soft key

-> **Setting Menu** page

In the **Setting Menu** page you can access the device settings or the default settings for a new CT test. Select an entry using the ▲ ▼ cursor keys and then press the **Select** soft key to open the corresponding settings page.

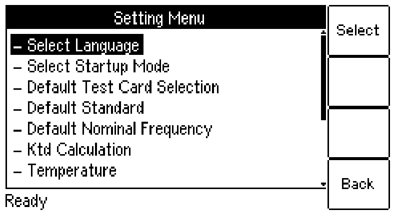


Figure 6-9 **Setting Menu** page

Available options in the Setting Menu

Select Language	Selection of the user interface language. One user language can be installed on the *CT Analyzer*. The English user interface is part of the firmware and therefore always available. The second language can be installed by the user as required (refer to section 6.1.8 on page 62).
Select Startup Mode	Using this option you can select the default test mode the *CT Analyzer* comes up each time when it is switched on. Select the mode using the soft keys: **Single Tap**: The *CT Analyzer* automatically initializes a normal single-ratio CT test. **Multi-Ratio**: The *CT Analyzer* automatically initializes a multi-ratio CT test using the *CT SB2* switch box (see the CT SB2 User Manual for more detailed information). **Quick**: The *CT Analyzer* automatically initializes the *Quick Test* measurement function (see chapter 9 on page 115 for more detailed information).
Default Test Card Selection	Select the test cards a new CT test should contain by default. Please refer to the corresponding subsection below.
Default Standard	Standard to be used for a new CT test: **IEC 60044-1**, **IEC 60044-6** or **IEEE C57.13**.
Default Nominal Frequency	Nominal frequency to be used for a new CT test: **16.7 Hz**, **50 Hz**, **60 Hz** or **400 Hz**.

Ktd Calculation	Select the calculation method for the K_{td} (transient dimensioning factor): **acc. to IEC 60044-6**: K_{td} is calculated exactly according to the standard. **acc. to OMICRON**: K_{td} calculation considers the CT remanence. **acc. to GB 16847**: K_{td} is calculated acc. to the Chinese standard GB16847. For details about the determination of the transient dimensioning factor, please refer to the CT Analyzer Reference Manual.
Temperature	Select the temperature unit (**°C** or **°F**) and the default values for the ambient temperature and the reference temperature (for winding resistance measurement and calculation).
Date/Time	Clock settings for the device-internal clock.
Display Contrast	Display contrast adjustment.
Accur. Limiting Error Graph	Enable or disable the accuracy limiting error graph. This graph is primarily required for Chinese standards. It shows the maximum possible primary current (K * I_{pn}) that can flow over a specific burden without exceeding the accuracy limit (5% or 10%).
Start Delay	Allows the definition of a delay time of up to 10s for the actual test start after pressing the start button. You can apply the defined delay for the burden test, the primary winding resistance measurement and the secondary winding resistance measurement.
Min. VA at M cores Isn 5A	Applies to IEC 60044-1 metering CTs with I_{sn} = 5A only! Here you can set the minimum VA value used for the CT assessment to **3.75VA**. This means, selecting the **3.75VA** soft key will cause the *CT Analyzer* to assess the CT only up to a lower nominal burden limit of 3.75VA instead of 1VA. When 3.75VA is active, it is not possible to enter VA values lower than 3.75VA in the **CT-Object** card. Selecting **0VA** deactivates this option. Assessment is then performed up to a lower burden value of 1VA. This is the factory default which is suitable for most cases. You should not change it without important reason.

Misc. Settings (with default for class multiplying factor)	In the **Miscellaneous Settings** page, the thresholds for the decision algorithms of the guesser function can be defined. Please refer to the corresponding subsection below.

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- Settings

Select soft key

Setting Menu:
- Default Test Card Selection

Select soft key

-> **Select Cards** page

Default Test Card Selection

Enabling or disabling **test cards for the default test** is done using the **Default Test Card Selection** option from the **Setting Menu**. In this case, the test card selection made in this page becomes effective when starting a new CT test.

If you want to enable or disable **test cards for your currently active test** only, press the **Select Cards** soft key in the **CT-Object** card. In this case, the test card selection made in this page is immediately effective after pressing the **Back** soft key.

To enable or disable a test card, select its entry using the ▲ ▼ cursor keys and then press the **Add** or **Remove** soft key. Enabled cards are marked with a checkmark.

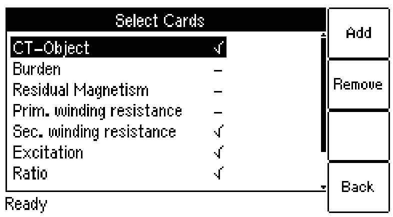


Figure 6-10 **Select Cards** page for selecting the default test cards

Some cards require the existence of other cards. This means that if you are adding such a card, the required other cards are automatically added, too. On the other hand, if you remove a card which is required by another card, the other card is removed, too. Figure 6-11 shows these dependencies.

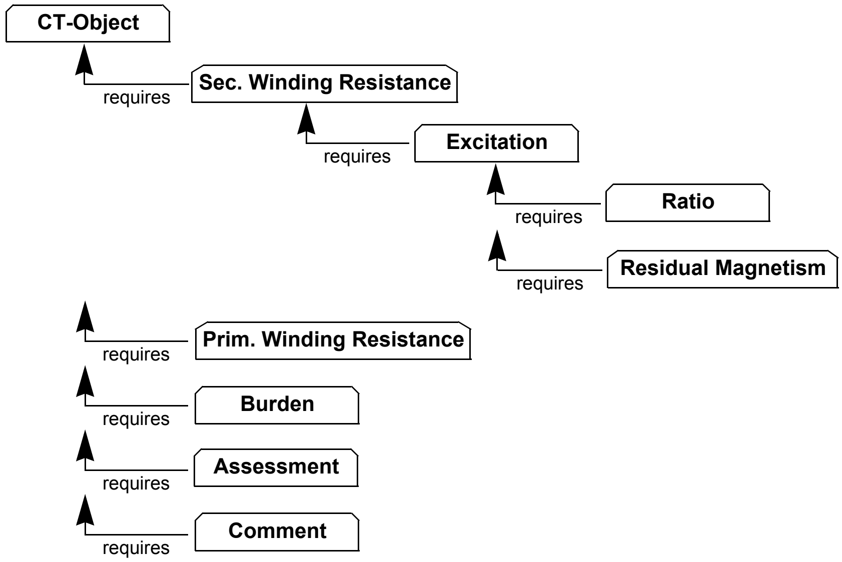


Figure 6-11 Dependencies of test cards

To save your selection and return to the setting menu press the **Back** soft key. To return to the setting menu without saving the selection, press the ESC key.

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- Settings

Select soft key

Setting Menu:
- Misc. Settings

Select soft key

-> **Miscellaneous Settings** page

Miscellaneous Settings

The **Miscellaneous Settings** page is used to define the thresholds for the decision algorithms of the guesser function.

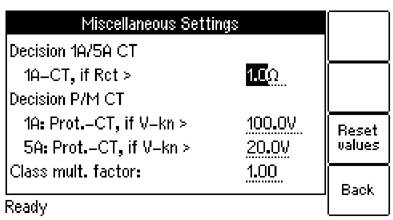


Figure 6-12 **Miscellaneous Settings** page

The following values can be defined in the **Miscellaneous Settings** page.

Decision 1A/5A CT	If the guesser function is active, the device uses the measured winding resistance to decide whether the CT is a 1A or 5A CT. This value specifies the decision threshold. Possible values: 0.5 to 2Ω. Default: 1Ω. If the measured winding resistance is higher than the defined value, the guesser function decides that the CT's nominal secondary current is 1A. Otherwise the secondary current is 5A.
Decision P/M CT	If the guesser function is active, the device uses the measured knee point voltage to decide whether the measured CT is a protection CT or a metering CT. This value specifies the decision threshold. If the knee point voltage is higher than the defined value, the guesser function decides that the measured CT is a protection CT. Otherwise it is a metering CT. • "1A: Prot. CT, if V-kn >" Possible values: 50 to 300V. Default: 100V. • "5A: Prot. CT, if V-kn >" Possible values: 15 to 60V. Default: 20V.
Class mult. factor	The default value for the class multiplying factor can be set. This default is used when the *CT Analyzer* is switched on or if a new CT test is selected in the main menu. The class multiplying factor increases the assessment level for the ratio test. For example, a class multiplier of 0.5 means that the maximum accepted tolerance for the ratio error is only half the standard tolerance. Possible values: 0.25 to 1.00. Default: 1.00

The **Reset Values** soft key resets all values to their default values.

6.1.8 Tools (Update Functions)

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- Tools

Select soft key

-> **Tools Menu** page

From the **Tools Menu** page you can access the update functions of the *CT Analyzer*.

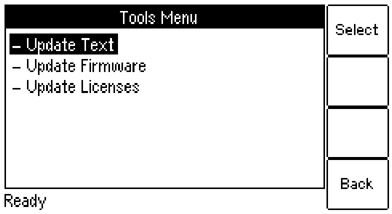
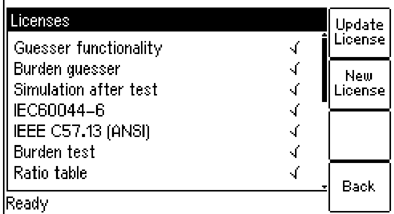


Figure 6-13 **Tools Menu** page

Available functions

Update Text	Using this item you can install a new user interface language file. The file system page opened after selecting **Update Text** only displays files named **CTUser_*.bin**. Please refer to the corresponding subsection below.
Update Firmware	Using this item you can update the firmware of your *CT Analyzer*. The file system page opened after selecting **Update Firmware** only displays files named **CTAnalyzer.bin**. Please refer to the corresponding subsection below.

Update Licenses	This function allows to add additional licenses to your *CT Analyzer*.  Using the **Update License** soft key you can read a license file from the Compact Flash card. Using the **New License** soft key you can add new licenses manually. For information on how to receive new licenses or a new license key for additional functions, please contact your local OMICRON distributor or the OMICRON electronics GmbH support.

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- Tools

Select soft key

Tools Menu:
- Update Text

-> File system card

Update Text

Note: Instead of using the **Update Text** function of the *CT Analyzer* you can also use the *Firmware Update* PC tool contained in the *CT Analyzer PC Toolset*. For detailed information, please refer to the help system of the *CT Analyzer PC Toolset*.

Using this function you can install a new user interface language file. The new language installed is then available for selection in the **Language** page.

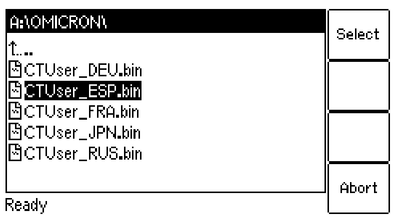


Figure 6-14 File system card for selecting a new language file

To install a new language, select the corresponding file **CTUser_xxx.bin** in the directory **A:\OMICRON** on the Compact Flash card using the ▲ ▼ cursor keys and press the **Select** soft key.

English is contained in the firmware and does not require a user language file.

Caution: Only install language files that are included in the package of the installed firmware version.

If you install a language file that **does not belong to the same package**, the user interface may become unreadable.

Refer to the OMICRON electronics GmbH website for available languages or ask your distributor for a special language file.

If the text update process is interrupted or fails, the device displays an error message and automatically resets the user interface to English when it is switched on the next time.

Press **Abort** to return to the tools menu without installing a new language.

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- Tools

Select soft key

Tools Menu:
- Update Firmware

-> File system card

Update Firmware

Note: Instead of using the **Update Firmware** function of the *CT Analyzer* you can also use the *Firmware Update* PC tool contained in the *CT Analyzer PC Toolset*. For detailed information, please refer to the help system of the *CT Analyzer PC Toolset*.

Using this function you can install new device firmware.

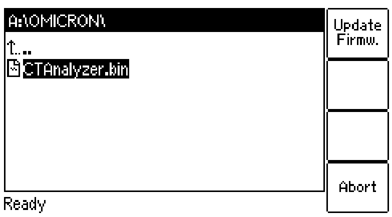


Figure 6-15 File system card for selecting a new firmware file

To perform a firmware update, a corresponding firmware file **CTAnalyzer.bin** has to be available in the directory **A:\OMICRON** on the Compact Flash card.

To update the firmware, select the desired firmware file **CTAnalyzer.bin** using the ▲ ▼ cursor keys and press the **Update Firmw.** soft key.

Note: The firmware update process may take some minutes. If the update process is interrupted or fails, switch the *CT Analyzer* off and on again. The device then tries to perform the firmware update again automatically.

It is also possible to install older firmware. In this case, the user interface text is deleted and the device automatically changes to the English user interface. After you have downgraded the firmware, you also have to install the user interface language file of this (older) firmware package.

After the installation of new firmware, the user interface language automatically changes to English if the installed user interface text is no longer compatible. If you are using a user interface language other than English, install the corresponding new user interface language file delivered with the new firmware.

Press **Abort** to return to the **Tools Menu** page without updating the firmware.

6.2 CT Analyzer Help System

The *CT Analyzer* provides a context-sensitive help system. Pressing the ? key displays a help page, the content of which depends on where the focus was set before the ? key was pressed.

For example:

- If the focus is set to the **CT-Object** card's tab, pressing the the ? key displays a help page showing the wiring for a CT test.
- If the focus is set to the **Burden** card's tab, pressing the the ? key displays a help page showing the wiring for a burden test.
- If a parameter field in the **CT-Object** card or the **Assessment** card is selected with the cursor, pressing the the ? key displays a help page with explanatory texts for this specific parameter.

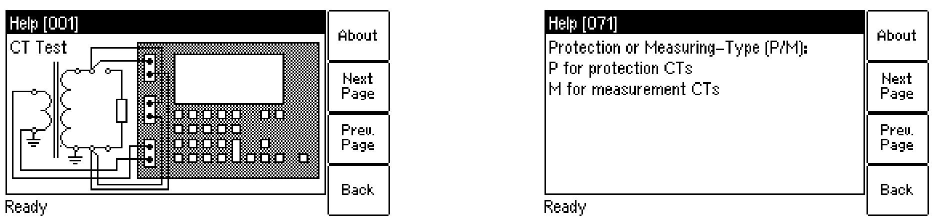


Figure 6-16 Help system showing the wiring diagram for a CT test (left) and explanatory text for a parameter (right)

When the help system is displayed, you can use the **Next Page** and **Prev. Page** soft keys to scroll through the available help pages. Pressing the **About** soft key opens a page with information about the *CT Analyzer* hardware, the installed firmware version, the serial number, etc.

6.3 Operating the CT Analyzer from a Computer

It is also possible to operate the *CT Analyzer* remote controlled from a computer. Diverse software tools are available from OMICRON electronics GmbH for this purpose.

For a detailed description, please refer to the help system of the *CT Analyzer PC Toolset*.

7 The CT Analyzer Test Cards

7.1 Overview of Test Cards

The following table provides an overview of all test cards available for the *CT Analyzer*. **The set of test cards actually available on your *CT Analyzer* depends on your purchased license(s).**

Note: For up-to-date information about available licenses for the *CT Analyzer* please refer to the OMICRON electronics GmbH website or contact your OMICRON electronics GmbH sales contact.

Card	Short description
CT-Object	This card contains the basic CT data and is always required to perform a CT test. Refer to page 68.
Burden	This card is used to measure a current transformer's secondary burden with AC current. Refer to page 81.
Res. Magnetism	This card is used to measure the residual magnetism of CTs. Refer to page 84.
Resistance	This card is used to measure the secondary winding resistance and the primary winding resistance of the CT. Refer to page 88.
Excitation	This card is used to trace the excitation curve of the current transformer and to determine further CT-specific parameters. Refer to page 92.
Ratio	This card is used to measure the current ratio of the CT considering the external load or the nominal burden and to determine the current ratio error and the phase displacement. Refer to page 102.
Assessment	This card shows the automatic assessment of the tested parameters according to the selected standard. In this card you can also perform a manual assessment. Refer to page 108.
Comment	In this card you can enter any text, e.g. additional notes regarding the test. Refer to page 112.

7.2 CT-Object Card

The **CT-Object** card is the most important card and always required for all types of tests. In this card all necessary settings for a test are done. Some of the settings contained in the **CT-Object** card are also shown in other cards for information.

Note: The **CT-Object** card is the top user interface level. Pressing the ESC key several times will always bring you back to the **CT-Object** card.

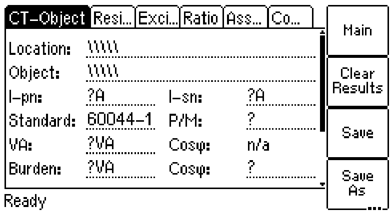


Figure 7-1 **CT-Object** card with default settings after initializing a new CT test

7.2.1 Available Soft Keys

Clear Results	Clears the results of the previous test and enables to start a new test. All measurement results as well as all the parameters previously determined using the "guesser function" are cleared. Text entries for "Location" and "Object" remain unchanged.
Save	Saves the test results and test settings to the currently loaded *CT Analyzer* report file. If the test results have not been saved yet, the **Save As** dialog is opened. Saving a file is described on page 56.
Save As	Saves the test results and test settings to a new .xml file. Saving a file is described on page 56.
Load	Allows to load a test stored on the Compact Flash card in order to check its results, to recalculate the results with different settings or to use its settings for a new test. **Note:** Recalculation of the existing CT test results in order to verify the behavior of the CT at different burdens or primary currents can be performed by changing the burden value on the **CT-Object** card or the primary current on the **Ratio** card. The recalculated results can then be stored again like for a regular test.

Select Cards	Opens the **Select Cards** page where you can select the test cards for the current test. The **Select Cards** page is described on page 59. **Note:** When loading a new CT test from the main menu (using the "New CT-Test" entry), the test card selection defined in the default test settings is used for this new test. The card selection performed in the **CT-Object** card will then be discarded.

7.2.2 Information Fields to be Filled by the User

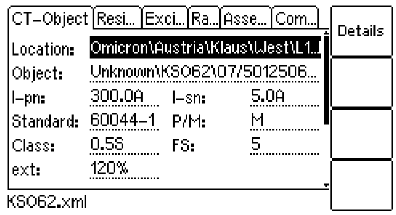


Figure 7-2 Editing the location settings in the **CT-Object** card

The "Location" and "Object" text fields are only used for reporting and documentation purposes. They can be filled by the user after the test is finished. These fields provide information about the location of the CT and the CT itself. The content of these fields is defined in the **Location settings** page and the **Object settings** page, respectively.

To open these settings cards, position the cursor on the "Location" or the "Object" field and then press the **Details** soft key or the ↵ key.

Location settings page	The **Location settings** page provides the following text fields. Each field can contain a maximum of 40 numbers or letters. • Company, Country, Station, Feeder: Information where the CT is installed. • Phase: Phase to which the CT is connected. • IEC-ID: IEC-ID of the CT or freely definable information.
Object settings page	The **Object settings** page provides the following text fields. Each field can contain a maximum of 40 numbers or letters. • Manufact.: Manufacturer of the CT under test. • Type: Type number or description of the CT under test. • Serial No.: Serial number of the CT under test. • Core: Number of the tested core. • Tap: Description of the tap (e.g. 1S1-1S3, X1-X4, ...). • Optional 1: Optional field for free use.

7.2.3 Parameters and Settings Used or Determined by the Test Process

The fields described in this section are used and/or determined by the test process.

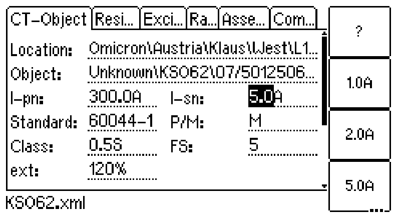


Figure 7-3 Editing the **CT-Object** card

Common Parameters and settings displayed for all standards, CT types and classes

The table below lists all parameters and settings that are displayed for all standards, CT types and classes.

In addition to these common parameters, specific additional parameters are displayed in the **CT-Object** card depending on the selected standard, CT type (protection or metering CT) and class. For these specific parameters, please refer to the tables on pages 74 to 80.

Parameter	Description
I-pn	Rated primary current. Possible values: 1 to 99000 A or **?**[1] soft key. Default: ?.
I-sn	Rated secondary current. Possible values: 0.0001 to 10 A or soft keys **1.0**, **2.0**, **5.0**, **1.0A/√3**, **2.0A/√3**, **5.0A/√3** or **?**[1]. Default: ?.
Standard	Standard according to which the test has to be performed. Possible values: Soft keys **IEC 60044-1**, **IEC 60044-6** or **IEEE C57.13**. Default: Standard defined in the default test settings. **Note:** Using the IEEE C57.13 standard for transformers with gapped cores may possibly deliver incorrect results.

Parameter	Description
P/M	Definition of CT type: Protection or metering CT. Possible values: Soft keys **Prot. CT**, **Meter. CT** or **?**[1]. Default: ?
Class	Accuracy class of the CT. Possible values: Depending on the selected standard or **?**[1]. The "Class" parameter is only displayed, after the parameters "Standard" and "P/M" have been defined or determined by the *CT Analyzer*. Depending on these parameters, the parameters for the CT class can be selected using the soft keys. **Note:** The class can be selected by soft keys or is determined by the *CT Analyzer* during the test. Automatic determination during the test only works for IEC 60044-1 metering CTs and IEEE C57.13 metering CTs. If the question mark has been entered for the "P/M" parameter, the "Class" cannot be defined by the user but is automatically determined by the *CT Analyzer* instead. For IEEE C57.13 metering CTs only: An additional soft key **Assess @ VA** is available for metering CTs according to IEEE C57.13. Use this option if the accuracy class of the CT only applies to one specific burden. CT assessment is normally performed for the maximum burden specified ("VA" or "Burden" parameter) **and** all lower burdens defined in the standard. Example: If the burden specified is B-0.9, the assessment is performed for the burdens B-0.9, B-0.5, B-0.2 and B-0.1 (and the electronic burdens E-0.2 and E-0.04). Selecting the **Assess @ VA** option in addition to the class setting will cause the *CT Analyzer* to consider **only** the burden value specified prior to testing for the CT assessment. The ratio table and the phase table in the **Ratio** card then only show the ratio error for this specific burden (see section 7.7.5 on page 106). When **Assess @ VA** is selected, the soft key changes to **Assess all VA** to enable deactivation of this option.

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>VA

Cos φ</td><td>Nominal burden of the CT, used to calculate the behavior of the CT at the nominal burden.

Possible values: 0 to 300VA or soft keys 1.0A to 30A or ?[1].

Depending on the burden and the selected test standard, the corresponding cos φ is used (cos φ not editable by the user).

<u>If the IEEE C57.13 standard is selected with the type "metering CT"</u>, the CT Analyzer offers some soft keys (e.g. B-0.1, B-0.2, B-0.5 etc.) with standard loads for the power. If these soft keys are used, the power is calculated according to table 9 of IEEE C57.13. If the rated current is not 5A, the resistance and inductance of the table is multiplied by the factor $\alpha = \left(\frac{5}{I_{rated}}\right)^2$

<u>If the IEEE C57.13 standard is selected with the type "protection CT" (class C, K or T)</u>, the CT Analyzer automatically calculates VA from the terminal voltage V_b.

The recommended procedure is as follows:
1. Select I_{sn}.
2. Select V_b using the soft keys.
3. VA is calculated by the CT Analyzer.

Although it is also possible to have V_b automatically calculated from VA, this is not the recommended sequence.

The automatic calculation is not performed if you enter V_b using the keyboard. This way it is possible to get round the automatic calculation and set user-defined values.</td></tr>
</table>

Parameter	Description
Burden Cos φ	"Burden" and "Cos φ" are used to define the operating burden connected to the CT. These parameters are used to calculate the behavior of the CT at the operating burden (connected burden) and the corresponding cos φ. Possible values for "Burden": 0 to 300 VA or soft keys **1.0A** to **30A** or **?**[1]. Possible values for "Cos φ": 0 to 1. These parameters can also be changed after the test or in a loaded test report in order to check the CT behavior at different burden values. Special behavior depending on available test cards: If the test contains a **Burden** card, a question mark is automatically entered to the fields "Burden" and "cos φ" and entering the burden is not possible until the test is finished. In this case, the value determined during the burden test is automatically entered after burden measurement. If I_{sn} is defined, the burden is updated immediately after the burden test is finished. If I_{sn} is not defined (entry "?"), the burden is updated after the resistance test.
f	Rated frequency of the CT. Possible values: Integer value between 16 and 400 Hz or soft keys **16.7 Hz**, **50 Hz**, **60 Hz** or **400 Hz**. Default: Frequency defined in the default test settings.
Rct	Specified secondary winding resistance. Possible values: 0 to 3000 ohms or soft key **?**[1]. Default: ?.
Rprim	Specified primary winding resistance. Possible values: 0 to 3000 ohms or soft key **?**[1]. Default: ?.

Parameter	Description
Class mult. factor	Class multiplying factor. This factor increases the assessment level for the ratio test. E.g. a class multiplier of 0.5 means that the maximum accepted tolerance for the ratio error is only half the standard tolerance. Possible values: 0.25 to 1.00 or soft key **1.0**. Default: 1.0 (as set in the device settings: **Main Menu**, entry "Settings" -> **Setting Menu**, entry "Misc. Settings").
Delta compensation	Correction factor for the ratio measurement. This factor enables the ratio measurement for CTs that are installed inside a delta winding transformer. Possible values: Soft keys **Ratio 1**, **Ratio 2/3** or **Ratio 1/3**. Default: Ratio 1. Choose "Ratio 1" if no correction is required. Choose "Ratio 2/3" if input PRIM is connected to the two terminals of that transformer winding, the CT is in series with. Choose "Ratio 1/3" if input PRIM is connected to the terminals of a transformer winding, the CT is not in series with.

1. If the question mark is entered for this parameter and a new test is started, the *CT Analyzer* automatically tries to determine the value using its integrated guesser function (see chapter 8 on page 113).

Specific parameters and settings displayed for IEC 60044-1 protection CTs

The following parameters are only displayed in the **CT-Object** card if the standard IEC 60044-1 is selected with the type "Protection CT".

Param.	Description	Available for IEC 60044-1 class		
		P	**PR**	**PX**
ALF	Accuracy limiting factor acc. to IEC 60044-1. Possible values: Integer value from 1 to 300 or soft keys **?**[1], **5**, **10**, **15**, **20** or **30**. Default: ?.	x	x	

Param.	Description	Available for IEC 60044-1 class		
		P	PR	PX
Ts	Specified secondary time constant. Possible values: 0.000 to 100.0 s or soft key **?**[1]. Default: 100 s.		x	
Ek	Accuracy limiting voltage acc. to IEC 60044-1, PX. Possible values: 0 to 20000 or soft key **?** [1]. Default: ?.			x
Kx	Dimensioning factor acc. to IEC 60044-1, PX. Possible values: 1 to 300 or soft key **?**[1]. Default: ?.			x
Ie	Accuracy limiting current acc. to IEC 60044-1, PX. Possible values: 0.03 mA to 30 A or soft key **?** [1]. Default: ?.			x
E1	User-defined e.m.f. to verify the excitation current at this specific e.m.f. Possible values: 0.1 to 20000 V or soft key **?**[2]. Default: ?.			x
Ie1	Maximum allowed excitation current at E_1. Possible values: 0.03 mA to 30000 mA or soft key **?**[3]. Default: ?.			x

1. If the question mark is entered for this parameter and a new test is started, the *CT Analyzer* automatically tries to determine the value using its integrated guesser function (see chapter 8 on page 113).
2. If the question mark is entered, half the voltage entered or measured for E_k is used.
3. If the question mark is entered, the *CT Analyzer* uses the excitation current measured at the voltage value defined at E_1. In this case, the assessment for this parameter is OK.

Specific parameters and settings displayed for IEC 60044-1 metering CTs

The following parameters are only displayed in the **CT-Object** card if the standard IEC 60044-1 is selected with the type "Metering CT".

Parameter	Description
FS	Instrument security factor acc. to IEC 60044-1. Possible values: Integer value from 1 to 30 or soft keys **?**[1], **FS1**, **FS1.5**, **FS2**, **FS5**, **FS10**, **FS20** or **FS30**. Default: ?.
ext	Extended current rating. Possible values: 100 to 400 % or soft keys **120%**, **150%**, **200%**, **300%**, **400%**. Default: 120 %.

1. If the question mark is entered for this parameter and a new test is started, the *CT Analyzer* automatically tries to determine the value using its integrated guesser function (see chapter 8 on page 113).

Specific parameters and settings displayed for IEC 60044-6

The following parameters are only displayed in the **CT-Object** card if the standard IEC 60044-6 is selected.

Param.	Description	Available for IEC 60044-6 class			
		TPS	TPX	TPY	TPZ
Kssc	Rated symmetrical short-circuit current factor. Possible values: 1 to 300 or soft keys **?**[1], **3**, **5**, **7.5**, **10**, **12.5**, **15**, **17.5**, **20**, **25**, **30**, **40** or **50**. Default: ?.	x	x	x	x
Tp	Primary time constant. Possible values: 0.000 to 5.000 s or soft keys **20ms**, **40ms**, **60ms**, **80ms**, **100ms** or **120ms**. T_p depends on K as follows: $T_p = \frac{K-1}{\omega}$	x	x	x	x

Param.	Description	Available for IEC 60044-6 class			
		TPS	TPX	TPY	TPZ
K	Dimensioning factor. Possible values: 1 to 1572. K depends on T_p as described above for T_p.	x			
V-al	Rated equivalent excitation limiting secondary voltage. Possible values: 0 to 9999V or soft key **?**. Default: ?.	x			
I-al	Accuracy limiting secondary excitation current. Possible values: 0.03mA to 30A or soft key **?**. Default: ?.	x			
E1	User-defined e.m.f. to verify the excitation current at this specific e.m.f. Possible values: 0.1 to 20000V or soft key **?**[2].	x			
Ie1	Maximum allowed excitation current at E_1 (user-defined e.m.f.). Possible values: 0.03mA to 30A or soft key **?**[3].	x			
Ktd	Rated transient dimensioning factor. Possible values: 1.0 to 2043 or soft key **?**. Default: ?.		x	x	x
Duty	Specified duty cycle. Using the soft keys, two different energizing cycles can be selected: **C-O** or **C-O-C-O** Default: C-O.		x	x	
t1	Duration of first current flow. The specified accuracy limit must not be reached within time t_{al1}. Possible values: 0.000 to 5.000s or soft key **100ms**. Default: 0.1s.		x	x	

Param.	Description	Available for IEC 60044-6 class			
		TPS	TPX	TPY	TPZ
t2	Duration of second current flow. The specified accuracy limit must not be reached within time t_{al2}. **Note:** Only displayed if "Duty" is C-O-C-O. Possible values: 0.000 to 5.000s or soft key **100ms**. Default: 0.1s.		x	x	
t-al1	Permissible time to accuracy limit for first energizing period of the duty cycle. Possible values: 0.000 to 5.000s and max. t_1 or soft key **40ms**. Default: 0.04s.		x	x	
t-al2	Permissible time to accuracy limit for second energizing period of the duty cycle. **Note:** Only displayed if "Duty" is C-O-C-O. Possible values: 0.000 to 5.000s and max. t_2 or soft key **40ms**. Default: 0.04s.		x	x	
tfr	Dead time between first opening and reclosure. **Note:** Only displayed if "Duty" is C-O-C-O. Possible values: 0.00 to 5.00s or soft key **300ms**. Default: 0.3s.		x	x	
Ts	Specified secondary time constant. Possible values: 0.000 to 100.0s or soft key **?**. Default: ?.			x	x

1. If the question mark is entered for this parameter and a new test is started, the *CT Analyzer* automatically tries to determine the value using its integrated guesser function (see chapter 8 on page 113).
2. If the question mark is entered, half the voltage entered or measured for E_k is used.
3. If the question mark is entered, the *CT Analyzer* uses the excitation current measured at the voltage value defined at E_1. In this case, the assessment for this parameter is OK.

Specific parameters and settings displayed for IEEE C57.13 protection CTs (class C, T and K)

The following parameter is only displayed in the **CT-Object** card if the IEEE C57.13 standard is selected with the type "Prot. CT" and the class "C", "K" or "T".

Parameter	Description
Vb	Rated secondary terminal voltage. Possible values: Integer values from 10 to 1200V or soft keys **?**[1], **10V**, **20V**, **50V**, **100V**, **200V**, **400V** or **800V**. Default: ?. If you select V_b using the soft keys, the *CT Analyzer* automatically calculates the corresponding nominal burden VA (see parameter "VA" on page 72"). The recommended procedure is as follows: 1. Select I_{sn}. 2. Select V_b using the soft keys. 3. VA is calculated by the *CT Analyzer*. Although it is also possible to have V_b automatically calculated from VA, this is not the recommended sequence. The automatic calculation is not performed if you enter V_b using the keyboard. This way it is possible to get round the automatic calculation and set user-defined values.

1. If the question mark is entered for this parameter and a new test is started, the *CT Analyzer* automatically tries to determine the value using its integrated guesser function (see chapter 8 on page 113).

Specific parameters and settings displayed for IEEE C57.13 protection CTs (class X)

The following parameter is only displayed in the **CT-Object** card if the IEEE C57.13 standard is selected with the type "Prot. CT" and the class "X".

Parameter	Description
RE(20*Isn)	Ratio error at 20 * I_{sn}. Possible values: Integer values from 1% to 99%. Default: 10%.

Specific parameters and settings displayed for IEEE C57.13 metering CTs

The following parameter is only displayed in the **CT-Object** card if the IEEE C57.13 standard is selected with the type "Metering CT".

Parameter	Description
RF	Continuous current rating factor. Possible values: Value from 1.0 to 4.0 or soft keys **RF1.5**, **RF2**, **RF3** or **RF4**. Default: 2.

7.3 Burden Card

The **Burden** card is only available if it is enabled on the **Select Cards** page (Default Test Card Selection or **Select Cards** soft key in the **CT-Object** card).

Using the **Burden** card, a current transformer's secondary burden impedance can be measured with the selected secondary current (I_{sn}) at nominal frequency. If a current other than I_{sn} should be used to test the burden, the desired test current can be entered in the "I-test" parameter field.

No soft keys are available in the **Burden** card.

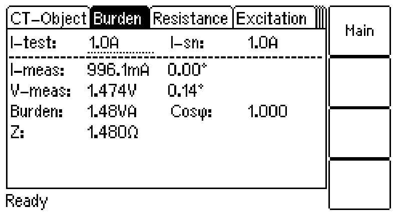


Figure 7-4 **Burden** card

If the *CT Analyzer* cannot reach the desired test current I_{test}, an overload message is displayed in the right-hand corner of the status line.

7.3.1 Test Settings

The following settings can be done in the **Burden** card.

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>I-test</td><td>Test current used to measure the external burden.

After clearing the test results or when starting a new CT test, the test current is automatically chosen as follows:
<table>
<tr><th>Value for I-sn in CT-Object card</th><th>Value for I-test in Burden card</th><th>Test current used for burden test</th></tr>
<tr><td>"?"</td><td>none</td><td>1A</td></tr>
<tr><td>e.g. "?"</td><td>e.g. 5A</td><td>5A (value of I-test)</td></tr>
<tr><td>e.g. 5A</td><td>none</td><td>5A (value of I-sn)</td></tr>
<tr><td>e.g. 5A</td><td>e.g. 1A</td><td>1A (value of I-test)</td></tr>
</table>
It is possible to overwrite the default test current using the keyboard (0.1 to 5A). Always verify the test current settings prior to starting the test in order to avoid damaging of the CT or other equipment.</td></tr>
</table>

7.3.2 Test Results

The lower part of the **Burden** card shows the results of the burden test after the test is finished.

Parameter	Description
I-meas	Current measured during the test.
V-meas	Voltage measured at the load during the test.
Burden / Cos φ	Burden and cos φ calculated from the measured quantities. If the rated secondary current is not known, the result field will only show "n/a" as long as I_{sn} is not defined.
Z	Impedance of the burden calculated from the measured quantities.

7.3.3 Connecting the Burden and Running the Burden Test

1. Press the **Select Cards** key soft in the **CT-Object** card to open the **Select Cards** page. Enable the **Burden** test card in the **Select Cards** page. Press the **Back** soft key to apply your test card selection and return to the **CT-Object** card.

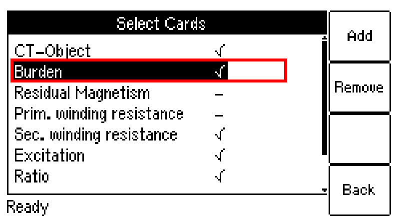


Figure 7-5 **Select Cards** page with **Burden** test card enabled

2. In the **Burden** card, use the default test current or enter the desired test current to parameter "I-test".
3. Start the test by pressing the I/0 key.
4. The *CT Analyzer* displays a message, asking you to check the wiring for the test. Connect the burden as shown in Figure 7-6 using the 4-wire method (i.e., using two clamps for each side). Connect the black sockets of the *CT Analyzer* to the grounded side. You can display the connection diagram by pressing the ? key while the wiring check message (or the **Burden** card) is displayed.

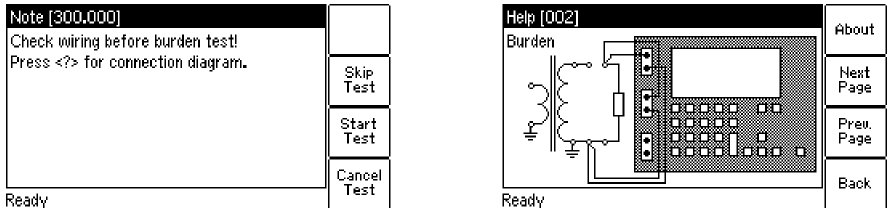


Figure 7-6 Burden test: Wiring check message (left) and wiring diagram (right)

5. Press the **Start Test** soft key to run the burden test.

   Note: If you do not want to perform the burden test, press **Skip Test** to skip the burden test and continue with the next test step or **Cancel Test** to abort the complete test.

6. After the burden test is finished, the test halts to allow rewiring for the next test step. Reconnect the CT accordingly and continue testing by pressing the **Start Test** soft key (or press **Skip Test** to skip the next test step or **Cancel Test** to abort the complete test).

Possible test steps following the burden test:

- Residual magnetism measurement, see section 7.4.2 on page 86.
- Primary resistance measurement, see section 7.5.1 on page 89.
- CT test, see chapter 5 on page 45.

7.4 Residual Magnetism Card

Note: *Residual magnetism* is an optional feature. The functionality described below is only available if you have purchased a corresponding license. For further information, please contact your OMICRON electronics GmbH sales contact or the OMICRON electronics GmbH office nearest you.

The **Residual Magnetism** card is only available if it is enabled on the **Select Cards** page (Default Test Card Selection or **Select Cards** soft key in the **CT-Object** card).

High-transient currents or DC currents applied to the primary side of a CT can cause saturation effects inside the CT with a possible subsequent displacement of the operating point on the CT's excitation curve. The CT then has a residual magnetic flux in its core even if no current is applied on the primary side. The CT has residual magnetism.

Residual magnetism in CTs may cause erroneous tripping or prevent tripping of the connected protection relay since the behavior of the CT is no longer as specified and expected.

Using the **Residual Magnetism** card it is possible to measure the residual magnetism of CTs.

The *CT Analyzer* performs demagnetization of the CT after the test is finished. Please note that the residual magnetism the CT had prior to testing gets lost through the test.

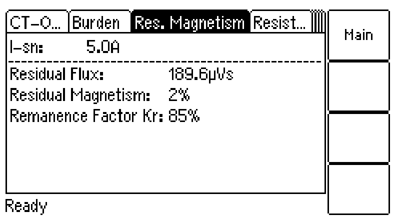


Figure 7-7 **Residual Magnetism** card

Note: The wiring for residual magnetism measurement is identical to the wiring for a normal CT test (see section 4.4 "4-Wire Measurement vs. 2-Wire Measurement" on page 27).

Note: Gapped cores normally have very low residual magnetism. The *CT Analyzer* is possibly not able to determine the knee point of gapped cores.

7.4.1 Test Settings and Results

The following settings and test results are displayed in the **Residual Magnetism** card.

Parameter	Description
I-sn	Nominal secondary current of the CT as entered in the **CT-Object** card. The I_{sn} of the CT has to be specified **prior to the execution** of the residual magnetism measurement. Otherwise, a corresponding message is displayed.
Residual Flux	Absolute value [in Vs] of the residual magnetic flux in the CT determined by the *CT Analyzer*. The residual flux is always displayed after measurement, even if the *CT Analyzer* could not determine the residual magnetism and the remanence factor.
Residual Magnetism	Residual magnetism [in %] of the CT, calculated from the residual flux and the saturation flux as follows: $\text{Residual magnetism } M_r = \frac{\text{Residual flux } \Psi_{res}}{\text{Saturation flux } \Psi_s} \times 100\ \%$ No value is displayed if the *CT Analyzer* was not able to reach the knee point of the excitation curve and thus could not determine the remanence factor K_r. The value displayed for the residual magnetism can exceed 100% since the CT may possibly provide a saturation flux higher than the saturation flux Ψ_s determined by the *CT Analyzer* during the measurement of the remanence factor K_r. The calculation of the residual magnetism however uses the saturation flux Ψ_s as defined in IEC 60044 and not the maximum possible saturation flux of the CT.
Remanence Factor Kr	Remanence factor [in %] of the CT, calculated from the remanent flux and the saturation flux as follows: $\text{Remanence factor } K_r = \frac{\text{Remanent flux } \Psi_r}{\text{Saturation flux } \Psi_s} \times 100\ \%$ No value is displayed if the *CT Analyzer* was not able to reach the knee point of the excitation curve.

7.4.2 Running a Residual Magnetism Measurement

1. Press the **Select Cards** soft key in the **CT-Object** card to open the **Select Cards** page. Enable the **Residual Magnetism** test card in the **Select Cards** page. Press the **Back** soft key to apply your test card selection and return to the **CT-Object** card.

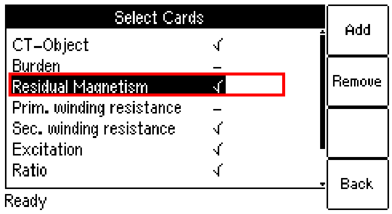


Figure 7-8 **Select Cards** page with **Residual Magnetism** test card enabled

2. If not already specified, enter the I_{sn} of the CT on the **CT-Object** card.
3. Connect the CT to the *CT Analyzer* as shown in Figure 7-9 using the 4-wire method (i.e., using two clamps for each side). Connect the black sockets of the *CT Analyzer* to the grounded side. Be sure that the polarity of all wires is correct.

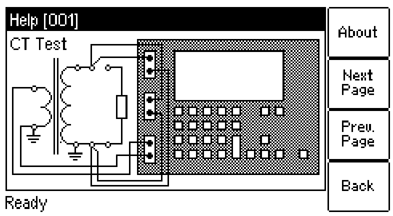


Figure 7-9 Wiring diagram for residual magnetism measurement and CT testing

4. Start the test by pressing the I/0 key.
5. **If the burden test is enabled**, the test halts and the *CT Analyzer* displays a corresponding message, asking you to check the wiring for the burden test. Connect the burden and run the burden test as described in section 7.3.3 on page 82.

   After the burden measurement is finished, the test halts to allow rewiring for the residual magnetism measurement. Reconnect the CT as described in step 3 above and continue testing by pressing the **Start Test** soft key.
6. The *CT Analyzer* runs the residual magnetism measurement.

7. **If the primary resistance measurement is enabled**, the test halts and the *CT Analyzer* displays a corresponding message, asking you to check the wiring for the test. Connect the CT accordingly and run the primary winding resistance measurement as described in section 7.5.1 on page 89.

   After the primary winding resistance is finished, the test halts to allow rewiring for the CT test. Reconnect the CT as described in step 3 above and continue testing by pressing the **Start Test** soft key.

8. The *CT Analyzer* automatically runs the CT test (see chapter 5 on page 45).

7.5 Resistance Card

The **Resistance** card is only available if winding resistance measurement is enabled in the **Select Cards** page (Default Test Card Selection or **Select Cards** soft key in the **CT-Object** card).

The **Select Cards** page offers two different types of winding resistance measurements for selection:

- **Primary winding resistance measurement** (only required in case of a perceptible primary winding resistance, i.e., if the primary winding actually consists of multiple turns). See section 7.5.1 on page 89 for more information.
- **Secondary winding resistance measurement** (always required for CT testing for particular calculations in the excitation and ratio test). See section 7.5.2 on page 90 for more information.

Depending on your selection on the **Select Cards** page, the **Resistance card** shows the parameters and results for the primary winding resistance measurement or the secondary winding resistance measurement only, or for both measurements.

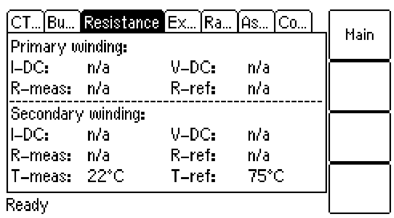


Figure 7-10 **Resistance card** showing parameters and results for primary ***and*** secondary winding resistance measurement

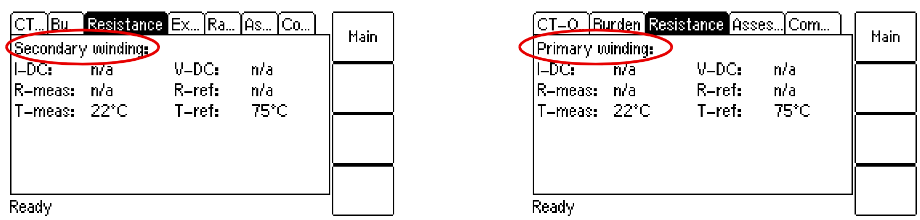


Figure 7-11 **Resistance card** for secondary winding resistance measurement only (left) and for primary winding resistance measurement only (right)

7.5.1 Primary Winding Resistance Measurement

Measuring the primary winding resistance is only required in case of a perceptible primary winding resistance, i.e., if the primary winding actually consists of multiple turns.

Primary winding resistance measurement is performed prior to the CT test and requires special wiring.

Note: If no CT test is performed following the primary winding resistance test, a demagnetizing cycle is performed after the test to guarantee complete demagnetization of the CT.

Running the primary winding resistance measurement

1. Press the **Select Cards** key soft in the **CT-Object** card to open the **Select Cards** page. Enable the **Primary winding resistance** measurement in the **Select Cards** page. Press the **Back** soft key to apply your selection and return to the **CT-Object** card.

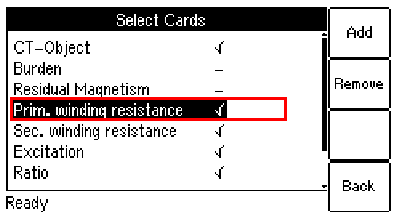


Figure 7-12 **Select Cards** page with **Primary winding resistance** measurement enabled

1. Press the I/0 key to start the test.
2. **If the burden test and/or the residual magnetism measurement are enabled**, the test halts and the *CT Analyzer* displays a corresponding message. Perform the test(s) as described in sections 7.3.3 on page 82 and 7.4.2 on page 86.
3. A message appears notifying you that you should check the wiring before running the primary winding resistance test.
4. Press the ? key to open the help page showing the connection diagram and connect the CT to the *CT Analyzer* as shown in Figure 7-13 using the 4-wire method.

   Note: If you do not want to execute the primary winding resistance measurement, press the **Skip Test** soft key instead of changing the wiring. This will skip the primary winding resistance measurement and immediately start the CT test. This allows you to repeat the CT test without repeating the primary winding resistance measurement.

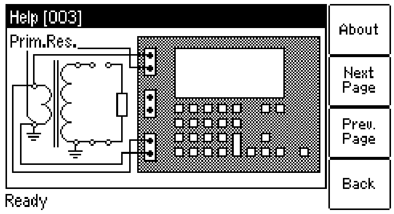


Figure 7-13 *CT Analyzer* help page for primary winding resistance measurement

5. Press the **Start Test** soft key to start the primary winding resistance measurement.
6. When the primary winding resistance measurement is finished, a message appears notifying you that you have to change the wiring again before running the CT test.
7. Press the **?** key to open the help page showing the connection diagram and change the wiring to connect the *CT Analyzer* for the CT test as shown in Figure 7-14.

   Note: If you do not want to execute the CT test, press the **Skip Test** soft key instead of changing the wiring. This will skip the CT test and immediately perform the demagnetization cycle to finish the test. This allows you to repeat the primary winding resistance measurement without repeating the CT test.

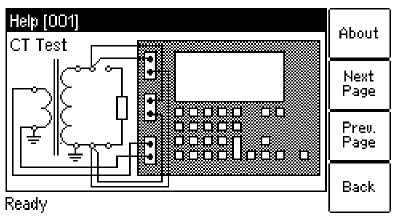


Figure 7-14 *CT Analyzer* help page for CT test wiring

8. Press the **Start Test** soft key to run the CT test (see chapter 5 on page 45).

7.5.2 Secondary Winding Resistance Measurement

During the CT test, secondary winding resistance measurement is necessary since the CT winding resistance is needed for particular calculations in the excitation and ratio test.

This measurement is performed completely automatically.

Note: If only a secondary winding resistance test is selected, a demagnetizing cycle is performed after the test to guarantee complete demagnetization of the CT.

7.5.3 Test Settings and Results

The following settings are required to perform a winding resistance test.

Parameter	Description
T-meas	Winding temperature of the CT at the time of measurement. Value used: Ambient Temperature defined in the **Settings** (main menu). If this temperature is not set correctly, the reference resistance value (R_{ref}) at reference temperature will not be calculated correctly.
T-ref	Reference temperature, i.e, temperature the CT is specified for. Value used: Reference temperature defined in the **Settings** (main menu). The winding resistance at reference temperature is calculated from the winding resistance measured at ambient temperature (T_{meas}) and the specified reference temperature.

The following parameters show the results of the winding resistance test after the test is finished.

Parameter	Description
I-DC	Current used for measurement. Selected automatically, cannot be changed by the user. **Secondary winding resistance measurement only:** If I_{sn} is between 0.1 and 1 A, I_{DC} is automatically set to I_{sn}. If I_{sn} is lower than 0.1 A, I_{DC} is automatically set to 0.1 A. Maximum value: 1 A. **Primary winding resistance measurement only:** Maximum value: 10 A.
V-DC	Measured voltage.
R-meas	Measured resistance at ambient temperature.
R-ref	Reference resistance (temperature-compensated resistance, compensated to T_{ref}).

7.6 Excitation Card

The **Excitation card** is only available if it is enabled in the **Select Cards** page (Default Test Card Selection or **Select Cards** soft key in the **CT-Object** card).

The excitation test is used to trace the excitation curve of the current transformer and to determine many CT-specific parameters (see test results below). The test is done completely automatically up to a current of 15 A_{peak}.

CTs with closed cores can be tested up to a knee point voltage of 30 kV. For CTs with gapped cores the maximum test voltage and current are limited depending on the maximum output power of the device. Typical maximum current and voltage values for a TPZ core are 9 A_{rms} at 1200 V_{rms}.

The settings for the excitation test are specified in the **CT-Object** card. For a better understanding of the test results, the most important settings from the **CT-Object** card are shown in the upper part of the **Excitation** card.

The test results displayed in the lower part of the **Excitation** card depend on the standard selected in the **CT-Object** card. Using the soft keys, the user can choose between different sets of results. If the **Results with Nom. Burden** soft key is pressed, the page shows the results related to the nominal burden ("VA" parameter in **CT-Object** card). If the **Results with Op. Burden** soft key is pressed, the page shows the results related to the operating burden ("Burden" parameter in **CT-Object** card).

Pressing the **Excit. Graph** soft key opens a page with the excitation graph (see page 98).

Pressing the **AL Error Graph** soft key opens a page with a graph showing the maximum possible primary current (K * I_{pn}) that can flow over a specific burden without exceeding the accuracy limit (5 % or 10 %).

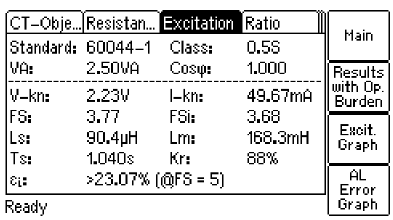
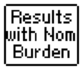
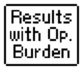
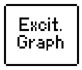
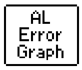


Figure 7-15 **Excitation** card with values related to nominal burden

If the *CT Analyzer* displays an overload in the **Excitation** card, either the desired knee point could not be reached or not all necessary measurement points could be taken (e.g. in the knee point area, not enough points for a proper calculation of the knee point could be measured).

7.6.1 Available Soft Keys

 or 	Displays the results related to the nominal burden of the CT. Displays the results related to the operating burden of the CT.
	Opens the excitation graph page (refer to section 7.6.4 on page 98).
	Opens the AL error graph page (refer to section 7.6.5 on page 100). This graph is part of Chinese standards and shows the maximum possible primary current (K * I_{pn}) that can flow over a specific burden without exceeding the accuracy limit.

7.6.2 Test Settings

The upper part of the **Excitation** card shows the test settings adjusted in the **CT-Object** card.

7.6.3 Test Results

The test results are displayed in the lower part of the **Excitation** card. The display of test results depends on the following:

- The standard defined in the **CT-Object** card, the class and the type of CT (measurement or protection CT).

  The following tables provide an overview of which test results (parameters) are displayed for which standard.

- The burden selected with the soft key (**Results with Nom. Burden** or **Results with Op. Burden**).

  Depending on the selected burden, the **Excitation** card shows the results either calculated with the nominal burden (**Results with Nom. Burden**) or calculated with the operating burden (**Results with Op. Burden**).

  The displayed pages are identical to a large extend, except the field label for the burden parameter ("VA" in case of nominal burden and "Burden" in case of operating burden) and the result values.

Test results displayed in the Excitation card for IEC 60044-1

Parameter	Description	Results displayed for IEC 60044-1			
		protection CTs			metering CTs
		P	PR	PX	
V-kn V-kn1	Knee point voltage (acc. to standard) of the topmost knee point found.	x	x	x	x
I-kn I-kn1	Knee point current (acc. to standard) of the topmost knee point found.	x	x	x	x
V-kn2	Knee point voltage (acc. to standard) of the lowermost knee point found.	x	x	x	x
I-kn2	Knee point current (acc. to standard) of the lowermost knee point found.	x	x	x	x
Ls	Saturated inductance.	x	x	x	x
Lm	Non-saturated inductance.	x	x	x	x
Ts	Secondary time constant.	x	x	x	x
Kr	Remanence factor.	x	x	x	x
ε_i	Indirect error (acc. to standard).	x	x		x
ALF	Accuracy limiting factor according to IEC 60044-1 direct measurement method, calculated for nominal and operating burden.[1]	x	x		
ALFi	Accuracy limiting factor according to IEC 60044-1 indirect measurement method, calculated for nominal and operating burden.[1]	x	x		
Kx	Dimensioning factor (acc. to IEC 60044-1 class PX) at accuracy limit with the selected load.			x	
Ek	Accuracy limiting voltage according to IEC 60044-1 for class PX (that point on the excitation graph where an increase of the e.m.f. r.m.s. voltage (core flux) by 10 % causes an increase of the r.m.s. current by 50 %).			x	
Ie	Accuracy limiting current according to IEC 60044-1 class PX (at E_k).			x	

Parameter	Description	Results displayed for IEC 60044-1			
		protection CTs			metering CTs
		P	PR	PX	
E1	User-defined e.m.f. to verify the excitation current at this e.m.f.			x	
Ie1	Max. allowed excitation current at E_1.			x	
FS	Instrument security factor according to IEC 60044-1 direct measurement method, calculated for nominal and operating burden.[1]				x
FSi	Instrument security factor according to IEC 60044-1 indirect measurement method, calculated for nominal and operating burden.[1]				x

1. If the *CT Analyzer* is not able to measure up to the actual value, the prefix ">" is displayed to indicate that the measurement value is larger than the displayed value.

Test results displayed in the Excitation card for IEC 60044-6

Parameter	Description	Results displayed for IEC 60044-6 prot. CTs			
		TPS	TPX	TPY	TPZ
V-kn	Knee point voltage according to standard.	x	x	x	x
I-kn	Knee point current according to standard.	x	x	x	x
Kssc	Rated symmetrical short-circuit current factor at accuracy limit with the selected load.[1]	x	x	x	x
Ls	Saturated inductance.	x	x	x	x
Lm	Non-saturated inductance.	x	x	x	x
Ts	Secondary time constant.	x	x	x	x
Kr	Remanence factor.	x	x	x	x
V-al	Accuracy limiting voltage according to IEC 60044-6 for class TPS (that point on the excitation graph where an increase of the e.m.f. r.m.s. voltage (core flux) by 10% causes an increase of the peak current by 100%).	x			
I-al	Accuracy limiting current according to IEC 60044-6 class TPS (at V_{al}).	x			
E1	User-defined e.m.f. to verify the excitation current at this e.m.f.	x			
Ie1	Max. allowed excitation current at E_1.	x			
E-max	Maximum e.m.f. voltage. This parameter allows the determination of the working point on the excitation curve that would be reached with the entered settings.		x	x	
$\hat{\varepsilon}$	Peak instantaneous error at voltage E_{max}.		x	x	
Ktd	Theoretical transient dimensioning factor.		x	x	x

1. If the *CT Analyzer* is not able to measure up to the actual value, the prefix ">" is displayed to indicate that the measurement value is larger than the displayed value.

Test results displayed in the Excitation card for IEEE C57.13

Parameter	Description	Results displayed for IEEE C57.13	
		protection CT	metering CT
V-kn	Knee point voltage according to standard.	x	x
I-kn	Knee point current according to standard.	x	x
Ls	Saturated inductance.	x	x
Lm	Non-saturated inductance.	x	x
Ts	Secondary time constant.	x	x
Kr	Remanence factor.	x	x
Vb	Rated secondary terminal voltage.	x	
FS	Instrument security factor (direct measurement method), calculated for nominal and operating burden.[1]		x
FSi	Instrument security factor (indirect measurement method), calculated for nominal and operating burden.[1]		x

1. If the *CT Analyzer* is not able to measure up to the actual value, the prefix ">" is displayed to indicate that the measurement value is larger than the displayed value.

7.6.4 Excitation Graph

The excitation graph page shows the graph calculated from the test results. To display the excitation graph, press the **Excit. Graph** soft key in the **Excitation** card. The graph shows the r.m.s. terminal/core voltage over the r.m.s./peak current depending on the selected standard.

On the bottom right of the diagram the voltage, current and inductance values for the selected point in the graph are displayed. The currently selected point in the graph is marked by a horizontal and a vertical dashed line.

In this page it is possible to load the excitation graph of an already saved test from the Compact Flash card in order to compare this graph with the one of the current test.

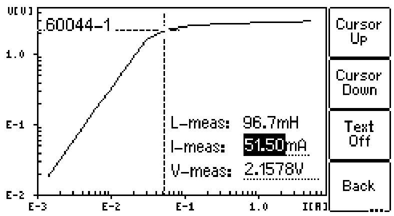
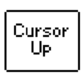
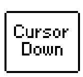
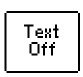


Figure 7-16 Excitation graph

Definition of axes in the excitation graph for different standards

Standard	Vertical axis	Horizontal axis
IEC 60044-1	r.m.s. terminal voltage	r.m.s. excitation current
IEC 60044-6	r.m.s. e.m.f. voltage	peak excitation current
IEEE C57.13	r.m.s. e.m.f. voltage	r.m.s. excitation current

Available soft keys

	Moves the cursor upwards on the excitation graph.
	Moves the cursor downwards on the excitation graph.
	Switches off the display of values on the bottom right of the diagram. If you have switched off the values, this soft key changes to **Text On** to switch the values display on again.

Back	Closes the excitation graph and brings you back to the **Excitation** card.
Knee Point	Moves the cursor to the knee point on the graph according to the selected standard. If two or more knee points could be found on the graph, this soft key is alternately labelled **Knee Point 1** or **Knee Point 2**, depending on which knee point the cursor is actually positioned to. By pressing the soft key you can switch between knee point 1 and knee point 2. After opening the excitation graph, the cursor shows the topmost knee point (knee point 1) and the soft key is labelled **Knee Point 2**.
Ref. Knee Point	Moves the cursor to the knee point on the reference graph. This soft key is only available if a reference graph is loaded. If the reference graph loaded has two or more knee points, this soft key is alternately labelled **Ref. Knee Point 1** or **Ref. Knee Point 2**, depending on which knee point the cursor is actually positioned to. By pressing the soft key you can switch between knee point 1 and knee point 2. After loading the reference graph, the cursor shows the topmost knee point (knee point 1) and the soft key is labelled **Ref. Knee Point 2**.
Load Ref. Curve	Opens the file system card to select a previous test in order to load the excitation curve of this test as a reference curve and compare it with the current one. The reference curve is displayed as a dotted line in addition to the excitation curve of the actual test. If a reference curve is loaded, the values V_{ref}, I_{ref} and L_{ref} are displayed in addition to the measured values.
Ref. Off	Switches off the reference curve from the display. If you have switched off the reference curve, the soft key changes to **Ref. On** to switch the reference curve on again. This soft key is only available if a reference curve has been loaded.
IEC 60044-1 IEC 60044-6 IEEE C57.13 IEEE C57.13 (30°)	By pressing one of these soft keys you can display the measured excitation graph and knee point as defined in the respective standard. **IEEE C57.13** displays the knee point for the 45° tangent. **IEEE C57.13 (30°)** displays the knee point for the 30° tangent. 30° is recommended for gapped cores in IEEE C37.110, chapter 4.3. **Note:** The test report only contains the graph for the standard selected in the **CT-Object** card.

Viewing the measured values for different points on the graph

By default, the knee point values are displayed after opening the excitation graph page. However, you can also view the corresponding voltage, current and inductance values for any point on the graph. To select a specific point on the graph,

- either use the soft keys (**Cursor Up**, **Cursor Down**, **Knee Point**)
- or enter a specific voltage or current value using the keyboard:
  – Select the desired edit field using the ▲ ▼ cursor keys.
  – Enter the desired voltage or current value using the keyboard.
  – Press the ↵ key to apply the entered value and read the corresponding values in the respective fields (e.g. "V-meas" and "L-meas" if you have entered a current "I-meas").

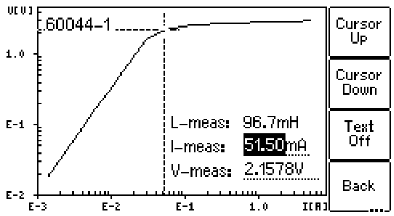


Figure 7-17 Entering a current value to display its corresponding voltage and inductance values on the excitation graph

7.6.5 Accuracy Limiting Error Graph*

* According to the "China Electric Regulations for protection CTs".

To display the AL error graph, press the **AL Error Graph** soft key in the **Excitation** card.

Note: The "AL Error Graph" function can be switched on or off in the device settings (**Main Menu**, entry "Settings" -> **Setting Menu**, entry "Accur. Limiting Error Graph"). If switched off, the AL error graph is not included in the test report.

All standards are supported, except IEC 60044-6 class TPZ.

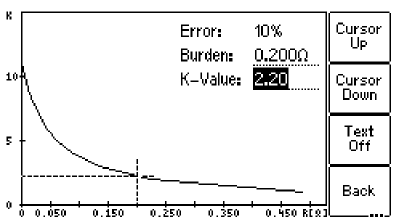


Figure 7-18 AL error graph

Available soft keys

Cursor Up	Moves the cursor upwards on the error graph.
Cursor Down	Moves the cursor downwards on the error graph.
Text Off	Switches off the display of values on the top right of the diagram. If you have switched off the values, this soft key changes to **Text On** to switch the values display on again.
Back	Closes the AL error graph and brings you back to the **Excitation** card.
Nominal Burden	Moves the cursor to that point on the error graph that corresponds to the nominal burden value defined in the "VA" field of the **CT-Object** card (value entered by the user or determined by the *CT Analyzer*).
Operat. Burden	Moves the cursor to that point on the error graph that corresponds to the operating burden value defined in the "Burden" field of the **CT-Object** card (value entered by the user or determined by the *CT Analyzer*).

Viewing the measured values for different points on the graph

By default, the cursor is positioned to the nominal burden values after opening this page.

To select a specific point on the graph:

- Select the desired edit field "K-Value" or "Burden" using the ▲ ▼ cursor keys and enter the desired value using the keyboard.
- Press the ↵ key to apply the entered value and read the corresponding value in the respective field.

7.7 Ratio Card

The **Ratio** card is only available if it is enabled in the **Select Cards** page (Default Test Settings or **Select Cards** soft key in the **CT-Object** card).

The ratio test measures the current ratio of the CT considering the operating burden (parameter "Burden" in **CT-Object** card) or the nominal burden (parameter "VA" in **CT-Object** card).

The results of the ratio test can be found in 3 pages:

- The **Ratio** card (refer to Figure 7-19) shows the polarity, the ratio error and the phase displacement for the primary current and the burden defined in the **CT-Object** card.

  If the **Results with Nom. Burden** soft key is pressed, the page shows the results related to the nominal burden ("VA" parameter in the **CT-Object** card). If the **Results with Op. Burden** soft key is pressed, the page shows the results related to the operating burden ("Burden" parameter in the **CT-Object** card).
- The **ratio table** shows the current ratio error for different currents (200 % down to 1 % of the rated current) at different burden values (depending on the selected standard, see section 7.7.4 on page 105 and 7.7.5 on page 106).
- The **phase table** shows the phase displacement for different currents at different burden values (depending on the selected standard, see section 7.7.4 on page 105 and 7.7.5 on page 106).

For a better understanding of the test results, the most important settings from the **CT-Object** card are shown once again in the upper part of the **Ratio** card.

Note: Although the test is not performed with the real current, the test results reflect the current ratio and not the voltage ratio.

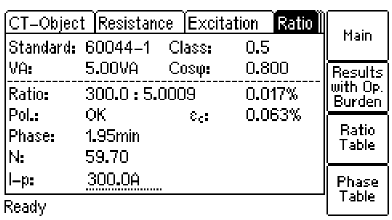


Figure 7-19 **Ratio** card

7.7.1 Available Soft Keys

Results with Op. Burden or Results with Nom Burden	Displays the results related to the operating burden of the CT. Displays the results related to the nominal burden of the CT.
Ratio Table	Displays the ratio table (refer to section 7.7.4 on page 105 and 7.7.5 on page 106). In the ratio table it is also possible to display the values related to the nominal burden or the operating burden of the CT.
Phase Table	Displays the phase table (refer to section 7.7.4 on page 105 and 7.7.5 on page 106). In the phase table it is also possible to display the values related to the nominal burden or the operating burden of the CT.

7.7.2 Test Settings

The following settings can be done in the **Ratio** test card.

Parameter	Description
I-p	Primary current for calculation of the ratio error and phase displacement with the burden (operating burden) defined in the **CT-Object** card. After the test is finished, it is possible to change the value for the primary current. The ratio error and/or the phase error are then recalculated and displayed again. When storing the test results, the currently displayed measurement results are stored. Changing this value only influences the results displayed in the **Ratio** card (operating burden related values). It does not affect the values displayed in the separate pages for the ratio and phase tables (values related to nominal burden). Default: Value of I_{pn}

7.7.3 Test Results

The following test results are displayed in the lower part of the **Ratio** card. In addition to the results displayed in the **Ratio** card you can view the ratio and phase table pages described in section 7.7.4 on page 105.

Parameter	Description
Ratio	Current ratio error (in %) at the specified primary current (I_p) and burden.
Pol.	OK: Polarity OK, phase angle is in the range of 0° ± 45°. Failed: Wrong polarity of the CT or wrong polarity of the measurement leads.
ε_C	Composite error in % at the specified primary current (I_p) and operating burden. This parameter is only displayed if the IEC 60044-1 standard is selected in the **CT-Object** card.
Phase	Phase displacement (in minutes) at the specified primary current (I_p) and burden.
N	Winding turns ratio.
εt	Turns ratio error acc. to IEC 60044-6 class TPS or IEC 60044-1 class PX.
RCF	Ratio correction factor. This parameter is only displayed if the IEEE C57.13 standard is selected in the **CT-Object** card.
TCF	Transformer correction factor. This parameter is only displayed if the IEEE C57.13 standard is selected in the **CT-Object** card.

7.7.4 Ratio Table and Phase Table for IEC 60044-1 and -6

To display the ratio table or the phase table, press the **Ratio Table** or **Phase Table** soft key in the **Ratio** card.

If the selected standard is **IEC 60044-1** or **IEC 60044-6**, these tables show the ratio error and the phase displacement

- for different current values between 1% and 200% of the rated current.
- at 100%, 50%, 25% and 12.5% of the burden defined on the **CT-Object** card ("VA" or "Burden" parameter) or at 1VA if one of these percentages results in a burden smaller than 1VA.

  Use the **Results with Op. Burden** or **Results with Nom. Burden** soft key to display the results related to the operating burden ("Burden" parameter in the **CT-Object** card) or related to the nominal burden ("VA" parameter in the **CT-Object** card).

The ratio table and the phase table contain all measurement points defined in the standards IEC 60044-1 and IEC 60044-6.

Use the ◀ ▶ cursor keys to scroll through the table columns (1% of rated current to 200% of rated current).

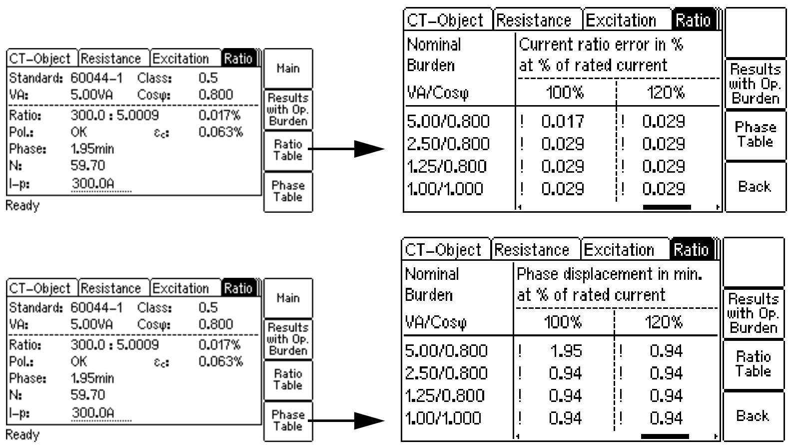


Figure 7-20 Displaying the ratio table and the phase table in the **Ratio** card (for IEC 60044-1 and -6)

Note: Values without the prefix "!" have guaranteed accuracy. The accuracy of values marked with a "!" in the tables is reduced by factor 2.

Note: For IEC 60044-1 metering CTs with I_{sn} = 5A, it is possible to increase the minimum **nominal burden** used for the assessment to 3.75VA in the device settings (**Main Menu**, entry "Settings" -> **Setting Menu**, entry "Min. VA at M cores Isn 5A"). In this case, the lowest nominal burden value displayed in the ratio table and the phase table is 3.75VA instead of 1VA. Please note that this only applies if the results are displayed with the nominal burden. It has no effect if the results in the ratio table and the phase table are displayed with the operating burden.

7.7.5 Ratio Table and Phase Table for IEEE C57.13

To display the ratio table or the phase table, press the **Ratio Table** or **Phase Table** soft key in the **Ratio** card.

If the selected standard is **IEEE C57.13**, these tables show the ratio error and the phase displacement

- for different current values between 1% and 200% of the rated current.
- at the burden specified in the **CT-Object** card ("VA" or "Burden" parameter) and all burden values defined in the IEEE C57.13 standard that are smaller than the specified burden.

  Use the **Results with Op. Burden** or **Results with Nom. Burden** soft key to display the results related to the operating burden ("Burden" parameter in the **CT-Object** card) or related to the nominal burden ("VA" parameter in the **CT-Object** card).

  Note: If the **Assess @ VA** option has been selected for the "Class" parameter of an IEEE C57.13 metering CT in the **CT-Object** card, the tables only show the ratio error and the phase displacement for the burden value specified in the **CT-Object** card.

  Note: If a high accuracy license is available for IEEE C57.13, metering burdens also include the electronic burdens.

The ratio table and the phase table contain all measurement points defined in the IEEE C57.13 standard.

Use the ◄ ► and ▲ ▼ cursor keys to scroll through the table columns (1% of rated current to 200% of rated current) and table lines (burden values).

Note: Values without the prefix "!" have guaranteed accuracy. The accuracy of values marked with a "!" in the tables is reduced by factor 2.

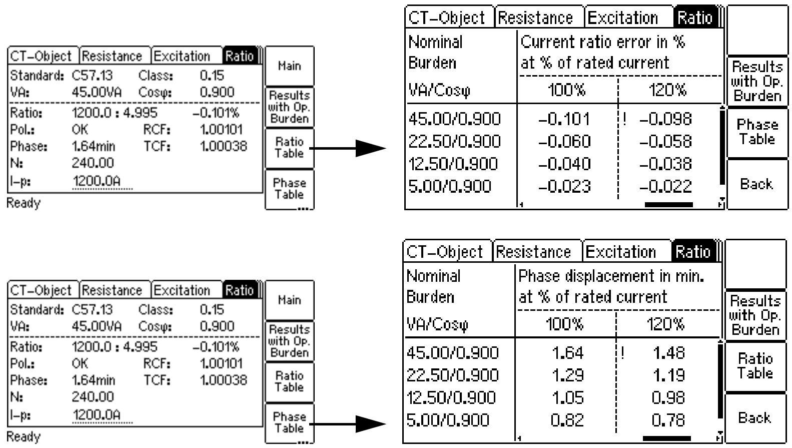


Figure 7-21 Displaying the ratio table and the phase table in the **Ratio** card (for IEEE C57.13)

7.8 Assessment Card

The **Assessment** card is only available if it is enabled in the **Select Cards** page (Default Test Card Selection or **Select Cards** soft key in the **CT-Object** card).

Depending on the standard and the type of CT (protection or metering CT), the according parameters are listed.

The column for automatic assessment ("Auto") is automatically filled after the test is finished. The following assessments are possible:

- "OK": The results measured for this parameter comply with the requirements defined by the selected standard and the parameters in the **CT-Object** card.
- "Failed": The results do not comply with the requirements.
- "n/a": No assessment possible due to one of the following reasons:
  - Comparison with input parameter is not possible.
  - Assessment does not make sense due to incorrect polarity or invalid measurement value.

It is also possible to perform a manual assessment for the individual parameters. To do this, select the parameter to be assessed using the ▲ ▼ cursor keys and apply your assessment using the **OK**, **Failed** or **?** soft key.

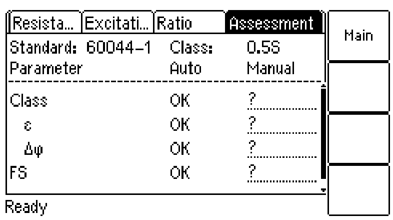


Figure 7-22 **Assessment** card (example)

Note: Automatic assessment is only performed for the CT behavior at nominal burden ("VA" parameter on the **CT-Object** card). For the CT behavior at operating burden ("Burden" parameter on the **CT-Object** card), no automatic assessment is performed.

7.8.1 Assessed Parameters

Parameters assessed for standard IEC 60044-1

Parameter	Description	Parameter assessed for IEC 60044-1, prot. CTs P	PR	PX	metering CTs 0.1	0.1s, 0.2, 0.2s, 0.5, 0.5s, 1	3, 5
Class	Accuracy class according to standard.	x	x	x	x	x	x
Burden	Manual assessment of the user for the burden test (no automatic assessment performed).	x	x	x	x	x	x
Rct	Secondary winding resistance.		x	x			
$\Delta\varphi$	Phase deviation.	x	x		x	x	
Kr	Remanence factor.	x	x		x	x	x
ε	Current ratio error.	x	x		x	x	x
ε_c	Composite error.	x	x				
εt	Turns ratio error (included in class).			x			
Ts	Secondary time constant.	x	x		x		
FS	Instrument security factor (direct measurement method).				x	x	x
FSi	Instrument security factor (indirect measurement method).				x	x	x
ALF	Accuracy limiting factor (direct measurement method).	x	x				
ALFi	Accuracy limiting factor (indirect measurement method).	x	x				
Ek	Rated knee point e.m.f.			x			
Kx	Dimensioning factor (according to IEC 60044-1 class PX).			x			
Ie	Accuracy limiting secondary excitation current.			x			
Ie1	Max. allowed secondary excitation current at E_1.			x			

Parameters assessed for standard IEC 60044-6

Parameter	Description	Parameter assessed for IEC 60044-6, protection CTs			
		TPS	TPX	TPY	TPZ
Class	Accuracy class according to standard.	x	x	x	x
Rct	DC winding resistance.	x	x	x	x
Burden	Manual assessment of the user for the burden test (no automatic assessment performed).	x	x	x	x
$\Delta\varphi$	Phase deviation.		x	x	x
ε	Current ratio error.		x	x	x
εt	Turns ratio error (included in class).	x			
$\hat{\varepsilon}$	Peak instantaneous error at voltage E_{max}.		x	x	
Ts	Secondary time constant.		x	x	x
Kr	Remanence factor.			x	
Ktd * Kssc	Transient dimensioning factor (K_{td}) multiplied by the rated symmetrical short-circuit current factor (K_{ssc}).		x	x	
K * Kssc	Dimensioning factor (K) multiplied by the rated symmetrical short-circuit current factor (K_{ssc}).	x			
V-al	Rated equivalent excitation limiting secondary voltage.	x			
I-al	Accuracy limiting secondary excitation current.	x			
Ie1	Max. allowed secondary excitation current at E_1.	x			

Parameters assessed for standard IEEE C57.13

Parameter	Description	Parameter assessed for					
		IEEE C57.13					IEEE C57.13.6
		prot. CTs, class				meter. CTs	high accuracy meter. CTs
		C	T	X	K[1]		
Class	Accuracy class according to standard.	x	x	x	x	x	x
Burden	Manual assessment of the user for the burden test (no automatic assessment performed).	x	x	x	x	x	x
ε @ Isn	Current ratio error at secondary current I_{sn}.	x	x	x	x		
ε @ 20 * Isn	Current ratio error at 20 times the secondary current I_{sn}.	x	x	x	x		
Rct	DC winding resistance.			x			
Vknee	Knee point voltage.				x		
Vk / Ik	User-defined measuring point.		x	x			
Vk1 / Ik1	User-defined measuring point 1.		x	x			
Δφ	Phase deviation.					x	x
RCF	Ratio correction factor.					x	x

1. Acc. to IEEE C57.13 (1993)

7.9 Comment Card

The **Comment** card is only available if it is enabled in the **Select Cards** page (Default Test Card Selection or **Select Cards** soft key in the **CT-Object** card).

