OMICRON

VOTANO 100

User Manual

Manual version: ENU 1105 05 06

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, up-to-date, and reliable. However, OMICRON 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 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.

Table of Contents

1 Introduction

1.1 About this document

This document provides information on how to use this product safely, properly and efficiently.

It contains important safety rules for working with this product and gets you familiar with operating this product. Following the instructions in this document will help you to prevent danger, repair costs, and avoid possible down time due to incorrect operation.

This document is to be supplemented by existing national safety standards for accident prevention and environmental protection.

1.2 Symbols and conventions

The following symbols indicate safety instructions for avoiding hazards.

⚠ DANGER

Death or severe injury will follow if the appropriate safety instructions are not observed.

⚠ WARNING

Death or severe injury may occur if the appropriate safety instructions are not observed.

⚠ CAUTION

Minor or moderate injury may occur if the appropriate safety instructions are not observed.

NOTICE

Equipment damage or loss of data possible.

In this document, the following symbols and formatting styles are used:

Symbol/format	Description
✔	Conditions to be met before starting the following task
▶	Instructions that can be carried out in any order
1. 2.	List of instructions and substeps to be carried out in the given order 1. Step 2. Step 2.1 Substep 2.2 Substep
➔ / ➔	Expected outcome of a step/task
Text in bold	Text shown on a device, its display or in a software
Text in italics	OMICRON product name
ⓘ / **Note:**	Additional information, explanations or tips

1.2.1 Terminal designations used in this documentation

The descriptions and diagrams presented in this documentation use the terminal markings according to the IEC standards. For the terminal markings used in other standards, please refer to the corresponding standard.

Examples for IEC terminal markings:
A and N for the primary winding of a VT and 1a-1n, 2a-2n etc. for the secondary windings.

Examples for IEEE terminal markings:
H1 and H2 for the primary winding of a VT and X1-X2, Y1-Y2 etc. for the secondary windings.

1.3 Compliance statements

In the following statement, the device is designated as "product", "equipment", or "apparatus".

The OMICRON contact address can be found on the last page (back page) of this document.

Declaration of conformity (EU)

The equipment adheres to the guidelines of the council of the European Community for meeting the requirements of the member states regarding the following directives:

- Electromagnetic compatibility (EMC) directive
- Low voltage directive (LVD)
- RoHS directive
- Radio equipment directive (RED)

Declaration of conformity (UK)

The equipment adheres to the regulations of the UK government for meeting the requirements regarding the following regulations:

- Electromagnetic Compatibility (EMC) Regulation
- Electrical Equipment Regulation (Safety)
- Regulation for Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment

FCC compliance (USA)

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. If this equipment does cause harmful interference to radio or television reception, contact OMICRON Support.

Declaration of compliance (Canada)

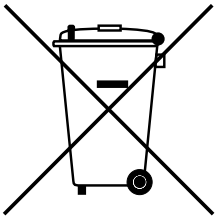
This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

The use of shielded LAN cables is required when connecting this equipment to any optional peripheral or host devices. Failure to do so may violate FCC and ICES rules, and the EMC directive.

Grounding is required to fulfill the immunity requirements according to the EMC directive.

1.4 Recycling



This device (including all accessories) is not intended for household use. At the end of its service life, do not dispose of the device with household waste.

For customers in EU countries (incl. European Economic Area)

OMICRON devices are subject to the EU Waste Electrical and Electronic Equipment Directive (WEEE directive). As part of our legal obligations under this legislation, OMICRON offers to take back the device and to ensure that it is disposed of by authorized recycling agents.

For customers outside the European Economic Area

Contact the authorities in charge for the relevant environmental regulations in your country and dispose of the OMICRON device only in accordance with your local legal requirements.

1.5 Related documents

The following documents complete the information covered in the VOTANO 100 User Manual:

Title	Description
VOTANO Suite Help System	Contains detailed information about the *VOTANO Suite* software. *VOTANO Suite* provides comprehensive features for controlling your *VOTANO 100* from a computer.

2 Safety

- ▶ Before operating the device, carefully read the instructions in this document. Only install and operate the device and any accessories after you have read this document, and fully understood all instructions.
- ▶ Contact the OMICRON Support (→ Support (page 196)) if you do not understand any of the instructions in this document.

2.1 Disclaimer

- ▶ Only use this device and its accessories in accordance with the corresponding user documentation.

Improper use may result in damage to persons or property and could invalidate warranty claims.

2.2 Operator qualifications

Only authorized and qualified personnel who are regularly trained in electrical engineering are permitted to operate the device and any accessories.

Personnel receiving training, instructions, directions, or education on the device must be under constant supervision of an experienced operator while working with the equipment. The supervising operator must be familiar with the equipment and the regulations on site.

- ▶ Before starting to work, clearly establish the responsibilities.
- ▶ The supervising operator must coordinate the communication with all persons involved in work activities.

2.3 Safety standards

While operating the device, users must read and adhere to all safety-relevant documents as well as comply with all local and national safety standards and regulations internal safety instructions including but not limited to:

- EN 50191 (VDE 0104) "Erection and Operation of Electrical Test Equipment"
- EN 50110-1 (VDE 0105 Part 100) "Operation of Electrical Installations"
- IEEE 510 "IEEE Recommended Practices for Safety in High-Voltage and High-Power Testing"
- LAPG 1710.6 NASA “Electrical Safety”

- ▶ Observe all applicable standards and regulations for accident prevention on site.

2.4 Safety rules

Always observe the five safety rules:

- ▶ Disconnect completely.
- ▶ Secure against re-connection.
- ▶ Verify that the installation is dead.

- ▶ Carry out grounding and short-circuiting.
- ▶ Provide protection against adjacent live parts.

2.5 Orderly measures

This document has to be available on the site where the device is operated, either digitally or in print.

- ▶ Read this document before operating the device, and comply with any included instructions and workflows.

Opening the device or any accessories without authorization invalidates all warranty claims.

- ▶ Contact OMICRON Support (→ Support (page 196)) for maintenance and repair.

2.6 General instructions

- ▶ Avoid interruptions or distractions that could affect safety.
- ▶ If the device or any accessory does not seem to function properly, do not use it. If in doubt, contact OMICRON Support (→ Support (page 196)).
- ▶ Only use cables supplied by OMICRON.
- ▶ Only use original accessories available from OMICRON.
- ▶ Make sure that the test object is isolated from other sources during testing.

OMICRON offers a range of accessories for added safety during the operation of our test systems. For further information and specifications, contact OMICRON Support (→ Support (page 196)).

Using the **Lock Device** function of *VOTANO 100*, you can lock the test set in a safe state, for example, when leaving the test setup temporarily or when entering the high-voltage area of a complex test environment where it is not possible to completely observe the entire test setup (*VOTANO 100* and high-voltage area with *VBO2* and test object) at any time.

2.7 Work environment

- ▶ Only use the device on dry, solid ground.
- ▶ Do not operate the device in a condensing environment.
- ▶ Do not operate the device in the presence of explosive gas or vapors.
- ▶ Do not operate the device under ambient conditions that exceed the temperature and humidity limits listed in the user documentation.
- ▶ Before use, check that the environmental conditions are suitable for any additional equipment such as a computer.
- ▶ Make sure that the device and all accessories are dry and clean. In dusty regions, use protective cable caps.

2.8 Personal safety

- Protect others from accessing the test area and accidentally touching live parts by setting up a suitable barrier and, if applicable, warning lights.
- Warn other people prior to any operation to make them aware of any possible disturbances.
- If you have a cardiac pacemaker, do not use the device. If you have another type of electronic medical implant consult a medical professional before operating the device. Make sure there is no person with an electronic medical implant such as a cardiac pacemaker in the immediate vicinity.
- Leave the test area before performing a test with the device. Stay in the work area during the test.

2.9 Mechanical safety

- Do not insert objects into any of the device's openings.
- Do not cover the device and make sure any ventilation openings remain unobstructed.
- Ensure that all safety-relevant components such as safety lamps and emergency stop buttons are always visible and accessible.
- Test leads wired to tall test objects must be sufficiently mechanically secured. Be aware of the hazard of falling adapters or cables.
- Do not block access to safety-relevant test set components, such as the emergency stop button.

See also

Support [▸ 196]

2.10 Test setup and work area

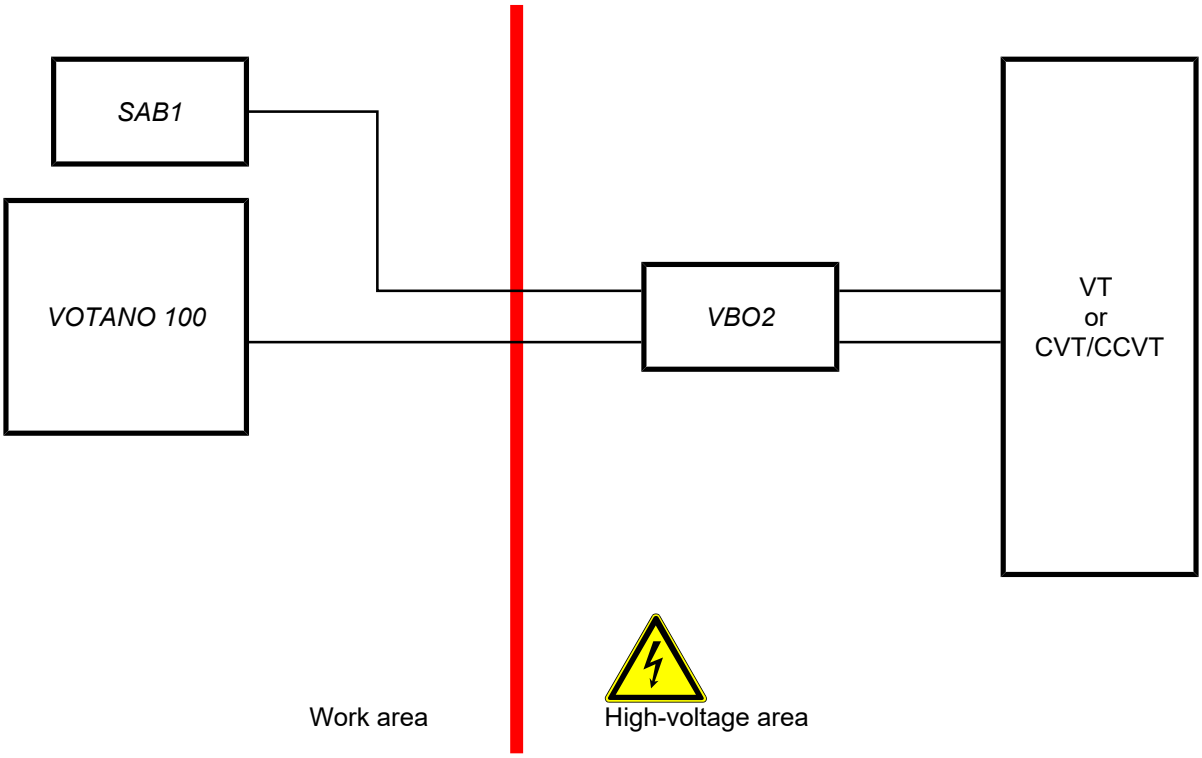


Figure 2-1: Schematic representation of the test setup showing the separation between work area and high-voltage area

- Define a high-voltage area around the test object and secure this area sufficiently against unauthorized access, for example using a barrier chain and a warning sign.
- Position the *VOTANO 100* test set and the *SAB1* safety box on dry, solid ground in the work area outside of the high-voltage area.
- Position the *VBO2* voltage booster on dry, solid ground close to the terminal box of the test object in the high-voltage area, and use the 3 m eight-core connection cables provided on delivery for connection to the low-voltage side of the test object. For high-voltage structures or for structures where the terminal box is not accessible from ground level, place the *VBO2* voltage booster on a dry, solid support next to the terminal box.
- Always stay in the work area during the test. Do not enter the high-voltage area during the test sequence if not explicitly requested by *VOTANO 100* or *VOTANO Suite*.
- Prevent the presence of other persons in the high-voltage area during the test.
- Always position the test equipment in a way that you can completely observe the entire test setup (*VOTANO 100* and high-voltage area with *VBO2* and test object) at any time.
- If this is not possible, the high-voltage area has to be observed by a second person which is in visual or acoustic communication with the operator of the *VOTANO 100* test set.
- Do not stand right next to or directly underneath a connection point because the clamps may fall off and touch you.

2.11 Performing tests

- Deactivate the outputs of the VBO2 voltage booster by pressing the emergency stop button before entering the high-voltage area for rewiring during the test sequence. Although *VOTANO 100* brings the test setup into a safe and de-energized state before requesting any wiring to be performed by the user during the test, you should always press the emergency stop button before entering the high-voltage area in order to increase safety.
- For some measurements, *VOTANO 100* injects voltage to the secondary side of the voltage transformer. This may cause high voltages on the primary terminals of the voltage transformer.
- Do not touch the primary terminals of the voltage transformer during the test.
- Always maintain adequate safety clearance according to EN 50191 from these terminals during the test.
- Do not touch any terminals without a visible connection to ground.
- 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.
- Do not leave unused high-voltage cables connected to the primary terminals of the voltage transformer if the other end of the cable is not connected to the *VBO2*. Always disconnect unused high-voltage cables from the primary terminals to prevent the transfer of high voltages to the unconnected cable connector of the high-voltage cables.
- Stay in the work area during the test.
- Never remove any cables from *VOTANO 100*/*VBO2* or the test object during a test.
- When disconnecting cables, always start at the device feeding the power.
- Start the test only if all safety precautions were taken and if you are absolutely sure that no other person is present in the high-voltage area around the test object.

2.12 Grounding

Operating *VOTANO 100*/*VBO2* without PE and ground connection is life-threatening and not permitted.

- Only operate *VOTANO 100*/*VBO2* with a mains power supply connected to protective earth (PE).
- Make sure that both the PE connection of the power supply and the ground connectors of *VOTANO 100* and *VBO2* have a solid and low-impedance connection to the grounding system on site.
- Make sure that grounding clamps have a good electrical contact to the grounding system on site and avoid connecting them to corroded or painted surfaces.
- Make sure that the grounding terminal connections of all grounded devices in use remain intact during the whole measurement procedure and are not accidentally disconnected.
- Only use ground and supply cables provided by OMICRON.

2.13 Power supply

Power supply from grounded grids (TN/TT)

Before a measurement is started, *VOTANO 100* automatically verifies the PE connection in grounded grids (TN/TT).

▶ If this check fails, check the power cord and power supply.

If the error message persists, there is no intact connection to protective earth (PE). This is life-threatening. In this case, measurements are not permitted and cannot be performed.

Additional information

Instead of supplying *VOTANO 100*/*VBO2* from phase-neutral (L1-N, A-N), the devices may also be supplied from phase-phase (for example, L1-L2; A-B). However, the voltage must not exceed 240 V_{AC}.

3 Preface

3.1 Designated use

Use *VOTANO 100*, *VBO2*, *SAB1*, and the cables provided on delivery exclusively according to their designated use described below. 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.

3.1.1 Designated use of VOTANO 100/VBO2

The *VOTANO 100* test set and the *VBO2* voltage booster are intended to perform guided testing, manual testing, and calibration of voltage transformers. The devices can be used in laboratories as well as on-site. The voltage transformers can be tested regarding to the ratio error and the phase displacement.

The following voltage transformers can be tested:

- Inductive voltage transformers (VT)
- Capacitive voltage transformers/coupling capacitor voltage transformers (CVT/CCVT). For CVT/CCVT voltage transformer testing and analysis, please observe the restrictions stated in Test restrictions (page 20).

The following measurements can be performed using *VOTANO 100* and *VBO2*:

- Measurement of the voltage transformer accuracy according to IEC and IEEE standards
- Transformer ratio measurement
- Measurement of the phase displacement
- Secondary winding resistance measurement
- Excitation characteristics measurement
- Short-circuit impedance measurement
- Burden measurement
- Measurement of the capacitances and the voltage ratio of the capacitor voltage divider of CVT/CCVT voltage transformers

The *VOTANO 100* test set and the *VBO2* voltage booster must only be used as a combination of these two devices. It is not permitted to use *VOTANO 100* or *VBO2* stand-alone without the other device connected properly as described in Setup and test preparation (page 39).

VOTANO 100 performs the accuracy measurement based on an indirect method, the so-called model-based approach. This method cannot fully substitute high-voltage primary injection test methods if the test voltage of *VOTANO 100* is below the rated voltage of the voltage transformer under test and the voltage transformer is not stressed dielectrically sufficiently. Nevertheless, *VOTANO 100* delivers accurate ratio and phase measurements comparable to conventional methods using high testing voltages.

The model-based method can be used in several stages of the voltage transformer lifetime (in-production test, additional routine test, commissioning, on-site acceptance, maintenance, …). The model-based approach makes voltage transformer testing easier, faster, more intuitive, safer and less complex.

3.1.2 Designated use of the six-core connection cable

The six-core cable delivered with *VOTANO 100* is exclusively intended to connect the input and output sockets of *VOTANO 100* to the MAIN UNIT multipole socket on the *VBO2* voltage booster.

3.1.3 Designated use of the eight-core test cables

The eight-core test cables delivered with *VOTANO 100* are exclusively intended to connect the secondary windings of the voltage transformer under test or the burden under test to the LOW VOLTAGE TEST multipole sockets on the *VBO2* voltage booster.

3.1.4 Designated use of the VBO2 high-voltage cables

The *VBO2* high-voltage cables are specifically designed for use with *VOTANO 100* and *VBO2*. These cables have to be used to connect the primary terminal and, if available, terminal NHF of the voltage transformer under test to the *VBO2* voltage booster.

3.1.5 Designated use of the SAB1 safety box

The *SAB1* safety box delivered with *VOTANO 100* is specifically designed for use with OMICRON test equipment. It provides:

- An emergency stop button to immediately switch off all outputs in case of emergency. This button can also be pressed before entering the high-voltage area during the test in order to increase safety during wiring actions.
- A start pushbutton, which has to be pressed by the user upon request of *VOTANO 100* or the *VOTANO Suite* software to launch the execution of the test or measurement.
- LEDs to indicate the status of the test and the test setup.

Refer to SAB1 safety box (page 37) for more detailed information on the *SAB1* safety box.

3.2 Test restrictions

The *VOTANO 100* test set is designed to test voltage transformers (Designated use of VOTANO 100/VBO2 (page 17)) used in electrical power systems. The test concept is based on the mathematical model of voltage transformers (inductive and capacitive/coupling capacitor voltage transformers). *VOTANO 100* uses test signals below the nominal voltage and above and below the nominal frequency.

Depending on the device under test, the results of this model-based test method may differ from the results obtained with other test methods (for example, conventional methods with injection of high voltages and comparison against reference devices). In case of doubt, *VOTANO 100* should be calibrated for the individual test object to find out potential differences between the different test methods. If an initial calibration has been performed for the individual test object, *VOTANO 100* can be used as an independent and accurate mobile calibration device.

The information below shall help to identify which types of voltage transformers can only be tested with reduced accuracy (compared to the accuracy stated in Technical data (page 177)) and for which types of voltage transformers difficulties may arise when testing them with *VOTANO 100*.

Inductive voltage transformers with air-gapped cores or a remarkably low inductance at secondary side measurements

When testing voltage transformers with air-gapped cores or a remarkably low inductance at secondary side measurements, *VOTANO 100* is possibly not able to deliver results for the entire measurement range of the voltage transformer (especially for the rated voltage factor 190 %). Measuring such voltage transformers possibly requires higher saturation than *VOTANO 100* is able to apply.

To enable the testing of high values such as 190 % of the rated voltage, a model extension is implemented, which, however, may lead to reduced accuracy of the results.

For voltage transformers with multiple secondary windings, an option is available to extend the possible range for measuring the excitation curve with *VOTANO 100*. Selecting this option may possibly resolve or improve such restrictions (see the 'Extended Excitation Curve' option (Test configuration (page 128)) for more information).

Capacitive voltage transformers/coupling capacitor voltage transformers (CVT/CCVT)

All designs and models of CVT voltage transformers that allow disconnection of the NHF terminal from ground can be tested with *VOTANO 100*. You can use the VT/CVT Test mode to obtain the functional parameters of CVT voltage transformers, such as ratio and phase displacement.

The Advanced VT/CVT Test mode allows a more detailed analysis, calibration and class assessment of CVT voltage transformers. The accuracy of the measurement results obtained with the Advanced VT/CVT Test mode of *VOTANO 100* may be lower than specified if the CVT voltage transformer under test is equipped with an integrated damping unit that cannot be accessed from outside to open the damping circuit during the test.

CVTs/CCVTs where the connection of the NHF terminal to ground cannot be opened during the test cannot be tested with *VOTANO 100*.

Voltage transformers that are equipped with additional devices for turns correction

Additional devices for turns correction installed inside the voltage transformer (for example, an additional inductive voltage transformer) might influence the *VOTANO 100* measurement results.

3-Phase inductive voltage transformers

Testing 3-phase voltage transformers using *VOTANO 100* in combination with *VBO2* is generally possible under consideration of certain constraints and restrictions.

For testing 3-phase inductive voltage transformers with the *VOTANO 100* single-phase test set, it is necessary to perform three individual single-phase tests in sequence. However, since the magnetic induction in the iron core for 3-phase injection differs from the induction for 1-phase injection, the results obtained with *VOTANO 100* might differ slightly from the results obtained with a 3-phase primary injection test (3-phase nominal voltage applied) depending on the design of the voltage transformer under test. To make sure that the tests are comparable, OMICRON recommends to initially calibrate *VOTANO 100* against the 3-phase test system for the VT type to be tested, because the inaccuracies specified for *VOTANO 100* are only valid for single-phase tests.

Please refer to the dedicated application notes or contact the OMICRON Technical Support for details, connection diagrams and other important settings.

Voltage transformers installed in GIS

For voltage transformers installed in gas insulated switchgears (GIS), the accuracy of the *VOTANO 100* measurement including the secondary side excitation measurement might be influenced by parasitic effects.

Therefore, the measurement accuracy may be lower than specified (for all relevant voltages and burden values). Due to this, running a VT/CVT test instead of the Advanced VT/CVT test may be regarded as an alternative for voltage transformers installed in GIS.

⚠ DANGER

Death or severe injury caused by high voltage or current

VOTANO 100 injects voltage to the secondary side of the voltage transformer for some of these measurements. This may cause high primary voltages.

- ▶ Do not enter the high-voltage area during the test.
- ▶ Always maintain adequate safety clearance according to EN 50191 from the primary terminals of the GIS during the test.

3.3 Definition: VT and CVT/CCVT

VTs are inductive voltage transformers (so-called potential transformers (PT)).

CVTs/CCVTs are capacitively coupled voltage transformers that use a combination of a capacitor voltage divider and an inductive voltage transformer to step down high voltages. In the ANSI standard they are referred to as CCVTs. In the IEC standards they are referred to as CVTs.

The following figure explains the difference between a VT and a CVT/CCVT.

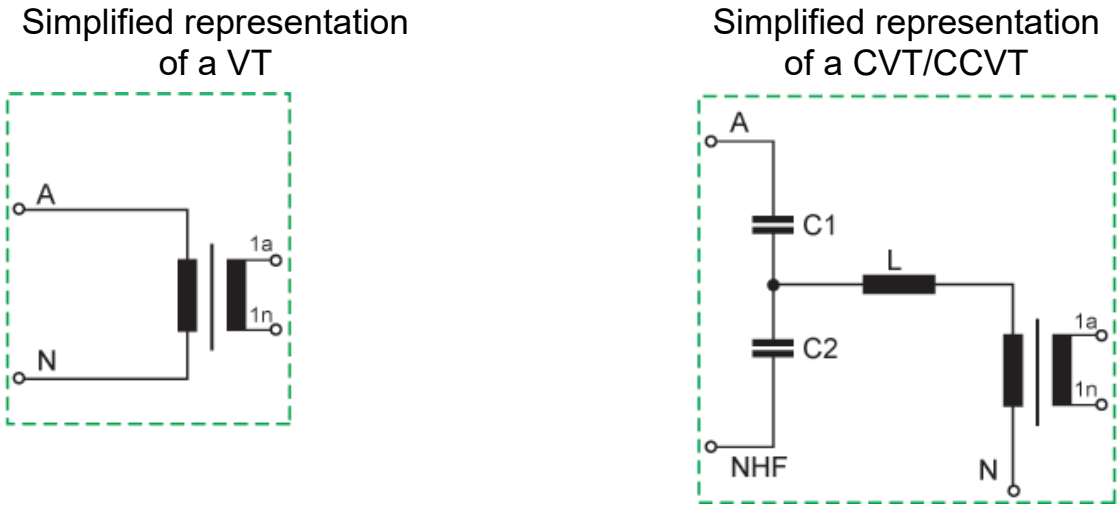


Figure 3-1: VT and CVT/CCVT

3.4 VOTANO 100 test set hardware

3.4.1 Overview

The following figure provides an overview of the operating and display elements and the connectors of the *VOTANO 100* test set. Refer to sections Grounding terminal (page 33) to HIGH VOLTAGE TEST sockets (page 36) for a more detailed description of the elements and connectors.

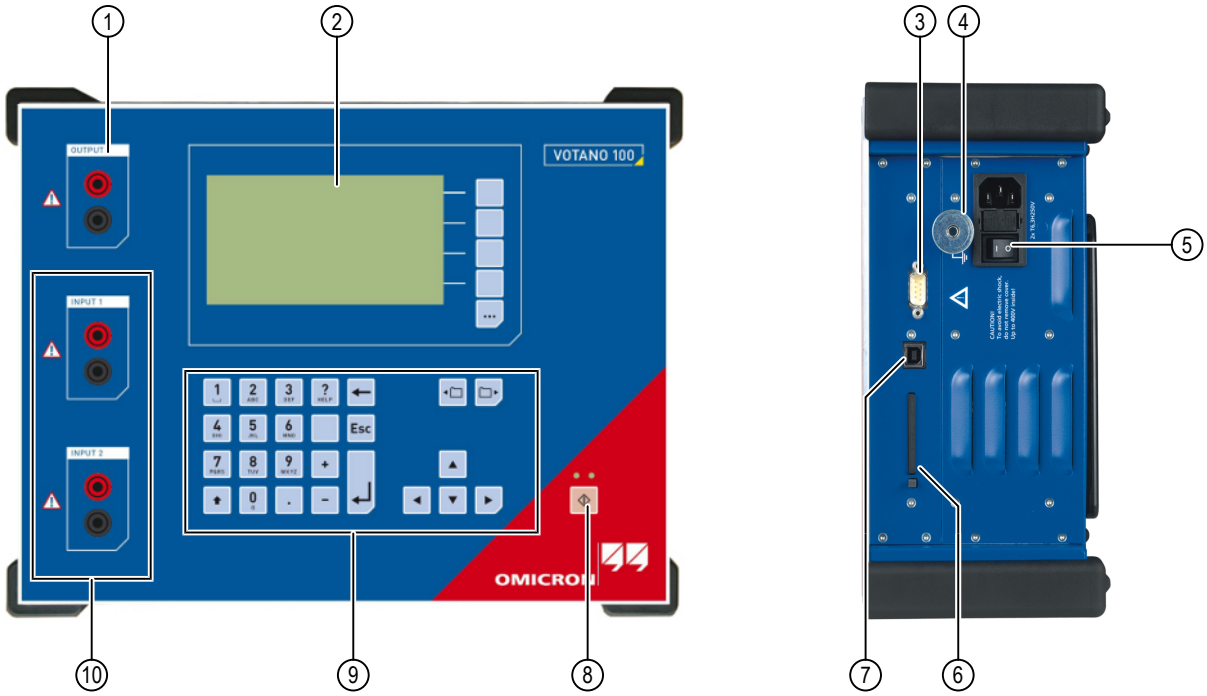


Figure 3-2: *VOTANO 100* overview

1	Generator output (connected to VBO2)	6	Compact Flash card slot
2	Display with context-dependent keys ("soft keys")	7	USB interface for PC connection
3	D-Sub 9 interface (communication interface to VBO2)	8	I/0 key with status LEDs
4	Grounding terminal	9	Keyboard with cursor keys and card selection keys
5	Mains connection unit: Mains socket with fuse and ON/OFF switch	10	Voltage measurement inputs (connected to VBO2)

3.4.2 Mains connection unit and grounding

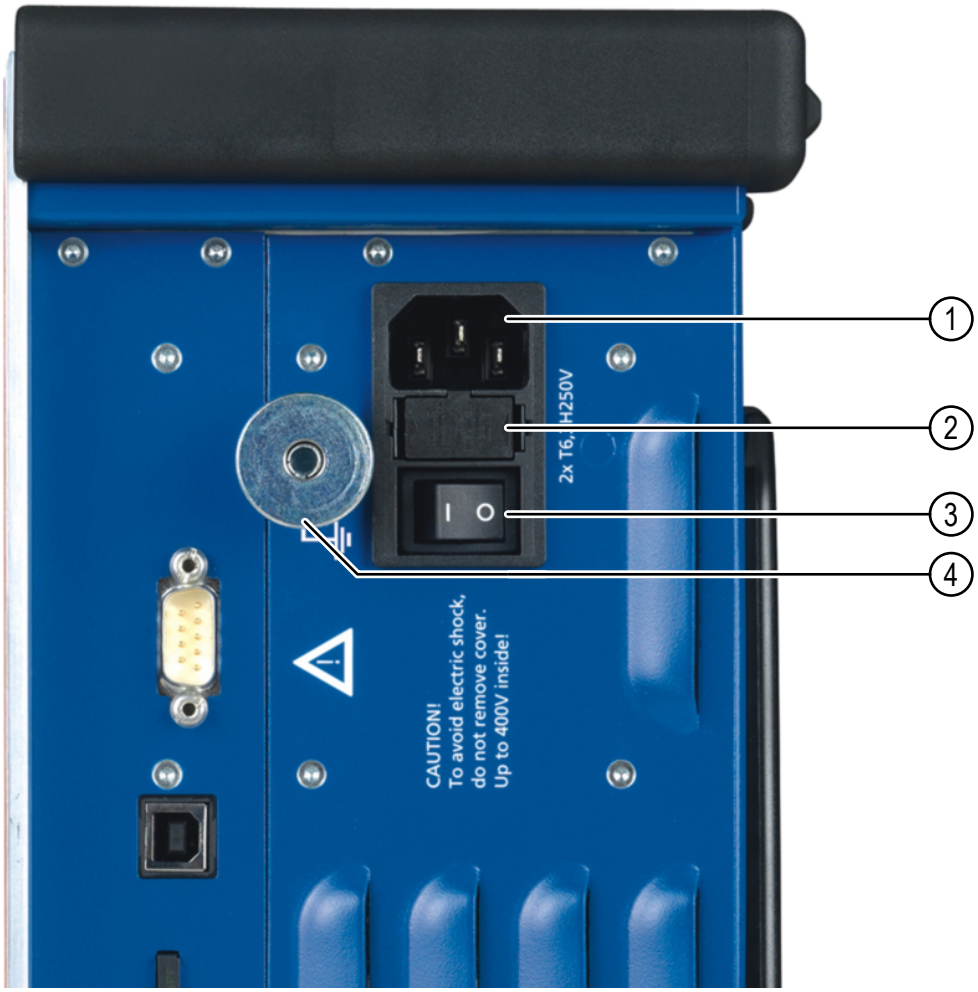


Figure 3-3: Mains connection unit and grounding terminal

1	Mains socket (IEC320)	3	ON/OFF switch
2	Mains fuse: 2 × T6.3A/250V, high breaking capacity	4	Grounding terminal (knurled nut)

3.4.3 Interfaces (VBO2 and PC connection)

To VBO2
D-Sub 9 interface: Communicatoin with VBO2
(use the RS232 crossover cable delivered by OMICRON)

To PC
USB interface (type B connector): Communication with PC
(use the original USB cable delivered by OMICRON
or a shielded USB cable with ferrite cores applied!)

Figure 3-4: Interfaces to *VBO2* and PC

3.4.4 Compact Flash card slot

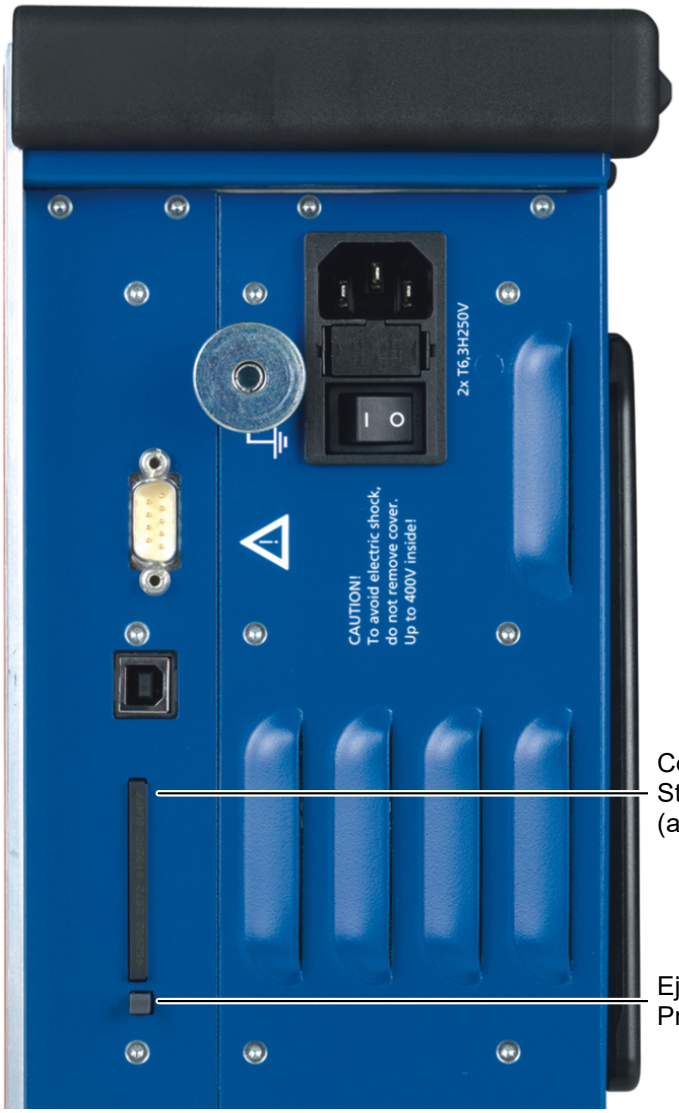
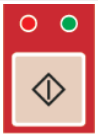


Figure 3-5: Compact Flash card slot

3.4.5 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 *VOTANO 100* test set on, both LEDs are on. The red LED goes off when the boot process is finished and *VOTANO 100* is ready for operation.

The **green LED lights continuously** to indicate that the equipment is operational, the grounding connections are applied properly and no voltage is applied to the test setup.

The **red LED flashes** to indicate that a test is in progress and voltage is applied to the test setup. Do not enter the dangerous high-voltage area or touch any part of the test setup while the red LED is flashing!

Any other behavior of the status LEDs than described above indicates an error. In this case, actuate the emergency stop button and do not enter the high-voltage area. Contact the OMICRON Technical Support (Support (page 196)).

3.4.6 Inputs and outputs

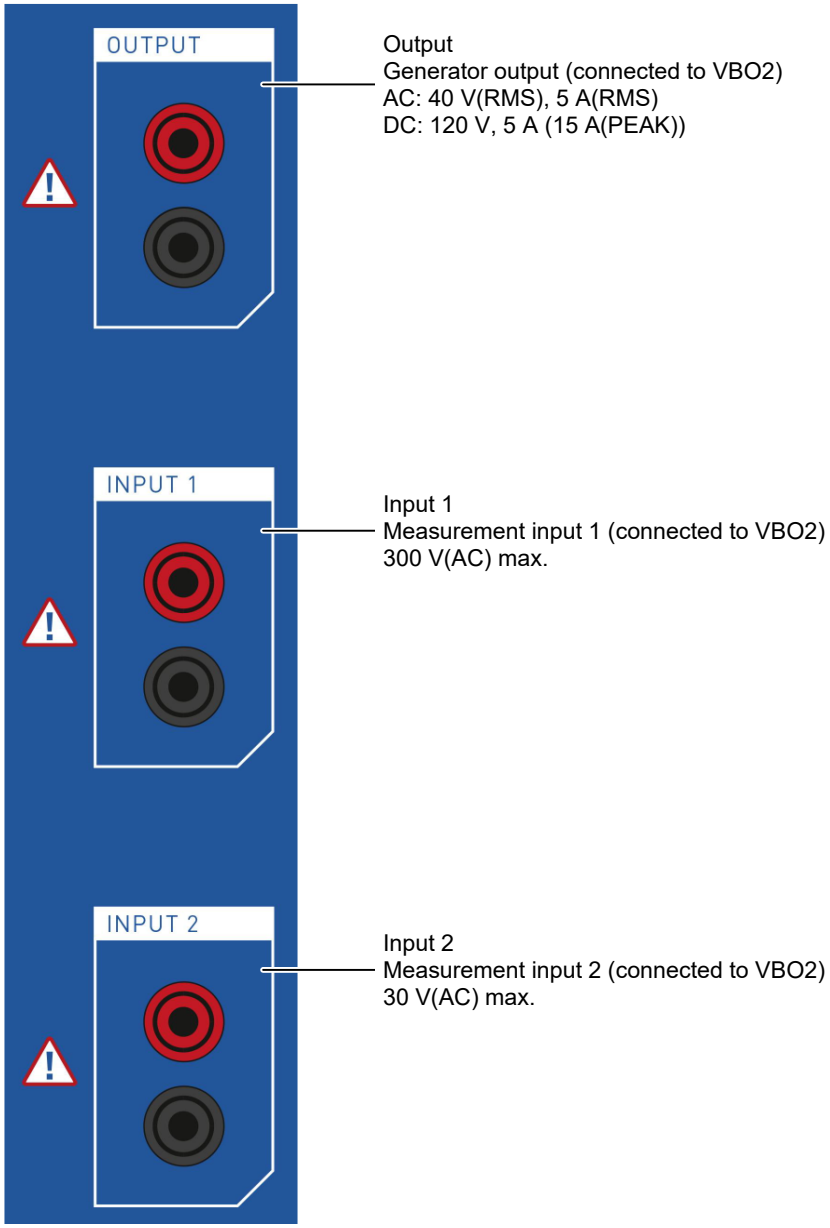


Figure 3-6: Inputs and outputs of *VOTANO 100*

3.4.7 Display with soft keys

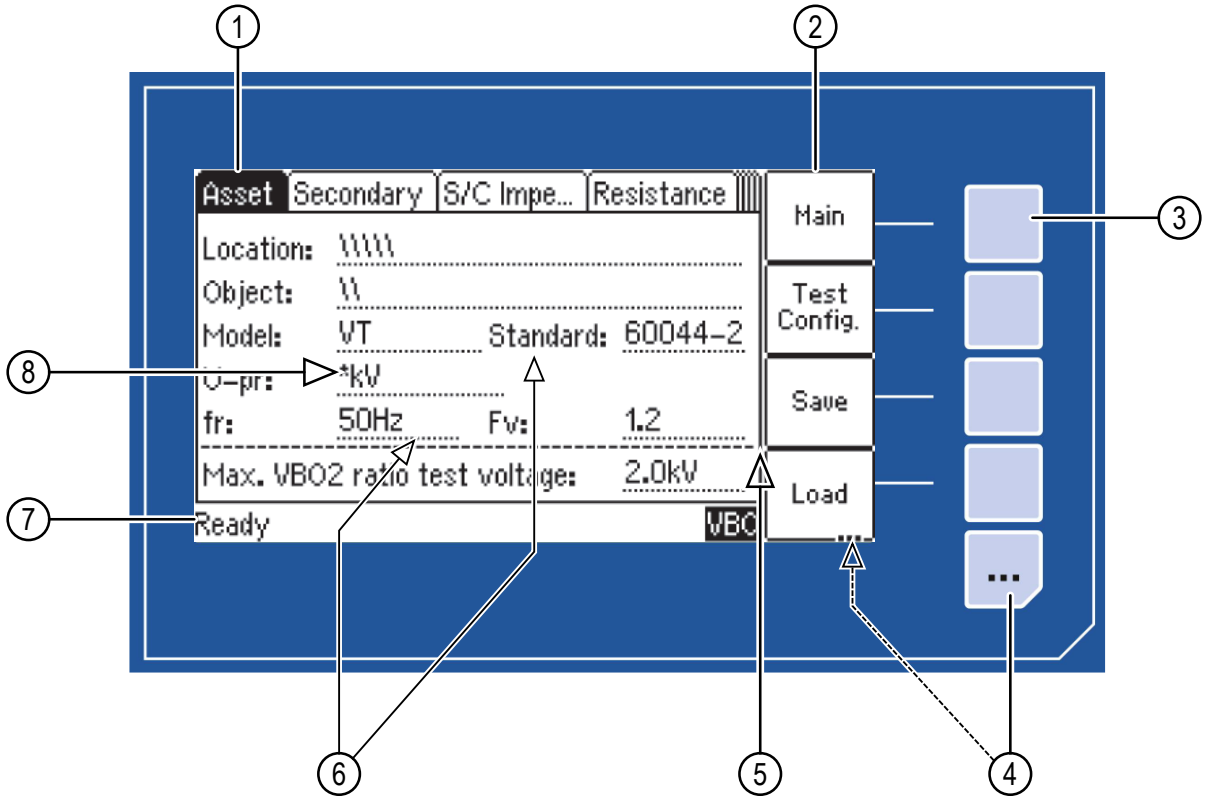


Figure 3-7: Display with context-dependent soft keys

1	Card area with tab	5	A scrollbar is displayed if the content of a card is too long to be displayed at a time. Use the up/down cursor keys on the keyboard to scroll through the card.
2	Soft key description fields	6	Edit fields are underlined by dotted lines. Display fields are not underlined.
3	Soft keys, labeled by the soft key description fields	7	Status line
4	If 3 points are visible in the lowermost soft key description field (see dashed arrow), this key can be used to open an additional set of soft keys.	8	Mandatory parameters that require user input prior to the test are marked with a star.

The following icons may be displayed in the status line:

Table 3-1: Icons displayed in the status line

Icon	Description
VBO	The *VBO2* voltage booster is connected to the *VOTANO 100* test set.
VBO	*VBO2* overtemperature or undertemperature. Wait until *VBO2* has cooled down or warmed up.
▷	The VT/CVT Test mode of *VOTANO 100* is selected.

Icon	Description
⫩	The C-Divider Test mode of *VOTANO 100* is selected.
	No test mode icon is displayed if the Advanced VT/CVT Test mode of *VOTANO 100* is selected.
	Remote control. *VOTANO 100* is connected to a computer and the *VOTANO Suite* software running on that computer has established connection to *VOTANO 100*.
	The *VOTANO 100* keyboard is locked • until the ongoing test is finished if a test was started from the *VOTANO Suite* software or • until the update process is finished if an update is performed from the *VOTANO Suite* software.
SIM	*VOTANO 100* is in simulation mode. The left part of the status line displays the file name of the test file currently loaded for simulation. Please refer to Simulation mode (page 64).

3.4.8 Keyboard

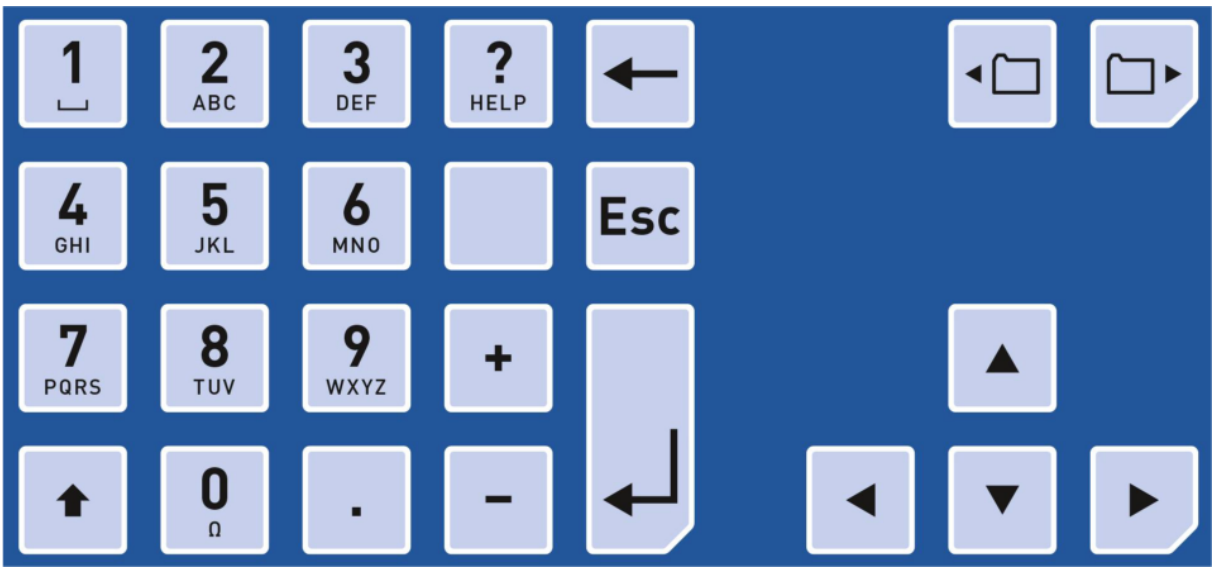
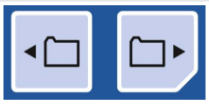


Figure 3-8: Keyboard

Table 3-2: Keyboard elements

Key	Description
	Numeric/character keys for entering values and text. After pressing a key, the status line displays the character set available for this 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.

Key	Description
	Press this key to enter capital letters.
	Press this key to display the context-sensitive help system (VOTANO 100 help system (page 122)).
	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 **Asset** card is the top user interface level. Pressing this key several times will always bring you back to the **Asset** card.
	Press this key to apply a change for an edit field. When working in the *VOTANO 100* 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.

3.5 VBO2 voltage booster hardware

3.5.1 Overview

The following figure provides an overview of the operating elements and the connectors of the VBO2 voltage booster. Refer to sections Grounding terminal (page 33) to HIGH VOLTAGE TEST sockets (page 36) for a more detailed description of the elements and connectors.

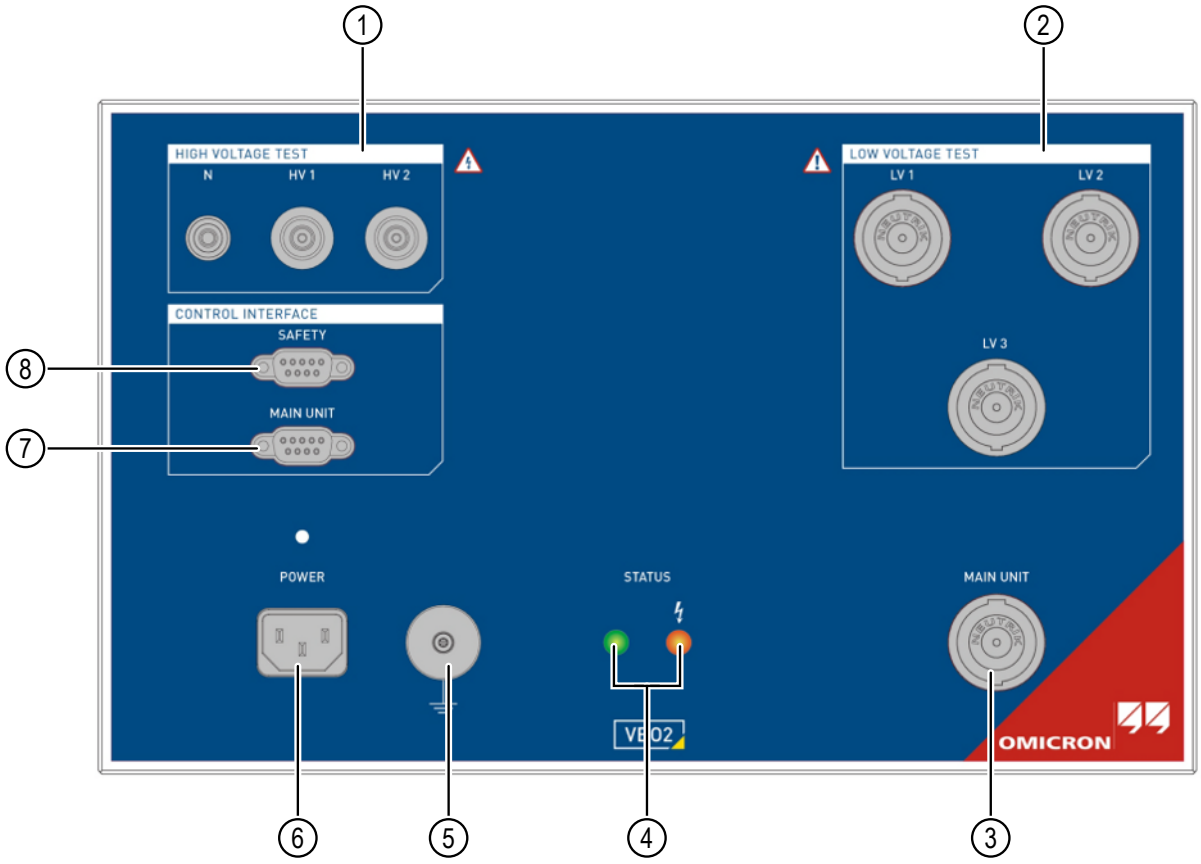


Figure 3-9: VBO2 overview

1	**To test object** High-voltage sockets to connect the primary terminals of the voltage transformer under test to *VBO2*. Connection as requested by *VOTANO 100* (Connecting and disconnecting the test object (page 75)).	2	**To test object** Multipole sockets for three eight-core test cables. Use these cables to connect the secondary windings of the voltage transformer under test or the burden under test to *VBO2*. Connection as requested by *VOTANO 100* (Connecting and disconnecting the test object (page 75)).
3	**To** *VOTANO 100* Multipole socket for the six-core connection cable to *VOTANO 100*.	4	Status LEDs
5	Grounding terminal	6	Mains socket
7	To *VOTANO 100* Male D-Sub 9 interface	8	Female D-Sub 9 interface for *SAB1* **safety box**.

3.5.2 Grounding terminal

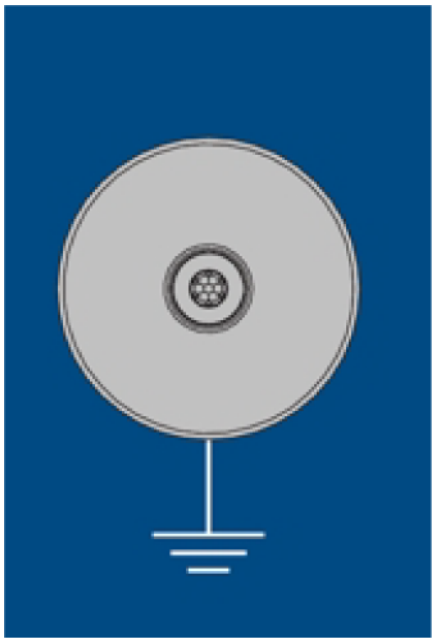
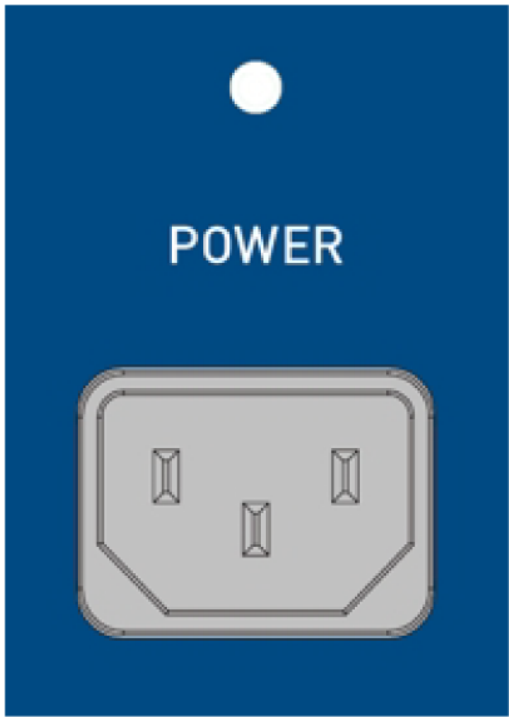


Figure 3-10: Grounding terminal on *VBO2* (knurled nut)

3.5.3 Mains socket



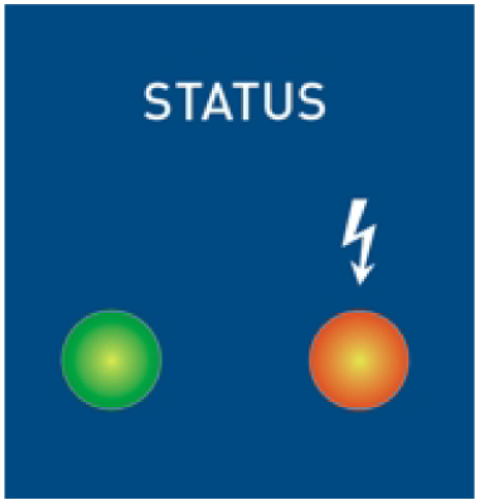
Mains socket (IEC 320).

VBO2 does not provide an ON/OFF switch.

The POWER LED **flashes slowly** to indicate that supply voltage is present but *VOTANO 100* is switched off or not connected.

The POWER LED **lights continuously** to indicate that *VOTANO 100* is switched on and able to communicate with *VBO2*.

3.5.4 Status LEDs



The **green LED lights continuously** to indicate that the equipment is operational, the grounding connections are applied properly and not voltage is applied to the test setup.

The **red LED flashes** to indicate that a test is in progress and voltage is applied to the test setup. Do not enter the dangerous high-voltage area or touch any part of the test setup when the red LED flashes!

Any other behavior of the status LEDs than described above indicates an error. In this case, press the emergency stop button and do not enter the high-voltage area.

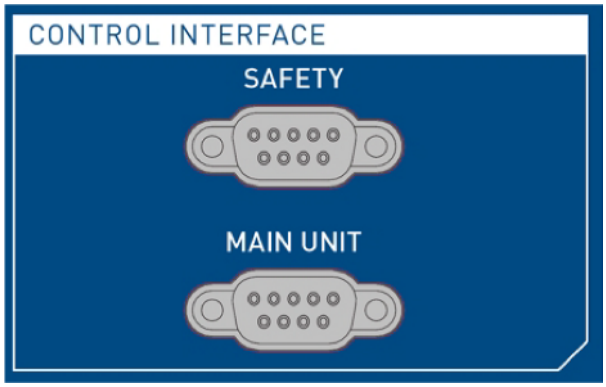
3.5.5 MAIN UNIT multipole socket

Multipole socket for the six-core connection cable to *VOTANO 100*. This cable connects the input and output sockets of the *VOTANO 100* to the *VBO2*.

Insert the cable connector with the broad nose to the top and turn it clockwise until it locks with a clearly audible click noise.

To disconnect the cable connector, pull the latch and turn the cable connector counterclockwise until you can pull it off the socket.

3.5.6 CONTROL INTERFACE D-Sub 9 interfaces

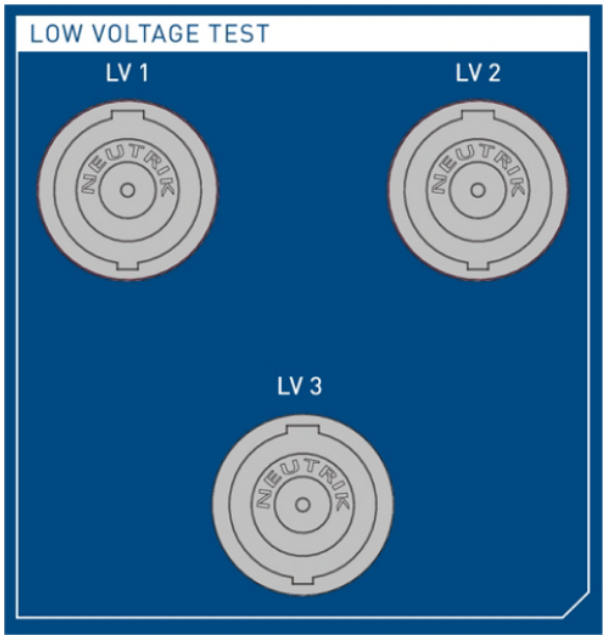


Use the SAFETY socket (female) to connect the *SAB1* safety box to the *VBO2* voltage booster. Pressing the emergency stop button switches off all outputs of the *VBO2* voltage booster.

Use the MAIN UNIT socket (male) to connect the *VBO2* voltage booster to the *VOTANO 100* test set. This connection is used for communication between *VOTANO 100* and *VBO2* (RS232 crossover cable).

Tighten the locking screws of the D-sub 9 connectors to prevent unintended disconnection.

3.5.7 LOW VOLTAGE TEST multipole sockets



Multipole sockets for the eight-core test cables. These test cables are used to connect the secondary windings of the voltage transformer under test or the burden under test to *VBO2*.

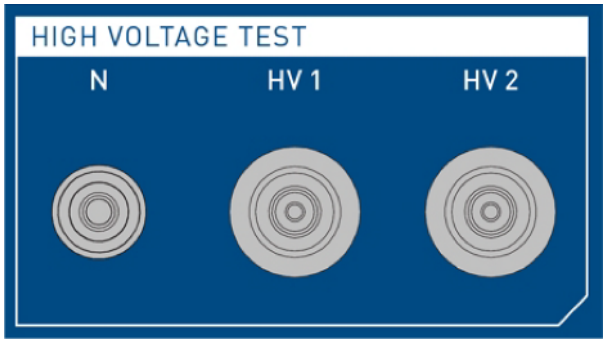
Only connect as many cables as required. Disconnect unused cables from *VBO2*.

Use socket LV1 to connect windings 1 and 2.
Use socket LV2 to connect windings 3 and 4.
Use socket LV3 to connect winding 5.

Insert the cable connector with the broad nose to the top and turn it clockwise until it locks with a clearly audible click noise.

To disconnect the cable connector, pull the latch and turn the cable connector counterclockwise until you can pull it off the socket.

3.5.8 HIGH VOLTAGE TEST sockets



High-voltage sockets to connect the primary side of the voltage transformer under test to *VBO2*.

Use sockets HV1 and N for testing VT voltage transformers. Use sockets HV1, HV2 and N for testing CVT/CCVT voltage transformers.

Only connect the original high-voltage test cables delivered by OMICRON to the sockets HV1 and HV2.

Insert the high-voltage cable connector into the socket until it locks with a clearly audible click noise. To disconnect the high-voltage cable connector, pull the outer sleeve of the plug backwards until the locking mechanism unlocks, then pull the plug off the socket.

The grounding connection of voltage transformer terminal N always has to be done on the voltage transformer side and not on socket N of *VBO2*.

⚠ WARNING

Death or severe injury caused by high voltage possible

- Do not extend the high-voltage test cables with other cables. A 15 m high-voltage cable is available from OMICRON. Refer to the OMICRON website for more information (Support (page 196)).

3.6 SAB1 safety box

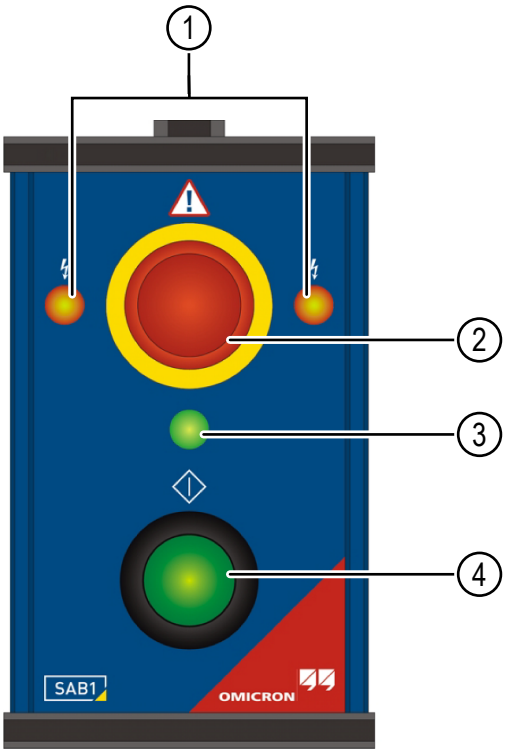


Figure 3-11: SAB1 safety box

1	**2 red status LEDs** The red LEDs flash to indicate that a test is in progress and voltage is applied to the test setup. Do not enter the dangerous high-voltage area or touch any part of the test setup while the red LEDs are flashing.	2	**Emergency stop button** Press to actuate the emergency stop button. All *VBO2* outputs are switched off immediately and the test setup is brought into a safe state, for example, to perform wiring work. Turn the button to the left or to the right to unlock and release the emergency stop button.
3	**Green status LED** The green LED lights continuously to indicate that the equipment is operational, the grounding connections are applied properly and not voltage is applied to the test setup.	4	**Start button** Press the start button when requested by *VOTANO 100* or the *VOTANO Suite* software to start the actual execution of the measurements and apply voltage to the test setup.

Any other behavior of the status LEDs than described above indicates an error. In this case, press the emergency stop button and do not enter the high-voltage area.

1. Connect the *SAB1* safety box to the SAFETY socket on *VBO2* and tighten the two locking screws of the D-Sub 9 connector to prevent unintended disconnection.

2. Position the *SAB1* safety box in the work area and near the *VOTANO 100* test set.

3.7 Licenses

For up-to-date information about the licenses and packages available for *VOTANO 100*, refer to the OMICRON website or contact the OMICRON Technical Support (Support (page 196)).

3.7.1 License-depending functional scope

The functional scope provided by *VOTANO 100* 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 *VOTANO 100*. 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, test cards and/or test modes.

3.7.2 License types

OMICRON offers two types of licenses for *VOTANO 100*: timely unlimited licenses and timed licenses.

- Timely unlimited license:
  Purchase license for a specific functional scope that is not limited with regard to time.
- Timed license:
  Timely limited license for a specific functional scope. The corresponding functional scope cannot be used any more after the expiry date of the license. *VOTANO 100* therefore displays a corresponding message in sufficient time before the expiry of the license.

VOTANO 100 may contain a mixture of timely unlimited licenses and timed licenses, however, with the restriction that only one expiry date is supported for timed licenses.

For information on how to add licenses to your *VOTANO 100*, refer to section Update Licenses function (page 121).

3.8 About the automatic wiring check function

The automatic wiring check performed by *VOTANO 100* is only intended as an aid for the user.

Due to the high number of potential errors, the results of this automatic wiring check cannot be regarded as binding, and thus do not release the user from its full responsibility for the correctness of all wiring performed for and during the test.

3.9 Scope of delivery, accessories

For up-to-date information about the scope of delivery and available accessories for *VOTANO 100*, refer to the OMICRON website (Support (page 196)).

4 Setup and test preparation

⚠ DANGER

Death or severe injury caused by high voltage or current

For some measurements, *VOTANO 100* injects voltage to the secondary side of the voltage transformer. This may cause high voltages on the primary terminals of the voltage transformer.

- ▶ Do not enter the high-voltage area during the test.
- ▶ Always maintain adequate safety clearance according to EN 50191 from the primary terminals of the voltage transformer during the test.

⚠ DANGER

Death or severe injury caused by high voltage or current

DC winding resistance measurements are performed during the test sequence. Feeding an inductance with DC current will charge the inductance. Interrupting the regular execution of a test sequence may prevent *VOTANO 100* from discharging the inductance after the measurement.

- ▶ Do not touch the test setup until the energy stored in the inductance has dissipated over time, if the measurement interrupted unexpectedly, for example, due to a loss of supply voltage or erroneous behavior of the *VOTANO 100*.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

- ▶ Increase safety by pressing the emergency stop button before entering the high-voltage area.
- ▶ Before connecting or disconnecting any leads, use a grounding rod to discharge all terminals of the voltage transformer, and to ground the high-voltage terminals of the voltage transformer.

Always observe the five safety rules (Safety rules (page 11)).

4.1 Preparing the test object

Prepare the test object as described in this section before setting up and connecting *VOTANO 100* and *VBO2*.

On the primary side of the voltage transformer:

1. Make sure that the line is switched off completely and no supply voltage is applied to the primary or secondary side of the test object.
2. Disconnection should be done as close as possible to the voltage transformer. The remaining connection lines on the primary side of the voltage transformer should be as short as possible in order to avoid any coupling of voltages into these lines.
3. Connect the primary lines to ground on both sides.
4. Discharge and connect the primary high-voltage terminal of the voltage transformer to ground.

5. Always keep primary low-voltage terminal N connected to ground.
6. Disconnect the voltage transformer completely from the supply line.
7. Disconnect the grounding of the primary high-voltage terminal of the voltage transformer only
   7.1 when requested by *VOTANO 100*, the *VOTANO Suite* software or the instructions given in this manual,
   7.2 and if necessary for a measurement.

On the secondary side of the voltage transformer:

1. Disconnect the burden wiring.
2. Make sure that all secondary windings of the voltage transformer are open on one side (terminal 1a, 2a, ...) and connected to ground on the other side (terminal 1n, 2n, ...).

For certain tests on capacitive voltage transformers/coupling capacitor voltage transformers (CVT/CCVT) only:

1. Disconnect the damping circuit.
2. Disconnect surge arresters and varistors.

4.2 Setting up VOTANO 100 and VBO2

⚠ WARNING

Death or severe injury caused by high voltage or current possible

- ▶ Prevent the presence of other persons in the high-voltage area during the test.
- ▶ Always position the test equipment in a way that you can completely observe the entire test setup (*VOTANO 100* and high-voltage area with *VBO2* and test object) at any time. If this is not possible, the high-voltage area has to be observed by a second person which is in visual or acoustic communication with the operator of *VOTANO 100*.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

Using inappropriate test cables and accessories may be very dangerous.

- ▶ Only use the original test cables delivered by OMICRON.
- ▶ Do not extend the high-voltage test cables with other cables. A 15 m high-voltage cable is available from OMICRON. Refer to the OMICRON website for more information (Support (page 196)).
- ▶ Check cables for any signs of insulation damage before testing.
- ▶ Damaged cables must not be used and need to be replaced immediately.
- ▶ Always handle cables with care and do not exceed their permitted bending radius to avoid damaging the cable's insulation.

▶ When setting up *VOTANO 100* and *VBO2*, always connect the grounding terminals of *VOTANO 100* **and** *VBO2* to protective earth (PE) using a solid connection of at least 6 mm² for protection against parasitic currents and voltages.

Proceed as follows to set up *VOTANO 100* and *VBO2* (→ Figure “Basic test setup: *VOTANO 100*, *VBO2* and *SAB1*” later in this section):

1. Define a high-voltage area around the test object and secure this area sufficiently against unauthorized access, for example using a barrier chain and a warning sign.
2. Set up and connect the *VBO2* voltage booster:
   2.1 Position *VBO2* on dry, solid ground inside the high-voltage area and next to the test object.
   2.2 Connect the grounding terminal of *VBO2* (VBO2 voltage booster hardware (page 31)) to protective earth (PE). Use a solid connection of at least 6 mm². Use a grounding point as close as possible to the test object.
   2.3 Connect *VBO2* to mains using the supplied power cord. Supply *VBO2* only from a power outlet that is equipped with protective earth (PE).
3. Set up the *VOTANO 100* test set:
   3.1 Position *VOTANO 100* on dry, solid ground outside the high-voltage area.
   3.2 Connect the grounding terminal of *VOTANO 100* (VOTANO 100 test set hardware (page 23)) to protective earth (PE). Use a solid connection of at least 6 mm². Use a grounding point as close as possible to the test object.

   Note: Connect *VOTANO 100* to mains using the supplied power cord. Supply *VOTANO 100* only from a power outlet that is equipped with protective earth (PE).
   An error message (901) appears if the protective earth (PE) connection is defective or if the power supply has no galvanic connection to ground. This can be the case in very special grid applications or if *VOTANO 100* is supplied by a generator or an isolating transformer. The error message 901 is a safety-relevant message!

⚠ WARNING

Death or severe injury caused by high voltage or current possible

▶ Always make sure that PE and equipotential ground are connected properly to ensure safe operation.

4. Connect the D-Sub 9 interface on *VOTANO 100* to the MAIN UNIT D-Sub 9 interface on *VBO2* using the supplied cable. Tighten the two locking screws of the D-Sub 9 connectors to prevent unintended disconnection.
5. Connect the *VOTANO 100* input and output sockets to the MAIN UNIT multipole socket on *VBO2* using the supplied six-core connection cable.
   5.1 Connect the 4 mm banana plugs of the six-core connection cable to their corresponding sockets on *VOTANO 100* as stated on the cable.
   5.2 Connect the multipole connector of the cable to the MAIN UNIT multipole socket on *VBO2*. Insert the cable connector with the broad nose to the top and turn it clockwise until it locks with a clearly audible click noise.
6. Position the *SAB1* safety box outside of the high-voltage area and next to *VOTANO 100*, and make sure that the emergency stop button is actuated.

7. Connect the connection cable of the *SAB1* safety box to the SAFETY socket on *VBO2*. Tighten the two locking screws of the D-Sub 9 connector to prevent unintended disconnection.

Connection of the test object (voltage transformer or burden) has to be performed on request of *VOTANO 100* or the *VOTANO Suite* software. This wiring depends on the test object to be tested (VT or CVT/CCVT, number of windings etc.) and the specific measurements and tests to be performed. Refer to Connecting and disconnecting the test object (page 75) for detailed descriptions how to connect the test object for a specific measurement.

⚠ WARNING

Death or severe injury caused by high voltage possible

Although *VOTANO 100* brings the test setup into a safe and de-energized state before requesting any wiring to be performed by the user during the test, you should always actuate the emergency stop button before entering the high-voltage area in order to increase safety.

▶ Deactivate the outputs of the *VBO2* voltage booster by pressing the emergency stop button before entering the high-voltage area for rewiring during the test sequence.

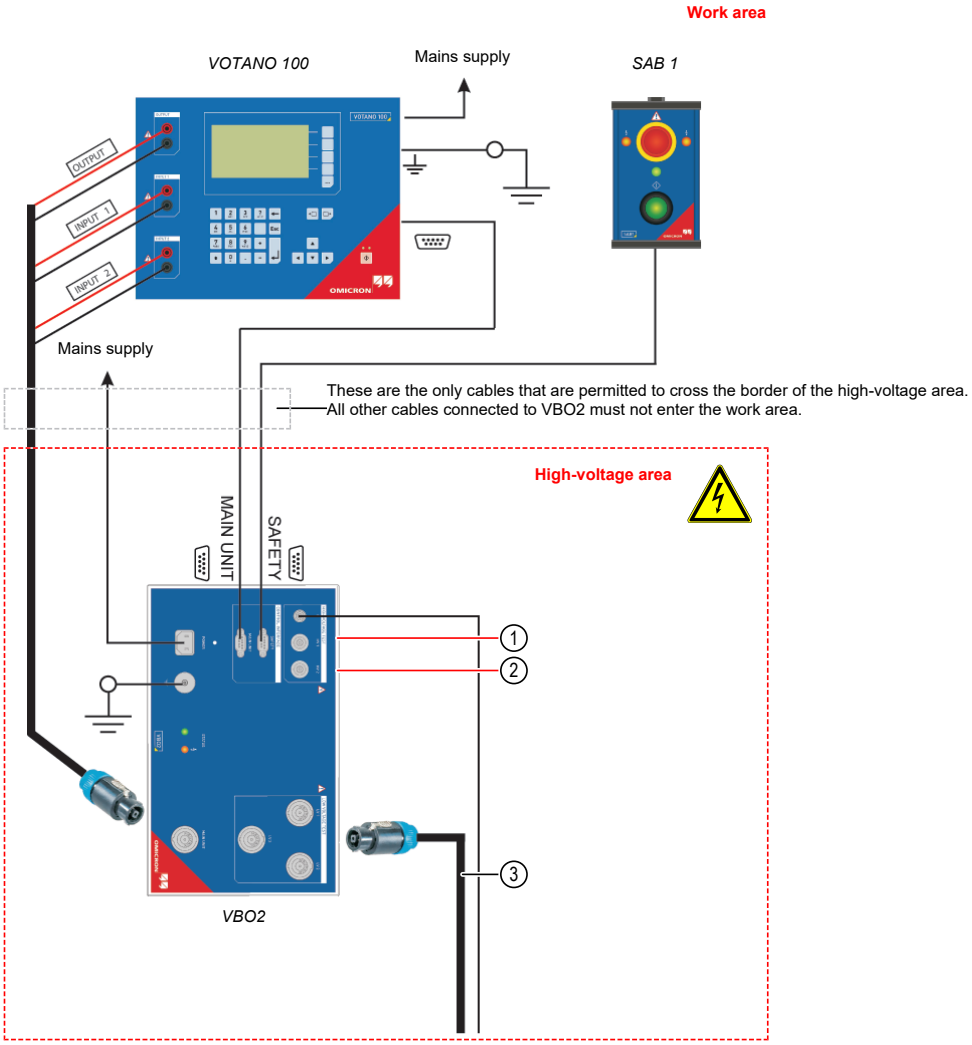


Figure 4-1: Basic test setup: *VOTANO 100*, *VBO2* and *SAB1*

1	High-voltage wiring to primary side of the voltage transformer as requested by *VOTANO 100* or *VOTANO Suite*.	2	The wiring depends on the type of voltage transformer to be tested and the test to be performed (Connecting and disconnecting the test object (page 75)).
3	Use the 3 m eight-core connection cables provided on delivery for connection to the low-voltage side of the test object. Place *VBO2* as close as possible to the terminal box of the test object and keep the contact resistances to the terminals as small as possible.		

The wiring to the test object depends on the test to be performed (Connecting and disconnecting the test object (page 75)):

- For voltage transformer tests:
  Wiring to voltage transformer depends on the number of windings (wiring for measurements with secondary voltage injection, see Wiring for secondary voltage injection test (page 76).
- For ratio checks:
  Wiring to voltage transformer, see Wiring for ratio checks (page 97).
- For stand-alone burden tests:
  Wiring to burden, see Wiring for burden test (page 92).

5 Running a test

When working with *VOTANO 100* and *VBO2*, always observe the safety instructions (Safety (page 11)) and the connection instructions (Connecting and disconnecting the test object (page 75)).

Advanced VT/CVT Test mode

Use the Advanced VT/CVT Test mode to perform comprehensive guided testing of VT or CVT voltage transformers with automatic assessment according to IEC or IEEE/ANSI standards (Advanced VT/CVT Test mode (page 45)).

Refer to Integrating burden measurement to the Advanced VT/CVT test (page 57) for information on how to **integrate the optional burden measurement** into a test performed using the Advanced VT/CVT Test mode.

VT/CVT Test mode

Use the VT/CVT Test mode to perform faster guided testing of VT or CVT voltage transformers regarding the ratio error and the phase displacement of the voltage transformer (VT/CVT Test mode (page 58)). The VT/CVT Test mode does not provide automatic assessment.

Simulation mode

Use this mode to perform a simulation of test results with changed settings based on 'real' measurement results obtained using the Advanced VT/CVT Test mode of *VOTANO 100* (Simulation mode (page 64)).

C-Divider Test mode

Use this mode to measure the capacitances and the voltage ratio of the capacitor voltage divider of CVT/CCVT voltage transformers (C-Divider Test mode (page 67)).

Ratio Check mode

Use the Ratio Check mode to quickly determine the ratio of a voltage transformer (Ratio Check mode (page 69)).

Burden Test mode

Use the Burden Test mode to perform a stand-alone burden measurement (Burden Test mode (page 72)).

5.1 Advanced VT/CVT Test mode

This section provides detailed descriptions on how to execute a guided voltage transformer test in the Advanced VT/CVT Test mode of *VOTANO 100*. Follow the sections Preparing the test object (page 49) to Running a test in the Advanced VT/CVT Test mode (page 55) below in the given order to execute a test.

Always observe the safety instructions (Safety (page 11)).

5.1.1 Test sequence overview

This section provides an overview of a complete test sequence for a voltage transformer using the Advanced VT/CVT Test mode. The test sequence shown includes all possible tests using all test cards available for *VOTANO 100*.

- Secondary short-circuit impedance measurement
- Secondary winding resistance measurement
- Excitation measurement
- Ratio measurement
- Primary short-circuit impedance measurement

Observe the safety instructions (Safety (page 11)).

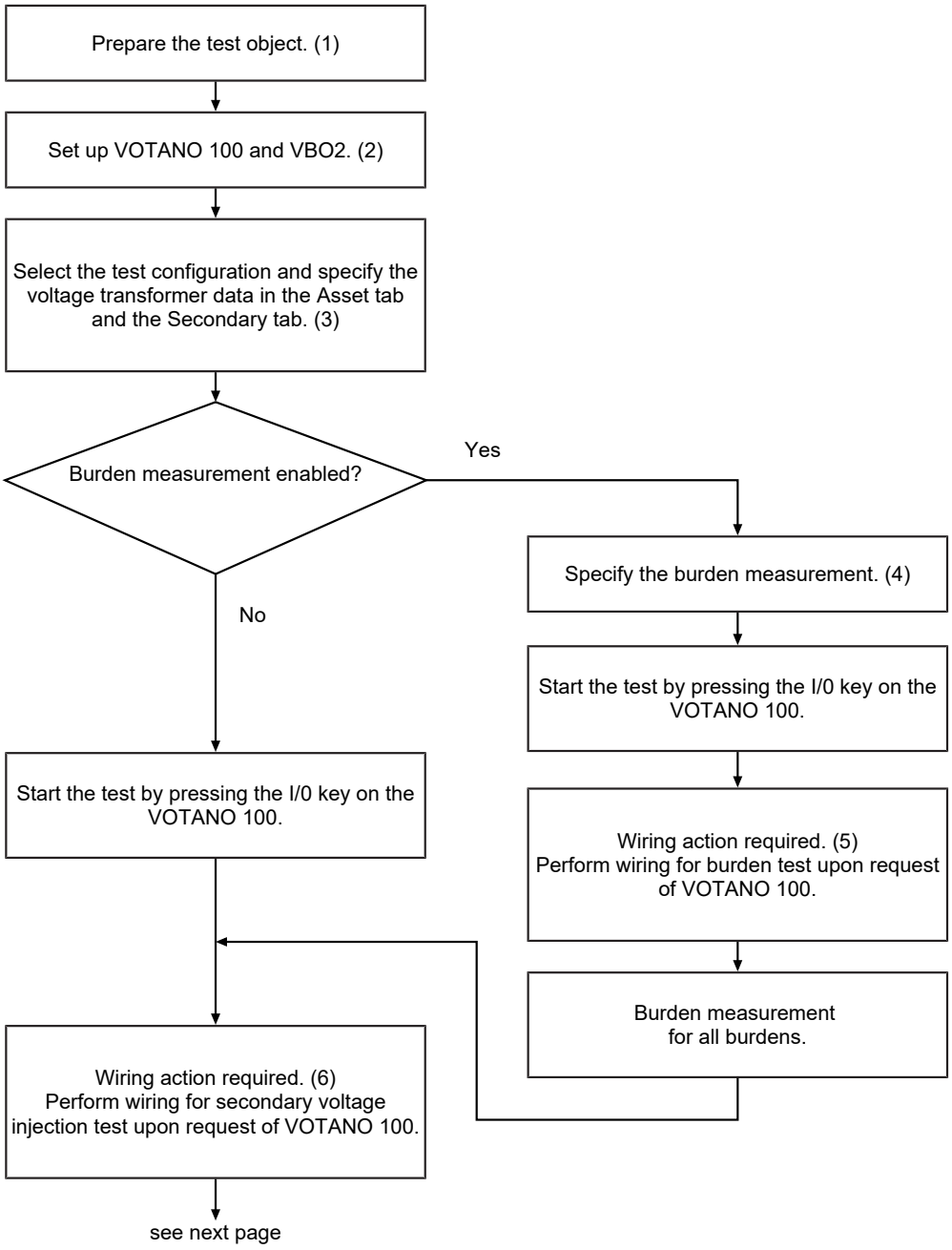


Figure 5-1: Test sequence overview (1)

1	Preparing the test object (page 39)	2	Setting up VOTANO 100 and VBO2 (page 40)
3	Selecting the test configuration (page 50) and Specifying the voltage transformer data (page 50)	4	Integrating burden measurement to the Advanced VT/CVT test (page 57)
5	Wiring for burden test (page 92)	6	Wiring for secondary voltage injection test (page 76)

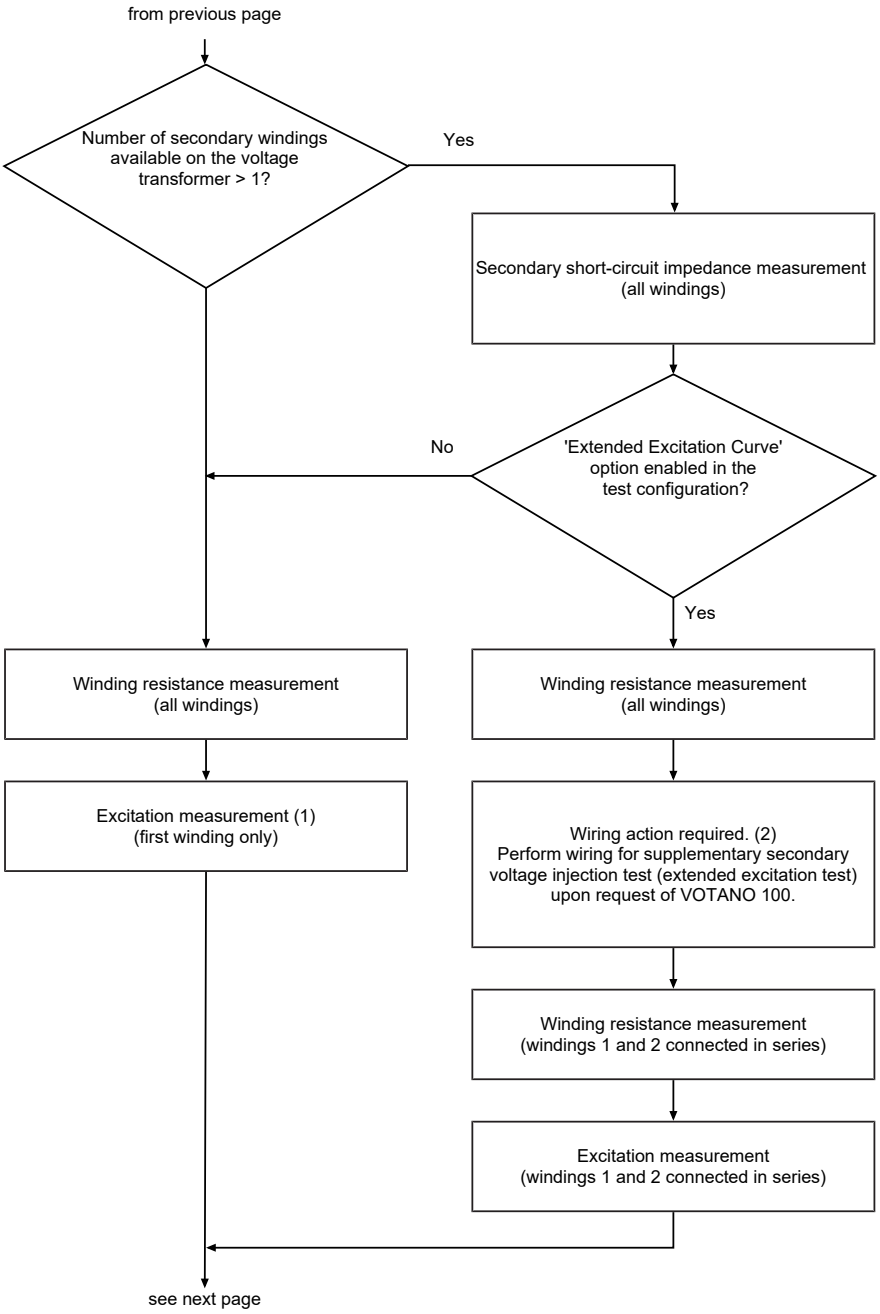


Figure 5-2: Test sequence overview (2)

1	This measurement is skipped if you loaded a reference excitation curve in the test configuration (to enable testing for the inner tap of a center-tapped voltage transformer). See "'Reference Excitation Curve' option" in Test configuration (page 128).	2	Wiring for supplementary secondary voltage injection test (extended excitation test) (page 81)

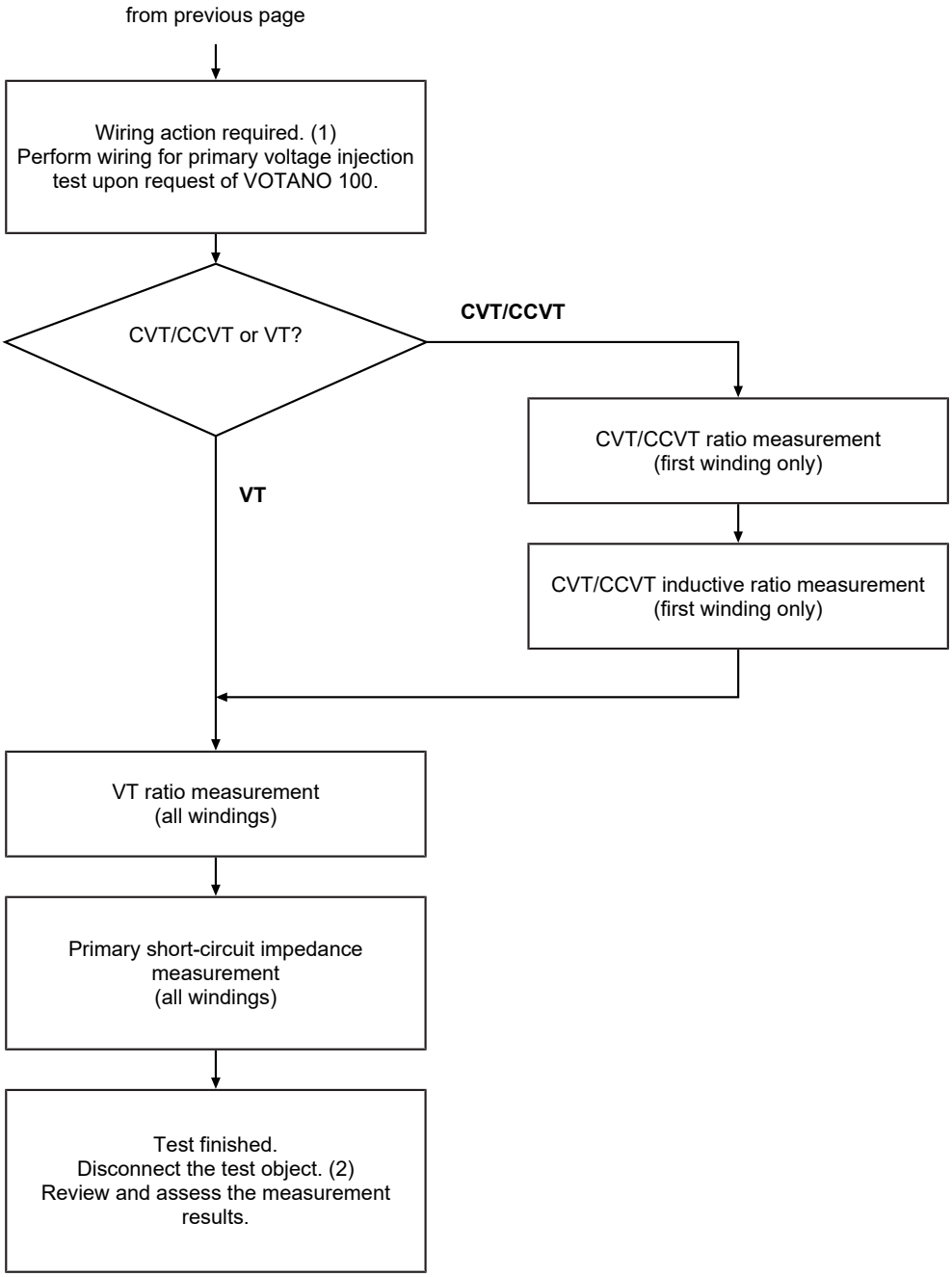


Figure 5-3: Test sequence overview (3)

1	Wiring for primary voltage injection test (page 85)	2	Disconnection (page 100)

5.1.2 Preparing the test object

Prepare the test object as described in Setup and test preparation (page 39).

5.1.3 Setting up VOTANO 100 and VBO2

Set up the *VOTANO 100* test set and the *VBO2* voltage booster as described in Setup and test preparation (page 39).

5.1.4 Selecting the test configuration

1. Proceed as follows to display the **Asset** card for a new test in the Advanced VT/CVT Test mode. If *VOTANO 100* is switched off:
   1.1 Switch the *VOTANO 100* test set on.
   1.2 After the boot process is finished, the green LED is on, and the red LED is off.
   1.3 The display shows the **Asset** card of the default test mode with the default settings. Press the **Main** soft key and select the Advanced VT/CVT Test mode as described below.
2. If *VOTANO 100* is already switched on:
   2.1 Press the **Main** soft key in any test card to display the main menu.
   2.2 In the main menu, select "Advanced VT/CVT Test" and press the **OK** soft key to initialize a new voltage transformer test.
   2.3 The display shows the **Asset** card with the default settings for the Advanced VT/CVT Test mode.
3. Press the **Test Config.** soft key to select the test cards and/or to specify the test configuration. Refer to Test configuration (page 128) for more detailed information about the test configuration. In our example test sequence we are using all test cards available for *VOTANO 100* (except the **Burden** card).

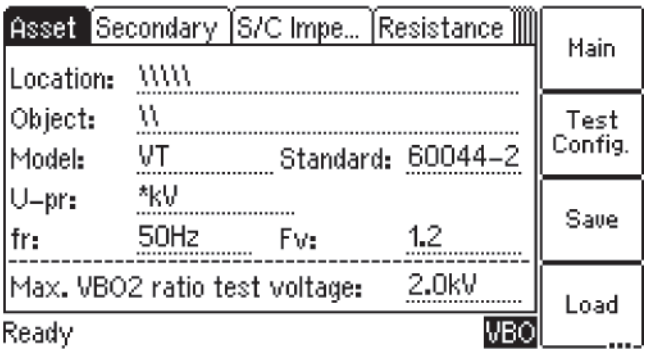


Figure 5-4: **Asset** card for the Advanced VT/CVT Test mode with default settings

5.1.5 Specifying the voltage transformer data

▶ Specify the voltage transformer data in the **Asset** card.

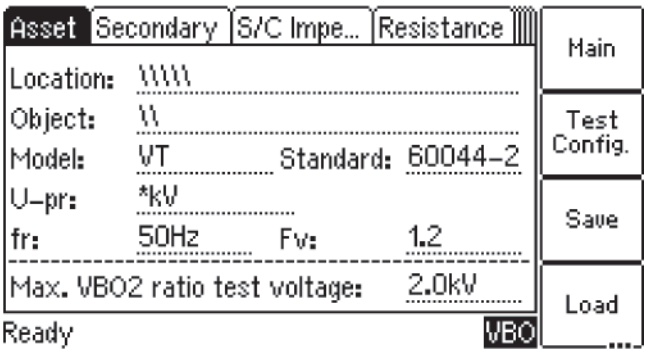


Figure 5-5: **Asset** card for the Advanced VT/CVT Test mode with default settings

Table 5-1: Voltage transformer data (**Asset** card)

Parameter	Description
Location	Open the details page to enter general information about the location where the voltage transformer is used: Company, country, station, etc.
Object	Open the details page to enter general information about the test object: Manufacturer, type and serial number.
Model	Select whether your voltage transformer under test is a VT or a CVT/CCVT.
Standard	Standard to be applied for the test.
U-pr*	Rated primary voltage of the voltage transformer.
Fr	Rated frequency of the voltage transformer: 50 Hz, 60 Hz, or 16.7 Hz. 16.7 Hz is only supported for VT voltage transformers tested according to an IEC standard.
Fv	Rated voltage factor up to which the voltage transformer must fulfill the accuracy requirements. **Note:** Only available if an IEC standard is selected.

Parameter	Description
Max. VBO2 ratio test voltage	Only available if enabled in the test configuration (Test configuration (page 128)). Use this parameter to define a reduced primary voltage for the test. The primary voltage applied during the ratio test is then limited to the voltage set in this field instead of the voltage selected automatically according to the rated primary voltage U_{pr} (Asset card (page 125)). **Note:** If 16.7 Hz is selected for the rated frequency of the transformer (f_r), *VOTANO 100* automatically limits the maximum *VBO2* ratio test voltage to ≤ 1.2 kV even if you specified a higher voltage in the 'Max. VBO2 ratio test voltage' field.

Mandatory parameters are marked by a star in the *VOTANO 100* user interface. The test cannot be started if no value is entered for one of these parameters.

For more detailed information about a specific parameter, refer to Asset card (page 125).

▶ Specify the voltage transformer data in the **Secondary** card.

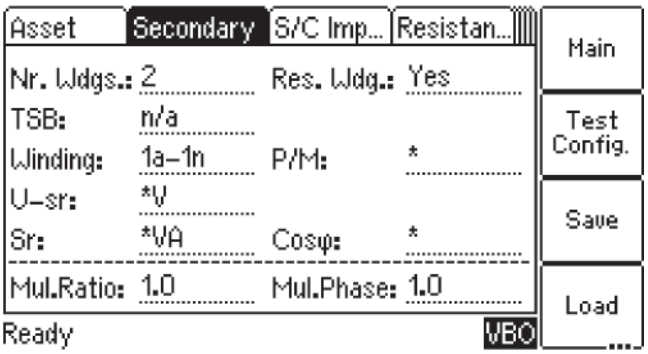


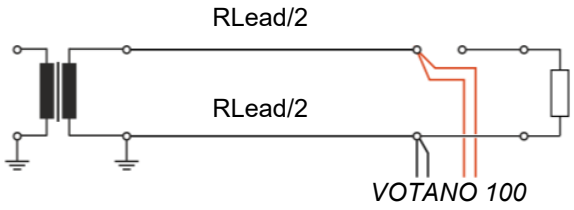
Figure 5-6: **Secondary** card for the Advanced VT/CVT Test mode with default settings

Table 5-2: Voltage transformer data (**Secondary** card)

Parameter	Description
Nr. Wdgs.	Number of secondary windings available on the voltage transformer (max. 5).
Res. Wdg.	Only available for IEC standards. Select whether your voltage transformer has a residual winding or not. The residual winding is named da-dn and counted in the amount of secondary windings.

Parameter	Description
TSB	Only available if enabled in the test configuration (Test configuration (page 128)). Only available for IEC standards and if number of windings > 1. Total simultaneous burden of the voltage transformer. Enter the total simultaneous burden as stated on the name plate and specify the burden distribution between the secondary windings for each measurement. Refer to sections Test configuration (page 128) and Setting the TSB and viewing the burden distribution (IEC standards only) (page 137) for more detailed information.
Winding	Select the active winding to be specified by the parameters in this card. Proceed as follows: 1. Select the first winding (for example, 1a-1n) and specify the parameters (P/M, Class (M-Class/P-Class), U_{sr}, S_r and cos φ, for example) for this winding. 2. Select the second winding and specify the parameters for this winding. 3. Proceed accordingly to specify the parameters for all remaining windings.
P/M*	Only displayed for IEC standards and ANSI C93.1. Type of the selected winding: protection or metering.
Class*	For IEC standards only displayed if the P/M parameter is set to "metering". Always displayed for IEEE C57.13 and ANSI C93.1. Winding class of the selected winding.
M-Class P-Class*	Only displayed for IEC 60044-2 and IEC 61869-3 and if the P/M parameter is set to "protection". P-Class: Protection class of the selected winding. Possible values: Soft keys **Class 3P**, **Class 6P**. M-Class: According to the IEC standards it is also possible to select a metering class for a protection winding.

Parameter	Description
P-Class* TP-Class	Only displayed for IEC 60044-5 and IEC 61869-5 and if the P/M parameter is set to "protection". P-Class: Protection class of the selected winding. Possible values: Soft keys **Class 3P**, **Class 6P**. TP-Class: Transient response class of the selected winding according to IEC 60044-5 and IEC 61869-5.
U-sr*	Rated secondary voltage of the selected winding. The voltage selected with the soft keys is the phase-phase voltage (1/1). If necessary, use the */√**3*** soft key to specify a phase-ground voltage. If applied, the soft key changes to ***x*√3** to remove the factor previously applied.
Sr*	Rated output of the selected winding.
Cos φ*	Power factor of the rated output specified (S_r or Burden parameter).
Burden*	Only displayed for IEEE C57.13 and ANSI C93.1. Standard burden of the selected winding.
Mul. Ratio and Mul. Phase	Only available for IEC standards and if the class multiplication factor is enabled in the test configuration (Test configuration (page 128)). Select or enter the factor to be used for this winding to customize the automatic assessment of the ratio error (Mul. Ratio) and the phase error (Mul. Phase). For example, a multiplication factor of 0.5 means that the maximum accepted tolerance for the error is only half the tolerance given in the standard.
Mul. Class	Only available for IEEE C57.13 or ANSI C93.1, and if the class multiplication factor is enabled in the test configuration (Test configuration (page 128)). Select or enter the factor to be used for this winding to customize the automatic assessment of the ratio error and the phase error. For example, a multiplication factor of 0.5 means that the maximum accepted tolerance for the error is only half the tolerance given in the standard.

Parameter	Description
RLead	Line resistance of the cabling between the terminals, *VOTANO 100* is connected to, and the voltage transformer (if applicable). *VOTANO 100* adds R_{Lead} to the operating burden value for results calculation and subtracts R_{Lead} from the measured winding resistance for rated burden assessment.  **Note:** The *VOTANO Suite* software provides a lead resistance calculator (Advanced VT/CVT test → Preparation section → Asset pane).

Mandatory parameters are marked by a star in the *VOTANO 100* user interface. The test cannot be started if no value is entered for one of these parameters.

For more detailed information about a specific parameter, refer to Secondary card (page 131).

5.1.6 Running a test in the Advanced VT/CVT Test mode

The example test procedure shown in this section is performed for a multi-winding CVT/CCVT.

The **Burden** card is not enabled, and the **Extended Excitation Curve** option is not selected in this example test procedure.

After setting up *VOTANO 100* and *VBO2*, and specifying the test configuration and voltage transformer data, you can start the test. *VOTANO 100* will guide you through the test procedure. Perform wiring and rewiring work only when requested by *VOTANO 100*, and exactly as described in the respective section.

⚠ DANGER

Death or severe injury caused by high voltage or current

DC winding resistance measurements are performed during the test sequence. Feeding an inductance with DC current will charge the inductance. Interrupting the regular execution of a test sequence may prevent *VOTANO 100* from discharging the inductance after the measurement.

▶ Do not touch the test setup until the energy stored in the inductance has dissipated over time, if the measurement interrupted unexpectedly, for example, due to a loss of supply voltage or erroneous behavior of the *VOTANO 100*.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

Although *VOTANO 100* brings the test setup into a safe and de-energized state before requesting any wiring to be performed by the user during the test, you should always actuate the emergency stop button before entering the high-voltage area in order to increase safety.