In the **Comment** card you can enter any text, e.g. additional notes regarding the current test.

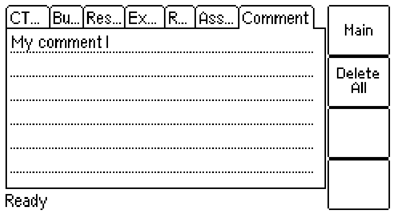


Figure 7-23 **Comment** card

8 CT Testing Using the Guesser Function

The guesser function of the *CT Analyzer* is intended as an aid for the user to find out single unknown name plate data of a CT, for example if parts of the CT's name plate are unreadable. If sufficient other name plate data of the CT are available and specified by the user, this function is often able to reliably determine single missing CT data, for example I_{prim}, I_{sec}, class or ratio.

The guesser function cannot release the user from specifying the CT's name plate data prior to testing. Always specify as many CT data as possible to increase the reliability of the values guessed by the*CT Analyzer*!

Caution: The data and values determined by the *CT Analyzer* using the guesser function are not guaranteed and have to be verified by the user.

8.1 Connecting the CT

Connect the CT to the *CT Analyzer* as shown on the front panel. Be sure that the polarity of all wires is correct.

1. Secondary side of the CT to input "Sec" and "Output" of the *CT Analyzer*.
2. Primary side of the CT to *CT Analyzer* input "Prim".

8.2 Preparing the Test

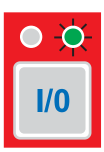
Proceed as follows to display the **CT-Object** card with a new CT test.

If the *CT Analyzer* is already switched on:

1. If necessary, display the **CT-Object** card and then press the **Main** soft key to display the main menu.
2. Select **New CT Test** from the main menu and press the **OK** soft key to initialize a new CT test.
3. The display shows the **CT-Object** card, ready to start a test.

If the *CT Analyzer* is switched off:

1. Switch the *CT Analyzer* on.
2. After the boot process is finished, the green LED is on and the red LED is off.
3. The display shows the **CT-Object** card, ready to start a test.



8.3 Running the Test

1. After switching the *CT Analyzer* on or after initializing a new test from the main menu, the default **CT-Object** card is displayed.

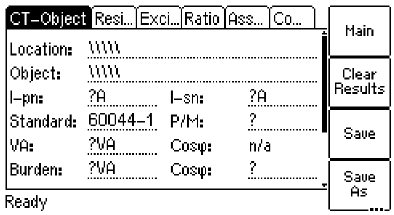


Figure 8-1 Empty **CT-Object** card after initializing a new test

2. Enter as many name plate data as available. The full set of CT data includes: I_{pn}, I_{sn}, standard, CT type (P/M), class and rated power of the CT (VA).
3. Start the test by pressing the I/0 key.
4. Possibly, the burden test and the primary winding resistance measurement are enabled for the default CT test.

   In this case, the *CT Analyzer* will display a corresponding message, asking you to check the wiring for the test (refer Figure 8-2). If so, press the **Skip Test** soft key to skip the burden test and/or the primary winding resistance measurement.

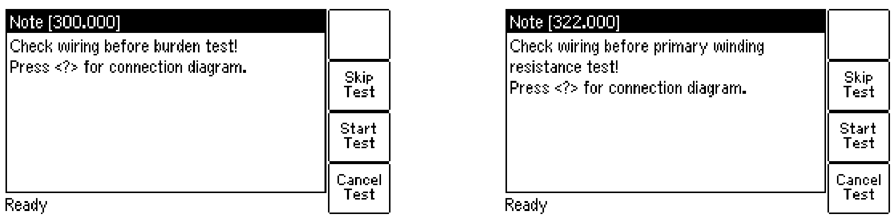


Figure 8-2 Check wiring message for burden test (left) and for primary winding resistance mesurement (right)

   Note: For information on how to enable or disable test cards, refer to section "Default Test Card Selection" on page 59.

5. The *CT Analyzer* then displays a message asking you to check the wiring for the CT test. Press the **Start Test** soft key to start the CT test.
6. The *CT Analyzer* starts the fully automatic CT test. When the test is over, the *CT Analyzer* displays a "Test finished" message showing the status of the test execution and the overall test assessment.

   For more detailed information about the test procedure, please refer to section 5.5 on page 47 and 5.6 on page 49.

9 Using the Quick Test Feature

Quick Test is an optional feature. The functionality described in this chapter is only available if you have purchased a corresponding license. For further information, please contact your OMICRON electronics GmbH sales contact or the OMICRON electronics GmbH office nearest you.

If your *CT Analyzer* provides a vaild license for *Quick Test*, the functional scope described in this chapter is also available in the *CTA Quick Test* PC software included in the *CT Analyzer PC Toolset*.

The *Quick Test* feature cannot be used when a *CT SB2* switch box is connected to the remote control interface of the *CT Analyzer*.

Measurements using *Quick Test* are not automatically stopped by the *CT Analyzer*. Such measurements have to be stopped manually.

The *CT Analyzer* possibly switches off its output automatically after a long period (> 15 min) of continuous operation at its maximum output power to prevent thermal overload of the device.

9.1 Safety Notes and Notes for Using Quick Test

Warning: For VT ratio measurement, the *CT Analyzer* output has to be connected to the primary side of the VT. Connecting the *CT Analyzer* output to the secondary side of the VT by mistake may cause hazardous voltages on the primary side!

Warning: Using the DC current mode of the Advanced measurement type may be very dangerous! It is not possible to interrupt the circuit using a standard relay or a standard circuit breaker. Due to the arc, contact clearances of up to 10 mm are required to switch off the current.

Caution: When using *Quick Test*, input "Sec" of the *CT Analyzer* is able to measure voltages up to 150 V_{RMS}. Do not connect voltages above 150 V or even mains voltages to the *CT Analyzer* inputs! This will damage the *CT Analyzer*!

Caution: When performing measurements on CTs using *Quick Test*, consider that the *CT Analyzer* does not perform automatic demagnetization of the CT. Therefore, it may be necessary to additionally run a normal CT test with its automatic demagnetizing cycle following *Quick Test* measurements for a CT.

9.2 Introduction to Quick Test

Using *Quick Test* it is possible to use the *CT Analyzer* as a versatile multimeter with included power source.

Possible fields of application for *Quick Test* are:

- Quick and easy resistance measurement, e.g. for wiring checks on the secondary side of CTs.
- Quick voltage ratio checks for VTs.
- Measurement of burden values, e.g. to determine the new burden value after changes of the relay equipment. This allows the re-calculation of the CT test results for the new burden value by the *CT Analyzer* and thus makes it unnecessary to run an additional CT test in order to determine the behavior of the CT with the new burden.

The user interface of *Quick Test* consists of two test cards, the **CT-Quick** card containing the measurement parameters and the **Results** card showing the results of the measurement. Figure 9-1 shows the test cards for a resistance measurement as an example.

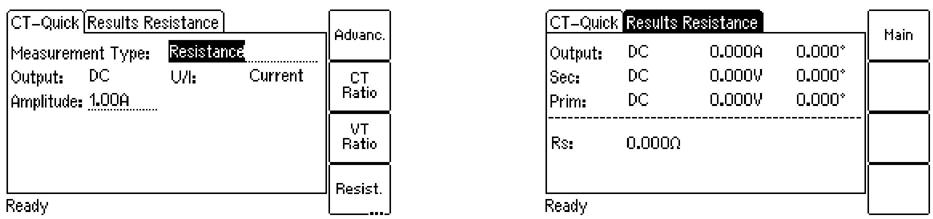


Figure 9-1 **CT-Quick** test card (left) and **Results** test card (right) for resistance measurement

Note: For a general description of the *CT Analyzer* user interface and basic procedures how to operate the *CT Analyzer* and the *Quick Test* tool, please refer to chapter 6 on page 51.

To select a measurement type, use the ▼ cursor key to move the cursor to the **Measurement Type** field in the **CT-Quick** card and then press the corresponding soft key of the measurement type.

The following measurement types are available in *Quick Test*.

Meas. type	Usage
Advanced Advanc.	Provides complete multimeter measurement functionality and free adjustment of all measurement quantities, such as AC or DC signal output, voltage or current output, output frequency, measurement mode (DC, RMS or frequency-selective) for the input, etc. For details, please refer to section 9.4 on page 118.
CT Ratio CT Ratio	Predefined type, especially intended for quick measurement of CT ratios. Adjustable measurement quantities are the voltage and the frequency of the output signal and the resistance and inductance of the CT to be measured. For details, please refer to section 9.5 on page 123.
VT Ratio VT Ratio	Predefined type, especially intended for quick measurement of VT ratios. Adjustable measurement quantities are the voltage and the frequency of the output signal. For details, please refer to section 9.6 on page 125.
Resistance Resist.	Predefined type, especially intended for quick measurement of resistances. The only adjustable measurement quantity is the value of the output current. For details, please refer to section 9.7 on page 128.
Impedance Imped.	Predefined type, especially intended for quick measurement of impedances. Adjustable measurement quantities are the amplitude and the frequency of the current output signal. For details, please refer to section 9.8 on page 130.
Reactance React.	Predefined type, especially intended for quick measurement of reactances. Adjustable measurement quantities are the voltage and the frequency of the output signal. For details, please refer to section 9.9 on page 131.

9.3 Performing Measurements with Quick Test

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- New Quick-Test

OK soft key

-> **CT-Quick** card

Measurements using *Quick Test* are not automatically stopped by the *CT Analyzer*. Such measurements have to be stopped manually by the user.

Proceed as follows to perform measurements using the *Quick Test* feature:

1. Select **New Quick-Test** from the main menu and press the **OK** soft key to open *Quick Test*. The display then shows the **CT-Quick** card.

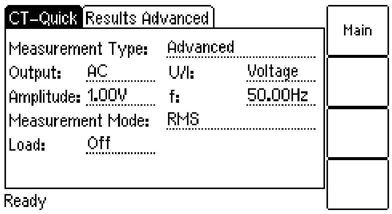


Figure 9-2 **CT-Quick** card

2. Select the measurement type and connect your test object to the *CT Analyzer* correspondingly (see sections 9.4 to 9.9 below).
3. Define your measurement quantities.
4. Start and stop your measurement by pressing the I/0 key.
5. After starting a measurement, the **Results** card is displayed automatically, showing the measurement results.

9.4 Advanced Measurement

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- New Quick-Test

OK soft key

CT-Quick card:
Measurement Type:
Advanced

The Advanced measurement type offers complete multimeter measurement functionality and free adjustment of all measurement quantities, such as AC or DC signal output, voltage or current output, output frequency, measurement mode (DC, RMS or frequency-selective) for the input, etc.

Using the Advanced measurement type it is also possible to use input "Sec" of the *CT Analyzer* as a voltmeter for **measuring external voltages** up to 150 V_{RMS} with frequencies up to 4 kHz.

Caution: When using *Quick Test*, input "Sec" of the *CT Analyzer* is able to measure voltages up to 150 V_{RMS}. Do not connect voltages above 150 V or even mains voltages to the *CT Analyzer* inputs! This will damage the *CT Analyzer*!

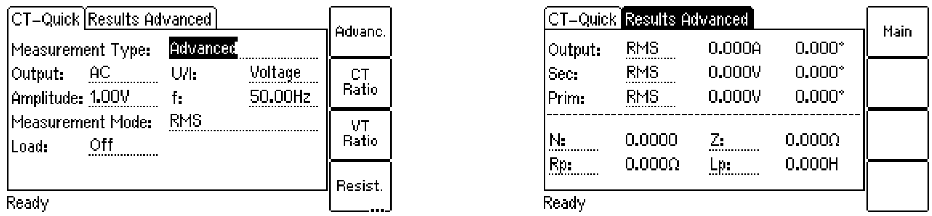


Figure 9-3 **CT-Quick** card and **Results** card for Advanced measurement type

For the Advanced measurement type, all measurement quantities available in the **CT-Quick** card can be adjusted by the user.

For this measurement type, the **CT-Quick** card holds the following measurement quantities:

Parameter	Description
Output	Output signal type AC or DC or output signal switched off. Possible values: **AC** or **DC** or **Off**. Default: AC.
U/I	Operating mode of the internal signal generator: voltage or current source. Possible values: **U** (voltage) or **I** (current). Default: Voltage
Amplitude	RMS voltage or current value of the output signal. Possible values: Mode "AC" and "Voltage": 0 to 40 V Mode "DC" and "Voltage": 0 to 120 V Mode "AC" and "Current": 0 to 5 A Mode "DC" and "Current": 0 to 10 A Default: 1.00 V or 1.00 A. **Warning: DC current mode is very dangerous!** In this mode, it is not possible to interrupt the circuit using a standard relay or a standard circuit breaker. Due to the electric arc, contact clearances of up to 10 mm are required to switch off the current.
f	Frequency of the output signal. Only available for AC voltage or current output. Possible values: Any value between 5.0 and 400.0 Hz or soft keys **16.7 Hz**, **50 Hz**, **60 Hz** or **400 Hz**. Default: 50 Hz

Parameter	Description
Measurement Mode	Measurement mode. Possible values: **DC**, **RMS** or **f-sel. filter**. Default: RMS DC measurement: Measures the DC part of the signal only. RMS measurement: Performs a standard true RMS measurement of the signal. Frequency selective measurement: Allows high precision measurement of the fundamental wave of an applied signal. All frequencies outside the output frequency plus/minus the filter bandwidth are supressed by at least 110 dB. This measurement mode is deactivated for output signal type DC. See also "B-width" below.
B-width	Filter bandwidth for frequency selective measurement. Only available for measurement mode **Freq. sel. filter**. Possible values: 3 Hz to 20 Hz. Default: 6 Hz Depending on the filter bandwidth selected, the measurement time can differ considerably. The typical time needed for a frequency selective measurement depends on the filter bandwidth as follows: Filter bandwidth — Measurement time 3 Hz — approx. 5 seconds 6 Hz — approx. 4 seconds
Load	Only available for AC signal output. Setting the **Load** parameter to "on" and specifying the winding resistance and the unsaturated inductance in the fields **R** and **L** will prevent saturation of the connected CT. The output generator of the *CT Analyzer* then keeps the DC part of the output current at zero using a current regulator permanently running during the output of AC signals. Possible values: **On** or **Off**. Default: Off

Parameter	Description
R, L	Only available if **Load** is set to "on". Winding resistance (R) and unsaturated inductance (L) of the CT, used by the internal output regulator to prevent saturation of the connected CT (see "Load" above). Possible values: 0 to 1000 Ω or 0 to 1000 H. Default: 1.00 Ω for **R** and 50.00 H for **L** If these values are not set correctly for the connected CT, the CT will saturate sooner or later, depending on the inaccuracy of the values used.

The **upper part** of the **Results Advanced** card (Figure 9-4) displays the measured values:

Value	Description
Output	Internally measured current value and phase of the output signal.[1]
Sec	Voltage measured at input "Sec".[1] Max. input voltage: 150 V_{RMS} Measurement is performed according to the measurement mode selected on the **CT-Quick** card. This input is considered as the phase reference, therefore the phase is always 0.
Prim	Value and phase of the voltage measured at input "Prim".[1] Max. input voltage: 30 V_{RMS} Measurement is performed according to the measurement mode" selected on the **CT-Quick** card.

1. Select the display mode for the current or voltage value using the soft keys: **RMS**, **DC**, **Peak+** (highest positive peak value) or **Peak-** (highest negative peak value).

The **lower part** of the **Results Advanced** card (Figure 9-4) displays the measurement results calculated from the measured values. In this area, you can freely define which result each single field should display.

Figure 9-4 shows the **Results Advanced** card with the default selection for the results fields.

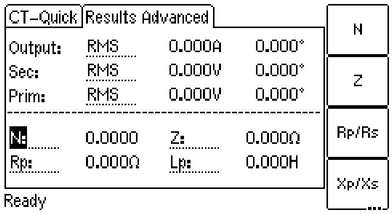


Figure 9-4 **Results Advanced** card with default selection for the displayed results

Use the cursor keys to move the cursor to a field and then select the result to be displayed in this field using the available soft keys **N**, **Z**, **Rp/Rs**, **Xp/Xs**, **cos** φ, **Lp/Ls** (or **Cp/Cs**) or **f**.

The following table lists the calculated results available for the Advanced measurement type.

Result	Description
N	Ratio calculated from the values measured at inputs "Sec" and "Prim".
Z	Impedance, calculated from the amplitude and phase angle of the output signal and the voltage measured at input "Sec".
Rp, Rs	Use the **Rp/Rs** soft key to switch between R_p and R_s. Parallel or serial resistance, calculated from the output signal and the voltage measured at input "Sec".
Xp, Xs	Use the **Xp/Xs** soft key to switch between X_p and X_s. Parallel or serial reactance, calculated from the output signal and the voltage measured at input "Sec".
cos φ	Power factor of the measured impedance.
Lp, Ls or Cp, Cs	Use the **Lp/Ls** (or **Cp/Cs**) soft key to switch between L_p (C_p) and L_s (C_s). Parallel or serial inductance or capacitance of the test object, calculated from the output signal and the voltage measured at input "Sec". The *CT Analyzer* automatically detects whether the test object is an inductance or a capacitance based on the phase angle.
f	Frequency measured at input "Sec".

Note: The results for $\mathbf{R_p}$, $\mathbf{X_p}$ and $\mathbf{L_p}$ ($\mathbf{C_p}$) are calculated using the parallel equivalent circuit diagram, the results for $\mathbf{R_s}$, $\mathbf{X_s}$ and $\mathbf{L_s}$ ($\mathbf{C_s}$) are calculated using the serial equivalent circuit diagram.

Use the following wiring (examples):

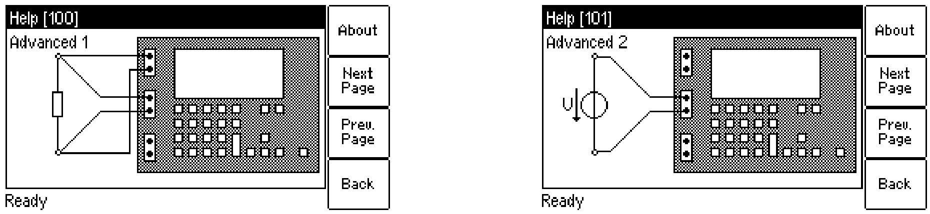


Figure 9-5 Wiring examples for Advanced measurement type

9.5 CT Ratio Measurement

Caution: CT ratio measurement using *Quick Test* is not a complete CT test! This measurement only determines the current ratio of CTs. The *CT Analyzer* does not perform automatic demagnetization after the measurement.

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- New Quick-Test

OK soft key

CT-Quick card:
Measurement Type:
CT Ratio

This is a predefined measurement type, intended especially for the quick measurement of CT ratios.

To select the CT Ratio measurement type, use the ▼ cursor key to move the cursor to the **Measurement Type** field in the **CT-Quick** card and then press the **CT Ratio** soft key.

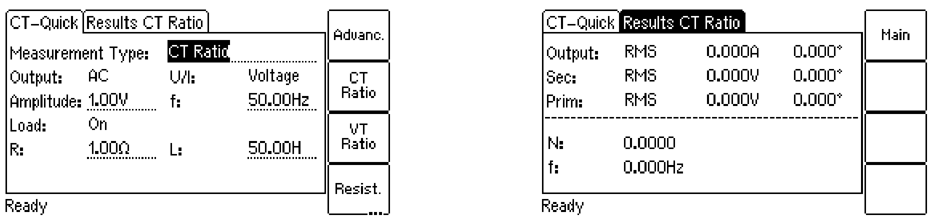


Figure 9-6 **CT-Quick** card and **Results** card for CT ratio measurement

For the **CT Ratio** measurement type, the **CT-Quick** card holds the following measurement quantities:

Parameter	Description
Output	The output signal type is fixed to "AC".
U/I	Operating mode of the internal signal generator: voltage or current source. Fixed to "Voltage".

Parameter	Description
Amplitude	RMS voltage of the output signal. Adjustable by the user. Possible values: 0 to 40 V. Default: 1.00 V.
f	Frequency of the output signal. Adjustable by the user. Possible values: 5.0 to 400.0 Hz or soft keys **16.7 Hz**, **50 Hz**, **60 Hz** or **400 Hz**. Default: 50 Hz
Load	Fixed to "On". Setting the **Load** parameter to "on" and specifying the winding resistance and the unsaturated inductance in the fields **R** and **L** will prevent saturation of the connected CT. The output generator of the *CT Analyzer* then keeps the DC part of the output current at zero using a current regulator permanently running during the output of AC signals.
R, L	Winding resistance (**R**) and unsaturated inductance (**L**) of the CT, used by the internal output regulator to prevent saturation of the connected CT (see **Load** above). Possible values: 0 to 1000 Ω or 0 to 1000 H. Default: 1.00 Ω for **R** and 50.00 H for **L** If these values are not set correctly for the connected CT, the CT will saturate sooner or later, depending on the inaccuracy of the values used.

The following values are displayed in the **Results CT Ratio** card:

Value	Description
Output	Internally measured RMS current value and phase of the output signal.
Sec	RMS value of the voltage measured at input "Sec". This input is considered as the phase reference, therefore the phase is always 0.
Prim	RMS value and phase of the voltage measured at input "Prim".
N	Current ratio of the CT calculated from the voltages measured at inputs "Sec" and "Prim".
f	Frequency measured at input "Sec".

Use the following wiring for CT ratio measurement (example):

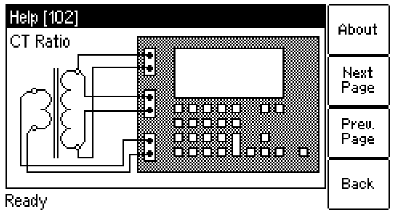


Figure 9-7 Wiring example for CT ratio measurement

9.6 VT Ratio Measurement

Warning: For VT ratio measurement, the *CT Analyzer* output has to be connected to the **primary side** of the VT. Connecting the *CT Analyzer* output to the secondary side of the VT by mistake may cause hazardous voltages on the primary side!

Caution: VT ratio measurement using *Quick Test* is not a complete VT test! This measurement only determines the voltage ratio of VTs. The *CT Analyzer* does not perform automatic demagnetization after the measurement.

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- New Quick-Test

OK soft key

CT-Quick card:
Measurement Type:
VT Ratio

This is a predefined measurement type, intended especially for the quick measurement of VT ratios.

To select the VT Ratio measurement type, use the ▼ cursor key to move the cursor to the **Measurement Type** field in the **CT-Quick** card and then press the **VT Ratio** soft key.

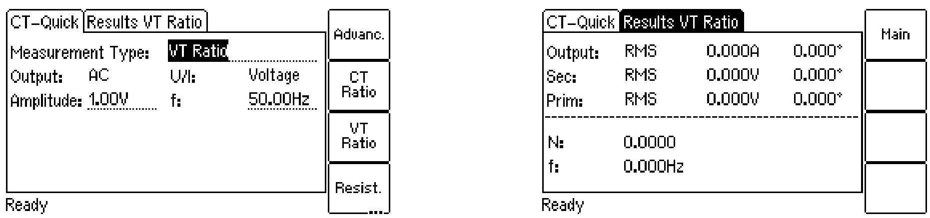


Figure 9-8 **CT-Quick** card and **Results** card for VT ratio measurement

For the **VT Ratio** measurement type, the **CT-Quick** card holds the following measurement quantities:

Parameter	Description
Output	The output signal type is fixed to "AC".
U/I	Operating mode of the internal signal generator: voltage or current source. Fixed to "Voltage".

Parameter	Description
Amplitude	RMS voltage of the output signal. Adjustable by the user. Possible values: 0 to 40 V. Default: 1.00 V.
f	Frequency of the output signal. Adjustable by the user. Possible values: 5.0 to 400.0 Hz or soft keys **16.7 Hz**, **50 Hz**, **60 Hz** or **400 Hz**. Default: 50 Hz

The following values are displayed in the **Results VT Ratio** card:

Value	Description
Output	Internally measured RMS current value and phase of the output signal.
Sec	RMS value of the voltage measured at input "Sec". This input is considered as the phase reference, therefore the phase is always 0.
Prim	RMS value and phase of the voltage measured at input "Prim".
N	Voltage ratio of the VT calculated from the voltages measured at inputs "Sec" and "Prim".
f	Frequency measured at input "Sec".

Proceed as follows to perform a VT ratio measurement:

1. Connect the "Output" sockets and input "Sec" of the *CT Analyzer* to the primary side of the VT and input "Prim" of the *CT Analyzer* to the secondary winding of the VT (see Figure 9-9).

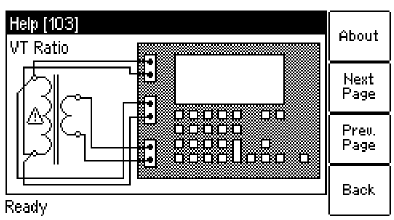


Figure 9-9 Wiring example for VT ratio measurement

Warning: Hazardous voltages may occur on the primary side of the VT if the *CT Analyzer* output is connected to the secondary side of the VT by mistake!

2. Open the *Quick Test* measurement function on the *CT Analyzer* or start the *CTA QuickTest* PC tool from the *CTA Start Page*.
3. Select the **VT Ratio** measurement type. Set the amplitude to the maximum output voltage of 40 V and the frequency to the mains frequency. Refer to Figure 9-10.

   Note: If it is necessary to suppress mains frequency interferences, use the **Advanced** measurement type with a frequency of e.g. 3 Hz above the mains frequency (e.g. 53 Hz) and choose the frequency-selective measurement mode with a filter bandwidth of 6 Hz. Mains frequency interferences are then suppressed by 120 dB.

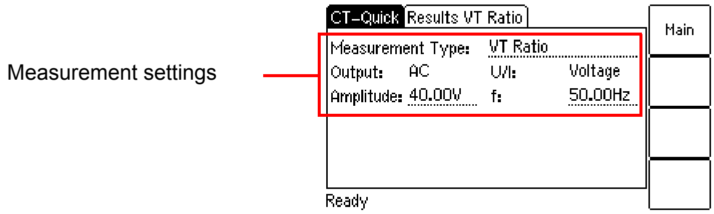


Figure 9-10 **CT-Quick** test card with settings for VT ratio measurement

4. Start the measurement by pressing the I/0 key on the *CT Analyzer* or clicking the **ON** button on the **VT Ratio** tab of the *CTA QuickTest* software. The measured values are displayed and permanently updated as long as the measurement is active. Refer to Figure 9-11.
5. Stop the measurement by pressing the I/0 key on the *CT Analyzer* again or clicking the **OFF** button on the **VT Ratio** tab of the *CTA QuickTest* software.

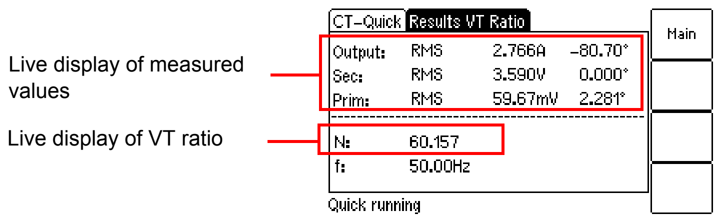


Figure 9-11 **Results** test card for VT ratio measurement

9.7 Resistance Measurement

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- New Quick-Test

OK soft key

CT-Quick card:
Measurement Type:
Resistance

This is a predefined measurement type, intended especially for the quick measurement of resistances.

To select the Resistance measurement type, use the ▼ cursor key to move the cursor to the **Measurement Type** field in the **CT-Quick** card and then press the **Resist.** soft key.

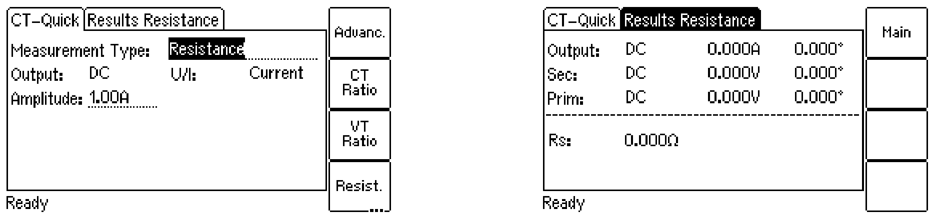


Figure 9-12 **CT-Quick** card and **Results** card for resistance measurement

For the **Resistance** measurement type, the **CT-Quick** card holds the following measurement quantities:

Parameter	Description
Output	The output signal type is fixed to "DC".
U/I	Operating mode of the internal signal generator: voltage or current source. Fixed to "Current".
Amplitude	Amplitude of the output current. Adjustable by the user. Possible values: 0 to 10 A. Default: 1.00 A.

The following values are displayed in the **Results Resistance** card:

Value	Description
Output	Internally measured output current.
Sec	Voltage measured at input "Sec".
Prim	Not used for resistance measurement.
Rs	Serial resistance, calculated from the output current and the voltage measured at input "Sec".

Note: The resistance measurement uses the serial equivalent circuit diagram for results calculation.

Use the following wiring for resistance measurement (example):

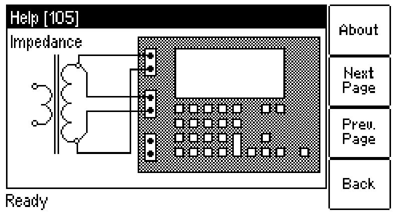


Figure 9-13 Wiring example for resistance measurement

Proceed as follows to perform winding resistance measurement on VTs:

1. Connect the "Output" sockets and input "Sec" of the *CT Analyzer* to the winding to be measured (see Figure 9-13).
2. Open the *Quick Test* measurement function on the *CT Analyzer* or start the *CTA QuickTest* PC tool from the *CTA Start Page*.
3. Select the **Resistance** measurement type and set the amplitude of the DC output current appropriately. Refer to Figure 9-14.

Caution: Use only low currents of e.g. 100 mA when measuring the primary side of VTs. **Too high currents could destroy the winding!**

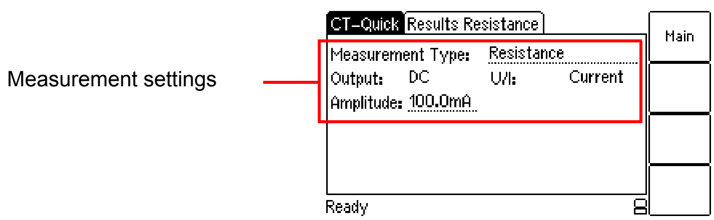


Figure 9-14 **CT-Quick** test card with settings for VT winding resistance measurement

4. Start the measurement by pressing the I/0 key on the *CT Analyzer* or clicking the **ON** button on the **Resistance** tab of the *CTA QuickTest* software. The measured values are displayed and permanently updated as long as the measurement is active. Refer to Figure 9-11.
5. Stop the measurement by pressing the I/0 key on the *CT Analyzer* again or clicking the **OFF** button on the **Resistance** tab of the *CTA QuickTest* software.

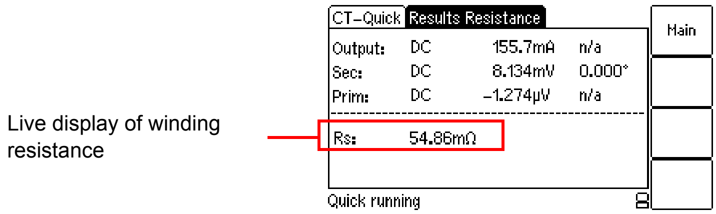


Figure 9-15 **Results** test card for VT winding resistance measurement

9.8 Impedance Measurement

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- New Quick-Test

OK soft key

CT-Quick card:
Measurement Type: Impedance

This is a predefined measurement type, intended especially for the quick measurement of impedances.

To select the Impedance measurement type, use the ▼ cursor key to move the cursor to the **Measurement Type** field in the **CT-Quick** card and then press the **Imped.** soft key.

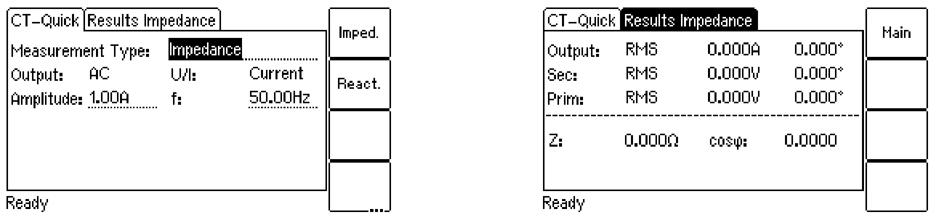


Figure 9-16 **CT-Quick** card and **Results** card for impedance measurement

For the **Impedance** measurement type, the **CT-Quick** card holds the following measurement quantities:

Parameter	Description
Output	The output signal type is fixed to "AC".
V/I	Operating mode of the internal signal generator: voltage or current source. Fixed to "Current".
Amplitude	RMS value of the output current. Adjustable by the user. Possible values: 0 to 5A. Default: 1.00A.
f	Frequency of the output signal. Adjustable by the user. Possible values: 5.0 to 400.0Hz or soft keys **16.7Hz**, **50Hz**, **60Hz** or **400Hz**. Default: 50Hz

The following values are displayed in the **Results Impedance** card:

Value	Description
Output	Internally measured RMS value and phase of the output current.
Sec	RMS value of the voltage measured at input "Sec". This input is considered as the phase reference, therefore the phase is always 0.
Prim	Not used for impedance measurement.
Z	Measured impedance, calculated from the magnitude and phase angle of the output signal and the voltage measured at input "Sec".
cos φ	Power factor of the measured impedance.

Use the following wiring for impedance measurement (example):

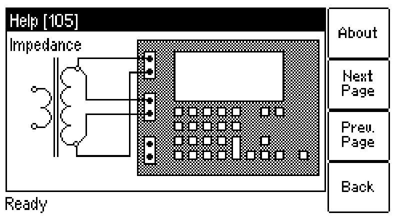


Figure 9-17 Wiring example for impedance measurement

9.9 Reactance Measurement

How to get there:

Press the **Main** soft key in any test card

Main Menu:
- New Quick-Test

OK soft key

CT-Quick card:
Measurement Type:
Reactance

This is a predefined measurement type, intended especially for the quick measurement of reactances.

To select the Reactance measurement type, use the ▼ cursor key to move the cursor to the **Measurement Type** field in the **CT-Quick** card and then press the **React.** soft key.

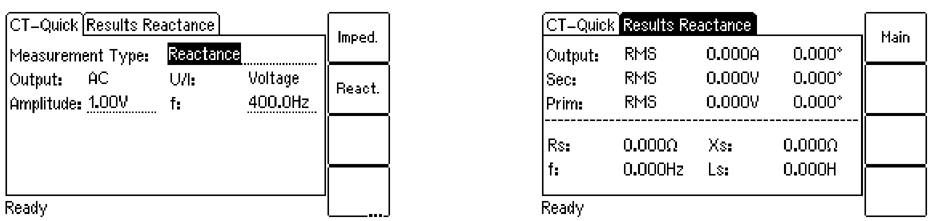


Figure 9-18 **CT-Quick** card and **Results** card for reactance measurement

For the **Reactance** measurement type, the **CT-Quick** card holds the following measurement quantities:

Parameter	Description
Output	The output signal type is fixed to "AC".
U/I	Operating mode of the internal signal generator: voltage or current source. Fixed to "Voltage".
Amplitude	RMS voltage of the output signal. Adjustable by the user. Possible values: 0 to 40 V. Default: 1.00 V.
f	Frequency of the output signal. Adjustable by the user. Possible values: 5.0 to 400.0 Hz or soft keys **16.7 Hz**, **50 Hz**, **60 Hz** or **400 Hz**. Default: 400 Hz

The following values are displayed in the **Results Reactance** card:

Value	Description
Output	Internally measured RMS current value and phase of the output signal.
Sec	RMS value of the voltage measured at input "Sec". This input is considered as the phase reference, therefore the phase is always 0.
Prim	Not used for reactance measurement.
Rs	Serial resistance, calculated from the output signal and the voltage measured at input "Sec".
Xs	Serial reactance, calculated from the magnitude and phase angle of the output signal and the voltage measured at input "Sec".
f	Frequency measured at input "Sec".
Ls or Cs	Serial inductance or capacitance of the test object, calculated from the measured values. The *CT Analyzer* automatically detects whether the test object is an inductance or a capacitance based on the phase angle.

Note: The reactance measurement uses the serial equivalent circuit diagram for results calculation.

Use the following wiring for reactance measurement (example):

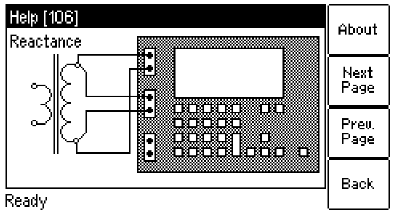


Figure 9-19 Wiring example for reactance measurement

10 CT Analyzer PC Toolset

The *CT Analyzer PC Toolset* contains a set of PC software that is necessary and helpful for your work with the *CT Analyzer* on a PC.

The following tools are installed with the *CT Analyzer PC Toolset*:

- *CTA Start Page*
- *CTA QuickTest*
- *CTA Firmware Update*
- *CT Report Tool (Remote Excel File Loader)* with templates for single-ratio CT measurement and multi-ratio CT measurement
- *Report Converter (XML to WORD)*
- *OMICRON Device Browser*
- *CTA Remote Control* incl. sample software
- CTA remote test sample for Visual Basic (VBA)
- CTA remote test sample for C++

For detailed information about the software of the *CT Analyzer PC Toolset*, please click the "CT Analyzer Help" hyperlink on the *CTA Start Page*.

10.1 System Requirements

The software of the *CT Analyzer PC Toolset* requires the following software installed on the system:

- Operating system:
  Windows XP SP3, Windows Vista SP1 32 bit, Windows 7 32 bit,
  Windows 7 64 bit.

  Note: Windows XP requires administrative rights for your local machine
- Microsoft Office® (required for *CT Report Tool* (Remote Excel File Loader) with *CTA Remote Control* software and *Report Converter (XML to WORD)*): Office 2002 (XP) SP3, Office 2003 SP3, Office 2007 SP2 or Office 2010.

10.2 Installing the CT Analyzer PC Toolset

The *CT Analyzer PC Toolset* and its installation program *Setup Wizard* are included on the "*CT Analyzer PC Toolset*" CD ROM accompanying the *CT Analyzer*. Proceed as follows to install the *CT Analyzer PC Toolset*:

1. Exit all other major programs running on your computer.

2. Insert the "*CT Analyzer PC Toolset*" CD ROM into your computer's CD ROM drive. The Setup Wizard starts automatically.

   Note: Should the Setup Wizard not start automatically a few seconds after the CD has been inserted into the CD ROM drive, change to the Windows Explorer and double-click **setup.exe** on the "*CT Analyzer PC Toolset*" CD ROM.

3. Follow the instructions displayed on the screen to install the software.

10.3 The CTA Start Page

The *CTA Start Page* is the central organizing element for the PC software tools available for the *CT Analyzer*.

There are two ways to launch the *CTA Start Page*:

1. Select **Programs | OMICRON | CT Analyzer | CTA Start Page** in the Windows **Start** menu.

2. Or double-click the **CTA Start Page** desktop icon.

Figure 10-1 CTA Start Page

In the *CTA Start Page*, click **CT Analyzer Help** to open the help system with detailed information about the software tools of the *CT Analyzer PC Toolset*.

11 Technical Data

Guaranteed data are specified for an ambient temperature of 23°C ± 5° (73°F ± 9°), a power supply of 115/230V_{AC}, and after a warm-up time longer than 15 minutes.

Guaranteed data are valid for the period of one year after factory adjustment.

11.1 Mains Power Supply

Mains power supply	
Connection	Connector according to IEC 60320
Mains voltage	100 - 240V_{AC} / 50/60Hz / 6A
Mains fuses	2 x T6AH 250V, (high-breaking capacity wire fuse 5 x 20mm)
Overvoltage category	II

11.2 Generator Output

Generator output	
Output current	5A_{rms} max.
Output voltage	0 - 120V_{AC}
Output power	400VA_{rms} max.

11.3 Measurement Inputs

Measurement input "Sec"	
Voltage ranges	0 - 0.3 / 3 / 30 / 300V_{AC} (auto ranging)
Accuracy	0.1% (guaranteed)
Input impedance	0 - 15V: 1MΩ 15 - 150V: 500kΩ to 1MΩ, depending on the voltage. Input current is compensated by the device.
Insulation	Reinforced insulation (R) to all other circuits

Measurement input "Prim"	
Voltage ranges	0 - 0.03 / 0.3 / 3 / 30V_{AC} (auto ranging)
Accuracy	0.1% (guaranteed)
Input impedance	0 - 15V: 330kΩ 15 - 30V: 120kΩ to 330kΩ, depending on the voltage.
Insulation	Reinforced insulation (R) to all other circuits

11.4 Winding Resistance Measurement Accuracy

Winding resistance measurement accuracy	
Resolution	1mΩ
Accuracy	0.05% (typical) 0.1% + 1mΩ (guaranteed)

11.5 Ratio and Phase Measurement Accuracy

The values given in the following table are only valid under the following conditions:

- All utility lines to the primary side of the CT are disconnected.
- One terminal of the primary side of the CT is connected to PE.
- The original measurement cables delivered by OMICRON electronics for the *CT Analyzer* are used.
- The CT under test is a CT with a non-gapped core.
- The knee point voltage according to IEEE C57.13 is > 3V.

Under interfering conditions the device has reduced accuracy.

Values without the prefix "!" in the ratio table of the **Ratio** card have guaranteed accuracy. The accuracy of values marked with a "!" in the table is reduced by factor 2 since these values are not directly measured but calculated from the measured values instead.

Ratio measurement accuracy for 1 A CTs at rated current				
CT ratio	I_{sn}	Rated power[1]	Typical accuracy	Guaranteed accuracy
0.2 - 1	1	1.0 - 30VA	0.05%	0.1%
> 1 - 2000	1	0 - 30VA	0.02%	0.05%
> 2000 - 5000	1	0 - 30VA	0.03%	0.1%
> 5000 - 10000	1	0 - 30VA	0.05%	0.2%

1. Nominal burden of the CT.

Ratio measurement accuracy for 5 A CTs at rated current				
CT ratio	I_{sn}	Rated power[1]	Typical accuracy	Guaranteed accuracy
0.2 - 1	5	1.0 - 75VA	0.05%	0.1%
> 1 - 2000	5	0 - 75VA	0.02%	0.05%
> 2000 - 5000	5	0 - 75VA	0.03%	0.1%
> 5000 - 10000	5	0 - 75VA	0.05%	0.2%

1. Nominal burden of the CT.

Phase measurement accuracy at rated current	
Resolution	0.01min
Accuracy (cos φ 0.8 - 1)	1min (typical) 3min (guaranteed)

Turns ratio measurement accuracy	
Resolution	0.01 turns
Accuracy	0.05% (typical) 0.1% (guaranteed)

11.6 Compact Flash Card Interface

Compact Flash card interface	
Card type	CF type 1
Allowed memory size	16 MB - 2 GB

11.7 Remote Control Interface

The remote control interface of the *CT Analyzer* is exclusively intended to connect the *CT Analyzer* to a computer (e.g. running the *CT Analyzer PC Toolset* software) or to the *CT SB2* switch box (for multi-ratio CT measurement).

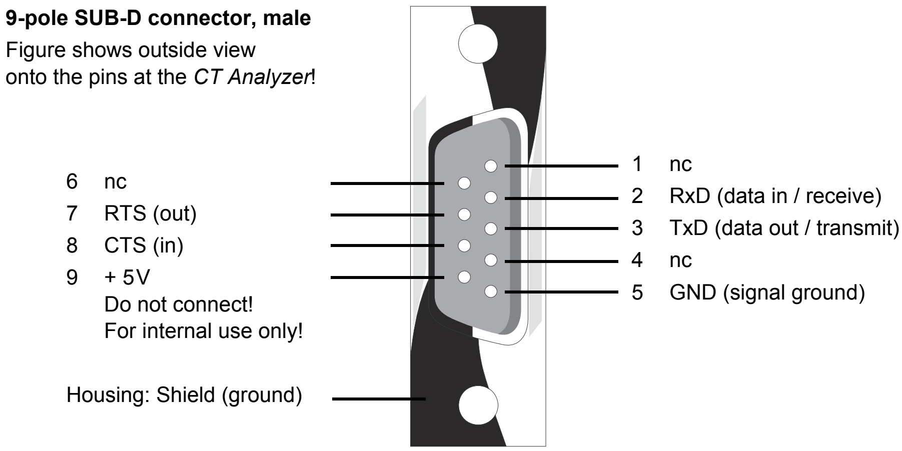


Figure 11-1 Pin assignment for remote control interface

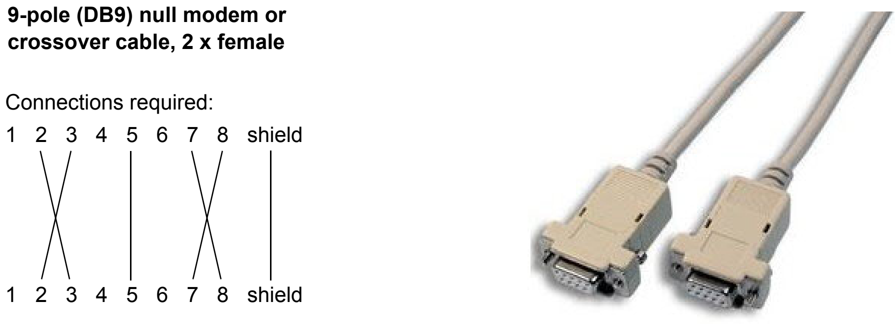


Figure 11-2 Connection cable for remote control interface

11.8 Environmental Conditions

11.8.1 Climate

Climate	
Operating temperature	-10 … +50°C (14 … 122°F)
Storage and transportation	–25 … +70°C (–13 … 158°F)
Max. altitude	2000m
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%

11.8.2 Shock and Vibration

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

11.8.3 Mechanical Data

Weight, Dimensions and Protection	
Weight	< 8kg (17.6lbs) without accessories
Dimensions W x H x D	360 x 285 x 145mm (14.2 x 11.2 x 5.7")

11.8.4 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

12 User Maintenance

12.1 Care and Cleaning

The *CT Analyzer* 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 Analyzer* prior to cleaning!

12.2 Replacing Fuses

1. Turn off the *CT Analyzer* and unplug the power cord.
2. Ground the test object, and disconnect it from the *CT Analyzer*. By disconnecting it you prevent a possibly faulty test object from feeding power back into the *CT Analyzer*.
3. Locate the blown fuse on the side panel of the *CT Analyzer* and replace it by an identical fuse type: T6.3H 250 V (6.3 Amps slow-acting high breaking capacity wire fuse 5 x 20mm). The *CT Analyzer* has two fuses of the same type.

12.3 Calibrating the CT Analyzer

OMICRON electronics GmbH offers a reference CT (calibration CT VEHZ0649) to verify the calibration of the *CT Analyzer*. This reference CT is delivered together with a calibration certificate of a national test laboratory.

The calibration CT has a ratio of 2000:1 and 2000:5. Its class is 0.02.

To verify the calibration of the *CT Analyzer*, it is necessary to measure both ratios (2000:1 and 2000:5). The *CT Analyzer* is within the specifications, if all measurement results are within class 0.02.

If the measurement results are not within class 0.02, we recommend to send the *CT Analyzer* back to OMICRON electronics GmbH for calibration in order to guarantee proper operation in accordance with the regulations.

13 Scope of Delivery, Accessories, Available Licenses

For up-to-date information about the scope of delivery and available accessories and licenses for the *CT Analyzer* please refer to the OMICRON electronics GmbH website or the OMICRON electronics GmbH office nearest you.

For contact in formation, please refer to chapter "Contact Information / Technical Support" on page 161.

14 Error and Warning Messages

001.xxx **Error [001] No valid CT software!**
Reason: No valid software in the device Flash memory or incorrect checksum.
Solution: Insert a Compact Flash card with valid software (**CTAnalyzer.bin**) in the **Omicron** directory and switch the *CT Analyzer* off and on again.

002.xxx **Error [002] Can't open file!**
Reason: The firmware cannot read the file **CTAnalyzer.bin** from the Compact Flash card since the CF card or the file is missing.
Solution: Insert a Compact Flash card with valid software (**CTAnalyzer.bin**) in the **Omicron** directory and switch the *CT Analyzer* off and on again.

003.xxx **Error [003] Download error!**
Reason: The downloaded software is corrupt.
Solution: Insert a Compact Flash card with valid software (**CTAnalyzer.bin**) in the **Omicron** directory and switch the *CT Analyzer* off and on again.

100.xxx **Warning [100.xxx] CT resistance > 3000 Ohms.**
Reason: The resistance measured during primary or secondary winding resistance measurement is > 3000 Ω.
Solution: The test cannot be continued. Check the connections to the CT. If the connections are ok, the CT resistance is > 3000 Ω. Such CTs cannot be tested using the *CT Analyzer*.

101.xxx **Warning [101.xxx] Timeout during measurement. No constant winding resistance can be determined within 10 sec.**
Reason: The *CT Analyzer* cannot determine a constant winding resistance within 10 sec. during primary or secondary winding resistance measurement.
Solution: The test cannot be continued. Check the connections to the CT.

110.xxx **Warning [110.xxx] The impedance of the CT is too high.**
Reason: The impedance of the CT or the load is too high to reach the minimum toggle frequency of 0.2 Hz / 0.8 Hz.
Solution: The test cannot be continued. Check the connections to the CT. If the connections are ok, it is not possible to test this CT due to its too high inductance.

111.xxx **Warning [111.xxx] Inductance of load too low.**
Reason: Measurement frequency is too high and cannot be decreased because of too low CT inductance.
Solution: The test cannot be continued. Check the connections to the CT. If the connections are ok, it is not possible to test this CT due to its too low inductance.

112.xxx **Warning [112.xxx] Measurement error, reduce noise level.**
Reason: It is not possible to obtain stable measurement results due to incorrect wiring, wiring short-circuit, connected load or external interferences.
Solution: Check the wiring. The primary side of the CT must not be short-circuited. Disconnect the primary side of the CT from the transmission lines, connect one primary side terminal to PE and open the other one. Use the delivered original coax cables for measurement (see section 4.5 "Noise Reduction Techniques" on page 28). Make sure that no burden is connected to the secondary side of the CT. This error may also indicate a winding short circuit of the CT.

113.xxx **Warning [113.xxx] Test not successful. Kneepoint not found.**
Reason: Knee point for specified standard not found.
Solution: The current required to reach the knee point for the specified standard cannot be delivered. The CT cannot be tested up to the knee point voltage.

114.xxx **Warning [114.xxx] Low inductance detected during excitation measurement.**
Reason: Low inductance was measured during the excitation test.
Solution: Verify that the primary side of the CT is not short-circuited.
This warning can also occur for CTs with very low excitation loss and high parasitic capacitance.

115.xxx **Warning [115.xxx] Invalid eddy loss measurement.**
Reason: Reliable determination of the eddy losses is not possible.
Solution: Verify the wiring and repeat the test. If the error message is displayed repeatedly, it is currently not possible to test this CT using the *CT Analyzer*.

116.xxx **Warning [116.xxx] Knee point too low! CTs with a knee point below 1 volt are not supported.**
Reason: The knee point voltage is smaller than 1 V.
Solution: Currently it is not possible to test CTs with such a low knee point using the *CT Analyzer*.

121.xxx **Warning [121.xxx] Test not successful! Reverse polarity. Check wiring and repeat the measurement.**
Reason: Measured polarity is wrong.
Solution: Reverse the polarity of the measurement cables on the primary or secondary side of the CT.

130.xxx **Warning [130.xxx] Burden impedance > 1kOhm.**
Reason: Burden impedance > 1kΩ.
Solution: The test cannot be continued. Check the connections to the Burden.

131.xxx **Warning [131.xxx] Overload during Burden measurement.**
Reason: The required test current cannot be reached, even at the maximum output voltage.
Solution: The *CT Analyzer* cannot deliver enough current. Reduce the test current or the impedance of the burden. Check the wiring for proper contacts; one connection possibly has a bad connection.

140.xxx **Warning [140.xxx] Timeout during remanence test. Measured magnetic flux is unstable. Reduce noise level.**
Reason: The magnetic flux during remanence measurement is not stable.
Solution: The test cannot be continued. Check the connections to the CT. Try to reduce the noise level for the measurement.

200.xxx **Warning [200.xxx] Check connection. Make sure burden is properly wired.**
Reason: The measured input voltage differs by more than 5V from the input voltage expected during burden test.
Solution: Check whether the output generator ("Output") and measurement input "Sec" are connected correctly.

200.xxx **Warning [200.xxx] Check CT SB2 switch box wiring: CTA OUTPUT and/or BURDEN terminal may be disconnected.**
Reason: The measured input voltage differs by more than 5V from the input voltage expected during the burden test using the *CT SB2* switch box.
Solution: Check whether the BURDEN OUT and the BURDEN IN sockets on the *CT SB2* are connected correctly.

201.xxx **Warning [201.xxx] Check connection. Measured ratio > 50000:1.**
Reason: Measurement input "Prim" is possibly not connected properly.
Solution: Check whether the primary side measurement input "Prim" is connected properly.

202.xxx **Warning [202.xxx] Check connection. Polarity of input SEC and power output are not the same.**
Reason: Polarity of input "Sec" and "Output" are not the same.
Solution: Check whether the output generator ("Output") and measurement input "Sec" are connected properly and with correct polarity.

203.xxx **Warning [203.xxx] Check connection. Input SEC may be disconnected.**
Reason: Input signal at input "Sec" differs from the expected one.
Solution: Check whether the output generator ("Output") and measurement input "Sec" are connected properly.

204.xxx **Warning [204.xxx] Check connection. Polarity of input PRIM and power output are not the same.**
Reason: Input signal at input "Prim" differs from the expected one: Reverse polarity at input "Prim".
Solution: Check whether the output generator ("Output") and measurement input "Prim" are connected properly and with correct polarity.

204.xxx **Warning [204.xxx] Check CT SB2 switch box wiring: Wrong polarity at PRIM terminal.**
Reason: Input signal at input "PRIM" differs from the expected one: Reverse polarity at *CT SB2* input "PRIM".
Solution: Check whether the PRIM IN sockets on the *CT SB2* are connected properly and with correct polarity. If necessary, connect with changed polarity.

205.xxx **Warning [205.xxx] Check connection. Input PRIM may be disconnected.**
Reason: Input signal at input "Prim" differs from the expected one.
Solution: Check whether the output generator ("Output") and measurement input "Prim" are connected properly.

205.xxx **Warning [205.xxx] Check CT SB2 switch box wiring: PRIM IN terminal may be disconnected.**
Reason: Input signal at input "Prim" differs from the expected one.
Solution: Check whether the PRIM IN sockets on the *CT SB2* are connected properly.

206.xxx **Warning [206.xxx] Check connection. Ensure that the output is connected to the primary side of the CT.**
Reason: Input signal at input "Prim" differs from the expected one.
Solution: Check that the output generator ("Output") is connected to the CT and that the primary side of the CT is connected to input "Prim".

206.xxx **Warning [206.xxx] Check CT SB2 switch box wiring: CTA OUTPUT and/or PRIM OUT terminal may be disconnected.**
Reason: Input signal at input "Prim" differs from the expected one.
Solution: Check whether the PRIM OUT and the PRIM IN sockets on the *CT SB2* are connected correctly to the primary side of the CT.

207.xxx **Warning [207.xxx] Check connection! OUTPUT may be disconnected.**
Reason: The current signal differs from the expected one.
Solution: Check whether the output generator ("Output") and measurement input "SEC" are connected properly to the secondary side of the CT.

210.xxx **Warning [210.xxx] Permanent data overflow.**
Reason: Internal data buffer overflow. The data could not be fetched fast enough from the internal data buffer.
Solution: Try to repeat the measurement. If this error occurs more frequently, you should contact your next OMICRON service center.

211.xxx **Warning [211.xxx] AC mode measurement timeout.**
Reason: Measurement timeout due to frequent range switching or invalid data from the measurement inputs.
Solution: Check the wiring and repeat the measurement. Try to reduce noise for the measurement.

220.xxx **Warning [220.xxx] Test aborted!**
Reason: The test sequence has been interrupted by the user.
Solution: Repeat the test without interrupting it.

310.xxx **Note [310.xxx] License: <Guesser functionality> is missing! Values for: Ipn, Isn, P/M, Class, FS/ALF should be provided.**
Reason: The license required for class guessing is not available.
Solution: Specify the values for I_{pn}, I_{sn}, Class, P/M and FS/ALF before starting the test.

311.xxx **Warning [311.xxx] License: <Simulation after test> is missing!**
Reason: The license required for simulation is not available.
Solution: Simulation of the results for changed test settings (e.g. different burden values) after the test is not possible. Purchase a corresponding license.

312.xxx **Warning [312.xxx] License: <...> is missing!**
Reason: The license specified in the message is not available.
Solution: The functionality included in the license is not available. Purchase a corresponding license.

313.xxx **Warning [313.xxx] License: <All languages> is missing! Test can be performed only if the Chinese user interface is set.**
Reason: The license required to use all languages is not available.
Solution: Perform the test with the Chinese user interface or purchase a corresponding license.

316.xxx **Note [316.xxx] Invalid user text. You must download at least version: <VersNo> or higher. The language is set to English.**
Reason: The version of the user interface language file is invalid.
Solution: Download a valid user interface language file to the *CT Analyzer*.

318.xxx **Warning [318.xxx] License: <Burden guesser> is missing! Values for VA, Burden, Cosφ should be provided.**
Reason: The license required for the burden guesser functionality is not available.
Solution: Specify the values for nominal and operating burden (VA, Burden and cosφ) or purchase a corresponding license.

319.xxx **Warning [319.xxx] License: <Quick test> is missing!**
Reason: The license required for the Quick Test functionality is not available.
Solution: Purchase a corresponding license if you want to perform measurements using Quick Test.

331.xxx **Note [331.xxx] Ipn is invalid! The value must be between the Ipn values of the neighboring taps.**
Reason: An invalid I_{pn} value has been entered to the **MR-Config.** card.
Solution: Enter a valid I_{pn} value.

332.xxx **Note [332.xxx] I-sn has to be specified. Vb and VA are calculated dependent on I-sn.**
Reason: You tried to enter values for V_b or VA without specifying the I_{sn} value first.
Solution: Enter a valid I_{sn} value before specifying values for V_b and VA.

333.xxx **Note [333.xxx] First define I-pn for this tap.**
Reason: You tried to enter a nominal burden (VA) value for a tap without specifying the I_{pn} for this tap first.
Solution: Enter a valid I_{pn} value for the tap before specifying the nominal burden (VA).

334.xxx **Note [334.xxx] Test cannot be started. Nominal burden (VA) should be >= 3.75VA.**
Reason: The nominal burden (VA) entered is lower than the limit specified in the device settings (parameter "Min. VA at M cores Isn 5A").
Solution: Enter a nominal burden (VA) higher than or equal to 3.75VA.

356.xxx **Warning [356.xxx] License: <All frequencies support> is missing! Only 60 Hz nominal frequency is supported.**
Reason: The license required to use all frequencies is not available.
Solution: Measurements are only possible for 60 Hz. Purchase a corresponding license if you want to perform testing with other frequencies.

357.xxx **Note [357.xxx] License: <P cores support> is missing! Only metering CTs can be measured.**
Reason: The license required to perform testing of protection cores is not available.
Solution: Testing is only possible for metering cores. Purchase a corresponding license if you want to perform testing of protection cores.

358.xxx **Warning [358.xxx] License: <M cores support> is missing! Only protection CTs can be measured.**
Reason: The license required to perform testing of metering cores is not available.
Solution: Testing is only possible for protection cores. Purchase a corresponding license if you want to perform testing of metering cores.

400.xxx **Warning [400.xxx] You cannot make a multi-ratio measurement without a CT SB2 switch box!**
Reason: No *CT SB2* is connected when starting a multi-ratio measurement.
Solution: Connect the *CT SB2* to the *CT Analyzer* before starting a multi-ratio test.

401.xxx **Warning [401.xxx] CT SB2 switch box is disconnected!**
Reason: The *CT SB2* is not properly connected to the *CT Analyzer*.
Solution: Restore proper connection between the *CT SB2* and the *CT Analyzer* and restart your test.

402.xxx **Warning [402.xxx] CT SB2 switch box communication error.**
Reason: Communication between the *CT SB2* and the *CT Analyzer* failed.
Solution: Restore proper connection between the *CT SB2* and the *CT Analyzer* and restart your test.

403.xxx **Warning [403.xxx] Check CT SB2 switch box wiring: CTA OUTPUT, TAPS XN and/or X1 may be disconnected.**
Reason: The CTA OUTPUT sockets of the *CT SB2* are not properly connected to the *CT Analyzer* output.
Solution: Make sure that the CTA OUTPUT sockets on the *CT SB2* are properly connected to the *CT Analyzer* and restart your test.

404.xxx **Warning [404.xxx] Check CT SB2 switch box wiring: CTA PRIM and/or PRIM IN terminal may be disconnected.**

Reason: The CTA PRIM sockets of the *CT SB2* are not properly connected to *CT Analyzer* input PRIM.

Solution: Make sure that the CTA PRIM sockets on the *CT SB2* are properly connected to *CT Analyzer* input PRIM and restart your test.

405.xxx **Warning [405.xxx] Check CT SB2 switch box wiring: CTA SEC terminal, TAPS XN IN and/or X1 IN may be disconnected.**

Reason: The CTA SEC sockets of the *CT SB2* are not properly connected to *CT Analyzer* input SEC.

Solution: Make sure that the CTA SEC sockets on the *CT SB2* are properly connected to *CT Analyzer* input SEC and restart your test.

406.xxx **Warning [406.xxx] Check CT SB2 switch box wiring: <text depending on connection actually detected>**

Reason: The CTA SEC sockets of the *CT SB2* are not properly connected to *CT Analyzer* input SEC.

Solution: Make sure that the CTA SEC sockets on the *CT SB2* are properly connected to *CT Analyzer* input SEC and restart your test.

407.xxx **Warning [407.xxx] Check CT SB2 switch box wiring: Wrong polarity at CTA SEC or CTA OUTPUT terminal**

Reason: Reverse polarity at the CTA SEC sockets or the CTA OUTPUT sockets of the *CT SB2*.

Solution: Make sure that the CTA SEC sockets and the CTA OUTPUT sockets on the *CT SB2* are properly connected to *CT Analyzer* and restart your test.

408.xxx **Warning [408.xxx] Check CT SB2 switch box wiring: <text depending on missing connection actually detected>**

Reason: At least one of the CT taps enabled for multi-ratio testing is not connected to the *CT SB2* correctly.

Solution: Make sure that all CT taps are connected correctly to the TAPS terminals on the *CT SB2* and restart your test.

409.xxx **Warning [409.xxx] Check CT SB2 switch box wiring: <text depending on incorrect connection actually detected>**

Reason: Wiring of at least two CT taps is mixed, e.g. CT tap X2 is connected to TAPS X3 on the *CT SB2* and vice versa.

Solution: Make sure that all CT taps are connected to the correct TAPS terminals on the *CT SB2* and restart your test.

411.xxx **Warning [411.xxx] Firmware download to switch box failed! Error: SBErrNo**

Reason: *CT SB2* firmware download failed.

Solution: Ensure that the *CT SB2* is connected to the *CT Analyzer* and repeat the firmware download to the *CT SB2*.

415.xxx **Warning [415.xxx] Quick measurement cannot be started. Please disconnect the CT SB2 switch box.**

Reason: You are trying to initiate a *Quick* measurement with the *CT SB2* switch box still connected to the *CT Analyzer*.

Solution: Measurements using *Quick Test* are not possible when the *CT SB2* is connected to the *CT Analyzer*. Remove all connections to the *CT SB2* and restart your *Quick* measurement on the *CT Analyzer*.

501.xxx No message displayed on the *CT Analyzer*. Message only displayed on remote PC connected to the *CT Analyzer*.
Reason: The remote interface handler couldn't decipher the command.
Solution: Remote interface error. Check the connection between *CT Analyzer* and PC.

504.xxx No message displayed on the *CT Analyzer*. Message only displayed on remote PC connected to the *CT Analyzer*.
Reason: Data transmission error.
Solution: Check the connection between *CT Analyzer* and PC.

510.xxx No message displayed on the *CT Analyzer*. Message only displayed on remote PC connected to the *CT Analyzer*.
Reason: Remote interface error: Failed to get the required measurement data because the measurement is still running.
Solution: Check the connection between *CT Analyzer* and PC.

511.xxx No message displayed on the *CT Analyzer*. Message only displayed on remote PC connected to the *CT Analyzer*.
Reason: Remote interface error: Failed to unzip the transmitted data block.
Solution: Check the connection between *CT Analyzer* and PC.

513.xxx No message displayed on the *CT Analyzer*. Message only displayed on remote PC connected to the *CT Analyzer*.
Reason: The current remote interface command is not allowed.
Solution: Make sure that the current *CT Analyzer* state allows the execution of the command.

514.xxx No message displayed on the *CT Analyzer*. Message only displayed on remote PC connected to the *CT Analyzer*.
Reason: Remote interface error: Remote command was submitted with an invalid parameter.
Solution: Verify the parameter (index) submitted with the remote interface command.

800.xxx **Warning [800.xxx] Flash card access error. Internal file system error.**
Reason: The file system sent an error message.
Solution: Compact Flash card is possibly corrupt. Use a new Compact Flash card.

801.xxx **Warning [801.xxx] Flash card access error. Invalid file name or path.**
Reason: The file system sent an error message.
Solution: The Compact Flash card is possibly corrupt. Try to save the data to a PC and format the CF card.

802.xxx **Warning [802.xxx] Flash card access error. Access denied.**
Reason: The file system sent an error message. You tried to open a "read only" file or a special directory.
Solution: Access the Compact Flash card on a PC and remove the "read-only" file attribute. File attributes cannot be modified with the *CT Analyzer*.

803.xxx **Warning [803.xxx] Flash card access error. File or folder already exists.**
Reason: The file system sent an error message.
Solution: Enter a different file or folder name.

804.xxx **Warning [804.xxx] Flash card access error. Disk full.**
Reason: The file system sent an error message.
Solution: Delete some files on the Compact Flash card or insert a new CF card.

805.xxx **Warning [805.xxx] Flash card access error. No or corrupt flash card.**
Reason: No or no valid CF card can be found.
Solution: Insert a valid Compact Flash card.

806.xxx **Warning [806.xxx] Flash card access error. Corrupt directory structure.**
Reason: The file system sent an error message.
Solution: Try to backup the data on the Compact Flash card to a PC and perform formatting of the Compact Flash card.

807.xxx **Warning [807.xxx] Nothing to paste.**
Reason: No file(s) selected to paste.
Solution: Select one or more files using the **Copy** or **Cut** function and try again.

808.xxx **Warning [808.xxx] Renaming of folders not supported.**
Reason: This action is not supported.
Solution: Renaming of folders is not supported by the *CT Analyzer*.

809.xxx **Warning [809.xxx] Are you sure you want to format the CF card? All data will be lost!**
Reason: This warning always appears before formatting of a Compact Flash card is executed, since all data stored on the Compact Flash card will be erased during formatting.
Solution: Press **Format** to start formatting or **Abort** to cancel the operation without formatting the Compact Flash card.

810.xxx **Warning [810.xxx] File exists. Do you want to overwrite it?**
Reason: The file name used to save the data already exists. This warning always appears before overwriting files on the Compact Flash card.
Solution: Enter another file name, if desired.

811.xxx **Warning [811.xxx] Are you sure you want to delete <File Name>?**
Reason: This warning always appears prior to the deletion of a file on the Compact Flash card.
Solution: Press **Yes** to delete the file or **No** to return to the file system card without deleting the file.

812.xxx **Warning [812.xxx] Are you sure you want to delete all selected files?**
Reason: This warning always appears prior to the deletion of files on the Compact Flash card.
Solution: Press **Yes** to delete the files or **No** to return to the file system card without deleting the files.

813.xxx **Warning [813.xxx] One or more parameters could not be found. Some calculations may not work.**
Reason: The .xml report file read from the Compact Flash card is of a newer format than the device can generate.
Solution: The loaded file is incompatible or the software version on your *CT Analyzer* is older than the software version that has generated the report. To enable your *CT Analyzer* to read this report, it is necessary to update the *CT Analyzer* software.

814.xxx **Warning [814.xxx] You tried to load an old report. One or more parameters could not be found. Some calculations may not work.**
Reason: One or more entries could not be found in the .xml report file.
Solution: The software version on the *CT Analyzer* is newer than the software version used to generate the report. The report probably does not contain all parameters supported by the new *CT Analyzer* software.

815.xxx **Error [815.xxx] Folder must be empty. Can't remove folder <Folder Name>.**
Reason: The folder selected for deletion is not empty. Only empty folders can be deleted.
Solution: Navigate to the folder you want to delete. Open the folder and delete all contained files and subfolders. Then you can delete the empty folder.

816.xxx **Error [816.xxx] You tried to load a report built with a <Device>.**
Reason: The .xml file seems to be not a *CT Analyzer* report.
Solution: The report cannot be loaded by the *CT Analyzer*.

817.xxx **Error [817.xxx] The xml file has no valid OMICRON report style.**
Reason: The .xml file has no valid OMICRON report style.
Solution: The report cannot be loaded by the *CT Analyzer*.

818.xxx **Warning [818.xxx] Moving of folders not supported.**
Reason: Moving of folders is not supported by the *CT Analyzer*.
Solution: Select only files to move, not folders. Using the shift key and the up/down cursor keys it is possible to select any number of files within a folder.

819.xxx **Warning [819.xxx] File name contains an invalid character.**
Reason: An invalid character was used to specify the file name.
Invalid characters: \ / : * ? \ < > |
Solution: Only use valid characters for the file name.

820.xxx **Error [820.xxx] Memory management error. Contact the next OMICRON service center.**
Reason: Memory management error.
Solution: Switch the *CT Analyzer* off, wait a second then switch it on again. If this error occurs more frequently, you should contact your next OMICRON service center.

821.xxx **Error [821.xxx] Could not update firmware.**
Reason: An error has occurred in the boot loader software.
Solution: Insert a Compact Flash card with valid software (**CTAnalyzer.bin**) in the directory **A:\Omicron** and switch the *CT Analyzer* off and on again.

823.xxx **Error [823.xxx] Could not update user text!**
Reason: An error has occurred in the user text loader software.
Solution: Insert a Compact Flash card with valid software (**CTUser_xxx.bin**) in the directory **A:\Omicron** and try again.

824.xxx **Error [824.xxx] An internal software error has occurred at address xxxxxxxH. To log this error, make sure that a CF card is inserted and then press OK. Please send the file \OMICRON\ErrorLog.xml on the CF card to the next OMICRON service center.**
Reason: Invalid result in a floating point operation (NaN).
Solution: Contact your next OMICRON service center.

825.xxx **Warning [825.xxx] Size of file [FileName] >= 1Mbyte.**
Reason: The size of the file copied to the *CT Analyzer* Compact Flash card or virtual disc is > 1 MB.
Solution: Avoid transfer of large files > 1 MB to the *CT Analyzer*.

830.xxx **License < ... > is invalid.**
Reason: An invalid license entry was found in the license file **Omicron.lic** on the CF Card.
Solution: Specify a valid license key.

831.xxx **Setting value for < ... > is invalid. The default value of < ... > is used.**

Reason: Invalid item in file **Settings.inf**.

Solution: The file **Settings.inf** in the **Omicron** directory on the CF card of the *CT Analyzer* has a formatting error in one of the parameters. Delete this file and check the settings in the menu **Main Menu -> Settings -> Misc. Settings**. If necessary, change the settings and store the file again.

832.xxx **Lifetime of relays near end. Contact the next OMICRON service center soon to arrange a hardware service.**

Reason: The relays inside the *CT Analyzer* near the end of their lifetime (more than 1,000,000 measurements performed).

Solution: Arrange a hardware service in order to replace the relays.

833.xxx **You are about to load a report with an invalid hash code. Some measurement values may not be authentic.**

Reason: The file checksum is not valid.

Solution: Check the authenticity of the report file loaded.

834.xxx **No valid license was found in this file!**

Reason: No valid license found.

Solution: Check the license file. The license possibly does not correspond to the serial number of the *CT Analyzer*.

900.xxx **Error [900.xxx] Power supply error. Switch off the device and wait 1 minute to restart.**

Reason: The output power was larger than 350 VA or the power supply is defective.

Solution: Switch the *CT Analyzer* off, wait 1 minute and then switch it on again. If this error occurs more frequently, you should contact your next OMICRON service center.

901.xxx **Warning [901.xxx] Protective earth (PE) connection in power supply cord missing. Connect PE to equipotential terminal. Lethal voltage may occur on housing and all terminals.**

Reason: Earth wire break, no earth wire connected or device is supplied via an isolation transformer.

Solution: The mains supply does not have reference to protective earth or protective earth is not connected. The mains supply must have galvanic connection to PE. If you are using an isolation transformer, connect one supply line of the *CT Analyzer* to PE.

Warning: Lethal voltages may occur at the housing if the equipotential bonding terminal of the device is not connected to protective earth potential!

Caution: If the mains supply is galvanically isolated from earth potential, the device may become damaged.

Comment: If a galvanically isolated mains supply is used, voltage stress may occur for the insulation system, the device is not constructed for. **Safety is no longer guranteed!** Therefore, always use a mains power cord with a protective earthing conductor connected to PE of the mains supply. Connect the equipotential bonding connection of the device to protective earth in order to prevent electric shock caused by lethal voltages possibly present at the housing. If this error is ignored, the device will probably work but safety is no longer guaranteed.

903.xxx **Warning [903.xxx] Excessive reverse power, don't disconnect any wires, don't switch off mains, wait until power is dissipated.**
ATTENTION: Lethal voltages on output terminals!

Reason: The device receives excessive reverse power so that the power output had to be shortened to prevent overload of the internal output stage.

Solution: This error is displayed if an excess amount of energy is fed back into the *CT Analyzer*. The *CT Analyzer* discharges the connected inductor with approximately 20Ws, but depending on the connected inductance the discharge process may take some time.

Safety action: All measurements are stopped until reverse power is dissipated.

Warning: Lethal voltages of up to many kV may occur if wires are unplugged as long as this message is displayed.

904.xxx **Error [904.xxx] Power supply error. Contact next Omicron service center.**

Reason: Temperature limit of secondary power supply exceeded.

Solution: It is not possible to acknowledge this error until the temperature is back in safe limits. If this error occurs, please contact your next OMICRON service center.

Safety action: All measurements are stopped.

905.xxx **Error [905.xxx] Over-temperature of power supply, wait until device has cooled down.**

Reason: Secondary side power supply has reached the warning temperature limit and entered save mode to cool down.

Solution: When this error is acknowledged as long it is active, the popup window is closed and only the message in the status line remains active until the overtemperature disappears. If the error is not acknowledged, the popup window remains active.

Comment: The status line displays the flashing message "905.xxx Overtemp.".

Safety action: All measurements are stopped and the error message is displayed in the status line and a popup window. After acknowledgement, the software waits at least 1 minute before the test can be started again.

906.xxx **Error [906.xxx] Excess temperature of power supply, wait until device has cooled down.**

Reason: The primary side power supply has reached its warning temperature limit and entered save mode to cool down.

Solution: When this error is acknowledged as long it is active, the popup window is closed and only the message in the status line remains active until the overtemperature disappears. If the error is not acknowledged, the popup window remains active.

Comment: The status line displays the flashing message "906.xxx Overtemp.".

Safety action: All measurements are stopped and the error message is displayed in the status line and a popup window. After acknowledgement, the software waits at least 1 minute before the test can be started again.