▶ Deactivate the outputs of the *VBO2* voltage booster by actuating the emergency stop button before entering the high-voltage area for rewiring during the test sequence.

Proceed as follows:

Starting the test

▶ Start the test by pressing the  key on the *VOTANO 100* test set.

Secondary voltage injection test

1. Perform the wiring for the measurements with secondary voltage injection as described in Wiring for supplementary secondary voltage injection test (extended excitation test) (page 81) when requested by *VOTANO 100*.
2. Check the wiring. If correct, release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on *VOTANO 100*.
3. When requested by *VOTANO 100*, press the green start button on the *SAB1* safety box within one minute to start the test.
4. The red LEDs flash while *VOTANO 100* performs its measurements:
   4.1 Secondary short-circuit impedance measurement for all windings
   4.2 Winding resistance measurement for all windings
   4.3 Excitation measurement for the first winding
5. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.

Primary voltage injection test

1. Perform the high-voltage wiring for the measurements with primary voltage injection as described in Wiring for primary voltage injection test (page 85) when requested by *VOTANO 100*.
2. Check the wiring. If correct, release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on *VOTANO 100*.

3. When requested by *VOTANO 100*, press the green start button on the *SAB1* safety box within one minute to start the test.
4. The red LEDs flash while *VOTANO 100* performs its measurements:
   4.1 CVT ratio measurement for the first winding (CVTs/CCVTs only)
   4.2 CVT inductive ratio measurement for the first winding (CVTs/CCVTs only)
   4.3 VT Ratio measurement for all windings
   4.4 Primary short-circuit impedance measurement for all windings

Test finished

1. When finished, VOTANO 100 automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
2. The voltage transformer test is finished.

The test results and settings of each test finished with the "Test ok" status are automatically stored to the file **OMICRON\AutoSave\VOTANO.vta** on the Compact Flash card. The VOTANO.vta file is written anew with each successful test. Tests that could not be finished successfully or were aborted by the user are not stored and thus do not overwrite the existing VOTANO.vta file.

Disconnection

Disconnect the test setup as described in Disconnection (page 100).

5.1.7 Integrating burden measurement to the Advanced VT/CVT test

Enable the **Burden** test card in the test configuration to integrate the burden measurement to the test (Test Card Selection, Test configuration (page 128) or Default Test Card Selection, Default test card selection (page 115)). Burden measurement is then performed as the first measurement during the test procedure (Test sequence overview (page 46)).

Specifying the burden measurement

Burden measurement has to be specified after selecting the test configuration and specifying the voltage transformer data in the **Asset** and **Secondary** card (Specifying the voltage transformer data (page 50)). Display the **Burden** card and proceed as follows to specify the burden measurement:

1. Select the Winding field.
2. Select a winding using the available soft keys.
3. Move to the Measure field. Press the **Yes** soft key if you want to measure the burden of this winding. Select the **No** soft key if you do not want to measure the burden of this winding.
4. Move back to the Winding field and select the next winding.
5. Repeat the steps 3 to 4 until you have specified all windings.

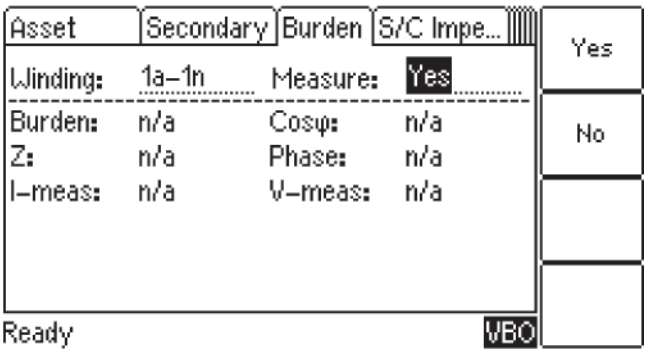


Figure 5-7: Specifying the burden test in the **Burden** card

Burden test

The test procedure is extended by the following steps when burden measurement is enabled:

1. After starting the test by pressing the key on the *VOTANO 100* test set, *VOTANO 100* asks you to perform wiring for the burden test.
2. Connect all burdens to be measured to *VBO2* using the eight-core test cables as described in Wiring for burden test (page 92).
3. Check the wiring. If correct, release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on *VOTANO 100*.
4. When requested by *VOTANO 100*, press the green start button on the *SAB1* safety box within one minute to start the test.
5. The red LEDs (*VOTANO 100*, *VBO2* and *SAB1*) flash while *VOTANO 100* performs its measurements.
6. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
7. The test continues with step 2 of the previous chapter (Running a test in the Advanced VT/CVT Test mode (page 55)).

Output voltage used and limitations for burden measurement

The maximum output voltage applied for burden measurement is determined by the rated secondary voltage U-sr of the corresponding winding. If U-sr is < 40 V, the maximum measurement voltage applied corresponds to U-sr. If U-sr is > 40 V, a maximum measurement voltage of 40 V is applied.

For possible limitations regarding burden measurement, please refer to the output and input specifications of *VOTANO 100* given in Technical data (page 177).

5.2 VT/CVT Test mode

Use the VT/CVT Test mode to perform faster guided testing of voltage transformers regarding the ratio error and the phase displacement of the voltage transformer. The VT/CVT Test mode does not provide automatic assessment.

5.2.1 Preparing the test object

Prepare the test object as described in Setup and test preparation (page 39).

5.2.2 Setting up VOTANO 100 and VBO2

Set up the *VOTANO 100* test set and the *VBO2* voltage booster as described in Setup and test preparation (page 39).

5.2.3 Selecting the test configuration

Proceed as follows to display the **Asset** card for a new test in the VT/CVT Test mode.

1. If *VOTANO 100* is switched off:
   1.1 Switch the *VOTANO 100* test set on.
   1.2 After the boot process is finished, the green LED is on and the red LED is off.
   1.3 The display shows the **Asset** card of the default test mode with the default settings. If the status line does not display the ▷ symbol, press the **Main** soft key and select the VT/CVT Test mode as described below.
2. If *VOTANO 100* is already switched on:
   2.1 Press the **Main** soft key in any test card to display the main menu.
   2.2 In the main menu, select "VT/CVT Test" and press the **OK** soft key to initialize a new voltage transformer test.
   2.3 The display shows the **Asset** card with the default settings for the VT/CVT Test mode.
3. Press the **Test Config.** soft key to specify the test configuration.
4. Select whether you want to limit the voltage applied to the voltage transformer during the test (may be required for voltage transformers with a rated primary voltage lower than 4 kV). When testing a CVT/CCVT, select whether you want to specify the rated capacitances of the voltage transformer's capacitor voltage divider.
5. Refer to Test configuration (page 161) for detailed information about the test configuration.

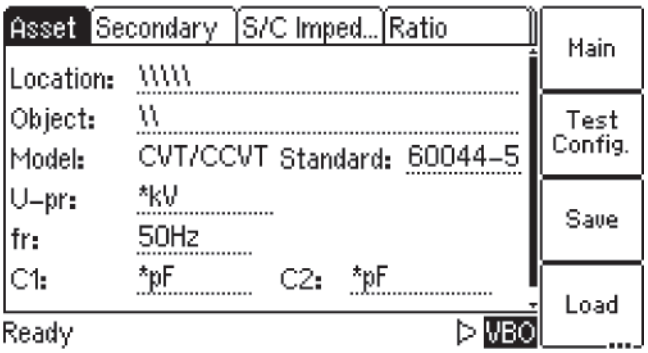


Figure 5-8: **Asset** card for VT/CVT Test mode with default settings

5.2.4 Specifying the voltage transformer data

Specify the voltage transformer data in the **Asset** card.

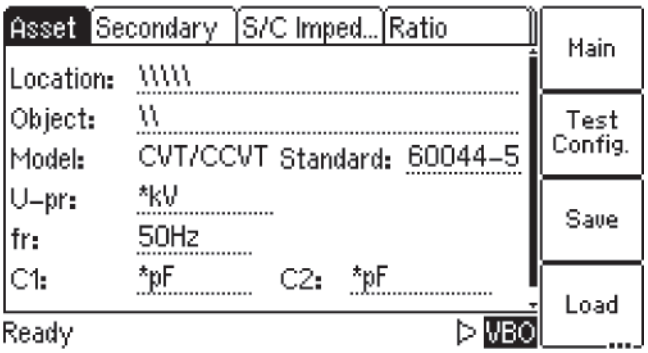


Figure 5-9: **Asset** card for VT/CVT Test mode with default settings

Table 5-3: Voltage transformer data (**Asset** card)

Parameter	Description
Location	Open the details page to enter general information about the location where the voltage transformer is used: Company, country, station, etc.
Object	Open the details page to enter general information about the test object: Manufacturer, type and serial number.
Model	Select whether your voltage transformer under test is a VT or a CVT/CCVT.
Standard	Standard to be applied for the test.
U-pr*	Rated primary voltage of the voltage transformer.
fr	Rated frequency of the voltage transformer: 50 Hz, 60 Hz, or 16.7 Hz. 16.7 Hz is only supported for VT voltage transformers tested according to an IEC standard.
C1* and C2*	Only available for CVT/CCVT voltage transformers, and if enabled in the test configuration (Test configuration (page 161)). Rated capacitances of the voltage transformer's capacitor voltage divider: C1: Rated capacitance of the high-voltage capacitor. C2: Rated capacitance of the intermediate-voltage capacitor.

Parameter	Description
Max. VBO2 ratio test voltage	Only available if enabled in the test configuration (Test configuration (page 161)). Use this parameter to define a reduced primary voltage for the test. The primary voltage applied during the ratio test is then limited to the voltage set in this field instead of the voltage selected automatically according to the rated primary voltage U_{pr} (Asset card (page 158)). **Note:** If 16.7 Hz is selected for the rated frequency of the transformer (f_r), *VOTANO 100* automatically limits the maximum *VBO2* ratio test voltage to ≤ 1.2 kV even if you specified a higher voltage in the 'Max. VBO2 ratio test voltage' field.

Mandatory parameters are marked by a star in the *VOTANO 100* user interface. The test cannot be started if no value is entered for one of these parameters.

For more detailed information about a specific parameter, refer to Asset card (page 158).

Specify the voltage transformer data in the **Secondary** card.

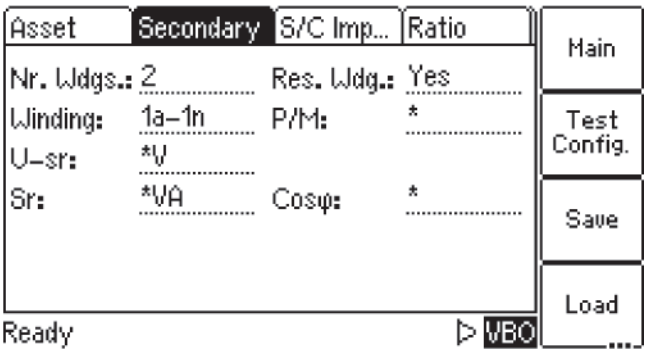


Figure 5-10: **Secondary** card for VT/CVT Test mode with default settings

Table 5-4: Voltage transformer data (**Secondary** card)

Parameter	Description
Nr. Wdgs.	Number of secondary windings available on the voltage transformer (max. 5).
Res. Wdg.	Only available for IEC standards. Select whether your voltage transformer has a residual winding or not. The residual winding is named da-dn and counted in the amount of secondary windings.

Parameter	Description
Winding	Select the active winding to be specified by the parameters in this card. Proceed as follows: 1. Select the first winding (for example, 1a-1n) and specify the parameters (P/M, class, U_{sr}, S_r and cos φ, for example) for this winding. 2. Select the second winding and specify the parameters for this winding. 3. Proceed accordingly to specify the parameters for all remaining windings.
P/M*	Only displayed for IEC standards and ANSI C93.1. Type of the selected winding: protection or metering.
Class*	For IEC standards only displayed if the P/M parameter is set to "metering". Always displayed for IEEE C57.13 and ANSI C93.1. Winding class of the selected winding.
M-Class P-Class*	Only displayed for IEC 60044-2 and IEC 61869-3 and if the P/M parameter is set to "protection". P-Class: Protection class of the selected winding. M-Class: According to the IEC standards it is also possible to select a metering class for a protection winding.
P-Class*	Only displayed for IEC standards and if the P/M parameter is set to "protection". Protection class of the selected winding.
U-sr*	Rated secondary voltage of the selected winding. The voltage selected with the soft keys is the phase-phase voltage (1/1). If necessary, use the */√**3*** soft key to specify a phase-ground voltage. If applied, the soft key changes to ***x*√3** to remove the factor previously applied.
Sr*	Rated output of the selected winding.
Cos φ*	Power factor of the rated output specified (S_r or Burden parameter).
Burden*	Only displayed for IEEE C57.13 and ANSI C93.1. Standard burden of the selected winding.

Mandatory parameters are marked by a star in the *VOTANO 100* user interface. The test cannot be started if no value is entered for one of these parameters.

For more detailed information about a specific parameter, refer to Secondary card (page 162).

5.2.5 Running a test in the VT/CVT Test mode

After setting up *VOTANO 100* and *VBO2*, and specifying the test configuration and voltage transformer data, you can start the test. *VOTANO 100* will guide you through the test procedure. Perform wiring only when requested by *VOTANO 100*, and exactly as described in the respective section.

⚠ DANGER

Death or severe injury caused by high voltage or current

DC winding resistance measurements are performed during the test sequence. Feeding an inductance with DC current will charge the inductance. Interrupting the regular execution of a test sequence may prevent *VOTANO 100* from discharging the inductance after the measurement.

▶ Do not touch the test setup until the energy stored in the inductance has dissipated over time, if the measurement interrupted unexpectedly, for example, due to a loss of supply voltage or erroneous behavior of the *VOTANO 100*.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

Although *VOTANO 100* brings the test setup into a safe and de-energized state before requesting any wiring to be performed by the user during the test, you should always actuate the emergency stop button before entering the high-voltage area in order to increase safety.

▶ Deactivate the outputs of the *VBO2* voltage booster by actuating the emergency stop button before entering the high-voltage area for wiring or rewiring work.

Proceed as follows:

Starting the test

▶ Start the test by pressing the  key on the *VOTANO 100* test set.

Primary voltage injection test

1. When requested by *VOTANO 100*, perform the wiring for measurements with primary voltage injection (Wiring for primary voltage injection test (page 85)).
2. Check the wiring. If correct, release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on the *VOTANO 100* test set.
3. When requested by *VOTANO 100*, press the green start button on the *SAB1* safety box within one minute to start the test.
4. The red LEDs flash while *VOTANO 100* performs its measurements.

Test finished

1. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
2. The voltage transformer test is finished.

The test results and settings of each test finished with the "Test ok" status are automatically stored to the file **OMICRON\AutoSave\VOTANO.vta** on the Compact Flash card. The VOTANO.vta file is written anew with each successful test. Tests that could not be finished successfully or were aborted by the user are not stored and thus do not overwrite the existing VOTANO.vta file.

Disconnection

Disconnect the test setup as described in Disconnection (page 100).

5.3 Simulation mode

Use the **Simulation** mode to perform a **simulation of test results** based on 'real' test results measured using the Advanced VT/CVT Test mode of *VOTANO 100*.

This section provides detailed descriptions how to perform a simulation. Using the simulation mode it is possible to simulate the behavior of a voltage transformer with changed settings (for example, with a changed burden or for a changed voltage factor F_v).

You can perform simulations using the results of the currently displayed test (executed immediately before) or using the results of a test performed earlier and stored on the Compact Flash card.

The following parameters can be changed in simulation mode (fields of editable parameters are underlined by dotted lines in the user interface; display fields that cannot be changed are not underlined).

Table 5-5: Overview of editable parameters depending on the standard

Card	Editable parameters depending on the standard					
	IEC 60044-2	**IEC 61869-3**	**IEEE C57.13**	**IEC 60044-5**	**IEC 61869-5**	**ANSI C93.1**
Asset card	Fv Up	Fv Up	- Up	Fv Up	Fv Up	- Up
Secondary card (parameters available for each winding)	P/M M-Class & P-Class or Class TSB ext. Sr Mul.Ratio Mul.Phase Rlead	P/M M-Class & P-Class or Class TSB Mul.Ratio Mul.Phase Rlead	Class Burden Mul.Class Rlead	P/M P-Class & TP-Class or Class TSB Mul.Ratio Mul.Phase Rlead	P/M P-Class & TP-Class or Class TSB Mul.Ratio Mul.Phase Rlead	P/M Class Burden Mul.Class Rlead

Card	Editable parameters depending on the standard					
	IEC 60044-2	IEC 61869-3	IEEE C57.13	IEC 60044-5	IEC 61869-5	ANSI C93.1
Burden card (parameters available for each winding)	Op. burden cos φ					

Table 5-6: Availability of parameters

Parameter	Condition
Up	Only available if the 'Up simulation' option is selected in the test configuration of the simulation mode.
M-Class P-Class TP-Class	For protection cores only.
Class	For metering cores only.
TSB	If number of windings > 1 only.
Ext. Sr	For M classes 0.1 and 0.2 if Sr < 10 VA only.
Mul.Ratio Mul.Phase Mul.Class	Only available if the 'Class Multiplication Factor' option is selected in the test configuration (Test configuration (page 128)).

For more detailed information about a specific parameter, please refer to sections Asset card (page 125), Secondary card (page 131) and Burden card (page 140).

After changing a value, *VOTANO 100* recalculates the error tables and the test assessment according to the changed values.

The **SIM** indication in the status line indicates that *VOTANO 100* is in simulation mode.

Proceed as follows to perform a simulation:

1. If not already done, enter the simulation mode:
   1.1 Press the **Main** soft key in any test card to display the main menu.
   1.2 In the main menu, select "Simulation" and press the **OK** soft key.
2. Select the test to be used as a basis for the simulation:
   2.1 If the test displayed when pressing the **Main** soft key is an Advanced VT/CVT test with valid test data, the **Asset** card is displayed in simulation mode, ready to perform the simulation.
   2.2 If the test displayed when pressing the **Main** soft key is a VT/CVT test or a new Advanced VT/CVT test without test results or with invalid test data, a message is displayed, asking you to load a test stored on the Compact Flash card. Press the **Load** soft key and select the test to be used for the simulation. The **Asset** card is displayed in simulation mode, ready to perform the simulation.
   2.3 To load another test for the simulation than the test displayed when pressing the **Main** soft key, press the **Load** soft key in the **Asset** card and select the test to be used for the simulation. The **Asset** card is displayed in simulation mode, ready to perform the simulation.

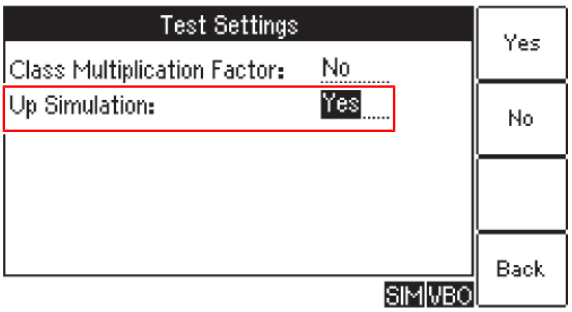
3. Change your settings in the **Asset** card, the **Secondary** card or the **Burden** card and display the **Ratio** and/or the **Assessment** card to view the simulated test results for your changed settings.
4. If necessary, save your simulation to the Compact Flash card.

The simulation mode can only be used for tests performed in the Advanced VT/CVT Test mode.

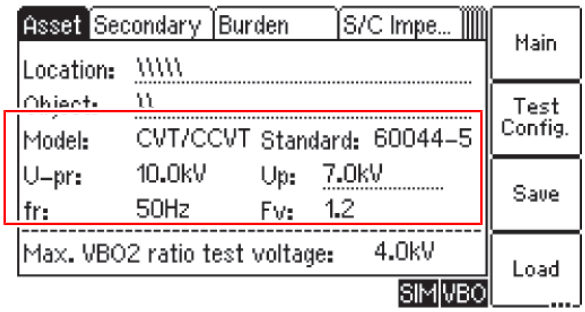
Up Simulation option

In simulation mode, an additional option is available in the test configuration: **Up Simulation**. When this option is selected, the simulation delivers the results for the primary voltage specified in the **Asset** card.

To select or deselect this option, press the **Test Config.** soft key in the **Asset** card to display the **Test Configuration Menu** page. Then, select **Test Settings** and press **Select** to display the **Test Settings** page.



Test settings page in simulation mode, Up Simulation option selected.



Asset card if the Up Simulation option is selected.

Figure 5-11: Selecting the **Up Simulation** option (left) and **Asset** card if **Up Simulation** is selected (right)

When the **Up Simulation** option is selected, two primary voltage fields are available in the **Asset** card (see figure above):

Table 5-7: Fields available in the card when the option is selected

Field/parameter	Description
U-pr	Rated primary voltage of the voltage transformer. Not editable.
Up	Primary voltage to be used for the simulation. Use this field to enter a primary voltage for which you want to display simulation results. The simulation then delivers the results for this primary voltage. Use the keyboard to enter a value or the soft keys to select a predefined value. The voltage selected with the soft keys is the phase-phase voltage (1/1). If necessary, use the ***/*√**3** soft key to specify a phase-ground voltage. If applied, the soft key changes to **x**√**3** to remove the factor previously applied.

Class Multiplication Factor option

Refer to Test configuration (page 128) for information on the Class Multiplication Factor option.

Using a reference excitation curve (for inner tap measurement of center tapped voltage transformers)

When measuring the inner tap of a center tapped voltage transformer, it may occur that the excitation measurement fails due to the output current limitations of *VOTANO 100*. For such cases, *VOTANO 100* allows you to load the excitation curve of a previous test performed for the outer tap combination of the same voltage transformer into a simulation. By using these excitation curve data as a reference, you can determine the behavior and data of the inner tap by simulation, without repeating a previously failed inner tap test.

▶ To load a reference excitation curve, select the Winding field of the **Secondary** card and press the **Ref. Excit. Curve** soft key.

For more detailed information, refer to Test configuration (page 128).

Test cards of the Simulation mode

Refer to the following sections:

- Asset card (page 125)
- Secondary card (page 131)
- Burden card (page 140)
- Ratio card (page 145)
- Assessment card (page 151)

5.4 C-Divider Test mode

Use the C-Divider Test mode to measure the capacitances and the voltage ratio of the capacitor voltage divider of CVT/CCVT voltage transformers. The C-Divider Test mode does not provide automatic assessment.

5.4.1 Preparing the test object

Prepare the test object as described in Setup and test preparation (page 39).

5.4.2 Setting up VOTANO 100 and VBO2

Set up the *VOTANO 100* test set and the *VBO2* voltage booster as described in Setup and test preparation (page 39).

5.4.3 Specifying the voltage transformer data

▶ Specify the voltage transformer data in the **Asset** card.

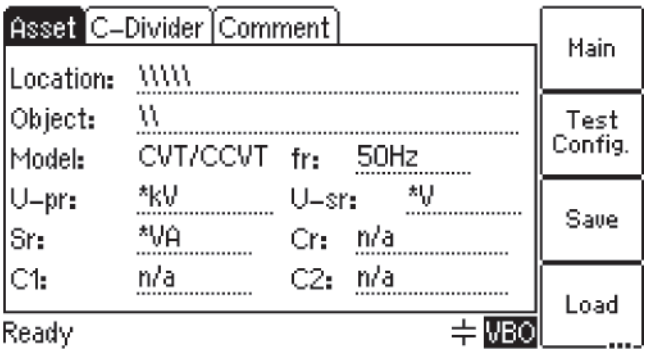


Figure 5-12: **Asset** card for C-Divider Test mode with default settings

Table 5-8: Voltage transformer data (**Asset** card)

Parameter	Description
Location	Open the details page to enter general information about the location where the voltage transformer is used: Company, country, station, etc.
Object	Open the details page to enter general information about the test object: Manufacturer, type and serial number.
Model	CVT/CCVT (fixed setting).
fr	Rated frequency of the voltage transformer: 50 Hz or 60 Hz.
U-pr*	Rated primary voltage of the voltage transformer.
U-sr*	Rated secondary voltage of the voltage transformer.
Sr*	Rated output power of the winding connected for the C-Divider measurement.
Cr, C1, C2	Capacitance values of the capacitor voltage divider as stated on the type plate. Cr: Rated total capacitance of the capacitor voltage divider. C1: Rated capacitance of the high-voltage capacitor. C2: Rated capacitance of the intermediate-voltage capacitor.

Mandatory parameters are marked by a star in the *VOTANO 100* user interface. The test cannot be started if no value is entered for one of these parameters.

5.4.4 Running a test in the C-Divider Test mode

After setting up *VOTANO 100* and *VBO2*, and specifying the test configuration and voltage transformer data, you can start the test. *VOTANO 100* will guide you through the test procedure. Perform wiring only when requested by *VOTANO 100*, and exactly as described in the respective section.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

Although *VOTANO 100* brings the test setup into a safe and de-energized state before requesting any wiring to be performed by the user during the test, you should always actuate the emergency stop button before entering the high-voltage area in order to increase safety.

▶ Deactivate the outputs of the *VBO2* voltage booster by actuating the emergency stop button before entering the high-voltage area for wiring or rewiring work.

Proceed as follows:

1. Start the test by pressing the  key on the *VOTANO 100* test set.
2. When requested by VOTANO 100, connect the voltage transformer for the first measurement (C2 measurement) as described in Wiring for C-Divider test (page 88).
3. Check the wiring. If correct, release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on the *VOTANO 100* test set.
4. When requested by *VOTANO 100*, press the green start button on the *SAB1* safety box within one minute to start the test.
5. The red LEDs flash while *VOTANO 100* performs the C2 measurement.
6. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
7. When requested by *VOTANO 100*, perform the high-voltage wiring for the second measurement (C1/Cr measurement) as described in Wiring for C-Divider test (page 88).
8. Check the wiring. If correct, release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on the *VOTANO 100* test set.
9. When requested by *VOTANO 100*, press the green start button on the *SAB1* safety box within one minute to start the test.
10. The red LEDs flash while *VOTANO 100* performs the C1/Cr measurement.
11. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
12. The C-Divider test is finished. The **C-Divider** card displays the test results.
13. Disconnect the test setup as described in Disconnection (page 100).

5.5 Ratio Check mode

Use the **Ratio Check** mode to quickly determine the ratio of a voltage transformer. Follow the sections below in the given order to perform a ratio check.

Always observe the safety instructions given in Safety (page 11).

The accuracy of the ratio measurement performed using this mode may differ from the accuracy obtained with the Advanced VT/CVT Test mode or the VT/CVT Test mode of *VOTANO 100*.

5.5.1 Preparing the test object

Prepare the test object as described in Setup and test preparation (page 39).

5.5.2 Setting up VOTANO 100 and VBO2

Set up the *VOTANO 100* test set and the *VBO2* voltage booster as described in Setup and test preparation (page 39).

5.5.3 Running a ratio check

⚠ WARNING

Death or severe injury caused by high voltage or current possible

- ▶ Make sure that the terminals of the test object to be connected to *VBO2* do not carry any voltage potential.
- ▶ Make sure that the test object is completely disconnected from the power system.
- ▶ During the ratio check, *VOTANO 100*/*VBO2* is the only permitted power source for the test object.

⚠ WARNING

Death, severe injury or equipment damage caused by high voltage or current is possible in case of incorrect wiring

- ▶ Avoid incorrect wiring. *VOTANO 100* does not perform a wiring check in the ratio check mode.
- ▶ Make sure that the wiring is correct before running a ratio check.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

Although *VOTANO 100* brings the test setup into a safe and de-energized state before requesting any wiring to be performed by the user during the test, you should always actuate the emergency stop button before entering the high-voltage area in order to increase safety.

- ▶ Deactivate the outputs of the *VBO2* voltage booster by actuating the emergency stop button before entering the high-voltage area for rewiring during the test sequence.

NOTICE

Equipment damage caused by high voltage possible

VOTANO 100 is able to output voltages that are possibly higher than the nominal voltage of the test object.

- ▶ Make sure that the test voltage applied during the ratio check does not exceed the nominal voltage of the voltage transformer.

Proceed as follows to perform a ratio check:

1. If not already done, switch *VOTANO 100* on and enter the Ratio Check mode:
   1.1 Press the **Main** soft key in any test card to display the main menu.
   1.2 In the main menu, select "Ratio Check" and press the **OK** soft key.
   1.3 The display shows the **Ratio** card with the default ratio check settings.

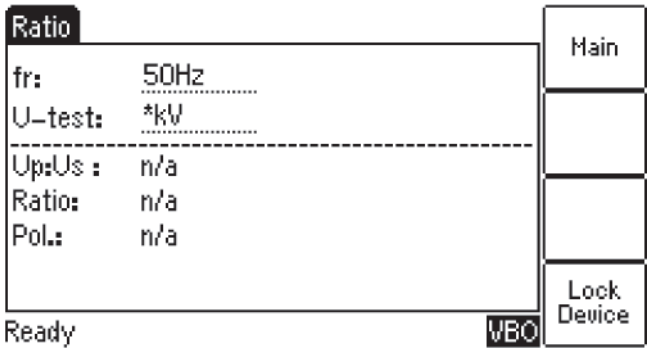


Figure 5-13: **Ratio** card for the Ratio Check mode

2. If necessary, change the rated frequency "fr" of the voltage transformer (soft keys **50Hz**, **60Hz**, or **16.7Hz**).

   Note: Enter the test voltage "U-test". Use the **4kV** soft key or enter any other value in kV between 0.001 kV and 4 kV using the keyboard.
   If the rated frequency is set to 16.7 Hz, *VOTANO 100* automatically limits the maximum test voltage to ≤ 1.2 kV even if you specified a higher test voltage.

3. Start the test by pressing the key on the *VOTANO 100* test set.
4. When requested by *VOTANO 100*, connect the voltage transformer to be measured to the *VBO2* as described in Wiring for ratio checks (page 97).
5. Check the wiring. If correct, release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on the *VOTANO 100* test set.
6. When requested by *VOTANO 100*, press the green start button on the *SAB1* safety box within one minute to start the test.
7. The red LEDs (*VOTANO 100*, *VBO2* and *SAB1*) flash while *VOTANO 100* performs the measurements required to determine the voltage transformer ratio.
8. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
9. The lower part of the **Ratio** test card displays the results:

Table 5-9: Results in the lower part of the **Ratio** test card

Result	Description
Up : Us	Primary and secondary voltage measured at the voltage transformer.
Ratio	Voltage ratio of the voltage transformer, calculated from U_p and U_s
Polarity	OK: Phase angle is within a range of ± 90°. Not ok: Wrong polarity of the voltage transformer or wrong polarity of the measurement leads.
Phase	Phase displacement of the voltage transformer in minutes.

▶ Disconnect the test setup as described in Disconnection (page 100).

5.6 Burden Test mode

Use the **Burden Test** mode to measure the burden of a voltage transformer stand-alone by just specifying the rated secondary voltage and the frequency. Follow the sections below in the given order to perform a burden test.

It is also possible to perform burden measurement as a part of an Advanced VT/CVT test Integrating burden measurement to the Advanced VT/CVT test (page 57).

Always observe the safety instructions given in Safety (page 11).

5.6.1 Output voltage used and limitations for burden measurement

NOTICE

Equipment damage caused by high voltage possible

VOTANO 100 is able to output voltages that are possibly higher than the nominal voltage of the burden.

▶ Make sure that the test voltage applied during the burden test does not exceed the nominal voltage of the burden.

The maximum output voltage applied for burden measurement is determined by the winding's rated secondary voltage entered in the **U-sr** field. If U-sr is < 40 V, the maximum measurement voltage applied corresponds to U-sr. If U-sr is > 40 V, a maximum measurement voltage of 40 V is applied.

For possible limitations regarding burden measurement, please refer to the *VOTANO 100* output and input specifications given in Technical data (page 177).

5.6.2 Preparing the test object

Disconnect the burden from the voltage transformer (Setup and test preparation (page 39)).

5.6.3 Setting up VOTANO 100 and VBO2

Set up the *VOTANO 100* test set and the *VBO2* voltage booster as described in Setup and test preparation (page 39)

5.6.4 Running a stand-alone burden test

⚠ WARNING

Death or severe injury caused by high voltage or current possible

- ▶ Make sure that the terminals of the burden to be connected to the *VBO2* do not carry any voltage potential.
- ▶ During the burden test, *VOTANO 100*/*VBO2* is the only permitted power source for the burden.

⚠ WARNING

Death, severe injury or equipment damage caused by high voltage or current is possible in case of incorrect wiring

- ▶ Avoid incorrect wiring. *VOTANO 100* does not perform a wiring check for the stand-alone burden test.
- ▶ Make sure that the wiring is correct before running a burden test.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

Although *VOTANO 100* brings the test setup into a safe and de-energized state before requesting any wiring to be performed by the user during the test, you should always actuate the emergency stop button before entering the high-voltage area in order to increase safety.

- ▶ Deactivate the outputs of the *VBO2* voltage booster by actuating the emergency stop button before entering the high-voltage area for rewiring during the test sequence.

Proceed as follows to perform a stand-alone burden test:

1. If not already done, switch *VOTANO 100* on and enter the burden test mode:
   1.1 Press the **Main** soft key in any test card to display the main menu.
   1.2 In the main menu, select "Burden Test" and press the **OK** soft key.
   1.3 The display shows the **Burden** card with the default burden test settings.

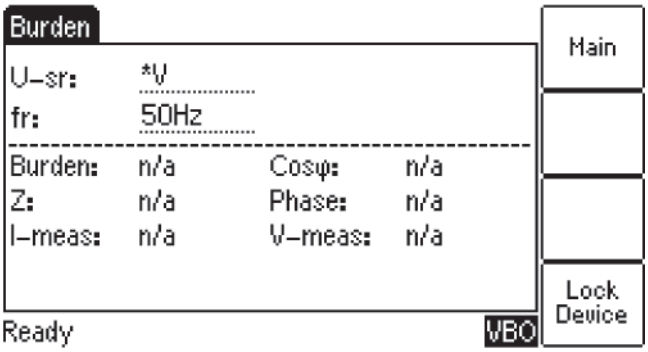


Figure 5-14: **Burden** card for a stand-alone burden test

2. Enter the rated secondary voltage of the winding feeding the burden during operation to the "U-sr" field. Use the available soft keys or enter any other value between 0.001 and 1000 V using the keyboard. The voltage entered determines the output voltage applied to the burden (Output voltage used and limitations for burden measurement (page 72)).
   The voltage entered or selected with the soft keys is the phase-phase voltage. If necessary, use the */√**3*** soft key as a factor to specify a phase-ground voltage (or the /3 soft key for a residual winding). If applied, a ***x*√*3*** (or ***x3***) soft key is displayed to remove the factor previously applied.
3. If necessary, change the rated frequency "fr" of the voltage transformer (soft keys **50Hz**, **60Hz**, or **16.7Hz**).
4. Start the test by pressing the  key on the *VOTANO 100* test set.
5. When requested by *VOTANO 100*, connect the burden under test to *VBO2* as described in Wiring for burden test (page 92).
6. Check the wiring. If correct, release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on the *VOTANO 100* test set.
7. When requested by *VOTANO 100*, press the green start button on the *SAB1* safety box within one minute to start the burden measurement.
8. The red LEDs (*VOTANO 100*, *VBO2* and *SAB1*) flash while *VOTANO 100* performs the burden measurement.
9. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
10. The lower part of the **Burden** test card displays the results:

Table 5-10: Results displayed in the **Burden** test card

Result	Description
Burden	Burden value in VA (with respect to the rated secondary voltage U-sr) calculated from the measured quantities.
Cos ϕ	Cos φ of the burden calculated from the measured quantities.
Z	Impedance of the burden in ohms calculated from the measured quantities.
Phase	Phase displacement of the burden in degrees.
I-meas	Current in A measured during the burden measurement.
V-meas	Voltage in V measured at the burden during the measurement.

▶ Disconnect the test setup as described in Disconnection (page 100).

6 Connecting and disconnecting the test object

The proper connection of the test object to the *VBO2* voltage booster depends on the specific measurement to be performed by *VOTANO 100*. *VOTANO 100* or the *VOTANO Suite* software therefore request according rewiring during the running test sequence depending on the test object and the scope of measurements selected on *VOTANO 100* or the *VOTANO Suite* software.

Perform wiring only when requested by *VOTANO 100* or *VOTANO Suite* and as described in the sections Wiring for secondary voltage injection test (page 76) to Wiring for ratio checks (page 97) below. *VOTANO 100* must only be operated with original OMICRON accessories and cables.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

- ▶ Make sure that the terminals of the test object to be connected to *VBO2* do not carry any voltage potential.
- ▶ Make sure that the test object is completely disconnected from the power system.
- ▶ During a test, *VOTANO 100*/*VBO2* is the only permitted power source for the test object.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

As long as the red LEDs on *VOTANO 100*, *VBO2* and *SAB1* are flashing, the output is active and lethal voltages can occur due to the high energy stored in external inductors.

- ▶ Do not enter the high-voltage area while the red LEDs on *VOTANO 100*, *VBO2* and *SAB1* are flashing.
- ▶ Wait until the red LEDs are off and the green LEDs are on.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

Some measurements may charge the voltage transformer under test with a high amount of energy. *VOTANO 100* then possibly requires some time to dissipate the energy stored in the test object. In this case, a corresponding warning (Warning 903.000) is displayed.

- ▶ Do not touch the test object, disconnect measurement leads or switch off *VOTANO 100* while the warning 903.000 is displayed.
- ▶ Always maintain adequate safety clearance according to EN 50191 from the primary terminals of the voltage transformer during the test.
- ▶ Wait until the warning disappears.
- ▶ Do not touch the test setup until the energy stored in the inductance has dissipated over time, if the measurement interrupted unexpectedly, for example, due to a loss of supply voltage or erroneous behavior of the *VOTANO 100*.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

Although *VOTANO 100* brings the test setup into a safe and de-energized state before requesting any wiring to be performed by the user during the test, you should always actuate the emergency stop button before entering the high-voltage area in order to increase safety.

▶ Deactivate the outputs of the *VBO2* voltage booster by actuating the emergency stop button before entering the high-voltage area for rewiring during the test sequence.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

While performing measurements on combined CTVTs, dangerous voltages may occur at the current transformer terminals.

▶ When testing combined CTVTs, make sure that no CT secondary windings are open. Short-circuit the CT secondary windings manually.

Terminal designations used in this documentation

The descriptions and diagrams presented in this documentation use the terminal markings according to the IEC standards. For the terminal markings used in other standards, please refer to the corresponding standard.

Examples for IEC terminal markings:
A and N for the primary winding of a VT and 1a-1n, 2a-2n etc. for the secondary windings.

Examples for IEEE terminal markings:
H1 and H2 for the primary winding of a VT and X1-X2, Y1-Y2 etc. for the secondary windings.

6.1 Wiring for secondary voltage injection test

Applicable for Advanced VT/CVT Test mode only.

For these measurements, voltage is applied to the secondary side of the voltage transformer. The secondary wiring shown in this section is always required when running an Advanced VT/CVT test using *VOTANO 100* and *VBO2*.

Observe the safety instructions given in Safety (page 11) and Connecting and disconnecting the test object (page 75).

⚠ DANGER

Death or severe injury caused by high voltage or current

VOTANO 100 injects voltage to the secondary side of the voltage transformer for these measurements. This may cause high voltages on the primary terminals of the voltage transformer.

- ▶ Do not enter the high-voltage area during the test.
- ▶ Always maintain adequate safety clearance according to EN 50191 from the primary terminals of the voltage transformer during the test.
- ▶ Do not leave any unused cables connected to the primary terminals of the voltage transformer during the test.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

- ▶ Before connecting or disconnecting any leads, use a grounding rod
- ▶ to discharge all terminals of the voltage transformer,
- ▶ and to ground the high-voltage terminals of the voltage transformer.

⚠ WARNING

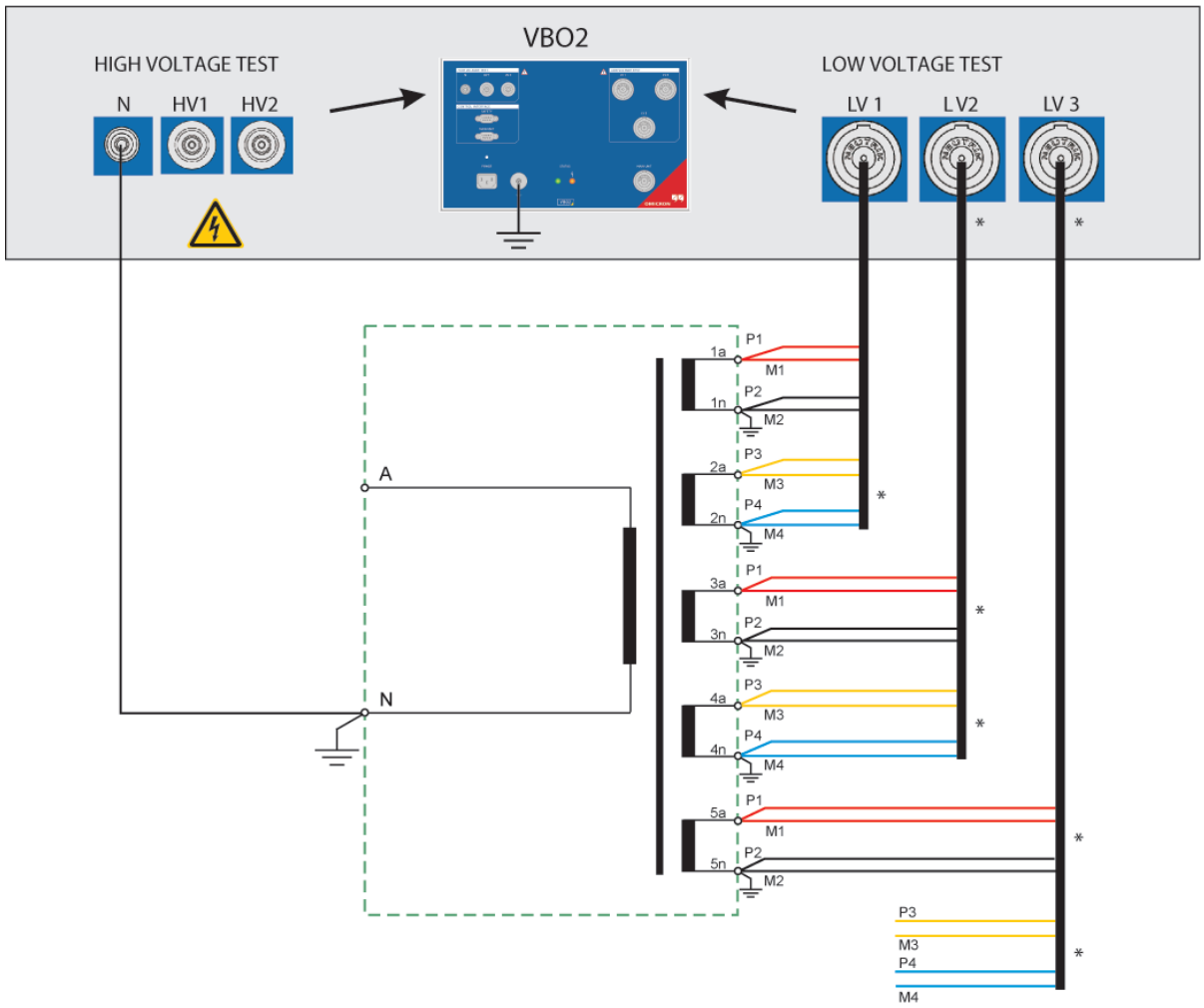
Death or severe injury caused by high voltage or current possible

- ▶ Be aware that lethal voltages may occur at terminal NHF during the secondary voltage injection test.

Proceed as follows when requested by *VOTANO 100* or the *VOTANO Suite* software:

1. Connect the primary high-voltage terminal A of the voltage transformer to ground.
2. For CVTs/CCVTs only:
   If accessible, disconnect the ferroresonance suppression unit (FSU) for the secondary voltage injection test to improve the accuracy of the measurement results.
3. Use the delivered eight-core test cables to connect all secondary windings of the voltage transformer under test to the *VBO2* voltage booster.
   See figures later in this section:
   - 3.1 Connect windings 1 and 2 of the voltage transformer to socket LV1 of VBO2.
   - 3.2 Connect windings 3 and 4 of the voltage transformer to socket LV2 of VBO2.
   - 3.3 Connect winding 5 of the voltage transformer to socket LV3 of VBO2.
     Do not mix up the windings or the LVx sockets on *VBO2*.
4. Connect the grounded terminal N of the voltage transformer to socket N of the HIGH VOLTAGE TEST section on *VBO2*.
5. Disconnect the grounding from the primary high-voltage terminal A of the voltage transformer.
6. For CVTs/CCVTs only:
   Disconnect the grounding from primary terminal NHF of the voltage transformer.
7. Check the wiring. See figures later in this section.

8. Leave the high-voltage area and secure this area against unauthorized access.
9. Release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on *VOTANO 100* (or the **Confirm Wiring** button in the *VOTANO Suite* software, respectively).
10. When requested by *VOTANO 100* or *VOTANO Suite*, press the green start button on the *SAB1* safety box within one minute to start the test execution.
11. The red LEDs flash while *VOTANO 100* performs its measurements.
12. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
13. Proceed with Wiring for supplementary secondary voltage injection test (extended excitation test) (page 81) to perform the wiring for the supplementary secondary voltage injection test (extended excitation test), or Wiring for primary voltage injection test (page 85) to perform the wiring for the measurements with primary voltage injection as requested by *VOTANO 100* or the *VOTANO Suite* software.
14. For CVTs/CCVTs only:
    If previously disconnected for the secondary voltage injection test, reconnect the FSU.



* Connect as required according to the number of windings. Unused banana plugs of the cable may be left open.

Figure 6-1: Wiring for measurements with secondary voltage injection on a VT voltage transformer

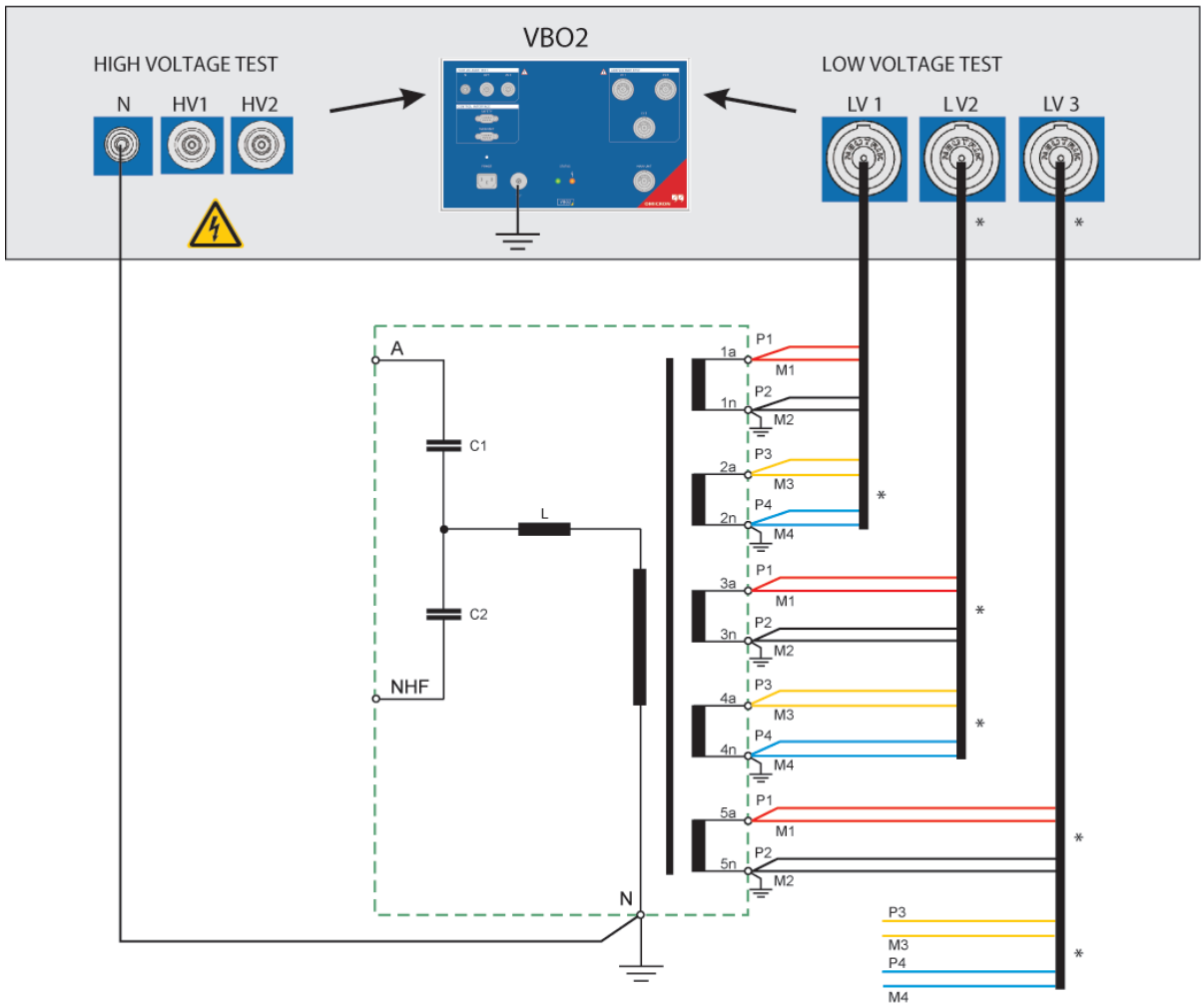
⚠ WARNING

Death or severe injury caused by high voltage or current possible

▶ Disconnect unused HV cables from HV1, HV2 and from the asset under test.