908.xxx **Error [908.xxx] Device shut down.**

Reason: Internal power failure on the measurement interface module.

Solution: The message is active as long as the internal power for the measurement interface fails. Contact the next OMICRON service center if the error does not disappear.

911.xxx **Error [911.xxx] Power supply error, contact next Omicron service center. Desired voltage xxxx, measured voltage yyyy.**
Reason: One supply voltage on the measurement interface boards is out of tolerance.
Solution: Contact your next OMICRON service center.
Comment: It is no longer possible to work with the device.

912.xxx **Error [912.xxx] Excess internal temperature, wait until device has cooled down.**
Reason: Device-internal temperature at measurement interface > 75°C.
Solution: Excessive heating of the device. Prevent the device from direct sunlight and wait until it has cooled down. If the error occurs without previous exposure to direct sunlight, the error is probably caused by a hardware error. Please contact your next OMICRON service center.
Comment: The status line displays the flashing message "912.xxx Overtemp.".
Safety action: All measurements are stopped and the error is displayed in the status line and in a popup window. The error is active until the temperature falls below 60°C.

929.xxx **Error [929.xxx] Hardware failure, contact next Omicron service center.**
Reason: The circuit for reverse power dissipation does not work properly.
Solution: Contact your next OMICRON service center.
Safety action: All measurements are stopped and the power supply is switched off.

930.xxx **Error [930.xxx] Measurement input Vsec defective, contact next Omicron service center.**
Reason: Power supply for analog input "Sec" is defective.
Solution: Contact your next OMICRON service center.

931.xxx **Error [931.xxx] Measurement input Vprim defective, contact next Omicron service center.**
Reason: Power supply for analog input "Prim" is defective.
Solution: Contact your next OMICRON service center.

932.xxx **Error [932.xxx] Data error.**
Reason: The sequence of reading of the analog input channels is not correct.
Solution: If this error occurs more frequently, contact your next OMICRON service center.

933.xxx **Error [933.xxx] Hardware failure, contact next Omicron service center.**
Reason: Temperature detection circuit on secondary side is defective.
Solution: Send the device to your next OMICRON service center.
Safety action: Power supply is switched off and all measurements are disabled.

934.xxx **Warning [934.xxx] Reverse power, don't disconnect any wires, don't switch off mains, wait until power is dissipated. I = xxxxA.**
Reason: The device receives reverse power of > 20 mA.
Solution: Wait until the power is dissipated within the device and the error message disappears.
Safety action: All measurements are stopped until reverse power is dissipated.

935.xxx **Error [935.xxx] No valid CT Analyzer software. Insert a CF-Card with valid Software and press "Update Firmw.".**
Reason: Cannot find valid *CT Analyzer* software.
Solution: Insert a Compact Flash card with valid software (**CTAnalyzer.bin**) in the directory **A:\Omicron**.

936.xxx **Warning [936.xxx] Corrupt Calibration Data for voltage inputs. Change to tools menu and try to reset factory calibration. Until update of calibration data the device will be not calibrated.**

Reason: The calibration data checksum for the analog inputs is not correct.

Solution: Try to update the factory calibration using the tools menu. If this does not solve the problem, contact your next OMICRON service center.

937.xxx **Warning [937.xxx] Corrupt Calibration Data for power output. Change to tools menu and try to update factory calibration. Until update of calibration data the device will be not calibrated.**

Reason: The calibration data checksum for the power output is not correct.

Solution: Try to update the factory calibration using the tools menu. If this does not solve the problem, contact your next OMICRON service center.

938.xxx **Warning [938.xxx] MIF data block 1 corrupt.**

Reason: The checksum of the factory settings data is faulty.

Solution: Licensing or device settings data are possibly corrupt. Contact your next OMICRON service center.

939.xxx **Warning [939.xxx] MIF data block 2 corrupt.**

Reason: The checksum of the factory settings data is faulty.

Solution: Licensing or device settings data are possibly corrupt. Contact your next OMICRON service center.

940.xxx **Warning [940.xxx] CMOS data block corrupt. Check all device settings. Press Clear Values to work with default values. Press OK to work with corrupt device settings.**

Reason: Device settings data block corrupt.

Solution: Check all device settings.

941.xxx **Error [941.xxx] Corrupt factory calibration data for voltage inputs. Contact next Omicron service center.**

Reason: Factory calibration data block for voltage inputs corrupt.

Solution: Contact your next OMICRON service center.

942.xxx **Error [942.xxx] Corrupt factory calibration data for power unit. Contact next Omicron service center.**

Reason: Factory calibration data corrupt.

Solution: Contact your next OMICRON service center.

943.xxx **Error [943.xxx] Error overwriting calibration data.**

Reason: Factory calibration data cannot be restored.

Solution: Contact your next OMICRON service center.

944.xxx **Warning [944.xxx] Corrupt user text! Change to tools menu and try to update text. Until update of user text, the device will use default text.**

Reason: Checksum for user language support data invalid.

Solution: Copy a user text file (**CTUser_xxx.bin**) to the directory **A:\Omicron** on the Compact Flash card and try to update the user language support data using the "Update Text" function in the tools menu.

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OMICRON

CT Analyzer

Reference Manual

Manual Version: CTAnalyzerRM.AE.2

Contents

Preface

Using This Manual

This Reference Manual provides detailed reference data for the *CT Analyzer* as well as background information regarding measurement and calculation methods used by the *CT Analyzer*, and relevant normative definitions. It does not provide operating instructions. For information how to use and operate the *CT Analyzer* and safety instructions to be observed when working with the *CT Analyzer*, please refer to the CT Analyzer User Manual.

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 Analyzer Reference 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 SB2 User Manual	Contains information how to use and operate the optional *CT SB2* switch box for multi-ratio CT measurement with the *CT Analyzer* as well as safety instructions for working with the *CT SB2*.
Help System for *CT Analyzer PC Toolset*	Contains detailed information about the software tools provided with the *CT Analyzer PC Toolset*.

1 Designated Use and Features

1.1 Designated Use

The *CT Analyzer* is intended to perform automatic testing and calibration of low leakage flux current transformers (i.e., CTs with non-gapped cores) in laboratories as well as on-site in utilities. Testing of CTs with gapped cores is also possible with restricted accuracy. The following tests can be performed using the *CT Analyzer*:

- Burden measurement
- Residual magnetism measurement of CTs
- CT winding resistance measurement
- CT excitation characteristic measurement according to IEC 60044-1, IEC 60044-6 (TPS, TPX, TPY, TPZ) and IEEE C57.13.
- CT ratio measurement with consideration of a connected burden
- CT phase and polarity measurement
- Determination of accuracy limiting factor, instrument security factor, secondary time constant, symmetrical short-circuit current factor, transient dimensioning factor, remanence factor, knee point voltage/current, class, saturated inductance and non-saturated inductance.

Using the *Quick Test* feature it is also possible to use the *CT Analyzer* as a versatile multimeter with included power source, e.g. for:

- Quick and easy resistance measurement, e.g. for wiring checks on the secondary side of CTs.
- Quick voltage ratio checks for VTs.
- Measurement of burden values, e.g. to determine the new burden value after changes of the relay equipment. This allows the re-calculation of the CT test results for the new burden value by the *CT Analyzer* and thus makes it unnecessary to run an additional CT test in order to determine the behavior of the CT with the new burden.

The *CT Analyzer* 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.

1.2 Features

The features listed below refer to the complete functional scope of the *CT Analyzer* provided when the complete set of licenses is available. The actual functional scope provided by the *CT Analyzer* may differ depending on the licenses actually available on the device.

For up-to-date information about the licenses and packages available for the *CT Analyzer* please refer to the OMICRON electronics GmbH website.

- Reduced commissioning time due to fully automatic testing within seconds.
- Allows testing according to IEC 60044-1, IEC 60044-6 or IEEE C57.13.
- Maximum output voltage = 120V (safety).
- Automatic assessment of the test results.
- Automatic analysis of CTs with unknown data ("guesser" function). This means that for CTs defined according to IEC60044-1, testing can be performed without any previous specification of CT data by the user. The *CT Analyzer* is able to determine the CT data (I_{prim}, I_{sec}, class, ratio, etc.) and to assess whether the connected CT fulfills the specifications or not. The guesser function is intended as an aid for the user to find out the data of unknown CTs.
- For metering transformers: A typical accuracy of 0.02% / 1’ enables field calibration and verification of class 0.1 CTs for metering.
- For protection transformers: Automatic result assessment according to the defined standard (IEC 60044-1, IEC 60044-6 or IEEE C57.13) using implemented expert knowledge (regarding standards, etc.) even for CTs defined according to IEC 60044-6 with defined transient performance (TPS, TPX, TPY, TPZ).
- Test of CTs with very high knee point voltages (up to 30kV).
- Residual magnetism measurement of CTs
- Measurement of the following CT parameters:

  General:

  – L_s (saturated inductance)

  – L_m (unsaturated inductance)

  – K_r (remanence flux)

  – T_s (secondary time constant)

  – R_{ct} (winding resistance)

IEC 60044-1

- ALF (accuracy limiting factor acc. to direct measurement method)
- ALFi (accuracy limiting factor acc. to indirect measurement method)
- FS (instrument security factor acc. to direct measurement method)
- FSi (instrument security factor acc. to indirect measurement method)
- K_x (dimensioning factor according to class PX)
- E_k (accuracy limiting voltage according to class PX)
- I_e (accuracy limiting current according to class PX)
- N (turns ratio according to class PX)
- ε_t (turns ratio error)
- ε_c (composite error)
- ε_i (indirect error)
- V_{kn} (knee point voltage according to IEC 60044-1)
- I_{kn} (knee point current according to IEC 60044-1)
- current ratio error and phase error for all measurement points defined in the standard

IEC 60044-6

- K_{ssc} (rated symmetrical short-circuit current factor)
- K_{td} (transient dimensioning factor)
- N (turns ratio according to class TPS)
- ε_t (turns ratio error according to class TPS)
- $\hat{\varepsilon}$ (peak instantaneous error)
- E_{max} (maximum e.m.f. voltage incl. the transient component)
- V_{kn} (knee point voltage according to IEC 60044-6)
- I_{kn} (knee point current according to IEC 60044-6)
- current ratio error and phase error for all measurement points defined in the standard

IEEE C57.13

- V_b (secondary terminal voltage rating according to IEEE C57.13)
- V_{kn} (knee point voltage according to IEEE C57.13 (30° and 45° tangent))
- I_{kn} (knee point current according to IEEE C57.13 (30° and 45° tangent))
- current ratio error and phase error for all measurement points defined in the standard

- Almost unlimited in:
  - Ratio (50 000 : 1)
  - Primary current (999 000 A max.)
  - Knee point voltage (30 kV max.)
- Precise measurement of ratio error and phase displacement up to x times the rated current and for all burden values without the need to connect burden hardware, independent of the application (e.g. bushings and GIS).
- Automatic demagnetization of the CT after the test.
- Data storage on a removable Compact Flash (CF) card which can be read by any standard memory card reader.
- Automatic test report generation. Viewing and printing of test reports on a PC.
- Existing test reports can be loaded at any time to recalculate the test results for different burden values. This way, no further on-site measurements are necessary to verify whether a changed burden influences the behavior of a CT. The recalculation of the test results can be performed easily in the laboratory using the existing measurement data either on the *CT Analyzer*, in the *CTA Remote Excel File Loader* tool or by using the *CTA Remote Control* software.
- PC Tool (*CTA Quick Test*) for a large variety of measurements usually necessary in a utility using the *CT Analyzer* as a multimeter with integrated current/voltage source (measurement of burden, L, C, ratio, polarity, etc.).
- Remote interface enabling the integration of the *CT Analyzer* into automatic production processes. The *CT Analyzer* can be controlled completely via the remote control interface. All parameters can be read from the device or from a test report with an easy to use software interface.
- Possibility to create user defined test reports using the *CTA Remote Excel File Loader* tool or by adaption of sample software running under visual basic, Delphi, C++ or C#.

2 Hardware

2.1 Overview

Figure 2-1 provides an overview of the operating and display elements and the connectors of the *CT Analyzer*.

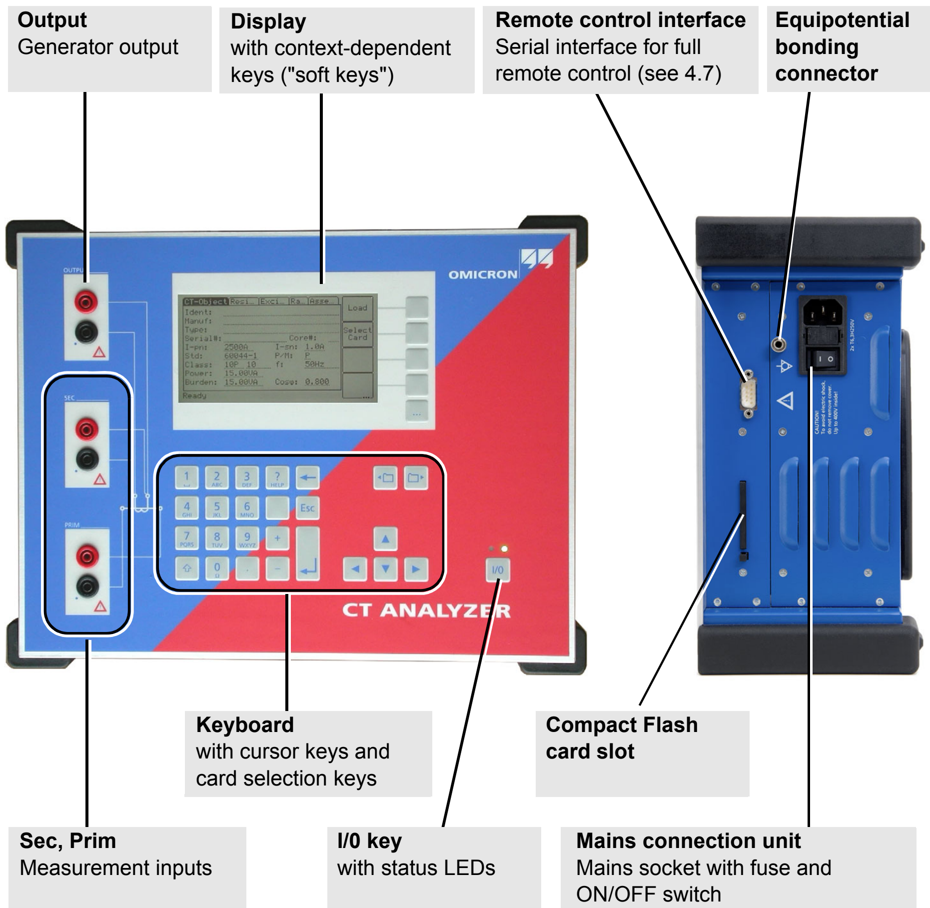


Figure 2-1 *CT Analyzer* overview

2.2 Block Diagram (Simplified)

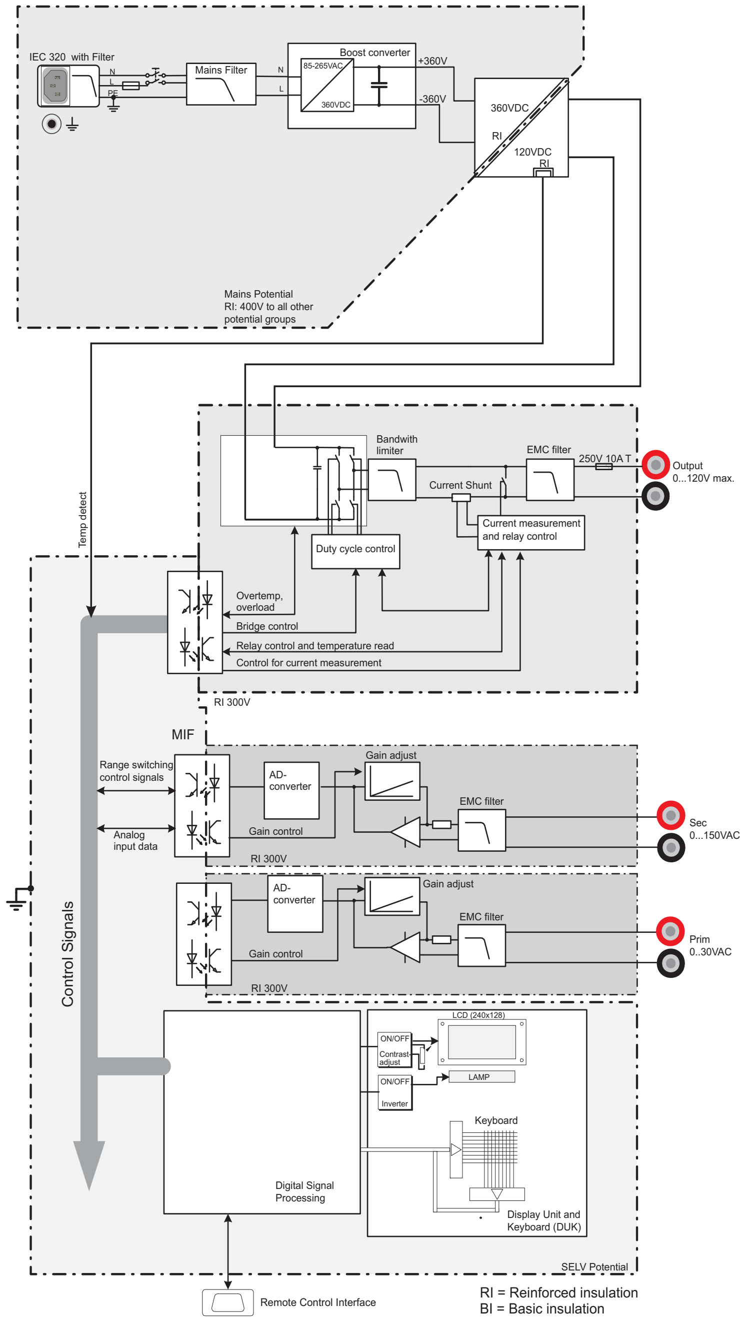


Figure 2-2 Simplified block diagram of the *CT Analyzer*

3 CT Analyzer Test Cards

The set of test cards actually available on your *CT Analyzer* depends on your purchased license(s).

Note: For up-to-date information about available licenses for the *CT Analyzer*, please refer to the OMICRON electronics GmbH website or contact your OMICRON electronics GmbH sales contact.

3.1 CT-Object Card

The **CT-Object** card is the most important card and always required for all types of tests. In this card all necessary settings for a test are done. Some of the settings contained in the **CT-Object** card are also shown in other cards for information.

3.1.1 Information Fields to be Filled by the User

The "Location" and "Object" text fields are only used for reporting and documentation purposes. They can be filled by the user after the test is finished. These fields provide information about the location of the CT and the CT itself. The content of these fields is defined in the **Location settings** page and the **Object settings** page, respectively.

Location settings page	The **Location settings** page provides the following text fields. Each field can contain a maximum of 40 numbers or letters. • Company, Country, Station, Feeder: Company, country, station and feeder where the CT is installed. • Phase: Phase to which the CT is connected. • IEC-ID: IEC-ID number of the CT or freely definable information.
Object settings page	The **Object settings** page provides the following text fields. Each field can contain a maximum of 40 numbers or letters. • Manufact.: Manufacturer of the CT under test. • Type: Type number or description of the CT under test. • Serial No.: Serial number of the CT under test. • Core: Number of the tested core. • Tap: Description of the tap (e.g. 1S1-1S3, X1-X4, ...). • Optional 1: Optional field for free use.

3.1.2 Parameters and Settings Used or Determined by the Test Process

Common Parameters and settings displayed for all standards, CT types and classes

The table below lists all parameters and settings that are displayed for all standards, CT types and classes.

In addition to these common parameters, specific additional parameters are displayed in the **CT-Object** card depending on the selected standard, CT type (protection or metering CT) and class. For these specific parameters, please refer to the tables on pages 20 to 25.

Parameter	Description
I-pn	Rated primary current. Possible values: 1 to 99000 A or **?**[1] soft key. Default: ?.
I-sn	Rated secondary current. Possible values: 0.0001 to 10 A or soft keys **1.0**, **2.0**, **5.0**, **1.0A/√3**, **2.0A/√3**, **5.0A/√3** or **?**[1]. Default: ?.
Standard	Standard according to which the test has to be performed. Possible values: Soft keys **60044-1**, **60044-6** or **IEEE C57.13**. Default: Standard defined in the default test settings. **Note:** Using IEEE C57.13 for transformers with gapped cores may possibly deliver incorrect results.
P/M	Definition of CT type: Protection or metering CT. Possible values: Soft keys **Prot. CT**, **Meter. CT** or **?**[1]. Default: ?

Parameter	Description
Class	Accuracy class of the CT. Possible values: Depending on the selected standard or **?**[1]. **Note:** The "Class" parameter is only displayed, after the parameters "Standard" and "P/M" have been defined or determined by the *CT Analyzer*. Depending on these parameters, the parameters for the CT class can be selected using the soft keys. **Note:** The class can be selected by soft keys or is determined by the *CT Analyzer* during the test. Automatic determination during the test only works for IEC 60044-1 metering CTs and IEEE C57.13 metering CTs. If the question mark has been entered for the parameter "P/M", the "Class" cannot be defined by the user but is automatically determined by the *CT Analyzer* instead. <u>For IEEE C57.13 metering CTs only:</u> An additional soft key **Assess @ VA** is available for metering CTs according to IEEE C57.13. Use this option if the accuracy class of the CT only applies to one specific burden. CT assessment is normally performed for the maximum burden specified ("VA" or "Burden" parameter) **and** all lower burdens defined in the standard. Example: If the burden specified is B-0.9, the assessment is performed for the burdens B-0.9, B-0.5, B-0.2 and B-0.1 (and the electronic burdens E-0.2 and E-0.04). Selecting the **Assess @ VA** option in addition to the class setting will cause the *CT Analyzer* to consider **only** the burden value specified prior to testing for the CT assessment. The ratio table and the phase table in the **Ratio** card then only show the ratio error for this specific burden (see section 3.6.4 on page 43). When **Assess @ VA** is selected, the soft key changes to **Assess all VA** to enable deactivation of this option.

<table>
<tr><th>Parameter</th><th>Description</th></tr>
<tr><td>VA

Cos φ</td><td>
Nominal burden of the CT, used to calculate the behavior of the CT at the nominal burden.
Possible values: 0 to 300 VA or soft keys 1.0A to 30A or ?[1].
Depending on the burden and the selected test standard, the corresponding cos φ is used (cos φ not editable by the user).
<table>
<tr><th colspan="7">cos φ used depending on selected nominal burden and standard</th></tr>
<tr><th rowspan="2">Nominal burden [VA]</th><th colspan="6">Selected standard</th></tr>
<tr><th>60044-1 P</th><th>60044-1 M</th><th>60044-1 PX</th><th>60044-6</th><th>C57.13 P</th><th>C57.13 M</th></tr>
<tr><td>< 5.0</td><td>1.0</td><td>1.0</td><td>1.0</td><td>1.0</td><td>0.5</td><td>0.9</td></tr>
<tr><td>>= 5.0</td><td>0.8</td><td>0.8</td><td>1.0</td><td>1.0</td><td>0.5</td><td>0.9</td></tr>
</table>
If IEEE C57.13 is selected, the CT Analyzer offers some soft keys (B-1, B-2, B-4, B-8) with standard loads for the power. If these soft keys are used, the power is calculated according to table 9 of IEEE C57.13. If the rated current is not 5 A, the resistance and inductance of the table is multiplied by the factor
$$\alpha = \left(\frac{5}{I_{rated}}\right)^2$$
If the IEEE C57.13 standard is selected with the type "protection CT" (class C, K or T), the CT Analyzer automatically calculates VA from the terminal voltage V_b if V_b is set using the soft keys. The automatic calculation is not performed if you enter V_b using the keyboard. This way it is possible to get round the automatic calculation and set user-defined values.
</td></tr>
</table>

Parameter	Description
Burden Cos φ	"Burden" and "Cos φ" are used to define the operating burden connected to the CT. These parameters are used to calculate the behavior of the CT at the operating burden (connected burden) and the corresponding cos φ. Possible values for "Burden": 0 to 300 VA or soft keys **1.0VA** to **30VA** or **?**[1]. Possible values for "Cos φ": 0 to 1. These parameters can be changed after the test or in a loaded test report to check the CT behavior at different burden values. Special behavior depending on available test cards: If the test contains a **Burden** card, a question mark is automatically entered to the fields "Burden" and "cos φ" and entering the burden is not possible until the test is finished. In this case, the value determined during the burden test is automatically entered after burden measurement. If I_{sn} is defined, the burden is updated immediately after the burden test is finished. If I_{sn} is not defined (entry "?"), the burden is updated after the resistance test.
f	Rated frequency of the CT. Possible values: Integer value between 16 and 400 Hz or soft keys **16.7 Hz**, **50 Hz**, **60 Hz** or **400 Hz**. Default: Frequency defined in the default test settings.
Rct	Specified secondary winding resistance. Possible values: 0 to 3000 ohms or soft key **?**[1]. Default: ?.
Rprim	Specified primary winding resistance. Possible values: 0 to 3000 ohms or soft key **?**[1]. Default: ?.
Class mult. factor	Class multiplying factor. This factor increases the assessment level for the ratio test. For example, a class multiplier of 0.5 means that the maximum accepted tolerance for the ratio error is only half the standard tolerance. Possible values: 0.25 to 1.00 or soft key **1.0**. Default: 1.0.

Parameter	Description
Delta compensation	Correction factor for the ratio measurement. This factor enables the ratio measurement for CTs that are installed inside a delta winding transformer. Possible values: Soft keys **Ratio 1**, **Ratio 2/3** or **Ratio 1/3**. Default: Ratio 1. Choose "Ratio 1" if no correction is required. Choose "Ratio 2/3" if input PRIM is connected to the two terminals of that transformer winding, the CT is in series with. Choose "Ratio 1/3" if input PRIM is connected to the terminals of a transformer winding, the CT is not in series with.

1. If the question mark is entered for this parameter and a new test is started, the *CT Analyzer* automatically tries to determine the value using its integrated guesser function.

Specific parameters and settings displayed for IEC 60044-1 protection CTs

The following parameters are only displayed in the **CT-Object** card if the standard IEC 60044-1 is selected with the type "Protection CT".

Param.	Description	Available for IEC 60044-1 class		
		P	**PR**	**PX**
ALF	Accuracy limiting factor acc. to IEC 60044-1. Possible values: Integer value from 1 to 300 or soft keys **?**[1], **5**, **10**, **15**, **20** or **30**. Default: ?.	x	x	
Ts	Specified secondary time constant. Possible values: 0.000 to 100.0 s or soft key **?**[1]. Default: 100 s.		x	
Ek	Accuracy limiting voltage acc. to IEC 60044-1, PX. Possible values: 0 to 20000 or soft key **?**[1]. Default: ?.			x

Param.	Description	Available for IEC 60044-1 class		
		P	PR	PX
Kx	Dimensioning factor acc. to IEC 60044-1, PX. Possible values: 1 to 300 or soft key **?**[1]. Default: ?.			x
Ie	Accuracy limiting current acc. to IEC 60044-1, PX. Possible values: 0.03 mA to 30 A or soft key **?** [1]. Default: ?.			x
E1	User-defined e.m.f. to verify the excitation current at this specific e.m.f. Possible values: 0.1 to 20000 V or soft key **?**[2]. Default: ?.			x
Ie1	Maximum allowed excitation current at E_1. Possible values: 0.03 mA to 30000 mA or soft key **?**[3]. Default: ?.			x

1. If the question mark is entered for this parameter and a new test is started, the *CT Analyzer* automatically tries to determine the value using its integrated guesser function.
2. If the question mark is entered, half the voltage entered or measured for E_k is used.
3. If the question mark is entered, the *CT Analyzer* uses the excitation current measured at the voltage value defined at E_1. In this case, the assessment for this parameter is OK.

Specific parameters and settings displayed for IEC 60044-1 metering CTs

The following parameters are only displayed in the **CT-Object** card if the standard IEC 60044-1 is selected with the type "Metering CT".

Parameter	Description
FS	Instrument security factor acc. to IEC 60044-1. Possible values: Integer value from 1 to 30 or soft keys **?**[1], **FS1**, **FS1.5**, **FS2**, **FS5**, **FS10**, **FS20** or **FS30**. Default: ?.
ext	Extended current rating. Possible values: 100 to 400% or soft keys **120%**, **150%**, **200%**, **300%**, **400%**. Default: 120%.

1. If the question mark is entered for this parameter and a new test is started, the *CT Analyzer* automatically tries to determine the value using its integrated guesser function.

Specific parameters and settings displayed for IEC 60044-6

The following parameters are only displayed in the **CT-Object** card if the standard IEC 60044-6 is selected.

Param.	Description	Available for IEC 60044-6 class TPS	TPX	TPY	TPZ
Kssc	Rated symmetrical short-circuit current factor. Possible values: 1 to 300 or soft keys **?**[1], **3**, **5**, **7.5**, **10**, **12.5**, **15**, **17.5**, **20**, **25**, **30**, **40** or **50**. Default: ?.	x	x	x	x
Tp	Primary time constant. Possible values: 0.000 to 5.000s or soft keys **20ms**, **40ms**, **60ms**, **80ms**, **100ms** or **120ms**. T_p depends on K as follows: $T_p = \frac{K-1}{\omega}$	x	x	x	x

Param.	Description	Available for IEC 60044-6 class			
		TPS	TPX	TPY	TPZ
K	Dimensioning factor. Possible values: 1 to 1572. K depends on T_p as described above for T_p.	x			
V-al	Rated equivalent excitation limiting secondary voltage. Possible values: 0 to 9999V or soft key **?**. Default: ?.	x			
I-al	Accuracy limiting secondary excitation current. Possible values: 0.03mA to 30A or soft key **?**. Default: ?.	x			
E1	User-defined e.m.f. to verify the excitation current at this specific e.m.f. Possible values: 0.1 to 20000V or soft key **?**[2].	x			
Ie1	Maximum allowed excitation current at E_1 (user-defined e.m.f.). Possible values: 0.03mA to 30A or soft key **?**[3].	x			
Ktd	Rated transient dimensioning factor. Possible values: 1.0 to 2043 or soft key **?**. Default: ?.		x	x	x
Duty	Specified duty cycle. Using the soft keys, two different energizing cycles can be selected: **C-O** or **C-O-C-O** Default: C-O.		x	x	
t1	Duration of first current flow. The specified accuracy limit must not be reached within time t_{al1}. Possible values: 0.000 to 5.000s or soft key **100ms**. Default: 0.1 s.		x	x	

Param.	Description	Available for IEC 60044-6 class			
		TPS	TPX	TPY	TPZ
t2	Duration of second current flow. The specified accuracy limit must not be reached within time t_{al2}. **Note:** Only displayed if "Duty" is C-O-C-O. Possible values: 0.000 to 5.000 s or soft key **100ms**. Default: 0.1 s.		x	x	
t-al1	Permissible time to accuracy limit for first energizing period of the duty cycle. Possible values: 0.000 to 5.000 s and max. t_1 or soft key **40ms**. Default: 0.04 s.		x	x	
t-al2	Permissible time to accuracy limit for second energizing period of the duty cycle. **Note:** Only displayed if "Duty" is C-O-C-O. Possible values: 0.000 to 5.000 s and max. t_2 or soft key **40ms**. Default: 0.04 s.		x	x	
tfr	Dead time between first opening and reclosure. **Note:** Only displayed if "Duty" is C-O-C-O. Possible values: 0.00 to 5.00 s or soft key **300ms**. Default: 0.3 s.		x	x	
Ts	Specified secondary time constant. Possible values: 0.000 to 100.0 s or soft key **?**. Default: ?.			x	x

1. If the question mark is entered for this parameter and a new test is started, the *CT Analyzer* automatically tries to determine the value using its integrated guesser function.
2. If the question mark is entered, half the voltage entered or measured for E_k is used.
3. If the question mark is entered, the *CT Analyzer* uses the excitation current measured at the voltage value defined at E_1. In this case, the assessment for this parameter is OK.

Specific parameters and settings displayed for IEEE C57.13 protection CTs

The following parameters are only displayed in the **CT-Object** card if the IEEE C57.13 standard is selected with the type "Protection CT".

Parameter	Description
Vb	Rated secondary terminal voltage. Possible values: Integer values from 10 to 1200V or soft keys **?**[1], **10V**, **20V**, **50V**, **100V**, **200V**, **400V** or **800V**. Default: ?.

1. If the question mark is entered for this parameter and a new test is started, the *CT Analyzer* automatically tries to determine the value using its integrated guesser function.

Specific parameters and settings displayed for IEEE C57.13 metering CTs

The following parameters are only displayed in the **CT-Object** card if the IEEE C57.13 standard is selected with the type "Metering CT".

Parameter	Description
RF	Continuous current rating factor. Possible values: Value from 1.0 to 4.0 or soft keys **RF1.5**, **RF2**, **RF3** or **RF4**. Default: 2.

3.2 Burden Card

The **Burden** card is only available if it is enabled on the **Select Cards** page.

Using the **Burden** card, a current transformer's secondary burden impedance can be measured with the selected secondary current (I-sn) at nominal frequency. If a current other than I-sn should be used to test the burden, the desired test current can be entered in the parameter field "I-test".

3.2.1 Test Settings

The following settings can be done in the **Burden** card.

Parameter	Description
I-test	Test current used to measure the external burden. After clearing the test results or when starting a new CT test, the test current is automatically chosen as follows: It is possible to overwrite the default test current using the keyboard (0.1 to 5A).

Value for I-sn in CT-Object card	Value for I-test in Burden card	Test current used for burden test
"?"	none	1A
e.g. "?"	e.g. 5A	5A(value of I-test)
e.g. 5A	none	5A(value of I-sn)
e.g. 5A	e.g. 1A	1A(value of I-test)

3.2.2 Test Results

The lower part of the **Burden** card shows the results of the burden test after the test is finished.

Parameter	Description
I-meas	Current measured during the test.
V-meas	Voltage measured at the load during the test.

Parameter	Description
Burden / Cos φ	Burden and cos φ calculated from the measured quantities. $$\text{Burden} = I_{sn}^2 \times Z \qquad \cos\varphi = \frac{R}{\sqrt{X_L^2 + R^2}}$$ If the rated secondary current is not known, the result field will only show "n/a" as long as I-sn is not defined.
Z	Impedance of the burden calculated from the measured quantities. $$\lvert Z \rvert = \frac{U_{AC}}{I_{AC}}$$

3.3 Residual Magnetism Card

The **Residual Magnetism** card is only available if it is enabled on the **Select Cards** page.

Using the **Residual Magnetism** card it is possible to measure the residual magnetism of CTs.

Note: Gapped cores normally have very low residual magnetism. The *CT Analyzer* is possibly not able to determine the knee point of gapped cores.

3.3.1 Test Settings and Results

The following settings and test results are displayed in the **Residual Magnetism** card.

Parameter	Description
I-sn	Nominal secondary current of the CT as entered in the **CT-Object** card. The I_{sn} of the CT has to be specified **prior to the execution** of the residual magnetism measurement. Otherwise, a corresponding message is displayed.
Residual Flux	Absolute value [in Vs] of the residual magnetic flux in the CT determined by the *CT Analyzer*. The residual flux is always displayed after measurement, even if the *CT Analyzer* could not determine the residual magnetism and the remanence factor.
Residual Magnetism	Residual magnetism [in %] of the CT, calculated from the residual flux and the saturation flux as follows: $\text{Residual magnetism } M_r = \frac{\text{Residual flux } \Psi_{res}}{\text{Saturation flux } \Psi_s} \times 100\ \%$ No value is displayed if the *CT Analyzer* was not able to reach the knee point of the excitation curve and thus could not determine the remanence factor K_r. The value displayed for the residual magnetism can exceed 100% since the CT may possibly provide a saturation flux higher than the saturation flux Ψ_s determined by the *CT Analyzer* during the measurement of the remanence factor K_r. The calculation of the residual magnetism however uses the saturation flux Ψ_s as defined in IEC 60044 and not the maximum possible saturation flux of the CT.

Parameter	Description
Remanence Factor Kr	Remanence factor [in %] of the CT, calculated from the remanent flux and the saturation flux as follows: $\text{Remanence factor } K_r = \frac{\text{Remanent flux } \Psi_r}{\text{Saturation flux } \Psi_s} \text{ x } 100\ \%$ No value is displayed if the *CT Analyzer* was not able to reach the knee point of the excitation curve.

3.4 Resistance Card

The **Resistance** card is only available if winding resistance measurement is enabled in the **Select Cards** page.

The **Select Cards** page offers two different types of winding resistance measurements for selection:

- **Primary winding resistance measurement**
- **Secondary winding resistance measurement**

Depending on your selection on the **Select Cards** page, the **Resistance card** shows the parameters and results for the primary winding resistance measurement or the secondary winding resistance measurement only, or for both measurements.

3.4.1 Primary Winding Resistance Measurement

Measuring the primary winding resistance is only required in case of a perceptible primary winding resistance, i.e. if the primary winding actually consists of multiple turns.

Note: If no CT test is performed following the primary winding resistance test, a demagnetizing cycle is performed after the test to guarantee complete demagnetization of the CT.

3.4.2 Secondary Winding Resistance Measurement

During the CT test, secondary winding resistance measurement is necessary since the CT winding resistance is needed for particular calculations in the excitation and ratio test.

This measurement is performed completely automatically.

Note: If only a secondary winding resistance test is selected, a demagnetizing cycle is performed after the test to guarantee complete demagnetization of the CT.

3.4.3 Test Settings and Results

The following settings are required to perform a winding resistance test.

Parameter	Description
T-meas	Winding temperature of the CT at the time of measurement. Value used: Ambient Temperature (-40 to 150°C or -40 to 302°F) defined in the **Settings** (main menu). If this temperature is not set correctly, the reference resistance value (R_{ref}) at reference temperature will not be calculated correctly.
T-ref	Reference temperature, i.e, temperature the CT is specified for. Value used: Reference temperature (-40 to 150°C or -40 to 302°F) defined in the **Settings** (main menu). The winding resistance at reference temperature is calculated from the winding resistance measured at ambient temperature (T_{meas}) and the specified reference temperature.

The following parameters show the results of the winding resistance test after the test is finished.

Parameter	Description
I-DC	Current used for measurement. Selected automatically, cannot be changed by the user. **Secondary winding resistance measurement only:** If I_{sn} is between 0.1 and 1 A, I_{DC} is automatically set to I_{sn}. If I_{sn} is lower than 0.1 A, I_{DC} is automatically set to 0.1 A. Maximum value: 1 A. **Primary winding resistance measurement only:** Maximum value: 10 A.
V-DC	Measured voltage.

Parameter	Description
R-meas	Measured resistance at ambient temperature. $R_{meas} = V_{DC} / I_{DC}$
R-ref	Reference resistance (temperature-compensated resistance, compensated to T_{ref}). $$R_{ref} = R_{meas} \times \left(\frac{\frac{1}{\alpha_{20^\circ}} - T_{20^\circ} + T_{ref}}{\frac{1}{\alpha_{20^\circ}} - T_{20^\circ} + T_{meas}} \right)$$ α_{20° for copper $= 3.9 \cdot 10^{-3}\ K^{-1}$ $T_{ref} = 273.15K + 75K$ $T_{20^\circ} = 273.15K + 20K$ T_{meas} (e.g. for 25°C) $= 273.15K + 25K$

3.5 Excitation Card

The **Excitation card** is only available if it is enabled in the **Select Cards** page.

The excitation test is used to trace the excitation curve of the current transformer and to determine many CT-specific parameters (see test results below). The test is done completely automatically up to a current of $15A_{peak}$.

CTs with closed cores can be tested up to a knee point voltage of 30 kV. For CTs with gapped cores the maximum test voltage and current are limited depending on the maximum output power of the device. Typical maximum current and voltage values for a TPZ core are $9A_{rms}$ at $1200V_{rms}$.

The settings for the excitation test are specified in the **CT-Object** card. For a better understanding of the test results, the most important settings from the **CT-Object** card are shown in the upper part of the **Excitation** card.

The test results displayed in the lower part of the **Excitation** card depend on the standard selected in the **CT-Object** card. Using the soft keys, the user can choose between different sets of results. If the **Results with Nom. Burden** soft key is pressed, the page shows the results related to the nominal burden (parameter "VA" in **CT-Object** card). If the **Results with Op. Burden** soft key is pressed, the page shows the results related to the operating burden (parameter "Burden" in **CT-Object** card).

Note: If the *CT Analyzer* displays an overload in the **Excitation** card, either the desired knee point could not be reached or not all necessary measurement points could be taken (e.g. in the knee point area, not enough points for a proper calculation of the knee point could be measured).

3.5.1 Test Settings

The upper part of the **Excitation** card shows the test settings adjusted in the **CT-Object** card.

3.5.2 Test Results

The test results are displayed in the lower part of the **Excitation** card. The display of test results depends on the following:

- The standard defined in the **CT-Object** card, the class and the type of CT (metering or protection CT).

  The following tables provide an overview of which test results (parameters) are displayed for which standard.

- The burden selected with the soft key (**Results with Nom. Burden** or **Results with Op. Burden**).

  Depending on the selected burden, the **Excitation** card shows the results either calculated with the nominal burden (**Results with Nom. Burden**) or calculated with the operating burden (**Results with Op. Burden**).

  The displayed pages are identical to a large extend, except the field label for the burden parameter ("VA" in case of nominal burden and "Burden" in case of operating burden) and the result values.

Note: For details regarding the calculation methods for specific parameters, please refer to chapter 6 "Formulas and Definitions" on page 77.

Test results displayed in the Excitation card for IEC 60044-1

Parame-ter	**Description**	**Results displayed for IEC 60044-1**			
		protection CTs			**metering CTs**
		P	**PR**	**PX**	
V-kn V-kn1	Knee point voltage (acc. to standard) of the topmost knee point found.	x	x	x	x
I-kn I-kn1	Knee point current (acc. to standard) of the topmost knee point found.	x	x	x	x
V-kn2	Knee point voltage (acc. to standard) of the lowermost knee point found.	x	x	x	x
I-kn2	Knee point current (acc. to standard) of the lowermost knee point found.	x	x	x	x
Ls	Saturated inductance.	x	x	x	x
Lm	Non-saturated inductance.	x	x	x	x
Ts	Secondary time constant.	x	x	x	x
Kr	Remanence factor.	x	x	x	x
ε_i	Indirect error (acc. to standard)	x	x		x
ALF	Accuracy limiting factor according to IEC 60044-1 direct measurement method, calculated for nominal and operating burden.[1]	x	x		
ALFi	Accuracy limiting factor according to IEC 60044-1 indirect measurement method, calculated for nominal and operating burden.[1]	x	x		

Parameter	Description	Results displayed for IEC 60044-1			
		protection CTs			metering CTs
		P	PR	PX	
Kx	Dimensioning factor (acc. to IEC 60044-1 class PX) at accuracy limit with the selected load.			x	
Ek	Accuracy limiting voltage according to IEC 60044-1 for class PX (that point on the excitation graph where an increase of the e.m.f. r.m.s. voltage (core flux) by 10% causes an increase of the r.m.s. current by 50%).			x	
Ie	Accuracy limiting current according to IEC 60044-1 class PX (at E_k).			x	
E1	User-defined e.m.f. to verify the excitation current at this e.m.f.			x	
Ie1	Max. allowed excitation current at E_1.			x	
FS	Instrument security factor according to IEC 60044-1 direct measurement method, calculated for nominal and operating burden.[1]				x
FSi	Instrument security factor according to IEC 60044-1 indirect measurement method, calculated for nominal and operating burden.[1]				x

1. If the *CT Analyzer* is not able to measure up to the actual value, the prefix ">" is displayed to indicate that the measurement value is larger than the displayed value.

Test results displayed in the Excitation card for IEC 60044-6

Parameter	Description	Results displayed for IEC 60044-6, class		
		TPS	TPX / TPY	TPZ
V-kn	Knee point voltage according to standard.	x	x	x
I-kn	Knee point current according to standard.	x	x	x
Kssc	Rated symmetrical short-circuit current factor at accuracy limit with the selected load.[1]	x	x	x
Ktd	Theoretical transient dimensioning factor.		x	x
Ls	Saturated inductance.	x	x	x
Lm	Non-saturated inductance.	x	x	x
Ts	Secondary time constant.	x	x	x
Kr	Remanence factor.	x	x	x
V-al	Accuracy limiting voltage according to IEC 60044-6 for class TPS (that point on the excitation graph where an increase of the e.m.f. r.m.s. voltage (core flux) by 10 % causes an increase of the peak current by 100 %).	x		
I-al	Accuracy limiting current according to IEC 60044-6 class TPS (at V_{al}).	x		
E1	User-defined e.m.f. to verify the excitation current at this e.m.f.	x		
Ie1	Max. allowed excitation current at E_1.	x		
E-max	Maximum e.m.f. voltage. $E_{max} = K_{dt\_meas} \cdot K_{ssc} \cdot I_{sn} \cdot \sqrt{(R_{CT} + R_b)^2 + X_b^2}$ This parameter allows the determination of the working point on the excitation curve that would be reached with the entered settings.		x	
$\hat{\varepsilon}$	Peak instantaneous error at voltage E_{max}.		x	

1. If the *CT Analyzer* is not able to measure up to the actual value, the prefix ">" is displayed to indicate that the measurement value is larger than the displayed value.

Test results displayed in the Excitation card for IEEE C57.13

Parame-ter	Description	Results displayed for IEEE C57.13	
		protection CT	metering CT
V-kn	Knee point voltage according to standard.	x	x
I-kn	Knee point current according to standard.	x	x
Ls	Saturated inductance.	x	x
Lm	Non-saturated inductance.	x	x
Ts	Secondary time constant.	x	x
Kr	Remanence factor.	x	x
Vb	Rated secondary terminal voltage.	x	
FS	Instrument security factor (direct measurement method), calculated for nominal and operating burden.[1]		x
FSi	Instrument security factor (indirect measurement method), calculated for nominal and operating burden.[1]		x

1. If the *CT Analyzer* is not able to measure up to the actual value, the prefix ">" is displayed to indicate that the measurement value is larger than the displayed value.

3.5.3 Excitation Graph

The excitation graph page shows the graph calculated from the test results. To display the excitation graph, press the **Exit. Graph** soft key in the **Excitation** card. The graph shows the r.m.s. terminal/core voltage over the r.m.s./peak current depending on the selected standard.

On the bottom right of the diagram the voltage, current and inductance values for the selected point in the graph are displayed. The currently selected point in the graph is marked by a horizontal and a vertical dashed line.

In this page it is possible to load the excitation graph of an already saved test from the Compact Flash card in order to compare this graph with the one of the current test.

The labeling of the axes in the excitation graph depends on the standard selected in the **CT-Object** card:

Standard	Vertical axis	Horizontal axis
IEC 60044-1	r.m.s. terminal voltage	r.m.s. excitation current
IEC 60044-6	r.m.s. e.m.f. voltage[1]	peak excitation current
IEEE C57.13	r.m.s. e.m.f. voltage[1]	r.m.s. excitation current

1. Calculation of the r.m.s. e.m.f. voltage, please refer to section 6.4 on page 80.

3.5.4 Accuracy Limiting Error Graph*

According to the China Electric Regulations for Protection CTs, it is necessary to plot an error curve that shows the maximum possible primary current (K * I_{pn}) that can flow over a specific burden without exceeding the accuracy limit (or, in other words, that shows which burden value can be connected at which primary current (K * I_{pn}) without exceeding the accuracy limit).

Depending on the class (5P or 10P), the accuracy limit is 5% or 10%:

$$\frac{I_{ext}}{I_{sn} \cdot ALFi} \cdot 100 = 10 \text{ or } 5$$

To display the AL error graph, press the **AL Error Graph** soft key in the **Excitation** card.

Note: The "AL Error Graph" function can be switched on or off in the device settings. If switched off, the AL error graph is not included in the test report.

All standards are supported, except IEC 60044-6 class TPZ.

* According to the China Electric Regulations for Protection CTs.

3.6 Ratio Card

The **Ratio** card is only available if it is enabled in the **Select Cards** page.

The ratio test measures the current ratio of the CT considering the operating burden (parameter "Burden" in **CT-Object** card) or the nominal burden (parameter "VA" in **CT-Object** card).

The results of the ratio test can be found in 3 pages:

- The **Ratio** card shows the polarity, the ratio error and the phase displacement for the primary current and the burden defined in the **CT-Object** card.

  If the **Results with Nom. Burden** soft key is pressed, the page shows the results related to the nominal burden ("VA" parameter in the **CT-Object** card). If the **Results with Op. Burden** soft key is pressed, the page shows the results related to the operating burden ("Burden" parameter in the **CT-Object** card).
- The **ratio table** shows the current ratio error for different currents (200 % down to 1 % of the rated current) at different burden values (depending on the selected standard, see section 3.6.3 on page 42 and 3.6.4 on page 43).
- The **phase table** shows the phase displacement for different currents at different burden values (depending on the selected standard, see section 3.6.3 on page 42 and 3.6.4 on page 43).

For a better understanding of the test results, the most important settings from the **CT-Object** card are shown once again in the upper part of the **Ratio** card.

Note: Although the test is not performed with the real current, the test results reflect the current ratio and not the voltage ratio.

3.6.1 Test Settings

The following settings can be done in the **Ratio** test card.

Parameter	Description
I-p	Primary current for calculation of the ratio error and phase displacement with the burden (operating burden) defined in the **CT-Object** card. After the test is finished, it is possible to change the value for the primary current. The ratio error and/or the phase error are then recalculated and displayed again. When storing the test results, the currently displayed measurement results are stored. Changing this value only influences the results displayed in the **Ratio** card (operating burden related values). It does not affect the values displayed in the separate pages for the ratio and phase tables (values related to nominal burden). Default: Value of I_{pn}

3.6.2 Test Results

The following test results are displayed in the lower part of the **Ratio** card. In addition to the results displayed in the **Ratio** card you can view the ratio and phase table pages described in section 3.6.3 on page 42.

Parameter	Description
Ratio	Current ratio error (in %) at the specified primary current (I_p) and burden.
Pol.	OK: Polarity OK, phase angle is in the range of 0° ± 45°. Failed: Wrong polarity of the CT or wrong polarity of the measurement leads.
ε_C	Composite error in % at the specified primary current (I_p) and operating burden. This parameter is only displayed if the IEC 60044-1 or the IEEE C57.13 standard is selected in the **CT-Object** card.
Phase	Phase displacement (in minutes) at the specified primary current (I_p) and burden.
N	Winding turns ratio.

Parameter	Description
εt	Turns ratio error acc. to IEC 60044-6 class TPS or IEC 60044-1 class PX.
RCF	Ratio correction factor. This parameter is only displayed if the IEEE C57.13 standard is selected in the **CT-Object** card.
TCF	Transformer correction factor. This parameter is only displayed if the IEEE C57.13 standard is selected in the **CT-Object** card.

3.6.3 Ratio Table and Phase Table for IEC 60044-1 and -6

To display the ratio table or the phase table, press the **Ratio Table** or **Phase Table** soft key in the **Ratio** card.

If the selected standard is **IEC 60044-1** or **IEC 60044-6**, these tables show the ratio error and the phase displacement

- for different current values between 1% and 200% of the rated current.
- at 100%, 50%, 25% and 12.5% of the burden defined on the **CT-Object** card ("VA" or "Burden" parameter) or at 1VA if one of these percentages results in a burden smaller than 1VA.

  Use the **Results with Op. Burden** or **Results with Nom. Burden** soft key to display the results related to the operating burden ("Burden" parameter in the **CT-Object** card) or related to the nominal burden ("VA" parameter in the **CT-Object** card).

The ratio table and the phase table contain all measurement points defined in the standards IEC 60044-1 and IEC 60044-6.

Note: Values without the prefix "!" have guaranteed accuracy. The accuracy of values marked with a "!" in the tables is reduced by factor 2.

Note: For IEC 60044-1 metering CTs with I_{sn} = 5A, it is possible to increase the minimum **nominal burden** used for the assessment to 3.75VA in the device settings (**Main Menu**, entry "Settings" -> **Setting Menu**, entry "Min. VA at M cores Isn 5A"). In this case, the lowest nominal burden value displayed in the ratio table and the phase table is 3.75VA instead of 1VA. Please note that this only applies if the results are displayed with the nominal burden. It has no effect if the results in the ratio table and the phase table are displayed with the operating burden.

3.6.4 Ratio Table and Phase Table for IEEE C57.13

To display the ratio table or the phase table, press the **Ratio Table** or **Phase Table** soft key in the **Ratio** card.

If the selected standard is **IEEE C57.13**, these tables show the ratio error and the phase displacement

- for different current values between 1% and 200% of the rated current.
- at the burden specified in the **CT-Object** card ("VA" or "Burden" parameter) and all burden values defined in the IEEE C57.13 standard that are smaller than the specified burden.

  Use the **Results with Op. Burden** or **Results with Nom. Burden** soft key to display the results related to the operating burden ("Burden" parameter in the **CT-Object** card) or related to the nominal burden ("VA" parameter in the **CT-Object** card).

  Note: If the **Assess @ VA** option has been selected for the "Class" parameter of an IEEE C57.13 metering CT in the **CT-Object** card, the tables only show the ratio error and the phase displacement for the burden value specified in the **CT-Object** card.

  Note: If a high accuracy license is available for IEEE C57.13, metering burdens also include the electronic burdens.

The ratio table and the phase table contain all measurement points defined in the IEEE C57.13 standard.

Note: Values without the prefix "!" have guaranteed accuracy. The accuracy of values marked with a "!" in the tables is reduced by factor 2.

Calculation of burden values for "Ratio Table" and "Phase Table" if IEEE C57.13 is selected

Internally, the device has a sorted table with all burden values defined in the standard. The value entered in the "VA" parameter field on the **CT-Object** card is added to this sorted table at the corresponding position. The ratio table and the phase table use the value specified on the **CT-Object** card and all other burden values defined in the IEEE C57.13 standard that are smaller than the specified burden.

The following tables show the values used in the ratio table and the phase table for some example VA parameter values entered in the **CT-Object** card. The values used are highlighted by light gray background.

For IEEE C57.13 metering (M) cores

Internal table of standard burden values	Values used in the ratio table and the phase table if VA parameter value is ...			
	VA = B-1.8	VA = 15.0	VA = 60.0	VA = B 0.5
45.0 (B-1.8)	**45.0 (B-1.8)**	45.0 (B-1.8)	**60.0 VA** 45.0 (B-1.8)	45.0 (B-1.8)
22.5 (B-0.9)	22.5 (B-0.9)	22.5 (B-0.9)	22.5 (B-0.9)	22.5 (B-0.9)
12.5 (B-0.5)	12.5 (B-0.5)	**15.0 VA** 12.5 (B-0.5)	12.5 (B-0.5)	**12.5 (B-0.5**)
5.0 (B-0.2)	5.0 (B-0.2)	5.0 (B-0.2)	5.0 (B-0.2)	5.0 (B-0.2)
2.5 (B-0.1)	2.5 (B-0.1)	2.5 (B-0.1)	2.5 (B-0.1)	2.5 (B-0.1)

If the **Assess @ VA** option has been selected in addition to the class setting, the *CT Analyzer* considers **only** the burden value specified in the **CT-Object** card. The ratio table and the phase table in the **Ratio** card then only show the ratio error for this specific burden.

For IEEE C57.13 protection (P) cores

Internal table of standard burden values	Values used in the ratio table and the phase table if VA parameter value is ...			
	Vb = 800V or VA = 200VA	Vb = 400V or VA = 100VA	VA = 75VA	Vb = 100V or VA = 25VA
200.0 VA (B-8)	**200.0 VA (B-8)**	200.0 VA (B-8)	200.0 VA (B-8)	200.0 VA (B-8)
100.0 VA (B-4)	100.0 VA (B-4)	**100.0 VA (B-4)**	100.0 VA (B-4)	100.0 VA (B-4)
50.0 VA (B-2)	50.0 VA (B-2)	50.0 VA (B-2)	**75.0 VA** 50.0 VA (B-2)	50.0 VA (B-2)
25.0 VA (B-1)	25.0 VA (B-1)	25.0 VA (B-1)	25.0 VA (B-1)	**25.0 VA (B-1)**

3.7 Assessment Card

The **Assessment** card is only available if it is enabled in the **Select Cards** page.

Depending on the standard and the type of CT (protection or metering CT), the according parameters are listed.

The column for automatic assessment ("Auto") is automatically filled after the test is finished. The following assessments are possible:

- "OK": The results measured for this parameter comply with the requirements defined by the selected standard and the parameters in the **CT-Object** card.
- "Failed": The results do not comply with the requirements.
- "n/a": No assessment possible due to one of the following reasons:
  - Comparison with input parameter is not possible.
  - Assessment does not make sense due to incorrect polarity or invalid measurement value.

It is also possible to perform manual assessment for the individual parameters.

Note: Automatic assessment is only performed for the CT behavior at nominal burden (parameter "VA" on the **CT-Object** card). For the CT behavior at operating burden (parameter "Burden" on the **CT-Object** card), no automatic assessment is performed.

3.7.1 Assessed Parameters

The parameters assessed for a CT and displayed in the **Assessment** card depend on the selected **standard** as well as the **type** and the **class** of the CT under test.

Note: For details regarding the calculation methods for specific parameters, please refer to chapter 6 "Formulas and Definitions" on page 77.

Parameters assessed for standard IEC 60044-1

Parameter	Description	Parameter assessed for IEC 60044-1, prot. CTs: P	prot. CTs: PR	prot. CTs: PX	metering CTs: 0.1	metering CTs: 0.1s, 0.2, 0.2s, 0.5, 0.5s, 1	metering CTs: 3, 5
Class	Accuracy class according to standard.	x	x	x	x	x	x
Burden	Manual assessment of the user for the burden test (no automatic assessment performed).	x	x	x	x	x	x
Rct	Secondary winding resistance.		x	x			
$\Delta\varphi$	Phase deviation.	x	x		x	x	
Kr	Remanence factor.	x	x		x	x	x
ε	Current ratio error.	x	x		x	x	x
ε_c	Composite error.	x	x				
εt	Turns ratio error.			x			
Ts	Secondary time constant.	x	x		x		
FS	Instrument security factor (direct measurement method).				x	x	x
FSi	Instrument security factor (indirect measurement method).				x	x	x
ALF	Accuracy limiting factor (direct measurement method).	x	x				
ALFi	Accuracy limiting factor (indirect measurement method).	x	x				
Ek	Rated knee point e.m.f.			x			
Kx	Dimensioning factor (according to IEC 60044-1 class PX).			x			
Ie	Accuracy limiting secondary excitation current.			x			
Ie1	Max. allowed secondary excitation current at E_1.			x			

Parameters assessed for standard IEC 60044-6

Parame-ter	Description	Parameter assessed for IEC 60044-6, protection CTs			
		TPS	TPX	TPY	TPZ
Class	Accuracy class according to standard.	x	x	x	x
Rct	Secondary winding resistance.	x	x	x	x
Burden	Manual assessment of the user for the burden test (no automatic assessment performed).	x	x	x	x
$\Delta\varphi$	Phase deviation.		x	x	x
ε	Current ratio error.		x	x	x
εt	Turns ratio error.	x			
$\hat{\varepsilon}$	Peak instantaneous error at voltage E_{max}.		x	x	
Ts	Secondary time constant.		x	x	x
Kr	Remanence factor.			x	
Ktd * Kssc	Transient dimensioning factor (K_{td}) multiplied by the rated symmetrical short-circuit current factor (K_{ssc}).		x	x	
K * Kssc	Dimensioning factor (K) multiplied by the rated symmetrical short-circuit current factor (K_{ssc}).	x			
V-al	Rated equivalent excitation limiting secondary voltage.	x			
I-al	Accuracy limiting secondary excitation current.	x			
Ie1	Max. allowed secondary excitation current at E_1.	x			

Parameters assessed for standard IEEE C57.13

Parameter	Description	Parameter assessed for					
		IEEE C57.13					IEEE C57.13.6
		prot. CTs, class				meter. CTs	high accuracy meter. CTs
		C	T	X	K[1]		
Class	Accuracy class according to standard.	x	x	x	x	x	x
Burden	Manual assessment of the user for the burden test (no automatic assessment performed).	x	x	x	x	x	x
ε @ Isn	Current ratio error at secondary current I_{sn}.	x	x	x	x		
ε @ 20 * Isn	Current ratio error at 20 times the secondary current I_{sn}.	x	x	x	x		
Rct	Secondary winding resistance.			x			
Vknee	Knee point voltage.				x		
Vk / Ik	User-defined measuring point.		x	x			
Vk1 / Ik1	User-defined measuring point 1.		x	x			
Δφ	Phase deviation.					x	x
RCF	Ratio correction factor.					x	x

1. According to IEEE C57.13 (1993)

3.7.2 Conditions for Positive Assessment

The conditions to be fulfilled for positive automatic assessment of the CT under test depend on the selected **standard** as well as the **type** and **class** of the CT.

IEEE C57.13 standard, protection CTs

Class	Conditions for auto-assessment "OK"
C	**V_b**: $V_{b\ max} \geq V_{b\ rated}$ [1] **&** I_{sec} (at $V_{b\ max}$) $\geq 20 * I_{sec\ rated}$
	Class: Ratio error at I_{sn} AND at $20 * I_{sn} < 10\%$ **&** Ratio error at $V_{b\ rated} < 3\%$
T	**V_b**: $V_{b\ max} \geq V_{b\ rated}$ [1] **&** I_{sec} (at $V_{b\ max}$) $\geq 20 * I_{sec\ rated}$
	Class: Ratio error at I_{sn} AND at $20 * I_{sn} < 10\%$ **&** Ratio error at $V_{b\ rated} < 3\%$
	Vk/Ik (point #1): I_k at $V_{k\ rated} \geq I_{k\ rated}$ (user-defined, from **CT-Object** card)
	Vk1/Ik1 (point #2): I_{k1} at $V_{k1\ rated} \geq I_{k1\ rated}$ (user-defined, from **CT-Object** card)
X	**Class**: Ratio error at $I_{sn} \leq 1\%$ **&** Ratio error at $20 * I_{sn} \leq$ Ratio error at $20 * I_{sn\ rated}$ (user-defined, from **CT-Object** card field **RE(20*Isn)**)
	Vk/Ik (point #1): I_k at $V_{k\ rated} \geq I_{k\ rated}$ (user-defined, from **CT-Object** card)
	Vk1/Ik1 (point #2): I_{k1} at $V_{k1\ rated} \geq I_{k1\ rated}$ (user-defined, from **CT-Object** card)

Class	Conditions for auto-assessment "OK"
K [2]	**V_b**: $V_{b\ max} \ge V_{b\ rated}$ [1] **&** I_{sec} (at $V_{b\ max}$) $\ge 20 * I_{sec\ rated}$
	Class: Knee point voltage $\ge$ 70% of $V_{b\ rated}$ **&** Ratio error at I_{sn} AND at 20 * I_{sn} < 10% **&** Ratio error at $V_{b\ rated}$ < 10% If no V_b has been determined in the **CT-Object** card: Knee point voltage $\ge$ 70% of V_b at 20 * I_{sn} **&** Ratio error at I_{sn} AND at 20 * I_{sn} < 10% **&** Ratio error at $V_{b\ rated}$ < 10% If no value is entered on the **CT-Object** card, the value for 20 * I_{sn} * Z (parameter "VA" on the **CT-Object** card) is displayed.

1. $V_{b\ rated}$ = Rated secondary terminal voltage acc. to IEEE C57.13
   $V_{b\ max}$ = Terminal voltage at 10% ratio error
2. According to IEEE C57.13 (1993)

IEEE C57.13 standard, metering CTs

Class	Conditions for auto-assessment "OK"
0.15 [1]	**Class**:

	at % of rated current 5%	100% / 100%*RF
RCF	0.9970 ≤ RCF ≤ 1.0030	0.9985 ≤ RCF ≤ 1.0015
AND		
Phase error Δφ [min]	2600 (RCF - 1.0030) ≤ Δφ ≤ 2600 (RCF - 0.9970)	2600 (RCF - 1.0015) ≤ Δφ ≤ 2600 (RCF - 0.9985)

Class	Conditions for auto-assessment "OK"
0.15S [1]	**Class**:

	at % of rated current 5%	100% / 100%*RF
RCF	0.9985 ≤ RCF ≤ 1.0015	0.9985 ≤ RCF ≤ 1.0015
AND		
Phase error Δφ [min]	2600 (RCF - 1.0015) ≤ Δφ ≤ 2600 (RCF - 0.9985)	2600 (RCF - 1.0015) ≤ Δφ ≤ 2600 (RCF - 0.9985)

Class	Conditions for auto-assessment "OK"
0.3	**Class**:

	at % of rated current		
	10%	**100%**	**100%*RF**
RCF	0.994 ≤ RCF ≤ 1.006	0.997 ≤ RCF ≤ 1.003	
AND			
Phase error Δφ [min]	2600 (RCF - 1.006) ≤ Δφ ≤ 2600 (RCF - 0.994)	2600 (RCF - 1.003) ≤ Δφ ≤ 2600 (RCF - 0.997)	

Class	Conditions for auto-assessment "OK"
0.6	**Class**:

	at % of rated current		
	10%	**100%**	**100%*RF**
RCF	0.988 ≤ RCF ≤ 1.012	0.994 ≤ RCF ≤ 1.006	
AND			
Phase error Δφ [min]	2600 (RCF - 1.012) ≤ Δφ ≤ 2600 (RCF - 0.988)	2600 (RCF - 1.006) ≤ Δφ ≤ 2600 (RCF - 0.994)	

Class	Conditions for auto-assessment "OK"
1.2	**Class**:

	at % of rated current		
	10%	**100%**	**100%*RF**
RCF	0.976 ≤ RCF ≤ 1.024	0.988 ≤ RCF ≤ 1.012	
AND			
Phase error Δφ [min]	2600 (RCF - 1.024) ≤ Δφ ≤ 2600 (RCF - 0.976)	2600 (RCF - 1.012) ≤ Δφ ≤ 2600 (RCF - 0.988)	

1. According to IEEE C57.13.6

RCF of the measurement can be calculated from the ratio table: $RCF = \frac{1}{(\varepsilon/100)+1}$

IEC 60044-1 standard, protection CTs

Class	Conditions for auto-assessment "OK"
5P	**ALF**: $ALF_{measured} \geq ALF_{rated}$ Example: $ALF_{measured}$ = 27, ALF_{rated} = 5P20
	Class: Ratio error at 100% of rated current ≤ 1% **&** Phase at 100% of rated current ≤ 60min **&** Composite error ε_C at accuracy limit ≤ 5% If ε_C is < 5% and prefixed by a ">" sign (e.g. > ε_C = 3.20), the class assessment is "n/a".
10P	**ALF**: $ALF_{measured} \geq ALF_{rated}$
	Class: Ratio error at 100% of rated current ≤ 3% **&** Composite error ε_C at accuracy limit ≤ 10% If ε_C is < 10% and prefixed by a ">" sign (e.g. > ε_C = 3.20), the class assessment is "n/a".
5PR	**ALF**: $ALF_{measured} \geq ALF_{rated}$
	Class: Ratio error at 100% of rated current ≤ 1% **&** Phase at 100% of rated current ≤ 60min **&** Composite error ε_C at accuracy limit ≤ 5% If ε_C is < 5% and prefixed by a ">" sign (e.g. > ε_C = 3.20), the class assessment is "n/a".
	K_r: $K_r \leq 10\%$

Class	Conditions for auto-assessment "OK"
10PR	**ALF**: $ALF_{measured} \geq ALF_{rated}$
	Class: Ratio error at 100% of rated current ≤ 3% **&** Composite error ε_C at accuracy limit ≤ 10% If ε_C is < 10% and prefixed by a ">" sign (e.g. > ε_C = 3.20), the class assessment is "n/a".
	K_r: $K_r \leq 10\%$
PX	**Class**: Turns ratio error $\varepsilon_t \leq 0.25\%$ $\varepsilon_t = \frac{(N_{measured} - N_{rated}) \cdot 100\%}{N_{rated}}$
	E_k: Measured knee point e.m.f. ≥ rated E_k Rated E_k = Rated knee point e.m.f at 10/50% point.
	I_e: Measured excitation current at rated knee point e.m.f < rated excitation current at rated knee point e.m.f. (see IEC 60044-1, § 14.4.1)
	K_x: Rated dimensioning factor ≤ measured dimensioning factor
	R_{ct}: Rated R_{ct} (at T_{ref}) ≥ measured R_{ct}

IEC 60044-1 standard, metering CTs

Class	Conditions for auto-assessment "OK"
0.2S	**FS**: $FS_{measured} \le FS_{rated}$ — Example: $FS_{measured}$ = 4.3, FS_{rated} = 0.1FS5
	Class: For 100%, 50%, 25% of nominal burden: (see table below)

	at % of rated current				
	1%	**5%**	**20%**	**100%**	**120%**
Ratio error [%]	≤ 0.75	≤ 0.35	≤ 0.2	≤ 0.2	≤ 0.2
AND					
Phase error [min]	≤ 30	≤ 15	≤ 10	≤ 10	≤ 10

Class	Conditions for auto-assessment "OK"
0.5S	**FS**: $FS_{measured} \le FS_{rated}$
	Class: For 100%, 50%, 25% of nominal burden: (see table below)

	at % of rated current				
	1%	**5%**	**20%**	**100%**	**120%**
Ratio error [%]	≤ 1.5	≤ 0.75	≤ 0.5	≤ 0.5	≤ 0.5
AND					
Phase error [min]	≤ 90	≤ 45	≤ 30	≤ 30	≤ 30

Class	Conditions for auto-assessment "OK"
0.1	**FS**: $FS_{measured} \le FS_{rated}$
	Class: For 100%, 50%, 25% of nominal burden: (see table below)

	at % of rated current			
	5%	**20%**	**100%**	**120%**
Ratio error [%]	≤ 0.4	≤ 0.2	≤ 0.1	≤ 0.1
AND				
Phase error [min]	≤ 15	≤ 8	≤ 5	≤ 5

<table>
<tr><th>Class</th><th>Conditions for auto-assessment "OK"</th></tr>
<tr><td rowspan="2">0.2</td><td>FS:
$FS_{measured} \le FS_{rated}$</td></tr>
<tr><td>Class: For 100%, 50%, 25% of nominal burden:
<table>
<tr><th></th><th colspan="4">at % of rated current</th></tr>
<tr><th></th><th>5%</th><th>20%</th><th>100%</th><th>120%</th></tr>
<tr><td>Ratio error [%]</td><td>≤ 0.75</td><td>≤ 0.35</td><td>≤ 0.2</td><td>≤ 0.2</td></tr>
<tr><td>AND</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Phase error [min]</td><td>≤ 30</td><td>≤ 15</td><td>≤ 10</td><td>≤ 10</td></tr>
</table></td></tr>
<tr><td rowspan="2">0.5</td><td>FS:
$FS_{measured} \le FS_{rated}$</td></tr>
<tr><td>Class: For 100%, 50%, 25% of nominal burden:
<table>
<tr><th></th><th colspan="4">at % of rated current</th></tr>
<tr><th></th><th>5%</th><th>20%</th><th>100%</th><th>120%</th></tr>
<tr><td>Ratio error [%]</td><td>≤ 1.5</td><td>≤ 0.75</td><td>≤ 0.5</td><td>≤ 0.5</td></tr>
<tr><td>AND</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Phase error [min]</td><td>≤ 90</td><td>≤ 45</td><td>≤ 30</td><td>≤ 30</td></tr>
</table></td></tr>
<tr><td rowspan="2">1.0</td><td>FS:
$FS_{measured} \le FS_{rated}$</td></tr>
<tr><td>Class: For 100%, 50%, 25% of nominal burden:
<table>
<tr><th></th><th colspan="4">at % of rated current</th></tr>
<tr><th></th><th>5%</th><th>20%</th><th>100%</th><th>120%</th></tr>
<tr><td>Ratio error [%]</td><td>≤ 3</td><td>≤ 1.5</td><td>≤ 1</td><td>≤ 1</td></tr>
<tr><td>AND</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Phase error [min]</td><td>≤ 180</td><td>≤ 90</td><td>≤ 60</td><td>≤ 60</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Class</th><th>Conditions for auto-assessment "OK"</th></tr>
<tr><td rowspan="2">3</td><td>FS:
$FS_{measured} \leq FS_{rated}$</td></tr>
<tr><td>Class: For 100 %, 50 % of nominal burden:
<table>
<tr><th></th><th colspan="2">at % of rated current</th></tr>
<tr><th></th><th>50 %</th><th>120 %</th></tr>
<tr><td>Ratio error [%]</td><td>≤ 3</td><td>≤ 3</td></tr>
</table></td></tr>
<tr><td rowspan="2">5</td><td>FS:
$FS_{measured} \leq FS_{rated}$</td></tr>
<tr><td>Class: For 100 %, 50 % of nominal burden:
<table>
<tr><th></th><th colspan="2">at % of rated current</th></tr>
<tr><th></th><th>50 %</th><th>120 %</th></tr>
<tr><td>Ratio error [%]</td><td>≤ 5</td><td>≤ 5</td></tr>
</table></td></tr>
</table>

IEC 60044-6 standard, protection CTs

Class	Conditions for auto-assessment "OK"
TPS	**Class**: Turns ratio error $\varepsilon_t \leq 0.25\%$ — $\varepsilon_t = \frac{(N_{measured} - N_{rated}) \cdot 100\%}{N_{rated}}$
	V_{al}: $V_{al} \geq V_{al\ rated}$ — An increase of 10% in V_{al} should not result in an increase of I_{al} of more than 100%.
	I_{al}: $I_{al} \leq I_{al\ rated}$ — An increase of 10% in V_{al} should not result in an increase of I_{al} of more than 100%.
	K_{ssc}: $K * K_{ssc\ measured} \geq K * K_{ssc\ rated}$
	R_{ct}: R_{ct} (at T_{ref}) $\leq R_{ct\ rated}$
TPX	**Class**: Ratio error at rated current $\leq 0.5\%$ **&** Phase at rated current $\leq \pm 30$ min **&** ε_{peak} at accuracy limit ($K_{ssc} * K_{td}$) $\leq 10\%$ If ε_{peak} is < 10% and prefixed by a ">" sign (e.g. > ε_{peak} = 3.200), the class assessment is "n/a".
	K_{ssc}: $K_{td} * K_{ssc\ measured} \geq K_{ssc} * K_{td\ rated}$
	R_{ct}: R_{ct} (at T_{ref}) $\leq R_{ct\ rated}$

Class	Conditions for auto-assessment "OK"
TPY	**Class**: Ratio error at rated current ≤ 1.0% **&** Phase at rated current ≤ ± 60min **&** ε_{peak} at accuracy limit (K_{ssc} * K_{td}) ≤ 10% If ε_{peak} is < 10% and prefixed by a ">" sign (e.g. > ε_{peak} = 3.200), the class assessment is "n/a".
	K_{ssc}: K_{td} * $K_{ssc\ measured}$ ≥ K_{ssc} * $K_{td\ rated}$
	T_s: T_s ≤ ±30% of $T_{s\ rated}$
	K_r: K_r ≤ 10%
	R_{ct}: R_{ct} (at T_{ref}) ≤ $R_{ct\ rated}$

Class	Conditions for auto-assessment "OK"
TPZ	**Class**: Ratio error at rated current ≤ 1.0% **&** Phase at rated current ≤ 180 ± 18 min
	$\mathbf{K_{ssc}}$: K_{td} * $K_{ssc\ measured}$ ≥ K_{ssc} * $K_{td\ rated}$
	$\mathbf{T_s}$: T_s ≤ ±10% of $T_{s\ rated}$
	$\mathbf{R_{ct}}$: R_{ct} (at T_{ref}) ≤ $R_{ct\ rated}$

3.8 Comment Card

The **Comment** card is only available if it is enabled in the **Select Cards** page. In the **Comment** card you can enter any text, e.g. additional notes regarding the current test.

3.9 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*.

3.9.1 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.

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. <u>For IEEE C57.13 only:</u> If the selected standard is IEEE C57.13 and the "Number of Taps" is set to 5 in the **MR-Config.** card, the *CT Analyzer* offers soft keys with predefined ratios (according to the standard) for 5-tap CTs when the "I-pn" field is selected with the cursor. If the selected standard is IEEE C57.13 and the "Number of Taps" is set to 3 in the **MR-Config.** card, the *CT Analyzer* offers soft keys with predefined ratios for common 3-tap CTs when the "I-pn" field is selected with the cursor. 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:** 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.
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.

3.9.2 MR-Config. Card

Use the **MR-Config.** card to configure the multi-ratio CT test.

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.

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.

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.

Parameter	Description
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).
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, you can switch the common tap.
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, 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. 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.

3.9.3 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.

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

- the ratio results or the excitation results (see ”Ratio results or excitation results” on page 66),
- the results for the tap combinations or the intertap combinations of the CT, and
- the results with the nominal burdens or the operating burden (see subsequent section).

Test 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. 25 VA for X1-X5, 12.5 VA 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: 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.

Ratio results or excitation results

The measurement results are displayed on two different pages. 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.