▶ Refer to Preparing the test object (page 39) for information on how to prepare the test object.

▶ Refer to Setting up VOTANO 100 and VBO2 (page 40) for information on how to set up *VOTANO 100*, *VBO2*, and *SAB1*.



* Connect as required according to the number of windings. Unused banana plugs of the cable may be left open.

Figure 6-2: Wiring for measurements with secondary voltage injection on a CVT/CCVT voltage transformer

⚠ WARNING

Death or severe injury caused by high voltage or current possible

▶ Disconnect unused HV cables from HV1, HV2 and from the asset under test.

▶ Refer to Preparing the test object (page 39) for information on how to prepare the test object.

▶ Refer to Setting up VOTANO 100 and VBO2 (page 40) for information on how to set up *VOTANO 100*, *VBO2*, and *SAB1*.

See also

6.2 Wiring for supplementary secondary voltage injection test (extended excitation test)

Applicable for Advanced VT/CVT Test mode only.

For some types of voltage transformers, measuring the excitation curve in the Advanced VT/CVT Test mode possibly requires higher induction than *VOTANO 100* can apply. For voltage transformers with multiple secondary windings, an option is available to extend the possible range for measuring the excitation curve with *VOTANO 100* (Test configuration (page 128)).

If the **Extended excitation curve** option is selected in the test configuration, the test procedure is interrupted for an additional wiring change to be performed by the user (Test sequence overview (page 46)).

Observe the safety instructions given in Safety (page 11) and Connecting and disconnecting the test object (page 75).

⚠ DANGER

Death or severe injury caused by high voltage or current

VOTANO 100 injects voltage to the secondary side of the voltage transformer for these measurements. This may cause high voltages on the primary terminals of the voltage transformer.

- ▶ Do not enter the high-voltage area during the test.
- ▶ Always maintain adequate safety clearance according to EN 50191 from the primary terminals of the voltage transformer during the test.
- ▶ Do not leave any unused cables connected to the primary terminals of the voltage transformer during the test.

⚠ WARNING

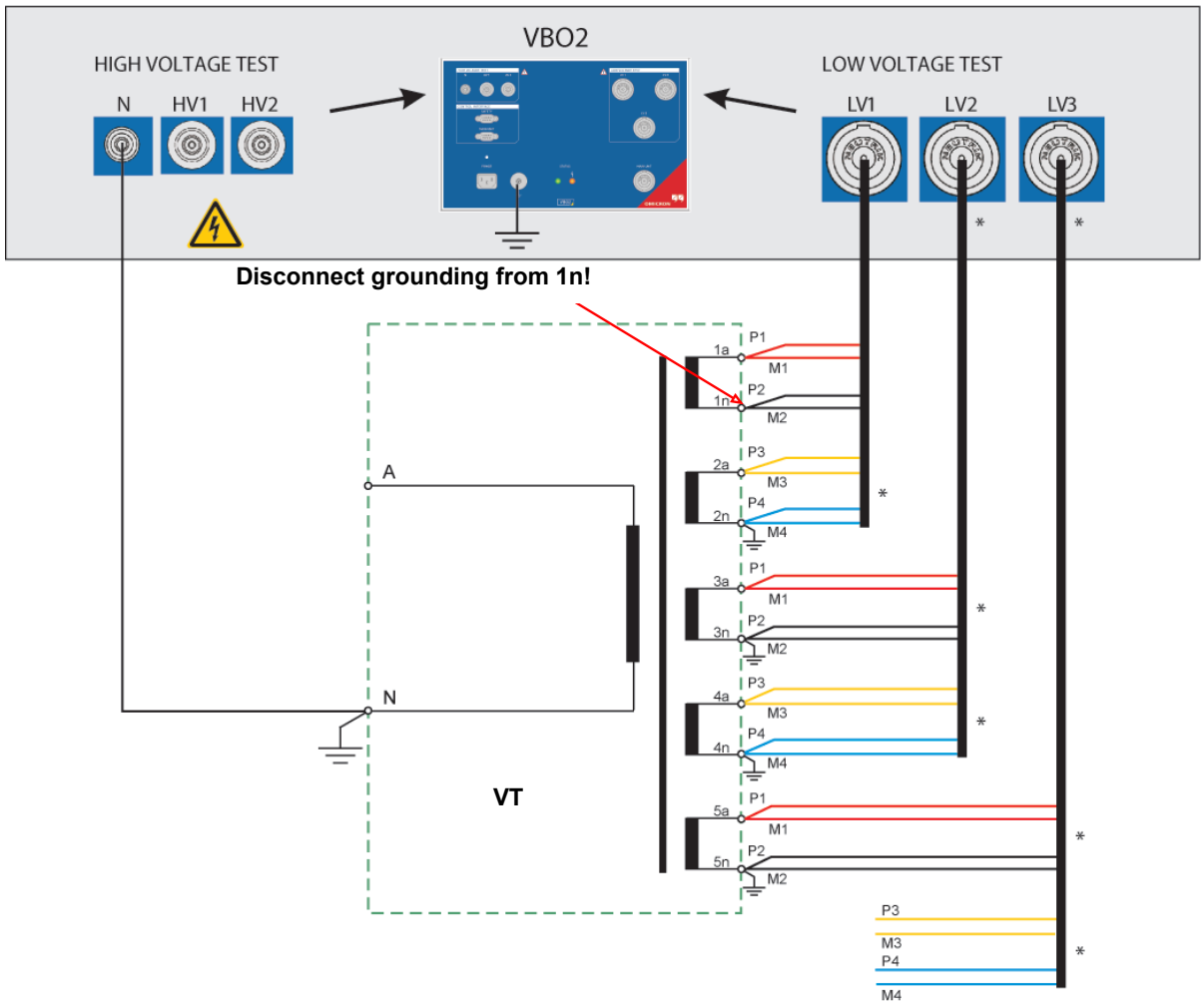
Death or severe injury caused by high voltage or current possible

- ▶ Before connecting or disconnecting any leads, use a grounding rod
- ▶ to discharge all terminals of the voltage transformer,
- ▶ and to ground the high-voltage terminals of the voltage transformer.

Proceed as follows when requested by *VOTANO 100* or the *VOTANO Suite* software:

1. Disconnect the grounding connection from terminal 1n.

2. For CVTs/CCVTs only:
   If accessible, disconnect the ferroresonance suppression unit (FSU) for the secondary voltage injection test to improve the accuracy of the measurement results.
3. Check the wiring. See figures below.
4. Leave the high-voltage area and secure this area against unauthorized access.
5. Release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on *VOTANO 100* (or the **Confirm Wiring** button in the *VOTANO Suite* software, respectively).
6. When requested by *VOTANO 100* or *VOTANO Suite*, press the green start button on the *SAB1* safety box within one minute to start the test execution.
7. The red LEDs flash while *VOTANO 100* performs its measurements.
8. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
9. Connect the grounding connection to terminal 1n again.
10. Proceed with Wiring for primary voltage injection test (page 85) to perform the wiring for the measurements with primary voltage injection when requested by *VOTANO 100* or the *VOTANO Suite* software.
11. For CVTs/CCVTs only:
    If previously disconnected for the supplementary secondary voltage injection test described above, reconnect the FSU.



* Connect as required according to the number of windings. Unused banana plugs of the cable may be left open.

Figure 6-3: Wiring for extended excitation curve measurement on a VT voltage transformer

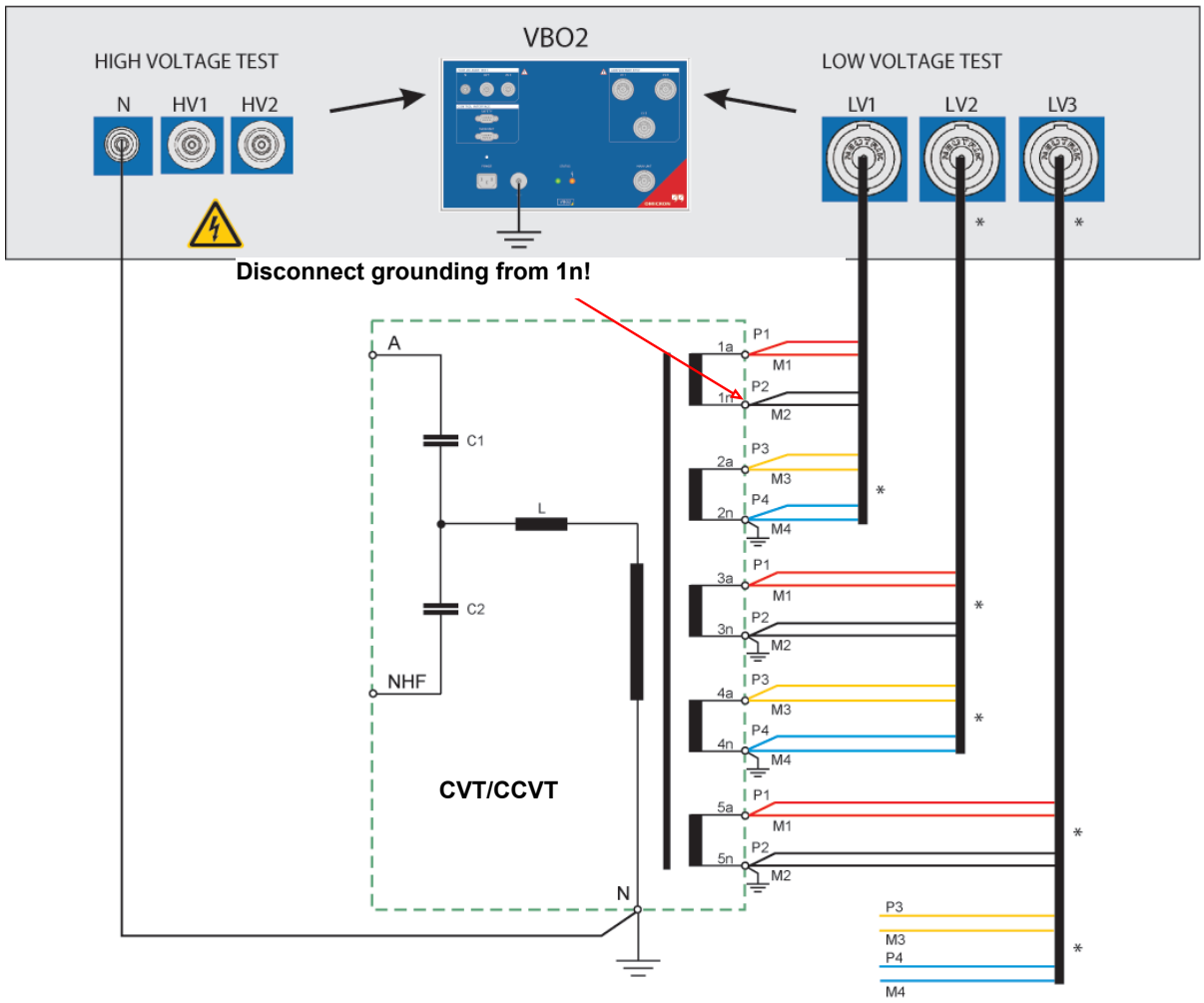
⚠ WARNING

Death or severe injury caused by high voltage or current possible

▶ Disconnect unused HV cables from HV1, HV2 and from the asset under test.

▶ Refer to Preparing the test object (page 39) for information on how to prepare the test object.

▶ Refer to Setting up VOTANO 100 and VBO2 (page 40) for information on how to set up *VOTANO 100*, *VBO2*, and *SAB1*.



* Connect as required according to the number of windings. Unused banana plugs of the cable may be left open.

Figure 6-4: Wiring for extended excitation curve measurement on a CVT/CCVT voltage transformer

⚠ WARNING

Death or severe injury caused by high voltage or current possible

▶ Disconnect unused HV cables from HV1, HV2 and from the asset under test.

▶ Refer to Preparing the test object (page 39) for information on how to prepare the test object.

▶ Refer to Setting up VOTANO 100 and VBO2 (page 40) for information on how to set up *VOTANO 100*, *VBO2*, and *SAB1*.

6.3 Wiring for primary voltage injection test

Applicable for Advanced VT/CVT Test mode and VT/CVT Test mode.

For these measurements, voltage is applied to the primary side of the voltage transformer. During a guided voltage transformer test, *VOTANO 100* or the *VOTANO Suite* software request wiring on the primary side of the voltage transformer under test.

The primary wiring differs depending on whether you are testing a VT or a CVT/CCVT.

Observe the safety instructions given in Safety (page 11) and Connecting and disconnecting the test object (page 75).

⚠ WARNING

Death or severe injury caused by high voltage or current possible

High voltages of up to 4 kV are applied to the primary side (and to the NHF connection point in case of a CVT/CCVT) during the test.

- ▶ Be aware of the particular danger of such high voltages.
- ▶ Make sure not to connect the high-voltage cable to the secondary side of the voltage transformer erroneously.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

The measurements conducted during the test possibly may charge the connected inductance.

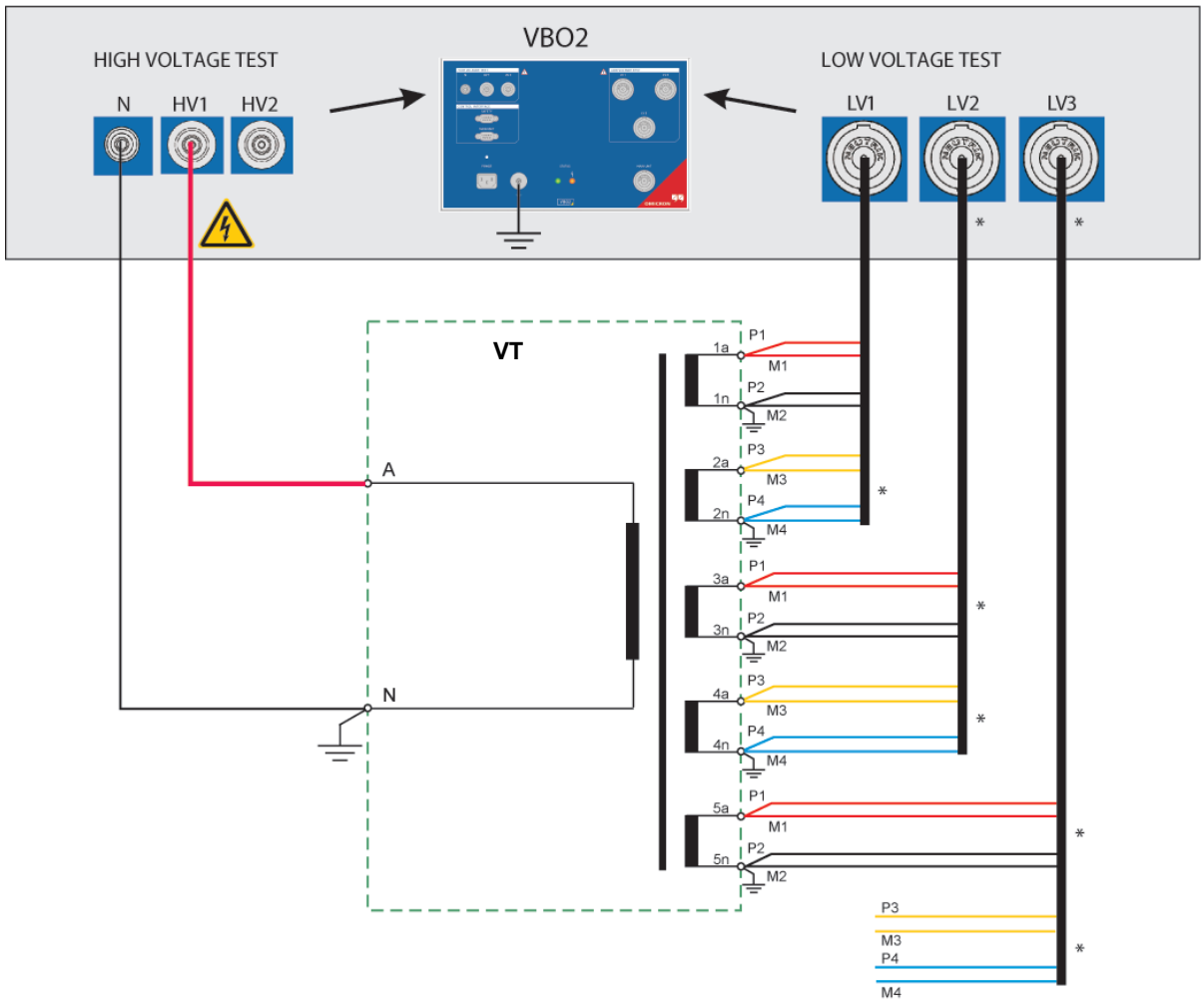
- ▶ Before connecting or disconnecting any leads, use a grounding rod
- ▶ to discharge all terminals of the voltage transformer,
- ▶ and to ground the high-voltage terminals of the voltage transformer.

Proceed as follows when requested by *VOTANO 100* or the *VOTANO Suite* software:

1. Temporarily connect the primary high-voltage terminal A of the voltage transformer to ground.
2. For CVTs/CCVTs only:
   Temporarily connect terminal NHF of the voltage transformer to ground.

   Note: Connect high-voltage socket HV1 of the HIGH VOLTAGE TEST section on *VBO2* to primary terminal A of the voltage transformer using a high-voltage cable (see figures below).
   During the ratio test, the high-voltage cable must have a distance greater than 1 m to the bushing head of the voltage transformer. Routing the high-voltage cable with a smaller distance to the bushing head may reduce the accuracy of the measurement results.
3. For CVTs/CCVTs only:
   Connect high-voltage socket HV2 of the HIGH VOLTAGE TEST section on *VBO2* to terminal NHF of the voltage transformer using a high-voltage cable (see figure below).
4. Disconnect the grounding from primary high-voltage terminal A of the voltage transformer.
5. For CVTs/CCVTS only:
   Disconnect the grounding from primary terminal NHF of the voltage transformer.

6. Check the wiring. See figures below.
7. Leave the high-voltage area and secure this area against unauthorized access.
8. Release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on *VOTANO 100* (or the **Confirm Wiring** button in the *VOTANO Suite* software, respectively).
9. When requested by *VOTANO 100* or *VOTANO Suite*, press the green start button on the *SAB1* safety box within one minute to start the test execution.
10. The red LEDs flash while *VOTANO 100* performs its measurements.
11. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
12. Proceed with Disconnection (page 100) to disconnect the test setup.



* Connect as required according to the number of windings. Unused banana plugs of the cable may be left open.

Figure 6-5: Wiring for measurements with primary voltage injection on a VT voltage transformer

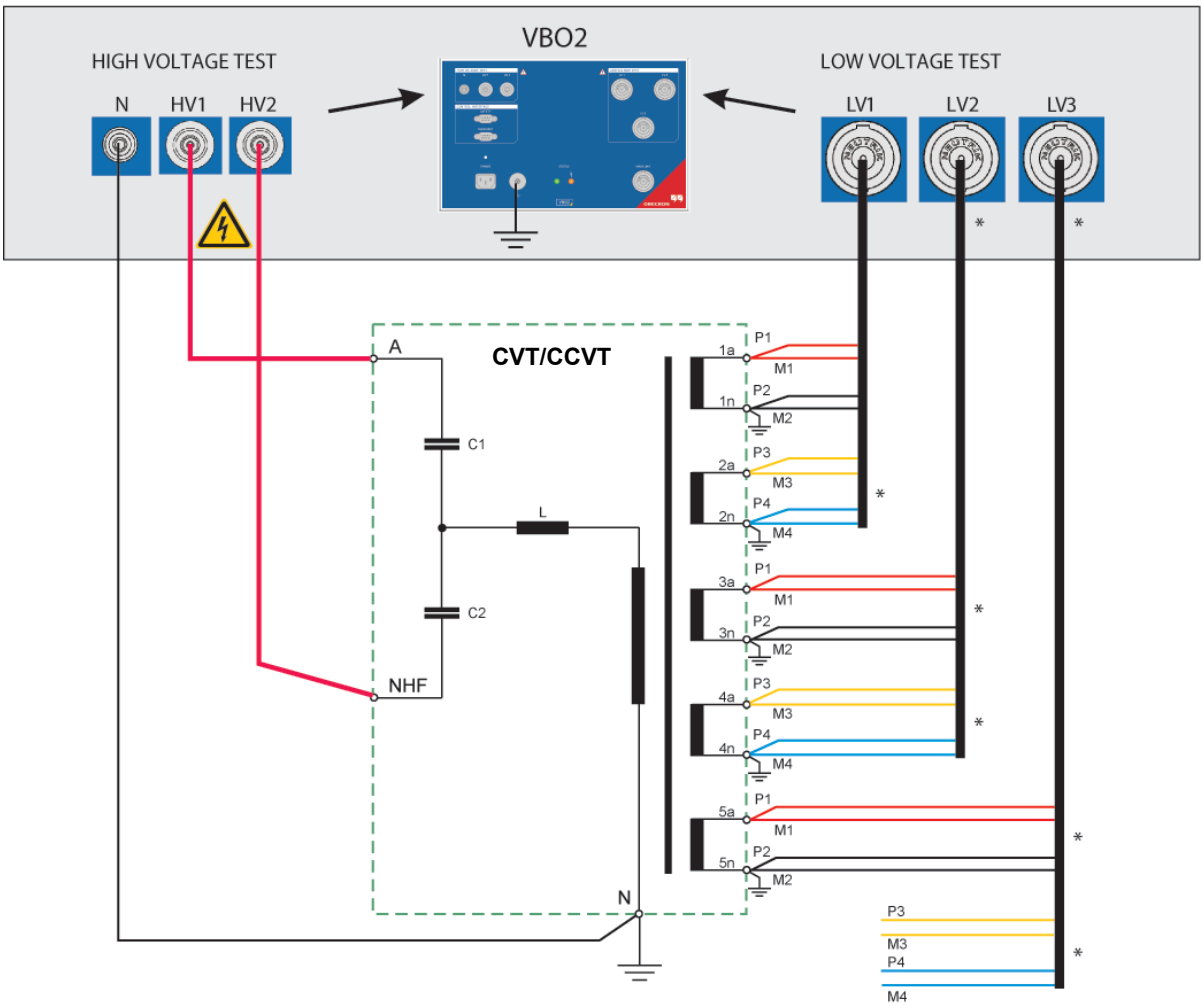
⚠ WARNING

Death or severe injury caused by high voltage or current possible

▶ Disconnect the unused HV cable from HV2 and from the asset under test.

▶ Refer to Preparing the test object (page 39) for information on how to prepare the test object.

▶ Refer to Setting up VOTANO 100 and VBO2 (page 40) for information on how to set up *VOTANO 100*, *VBO2*, and *SAB1*.



* Connect as required according to the number of windings. Unused banana plugs of the cable may be left open.

Figure 6-6: Wiring for measurements with primary voltage injection on a CVT/CCVT voltage transfomer

- ▶ Refer to Preparing the test object (page 39) for information on how to prepare the test object.
- ▶ Refer to Setting up VOTANO 100 and VBO2 (page 40) for information on how to set up *VOTANO 100*, *VBO2*, and *SAB1*.

6.4 Wiring for C-Divider test

Applicable for C-Divider Test mode only.

The C-Divider test comprises a two-stage measurement process: C2 measurement and C1/Cr measurement. Therefore, *VOTANO 100* or the *VOTANO Suite* software will request rewiring on the primary side of the voltage transformer during the test.

Observe the safety instructions given in Safety (page 11) and Connecting and disconnecting the test object (page 75).

⚠ WARNING

Death or severe injury caused by high voltage or current possible

High voltages of up to 4 kV are applied to the primary side and to the NHF connection point of the CVT/CCVT voltage transformer during the test.

- ▶ Be aware of the particular danger of such high voltages.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

The measurements conducted during the test possibly may charge the connected inductance.

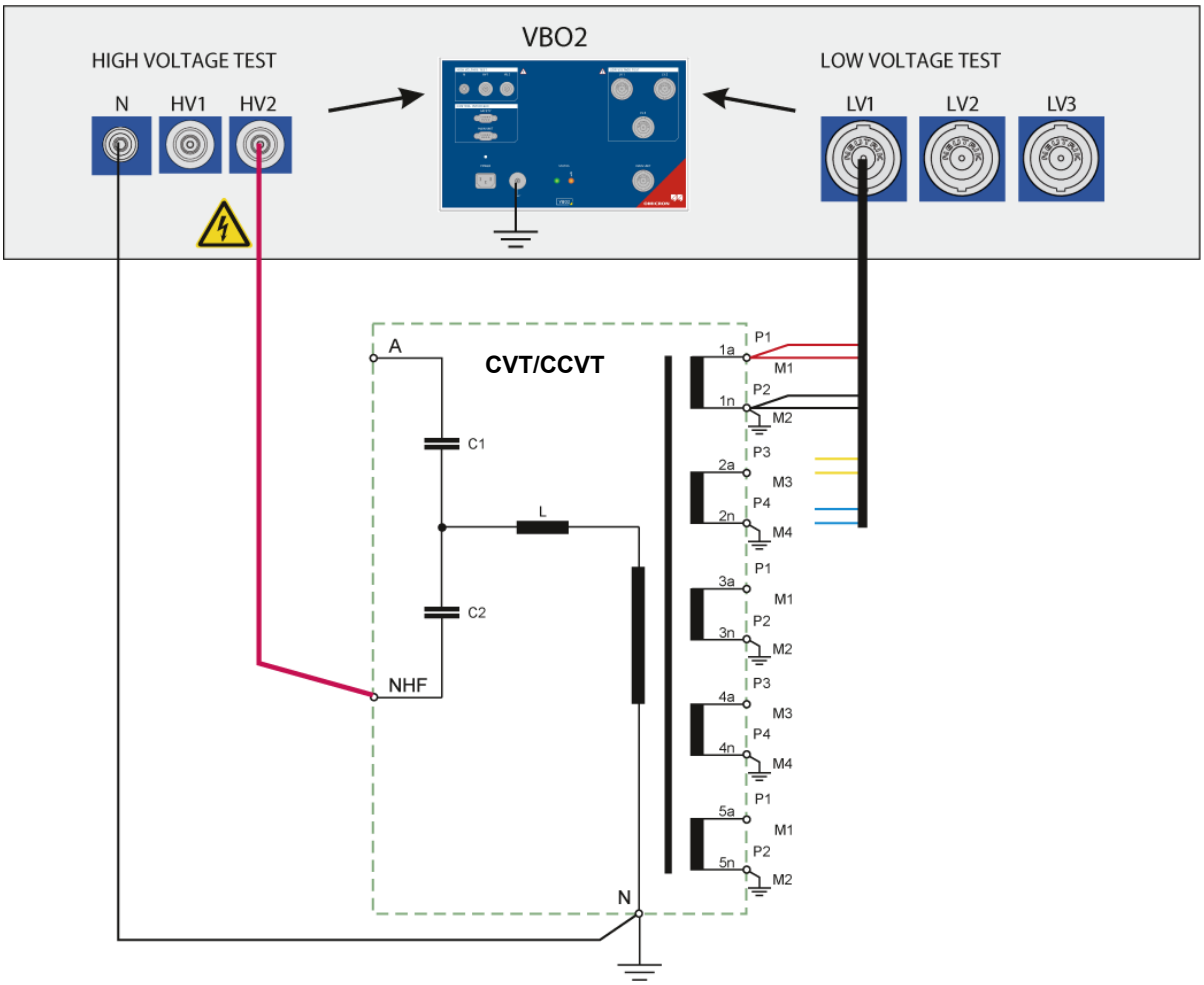
- ▶ Before connecting or disconnecting any leads, use a grounding rod
- ▶ to discharge all terminals of the voltage transformer,
- ▶ and to ground the high-voltage terminals of the voltage transformer.

Proceed as follows when requested by *VOTANO 100* or the *VOTANO Suite* software:

C2 measurement

1. Connect an eight-core test cable to the LV1 socket of the LOW VOLTAGE TEST section on *VBO2*, and connect the red and black wires of the test cable to one of the secondary windings of the voltage transformer under test, for example, to winding 1 (1a/1n). See figure below.
2. Temporarily connect the primary high-voltage terminal A of the capacitive voltage divider to ground.
3. Temporarily connect terminal NHF of the capacitive voltage divider to ground.
4. Connect high-voltage socket HV2 of the HIGH VOLTAGE TEST section on VBO2 to primary terminal NHF of the capacitive voltage divider using a high-voltage cable. See figure below.
5. Disconnect the grounding from primary high-voltage terminal A of the capacitive voltage divider.

6. Disconnect the grounding from primary terminal NHF of the capacitive voltage divider.
7. Check the wiring. See figure below.
8. Leave the high-voltage area and secure this area against unauthorized access.
9. Release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on *VOTANO 100* (or the **Confirm Wiring** button in the *VOTANO Suite* software, respectively).
10. When requested by *VOTANO 100* or *VOTANO Suite*, press the green start button on the *SAB1* safety box within one minute to start the test execution.
11. The red LEDs flash while *VOTANO 100* performs the measurement.
12. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
13. *VOTANO 100* or the *VOTANO Suite* software request rewiring for the C1/Cr measurement.



Make sure that all unused secondary windings of the voltage transformer are open on one side and connected to ground on the other side.
Unused banana plugs of the test cable (yellow and blue wires) may be left open.

Figure 6-7: Wiring for C2 measurement during a C-Divider test

⚠ WARNING

Death or severe injury caused by high voltage or current possible

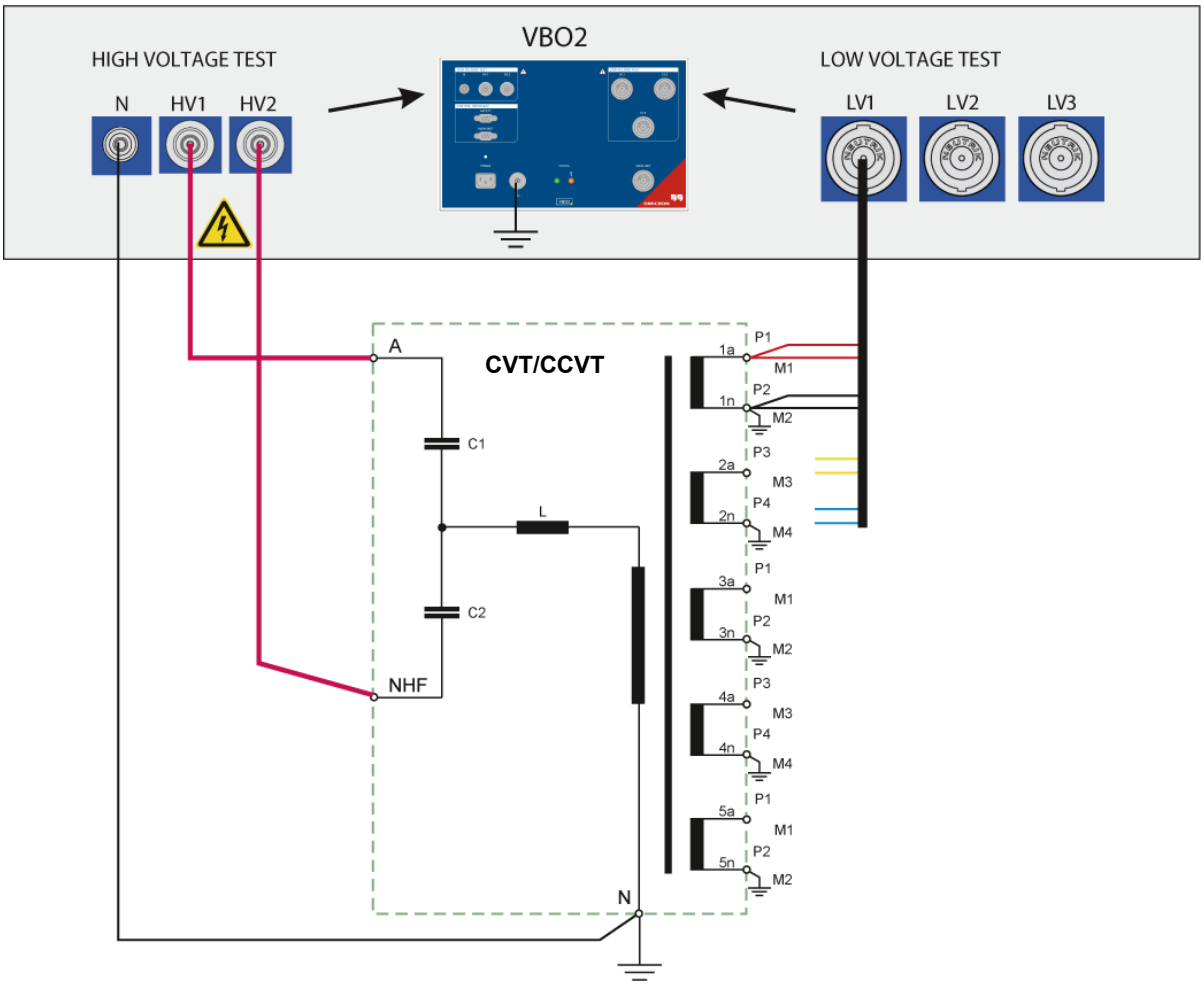
▶ Disconnect the unused HV cable from HV1 and from the asset under test.

▶ Refer to Preparing the test object (page 39) for information on how to prepare the test object.

▶ Refer to Setting up VOTANO 100 and VBO2 (page 40) for information on how to set up *VOTANO 100*, *VBO2*, and *SAB1*.

C1/Cr measurement

1. Temporarily connect the primary high-voltage terminal A of the capacitive voltage divider to ground.
2. Temporarily connect terminal NHF of the capacitive voltage divider to ground.
3. Connect high-voltage socket HV1 of the HIGH VOLTAGE TEST section on *VBO2* to primary terminal A of the capacitive voltage divider using a high-voltage cable. See figure below.
4. Disconnect the grounding from primary high-voltage terminal A of the capacitive voltage divider.
5. Disconnect the grounding from primary terminal NHF of the capacitive voltage divider.
6. Check the wiring. See figure below.
7. Leave the high-voltage area and secure this area against unauthorized access.
8. Release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on *VOTANO 100* (or the **Confirm Wiring** button in the *VOTANO Suite* software, respectively).
9. When requested by *VOTANO 100* or *VOTANO Suite*, press the green start button on the *SAB1* safety box within one minute to start the test execution.
10. The red LEDs flash while *VOTANO 100* performs the measurement.
11. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
12. Proceed with Disconnection (page 100) to disconnect the test setup.



Make sure that all unused secondary windings of the voltage transformer are open on one side and connected to ground on the other side.
Unused banana plugs of the test cable (yellow and blue wires) may be left open.

Figure 6-8: Wiring for C1/Cr measurement during a C-Divider test

- ▶ Refer to Preparing the test object (page 39) for information on how to prepare the test object.
- ▶ Refer to Setting up VOTANO 100 and VBO2 (page 40) for information on how to set up *VOTANO 100*, *VBO2*, and *SAB1*.

6.5 Wiring for burden test

Applicable for Advanced VT/CVT Test mode and Burden Test mode.

Use the wiring shown in this section to perform a burden measurement. The burden measurement can be included in the Advanced VT/CVT test (Advanced VT/CVT Test mode (page 45) or Integrating burden measurement to the Advanced VT/CVT test (page 57)) or be performed separately as a stand-alone burden test (Burden Test mode (page 72)).

▶ Observe the safety instructions given in Safety (page 11).

⚠ WARNING

Death or severe injury caused by high voltage or current possible

▶ Make sure that the terminals of the burden to be connected to the *VBO2* do not carry any voltage potential.

▶ During a test, *VOTANO 100*/*VBO2* is the only permitted signal source on the burden.

▶ Make sure that the high-voltage terminal A/H1 of the voltage transformer is connected to ground.

▶ Disconnect the burden from the secondary winding of the voltage transformer before starting the burden test and make sure that it is properly grounded.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

As long as the red LEDs on *VOTANO 100*, *VBO2* and *SAB1* are flashing, the output is active and lethal voltages can occur.

▶ Do not enter the high-voltage area while the red LEDs on *VOTANO 100*, *VBO2* and *SAB1* are flashing.

▶ Wait until the red LEDs are off and the green LEDs are on.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

Although *VOTANO 100* brings the test setup into a safe and de-energized state before requesting any wiring to be performed by the user during the test, you should always actuate the emergency stop button before entering the high-voltage area in order to increase safety.

▶ Deactivate the outputs of the *VBO2* voltage booster by actuating the emergency stop button before entering the high-voltage area for rewiring during the test sequence.

NOTICE

Equipment damage caused by high voltage possible

VOTANO 100 can output voltages that are possibly higher than the nominal voltage of the burden.

▶ Make sure that the test voltage applied during the burden measurement does not exceed the nominal voltage of the burden.

Proceed as follows when requested by *VOTANO 100* or the *VOTANO Suite* software after starting the Advanced VT/CVT test or the stand-alone burden test:

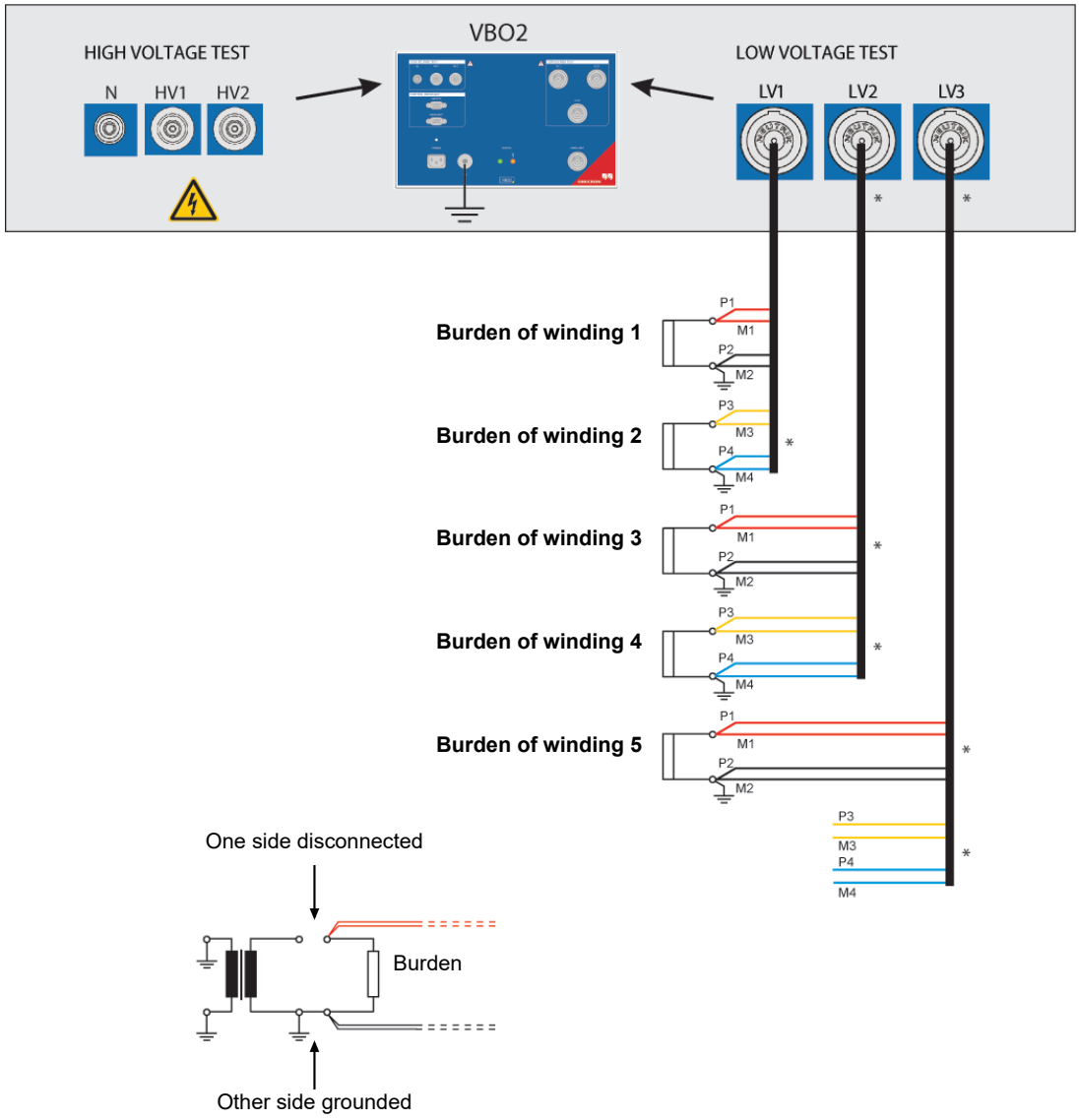
1. Use the delivered eight-core test cables to connect all burdens under test to the *VBO2* voltage booster.
2. If the burden test is executed as a part of an Advanced VT/CVT test (see figures below):
   2.1 Connect burden 1 and 2 to socket LV1 of VBO2.
   2.2 Connect burden 3 and 4 to socket LV2 of VBO2.
   2.3 Connect burden 5 to socket LV3 of VBO2.
   Do not mix up the burdens or the LVx sockets on *VBO2***.**
3. If you are running a stand-alone burden test (see figures below):
   3.1 Connect the multipole plug of the eight-core test cable to socket LV1 of the LOW VOLTAGE TEST section on *VBO2*.
   3.2 Connect the connectors P1 and M1 as well as P2 and M2 of the eight-core test cable to the burden to be measured.
4. Check the wiring. See figures below.

⚠ WARNING

Death, severe injury or equipment damage caused by high voltage or current is possible in case of incorrect wiring

- ▶ Avoid incorrect wiring. *VOTANO 100* does not perform a wiring check for a stand-alone burden test.
- ▶ Make sure that the wiring is correct before running a stand-alone burden test.

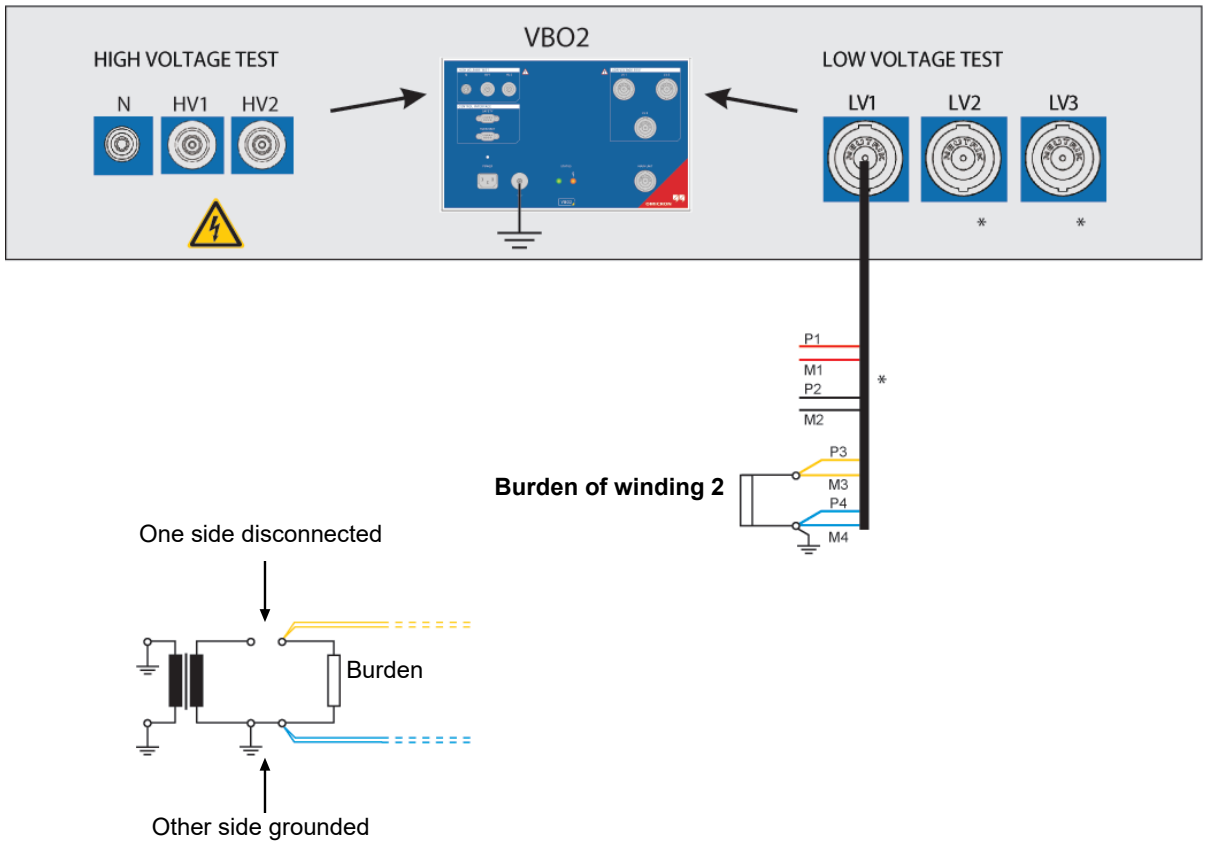
5. Leave the high-voltage area and secure this area against unauthorized access.
6. Release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on *VOTANO 100* (or the **Confirm Wiring** button in the *VOTANO Suite* software, respectively).
7. When requested by *VOTANO 100* or *VOTANO Suite*, press the green start button on the *SAB1* safety box within one minute to start the test execution.
8. The red LEDs flash while *VOTANO 100* performs the measurement.
9. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
10. Proceed with Wiring for secondary voltage injection test (page 76) when requested by *VOTANO 100* or the *VOTANO Suite* software during an Advanced VT/CVT test, or disconnect the test setup (Disconnection (page 100)) if you performed a stand-alone burden test.



* Connect as required according to the burdens to be measured.
Unused banana plugs of the cable may be left open.

Figure 6-9: Wiring for burden test if executed as a part of an Advanced VT/CVT test (all secondary windings are connected to a burden)

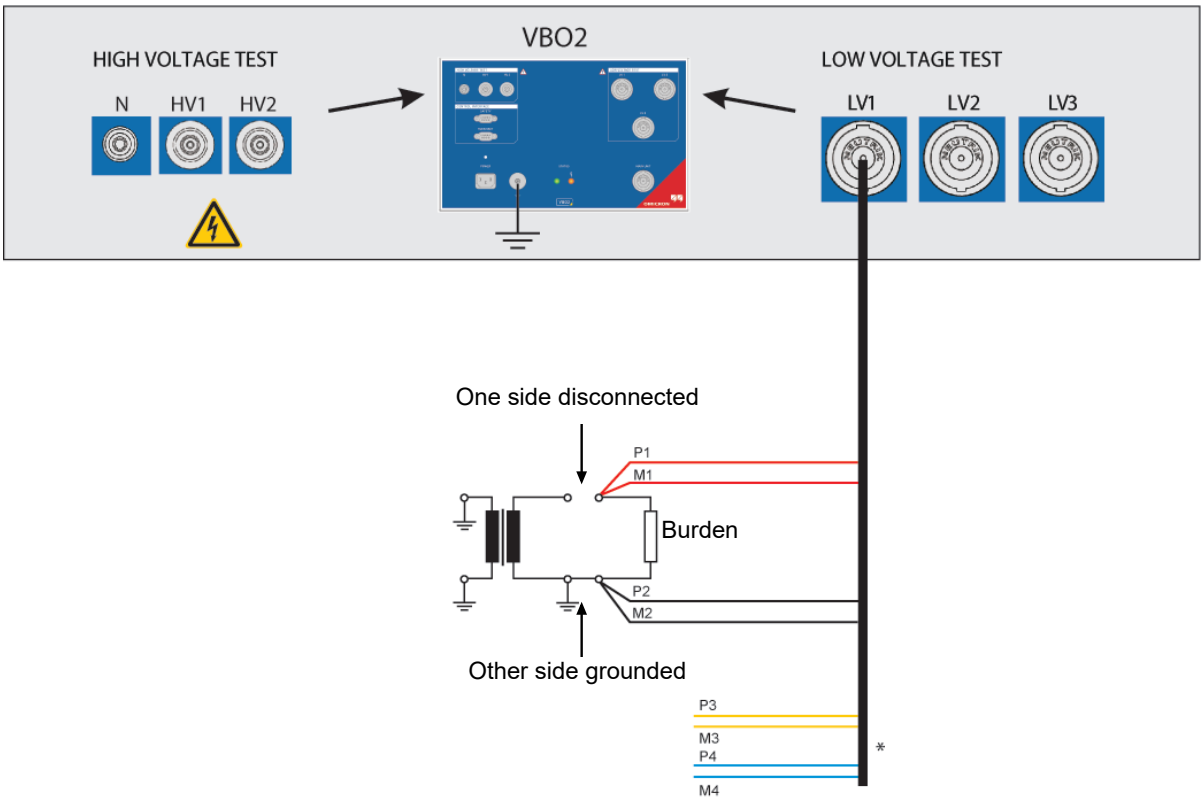
- ▶ Refer to Preparing the test object (page 39) for information on how to prepare the test object.
- ▶ Refer to Setting up VOTANO 100 and VBO2 (page 40) for information on how to set up *VOTANO 100*, *VBO2*, and *SAB1*.



* Unused banana plugs of the cable may be left open.

Figure 6-10: Example wiring for a burden test when executed as a part of an Advanced VT/CVT test (only the burden of winding 2 is selected for testing)

- ▶ Refer to Preparing the test object (page 39) for information on how to prepare the test object.
- ▶ Refer to Setting up VOTANO 100 and VBO2 (page 40) for information on how to set up *VOTANO 100*, *VBO2*, and *SAB1*.