3.9.4 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.

3.9.5 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).

4 Technical Data

Guaranteed data are specified for an ambient temperature of 23°C ± 5° (73°F ± 9°), a power supply of 115/230V_{AC}, and after a warm-up time longer than 15minutes.

Guaranteed data are valid for the period of one year after factory adjustment.

4.1 Mains Power Supply

Mains power supply	
Connection	Connector according to IEC 60320
Mains voltage	100 - 240V_{AC} / 50/60Hz / 6A
Mains fuses	2 x T6AH 250V, (high-breaking capacity wire fuse 5 x 20mm)
Overvoltage category	II

4.2 Generator Output

Generator output	
Output current	5A_{rms} max.
Output voltage	0 - 120V_{AC}
Output power	400VA_{rms} max.

4.3 Measurement Inputs

Measurement input "Sec"	
Voltage ranges	0 - 0.3 / 3 / 30 / 300V_{AC} (auto ranging)
Accuracy	0.1% (guaranteed)
Input impedance	0 - 15V: 1MΩ 15 - 150V: 500kΩ to 1MΩ, depending on the voltage. Input current is compensated by the device.
Insulation	Reinforced insulation (R) to all other circuits

Measurement input "Prim"	
Voltage ranges	0 - 0.03 / 0.3 / 3 / 30V_{AC} (auto ranging)
Accuracy	0.1% (guaranteed)
Input impedance	0 - 15V: 330kΩ 15 - 30V: 120kΩ to 330kΩ, depending on the voltage.
Insulation	Reinforced insulation (R) to all other circuits

4.4 Winding Resistance Measurement Accuracy

Winding resistance measurement accuracy	
Resolution	1mΩ
Accuracy	0.05% (typical) 0.1% + 1mΩ (guaranteed)

4.5 Ratio and Phase Measurement Accuracy

The values given in the following table are only valid under the following conditions:

- All utility lines to the primary side of the CT are disconnected.
- One terminal of the primary side of the CT is connected to PE.
- The original measurement cables delivered by OMICRON electronics GmbH for the *CT Analyzer* are used.
- The CT under test is a CT with a non-gapped core.
- The knee point voltage according to IEEE C57.13 is > 3V.

Under interfering conditions the device has reduced accuracy.

Values without the prefix "!" in the ratio table of the **Ratio** card have guaranteed accuracy. The accuracy of values marked with a "!" in the table is reduced by factor 2 since these values are not directly measured but calculated from the measured values instead.

Ratio measurement accuracy for 1 A CTs at rated current				
CT ratio	I_{sn}	**Rated power**[1]	**Typical accuracy**	**Guaranteed accuracy**
0.2 - 1	1	1.0 - 30VA	0.05%	0.1%
> 1 - 2000	1	0 - 30VA	0.02%	0.05%
> 2000 - 5000	1	0 - 30VA	0.03%	0.1%
> 5000 - 10000	1	0 - 30VA	0.05%	0.2%

1. Nominal burden of the CT.

Ratio measurement accuracy for 5 A CTs at rated current				
CT ratio	I_{sn}	**Rated power**[1]	**Typical accuracy**	**Guaranteed accuracy**
0.2 - 1	5	1.0 - 75VA	0.05%	0.1%
> 1 - 2000	5	0 - 75VA	0.02%	0.05%
> 2000 - 5000	5	0 - 75VA	0.03%	0.1%
> 5000 - 10000	5	0 - 75VA	0.05%	0.2%

1. Nominal burden of the CT.

Phase measurement accuracy at rated current	
Resolution	0.01min
Accuracy (cos φ 0.8 - 1)	1min (typical) 3min (guaranteed)

Turns ratio measurement accuracy	
Resolution	0.01 turns
Accuracy	0.05% (typical) 0.1% (guaranteed)

4.6 Compact Flash Card Interface

Compact Flash card interface	
Card type	CF type 1
Allowed memory size	16 MB - 2 GB

4.7 Remote Control Interface

The remote control interface of the *CT Analyzer* is exclusively intended to connect the *CT Analyzer* to a computer (e.g. running the *CT Analyzer PC Toolset* software) or to the *CT SB2* switch box (for multi-ratio CT measurement).

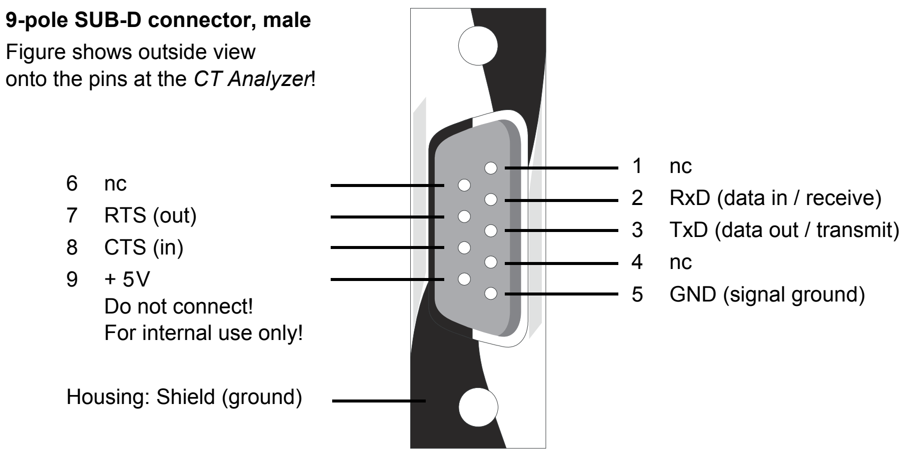


Figure 4-1 Pin assignment for remote control interface

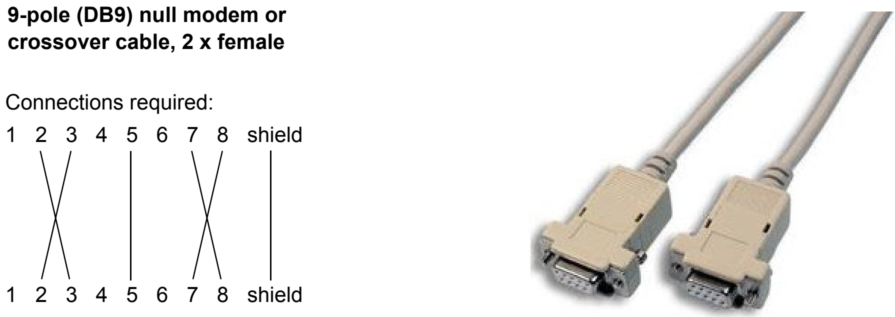


Figure 4-2 Connection cable for remote control interface

4.8 Environmental Conditions

4.8.1 Climate

Climate	
Operating temperature	-10 … +50 °C (14 … 122 °F)
Storage and transportation	–25 … +70 °C (–13 … 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 %

4.8.2 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

4.8.3 Mechanical Data

Weight, Dimensions and Protection	
Weight	< 8 kg (17.6 lbs) without accessories
Dimensions W x H x D	360 x 285 x 145 mm (14.2 x 11.2 x 5.7")

4.8.4 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

5 Overview of Standards Supported by the CT Analyzer

Standard and version	Title	Reference number
IEC 60044-1 [1] Edition 1.2 2003-02	Instrument transformers - Part 1: Current transformers	CEI/IEC 60044-1:1996+A1:2000+A2:2002
IEC 60044-6 [1] First Edition 1992-03	Instrument transformers - Part 6: Requirements for protective current transformers for transient performance	CEI/IEC 44-6:1992
IEEE C57.13-1993 (R2003) 26.04.2004	IEEE Standard Requirements for Instrument Transformers	Print version: ISBN 0-7381-356-3
IEEE C57.13-2008 [1] 28.07.2008	IEEE Standard Requirements for Instrument Transformers	PDF version: ISBN 978-0-7381-5410-7 STD95778 Print version: ISBN 978-0-7381-5411-4 STDPD95778
IEEE C57.13.6-2005 [1] 09.12.2005	IEEE Standard for High-Accuracy Instrument Transformers	PDF version: ISBN 0-7381-4829-6 SS95386 Print version: ISBN 0-7381-4828-8 SH95386

1 *CT Analyzer* default

6 Formulas and Definitions

6.1 Calculation of Ratio Error (Current Ratio)

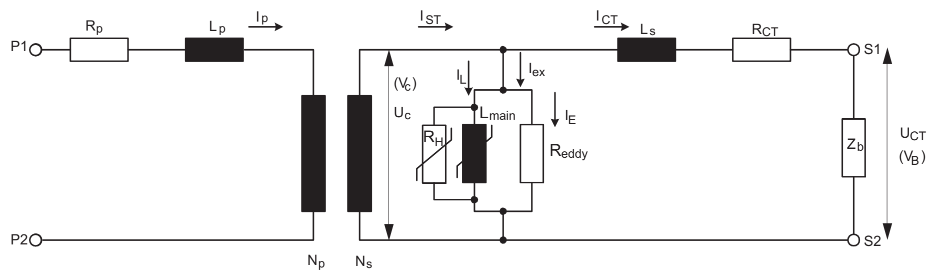


Figure 6-1 Equivalent circuit of a current transformer

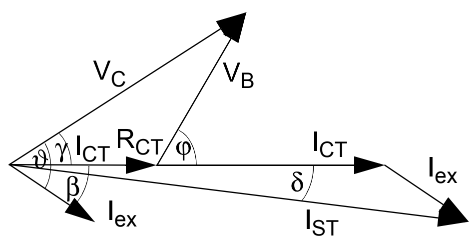


Figure 6-2 Phasor diagram of a current transformer

I_{ex}	total excitation current
I_{CT}	current over the secondary terminals
I_{ST}	total secondary current
I_p	primary current $I_p = \frac{N_s}{N_p} \cdot (I_{ex} + I_{CT})$
L_p	leakage inductance of the primary winding (negligible)
L_{main}	main inductance
L_s	leakage inductance of the secondary winding (negligible)
N_p, N_s	turns of the ideal transformer
N	turns ratio $N_{turns} = \frac{N_s}{N_p}$

R_{ct}	resistance of the secondary winding
R_{eddy}	eddy-current resistance
R_H	hysteresis resistance
R_p	resistance of the primary winding (negligible)
U_C (V_C)	secondary excitation voltage on the main inductance (L_{main})
U_{CT} (V_B)	voltage at the secondary terminals
Z_B	burden
Z_{load}	total load impedance ($Z_B + R_{CT}$)

The calculation of the ratio error is based on the excitation table. With a given excitation voltage V_C, the excitation table allows to find the corresponding excitation current I_{ex} and the phase between I_{ex} and V_C. Since the ratio error is defined by the primary current I_p and the secondary load current I_{CT}, the excitation table can be used to determine the value of I_{CT} that corresponds to the given V_C for a particular core. Provided that the rated turns ratio N_{rated} and the turns ratio N_{turns} are known, the ratio error calculation for the given primary current I_p and the burden impedance Z_B,φ is as follows ($\vec{I}_S$ is always a reference pointer):

1. Calculate the real and imaginary parts of the burden impedance:

   $$R_B = Z_B \cdot \cos\varphi \qquad X_B = Z_B \cdot \sin\varphi$$

2. Calculate the total load impedance:

   $$\vec{Z}_{load} \ ; \ R_{load} = R_{CT} + R_B \ ; \ X_{load} = X_B \ ; \ Z_{load} = \sqrt{R_{load}^2 + X_{load}^2}$$

   $$\gamma = \arg(\vec{Z}_{load}) = \arctan\left(\frac{X_{load}}{R_{load}}\right)$$

3. Given desired total secondary current I_{CT}.
4. Calculate the secondary excitation voltage by

   $$V_C = I_{CT} \cdot Z_{load}$$

5. Look up the excitation current corresponding to this voltage and the phase ϑ between them in the excitation table:

   $$I_{ex} \Leftrightarrow V_C \quad ; \ \vartheta = \angle I_E, V_S$$

6. Calculate the phase between the secondary load current and the excitation current:

   $$\beta = \vartheta - \gamma$$

7. Calculate the total secondary current:

$$\overrightarrow{I_{ST}} = \overrightarrow{I_{CT}} + \overrightarrow{I_{ex}} \quad ; \quad I_{ST} = \sqrt{(I_{CT} + I_{ex} \cdot \cos\beta)^2 + (I_{ex} \cdot \sin\beta)^2}$$

8. Calculate the primary current:

$$I_p = \overrightarrow{I_{ST}} \cdot N_{turns}$$

9. Calculate the ratio (current) error:

$$Err_{ratio} = \frac{\left(I_{CT} - \frac{I_p}{N_{rated}}\right)}{\frac{I_p}{N_{rated}}}$$

10. Calculate the phase displacement as the phase between $\vec{I}_{ST}$ and $\vec{I}_{CT}$:

$$\delta = \arg(\overrightarrow{I_{ST}}) = \arctan\left(\frac{I_{ex} \cdot \sin\beta}{I_{CT} + I_{ex} \cdot \cos\beta}\right)$$

6.2 Turns Ratio Error

Turns ratio error calculation according to IEC 60044-1, §2.3.14:

$$\text{Turns ratio error (\%)} = \frac{N_{measured} - (I_{pn}/I_{sn})}{(I_{pn}/I_{sn})} \cdot 100$$

6.3 Calculation of RCF for IEEE C57.13

The *CT Analyzer* calculates the RCF as follows:

$$RCF = \frac{I_p}{I_s \cdot K}$$

RCF ratio correction factor

I_p primary r.m.s. current

I_s secondary r.m.s. current

K I_{pn}/I_{sn} (nominal primary current / nominal secondary current)

6.4 Calculation of e.m.f. r.m.s. Voltage (U_c)

The following formula is used to calculate the e.m.f r.m.s. voltage (U_C) if voltage is applied at the secondary terminal (refer to Figure 6-1 on page 77):

$$U_c = \frac{2\pi f}{\sqrt{2}} \cdot \int_0^t (U_{ct} - R_{ct} i_{ct}) dt$$

6.5 Calculation of Instrument Security Factor (FS)

According to IEC 60044-1 the instrument security factor is the ratio of the rated instrument limit primary current to the rated primary current. The rated instrument limit primary current is defined as that minimum primary current at which the composite error of the CT is equal to or greater than 10%.

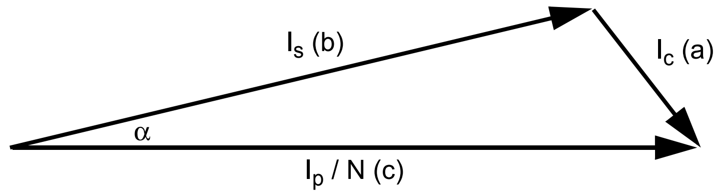
The standard delivers two methods to calculate FS:

- The indirect method for calculating the FS (refer to section 6.5.2 on page 82).
- The direct method as described in appendix A of the standard (refer to section 6.5.1).

The *CT Analyzer* supports both methods, the calculation according to the direct method as well as the calculation according to the indirect method.

6.5.1 Calculation of Instrument Security Factor (FS) According to the Direct Measurement Method

The direct method considers the ratio error of the CT and is therefore more accurate than the indirect method. The direct method is implemented as follows:



For calculation of FS, the measured secondary winding resistance is corrected to 75°C. The device calculates the FS for the nominal burden and the operating burden.

Calculation of the composite current I_c is performed as follows, according to the equation $a^2 = b^2 + c^2 - 2\,b\,c\,\cos\alpha$.

$$I_c = \sqrt{I_s{}^2 + \left(\frac{I_p}{N}\right)^2 - \left(2 \cdot I_s \cdot \frac{I_p}{N} \cdot \cos\alpha\right)}$$

$FS = \frac{I_{psc}}{I_{pn}}$ at that point where the composite current is 10% of $\frac{I_p}{N}$

$$\varepsilon_c = \frac{I_c}{\frac{I_{pn}}{N} \cdot FS} \cdot 100$$

I_{sn}	rated secondary current
I_{exc}	excitation current
I_s	secondary r.m.s. current
I_c	calculated composite current
I_{pn}	nominal primary current
I_p	primary r.m.s. current
I_{psc}	rated primary short curcuit current
FS	instrument security factor
N	rated transformer winding ratio
ε_c	Composite error

Note: The composite current cannot be compared to the excitation current in the excitation graph, since the composite current is calculated with R_{ct} at 75°C and the excitation current is measured at ambient temperature. Furthermore, the winding compensation is included in the value of the used secondary current I_s. In order to verify the calculated value, use the following formula to calculate the excitation current:

$$I_{ext} = \frac{I_{pn} \cdot FS}{N} \cdot 0.1$$

The excitation current now delivers an according value on the excitation curve that can be used to calculate the burden current.

Note: The output current is not measured, but calculated instead. Therefore, the accuracy of FS can differ by up to 10% from the reality.

6.5.2 Calculation of Instrument Security Factor (FSi) According to the Indirect Measurement Method

The calculation of FSi according to the IEC 60044-1 indirect measurement method is implemented as follows:

1. Calculation of the total impedance under consideration of the phase of the load (burden).

$$Z = \sqrt{(R_{burden} + R_{CT\_75°})^2 + X_b^2}$$

$$R_{burden} = Z_{burden} \cdot \cos\varphi$$

$$X_b = Z_{burden} \cdot \sqrt{1 - \cos\varphi^2}$$

2. Stepping up the current through the load (Z) (CT output current) until the excitation current reaches 10% of the current flowing through the load (Z) ($\frac{I_{ext}}{I_{out}} = 0.1$).

   For each step, the calculation $V_{e.m.f.} = I_{out} \cdot Z$ has to be done to read the corresponding I_{ext} from the excitation graph.

   Attention: The e.m.f. voltage has to be used to find out I_{ext} for the calculation of FSi as defined in the standard IEC 60044-1. Do not use the terminal voltage to find the corresponding I_{ext}, since this would lead to incorrect results. Because the standard excitation graph according to IEC 60044-1 only shows the terminal voltage, you should switch to the IEEE C57.13

excitation graph on the *CT Analyzer*. With the tools *CTA Remote Excel File Loader* or *CTA Remote Control* it is possible to get the e.m.f. values from the excitation graph.

3. After the point where the excitation current is 10 % of the output current is found, the FSi can be calculated as follows:

$$FSi = \frac{I_{out}}{I_{sn}}$$

The result is displayed as FSi in the user interface and in all reports.

6.5.3 Example for Verification of FSi

Refer to the *CT Analyzer* test cards shown below.

- Nominal load = 10 VA, cosφ = 0.8
- I_{sn} = 1 A
- R_{ct} at 75 °C = 3.907 Ω
- FSi = 6.16
- FS = 10

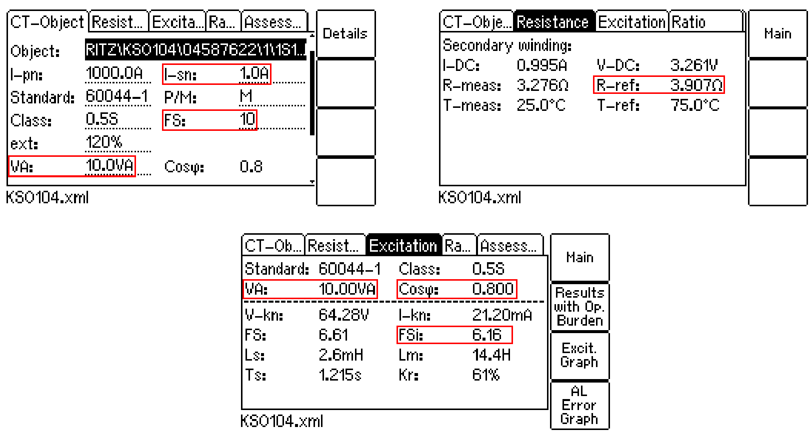


Figure 6-3 Values determined by the *CT Analyzer*

Proceed as follows to verify the FSi value:

1. Calculate the total impedance of the CT incl. the winding resistance Rct:

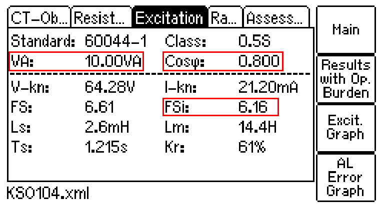
$$Z = \sqrt{(10 \cdot \cos\varphi + 3.907)^2 + \left(10 \cdot \sqrt{1 - \cos\varphi^2}\right)^2} \quad => 13.33\ \Omega$$

2. Calculate $V_{e.m.f.}$ as follows: $V_{e.m.f.}$ = FSi * I_{sn} * Z

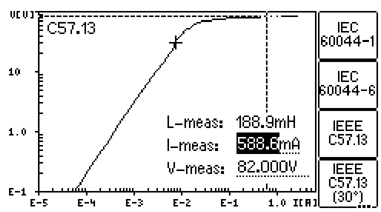
$$V_{e.m.f.} = FSi \cdot I_{sn} \cdot Z$$

$$V_{e.m.f.} = 6.16 \cdot 1 \cdot 13.33$$

$$V_{e.m.f.} = 82.1\ V$$



3. Read I_{ext} from the IEEE C57.13 excitation graph at $V_{e.m.f.}$ (e.g. at 82 V: I_{ext} = 0.588 A).



4. Calculate whether FSi is really at the 10% error border:

$$FSi = \frac{I_{ext} \cdot 10}{I_{sn}} = \frac{0.588\ A \cdot 10}{1\ A} \quad => \quad FSi \sim 5.88$$

Or calculate the error at FSi:

$$Error\ [\%] = \frac{I_{ext}}{FSi \cdot I_{sn}} \cdot 100 = \frac{0.588}{6.16 \cdot 1} \cdot 100 \quad => \quad Error \sim 9, 5\ \%$$

5. FSi must be lower than the FS on the **CT-Object** card (FSi ≤ FS_{rated}):

   5.88 < 10 = true => ok

Attention: Often it is not possible to read the point where the CT reaches an error of 10% on the excitation graph because the excitation graph is not measured far enough. In this case, use the highest available point to verify FSi.

6.6 Calculation of Accuracy Limiting Factor (ALF)

According to IEC 60044-1 the accuracy limiting factor is the ratio of the rated accuracy limit primary current to the rated primary current. Depending on the accuracy class, the accuracy limiting factor is defined as that primary current at which the composite error is equal to or smaller than 5% or 10%.

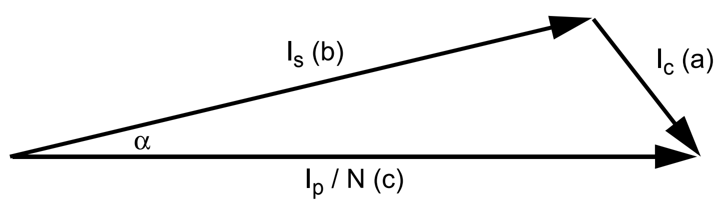
The standard delivers two methods to calculate ALF:

- The direct method as described in appendix A of the standard (refer to section 6.6.1).
- The indirect method for calculating the ALF (refer to section 6.6.2 on page 87).

The *CT Analyzer* supports both methods, the calculation according to the direct method as well as the calculation according to the indirect method.

6.6.1 Calculation of Accuracy Limiting Factor (ALF) According to the Direct Measurement Method

The direct method considers the ratio error of the CT and is therefore more accurate than the indirect method. The direct method is implemented as follows:



For calculation of ALF, the measured secondary winding resistance is corrected to 75°C. The device calculates the ALF for the nominal burden and the operating burden.

Calculation of the composite current I_c is performed as follows, according to the equation $a^2 = b^2 + c^2 - (2 \cdot b \cdot c \cdot \cos\alpha)$

$$I_c = \sqrt{I_s^2 + \left(\frac{I_p}{N}\right)^2 - \left(2 \cdot I_s \cdot \frac{I_p}{N} \cdot \cos\alpha\right)}$$

$ALF = \frac{I_{psc}}{I_{pn}}$ at that point where the composite current is 5% or 10% of $\frac{I_p}{N}$

$$\varepsilon_c = \frac{I_c}{\frac{I_{pn}}{N} \cdot ALF} \cdot 100$$

I_{sn}	rated secondary current
I_{exc}	excitation current
I_s	secondary r.m.s. current
I_c	calculated composite current
I_{pn}	nominal primary current
I_p	primary r.m.s. current
I_{psc}	rated primary short curcuit current
ALF	accuracy limiting factor
N	rated transformer winding ratio
ε_c	Composite error

Note: The composite current cannot be compared with the excitation current in the excitation graph since the composite current is calculated with R_{ct} at 75°C and the excitation current is measured at ambient temperature. Furthermore, the winding compensation is included in the value of the used secondary current I_s. In order to verify the calculated value, use the following formula to calculate the excitation current:

$I_{ext} = \frac{I_{pn} \cdot ALF}{N} \cdot 0.1$ for a 5% CT, use factor 0.05 instead of 0.1

The excitation current now delivers an according value on the excitation curve that can be used to calculate the burden current.

Note: The output current is not measured, but calculated instead. Therefore, the accuracy of ALF can differ by up to 10% from reality.

6.6.2 Calculation of Accuracy Limiting Factor (ALFi) According to the Indirect Measurement Method

The calculation of ALFi according to the IEC 60044-1 indirect measurement method is implemented as follows:

1. Calculation of the total impedance under consideration of the phase of the load.

$$Z = \sqrt{(R_{burden} + R_{CT\_75°})^2 + X_b^2}$$

$$R_{burden} = Z_{burden} \cdot \cos\varphi$$

$$X_b = Z_{burden} \cdot \sqrt{1 - \cos\varphi^2}$$

2. Determination of the excitation current where $\frac{I_{ext}}{I_{out}} \cdot 10 = 1$ with $I_{out} = \frac{V_{emf}}{Z}$

3. Reading of the e.m.f. voltage (Val) from the excitation cuve (e.m.f. voltage that corresponds to the excitation current determined in step 2.).

   Attention: The e.m.f. voltage has to be used to find out I_{ext} for the calculation of ALFi as defined in the standard IEC 60044-1. Do not use the terminal voltage to find the corresponding I_{ext}, since this would lead to incorrect results. Because the standard excitation graph according to IEC 60044-1 only shows the terminal voltage, you should switch to the IEEE C57.13 excitation graph on the *CT Analyzer*. With the tools *CTA Remote Excel File Loader* or *CTA Remote Control* it is possible to get the e.m.f. values from the excitation graph.

4. Calculation of ALF: $ALF = \frac{V_{al}}{Z \cdot I_{sn}}$

   The result is displayed as ALFi in the user interface and in all reports.

The ALFi can be verified using the following equation:

$$ALF \cdot I_{sn} \geq \frac{V_{al}}{Z}$$

V_{al} is the voltage where $\frac{I_{ext}}{I_{out}} \cdot 10 = 1$ (10% error current).

6.7 Calculation of Indirect Error (ε_i)

The calculation of ε_i according to the IEC 60044-1 indirect measurement method is implemented as follows:

$$\varepsilon_i = \frac{I_{exc}}{ALF \cdot I_{sn}} \quad \text{or} \quad \varepsilon_i = \frac{I_{exc}}{FS \cdot I_{sn}}$$

I_{exc}	excitation current
I_{sn}	rated secondary current
ALF	accuracy limiting factor
FS	instrument security factor

6.8 Calculation of Peak Instantaneous Error ($\hat{\varepsilon}$)

The *CT Analyzer* calculates $\hat{\varepsilon}$ according to IEC 60044-6, §3.3:

$\hat{\varepsilon}$	$\hat{\varepsilon} = \frac{100 \cdot \hat{I}_{ext}}{\sqrt{2} \cdot I_{sn} \cdot K_{ssc}}$
I_{ext}	Peak excitation current read from the excitation graph at E_{max}.
E_{max}	$E_{max} = K_{dt\_meas} \cdot K_{ssc} \cdot (I_{sn} \cdot \sqrt{(R_{CT} + R_b)^2 + X_b^2})$
$K_{td\ meas}$	K_{td} calculated (parameter from **Excitation** card), refer to section 6.18 ”Determination of Transient Dimensioning Factor (K_{td})” on page 97.
K_{ssc}	K_{ssc} from the settings (**CT-Object** card).
R_{CT}	Measured winding resistance (R_{CT}) at 75°C.
R_b	Burden entered in **CT-Object** card for parameter "VA" or "Burden", depending on the selected page on the **Excitation** card (using the soft key **Result with Nom. Burden** or **Result with Op. Burden**).

6.9 Calculation of Rated Symmetrical Short Circuit Current Factor (K_{ssc})

The calculation of the symmetrical short-circuit current current factor is done according to IEC 60044-6, §3.15:

$$K_{ssc} = \frac{I_{psc}}{I_{pn}}$$

6.10 Calculation of Dimensioning Factor (K_x)

The dimensioning factor K_x is only used for IEC 60044-1 class PX.

$$K_x = \frac{E_k}{(R_{ct} + R_b) \cdot I_{sn}}$$

E_k	rated knee point e.m.f.
R_b	rated resistive burden
R_{ct}	resistance of secondary winding at 75°C
I_{sn}	rated secondary current

On the **Excitation** card, K_x is calculated at the I_{prim} where the accuracy limit (E_k) is reached with the selected load. The selected load can be the nominal burden (parameter "VA", soft key **Result with Nom. Burden**) or the operating burden (parameter "Burden", soft key **Result with Op. Burden**).

6.11 Calculation of Secondary Loop Time Constant (T_s)

Value of the time constant of the secondary loop of the current transformer obtained from the sum of CT inductance and resistance and secondary loop inductance and resistance.

$$T_S = \frac{L_s}{R_s} \qquad R_S = R_b + R_{ct75°C}; R_b = R_{wire} + R_{relay}; L_S = L_{ct} + L_b$$

L_s	sum of magnetizing and leakage inductances
L_{ct}	unsaturated inductance of the CT

L_b	inductance of the measured burden
R_s	secondary loop resistance
R_{ct}	CT resistance at 75°C
R_b	resistive portion of measured burden without temperature correction

6.12 Calculation of Rated Secondary Terminal Voltage (V_B) Acc. to IEEE C57.13

The rated secondary terminal voltage is calculated at the point where the current ratio error is 10%. We defined this error as follows:

$$(I_{prim} - (I_{CT} \times ratio)) \times 10 = 0$$

In other words, I_{prim} is the primary current where the CT has an error of 10%.

Then, the rated secondary terminal voltage can be calculated as follows:

$$V_B = I_{CT} \times Z_b$$

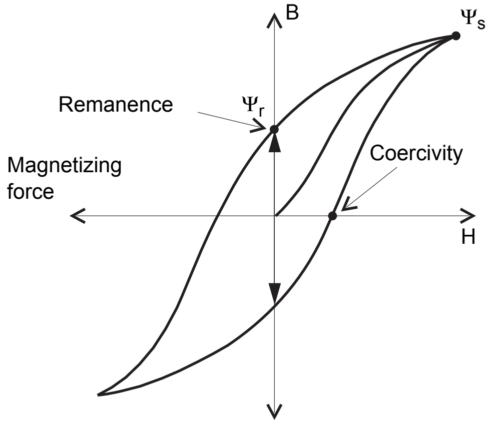
Furthermore, the secondary excitation voltage V_C can then be calculated as follows:

$$V_c = I_{CT} \times \sqrt{X_b^2 + (R_b + R_{ct})^2}$$

To understand the formulas please refer to the equivalent circuit for current transformer (refer to section 6.1 on page 77).

I_{sn}	rated secondary current
I_{pn}	rated primary current
I_{prim}	primary AC current
V_C, U_C	secondary excitation voltage at main inductance (L_{main})
R_{ct}	resistance of secondary winding
Z_b	external impedance at rated frequency
R_b	resistive part of burden
X_b	reactance of burden
U_{CT}, V_B	voltage at secondary terminal
I_{CT}	current at the secondary terminals

6.13 Remanence Factor (K_r)



Remanence factor (K_r):

$$K_r = 100 * \frac{\Psi_r}{\Psi_s}$$

Ψ_r = remanent flux

Ψ_s = saturation flux

K_r = remanence factor in %

Used measurement method

An AC method very similar to the definition in IEC 60044-6, annex B2, is used.

The *CT Analyzer* measures the flux in the main inductivity and not at the terminals. This is possible because the *CT Analyzer* subtracts the voltage over the winding resistance R_{ct} from the voltage measured at the terminals ($U_c = U_{ct} – (R_{ct} \times I_{ct})$).

Measuring the flux in the main inductivity (i.e., behind the winding resistor) delivers the same result as measuring the flux on a second transformer winding with the same number of turns. In other words, the *CT Analyzer* measures the hysteresis loop in the core and therefore measures that flux that is really of interest.

It is not necessary for the *CT Analyzer* to wait 3 minutes after the test is finished (as described in IEC 60044-6, § 3.25) because no burden is connected to the CT during the test and therefore the current almost immediately returns to zero after the deactivation of the voltage at the terminals. In a real CT, the current only decreases with the secondary time constant (L/R) and thus can require up to 3 minutes until it is actually zero.

Saturation flux (Ψ_s)

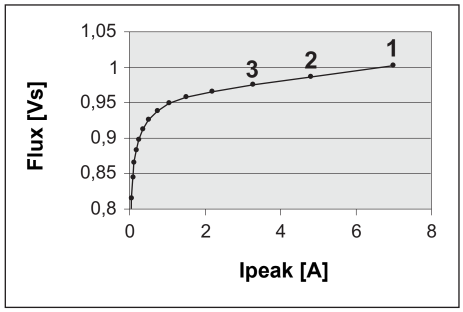
That peak value of the flux which would exist in a core in the transition from the non-saturated to the fully saturated condition and deemed to be that point on the B-H characteristic for the core concerned at which a 10% increase in B causes H to be increased by 50%

Remanent flux (Ψ_r)

That value of flux which would remain in the core 3 min after the interruption of an exciting current of sufficient magnitude to induce the saturation flux (Ψ_s).

6.14 Saturated Inductance (L_S)

The following steps are used to determine the saturated inductance.



1. Calculation of inductance of the two most top measurement points:

   $$L_{12} = \frac{\Psi_1 - \Psi_2}{I_1 - I_2}$$

   Ψ = measured flux

   I = peak current at measurement point

   Point 1 is the highest measured point of the IEC 60044-6 excitation curve, and point 2 is the second highest point of the same curve.

2. Calculation of inductance between points 2 and 3:

   $$L_{23} = \frac{\Psi_2 - \Psi_3}{I_2 - I_3}$$

   Point 2 is the second highest measured point of the IEC 60044-6 excitation curve and point 3 is the third highest point of the same curve.

3. Calculation of inductance between points 1 and 3:

   $$L_{13} = \frac{\Psi_1 - \Psi_3}{I_1 - I_3} = L_s$$

4. If one of the following conditions applies, the saturated inductance cannot be determined and n/a will be shown as result:

   $$I_{knee} < 1A \;\; AND \;\; I_1 < 5I_{knee} \qquad (1)$$

   $$0.5 < \frac{L_{12}}{L_{23}} < 1.5 \qquad (2)$$

   $$L_{13} > 30mH \qquad (3)$$

I_{knee} = knee point current according to IEC 60044-6

6.15 Non-Saturated Inductance (L_m)

The non-saturated inductance is calculated as the mean inductance within the linear region of the excitation curve in the range between 20% and 90% of the knee point. If the curve is reaching the non-linear zone at a value smaller than 90% of the knee point, the last point before the curve reaches the non-linear zone is taken as the topmost measurement point. The zone between 20% and 90% (or the topmost point) is linearly divided into 10 segments and the non-saturated inductance is calculated as the arithmetic mean value of these 10 segments.

One point is calculated as follows:

$$L_n = \frac{\Psi_n}{I_n}$$

Ψ_n, I_n = peak flux and peak current at one point of the excitation curve

The total unsaturated inductance is calculated as follows:

$$L_m = \frac{\sum_{L_{20\%}}^{L_{90\%}} L_n}{n}$$

6.16 Knee Point

According to IEC 60044-1

The point on the excitation graph (V_{kn}, I_{kn}) where an increase of the secondary terminal r.m.s. voltage by 10% causes a 50% increase of the r.m.s. current into the secondary terminals.

According to IEEE C57.13

For current transformers with non-gapped cores, the knee point is defined as the point (V_{kn}, I_{kn}) where the tangent is at 45 degrees to the abscissa. For current transformers with gapped cores, the knee is defined as the point where the tangent is at 30 degrees to the abscissa (C57.13(30°) acc. to C37.110™-2007).

6.17 Class Definition

6.17.1 Class Definition According to IEEE C57.13

Accuracy classes for metering CTs
(the accuracy has to be kept for all power factors in the range of 0.6 to 1):

Metering accuracy class	At 100% rated current x RF		At 10% rated current	
	min	max	min	max
0.3	0.997	1.003	0.994	1.006
0.6	0.994	1.006	0.988	1.012
1.2	0.988	1.012	0.976	1.024

Accuracy classes for high accuracy metering CTs according to IEEE C57.13.6
(the accuracy has to be kept for all power factors in the range of 0.6 to 1):

Metering accuracy class (IEEE C57.13.6)	At 100% rated current x RF		At 5% rated current	
	min	max	min	max
0.15	0.9985	1.0015	0.9970	1.0030
0.15S	0.9985	1.0015	0.9985	1.0015

Accuracy classes for protection CTs:

Protection accuracy class	Max. peak instantaneous error in % at 20 x I_{pn}
C, T	$\varepsilon = 10$
X	user defined
K[1]	$\varepsilon = 10$ **AND** $V_b < 0.7 \times U_{kn}$

1. According to IEEE C57.13 (1993)

6.17.2 Class Definition According to IEC 60044-6

Class	At rated primary current			At accuracy limit condition
	Ratio error in %	Phase displacement		Max. peak instantaneous error in %
		min	centiradians	
S	nd			ε = 10
TPS	0.25			ε = 10
TPX	0.5	30	0.9	ε = 10
TPY	1.0	60	1.8	ε = 10
TPZ	1.0	180 ± 18	5.3 ± 0.6	ε = 10

6.17.3 Class Definition According to IEC 60044-1

Instrument transformers according to 60044-1

Limits for metering current transformer classes from 0.1 to 1:

Accuracy class	Permitted current (ratio) error (± in %) at percentage of rated current I_{pn}			
	5% of I_{pn}	20% of I_{pn}	100% of I_{pn}	120% of I_{pn}
0.1	0.4	0.2	0.1	0.1
0.2	0.75	0.35	0.2	0.2
0.5	1.5	0.75	0.5	0.5
1.0	3.0	1.5	1.0	1.0

Accuracy class	Permitted phase displacement (±) at percentage of rated current I_{pn}							
	in minutes				in centiradians			
	5%	20%	100%	120%	5%	20%	100%	120%
0.1	15	8	5	5	0.45	0.24	0.15	0.15
0.2	30	15	10	10	0.9	0.45	0.3	0.3
0.5	90	45	30	30	2.7	1.35	0.9	0.9
1.0	180	90	60	60	5.4	2.7	1.8	1.8

Limits for special application transformers:

Accuracy class	Permitted current (ratio) error (± in %) at percentage of rated current I_{pn}				
	1% of I_{pn}	5% of I_{pn}	20% of I_{pn}	100% of I_{pn}	120% of I_{pn}
0.2S	0.75	0.35	0.2	0.2	0.2
0.5S	1.5	0.75	0.5	0.5	0.5

Accuracy class	Permitted phase displacement (±) at percentage of rated current I_{pn}									
	in minutes					in centiradians				
	1%	5%	20%	100%	120%	1%	5%	20%	100%	120%
0.2S	30	15	10	10	10	0.9	0.45	0.3	0.3	0.3
0.5S	90	45	30	30	30	2.7	1.35	0.9	0.9	0.9

Limits of current error for metering current transformers (class 3 and 5):

Accuracy class	Permitted current (ratio) error (± in %) at percentage of rated current I_{pn}	
	50% of I_{pn}	120% of I_{pn}
3	3	3
5	5	5

The load must have a cos φ of 0.8 if the load is above 5VA and a cos φ of 1 if it is between 1 and 5VA. A load < 1VA is not allowed (see section 11.2 of IEC 60044-1).

Error limits for protection CTs according to IEC 60044-1

Accuracy class	Permitted current error (±) at rated primary current	Permitted phase displacement (±) at rated primary current		Composite error at rated accuracy limit primary current
	in %	minutes	centiradians	in %
5P	1	60	1.8	5
10P	3	-	-	10

6.18 Determination of Transient Dimensioning Factor (K_{td})

6.18.1 Calculation for Class TPZ

Calculated according to IEC 60044-6, A5:

$$K_{td} = K_{tf} = \omega T_p \left(\frac{T_p}{T_s}\right)^{\frac{T_p}{T_s - T_p}} + 1 \qquad = K_{tf} \text{ at } t_{max}$$

6.18.2 Calculation for Class TPX, TPY

A worst case value is calculated. All formulas given below are calculated and the worst case value is taken.

Step 1

Calculation of K_{tf} at t_{max}.

K_{td} at t_{max} is calculated according to IEC 60044-6, A5:

$$K_{td} = K_{tf} = \omega T_p \left(\frac{T_p}{T_s}\right)^{\frac{T_p}{T_s - T_p}} + 1 \qquad = K_{tf} \text{ at } t_{max}$$

$$t_{max} = \frac{T_p \cdot T_s}{T_p - T_s} \cdot \ln\left(\frac{T_p}{T_s}\right)$$

Step 2

Calculation of K_{td} at accuracy limiting time of cycle 1:

K_{td}' for single duty cycle (CO): $$K_{td}' = \left\{\left[\frac{\omega T_p T_s}{T_p - T_s}\right]\left[e^{\frac{-t_{al}'}{T_p}} - e^{\frac{-t_{al}'}{T_s}}\right]\right\} + 1$$

Step 3

Calculation of K_{td} at accuracy limiting time of cycle 2 (if defined).

K_{td}" for COCO cycle:

1. Calculation according to IEC 60044-6:

$$K_{td}'' = \left\{\left[\frac{\omega T_p T_s}{T_p - T_s}\right]\left[e^{\frac{-t'}{T_p}} - e^{\frac{-t_{al}'}{T_s}}\right] - \sin\omega t'\right\} e^{\frac{-(t_{fr} + t_{al}'')}{T_s}} + \left[\frac{\omega T_p T_s}{T_p - T_s}\right]\left[e^{\frac{-t_{al}''}{T_p}} - e^{\frac{-t_{al}''}{Ts}}\right] + 1$$

2. Calculation according to Chinese standard GB 16847:

$$K_{td}'' = \left\{\left[\frac{\omega T_p T_s}{T_p - T_s}\right]\left[e^{\frac{-t'}{T_p}} - e^{\frac{-t'}{T_s}}\right] - \sin\omega t'\right\} e^{\frac{-(t_{fr} + t_{al}'')}{T_s}} + \left[\frac{\omega T_p T_s}{T_p - T_s}\right]\left[e^{\frac{-t_{al}''}{T_p}} - e^{\frac{-t_{al}''}{Ts}}\right] + 1$$

3. Calculation according to OMICRON:

$$K_{td}'' = \left\{\left[\frac{\omega T_p T_s}{T_p - T_s}\right]\left[e^{\frac{-t'}{T_p}} - e^{\frac{-t_{al}'}{T_s}}\right] + 1\right\} e^{\frac{-(t_{fr} + t_{al}'')}{T_s}} + \left[\frac{\omega T_p T_s}{T_p - T_s}\right]\left[e^{\frac{-t_{al}''}{T_p}} - e^{\frac{-t_{al}''}{Ts}}\right] + 1$$

Consideration of Remanence:

In order to consider the remanence in the term $e^{\frac{-(t_{fr} + t_{al}'')}{T_s}}$ we limit the value of the term to the remanence value. Therefore, the value of this term cannot be smaller than 0.8 if the remanence is 0.8.

Under **Main menu** -> **Settings** -> **Ktd Calculation**, you can select whether you want to have K_{td} calculated according to IEC 60044-6 (remanence not considered), according to the Chinese standard GB 16847 or according to OMICRON (remanence considered).

Result: The highest of the values K_{td}, K_{td}' or K_{td}'' is the value used for K_{td}.

6.19 Burden Entry Logic

Depending on whether

- the test contains a **Burden** card or not,
- the burden is defined in the **CT-Object** card or not, and
- the parameter I_{sn} is defined in the **CT-Object** card or not,

the *CT Analyzer* reads the burden value from a different source.

The "Burden" parameter defines the operating burden connected to the CT and therefore distinguishes from the "VA" parameter which defines the nominal burden the CT is made for.

Note: For multi-ratio measurements using the *CT SB2* switch box, the operating burden defined by the "Burden" parameter in the **CT-Object** card is used for all tap combinations specified in the **MR-Config.** card. In contrast to the nominal burden defined by the "VA" parameter, the operating burden is not scaled down for the tap combinations according to their ratios (see "VA" parameter on page 64).

Default values

If the test does not contain a **Burden** card, the default burden value is "?". Therefore, the software tries to determine the correct burden using the guesser function.

If a **Burden** card is included in the test, a "?" is entered for the "Burden" parameter in the **CT-Object** card to indicate that the burden has to be found by the *CT Analyzer* by means of a burden test. Entering a value for the "Burden" parameter in the **CT-Object** card is not possible until the test is finished.

Behavior after the Clear Results soft key has been pressed

If the test does not contain a **Burden** card, the burden value is changed to "?" if the *CT Analyzer* determined the burden using the guesser function. If a value was entered in the **CT-Object** card, this value is not changed.

If a **Burden** card is included in the test, a "?" is entered for the "Burden" parameter in the **CT-Object** card to indicate that the burden has to be found by the *CT Analyzer* by means of a burden test. Entering a value for the "Burden" parameter in the **CT-Object** card is not possible until the test is finished.

The following table defines the behavior of the *CT Analyzer* depending on the specified definitions and parameters.

Burden card included in the test	"Burden" parameter in CT-Object card	Behavior of the *CT Analyzer*
No	Value defined (e.g. 10VA)	All calculations are performed with the burden value defined in the **CT-Object** card (10VA).
No	"?"	All calculations are performed with the burden value measured during the excitation test. The burden is calculated and entered into the "Burden" field after the excitation test.
Yes	"?"	All calculations are performed with the burden value measured during the burden test. The burden is calculated and entered into the "Burden" field after the burden test. Value entry in the "Burden" field in the **CT-Object** card is not possible until the test is finished.
Yes	Value defined (e.g. 10VA)	The value in the "Burden" parameter field is automatically changed to "?" when the **Burden** card is added, even if a value has been entered before.

7 Parameter Definition Syntax for the Different Standards

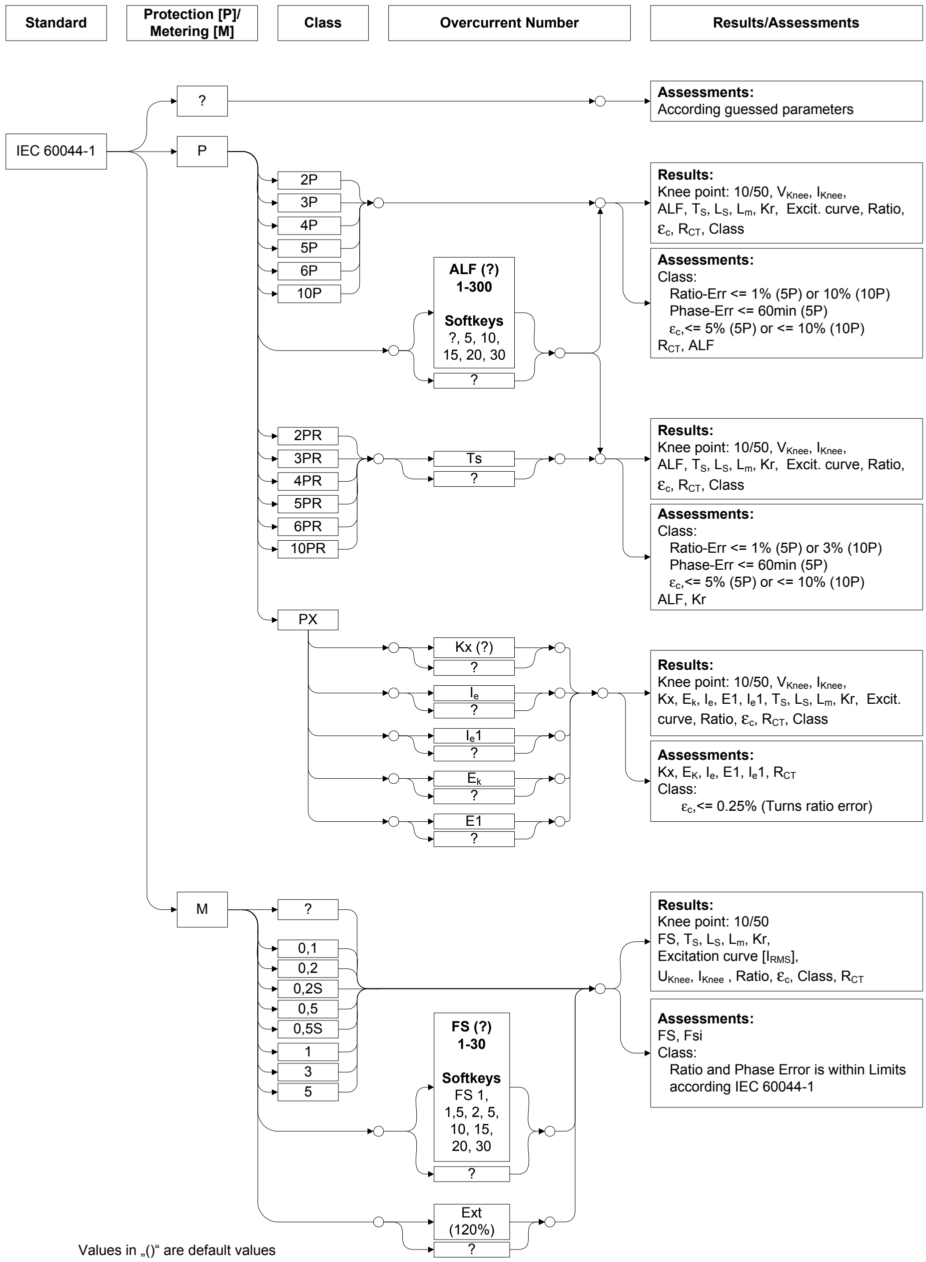
7.1 How to Read the Parameter Definition Syntax Charts

The parameter definition syntax charts shown on the following pages have to be read from the left to the right. How to read them is described below using the IEC 60044-1 chart on page 102 as an example:

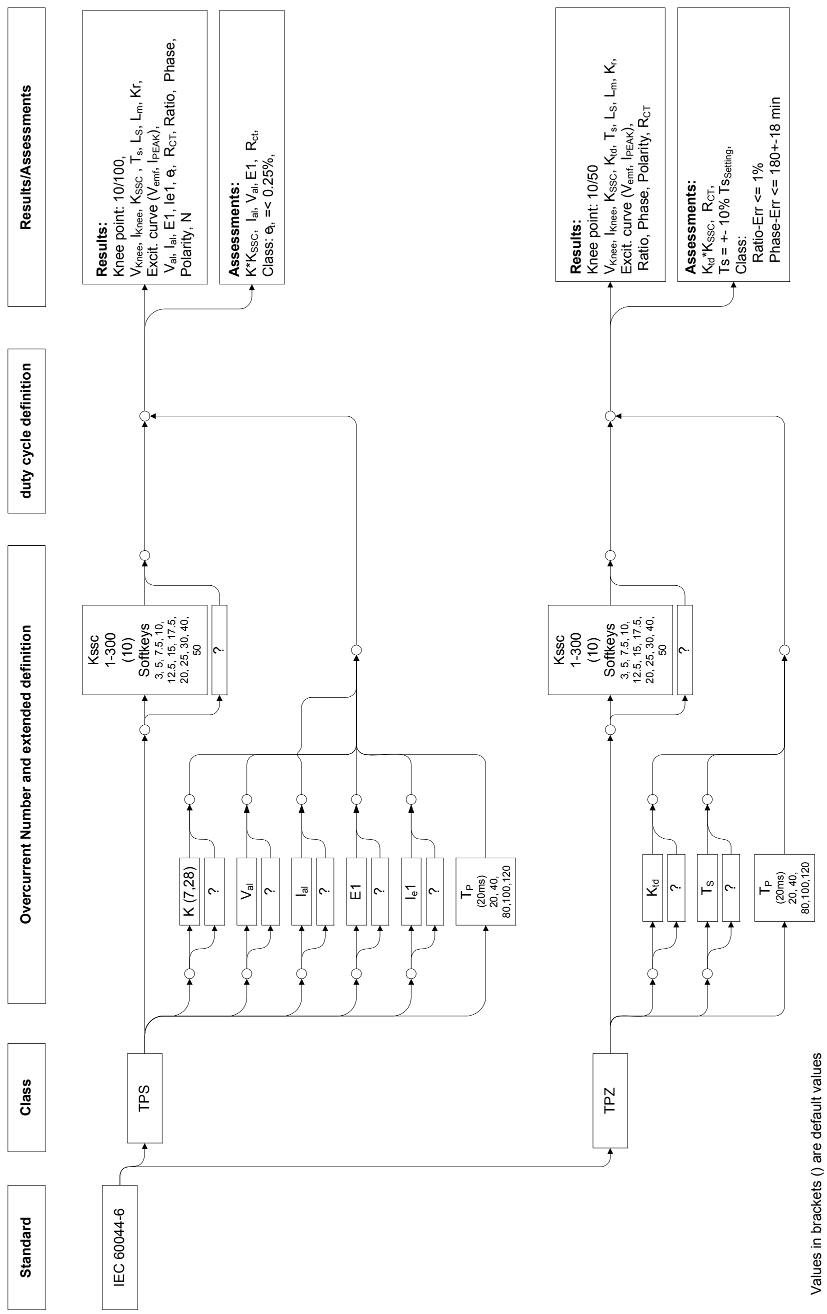
1. First, the **standard** has to be defined (in our example: "IEC 60044-1").
2. Then you have to define whether the CT is a **protection CT or a metering CT** ("P" or "M"). If you do not define this parameter ("?"), class definition is not possible.
3. After this, the **class** has to be defined. Depending on whether the CT is a metering CT ("M") or a protection CT ("P"), a different set of classes is available. If no class definition is done ("?"), it is not possible to define an overcurrent number and no assessment of the calculated results can be performed.
4. If you have defined the class of the CT, you have to enter an **overcurrent number**.
5. If you have previously defined the class and the overcurrent number, the *CT Analyzer* performs the results calculation, and an assessment for ALF and the class (in case of a protection CT) or for FS and the class (in case of a metering CT).

   If no class definition has been performed ("?" for the class definition), the *CT Analyzer* performs results calculation but is not able to perform an assessment.

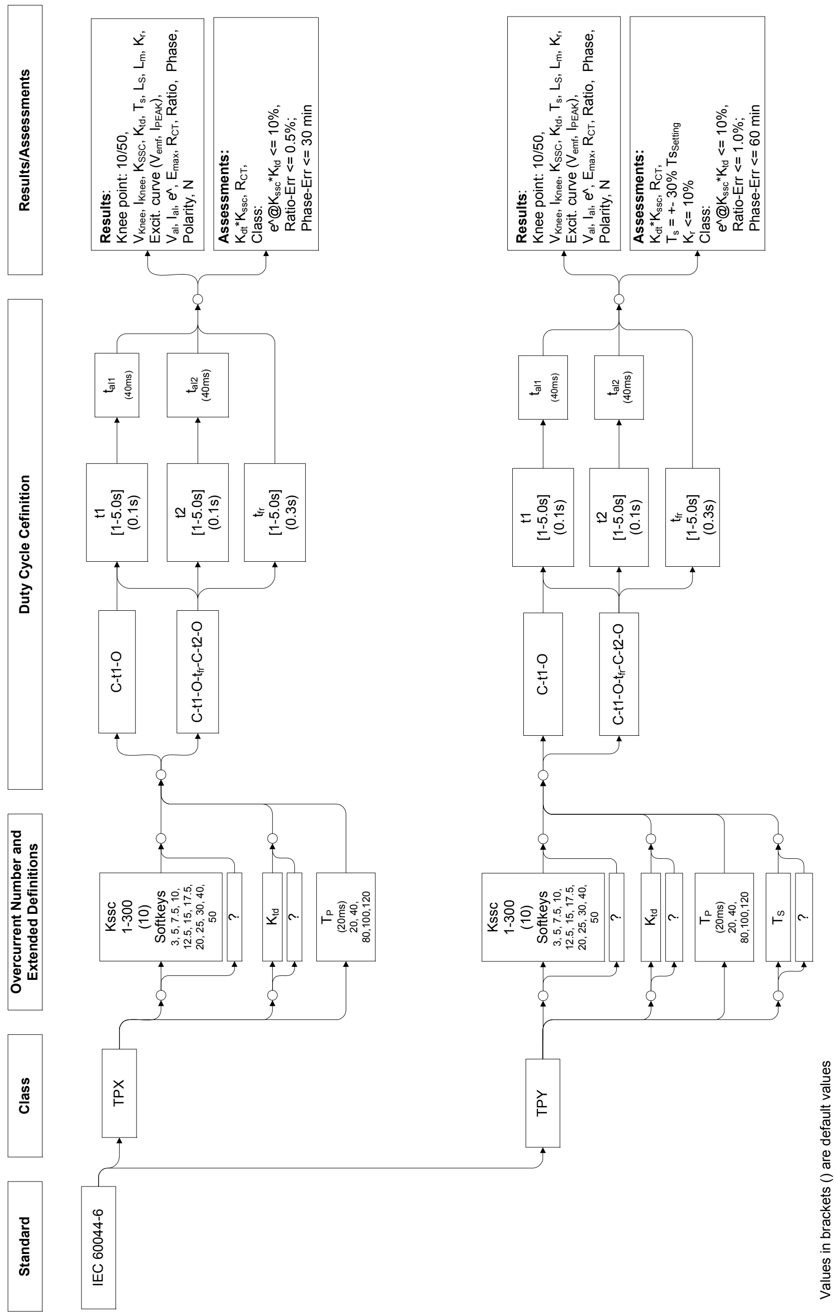
7.2 Parameter Definition Syntax for IEC 60044-1



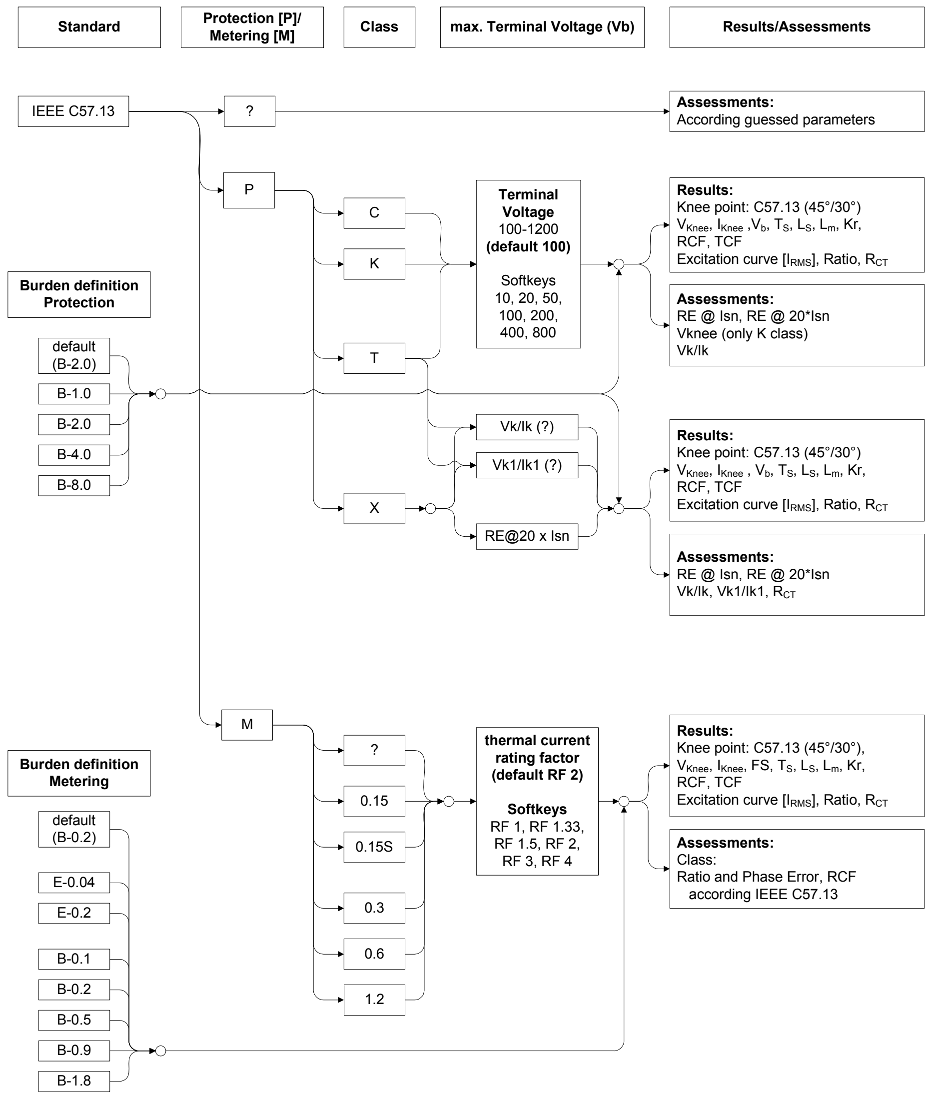
7.3 Parameter Definition Syntax for IEC 60044-6 Classes TPS and TPZ



7.4 Parameter Definition Syntax for IEC 60044-6 Classes TPX and TPY



7.5 Parameter Definition Syntax for IEEE C57.13



8 Theoretical Background and Principles Used

Instead of testing a current transformer with a high-power sinusoidal voltage generator, a low-power signal generator is used. Instead of testing with nominal frequency, a signal of lower frequency and lower voltage is partly used, producing the same flux in the magnet core as a signal with nominal frequency.

In Appendix B of IEC 60044-6 the dependence of the interlinked flux Ψ on the voltage-time area on the connection terminals is given by the formula

$$\Psi(t) = \int_0^t [U_{CT}(t) - R_{CT} \cdot I_{CT}(t)]dt + \Psi_0$$

and it is proposed to use a voltage generator with a lower frequency in order to protect the transformer with respect to the applied voltage. Testing at only one low frequency will result (depending on the transformer type) in erroneous results due to the different behavior of the iron core at low frequencies. Testing at low frequencies without considering the frequency-dependent behavior of the iron core allows only inaccurate predictions of the behavior at nominal frequency. In order to obtain correct measurement results, it is necessary to define a model of the transformer which allows description of the frequency-dependent behavior by means of a few parameters.

In the equivalent circuit of the metering transformer, the classical equivalent circuit diagram of a transformer is used. However, the magnetizing inductance is not considered linearly but described by a frequency-dependent hysteresis curve instead.

The iron core is modeled by means of

- a non-linear pure inductance L_{main} describing the non-linear behavior of the iron core without considering the hysteresis behavior,
- a non-linear hysteresis loss resistance R_h representing the hysteresis loss, and
- a linear eddy-current resistance R_{eddy} representing the eddy-current loss in the iron.

Both the non-linear inductance L_{main} and the hysteresis loss resistance R_h are described by means of a frequency-independent hysteresis curve. The hysteresis curve is periodically run through. Its shape, however, does not depend on the run-through speed, and is therefore independent of the time curve of the measured quantities. On the other hand, the hysteresis curve depends on the degree of saturation and, consequently, its shape depends on the signal amplitude. One parameter is the maximum interlinked flux Ψ_{max}.

The winding resistances (R_p and R_{ct}) and the leakage inductances (L_p and L_s) are described in the same way as in the conventional equivalent circuit diagram of the transformer.

The model parameters of the current transformer are resolved and the operation at nominal frequency is simulated using the model and the determined parameters. The obtained results are displayed according to the existing standards and can be compared with the available measurement results at nominal frequency.

A signal generator with low output voltage generates a periodic signal which is independent of the mains frequency. Using low frequencies allows to keep the apparent power of the signal generator low.

All following explanations refer to Figure 8-1 below.

8.1 Equivalent Circuit of a Current Transformer

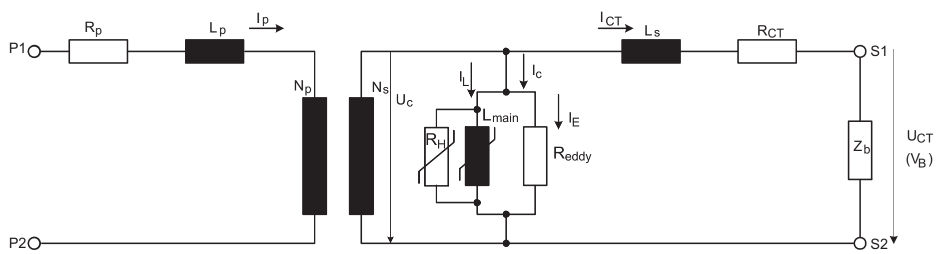


Figure 8-1 Simplified equivalent circuit of a current transformer

I_p	primary current
I_{CT}	current over the secondary terminals
L_{main}	main inductance
L_p	leakage inductance of the primary winding
L_s	leakage inductance of the secondary winding
N_p, N_s	windings of the ideal transformer
R_{ct}	resistance of the secondary winding
R_{eddy}	eddy-current resistance
R_H	hysteresis resistance

R_p resistance of the primary winding

U_C voltage at the main inductance (L_{main})

$U_{C\ r.m.s.}$ r.m.s. value of the voltage at the main inductance

U_{CT}, V_B voltage at the secondary terminals

Z_b external impedance at rated frequency

Note: Throughout this section, all voltage and current values are instantaneous values. Root-mean-square (r.m.s.) values are marked by the subscript "r.m.s.".

Note: The primary resistance R_p and the primary leakage inductance L_p are not relevant when testing the current transformer and therefore do not have to be measured. The secondary leakage inductance L_s affects testing only slightly and can be neglected.

8.2 Determination of the Secondary Winding Resistance

The signal generator generates a DC current which flows through the connection terminals (S1 and S2) into the secondary winding of the current transformer. The secondary resistance R_{ct} of the current transformer is calculated from the measured current and voltage values at the connection terminals of the secondary winding (S1 and S2).

8.3 Modeling the Effect of the Iron Core

Good modeling of the iron core is important for correct measurement results. The behavior of the iron core is best characterized by the hysteresis curve which describes the dependence of the magnetic flux density B on the magnetic field strength H. The time-variable flux density produces electric curl fields which in turn produce eddy currents in the conducting iron core. Due to the eddy currents in the iron core, the hysteresis curve strongly depends on the frequency of the excitation. The effect of the eddy currents can be best modeled by a linear resistance connected in parallel to the magnetizing inductance. To determine this resistance, the hysteresis loss and the eddy-current loss have to be separated, however.

8.4 Determination of Eddy-Current Loss and Eddy-Current Resistance

In principle, only the total loss can be measured in the iron core. The total loss is measured by applying a periodic voltage to the secondary winding of the current transformer while the primary winding is open and by evaluating the incoming power. A portion of the incoming power is lost in the secondary winding, the remaining power is lost in the iron core.

At the same maximum flux, the hysteresis loss increases in proportion to the frequency and the eddy-current loss increases in proportion to the square of the frequency. This allows splitting the total loss into the hysteresis loss and the eddy-current loss. By performing two measurements at different excitation frequencies, the hysteresis and the eddy-current losses can be determined.

$$P_T(f) = P_H + P_E$$

P_T	total loss
P_H	hysteresis loss
P_E	eddy-current loss

Hysteresis loss: $P_H(f) = \alpha \cdot f$

Eddy-current loss: $P_E(f) = \beta \cdot f^2$

8.5 Hysteresis Curve Measurement

For measuring the hysteresis curve, a periodic signal is applied to the connection terminals of the secondary winding. The voltage and current time curves (U_C and I_L) can be calculated from the current and voltage values measured at the connection terminals and from the eddy-current resistance determined previously. The frequency of the periodic signal may differ from the nominal frequency of the current transformer.

$$U_C = U_{CT} - R_{CT} \times I_{CT}$$

The leakage inductance is neglected.

$$I_L = I_{CT} - \frac{U_C}{R_{Eddy}}$$

The interlinked flux $\Psi(t)$ can be calculated from the voltage $U_C(t)$ as follows:

$$\psi(t) = \int_0^t U_C(t)dt + \psi_0$$

Since the eddy-current loss is already considered in the current I_L, the hysteresis curve is to a large extent independent of the frequency.

8.6 Transfer of Measurement Results to Another Frequency

If all parameters of the mathematical model are known, the behavior of the current transformer at another frequency can be determined.

To transfer the hysteresis curve to the nominal frequency, calculation is performed with a sinusoidal time curve of the interlinked flux at nominal frequency f_N.

Time-dependent interlinked flux: $\psi(t) = -\psi_{max} \cdot \cos(2\pi f_N t)$

From the above interlinked flux, the induced voltage in the secondary winding is given by the following formula:

Time-dependent induced voltage in the secondary winding: $U_C = 2\pi f \cdot \psi_m \cdot \sin(2\pi f_N t)$

Now, the time-dependent interlinked flux can be calculated and the current I_L can be determined using the hysteresis curve. As a result, the time-dependent current I_L can be calculated at any frequency.

Terminal current: $I_{CT} = I_L + \frac{U_C}{R_E}$

Terminal voltage: $U_{CT} = U_C + I_{CT} \cdot R_{CT}$

Usually, the magnetization characteristic provides the voltage as a function of the current (r.m.s. values) on the secondary side of the current transformer while the primary winding is open. Since the time-dependent voltage is not sinusoidal, a corrected rectified mean value is used instead of the r.m.s. value. As a correction factor, the form factor of the sinusoidal signal is used. Using the steps above it is possible to keep the maximum flux constant and to a large extent independent of the time curve.

$$U_{CTcurve} = \frac{\pi}{T\sqrt{8}}\int_0^T |U_{CT}(t)|\,dt$$

$$I_{CTcurve} = \sqrt{\frac{1}{T}\int I_{CT}^2(t)\,dt}$$

Using the procedure above, one point of the magnetization characteristic is determined from one hysteresis curve. The overall magnetization characteristic is then determined from a number of hysteresis curves.

9 Normative Definitions

9.1 Definitions According to IEC 60044-1

For the terminology and definitions applicable for this standard, please refer to IEC 60044-1 (2003-02) Ed. 1.2.

9.2 Definitions According to IEC 60044-6

For the terminology and definitions applicable for this standard, please refer to IEC 60044-6 (1992-03) Ed. 1.0.

9.3 Definitions According to IEEE C57.13

For the terminology and definitions applicable for this standard, please refer to IEEE C57.13-2008 and IEEE C57.13.6-2005.

9.3.1 Standard Burdens for CTs with 5A Secondary Windings According to IEEE C57.13 (Table 9)

Burden	Burden designation	Resistance [Ω]	Inductance [mH]	Impedance [Ω]	Total power (VA @ 5A)	Power factor
Metering burdens	B-0.1	0.09	0.116	0.1	2.5	0.9
	B-0.2	0.18	0.232	0.2	5.0	0.9
	B-0.5	0.45	0.580	0.5	12.5	0.9
	B-0.9	0.81	1.040	0.9	22.5	0.9
	B-1.8	1.62	2.080	1.8	45.0	0.9
Relaying burdens	B-1	0.5	2.300	1.0	25.0	0.5
	B-2	1.0	4.600	2.0	50.0	0.5
	B-4	2.0	9.200	4.0	100.0	0.5
	B-8	4.0	18.400	8.0	200.0	0.5

If a current transformer secondary winding is rated at other than 5 A, ohmic burdens for specification and rating shall be derived by multiplying the resistance and inductance of the table by $[5/(\text{ampere rating})]^2$, the VA at rated current, the power factor, and the burden designation remaining the same.

The standard burden designations given in column 2 have no significance at frequencies other than 60 Hz.

The impedance tolerance (column 5) is +5% and -0%.

9.3.2 Standard Burdens for High Accuracy Metering CTs with 5A Secondary Windings According to IEEE C57.13.6 (Table 2)

Burden type	Burden designa-tion	Resis-tance [Ω]	Induc-tance [mH]	Imped-ance [Ω]	Total power (VA @ 5A)	Power factor
Electronic metering burden	E-0.2	0.20	0.0	0.20	5.0	1.0
	E-0.04	0.04	0.0	0.04	1.0	1.0

If a current transformer secondary winding is rated at other than 5 A, ohmic burdens for specification and rating shall be derived by multiplying the resistance and inductance values provided in the table by the factor $[5/(\text{current rating in amperes})]^2$. The burden designation, total power and the power factor remain unchanged.

The standard burden designations given in column 2 have no significance at frequencies other than 60 Hz.

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OMICRON

CT Analyzer

Remote Control Software Programming Manual

Manual Version: CTARemoteSoftware.AE.6

With regard to the functionality of the software, this manual refers to version 4.10 of the *CTA Remote Control Software*.

Table of Contents

Preface

The *CTA Remote Control Software* is used to remote control *CT Analyzer* test sets via PC. It does not offer a graphical user interface and can be operated using all common programming languages. The purpose of this manual is to familiarize programmers and users with the *CTA Remote Control Software* and its programming.

In addition to this programming manual, the CT Analyzer User Manual has to be observed. The CT Analyzer User Manual always has to be available at the site where the *CT Analyzer* is used.

Programming of remote control programs and testing with the *CT Analyzer* should only be carried out by authorized and qualified personnel. Although it is not absolutely necessary, it is recommended and useful that persons entrusted with the programming of remote control programs have fundamental programming knowledge.

Due to reasons of clarity, all explanations regarding programming and all programming examples given in this manual refer to the programming language Visual Basic.

Conventions

The names of interfaces, functions, properties, (enumeration) types and variables/parameters of the *CTA Remote Control Software* are written in `Courier` font.

Interfaces are prefixed by the identifier "`I`", e.g. `ICTASettings`.

Enumeration types are prefixed by the identifier "`T`", e.g. `TCTAStatus`.

Program code is written in **`Courier Bold`** font.

Whenever a given path refers to the file system of the PC, it is written in the common form, using the drive letter and backslash characters, e.g. `D:\CT Analyzer\CTATests\MyTests\`.

Whenever a path refers to the file system of the *CT Analyzer* (i.e. the Compact Flash card), it is written using forward slashes, e.g. `A:/Tests/MyTests/Manufacturer1/`. Only two drive letters are allowed by the *CT Analyzer:* A is the Compact Flash card, B is the internal RAM. When no drive letter is specified, drive A is taken by default.

Glossary of Symbols

☞ **Note**

Indicates notes with special meaning, i.e., additional important information.

⚠ **Caution**

Indicates sections with special safety-relevant meaning.

Safety Instructions

⚠

Before operating the *CT Analyzer*, carefully read the CT Analyzer User Manual and the safety instructions given there. It is not recommended to use (or even switch on) the *CT Analyzer* without understanding the information given in the CT Analyzer User Manual. If some points of the safety instructions are unclear, please contact OMICRON electronics.

Before starting a test on the *CT Analyzer* via PC remote control, make sure that the *CT Analyzer* is in a technically sound condition and that no other persons are working on the site where the *CT Analyzer* is used.

If the *CT Analyzer* is out of sight of the controlling PC, it can be necessary to set up a barrier around the test site and warning signs to warn other persons that the test set is switched on and operated remote controlled.

Prior to actual testing procedures, you should test your programs used to control the *CT Analyzer* in detail and verify the results in order to guarantee the reliability of the obtained results.

1 Designated Use

The *CTA Remote Control Software* is intended to control *CT Analyzer* test sets via PC for the purpose of remote control and/or to automate test procedures performed using the *CT Analyzer*.

It may only be used together with *CT Analyzer* test sets.

Any other use of the *CTA Remote Control Software* but the one mentioned above is considered as improper use, and will not only invalidate all customer warranty claims but also exempt the manufacturer from its liability to recourse.

2 Installing the CTA Remote Control Software

2.1 System Requirements

To run the *CTA Remote Control Software*, your PC must meet the following minimum requirements:

- PC with 1 serial interface or 1 USB interface (USB 1.1 or 2.0).
- Operating System Windows 2000/XP/Vista/Windows 7.
- Programming environment of the desired programming language installed (e.g. Visual Basic (VB), Visual Basic for Applications (VBA), C, C++, C#, VB.Net, etc.).
- The Visual Basic editor of Microsoft Excel® is required to run the example programs given in this manual (these example programs are included on the *CTA Remote Control Software* CD-ROM).

2.2 Installing the Software

To install the *CTA Remote Control Software*, insert the delivered *CTAnalyzer PC Toolset* CD-ROM into your CD-ROM drive and follow the instructions on the screen.

3 Connecting the CT Analyzer to the PC

3.1 Connecting the CT Analyzer via a Serial Interface

1. Connect one side of the null modem cable included in the scope of delivery to the remote control interface of the *CT Analyzer*.
2. Connect the other side of the null modem cable to the serial port of your PC.

   Note If the *CT Analyzer* is connected to a serial port of your PC, you have to specify the port number in your program.