* Unused banana plugs of the cable may be left open.

Figure 6-11: Wiring for a stand-alone burden test

- ▶ Refer to Preparing the test object (page 39) for information on how to prepare the test object.
- ▶ Refer to Setting up VOTANO 100 and VBO2 (page 40) for information on how to set up *VOTANO 100*, *VBO2*, and *SAB1*.

6.6 Wiring for ratio checks

Applicable for Ratio Check mode only.

A ratio check (Ratio Check mode (page 69)) can be performed separately for any secondary winding of a voltage transformer (CVT/CCVT or VT) in order to quickly determine the ratio.

- ▶ Observe the safety instructions given in Safety (page 11).

⚠ WARNING

Death or severe injury caused by high voltage or current possible

- ▶ Make sure that the terminals of the test object to be connected to *VBO2* do not carry any voltage potential.
- ▶ Make sure that the test object is completely disconnected from the power system.
- ▶ During a test, *VOTANO 100*/*VBO2* is the only permitted power source for the test object.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

As long as the red LEDs on *VOTANO 100*, *VBO2* and *SAB1* are flashing, the output is active and lethal voltages can occur due to the high energy stored in external inductors.

- ▶ Do not enter the high-voltage area while the red LEDs on *VOTANO 100*, *VBO2* and *SAB1* are flashing.
- ▶ Wait until the red LEDs are off and the green LEDs are on.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

Although *VOTANO 100* brings the test setup into a safe and de-energized state before requesting any wiring to be performed by the user during the test, you should always actuate the emergency stop button before entering the high-voltage area in order to increase safety.

- ▶ Deactivate the outputs of the *VBO2* voltage booster by actuating the emergency stop button before entering the high-voltage area for rewiring during the test sequence.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

High voltages are applied to the primary side of the voltage transformer during the test.

- ▶ Be aware of the particular danger of such high voltages.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

The measurements conducted during the test possibly may charge the connected inductance.

- ▶ Before connecting or disconnecting any leads, use a grounding rod
- ▶ to discharge all terminals of the voltage transformer,
- ▶ and to ground the high-voltage terminals of the voltage transformer.

NOTICE

Equipment damage caused by high voltage possible

VOTANO 100 can output voltages that are possibly higher than the nominal voltage of the test object.

▶ Make sure that the test voltage applied during the ratio check does not exceed the nominal voltage of the voltage transformer.

Proceed as follows when requested by *VOTANO 100* or the *VOTANO Suite* software after starting the ratio check:

1. Temporarily connect the primary high-voltage terminal A of the voltage transformer to ground.
2. Connect the voltage transformer under test to *VBO2*.
   See figure below:
   2.1 Connect the multipole socket of the eight-core test cable to socket LV1 of the LOW VOLTAGE TEST section on *VBO2*.
   2.2 Connect the connectors P1 and M1 as well as P2 and M2 of the eight-core test cable to the secondary winding to be measured.
   2.3 Connect socket N of the HIGH VOLTAGE TEST section on *VBO2* to the grounded terminal N of the voltage transformer under test.
   2.4 Connect high-voltage socket HV1 of the HIGH VOLTAGE TEST section on *VBO2* to high-voltage terminal A of the voltage transformer using a high-voltage cable.

Note: During the ratio check, the high-voltage cable must have a distance greater than 1 m to the bushing head of the voltage transformer. Routing the high-voltage cable with a smaller distance to the bushing head may reduce the accuracy of the measurement results.

1. Disconnect the grounding from primary high-voltage terminal A of the voltage transformer.
2. Check the wiring. See figure below.

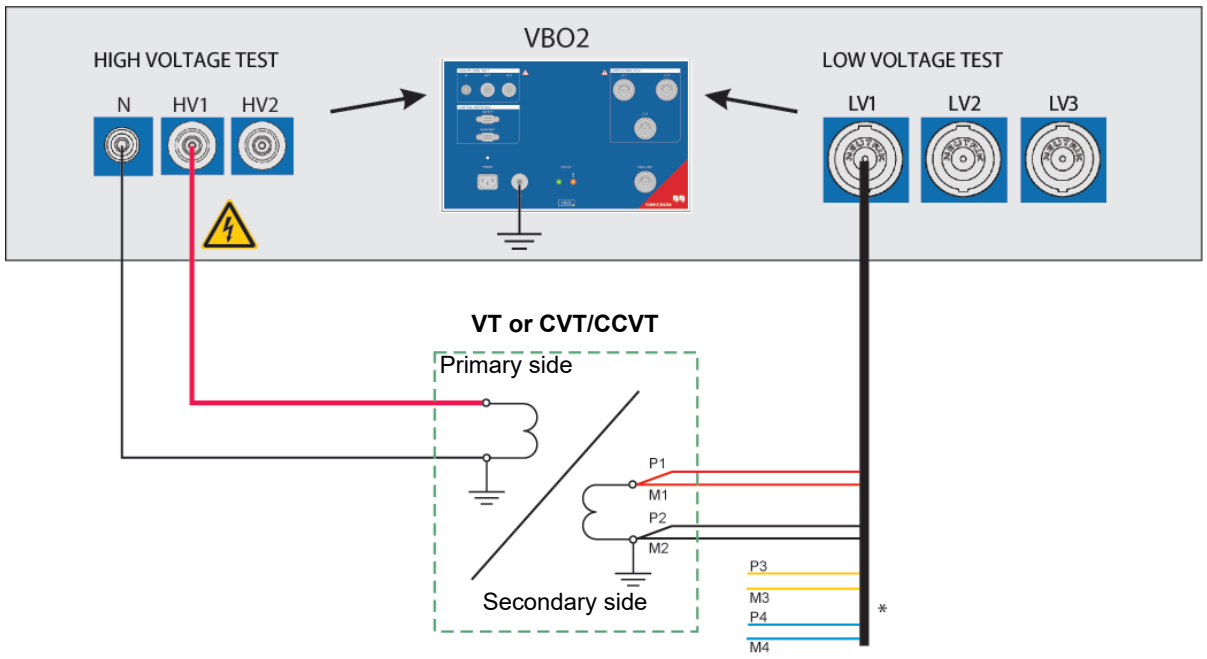
⚠ WARNING

Death, severe injury or equipment damage caused by high voltage or current is possible in case of incorrect wiring

Avoid incorrect wiring. *VOTANO 100* does not perform a wiring check for the ratio check.

▶ Make sure that the wiring is correct before running a ratio check.

3. Leave the high-voltage area and secure this area against unauthorized access.
4. Release the emergency stop button (if actuated before) and press the **Confirm Wiring** soft key on *VOTANO 100* (or the **Confirm Wiring** button in the *VOTANO Suite* software, respectively).
5. When requested by *VOTANO 100* or *VOTANO Suite*, press the green start button on the *SAB1* safety box within one minute to start the test execution.
6. The red LEDs flash while *VOTANO 100* performs its measurements.
7. When finished, *VOTANO 100* automatically stops the measurement and brings the test setup into a safe state. The red LEDs go off and the green LEDs are on to indicate the safe and de-energized state.
8. Proceed with Disconnection (page 100) to disconnect the test setup.



* Unused banana plugs of the cable may be left open.

Figure 6-12: Wiring for a ratio check on a voltage transformer

6.7 Disconnection

Applicable for all test modes.

⚠ DANGER

Death or severe injury caused by high voltage or current

DC winding resistance measurements are performed during the test sequence. Feeding an inductance with DC current will charge the inductance. Interrupting the regular execution of a test sequence may prevent *VOTANO 100* from discharging the inductance after the measurement.

▶ Do not touch the test setup until the energy stored in the inductance has dissipated over time, if the measurement interrupted unexpectedly, for example, due to a loss of supply voltage or erroneous behavior of the *VOTANO 100*.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

As long as the red LEDs on *VOTANO 100*, *VBO2* and *SAB1* are flashing, the output is active and lethal voltages can occur due to the high energy stored in external inductors.

- ▶ Do not enter the high-voltage area while the red LEDs on *VOTANO 100*, *VBO2* and *SAB1* are flashing.
- ▶ Wait until the red LEDs are off and the green LEDs are on.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

Although *VOTANO 100* brings the test setup into a safe and de-energized state before requesting any wiring to be performed by the user during the test, you should always actuate the emergency stop button before entering the high-voltage area in order to increase safety.

- ▶ Deactivate the outputs of the *VBO2* voltage booster by actuating the emergency stop button before entering the high-voltage area for rewiring during the test sequence.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

The measurements conducted during the test possibly may charge the connected inductance.

- ▶ Before connecting or disconnecting any leads, use a grounding rod
- ▶ to discharge all terminals of the voltage transformer,
- ▶ and to ground the high-voltage terminals of the voltage transformer.

Proceed as follows to disconnect *VOTANO 100* and *VBO2*:

1. Wait until the red LEDs on *VOTANO 100*, *VBO2* and *SAB1* are off.
2. Switch off the *VOTANO 100* test set at its mains switch.
3. Discharge all terminals of the voltage transformer using a grounding rod.
4. Connect the primary high-voltage terminal A of the voltage transformer to ground.
5. Disconnect all test cables.
6. Disconnect all connections between *VOTANO 100* and *VBO2* starting at *VOTANO 100*.
7. Disconnect the *SAB1* safety box from *VBO2*.
8. Disconnect the grounding wires from *VOTANO 100* and *VBO2*.
9. Disconnect the grounding wires of *VOTANO 100* and *VBO2* from the grounding point.
10. Remove the barrier between the work area and the high-voltage area.

Do not forget to reconnect the voltage transformer and the burden after your test. Restore the original condition of the voltage transformer/burden as found.

Some remanence may remain in the core if the last Advanced VT/CVT Test sequence performed was interrupted or if the excitation curve measurement was skipped or could not be completed properly. In this case, perform a complete Advanced VT/CVT Test sequence at the end of your test session to remove the remanence.

7 Operating and configuring VOTANO 100

7.1 Working in the user interface

7.1.1 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.

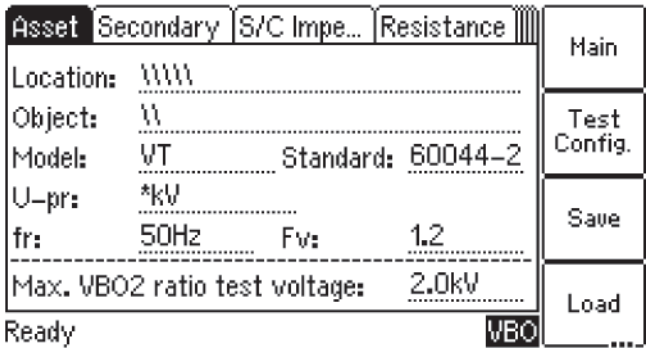


Figure 7-1: **Asset** card selected

7.1.2 Using the soft keys

Using the soft keys you can operate *VOTANO 100* and change the user interface level of the software.

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

If more than 4 soft keys are available, the lowermost soft key description field contains 3 points (see 110 kV in the figure below). Then you can switch the set of displayed soft keys using the key located below the soft keys (Display with soft keys (page 29)).

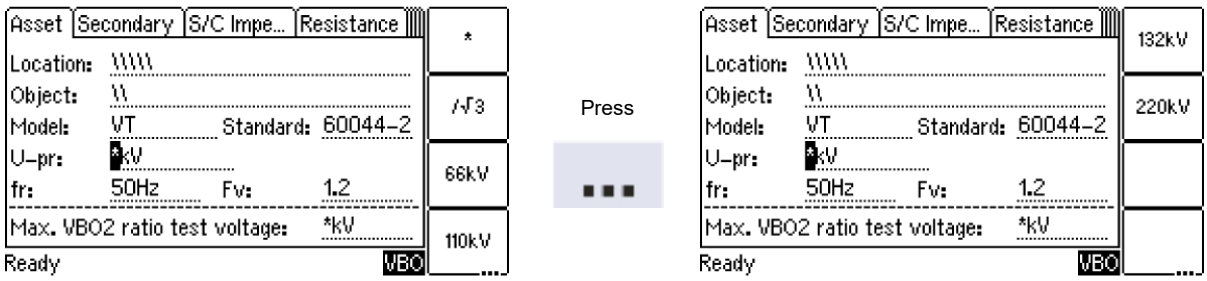


Figure 7-2: Switching the set of soft keys

7.1.3 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 below). 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.

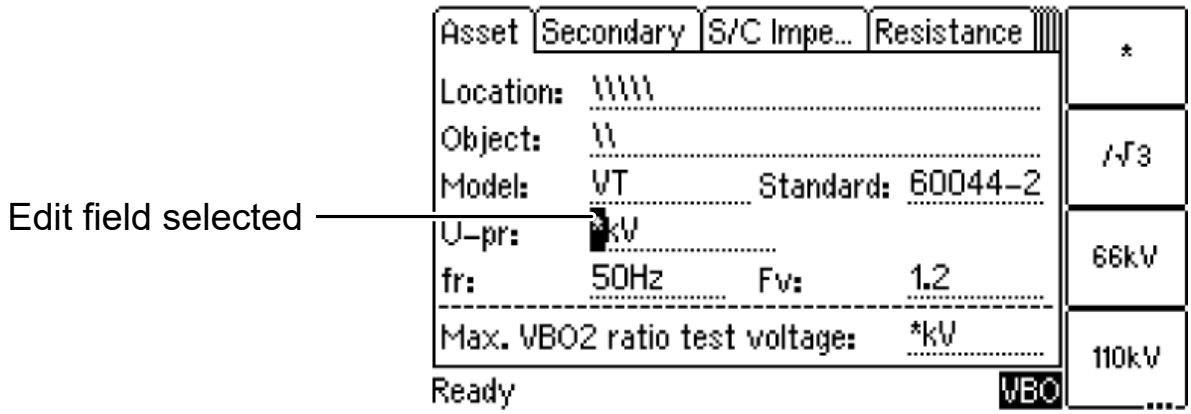


Figure 7-3: Edit field selected in the **Asset** card

Proceed as follows to edit a card:

1. Select the edit field using the cursor keys.
2. Enter or edit the value or text:
   2.1 Select an entry offered by the soft keys (if available)
   2.2 or enter the value or text using the keyboard and then press the ↵ key or one of the ▲ ▼ cursor keys 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).

7.2 The 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.	**How to get there:** Press the **Main** soft key in any test card. → **Main menu** page

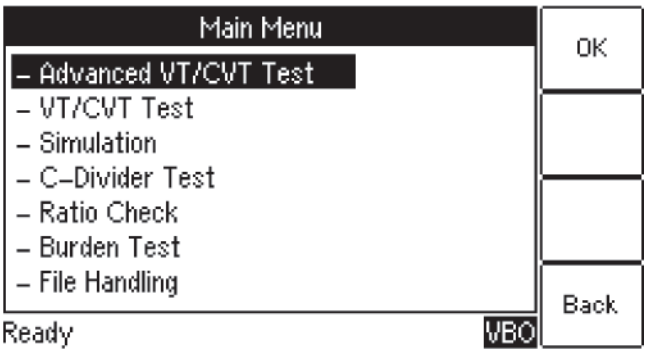


Figure 7-4: **Main Menu** page

7.3 Advanced VT/CVT Test mode

Select "Advanced VT/CVT Test" in the main menu and then press the **OK** soft key to open the Advanced VT/CVT Test mode. The **Asset** card is displayed with the default parameter settings for a new voltage transformer test in this mode.

Some of the defaults can be defined in the settings (Default VT Parameters and Default CVT/CCVT Parameters, Settings (page 112)). Press the **Test Config.** soft key to select the test configuration (for example, available test cards, factor for assessment customization etc., Test configuration (page 128)).

How to get there:

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

Main menu → Advanced VT/CVT Test

OK soft key

→ **Asset** card

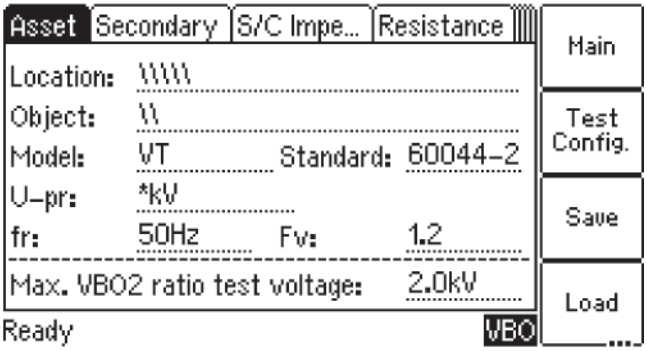


Figure 7-5: **Asset** card with default test settings after initializing a new Advanced VT/CVT test

For more detailed information about the Advanced VT/CVT Test mode, refer to Advanced VT/CVT Test mode (page 45). For more detailed information about the test cards available in the Advanced VT/CVT Test mode, refer to Test cards for Advanced VT/CVT Test mode (page 125).

7.4 VT/CVT Test mode

Select "VT/CVT Test" in the main menu and then press the **OK** soft key to open the VT/CVT Test mode. The **Asset** card is displayed with the default parameter settings for a new voltage transformer test in this mode.

Some of the defaults can be defined in the settings (Default VT Parameters and Default CVT/CCVT Parameters, Settings (page 112)). Press the **Test Config.** soft key to select the test configuration (Test configuration (page 161)).

How to get there:

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

Main menu → VT/CVT Test

OK soft key

→ **Asset** card

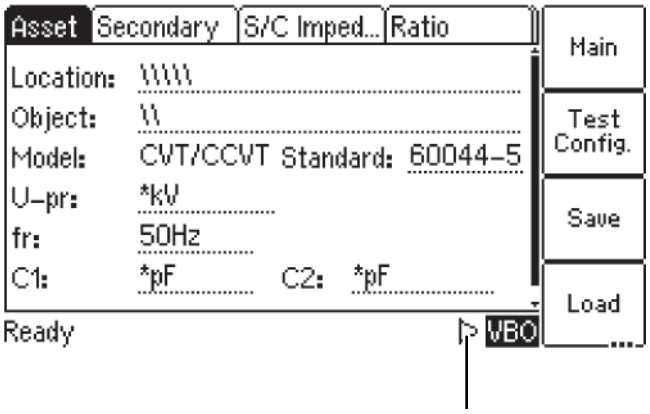


Figure 7-6: **Asset** card with default settings after initializing a new VT/CVT test

For more detailed information about the VT/CVT Test mode, refer to VT/CVT Test mode (page 58). For more detailed information about the test cards available in the VT/CVT Test mode, refer to Test cards for VT/CVT Test mode (page 158).

7.5 Simulation mode

By selecting "Simulation" in the main menu and then pressing the **OK** soft key, you can load a voltage transformer test previously performed in the Advanced VT/CVT Test mode or a previously performed simulation from the Compact Flash card in order to simulate the test results with changed settings.	**How to get there:** Press the **Main** soft key in any test card. **Main menu → Simulation** **OK** soft key → Request to load a test report or **Asset** card with existing test

For more detailed information about the Simulation mode, refer to Simulation mode (page 64).

7.6 C-Divider Test mode

Select "C-Divider Test" in the main menu and then press the **OK** soft key to open the C-Divider Test mode. The **Asset** card is displayed with the default parameter settings for a new C-Divider test in this mode. The default frequency can be defined in the settings (Default CVT/CCVT Parameters, Settings (page 112)). Press the **Test Config.** soft key to select the test configuration (Test configuration (page 161)).	**How to get there:** Press the **Main** soft key in any test card. **Main menu → C-Divider Test** **OK** soft key → **Asset** card

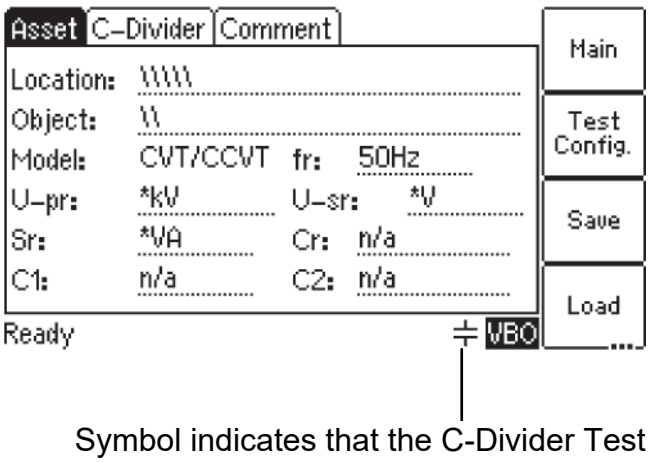


Figure 7-7: **Asset** card with default test settings after initializing a new C-Divider test

For more detailed information about the C-Divider Test mode, refer to C-Divider Test mode (page 67). For more detailed information about the test cards available in the C-Divider Test mode, refer to Test cards for C-Divider Test mode (page 168).

7.7 Ratio Check mode

Select "Ratio Check" in the main menu and press the **OK** soft key to open the Ratio Check mode. You can use ratio checks to quickly determine the ratio of a voltage transformer.	**How to get there:** Press the **Main** soft key in any test card. **Main menu → Ratio Check** **OK** soft key → **Ratio** card for ratio check mode

For more detailed information about the Ratio Check mode, refer to Ratio Check mode (page 69).

7.8 Burden Test mode

Select "Burden Test" in the main menu and press the **OK** soft key to open the Burden Test mode. You can use this mode to measure the burden of a voltage transformer stand-alone by just specifying the rated secondary voltage and the frequency.	**How to get there:** Press the **Main** soft key in any test card. **Main menu → Burden Test** **OK** soft key → **Burden** card for burden test mode

For more detailed information about the Burden Test mode, refer to Burden Test mode (page 72).

7.9 File handling

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.	**How to get there:** Press the **Main** soft key in any test card. **Main menu → File Handling** **OK** soft key → **File menu** page

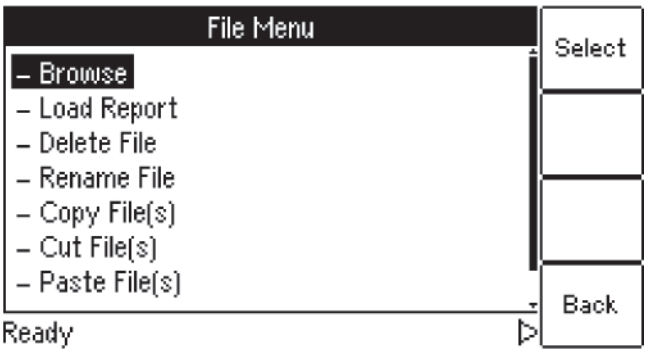


Figure 7-8: **File Menu** page

7.9.1 Available functions

Table 7-1: File handling functions

Function	Description
Browse	Browsing the Compact Flash card for files.
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 **Asset** card.

Function	Description
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.
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 in Working in the file system (page 109).
Format CF card	Formatting the Compact Flash card. All data on the Compact Flash card will be lost!

In the *VOTANO 100* 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.

7.9.2 Working in the file system

After selecting one of the available file operation functions in the **File Menu** page, 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 the figure below).	**How to get there:** Press the **Main** soft key in any test card. **Main menu** → **File Handling** **OK** soft key **File menu**: → **Browse** or → **Load Report** or → **Delete File** or → **Rename File** or → **Copy File(s)** or → **Cut File(s)** or → **Paste File(s)**

Navigating in the file system

1. To open a folder, select its entry (see figure below, left) using the ▲ ▼ cursor keys, and then press the ↵ key.
2. To go one level higher in the directory structure, select the "one level higher" entry and then press the ↵ key.

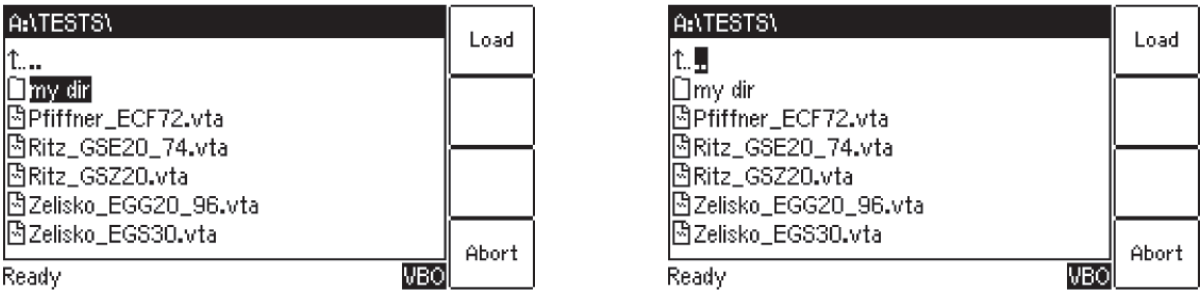


Figure 7-9: File system card for loading a report

Creating a new folder

Creating a new folder is only possible for the functions **Browse** and **Paste File(s)** of the **File Menu**. To create a new folder in the file system, select **Browse** in the **File Menu** page 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 or the **New Dir** soft key.	**How to get there:** Press the **Main** soft key in any test card. **Main menu → File Handling** **OK** soft key **File menu**: → **Browse** or → **Paste File(s)**

To create a new folder if you copied or cut a file beforehand:

1. Select **Paste Files(s)** in the **File Menu** page and then navigate to the desired location in the file system.
2. Press the **New Dir** soft key. A new folder with an empty name is created.
3. Enter a name for the new folder and press the ↵ key or the **New Dir** soft key to create the folder.
4. Press the ↵ key to open your new folder and then press the **Paste** soft key to store the file to this folder.

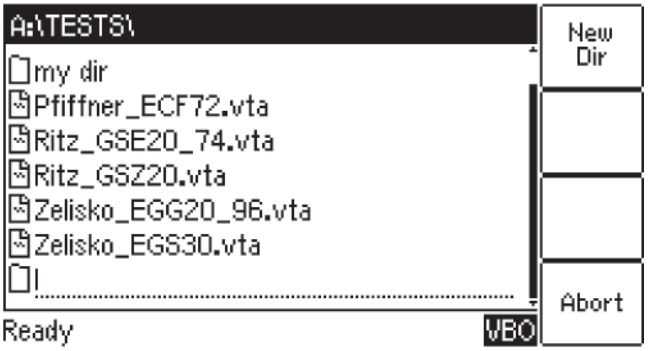


Figure 7-10: File system card after creating a new folder

In the *VOTANO 100* 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 *VOTANO 100*.

Saving a file

1. Press the **Save** soft key in the **Asset** card.
2. Navigate to the desired folder in the file system where you want to save the file:
   2.1 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.
   2.2 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 `*.vta` file entry with the selected file name is added. Edit this file name and then press again **Save**, **Save As** or the ↵ key.

The test results and settings of each test finished with the “Test ok” status are automatically stored to the file **OMICRON\AutoSave\VOTANO.vta** on the Compact Flash card. The VOTANO.vta file is written anew with each successful test. Tests that could not be finished successfully or that were aborted by the user are not stored and thus do not overwrite the existing VOTANO.vta file.

*.vta files stored by *VOTANO 100* can be loaded to *VOTANO 100* or the *VOTANO Suite* software.

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

Copying/cutting and pasting folders is not possible on *VOTANO 100*.

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. **Note:** 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**. To select several neighboring files at a time, keep the ▲ key pressed while selecting files using the ▲ ▼ cursor keys. 3. The file system card is closed, and the file menu is displayed. Select **Paste File(s)**. 4. The file system card appears again. Navigate to the desired location in the file system where you want to paste the file, and press the **Paste** soft key to paste it. 5. Alternatively, to create a new folder for your file: 5.1 Press the **New Dir** soft key. A new folder with an empty name is created. 5.2 Enter a name for the new folder and press the ↵ key or the **New Dir** soft key. 5.3 Press the ↵ key to open your new folder, and then press the **Paste** soft key to store the file to this folder.	**How to get there:** Press the **Main** soft key in any test card. **Main menu → File Handling** **OK** soft key **File menu**: → **Copy File(s)** or → **Cut File(s)**

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.

7.10 Settings

In the **Setting Menu** page, you can access the device settings or the default settings for new voltage transformer tests. Select an entry using the ▲ ▼ cursor keys and then press the **Select** soft key to open the corresponding settings page.	**How to get there:** Press the **Main** soft key in any test card. **Main menu → Settings** **OK** soft key → **Setting Menu** page

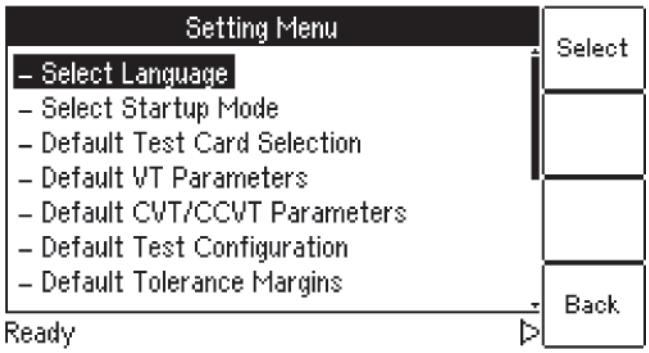


Figure 7-11: **Setting Menu** page

7.10.1 Available options in the Setting Menu page

Table 7-2: **Setting Menu** options

Option	Description
Select Language	Select the user interface language. One additional user language can be installed on *VOTANO 100*. The English user interface is part of the firmware and therefore always available. The second language can be installed by the user as required (Tools (update functions) (page 119)).
Select Startup Mode	Use this option to select the default test mode and voltage transformer model *VOTANO 100* comes up after switching the device on. **Mode at Startup**: Use the soft keys to select the default test mode: Advanced VT/CVT Test mode, VT/CVT Test mode, C-Divider Test mode or Ratio Check mode. **Model***: Use the soft keys to select between VT and CVT/CCVT. * Only available for Advanced VT/CVT Test mode and VT/CVT Test mode.
Default Test Card Selection	Select the test cards a new Advanced VT/CVT test should contain by default (Default test card selection (page 115)).
Default VT Parameters	Select the default settings used in the **Asset** card and the **Secondary** card for VTs: Standard, frequency, number of windings, residual winding available or not.
Default CVT/CCVT Parameters	Select the default settings used in the **Asset** card and the **Secondary** card for CVTs or CCVTs: Standard, frequency, number of windings, residual winding available or not.

Option	Description
Default Test Configuration	Select the following default settings: • Wiring check enabled/disabled • Limitation for *VBO2* test voltage enabled/disabled • Parameter fields for CVT capacitances enabled/disabled (VT/CVT Test mode only) • Activation of burden measurement for all windings enabled/disabled (Advanced VT/CVT Test mode only) • Class multiplication factor (assessment customization) enabled/ disabled (Advanced VT CVT Test mode only) Refer to Default test configuration (page 116) for more detailed information.
Default Tolerance Margins	*VOTANO 100* offers the option to customize the automatic assessment of the Advanced VT/CVT Test mode by defining an additional user-defined ratio and phase tolerance for the assessment. Use this option to define the default settings for this functionality. 1. Select this option to display the **Set Tolerance Margins** page. 2. In this page, select **Yes** for the 'Tolerance Margins Enabled' option to apply an additional ratio and phase tolerance for the assessment by default, or **No** if you do not want to apply additional tolerances by default. 3. Selecting **Yes** for the 'Tolerance Margins Enabled' option displays the 'Ratio Tolerance' and 'Phase Tolerance' parameter fields. Use these fields to define your default values for additional tolerances 3.1 between 0 % and 0.1 % for an additional ratio tolerance and/or 3.2 between 0 min and 5 min for an additional phase tolerance. Refer to Assessment card (page 151) for more detailed information regarding assessment customization.
Temperature	Select the temperature unit (**°C** or **°F**) and the default ambient temperature (for winding resistance measurement and calculation).
Date/Time	Clock settings for the device-internal clock.
Display Contrast	Display contrast adjustment.
Start Delay	Allows the definition of a delay time for the beginning of the actual test after pressing the start button. You can apply the defined delay for: • Burden measurements • Measurements with secondary voltage injection (that is, measurement of secondary short-circuit impedance, winding resistance and excitation in the Advanced VT/CVT Test mode) • Measurements with primary voltage injection (that is, all measurements in the VT/CVT Test mode and measurement of CVT ratio, CVT inductive ratio, VT ratio and primary short-circuit impedance in the Advanced VT/CVT Test mode)

Option	Description
Sound	*VOTANO 100* indicates active measurement phases during which voltage is applied to the test object with a beep sound. This indication is intended as an aid to increase user safety. On: Intermittent beep sound during the entire measurement phase. Off: Short beep sound at the beginning and the end of a measurement phase. This option is set to On by default.

7.10.2 Default test card selection

Enabling or disabling the default test cards for new Advanced VT/CVT tests 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 Advanced VT/CVT test.

The test card selection made here can be changed in the test configuration of an Advanced VT/CVT test (Test configuration (page 128)).

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 check mark, see figure below.

How to get there:

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

Main menu → Settings

OK soft key

Setting Menu → Default Test Card Selection

Select soft key

→ **Select Cards** page

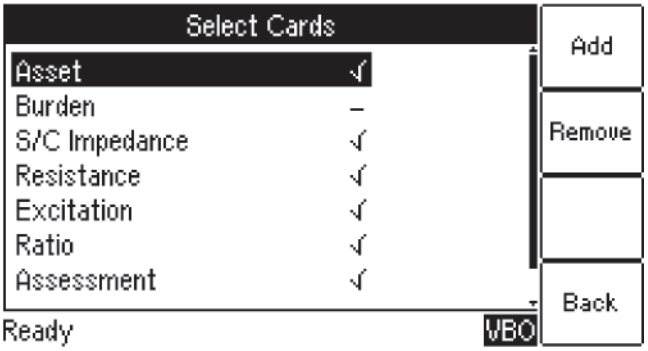


Figure 7-12: **Select Cards** page for selecting the default test cards

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. The following figure shows these dependencies.

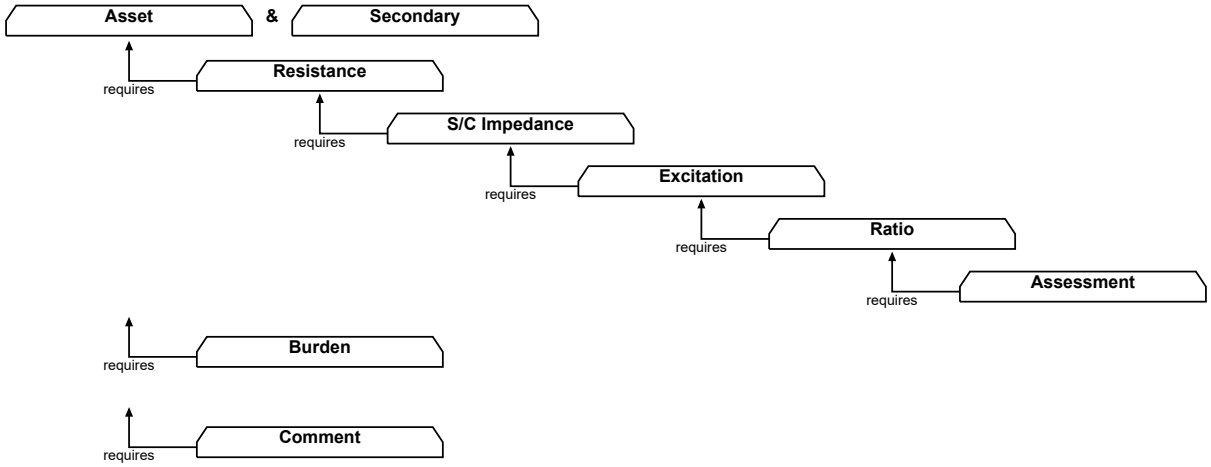


Figure 7-13: Dependencies of test cards

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.

7.10.3 Default test configuration

Use this option to select the following default settings:

- Wiring check enabled/disabled
- Limitation for VBO2 test voltage enabled/disabled
- Parameter fields for CVT capacitances enabled/disabled
  (Only available if the VT/CVT Test mode with a CVT/CCVT voltage transformer selected was active before accessing the default test configuration from the main menu.)
- Activation of burden measurement for all windings enabled/disabled
  (Only available if the Advanced VT/CVT Test mode was active before accessing the default test configuration from the main menu.)
- Class multiplication factor (assessment customization) enabled/disabled
  (Only available if the Advanced VT/CVT Test mode was active before accessing the default test configuration from the main menu.)

The available options and parameters are described in the sections below.

How to get there:

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

Main menu → Settings

OK soft key

Setting Menu → Default Test Configuration

Select soft key

→ **Test Settings** page

’Wiring Check’ option

The ’Wiring Check’ option gives you the possibility to ignore the results of the automatic wiring checks performed by *VOTANO 100*. This way it is possible to continue the test even if a wiring check of *VOTANO 100* failed. This may be required in some rare cases where *VOTANO 100* possibly considers the wiring check as failed although the wiring is obviously correct.

1. Select **Enable** (Yes) to switch the wiring check on (default setting). **This setting is recommended.** *VOTANO 100* then displays an according message if an automatic wiring check failed. You can choose as follows:
   1.1 Check the wiring and press **Repeat Test** to repeat the failed wiring check.
   1.2 Press **Continue Test** to continue the test even if the wiring check failed.

1.3 Press **Cancel Test** to abort the test.

2. Select **Ignore** (No) to ignore the results of the automatic wiring check function. *VOTANO 100* then does not display any message, and automatically continues the test in case of a wrongly failed wiring check or an actually incorrect wiring. Be aware that working with this setting is entirely at the user's risk. Pay special attention to the wiring and be extremely careful.

VOTANO 100 preserves this setting even after switch-off. If the 'Wiring Check' option is set to **Ignore**, *VOTANO 100* displays a corresponding warning when switched on the next time.

⚠ WARNING

Death, severe injury or equipment damage caused by high voltage or current is possible in case of incorrect wiring

- ▶ Avoid incorrect wiring.
- ▶ Make sure that the wiring is correct before running a test with the 'Wiring Check' option set to **Ignore** or before continuing the test after a wiring check failed message.

'Limit VBO2 test voltage' option

Using the 'Limit VBO2 test voltage' option you can enable a limitation of the primary voltage applied during the ratio test. This may be required for voltage transformers with a rated voltage lower than 4 kV.

1. If the 'Limit VBO2 test voltage' option is switched off, the primary voltage applied during the test is chosen automatically according to the rated primary voltage of the voltage transformer set in the **Asset** card.
2. Switch the 'Limit VBO2 test voltage' option on to display an additional parameter 'Max. VBO2 ratio test voltage' in the **Asset** card allowing the selection of a reduced primary voltage for the test (Asset card (page 125)).

If the 'Limit VBO2 test voltage' option is switched on, the 'Max. VBO2 test voltage' field is available. Use this field to define a default voltage for the 'Max. VBO2 ratio test voltage' parameter in the **Asset** card.

If 16.7 Hz is selected for the rated frequency of the transformer (f_r), *VOTANO 100* automatically limits the maximum *VBO2* ratio test voltage to ≤ 1.2 kV even if the user specified a higher voltage for the 'Max. VBO2 ratio test voltage' parameter.

This option can also be set in the test configuration of the specific test (Test configuration (page 128) for Advanced VT/CVT Test mode, Test configuration (page 161) for VT/CVT Test mode, or Test configuration (page 170) for C-Divider Test mode).

'Enter rated capacitances' option

This option is only available if the VT/CVT Test mode with a CVT/CCVT voltage transformer selected was active before accessing the default test configuration from the main menu.

Using the ’Enter rated capacitances’ option you can enable or disable the "C1" and "C2" parameter fields in the **Asset** card used to specify the capacitances of the capacitor voltage divider of CVT/CCVT voltage transformers (high-voltage capacitance (C1) and intermediate voltage capacitance (C2)).

This option can also be set in the test configuration of a VT/CVT test for a CVT/CCVT voltage transformer (Test configuration (page 161)).

’Default enable burden test’ option

This option is only available if the Advanced VT/CVT Test mode was active before accessing the default test configuration from the main menu, and only relevant if the **Burden** test card is enabled in this test mode.

If the **Burden** test card is enabled to include burden measurement to an Advanced VT/CVT test, you have to select for each winding whether burden measurement should be performed for this winding or not using the ’Measure’ field in the **Burden** card.

1. Select **Yes** to activate burden measurement for all windings by default. Then, the ’Measure’ field of the **Burden** card is set to Yes for all windings by default.
2. Select **No** to deactivate burden measurement for all windings by default.

Refer to Burden card (page 140) for a detailed description of the **Burden** card for the Advanced VT/CVT Test mode.

’Class Multiplication Factor’ option

This option is only available if the Advanced VT/CVT Test mode was active before accessing the default test configuration from the main menu.

You can use a multiplication factor to customize the automatic test assessment. For example, a multiplication factor of 0.5 for the ratio error and the phase error means that the maximum accepted tolerance for the ratio and phase error is only half the tolerance given in the standard.

1. Select **Yes** if you want to customize the assessment using a multiplication factor by default. If the ’Class Multiplication Factor’ option is selected, you have to specify this factor for each winding in the "Mul. Ratio" and "Mul. Phase" fields (IEC standards) or the "Mul. Class" field (IEEE and ANSI standard) of the **Secondary** card.
2. Select **No** if you do not want to customize the assessment by default.

Refer to the descriptions for "Mul. Ratio", "Mul. Phase" and "Mul. Class" in Parameter fields to be filled by the user (page 132) for more detailed information about the parameters used for assessment customization.

This option can also be set in the test configuration of an Advanced VT/CVT test (Test configuration (page 128)).

7.11 Tools (update functions)

You can access the update functions of *VOTANO 100* from the **Tools Menu** page.	**How to get there:** Press the **Main** soft key in any test card. **Main menu** → **Tools** **OK** soft key **Tools Menu** page

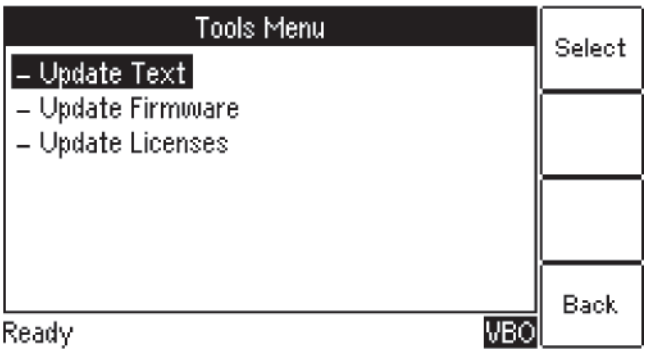


Figure 7-14: **Tools Menu** page

7.11.1 Available functions

Table 7-3: **Tools Menu** options

Option	Description
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 **VTUser_*.bin**. Update Text function (page 120)
Update Firmware	Using this item you can update the firmware (that is, the device-internal software) of your VOTANO 100. The file system page opened after selecting **Update Firmware** only displays files named **VOTANO.bin**. Update Firmware function (page 120)
Update Licenses	This function allows you to view the scope of licenses currently available on your *VOTANO 100* and to add additional licenses to your *VOTANO 100*. Update Licenses function (page 121)

7.11.2 Update Text function

Instead of using the *VOTANO 100* **Update Text** function, you can also use the *VOTANO Suite* operation software or the optional *VOTANO API* automation software. For detailed information, refer to the help system of the *VOTANO Suite* software or the VOTANO API User Manual.

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. To install a new language, select the corresponding file **VTUser_xxx.bin** in the directory **A:\OMICRON** on the Compact Flash card using the ▲ ▼ cursor keys and press the **Select** soft key. English is included in the firmware and does not require a user language file.	**How to get there:** Press the **Main** soft key in any test card. **Main menu** → **Tools** **OK** soft key **Tools Menu** → **Update Text** → **File system** card

NOTICE

Equipment damage or loss of data possible

- ▶ Do not install a language file that does not belong to the same package as the installed firmware version. The user interface may become unreadable.
- ▶ Only install language files that are included in the package of the installed firmware version.

Refer to the OMICRON 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** page without installing a new language.

7.11.3 Update Firmware function

Instead of using the **Update Firmware** function of *VOTANO 100*, you can also use the *VOTANO Suite* operation software or the optional *VOTANO API* automation software. For detailed information, refer to the help system of the *VOTANO Suite* software or the VOTANO API User Manual.

Using this function, you can install new device firmware. To perform a firmware update, a corresponding firmware file **VOTANO.bin** has to be available in the directory **A:\OMICRON** on the Compact Flash card. To update the firmware, select the desired firmware file **VOTANO.bin** using the ▲ ▼ cursor keys and press the **Update Firmw.** soft key.	**How to get there:** Press the **Main** soft key in any test card. **Main menu** → **Tools** **OK** soft key **Tools Menu** → **Update Firmware** → **File system** card

The firmware update process may take some minutes. If the update process is interrupted or fails, switch *VOTANO 100* off and on again. The device then tries to perform the firmware update again automatically.

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

VOTANO 100 devices with **firmware version 2.00 or higher** are intended for operation with the *VBO2* voltage booster only. Such devices cannot be used with the *VBO1* voltage booster.

VOTANO 100 devices with a **firmware version < 2.00** are intended for operation with the *VBO1* voltage booster. Such devices cannot be used with the *VBO2* voltage booster. If necessary, perform a firmware downgrade to version 1.30 if you want to operate your *VOTANO 100* with a *VBO1* voltage booster.

It is also possible to install older firmware down to version 1.11 (installing a firmware version older than 1.11 is not possible). 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.

7.11.4 Update Licenses function

Instead of using the Update Licenses function of *VOTANO 100*, you can also use the *VOTANO Suite* operation software or the optional *VOTANO API* automation software. For detailed information, refer to the *VOTANO Suite* software help system or the VOTANO API User Manual.

This function allows you to view the scope of licenses currently available on your *VOTANO 100* and to add additional licenses to your *VOTANO 100*. • Timely unlimited licenses available on your *VOTANO 100* are marked by a **check mark**. • Timed licenses available on your *VOTANO 100* are marked by a **check mark followed by a star**. The expiry date of the licenses is displayed in the header of the page. • Expired timed licenses are marked by an **X followed by a star**.	**How to get there:** Press the **Main** soft key in any test card. **Main menu → Tools** **OK** soft key **Tools Menu → Update Licenses** → **Licenses** page

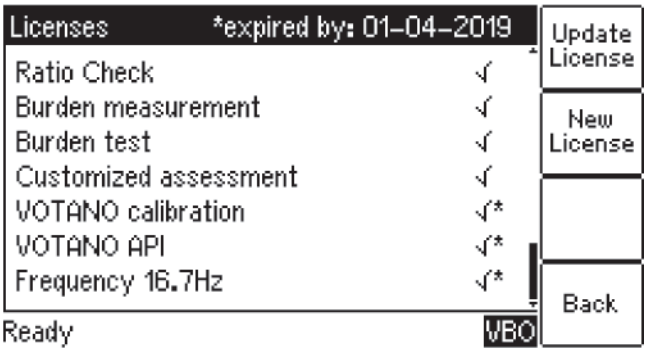


Figure 7-15: **Licenses** page

Proceed as follows:

Note: Use **the Update License** soft key to add new licenses by reading a license file stored on the Compact Flash card of your *VOTANO 100*. A license file may contain timely unlimited licenses and timed licenses. All timed licenses in a license file have the same expiry date.
A warning is displayed if timed licenses contained in the license file have a different expiry date than existing timed licenses currently installed on *VOTANO 100*. Installing the new timed licenses from the license file will first remove all existing timed licenses available on *VOTANO 100* and then install the new timed licenses with the new expiry date.

1. Use the **New License** soft key to add a new license manually by entering a license key.
2. For information on how to receive new licenses, contact the OMICRON Technical Support (Support (page 196)).

7.12 VOTANO 100 help system

VOTANO 100 provides a context-sensitive help system. Pressing the ? key displays a help page, the content of which depends on where the focus is set when pressing the ? key.

Example:

1. If the focus is set to the **Asset** card's tab, pressing the ? key displays a help page with explanatory text about the **Asset** card.

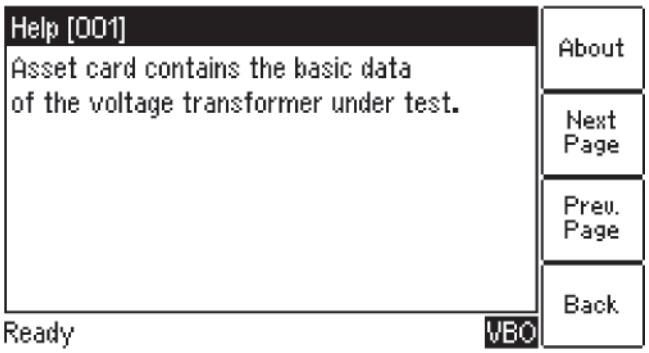


Figure 7-16: Help page with explanatory text about the **Asset** card

2. If a parameter field is selected with the cursor, pressing the ? key displays a help page with explanatory texts for this specific parameter.
3. If a wiring message is displayed, pressing the ? key displays a help page with the correct wiring diagram.

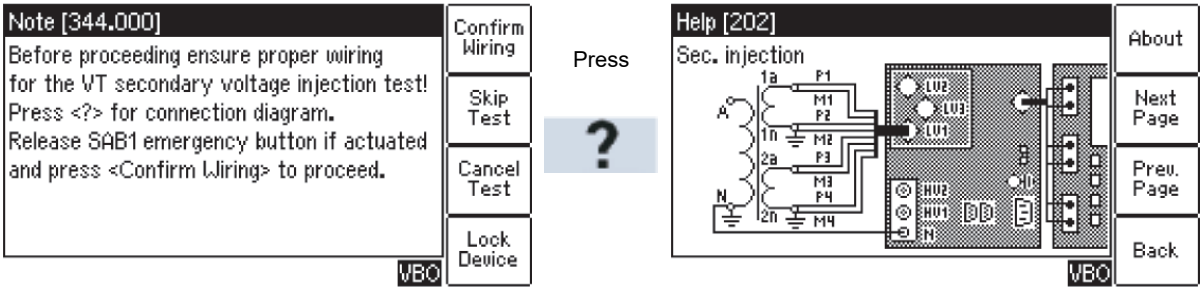


Figure 7-17: Displaying a help page showing the wiring diagram

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 *VOTANO 100* hardware, the installed firmware version, the serial number, etc.