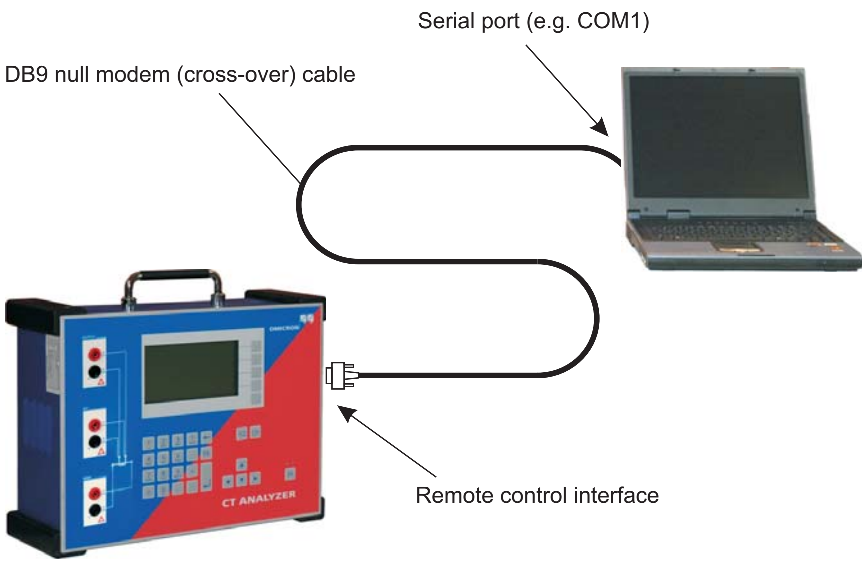


Figure 1 *CT Analyzer* connected to PC via serial interface

3.2 Connecting the CT Analyzer via USB

Note Although it is generally possible to connect more than one *CT Analyzer* test sets to a PC via USB (e.g. using an USB hub), the *CTA Remote Control Software* can control only one *CT Analyzer* test set simultaneously.

If several *CT Analyzer* test sets are connected to the PC via USB, you have to specify the serial number of the *CT Analyzer* test set you want to access in your program.

1. Connect the USB-RS232 adapter included in the scope of delivery to one side of the USB cable and then connect the other side of the USB cable to the USB port of your PC.
2. Connect one side of the null modem cable included in the scope of delivery to the remote control interface of the *CT Analyzer* and the other side to the USB-RS232 adapter.

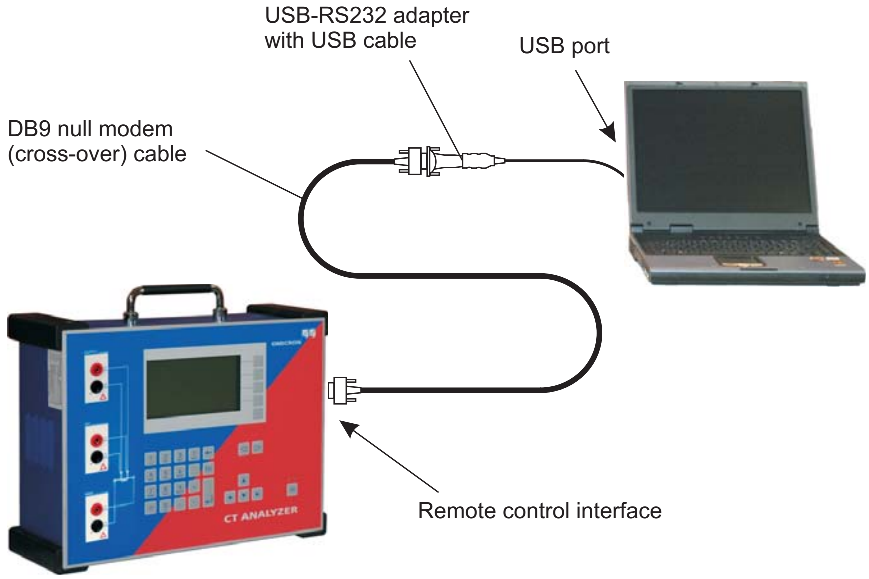


Figure 2 *CT Analyzer* connected to PC via USB

3.3 Connecting the CT Analyzer and the CT SB2

For connecting the CT Analyzer and the CT SB2 with the PC please refer to the CT SB2 User Manual.

4 Description

4.1 What is the CTA Remote Control Software?

The *CTA Remote Control Software* is a remote component installed on the PC. It works as a Common Object Model (COM) server and provides a number of access interfaces to the *CT Analyzer* with numerous functions to control the *CT Analyzer*.

The *CTA Remote Control Software* itself does not offer a graphical user interface. It can be operated using all common programming languages, e.g. Visual Basic (VB), Visual Basic for Applications (VBA), .NET (C#), C++, etc.

By means of application programs, it is possible to remote control a connected *CT Analyzer* test set completely and/or to automate test procedures performed using the *CT Analyzer*.

4.2 Overview of Data Communication and Interfaces Provided by the Software

Figure 3 shows an overview of the data communication and the interfaces provided by the *CTA Remote Control Software* (CTA remote component). The figure is explained in the subsequent legend.

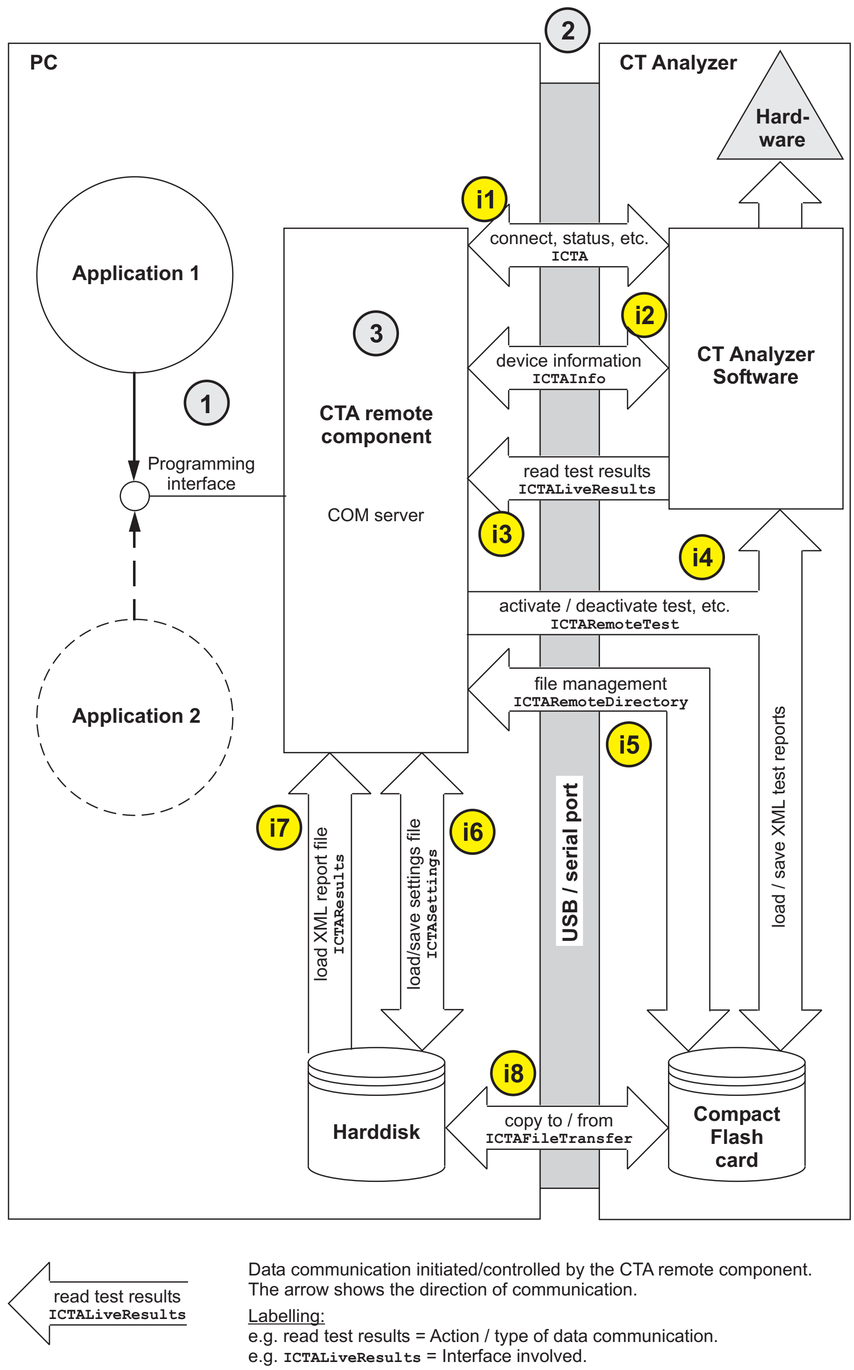


Figure 3 Data communication and interfaces

(1) The *CTA Remote Control Software* can be accessed by one or more customer applications in order to control a *CT Analyzer* test set connected to the PC. However, parallel access of several application programs to one *CT Analyzer* is restricted by the *CT Analyzer* test set.

(2) Concurrent control of several *CT Analyzer* test sets is not possible. The *CTA Remote Control Software* is able to control only one *CT Analyzer* test set simultaneously. Access to another *CT Analyzer* test set possibly connected to the USB port at the same time is only possible after disconnecting from the previously accessed test set (see functions SerialConnect / USBConnect and Disconnect on page 36).

(3) The *CTA Remote Control Software* provides several access interfaces providing the following functionality:

(i1) ICTA interface: Administrative tasks, see page 35.

Functions: e.g. establishing a connection to the *CT Analyzer*, reading the operating state or the serial number of the *CT Analyzer*, initiating a firmware update, etc.

(i2) ICTAInfo interface: Reading device information (hints, warning or error conditions) from the *CT Analyzer* and clearing the information on the *CT Analyzer*, see page 53.

(i3) ICTALiveResults interface: Reading test results directly from the *CT Analyzer*, see page 87.

In contrast to the ICTAResults interface, it is not necessary to save a test report on the *CT Analyzer* and to transfer the report file to the PC before reading the values. The values are read directly from the *CT Analyzer* memory.

(i4) ICTARemoteTest interface: Test execution, see page 61.

Functions: e.g. directing the *CT Analyzer* to load a test definition file from the Compact Flash card, activating the test, saving the test report to the Compact Flash card, etc.

(i5) ICTARemoteDirectory interface: File management on the Compact Flash card, see page 69.

Functions: e.g. querying file directories, renaming or deleting files, creating or removing directories, etc.

(i6) ICTASettings interface: Specification of test definitions, see page 57.

Functions: e.g. loading a test settings file from the local harddisk, saving a changed test settings file to the local harddisk, etc.

(i7) ICTAResults interface: Reading test results from test reports, see page 74.

Functions: e.g. loading a test report file from the local harddisk, reading individual result values, etc.

(i8) ICTAFileTransfer interface: File exchange, see page 67.

Functions: e.g. copying a file from the local harddisk to the Compact Flash card of the *CT Analyzer* or vice versa.

ICTAQuick interface: Quick measurement access

4.3 Overview of Connection States and State Transitions

The connection state can be read using the eStatus property of the ICTA interface (see page 35). The available states are described below (see also enumeration type TCTAStatus on page 133).

`CTA_STAT_NOT_CONNECTED`
Initial status after the instantiation of the CTA remote component and status after applying the `Disconnect` function.

`CTA_STAT_READY`
CT Analyzer is sucessfully connected and the device is not in a warning or an error state. The *CT Analyzer* is ready for operation. This status is also entered, when a performed test has successfully completed.

`CTA_STAT_ACTIVATED`
Status after starting the test using the `Activate` function.

`CTA_STAT_PAUSED`
The *CT Analyzer* is activated but the test is paused because rewiring of the test object is required to continue the test.

`CTA_STAT_WAIT_FOR_ACKNOWLEDGE`
The *CT Analyzer* is connected and waiting for an acknowledgement of a message (an error or warning). This is when a test has stopped with a failure or has been aborted using the `Deactivate` function.

4.4 Log File

During operation, the CTA remote component writes a log file for the purpose of error diagnosis. The log file is stored in the installation folder of the *CTA Remote Control Software,* which is by default `C:\Program Files\OMICRON\CT Analyzer PC Toolset\CTARemote.exe.log`. It can be useful for debugging purposes.

5 Operation

5.1 Possible Programming Languages

The *CTA Remote Control Software* can be operated using the following programming languages:

- Visual Basic (VB)
- Visual Basic for Applications (VBA, included e.g. in Microsoft Excel®, WORD®, Access®, etc.)
- .NET (C#, VB.Net)
- C++
- Borland Delphi
- Any other programming language supporting COM (Common Objects Model).

Note Due to reasons of clarity, the explanations regarding programming and the programming examples given in this manual refer to the programming language Visual Basic included in Microsoft Excel®.

5.2 The Most Important Visual Basic Statements

This section gives some fundamental information about the most important and most frequently used Visual Basic statements.

For more detailed information and information about the full scope of the programming language Visual Basic, please refer to the Visual Basic online help system, the standard literature about Visual Basic or visit Microsoft's MSDN library in the internet:
http://msdn2.microsoft.com/en-us/library/sh9ywfdk.aspx

`Comments and remarks`

Comments and remarks within the code are written with a preceding apostrophe `'`.

`Debug.Print`

The `Debug.Print` statement is used to display information or results in the Immediate window of the Visual Basic editor.

`Dim`

The `Dim` declaration is used to declare variables and objects.

`Do...Loop`

The `Do...Loop` statement is used to repeat a set of statements an indeterminate number of times. The execution of the statements is repeated while a Boolean condition is true or until the condition becomes true.

`Exit`

The `Exit` statement is used to exit a code block or procedure. This statement transfers control immediately to the statement following the procedure call or the block definition.

`For...Next`

`For...Next` structures are used to repeat statements a specified number of times. For this purpose, it is necessary to use a counting variable the value of which is increased or decreased with each execution of the `For...Next` structure. If the specified number of executions is reached, the code following the `Next` statement is executed.

`For Each...Next`

The `For Each...Next` statement repeats a block of statements for each element of a collection or array.

`Function - End Function`

The `Function` statement declares the name, parameters, and code that define a `Function` procedure. The procedure starts with a `Function` statement and ends with an `End Function` statement.

`GoTo`

The `GoTo` statement is used to unconditionally branch to a specified code line within a procedure.

`If...Then...Else - End If`

`If...Then` structures are used to make the execution of statements conditional upon whether a specific condition is fulfilled. Using the additional instruction `Else`, it is possible to specify what to do if the condition is not fulfilled.

`If...Then...Else` structures have to be terminated with an `End If` statement.

On Error

The `On Error` statement is used to specify what to do in case of an error. For example, it could be used together with the `GoTo` statement to specify that the program execution should continue at a specified code line in case of an error.

Without an `On Error` statement, any run-time error that occurs is fatal: an error message is displayed, and program execution stops.

Select...Case

The `Select...Case` statement executes one of several groups of statements, depending on the value of an expression.

Set

The `Set` statement is used to assign an object reference to a variable or a property. E.g. `Set rt = cta` assigns an object reference between the variable `rt` and the object `cta`.

Stop

The `Stop` statement interrupts the execution of a program. This statement is similar to setting a breakpoint in the code. The `Stop` statement interrupts execution, but unlike `End`, it does not close any files or clear any variables.

Sub - End Sub

The `Sub` statement declares the name, parameters, and code that define a `Sub` procedure. The procedure starts with a `Sub` statement and ends with an `End Sub` statement.

While...Wend (or While...End While)

`While...Wend` structures are used to execute a statement or a series of statements as long as a given condition is fulfilled (true). If the condition is no longer fulfilled, the code following the `Wend` statement is executed.

With...End With

Using the `With...End With` statement you can perform a series of statements on a specified object without requalifying the name of the object. I.e., using this statement you can specify an object or a user-defined type once and then use it for a series of statements.

`With...End With` statements can accelerate the execution of procedures and reduce repetitive typing. A code structure starting with `With` has to be terminated with an `End With` statement.

5.3 Working in the Visual Basic Editor

Working with the Visual Basic editor is described using the Visual Basic editor of Microsoft Excel®. However, you could also use any other Visual Basic editor (e.g. of Microsoft WORD®) as an alternative.

5.3.1 Starting the Visual Basic Editor

Start Microsoft Excel® and then select **Tools | Macros | Visual Basic Editor** from the Excel® menu or press <Alt> + <F11> on the keyboard to open the Visual Basic editor window.

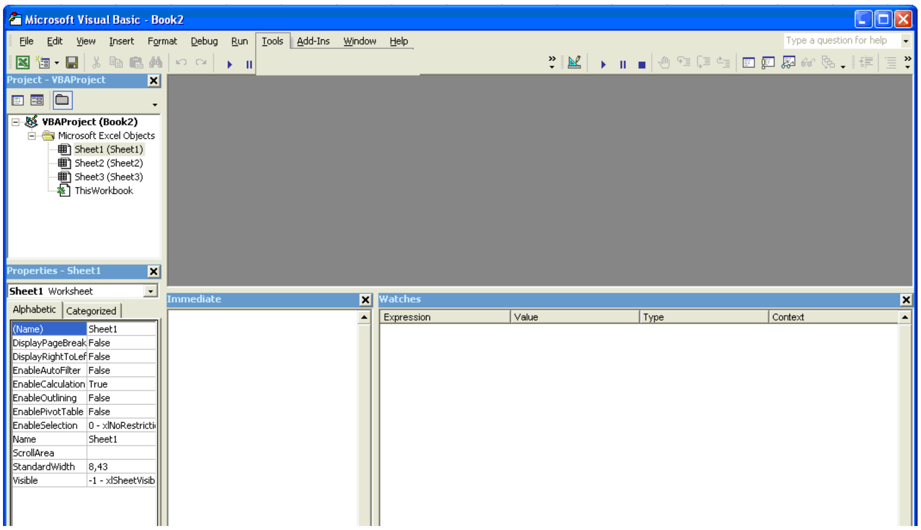


Figure 4 Visual Basic editor window

5.3.2 Including the CTA Remote Type Library

The CTA Remote Type Library enables the access to the CTA remote component of the *CTA Remote Control Software*. The CTA Remote Type Library has to be included as follows in order to announce that this component is used, i.e. to make the interfaces and functions provided by the CTA Remote Type Library available.

1. In the Visual Basic editor window, select **Tools | References**.

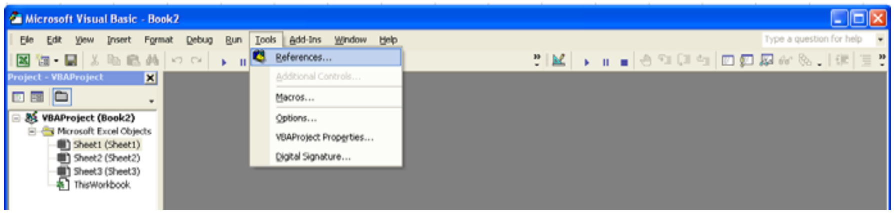


Figure 5 Visual Basic editor window

2. The dialog "References - VBAProject" appears. In the "Available References" list, scroll to the entry "CTARemote x.x Type Library" and click on the checkbox in front of this entry to check it (refer to Figure 6).

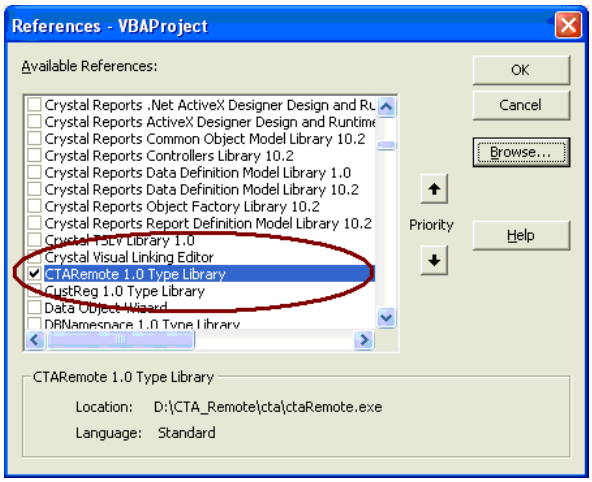


Figure 6 "References - VBAProject" dialog, entry "CTARemote Type Library" checked

3. Click **OK**. You'll return to the main window of the Visual Basic editor.
4. All interfaces and functions provided by the CTA Remote Type Library are now available for programming and can be selected from the Object browser.

5.3.3 Window areas of the Visual Basic editor

Figure 7 shows the most important window areas of the Visual Basic editor. You can show or hide individual windows using the options in the **View** menu.

This section gives only brief descriptions of the window areas. For detailed information, please refer to the Visual Basic online help system.

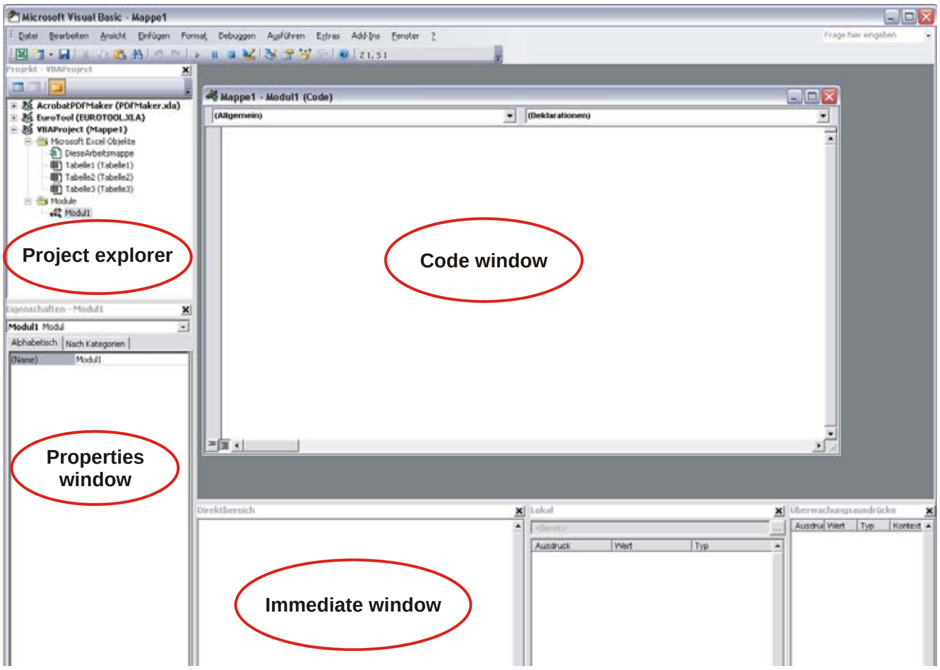


Figure 7 Most important window areas in the Visual Basic editor

Project explorer

The project explorer shows the projects and all elements contained in the projects in a hierarchical tree structure. E.g. after inserting a new module, a new element with the default name (e.g. "Module1") is displayed as an element of the Modules folder.

Properties window

The Properties window shows the properties of the element highlighted in the project explorer. In this window you can change the properties, e.g. give a module a new name.

Code window

The code window contains the program code. Refer to section 5.3.5 on page 22.

Immediate window

The Immediate window can be used to display information resulting from instructions. Refer to section 5.3.5 on page 22.

5.3.4 Inserting, renaming and deleting modules

Inserting a new module

To insert a new module in the Visual Basic editor, select **Insert | Module** from the menu. A new module is inserted in the project explorer on the left and a new code window is opened (refer to Figure 8).

Renaming a module

To rename a module, click on the corresponding module entry in the project explorer to highlight it. The module name is then displayed in the "Name" field of the Properties window. Click in the "Name" field and enter the new name.

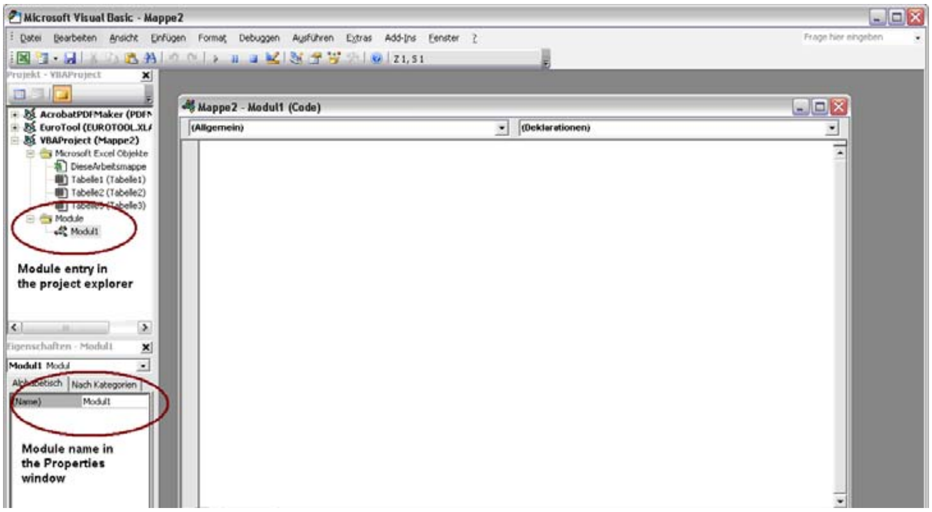


Figure 8 Project explorer and properties window after inserting a new module

Deleting a module

To delete a module, click on the corresponding module entry in the project explorer and select **File | Remove *modulename***.

5.3.5 Working in the Visual Basic code window

This section can only give some fundamental information for working in the Visual Basic editor. Since this is only a very small excerpt of the extensive functionality of the Visual Basic editor, please refer to the Visual Basic online help system for detailed information.

Writing program code

Note If not already done, include the CTA Remote Type Library (refer to section 5.3.2 on page 18) before writing program code.

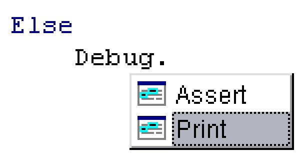
Click in the code window to position the cursor to the desired location and enter the desired program code.

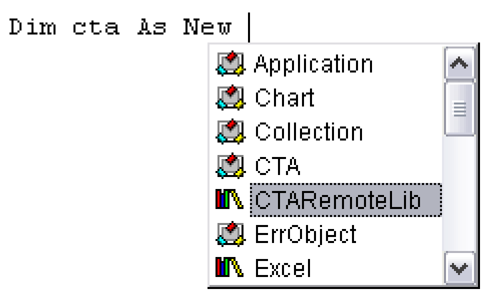
Refer to chapter 6 for descriptions of the functions provided by the *CTA Remote Control Software* and code examples or chapter 9 for application examples.

The code window of the Visual Basic editor provides the following functions in addition to the "normal" text editor functions:

- The standard behavior of the code window (e.g. step/indent width of the tab key, drag&drop usage) can be specified by selecting **Tools | Options**.
- For better clarity of the code representation, different colors are used: Commands, instructions, data types, etc. are displayed in blue. Comments (following an apostrophe character) are displayed in green. Incomplete code elements or elements with syntax errors are displayed in red.
- An IntelliSense function is available for the automatic completion of code elements known by the Visual Basic editor.

  E.g. when writing a `Debug.Print` instruction, a corresponding selection box appears after typing `Debug.` or when writing the declaration `Dim cta As New CTARemoteLib.CTA`, a corresponding selection box appears after typing `Dim cta As New` :





Use the arrow keys on your keyboard to select the desired entry from the selection box and press the <Tab> key to insert it into your code.

Note You can open the IntelliSense selection box at any time by selecting **List Properties/Methods** from the context menu of the code window.

- An object browser is available containing all available objects, interfaces, functions or methods and properties. Refer to the following subsection.

Using the object browser

To open the object browser, select **View | Object Browser** from the menu, press the <F2> key or click on the object browser icon on the toolbar.

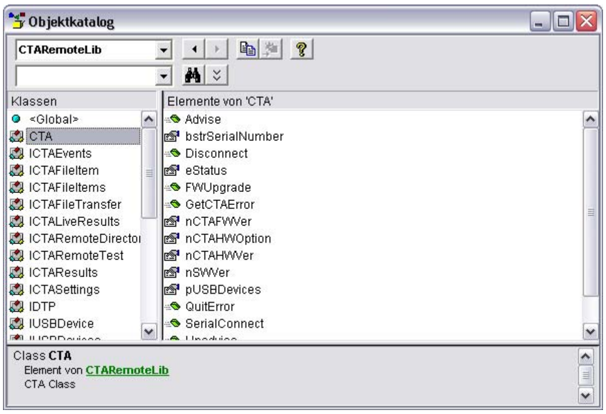
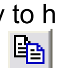


Figure 9 Object browser displaying elements of the CTA Remote Type Library

In the upper left list box, select the entry CTARemoteLib to display all available elements of the CTA Remote Type Library.

The "Classes" area on the left then lists all interfaces and types included in the CTA Remote Type Library. If you click on an entry in the "Classes" list, the "Elements of" area on the right displays all elements available for this interface or type (functions and properties in case of a selected interface or parameters, setting variables or values in case of a selected type).

The information area on the bottom displays the code syntax and information about the element selected in one of the lists mentioned above.

To enter an element of the object browser into your program code, click on the respective entry to highlight it. Select **Copy** from the context menu or click on the copy button  and paste it at the desired position in the code window.

Using the Immediate window

Using the `Debug.Print` statement you can display information in the Immediate window. For example you could display the status during program execution using the instruction `Debug.Print cta.eStatus` or display the content of the variable `xyz` using the instruction `Debug.Print xyz`.

5.3.6 Loading an existing Visual Basic program

Note The example programs delivered with the *CTA Remote Control Software* were created using the Visual Basic Editor of Microsoft Excel®. Thus, the examples are stored in Excel files with the file extension .xls.

1. If not already done, open Microsoft Excel®.
2. Select **File | Open** from the menu. Then, select the desired file in the Open dialog and click on **OK** to open the file.
3. A safety warning appears on the screen, notifying you that the file contains macros. Click on **Activate Macros** to continue opening.

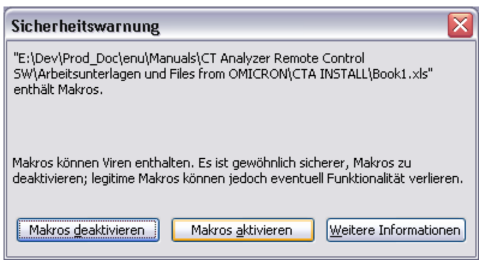


Figure 10 Safety Warning: File contains macros

4. The Microsoft Excel® window is displayed with an empty Excel sheet. Select **Tools | Macros | Visual Basic editor** from the menu or press <Alt> + <F11> on the keyboard.
5. The Visual Basic editor window appears showing the program code in the code window.
6. Execute the program.

5.4 Creating an Application Program Step by Step

This section explains the creation of a new Visual Basic application program step by step using a small example.

Detailed descriptions of the available interfaces and functions can be found in chapter 6 on page 29.

5.4.1 Assumptions for the descriptions given in this section

The following descriptions assume the following:

- A Visual Basic editor is installed on your PC.
- The *CTA Remote Control Software* is installed on your PC (see section 2.2 on page 7).
- The *CT Analyzer* is connected to the PC via USB (see section 3.2 on page 9).
- The *CT Analyzer* test set is switched on and ready for a new default test using the guesser function.

5.4.2 Creating the program code

Task

In our small example program explained below we want to

- start a new default test on the *CT Analyzer* and
- read the CT ratio and the ratio deviation determined during the test directly from the *CT Analyzer* and
- display the results in the Immediate window of the Visual Basic editor.

Program creation

Start the Visual Basic editor (refer to section 5.3.1 on page 18).

If necessary, include the CTA Remote Type Library (refer to section 5.3.2 on page 18).

Insert a new module (refer to section 5.3.4 on page 21).

Click into the code area of the code window and proceed as follows to create the program (refer to the code example given in Figure 11):

1. First of all, it is necessary to instantiate the CTA remote component. The object is `cta`.

   ```
   Dim cta As New CTARemoteLib.CTA
   ```

2. Declare a new procedure using the `Sub` statement. In our example we are using the name `MyCode`. After pressing the <Enter> key, the `End Sub` statement (which is required to close the procedure) is automatically inserted. Enter your further code between the `Sub` and the `End Sub` statements.

   ```
   Sub MyCode()
   ```

3. Connect the CTA remote component to the *CT Analyzer* test set connected via USB:

   ```
   cta.USBConnect
   ```

4. Start the test using the `Activate` function of the `ICTARemoteTest` interface.

   ```
   cta.Test.Activate
   ```

5. Now, we have to wait until the test results are available, i.e. until the test is finished. In our example we are using the `eStatus` property of the `ICTA` interface to read the status in a `While-Wend` loop. The loop is executed as long as the test is running (during this time, the status is `CTA_STAT_ACTIVATED`. After the test is finished, the status returns to `CTA_STAT_READY`. The condition given in the `While-Wend` loop is no longer fulfilled and program execution continues with the code after `Wend`.

   ```
   While cta.eStatus = CTA_STAT_ACTIVATED
   Wend
   ```

6. Read the results using the `GetLiveValue` function of the `ICTALiveResults` interface and output them to the Immediate window using the `Debug.Print` statement.

   ```
   Debug.Print cta.LiveResults.GetLiveValue(RV_RATIO_DISPL_STRING)

   Debug.Print cta.LiveResults.GetLiveValue(RV_RATIO_DEVIATION_PERC)
   ```

   This will display the results in the Immediate window e.g. like:

   ```
   200:5.0056
   0.112
   ```

7. Disconnect from the *CT Analyzer*.

   ```
   cta.Disconnect
   ```

8. The `End Sub` statement was inserted automatically before with the declaration of the `Sub` procedure (see step 2).

   ```
   End Sub
   ```

```
Dim cta As New CTARemoteLib.cta

Sub MyCode()

   cta.USBConnect
   cta.Test.Activate

   While cta.eStatus = CTA_STAT_ACTIVATED
   Wend

   Debug.Print cta.LiveResults.GetLiveValue(RV_RATIO_DISPL_STRING)
   Debug.Print cta.LiveResults.GetLiveValue(RV_RATIO_DEVIATION_PERC)

   cta.Disconnect

End Sub
```

Figure 11   Example program code

6 Description of Interfaces and Functions

This chapter describes the interfaces and functions provided by the *CTA Remote Control Software*. In Visual Basic, the interfaces and functions are available in the Object browser.

The identifiers for the interfaces, types, properties and parameters follow some naming conventions. They are prefixed by one or several lower case characters, indicating the identifier type as follows:

Name Prefix	Type
nXXX	Value of a 4 byte integer number type.
bXXX	Value of the type BOOLEAN (values: TRUE or FALSE).
bstrXXX	Value of the type BSTR. A binary or basic string which is a pointer to a wide character string used by automation data functions.
eXXX	Value of an enumeration type.
pXXX	Value which is a pointer to a type indicated by the following name prefix (e.g. “pn” means: pointer to a number).
IXXX	Interface type.
TXXX	Enumeration type.

6.1 Overview of Interfaces and Functions / Properties

6.2 Description of the Syntax Given for the Functions and Properties

Since programming is possible using many different programming languages, the syntax of the functions and properties given in this chapter is represented in a neutral form as explained below.

6.2.1 Syntax of functions

The syntax of functions is given as follows:

Function **FunctionName**(*[direction]Datatype Parametername*)

or

Function **FunctionName**(*[direction]Datatype Parametername*):Datatype

Explanation:

Function	Points out that it is a function.
FunctionName	Name identifier of the function, e.g. LocalLoadSettings.
()	The parameters and information about the parameters are enclosed in round brackets.
[direction]	Specifies the direction of value transfer: in (input for the CTA remote component) or out (output of the CTA remote component)
Datatype	Specifies the data type of the parameter, e.g. String.
Parametername	Identifier of the parameter (e.g. LocalPath). The content this parameter stands for is described under "Parameters" (in case of LocalPath: full path on the PC).
:Datatype	Optional. If functions return a value, its type is given after a final colon. Otherwise it's left blank.

If the function requires more than one parameter, the parameters are separated by a comma, e.g.
(*[direction]Datatype Param1, [direction]Datatype Param2*).

If a parameter is optional, the data type and the parameter name are enclosed in square brackets, e.g. (*[direction][Datatype Parameter1]*).

6.2.2 Syntax of properties

The syntax of properties is given as follows:

Property **PropertyName :** *Datatype [read-only]*

Explanation:

`Property`	Points out that it is a property.
`PropertyName`	Name identifier of the property, e.g. `eStatus`.
`:`	Separator between name and type used in this syntax representation.
`Datatype`	Specifies the data type (e.g. `Long`, `String` or type specified in the library, e.g. `TCTAStatus`).
`[read-only]`	Optional. Specifies that the value is read-only.

6.3 ICTA (Administrative Tasks)

In order to use the functions of the ICTA interface, the CTA remote component has to be instantiated in the program, e.g. using the declaration

```
Dim cta As New CTARemoteLib.CTA
```

6.3.1 Overview of functions and properties

Functions	Brief description
SerialConnect	Establishes the connection to the *CT Analyzer* test set connected to the serial interface.
USBConnect	Establishes the connection to the *CT Analyzer* test set connected via USB. Requires the serial number of the *CT Analyzer*, if more than one test set is connected via USB.
Disconnect	Terminates the connection to the *CT Analyzer*.
UpgradeFirmware	Upgrading the *CT Analyzer* firmware.
UpgradeText	Upgrading the language texts on the *CT Analyzer.*
UpgradeLicenses	Upgrading the licenses on the *CT Analyzer.*
AddLicenses	Used to perform an upgrade of the licenses on the *CT Analyzer*.
Advise	Registration for event notification from the *CT Analyzer,* used for asynchronous handling of error and status messages.
Unadvise	Deregistration of event notifications.

Properties	Brief description
eStatus	Device status.
bstrFirmwareVersion	Firmware version of the *CT Analyzer*.
bstrHardwareVersion	Hardware version of the *CT Analyzer*.
bstrSoftwareVersion	Version of the *CTA Remote Control Software*.
bstrSerialNumber	Serial number of the *CT Analyzer*.
Info	A record containing device information.
USBDevices	Accesses the list of serial numbers of all *CT Analyzer* test sets connected via USB.

Properties	Brief description
HasLicense	Used to query whether certain licenses are available on the *CT Analyzer*.
MissingLicenses	Returns an array of license-values which are missing to start a measurement on the *CT Analyzer*.
AvailableLicenses	Reads a list of actual available licenses.
NotAvailableLicenses	Reads a list of not available licenses.
Settings	Access to the ICTASettings interface for querying and defining the test settings.
Results	Access to the ICTAResults interface for querying test results.
LiveResults	Access to the ICTALiveResults interface.
FileTransfer	Access to the ICTAFileTransfer interface.
Directory	Access to the ICTARemoteDirectory interface.
Calculate	Access to the ICTACalc interface
Quick	Access to the ICTAQuick interface

6.3.2 Description of functions

6.3.2.1 SerialConnect

Scope: `ICTA`

Syntax: *Function* **SerialConnect**(*[in]long nSCCline*)

Description: Establishes a connection between the CTA remote component and the *CT Analyzer* test set connected to a serial interface of the PC.

If the connection is established successfully, the connection status changes from `CTA_STAT_NOT_CONNECTED` to `CTA_STAT_READY` or `CTA_STAT_WAIT_FOR_ACKNOWLEDGE` (refer to property eStatus on page 43) and the *CT Analyzer* display shows a corresponding connection symbol.

Parameters: *nSCCLine*
Number of serial interface (1 for COM1, etc.).

Example in VB:

```
Dim cta as New CTARemoteLib.CTA
cta.SerialConnect 1
```

Connects to the *CT Analyzer* at serial port 1.

Example in C++

```
ICTAPtr cta(CLSID_CTA);
cta->SerialConnect(1);
```

6.3.2.2 USBConnect

Scope `ICTA`

Syntax *Function* **USBConnect**(*[in,optional]string bstrDeviceName*)

Description

Establishes a connection between the CTA remote component and a *CT Analyzer* test set connected to the PC via USB.

When the connection is established successfully, the connection status changes from `CTA_STAT_NOT_CONNECTED` to `CTA_STAT_READY` or `CTA_STAT_WAIT_FOR_ACKNOWLEDGE` (refer to property eStatus on page 43) and the *CT Analyzer* display shows a corresponding connection symbol.

Parameters

bstrDeviceName
Optional Parameter.
Six character serial number of the *CT Analyzer* test set according to the nameplate.

Note:
If only one *CT Analyzer* test set is connected via USB, no parameter is required. If several test sets are connected via USB, you have to specify the serial number of the *CT Analyzer* to be accessed.

Read the serial number from the nameplate of the *CT Analyzer* or retrieve it by means of the USBDevices property.

Example in VB

```
cta.USBConnect
```

Connects to the *CT Analyzer* connected via USB. No parameter is necessary, if only one *CT Analyzer* is connected.

```
cta.USBConnect "AI153T"
```

Connects to test set AI153T (if more than one *CT Analyzer* is connected via USB).

Example in C++

```
HRESULT hr = cta->USBConnect(_bstr_t(L"AI153T"));
if (SUCCEEDED(hr)) { … }
```

6.3.2.3 Disconnect

Scope	`ICTA`
Syntax	*Function* **Disconnect**()
Description	Terminates the connection to the *CT Analyzer*. After the connection is terminated, the connection status changes to `CTA_STAT_NOT_CONNECTED` (refer to property eStatus on page 43)) and the connection symbol disappears from the *CT Analyzer* display.
Example in VB	**`cta.Disconnect`**
Example in C++	**`cta->Disconnect();`**

6.3.2.4 UpgradeFirmware

Scope	`ICTA`
Syntax	*Function* **UpgradeFirmware**(*[in]string bstrFile*)
Description	Used to perform an upgrade of the firmware on the *CT Analyzer*. Copies the firmware file from the specified path on the PC to the Compact Flash card of the *CT Analyzer* and then automatically performs the firmware upgrade on the *CT Analyzer*. Blocks the further program execution until the firmware update process is finished. This can take several minutes. The file is transferred to a temporary location and is renamed when the transmission has successfully completed. However, for reasons of security, do not disconnect the cable between *CT Analyzer* and PC or switch off the *CT Analyzer* during this process.
Parameters	*pbstrFile* Full path to the file `CTAnalyzer.bin` on the PC.
Example in VB	**`cta.UpgradeFirmware "D:\CTA\Firmware\CTAnalyzer.bin"`**
Example in C++	**`cta->UpgradeFirmware(_bstr_t(L”D:\CTA\Firmware\CTAnalyzer.bin”));`**

6.3.2.5 UpgradeText

Scope	`ICTA`
Syntax	*Function* **`UpgradeText`**`(`*`[in]string bstrFile`*`)`
Description	Used to perform an upgrade of the language text on the *CT Analyzer*. Copies the firmware file from the specified path on the PC to the Compact Flash card of the *CT Analyzer* and then automatically upgrades the language text on the device. Blocks the further program execution until the firmware update process is finished. This can take some minutes. The file is transferred to a temporary location and is renamed when the transmission has successfully completed. However, for reasons of security, do not disconnect the cable between *CT Analyzer* and PC or switch off the *CT Analyzer* during this process.
Parameters	*`pbstrFile`* Full path to the language text file on the PC.
Example in VB	**`cta.UpgradeFirmware "D:\CTA\Firmware\CTUser_V1_04_FRA.bin"`**
Example in C++	**`cta->UpgradeFirmware(_bstr_t(L"D:\CTA\Firmware\CTUser_V1_04_FRA.bin"));`**

6.3.2.6 UpgradeLicenses

Scope	`ICTA`
Syntax	*Function* **`UpgradeLicenses`**`(`*`[in]string bstrFile`*`)`
Description	Used to perform an upgrade of the licenses on the *CT Analyzer*. Copies the license file from the specified path on the PC to the Compact Flash card of the *CT Analyzer* and then automatically upgrades the licenses on the device. Blocks the further program execution until the license update process is finished. Handle with care! All existing licenses on the *CT Analyzer* will be overwritten.
Parameters	*`bstrFile`* Full path to the license file on the PC.
Example in VB	**`cta.UpgradeLicenses "D:\CTA\LicenseBB170U.lic"`**

Example in C++

```
cta->UpgradeLicenses(bstr_t(L"D:\CTA\LicenseBB170U.lic"));
```

6.3.2.7 Advise

Scope `ICTA`

Syntax *`Function`* **`Advise`**`(`*`[in]ICTAEvents objCallback`*`) :` *`long`*

Description

Used to register for asynchronous event notification. Whenever changes in the device status (see eStatus on page 43) occur or new information is available, the *CT Analyzer* reports them by calling the appropriate functions in the callback object.

Only one object can be registered at the same time. The caller of `Advise()` has to implement the `ICTAEvents` interface (this interface is not separately described).

The returned value needs to be passed when calling Unadvise().

Hint: It is difficult to use this feature with VB6 or VBA (used in Excel), because these programming languages are not designed for asynchronous operation. Therefore, it is recommended to do without this function when using these programming languages.

Using synchronous mechanisms instead, it is possible to solve any task without exploiting this feature and without any drawback for the system (refer to chapter Error Handling on page 221).

Parameters

`objCallback`
An object of type `ICTAEvents`. The interface has to be implemented by the calling application.

Return value

A cookie is returned which identifies the advising application. This cookie has to be passed to a successive call to Unadvise().

Example in VB

No example is given here.

Example in C++

Refer to the following code:

```
// include CTARemote support
#include <atlbase.h>
#include <CTARemote.h>
#include <CTARemote_i.c>
// implementation of ICTAEvents callback interface
CComModule _Module;

class CCTACallback :
   public
ComObjectRootEx<CComMultiThreadModelNoCS>,
   public ICTAEvents
{
public:
   DECLARE_AGGREGATABLE(CCTACallback)
   DECLARE_PROTECT_FINAL_CONSTRUCT()

   BEGIN_COM_MAP(CCTACallback)
      COM_INTERFACE_ENTRY(ICTAEvents)
   END_COM_MAP()
// ICTAEvents
public:
   STDMETHODIMP OnStatusNotification(ICTA* pCTA, TCTAStatus eStat, long nInfo = 0)
   {
      switch (eStat) {
         case CTA_STAT_NOT_CONNECTED: // TODO: add implementation
            _tprintf(_T("\t <disconnected>\n"));
            break;

         case CTA_STAT_READY: // TODO: add implementation
            _tprintf(_T("\t <ready>\n"));
            break;

         case CTA_STAT_WAIT_FOR_ACKNOWLEDGE: // TODO: add implementation
            _tprintf(_T("\t <wait for ack>\n"));
            break;

         case CTA_STAT_ACTIVATED: // TODO: add implementation
            _tprintf(_T("\t <activated>\n"));
            break;

         case CTA_STAT_PAUSED: // TODO: add implementation
            _tprintf(_T("\t <paused>\n"));
            _tprintf(_T("\t please rewire the connectors and <press any key>"), nInfo);
            _gettchar();
            // pCTA->Activate is automatically called when the pause notification handler
            returns S_OK
            break;

         default:
            _tprintf(_T("\t <unknown CTA notification: %d>\n"), eStat);
```

```
      }//endswitch
      return S_OK;
   }// OnCTANotification
   STDMETHODIMP OnInfoNotifiation(ICTA* pCTA, TCTAInfoClass eErrorClass, long nErrorCode,
   long nErrorLocation, BSTR bstrErrorDescription)
   {
      _tprintf(_T("\t * %s: number %d, location %d: %s\n"), GetErrorClassString(eErrorClass),
      nErrorCode, nErrorLocation, bstrErrorDescription);
      return S_OK;
   }// OnCTAError
};// CCTACallback

...

// create a callback object
CComObject<CCTACallback>* pEventSink = 0;
hr = pEventSink->CreateInstance(&pEventSink);
// advise the callback object
long nSinkCookie;
hr = pCTA->Advise(pEventSink, &nSinkCookie);
```

6.3.2.8 Unadvise

Scope	`ICTA`
Syntax	*Function* **Unadvise**(*[in]long nCookie*)
Description	Deregisters the asynchronous event sink. The cookie retrieved from the previous call to Advise() has to be passed.
Parameters	`nCookie` The cookie returned from the previous call of Advise().
Example in VB	No example is given here. See description for Advise() above.
Example in C++	`cta->Unadvise(nSinkCookie);`

6.3.3 Description of properties

6.3.3.1 eStatus

Scope `ICTA`

Syntax *Property* **eStatus** *: TCTAStatus [read-only]*

Description This function is used to query the device status. The possible states are:

- `CTA_STAT_NOT_CONNECTED`
- `CTA_STAT_READY`
- `CTA_STAT_ACTIVATED`
- `CTA_STAT_WAIT_FOR_ACKNOWLEDGE`
- `CTA_STAT_PAUSED`

Return value Current device status (element of the type TCTAStatus, see page 133).

Example in VB

```
Debug.Print cta.eStatus
```

Displays the current status in the Immediate window of the Visual Basic editor.

```
Dim s As TCTAStatus
s = cta.eStatus
If s = CTA_STAT_READY Then
…
```

The instructions following `Then` are only executed if the connection status is `CTA_STAT_READY`.

Example in C++

```
TCTAStatus eStatus;
if (SUCCEEDED(cta->get_eStatus(&eStatus)) && eStatus
== CTA_STAT_READY) {
        …
}
```

6.3.3.2 bstrFirmwareVersion

Scope `ICTA`

Syntax *Property* **bstrFirmwareVersion** *: string [read-only]*

Description Used to query the firmware version of the *CT Analyzer*.

Return value Firmware version number.
This string has the following format: "m.n"

m is the major and *n* the minor version number

Example in VB
```
Dim strVer As string
strVer = cta.bstrFirmwareVersion
Debug.Print strVer
```
Displays the firmware version in the Immediate window of the Visual Basic editor.

Example in C++
```
printf(L"FWVersion %s", cta->bstrFirmwareVersion);
```

6.3.3.3 bstrHardwareVersion

Scope	`ICTA`
Syntax	*Property* **bstrHardwareVersion :** *string [read-only]*
Description	Used to query the hardware version of the *CT Analyzer*.
Return value	String containing the hardware version number in the following format: "aa/bb/cc/dd/ee". Each part indicates the version of an internal device part.
Example in VB	`Debug.Print cta.bstrHardwareVersion`
Example in C++	`printf(L"HWVersion %s", cta->bstrHardwareVersion);`

6.3.3.4 bstrSoftwareVersion

Scope	`ICTA`
Syntax	*Property* **bstrSoftwareVersion :** *string [read-only]*
Description	Used to query the software version of the *CTA Remote Control Software*.
Return value	Software version number.
Example in VB	`Debug.Print cta.bstrSoftwareVersion`
Example in C++	`printf(L"SWVersion %s", cta->bstrSoftwareVersion);`

6.3.3.5 bstrSerialNumber

Scope	`ICTA`
Syntax	*`Property`* **`bstrSerialNumber :`** *`string [read-only]`*
Description	Used to query the serial number of the *CT Analyzer*.
Return value	Serial number of the *CT Analyzer*.

Example in VB	`Dim sernum As String`
	`sernum = cta.bstrSerialNumber`
	`Debug.Print sernum`
	Displays the serial number in the Immediate window of the Visual Basic editor.

Example in C++	`printf(L"Serial %s", cta->bstrSerialNumber);`

6.3.3.6 Info

Scope	`ICTA`
Syntax	*`Property`* **`Info :`** *`ICTAInfo [read-only]`*
Description	Used to access device messages through the ICTAInfo interface. A message can be an operating error, a warning or a hint.
Return value	Access to the ICTAInfo interface (page 53).

Example in VB	`If cta.Info.eClass = CTA_INFO_CLS_ERROR Then`
	`msgbox cta.Info.bstrDescription`
	`End If`
	`cta.Info.Clear`

Example in C++	`if (cta->Info->eClass == CTA_INFO_CLS_ERROR) {`
	`_tprintf(_T("uuhps: %s"), cta->Info->bstrDescription);`
	`}`
	`cta->Info->Clear();`

6.3.3.7 USBDevices

Scope `ICTA`

Syntax *Property* **USBDevices** *: IUSBDevices [read-only]*

Description Used to access the list of serial numbers of all *CT Analyzer* test sets connected via USB. This function returns the `IUSBDevices` interface (this interface is not described separately but the example below should suffice).

If more than one device is connected via USB, the serial number of the desired device is passed to the USBConnect() function. Otherwise, the first device found on the USB bus is used.

Return value Access to the `IUSBDevices` interface.

Example in VB

```
cta.USBDevices.Refresh
For i = 0 To cta.USBDevices.Count - 1
Debug.Print "CTA Device: "
  cta.USBDevices.Item2(i).bstrSerialNumber
Next
```

Explanation of the example:

With each execution of the `For-Next` loop, the serial number of one *CT Analyzer* connected via USB is displayed in the Immediate window of the Visual Basic editor (e.g. "CTA Device: AI153T"). The value `i` is increased by 1 with each execution until all *CT Analyzer* test sets detected on the USB bus are listed. After this, the program code following `Next` is executed.

Example in C++

```
_tprintf(_T("enumerating USB devices...\n"));
_HR(pCTA->USBDevices->Refresh());
for (int i = 0; i < pCTA->USBDevices->Count; ++i) {
        _tprintf(_T("'%s'\n"), BSTR(pCTA->USBDevices-
>Item2[i]->bstrSerialNumber));
}
```

6.3.3.8 HasLicense

Scope `ICTA`

Syntax *Function* **HasLicense***([in] TCTALicense eLic): BOOL*

Description Used to query whether a certain functionality or feature is licensed on the *CT Analyzer*. The *CT Analyzer* must be connected.

Parameters
`eLic`
License to be queried (element of TCTALicense, see page 131.

Return value
`True`, if license exists. Otherwise `False` is returned.

If the *CT Analyzer* is not connected, an error is returned.

Example in VB

```
If cta.HasLicense(CTA_LIC_RATIO_CARD) Then
        ' enable ratio card
        cta.Settings.SetValue SV_CARD_RATIO, True
End If
```

Example in C++

```
BOOL bLicensed = cta->HasLicense(CTA_LIC_RATIO_CARD);
if (bLicensed) {
        cta->Settings->SetValue(SV_CARD_RATIO, TRUE);
}
```

6.3.3.9 MissingLicenses

Scope
`ICTA`

Syntax
`Function MissingLicenses(): Variant`

Description
Reads a list of missing licenses.

These licenses prevent a start of a certain measurement on the *CT Analyzer*.

Apply this Command just before an "ICTARemoteTest.Activate" Command, to consider if you can start a measurement.

Parameters

Return value
List of license ID's.

See `enum TCTALicense.`

Example in VB

```
Dim v As Variant
v = MissingLicenses
Debug.Print "Number of licenses ="; UBound(v) -
IBound(v)
If UBound(v) <> -1 Then
   For i = 0 To UBound(v)
      Debug.Print "L ["; i; "]"; v(i)
   Next i
End If
```

6.3.3.10 AvailableLicenses

Scope	`ICTA`
Syntax	*Function* **AvailableLicenses**(): *Variant*
Description	Reads a list of actual available licenses. These licenses are enabled on the *CT Analyzer*.
Parameters	
Return value	List of license ID's. See enum `TCTALicense`.

Example in VB

```
Dim v As Variant
v = AvailableLicenses
Debug.Print "Number of licenses ="; UBound(v) -
IBound(v)
If UBound(v) <> -1 Then
   For i = 0 To UBound(v)
      Debug.Print "L ["; i; "]"; v(i)
   Next i
End If
```

6.3.3.11 NotAvailableLicenses

Scope	`ICTA`
Syntax	*Function* **NotAvailableLicenses**(): *Variant*
Description	Reads a list of not available licenses.
Parameters	
Return value	List of license ID's. See enum `TCTALicense`.

Example in VB

```
Dim v As Variant
v = NotAvailableLicenses
Debug.Print "Number of licenses ="; UBound(v) -
IBound(v)
If UBound(v) <> -1 Then
   For i = 0 To UBound(v)
      Debug.Print "L ["; i; "]"; v(i)
   Next i
End If
```

6.3.3.12 AddLicenses

Scope	`ICTA`
Syntax	*Function* **AddLicenses**(*[in]string bstrFile*)
Description	Used to perform an upgrade of the licenses on the *CT Analyzer*. Copies the license file from the specified path on the PC to the Compact Flash card of the *CT Analyzer* and then automatically upgrades the licenses on the device. Blocks the further program execution until the license update process is finished. Unlike *UpgradeLicensis()* this function keeps the existing licenses on the *CT Analyzer* and adds only the new licenses.
Parameters	*bstrFile* Full path to the license file on the PC.
Example in VB	`cta.AddLicenses "D:\CTA\License.lic"`
Example in C++	`cta->AddLicenses(bstr_t(L”D:\CTA\License.lic”));`

6.3.3.13 Test

Scope	`ICTA`
Syntax	*Property* **Test** **:** *ICTARemoteTest [read-only]*
Return value	Access to the ICTARemoteTest interface (page 61).
Example in VB	`cta.Test.Activate`
Example in C++	`cta->Test->Activate();`

6.3.3.14 Settings

Scope	`ICTA`
Syntax	*Property* **Settings** **:** *ICTASettings [read-only]*
Return value	Access to the ICTASettings interface (page 57).

Example in VB	`cta.Settings.LocalLoadSettings "mysettings.xml"`
	`cta.Settings.SetValue SV_SER_NR, "1234567"`
	`cta.Settings.LocalSaveSettings "mysettings.xml"`

Example in C++

```
#import <CTARemote.tlb> no_namespace named_guids
ICTAPtr cta(CLSID_CTA);
cta->Settings-
>LocalLoadSettings(_bstr_t(L"mysettings.xml"));
cta->Settings->SetValue(SV_SER_NR,
_variant_t(L"1234567"));
cta->Settings-
>LocalSaveSettings(_bstr_t(L"mysettings.xml"));
```

6.3.3.15 Results

Scope `ICTA`

Syntax *Property* **Results** *: ICTAResults [read-only]*

Return value Access to the ICTAResults interface (page 74).

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "myreport.xml"
Debug.Print
cta.Results.GetValue(RV_GENERAL_XML_FILE_VERSION)
```

Example in C++

```
#import <CTARemote.tlb> no_namespace named_guids
ICTAPtr cta(CLSID_CTA);
cta->Results-
>LocalLoadReport(_bstr_t(L"myreport.xml"));
_tprintf(_T("%s"), cta->Results-
>GetValue(RV_GENERAL_XML_FILE_VERSION));
```

6.3.3.16 LiveResults

Scope `ICTA`

Syntax *Property* **LiveResults** *: ICTALiveResults [read-only]*

Return value Access to the ICTALiveResults interface (page 87).

Example in VB

```
Dim cta as new CTA
Debug.Print
cta.Results.GetValue(RV_OBJECT_CT_MANUFACTURER)
```

Example in C++

```
ICTAPtr cta(CLSID_CTA);
_tprintf(_T("%s"), cta->Results-
>GetValue(RV_OBJECT_CT_MANUFACTURER));
```

6.3.3.17 FileTransfer

Scope	`ICTA`
Syntax	*Property* **FileTransfer** **:** *ICTAFileTransfer [read-only]*
Return value	Access to the ICTAFileTransfer interface (page 67).
Example in VB	`cta.FileTransfer.CopyToCTA "localfile.xml", "remotefile.xml"`
Example in C++	`cta->FileTransfer->CopyToCTA(_bstr_t(L"localfile.xml"), _bstr_t(L"remotefile.xml"));`

6.3.3.18 Directory

Scope	`ICTA`
Syntax	*Property* **Directory** **:** *ICTARemoteDirectory [read-only]*
Return value	Access to the ICTARemoteDirectory interface (page 69).
Example in VB	`cta.Directory.FileRename "ctafileold.xml", "ctafilenew.xml"`
Example in C++	`cta->Directory.FileRename(_bstr_t(L"ctafileold.xml"), _bstr_t(L"ctafilenew.xml"));`

6.3.3.19 Calculate

Scope	`ICTA`
Syntax	*Property* **Calculate** **:** *ICTACalc [read-only]*
Return value	Access to the ICTACalc interface (page 92).

Example in VB

```
Dim cta as new CTA
Dim status As TCTAQualifier
Dim dbResult As Double
dbResult = cta.Calculat.EvalCompositeError (1000, 15, 1, status)
Debug.Print dbResult
```

Example in C++

```
#import <CTARemote.tlb> no_namespace named_guids
ICTAPtr cta(CLSID_CTA);
TCTAQualifier status;
double result = cta->Calculate->EvalCompositeError(1000, 15, 1, &status);
printf("%f", result);
```

6.3.3.20 Quick

Scope	`ICTA`
Syntax	*Property* **Quick** **:** *ICTAQuick [read-only]*
Return value	Access to the ICTAQuick interface (page 115).
Example in VB	**`cta.Quick.StartMeasurement`**

6.4 `ICTAInfo` (Device Information)

The `ICTAInfo` interface is accessed through the ICTA::Info property.

Whenever a hint, a warning or an error condition occurs, the information is stored in this object. Fault conditions of higher severity overwrite conditions of a lower severity. The information needs to be cleared explicitly using the Clear() function.

In case of warnings and errors, the Error object is set and, if no statement like

```
On Error Resume Next
```

is used, the Visual Basic runtime system is halted.

6.4.1 Overview of functions and properties

Function	Brief description
Clear	Clears the device information. `eClass`, `nNumber`, `nLocation` and `bstrDescription` is reset, unless another device information is pending.

Property	Brief description
eClass	Information class: error, warning, tooltip, hint or none.
nNumber	Information number.
nLocation	Information location.
bstrDescription	Verbose information about the information number.
nMeasurementInfo	Details about the internal device operation.

6.4.2 Description of functions

6.4.2.1 Clear

Scope	`ICTAInfo`
Syntax	*`Function`* **`Clear`**`()`
Description	Resets the device information.
Parameters	none
Example in VB	**`cta.Info.Clear`**
Example in C++	**`cta->Info->Clear();`**

6.4.3 Description of properties

6.4.3.1 eClass

Scope	`ICTAInfo`
Syntax	*`Property`* **`eClass`** *`: TCTAInfoClass`*
Description	Returns the error class. If no error or information is available, `CTA_INFO_CLS_NONE` is returned.
Return value	Error class (element of TCTAInfoClass, see page 130).
Example in VB	**`Debug.Print cta.Info.eClass`**
Example in C++	**`printf("%d", cta->Info->eClass);`**

6.4.3.2 nNumber

Scope	`ICTAInfo`
Syntax	*`Property`* **`nNumber`** *`: integer`*
Description	Returns the error/information number.
Return value	Error/information number (refer to the CT Analyzer User Manual). With this number the error description can be found in the User Manual.
Example in VB	**`Debug.Print cta.Info.nNumber`**
Example in C++	**`printf("%d", cta->Info->nNumber);`**

6.4.3.3 nLocation

Scope	`ICTAInfo`
Syntax	*`Property`* **`nLocation`** *`: integer`*
Description	Provides further details about the error condition. This information is important for OMICRON to determine the exact reason of the error.
Return value	Location number. Location in the software where the error was detected. Necessary to determine the exact cause of error. This value is necessary for OMICRON Support to exactly determine where the error was generated in the software.
Example in VB	**`Debug.Print cta.Info.nLocation`**
Example in C++	**`printf("%d", cta->Info->nLocation);`**

6.4.3.4 bstrDescription

Scope	`ICTAInfo`
Syntax	*`Property`* **`bstrDescription`** *`: string`*
Description	A verbose description of the error condition. Only available in English.
Return value	Returns the descriptive string.
Example in VB	**`Debug.Print cta.Info.bstrDescription`**
Example in C++	**`printf("%s", cta->Info->bstrDescription);`**

6.4.3.5 nMeasurementInfo

Scope	`ICTAInfo`
Syntax	*`Property`* **`nMeasurementInfo`** *`: TCTAMeasurementInfo`*
Description	This property provides detailed information about the current *CT Analyzer* operation. This information can be queried at any time (not only in context with an error condition) to see what the device is currently doing.

Return value

Integer value with the following meaning:

Name	**Value (range)**	**Meaning**
MI_NO_MEAS	0	No measurement routine is currently active.
MI_AC_TEST	5	An AC test is running.
MI_AUTO_CAL	6	An auto calibration is in progress.
MI_WIRING_BUR	7	Device is waiting for wiring check prior to burden test.
MI_WIRING_CT	8	Device is waiting for wiring check prior to resistance test.
MI_MEAS_DEMAG	10	Demagnetization process is running.
MI_MEAS_BUR	20 - 29	nMEasurementInfo >= MI_MEAS_BUR and < MI_MEAS_RES indicates that the CT Analyzer is currently measuring the burden.
MI_MEAS_RES	30 - 39	nMEasurementInfo >= MI_MEAS_RES and < MI_MEAS_EXC indicates that the CT Analyzer is currently measuring the winding resistance.
MI_MEAS_EXC	40 - 69	nMEasurementInfo >= MI_MEAS_EXC and < MI_MEAS_RAT indicates that the CT Analyzer is currently measuring the excitation characteristics.
MI_MEAS_RAT	70 - 79	nMEasurementInfo >= MI_MEAS_RAT and < MI_MEAS_RESERVED indicates that the CT Analyzer is currently measuring the ratio.
MI_MEAS_ RESERVED	>= 80	nMEasurementInfo >= MI_MEAS_RESERVED is reserved for future use.

Example in VB

```
Debug.Print cta.Info.nMeasurementInfo
```

Example in C++

```
printf("%d", cta->Info->nMeasurementInfo);
```

6.5 `ICTASettings` (Specifying Test Settings)

The `ICTASettings` interface is accessed through the ICTA::Settings property.

Test settings files (test definitions) and test report files are of the same file structure and have the same file extension (.XML). The difference is that settings files do not contain any test results and therefore have a much smaller file size. Using ICTARemoteTest::RemoteLoadReport(), the *CT Analyzer* is able to load both file types, settings files and report files.

Similarly, the difference between the functions LocalSaveSettings() and LocalLoadSettings() is that the former is only able to save settings files while the latter is able to load settings files and report files. However, when loading report files using `LocalLoadSettings()`, the results contained in the report files are lost.

Please note that the internal handling of setting values differs from the handling of the result values. In fact, they are kept in distinct memory areas without any interrelation. For example, it is possible to load and manipulate the settings of one file and at the same time load the results of another file.

Note All functions in `ICTASettings` can be executed offline, without a *CT Analyzer* test set connected.

6.5.1 Overview of functions

Function	Brief description
LocalLoadSettings	Load a settings file or a report file from a local drive on the PC.
LocalSaveSettings	Save a settings file (test definitions) to a local drive on the PC.
ClearSettings	Reset all setting values to the default values.
GetValue	Read the value of a particular test setting.
SetValue	Set the value of a particular test setting.

6.5.2 Description of functions

6.5.2.1 LocalLoadSettings

Scope	`ICTASettings`
Syntax	*Function* **LocalLoadSettings**(*[in]string LocalPath*)
Description	Loads a settings file (test definition) from a local drive on the PC. After this, the individual settings can be queried using the `GetValue()` function, changed using `SetValue()` and stored again using `LocalSaveSettings()`. Using this function, it is possible to load settings files and test report files, since both file types share the same file structure and format (XML). The difference is that test report files contain test results in addition to the test settings. When loading a test report file using this function, all test results contained in this file are discarded, and will be lost when calling `LocalSaveSettings()`.
Parameters	*LocalPath* (full path to the settings file on the PC)

Example in VB	`Dim sett As ICTASettings`
	`set sett = cta.Settings`
	`sett.LocalLoadSettings "D:\CTA_Test\settings1.xml"`

Example in C++	`cta->Settings->LocalLoadSettings (_bstr_t(L"D:\CTA_Test\settings1.xml"));`

6.5.2.2 LocalSaveSettings

Scope	`ICTASettings`
Syntax	*Function* **LocalSaveSettings**(*[in]string LocalPath*)
Description	Saves a settings file (test definition, file extension .XML) to a local drive on the PC.
Parameters	*LocalPath* (full path on the PC and file name)
Example in VB	`cta.Settings.LocalSaveSettings "D:\CTA_Test\settings2.xml"`
Example in C++	`cta->Settings->LocalLoadSettings (_bstr_t(L"D:\CTA_Test\settings2.xml"));`

6.5.2.3 ClearSettings

Scope	`ICTASettings`
Syntax	*Function* **ClearSettings**()
Description	This function is used to reset all settings to the default values.

Example in VB	`Dim sett As ICTASettings`
	`set sett = cta.Settings`
	`sett.LocalLoadSettings "D:\CTA_Test\settings1.xml"`
	`sett.ClearSettings`

Example in C++	`cta->Settings->LocalLoadSettings (_bstr_t(L"D:\CTA_Test\settings1.xml"));` `cta->Settings->ClearSettings();`

6.5.2.4 GetValue

Scope	`ICTASettings`
Syntax	*Function* **GetValue**(*[in]TCTASettingValue id*)**:** *Variant*
Description	Reads the value of a particular test setting.
Parameters	`id` (ID of the setting value to be read (element of TCTASettingValue, see page 138))
Return value	Setting value of the test parameter. Data type: Variant.
Example in VB	`cta.Settings.LocalLoadSettings "D:\CTA_Test\settings1.xml"` `Debug.Print cta.Settings.GetValue(SV_ALF)`

Example in C++	`cta->Settings->LocalLoadSettings(_bstr_t(L" D:\CTA_Test\settings1.xml "));`
	`_variant_t v = cta->Settings->GetValue(SV_ALF);`
	`_tprintf(_T("%d"), cta->Settings->GetValue(SV_ALF));`

6.5.2.5 SetValue

Scope `ICTASettings`

Syntax *Function* **SetValue**(*[in]TCTASettingValue paramid, [in]Variant value) : Variant*

Description
Used to set the value of a particular test setting.

The specified value may be reduced or corrected automatically, if it exceeds the allowed value range. In this case, the corrected value is returned. The same value would be returned when using the function `GetValue()` subsequently.

Parameters
`paramid`
(test parameter, the value of which you want to set (element of TCTASettingValue, see page 138))

`value`
(new value of the test setting; since a Variant type is requested, values of any type can be passed)

`Return Parameter`:
The return parameter should be the same as [in]Variant value but may be reduced or corrected automatically, if it exceeds the allowed value range. In this case, the corrected value is returned. The same value would be returned when using the function `GetValue()` subsequently.

Example in VB

```
Dim sett As ICTASettings
set sett = cta.Settings
If sett.SetValue(SV_IAL, v) <> v Then
Debug.Print "value " & v & " has been rounded"
End If
```

Example in C++

```
_variant_t vin = 3.4;
_variant_t vout;
vout = cta->Settings->SetValue(SV_IAL, vin);
if (vin != vout) {
printf("rounded");
}
```

6.6 `ICTARemoteTest` (Test Execution on the CT Analyzer)

The `ICTARemoteTest` interface is accessed through the ICTA::Test property.

All functions of this interface require a previous connection establishment to the *CT Analyzer*.

6.6.1 Overview of functions

Function	Brief description
RemoteLoadReport	Loads a test report or a test settings file on the *CT Analyzer*.
RemoteSaveReport	Saves the current test report on the *CT Analyzer*.
Activate	Activates the test.
Deactivate	Aborts the test.
LoadRefExcitationCurve	Loads a reference curve for the excitation test.
LockDevice	Locks the keyboard of the *CT Analyzer*, except the "I/O" key.
UnlockDevice	Unlocks the keyboard of the *CT Analyzer*.

6.6.2 Description of functions

6.6.2.1 RemoteLoadReport

Scope	`ICTARemoteTest`
Syntax	*`Function`* **`RemoteLoadReport`**`(`*`[in]string RemotePath`*`)`
Description	Loads a specified test report or test settings file on the *CT Analyzer* (from the Compact Flash card or the internal RAM disk). **Hint:** Always use the RAM disk to avoid that the limit of possible write cycles of the Compact Flash card is reached.
Parameters	*`RemotePath`* (full path of the file)
Example in VB	**`cta.Test.RemoteLoadReport "b:/Tests/test1.xml"`**
Example in C++	**`cta->Test->RemoteLoadReport(_bstr_t(L"b:/Tests/test1.xml"));`**

6.6.2.2 RemoteSaveReport

Scope	`ICTARemoteTest`
Syntax	*Function* **RemoteSaveReport**(*[in]string RemotePath*)
Description	Saves the current test report on the *CT Analyzer* (to the Compact Flash card or the internal RAM disk). **Hint:** Always use the RAM disk to avoid that the limit of possible write cycles of the Compact Flash card is reached.
Parameters	*RemotePath* (full path on the *CT Analyzer* and file name)
Example in VB	`cta.Test.RemoteSaveReport "b:/Tests/test2.xml"`
Example in C++	`cta->Test->RemoteSaveReport(_bstr_t(L"b:/Tests/test2.xml"));`

6.6.2.3 Activate

Scope	`ICTARemoteTest`
Syntax	*Function* **Activate**()
Description	Activates a test. Unlike the other functions, `Activate()` does not wait until its execution is completed. Control is immediately returned to the caller while the *CT Analyzer* performs the test procedure concurrently.

Activating the test is only possible, if the device status (to be queried by the ICTA::eStatus property) is `CTA_STAT_READY`. If the device status is `CTA_STAT_WAIT_FOR_ACKNOWLEDGE`, a message is still pending and needs to be acknowledged using ICTA::Info.Clear().

After the test activation, the device status changes to `CTA_STAT_ACTIVATED`. This status is kept until one of the following occurs:

1. The test completed successfully. The device status changes to `CTA_STAT_READY`.
2. The test failed or was aborted. In this case, the device status changes to `CTA_STAT_WAIT_FOR_ACKNOWLEDGE`.
3. The test is still active but the execution is paused, since rewiring of the test object is required. This is the case if you have to measure the burden and the winding resistance in one test procedure.

Then, the device status changes to CTA_STAT_PAUSED. After rewiring is finished, Activate() has to be called again to continue. After this, the device status returns to CTA_STAT_ACTIVATED (see the example below for a proper implementation).

Example (VB)

```
'start test
cta.Test.Activate
' loop while test is running
  While cta.eStatus >= CTA_STAT_ACTIVATED
     'check if rewiring is needed
     If cta.eStatus = CTA_STAT_PAUSED Then
         ' block until rewired…
        MsgBox "Change wiring and click OK"
        'wiring change finished, continue test
        rt.Activate
     End If
  Wend
'query and display error status
If cta.eStatus = CTA_STAT_WAIT_FOR_ACKNOWLEDGE Then
     Debug.Print cta.Info.bstrDescription
     If cta.Info.eClass = CTA_INFO_CLS_ERROR Then
          MsgBox "ERROR"
          Exit
     End If
     ' acknowledge any notification
     cta.Info.Clear
End If
```

Explanation of the example:

The test is started using cta.Test.Activate. The While-Wend loop is executed as long as the test is running (status not CTA_STAT_ACTIVATED).

If the *CT Analyzer* requests rewiring, the status changes to CTA_STAT_PAUSED. In this case, the If-Then instruction is fulfilled and a message box containing the text "Change wiring and click OK" appears. While the message box is displayed, program execution is blocked. After you have changed the wiring and clicked on OK, the cta.Test.Activate instruction in the next line is executed and the test continues (status returns to CTA_STAT_ACTIVATED).

When the test is finished or aborted, a status of

`CTA_STAT_WAIT_FOR_ACKNOWLEDGE` indicates that something unexpected has happened during the test. A description of the problem is displayed and, if this is an error, another message box appears and the execution is terminated. Otherwise, the message is acknowledged by `cta.Info.Clear()`.

See also chapter Error Handling on page 221.

Example in C++

```
// start test
ICTAPtr cta(CLSID_CTA);
cta->Test->Activate();
// loop while test is running
while (cta->eStatus >= CTA_STAT_ACTIVATED) {
        //check for rewiring
        if (cta->eStatus == CTA_STAT_PAUSED) {
                //let rewire…
                _tprintf(_T("do rewire and press
                <return>\n"));
                getchar();
                cta->Test->Activate();
        }
}
// query for errors
if (cta->eStatus == CTA_STAT_WAIT_FOR_ACKNOWLEDGE) {
        _tprintf(_T("msg: %s"), cta->Info-
        >bstrDescription);
        if (cta->Info->eClass == CTA_INFO_CLS_ERROR) {
                _tprintf(_T("ERROR"));
                getchar();
                return;
        }
        // acknowledge any notification
        cta->Info->Clear();
}
```

6.6.2.4 Deactivate

Scope	`ICTARemoteTest`
Syntax	*Function* **Deactivate**()
Description	Aborts a running test. The `Deactivate` function can take several minutes, depending on whether demagnetization of the test object is required or not. In contrast to Activate(), the `Deactivate()` function does not return before the action is completed.
Example in VB	**`cta.Test.Deactivate`**
Example in C++	**`cta->Test->Deactivate();`**

6.6.2.5 LoadRefExcitationCurve

Scope	`ICTARemoteTest`
Syntax	*Function* **LoadRefExcitationCurve**(*[in]string RemotePath*)
Description	Loads an excitation curve of a previous test as a reference curve. This is used to compare the current results with a previous test. `LoadRefExcitationCurve()` must not be called until the test is completed. The test report file containing the reference curve has to be available on the Compact Flash card or the internal RAM disk.
Parameters	*RemotePath* (full path to a report file)
Example in VB	**`cta.Test.LoadRefExcitationCurve "/Tests/test1.xml"`**
Example in C++	**`cta->Test->LoadRefExcitationCurve(_bstr_t(L"/Tests/test1.xml"));`**

6.6.2.6 LockDevice

Scope	`ICTARemoteTest`
Syntax	*Function* **LockDevice**()
Description	Locks the keyboard of the *CT Analyzer*. This prevents e.g. unauthorized changes of settings as long as the device is under remote control. All keys except the "I/O" key are locked, so that a manual abortion of a running test is still possible. Use the `UnlockDevice` function to unlock the keyboard again.
Example in VB	**`cta.Test.LockDevice`**
Example in C++	**`cta->Test->LockDevice();`**

6.6.2.7 UnlockDevice

Scope	`ICTARemoteTest`
Syntax	*Function* **UnlockDevice**()
Description	Unlocks the keyboard of the *CT Analyzer*.
Example in VB	**`cta.Test.UnlockDevice`**
Example in C++	**`cta->Test->UnlockDevice();`**

6.7 `ICTAFileTransfer` (File Exchange)

The `ICTAFileTransfer` interface is accessed through the ICTA::FileTransfer property.

All functions of this interface require a previous connection establishment to the *CT Analyzer*.

6.7.1 Overview of functions

Function	Brief description
CopyToCTA	Copy file from PC to *CT Analyzer*.
CopyFromCTA	Copy file from *CT Analyzer* to PC.

6.7.2 Description of functions

6.7.2.1 CopyToCTA

Scope: `ICTAFileTransfer`

Syntax: *Function* **CopyToCTA**(*[in]string LocalPath, [in]string RemotePath*)

Description: Copies a file from a local drive on the PC to the Compact Flash card or the internal RAM disk of the *CT Analyzer*.

The file transfer can take some seconds.

Hint: Always use the RAM disk to avoid that the limit of possible write cycles of the Compact Flash card is reached.

Parameters: *LocalPath*
(full local PC path of the file to be copied)

RemotePath
(full remote path of the file on the *target device*)

Example in VB

```
cta.FileTransfer.CopyToCTA
"D:\CTA_Tests\settings1.xml", "b:/Tests/test1.xml"
```

Example in C++

```
cta->FileTransfer-
>CopyToCTA(_bstr_t(L"D:\CTA_Tests\settings1.xml"),
_bstr_t(L"b:/Tests/test1.xml"));
```

6.7.2.2 CopyFromCTA

Scope	`ICTAFileTransfer`
Syntax	*Function* **CopyFromCTA**(*[in]string RemotePath, [in]string LocalPath*)
Description	Copies a file from the Compact Flash card or the internal RAM disk of the *CT Analyzer* to a local drive on the PC. The file transfer can take some seconds.
Parameters	*RemotePath* (full remote path of the file on the *target device*) *LocalPath* (full local PC path of the file to be copied)
Example in VB	**`cta.FileTransfer.CopyFromCTA "b:/Tests/test1.xml", "D:\CTA_Tests\test1.xml"`**
Example in C++	**`cta->FileTransfer->CopyFromCTA(_bstr_t(L"b:/Tests/test1.xml"), _bstr_t(L"D:\CTA_Tests\settings1.xml"));`**

6.8 `ICTARemoteDirectory` (File Management on the CT Analyzer)

The `ICTARemoteDirectory` interface is accessed through the ICTA::Directory property. All functions of this interface require a previous connection establishment to the *CT Analyzer*.

6.8.1 Overview of functions

Function	Brief description
QueryFileItems	Queries for subfolders and files contained in a specific folder on the *CT Analyzer*.
FileMove	Moves a file on the *CT Analyzer*.
FileRename	Renames a file on the *CT Analyzer*.
FileCopy	Copies a file on the *CT Analyzer.*
FileRemove	Deletes a file on the *CT Analyzer*.
DirectoryCreate	Creates a new folder on the *CT Analyzer*.
DirectoryRemove	Deletes an empty folder on the *CT Analyzer*.
FormatDisk	Formats the Compact Flash card. All data stored on the Compact Flash card will be lost.

6.8.2 Description of functions

6.8.2.1 QueryFileItems

Scope `ICTARemoteDirectory`

Syntax *`Function`* **`QueryFileItems`**`(`*`[in]string bstrRemoteDirectoryPath, [out]ICTAFileItems Directories, [out]ICTAFileItems Files`*`)`

Description Used to query for subfolders and files contained in the folder *RemoteDirectoryPath* on the *CT Analyzer*. The path of the root folder is "/".

Note:
This function returns

- a list of file names stored in the queried folder and
- a list of subfolder names in the queried folder.

The file names and the folder names are the item names without the full path.

Parameters *bstrRemoteDirectoryPath*
Path to the folder to be queried.

Return value *Directories* (list of contained folders9

Files (list of contained files)

Example in VB

```
'instantiate the CTA remote component
Dim cta As New CTARemoteLib.CTA
'connect to CT Analyzer
cta.USBConnect
'instantiate ICTARemoteDirectory interface
Dim rd As ICTARemoteDirectory
'Assign object reference
Set rd = cta
'declaration of variables di and fi as elements of
'ICTAFileItems
Dim di As ICTAFileItems
Dim fi As ICTAFileItems
'call function QueryFileItems for the root directory
'output parameters are di and fi
Call rd.QueryFileItems("/", di, fi)
'declaration of variable I as type integer
Dim i As Integer
  'list contained directories in the Immediate window
  For i = 0 To di.Count - 1
    Debug.Print "dir: " & di.Item2(i).bstrName & ","
    & di.Item2(i).dateDateTime & ","
    & di.Item2(i).nSize
  Next
  'list contained files in the Immediate window
  For i = 0 To fi.Count - 1
    Debug.Print "file: " & fi.Item2(i).bstrName & ","
    & fi.Item2(i).dateDateTime & ","
    & fi.Item2(i).nSize
  Next
```

Explanation of the example:

With each execution of the first `For-Next` loop, the name of one contained folder is displayed (e.g. "*dir: Test, 11.11.2004 19:21:18, 27200*").

The second `For-Next` loop works exactly as the first `For-Next` loop but lists files instead of folders.

Example in C++

```
ICTAFileItemsPtr di, fi;
cta->Directory->QueryFileItems(_bstr_t(L"/"), &di,
&fi);
for (int i = 0; i < di->Count - 1; ++i) {
        _tprintf(_T("dir: %s"), di->Item2[i]-
        >bstrName);
}
// ...
```

6.8.2.2 FileMove

Scope: ICTARemoteDirectory

Syntax: *Function* **FileMove**(*[in]string bstrRemoteFileOld, [in]string bstrRemoteFileNew*)

Description: Using this function, you can move a file stored on the *CT Analyzer*.

Parameters: *bstrRemoteFileOld* (full path of the file to be moved)

bstrRemoteFileNew (new full path)

Example in VB

```
cta.Directory.FileMove "A:/Tests1/test1.xml",
"A:/Tests2/test1.xml"
```

Example in C++

```
cta->Directory-
>FileMove(_bstr_t(L"A:/Tests1/test1.xml"),
_bstr_t(L"A:/Tests2/test1.xml"));
```

6.8.2.3 FileRename

Scope: ICTARemoteDirectory

Syntax: *Function* **FileRename**(*[in]string bstrRemoteFileOld, [in]string bstrRemoteFileNew*)

Description: Using this function, you can rename a file stored on the *CT Analyzer*.

Parameters: *bstrRemoteFileOld* (full path of the file to be renamed)

bstrRemoteFileNew (new full path)

Example in VB

```
cta.Directory.FileRename "A:/Tests/test1.xml",
"A;/Tests/test1renamed.xml"
```

Example in C++

```
cta->Directory->FileRename(_bstr_t(L"A:/Tests/
test1.xml"), _bstr_t(L"A:/Tests/test1renamed.xml"));
```

6.8.2.4 FileCopy

Scope	`ICTARemoteDirectory`
Syntax	*Function* **FileCopy**(*[in]string bstrRemoteFileOld, [in]string bstrRemoteFileNew*)
Description	Using this function, you can copy a file stored on the *CT Analyzer*.
Parameters	*bstrRemoteFileOld* (full path of the file to be renamed) *bstrRemoteFileNew* (new full path)
Example in VB	`cta.Directory.FileCopy "A:/Tests1/test1.xml", "A:/Tests2/test1.xml"`
Example in C++	`cta->Directory->FileCopy(_bstr_t(L"A:/Tests1/test1.xml"), _bstr_t(L"A:/Tests2/test1.xml"));`

6.8.2.5 FileRemove

Scope	`ICTARemoteDirectory`
Syntax	*Function* **FileRemove**(*[in]string bstrRemoteFile*)
Description	Deletes a file on the *CT Analyzer*.
Parameters	*bstrRemoteFile* (full path of the file to be deleted)
Example in VB	`cta.Directory.FileRemove "/Tests/test1.xml"`
Example in C++	`cta->Directory->FileRemove(_bstr_t(L"/Tests/test1.xml"));`

6.8.2.6 DirectoryCreate

Scope	`ICTARemoteDirectory`
Syntax	*Function* **DirectoryCreate**(*[in]string bstrRemoteDir*)
Description	Using this function, you can create a new folder on the *CT Analyzer*.
Parameters	*bstrRemoteDir* (full path of the new folder)
Example in VB	`cta.Directory.DirectoryCreate "/Tests/MyNewTests"`
Example in C++	`cta->Directory->DirectoryCreate(_bstr_t(L"/Tests/MyNewTests"));`

6.8.2.7 DirectoryRemove

Scope	`ICTARemoteDirectory`
Syntax	*Function* **DirectoryRemove**(*[in]string bstrRemoteDir*)
Description	Deletes a folder on the *CT Analyzer*. Only empty folders can be deleted. If you try to delete a folder containing files or subfolders, an error message is displayed.
Parameters	*bstrRemoteDir* (full path of the folder to be deleted)
Example in VB	`cta.Directory.DirectoryRemove "/Tests/MyTests"`
Example in C++	`cta->Directory->DirectoryRemove(_bstr_t(L"/Tests/MyTests"));`

6.8.2.8 FormatDisk

Scope	`ICTARemoteDirectory`
Syntax	*Function* **FormatDisk**()
Description	Formats the Compact Flash card inserted in the *CT Analyzer*. **Warning:** All data stored on the Compact Flash card will be lost.
Example in VB	`cta.Directory.FormatDisk`
Example in C++	`cta->Directory->FormatDisk();`

6.9 `ICTAResults` (Reading Test Results From a Test Report)

The `ICTAResults` interface is accessed through the ICTA::Results property.

Using the functions of the `ICTAResults` interface, you can read the result values previously saved in a test report. In contrast to the functions of the ICTALiveResults interface (which allows direct access to values on the *CT Analyzer*, see page 87), it is necessary to save a test report on the *CT Analyzer* and to transfer the test report file to the PC before reading the values.

The values in `ICTAResults` are not coupled to the values in `ICTASettings`. Therefore, it is possible to treat the results of one file while changing the settings of another file. Consequently, when you load the same file with `ICTAResults` and `ICTASettings`, changing the setting values has no effect on the available results.

Note All functions in `ICTAResults` can be executed offline, without a *CT Analyzer* test set connected.

6.9.1 Overview of functions

Function	Brief description
LocalLoadReport	Load a test report file from a local PC drive.
GetValue	Read a particular result value.
GetIndexedValue	Read a single value of a particular result curve (e.g. the excitation curve). A result curve is an array of result values.
GetIndexedValues	Read all values of a particular result curve at once. A result curve is an array of result values.
GetCompositeError	Composite error according to IEC60044-1. Refer to CT Analyzer User Manual, section "Calculation of Instrument Security Factor (FS)".
GetPhaseDeviation	Phase deviation according to direct measurement method.
GetRatioDeviation	Current ratio deviation according direct measurement method.
GetMaxPrimaryCurrent	Maximum primary current that can be entered to calculate the ratio error.

GetISec	Secondary current for a specified primary current on a specified burden.
GetErrorDescription	Get a verbose description for an error number retrieved by `GetValue(RV_GENERAL_ERROR_NR)`.
SetValue	Write a particular result value.
LocalSaveReport	Save a test report file to a local PC drive.
IsReportSecure	Check if the checksum of the loaded report is valid.

6.9.2 Description of functions

6.9.2.1 LocalLoadReport

Scope	`ICTAResults`
Syntax	*Function* **LocalLoadReport**(*[in]string LocalPath*)
Description	Loads a test report file (XML file) from a local drive on the PC for further processing using the functions `GetValue`, `GetIndexedValue` and `GetIndexedValues`. **Note:** Test report files and test settings files (test definitions) are of the same file structure and have the same file extension (.XML). Setting files, however, do not contain test results and therefore loading a settings file using this function will fail.
Parameters	*LocalPath* (full path and file name of the report file to be loaded)
Example in VB	`cta.results.LocalLoadReport "D:\CTA_Test\test1.xml"`
Example in C++	`cta->Results->LocalLoadReport(_bstr_t(L"D:\CTA_Test\test1.xml"));`

6.9.2.2 GetValue

Scope	`ICTAResults`
Syntax	*Function* **GetValue**(*[in]TCTAResultValue id*) **:** *Variant*
Description	Reads a particular result value. See TCTAResultValue on page 151 for the available result values.
Parameters	*id* ID of the value you want to query, see TCTAResultValue (page 151).
Return value	The result value (type: Variant). A Variant is able to hold values of any data type. So, the returned value can be a float, an enumeration type, an integer or a string. For the actual data types of the requested ID, please refer to TCTAResultValue (page 151).
Example in VB	`cta.Results.LocalLoadReport "D:\CTA_Test\test1.xml"` `Debug.Print cta.Results.GetValue (RV_OBJECT_CT_MANUFACTURER)`
Example in C++	`cta->Results->LocalLoadReport(_bstr_t(L"D:\CTA_Test\test1.xml"));` `_tprintf(_T("%s"), (_bstr_t)(cta->Results->GetValue(RV_OBJECT_CT_MANUFACTURER));`

6.9.2.3 GetIndexedValue

Scope	`ICTAResults`
Syntax	*Function* **GetIndexedValue**(*[in]TCTAResultIndexedValue id, [in]integer idx*) **:** *Variant*
Description	Reads a single value of a particular result value list (e.g. the excitation curve). If a particular test result is not a single value but consists of a list of values instead (e.g. an excitation curve, a table, etc.), all values in this list have an index number assigned. Please refer to TCTAResultIndexedValue (page 188) for the available value lists. **Note:** If you access an index number which is not available, an error is thrown. When iterating through the list, this can be used to terminate the iteration.

Parameters	*id* ID of the value list you want to query, see TCTAResultIndexedValue (page 188). *idx* Index number of the particular result you want to query.
Return value	The result value (type: Variant). A Variant is able to hold values of any data type. So, the returned value can be a float, an enumeration type, an integer or a string. For the actual data types of the requested ID, please refer to TCTAResultIndexedValue (page 188).

Example 1 (VB)

```
cta.Results.LocalLoadReport "D:\CTA_Test\test1.xml"
cta.Results.GetIndexedValue(RV_RATIO_CURVE_EMF_V, 9)
```

Queries the 9th value of the results list for `RV_RATIO_CURVE_EMF_V`.

Example 2 (VB) (query number of existing values)

```
cta.Results.LocalLoadReport "D:\CTA_Test\test1.xml"

Dim i As Integer
i = 0
On Error GoTo finish
   While True
      Debug.Print
cta.Results.GetIndexedValue(RV_RATIO_CURVE_EMF_V, i)
      i = i + 1
   Wend
finish: Debug.Print "Number of values:"; i
```

Explanation of the example:

The code shown in this example prints all values of the `RV_RATIO_CURVE_EMF_V` value list (curve).

All values are successively read until the end of the list is exceeded. Since an invalid index is requested then, an error is thrown. Due to the preceding declaration `On Error Goto finish`, the program execution then jumps to the label named "finish".

Example in C++

```
int i = 0;
CComVariant v;
while (SUCCEEDED(cta->Results-
>raw_GetIndexedValue(RV_RATIO_CURVE_EMF_V, i, &v))) {
       _tprintf(_T(L"%f"), v.fltVal);
}
// number of values is i
```

6.9.2.4 GetIndexedValues

Scope `ICTAResults`

Syntax *Function* **GetIndexedValues**(*[in]TCTAResultIndexedValue id*) **:** *Variant*

Description Reads all values of a particular result values list at once. Most of the value lists are measurement curves with the values representing the individual points.

Please refer to TCTAResultIndexedValue on page 188 for a summary of all available lists.

Using this function you can read the complete list of values (e.g. all values of the excitation curve) at once.

Parameters *id*
(ID of the value list you want to query, see TCTAResultIndexedValue (page 188))

Return value List of result values. The list is delivered as a value array packed into a Variant type. How to access the individual values is shown in the example below.

Example in VB

```
cta.Results.LocalLoadReport "D:\CTA_Test\test1.xml"

Dim v As Variant
v = cta.Results.GetIndexedValues(RV_RATIO_CURVE_EMF_V)

  Debug.Print "Number of values = "; UBound(v) - LBound(v)
  If UBound(v) <> -1 Then
     For i = 0 To UBound(v)
        Debug.Print "V ["; i; "]"; v(i)
     Next i
  End If
```

Explanation of the example:

The code shown in this example first determines the number of values available in the results list of the parameter `RV_RATIO_CURVE_EMF_V` by subtracting the lowest index number (`LBound` – "lower bound") from the highest one (`UBound` – "upper bound"). Then, the values are printed one after the other. The elements are accessed by `v(i)`. The check `UBound(v) <> -1` is successful, if values are available in the list.

6.9.2.5 GetCompositeError

Scope `ICTAResults`

Syntax *`Function`* **`GetCompositeError`**`(`*`[in]float fIPrim, [in]float fBurden, [in]fCosPhi`*`)` **`:`** *`float`*

Description This function returns the composite error according to the IEC 60044-1 direct measurement method for the specified primary current, burden and CosPhi. The composite error can only be calculated up to a maximum primary current (see GetMaxPrimaryCurrent on page 82).

LocalLoadReport has to be called before using this function.

Parameters `fIPrim` (primary current)

`fBurden` (operating burden)

`fCosPhi` (cosine of phase angle)

All values are passed as of type float.

Return value The calculated composite error for the current report and the parameters passed.

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim isec, burden, cosphi As Single
isec = 1.0
burden = 33.3
cosphi = 0.5
Debug.Print cta.Results.GetCompositeError(isec,
burden, cosphi)
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
float fCompErr = cta->Results->GetCompositeError(1.0,
33.3, 0.5);
```

6.9.2.6 GetPhaseDeviation

Scope `ICTAResults`

Syntax *Function* **GetPhaseDeviation**(*[in]float fIPrim, [in]float fBurden, [in]fCosPhi)* **:** *float*

Description This function returns the phase deviation in degrees of the secondary current for the specified primary current, burden and CosPhi. The phase deviation can only be calculated up to a maximum primary current (see GetMaxPrimaryCurrent on page 82).

LocalLoadReport has to be called before using this function.

Parameters `fIPrim` (primary current)

`fBurden` (operating burden)

`fCosPhi` (cosine of phase angle)

All values are passed as of type float.

Return value The calculated phase deviation for the current report and the parameters passed.

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim isec, burden, cosphi As Single
isec = 1.0
burden = 33.3
cosphi = 0.5
Debug.Print cta.Results.GetPhaseDeviation(isec, burden, cosphi)
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my report.xml"));
float fCompErr = cta->Results->GetPhaseDeviation(1.0, 33.3, 0.5);
```

6.9.2.7 GetRatioDeviation

Scope `ICTAResults`

Syntax *`Function`* **`GetRatioDeviation`**`(`*`[in]float fIPrim, [in]float fBurden, [in]fCosPhi`*`)` **`:`** *`float`*

Description This function returns the current ratio deviation for the specified primary current, burden and CosPhi. The current ratio deviation can only be calculated up to a maximum primary current (see GetMaxPrimaryCurrent on page 82).

LocalLoadReport has to be called before using this function.

Parameters `fIPrim` (primary current)

`fBurden` (operating burden)

`fCosPhi` (cosine of phase angle)

All values are passed as of type float.

Return value The calculated ratio deviation for the current report and the parameters passed.

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim isec, burden, cosphi As Single
isec = 1.0
burden = 33.3
cosphi = 0.5
Debug.Print cta.Results.GetRatioDeviation(isec,
burden, cosphi)
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
float fCompErr = cta->Results->GetRatioDeviation(1.0,
33.3, 0.5);
```

6.9.2.8 GetMaxPrimaryCurrent

Scope `ICTAResults`

Syntax *Function* **GetMaxPrimaryCurrent**(*[in]float fBurden, [in]fCosPhi)* **:** *float*

Description Delivers that maximum value for the primary current, the software can deliver valid results for GetCompositeError, GetPhaseDeviation and GetRatioDeviation. The device can only calculate this parameters in that range of the CT where a excitation curve could be measured.

LocalLoadReport has to be called before using this function.

Parameters `fBurden` (operating burden

`fCosPhi` (cosine of phase angle)

All values are passed as of type float.

Return value The calculated maximum primary current for the current report and the parameters passed. LocalLoadReport has to be called before.

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim isec, burden, cosphi As Single
isec = 1.0
burden = 33.3
cosphi = 0.5
Debug.Print cta.Results.GetMaxPrimaryCurrent(isec,
burden, cosphi)
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
float fCompErr = cta->Results-> GetMaxPrimaryCurrent
(1.0, 33.3, 0.5);
```

6.9.2.9 GetISec

Scope `ICTAResults`

Syntax *`Function`* **`GetISec`**`(`*`[in]float fIPrim, [in]float fBurden, [in]fCosPhi`*`)` **`:`** *`float`*

Description This function returns the secondary current for the specified primary current, burden and CosPhi. The secondary current can only be calculated up to a maximum primary current (see GetMaxPrimaryCurrent on page 82).

LocalLoadReport has to be called before using this function.

Parameters `fIPrim` (primary current)

`fBurden` (operating burden)

`fCosPhi` (cosine of phase angle)

All values are passed as of type float.

Return value The calculated secondary current for the current report and the parameters passed. LocalLoadReport has to be called before.

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport “C:\my report.xml”
Dim isec, burden, cosphi As Single
isec = 1.0
burden = 33.3
cosphi = 0.5
Debug.Print cta.Results.GetISec(isec, burden, cosphi)
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
float fCompErr = cta->Results->GetISec(1.0, 33.3,
0.5);
```

6.9.2.10 GetErrorDescription

Scope	`ICTAResults`
Syntax	*Function* **GetErrorDescription**(*[in]long nErrorNumber*) **:** *String*
Description	Get a verbose description of the error number. The number might have been read by `GetValue(RV_GENERAL_ERROR_NR)`
Parameters	`nErrorNumber` (*CT Analyzer* error number)
Return value	descriptive string
Example in VB	**`Debug.Print cta.Results.GetErrorDescription(cta.Results.GetValue(RV_GENERAL_ERROR_NR))`**
Example in C++	**`variant_t varErrNumber = cta->Results->GetValue(RV_GENERAL_ERROR_NR);`** **`_bstr_t bstrErrDescr = cta->Results->GetErrorDescription(varErrNumber);`**

6.9.2.11 SetValue

Scope `ICTAResults`

Syntax *`Function`* **`SetValue`**`(`*`[in]TCTAResultValue paramid, [in]Variant value`*`)` *`: Variant`*

Description Used to set the value of a particular test result.

The same value would be returned when using the function `GetValue()` subsequently.

Parameters `paramid`
(result parameter, the value of which you want to set (element of TCTAResultValue, see page 151))

The following parameters are possible:

```
RV_OBJECT_LOC_COMPANY
RV_OBJECT_LOC_COUNTRY
RV_OBJECT_LOC_STATION
RV_OBJECT_LOC_FEEDER
RV_OBJECT_LOC_PHASE
RV_OBJECT_LOC_IECID
RV_OBJECT_OBJ_CT_TAP
RV_OBJECT_OBJ_OPTION1
RV_OBJECT_OBJ_MANUF
RV_OBJECT_OBJ_CT_TYPE
RV_OBJECT_OBJ_CT_SER_NR
RV_OBJECT_OBJ_CT_CORE_NR
RV_COMMENT_TEXT
```

`value`
(new value of the result setting; since a Variant type is requested, values of any type can be passed)

Example in VB

```
Dim result As ICTAResults
set result = cta.Results
result.SetValue(RV_OBJECT_LOC_COMPANY, v)
```

Example in C++

```
_variant_t vin = "Company";
_variant_t vout;
vout = cta->Results->SetValue(RV_OBJECT_LOC_COMPANY,
vin);
```

6.9.2.12 LocalSaveReport

Scope	`ICTAResults`
Syntax	*Function* **LocalSaveReport**(*[in]string LocalPath*)
Description	Saves a report to a local drive on the PC.
Parameters	*LocalPath* (full path on the PC and file name)
Example in VB	`cta.Results.LocalSaveReport "D:\CTA_Test\report2.xml"`
Example in C++	`cta->Results->LocalLoadReport (_bstr_t(L"D:\CTA_Test\report2.xml"));`

6.9.2.13 IsReportSecure

Scope	`ICTAResults`
Syntax	*Property* **IsReportSecure : ** *TCTAChecksResult*
Description	Checks if the checksum of the actual loaded report is valid (see also TCTAChecksResult on page 136).

6.10 `ICTALiveResults` (Reading Test Results Directly From the CT Analyzer)

The `ICTALiveResults` interface is accessed through the ICTA::LiveResults property.

Using the functions of the `ICTALiveResults` interface, you can read result values directly on the *CT Analyzer*, as soon as the *CT Analyzer* software has calculated them. In contrast to the functions of the ICTAResults interface, it is not necessary to save a test report on the *CT Analyzer* and to transfer the test report file to the PC before reading the values. The values are read directly from the *CT Analyzer* software.

The functions of this interface are useful to query individual values during the test, e.g. for calibration purposes. For such an application, you could stop the test, if the value is not within the tolerance, adjust the calibration and then repeat the test. As soon as the value is within the tolerance range, you can automatically have a test report created for documentation.

Using the functions of the `ICTALiveResults` interface is not recommended to read all test results. In this case, the functions of the ICTAResults interface are more suitable.

6.10.1 Overview of functions

Function	Brief description
GetLiveValue	Read a particular result value directly on the *CT Analyzer*.
GetLiveIndexedValue	Read a single value of a particular result curve (e.g. the excitation curve) directly on the *CT Analyzer*. A result curve is an array of result values.
GetLiveIndexedValues	Read all values of a particular result curve at once directly on the *CT Analyzer*. A result curve is an array of result values.
GetLiveErrorDescription	Get a verbose description for an error number retrieved by `GetValue(RV_GENERAL_ERROR_NR)`

6.10.2 Description of functions

6.10.2.1 GetLiveValue

Scope	`ICTALiveResults`
Syntax	*Function* **GetLiveValue**(*[in]TCTAResultValue id*) **:** *Variant*
Description	Reads a particular result value directly on the *CT Analyzer*. See TCTAResultValue on page 151 for the available result values.
Parameters	*id* (ID of the value you want to query, see TCTAResultValue (page 151))
Return	The result value (type: Variant). A Variant is able to hold values of any data type. So, the returned value can be a float, an enumeration type, an integer or a string. For the actual data types of the requested ID, please refer to TCTAResultValue (page 151).
Example in VB	`Debug.Print cta.LiveResults.GetLiveValue (RV_BURDEN_AUTO_ASSESS)`
Example in C++	`bool bAssessBurden = (bool)(cta->LiveResults-> GetLiveValue(RV_BURDEN_AUTO_ASSESS));`

6.10.2.2 GetLiveIndexedValue

Scope	`ICTALiveResults`
Syntax	*Function* **GetLiveIndexedValue**(*[in]TCTAResultIndexedValue id, [in]integer idx*) **:** *Variant*
Description	Reads a single value of a particular result value list (e.g. the excitation curve) directly on the *CT Analyzer*. If a particular test result is not a single value but consists of a list of values instead (e.g. an excitation curve, a table, etc.), all values in this list have an index number assigned. Please refer to TCTAResultIndexedValue (page 188) for the available value lists. **Note:** If you access an index number which is not available, an error is thrown. When iterating through the list, this can be used to terminate the iteration.

Parameters

id
(ID of the value list you want to query, see TCTAResultIndexedValue (page 188))

idx
(index number of the result you want to query)

Return

The result value (type: Variant).

A Variant is able to hold values of any data type. So, the returned value can be a float, an enumeration type, an integer or a string.

For the actual data types of the requested ID, please refer to TCTAResultIndexedValue (page 188).

Example 1 (VB)

```
cta.LiveResults.GetLiveIndexedValue
(RV_RATIO_CURVE_EMF_V, 9)
```

Query the 9th value of the results list for `RV_RATIO_CURVE_EMF_V`.

Example 2 (VB) (query number of existing values)

```
Dim i As Integer
i = 0
On Error GoTo finish
   While True
      Debug.Print
cta.LiveResults.GetLiveIndexedValue(RV_RATIO_CURVE_EMF
_V, i)
      i = i + 1
   Wend
finish: Debug.Print "Number of values:"; i
```

Explanation of the example:

The code shown in this example prints all values of the `RV_RATIO_CURVE_EMF_V` value list (curve).

All values are successively read until the end of the list is exceeded. Since an invalid index is requested then, an error is thrown. Due to the preceding declaration `On Error Goto finish`, the program execution then jumps to the label named "finish".

6.10.2.3 GetLiveIndexedValues

Scope	`ICTALiveResults`
Syntax	*Function* **GetLiveIndexedValues**(*[in]TCTAResultIndexedValue id*) **:** *Variant*
Description	Reads all values of a particular result values list on the *CT Analyzer* at once. Most of the value lists are measurement curves with the values representing the individual points. Please refer to TCTAResultIndexedValue on page 188 for a summary of all available lists. Using this function you can read the complete list of values (e.g. all values of the excitation curve) at once.
Parameters	*id* (ID of the value list you want to query, see TCTAResultIndexedValue (page 188))
Return	List of result values. The list is delivered as a value array packed into a Variant type. How to access the individual values is shown in the example below.

Example in VB

```
Dim v As Variant
v = cta.LiveResults.GetLiveIndexedValues(RV_RATIO_
CURVE_EMF_V)

  Debug.Print "Number of values = "; UBound(v) - LBound(v)
  If UBound(v) <> -1 Then
     For i = 0 To UBound(v)
        Debug.Print "V ["; i; "]"; v(i)
     Next i
  End If
```

<u>Explanation of the example:</u>

The code shown in this example first determines the number of values available in the results list of the parameter `RV_RATIO_CURVE_EMF_V` by subtracting the lowest index number (`LBound` – "lower bound") from the highest one (`UBound` – "upper bound"). Then, the values are printed one after the other. The elements are accessed by `v(i)`. The check `UBound(v) <> -1` is successful, if values are available in the list.

6.10.2.4 GetLiveErrorDescription

Scope	`ICTAResults`
Syntax	*Function* **GetLiveErrorDescription**(*[in]long nErrorNumber*) **:** *String*
Description	Get a verbose description of the error number. The number might have been read using `GetValue(RV_GENERAL_ERROR_NR)`
Parameters	`nErrorNumber` (*CT Analyzer* error number)
Return value	descriptive string
Example in VB	**`Debug.Print cta.Results.GetLiveErrorDescription(cta.Results.GetValue(RV_GENERAL_ERROR_NR))`**
Example in C++	**`variant_t varErrNumber = cta->Results->GetValue(RV_GENERAL_ERROR_NR);`** **`_bstr_t bstrErrDescr = cta->Results->GetLiveErrorDescription(varErrNumber);`**

6.11 ICTACalc (Enhanced Calculation of Results)

The ICTACalc interface is accessed through the ICTA::Calculate property.

Using the functions of the ICTACalc interface, you can calculate some parameters in the same way as they are calculated in the *CT Analyzer.*

The functions of this interface are useful to obtain further information about a successful measurement included in the protocol, or to perform a recalculation of specific results with different input parameters (burden, primary current, etc.).

Before using these functions, a valid measurement must be available.

6.11.1 Overview of functions

Function	Brief description
EvalCompositeError	Composite error according to IEC 60044-1. Refer to section "Calculation of Instrument Security Factor (FS)" in the CT Analyzer User Manual. Identical with ICTAResults::GetCompositeError but accessible through this interface.
EvalPhaseDeviation	Phase deviation according to direct measurement method. Identical with ICTAResults::GetPhaseDeviation but accessible through this interface.
EvalRatioDeviation	Current ratio deviation according to direct measurement method. Identical with ICTAResults::GetRatioDeviation but accessible through this interface.
EvalSecondaryCurrent	Secondary current for a specified primary current at a specified burden. Identical with ICTAResults::GetIsec but accessible through this interface.
EvalMaxPrimaryCurrent	Maximum primary current that can be entered to calculate the ratio error. Identical with ICTAResults::GetMaxPrimaryCurrent but accessible through this interface.

EvalExcitationCurrentRms	Excitation current rms value for a specified primary current at a specified burden.
EvalExcitationCurrentPeak	Excitation current peak value for a specified primary current at a specified burden (according to IEC 60044-6).
EvalCoreVoltage	Core voltage for a specified primary current at a specified burden.
EvalExcitationCurrent RmsAtVcore	Excitation current rms value at a specified core voltage.
EvalExcitationCurrent RmsAtVTerm	Excitation current rms value at a specified terminal voltage.
EvalExcitationCurrent PeakAtVcore	Excitation current peak value at a specified core voltage.
EvalVTermAtExcitation CurrentRms	Terminal voltage at a specified excitation current rms value.
EvalVCoreAtExcitation CurrentRms	Core voltage at a specified excitation current rms value.
EvalVCoreAtExcitation CurrentPeak	Core voltage at a specified excitation current peak value.
AL_MaxPrimaryCurrent	AL-Error graph. Max. primary current for a specified error (and at burden impedance = 0 ohms).
AL_MaxImpedance	AL-Error graph. Max. impedance for a specified error (and at nominal primary current).
AL_Impedance AtPrimaryCurrent	AL-Error graph. Impedance for a specified error and a specified primary current at a specified CosPhi.
AL_PrimaryCurrent AtImpedance	AL-Error graph. Primary current for a specified error and a specified impedance and CosPhi.
AL_PrimaryCurrent AtNomBurden	AL-Error graph. Primary current at nominal burden. (Error value and burden are taken from the actually loaded measurement).
AL_PrimaryCurrent AtOprBurden	AL-Error graph. Primary current at operating burden. (Error value and burden are taken from the actually loaded measurement)

6.11.2 Description of functions

6.11.2.1 EvalCompositeError

Scope	`ICTACalc`
Syntax	*Function* **EvalCompositeError**(*[in]float fIprim, [in]float fBurden, [in]float fCosPhi, [out]enum TCTAQualifier* peStatus*) : float
Description	This function returns the composite error according to the IEC 60044-1 direct measurement method for the specified primary current, burden and CosPhi. The composite error can only be calculated up to a maximum primary current (see GetMaxPrimaryCurrent on page 82). If the primary current exceeds this value, the composite error is limited, and the value of *peStatus returns QV_BOUNDED (= 1). LocalLoadReport has to be called before using this function.
Parameters	`float fIPrim` (primary current) `float fBurden` (operating burden) `float fCosPhi` (cosine of phase angle) `enum TCTAQualifier* peStatus` (address to a status value)

Return value	The composite error calculated for the currently loaded report and for the parameter values passed with this function call.
	The status value *peStatus contains the qualifier:
	`QV_INVALID = -1,`
	`QV_VALID = 0,`
	`QV_BOUNDED = +1`

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.EvalCompositeError(2000.0, 2.5, 1.0, status)
if status = QV_VALID then
        Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fCompErr = cta->Calculate-
>EvalCompositeError(2000.0, 2.5, 1.0, &status);
```

6.11.2.2 EvalPhaseDeviation

Scope `ICTACalc`

Syntax *Function* **EvalPhaseDeviation**(*[in]float fIprim, [in]float fBurden, [in]float fCosPhi, [out]enum TCTAQualifier* peStatus*) : float

Description This function returns the phase deviation in degrees of the secondary current for the specified primary current, burden and CosPhi. The phase deviation can only be calculated up to a maximum primary current (see GetMaxPrimaryCurrent on page 82). If the primary current exceeds this value, the phase deviation is limited, and the value of *peStatus returns QV_BOUNDED (= 1).

LocalLoadReport has to be called before using this function.

Parameters `float fIPrim` (primary current)

`float fBurden` (operating burden)

`float fCosPhi` (cosine of phase angle)

`enum TCTAQualifier* peStatus` (address to a status value)

Return value The phase deviation calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.EvalPhaseDeviation(2000.0, 2.5,
1.0, status)
if status = QV_VALID then
        Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fPhaseDeviation = cta->Calculate-
>EvalPhaseDeviation(2000.0, 2.5, 1.0, &status);
```

6.11.2.3 EvalRatioDeviation

Scope: `ICTACalc`

Syntax: *Function* **EvalRatioDeviation**(*[in]float fIPrim, [in]float fBurden, [in]float fCosPhi, [out]enum TCTAQualifier* peStatus*) **:** *float*

Description: This function returns the current ratio deviation for the specified primary current, burden and CosPhi. The current ratio deviation can only be calculated up to a maximum primary current (see GetMaxPrimaryCurrent on page 82). If the primary current exceeds this value, the ratio deviation is limited, and the value of *peStatus returns QV_BOUNDED (= 1).

LocalLoadReport has to be called before using this function.

Parameters:

`float fIPrim` (primary current)

`float fBurden` (operating burden)

`float fCosPhi` (cosine of phase angle)

`enum TCTAQualifier* peStatus` (address to a status value)

Return value

The ratio deviation calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.EvalRatioDeviation(2000.0, 2.5, 1.0, status)
if status = QV_VALID then
        Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my report.xml"));
enum TCTAQualifier status;
float fRatioDeviation = cta->Calculate->EvalRatioDeviation(2000.0, 2.5, 1.0, &status);
```

6.11.2.4 EvalSecondaryCurrent

Scope

`ICTACalc`

Syntax

Function **EvalSecondaryCurrent**(*[in]float fIPrim, [in]float fBurden, [in]float fCosPhi, [out]enum TCTAQualifier* peStatus*) **:** *float*

Description

This function returns the secondary current for the specified primary current, burden and CosPhi. The secondary current can only be calculated up to a maximum primary current (see GetMaxPrimaryCurrent on page 82). If the primary current exceeds this value, the secondary current is limited, and the value of *peStatus returns QV_BOUNDED (= 1).

LocalLoadReport has to be called before using this function.

Parameters

`float fIPrim` (primary current)

`float fBurden` (operating burden)

`float fCosPhi` (cosine of phase angle)

`enum TCTAQualifier* peStatus`
(address to a status value)

Return value

The secondary current calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport “C:\my report.xml”
Dim status As TCTAQualifier
result = cta.Calculate.EvalSecondaryCurrent(2000.0,
2.5, 1.0, status)
if status = QV_VALID then
       Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fSecondaryCurrent = cta->Calculate-
>EvalSecondaryCurrent(2000.0, 2.5, 1.0, &status);
```

6.11.2.5 EvalMaxPrimaryCurrent

Scope	`ICTACalc`
Syntax	*Function* **EvalMaxPrimaryCurrent**(*[in]float fBurden, [in]float fCosPhi, [out]enum TCTAQualifier* peStatus*) **:** *float*
Description	Delivers that maximum value of the primary current, the software can deliver valid results for GetCompositeError, GetPhaseDeviation and GetRatioDeviation. The device can only calculate this parameter for that operating range of the CT that allows a measurement of the excitation curve. LocalLoadReport has to be called before using this function.
Parameters	`float fBurden` (operating burden) `float fCosPhi` (cosine of phase angle) `enum TCTAQualifier* peStatus` (address to a status value)
Return value	The maximum primary current calculated for the currently loaded report and for the parameter values passed with this function call. The status value *peStatus always contains `QV_VALID =  0`

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport “C:\my report.xml”
Dim status As TCTAQualifier
Debug.Print cta.Calculate.EvalMaxPrimaryCurrent(2.5,
1.0, status)
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate-
>EvalMaxPrimaryCurrent (2.5, 1.0, &status);
```

6.11.2.6 EvalExcitationCurrentRms

Scope `ICTACalc`

Syntax *Function* **EvalExcitationCurrentRms**(*[in]float fIPrim, [in]float fBurden, [in]float fCosPhi, [out]enum TCTAQualifier* peStatus*) ***:*** *float*

Description This function returns the excitation current rms value for a specified primary current at a specified burden and cosPhi.

The excitation current can only be calculated up to a maximum primary current (see GetMaxPrimaryCurrent on page 82). If the primary current exceeds this value, the excitation current is limited, and the value of *peStatus returns QV_BOUNDED (= 1).

LocalLoadReport has to be called before using this function.

Parameters `float fIPrim` (primary current)

`float fBurden` (operating burden)

`float fCosPhi` (cosine of phase angle)

`enum TCTAQualifier* peStatus` (address to a status value)

Return value The excitation current calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.EvalExcitationCurrentRms
(2000.0, 2.5, 1.0, status)
if status = QV_VALID then
        Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate-
>EvalExcitationCurrentRms (2.5, 1.0, &status);
```

6.11.2.7 EvalExcitationCurrentPeak

Scope `ICTACalc`

Syntax

```
Function
EvalExcitationCurrentPeak([in]float fIPrim,
[in]float fBurden, [in]float fCosPhi,
[out]enum TCTAQualifier* peStatus) : float
```

Description

This function returns the excitation current peak value for a specified primary current at a specified burden and cosPhi.

The excitation current can only be calculated up to a maximum primary current (see GetMaxPrimaryCurrent on page 82). If the primary current exceeds this value, the excitation current is limited, and the value of *peStatus returns QV_BOUNDED (= 1).

LocalLoadReport has to be called before using this function.

Parameters

`float fIPrim` (primary current)

`float fBurden` (operating burden)

`float fCosPhi` (cosine of phase angle)

`enum TCTAQualifier* peStatus`
(address to a status value)

Return value

The excitation current calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.EvalExcitationCurrentPeak
(2000.0, 2.5, 1.0, status)
if status = QV_VALID then
       Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate-
>EvalExcitationCurrentPeak (2.5, 1.0, &status);
```

6.11.2.8 EvalCoreVoltage

Scope `ICTACalc`

Syntax *Function* **EvalCoreVoltage**(*[in]float fIPrim, [in]float fBurden, [in]float fCosPhi, [out]enum TCTAQualifier* peStatus*) **:** *float*

Description This function returns the core voltage for a specified primary current at a specified burden and cosPhi.

The core voltage can only be calculated up to a maximum primary current (see GetMaxPrimaryCurrent on page 82). If the primary current exceeds this value, the core voltage is limited, and the value of *peStatus returns QV_BOUNDED (= 1).

LocalLoadReport has to be called before using this function.

Parameters `float fIPrim` (primary current)

`float fBurden` (operating burden)

`float fCosPhi` (cosine of phase angle)

`enum TCTAQualifier* peStatus` (address to a status value)

Return value The core voltage calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.EvalCoreVoltage(2000.0, 2.5,
1.0, status)
if status = QV_VALID then
        Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate->EvalCoreVoltage
(2.5, 1.0, &status);
```

6.11.2.9 EvalExcitationCurrentRmsAtVcore

Scope
`ICTACalc`

Syntax
Function **EvalExcitationCurrentRmsAtVcore**(*[in]float fVcore, [out]enum TCTAQualifier* peStatus*) **:** *float*

Description
This function returns the excitation current rms value for the specified core voltage. If the specified core voltage exceeds the maximum core voltage listed in the excitation table, the excitation current is limited, and the value of *peStatus returns QV_BOUNDED (= 1).

LocalLoadReport has to be called before using this function.

Parameters
`float fVcore` (core voltage)

`enum TCTAQualifier* peStatus` (address to a status value)

Return value
The excitation current calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.EvalExcitationCurrentRmsAtVcore
(50.0, status)
if status = QV_VALID then
       Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate-
>EvalExcitationCurrentRmsAtVcore (50.0, &status);
```

6.11.2.10 EvalExcitationCurrentRmsAtVTerm

Scope `ICTACalc`

Syntax *Function* **EvalExcitationCurrentRmsAtVTerm**(*[in]float fVTerm, [out]enum TCTAQualifier* peStatus*) **:** *float*

Description This function returns the excitation current rms value for the specified terminal voltage. If the specified terminal voltage exceeds the maximum terminal voltage listed in the excitation table, the excitation current is limited, and the value of *peStatus returns QV_BOUNDED (= 1).

LocalLoadReport has to be called before using this function.

Parameters `float fVTerm` (terminal voltage)

`enum TCTAQualifier* peStatus` (address to a status value)

Return value The excitation current calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport “C:\my report.xml”
Dim status As TCTAQualifier
result = cta.Calculate.EvalExcitationCurrentRmsAtVTerm
(50.0, status)
if status = QV_VALID then
       Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate-
>EvalExcitationCurrentRmsAtVTerm (50.0, &status);
```

6.11.2.11 EvalExcitationCurrentPeakAtVcore

Scope `ICTACalc`

Syntax *Function* **EvalExcitationCurrentPeakAtVcore**(*[in]float fVcore, [out]enum TCTAQualifier* peStatus*) **:** *float*

Description This function returns the excitation current peak value for the specified core voltage. If the specified core voltage exceeds the maximum core voltage listed in the excitation table, the excitation current is limited, and the value of *peStatus returns QV_BOUNDED (= 1).

LocalLoadReport has to be called before using this function.

Parameters `float fVcore` (core voltage)

`enum TCTAQualifier* peStatus` (address to a status value)

Return value The excitation current calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result =
cta.Calculate.EvalExcitationCurrentPeakAtVcore(50.0,
status)
if status = QV_VALID then
        Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate-
>EvalExcitationCurrentPeakAtVcore (50.0, &status);
```

6.11.2.12 EvalVTermAtExcitationCurrentRms

Scope
`ICTACalc`

Syntax
Function **EvalVTermAtExcitationCurrentRms** *([in]float fCurrent, [out]enum TCTAQualifier* peStatus)* **:** *float*

Description
This function returns the terminal voltage for the specified excitation current rms value. If the specified excitation current exceeds the maximum excitation current listed in the excitation table, the terminal voltage is limited, and the value of *peStatus returns QV_BOUNDED (= 1).

LocalLoadReport has to be called before using this function.

Parameters
`float fCurrent` (rms excitation current)

`enum TCTAQualifier* peStatus` (address to a status value)

Return value
The terminal voltage calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.EvalVTermAtExcitationCurrentRms (50.0, status)
if status = QV_VALID then
        Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate->EvalVTermAtExcitationCurrentRms (50.0, &status);
```

6.11.2.13 EvalVCoreAtExcitationCurrentRms

Scope
`ICTACalc`

Syntax
Function **EvalVCoreAtExcitationCurrentRms** *([in]float fCurrent, [out]enum TCTAQualifier* peStatus)* **:** *float*

Description
This function returns the core voltage for the specified excitation current rms value. If the specified excitation current exceeds the maximum excitation current listed in the excitation table, the core voltage is limited, and the value of *peStatus returns QV_BOUNDED (= 1).

LocalLoadReport has to be called before using this function.

Parameters
`float fCurrent` (rms excitation current)

`enum TCTAQualifier* peStatus`
(address to a status value)

Return value
The core voltage calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.EvalVCoreAtExcitationCurrentRms
(50.0, status)
if status = QV_VALID then
        Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate-
>EvalVCoreAtExcitationCurrentRms (50.0, &status);
```

6.11.2.14 EvalVCoreAtExcitationCurrentPeak

Scope

`ICTACalc`

Syntax

Function **EvalVCoreAtExcitationCurrentPeak** *([in]float fCurrent, [out]enum TCTAQualifier* peStatus)* **:** *float*

Description

This function returns the core voltage for the specified excitation current peak value. If the specified excitation current exceeds the maximum excitation current listed in the excitation table, the core voltage is limited, and the value of *peStatus returns QV_BOUNDED (= 1).

LocalLoadReport has to be called before using this function.

Parameters

`float fCurrent` (peak excitation current)

`enum TCTAQualifier* peStatus`
(address to a status value)

Return value

The core voltage calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result =
cta.Calculate.EvalVCoreAtExcitationCurrentPeak(50.0,
status)
if status = QV_VALID then
        Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate-
>EvalVCoreAtExcitationCurrentPeak (50.0, &status);
```

6.11.2.15 AL_MaxPrimaryCurrent

Scope: `ICTACalc`

Syntax: *Function* **AL_MaxPrimaryCurrent**(*[in]float fError, [out]enum TCTAQualifier* peStatus*) **:** *float*

Description: This function returns the max. primary current for a specified ratio error and at burden impedance = 0 ohms.

Used to build the AL-Error graph.

LocalLoadReport has to be called before using this function.

Parameters: `float fError` (ratio error)

`enum TCTAQualifier* peStatus` (address to a status value)

Return value: The max. primary current calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.AL_MaxPrimaryCurrent(10.0, status)
if status = QV_VALID then
       Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate->AL_MaxPrimaryCurrent (10.0, &status);
```

6.11.2.16 AL_MaxImpedance

Scope `ICTACalc`

Syntax *Function* **AL_MaxImpedance**(*[in]float fError, [in]float fCosPhi, [out]enum TCTAQualifier* peStatus*) **:** *float*

Description This function returns the max. burden impedance for a specified ratio error and cosPhi at nominal primary current.

Used to build the AL-Error graph.

LocalLoadReport has to be called before using this function.

Parameters `float fError` (ratio error)

`float fCosPhi` (cosine of phase angle)

`enum TCTAQualifier* peStatus` (address to a status value)

Return value The max. burden impedance calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.AL_MaxImpedance(10.0, 1.0,
status)
if status = QV_VALID then
       Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate->AL_MaxImpedance
(10.0, 1.0, &status);
```

6.11.2.17 AL_ImpedanceAtPrimaryCurrent

Scope `ICTACalc`

Syntax *Function* **AL_ImpedanceAtPrimaryCurrent** *([in]float fError, [in]float fIprim, [in]float fCosPhi, [out]enum TCTAQualifier* peStatus)* **:** *float*

Description This function returns the burden impedance for a specified error, primary current and cosPhi.

Used to build the AL-Error graph.

LocalLoadReport has to be called before using this function.

Parameters `float fError` (ratio error)

`float fIprim` (primary current)

`float fCosPhi` (cosine of phase angle)

`enum TCTAQualifier* peStatus` (address to a status value)

Return value The burden impedance calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport “C:\my report.xml”
Dim status As TCTAQualifier
result = cta.Calculate.AL_ImpedanceAtPrimaryCurrent
(10.0, 2000.0, 1.0, status)
if status = QV_VALID then
        Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate-
>AL_ImpedanceAtPrimaryCurrent (10.0, 2000.0, 1.0,
&status);
```

6.11.2.18 AL_PrimaryCurrentAtImpedance

Scope `ICTACalc`

Syntax *Function* **AL_PrimaryCurrentAtImpedance** *([in]float fError, [in]float fImpedance, [in]float fCosPhi, [out]enum TCTAQualifier* peStatus)* **:** *float*

Description This function returns the primary current for a specified error and a specified burden impedance and a specified cosPhi.

Used to build the AL-Error graph.

LocalLoadReport has to be called before using this function.

Parameters `float fError` (ratio error)

`float fImpedance` (burden impedance)

`float fCosPhi` (cosine of phase angle)

`enum TCTAQualifier* peStatus` (address to a status value)

Return value The primary current calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.AL_PrimaryCurrentAtImpedance
(10.0, 2.5, 1.0, status) (ratio error of 10 %?!)
if status = QV_VALID then
        Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate-
>AL_PrimaryCurrentAtImpedance (10.0, 2.5, 1.0,
&status);
```

6.11.2.19 AL_PrimaryCurrentAtNomBurden

Scope
`ICTACalc`

Syntax
Function **AL_PrimaryCurrentAtNomBurden** *([out]enum TCTAQualifier* peStatus)* **:** *float*

Description
This function returns the primary current at nominal burden. (Error value, burden and cosPhi are taken from the actually loaded measurement.)

Used to build the AL-Error graph.

LocalLoadReport has to be called before using this function.

Parameters
`enum TCTAQualifier* peStatus`
(address to a status value)

Return value
The primary current calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.AL_PrimaryCurrentAtNomBurden
(status)
if status = QV_VALID then
        Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate-
>AL_PrimaryCurrentAtNomBurden (&status);
```

6.11.2.20 AL_PrimaryCurrentAtOprBurden

Scope `ICTACalc`

Syntax *Function* **AL_PrimaryCurrentAtOprBurden** *([out] enum TCTAQualifier* peStatus)* **:** *float*

Description This function returns the primary current at operating burden. (Error value, burden and cosPhi are taken from the actually loaded measurement.)

Used to build the AL-Error Graph.

LocalLoadReport has to be called before using this function.

Parameters `enum TCTAQualifier* peStatus`
(address to a status value)

Return value The primary current calculated for the currently loaded report and for the parameter values passed with this function call.

The status value *peStatus contains the qualifier:

```
QV_INVALID = -1,
QV_VALID   =  0,
QV_BOUNDED = +1
```

Example in VB

```
Dim cta as new CTA
cta.Results.LocalLoadReport "C:\my report.xml"
Dim status As TCTAQualifier
result = cta.Calculate.AL_PrimaryCurrentAtOprBurden
(status)
if status = QV_VALID then
       Debug.Print result
end if
```

Example in C++

```
ICTAPtr pCTA(CLSID_CTA);
cta->Results->LocalLoadReport(_bstr_t(L"C:\my
report.xml"));
enum TCTAQualifier status;
float fMaxCurrent = cta->Calculate-
>AL_PrimaryCurrentAtOprBurden (&status);
```

6.12 `ICTAQuick` (Quick measurement device)

The `ICTAQuick` interface is accessed through the ICTA::Quick property.

Using the functions of the `ICTAQuick` interface, you can use the *CT Analyzer* as a signal generator and a general multimeter.

The power amplifier of the *CT Analyzer* can be adjusted to output a sinus or DC signal in voltage or current mode.

The measurement input SEC can be adjusted to measure general input signals.

For ratio measurement on CTs and VTs the ratio between input SEC and input PRIM is calculated.

To simplify the configuration for some typical measurements on a CT or VT, some predefined setting parameters are available.

In addition to the direct measurement of values from the terminals I-OUT, V-SEC and V-PRIM some derived values are calculated and may be read out:

N	… Ratio (V-SEC rms / V-PRIM rms)
Z	… Impedance (V-SEC rms / I-OUT rms)
Phase	… between V-SEC and I-OUT
Rs	… Real part of the Impedance in the serial equivalent circuit
Rp	… Real part of the Impedance in the parallel equivalent circuit
Xs	… Imaginary part of the Impedance in the serial equivalent circuit
Xp	… Imaginary part of the Impedance in the parallel equivalent circuit
Ls	… Inductivity in the serial equivalent circuit
Lp	… Inductivity in the parallel equivalent circuit
Cs	… Capacity in the serial equivalent circuit
Cp	… Capacity in the parallel equivalent circuit

Before using these functions, a valid connection to a CT Analyzer must be available.

6.12.1 Overview of functions

Function	Brief description
SetSetting	Set the value of a particular Quick test parameter.
GetSetting	Read the value of a particular Quick test parameter.
GetResult	Read the value of a particular Quick test measurement result.
GetV1Results	Read all voltage values of the SEC measurement input at once.
GetV2Results	Read all voltage values of the PRIM measurement input at once.
GetI1Results	Read all current values flowing out of the OUTPUT terminal at once.
GetCalculatedResults	Read all calculated values at once. Calculated values means some important terms for CTs and VTs, derived from real measurement data (R, L, X, Z, …).
StartMeasurement	Starts a Quick measurement.
StopMeasurement	Stops a running Quick measurement.
Status	Obtain the Quick measurement status.

6.12.2 Description of functions

6.12.2.1 SetSetting

Scope `ICTAQuick`

Syntax `Function` **`SetSetting`** *`([in]TCTAQuickSetting eData, [in]VARIANT vData) : VARIANT`*

Description Used to set the value of a particular quick test setting.

The specified value may be corrected automatically, if it exceeds the allowed value range. The same value would be returned when using the function `GetSetting()` subsequently.

Parameters `eData`

(test parameter, the value of which you want to set (element of TCTAQuickSetting, see page 202)).

Return value	The return value should be the same as the in-parameter *vData* but may be corrected automatically, if it exceeds the allowed value range.
Example in VB	See Example on page 123.

6.12.2.2 GetSetting

Scope	`ICTAQuick`
Syntax	`Function` **`GetSetting`** *`([in]TCTAQuickSetting eData) : VARIANT`*
Description	Reads the value of a particular quick test setting.
Parameters	`eData` (ID of the setting value to be read (element of TCTAQuickSetting, see page 202))
Return value	Setting value of the test parameter.
Example in VB	See Example on page 123.

6.12.2.3 GetResult

Scope	`ICTAQuick`
Syntax	`Function` **`GetResult`** *`([in]TCTAQuickResult eData) : VARIANT`*
Description	Reads a particular result value.
Parameters	`eData` (ID of the result value to be read (element of TCTAQuickResult, see page 205))
Return value	The result value (type: Variant). A Variant is able to hold values of any data type. So the returned value can be a float, an enumeration type or an integer value. For the actual data types of the requested ID, please refer to TCTAQuickResult, see page 205.
Example in VB	See Example on page 123.

6.12.2.4 GetV1Results

Scope	`ICTAQuick`
Syntax	`Function` **`GetV1Results`** `() :` *`VARIANT`*
Description	Reads all values of the SEC measurement channel at once. Using this function you can read the complete list of available measurement values.
Parameters	
Return value	List of result values. This list is delivered as a value array packed into a Variant type: array[0] … V1 Range as integer array[1] … V1 RMS value (volts) as float array[2] … V1 AC value (volts) as float array[3] … V1 DC value (volts) as float array[4] … V1 frequency (Hz) as float array[5] … V1 phase (degrees) as float array[6] … V1 peak value + (volts) as float array[7] … V1 peak value – (volts) as float
Example in VB	See Example on page 123.

6.12.2.5 GetV2Results

Scope	`ICTAQuick`
Syntax	`Function` **`GetV2Results`** `() :` *`VARIANT`*
Description	Reads all values of the PRIM measurement channel at once. Using this function you can read the complete list of available measurement values.
Parameters	
Return value	List of result values. This list is delivered as a value array packed into a Variant type: array[0] … V2 Range as integer array[1] … V2 RMS value (volts) as float array[2] … V2 AC value (volts) as float array[3] … V2 DC value (volts) as float array[4] … V2 frequency (Hz) as float

	array[5] … V2 phase (degrees) as float
	array[6] … V2 peak value + (volts) as float
	array[7] … V2 peak value – (volts) as float
Example in VB	See Example on page 123.

6.12.2.6 GetI1Results

Scope	`ICTAQuick`
Syntax	`Function` **`GetI1Results`** () *: VARIANT*
Description	Reads all values of the OUTPUT measurement channel at once. Using this function you can read the complete list of available measurement values.
Parameters	
Return value	List of result values. This list is delivered as a value array packed into a Variant type: array[0] … I1 Range as integer array[1] … I1 RMS value (ampere) as float array[2] … I1 AC value (ampere) as float array[3] … I1 DC value (ampere) as float array[4] … I1 frequency (Hz) as float array[5] … I1 phase (degrees) as float array[6] … I1 peak value + (ampere) as float array[7] … I1 peak value – (ampere) as float
Example in VB	See Example on page 123.

6.12.2.7 GetCalculatedResults

Scope `ICTAQuick`

Syntax `Function` **`GetCalculatedResults`** `()` *`: VARIANT`*

Description Reads all values of the calculated results at once.

Calculated results are some specific values for CTs and VTs derived from the values of the measurement channels.

Using this function you can read the complete list of available calculated results.

Parameters

Return value List of result values. This list is delivered as a value array packed into a Variant type:

array[0] … N = Ratio (V1rms/V2rms) as float

array[1] … Z = Impedance (V1rms/I1rms) as float

array[2] … Phase between V1 and I1 as float

array[3] … Rs = Real part of the Impedance in the serial equivalent circuit as float

array[4] … Rp = Real part of the Impedance in the parallel equivalent circuit as float

array[5] … Xs = Imaginary part of the Impedance in the serial equivalent circuit as float

array[6] … Xp = Imaginary part of the Impedance in the parallel equivalent circuit as float

array[7] … Ls = Inductivity in the serial equivalent circuit as float

array[8] … Lp = Inductivity in the parallel equivalent circuit as float

array[9] … Cs = Capacity in the serial equivalent circuit as float

array[10] …Cp = Capacity in the parallel equivalent circuit as float

Example in VB See Example on page 123.

6.12.2.8 StartMeasurement

Scope `ICTAQuick`

Syntax `Function` **`StartMeasurement`** ()

Activates a quick test.

Control is immediately returned to the caller while the *CT Analyzer* performs the test prodedure concurrently.

After the test activation, the quick status is `QST_NO_RESULTS`.

This status is kept until one of the following occurs:

1. New measurement values are available on the *CT Analyzer*. The status is changed to `QST_NEW_RESULTS`.
2. A current overload occurs during the last measurement cycle. The status is changed to `QST_CURRENT_OVL`.
3. A power overload occurs during the last measurement cycle. The status is changed to `QST_POWER_OVL`.
4. The user aborts the measurement by pressing the I/O-key or ESC-key on the *CT Analyzer*. The status is changed to `QST_USER_ABORT`.
5. The connection between PC and *CT Analyzer* is lost. The status is changed to `QST_CONN_LOST`.

After reading the status, the status is changed back to `QST_NO_RESULTS`.

Parameters

Return value

Example in VB See Example on page 123.

6.12.2.9 StopMeasurement

Scope	`ICTAQuick`
Syntax	`Function` **`StopMeasurement`** ()
Description	Aborts a running quick test.
Parameters	
Return value	
Example in VB	See Example on page 123.

6.12.2.10 Status

Scope	`ICTAQuick`
Syntax	*`Property`* **`Status :`** *`TCTAQuickStatus`*
Description	This function is used to query the quick status. The possible states are: • `QST_NO_RESULTS` • `QST_NEW_RESULTS` • `QST_USER_ABORT` • `QST_CURRENT_OVL` • `QST_POWER_OVL` • `QST_CONN_LOST`
Return value	Current Quick measurement status (element of TCTAQuickStatus, see page 210).
Example in VB	See Example on page 123.

6.12.3 Example

```
Dim CTAnalyzer As New CTARemoteLib.CTA
Dim MwArray
Dim Status
Dim Value

' start a Quick measurement, read measured and calculated values, stop measurement
Sub Main()
    CTAnalyzer.USBConnect
    If CTAnalyzer.eStatus <> CTA_STAT_NOT_CONNECTED Then
        Value = CTAnalyzer.Quick.SetSetting(QSV_MEAS_TYPE, QMT_ADVANCED)
        CTAnalyzer.Quick.StartMeasurement