7.13 Locking VOTANO 100 in a safe state

Using the **Lock Device** function of *VOTANO 100*, you can lock the *VOTANO 100* test set in a safe state, for example, when leaving the test setup temporarily or when entering the high-voltage area of a complex test environment where it is not possible to completely observe the entire test setup (*VOTANO 100* and high-voltage area with *VBO2* and test object) at any time.

When *VOTANO 100* is locked, it is no longer possible to operate *VOTANO 100* via the keyboard or via the *VOTANO Suite* software.

For this purpose, a **Lock Device** soft key is available in various test cards and message screens:

- **Asset** card and **Secondary** card of an Advanced VT/CVT test or a VT/CVT test.
- **Ratio** card of the stand-alone Ratio Check mode.
- **Burden** card of the stand-alone Burden Test mode.
- "Confirm Wiring" message screen.

Proceed as follows to lock and unlock *VOTANO 100*:

1. Wait until the green LEDs on *VOTANO 100*, *VBO2*, and *SAB1* light continuously and the red LEDs are off. Then, the outputs are inactive and the test setup is in a safe state.
2. Press the **Lock Device** soft key.
3. Enter a 4-digit numerical code and press the **OK** soft key to lock *VOTANO 100*.
4. While *VOTANO 100* is locked, it is not possible to operate *VOTANO 100* via the keyboard or via the *VOTANO Suite* software.
5. Enter your 4-digit code again to unlock *VOTANO 100* again.

The code used to lock *VOTANO 100* is not permanently stored in *VOTANO 100*. Switching *VOTANO 100* off and on again resets the locking.

7.14 Operating VOTANO 100 from a computer

It is also possible to operate *VOTANO 100* remote-controlled from a computer. For more detailed information, refer to Remote control via computer (page 173).

8 Test cards for Advanced VT/CVT Test mode

8.1 Overview of test cards

Use the Advanced VT/CVT Test mode to perform comprehensive guided testing of VT or CVT voltage transformers with automatic assessment according to IEC or IEEE/ANSI standards. The following table provides an overview of all test cards available in the Advanced VT/CVT Test mode of *VOTANO 100*. **The set of test cards actually available on your *VOTANO 100* depends on your purchased license(s).**

For up-to-date information about the licenses and packages available for VOTANO 100 please refer to the OMICRON website or contact the OMICRON Technical Support (Support (page 196)).

Table 8-1: Overview of test cards available in the Advanced VT/CVT Test mode of *VOTANO 100*

Card	Short description
Asset	This card contains the basic data of the voltage transformer (Asset card (page 125)).
Secondary	Use this card to specify the secondary side of the voltage transformer (Secondary card (page 131)).
Burden	This card is used to measure the voltage transformer's secondary burdens (Burden card (page 140)).
S/C Impedance	This card is used to measure the primary and secondary short-circuit impedances of the voltage transformer (S/C Impedance card (page 141)).
Resistance	This card is used to measure the winding resistances of the voltage transformer's secondary windings (Resistance card (page 142)).
Excitation	This card is used to trace the excitation curve of the voltage transformer's secondary windings (Excitation card (page 143)).
Ratio	This card is used to measure the ratio of the voltage transformer considering the nominal burden (Ratio card (page 145)).
Assessment	This card shows the automatic assessment of the tested parameters according to the selected standard and settings. In this card you can also perform a manual assessment (Assessment card (page 151)).
Comment	In this card you can enter any text, for example, additional notes regarding the test (Comment card (page 157)).

8.2 Asset card

The **Asset** card contains the basic data of the voltage transformer under test.

The **Asset** card is the top user interface level. Pressing the Esc key several times will always bring you back to the **Asset** card.

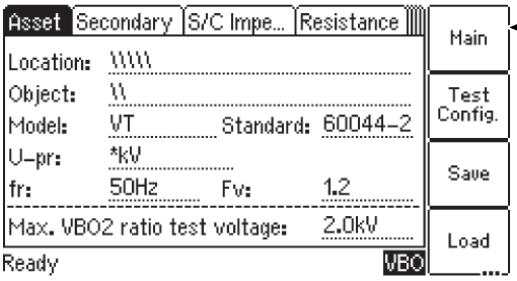


Figure 8-1: **Asset** card with default settings after initializing a new test (Advanced VT/CVT Test mode)

8.2.1 Available soft keys

Table 8-2: Soft keys available in the **Asset** card

Soft key	Description
Test Config.	Allows to select the test configuration (for example, available test cards, factor for assessment customization etc.) and to clear the results of the previous test. See Test configuration (page 128) for more detailed information.
Save	Saves the test results and test settings to the currently loaded *VOTANO 100* report file. Saving a file is described in Working in the file system (page 109).
Load	Allows to load a test stored on the Compact Flash card in order to check its results or to use its settings for a new test.
Lock Device	Allows to lock the *VOTANO 100* test set and the test setup in a safe state. Locking *VOTANO 100* is described in Locking VOTANO 100 in a safe state (page 123).

8.2.2 Parameter fields to be filled by the user

Table 8-3: Parameter fields to be filled by the user

Field/parameter	Description
Location	The Location text field is used for reporting and documentation purposes. The content of this field is defined in the **Location settings** page. To open this settings page, position the cursor to the Location field and then press the **Details** soft key or the ↵ key. 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 voltage transformer is installed. • Phase: Phase to which the voltage transformer is connected. • IEC-ID: IEC-ID of the voltage transformer or freely definable information.

Field/parameter	Description
Object	The Object text field is used for reporting and documentation purposes. The content of this field is defined in the **Object settings** page. To open this settings page, position the cursor to the Object field and then press the **Details** soft key or the ↵ key. The **Object settings** page provides the following text fields. Each field can contain a maximum of 40 numbers or letters. • Manufact.: Manufacturer of the voltage transformer. • Type: Type number or description of the voltage transformer. • Serial No.: Serial number of the voltage transformer.
Model	Inductive voltage transformer (VT) or capacitive voltage transformer/coupling capacitor voltage transformer (CVT/CCVT). Possible values: Soft keys **VT** or **CVT/CCVT** Default: As defined in the settings (Default VT Parameters or Default CVT/ CCVT Parameters).
Standard	Standard according to which the test has to be performed. Possible values: Soft keys **IEC 60044-2**, **IEC 61869-3** or **IEEE C57.13** for VTs or **IEC 60044-5**, **IEC 61869-5** or **ANSI C93.1** for CVTs/CCVTs Default: As defined in the settings (Default VT Parameters or Default CVT/ CCVT Parameters). **Note:** Selecting an IEC standard automatically sets the "fr" parameter (see below) to 50 Hz. Selecting the IEEE C57.13 or ANSI C93.1 standard automatically sets the "fr" parameter to 60 Hz.
U-pr*	Rated primary voltage of the voltage transformer. Possible values: Value (between 1 kV and 2 MV) entered using the keyboard or soft keys depending on the standard (for example, **66kV**, **110kV**, **132kV**, **220kV**). The voltage selected with the soft keys is the phase-phase voltage (1/1). If necessary, use the **/√3** soft key to specify a phase-ground voltage. If applied, the soft key changes to **x√3** to remove the factor previously applied.
fr	Rated frequency of the voltage transformer. Possible values: Soft keys **50Hz**, **60Hz** or **16.7Hz** Default: As defined in the settings (Default VT Parameters or Default CVT/ CCVT Parameters). **Note:** Selecting an IEC standard in the "Standard" field automatically sets "fr" to 50 Hz. Selecting the IEEE C57.13 or ANSI C93.1 standard automatically sets "fr" to 60 Hz. **Note:** 16.7 Hz is only supported for VT voltage transformers tested according to an IEC standard.

Field/parameter	Description
Fv	Rated voltage factor up to which the voltage transformer must fulfill the accuracy requirements. Possible values: Value (between 1.0 and 3.0) entered using the keyboard or soft keys **1.2**, **1.5** or **1.9** **Note:** Only available if an IEC standard is selected.
Max. VBO2 ratio test voltage	Only displayed if selected in the test configuration (Test configuration (page 128)) or the default test configuration (Available options in the Setting Menu page (page 113)). The primary voltage applied during the ratio test is limited to the voltage set in this field (instead of applying the voltage chosen automatically according to the rated primary voltage U_{pr} set for the voltage transformer in this card). Possible values: Value (between 40 V and 4 kV) entered using the keyboard or the soft keys **4kV** or **Default** (default value defined in the default test configuration settings, Default test configuration (page 116)). **Note:** If 16.7 Hz is selected for the rated frequency of the transformer (f_r), *VOTANO 100* automatically limits the maximum *VBO2* ratio test voltage to ≤ 1.2 kV even if you specified a higher voltage in the 'Max. VBO2 ratio test voltage' field.

Mandatory parameters are marked by a star in the *VOTANO 100* user interface. The test cannot be started if no value is entered for one of these parameters.

8.2.3 Test configuration

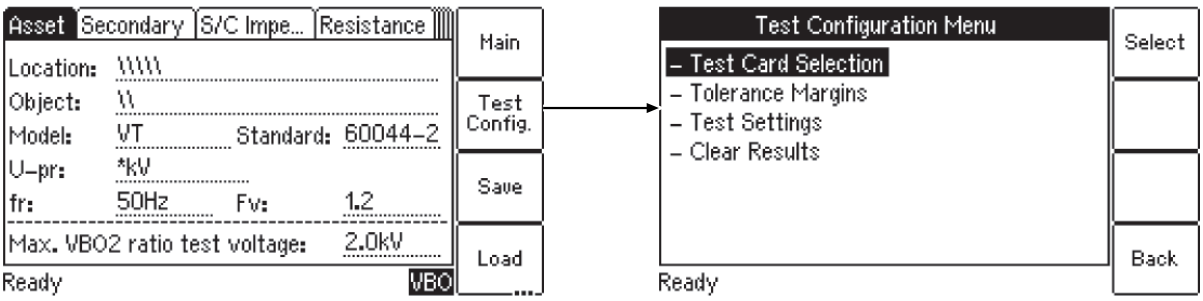


Figure 8-2: Displaying the **Test Configuration Menu** page from the **Asset** card

Press the **Test Config.** Soft key in the **Asset** card or the **Secondary** card to display the **Test Configuration Menu** page. This page provides the following entries:

Table 8-4: Test configuration parameters

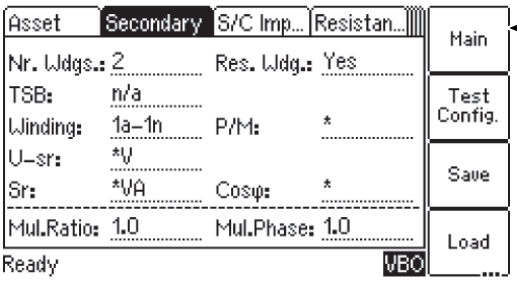
Field/parameter	Description
Test Card Selection	Displays the **Select Cards** page where you can select the test cards available for your test. Select a test card and press **Add** or **Remove** to enable or disable a test card. Refer to Default test card selection (page 115) for more information about test card selection and the test card dependencies.
Tolerance Margins	Displays the **Set Tolerance Margins** page. The 'Tolerance margins' option allows to customize the automatic assessment of the Advanced VT/CVT Test mode by defining an additional user-defined ratio and phase tolerance for the assessment. The default settings for this option are defined by the 'Default Tolerance Margins' option of the **Setting Menu** (Available options in the Setting Menu page (page 113)). 1. Select **Yes** for the 'Tolerance Margins Enabled' option to apply an additional ratio and phase tolerance for the assessment. This will display the 'Ratio Tolerance' and 'Phase Tolerance' parameter fields. 2. In the 'Ratio Tolerance' and 'Phase Tolerance' fields, use the default settings as defined in the device settings or enter any value 2.1 between 0 % and 0.1 % for an additional ratio tolerance and/or 2.2 between 0 min and 5 min for an additional phase tolerance.

Field/parameter	Description
Test Settings	Displays the **Test Settings** page providing the options described below. The default settings for these options are defined in the Default Test Configuration (Default test configuration (page 116)). **'Limit VBO2 test voltage' option** Using this option. you can enable a limitation of the primary voltage applied during the ratio test. This may be required for voltage transformers with a rated voltage lower than 4 kV. 1. Select **Yes** to enable the limitation and to display an additional parameter 'Max. VBO2 ratio test voltage' in the **Asset** card allowing the selection of a reduced primary voltage for the test. 2. If the 'Limit VBO2 test voltage' option is switched off (**No**), the primary voltage applied during the test is chosen automatically according to the rated primary voltage of the voltage transformer set in the **Asset** card. **Note:** If 16.7 Hz is selected for the rated frequency of the transformer (fr), *VOTANO 100* automatically limits the maximum *VBO2* ratio test voltage to ≤ 1.2 kV even if you specified a higher voltage in the 'Max. VBO2 ratio test voltage' field. **'Class Multiplication Factor' option** You can use a multiplication factor to customize the automatic assessment of the ratio test. For example, a multiplication factor of 0.5 for the ratio error and the phase error means that the maximum accepted tolerance is only half the tolerance given in the standard. ▶ Select **Yes** if you want to customize the assessment using a multiplication factor. Then you have to specify this factor for each winding in the "Mul. Ratio" and "Mul. Phase" fields (IEC standards) or the "Mul. Class" field (IEEE and ANSI standard) of the **Secondary** card. Refer to the descriptions for "Mul. Ratio", "Mul. Phase" and "Mul. Class" in Parameter fields to be filled by the user (page 132) for more detailed information about the parameters used for assessment customization. **'Extended Excitation Curve' option** **Note:** Only available if the number of windings is > 1. Due to the output current limitations of *VOTANO 100*, it is sometimes not possible to measure the excitation curve of a voltage transformer up to a saturation level that is high enough to allow determination of the voltage transformer ratio and the phase error for all percentages of the rated voltage stipulated in the selected standard. This applies to voltage transformers with a remarkably low inductance, for example, voltage transformers with special core material, air-gapped cores or a low number of secondary winding turns. Selecting this option allows *VOTANO 100* to apply higher induction to the voltage transformer, thus extending the range for measuring the excitation curve. Select **Yes** to use this option and to extend the range for measuring the excitation curve. Then, an additional interruption is performed during the Advanced VT/CVT test to allow rewiring for this special measurement (Test sequence overview (page 46)). **Note:** Changing the setting of the Extended Excitation Curve option is only possible if "n/a" is selected for the Reference Excitation Curve option.

Field/parameter	Description
Test Settings (cont.)	**'Reference Excitation Curve' option** When measuring the inner tap of a center tapped voltage transformer, it may occur that the excitation measurement fails due to the output current limitations of *VOTANO 100*. *VOTANO 100* is then not able to determine the excitation curve completely for this tap combination. For such cases, this option allows you to load the excitation curve of a previous test performed for the outer tap combination of the same voltage transformer. **VOTANO 100** will then use these excitation curve data as a reference for its measurements and calculations for the inner tap instead of determining the excitation curve data by measurement during the test. This enables testing of the inner tap of the voltage transformer despite the mentioned power limitations. 1. Select **Load** to load the excitation curve of a previous test in order to use it as a reference for your test and repeat/run your test for the inner tap. 2. Otherwise select **n/a**. **Note:** The excitation measurement is skipped if you loaded a reference excitation curve for the test (see test sequence in Test sequence overview (page 46)). In this case, some remanence may remain in the core after the test. Perform a complete Advanced VT/CVT Test sequence at the end of your test session to remove this remanence. **Note:** It is also possible to load a reference excitation curve in Simulation mode. This allows determination of the behaviour and data of the inner tap by simulation, without repeating a previously failed inner tap test. See also Simulation mode (page 64).
Clear Results	Clears the results of the previous test and enables starting a new test.

8.3 Secondary card

Use the **Secondary** card to specify the secondary side of the voltage transformer.

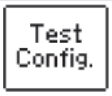


Press to open the main menu.
(Only available if the card is not in the edit mode.
If necessary, press the ESC key to exit the edit mode and display the Main soft key.)

Figure 8-3: **Secondary** card with default settings after initializing a new Advanced VT/CVT test

8.3.1 Available soft keys

Table 8-5: Soft keys available in the **Secondary** card

Soft key	Description
	Allows to select the test configuration (for example, available test cards, factor for assessment customization etc.) and to clear the results of the previous test. See Test configuration (page 128) for more detailed information.
	Saves the test results and test settings to the currently loaded VOTANO 100 report file. Saving a file is described in Working in the file system (page 109).
	Allows to load a test stored on the Compact Flash card in order to check its results or to use its settings for a new test.
	Allows to lock the *VOTANO 100* test set and the test setup in a safe state. Locking *VOTANO 100* is described in Locking VOTANO 100 in a safe state (page 123).

8.3.2 Parameter fields to be filled by the user

Table 8-6: Parameter fields to be filled by the user

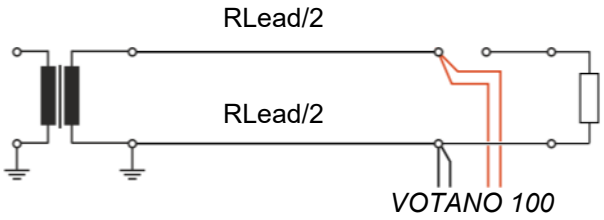
Field/parameter	Description
Nr. Wdgs.	Number of secondary windings available on the voltage transformer (max. 5). Possible values: Soft keys **1** to **5** Default: As defined in the settings (Default VT Parameters or Default CVT/ CCVT Parameters).
Res. Wdg.	Only displayed for IEC standards. Select whether your voltage transformer has a residual winding or not. The residual winding is named da-dn and counted in the amount of secondary windings. Possible values: Soft keys **Yes** or **No** Default: As defined in the settings (Default VT Parameters or Default CVT/ CCVT Parameters).

Field/parameter	Description
TSB	Only displayed for IEC standards, if number of windings > 1. Total Simultaneous Burden of the voltage transformer. Possible values: 0.00 to 9999 VA (keyboard) or **n/a** soft key Default: n/a. When testing voltage transformers with more than one secondary winding, it may be necessary to specify the burden distribution between the secondary windings for each measurement (that is, for each secondary winding to be measured). **Example:** The rated burdens for the secondary windings 1, 2 and 3 are 30 VA, 40 VA and 75 VA at a TSB of 120 VA. A possible burden distribution for the individual measurements could be as follows: • For measurement on winding 1a-1n: 30 VA for 1a-1n; 40 VA for 2a-2n; 50 VA for 3a-3n • For measurement on winding 2a-2n: 30 VA for 1a-1n; 40 VA for 2a-2n; 50 VA for 3a-3n • For measurement on winding 3a-3n: 30 VA for 1a-1n; 15 VA for 2a-2n; 75 VA for 3a-3n Enter the TSB as stated on the name plate or use the n/a soft key if you do not want to consider the TSB for your test. Refer to Setting the TSB and viewing the burden distribution (IEC standards only) (page 137) for information how to set the TSB.

Field/parameter	Description
Winding	Use this field to select the secondary winding to be specified by the parameters in this card. The parameters have to be specified separately for each winding of the voltage transformer. Possible values: Depends on the number of windings set with the Nr. Wdgs. parameter. One soft key for each winding: for example, **1a-1n**, **2a-2n**, etc. Proceed as follows: 1. Select the first secondary winding using the soft keys and specify the parameters (Class, U_{sr}, S_r and cos φ, for example) for this winding. 2. Select the second secondary winding using the soft keys and specify the parameters for this winding. 3. Proceed accordingly to specify the parameters for all remaining secondary windings. **Simulation mode only:** In Simulation mode, the additional **Ref. Excit. Curve** soft key is available for the Winding field. When measuring the inner tap of a center tapped voltage transformer, it may occur that the excitation measurement fails due to the output current limitations of *VOTANO 100*. The **Ref. Excit. Curve** soft key allows you to load the excitation curve of a previous test performed for the outer tap combination of the same voltage transformer into a simulation. By using these excitation curve data as a reference you can determine the behavior and data of the inner tap by simulation, without repeating a previously failed inner tap test. ▶ Select the Winding field of the **Secondary** card and press the **Ref. Excit. Curve** soft key to load a reference excitation curve. For more detailed information, refer to Test configuration (page 128).
P/M*	Only displayed for IEC standards and ANSI C93.1. Winding type of the selected winding: protection or metering. Possible values: Soft keys **Prot.** (protection) **Meas.** (metering)

Field/parameter	Description
Class*	For IEC standards only displayed if the P/M parameter is set to "metering". Always displayed for IEEE C57.13 and ANSI C93.1. Accuracy class of the selected winding. Possible values: Soft keys depending on the selected standard (for example, **Class 0.15**, **Class 0.2** etc.). **For IEEE C57.13 only:** An additional soft key **At specific burden** is available for the Class parameter if the IEEE C57.13 standard is selected. Use this option if the accuracy class of the voltage transformer only applies to one specific burden. Assessment is normally performed for the burden specified and all lower burdens defined in the standard (burden definitions stated in the IEEE C57.13 standard apply to 60 Hz only). Example: If the burden specified is M, assessment or condition estimation is performed for the burdens M, X, W and 0. Selecting the **At specific burden** option in addition to the class setting will cause *VOTANO 100* to consider only the burden value specified prior to testing for the assessment or condition estimation. The ratio error table and the phase displacement table of the **Ratio** card then only show the error for this specific burden (Ratio error table and phase displacement table for IEEE and ANSI standard (tests without burden measurement) (page 148)). When **At specific burden** is selected, the soft key changes to **At this & lower burdens** to enable deactivation of this option.
M-Class P-Class*	Only displayed for IEC 60044-2 and IEC 61869-3, and if the P/M parameter is set to "protection". M-Class: According to the IEC standards it is also possible to specify a metering class for a protection winding. Possible values: Soft keys **Class 0.1**, **Class 0.2**, **Class 0.5**, **Class 1** or **Class 3**. P-Class: Protection class of the selected winding. Possible values: Soft keys **Class 3P**, **Class 6P**.
P-Class* TP-Class	Only displayed for IEC 60044-5 and IEC 61869-5, and if the P/M parameter is set to "protection". P-Class: Protection class of the selected winding. Possible values: Soft keys **Class 3P**, **Class 6P**. TP-Class: Transient response class of the selected winding according to IEC 60044-5 and IEC 61869-5. Possible values: Soft keys **Class T1**, **Class T2** or **Class T3**.
U-sr*	Rated secondary voltage of the selected winding. Possible values: Value (between 0.1 V and 1 kV) entered using the keyboard or soft keys **100V**, **110V**, or **200V**. The voltage selected with the soft keys is the phase-phase voltage (1/1). If necessary, use the **/√3** soft key to specify a phase-ground voltage (or the **/3** soft key for a residual winding). If applied, a **x√3** (or **x3**) soft key is displayed to remove the factor previously applied.

Field/parameter	Description
ext. Sr	Only displayed for IEC 60044-2 metering class 0.1 and 0.2, and if the rated burden S_r is smaller than 10 VA. Extended burden range for ratio and phase error table. If switched on, the ratio error table and the phase displacement table show the ratio error and the phase displacement down to a burden of 0 VA. Possible values: Soft keys **On** or **Off**.
Sr*	Rated output of the selected winding. Possible values: Value (between 0 VA and 1500 VA) entered using the keyboard or soft keys depending on the selected standard (for example, **1.0VA**, **5.0VA**, **10VA PF 1.0**, **10VA PF 0.8** etc.).
Cos ϕ*	Power factor of the rated output specified (S_r or Burden parameter). Possible values: Value (between 0 and 1) entered using the keyboard or soft keys **0.8** or **1.0**.
Burden*	Only displayed for IEEE C57.13 and ANSI C93.1. Standard burden of the selected winding. Possible values: Soft keys **0**, **W**, **X**, **M**, **Y**, **Z** or **ZZ** or custom burden value entered using the keyboard. **Note:** Burden definitions stated in the IEEE/ANSI standard apply to 60 Hz only.
Mul. Ratio and Mul. Phase	Only available for IEC standards and if the class multiplication factor is enabled in the test configuration (Test configuration (page 128)). Select or enter the factor to be used for this winding to customize the automatic assessment of the ratio error (Mul. Ratio) and the phase error (Mul. Phase). For example, a multiplication factor of 0.5 means that the maximum accepted tolerance for the error is only half the tolerance given in the standard.
Mul. Class	Only available for IEEE C57.13 or ANSI C93.1, and if the class multiplication factor is enabled in the test configuration (Test configuration (page 128)). Select or enter the factor to be used for this winding to customize the automatic assessment of the ratio error and the phase error. For example, a multiplication factor of 0.5 means that the maximum accepted tolerance for the error is only half the tolerance given in the standard.

Field/parameter	Description
RLead	Line resistance of the cabling between the terminals, *VOTANO 100* is connected to, and the voltage transformer (if applicable). *VOTANO 100* adds R_{Lead} to the operating burden value for results calculation and subtracts R_{Lead} from the measured winding resistance for rated burden assessment.  Possible values: 0 ... 3000 mΩ **Note:** The *VOTANO Suite* software provides a lead resistance calculator (Advanced VT/CVT test → Preparation section → Asset pane).

Mandatory parameters are marked by a star in the *VOTANO 100* user interface. The test cannot be started if no value is entered for one of these parameters.

8.3.3 Setting the TSB and viewing the burden distribution (IEC standards only)

Example of a TSB distribution

The following example shows a possible TSB distribution for the measurements on a voltage transformer with three secondary windings:

TSB of the voltage transformer: 120 VA
Rated burden for secondary winding 1: 30 VA
Rated burden for secondary winding 2: 40 VA
Rated burden for secondary winding 3: 75 VA

A possible TSB distribution for the individual measurements could be as follows:

- For measurement on winding **1a-1n**:
  30 VA for 1a-1n; 40 VA for 2a-2n; 50 VA for 3a-3n
  (120 VA TSB, 30 VA on 1a-1n, the remaining 90 VA can be distributed to 2a-2n and 3a-3n in any desired way)
- For measurement on winding **2a-2n**:
  30 VA for 1a-1n; **40 VA for 2a-2n**; 50 VA for 3a-3n
  (120 VA TSB, 40 VA on 2a-2n, the remaining 80 VA can be distributed to 1a-1n and 3a-3n in any desired way)
- For measurement on winding **3a-3n**:
  30 VA for 1a-1n; 15 VA for 2a-2n; **75 VA for 3a-3n**
  (120 VA TSB, 75 VA on 3a-3n, the remaining 45 VA can be distributed to 1a-1n and 2a-2n in any desired way)

Setting the TSB

Proceed as follows to set the TSB in the **Secondary** card:

1. Define the total number of secondary windings in the Nr. Wdgs field.
2. Select whether your voltage transformer has a residual winding or not in the Res. Wdg. field.

   Note: If known, enter the total simultaneous burden to the TSB field using the keyboard (any value between 0.00 VA and 9999 VA).
   It is also possible to define the burden distribution without specifying a TSB value before (Changing the burden distribution manually (IEC standards only) (page 139)).
3. Go to the Winding field. Specify all parameters for each secondary winding of the voltage transformer (Parameter fields to be filled by the user (page 132)).
   - 3.1 Select the first secondary winding and specify the parameters for this winding.
   - 3.2 Select the second secondary winding and specify the parameters for this winding.
   - 3.3 Proceed accordingly to specify the parameters for all remaining secondary windings.
4. Go back to the TSB field. Press the **Burden Distr.** soft key to view and/or change the burden distribution (see the subsection below and Changing the burden distribution manually (IEC standards only) (page 139)).

Viewing the burden distribution

▶ Press the **Burden Distr.** soft key to display the burden distribution details page.

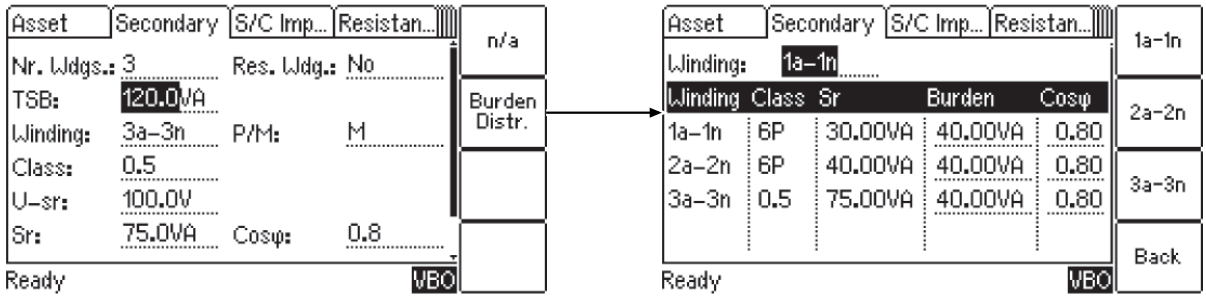


Figure 8-4: Displaying the burden distribution details page

This page contains by default an automatic burden distribution proposed by OMICRON according to the TSB and Res. Wdg. settings and the Sr specified for the secondary windings in the **Secondary** card before. Select a winding using the soft keys to display the burden distribution for the measurement of this specific winding. The following figure shows an example.

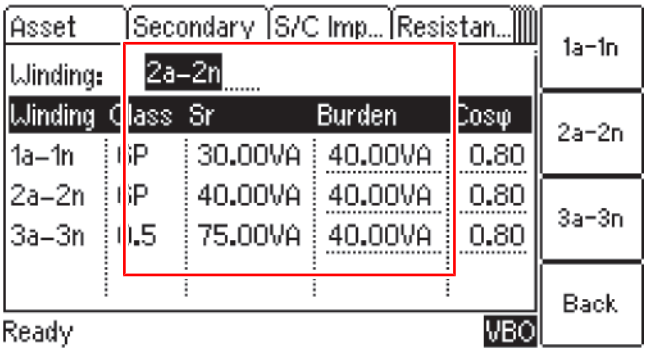


Figure 8-5: Example burden distribution for winding 2a-2n

▶ Press the Esc key to go back to the **Secondary** card and use the automatic burden distribution. Or proceed with Changing the burden distribution manually (IEC standards only) (page 139) to customize the burden distribution manually.

8.3.4 Changing the burden distribution manually (IEC standards only)

If the automatic burden distribution proposed by OMICRON does not meet your requirements or if you do not know the TSB of your voltage transformer, you can change or set the burden distribution manually according to your needs. Proceed as follows:

1. In the **Secondary** card, select the TSB field and specify the TSB, if known (Setting the TSB and viewing the burden distribution (IEC standards only) (page 137)). Leave the TSB field blank if you do not know the TSB of your voltage transformer.
2. After selecting the TSB field, the **Burden Distr.** soft key becomes available. Press **Burden Distr.** to display the burden distribution details page.
3. In the Winding field, select the first winding to be measured using the soft keys, for example 1a-1n.
4. Position the cursor in the table and overwrite the existing burden or cos φ values with your new values for this measurement.

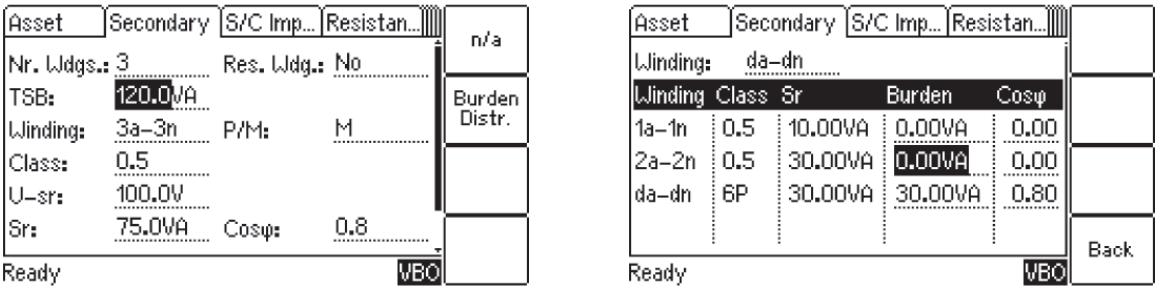


Figure 8-6: Changing the burden distribution manually

5. Set the cursor to the Winding field and select the next secondary winding to be measured using the soft keys, for example 2a-2n.
6. Position the cursor in the table and overwrite the existing burden or cos φ values with your new values for this measurement.
7. Proceed as described above to specify the burden distribution for all other windings available.
8. Use the **Back** soft key or the Esc key to apply your changes and return to the **Secondary** card.

A warning is displayed if your burden distribution (the sum of your manually defined burden values) specified for one or more windings does not match the TSB defined in the **Secondary** card. Press the **Change** soft key of the warning page displayed to return to the burden distribution details page and change your burden distribution accordingly, or press **Confirm** to apply your burden distribution.

Changing the TSB value or the number of secondary windings in the **Secondary** card will overwrite any manually defined burden distributions with a new automatic burden distribution.

8.4 Burden card

The **Burden** card is only available if burden measurement is enabled in the test configuration (Test Card Selection, Test configuration (page 128)) or in the settings (Default test card selection (page 115)).

It is also possible to enable or disable test cards in the test configuration of the *VOTANO Suite* software. The test card selection defined in *VOTANO Suite* always overrides the selection defined on *VOTANO 100*.

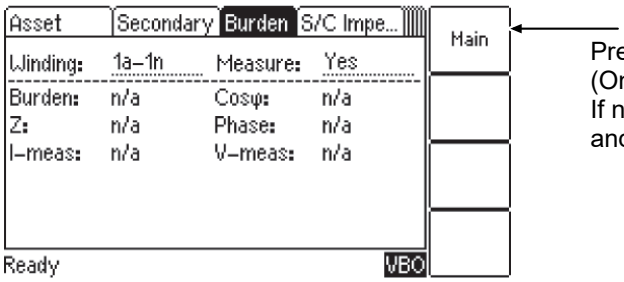


Figure 8-7: **Burden** card for the Advanced VT/CVT Test mode

The **Burden** card is necessary to measure the burdens connected to the secondary windings of the voltage transformer during the Advanced VT/CVT test.

1. **Prior to the test**, you have to select for which secondary windings burden measurement should be performed during the Advanced VT/CVT test (see table below).
2. **After completion** of the Advanced VT/CVT test, the **Burden** card displays the results separately for each winding (see table below).

Table 8-7: Parameter fields available in the **Burden** card

Field/parameter	Description
Winding and Measure	**Prior to the test:** Select the Winding field and choose a winding using the soft keys. Then move to the Measure field and select **Yes** or **No** to specify whether burden measurement should be performed for this winding or not. **After completion of the test:** Select the Winding field and choose a winding using the soft keys to display the results for this specific burden. Default for Winding field: 1a-1n. Default for Measure field: As defined in the settings (Default Test Configuration, 'Default enable burden test' option)
Burden	Burden value in VA (with respect to the rated secondary voltage U-sr) calculated from the measured quantities.
cos φ	cos φ of the burden calculated from the measured quantities.
Z	Impedance of the burden in ohms calculated from the measured quantities.
Phase	Phase displacement of the burden in degrees.
I-meas.	Measured current in A flowing through the burden.
V-meas.	Voltage in V measured at the burden.

Behavior in simulation mode

In simulation mode, the upper part of the **Burden** card provides additional fields. Use these fields to specify an operating burden and cos φ to be simulated.

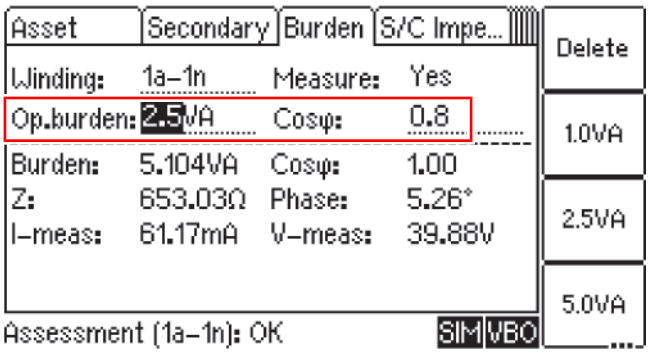


Figure 8-8: **Burden** card in simulation mode (Advanced VT/CVT Test mode)

Table 8-8: Additional fields available in simulation mode

Field/parameter	Description
Op. burden	Operating burden in VA to be used for the simulation. Select a value using the soft keys or enter a value between 0 VA and 1500 VA using the keyboard.
cos φ	cos φ of the operating burden. Select a value using the soft keys or enter a value between 0 and 1 using the keyboard.

Output voltage used and limitations for burden measurement

The maximum output voltage applied for burden measurement is determined by the winding's rated secondary voltage entered in the **U-sr** field of the **Secondary** card. If U-sr is < 40 V, the maximum measurement voltage applied corresponds to U-sr. If U-sr is > 40 V, a maximum measurement voltage of 40 V is applied.

For possible limitations regarding burden measurement, please refer to the *VOTANO 100* output and input specifications given in Technical data (page 177).

8.5 S/C Impedance card

In the Advanced VT/CVT Test mode, the **S/C Impedance** card is only available if short-circuit impedance measurement is enabled in the test configuration (Test Card Selection, Test configuration (page 128)) or in the settings (Default Test Card Selection, Default test card selection (page 115)).

It is also possible to enable or disable test cards in the test configuration of the *VOTANO Suite* software. The test card selection defined in *VOTANO Suite* always overrides the selection defined on *VOTANO 100*.

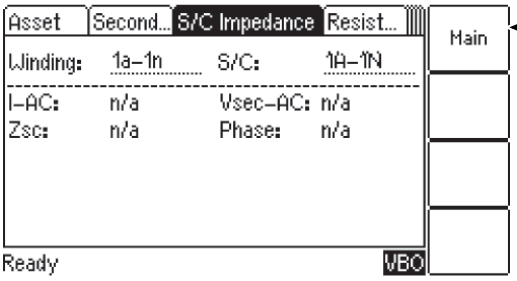


Figure 8-9: **S/C Impedance** card

The **S/C Impedance** card shows the results of the primary and secondary short-circuit impedance measurements:

1. The results of the primary short-circuit impedance measurement are displayed separately for each secondary winding. Select the winding to be displayed in the Winding field.
2. The results of the secondary short-circuit impedance measurement are displayed for the winding selected in the S/C field.

Table 8-9: Results displayed in the S/C Impedance card

Field/parameter	Description
Winding	The results of the primary short-circuit impedance measurements are displayed for the winding selected in this field. Select the winding using the soft keys. Possible values: Soft keys depending on the selected standard (for example, **1a-1n**, **2a-2n** etc. depending on the number of windings selected in the **Secondary** card). Default: 1a-1n.
S/C	Select this field to display the results of the secondary short-circuit impedance measurements conducted in the Advanced VT/CVT Test mode. The results are displayed for the winding selected in this field using the soft keys. Possible values: Soft keys depending on the selected standard. Default: 1A-1N. In the VT/CVT Test mode, this field is not relevant.
I-AC	AC current used for the measurement.
Vsec-AC	Secondary AC voltage used for the measurement.
Zsc	Short-circuit impedance.
Phase	Phase angle.

8.6 Resistance card

The **Resistance** card is only available if secondary winding resistance measurement is enabled in the test configuration (Test Card Selection, Test configuration (page 128)) or in the settings (Default Test Card Selection, Default test card selection (page 115)).

It is also possible to enable or disable test cards in the test configuration of the *VOTANO Suite* software. The test card selection defined in *VOTANO Suite* always overrides the selection defined on *VOTANO 100*.

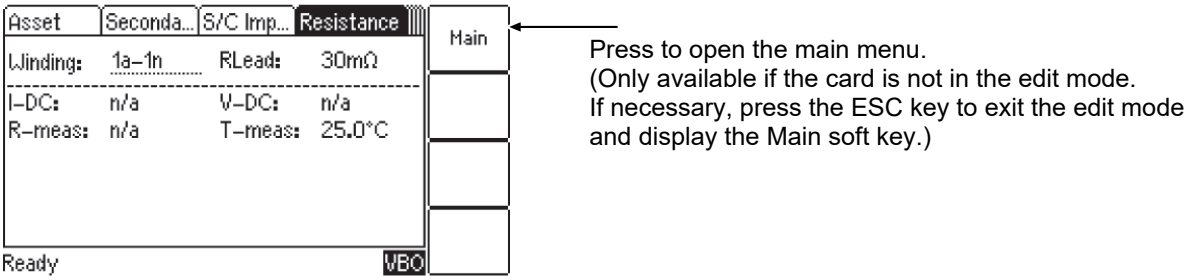


Figure 8-10: **Resistance** Card (Advanced VT/CVT Test mode)

The **Resistance** card shows the results of the winding resistance measurements. The results can be displayed separately for each secondary winding. Select the winding in the Winding field.

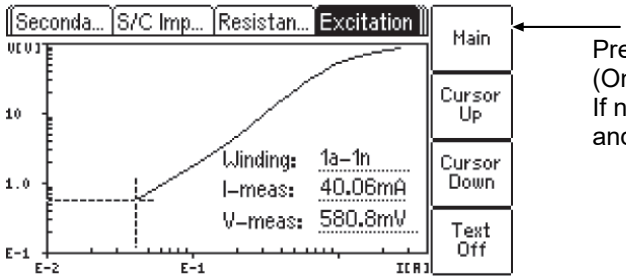
Table 8-10: Results displayed in the **Resistance** card

Field/parameter	Description
Winding	The results of the winding resistance measurements are displayed for the winding selected in this field. Select the winding using the soft keys. Possible values: Soft keys depending on the selected standard (for example, **1a-1n**, **2a-2n** etc., depending on the number of windings set in the **Secondary** card). Default: 1a-1n.
RLead	Only available if R_{Lead} > 0 mΩ has been specified in the **Secondary** card. Line resistance of the cabling between the terminals, VOTANO 100 is connected to, and the voltage transformer as specified in the Secondary card (Parameter fields to be filled by the user (page 132)).
I-DC	DC current used for the measurement.
V-DC	DC voltage used for the measurement.
R-meas	Winding resistance of the voltage transformer determined by measurement at ambient temperature. The value displayed does not include R_{Lead}.
T-meas	Winding temperature of the voltage transformer at the time of measurement. Value used: Ambient Temperature defined in the settings (Temperature).

8.7 Excitation card

The **Excitation** card is only available if excitation measurement is enabled in the test configuration (Test Card Selection, Test configuration (page 128)) or in the settings (Default Test Card Selection, Default test card selection (page 115)).

It is also possible to enable or disable test cards in the test configuration of the *VOTANO Suite* software. The test card selection defined in *VOTANO Suite* always overrides the selection defined on *VOTANO 100*.



Press to open the main menu.
(Only available if the card is not in the edit mode. If necessary, press the ESC key to exit the edit mode and display the Main soft key.)

Figure 8-11: **Excitation** card (Advanced VT/CVT Test mode)

The **Excitation** card shows the excitation graph calculated from the test results for each winding. The graph shows the rms core voltage over the rms exciting current.

Available soft keys

Table 8-11: Soft keys available in the **Excitation** card

Soft key	Description
Cursor Up	Moves the cursor upwards on the excitation graph.
Cursor Down	Moves the cursor downwards on the excitation graph.
Text Off	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.

Viewing the measured values for different points on the graph

You can view the corresponding voltage and current values for any point on the graph and for each winding:

1. Use the ▼ cursor key to select the Winding field. Select the winding using the soft keys.
2. Use the ▲ ▼ cursor keys to select the I-meas or the V-meas field.
3. Use the soft keys (**Cursor Up**, **Cursor Down**) to select predefined points on the graph. Or enter a voltage or current value using the keyboard and press the ↵ key to apply the entered value.
4. Read the associated voltage or current value.

'Extended Excitation Curve' option

Due to the output current limitations of *VOTANO 100*, it is sometimes not possible to measure the excitation curve of a voltage transformer up to a saturation level that is high enough to allow determination of the VT ratio and the phase error for all percentages of the rated voltage stipulated in the selected standard.

If so, you can try to extend the range for measuring the excitation curve by selecting the 'Extended Excitation Curve' option in the test configuration (Test configuration (page 128)).

The 'Extended Excitation Curve' option is only available for voltage transformers with more than one secondary winding.

'Reference Excitation Curve' option

When measuring the inner tap of a center tapped voltage transformer, it may occur that the excitation measurement fails due to the output current limitations of *VOTANO 100*.

For such cases, the 'Reference Excitation Curve' option allows you to load the excitation curve of a previous test performed for the outer tap combination of the same voltage transformer. *VOTANO 100* will then use these excitation curve data as a reference for its measurements and calculations for the inner tap instead of determining the excitation curve data by measurement during the test. This enables testing of the inner tap of the voltage transformer despite the mentioned power limitations.

If the excitation measurement for the inner tap of a center tapped voltage transformer failed:

1. Repeat/run your inner tap test with a reference excitation curve loaded (Test configuration (page 128)):
   1.1 Select the 'Reference Excitation Curve' option in the test configuration to load a reference excitation curve.
   1.2 Repeat your test for the inner tap.
2. Or determine the behavior and data of the inner tap by simulation (Simulation mode (page 64)):
   2.1 Open the test file of your previously failed inner tap test in Simulation mode.
   2.2 Select the Winding field of the **Secondary** card and press the **Ref. Excit. Curve** soft key to load a reference excitation curve.
   2.3 Start the simulation to determine the behavior and data of the inner tap by simulation.

8.8 Ratio card

In the Advanced VT/CVT Test mode, the **Ratio** card is only available if ratio measurement is enabled in the test configuration (Test Card Selection, Test configuration (page 128)) or in the settings (Default Test Card Selection, Default test card selection (page 115)).

It is also possible to enable or disable test cards in the test configuration of the *VOTANO Suite* software. The test card selection defined in *VOTANO Suite* always overrides the selection defined on *VOTANO 100*.

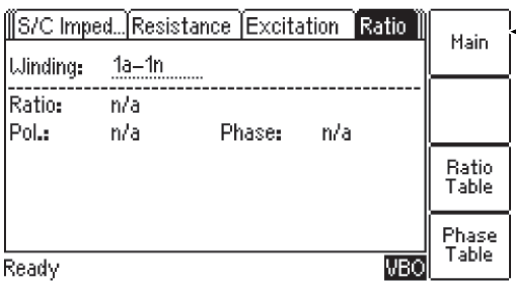


Figure 8-12: **Ratio** card for Advanced VT/CVT Test mode

The **Ratio** card shows the results of the ratio measurements. The results can be displayed for each secondary winding. Select the winding in the Winding field.

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

- The **Ratio** card shows the voltage ratio and ratio error, the polarity, and the phase displacement for the primary voltage, burden and power factor defined in the **Asset** and **Secondary** cards.
- The **ratio error table** shows the voltage ratio error for different primary voltages at different burden values.
- The **phase displacement table** shows the phase displacement for different primary voltages at different burden values.

The behavior and content of the ratio error table and the phase displacement table differs depending on the specific test and standard. Please refer to the following sections for more detailed information:

- Ratio error table and phase displacement table for IEC standards (tests without burden measurement) (page 147) describes the ratio error and phase displacement table for IEC standards (tests without burden measurement).
- Ratio error table and phase displacement table for IEEE and ANSI standard (tests without burden measurement) (page 148) describes the ratio error and phase displacement table for the IEEE and ANSI standard (tests without burden measurement).
- Ratio error table and phase displacement table for voltage transformers with multiple secondary windings (tests without burden measurement) (page 149) describes the ratio error and phase displacement table for voltage transformers with multiple secondary windings.
- Ratio error table and phase displacement table for tests including burden measurement (page 150) describes the ratio error and phase displacement table for tests including burden measurement.

8.8.1 Available soft keys

Table 8-12: Soft keys available in the **Ratio** card

Soft key	Description
Ratio Table	Displays the ratio error table (refer to sections Ratio error table and phase displacement table for IEC standards (tests without burden measurement) (page 147) to Ratio error table and phase displacement table for tests including burden measurement (page 150)).
Phase Table	Displays the phase displacement table (refer to sections Ratio error table and phase displacement table for IEC standards (tests without burden measurement) (page 147) to Ratio error table and phase displacement table for tests including burden measurement (page 150)).

8.8.2 Settings and results

Table 8-13: Settings and results in the card

Field/parameter	Description
Winding	The results of the ratio measurements are displayed for the winding selected in this field. Select the winding using the soft keys. Possible values: Soft keys depending on the selected standard (for example, **1a-1n**, **2a-2n** etc. depending on the number of windings set in the **Secondary** card). Default: 1a-1n.

Field/parameter	Description
Ratio	Measured voltage ratio and voltage ratio error (in %) for the primary voltage, burden and power factor defined in the **Asset** and **Secondary** cards.
Pol.	OK: Polarity OK, phase angle is in the range of 0° ± 90°. Failed: Wrong polarity of the voltage transformer or wrong polarity of the measurement leads.
Phase	Phase displacement for the primary voltage, burden and power factor defined in the **Asset** and **Secondary** cards.
RCF TCF	Only displayed for IEEE C57.13 and ANSI C93.1. RCF: Ratio correction factor. TCF: Transformer correction factor.

8.8.3 Ratio error table and phase displacement table for IEC standards (tests without burden measurement)

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

If the selected standard is **IEC 60044-2** or **IEC 61869-3** (for VTs), or **IEC 60044-5** or **IEC 61869-5** (for CVTs), these tables show the ratio error and the phase displacement

- for different voltage values (depending on the voltage transformer type), and
- at different percentages of the **nominal burden** defined in the **Asset** card.