        ' read measurement values
        Status = CTAnalyzer.Quick.Status
        While Status <> QST_USER_ABORT
            If Status = QST_NEW_RESULTS Then
                Value = CTAnalyzer.Quick.GetResult(QRV_MEAS_TYPE)
                Debug.Print Value
                MwArray = CTAnalyzer.Quick.GetV1Results
                Debug.Print "V1 ="; MwArray(0); MwArray(1); MwArray(2); MwArray(3);
                              MwArray(4); MwArray(5); MwArray(6); MwArray(7)
                MwArray = CTAnalyzer.Quick.GetV2Results
                Debug.Print "V2 ="; MwArray(0); MwArray(1); MwArray(2); MwArray(3);
                              MwArray(4); MwArray(5); MwArray(6); MwArray(7)
                MwArray = CTAnalyzer.Quick.GetI1Results
                Debug.Print "I1 ="; MwArray(0); MwArray(1); MwArray(2); MwArray(3);
                              MwArray(4); MwArray(5); MwArray(6); MwArray(7)
                MwArray = CTAnalyzer.Quick.GetCalculatedResults
                Debug.Print "CR ="; MwArray(0); MwArray(1); MwArray(2); MwArray(3);
                              MwArray(4); MwArray(5); MwArray(6); MwArray(7);
                              MwArray(8); MwArray(9); MwArray(10)
            End If
            Status = CTAnalyzer.Quick.Status
        Wend
        CTAnalyzer.Quick.StopMeasurement
    End If
    CTAnalyzer.Disconnect
    Set CTAnalyzer = Nothing
End Sub
```

7 Enumeration Types, Test Settings and Test Results

7.1 Overview of Types

7.2 Enumeration Types

7.2.1 TCTAAssessment

The elements of the type `TCTAAssessment` specify the possible values for the assessment of a parameter (see Assessment card of the *CT Analyzer*). The elements are used by the `RV_ASSESSMENT_` parameters of the type TCTAResultValue, refer to page 151.

Element	Description
`ASS_FAILED`	Results do not comply with the requirements.
`ASS_NOT_ASSESSED`	No assessment possible.
`ASS_OK`	The results measured for this parameter comply with the requirements defined by the selected standard and the parameters of the CT-Object card.

7.2.2 TCTACard

The elements of the type `TCTACard` specify whether a test card is used in a test or not (see Select Cards page of the *CT Analyzer*). The elements are used by the `SV_CARD_` parameters of the type TCTASettingValue, refer to page 138.

Element	Description
`CARD_DISABLE`	The corresponding card is not included in the test.
`CARD_ENABLE`	The corresponding card is included in the test.

7.2.3 TCTAClass

The elements of the type `TCTAClass` specify the accuracy class of the CT (see CT-Object card and Assessment card of the *CT Analyzer*). The elements are used by the parameter SV_CLASS of the type TCTASettingValue (refer to page 138) and the parameter RV_OBJECT_CT_CLASS of the type TCTAResultValue, refer to page 151.

Element	Description
`CLS_0_15`	Class 0.15 according to IEEE C57.13.
`CLS_0_15S`	Class 0.15S according to IEEE C57.13.
`CLS_0_3`	Class 0.3 according to IEEE C57.13.
`CLS_0_6`	Class 0.6 according to IEEE C57.13.
`CLS_1_2`	Class 1.2 according to IEEE C57.13.
`CLS_C`	Class C according to IEEE C57.13.
`CLS_K`	Class K according to IEEE C57.13.
`CLS_T`	Class T according to IEEE C57.13.
`CLS_X`	Class X according to IEEE C57.13.
`CLS_0_1`	Class 0.1 according to standard IEC 60044-1.
`CLS_0_2`	Class 0.2 according to standard IEC 60044-1.
`CLS_0_2S`	Class 0.2S according to standard IEC 60044-1.
`CLS_0_5`	Class 0.5 according to standard IEC 60044-1.
`CLS_0_5S`	Class 0.5S according to standard IEC 60044-1.
`CLS_1`	Class 1.0 according to standard IEC 60044-1.
`CLS_3`	Class 3 according to standard IEC 60044-1.
`CLS_5`	Class 5 according to standard IEC 60044-1.
`CLS_2P`	Class 2P according to standard IEC 60044-1.
`CLS_3P`	Class 3P according to standard IEC 60044-1.
`CLS_4P`	Class 4P according to standard IEC 60044-1.
`CLS_5P`	Class 5P according to standard IEC 60044-1.
`CLS_6P`	Class 6P according to standard IEC 60044-1.
`CLS_10P`	Class 10P according to standard IEC 60044-1.
`CLS_2PR`	Class 2PR according to standard IEC 60044-1.
`CLS_3PR`	Class 3PR according to standard IEC 60044-1.
`CLS_4PR`	Class 4PR according to standard IEC 60044-1.
`CLS_5PR`	Class 5PR according to standard IEC 60044-1.

CLS_6PR	Class 6PR according to standard IEC 60044-1.
CLS_10PR	Class 10PR according to standard IEC 60044-1.
CLS_PX	Class PX according to standard IEC 60044-1.
CLS_TPS	Class TPS according to standard IEC 60044-6.
CLS_TPX	Class TPX according to standard IEC 60044-6.
CLS_TPY	Class TPY according to standard IEC 60044-6.
CLS_TPZ	Class TPY according to standard IEC 60044-6.
UNKNOWN_CLASS	Class not specified, to be determined using the guesser function (test settings) or class could not be determined during the test (test results).

7.2.4 TCTACoreType

The elements of the type TCTACoreType specify the core type of the CT (see CT-Object card of the *CT Analyzer*). The elements are used by the parameter SV_CT_CORE_P_M of the type TCTASettingValue (page 138) and the parameter RV_OBJECT_CT_CORE_P_M of the type TCTAResultValue (page 151.

Element	**Description**
CORE_M	Measurement CT.
CORE_P	Protection CT.
UNKNOWN_CORE	Core type not specified, to be determined using the guesser function (test settings) or core type could not be determined during the test (test results).

7.2.5 TCTACompensation

The elements of the type `TCTACompensation` specify the factor the ratio measurement is corrected. This factor allows measuring the ratio of a CT inside a delta winding transformer. Choose `DELTACOMP_2div3` if input PRIM is connected to that two terminals of the transformer winding the CT is in series. Choose `DELTACOMP_1div3` if the PRIM input is connected to that transformer terminals no CT is in series.

Element	Description
`DELTACOMP_1`	Ratio measurement, not corrected.
`DELTACOMP_2div3`	Ratio measurement corrected by factor 2/3. This correction allows the measurement of a CT in a delta transformer (see CT Analyzer User Manual, section "Measurement at a Delta Winding Transformer").
`DELTACOMP_1div3`	Ratio measurement corrected by factor 1/3. This correction allows the measurement of a CT in a delta transformer (see CT-Analyzer User Manual, section "Measurement at a Delta Winding Transformer").

7.2.6 TCTAInfoClass

The elements of the type `TCTAInfoClass` specify the class (severity) of occurring error messages or information messages. It can be queried using the ICTA::Info property (refer to page 53).

Element	Description
`CTA_INFO_CLS_ERROR`	An error occurred during test operation. Errors are critical events that lead to a test abortion. In case of an error, the device either has a hardware problem or can no longer be used until the error is solved.
`CTA_INFO_CLS_WARNING`	An operation warning. The device is still under the control of the software but had a problem during measurement or can not execute the expected function.
`CTA_INFO_CLS_TOOLTIP`	A tooltip comes up. Information of this kind are not exposed to the remote component, but are kept for compatibility with the *CT Analyzer*'s way

	of categorizing the messages.
CTA_INFO_CLS_HINT	An informational hint is displayed on the *CT Analyzer*, everything still works as expected.
CTA_INFO_CLS_NONE	No error or information pending.

7.2.7 TCTAKtdCalculation

The elements of the type TCTAKtdCalculation specify whether the Ktd is calculated with consideration of the remanence (KTDCALC_OMIC) or according to IEC 60044-6 without consideration of the CT remanence (KTDCALC_NORM).

Element	Description
KTDCALC_NORM	Calculation of the Ktd (transient dimensioning factor) according to the formulas defined in IEC 60044-6. See CT Analyzer Users Manual, chapter "Ktd calculation").
KTDCALC_OMIC	Calculation of the Ktd according to the formulas in IEC 60044-6 and with consideration of the remanence of the CT. See CT-Analyzer Users Manual, chapter "Ktd calculation").

7.2.8 TCTALicense

The elements of the type TCTALicense represent operations or features of the *CT Analyzer* that require a license. Use the ICTA::HasLicense function to query whether a certain license is present (refer to page 46).

Element	Description
CTA_LIC_CLASS_GUESS	Class guessing feature.
CTA_LIC_BURDEN_GUESS	Burden guessing feature.
CTA_LIC_SIMULATION	Simulation calculations feature.
CTA_LIC_IEC_60044_6	Test acc. to standard IEC 60044-6.
CTA_LIC_IEEE_C57_13	Test acc. to standard IEEE C57.13.
CTA_LIC_BURDEN_CARD	Burden testing feature.
CTA_LIC_RATIO_TABLE	Ratio measurement table feature.
CTA_LIC_RATIO_CARD	Ratio testing feature.
CTA_LIC_ASSESSMENT_CARD	Assessment information feature.
CTA_LIC_REMOTE_CONTROL	Remote control feature enabled.

CTA_LIC_REFERENCE_CURVE	Reference curve feature.
CTA_LIC_15kV_KNEE	Allows testing of knee points of up to 15 kV (instead of 4 kV max. knee point voltage).
CTA_LIC_ALL_LANG	Device can be used with all languages.
CTA_LIC_QUICK_CARD	Quick testing feature.
CTA_LIC_VT_TEST_CARD	VT testing feature.
CTA_LIC_AL_GRAPH	AL-Error graph feature.
CTA_LIC_IEC_60044_1	Test acc. to standard IEC 60044-1.
CTA_LIC_ENH_IEC1	Test enhanced IEC 60044-1 classes.
CTA_LIC_ENH_ANSI	Test enhanced IEEE C57.13 classes.
CTA_LIC_PRIM_RESISTANCE_CARD	Allows testing of primary resistance.
CTA_LIC_REMANENCE_CARD	Allows testing of residual magnetism.
CTA_LIC_SWITCHB_SINGLE_RATIO	Allows testing of single-ratio CTs with a connected switchbox.
CTA_LIC_SWITCHB_MULTI_RATIO	Allows testing of multi-ratio CTs with a connected switchbox.
CTA_LIC_ALL_CORES	Allows testing of protection and metering CTs.
CTA_LIC_ALL_FREQUENCIES	Allows testing with all frequencies.
CTA_LIC_ONLY_60Hz	Allows testing only with 60Hz.
CTA_LIC_ONLY_P_CORES	Allows testing only relaying CTs.
CTA_LIC_ONLY_M_CORES	Allows testing only measurement CTs.

7.2.9 TCTAResultTestStatus

The elements of the type `TCTAResultTestStatus` specify the status of the test, i.e. whether the test has been finished successfully or not. The elements are used by the `..._TEST_STATUS` parameters of the type TCTAResultValue, refer to page 151.

Element	Description
STAT_ABORT	Test aborted, test results are not valid.
STAT_NA	Test status cannot be determined, test results are not valid.
STAT_NOK	Test not OK, test results are not valid.
STAT_OK	Test OK, test results are valid.

7.2.10 TCTASequence

The elements of the type `TCTASequence` specify the duty cycle according to IEC 60044-6. The elements are used by the parameter SV_SEQ of the type TCTASettingValue (page 138) and the parameter RV_OBJECT_SEQ of the type TCTAResultValue (page 151).

Element	Description
`SEQ_C_O`	Single energization acc. to IEC 60044-6.
`SEQ_C_O_C_O`	Double energization acc. to IEC 60044-6.

7.2.11 TCTAStandard

The elements of the type `TCTAStandard` specify the possible test standards (see CT-Object card of the *CT Analyzer*) according to which the test can be performed. The elements are used by the parameter SV_STD of the type TCTASettingValue (page 138) and the parameter RV_OBJECT_STD of the type TCTAResultValue (page 151).

Element	Description
`STD_60044_1`	Standard IEC 60044-1.
`STD_60044_6`	Standard IEC 60044-6.
`STD_ANSI_30`	Standard IEEE C57.13 (30°).
`STD_ANSI_45`	Standard IEEE C57.13 (45°).

7.2.12 TCTAStatus

The elements of the type `TCTAStatus` specify the possible states of the CTA remote component. The status is returned by the ICTA::eStatus property. (refer to page 43).

Element	Description
`CTA_STAT_NOT_CONNECTED`	No connection to the *CT Analyzer* established.
`CTA_STAT_READY`	The *CT Analyzer* is connected and ready for operation.
`CTA_STAT_WAIT_FOR_ACKNOWLEDGE`	The *CT Analyzer* is connected and waiting for the acknowledgement of an error or information. This can be done using the Clear() function of the ICTA::Info property.

CTA_STAT_ACTIVATED	The *CT Analyzer* is activated and test is running.
CTA_STAT_PAUSED	The *CT Analyzer* is activated, but the test is paused since the test procedure requires the rewiring of the test object in order to continue the test.

7.2.13 TCTATempUnit

The elements of the type `TCTATempUnit` specify the temperature unit (see Units page (default test settings) of the *CT Analyzer*). The elements are used by the parameter SV_RESISTANCE_TEMP_UNIT of the type TCTASettingValue (page 138) and the parameters RV_RESISTANCE_TEMP_UNIT.

Element	Description
TEMPUNIT_C	Temperature unit "Celsius".
TEMPUNIT_F	Temperature unit "Fahrenheit".

7.2.14 TCTAMeasInfo

The elements of the type `TCTAMeasInfo` specify the actual state of a running measurement. The meas info is returned by the ICTA::nMeasurementInfo property.

Element	Description
MI_NO_MEAS	No measurement is running
MI_AC_TEST	State during inhouse calibration cycles
MI_AUTO_CAL	State during auto calibration
MI_WIRING_BUR	State while the message "Check wiring before burden test! Press <?> for connection diagram." appears on the CT Analyzer display.
MI_WIRING_CT	State while the message "Check wiring before CT-test! Press <?> for connection diagram." appears on the CT Analyzer display.

MI_WIRING_RES_REM	State while the message "Check wiring before residual magnetism test! Press <?> for connection diagram." appears on the CT Analyzer display.
MI_MEAS_DEMAG	State during demagnetization cycle.
MI_WIRING_PRI_RES	State while the message "Check wiring before primary winding resistance test! Press <?> for connection diagram." appears on the CT Analyzer display.
MI_START_DELAY	State during start delay.
MI_MEAS_BUR	State during burden measurement.
MI_MEAS_RES_REM	State during residual magnetism measurement.
MI_MEAS_PRI_RES	State during primary resistance measurement.
MI_MEAS_REV_POL_DETECT	State during reverse polarity detection.
MI_MEAS_RES	State during secondary resistance measurement.
MI_MEAS_EXC	State during excitation curve measurement.
MI_MEAS_RAT	State during current ratio measurement.
MI_MEAS_MAGNET	State during demagnetisation cycle.
MI_MEAS_TAP_WIND_RATIO	State during tap winding ratio measurement.
MI_MR_MEAS_RES	State during multi-ratio resistance measurement.
MI_MR_MEAS_RAT	State during multi-ratio ratio measurement.
MI_QUICK_REMOTE	State during remote quick measurement.

7.2.15 TCTAQualifier

The elements of the type `TCTAQualifier` specify the return parameter of all functions of the ICTACalc::… interface.

Element	Description
QV_INVALID	The calculation of the desired function failed.
QV_VALID	The calculationof the desired function was successful.

QV_BOUNDED	The calculationof the desired function failed. All calculation functions are based on some values out of the excitation table. For this case, the desired values are out of range of the excitation table.

7.2.16 TCTAChecksResult

The elements of the type `TCTAChecksResult` specify the return parameter from the function ICTAResults::IsReportSecure.

Element	Description
CHKS_NOT_AVAIL	No Node <Checksum> was found in the report file.
CHKS_VALID	Checksum was valid.
CHKS_INVALID	Checksum was invalid. The report file may be manipulated.

7.2.17 TCTABurdenType

The elements of the type `TCTABurdenType` specify the burden designation for the standard IEEE C57.13.

Element	Description
UNKNOWN_BURDEN_TYPE	Guesser value "?"
BRD_TYPE_B8	Impedance = 8.0Ω, 200.0 VA at 5A, CosPhi 0.5
BRD_TYPE_B4	Impedance = 4.0Ω, 100.0VA at 5A, CosPhi 0.5
BRD_TYPE_B2	Impedance = 2.0Ω, 50.0VA at 5A, CosPhi 0.5
BRD_TYPE_B1	Impedance = 1.0Ω, 25.0VA at 5A, CosPhi 0.5
BRD_TYPE_B18	Impedance = 1.8Ω, 45.0VA at 5A, CosPhi 0.9
BRD_TYPE_B09	Impedance = 0.9Ω, 22.5VA at 5A, CosPhi 0.9
BRD_TYPE_B05	Impedance = 0.5Ω, 12.5VA at 5A, CosPhi 0.9
BRD_TYPE_B02	Impedance = 0.2Ω, 5.0VA at 5A, CosPhi 0.9
BRD_TYPE_B01	Impedance = 0.1Ω, 2.5VA at 5A, CosPhi 0.9
BRD_TYPE_E02	Impedance = 0.2Ω, 5.0VA at 5A, CosPhi 1.0
BRD_TYPE_E004	Impedance = 0.04Ω, 1.0VA at 5A, CosPhi 1.0

If a current transformer secondary winding is rated at other than 5 A, ohmic burdens for specification and rating shall be derived by multiplying the resistance and iductance values derived from the table above by the factor:

[5A / (current rating in amperes)]. The burden designation, power and CosPhi remain unchanged.

7.3 Test Settings

The test settings are elements of the type `TCTASettingValue`.

7.3.1 TCTASettingValue

The elements of the type `TCTASettingValue` specify the setting parameters (test settings) of the *CT Analyzer*.

Note The CTA remote component automatically limits the adjusted values to their valid ranges.

Use the value -1 for parameters you want to have determined during the test using the guesser function of the *CT Analyzer*. The value -1 corresponds to the question mark "?" displayed on the *CT Analyzer*.

Element (parameter)	Type and description
`SV_ALF`	Type: double Possible values: 1 - 300 Accuracy limiting factor the CT is rated for. Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first. This parameter is part of the parameter Class on the CT-Object card.
`SV_OP_BURDEN`	Type: double Possible values: 0 - 300 Value of the used operating burden (parameter Burden on the CT-Object card).
`SV_OP_BURDEN_ COSPHI`	Type: double Possible values: 0 - 1 cosφ of the used operating burden (parameter Cosφ on the CT-Object card).
`SV_BURDEN_I_TEST`	Type: double Possible values: 0.1 - 5 Test current used to measure the external burden (parameter I-test on the Resistance card). If no value is defined for this parameter, I-sn is used instead.
`SV_CARD_ASSESSMENT`	Type: enum TCTACard (page 128). Enable/disable the Assessment card for the test.

SV_CARD_BURDEN	Type: enum TCTACard (page 128). Enable/disable the Burden card for the test.
SV_CARD_COMMENT	Type: enum TCTACard (page 128). Enable/disable the Comment card for the test.
SV_CARD_EXCITATION	Type: enum TCTACard (page 128). Enable/disable the Excitation card for the test.
SV_CARD_RATIO	Type: enum TCTACard (page 128). Enable/disable the Ratio card for the test.
SV_CARD_RESISTANCE	Type: enum TCTACard (page 128). Enable/disable the Resistance card for the test.
SV_CLASS	Type: enum TCTAClass (page 128). Accuracy class of the CT. Before defining this parameter, the standard (SV_STD) and the CT type (SV_CT_TYPE) have to be defined first.
SV_CLASS_MULTIPLIER	Type: double Possible values: 0.25 - 1 Increases the assessment level for the ratio test. E.g. a class multiplier of 0.5 means that the maximum accepted tolerance for the ratio error is only half the standard tolerance (standard error * SV_CLASS_MULTIPLIER).
SV_COMMENT_TEXT	Type: string Possible values: 4095 characters max. Comment to describe the test (content of the Comment card).
SV_CORE_NR identical to SV_OBJ_CORE_NR	Type: string Possible values: 40 characters max. Number of the core tested. Part of the CT-Object definition.
SV_CT_CORE_P_M	Type: enum TCTACoreType (page 129). Definition of the CT core type: CORE_P for protection CT, CORE_M for measurement CT or Unknown_CORE to use the guesser function of the CT Analyzer. Before defining this parameter, the standard (SV_STD) has to be defined first.
SV_CT_TYPE	Type: string Possible values: 40 characters max. Type of the CT (parameter Type on the CT-Object card). Part of the CT-Object definition.

SV_DELTA_ COMPENSATION	Type: enum TCTACompensation (page 130). Possible values: Ratio 1, Ratio 2/3 Ratio 1/3 Allows that the measured ratio is corrected by the error that would one get if a CT inside a delta winding transformer is measured.
SV_FS	Type: double Possible values: 1 - 30 Instrument security factor the CT is rated for. Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first. This parameter is part of the parameter Class on the CT-Object card.
SV_I_PN	Type: double Possible values: 1 - 99000 Rated primary current (parameter I-pn on the CT-Object card).
SV_I_SN	Type: double Possible values: 0.001 - 10 Rated secondary current (parameter I-sn on the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first.
SV_IAL	Type: double Possible values: 0 - 30 Accuracy limiting secondary excitation current (parameter Ial or Ie on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first.
SV_IE	Type: double Possible values: 0 - 30 Accuracy limiting secondary excitation current acc. to IEC 60044-1 class PX (parameter Ie on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first.

SV_IDENT	Type: string Possible values: 40 characters max. Test identification (to identify the location of the CT). If the parameter is read from a new report, the location information SV_LOCATION limited to 40 characters is delivered. This parameter should not be used in new software versions. If this parameter is read from an old report that has no location information, the content of the ident string is delivered. **Note:** See also SV_LOCATION on page 146.
SV_K	Type: double Possible values: 0 - 1572 Dimensioning factor according to IEC 60044-6 class TPS (parameter K on the extended parameter page of the CT-Object card). The parameter K overwrites the parameter Tp according to the formula $T_p = \frac{K-1}{\omega}$ and vice versa. Before defining this parameter, the standard (SV_STD) and the class (SV_CLASS) have to be defined first.
SV_KSSC	Type: double Possible values: 1 - 300 Rated symmetrical short-circuit current factor acc. to IEC 60044-6 (parameter Kssc on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD) and the class (SV_CLASS) have to be defined first.
SV_KTD	Type: double Possible values: 1 - 2043 Rated transient dimensioning factor according to IEC 60044-6 (parameter Ktd on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD) and the class (SV_CLASS) have to be defined first.

SV_KTD_CALCULATION	Type: enum TCTAKtdCalculation (page 131) The transient dimensioning factor according to IEC 60044-6 can be calculated exactly as defined in the standard or with consideration of the CT remanence.
SV_KX	Type: double Possible values: 1 - 300 Dimensioning factor acc. to IEC 60044-1 class PX (parameter Kx on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD) and the class (SV_CLASS) have to be defined first.
SV_MANUF	Type: string Possible values: 40 characters max. CT manufacturer (parameter Manuf. on the CT-Object card).
SV_NOM_FREQ	Type: double Possible values: 16 - 400 Rated frequency of the CT (parameter f on the CT-Object card).
SV_NOM_BURDEN	Type: double Possible values: 0 - 300 Nominal burden of the CT as defined on the name plate, used to calculate the behavior of the CT at the nominal burden. For the nominal burden, no definition of the cosφ is allowed. The cosφ is defined automatically according to the selected standard instead. Refer to the table "cosφ depending on the selected nominal burden and standard" at the end of this table.
SV_RCT	Type: double Possible values: 0 - 300 Secondary winding resistance (parameter Rct on the extended parameter page of the CT-Object card).
SV_RESISTANCE_TEMP_UNIT	Type: enum TCTATempUnit (page 134). Unit of the entered temperature (Celsius of Fahrenheit). On the *CT Analyzer*, the temperature unit can only be defined in the default test settings.

SV_RESISTANCE_TMEAS	Type: double Possible values: -40 to +150 Winding temperature of the CT during measurement (parameter T-meas on the Resistance card).
SV_RESISTANCE_TREF	Type: double Possible values: -40 to +150 Reference temperature, i.e. the temperature the CT is specified for (parameter T-ref on the Resistance card).
SV_RF	Type: double Possible values: 1 - 4 Thermal current rating factor. Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first. This parameter is part of the parameter Class on the CT-Object card.
SV_SEQ	Type: enum TCTASequence (page 133). Duty cycle acc. to IEC 60044-6 (parameter Seq on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first.
SV_SER_NR	Type: string. Possible values: 40 characters max. Serial number of the CT as stated on the name plate of the CT. Part of the CT-Object definition.
SV_STD	Type: enum TCTAStandard (page 133). Standard according to which the test is to be performed. Defining the standard is mandatory for every test.
SV_T1	Type: double Possible values: 0 - 5 Duration of the first current flow according to IEC 60044-6 (parameter t1 on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE), the Class (SV_CLASS) and the duty cycle (SV_SEQ) have to be defined first.

SV_T2	Type: double Possible values: 0 - 5 Duration of the second current flow according to IEC 60044-6 (parameter t2 on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE), the Class (SV_CLASS) and the duty cycle (SV_SEQ) have to be defined first.
SV_TAL1	Type: double Possible values: 0 - 5, but max. t1 Permissible time to accuracy limit for first energizing period of the duty cycle according to IEC 60044-6 (parameter t-al1 on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE), the Class (SV_CLASS), the duty cycle (SV_SEQ) and the duration (SV_T1) have to be defined first.
SV_TAL2	Type: double Possible values: 0 - 5, but max. t2 Permissible time to accuracy limit for second energizing period of the duty cycle according to IEC 60044-6 (parameter t-al2 on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE), the Class (SV_CLASS), the duty cycle (SV_SEQ) and the duration (SV_T2) have to be defined first.
SV_TFR	Type: double Possible values: 0 - 5 Dead time between first opening and reclosure according to IEC 60044-6 (parameter tfr on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE), the Class (SV_CLASS) and the duty cycle (SV_SEQ) have to be defined first.

SV_TP	Type: double Possible values: 0 - 5 Primary time constant according to IEC 60044-6 (parameter Tp on the extended parameter page of the CT-Object card). If the class TPS is used, the parameter can be overwritten by the K factor (see SV_K for details). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first.
SV_TS	Type: double Possible values: 0 - 100 Secondary loop time constant (parameter Ts on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first.
SV_VAL	Type: double Possible values: 0.1 - 20000 Rated equivalent excitation limiting secondary voltage according to IEC 60044-6 (parameter V-al on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first.
SV_EK	Type: double Possible values: 0.1 - 20000 Rated equivalent excitation limiting secondary voltage according to IEC 60044-1 class PX (parameter Ek on the extended parameter page of the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first.
SV_VB	Type: double Possible values: 0 - 20000 Rated secondary terminal voltage according to IEEE C57.13. Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first. This parameter is part of the parameter Class on the CT-Object card.

Additional settings since version 3.0

Element (parameter)	Type and description
SV_LOCATION	Type: string Possible values: 255 characters max. Test identification (to identify the location of the CT). **Note:** GetValue(SV_LOCATION) delivers a string consisting of SV_LOC_COMPANY SV_LOC_COUNTRY SV_LOC_STATION SV_LOC_FEEDER SV_LOC_PHASE SV_LOC_IEC_ID The strings are separated by a "\" character. If the parameter is read from an old report that contains a parameter "ident" instead of the location parameters, the ident string is delivered. SetValue(SV_LOCATION) has no effect. Use instead: SV_LOC_COMPANY SV_LOC_COUNTRY SV_LOC_STATION SV_LOC_FEEDER SV_LOC_PHASE SV_LOC_IEC_ID
SV_LOC_COMPANY	Type: string Possible values: 40 characters max. Company where the CT is installed. If the parameter is read from an old report that contains a parameter "ident" instead of the location parameters, the ident string is delivered.
SV_LOC_COUNTRY	Type: string Possible values: 40 characters max. Country where the CT is installed.
SV_LOC_STATION	Type: string Possible values: 40 characters max. Station name where the CT is installed.

SV_LOC_FEEDER	Type: string Possible values: 40 characters max. Feeder or bay where the CT is installed.
SV_LOC_PHASE	Type: string Possible values: 40 characters max. Phase the CT is connected to.
SV_LOC_IEC_ID	Type: string Possible values: 40 characters max. IEC ID number of the CT.
SV_OBJECT	Type: string Possible values: 255 characters max. Object identification (to identify the CT). **Note:** GetValue(SV_OBJECT) reads a string consisting of SV_OBJ_MANUF SV_OBJ_CT_TYPE SV_OBJ_SER_NR SV_OBJ_CORE_NR SV_OBJ_TAP SV_OBJ_OPTION1 The strings are separated by a "\" character. SetValue(SV_OBJECT) has no effect. Use instead: SV_OBJ_MANUF SV_OBJ_CT_TYPE SV_OBJ_SER_NR SV_OBJ_CORE_NR SV_OBJ_TAP SV_OBJ_OPTION1
SV_OBJ_MANUF	Identical to (SV_MANUF).
SV_OBJ_CT_TYPE	Identical to (SV_CT_TYPE).
SV_OBJ_SER_NR	Identical to (SV_SER_NR).
SV_OBJ_CORE_NR	Identical to (SV_CORE_NR).

SV_OBJ_TAP	Type: string Possible values: 40 characters max. Description of taps, the tested winding is connected to (e.g. "1S1-1S3). (Improvement of the CT-Object identification.)
SV_OBJ_OPTION1	Type: string Possible values: 40 characters max. Optional definition (improvement of the CT-Object identification).
SV_EXT	Type: double Possible values: 120 - 400 Rated extended primary current represented as percentage of the rated primary current. Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first. This parameter extends the class definition for standard IEC 60044-1 and measuring current transformers on the CT-Object card.
SV_IE1	Type: double Possible values: 30µA – 30A The default value is the value entered for SV_IE. Rated secondary excitation current at the excitation voltage defined in parameter SV_E1. On the device, this parameter is defined in parameter Ie1 on the CT-Object card. Together with SV_E1, this is a second setpoint for assessments for class PX and TPS CTs. Depending on the standard, the rms or the peak current has to be defined (peak current for standard IEC 60044-6 (TPS), rms current for standard IEC 60044-1 (PX)). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined.

SV_E1	Type: double Possible values: 0.1 V – 20000 V The default value is the value entered for parameter SV_EK or SV_VAL. Rated e.m.f. voltage on specified voltage according to IEC 60044-1 (parameter E1 on the the CT-Object card). Before defining this parameter, the standard (SV_STD), the CT type (SV_CT_TYPE) and the class (SV_CLASS) have to be defined first. The parameters SV_E1 and SV_IE1 define a second point on the excitation graph that is assessed by the device for class PX and TPS CTs. The device compares whether the current at voltage SV_E1 is lower than the current defined in parameter SV_IE1.
SV_AL_ERROR_GRAPH_ ENABLE	Type: TCTACard Enable/disable the AL error graph for the test.
SV_CARD_PRIM_ RESISTANCE	Type: TCTACard Enable/disable the primary resistance test.
SV_CARD_RES_REMANENCE	Type: TCTACard Enable/disable the residual magnetism test.
SV_RPRIM	Type: double Possible values: 0.0001 – 3000.0 ohms Primary resistance.
SV_RE20	Type: int Possible values: 1 - 20 Ratio error @ 20 * Isn [%]
SV_NOM_BURDEN_COSPHI	Type: double Possible values: 0.0 – 1.0 cosφ of the used nominal burden (see table below)
SV_CLASS_ASSESS_AT	Type: Boolean Possible values: 0, 1 Defines the accuracy class for C57.13. If the accuracy class given is specific only to that burden it is assigned, e.g. 0.3 @ B-0.5, then the aqccuracy class is not guaranteed for other burdens.

`SV_BURDEN_TYPE_OPR_BURDEN`	Type: enum TCTABurdenType Burden designation for used operational burden

cosφ depending on the selected nominal burden and standard					
Nominal burden [VA]	**Selected standard**				
	60044-1 P	**60044-1 M**	**60044-6**	**IEEE C57.13 P**	**IEEE C57.13 M**
< 5.0	1.0	1.0	1.0	0.5	0.9
>= 5.0	0.8	0.8	1.0	0.5	0.9

7.4 Test Results

The test results are elements of the types TCTAResultValue or TCTAResultIndexedValue, depending on whether the result is a single value or a list (array) of values.

7.4.1 TCTAResultValue

The type `TCTAResultValue` contains the test result parameters the result of which is a single value.

Element (parameter)	Description
RV_ASSESSMENT_CARD_EN	Type: bool Assessment card activated or deactivated.
RV_ASSESSMENT_AUTO_ASSESS_BURDEN	Type: enum TCTAAssessment (page 127). This value can only be assessed manually, no automatic assessment available at the moment.
RV_ASSESSMENT_AUTO_ASSESS_ALF	Type: enum TCTAAssessment (page 127). Assessment result for ALF (accuracy limiting factor) according to the IEC 60044-1 direct measurement method. For details about the assessment, please refer to the CT Analyzer User Manual.
RV_ASSESSMENT_AUTO_ASSESS_ALFI	Type: enum TCTAAssessment (page 127). Assessment result for accuracy limiting factor (ALF) calculated according to the IEC 60044-1 indirect method. For details about the assessment, please refer to the CT Analyzer User Manual
RV_ASSESSMENT_AUTO_ASSESS_EK	Type: enum TCTAAssessment (page 127). Assessment result for accuracy limiting voltage according to IEC 60044-1class PX. For details about the assessment, please refer to the CT Analyzer User Manual
RV_ASSESSMENT_AUTO_ASSESS_FS	Type: enum TCTAAssessment (page 127). Assessment result for instrument security factor (FS) according to the IEC 60044-1 direct measurement method. For details about the assessment, please refer to the CT Analyzer User Manual.

RV_ASSESSMENT_AUTO_ASSESS_FSI	Type: enum TCTAAssessment (page 127). Assessment result for instrument security factor (FS) calculated according to the IEC 60044-1 indirect method. For details about the assessment, please refer to the CT Analyzer User Manual.
RV_ASSESSMENT_AUTO_ASSESS_CLASS	Type: enum TCTAAssessment (page 127). Assessment for the class. Depending on the selected standard and class, different parameters are assessed (see CT Analyzer User Manual, chapter "Assessment Card" for detailed information).
RV_ASSESSMENT_AUTO_ASSESS_RCT	Type: enum TCTAAssessment (page 127). Assessment, if the resistance entered in the object page is > than the resistance measured.
RV_ASSESSMENT_AUTO_ASSESS_KR	Type: enum TCTAAssessment (page 127). Assessment result for Kr. For details about the assessment, please refer to the CT Analyzer User Manual.
RV_ASSESSMENT_AUTO_ASSESS_KSSC	Type: enum TCTAAssessment (page 127). Assessment result for Kssc. For details about the assessment, please refer to the CT Analyzer User Manual.
RV_ASSESSMENT_AUTO_ASSESS_KxKSSC	Type: enum TCTAAssessment (page 127). Assessment for the product of the symmetrical short-circuit overcurrent factor and dimensioning parameter according to IEC 60044-6 class TPS. Refer to CT Analyzer User Manual, chapter "Assessment Card".
RV_ASSESSMENT_AUTO_ASSESS_KTDxKSSC	Type: enum TCTAAssessment (page 127). Assessment for the product of the symmetrical short-circuit overcurrent factor and transient dimensioning factor according to IEC 60044-6 class TPX, TPY, TPZ. Refer to CT Analyzer User Manual, chapter "Assessment Card".
RV_ASSESSMENT_AUTO_ASSESS_TS	Type: enum TCTAAssessment (page 127). Assessment result for Ts. For details about the assessment, please refer to the CT Analyzer User Manual.

RV_ASSESSMENT_AUTO_ASSESS_VB	Type: enum TCTAAssessment (page 127). Assessment result for Vb. For details about the assessment, please refer to the CT Analyzer User Manual.
RV_ASSESSMENT_AUTO_ASSESS_IAL	Type: enum TCTAAssessment (page 127). Assessment result for Ial (accuracy limiting current) according to IEC 60044-6 class TPS). For details about the assessment, please refer to the CT Analyzer User Manual.
RV_ASSESSMENT_AUTO_ASSESS_IE	Type: enum TCTAAssessment (page 127). Assessment result for Ie (accuracy limiting current) according to IEC 60044-1 class PX). For details about the assessment, please refer to the CT Analyzer User Manual.
RV_ASSESSMENT_AUTO_ASSESS_VAL	Type: enum TCTAAssessment (page 127). Assessment result for accuracy limiting voltage (Val) according to IEC 60044-6 class TPS). For details about the assessment, please refer to the CT Analyzer User Manual.
RV_ASSESSMENT_MANUAL_ASSESS_BURDEN	Type: enum TCTAAssessment (page 127). Shows the status of the manual assessment entered by the user for the respective parameter on the Assessment card. This assessment is fully independent from the automatic assessment of the *CT Analyzer*.
RV_ASSESSMENT_MANUAL_ASSESS_ALF	
RV_ASSESSMENT_MANUAL_ASSESS_ALFI	
RV_ASSESSMENT_MANUAL_ASSESS_EK	
RV_ASSESSMENT_MANUAL_ASSESS_FS	
RV_ASSESSMENT_MANUAL_ASSESS_FSI	
RV_ASSESSMENT_MANUAL_ASSESS_CLASS	
RV_ASSESSMENT_MANUAL_ASSESS_IAL	
RV_ASSESSMENT_MANUAL_ASSESS_RCT	
RV_ASSESSMENT_MANUAL_ASSESS_KR	
RV_ASSESSMENT_MANUAL_ASSESS_KSSC	

RV_ASSESSMENT_MANUAL_ ASSESS_KxKSSC	
RV_ASSESSMENT_MANUAL_ ASSESS_KTDxKSSC	
RV_ASSESSMENT_MANUAL_ ASSESS_TS	
RV_ASSESSMENT_MANUAL_ ASSESS_VB	
RV_ASSESSMENT_MANUAL_ ASSESS_IAL	
RV_ASSESSMENT_MANUAL_ ASSESS_IE	
RV_ASSESSMENT_MANUAL_ ASSESS_VAL	
RV_BURDEN_CARD_EN	Type: bool Burden card activated or deactivated.
RV_BURDEN_COSPHI	Type: double Cosφ of the measured external burden.
RV_BURDEN_ERROR_LOC	Type: integer Location in the software where the error was detected. Necessary to determine the exact cause of error.
RV_BURDEN_ERROR_NR	Type: integer For each error number, a detailed description is available in the CT Analyzer User Manual, explaining the error cause and possible solutions.
RV_BURDEN_ERROR_PRIOR	Type: integer Indicates the severity of an error. See chapter "Appendix: Error priority classes".
RV_BURDEN_IMEAS_I	Type: double Current measured during the burden test.
RV_BURDEN_IMEAS_PH	Type: double Phase angle between voltage and current during burden measurement.
RV_BURDEN_IMPEDANCE	Type: double Impedance of the burden.
RV_BURDEN_ITEST	Type: double Test current selected for burden measurement (not the current measured during the test).

RV_BURDEN_OVL	Type: bool Indicates whether an overload occurred during the test.
RV_BURDEN_TEST_STATUS	Type: enum TCTAResultTestStatus (page 132). Shows the status of the burden test.
RV_BURDEN_VA	Type: double Measured external burden. Burden = $Isn^2 * Z$
RV_BURDEN_VMEAS_PH	Type: double Always zero.
RV_BURDEN_VMEAS_V	Type: double Voltage measured at the burden during the test.
RV_COMMENT_CARD_EN	Type: bool Comment card activated or deactivated.
RV_COMMENT_TEXT	Type: string Text contained in the comment card.
RV_DEBUG_NUMBER	Type: integer Number of debug variables in the protocol. This value is a device internal variable and not relevant for the user.
RV_EXCITATION_BURDEN_ALF	Type: double Accuracy limiting factor (ALF) according to IEC 60044-1 direct measurement method at operating burden (parameter Burden on the CT-Object card). For the calculation, please refer to the CT Analyzer User Manual.
RV_EXCITATION_BURDEN_ALF_Q	Type: string (value ">" or empty) Qualifier for ALF at operating burden. ALF is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the accuracy limit.
RV_EXCITATION_BURDEN_ALFI	Type: double Accuracy limiting factor (ALF) according to IEC 60044-1 indirect measurement method at operating burden (parameter Burden on the CT-Object card). For the calculation, please refer to the CT Analyzer User Manual.

RV_EXCITATION_BURDEN_ALFI_Q	Type: string (value ">" or empty) Qualifier for ALFI at operating burden. ALFI is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the accuracy limit.
RV_EXCITATION_BURDEN_EK	Type: double Accuracy limiting voltage (Val) according to IEC 60044-1 class PX. For the calculation, please refer to the CT Analyzer User Manual.
RV_EXCITATION_BURDEN_EMAX	Type: double Maximum emf voltage at operating burden. $E_{\max} = K_{dt\_meas} \cdot K_{ssc} \cdot (I_{sn} \cdot \sqrt{(R_{CT} + R_b)^2 + X_b^2})$ This parameter allows the determination of the working point on the excitation curve that would be reached with the entered settings on the measured CT.
RV_EXCITATION_BURDEN_EPS_PEAK	Type: double Peak instantaneous error (ε^) at operating burden according to IEC 60044-6 class TPX, TPY.
RV_EXCITATION_BURDEN_EPS_PEAK_Q	Type: string (value ">" or empty) ε^ is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the accuracy limit with operation burden.
RV_EXCITATION_BURDEN_FC	Type: double Factor of construction. Not yet supported by the *CT Analyzer*.
RV_EXCITATION_BURDEN_FS	Type: double Instrument security factor (FS) according to IEC 60044-1 direct measurement method at operating burden (parameter Burden on the CT-Object card). For the calculation, please refer to the CT Analyzer User Manual.
RV_EXCITATION_BURDEN_FS_Q	Type: string (value ">" or empty) Qualifier for FS at operating burden. FS is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the accuracy limit.

RV_EXCITATION_BURDEN_FSI	Type: double Instrument security factor (FS) according to IEC 60044-1 indirect measurement method at operating burden (parameter Burden on the CT-Object card). For the calculation, please refer to the CT Analyzer User Manual.
RV_EXCITATION_BURDEN_FSI_Q	Type: string (value ">" or empty) Qualifier for FSI at nominal burden. FSI is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the accuracy limit.
RV_EXCITATION_BURDEN_IAL	Type: double Accuracy limiting current (Ial) according to IEC 60044-6 class TPS.
RV_EXCITATION_BURDEN_IE	Type: double Accuracy limiting voltage (Ie) according to IEC 60044-1 class PX.
RV_EXCITATION_BURDEN_KSSC	Type: double Rated symmetrical short-circuit current factor at operating burden. See CT Analyzer User Manual for the calculation method.
RV_EXCITATION_BURDEN_KSSC_Q	Type: string (value ">" or empty) Kssc is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the accuracy limit.
RV_EXCITATION_BURDEN_KTD	Type: double Transient dimensioning factor according to IEC 60044-6 at operating burden. Two calculation methods are offered (see SV_KTD_CALCULATION on page 142). See also the CT Analyzer User Manual, chapter "Ktd calculation".
RV_EXCITATION_BURDEN_KX	Type: double Dimensioning factor according to IEC 60044-1 class PX.
RV_EXCITATION_BURDEN_KX_Q	Type: string (value ">" or empty) Qualifier for KX at nominal burden. KX is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the accuracy limit.

RV_EXCITATION_BURDEN_TS	Type: double Secondary time constant at operating burden. For the calculation method, please refer to the CT Analyzer User Manual.
RV_EXCITATION_BURDEN_VAL	Type: double Accuracy limiting voltage according to IEC 60044-6 class TPS.
RV_EXCITATION_BURDEN_VB	Type: double Terminal voltage at operating burden according to IEEE C57.13.
RV_EXCITATION_BURDEN_VB_Q	Type: string (value ">" or empty) VB is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the secondary terminal voltage for a 10% ratio error.
RV_EXCITATION_CARD_EN	Type: bool Excitation card activated or deactivated.
RV_EXCITATION_CURVE_NUMBER_POINTS	Type: integer Number of measurement points available for the excitation curve.
RV_EXCITATION_EDDYRES	Type: double Determined eddy resistance.
RV_EXCITATION_ERROR_LOC	Type: integer Location in the software where the error was detected. Necessary to determine the exact cause of error.
RV_EXCITATION_ERROR_NR	Type: integer For each error number, a detailed description is available in the CT Analyzer User Manual, explaining the error cause and possible solutions.
RV_EXCITATION_ERROR_PRIOR	Type: integer Indicates the severity of an error. See chapter "Appendix: Error priority classes".
RV_EXCITATION_KNEEPOINT_ANSI30_I	Type: double Knee point current acc. to IEEE C57.13 (30°). -1 is returned, if no knee point exists.

RV_EXCITATION_KNEEPOINT_ANSI30_V	Type: double Knee point voltage acc. to IEEE C57.13 (30°). -1 is returned, if no knee point exists.
RV_EXCITATION_KNEEPOINT_ANSI45_I	Type: double Knee point current acc. to IEEE C57.13 (45°) -1 is returned, if no knee point exists.
RV_EXCITATION_KNEEPOINT_ANSI45_V	Type: double Knee point voltage acc. to IEEE C57.13 (45°). -1 is returned, if no knee point exists.
RV_EXCITATION_KNEEPOINT_IEC_44_1_I	Type: double Returns the highest knee point current acc. to IEC 60044-1. -1 is returned, if no knee point exists.
RV_EXCITATION_KNEEPOINT_2_IEC_44_1_I	Type: double Returns the knee point current acc. to IEC 60044-1 of the lowest knee point found, if a second knee point exists. -1 is returned, if no second knee point exists.
RV_EXCITATION_KNEEPOINT_IEC_44_1_V	Type: double Returns the highest knee point voltage acc. to IEC 60044-1. -1 is returned, if no knee point exists.
RV_EXCITATION_KNEEPOINT_2_IEC_44_1_V	Type: double Returns the knee point voltage acc. to IEC 60044-1 of the lowest knee point found, if a second knee point exists. -1 is returned, if no second knee point exists.
RV_EXCITATION_KNEEPOINT_IEC_44_6_I	Type: double Returns the highest knee point current acc. to IEC 60044-6. -1 is returned, if no knee point exists.
RV_EXCITATION_KNEEPOINT_2_IEC_44_6_I	Type: double Returns the knee point current acc. to IEC 60044-6 of the lowest knee point found, if a second knee point exists. -1 is returned, if no second knee point exists.

RV_EXCITATION_KNEEPOINT_ IEC_44_6_V	Type: double Returns the highest knee point voltage acc. to IEC 60044-6. -1 is returned, if no knee point exists.
RV_EXCITATION_KNEEPOINT_2_ IEC_44_6_V	Type: double Returns the knee point voltage acc. to IEC 60044-6 of the lowest knee point found, if a second knee point exists. -1 is returned, if no second knee point exists.
RV_EXCITATION_KR	Type: double Remanence factor.
RV_EXCITATION_KTD_ CALCULATION identical to RV_OBJECT_KTD_CALCULATION	Type: enum TCTAKtdCalculation (page 131) It is possible to select whether the calculation of the Ktd is done according to IEC 60044-6 (remanence not considered) or according to OMICRON (remanence considered).
RV_EXCITATION_LS	Type: double Saturated inductance. Refer to the CT Analyzer User Manual.
RV_EXCITATION_LU	Type: double Non-saturated inductance. Refer to the CT Analyzer User Manual.
RV_EXCITATION_OVL	Type: bool Indicates whether an overload occurred during the excitation test. An overload occurs, if the knee point cannot be reached or if the *CT Analyzer* had problems to measure all necessary points.
RV_EXCITATION_REFCURVE_ EXIST	Type: bool Indicates whether a reference curve has been loaded.
RV_EXCITATION_REFCURVE_ KNEEPOINT_ANSI30_I	Type: double Knee point current acc. to IEEE C57.13 (30°) of the reference curve.
RV_EXCITATION_REFCURVE_ KNEEPOINT_ANSI30_V	Type: double Knee point voltage acc. to IEEE C57.13 (30°) of the reference curve.

`RV_EXCITATION_REFCURVE_KNEEPOINT_ANSI45_I`	Type: double Knee point current acc. to IEEE C57.13 (45°) of the reference curve.
`RV_EXCITATION_REFCURVE_KNEEPOINT_ANSI45_V`	Type: double Knee point voltage acc. to IEEE C57.13 (45°) of the reference curve.
`RV_EXCITATION_REFCURVE_KNEEPOINT_IEC_44_1_I`	Type: double Knee point current acc. to IEC 60044-1 of the reference curve.
`RV_EXCITATION_REFCURVE_KNEEPOINT_2_IEC_44_1_I`	Type: double Returns the knee point current acc. to IEC 60044-1 of the lowest knee point found, if a second knee point exists. -1 is returned, if no second knee point exists.
`RV_EXCITATION_REFCURVE_KNEEPOINT_IEC_44_1_V`	Type: double Knee point voltage acc. to IEC 60044-1 of the reference curve.
`RV_EXCITATION_REFCURVE_KNEEPOINT_2_IEC_44_1_V`	Type: double Returns the knee point voltage acc. to IEC 60044-1 of the lowest knee point found, if a second knee point exists. -1 is returned, if no second knee point exists.
`RV_EXCITATION_REFCURVE_KNEEPOINT_IEC_44_6_I`	Type: double Knee point current acc. to IEC 60044-6 of the reference curve.
`RV_EXCITATION_REFCURVE_KNEEPOINT_2_IEC_44_6_I`	Type: double Returns the knee point current acc. to IEC 60044-6 of the lowest knee point found, if a second knee point exists. -1 is returned, if no second knee point exists.
`RV_EXCITATION_REFCURVE_KNEEPOINT_IEC_44_6_V`	Type: double Knee point voltage acc. to IEC 60044-6 of the reference curve.

RV_EXCITATION_REFCURVE_KNEEPOINT_2_IEC_44_6_V	Type: double Returns the knee point voltage acc. to IEC 60044-6 of the lowest knee point found, if a second knee point exists. -1 is returned, if no second knee point exists.
RV_EXCITATION_REFCURVE_NUMBER_POINTS	Type: integer Number of measurement points available for the excitation curve of the reference file.
RV_EXCITATION_TEST_STATUS	Type: enum TCTAResultTestStatus (page 132). Shows the status of the excitation test.
RV_EXCITATION_VA_ALF	Type: double Calculated accuracy limiting factor (ALF) according to IEC 60044-1 direct measurement method at nominal burden (parameter VA on the CT-Object card).
RV_EXCITATION_VA_ALF_Q	Type: string (value ">" or empty) Qualifier for ALF at nominal burden. ALF is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the accuracy limit.
RV_EXCITATION_VA_ALFI	Type: double Accuracy limiting factor (ALF) according to IEC 60044-1 indirect measurement method at nominal burden (parameter VA on the CT-Object card). For the calculation method, please refer to the CT Analyzer User Manual.
RV_EXCITATION_VA_ALFI_Q	Type: string (value ">" or empty) Qualifier for ALFI at nominal burden. ALFI is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the accuracy limit.
RV_EXCITATION_VA_EK	Type: double Accuracy limiting voltage (Val) according to IEC 60044-1 class PX. For the calculation method, please refer to the CT Analyzer User Manual.

RV_EXCITATION_VA_EMAX	Type: double Maximum emf voltage at nominal burden. $E_{\max} = K_{dt\_meas} \cdot K_{ssc} \cdot (I_{sn} \cdot \sqrt{(R_{CT} + R_b)^2 + X_b^2})$ This parameter allows the determination of the working point on the excitation curve that would be reached with the entered settings on the measured CT.
RV_EXCITATION_VA_EPS_PEAK	Type: double Peak instantaneous error (ε^) at nominal burden according to IEC 60044-6 class TPX, TPY.
RV_EXCITATION_VA_EPS_PEAK_Q	Type: string (value ">" or empty) ε^ is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the accuracy limit with nominal burden.
RV_EXCITATION_VA_FC	Type: double Not supported by the *CT Analyzer*.
RV_EXCITATION_VA_FS	Type: double Instrument security factor (FS) according to IEC 60044-1 direct measurement method at nominal burden (parameter VA on the CT-Object card). For the calculation method, please refer to the CT Analyzer User Manual.
RV_EXCITATION_VA_FS_Q	Type: string (value ">" or empty) Qualifier for FS at nominal burden. FS is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the actual instrument security current.
RV_EXCITATION_VA_FSI	Type: double Instrument security factor (FS) according to IEC 60044-1 indirect measurement method at nominal burden (parameter VA on the CT-Object card). For the calculation method, please refer to the CT Analyzer User Manual.
RV_EXCITATION_VA_FSI_Q	Type: string (value ">" or empty) Qualifier for FSI at nominal burden. FSI is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the actual instrument security current.

`RV_EXCITATION_VA_IAL`	Type: double Accuracy limiting current (Ial) according to IEC 60044-6 class TPS.
`RV_EXCITATION_VA_IE`	Type: double Accuracy limiting voltage (Ie) according to IEC 60044-1 class PX.
`RV_EXCITATION_VA_KSSC`	Type: double Rated symmetrical short-circuit current factor at nominal burden. For the calculation method, please refer to the CT Analyzer User Manual.
`RV_EXCITATION_VA_KSSC_Q`	Type: string (value ">" or empty) Kssc is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the actual short circuit current factor.
`RV_EXCITATION_VA_KTD`	Type: double Transient dimensioning factor according to IEC 60044-6 at nominal burden. Two calculation methods are offered (see SV_KTD_CALCULATION on page 142). Refer also to the CT Analyzer User Manual chapter Ktd calculation.
`RV_EXCITATION_VA_KX`	Type: double Dimensioning factor according to IEC 60044-1 class PX.
`RV_EXCITATION_VA_KX_Q`	Type: string (value ">" or empty) Kx is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the actual short circuit current factor.
`RV_EXCITATION_VA_TS`	Type: double Secondary time constant at nominal burden.
`RV_EXCITATION_VA_VAL`	Type: double Accuracy limiting voltage according to IEC 60044-6 class TPS.
`RV_EXCITATION_VA_VB`	Type: double Terminal voltage at nominal burden according to IEEE C57.13.

RV_EXCITATION_VA_VB_Q	Type: string (value ">" or empty) VB is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the secondary terminal voltage for a 10% ratio error.
RV_GENERAL_DEVICE_CATEGORY	Type: string Returns "CT Analyzer".
RV_GENERAL_DEVICE_SERIAL_NUMBER	Type: string Serial number of the *CT Analyzer*.
RV_GENERAL_DEVICE_TYPE	Type: string Returns "CT Analyzer".
RV_GENERAL_ERROR_LOC	Type: integer Location in the software where the error was detected. Necessary to determine the exact cause of error.
RV_GENERAL_ERROR_NR	Type: integer For each error number, a detailed description is available in the CT Analyzer User Manual, explaining the error cause and possible solutions.
RV_GENERAL_ERROR_PRIOR	Type: integer Indicates the severity of an error. See chapter "Appendix: Error priority classes".
RV_GENERAL_FILETYPE	Type: string Possible values: "Results", "Settings" Indicates whether a file is a "Results" file or a "Settings" file.
RV_GENERAL_HARDWARE_VERSION	Type: string e.g: 01/00/07/05/00/10/01 Indicates the versions of the different Hardware components of the *CT Analyzer*.
RV_GENERAL_SOFTWARE_VERSION	Type: string e.g. "2.00 ALPHA 6 (06-11-22 13:35)" Software version of the *CT Analyzer*.
RV_GENERAL_TEST_STATUS	Type: enum TCTAResultTestStatus (page 132). Shows the test status of the full test.

RV_GENERAL_TIME	Type: string Date and time (*CT Analyzer* time) when the test was performed (live value returns the actual time on the *CT Analyzer).* (Format: DD-MM-YYYY, hh:mm:ss).
RV_GENERAL_XML_FILE_NAME	Type: string XML file name (live value returns an empty string).
RV_GENERAL_XML_FILE_ VERSION	Type: string XML file version (live value returns an empty string).
RV_GENERAL_XML_LANGUAGE	Type: string Language of the XML file (live value returns an empty string).
RV_OBJECT_ALF	Type: double Defined Accuracy Limiting Factor at nominal burden the CT is defined for (second parameter for Class on the CT-Object card). The value returned is either the value defined by the user or the value determined by the guesser function. Question mark is returned with the value -1.
RV_OBJECT_CT_CLASS	Type: enum TCTAClass (page 128). Values: e.g. 0.1, 5P, PX, 0.3, TPS, TPX… Defined accuracy class of the CT (parameter Class on the CT-Object card) without accuracy limiting factor (ALF) or instrument security factor (FS).
RV_OBJECT_CT_CLASS_ MULTIPLIER	Type: double Returns the class multiplier as defined on the ratio card (see also SV_CLASS_MULTIPLIER on page 139).
RV_OBJECT_CT_CLASS_STRING	Type: string For internal use only!
RV_OBJECT_CT_CLASSGUESS	Type: bool Indicates whether the class and the class string were determined by the guesser function or defined by the user.

`RV_OBJECT_CT_CORE_NR`	Type: string (40 characters max.). Text specified in the "Core:" field on the Object settings menu. Improvement of the CT object definition.
`RV_OBJECT_CT_COREGUESS`	Type: bool Value: 1 = guessed Indicates whether the core type (P/M) was determined by the guesser function or defined by the user.
`RV_OBJECT_CT_CORE_P_M`	Type: enum TCTACoreType (page 129). Core type of the CT (parameter P/M on the CT-Object card). The core type can be defined by the user or determined by the guesser function (see `RV_OBJECT_CT_COREGUESS` above).
`RV_OBJECT_CT_MANUFACTURER`	Type: string (40 characters max.). Text specified in the parameter "Manufact:" on the Object settings menu. Improvement of the CT object definition.
`RV_OBJECT_CT_NOM_FREQ`	Type: double Rated frequency of the CT (parameter f on the CT-Object card).
`RV_OBJECT_CT_SERIAL_NR`	Type: string (40 characters max.). Text specified in the parameter "SerialNo:" on the Object settings menu. Improvement of the CT object definition.
`RV_OBJECT_CT_TYPE`	Type: string (40 characters max.). Text specified in the parameter "SerialNo:" on the Object settings menu. Improvement of the CT object definition.
`RV_OBJECT_EK`	Type: double Defined accuracy limiting voltage in the Object page. This parameter can be defined by the user or determined by the guesser function.
`RV_OBJECT_EK_GUESS`	Type: bool Value: 1 = guessed Indicates whether the accuracy limiting voltage (Ek) was determined by the guesser function or defined by the user.

RV_OBJECT_FS	Type: double Defined Instrument security factor at nominal burden the CT is defined for (second parameter for Class on the CT-Object card). This parameter can be defined by the user or determined by the guesser function. Question mark is returned with the value -1.
RV_OBJECT_I_PN	Type: double Rated primary current (parameter I-pn on the CT-Object card). This parameter can be defined by the user or determined by the guesser function (see RV_OBJECT_I_PN_GUESS below).
RV_OBJECT_I_PN_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the value for I-pn was determined by the guesser function or defined by the user.
RV_OBJECT_I_SN	Type: double Rated secondary current (parameter I-sn on the CT-Object card). This parameter can be defined by the user or determined by the guesser function (see RV_OBJECT_I_SN_GUESS below).
RV_OBJECT_I_SN_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the value for I-sn was determined by the guesser function or defined by the user.
RV_OBJECT_IAL	Type: double Defined accuracy limiting secondary excitation current on the Object page. This parameter can be defined by the user or determined by the guesser function.
RV_OBJECT_IAL_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the value for Ial was determined by the guesser function or defined by the user.

`RV_OBJECT_IDENTITY`	Type: string Test identification (parameter Ident.) specified on the CT-Object card (40 characters max.).
`RV_OBJECT_IE`	Type: double Defined accuracy limiting secondary excitation current on the Object page according to IEC 60044-1 class PC. This parameter can be defined by the user or determined by the guesser function.
`RV_OBJECT_IE_GUESS`	Type: bool Value: 1 = determined by guesser function Indicates whether the value for Ie was determined by the guesser function or defined by the user.
`RV_OBJECT_K`	Type: double K factor for IEC 60044-6 class TPS.
`RV_OBJECT_KSSC`	Type: double Rated symmetrical short-circuit current factor.
`RV_OBJECT_KSSC_GUESS`	Type: bool Value: 1 = determined by guesser function Indicates whether the value for Kssc was determined by the guesser function or defined by the user.

`RV_OBJECT_KTD_CALCULATION`
identical to
`RV_EXCITATION_KTD_ CALCULATION`
	Type: enum TCTAKtdCalculation (page 131)
	It is possible to select whether the calculation of the Ktd is done according to IEC 60044-6 (remanence not considered) or according to OMICRON (remanence considered).

`RV_OBJECT_KTD`	Type: double Rated transient dimensioning factor.
`RV_OBJECT_KTD_GUESS`	Type: bool Value: 1 = determined by guesser function Indicates whether the value for Ktd was determined by the guesser function or defined by the user.

RV_OBJECT_KX	Type: double Dimensioning factor defined on the CT Object card.
RV_OBJECT_KX_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the value for Kx was determined by the guesser function or defined by the user.
RV_OBJECT_NOM_BURDEN_COSPHI	Type: double Cosφ of the nominal burden (not the parameter Cosφ on the CT-Object card). This parameter is used for nominal burden dependent calculations. The parameter cannot be entered. It is chosen by the device automatically depending on the selected standard and the selected nominal burden.
RV_OBJECT_NOM_BURDEN	Type: double Nominal burden of CT. Used to calculate the behavior of the CT at nominal burden (parameter VA on the CT-Object card). For the nominal burden, the cosφ cannot be adjusted since the cosφ value defined in the according standards is used instead.
RV_OBJECT_NOM_BURDEN_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the value for the nominal burden (VA) was determined by the guesser function or defined by the user.
RV_OBJECT_OP_BURDEN	Type: double Operating burden (parameter Burden on the CT-Object card). This parameter is used for operating burden-dependent calculations.
RV_OBJECT_OP_BURDEN_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the value for the operating burden (Burden) was determined by the guesser function or defined by the user.

RV_OBJECT_OP_BURDEN_COSPHI	Type: double cosφ of the operating burden (parameter Cosφ on the CT-Object card). This parameter is used for operating burden-dependent calculations.
RV_OBJECT_OP_BURDEN_COSPHI_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the CosPhi (CosPhi) value for the operating burden was determined by the guesser function or defined by the user.
RV_OBJECT_RCT	Type: double Secondary winding resistance (parameter Rct on the extended parameter page of the CT-Object card). Only used for assessment.
RV_OBJECT_RCT_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the value for Rct was determined by the guesser function or defined by the user.
RV_OBJECT_RF	Type: double Continuous current rating factor according to IEEE C57.13 (parameter RF (Class) on the CT-Object card).
RV_OBJECT_SEQ	Type: enum TCTASequence (page 133). Specified duty cycle according to IEC 60044-6 (parameter Seq on the extended parameter page of the CT-Object card).
RV_OBJECT_STD	Type: enum TCTAStandard (page 133). Defined standard for the CT test (parameter Std on the CT-Object card).
RV_OBJECT_T1	Type: double Duration of the first current flow according to IEC 60044-6 (parameter t1 on the extended parameter page of the CT-Object card)

RV_OBJECT_T2	Type: double Duration of the second current flow according to IEC 60044-6 (parameter t2 on the extended parameter page of the CT-Object card).
RV_OBJECT_TAL1	Type: double Permissible time to accuracy limit for first energizing period of the duty cycle according to IEC 60044-6 (parameter t-al1 on the extended parameter page of the CT-Object card).
RV_OBJECT_TAL2	Type: double Permissible time to accuracy limit for second energizing period of the duty cycle cycle according to IEC 60044-6 (parameter t-al2 on the extended parameter page of the CT-Object card).
RV_OBJECT_TFR	Type: double Dead time between first opening and reclosure cycle according to IEC 60044-6 (parameter tfr on the extended parameter page of the CT-Object card).
RV_OBJECT_TP	Type: double Specified primary time constant (parameter Tp on the extended parameter page of the CT-Object card).
RV_OBJECT_TS	Type: double Secondary loop time constant (parameter Ts on the extended parameter page of the CT-Object card).
RV_OBJECT_TS_GUESS	Type bool Value: 1 = determined by guesser function Indicates whether the value for Ts was determined by the guesser function or defined by the user.
RV_OBJECT_VAL	Type: double Rated equivalent excitation limiting secondary voltage (parameter V-al on the extended parameter page of the CT-Object card).

RV_OBJECT_VAL_GUESS	Type bool Value: 1 = determined by guesser function Indicates whether the value for the accuracy limiting voltage (Val) was determined by the guesser function or defined by the user.
RV_OBJECT_VB	Type: double Rated secondary terminal voltage according to IEEE C57.13 (second parameter of Class on the CT-Object card). Question mark is returned with the value -1.
RV_RATIO_CARD_EN	Type: bool Ratio card activated or deactivated.
RV_RATIO_COMPOSITE_ERROR_PERC	Type: double Composite error according to IEC 60044-1 at the specified primary current and operating burden (parameter ε_c on the Ratio card).
RV_RATIO_CORE_MEASURMENT_I1_V	Type: double Debug parameter, returns the rms current measured during core ratio measurement.
RV_RATIO_CORE_MEASURMENT_NR_POINTS	Type: integer Number of measurement points during core ratio measurement.
RV_RATIO_CORE_MEASURMENT_PHV1_VCORE_DEGREES	Type: double Debug parameter, returns the phase between input SEC and Vcore during core ratio measurement.
RV_RATIO_CORE_MEASURMENT_PHV12_DEGREES	Type: double Debug parameter, returns the phase between inputs SEC and PRIM during core ratio measurement.
RV_RATIO_CORE_MEASURMENT_PHV1I_DEGREES	Type: double Debug parameter, returns the phase between input SEC and the output current during core ratio measurement.
RV_RATIO_CORE_MEASURMENT_V1_V	Type: double Debug parameter, returns the rms voltage at input SEC during core ratio measurement.

RV_RATIO_CORE_MEASURMENT_V2_V	Type: double Debug parameter, returns the rms voltage at input PRIM during core ratio measurement.
RV_RATIO_CORE_MEASURMENT_VCORE_V	Type: double Debug parameter, returns the rms voltage in the core during core ratio measurement.
RV_RATIO_CORE_RATIO	Type: double Measured turns ratio (parameter N on the Ratio card).
RV_RATIO_CURVE_NUMBER_POINTS	Type: integer Number of measurement points available for the extended excitation curve (points at low voltage).
RV_RATIO_DELTA_COMPENSATION	Type: enum TCTACompensation (page 130) Possible values: Ratio 1, Ratio 2/3, Ratio 1/3 Defined type of ratio correction factor for the measurements of CTs in delta winding transformers.
RV_RATIO_DEVIATION_PERC	Type: double Deviation from the rated ratio in % (second value of parameter Ratio on the Ratio card).
RV_RATIO_DISPL_STRING	Type: string Ratio shown as string (e.g. 2000:0.9997). The deviation is not included.
RV_RATIO_ERROR_LOC	Type: integer Location in the software where the error was detected. Necessary to determine the exact cause of error.
RV_RATIO_ERROR_NR	Type: integer For each error number, a detailed description is available in the CT Analyzer User Manual, explaining the error cause and possible solutions.
RV_RATIO_ERROR_PRIOR	Type: integer Indicates the severity of an error. See chapter "Appendix: Error priority classes".

RV_RATIO_PHASE_ERROR_DEGREE	Type: double Phase displacement (in degree) at nominal primary current and operating burden.
RV_RATIO_POLARITY	Type: integer Values: 0 = not ok / 1 = ok Polarity OK, phase error in the range of 0° ± 45°.
RV_RATIO_PRIM_A	Type: integer Primary current of the parameter Ratio on the Ratio card, identical with primary current on CT-Object card.
RV_RATIO_RCF	Type: double Ratio correction factor according to IEEE C57.13 (parameter RCF on the Ratio card).
RV_RATIO_SEC_A	Type: double Secondary current of the parameter Ratio on the Ratio card. The secondary current is calculated at I-pn and the operating burden.
RV_RATIO_SIMUL_PRIMARY_ I_P_A	Type: double Primary current for the calculation of the ratio error and the phase displacement with the operating burden, defined in the CT-Object card (parameter I-p on the Ratio card).
RV_RATIO_TABLE_NR_COLUMNS	Type: integer Number of columns in the Ratio Table and the Phase Table (of the Ratio card).
RV_RATIO_TABLE_NR_ROWS	Type: integer Number of rows in the Ratio Table and the Phase Table (of the Ratio card).
RV_RATIO_TEST_STATUS	Type: enum TCTAResultTestStatus (page 132). Shows the status of the Ratio test.
RV_RESISTANCE_CARD_EN	Type: bool Resistance card activated or deactivated.
RV_RESISTANCE_ERROR_LOC	Type: integer Location in the software where the error was detected. Necessary to determine the exact cause of error.

RV_RESISTANCE_ERROR_NR	Type: integer For each error number, a detailed description is available in the CT Analyzer User Manual, explaining the error cause and possible solutions.
RV_RESISTANCE_ERROR_PRIOR	Type: integer Indicates the severity of an error. See chapter "Appendix: Error priority classes".
RV_RESISTANCE_IDC_MEAS	Type: double Measurement current during winding resistance test (parameter I-DC on the Resistance card).
RV_RESISTANCE_ITEST	Type: double Selected test current to measure the winding resistance (parameter I-test on the Resistance card).
RV_RESISTANCE_R_MEAS	Type: double Measured resistance at ambient temperature (parameter R-meas on the Resistance card).
RV_RESISTANCE_R_REF	Type: double Reference resistance (temperature-compensated resistance, compensated to T-ref) (parameter R-ref on the Resistance card).
RV_RESISTANCE_TEST_STATUS	Type: enum TCTAResultTestStatus (page 132). Shows the status of the resistance test.
RV_RESISTANCE_TMEAS	Type: double Defined ambient temperature (parameter T-meas on the Resistance card).
RV_RESISTANCE_TEMP_UNIT	Type: enum TCTATempUnit (page 134). Temperature unit used for T-meas in the Resistance card (°C or °F).
RV_RESISTANCE_TREF	Type: double Reference temperature (parameter T-ref on the Resistance card).
RV_RESISTANCE_VDC_MEAS	Type: double Measurement voltage during winding resistance test (parameter V-DC on the Resistance card).

RV_SENSORS_SENSOR_V1_GAIN	Type: double For external sensors, currently not used.
RV_SENSORS_SENSOR_V1_OFFS	Type: double For external sensors, currently not used.
RV_SENSORS_SENSOR_V1_PHASE	Type: double For external sensors, currently not used.
RV_SENSORS_SENSOR_V2_GAIN	Type: double For external sensors, currently not used.
RV_SENSORS_SENSOR_V2_OFFS	Type: double For external sensors, currently not used.
RV_SENSORS_SENSOR_V2_PHASE	Type: double For external sensors, currently not used.
RV_RATIO_TURNS_ERROR	Type: double Shows the turns ratio error.

Additional result values since version 3.0

Element (parameter)	Type and description
RV_OBJECT_LOCATION	Type: string (255 characters max.) Text specified in the "Location:" field on the CT-Object card.
RV_OBJECT_LOC_COMPANY	Type: string (40 characters max.) Text specified in the "Company:" field on the Location settings menu. Improvement of the CT location definition.
RV_OBJECT_LOC_COUNTRY	Type: string (40 characters max.) Text specified in the "Country:" field on the Location settings menu. Improvement of the CT location definition.
RV_OBJECT_LOC_STATION	Type: string (40 characters max.) Text specified in the "Station:" field on the Location settings menu. Improvement of the CT location definition.
RV_OBJECT_LOC_FEEDER	Type: string (40 characters max.) Text specified in the "Feeder:" field on the Location settings menu. Improvement of the CT location definition.
RV_OBJECT_LOC_PHASE	Type: string (40 characters max.) Text specified in the "Phase:" field on the Location settings menu. Improvement of the CT location definition.
RV_OBJECT_LOC_IECID	Type: string (40 characters max.) Text specified in the "IEC-ID:" field on the Location settings menu. Improvement of the CT location definition.

RV_OBJECT_OBJECT	Type: string (255 characters max.) Text specified in the "Object:" field on the CT-Object card. **Note:** Delivers a string consisting of RV_OBJECT_OBJ_MANUF RV_OBJECT_OBJ_CT_TYPE RV_OBJECT_OBJ_SER_NR RV_OBJECT_OBJ_CORE_NR RV_OBJECT_OBJ_TAP RV_OBJECT_OBJ_OPTION1 The strings are separated by a "\" character
RV_OBJECT_OBJ_MANUF	Identical to RV_OBJECT_CT_MANUFACTURER.
RV_OBJECT_OBJ_CT_TYPE	Identical to RV_OBJECT_CT_TYPE.
RV_OBJECT_OBJ_CT_SER_NR	Identical to RV_OBJECT_CT_SERIAL_NR.
RV_OBJECT_OBJ_CT_CORE_NR	Identical to RV_OBJECT_CT_CORE_NR.
RV_OBJECT_OBJ_CT_TAP	Type: string (40 characters max.) Text specified in the "Tap:" field on the Object settings menu. Improvement of the CT object definition.
RV_OBJECT_OBJ_OPTION1	Type: string (40 characters max.) Text specified in the "Optional 1:" field on the Object settings menu. Improvement of the CT object definition.
RV_OBJECT_EXT	Type: double Rated extended primary current represented as percentage of the rated primary current. The value returned is the value as it was defined on the CT-Object card.
RV_OBJECT_FS_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the value for the instrument security factor (FS) was determined by the guesser function or defined by the user.

RV_OBJECT_ALF_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the value for the accuracy limiting factor (ALF) was determined by the guesser function or defined by the user.
RV_OBJECT_VB_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the value for the rated secondary terminal voltage (Vb) was determined by the guesser function or defined by the user.
RV_OBJECT_IE1	Type: double Second setpoint (excitation current at E1) defined on the Object page. This parameter can be defined by the user or determined by the guesser function. Depending on the standard, this result represents the peak current (for standard IEC 60044-6 (TPS)) or the rms current (for standard IEC 60044-1 (PX)).
RV_OBJECT_IE1_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the value for Ie1 was determined by the guesser function or defined by the user.
RV_OBJECT_E1	Type: double Second setpoint (EMF voltage 1) defined on the Object page. This parameter can be defined by the user or determined by the guesser function
RV_OBJECT_E1_GUESS	Type: bool Value: 1 = determined by guesser function Indicates whether the value for E1 was determined by the guesser function or defined by the user.

RV_EXCITATION_IE1	Type: double Second measuring point (excitation current at E1). Depending on the standard, this result represents the peak current (for standard IEC 60044-6 (TPS)) or the rms current (for standard IEC 60044-1 (PX)).
RV_EXCITATION_E1	Type: double Second measuring point defined (EMF voltage 1). Delivers the same value as RV_OBJECT_E1.
RV_ASSESSMENT_AUTO_ ASSESS_IE1	Type: enum TCTAAssessment (page 127). Assessment result for Ie1 (excitation current at E1) according to IEC 60044-6 (for class TPS) or according to IEC 60044-1 (for class PX). For details about the assessment, please refer to the CT Analyzer User Manual.
RV_ASSESSMENT_AUTO_ ASSESS_EPSILON_AT_20ISN	Type: enum TCTAAssessment (page 127). Assessment result for ratio error at 20 * I-sn according to IEEE C57.13 protection CTs. For details about the assessment, please refer to the CT Analyzer User Manual.
RV_ASSESSMENT_AUTO_ ASSESS_EPSILON_AT_VB	Type: enum TCTAAssessment (page 127). Assessment result for Vb according to IEEE C57.13 protection CTs. For details about the assessment, please refer to the CT Analyzer User Manual.
RV_ASSESSMENT_AUTO_ ASSESS_EPSILON	Type: enum TCTAAssessment (page 127). Assessment result for ratio error. Depending on the selected standard and class, different ranges of the ratio error are assessed (see CT Analyzer User Manual, chapter "Assessment Card" for detailed information).

RV_ASSESSMENT_AUTO_ASSESS_DELTAPHI	Type: enum TCTAAssessment (page 127). Assessment result for phase error. Depending on the selected standard and class, different ranges of the phase error are assessed (see CT Analyzer User Manual, chapter "Assessment Card" for detailed information).
RV_ASSESSMENT_AUTO_ASSESS_EPSILON_C	Type: enum TCTAAssessment (page 127). Assessment result for composite error. Depending on the selected standard and class, different ranges of the composite error are assessed (see CT Analyzer User Manual, chapter "Assessment Card" for detailed information).
RV_ASSESSMENT_AUTO_ASSESS_EPSILON_PEAK	Type: enum TCTAAssessment (page 127). Assessment result for peak error. Depending on the class selected for standard IEC 60044-6, different ranges of the peak error are assessed (see CT Analyzer User Manual, chapter "Assessment Card" for more information).
RV_ASSESSMENT_AUTO_ASSESS_EPSILON_T	Type: enum TCTAAssessment (page 127). Assessment result for turns error according to class PX (for IEC 60044-1) and class TPS (for IEC 60044-6). See CT Analyzer User Manual, chapter "Assessment Card" for detailed information.
RV_ASSESSMENT_MANUAL_ASSESS_IE1	Type: enum TCTAAssessment (page 127). Shows the status of the manual assessment entered by the user for the respective parameter on the Assessment card. This assessment is fully independent from the automatic assessment of the *CT Analyzer*.
RV_ASSESSMENT_MANUAL_ASSESS_EPSILON_AT_20ISN	
RV_ASSESSMENT_MANUAL_ASSESS_EPSILON_AT_VB	
RV_ASSESSMENT_MANUAL_ASSESS_EPSILON	
RV_ASSESSMENT_MANUAL_ASSESS_DELTAPHI	
RV_ASSESSMENT_MANUAL_ASSESS_EPSILON_C	
RV_ASSESSMENT_MANUAL_ASSESS_EPSILON_PEAK	
RV_ASSESSMENT_MANUAL_ASSESS_EPSILON_T	

RV_AL_ERROR_GRAPH_ERROR	Type: double Delivers the defined accuracy limiting error in % that is used to calculate the AL-Error graph.
RV_AL_ERROR_GRAPH_NUMBER_ POINTS	Type: double Delivers the number of points of the AL-Error graph.
RV_AL_ERROR_GRAPH_NOM_ BURDEN_KVALUE	Type: double Delivers the K value (= Ip at ALFi / Ip nom.) calculated for the resistive nominal burden and the specified error in the AL-Error graph.
RV_AL_ERROR_GRAPH_NOM_ BURDEN_RESISTANCE	Type: double Delivers the resistive nominal burden used to calculate the accuracy limit at the specified K value (= Ip at ALFi / Ip nom.) in the AL-Error graph.
RV_AL_ERROR_GRAPH_OP_ BURDEN_KVALUE	Type: double Delivers the K value (= Ip at ALFi / Ip nom.) calculated for the resistive operating burden and the specified error in the AL-Error graph.
RV_AL_ERROR_GRAPH_OP_ BURDEN_RESISTANCE	Type: double Delivers the resistive operating burden used to calculate the accuracy limit at the K value (= Ip at ALFi / Ip nom.) in the AL-Error graph.
RV_AL_ERROR_GRAPH_ENABLE	Type: bool Delivers true, if the AL-Error graph is enabled. Delivers false, if the AL-Error graph is not enabled.
RV_ASSESSMENT_AUTO_ASSESS_ VKNEE RV_ASSESSMENT_MANUAL_ ASSESS_VKNEE	Type: enum TCTAAssessment (page 127). Assessment result for Vknee. Depending on the selected standard (see CT Analyzer User Manual, chapter "Assessment Card" for detailed information).

RV_ASSESSMENT_AUTO_ASSESS_RCF RV_ASSESSMENT_MANUAL_ASSESS_RCF	Type: enum TCTAAssessment (page 127). Assessment result for RCF. Depending on the selected standard (see CT Analyzer User Manual, chapter "Assessment Card" for detailed information).
RV_ASSESSMENT_AUTO_ASSESS_EPSILON_AT_ISN RV_ASSESSMENT_MANUAL_ASSESS_EPSILON_AT_ISN	Type: enum TCTAAssessment (page 127). Assessment result for ratio error @ Isn. Depending on the selected standard (see CT Analyzer User Manual, chapter "Assessment Card" for detailed information).
RV_ASSESSMENT_AUTO_ASSESS_VK_IK RV_ASSESSMENT_MANUAL_ASSESS_VK_IK	Type: enum TCTAAssessment (page 127). Assessment result for user defined test point Vk/Ik. Depending on the selected standard (see CT Analyzer User Manual, chapter "Assessment Card" for detailed information).
RV_ASSESSMENT_AUTO_ASSESS_VK1_IK1 RV_ASSESSMENT_MANUAL_ASSESS_VK1_IK1	Type: enum TCTAAssessment (page 127). Assessment result for user defined test point Vk1/Ik1. Depending on the selected standard (see CT Analyzer User Manual, chapter "Assessment Card" for detailed information).
RV_ASSESSMENT_AUTO_ASSESS_TOTAL RV_ASSESSMENT_MANUAL_ASSESS_TOTAL	Type: enum TCTAAssessment (page 127). Total assessment for the whole measurement. This assessment is Ok if all assessments for the different measurements are Ok.
RV_OBJ_RE20, RV_OBJECT_RE20	Type: integer User defined setting value for epsilon @ 20 * Isn
RV_RATIO_TCF	Type: double Result value for TCF (C57.13)
RV_RES_REMANENCE_FLUX	Type: double Residual flux - absolute value [in Vs]" "of the residual magnetic flux in the CT, determined by the CT Analyzer.

RV_RES_REMANENCE_PERCENT	Type: double Residual magnetism - ratio of measured residual flux to saturation flux [in %].
RV_RES_REMANENCE_CARD_EN	Type: bool Remanence card enabled or disabled.
RV_RES_REMANENCE_TEST_ STATUS	Type: enum TCTAResultTestStatus Test status of the remanence measurement.
RV_RES_REMANENCE_ERROR_ PRIOR	Type: integer The priority of the error during the remanence measurement (if any).
RV_RES_REMANENCE_ERROR_NR	Type: integer The error number during the remanence measurement (if any).
RV_RES_REMANENCE_ERROR_LOC	Type: integer The error location during the remanence measurement (if any).
RV_PRIM_RESISTANCE_CARD_EN	Type: bool Primary resistance card activated or deactivated.
RV_PRIM_RESISTANCE_ERROR_ LOC	Type: integer Location in the software where the error was detected. Necessary to determine the exact cause of error.
RV_PRIM_RESISTANCE_ERROR_NR	Type: integer For each error number, a detailed description is available in the CT Analyzer User Manual, explaining the error cause and possible solutions.
RV_PRIM_RESISTANCE_ERROR_PR IOR	Type: integer Indicates the severity of an error. See chapter "Appendix: Error priority classes".
RV_PRIM_RESISTANCE_IDC_MEAS	Type: double Measurement current during primary winding resistance test (parameter I-DC on the Resistance card).
RV_PRIM_RESISTANCE_ITEST	Type: double Selected test current to measure the primary winding resistance (parameter I-test on the Resistance card).

RV_PRIM_RESISTANCE_R_MEAS	Type: double Measured resistance at ambient temperature (parameter R-meas on the Resistance card).
RV_PRIM_RESISTANCE_R_REF	Type: double Reference resistance (temperature-compensated resistance, compensated to T-ref) (parameter R-ref on the Resistance card).
RV_PRIM_RESISTANCE_TEST_STATUS	Type: enum TCTAResultTestStatus (page 132). Shows the status of the resistance test.
RV_PRIM_RESISTANCE_TMEAS	Type: double Defined ambient temperature (parameter T-meas on the Resistance card).
RV_PRIM_RESISTANCE_TEMP_UNIT	Type: enum TCTATempUnit (page 134). Temperature unit used for T-meas in the Resistance card (°C or °F).
RV_PRIM_RESISTANCE_TREF	Type: double Reference temperature (parameter T-ref on the Resistance card).
RV_PRIM_RESISTANCE_VDC_MEAS	Type: double Measurement voltage during winding resistance test (parameter V-DC on the Resistance card).
RV_ASSESSMENT_AUTO_ASSESS_RPRIM RV_ASSESSMENT_MANUAL_ASSESS_RPRIM	Type: enum TCTAAssessment (page 127). Assessment, if the resistance entered in the object page is > than the resistance measured.
RV_SWITCHBOX_SERIAL_NUMBER	Type: string The serial number of a connected Switchbox: (e.g. "AC015S")
RV_SWITCHBOX_VERSION	Type: string The version of a connected Switchbox: e.g. "0.06/0.00" ... Firmware / Hardware
RV_SWITCHBOX_TYPE	Type: string The type of a connected Switchbox: e.g. "CT SB2"

RV_EXCITATION_VA_EPSI	Type: double Indirect composite error (epsilon_i) at nominal burden (parameter VA on the CT-Object card). For the calculation, please refer to the CT Analyzer User Manual.
RV_EXCITATION_VA_EPSI_Q	Type: string (value ">" or empty) Qualifier for epsilon_i at nominal burden. Epsilon_i is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the accuracy limit
RV_EXCITATION_BURDEN_EPSI	Type: double Indirect composite error (epsilon_i) at operating burden (parameter Burden on the CT-Object card). For the calculation, please refer to the CT Analyzer User Manual.
RV_EXCITATION_BURDEN_EPSI_Q	Type: string (value ">" or empty) Qualifier for epsilon_i at nominal burden. Epsilon_i is prefixed by the ">" sign, if the *CT Analyzer* is not able to measure up to the accuracy limit
RV_OBJECT_MIN_BURDEN	Type: double Used setting on the *CT Analyzer* for: "Min. VA at M-cores Isn 5A"
RV_RATIO_TABLE_NR_ROWS_EX	Type: integer Number of rows in the extended Ratio-Table and the extended Phase-Table (of the Ratio card).
RV_RATIO_TABLE_NR_COLUMNS_EX	Type: integer Number of columns in the extended Ratio-Table and the extended Phase-Table (of the Ratio card).
RV_GENERAL_XML_FILE_SUBVERSION	Type: integer The subversion of the result XML-file.
RV_GENERAL_XML_FILE_VERSION_EX	Type: string The combined version / subversion of the XML-file as a string: e.g. "4.10"

7.4.2 TCTAResultIndexedValue

The type `TCTAResultIndexedValue` contains the test result parameters the result of which is not a single value but a list (array) of values instead.

Element (parameter)	Description
`RV_EXCITATION_CURVE_ANSI30_EMF_V`	Type: double (e.m.f. voltage [Vrms]) Measured voltage curve acc. to IEEE C57.13 (30°).
`RV_EXCITATION_CURVE_ANSI30_RMS_I`	Type: double (excitation current [Arms]) Measured current curve acc. to IEEE C57.13 (30°).
`RV_EXCITATION_CURVE_ANSI45_EMF_V`	Type: double (e.m.f. voltage [Vrms]) Measured voltage curve acc. to IEEE C57.13 (45°).
`RV_EXCITATION_CURVE_ANSI45_RMS_I`	Type: double (excitation current [Arms]) Measured current curve acc. to IEEE C57.13 (45°).
`RV_EXCITATION_CURVE_IEC60044_1_RMS_V`	Type: double (terminal voltage [Vrms]) Measured voltage curve acc. to IEC 60044-1.
`RV_EXCITATION_CURVE_IEC60044_1_RMS_I`	Type: double (excitation current [Arms]) Measured current curve acc. to IEC 60044-1.
`RV_EXCITATION_CURVE_IEC60044_6_EMF_V`	Type: double (e.m.f. voltage [Vrms]) Measured voltage curve acc. to IEC 60044-6.
`RV_EXCITATION_CURVE_IEC60044_6_PEAK_I`	Type: double (excitation current [Apeak]) Measured current curve acc. to IEC 60044-6.
`RV_EXCITATION_CURVE_FLUX_VS`	Type: double (flux in CT core [Vs]) Calculated flux out of the emf voltage (core voltage).
`RV_EXCITATION_CURVE_EMF_V`	Type: double (e.m.f. voltage [Vrms]) emf voltage for measurement points of excitation curve, identical with `_ANSI30_EMV_V`.

RV_EXCITATION_CURVE_ TERMINAL_V	Type: double (terminal voltage [Vrms]) Terminal voltage from measurement points of excitation curve.
RV_EXCITATION_CURVE_ICTRMS_I	Type: double (excitation current [Arms]) Excitation current for measurement points of the excitation curve, identical with ..._IEC60044_1_RMS_I.
RV_EXCITATION_CURVE_ ICTPEAK_I	Type: double (excitation current [Apeak]) Peak excitation current for measurement points of the excitation curve, identical with ..._IEC60044_6_PEAK_I.
RV_EXCITATION_CURVE_ ICTRECT_I	Type: double (rectified excitation current [Arms]) Rectified average excitation current calibrated to r.m.s.
RV_EXCITATION_CURVE_PH_UCT_ ICT_DEGREE	Type: double (phase [°]) Phase angle between terminal voltage (Uct) and excitation current (Ict).
RV_EXCITATION_CURVE_PH_ UCORE_ICT_DEGREE	Type: double (phase [°]) Phase angle between emf voltage (Ucore) and excitation current (Ict)
RV_EXCITATION_CURVE_REM_ FLUX_VS	Type: double (remanence flux [Vs]) Remanence Flux for measurement points of the excitation curve.
RV_EXCITATION_CURVE_ INDUCTIVITY_H	Type: double (inductance [H]) Inductance for measurement points of the excitation curve.
RV_EXCITATION_REFCURVE_ ANSI30_EMF_V	Type: double (e.m.f. voltage [Vrms]) Reference voltage curve acc. to IEEE C57.13 (30°). The reference curve has to be loaded on the *CT Analyzer*.
RV_EXCITATION_REFCURVE_ ANSI30_RMS_I	Type: double (excitation current [Arms]) Reference current curve acc. to IEEE C57.13 (30°).
RV_EXCITATION_REFCURVE_ ANSI45_EMF_V	Type: double (e.m.f. voltage [Vrms]) Reference voltage curve acc. to IEEE C57.13 (45°).

RV_EXCITATION_REFCURVE_ANSI45_RMS_I	Type: double (excitation current [Arms]) Reference current curve acc. to IEEE C57.13 (45°).
RV_EXCITATION_REFCURVE_IEC60044_1_RMS_V	Type: double (terminal voltage [Vrms]) Reference voltage curve acc. to IEC 60044-1.
RV_EXCITATION_REFCURVE_IEC60044_1_RMS_I	Type: double (excitation current [Arms]) Reference current curve acc. to IEC 60044-1.
RV_EXCITATION_REFCURVE_IEC60044_6_EMF_V	Type: double (e.m.f. voltage [Vrms]) Reference voltage curve acc. to IEC 60044-6.
RV_EXCITATION_REFCURVE_IEC60044_6_PEAK_I	Type: double (excitation current [Apeak]) Reference current curve acc. to IEC 60044-6.
RV_EXCITATION_REFCURVE_FLUX_VS	Type: double (flux in CT core [Vs]) Calculated flux out of the emf voltage (core voltage) of reference curve.
RV_EXCITATION_REFCURVE_EMF_V	Type: double (e.m.f. voltage [Vrms]) emf voltage for measurement points of reference excitation curve.
RV_EXCITATION_REFCURVE_TERMINAL_V	Type: double (terminal voltage [Vrms]) Terminal voltage from measurement points of reference excitation curve.
RV_EXCITATION_REFCURVE_ICTRMS_I	Type: double (excitation current [Arms]) Excitation current for measurement points of reference excitation curve.
RV_EXCITATION_REFCURVE_ICTPEAK_I	Type: double (excitation current [Apeak]) Peak excitation current for measurement points of reference excitation curve.
RV_EXCITATION_REFCURVE_ICTRECT_I	Type: double (rectified excitation current [Arms]) Rectified average excitation current calibrated to r.m.s.
RV_EXCITATION_REFCURVE_PH_UCT_ICT_DEGREE	Type: double (phase [°]) Phase angle between terminal voltage (Uct) and excitation current (Ict).

RV_EXCITATION_REFCURVE_PH_ UCORE_ICT_DEGREE	Type: double (phase [°]) Phase angle between emf voltage (Ucore) and excitation current (Ict).
RV_EXCITATION_REFCURVE_REM_ FLUX_VS	Type: double (remanence flux [Vs]) Remanence flux for measurement points of reference excitation curve.
RV_EXCITATION_REFCURVE_ INDUCTIVITY_H	Type: double (inductance [H]) Inductance for measurement points of reference excitation curve.
RV_RATIO_REFCURVE_TERMINAL_V	Type: double (terminal voltage [Vrms]) Terminal voltage points of reference excitation curve.
RV_RATIO_TABLE_ROWHEADER_ NOM_BURDEN_VA	Type: double (power [VA]) Burden values shown in the row header of the ratio table.
RV_RATIO_TABLE_ROWHEADER_ NOM_BURDEN_COSPHI	Type: double Cos φ values shown in the row header of the ratio table.
RV_RATIO_TABLE_COLUMNHEADER_ CURRENT_PERCENTAGE	Type: double (% of nominal current) Current ratio error in % at % of rated current shown in the column header of the ratio table.
RV_RATIO_TABLE_ROW1_ CURRENT_DEVIATION	Type: double (current deviation [%]) Values shown in the corresponding row of the ratio table (1st to 4th row).
RV_RATIO_TABLE_ROW2_ CURRENT_DEVIATION	
RV_RATIO_TABLE_ROW3_ CURRENT_DEVIATION	
RV_RATIO_TABLE_ROW4_ CURRENT_DEVIATION	
RV_RATIO_TABLE_ROW1_ CURRENT_DEVIATION_Q	Type: string (value "!" or empty) Qualifier for the values shown in the corresponding row of the ratio table (1st to 4th row). Values without the prefix "!" have
RV_RATIO_TABLE_ROW2_ CURRENT_DEVIATION_Q	
RV_RATIO_TABLE_ROW3_ CURRENT_DEVIATION_Q	

RV_RATIO_TABLE_ROW4_ CURRENT_DEVIATION_Q	guaranteed accuracy. The accuracy of values marked with the prefix "!" is reduced by factor 2 since these values are not directly measured but calculated from the measured values instead.
RV_RATIO_TABLE_ROW1_ PHASE_DEVIATION	Type: double (phase deviation [°]) Values shown in the corresponding row of the phase table (1st to 4th row).
RV_RATIO_TABLE_ROW2_ PHASE_DEVIATION	
RV_RATIO_TABLE_ROW3_ PHASE_DEVIATION	
RV_RATIO_TABLE_ROW4_ PHASE_DEVIATION	
RV_RATIO_TABLE_ROW1_ PHASE_DEVIATION_Q	Type: string (value "!" or empty) Qualifier for the values shown in the corresponding row of the phase table (1st to 4th row). Values without the prefix "!" have guaranteed accuracy. The accuracy of values marked with the prefix "!" is reduced by factor 2 since these values are not directly measured but calculated from the measured values instead.
RV_RATIO_TABLE_ROW2_ PHASE_DEVIATION_Q	
RV_RATIO_TABLE_ROW3_ PHASE_DEVIATION_Q	
RV_RATIO_TABLE_ROW4_ PHASE_DEVIATION_Q	
RV_RATIO_CURVE_FLUX_VS	Type: double (flux in CT core [Vs]) Calculated flux (calculated from the core voltage) from the extended excitation curve (measured during ratio test).
RV_RATIO_CURVE_EMF_V	Type: double (e.m.f. voltage [Vrms]) emf voltage for measurement points of extended excitation curve (measured during ratio test).
RV_RATIO_CURVE_TERMINAL_V	Type: double (terminal voltage [Vrms]) Terminal voltage from measurement points of extended excitation curve (measured during ratio test).
RV_RATIO_CURVE_ICTRMS_I	Type: double (excitation current [Arms]) Excitation current for measurement points of extended excitation curve (measured during ratio test).

RV_RATIO_CURVE_ICTPEAK_I	Type: double (excitation current [Apeak]) Peak excitation current for measurement points of extended excitation curve (measured during ratio test).
RV_RATIO_CURVE_ICTRECT_I	Type: double (rectified excitation current [Arms]) Rectified average excitation current calibrated to r.m.s. (measured during ratio test).
RV_RATIO_CURVE_PH_UCT_ICT_DEGREE	Type: double (phase [°]) Phase angle between terminal voltage (Uct) and excitation current (Ict) of extended ratio curve (measured during ratio test).
RV_RATIO_CURVE_PH_UCORE_ICT_DEGREE	Type: double (phase [°]) Phase between emf voltage (Ucore) and extended excitation current (Ict) (measured during ratio test).
RV_RATIO_CURVE_REM_FLUX_VS	Type: double (remanence flux [Vs]) Remanence flux for measurement points of extended excitation curve (measured during ratio test).
RV_RATIO_CURVE_INDUCTIVITY_H	Type: double (inductance [H]) Inductance for measurement points of extended excitation curve (measured during ratio test).
RV_DEBUG_00	Type: internal parameter Not for customer use.
RV_RATIO_TABLE_ROWHEADER_NOM_BURDEN_COSPHI	Type: double CosPhi of the burden (operating burden) used to calculate the ratio error on the Ratio card.
RV_RATIO_TABLE_ROWHEADER_NOM_BURDEN_VA	Type: double VA value of the burden (operating burden) used to calculate the ratio error on the Ratio card.

Additional indexed values since version 3.0

Element (parameter)	Description
RV_AL_ERROR_GRAPH_KVALUE	Type: double K value (= Ip at ALFi / Ip nominal) at the specified index in the AL-Error graph table.
RV_AL_ERROR_GRAPH_RESISTANCE	Type: double Resistance at the specified index in the AL-Error graph table.
RV_EXCITATION_CURVE_ COERCIVITY_I	Type: double (coercivity [A]) Coercivity for measurement points of the excitation curve.
RV_EXCITATION_REFCURVE_ COERCIVITY_I	Type: double (coercivity [A]) Coercivity for measurement points of the reference excitation curve.
RV_RATIO_CURVE_COERCIVITY_I	Type: double (coercivity [H]) Coercivity for measurement points of extended excitation curve (measured during ratio test).
RV_RATIO_TABLE_ROWHEADER_ NOM_BURDEN_DESIGNATION_EX	Type: enum TCTABurdenType Burden designations corresponding to the burdens shown in the row header of the extended ratio table.
RV_RATIO_TABLE_ROWHEADER_ NOM_BURDEN_VA_EX	Type: double (power [VA]) Burden values shown in the row header of the extended ratio table.
RV_RATIO_TABLE_ROWHEADER_ NOM_BURDEN_COSPHI_EX	Type: double Cos φ values shown in the row header of the extended ratio table.
RV_RATIO_TABLE_COLUMNHEADER_ CURRENT_PERCENTAGE_EX	Type: double (% of nominal current) Current ratio error in % at % of rated current shown in the column header of the extended ratio table.

RV_RATIO_TABLE_ROW1_CURRENT_DEVIATION_EX, RV_RATIO_TABLE_ROW2_CURRENT_DEVIATION_EX, RV_RATIO_TABLE_ROW3_CURRENT_DEVIATION_EX, RV_RATIO_TABLE_ROW4_CURRENT_DEVIATION_EX, RV_RATIO_TABLE_ROW5_CURRENT_DEVIATION_EX, RV_RATIO_TABLE_ROW6_CURRENT_DEVIATION_EX, RV_RATIO_TABLE_ROW7_CURRENT_DEVIATION_EX, RV_RATIO_TABLE_ROW8_CURRENT_DEVIATION_EX	Type: double (current deviation [%]) Values shown in the corresponding row of the extended ratio table. There are max. 8 rows possible. The actual number of rows is defined with: *RV_RATIO_TABLE_NR_ROWS_EX*
RV_RATIO_TABLE_ROW1_CURRENT_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW2_CURRENT_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW3_CURRENT_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW4_CURRENT_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW5_CURRENT_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW6_CURRENT_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW7_CURRENT_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW8_CURRENT_DEVIATION_Q_EX	Type: string (value "!" or empty) Qualifier for the values shown in the corresponding row of the extended ratio table (1st to 8th row). Values without the prefix "!" have guaranteed accuracy. The accuracy of values marked with the prefix "!" is reduced by factor 2 since these values are not directly measured but calculated from the measured values instead.

RV_RATIO_TABLE_ROW1_CURRENT_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW2_CURRENT_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW3_CURRENT_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW4_CURRENT_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW5_CURRENT_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW6_CURRENT_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW7_CURRENT_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW8_CURRENT_DEVIATION_ASSESS_EX	Type: enum TCTAAssessment Assessment value for the values shown in the corresponding row of the extended ratio table. If this vale is *ASS_NOT_ASSESSED* the corresponding ratio value is not used for any class assessment.
RV_RATIO_TABLE_ROW1_PHASE_DEVIATION_EX, RV_RATIO_TABLE_ROW2_PHASE_DEVIATION_EX, RV_RATIO_TABLE_ROW3_PHASE_DEVIATION_EX, RV_RATIO_TABLE_ROW4_PHASE_DEVIATION_EX, RV_RATIO_TABLE_ROW5_PHASE_DEVIATION_EX, RV_RATIO_TABLE_ROW6_PHASE_DEVIATION_EX, RV_RATIO_TABLE_ROW7_PHASE_DEVIATION_EX, RV_RATIO_TABLE_ROW8_PHASE_DEVIATION_EX	Type: double (phase deviation [°]) Values shown in the corresponding row of the extended phase table (1st to 8th row). There are max. 8 rows possible. The actual number of rows is defined with: *RV_RATIO_TABLE_NR_ROWS_EX*

RV_RATIO_TABLE_ROW1_PHASE_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW2_PHASE_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW3_PHASE_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW4_PHASE_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW5_PHASE_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW6_PHASE_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW7_PHASE_DEVIATION_Q_EX, RV_RATIO_TABLE_ROW8_PHASE_DEVIATION_Q_EX,	Type: string (value "!" or empty) Qualifier for the values shown in the corresponding row of the extended phase table (1st to 8th row). Values without the prefix "!" have guaranteed accuracy. The accuracy of values marked with the prefix "!" is reduced by factor 2 since these values are not directly measured but calculated from the measured values instead.
RV_RATIO_TABLE_ROW1_PHASE_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW2_PHASE_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW3_PHASE_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW4_PHASE_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW5_PHASE_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW6_PHASE_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW7_PHASE_DEVIATION_ASSESS_EX, RV_RATIO_TABLE_ROW8_PHASE_DEVIATION_ASSESS_EX	Type: enum TCTAAssessment Assessment value for the values shown in the corresponding row of the extended phase table. If this vale is *ASS_NOT_ASSESSED* the corresponding phase value is not used for any class assessment.

7.5 Quick

7.5.1 TCTAQuickOutMode

The elements of the type `TCTAQuickOutMode` specify the operating mode of the built in signal generator. The elements are used by the function ICTAQuick::SetSetting(QSV_OUT_MODE, parameter) as possible parameter value.

Element	Description
`QSG_OFF`	Signal generator OFF
`QSG_AC_I`	Signal generator outputs AC current
`QSG_AC_U`	Signal generator outputs AC voltage
`QSG_DC_I`	Signal generator outputs DC current
`QSG_DC_U`	Signal generator outputs DC voltage

7.5.2 TCTAQuickRangeMode

The elements of the type `TCTAQuickRangeMode` specify the ranging mode of the measurement channels of the *CT Analyzer*. The elements are used by the function ICTAQuick::SetSetting(QSV_RANGE_MODE, parameter) as possible parameter value.

Element	Description
`QRM_MANUAL`	Manual ranging. Set ranges explicit with: SetSetting(QSV_V1_RANGE, …) SetSetting(QSV_V2_RANGE, …) SetSetting(QSV_I1_RANGE, …)
`QRM_AUTO`	Auto ranging for all 3 measurement channels.

7.5.3 TCTAQuickRangeV1

The elements of the type `TCTAQuickRangeV1` specify the range of the measurement channel SEC of the *CT Analyzer*. The elements are used by the functions ICTAQuick::SetSetting(QSV_V1_RANGE, parameter) as possible parameter value.

Element	Description
QRANGE_V1_300mV	Range SEC channel up to 300mV rms
QRANGE_V1_3V	Range SEC channel up to 3V rms
QRANGE_V1_30V	Range SEC channel up to 30V rms
QRANGE_V1_300V	Range SEC channel up to 300V rms

7.5.4 TCTAQuickRangeV2

The elements of the type TCTAQuickRangeV2 specify the range of the measurement channel PRIM of the *CT Analyzer*. The elements are used by the functions ICTAQuick::SetSetting(QSV_V2_RANGE, parameter) as possible parameter value.

Element	Description
QRANGE_V2_30mV	Range PRIM channel up to 30mV rms
QRANGE_V2_300mV	Range PRIM channel up to 300mV rms
QRANGE_V2_3V	Range PRIM channel up to 3V rms
QRANGE_V2_30V	Range PRIM channel up to 30V rms

7.5.5 TCTAQuickRangeI1

The elements of the type TCTAQuickRangeI1 specify the range of the measurement channel OUT of the *CT Analyzer*. The elements are used by the functions ICTAQuick::SetSetting(QSV_I1_RANGE, parameter) as possible parameter value.

Element	Description
QRANGE_I1_150mA	Range OUT channel up to 150mA rms For the current measurement an internal shunt of 1 ohm is used.
QRANGE_I1_1500mA	Range OUT channel up to 1500mA rms For the current measurement an internal shunt of 1 ohm is used.
QRANGE_I1_3A	Range OUT channel up to 3A rms For the current measurement an internal shunt of 0.05 ohms is used.

QRANGE_I1_30A	Range OUT channel up to 30A rms For the current measurement an internal shunt of 0.05 ohms is used.

7.5.6 TCTAQuickFilterMode

The elements of the type `TCTAQuickFilterMode` specify the operating mode of the input filters of the measurement channels. The elements are used by the functions ICTAQuick::SetSetting(QSV_MEAS_MODE, parameter) as possible parameter value.

Element	Description
QFM_RMS	The measurement values (amplitude) are built by means of standard RMS calculation algorithm.
QFM_FILTER	The input signals are fed through a digital filter with adjustable bandwidth. The bandwith can be adjusted with SetSetting(QSV_BANDWIDTH, …) and is centered to the nominal signal frequency.
QFM_DC	The measurement values (amplitude) are built by means of standard averaging algorithm.

7.5.7 TCTAQuickMeasType

The elements of the type `TCTAQuickMeasType` specify the predefined settings for some useful measurements. The elements are used by the functions ICTAQuick::SetSetting(QSV_MEAS_TYPE, parameter) as possible parameter value.

Element	Description
QMT_VT_RATIO	Configures all settings for VT-Ratio measurement: SetSetting(QSV_OUT_MODE, QSG_AC_U) SetSetting(QSV_OUT_AMPL, 1.0) SetSetting(QSV_OUT_FREQ, 50.0) SetSetting(QSV_MEAS_MODE, QFM_FILTER) SetSetting(QSV_BANDWIDTH, 6.0)

QMT_CT_RATIO	Configures all settings for CT-Ratio measurement: SetSetting(QSV_OUT_MODE, QSG_AC_U) SetSetting(QSV_OUT_AMPL, 1.0) SetSetting(QSV_OUT_FREQ, 50.0) SetSetting(QSV_MEAS_MODE, QFM_FILTER) SetSetting(QSV_BANDWIDTH, 6.0) SetSetting(QSV_LOAD_R, 1.0) SetSetting(QSV_LOAD_L, 50.0)
QMT_RESISTANCE	Configures all settings for resistance measurement: SetSetting(QSV_OUT_MODE, QSG_DC_I) SetSetting(QSV_OUT_AMPL, 1.0) SetSetting(QSV_MEAS_MODE, QFM_DC)
QMT_IMPEDANCE	Configures all settings for impedance measurement: SetSetting(QSV_OUT_MODE, QSG_AC_I) SetSetting(QSV_OUT_AMPL, 1.0) SetSetting(QSV_OUT_FREQ, 50.0) SetSetting(QSV_MEAS_MODE, QFM_FILTER) SetSetting(QSV_BANDWIDTH, 6.0)
QMT_REACTANCE	Configures all settings for reactance measurement: SetSetting(QSV_OUT_MODE, QSG_AC_U) SetSetting(QSV_OUT_AMPL, 1.0) SetSetting(QSV_OUT_FREQ, 400.0) SetSetting(QSV_MEAS_MODE, QFM_FILTER) SetSetting(QSV_BANDWIDTH, 6.0)
QMT_ADVANCED	Configures all settings for standard measurement: SetSetting(QSV_OUT_MODE, QSG_AC_U) SetSetting(QSV_OUT_AMPL, 1.0) SetSetting(QSV_OUT_FREQ, 50.0) SetSetting(QSV_MEAS_MODE, QFM_RMS) SetSetting(QSV_OFFS_REGULATION, 0)

7.5.8 TCTAQuickSetting

The elements of the type `TCTAQuickSetting` specify the setting parameters (quick test settings) of the *CT Analyzer*. The elements are used by the function ICTAQuick::SetSetting(setting-ID, parameter) as possible values of the setting-ID .

Note The CTA remote component automatically limits the adjusted values to their valid ranges.

Element	Description
`QSV_MEAS_TYPE`	Type: TCTAQuickMeasType Specify the predefined measurements on the *CT Analyzer*. This command automatically defines some other settings (see TCTAQuickMeasType on page 200).
`QSV_OUT_MODE`	Type: TCTAQuickOutMode Specify the operating mode of the built in signal generator of the *CT Analyzer* (see TCTAQuickOutMode on page 198)
`QSV_OUT_AMPL`	Type: double Possible values: for AC_I mode : 0 – 5A for AC_U mode: 0 – 40V for DC_I mode : 0 – 10A for DC_U mode: 0 – 120V Specify the output amplitude of the signal generator. For the modes AC_I and DC_I the value is in ampere (RMS), for the modes AC_U and DC_U the value is in volts (RMS).
`QSV_OUT_FREQ`	Type: double Possible values: 5 – 400Hz Specify the output frequency of the signal generator.

QSV_LOAD_R	Type: double Possible values: 0 – 1000 ohms Specify one of the regulation parameters for the built in offset regulator for the output current (see also QSV_OFFS_REGULATION)
QSV_LOAD_L	Type: double Possible values: 0 – 1000 henry Specify one of the regulation parameters for the built in offset regulator for the output current (see also QSV_OFFS_REGULATION)
QSV_RANGE_MODE	Type: TCTAQuickRangeMode Specify the ranging mode of the measurement channels OUTPUT, SEC and PRIM (see TCTAQuickRangeMode on page 198)
QSV_V1_RANGE	Type: TCTAQuickRangeV1 Specify the manual range of the measurement channel SEC (see TCTAQuickRangeV1 on page 198)
QSV_V2_RANGE	Type: TCTAQuickRangeV2 Specify the manual range of the measurement channel PRIM (see TCTAQuickRangeV2 on page 199)
QSV_I1_RANGE	Type: TCTAQuickRangeI1 Specify the manual range of the measurement channel OUTPUT (see TCTAQuickRangeI1 on page 199)
QSV_MEAS_MODE	Type: TCTAQuickFilterMode Specify the operating mode of the input filters of the measurement channels (see TCTAQuickFilterMode on page 200)
QSV_INTEGR_TIME	Type: double Possible values: 0.5 sec Specify the integration time (measurement time) of the measurement channels for RMS-measurements. **Note**: for filter-measurements, the integration time is automatically adjusted.
QSV_BANDWIDTH	Type: double

	Possible values: 3 – 20 Hz Specify the bandwidth of the built in digital filter. Only applicable in filter mode (see TCTAQuickFilterMode on page 200)
QSV_CUTOFF_FREQ	Type: double Possible values: 1.5 – 10 Hz Specify the cut off frequency of the built in digital filter. This is always the same as setting the bandwidth divided by 2. For example: SetSetting(QSV_BANDWIDTH, 6.0) is the same as SetSetting(QSV_CUTOFF_FREQ, 3.0)
QSV_INP_COMP	Type: BOOLEAN Specify the compensation of the input current on the SEC input. If TRUE, this input current must be subtracted from the measured OUTPUT-current. This is necessary for precise current measurement. Normally, keep this setting TRUE.
QSV_OFFS_REGULATION	Type: BOOLEAN Specify if the offset regulator for the output current is ON or OFF. This regulator is necessary for ratio-measurements, to prevent a slowly drift of the magnetic flux in the CT-core. For proper working of the regulator also the settings: QSV_LOAD_R … the winding resistance and QSV_LOAD_L … the inductivity of the connected CT are necessary.

7.5.9 TCTAQuickResult

The elements of the type `TCTAQuickResult` specify the measurement results (quick test) of the *CT Analyzer*. The elements are used by the function ICTAQuick::GetResult(setting-ID) as possible values of the setting-ID .

Element	Description
`QRV_COUNT`	Type: integer The number of measurement results (cycles) since the start of quick test.
`QRV_MEAS_TYPE`	Type: TCTAQuickMeasType The applied predefined meas type (see QSV_MEAS_TYPE).
`QRV_V1_RANGE`	Type: TCTAQuickRangeV1 The actual range of the SEC measurement channel. The same value as with GetV1Results() … array[0].
`QRV_V1_RMS`	Type: double The actual RMS value (volts) of the SEC measurement channel. The same value as with GetV1Results() … array[1].
`QRV_V1_AC`	Type: double The actual AC value (volts) of the SEC measurement channel. The same value as with GetV1Results() … array[2]. AC value means: before calculation of the RMS value, the DC portion of the input signal is subtracted.
`QRV_V1_DC`	Type: double The actual DC value (volts) of the SEC measurement channel. The same value as with GetV1Results() … array[3].
`QRV_V1_FREQU`	Type: double The actual frequency value (Hz) of the SEC measurement channel. The same value as with GetV1Results() … array[4].

QRV_V1_PHASE	Type: double This value is always 0.0 because the channel SEC is the reference for phase measurements. The same value as with GetV1Results() … array[5].
QRV_V1_PEAK_P	Type: double The actual positive peak value (volts) of the SEC measurement channel. The same value as with GetV1Results() … array[6].
QRV_V1_PEAK_N	Type: double The actual negative peak value (volts) of the SEC measurement channel. The same value as with GetV1Results() … array[7].
QRV_V2_RANGE	Type: TCTAQuickRangeV2 The actual range of the PRIM measurement channel. The same value as with GetV2Results() … array[0].
QRV_V2_RMS	Type: double The actual RMS value (volts) of the PRIM measurement channel. The same value as with GetV2Results() … array[1].
QRV_V2_AC	Type: double The actual AC value (volts) of the PRIM measurement channel. The same value as with GetV2Results() … array[2]. AC value means: before calculation of the RMS value, the DC portion of the input signal is subtracted.
QRV_V2_DC	Type: double The actual DC value (volts) of the PRIM measurement channel. The same value as with GetV2Results() … array[3].

QRV_V2_FREQU	Type: double The actual frequency value (Hz) of the SEC measurement channel. The same value as with GetV2Results() … array[4].
QRV_V2_PHASE	Type: double The actual phase difference between SEC channel and PRIM channel (degrees). The same value as with GetV2Results() … array[5].
QRV_V2_PEAK_P	Type: double The actual positive peak value (volts) of the PRIM measurement channel. The same value as with GetV2Results() … array[6].
QRV_V2_PEAK_N	Type: double The actual negative peak value (volts) of the PRIM measurement channel. The same value as with GetV2Results() … array[7].
QRV_I1_RANGE	Type: TCTAQuickRangeI1 The actual range of the OUTPUT measurement channel. The same value as with GetI1Results() … array[0].
QRV_I1_RMS	Type: double The actual RMS value (ampere) of the OUTPUT measurement channel. The same value as with GetI1Results() … array[1].
QRV_I1_AC	Type: double The actual AC value (ampere) of the OUTPUT measurement channel. The same value as with GetI1Results() … array[2]. AC value means: before calculation of the RMS value, the DC portion of the input signal is subtracted.

QRV_I1_DC	Type: double The actual DC value (ampere) of the OUTPUT measurement channel. The same value as with GetI1Results() … array[3].
QRV_I1_FREQU	Type: double The actual frequency value (Hz) of the SEC measurement channel. The same value as with GetI1Results() … array[4].
QRV_I1_PHASE	Type: double The actual phase difference between SEC channel and OUTPUT channel (degrees). The same value as with GetI1Results() … array[5].
QRV_I1_PEAK_P	Type: double The actual positive peak value (ampere) of the OUTPUT measurement channel. The same value as with GetI1Results() … array[6].
QRV_I1_PEAK_N	Type: double The actual negative peak value (ampere) of the OUTPUT measurement channel. The same value as with GetI1Results() … array[7].
QRV_CALC_N	Type: double The ratio between SEC and PRIM channel (V1rms / V2rms). The same value as with GetCalculatedResults() … array[0].
QRV_CALC_Z	Type: double The impedance of the device under test (V1rms / I1rms) in ohms. The same value as with GetCalculatedResults() … array[1].
QRV_CALC_PHASE	Type: double The phase between SEC and OUTPUT in degrees. The same value as with GetCalculatedResults() … array[2].

QRV_CALC_RS	Type: double The real part of the impedance in the serial equivalent circuit in ohms. The same value as with GetCalculatedResults() … array[3].
QRV_CALC_RP	Type: double The real part of the impedance in the parallel equivalent circuit in ohms. The same value as with GetCalculatedResults() … array[4].
QRV_CALC_XS	Type: double The imaginary part of the impedance in the serial equivalent circuit in ohms. The same value as with GetCalculatedResults() … array[5].
QRV_CALC_XP	Type: double The imaginary part of the impedance in the parallel equivalent circuit in ohms. The same value as with GetCalculatedResults() … array[6].
QRV_CALC_LS	Type: double The inductivity in the serial equivalent circuit in henry. The same value as with GetCalculatedResults() … array[7].
QRV_CALC_LP	Type: double The inductivity in the parallel equivalent circuit in henry. The same value as with GetCalculatedResults() … array[8].
QRV_CALC_CS	Type: double The capacity in the serial equivalent circuit in farad. The same value as with GetCalculatedResults() … array[9].
QRV_CALC_CP	Type: double The capacity in the parallel equivalent circuit in farad. The same value as with GetCalculatedResults() … array[10].

QRV_CUR_OVL	Type: boolean A current overload occurred in the actual measurement cycle.
QRV_PWR_OVL	Type: boolean A power overload occurred in the actual measurement cycle.

7.5.10 TCTAQuickStatus

The elements of the type `TCTAQuickStatus` sp.ecify the return value of the property ICTAQuick::Status.

Element	Description
QST_NO_RESULTS	Actually no new measurement result are available on the *CT Analyzer*.
QST_NEW_RESULTS	New measurement results are availabe on the *CT Analyzer*, and can be read out.
QST_USER_ABORT	The user has aborted the running Quick test, by pressing the I/O-key or the ESC-key on the *CT Analyzer*.
QST_CURRENT_OVL	A current overflow occured during the last measurement cycle.
QST_POWER_OVL	A power overflow occured during the last measurement cycle.
QST_CONN_LOST	The connection with the *CT Analyzer* was lost. Check the serial cable connection.

8 Multi-Ratio Support

8.1 Prepare a multi-ratio measurement

Defining a multi-ratio measurement is exactly the same job as defining a single-ratio measurement.

To address the requirements for multi-ratio measurement some types and enumeration values are added.

TCTASettingValue:

Beside the existing enumerating values these values are added:

Element (parameter)	Type and description

`SV_RATIO_TYPE`	Type: enum TCTARatioType
	Type of the CT measurement:
	`SINGLE_RATIO,`
	`MULTI_RATIO`
	measurement.

`SV_MR_NO_TAPS`	Type: integer Possible values: 2 – 6 Number of tap connections of the CT.
`SV_MR_COMMON_TAP`	Type: integer Possible values: 1 or the value set with SV_MR_NO_TAPS. The common tap is the tap that is used as reference for all tap combinations.
`SV_MR_TAP_IN_USE`	Type: enum TCTATapValue The tap in use is the tap combination actually used during operation of the CT.

`SV_MR_TEST_ENABLE_X1_X2`
`...`
`for all combinations between X1 and X6`
`...`
`SV_MR_TEST_ENABLE_X5_X6`
	Type: integer
	Possible values: 0 - 1
	Disable/enable a measurement or calculation on the appropriate tap combination.

SV_MR_I_PN_X1_X2 ... for all combinations between X1 and X6 ... SV_MR_I_PN_X5_X6	Type: double Possible values: 1.0 – 99000.0, -1.0 A value of -1.0 defines a "guesser – value". Defines the nominal primary current on the appropriate tap combination. (… see also 8.1.1 below)
SV_MR_NOM_BURDEN_X1_X2 ... for all combinations between X1 and X6 ... SV_MR_NOM_BURDEN_X5_X6	Type: double Possible values: 0.0 – 300.0, -1.0 A value of -1.0 defines a "guesser – value". Nominal burden of the CT on the appropriate tap combination, used to calculate the behavior of the CT at the nominal burden. (… see also 8.1.1 below)
SV_MR_NOM_COSPHI_X1_X2 ... for all combinations between X1 and X6 ... SV_MR_NOM_COSPHI_X5_X6	Type: double Possible values: 0.0 – 1.0, -1.0 A value of -1.0 defines a "guesser – value". cosφ of nominal burden on the appropriate tap combination.
SV_MR_NOM_BURDEN_TYPE_X1_X2 ... for all combinations between X1 and X6 ... SV_MR_NOM_BURDEN_TYPE_X5_X6	Type: enum TCTABurdenType Nominal burden designation of the CT on the appropriate tap combination, used to calculate the behavior of the CT at the nominal burden. (only for IEEE C57.13)

8.1.1 Recalculations

If you change the nominal primary current or the nominal burden (burden designation TCTABurdenType for C57.13) on the outer tap, all burdens for the inner tap-combinations are recalculated, according to following formula:

$$Burden_i = Burden_{outer\text{-}tap} * Ipn_{outer\text{-}tap} / Ipn_i$$

i ... inner tap combination X1-X2 to X5-X6

The resulting burden is then rounded to the nearest standard burden.

8.1.2 Enumeration types

TCTARatioType:

The elements of the type `TCTARatioType` specify the possible values of a multi-ratio measurement. The elements are used by the parameter SV_RATIO_TYPE of the type TCTASettingValue.

Element (parameter)	Description
SINGLE_RATIO	Measurement of a single-ratio CT.
MULTI_RATIO	Measurement of a multi-ratio CT.

TCTATapValue:

The elements of the type `TCTATapValue` specify a certain tap combination of the taps X1 – X6. The elements are used by the parameter SV_MR_TAP_IN_USE of the type TCTASettingValue.

Element (parameter)	Description
X1_X2	Specify the winding between the taps X1 and X2.
X1_X3	Specify the winding between the taps X1 and X3.
X1_X4	Specify the winding between the taps X1 and X4.
X1_X5	Specify the winding between the taps X1 and X5.
X1_X6	Specify the winding between the taps X1 and X6.
X2_X3	Specify the winding between the taps X2 and X3.
X2_X4	Specify the winding between the taps X2 and X4.
X2_X5	Specify the winding between the taps X2 and X5.
X2_X6	Specify the winding between the taps X2 and X6.
X3_X4	Specify the winding between the taps X3 and X4.
X3_X5	Specify the winding between the taps X3 and X5.
X3_X6	Specify the winding between the taps X3 and X6.
X4_X5	Specify the winding between the taps X4 and X5.
X4_X6	Specify the winding between the taps X4 and X6.
X5_X6	Specify the winding between the taps X5 and X6.

Example:

Define a multi ratio CT with 5 taps and standard ratios 1200:5A