The ratio error table and the phase displacement table contain all measurement points defined in the standards IEC 60044-2 or IEC 61869-3 (for VTs) or IEC 60044-5 or IEC 61869-5 (for CVTs).

Burden definitions stated in the IEC standards apply to 50 Hz only.

Use the ◀ ▶ and ▲ ▼ cursor keys to scroll through the table columns and table lines.

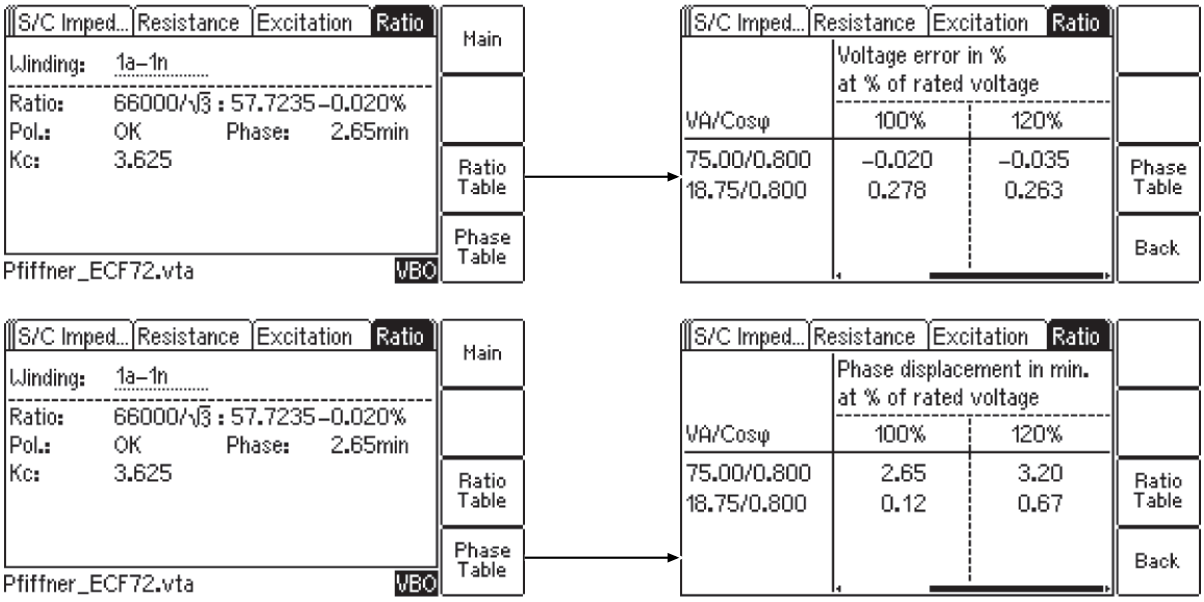


Figure 8-13: Displaying the ratio error table and the phase displacement table in the **Ratio** card (voltage transformer with one secondary winding; for IEC standards)

Values that caused a failed assessment are highlighted by black background in the tables if the **Assessment** card is enabled.

An additional soft key **All wdg.(s) loaded** is available for voltage transformers with more than one secondary winding. See Ratio error table and phase displacement table for voltage transformers with multiple secondary windings (tests without burden measurement) (page 149) for more detailed information.

An additional soft key **op. burden** is available for tests including burden measurement to display the error at the measured burden. See Ratio error table and phase displacement table for tests including burden measurement (page 150) for more detailed information.

8.8.4 Ratio error table and phase displacement table for IEEE and ANSI standard (tests without burden measurement)

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

If the selected standard is IEEE C57.13 (for VTs) or ANSI C93.1 (for CCVTs), these tables show the ratio error and the phase displacement

- for 90 %, 100 % and 110 % of the rated voltage in case of IEEE C57.13 or 90 % and 100 % in case of ANSI C93.1, and
- at the burden specified in the **Secondary** card and all burden values defined in the standard (burden definitions stated in the IEEE/ANSI standard apply to 60 Hz only) that are equal to or lower than the specified burden if the user selected the **At this & lower burdens** option for the Class parameter in the **Secondary** card (Parameter fields to be filled by the user (page 132)), or at the specific burden specified in the **Secondary** card if the user selected the **At specific burden** option for the Class parameter in the **Secondary** card (Parameter fields to be filled by the user (page 132)).

The ratio error table and the phase displacement table contain all measurement points defined in the standard.

Use the ◀ ▶ and ▲ ▼ cursor keys to scroll through the table columns and table lines.

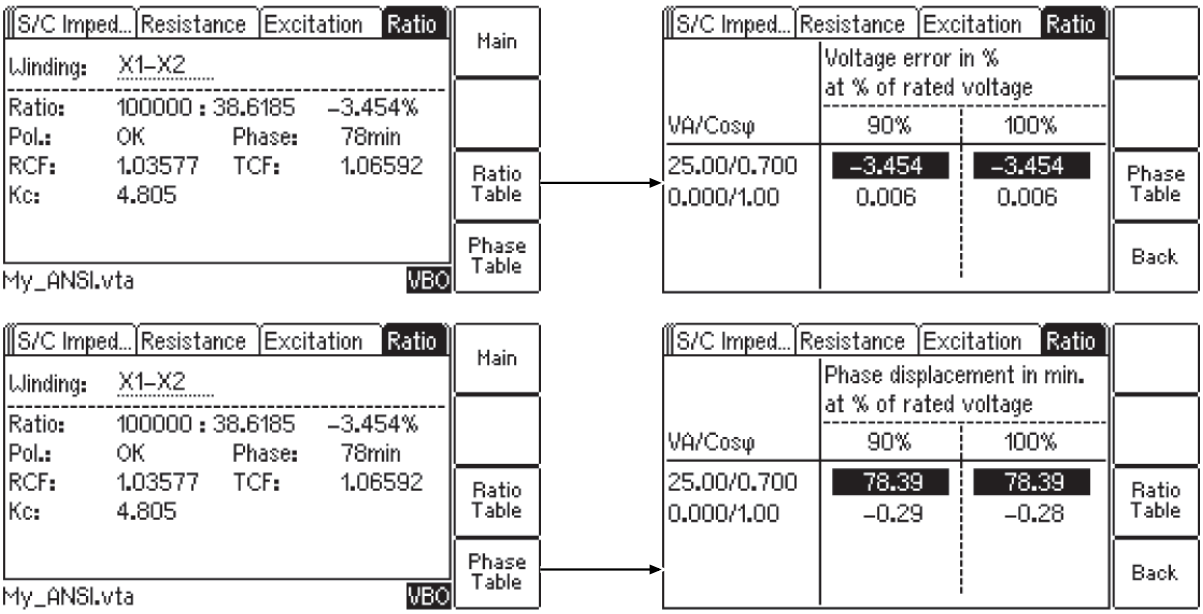


Figure 8-14: Displaying the ratio error table and the phase displacement table in the **Ratio** card (voltage transformer with one secondary winding; for IEEE and ANSI standard)

Values that caused a failed assessment are highlighted by black background in the tables if the **Assessment** card is enabled.

An additional soft key **All wdg.(s) loaded** is available for voltage transformers with more than one secondary winding. See Ratio error table and phase displacement table for voltage transformers with multiple secondary windings (tests without burden measurement) (page 149) for more detailed information.

An additional soft key **op. burden** is available for tests including burden measurement to display the error at the measured burden. See Ratio error table and phase displacement table for tests including burden measurement (page 150) for more detailed information.

8.8.5 Ratio error table and phase displacement table for voltage transformers with multiple secondary windings (tests without burden measurement)

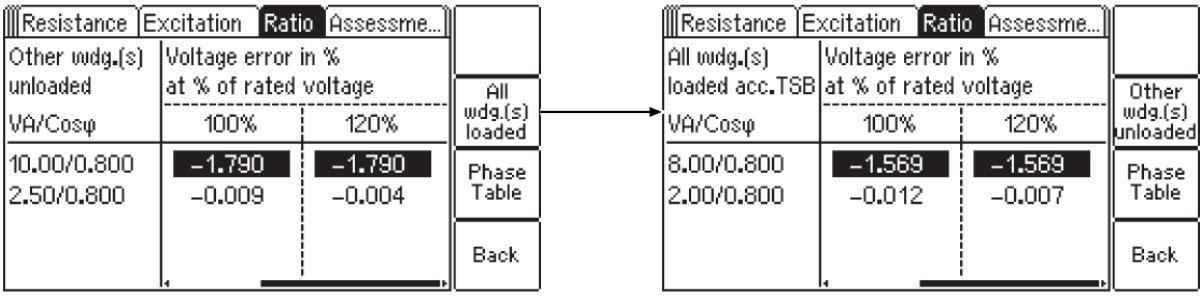
For voltage transformers with more than one secondary winding, an additional soft key **All wdg.(s) loaded** is available. By default, the values displayed in the ratio error table and the phase displacement table apply to an "unloaded" condition, which means that only the measured winding is loaded with the rated burden and the other secondary windings are unloaded.

The **All wdg.(s) loaded** soft key may not be available for some voltage transformers with two secondary windings, particularly if one winding is a residual winding.

Press the **All wdg.(s) loaded** soft key to display the values for a "loaded" condition where all secondary windings are loaded:

- If the TSB is specified in the **Secondary** card (Parameter fields to be filled by the user (page 132) and Setting the TSB and viewing the burden distribution (IEC standards only) (page 137)), the displayed values apply to a load condition where all secondary windings are loaded according to the specified TSB burden distribution (Setting the TSB and viewing the burden distribution (IEC standards only) (page 137) and Changing the burden distribution manually (IEC standards only) (page 139)).
- If no TSB is specified, the values shown in the table apply to a load condition where all secondary windings are loaded with their rated burden.

After pressing **All wdg.(s) loaded**, the soft key changes to **Other wdg.(s) unloaded** to enable the display of the default table again (that is, with the other secondary windings unloaded).



Ratio error table for other secondary windings unloadad (default)

Ratio error table for all secondary windings loaded according to the specified TSB burden distribution

Figure 8-15: Ratio error tables for voltage transformers with more than one secondary winding (other windings unloaded and all windings loaded)

8.8.6 Ratio error table and phase displacement table for tests including burden measurement

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

If the voltage transformer test includes burden measurement, the ratio table and the phase displacement table provide the possibility to display the ratio error and the phase displacement of the voltage transformer

- for different voltage values (depending on the voltage transformer type and standard selected),
- at different percentages of the rated burden according to the selected standard (as described in Ratio error table and phase displacement table for IEC standards (tests without burden measurement) (page 147) and Ratio error table and phase displacement table for IEEE and ANSI standard (tests without burden measurement) (page 148)),
- **and additionally at the measured burden determined during the burden test.**

For this purpose, an additional soft key **op. burden** is available. Press this soft key to display the ratio error or phase displacement at the measured burden. The soft key then changes to **rated burden** to switch the table back to the values for the rated burden.

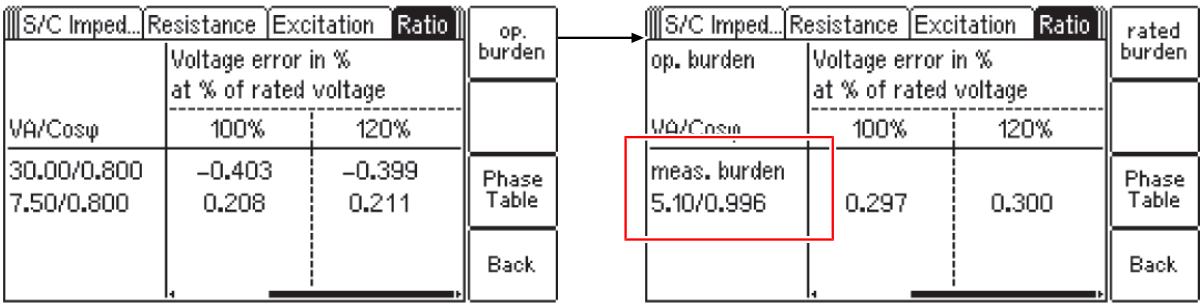


Figure 8-16: Ratio error table for a test including burden measurement: values for rated burden (left) and values for measured burden (right)

Behavior in simulation mode

When working in simulation mode, the **Burden** card provides the possibility to specify an operating burden and a connection impedance (Burden card (page 140)). The ratio error and phase displacement tables then additionally display the error at the specified operating burden and at the operating burden including the specified connection impedance. If necessary, use the scroll bar to display all values.

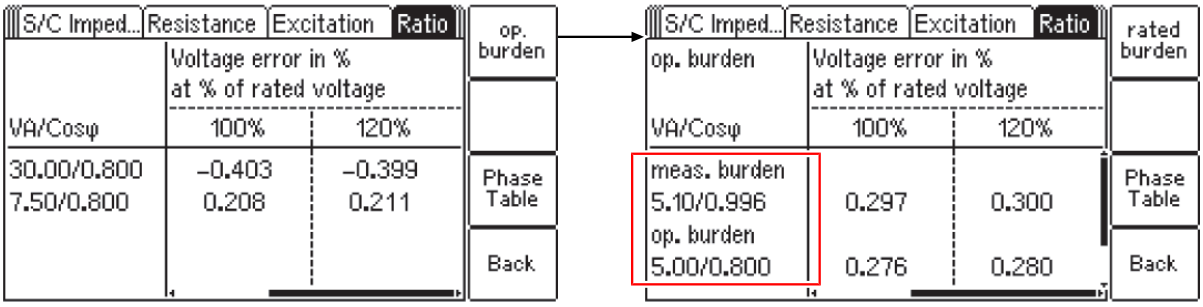


Figure 8-17: Ratio error table for a simulation of a test including burden measurement: values for rated burden (left) and values for measured burden and operating burden (right)

8.9 Assessment card

The **Assessment** card is only available if it is enabled in the test configuration (Test Card Selection, Test configuration (page 128)) or in the settings (Default Test Card Selection, Default test card selection (page 115)).

It is also possible to enable or disable test cards in the test configuration of the *VOTANO Suite* software. The test card selection defined in *VOTANO Suite* always overrides the selection defined on *VOTANO 100*.

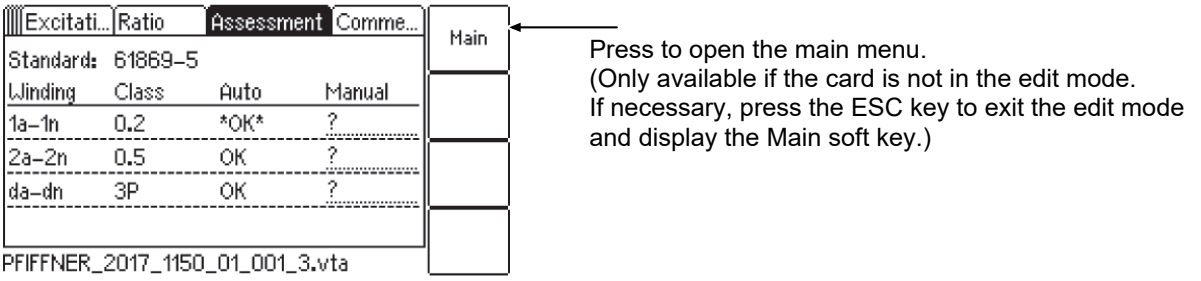


Figure 8-18: **Assessment** card for test without burden measurement (Advanced VT/CVT Test mode)

The **Assessment** card shows the standard used for the test together with the test assessments for the individual windings.

The automatic assessment is performed for each winding and, if applicable, for each M and P class of each winding. The following test assessments are possible:

- **OK**: The measurement results for this winding and class comply with the requirements defined by the selected standard and the parameters set in the **Asset** and the **Secondary** card.
- ***OK***: The user customized the default automatic assessment by defining an additional ratio and phase tolerance. The measurement result is very close to the class limit, but still within the extended tolerance range defined by the additional ratio/phase tolerance. Refer to "Customized automatic assessment" later in this section for more detailed information.
- **Failed**: The measurement results do not comply with the requirements.
- **n/a**: No assessment possible, for example due to incorrect polarity or invalid measurement results.

The automatic assessment can be customized by selecting a multiplication factor. See 'Class Multiplication Factor' option in Test configuration (page 128) or Default test configuration (page 116).

It is also possible to perform a manual assessment for a winding. To do this, select the winding to be assessed using the cursor keys and apply your assessment using the **OK**, **Failed** or **?** soft key (? = no manual assessment).

In case of the automatic assessment "Failed" or "n/a", you can display detailed results by selecting the automatic assessment using the cursor keys and then pressing the **Details** soft key. This will open a detailed error list showing each invalid measurement point and each point outside the class limits.

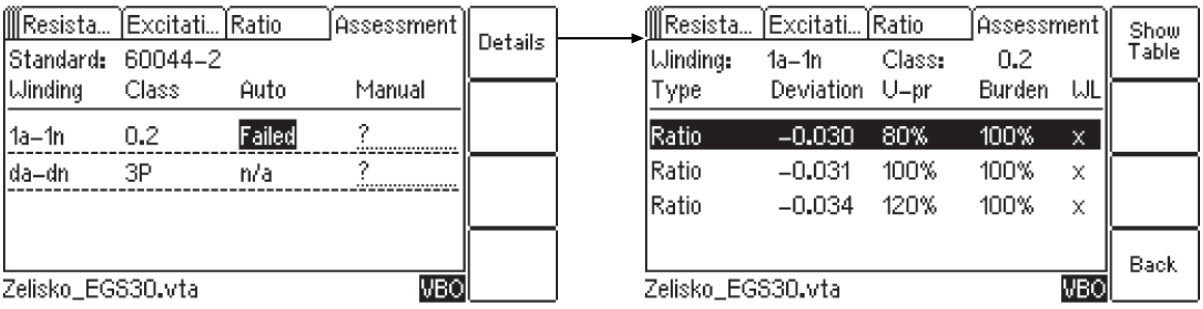


Figure 8-19: Displaying the error list in case of a failed automatic assessment

The error list shows the type of measurement that failed together with the deviation (difference between the class limit (here: class 0.2) and the actual value measured) for the corresponding percentage of U_{pr} and burden, and an indication if the other windings were loaded or not.

Use the **Show Table** soft key to display the corresponding ratio error or phase displacement table (Ratio error table and phase displacement table for IEC standards (tests without burden measurement) (page 147) and Ratio error table and phase displacement table for IEEE and ANSI standard (tests without burden measurement) (page 148)). Values that caused a failed assessment are highlighted by black background in these tables.

Customized automatic assessment

The automatic assessment of *VOTANO 100* uses predefined assessment rules based on the measurement value and the class definitions stated in the standards. It does not consider any uncertainty or inaccuracies caused, for example, by the measurement setup or other influencing factors by default. In other words, the default automatic assessment relies on an uncertainty of the measured ratio and phase values of ± 0 % or ± 0 min, respectively.

Measurement results very close to the class limits (for example, 0.5 % in ratio error) may possibly result in wrong assessment since measurement uncertainties are not considered. *VOTANO 100* therefore offers the option to customize the automatic assessment by defining an additional user-defined ratio and phase tolerance for the assessment. *VOTANO 100* then considers this tolerance for its assessment and highlights assessments that are based on boundary values very close to the class limit by stars (*OK*). Refer to the following figure.

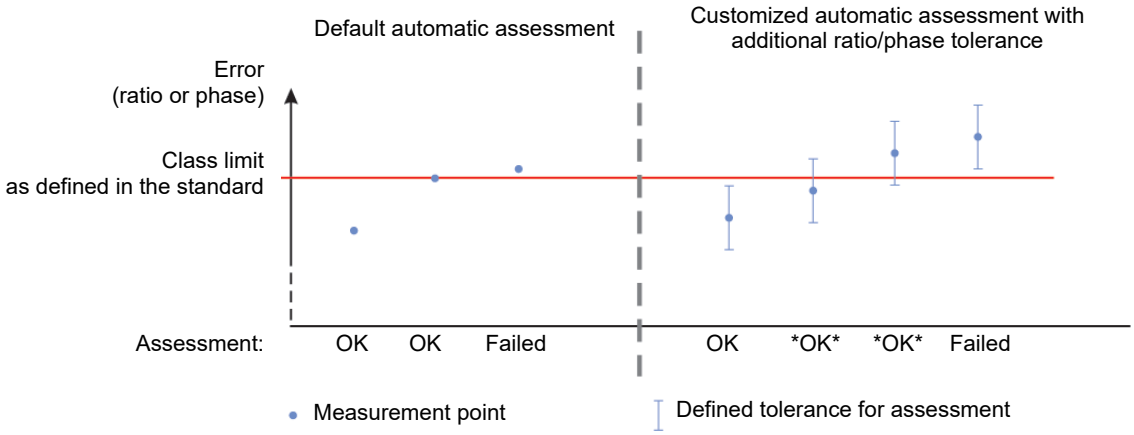


Figure 8-20: Default automatic assessment and customized automatic assessment (with additional ratio/phase tolerance)

You can define these additional tolerances in the settings (see the 'Default Assessment Rules' option in Available options in the Setting Menu page (page 113)).

Press the **Tol. Margins** soft key of the **Assessment** card to display the additional ratio and phase tolerances applied for the assessment displayed in the card.

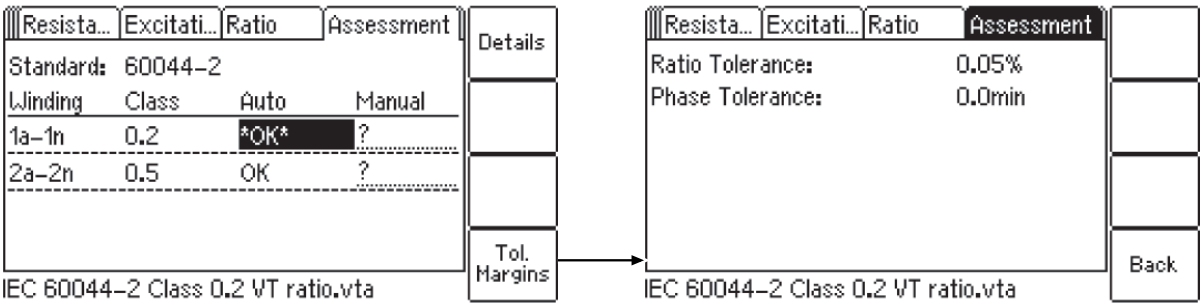


Figure 8-21: Displaying the additional tolerances applied to customize the automatic assessment

Behavior if the test includes burden measurement

If the test includes burden measurement, the **Assessment** card can be switched to display the assessment for the rated burden **or** for the measured burden. For this purpose, an additional soft key **Meas. burden** is available. Press this soft key to display the assessment at the measured burden. The soft key then changes to **Rated burden** to switch back to the assessment at the rated burden.

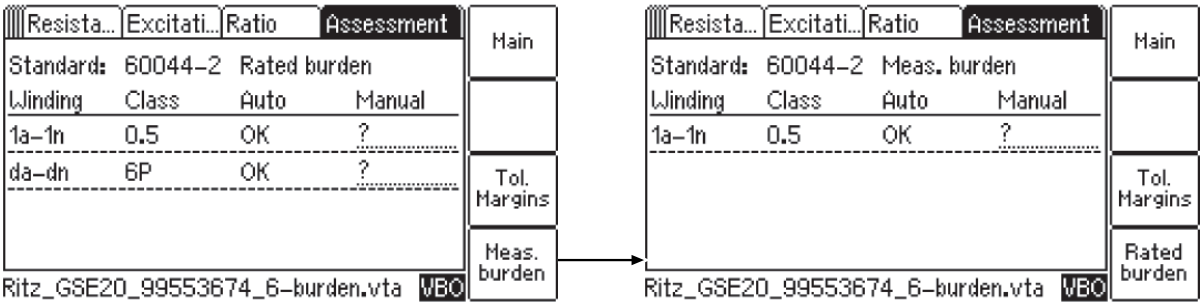


Figure 8-22: **Assessment** card for a test including burden measurement: assessment for rated burden (left) and assessment for measured burden (right)

8.9.1 Assessment conditions for VTs according to IEC 60044-2

Table 8-14: Assessment conditions for VTs according to IEC 60044-2

Class	Condition for auto assessment "OK"
3P	Assessment is performed • at 25 % and 100 % of the rated burden S_r and • at 2 %, 5 %, 100 % and 100 % * F_v of the rated primary voltage U_{pr}.
6P	
0.1	Assessment is performed • at 25 % and 100 % of the rated burden S_r if ext. Sr = off or at 0 % and 100 % of the rated burden S_r if ext. Sr = on and • at 80 %, 100 % and 120 % of the rated primary voltage U_{pr} **Note:** If the extended burden range is selected (parameter ext. Sr = On in **Secondary** card, only possible if S_r < 10 VA), assessment is performed with 0 % and 100 % of the rated burden S_r.
0.2	
0.5	Assessment is performed • at 25 % and 100 % of the rated burden S_r and • at 80 %, 100 % and 120 % of the rated primary voltage U_{pr}
1	
3	

If the test includes burden measurement, assessment is additionally performed for the measured burden.

8.9.2 Assessment conditions for VTs according to IEC 61869-3

Table 8-15: Assessment conditions for VTs according to IEC 61869-3

Class	Condition for auto assessment "OK"
3P	Assessment is performed • at 0 % and 100 % (range I; cos φ = 1) or 25 % and 100 % (range II; cos φ = 0.8) of the rated burden S_r and • at 2 %, 5 %, 100 % and 100 % * F_v of the rated primary voltage U_{pr}.
6P	
0.1	Assessment is performed • at 0 % and 100 % (range I; cos φ = 1) or 25 % and 100 % (range II; cos φ = 0.8) of the rated burden S_r and • at 80 %, 100 % and 120 % of the rated primary voltage U_{pr}
0.2	
0.5	
1	
3	

If the test includes burden measurement, assessment is additionally performed for the measured burden.

8.9.3 Assessment conditions for VTs according to IEEE C57.13

Table 8-16: Assessment conditions for VTs according to IEEE C57.13

Class	Condition for auto assessment "OK"
0.15	Assessment is performed at the rated burden S_r and at burden = 0.
0.3	Assessment is performed • at the rated burden S_r and all lower burdens defined in the standard (if the user selected the **At this & lower burdens** option for the Class parameter in the **Secondary** card) or only with the burden specified in the **Secondary** card (if the user selected the **At specific burden** option for the Class parameter in the **Secondary** card) and • at 90 %, 100 % and 110 % of the rated primary voltage U_{pr}.
0.6	
1.2	

If the test includes burden measurement, assessment is additionally performed for the measured burden.

8.9.4 Assessment conditions for CVTs according to IEC 60044-5

Table 8-17: Assessment conditions for CVTs according to IEC 60044-5

Class	Condition for auto assessment "OK"
3P	Assessment is performed • at 0 % and 100 % (range I; cos φ = 1) or 25 % and 100 % (range II; cos φ = 0.8) of the rated burden S_r and • at 2 %, 5 %, 100 % and 100 % * F_v of the rated primary voltage U_{pr}.
6P	
0.2	Assessment is performed • at 0 % and 100 % (range I; cos φ = 1) or 25 % and 100 % (range II; cos φ = 0.8) of the rated burden S_r and • at 80 %, 100 % and 120 % of the rated primary voltage U_{pr}.
0.5	
1	
3	

If the test includes burden measurement, assessment is additionally performed for the measured burden.

8.9.5 Assessment conditions for CVTs according to IEC 61869-5

Table 8-18: Assessment conditions for CVTs according to IEC 61869-5

Class	Condition for auto assessment "OK"
3P	Assessment is performed • at 0 % and 100 % (range I; cos φ = 1) or 25 % and 100 % (range II; cos φ = 0.8) of the rated burden S_r and • at 2 %, 5 %, 100 % and 100 % * F_v of the rated primary voltage U_{pr}.
6P	
0.2	Assessment is performed • at 0 % and 100 % (range I; cos φ = 1) or 25 % and 100 % (range II; cos φ = 0.8) of the rated burden S_r and • at 80 %, 100 % and 120 % of the rated primary voltage U_{pr}.
0.5	
1	
3	

If the test includes burden measurement, assessment is additionally performed for the measured burden.

8.9.6 Assessment conditions for CCVTs according to ANSI C93.1

Table 8-19: Assessment conditions for CCVTs according to ANSI C93.1

Class	Condition for auto assessment "OK"
1.2R	Assessment is performed at 0 % and 100 % of the rated burden S_r and at 5 %, 25 %, 90 % and 100 % of the rated primary voltage U_{pr}.

Class	Condition for auto assessment "OK"
0.3	Assessment is performed
0.6	at 0 % and 100 % of the rated burden S_r and
1.2	at 90 % and 100 % of the rated primary voltage U_{pr}.

If the test includes burden measurement, assessment is additionally performed for the measured burden.

8.10 Comment card

In the Advanced VT/CVT Test mode, the **Comment** card is only available if it is enabled in the test configuration (Test configuration (page 128)) or in the settings (Default test card selection (page 115)).

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

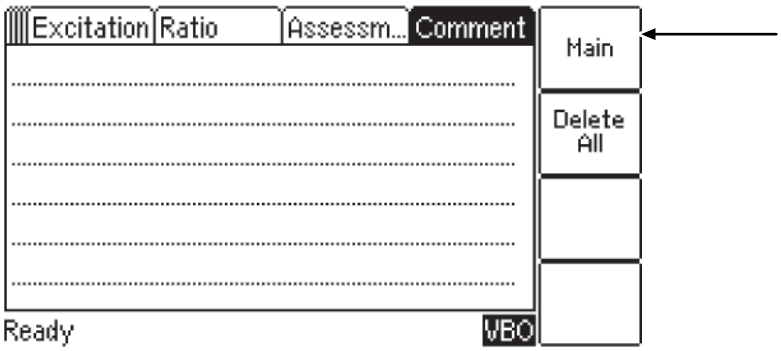


Figure 8-23: **Comment** card

9 Test cards for VT/CVT Test mode

9.1 Overview of test cards

Use the VT/CVT Test mode to perform faster guided testing of VT or CVT voltage transformers regarding the ratio error and the phase displacement of the voltage transformer. The VT/CVT Test mode does not provide automatic assessment. The following table provides an overview of the test cards available in the VT/CVT Test mode of *VOTANO 100*.

For up-to-date information about the licenses and packages available for *VOTANO 100* refer to the OMICRON website or contact the OMICRON Technical Support (Support (page 196)).

Table 9-1: Overview of test cards available in the VT/CVT Test mode of *VOTANO 100*

Card	Short description
Asset	This card contains the basic data of the voltage transformer (Asset card (page 158)).
Secondary	Use this card to specify the secondary side of the voltage transformer (Secondary card (page 162)).
S/C Impedance	Use this card to measure the primary and secondary short-circuit impedances of the voltage transformer (S/C Impedance card (page 165)).
Ratio	Use this card to measure the ratio of the voltage transformer considering the nominal burden (Ratio card (page 165)).
Comment	In this card you can enter any text, for example, additional notes regarding the test Comment card (page 167)).

9.2 Asset card

The **Asset** card contains the basic data of the voltage transformer under test.

The **Asset** card is the top user interface level. Pressing the Esc key several times will always bring you back to the **Asset** card.

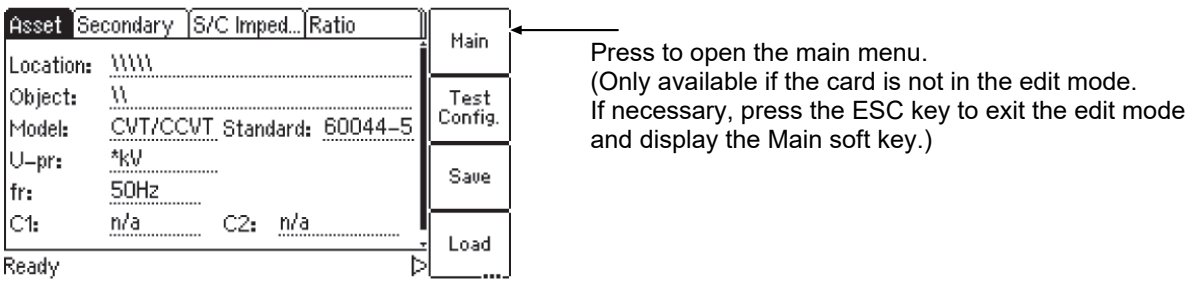


Figure 9-1: **Asset** card with default settings after initializing a new test (VT/CVT Test mode)

9.2.1 Available soft keys

Table 9-2: Soft keys available in the **Asset** card

Soft key	Description
Test Config.	Allows to select the test configuration (for example, factor for assessment customization etc.) and to clear the results of the previous test. See Test configuration (page 161) for more detailed information.
Save	Saves the test results and test settings to the currently loaded *VOTANO 100* report file. Saving a file is described in Working in the file system (page 109).
Load	Allows to load a test stored on the Compact Flash card in order to check its results or to use its settings for a new test.
Lock Device	Allows to lock the *VOTANO 100* test set and the test setup in a safe state. Locking *VOTANO 100* is described in Locking VOTANO 100 in a safe state (page 123).

9.2.2 Parameter fields to be filled by the user

Table 9-3: Parameter fields to be filled by the user

Field/parameter	Description
Location	The Location text field is used for reporting and documentation purposes. The content of this field is defined in the **Location settings** page. To open this settings page, position the cursor to the Location field and then press the **Details** soft key or the ↵ key. 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 voltage transformer is installed. • Phase: Phase to which the voltage transformer is connected. • IEC-ID: IEC-ID of the voltage transformer or freely definable information.
Object	The Object text field is used for reporting and documentation purposes. The content of this field is defined in the **Object settings** page. To open this settings page, position the cursor to the Object field and then press the **Details** soft key or the ↵ key. The **Object settings** page provides the following text fields. Each field can contain a maximum of 40 numbers or letters. • Manufact.: Manufacturer of the voltage transformer. • Type: Type number or description of the voltage transformer. • Serial No.: Serial number of the voltage transformer.

Field/parameter	Description
Model	Inductive voltage transformer (VT) or capacitive voltage transformer/coupling capacitor voltage transformer (CVT/CCVT). Possible values: Soft keys **VT** or **CVT/CCVT** Default: As defined in the settings (Default VT Parameters or Default CVT/CCVT Parameters).
Standard	Standard according to which the test has to be performed. Possible values: Soft keys **IEC 60044-2**, **IEC 61869-3** or **IEEE C57.13** for VTs or **IEC 60044-5**, **IEC 61869-5** or **ANSI C93.1** for CVTs/CCVTs Default: As defined in the settings (Default VT Parameters or Default CVT/CCVT Parameters). **Note:** Selecting an IEC standard automatically sets the "fr" parameter (see below) to 50 Hz. Selecting the IEEE C57.13 or ANSI C93.1 standard automatically sets the "fr" parameter to 60 Hz.
U-pr*	Rated primary voltage of the voltage transformer. Possible values: Value (between 1 kV and 2 MV) entered using the keyboard or soft keys depending on the standard (for example, **66kV**, **110kV**, **132kV**, **220kV**). The voltage selected with the soft keys is the phase-phase voltage (1/1). If necessary, use the **/√3** soft key to specify a phase-ground voltage. If applied, the soft key changes to **x√3** to remove the factor previously applied.
fr	Rated frequency of the voltage transformer. Possible values: Soft keys **50Hz**, **60Hz** or **16.7Hz** Default: As defined in the settings (Default VT Parameters or Default CVT/CCVT Parameters). **Note:** Selecting an IEC standard in the "Standard" field automatically sets "fr" to 50 Hz. Selecting the IEEE C57.13 or ANSI C93.1 standard automatically sets "fr" to 60 Hz. **Note:** 16.7 Hz is only supported for VT voltage transformers tested according to an IEC standard.
C1* and C2*	Only available for CVT/CCVT voltage transformers, and if enabled in the test configuration of the VT/CVT test (Test configuration (page 161)) or the default test configuration (Available options in the Setting Menu page (page 113)). Rated capacitances of the CVT/CCVT voltage transformer's capacitor voltage divider. C1: Rated capacitance of the high-voltage capacitor. Possible values: 1 pF … 99 999 pF C2: Rated capacitance of the intermediate-voltage capacitor. Possible values: 1 pF … 2 000 000 pF

Field/parameter	Description
Max. VBO2 ratio test voltage	Only displayed if selected in the test configuration (Test configuration (page 161)) or the default test configuration (Available options in the Setting Menu page (page 113)). The primary voltage applied during the ratio test is limited to the voltage set in this field (instead of applying the voltage chosen automatically according to the rated primary voltage U_{pr} set for the voltage transformer in this card). Possible values: Value (between 40 V and 4 kV) entered using the keyboard or the soft keys **4kV** or **Default** (default value defined in the default test configuration settings, Default test configuration (page 116)). **Note:** If 16.7 Hz is selected for the rated frequency of the transformer (f_r), *VOTANO 100* automatically limits the maximum *VBO2* ratio test voltage to ≤ 1.2 kV even if you specified a higher voltage in the 'Max. VBO2 ratio test voltage' field.

Mandatory parameters are marked by a star in the *VOTANO 100* user interface. The test cannot be started if no value is entered for one of these parameters.

9.2.3 Test configuration

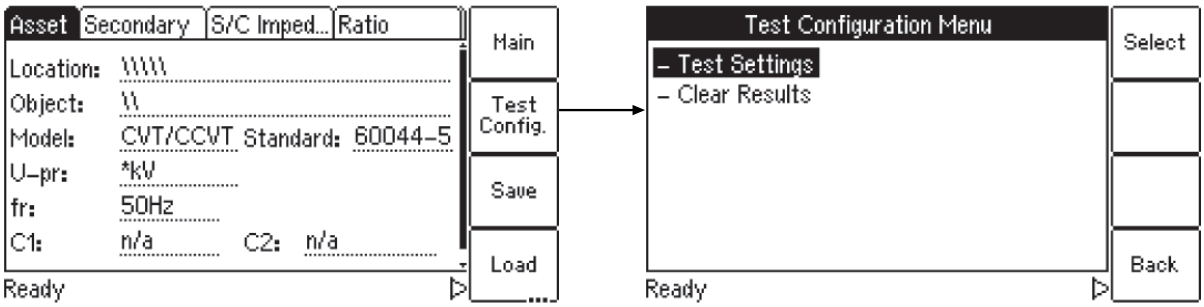


Figure 9-2: Displaying the **Test Configuration Menu** page from the **Asset** card

Press the **Test Config.** soft key in the **Asset** card or the **Secondary** card to display the **Test Configuration Menu** page. This page provides the following entries:

Table 9-4: Test configuration parameters

Field/parameter	Description
Test Settings	Displays the **Test Settings** page providing the options described below. The default settings for these options are defined in the Default Test Configuration (Default test configuration (page 116)). **'Limit VBO2 test voltage' option** Using this option. you can enable a limitation of the primary voltage applied during the ratio test. This may be required for voltage transformers with a rated voltage lower than 4 kV. 1. Select **Yes** to enable the limitation and to display an additional parameter 'Max. VBO2 ratio test voltage' in the **Asset** card allowing the selection of a reduced primary voltage for the test. 2. If the 'Limit VBO2 test voltage' option is switched off (**No**), the primary voltage applied during the test is chosen automatically according to the rated primary voltage of the voltage transformer set in the **Asset** card. **Note:** If 16.7 Hz is selected for the rated frequency of the transformer (fr), *VOTANO 100* automatically limits the maximum *VBO2* ratio test voltage to ≤ 1.2 kV even if you specified a higher voltage in the 'Max. VBO2 ratio test voltage' field. **'Enter rated capacitances' option** **Note:** Only available if a CVT/CCVT voltage transformer is selected. Using this option, you can enable or disable the "C1" and "C2" parameter fields in the **Asset** card used to specify the capacitances of the capacitor voltage divider of CVT/CCVT voltage transformers (high-voltage capacitance (C1) and intermediate voltage capacitance (C2)).
Clear Results	Clears the results of the previous test and enables to start a new test.

9.3 Secondary card

Use the **Secondary** card to specify the secondary side of the voltage transformer.

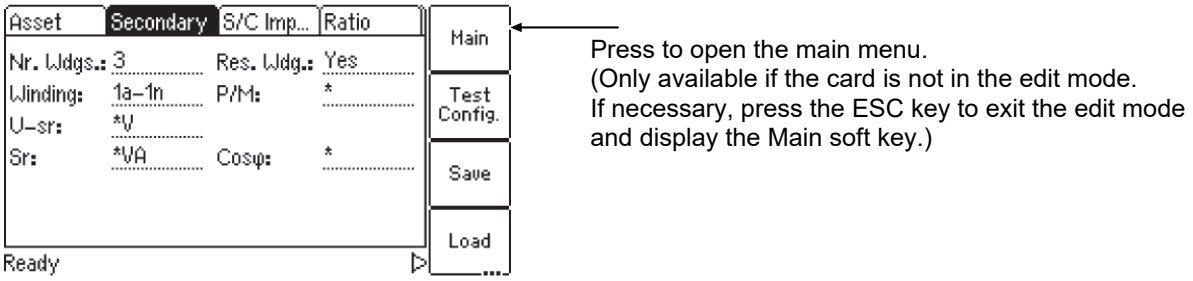


Figure 9-3: **Secondary** card with default settings after initializing a new VT/CVT test

9.3.1 Available soft keys

Table 9-5: Soft keys available in the **Secondary** card

Soft key	Description
Test Config.	Allows to select the test configuration (for example, available test cards, factor for assessment customization etc.) and to clear the results of the previous test. See Test configuration (page 161) for more detailed information.
Save	Saves the test results and test settings to the currently loaded *VOTANO 100* report file. Saving a file is described in Working in the file system (page 109).
Load	Allows to load a test stored on the Compact Flash card in order to check its results or to use its settings for a new test.
Lock Device	Allows to lock the *VOTANO 100* test set and the test setup in a safe state. Locking *VOTANO 100* is described in Locking VOTANO 100 in a safe state (page 123).

9.3.2 Parameter fields to be filled by the user

Table 9-6: Parameter fields to be filled by the user

Field/parameter	Description
Nr. Wdgs.	Number of secondary windings available on the voltage transformer (max. 5). Possible values: Soft keys **1** to **5** Default: As defined in the settings (Default VT Parameters or Default CVT/ CCVT Parameters).
Res. Wdg.	Only displayed for IEC standards. Select whether your voltage transformer has a residual winding or not. The residual winding is named da-dn and counted in the amount of secondary windings. Possible values: Soft keys **Yes** or **No** Default: As defined in the settings (Default VT Parameters or Default CVT/ CCVT Parameters).
Winding	Use this field to select the secondary winding to be specified by the parameters in this card. The parameters have to be specified separately for each winding of the voltage transformer. Possible values: Depends on the number of windings set with the Nr. Wdgs. parameter. One soft key for each winding: for example, **1a-1n**, **2a-2n**, etc. Proceed as follows: 1. Select the first secondary winding using the soft keys and specify the parameters (Class, U_{sr}, S_r and cos φ, for example) for this winding. 2. Select the second secondary winding using the soft keys and specify the parameters for this winding. 3. Proceed accordingly to specify the parameters for all remaining secondary windings.

Field/parameter	Description
P/M*	Only displayed for IEC standards and ANSI C93.1. Winding type of the selected winding: protection or metering. Possible values: Soft keys **Prot.** (protection) **Meas.** (metering)
Class*	For IEC standards only displayed if the P/M parameter is set to "metering". Always displayed for IEEE C57.13 and ANSI C93.1. Accuracy class of the selected winding. Possible values: Soft keys depending on the selected standard (for example, **Class 0.15**, **Class 0.2** etc.). **For IEEE C57.13 only:** An additional soft key **At specific burden** is available for the Class parameter if the IEEE C57.13 standard is selected. Use this option if the accuracy class of the voltage transformer only applies to one specific burden. Assessment is normally performed for the burden specified and all lower burdens defined in the standard (burden definitions stated in the IEEE C57.13 standard apply to 60 Hz only). Example: If the burden specified is M, assessment or condition estimation is performed for the burdens M, X, W and 0. Selecting the **At specific burden** option in addition to the class setting will cause *VOTANO 100* to consider only the burden value specified prior to testing for the assessment or condition estimation. When **At specific burden** is selected, the soft key changes to **At this & lower burdens** to enable deactivation of this option.
P-Class	Only displayed for IEC 60044-5 and IEC 61869-5, and if the P/M parameter is set to "protection". Protection class of the selected winding. Possible values: Soft keys **Class 3P**, **Class 6P**.
U-sr*	Rated secondary voltage of the selected winding. Possible values: Value (between 0.1 V and 1 kV) entered using the keyboard or soft keys **100V**, **110V**, or **200V**. The voltage selected with the soft keys is the phase-phase voltage (1/1). If necessary, use the **/√3** soft key to specify a phase-ground voltage (or the **/3** soft key for a residual winding). If applied, a **x√3** (or **x3**) soft key is displayed to remove the factor previously applied.
Sr*	Rated output of the selected winding. Possible values: Value (between 0 VA and 1500 VA) entered using the keyboard or soft keys depending on the selected standard (for example, **1.0VA**, **5.0VA**, **10VA PF 1.0**, **10VA PF 0.8** etc.).
Cos ϕ*	Power factor of the rated output specified (S_r or Burden parameter). Possible values: Value (between 0 and 1) entered using the keyboard or soft keys **0.8** or **1.0**.

Field/parameter	Description
Burden*	Only displayed for IEEE C57.13 and ANSI C93.1. Standard burden of the selected winding. Possible values: Soft keys **0**, **W**, **X**, **M**, **Y**, **Z** or **ZZ** or custom burden value entered using the keyboard. **Note:** Burden definitions stated in the IEEE/ANSI standard apply to 60 Hz only.

Mandatory parameters are marked by a star in the *VOTANO 100* user interface. The test cannot be started if no value is entered for one of these parameters.

9.4 S/C Impedance card

In the VT/CVT Test mode, the **S/C Impedance** card is always available.

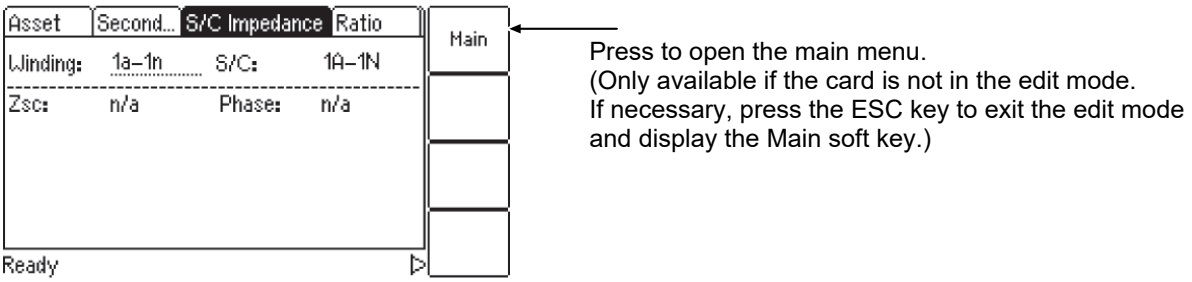


Figure 9-4: **S/C Impedance** card

The **S/C Impedance** card shows the results of the short-circuit impedance measurements. The results of the primary short-circuit impedance measurement are displayed separately for each secondary winding. Select the winding to be displayed in the Winding field.

Table 9-7: Results displayed in the **S/C Impedance** card

Field/parameter	Description
Winding	The results of the primary short-circuit impedance measurements are displayed for the winding selected in this field. Select the winding using the soft keys. Possible values: Soft keys depending on the selected standard (for example, **1a-1n**, **2a-2n** etc. depending on the number of windings selected in the **Secondary** card). Default: 1a-1n.
Zsc	Short-circuit impedance.
Phase	Phase angle.

9.5 Ratio card

In the VT/CVT Test mode, the **Ratio** card is always available.

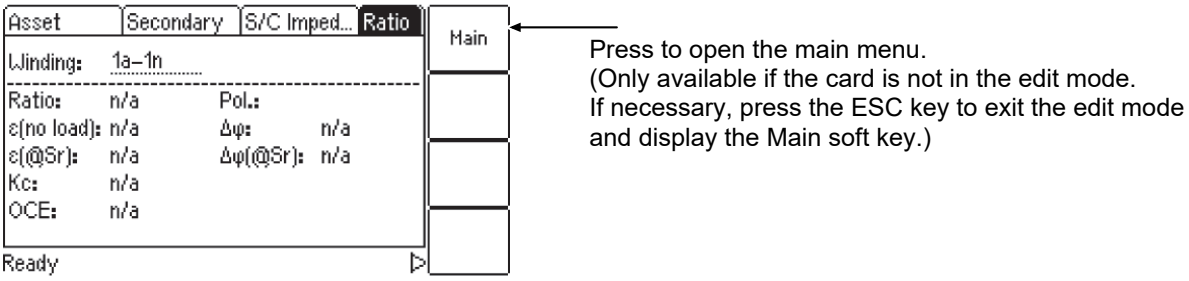


Figure 9-5: **Ratio** card for VT/CVT Test mode

The **Ratio** card shows the voltage ratio and ratio error, the polarity, and the phase displacement for the primary voltage, burden and power factor defined in the **Asset** and **Secondary** cards. The results can be displayed for each secondary winding. Select the winding in the Winding field.

9.5.1 Settings and results

Table 9-8: Settings and results in the **Ratio** card

Field/parameter	Description
Winding	The results of the ratio measurements are displayed for the winding selected in this field. Select the winding using the soft keys. Possible values: Soft keys depending on the selected standard (for example, **1a-1n**, **2a-2n** etc. depending on the number of windings set in the **Secondary** card). Default: 1a-1n.
Ratio	Measured voltage ratio and voltage ratio error (in %) for the primary voltage, burden and power factor defined in the **Asset** and **Secondary** cards.
Pol.	OK: Polarity OK, phase angle is in the range of 0° ± 90°. Failed: Wrong polarity of the voltage transformer or wrong polarity of the measurement leads.
ε(no load)	No-load ratio error in %.
ε(@Sr)	Total ratio error (tested secondary winding being loaded with rated burden).
Δϕ	Phase error in minutes.
Δϕ(@Sr)	Total phase error (tested secondary winding being loaded with rated burden).
Kc	Displayed for CVTs/CCVTs only. Measured voltage ratio of the capacitor voltage divider (ratio of the voltage applied to the capacitor divider to the open-circuit intermediate voltage).

Field/parameter	Description
OCE	Displayed for CVTs/CCVTs only. Result of the Overall Condition Estimator (OCE) for the CVT/CCVT voltage transformer under test. In the VT/CVT Test mode, *VOTANO 100* does not provide automatic assessment of the measurement results. For CVT/CCVT voltage transformers, *VOTANO 100* therefore provides the OCE functionality to assist the user in finding an overall condition evaluation quickly and easily. OCE helps to evaluate the measurement results and indicates the electrical integrity of a CVT/CCVT voltage transformer under test. It checks the measurement results regarding the capacitive ratio and the loading error of the voltage transformer and compares them with the rated values. OCE is able to cover obvious and common failure modes such as defective capacitive layers or a failure in the intermediate voltage transformer. OCE provides the following estimations: • **OK**: All internal evaluation criteria are fulfilled and the electrical condition of the CVT/CCVT voltage transformer under test is acceptable. • **Investigate**: OCE estimates the electrical condition of the CVT/CCVT voltage transformer under test to be not acceptable or possibly not acceptable. The user should perform further investigation. It is recommended to double-check the rated values of the voltage transformer and to perform a comprehensive test using the Advanced VT/CVT Test mode. Please note that OCE is only intended as an aid for the user and not as an equivalent substitute of the automatic assessment performed in the Advanced VT/CVT Test mode. The user alone is responsible for the proper interpretation of the measurement results and the final decision whether the electrical condition of the voltage transformer under test is acceptable or not.

9.6 Comment card

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

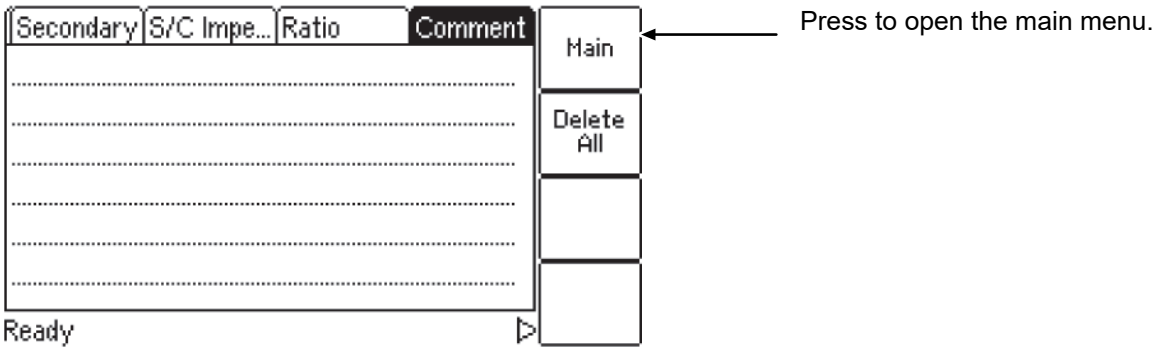


Figure 9-6: **Comment** card

10 Test cards for C-Divider Test mode

10.1 Overview of test cards

Use the C-Divider Test mode to measure the capacitances and the voltage ratio of the capacitor voltage divider of CVT/CCVT voltage transformers. The following table provides an overview of the test cards available in the C-Divider Test mode of *VOTANO 100*.

For up-to-date information about the licenses and packages available for *VOTANO 100* please refer to the OMICRON website or contact the OMICRON Technical Support (Support (page 196)).

Table 10-1: Overview of test cards available in the C-Divider Test mode of *VOTANO 100*

Card	Short description
Asset	This card contains the basic data of the voltage transformer (Asset card (page 168)).
C-Divider	This card shows the results of the C-Divider test (C-Divider card (page 171)).
Comment	In this card you can enter any text, for example, additional notes regarding the test (Comment card (page 172)).

10.2 Asset card

The **Asset** card contains the basic data of the voltage transformer under test.

The **Asset** card is the top user interface level. Pressing the Esc key several times will always bring you back to the **Asset** card.

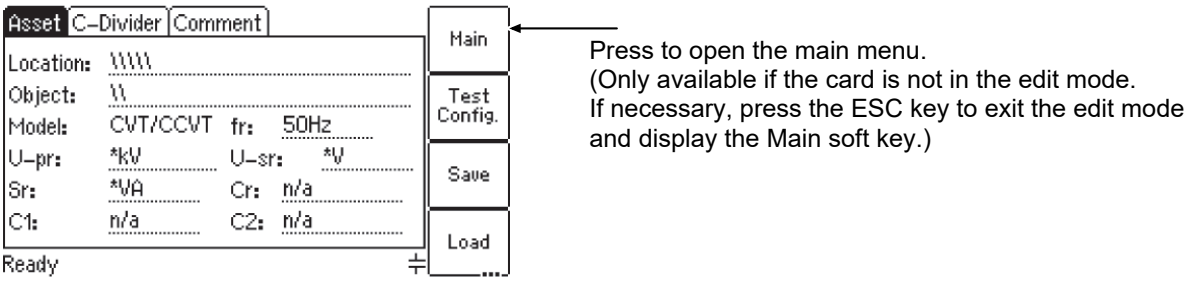


Figure 10-1: **Asset** card with default settings after initializing a new C-Divider test

10.2.1 Available soft keys

Table 10-2: Soft keys available in the **Asset** card

Soft key	Description
Test Config.	Allows to select the test configuration (for example, factor for assessment customization etc.) and to clear the results of the previous test. See Test configuration (page 170) for more detailed information.

Soft key	Description
Save	Saves the test results and test settings to the currently loaded *VOTANO 100* report file. Saving a file is described in Working in the file system (page 109).
Load	Allows to load a test stored on the Compact Flash card in order to check its results or to use its settings for a new test.
Lock Device	Allows to lock the *VOTANO 100* test set and the test setup in a safe state. Locking *VOTANO 100* is described in Locking VOTANO 100 in a safe state (page 123).

10.2.2 Parameter fields to be filled by the user

Table 10-3: Parameter fields to be filled by the user

Field/parameter	Description
Location	The Location text field is used for reporting and documentation purposes. The content of this field is defined in the Location settings page. To open this settings page, position the cursor to the Location field and then press the **Details** soft key or the ↵ key. 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 voltage transformer is installed. • Phase: Phase to which the voltage transformer is connected. • IEC-ID: IEC-ID of the voltage transformer or freely definable information.
Object	The Object text field is used for reporting and documentation purposes. The content of this field is defined in the **Object settings** page. To open this settings page, position the cursor to the Object field and then press the **Details** soft key or the ↵ key. The **Object settings** page provides the following text fields. Each field can contain a maximum of 40 numbers or letters. • Manufact.: Manufacturer of the voltage transformer. • Type: Type number or description of the voltage transformer. • Serial No.: Serial number of the voltage transformer.
Model	CVT/CCVT (fixed setting).
U-pr*	Rated primary voltage of the voltage transformer. Possible values: Value (between 1 kV and 2 MV) entered using the keyboard or soft keys depending on the standard (for example, **66kV**, **110kV**, **132kV**, **220kV**). The voltage selected with the soft keys is the phase-phase voltage (1/1). If necessary, use the **/√3** soft key to specify a phase-ground voltage. If applied, the soft key changes to **x√3** to remove the factor previously applied.

Field/parameter	Description
fr	Rated frequency of the voltage transformer. Possible values: Soft keys **50Hz** or **60Hz** Default: As defined in the settings (Default CVT/CCVT Parameters).
U-sr*	Rated secondary voltage of the capacitor voltage divider. Possible values: Value (between 0.1 V and 1 kV) entered using the keyboard or soft keys **100V**, **110V**, or **200V**. The voltage selected with the soft keys is the phase-phase voltage (1/1). If necessary, use the **/√3** soft key to specify a phase-ground voltage (or the **/3** soft key for a residual winding). If applied, a **x√3** (or **x3**) soft key is displayed to remove the factor previously applied.
Sr*	Rated output power of the winding connected for the C-Divider measurement. Possible values: Value (between 0 VA and 1500 VA) entered using the keyboard or soft keys depending on the selected standard (for example, **1.0VA**, **2.5VA**, **5.0VA**, **10VA**, **25VA** etc.).
Cr, C1, C2	Capacitance values of the capacitor voltage divider as stated on the type plate. Cr: Rated total capacitance of the capacitor voltage divider. Possible values: 1 pF … 99 999 pF C1: Rated capacitance of the high-voltage capacitor. Possible values: 1 pF … 99 999 pF C2: Rated capacitance of the intermediate-voltage capacitor. Possible values: 1 pF … 2 000 000 pF

Mandatory parameters are marked by a star in the *VOTANO 100* user interface. The test cannot be started if no value is entered for one of these parameters.

10.2.3 Test configuration

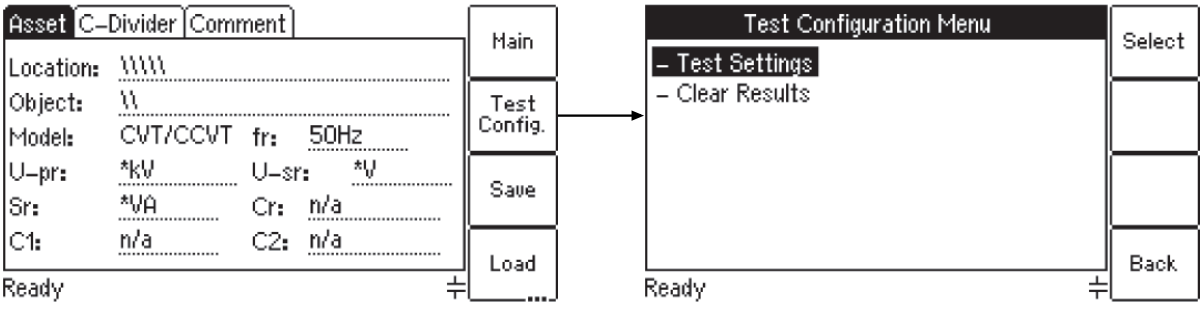


Figure 10-2: Displaying the **Test Configuration Menu** page from the **Asset** card

Press the **Test Config.** soft key in the **Asset** card to display the **Test Configuration Menu** page. This page provides the following entries:

Table 10-4: Test configuration parameters

Field/parameter	Description
Test Settings	Displays the **Test Settings** page providing the following: The default setting for this option is defined in the Default Test Configuration (Default test configuration (page 116)). **'Limit VBO2 test voltage' option** Using this option, you can enable a limitation of the primary voltage applied during the test. This may be required for voltage transformers with a rated voltage lower than 4 kV. 1. Select **Yes** to enable the limitation and to display an additional parameter 'Max. VBO2 ratio test voltage' in the **Asset** card allowing the selection of a reduced primary voltage for the test. 2. If the 'Limit VBO2 test voltage' option is switched off (**No**), the primary voltage applied during the test is chosen automatically according to the rated primary voltage of the voltage transformer set in the **Asset** card.
Clear Results	Clears the results of the previous test and enables to start a new test.

10.3 C-Divider card

The **C-Divider** test card shows the results of the C-Divider test.

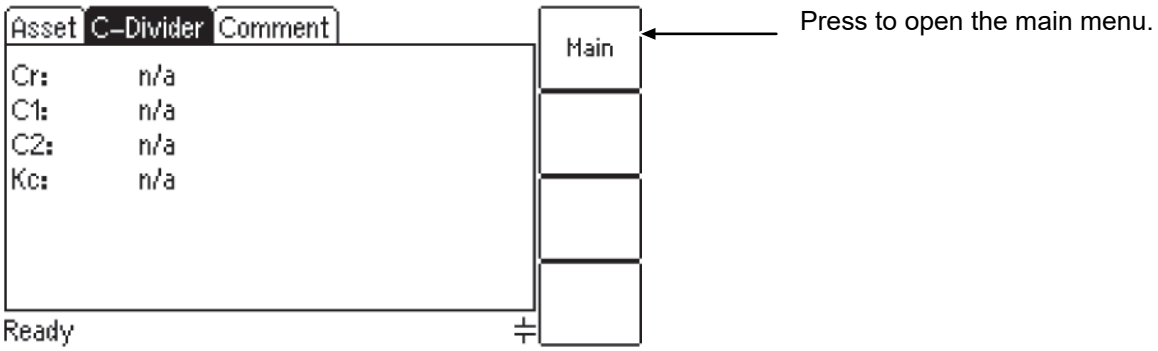


Figure 10-3: **C-Divider** card

Table 10-5: Test results displayed in the **C-Divider** card

Field/parameter	Description
Cr, C1, C2	Measured capacitance values of the capacitor voltage divider. Cr: Total capacitance of the capacitor voltage divider. C1: Capacitance of the high-voltage capacitor. C2: Capacitance of the intermediate-voltage capacitor.
Kc	Voltage ratio of the capacitor voltage divider determined by *VOTANO 100* (ratio of the voltage applied to the capacitor divider to the open-circuit intermediate voltage).

10.4 Comment card

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

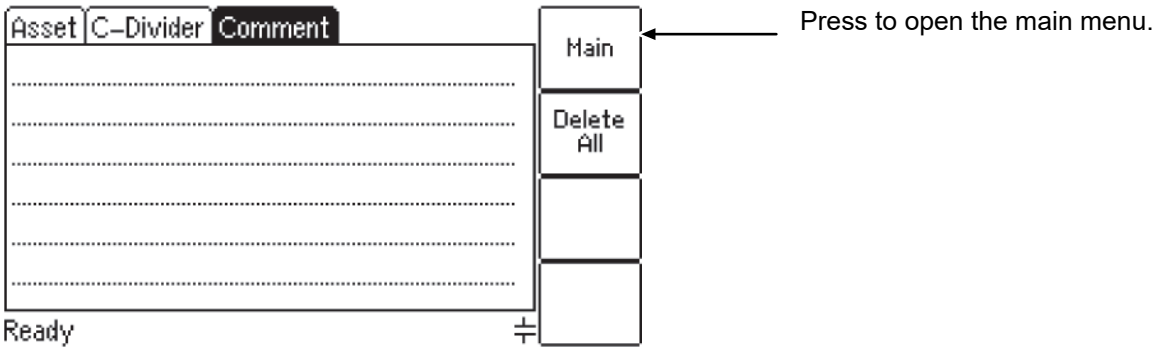


Figure 10-4: **Comment** card

11 Remote control via computer

It is also possible to operate *VOTANO 100* remote controlled from a computer. OMICRON offers two software packages for this purpose: the *VOTANO Suite* operation software and the optional *VOTANO API* automation software.

VOTANO API requires *VOTANO Suite* to be installed on the computer. However, *VOTANO API* and *VOTANO Suite* cannot be executed at the same time.

11.1 VOTANO Suite

VOTANO Suite is delivered with *VOTANO 100*.

The *VOTANO Suite* software provides comprehensive features for your work with *VOTANO 100* using a computer.

The following features and functions are available in *VOTANO Suite*:

- Running a new voltage transformer test and loading an existing (previously stored) test (VT/CVT Test or Advanced VT/CVT Test mode)
- Running a simulation to simulate the behavior of a voltage transformer for changed settings or conditions
- Creating a printable report from a test file previously stored
- Quick ratio measurement of a voltage transformer
- Stand-alone burden measurement
- Updating the firmware and licenses available on *VOTANO 100* and installing a new user interface language on the *VOTANO 100* test set
- Diverse additional functions to display the available *VOTANO 100* manuals and to check for available software updates and OMICRON news

For detailed information about the *VOTANO Suite* software, please launch *VOTANO Suite* and click the help button on the top of the *VOTANO Suite* home view.

11.1.1 System requirements

11.1.1.1 Hardware requirements

VOTANO Suite is exclusively intended for operation with *VOTANO 100* devices equipped with firmware version 2.00 or later and the *VBO2* voltage booster. It will not work with *VOTANO 100* devices equipped with firmware version 1.30 or older and the *VBO1* voltage booster. If necessary, perform a firmware update for your *VOTANO 100* and replace your *VBO1* voltage booster with a *VBO2* voltage booster.

11.1.1.2 Software requirements

VOTANO Suite requires the following software installed on the computer:

- Operating system:
  Windows 7 32 bit or 64 bit, Windows 10 32 bit or 64 bit.
- Microsoft Office® (required for report creation):
  Office 2007 SP2, Office 2010, Office 2013, Office 2016, Office 365, Office 2019.

11.1.2 Installing the VOTANO Suite software

The *VOTANO Suite* software and its installation program *Setup Wizard* are included on the "VOTANO Suite" CD ROM accompanying *VOTANO 100*. Proceed as follows to install the *VOTANO Suite* PC software:

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

   Note: Insert the "VOTANO Suite" CD ROM into your computer's CD ROM drive. The Setup Wizard starts automatically.
   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 "VOTANO Suite" CD ROM.

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

11.1.3 The VOTANO Suite home view

There are three ways to launch *VOTANO Suite*:

1. Select **OMICRON VOTANO** from the Windows **Start** menu.
2. Or double-click the OMICRON VOTANO desktop icon  .
3. Or double-click a **.vta** file available in your file system.

After launching *VOTANO Suite*, the home view opens providing an overview of all available features and functions. Clicking a button in the home view displays the corresponding view or executes the specific function.

Figure 11-1: *VOTANO Suite* home view

Click the help button on the top of the *VOTANO Suite* home view and select **Help** to display the help system providing detailed information about *VOTANO Suite*.

11.2 VOTANO API

VOTANO API is optional and only available if you purchased or rented a corresponding license.

VOTANO API provides a component that enables automation of the *VOTANO 100* test set.
VOTANO API enables:

- Running a voltage transformer test (VT/CVT Test or Advanced VT/CVT Test mode), including:
  - Initialization of test settings.
  - Validation of test settings to prevent measurements with invalid test settings.
  - Handling of necessary user actions during test execution.
  - Providing test execution results after performing a test.
- Updating the firmware and licenses available on *VOTANO 100* and installing a new user interface language on the *VOTANO 100* test set.

For more detailed information about *VOTANO API*, refer to the VOTANO API User Manual.

11.2.1 System requirements

VOTANO API is exclusively intended for operation with *VOTANO 100* devices equipped with firmware version 2.20 or later and the *VBO2* voltage booster. It will not work with *VOTANO 100* devices equipped with firmware version 2.00 or older, or the *VBO1* voltage booster. If necessary, perform a firmware update for your *VOTANO 100* and replace your *VBO1* voltage booster by a *VBO2* voltage booster.

VOTANO API requires *VOTANO Suite* 2.20 or higher to be installed on the computer. For detailed information about further software requirements and dependencies, please refer to the VOTANO API User Manual.

12 Technical data

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

12.1 Mains power supply

Table 12-1: Mains power supply for *VOTANO 100*

Characteristic	Rating
Connection	Connector according to IEC 60320-1 C14
Mains voltage	100 - 240 V_{AC} / 50/60 Hz / 6 A Instead of supplying *VOTANO 100* from phase-neutral (L1-N, A-N), it may also be supplied from phase-phase (for example, L1-L2, A-B). However, the nominal voltage must not exceed 240 V_{AC}.
Mains fuses	2 × T6 AH 250 V (high-breaking capacity wire fuse 5 × 20 mm)

Table 12-2: Mains power supply for *VBO2*

Characteristic	Rating
Connection	Connector according to IEC 60320-1 C14
Mains voltage	100 – 240 V_{AC} / 50/60 Hz / 0.2 A Instead of supplying *VBO2* from phase-neutral (L1-N, A-N), it may also be supplied from phase-phase (for example, L1-L2, A-B). However, the nominal voltage must not exceed 240 V_{AC}. The *VBO2* does not provide an ON/OFF switch.

12.2 Outputs

Table 12-3: LOW VOLTAGE TEST section on *VBO2*

Characteristic	Rating
Output voltage / current	AC: 40 V_{rms} / 5 A_{rms} max. DC: 120 V / 5 A (15 A_{peak})
Output power	400 VA_{rms} max.

Table 12-4: HIGH VOLTAGE TEST section on *VBO2*

Characteristic	Rating
Output voltage / current	4 kV_{rms} / 40 mA_{rms} max.
Output power	160 VA_{rms} max.

12.3 Measurement inputs

Table 12-5: Measurement input 1 on *VOTANO 100*

Characteristic	Rating
Voltage ranges	0 - 0.3 / 3 / 30 / 300 V_{AC} (auto ranging)
Accuracy	0.1 % (guaranteed)
Insulation	Reinforced insulation (R) to all other circuits

Table 12-6: Measurement input 2 on *VOTANO 100*

Characteristic	Rating
Voltage ranges	0 - 0.03 / 0.3 / 3 / 30 V_{AC} (auto ranging)
Accuracy	0.1 % (guaranteed)
Insulation	Reinforced insulation (R) to all other circuits

12.4 Ratio and phase measurement accuracy

The *VOTANO 100*/*VBO2* test system is factory calibrated prior to shipment using an ISO 17025 calibrated reference voltage transformer. To assure the accuracy of the measurement results, it is recommended to verify the calibration at least once per year using a calibrated voltage transformer. If the measurement results are not within the given limits, we recommend sending the *VOTANO 100* test set back to OMICRON for calibration (Support (page 196)).

VOTANO 100 uses a mathematical model based on the equivalent circuit diagram of an inductive voltage transformer to calculate the ratio and phase error. The stated typical accuracy values given for the ratio and phase error are based on empirical measurement data obtained from calibrated voltage transformers of different types and different age, and from different manufacturers.

The accuracy specified may be reduced under interfering conditions.

The accuracy is referred to the instrument transformer accuracy defined in IEC 61869/IEEE C57.13.

12.4.1 Accuracy for VT/CVT Test mode and Advanced VT/CVT Test mode

Table 12-7: Measurement accuracy for VT/CVT measurements

Voltage transformer type	Voltage level (line-line)	Typical accuracy for ratio measurement	Typical accuracy for phase measurement (resolution for phase measurement: 0.01 min)
VT	0.6 kV - 35 kV	0.03 %	2 min
	> 35 kV - 123 kV	0.05 %	3 min
	> 123 kV	0.08 %	4 min

Voltage transformer type	Voltage level (line-line)	Typical accuracy for ratio measurement	Typical accuracy for phase measurement (resolution for phase measurement: 0.01 min)
CVT/CCVT (An additional burden caused by the damping unit may influence the accuracy if it is not considered for the measurement results. If known, the burden value of the damping unit should be added to the highest winding.)	> 30 kV - 100 kV	0.05 %	2 min
	> 100 kV - 500 kV	0.07 %	3 min
	> 500 kV	0.09 %	4 min

12.4.2 Accuracy for direct ratio and phase measurements

The accuracy specified applies to the no-load error of the voltage transformer under test at the specified test point. *VOTANO 100* provides a typical reproducibility of ± 0.005 % and ± 0.5 min.

Table 12-8: Measurement accuracy for measurement of no-load ratio error and phase displacement

Typical accuracy for ratio measurements	Typical accuracy for phase measurements (resolution for phase measurement: 0.01 min)
0.02 %	0.7 min

12.5 Compact Flash card interface (VOTANO 100)

Table 12-9: Compact Flash card interface

Characteristic	Rating
Card type	CF type 1
Allowed memory size	16 MB – 2 GB

12.6 D-Sub 9 interfaces

12.6.1 Interface on VOTANO 100 & MAIN UNIT interface on VBO2

The D-Sub 9 interface on *VOTANO 100* and the DSub-9 MAIN UNIT interface on *VBO2* are exclusively intended to connect the *VBO2* voltage booster to *VOTANO 100*.

Only use the RS232 crossover cable delivered by OMICRON.

12.6.2 SAFETY interface on VBO2

The SAFETY interface of the CONTROL INTERFACE section on *VBO2* is exclusively intended to connect the *SAB1* safety box.

12.7 USB interface (VOTANO 100)

The USB interface on *VOTANO 100* is used to connect the *VOTANO 100* test set to a computer.

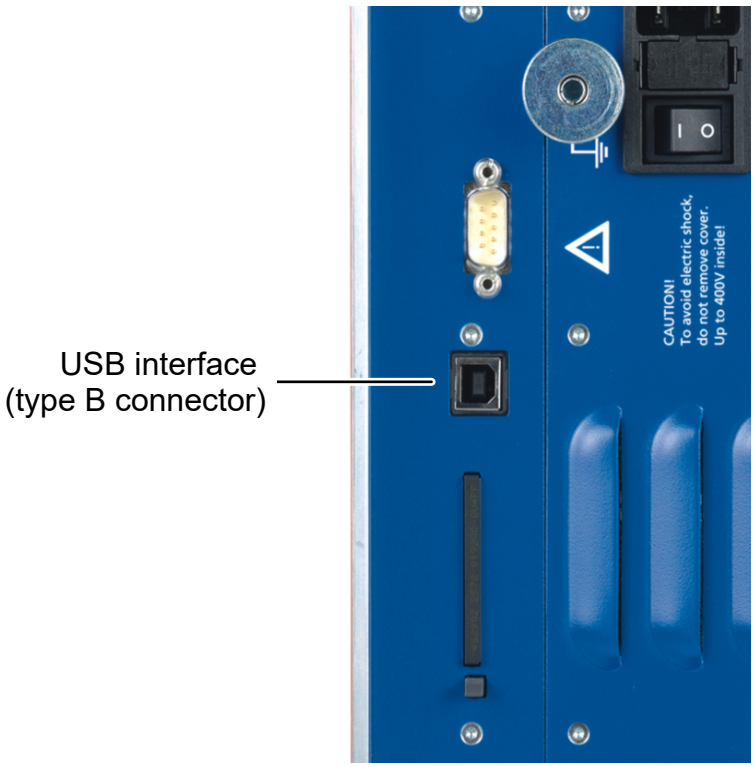


Figure 12-1: USB remote control interface (standard type B connector) on *VOTANO 100*

Only use the original USB cable delivered by OMICRON or a shielded USB cable with ferrite cores applied to connect *VOTANO 100* to a computer!

12.8 Environmental conditions

Table 12-10: Environmental conditions

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

12.9 Mechanical data

Table 12-11: Mechanical data for *VOTANO 100*

Characteristic	Rating
Weight	< 8 kg (17.1 lbs) without accessories

Characteristic	Rating
Dimensions W × H × D	360 × 285 × 145 mm (14.2 × 11.2 × 5.7")

Table 12-12: Mechanical data for *VBO2*

Characteristic	Rating
Weight	7.5 kg (16.5 lbs) without accessories
Dimensions W × H × D	358 × 230 × 114 mm (14.1 × 9.1 × 4.5")

12.10 Standards

Table 12-13: Standards conformity

EMC, safety		
EMC	IEC/EN 61326-1 (industrial electromagnetic environment) FCC subpart B of part 15, class A	
Safety	IEC/EN/UL 61010-1	
Other		
Shock	IEC/EN 60068-2-27 (15 g/11 ms, half-sinusoid, 3 shocks in each axis)	
Vibration	IEC/EN 60068-2-6 (frequency range 10 Hz … 150 Hz, acceleration 2 g continuous (20 m/s²/65 ft/s²), 20 cycles per axis)	
Humidity	IEC/EN 60068-2-78 (5 % … 95 % relative humidity, no condensation), tested at 40 °C/104 °F for 48 hours	
Protection class (*VOTANO 100* / *VBO2*)	IP20 according to EN 60529	

13 User maintenance

13.1 Cleaning

✓ All connection cables and accessories are disconnected from the device.

▶ Clean the device and its accessories with a cloth dampened with isopropanol alcohol.

13.2 Replacing fuses on VOTANO 100

1. Turn off the *VOTANO 100* test set and unplug the power cord.
2. Disconnect the *VBO2* from *VOTANO 100*.
3. Locate the blown fuse on the side panel of *VOTANO 100* and replace it by an identical fuse type: T 6.3 AH 250 V (6.3 Amps slow-acting high breaking capacity wire fuse 5 × 20 mm). *VOTANO 100* has two fuses of the same type.

13.3 Calibrating VOTANO 100

The *VOTANO 100*/*VBO2* test system is factory calibrated prior to shipment using an ISO 17025 calibrated reference voltage transformer. To assure the accuracy of the measurement results, it is recommended to verify the calibration at least once per year using a calibrated voltage transformer. If the measurement results are not within the given limits, we recommend sending the *VOTANO 100* test set back to OMICRON for calibration (Support (page 196)).

14 Error and warning messages

Table 14-1: Error and warning messages

001	**001 Error [001] No valid VOTANO SW found. Insert a CF card with valid software and press <Update Firmw.>!**
	Reason: No valid software in flash memory (checksum not correct).
	Solution: Insert a Compact Flash card with valid software (VOTANO.bin) in the directory A:\Omicron and switch the device on and off.
002	**Error [002] Can't open file!**
	Reason: The firmware cannot read the file VOTANO.bin from the Compact Flash card because of missing Compact Flash card or missing file.
	Solution: Insert a Compact Flash card with valid software (VOTANO.bin) in the directory A:\Omicron and switch the device on and off.
003	**Error [003] Download error!**
	Reason: The downloaded software is corrupt.
	Solution: Insert a Compact Flash card with valid software (VOTANO.bin) in the directory A:\Omicron and switch the device on and off.
101.xxx	**Warning [101.xxx] License <...> is missing!**
	Reason: The license displayed with the error message is missing.
	Solution: A corresponding license is required to perform the desired test. If necessary, add the license. For up-to-date information about the licenses and packages available for *VOTANO 100* please refer to the OMICRON website (Support (page 196)).
102.xxx	**Warning [102.xxx] Expiration date for timed license is: <…>**
	Reason: A timed licenses will expire soon.
	Solution: Contact the OMICRON Technical Support (Support (page 196)) and renew the specified license.
150.xxx	**Warning [150.xxx] VT resistance > 3000 ohms.**
	Reason: The secondary winding resistance test determined a resistance > 3000 ohms.
	Solution: The test cannot be continued. Check the connections to the voltage transformer. If the connections are ok, the winding resistance is > 3000 ohms. Such voltage transformers cannot be tested with *VOTANO 100*.
151.xxx	**Warning [151.xxx] Timeout during measurement. No constant winding resistance can be determined within 3 min.**
	Reason: No constant secondary or primary winding resistance can be determined within 3 minutes.
	Solution: The test cannot be continued. Check the connections to the voltage transformer.
155.xxx	**Warning [155.xxx] Invalid eddy losses measurement.**
	Reason: The eddy losses cannot be determined reliably.
	Solution: Verify the wiring and repeat the test. If the error message is displayed repeatedly, testing this voltage transformer with *VOTANO 100* is currently not possible.

219.xxx **Warning [219.xxx] Remote connection lost. Test aborted!**

Reason: Connection to the computer aborted during remote controlled measurement.

Solution: Restore the connection to the computer and restart the measurement.

220.xxx **Warning [220.xxx] Test aborted!**

Reason: The test sequence was interrupted by the user.

Solution: Repeat the test without interrupting it.

221.xxx **Warning [221.xxx] Permanent data overflow.**

Reason: Internal data buffer overflow. Data from the internal data buffer were not fetched fast enough.

Solution: Try to repeat the measurement. If this error occurs more frequently, contact the OMICRON Technical Support (Support (page 196)).

222.xxx **Warning [222.xxx] Measurement timeout. The time allotted for a given measurement to complete was exceeded. Verify the connections and, if possible, reduce disturbance level.**

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.

230.xxx **Warning [230.xxx] Test timeout. The time allotted for the entire VT test to complete was exceeded. Verify the connections and, if possible, reduce disturbance level.**

Reason: The duration of a single test exceeds the maximum time of 20 minutes.

Solution: Check the wiring/connection and repeat the measurement.

251.xxx … 254.xxx **Warning [25x.xxx] Check VOTANO I/O wiring! ... (Completed by a detailed description of the I/O wiring error. Text may vary depending on the specific wiring error.)**

Reason: The wiring of the inputs and the output of *VOTANO 100* is not connected or not properly connected.

Solution: Check the input/output wiring of *VOTANO 100* and correct it, if necessary.

261.xxx … 270.xxx **Warning [2xx.xxx] Check VT wiring / Check CVT/CCVT wiring … (Completed by a detailed description of the voltage transformer wiring error. Text may vary depending on the specific wiring error.)**

Reason: The wiring of the voltage transformer under test is not connected or not properly connected.

Solution: Check the wiring of the voltage transformer under test and correct it, if necessary.

271.xxx … 274.xxx **Warning [27x.xxx] Check burden wiring! … (Completed by a detailed description of the burden wiring error. Text may vary depending on the specific wiring error.)**

Reason: The wiring of the burden(s) under test is not connected or not properly connected.

Solution: Check the wiring of the burden(s) under test and correct it, if necessary.

308.xxx **Warning [308.xxx] Please select at least one test for a VT measurement.**

Reason: No measurement card selected.

Solution: Select at least one of the following test cards: Short-Circuit Impedance, Secondary Winding Resistance, Excitation or Ratio.

309.xxx **Note [309.xxx] Specify all VT settings marked with <*>.**

Reason: At least one of the required settings is not defined.

Solution: Make sure that all required settings marked with a star '*' are defined.

401.xxx **Warning [401.xxx] VBO2 is disconnected! Ensure that VBO2 is powered. Check D-Sub interface between VOTANO 100 and VB02.**

Reason: No connection between *VOTANO 100* and *VBO2* or connection interrupted.

Solution: Restore the connection between *VOTANO 100* and *VBO2* and restart the measurement.

402.xxx **Warning [402.xxx] VBO2 communication timeout error.**

Reason: Communication between *VOTANO 100* and *VBO2* failed.

Solution: Restore the connection between *VOTANO 100* and *VBO2* and restart the measurement.

403.xxx **Warning [403.xxx] VBO2 communication error.**

Reason: Communication between *VOTANO 100* and *VBO2* failed.

Solution: Restore the connection between *VOTANO 100* and *VBO2* and restart the measurement.

404.xxx **Warning [404.xxx] Firmware download to VBO2 failed! Error: …**

Reason: *VBO2* firmware download failed.

Solution: Make sure that *VBO2* is connected properly to *VOTANO 100* and repeat the firmware download for *VBO2*.

405.xxx **Warning [405.xxx] Invalid calibration data of VBO2. Contact the technical support.**

Reason: *VBO2* contains invalid calibration data.

Solution: *VBO2* should be calibrated properly for use with *VOTANO 100*. Contact the OMICRON Technical Support (Support (page 196)).

406.xxx **Warning [406.xxx] SAB1 is disconnected from the VBO2 SAFETY D-Sub 9 connector.**

Reason: The *SAB1* safety box is not connected to the *VBO2* voltage booster.

Solution: Properly connect the *SAB1* safety box to *VBO2* and restart the measurement.

407.xxx **Warning [407.xxx] No PE connection detected. Check VOTANO and VBO2 power cords and your power supply and make sure that PE is connected. Read user documentation carefully.**
>>>Danger: Operating VOTANO or VBO2 without PE is life-threatening and not permitted!

Reason: *VBO2* is not connected to protective earth (PE).

Solution: Restore PE connection for *VBO2* and restart the measurement.

408.xxx **Warning [408.xxx] VBO2 temperature out of range!**

Reason: Overtemperature or undertemperature of *VBO2* detected.

Solution: Wait until *VBO2* has cooled down or warmed up and restart the measurement.

412.xxx **Warning [412.xxx] Overvoltage on the earthing end of primary winding detected. Ensure that earthing end of primary winding is grounded.**

Reason: The earthing end of the primary winding is possibly not connected to ground.

Solution: Ground this end of the primary winding and restart the measurement.

413.xxx **Warning [413.xxx] Overvoltage on VBO2 connector HV1 or HV2 detected.**

Reason: A voltage higher than the normal operating voltage was detected on connector HV1 or HV2 on *VBO2*.

Solution: Make sure that no external voltage sources are connected and restart the measurement.

414.xxx **Warning [414.xxx] VBO2 supply error.**

Reason: One of the *VBO2* supply voltages is outside the defined range.

Solution: Check the *VBO2* supply voltage and restart the measurement.

415.xxx **Warning [415.xxx] SAB1 safety circuit error.**

Reason: The voltage from the safety circuit is outside the defined range.

Solution: Restart the measurement. If this error occurs more frequently, you should contact the OMICRON Technical Support (Support (page 196)).

416.xxx **Warning [416.xxx] SAB1 start button error.**

Reason: The voltage from the start button on the *SAB1* is outside the defined range.

Solution: Restart the measurement. If this error occurs more frequently, you should contact the OMICRON Technical Support (Support (page 196)).

417.xxx **Warning [417.xxx] SAB1 emergency stop button error.**

Reason: The voltage from the emergency stop button on *SAB1* is outside the defined range.

Solution: Restart the measurement. If this error occurs more frequently, you should contact the OMICRON Technical Support (Support (page 196)).

418.xxx **Warning [418.xxx] VBO2 PE error.**

Reason: The voltage measured in the protective earth circuit of VBO2 is outside the defined range.

Solution: Restart the measurement. If this error occurs more frequently, you should contact the OMICRON Technical Support (Support (page 196)).

419.xxx **Warning [419.xxx] SAB1 emergency stop button pressed.**

Reason: The emergency stop button on *SAB1* is actuated.

Solution: Release the emergency stop button on *SAB1* and restart the measurement.

420.xxx **Warning [420.xxx] VBO2 current limit is reached!**

Reason: Overcurrent in *VBO2* detected.

Solution: Make sure that the *VBO2* high-voltage output is not short-circuited.

421.xxx **Warning [421.xxx] VBO2 HW sequence error.**

Reason: *VBO2* hardware sequence cannot be executed.

Solution: Make sure that the N terminal of the asset is grounded.

501.xxx **No message displayed on VOTANO 100. Message only displayed on remote PC connected to VOTANO 100.**

Reason: The remote interface handler couldn't decipher the command.

Solution: Remote interface error. Check the connection between *VOTANO 100* and PC.

504.xxx **No message displayed on VOTANO 100. Message only displayed on remote PC connected to VOTANO 100.**

Reason: Data transmission error.

Solution: Check the connection between *VOTANO 100* and PC.

505.xxx **No message displayed on VOTANO 100. Message only displayed on remote PC connected to VOTANO 100.**

Reason: Data transmission error.

Solution: Check the connection between *VOTANO 100* and PC.

510.xxx **No message displayed on VOTANO 100. Message only displayed on remote PC connected to VOTANO 100.**

Reason: Failed to get the required measurement data because the measurement is still running.

Solution: Check the connection between *VOTANO 100* and PC.

511.xxx **No message displayed on VOTANO 100. Message only displayed on remote PC connected to VOTANO 100.**

Reason: Remote interface error: Failed to unzip the transmitted data block.

Solution: Check the connection between *VOTANO 100* and PC.

513.xxx **No message displayed on VOTANO 100. Message only displayed on remote PC connected to VOTANO 100.**

Reason: The current remote interface command is not allowed.

Solution: Make sure that the current *VOTANO 100* state allows the execution of the command.

514.xxx **No message displayed on VOTANO 100. Message only displayed on remote PC connected to VOTANO 100.**

Reason: Remote interface error: Remote command was submitted with an invalid parameter.

Solution: Verify the parameter (index) submitted with the remote interface command.

530.xxx **Warning [530.xxx] VOTANO PC software and firmware versions are incompatible.**

Reason: Version conflict between *VOTANO Suite* PC software and *VOTANO 100* firmware.

Solution: Update the firmware of your *VOTANO 100* test set to the version of the *VOTANO Suite* software using the Device update feature of *VOTANO Suite* or the **Update Firmware** function of *VOTANO 100* (Main Menu → Tools → Update Firmware).

564.xxx **No message displayed on VOTANO 100. Message only displayed on remote PC connected to VOTANO 100.**

Reason: The size of the file copied to the *VOTANO 100* Compact Flash card or virtual disc is > 1 MB.

Solution: Avoid transfer of large files (> 1 MB) to *VOTANO 100*.

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 backup the data to a PC and format the Compact Flash 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 *VOTANO 100*.

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. Card full.**

Reason: The file system sent an error message.

Solution: Delete some files on the Compact Flash card or insert a new Compact Flash card.

805.xxx **Warning [805.xxx] Flash card access error. No or corrupt flash card.**

Reason: No or no valid Compact Flash 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 *VOTANO 100*.

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 already 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.

814.xxx **Note [814.xxx] Invalid user text! You must download at least version : xxx or higher. The language is set to English.**

Reason: The user text file is not compatible with the installed firmware version.

Solution: Update the user texts with a file that is compatible to the installed firmware version (shown in error message).

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.

818.xxx **Warning [818.xxx] Moving of folders not supported.**

Reason: Moving of folders is not supported by *VOTANO 100*.

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 technical support if this error occurs often.**

Reason: Memory management error.

Solution: Switch *VOTANO 100* off, wait a second, and then switch it on again. If this error occurs more frequently, you should contact the OMICRON Technical Support (Support (page 196)).

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 (VOTANO.bin) in the directory A:\Omicron\ and switch *VOTANO 100* off and on again.

823.xxx **Error [823.xxx] Could not update user text!**

Reason: An error has occurred in the boot loader software.

Solution: Insert a Compact Flash card with valid software (VTUser_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 technical support.**

Reason: Invalid result in a floating point operation (NaN).

Solution: Contact the OMICRON Technical Support (Support (page 196)).

826.xxx **Error [826.xxx] Invalid firmware update file!**

Reason: You tried to perform a firmware update using a wrong firmware file (for example, not an VOTANO.bin file).

Solution: Insert a Compact Flash card with a valid firmware update file (VOTANO.bin) in the directory A:\Omicron\ and try again.

827.xxx **Error [827.xxx] Firmware downgrade blocked. Please contact technical support.**

Reason: Downgrade to versions < 2.20 is blocked if timed licenses are installed on *VOTANO 100*.

Solution: Contact the OMICRON Technical Support (Support (page 196)).

829.xxx **Error [829.xxx] Different expiry dates! All installed timed licenses will be removed first.**

Reason: The license file contains timed licenses with a different expiry date than the timed licenses currently installed on *VOTANO 100*.

Solution: Select to overwrite the existing timed licenses available on *VOTANO 100* with the timed licenses available in the license file or cancel the license update process.

830.xxx **License < … > is invalid.**

Reason: An invalid license entry was found in the license file Omicron.lic on the Compact Flash Card.

Solution: Specify a valid license key.

831.xxx **Error [831.xxx] Timed license update rejected!**

Reason: An invalid timed license entry was found in the "Omicron.lic" license file on the Compact Flash card.

Solution: Apply a valid license key.

832.000 **Lifetime of relays near end. Contact the technical support soon to arrange a hardware service.**

Reason: The relays inside *VOTANO 100* near the end of their lifetime (more than 1,000,000 measurements performed).

Solution: Arrange a hardware service in order to replace the relays (Support (page 196)).

833.000 **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.

834.000 **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 *VOTANO 100*.

835.000 **VOTANO-Report file error.**

Reason: Invalid xml report file.

Solution: Load only valid *VOTANO 100* reports.

836.000 **Xml file is not a valid VOTANO Report.**

Reason: Invalid xml report.

Solution: Load only valid *VOTANO 100* reports.

837.000 **Xml-Report: Node <%s> not found.**

Reason: Missing xml report node.

Solution: Load only valid *VOTANO 100* reports.

838.000 **Simulated file loaded for measurement. Results will be cleared.**

Reason: Licenses mismatch between *VOTANO 100* and simulation file.

Solution: Check the simulation file or add a corresponding license on *VOTANO 100*.

850.000 **Cannot set time! Time difference is limited to ± 31 days. Current real time: …**

Reason: The difference between the RTC real time and the system time of *VOTANO 100* is bigger than 31 days.

Solution: Use another system time on *VOTANO 100* or contact the OMICRON Technical Support (Support (page 196)).

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 *VOTANO 100* off, wait 1 minute and then switch it on again. If this error occurs more frequently, contact the OMICRON Technical Support (Support (page 196)).

901.xxx **Warning [901.xxx] No PE connection detected. Check VOTANO and VBO2 power cords and your power supply and make sure that PE is connected. Read user documentation carefully. >>>Danger: Operating VOTANO or VBO2 without PE is life-threatening and not permitted!**

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 *VOTANO 100* to PE.

⚠ WARNING

Death or severe injury caused by high voltage or current possible

- Do not use *VOTANO 100* without a solid connection to protective earth (PE). Lethal voltages may occur at the housing if the grounding terminal of the device is not connected to protective earth potential.
- Always connect the grounding terminals of *VOTANO 100* and *VBO2* to protective earth (PE) using a solid connection of at least 6 mm^2.

NOTICE

Equipment damage or loss of data possible

- ▶ Do not use *VOTANO 100* with a mains supply that is galvanically isolated from earth potential. This could damage the device.
- ▶ Only use *VOTANO 100* with a mains supply that is galvanically connected to PE.

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 guaranteed!** Therefore, always use a mains power cord with a protective earthing conductor connected to PE of the mains supply. Connect the grounding terminal of the device to protective earth in order to prevent electric shock caused by lethal voltages possibly present at the housing. If the error is ignored, the device can be used but safety is no longer given.

Table 14-2: Error and warning messages (cont.)

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 *VOTANO 100*. *VOTANO 100* discharges the connected inductor with approximately 20 Ws, but depending on the connected inductance the discharge process may take some time.
	Safety action:	All measurements are stopped until reverse power is dissipated. The beeper indicates this state by an intermittent beep (1 s interval).

⚠ WARNING

Death or severe injury caused by high voltage or current possible

- ▶ Do not disconnect any wires and do not switch off *VOTANO 100* while this message is displayed. Lethal voltages of up to many kV can occur otherwise.
- ▶ Wait until the power is dissipated and the message disappeared.

Table 14-3: Error and warning messages (cont.)

904.xxx	**Error [904.xxx] Power supply error. Contact the technical support.**	
	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 the OMICRON Technical Support (Support (page 196)).
	Safety action:	All measurements are stopped.

905.xxx **Error [905.xxx] Excess temperature in power supply. Wait until device has cooled down.**

Reason: The secondary side power supply has reached the warning temperature limit and entered the 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.

Note: 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 the 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.

Note: 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 OMICRON Technical Support (Support (page 196)) if the error does not disappear.

911.xxx **Error [911.xxx] Power supply error. Contact the technical support. Desired voltage xxxx, measured voltage yyyy.**

Reason: A supply voltage on the measurement interface board is out of tolerance.

Solution: Contact the OMICRON Technical Support (Support (page 196)).

Note: Working with the device is no longer possible.

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 the OMICRON Technical Support (Support (page 196)).

Note: 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 the technical support.**

Reason: The circuit for reverse power dissipation does not work properly.

Solution: Contact the OMICRON Technical Support (Support (page 196)).

Safety action: All measurements are stopped, and the power supply is switched off.

930.xxx **Error [930.xxx] Measurement input 1 defective. Contact the technical support.**

Reason: Power supply for analog input INPUT 1 on *VOTANO 100* is defective.

Solution: Contact the OMICRON Technical Support (Support (page 196)).

931.xxx **Error [931.xxx] Measurement input 2 defective. Contact the technical support.**

Reason: Power supply for analog input INPUT 2 on *VOTANO 100* is defective.

Solution: Contact the OMICRON Technical Support (Support (page 196)).

932.xxx **Error [932.xxx] Data error.**

Reason: The sequence for reading the analog input channels is not correct.

Solution: If this error occurs more frequently, contact the OMICRON Technical Support (Support (page 196)).

933.xxx **Error [933.xxx] Hardware failure. Contact the technical support.**

Reason: The temperature detection circuit on secondary side is defective.

Solution: Contact the OMICRON Technical Support (Support (page 196)).

Safety action: All measurements are stopped, and the power supply is switched off.

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. The beeper indicates this state by an intermittent beep (1 s interval).

935.xxx **Error [935.xxx] No valid VOTANO software. Insert a CF card with valid software and press "Update Firmw.".**

Note: This text is displayed in English only. If applicable, the error text is displayed during startup, when user texts are not yet available.

Reason: Cannot load the user interface texts of the firmware from the flash memory.

Solution: Insert a Compact Flash card with valid software (VOTANO.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 to 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 the OMICRON Technical Support (Support (page 196)).

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 the OMICRON Technical Support (Support (page 196)).

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 the OMICRON Technical Support (Support (page 196)).

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 the OMICRON Technical Support (Support (page 196)).

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 the technical support.**

Reason: Factory calibration data block for voltage inputs corrupt.

Solution: Contact the OMICRON Technical Support (Support (page 196)).

942.xxx **Error [942.xxx] Corrupt factory calibration data for power unit. Contact the technical support.**

Reason: Factory calibration data corrupt.

Solution: Contact the OMICRON Technical Support (Support (page 196)).

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

Reason: Factory calibration data cannot be restored.

Solution: Contact the OMICRON Technical Support (Support (page 196)).

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 text is invalid.

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

945.xxx **Warning [945.xxx] Corrupt or missing phase calibration data for power unit. Contact the technical support.**

Reason: The factory calibration data cannot be restored.

Solution: Contact the OMICRON Technical Support (Support (page 196)).

Support

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