```
ICTAPtr pCTA(CLSID_CTA);
pCTA->Settings->ClearSettings();
pCTA->Settings->SetValue(SV_RATIO_TYPE, MULTI_RATIO);// Define multi
                                                     // ratio
pCTA->Settings->SetValue(SV_I_SN, 5.0);              // Isn for all taps
pCTA->Settings->SetValue(SV_MR_NR_TAPS, 5);          // 5 Taps (X1 – X5)
pCTA->Settings->SetValue(SV_MR_COMMON_TAP, 1);       // Common Tap is X1
pCTA->Settings->SetValue(SV_MR_TAP_IN_USE, X1_X5);   // Tap in use is
                                                     // outer tap
                                                     // (default)
// Settings for outer tap (X1-X5)
pCTA->Settings->SetValue(SV_MR_TEST_ENABLE_X1_X5, 1);// Enable test
pCTA->Settings->SetValue(SV_MR_I_PN_X1_X5, 1200.0);  // Set Ipn

// Settings for tap X1-X4
pCTA->Settings->SetValue(SV_MR_TEST_ENABLE_X1_X4, 1);// Enable test
pCTA->Settings->SetValue(SV_MR_I_PN_X1_X4, 800.0);   // Set Ipn

// Settings for tap X1-X3
pCTA->Settings->SetValue(SV_MR_TEST_ENABLE_X1_X3, 1);// Enable test
pCTA->Settings->SetValue(SV_MR_I_PN_X1_X3, 300.0);   // Set Ipn

// Settings for tap X1-X2
pCTA->Settings->SetValue(SV_MR_TEST_ENABLE_X1_X2, 1);// Enable test
pCTA->Settings->SetValue(SV_MR_I_PN_X1_X2, 200.0);   // Set Ipn

// SetValue(SV_MR_TEST_ENABLE_..., 1) for inter taps are not necessary
// Settings for inter tap X2-X5
pCTA->Settings->SetValue(SV_MR_I_PN_X2_X5, 1000.0);  // Set Ipn

// Settings for inter tap X2-X4
pCTA->Settings->SetValue(SV_MR_I_PN_X2_X4, 600.0);   // Set Ipn

// Settings for inter tap X2-X3
pCTA->Settings->SetValue(SV_MR_I_PN_X2_X3, 100.0);   // Set Ipn

// Settings for inter tap X3-X5
pCTA->Settings->SetValue(SV_MR_I_PN_X3_X5, 900.0);   // Set Ipn
```

```
// Settings for inter tap X3-X4
pCTA->Settings->SetValue(SV_MR_I_PN_X3_X4, 500.0);   // Set Ipn

// Settings for inter tap X4-X5
pCTA->Settings->SetValue(SV_MR_I_PN_X4_X5, 400.0);   // Set Ipn

pCTA->Settings->LocalSaveSettings(L"C:\CTA_Test\MRSettings.xml");
```

8.2 Read a multi-ratio measurement (protocol)

Reading a multi-ratio measurement is exactly the same job as reading a single-ratio measurement.

To address the requirements for multi-ratio measurement some types and enumeration values are added.

TCTAResultValue:

Beside the existing enumerating values these values are added:

Element (parameter)	Type and description
RV_RATIO_TYPE	Type: enum TCTARatioType Type of the CT measurement: SINGLE_RATIO, MULTI_RATIO measurement.
RV_MR_NO_TAPS	Type: integer Possible values: 2 – 6 Number of tap connections of the CT.
RV_MR_TAP_IN_USE	Type: enum TCTATapValue The tap in use is the tap combination actually used during operation of the CT.

RV_MR_TEST_ENABLE_ X1_X2 ... for all combinations between X1 and X6 ... SV_MR_TEST_ENABLE_ X5_X6	Type: integer Possible values: 0 - 1 Disable/enable a measurement or calculation on the appropriate tap combination.
RV_MR_DEFINE_TAP	Type: enum TCTATapValue Select a certain tap combination. Subsequent readings of measurement values with *Results.GetValue(RV_...)* return the results of the selected tap combination. This selection is valid until a new selection is made.
RV_MR_SEC_WINDING_ RATIO	Type: double Possible values: 0.0 – 1.0 The measured secondary winding ratio of the selected tap combination.

Example:

Read some values of multi ratio CT

```
ICTAPtr pCTA(CLSID_CTA);
pCTA->Results->LocalLoadReport(L"C:\CTA_Test\MRResults.xml");

// Read the CT type (Single-/Multi-ratio)
TCTARatioType result = pCTA->Results->GetValue(RV_RATIO_TYPE);
// Read number of taps
int result = ->Results->GetValue(RV_MR_NO_TAPS);
// Rad tap in use
TCTATapValue result = pCTA->Results->GetValue(RV_MR_TAP_IN_USE);

// Read some values for tap X2 – X3
TCTATapValue result = pCTA->Results->SetValue(RV_MR_DEFINE_TAP, X2_X3);
double result = pCTA->Results->GetValue(RV_RATIO_COMPOSITE_ERROR_PERC);
double result = pCTA->Results->GetValue(RV_RATIO_RCF);
double result = pCTA->Results->GetValue(RV_RESISTANCE_R_MEAS);

// Read the same values for tap X1 – X5
TCTATapValue result = pCTA->Results->SetValue(RV_MR_DEFINE_TAP, X1_X5);
```

```
double result = pCTA->Results->GetValue(RV_RATIO_COMPOSITE_ERROR_PERC);
double result = pCTA->Results->GetValue(RV_RATIO_RCF);
double result = pCTA->Results->GetValue(RV_RESISTANCE_R_MEAS);
```

9 Application Examples

The following application examples are installed to your PC during the installation of the *CTA Remote Control Software*. You can find the corresponding files in the installation directory of the software.

The default installation directory is

`C:\Program Files\OMICRON\CT Analyzer PC Toolset\Samples\`

9.1 Available Application Examples

- Excel/VBA: Remote Excel Fileloader for *CT Analyzer*
- Excel/VBA: CTA Remote test.xlt
- VC++: CTA Remote Test

10 Error Handling

Errors can occur within the CTA remote component or can be sent from the device itself. An example for the first is when a local report or settings file can't be loaded (no communication with the *CT Analyzer* happens during these operations). An example for the latter is a failure in test execution.

For both cases, the error condition is communicated in several ways.

10.1 Overview of Error Communication Mechanisms

10.1.1 Result Code (HRESULT)

The CTA remote component is technically solved as a COM server. Every function or property call to a COM server returns a COM result code, a 4-byte integer value.

This result code is hidden in Visual Basic and not accessible, but for program languages such as C++, it's an easy way to check for errors:

```
HRESULT hr;
hr = cta->USBConnect();
if (FAILED(hr)) {
        …
}
hr = cta->Disconnect();
if (SUCCEEDED(hr)) {
        …
}
```

There are two useful C++ macros to deal with result codes. A look to their implementation makes clear how this mechanism works:

```
#define FAILED(hr) ((HRESULT)(hr) < 0)
#define SUCCEEDED(hr) ((HRESULT)(hr) >= 0)
```

Any negative value indicates a failure. To find out the reason of the error, the Device Information can be consulted.

10.1.2 Device Information

Refer to `ICTAInfo` on page 53 for a detailed description.

When an error occurs, the Device Information is updated with the error class, number, location code and a verbose description. If an information is already available from a previous error, this information is overwritten, unless it is of a higher error class than the new error condition: An error will overwrite a warning message, a warning message itself overwrites tooltips and hints, etc.

The Device Information is kept until it is explicitly cleared (using `Info.Clear`).

10.1.3 Error Object

At the time, the new content is placed into the Device Information record, an Error Object is set as well. The Error Object is the standard way to inform Visual Basic programs about errors (in contrast to C++, where the result code is used for this).

Note that the Error Object is created at the same time as the Device Information is updated, but it has to be cleared independently, i.e. by calling `Err.Clear` in Visual Basic. Clearing the Device Information does not clear the Error Object and vice versa.

In the section “Handling Errors in Visual Basic” you will find more information about this mechanism. For C++ this is not of importance.

10.1.4 Logfile

During operation, the CTA remote component writes a log file for the purpose of error diagnosis. The log file is stored in the installation folder of the *CTA Remote Control Software,* which is by default `C:\Program Files\OMICRON\CT Analyzer PC Toolset\CTARemote.exe.log`

The log file can be very useful for coping with failures that are hard to find, since it contains more information than the Device Information record and includes the access history.

10.2 Unstructured Exception Handling in Visual Basic

This section discusses the different ways to treat the Error Object in Visual Basic. In contrast to *structured exception handling* (`Try…Catch…Finally` statements), *unstructured* exception handling involves the `On Error` statement. Unstructured error handling using `On Error` can degrade application performance and result in code that is difficult to debug and maintain.

Therefore, it is generally recommended to use structured exception handling. However, *structured exception handling* is only available in Visual Basic.NET and not in Visual Basic for Applications ("Excel Visual Basic"). There, only unstructured exception handling is considered.

When no exception handling is done, Visual Basic raises a run-time error, shows a message box and stops the application.

10.2.1 Basics

In case of *unstructured exception handling*, an `On Error` statement is inserted at the beginning of a block of code in order to handle any errors occurring within that block. When an exception is raised in a procedure after the `On Error` statement executes, the program branches to the line argument specified in the `On Error` statement. The line argument (a line number or line label) indicates the exception handler location.

Sometimes, a call is made from the original procedure to another procedure, and an exception occurs in the called procedure. In this case, the exception will propagate back to the calling procedure and execution will branch to the line argument, if the called procedure does not handle the exception.

Note Unstructured error handling using `On Error` can degrade application performance and result in code that is difficult to debug and maintain.

10.2.2 On Error GoTo Line

The `On Error GoTo Line` statement assumes that error handling code starts at the line specified in the required line argument. If a run-time error occurs, control branches to the line label or line number specified in the argument, activating the error handler. The specified line must be in the same procedure as the `On Error GoTo Line` statement. Otherwise, Visual Basic generates a compiler error. The following example illustrates the use of an error handler with a line label:

```
Sub TestSub
   On Error GoTo ErrorHandler
      ' Code that may or may not contain errors.
   Exit Sub

   ErrorHandler:
      ' Code that handles errors.
Resume
End Sub
```

The example contains an error handler named `ErrorHandler`. If any code in the `TestSub` subroutine generates an error, Visual Basic immediately executes the code following the `ErrorHandler` label. At the end of the error handling block, the `Resume` statement passes control back to the code line where the error occurred. The rest of the subroutine then continues executing as if the error did not occur.

Note You must place an `Exit Sub` statement immediately before the error handling block. Otherwise, Visual Basic will run the error handling code when it reaches the end of the subroutine, and thus cause unwanted or unexpected results.

10.2.3 On Error Resume Next

The `On Error Resume Next` statement specifies that in the event of a run-time error, control passes to the statement immediately following the one in which the error occurred. Execution continues at that point. `On Error Resume Next` enables you to put error handling routines where errors will occur, rather than transferring control to another location in the procedure.

Note If your procedure calls another procedure, the `On Error Resume Next` statement becomes inactive during the execution of the called procedure. Therefore, you should place an `On Error Resume Next` statement to each called procedure that needs one. This is necessary because the `Resume Next` behavior only applies to the procedure containing the `On Error Resume Next` statement. If an unhandled error occurs in a called procedure, the exception propagates back to the calling procedure, and execution resumes at the statement following the call. In such cases, the error is not handled.

`Resume` can also be used alone, outside the `On Error` statement. When `Resume` is used this way, Visual Basic returns control to the statement that caused the error. You generally use `Resume` after an error handler corrects the error.

Visual Basic also provides the `Resume Next` statement, which directs control to the line immediately following the line of code that caused the error. You might use `Resume Next` for cases in which an error will not cause your application to stop working. You might also use it if an error will not change the expected results of your subroutine.

Another variation of the `Resume` statement is `Resume Line`, which is similar to `On Error GoTo Line`. `Resume Line` passes control to a line you specify in the line argument. You can use `Resume Line` only within an error handler.

Note When debugging your code, you must disable the `On Error Resume Next` statement.

10.2.4 On Error GoTo 0

The `On Error GoTo 0` statement disables any error handler in the current procedure. If you do not include an `On Error GoTo 0` statement, the error handler is still disabled when the procedure containing the exception handler ends.

Note The `On Error GoTo 0` statement is not meant to specify line 0 as the start of the error handling code, even if the procedure contains a line numbered 0.

10.2.5 On Error GoTo -1

The `On Error GoTo -1` statement disables any exception handlers in the current procedure. If you do not include an `On Error GoTo -1` statement, the exception is automatically disabled when its procedure ends.

Note The `On Error GoTo -1` statement is not meant to specify line -1 as the start of the error handling code, even if the procedure contains a line numbered -1.

10.2.6 An Example

In the following code, the exception handler is named `DivideByZero` and handles a specific error - that of attempting to divide by zero. If a different error occurs, Visual Basic raises a run-time error and stops the application.

```
Sub ErrorTest ()
' Declare variables.
   Dim x As Integer, y As Integer, z As Integer
   ' The exception handler is named "DivideByZero".
   On Error GoTo DivideByZero
   ' The main part of the code, which might cause an error.
   x = 2
   y = 0
   z = x \ y
   ' This line disables the exception handler.
   On Error GoTo 0
      Console.WriteLine(x & "/" & y & " = " & z)
   ' Exit the subroutine before the error-handling code.
   ' Failure to do so can create unexpected results.
   Exit Sub

   ' This is the exception handler, which deals with the error.
   DivideByZero:
   ' Include a friendly message to let the user know what is happening.
   Console.WriteLine("You have attempted to divide by zero!")

   ' Provide a solution to the error.
   y = 2

   ' The Resume statement returns to the point at which
   ' the error first occurred, so the application
   ' can continue to run.
   Resume
End Sub
```

11 Warning Messages of the CTA Remote Control Software

532 CTA:CopyFromCTA: error accessing remote file

Reason / Troubleshooting	File on the *CT Analyzer* cannot be accessed. File does not exist or is protected.

532 CTA:CopyToCTA: error accessing remote file

Reason / Troubleshooting	File cannot be created.

537 CTA:CTASettings: failed to save settings '%s'

Reason / Troubleshooting	An error occurred while saving the settings (indicates an internal error).

525 CTA:GetSerialNumber: CTA not connected

Reason / Troubleshooting	Device is not connected. Check the plugs and try to connect again.

520 CTA:InitCom: unable to setup communication line (%d)

Reason / Troubleshooting	The serial line couldn't be configured. Internal error.

525 CTA:ProcessMsg: CTA not connected

Reason / Troubleshooting	Command couldn't be processed because the device is not connected. Check the plugs and try again.

533 CTA:SaveNode: node %s not found

Reason / Troubleshooting	Internal error, possibly due to version incompatibility.

523 CTA:SendCmd: communication error: corrupted msg (%d bytes)

Reason / Troubleshooting	The data received from the device are invalid. This can be caused by mechanical problems with the plug, voltage coupling into the serial line or internal errors.

521 CTA:SendCmd: communication error: invalid msg size

Reason / Troubleshooting	The data received from the device are invalid. This can be caused by mechanical problems with the plug, voltage coupling into the serial line or internal errors.

538 CTA:SendCmd: communication error: loopback detected - no CTA connected

Reason / Troubleshooting	The data received from the device are invalid. This can be caused by mechanical problems with the plug, voltage coupling into the serial line or internal errors.

524 CTA:SendCmd: communication error: unexpected frame number

Reason / Troubleshooting	The data received from the device are invalid. This can be caused by mechanical problems with the plug, voltage coupling into the serial line or internal errors.

502 CTA:SendCmd: communication error: watchdog

Reason / Troubleshooting	The device does not answer. Check the plugs or reboot the device.

522 CTA:SendCmd: communication rx timeout

Reason / Troubleshooting	The device does not answer. Check the plugs or reboot the device.

522 CTA:SendCmd: communication rx timeout msg

Reason / Troubleshooting	The device does not answer. Check the plugs or reboot the device.

534 CTA:SerialConnect: error opening COM port %d, maybe it's in use (%d)

Reason / Troubleshooting	Another application has locked the serial line. Close that application.

528 CTA:UpgradeFirmware: download failed

Reason / Troubleshooting	Download of firmware image failed. Possible causes: Insufficient memory on the device or connection problems.

529 CTA:USB: unable to enlist devices

Reason / Troubleshooting	Internal error. USB device list cannot be accessed.

530 CTA:USB: unable to get device info

Reason / Troubleshooting	Internal error. Error reported by USB device driver.

531 CTA:USB: unable to set line characteristics

Reason / Troubleshooting	Internal error. Error reported by USB device driver.

532 CTAResults:GetNodeText: no file specified

Reason / Troubleshooting	A result value is accessed but no file was loaded. Call LocalLoadReport to load a file before.

533 CTAResults:LocalLoadReport: file %s couldn't be verified

Reason / Troubleshooting	The file is corrupted. It is not a well-formed XML file.

532 CTAResults:LocalLoadReport: file %s doesn't exist

Reason / Troubleshooting	File could not be opened for reading. The file does not exist or is possibly locked.

536 CTASettings: failed to load settings '%s'

Reason / Troubleshooting	`LocalLoadSettings` failed. Problems in data consistency. Check the log file for further information.

535 CTASettings:LoadNode: could't set value for %s

Reason / Troubleshooting	`LocalLoadSettings` failed. Problems in data consistency. Check the log file for further information.

533 CTASettings:LoadNode: node %s not found

Reason / Troubleshooting	`LocalLoadSettings` failed. Problems in data consistency. Check the log file for further information.

533 CTASettings:LoadNode: refnode %s not found

Reason / Troubleshooting	LocalLoadSettings failed. Problems in data consistency. Check the log file for further information.

532 CTASettings:LocalLoadSettings: file %s couldn't be opened

Reason / Troubleshooting	File could not be opened for reading. The file does not exist or is possibly locked.

533 CTASettings:LocalSaveSettings: couldn't verify file %s

Reason / Troubleshooting	The file is corrupted. It is not a well-formed XML file.

532 CTASettings:LocalSaveSettings: error opening file %s

Reason / Troubleshooting	File could not be opened for writing. The file is possibly locked.

533 CTASettings:OpenXMLFile: file %s couldn't be verified

Reason / Troubleshooting	The file is corrupted. It is not a well-formed XML file.

532 CTASettings:OpenXMLFile: file %s doesn't exist

Reason / Troubleshooting	File could not be opened for reading. The file does not exist or is possibly locked.

12 Error and Warning Messages of the CT Analyzer

Please refer to the CT Analyzer User Manual for a complete list of error and warning messages of the *CT Analyzer*.

13 Contact Information / Technical Support

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For addresses of OMICRON offices with customer service centers, regional sales offices or offices for training, consulting and commissioning please see our website.

CT SB2

User Manual

Manual Version: CTSB2.AE.2

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

PC and CTA interfaces

BURDEN
IN: Measurement input for burden measurement.
OUT: Generator output for burden measurement.
A green LED lights up when the output is active.

TAPS
Terminals for connection of CT taps X1 to X6.
Connect each CT tap to both sockets!
A green LED lights up to indicate which input/output is currently active.

See also Figure 2-2

Equipotential bonding connector

PRIM
IN: Measurement input for primary side of the CT.
OUT: Generator output for primary winding resistance measurement.
A green LED lights up when the output is active.

CT ANALYZER
Input and output terminals for connection to the *CT Analyzer* measurement inputs and generator output.

LEDs
I/0 Green power LED. Indicates that the *CT SB2* is switched on and ready for operation.
⎍ Status LED.

Mains connection unit
Mains socket with fuse and ON/OFF switch

Figure 2-1 *CT SB2* overview

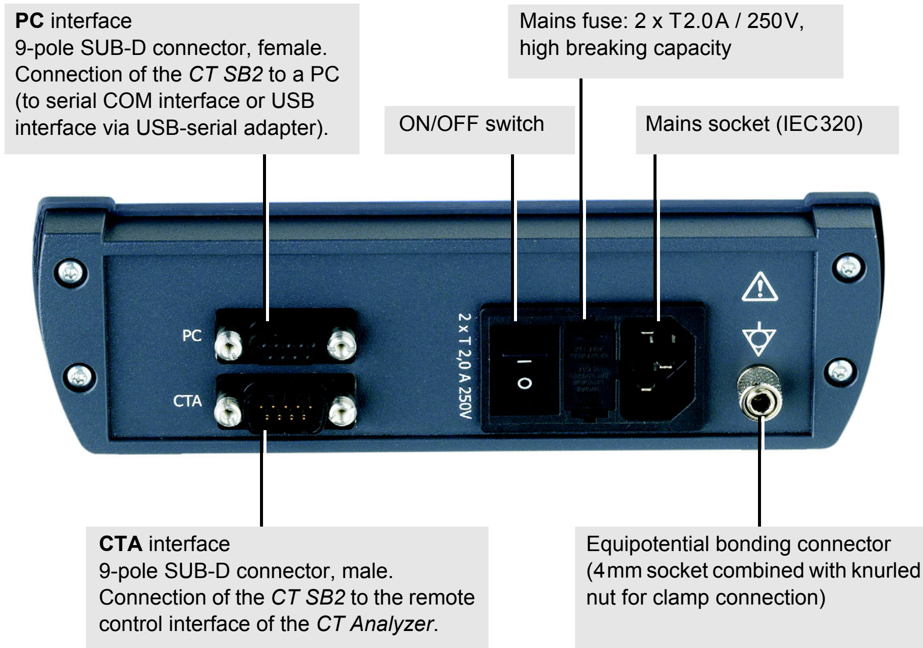


Figure 2-2 Side view to the *CT SB2* with mains connection unit, PC and CTA interfaces, and equipotential bonding connector

2.2 Block Diagram (Simplified)

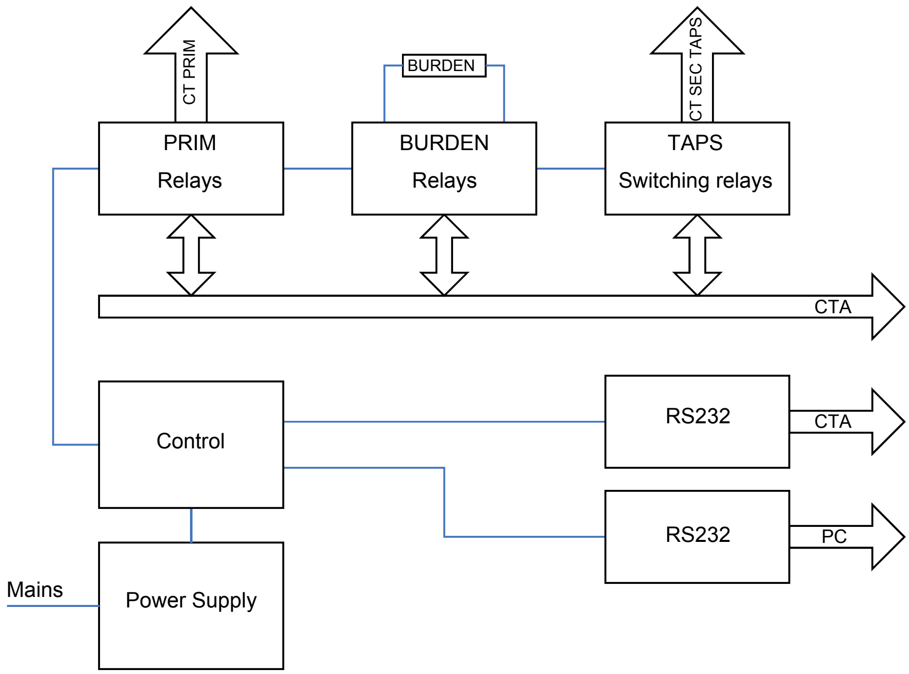
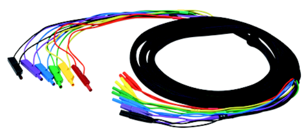


Figure 2-3 Simplified block diagram of the *CT SB2*

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

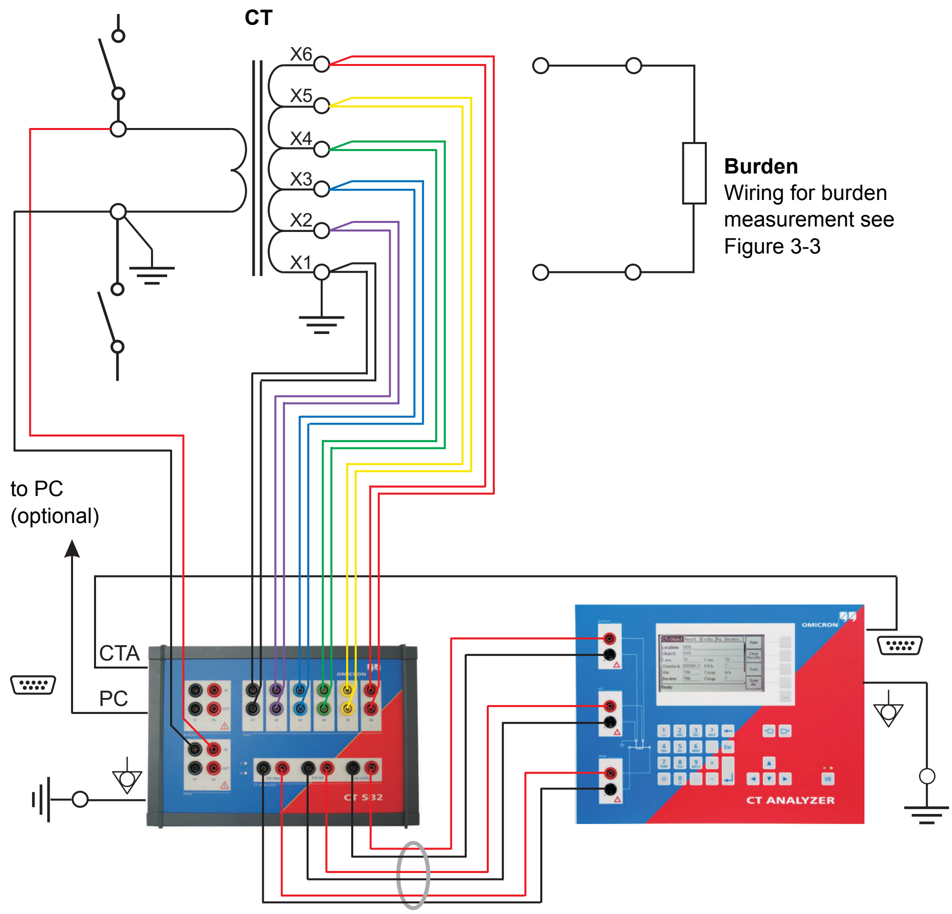


Figure 3-1 Basic measurement setup for multi-ratio CT testing (6 tap CT, no burden measurement, no primary winding resistance measurement)

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*.

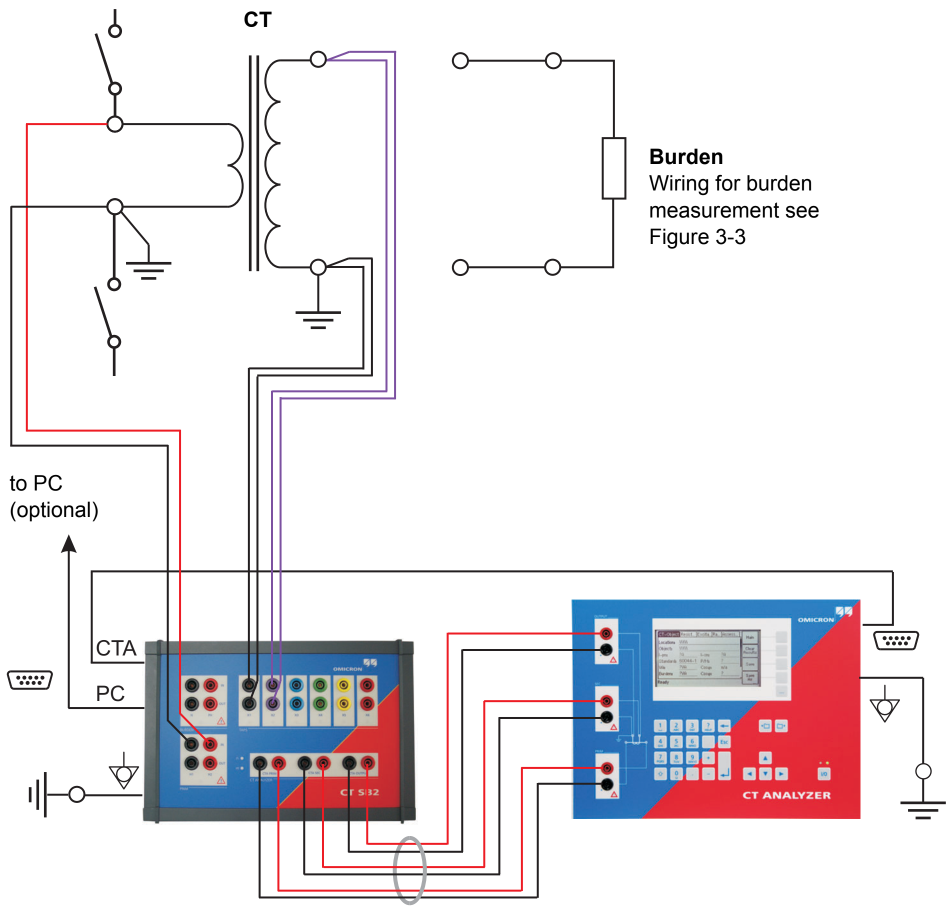


Figure 3-2 Basic measurement setup for single-ratio CT testing (no burden measurement, no primary winding resistance measurement)

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).

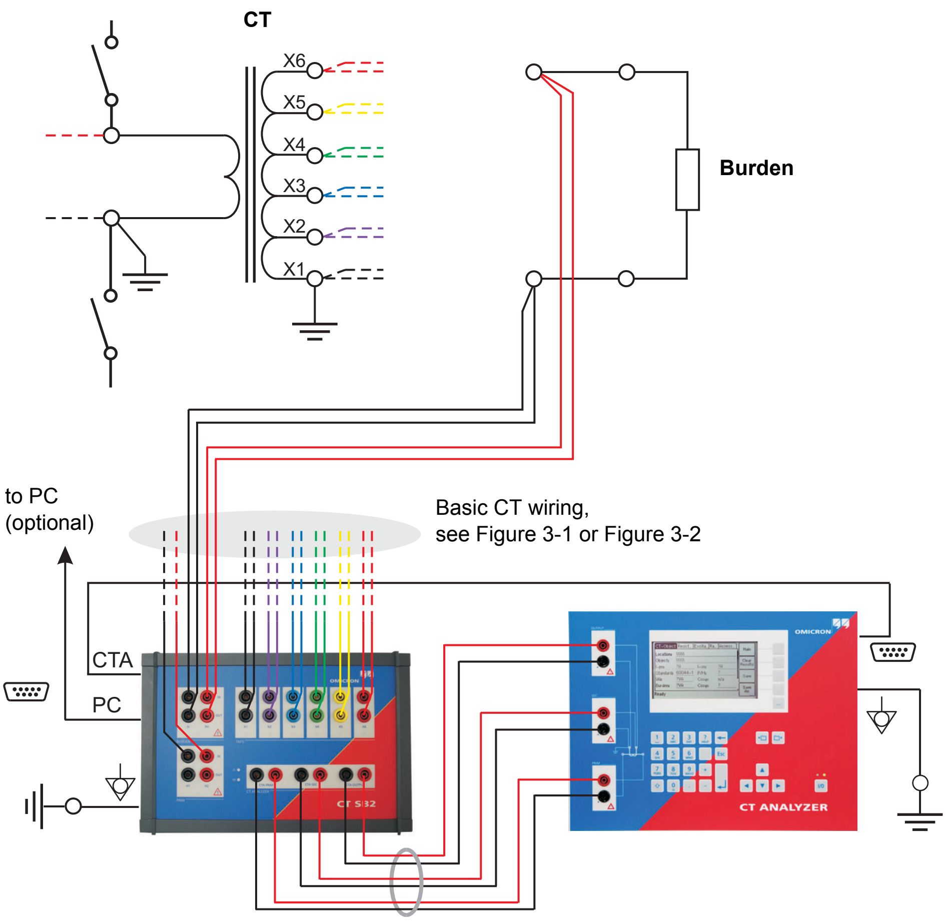


Figure 3-3 Additional wiring required for burden measurement

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).

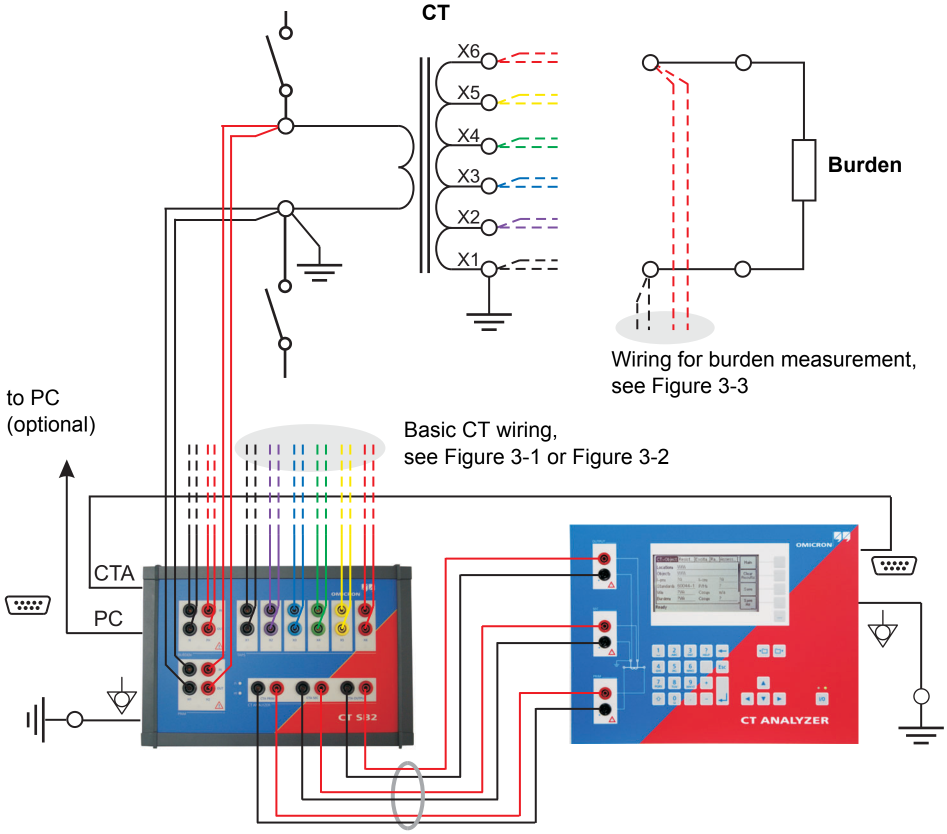


Figure 3-4 Additional wiring required for primary winding resistance measurement

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.

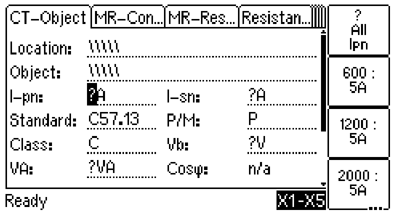


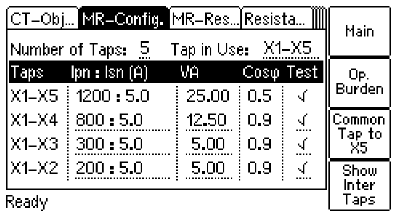
Figure 4-1 **CT-Object** card with soft keys for predefined CT ratios if the number of taps is set to 5

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.

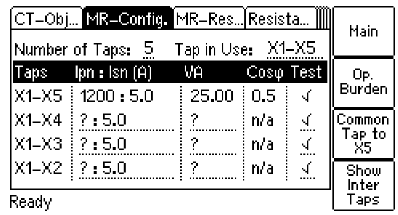
Burden cos φ	Operating burden and cos φ of the **tap in use**. If the value of the connected operating burden is available, enter the values to these fields. If you measure the burden during the CT test using the burden measurement function of the *CT Analyzer*, these fields are filled automatically. 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.



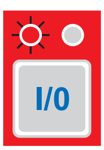
MR-Config. card for a new multi-ratio CT test after specifying the values for I_{pn} and I_{sn} manually in the **CT-Object** card.

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	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.
or	
Burden cos φ	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.



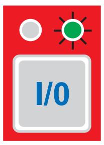
4. Start the multi-ratio CT test by pressing the I/0 key on the *CT Analyzer*. The red LED on the *CT Analyzer* flashes to indicate that the CT test is running.

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).

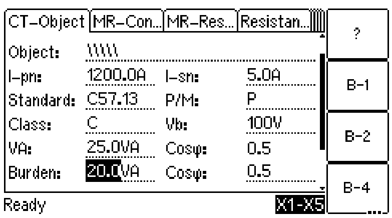


Figure 4-3 **CT-Object** card after the test is finished

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

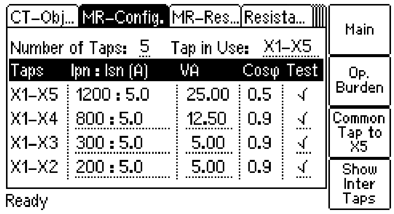
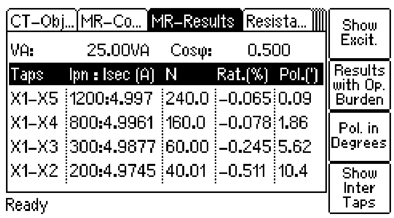


Figure 4-4 **MR-Config.** card

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.



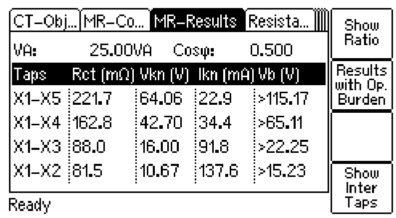


Figure 4-5 **MR-Results** card showing ratio results (left) and excitation results (right)

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.

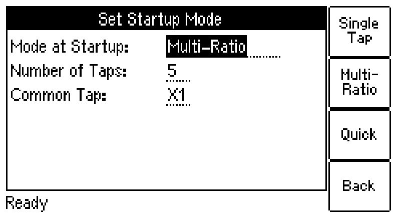


Figure 5-1 **Set Startup Mode** page with **Multi-Ratio** startup mode selected

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*.

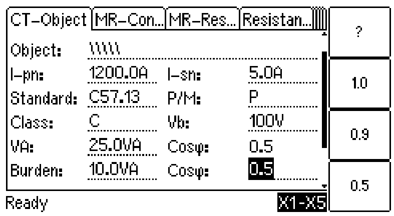
Common Tap	The common tap is the tap that is used as reference for all tap combinations (e.g. X1-X2, X1-X3, X1-X4, etc. if common tap is X1). Select the default common tap using the soft keys **X1** and **X#**, where # is the highest tap number available depending on the selected number of taps. The 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

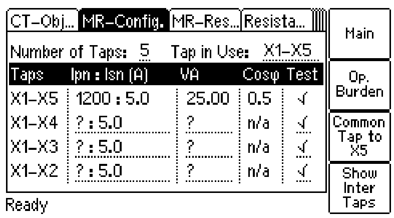
For multi-ratio CT testing using the *CT SB2* switch box, the *CT Analyzer* provides two additional test cards: **MR-Config.** and **MR-Results**.

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*.

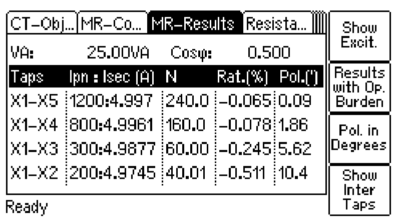
Depending on the selected standard, the behavior of the **CT-Object** card may differ slightly from the normal single-ratio CT test mode without using the *CT SB2*.



See section 6.1 on page 36.



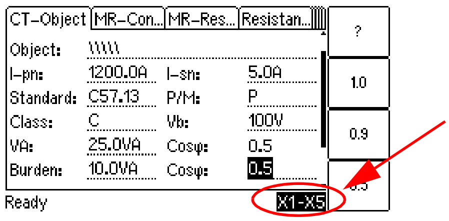
See section 6.2 on page 38.



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. <u>For IEEE C57.13 only:</u> 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).

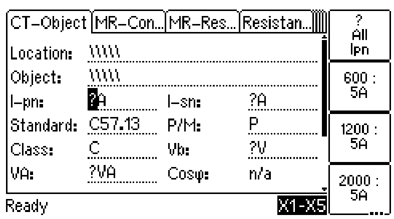


Figure 6-2 **CT-Object** card with soft keys for predefined CT ratios if the number of taps is 5

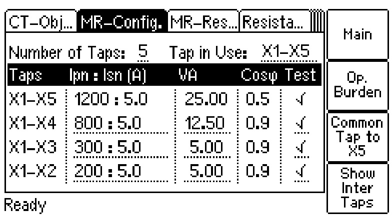
6.2 MR-Config. Card

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

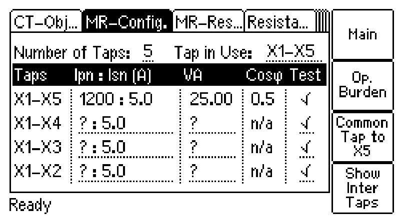
- the number of taps available on the CT,
- the "tap in use", i.e., the tap combination (ratio) which is actually used and connected to the operating burden during operation of the CT,
- the nominal CT ratios for the tap combinations,
- the nominal burden for each tap combination,
- and select the tap 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. 25VA for X1-X5, 12.5VA 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.

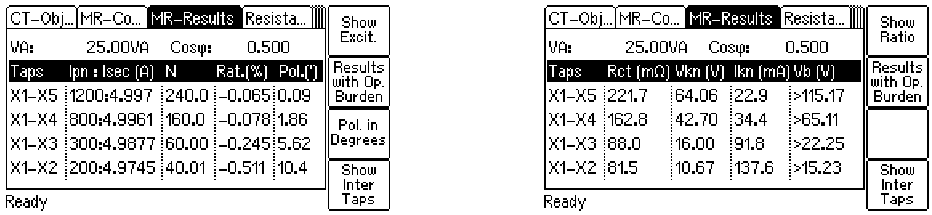


Figure 6-4 **MR-Results** card with measurement results: Page for **ratio** results (left) and page for **excitation** results (right)

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*.

PC interface

9-pole SUB-D connector, female

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

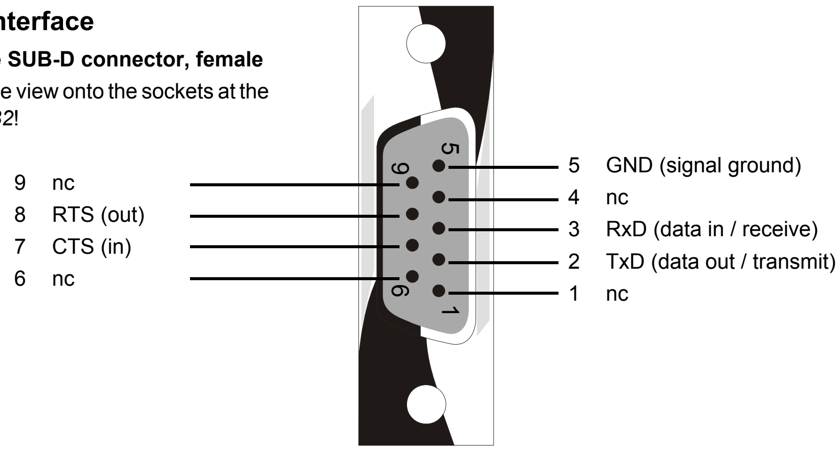


Figure 7-1 PC interface on the *CT SB2*

CTA interface

9-pole SUB-D connector, male

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

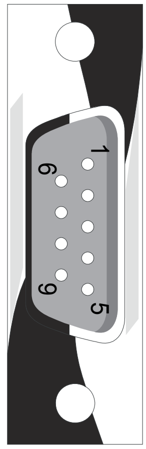


Figure 7-2 CTA interface on the *CT SB2*

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

Connections required:

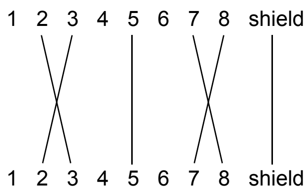


Figure 7-3 Connection cable *CT SB2* to *CT Analyzer*

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.

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