NDB TECHNOLOGIES INC.

CTT series - Current Transformer Tester

MU016-GEN-ENG Version 5.1

CTT Series User Manual

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1. Contact Us

Phone	1 (418) 877-7701
Address	1405 St-Jean-Baptiste Avenue, suite 111 Quebec, QC G2E 5K2 Canada
Web Site	www.ndbtech.com
Technical Support	1 (418) 877-7701 9AM to 4PM, Eastern Time (GMT -5) Email: support@ndbtech.com

2. Safety Warnings

Follow all the safety rules to avoid dangerous electric shocks. Only properly trained personnel should use the CTT. Safety is the responsibility of the user.

- Heed all safety warnings and operating instructions before using the CTT.
- Keep this user manual for future reference.
- Follow all operating instructions.

2.1 Safety Symbols

Hazard symbol referring to the instruction manual: The product is marked with this symbol when it is necessary for the user to refer to the user manual in order to protect himself against personal injury or to protect against damage to the product.

The hazardous high voltage symbol alerts the user of the presence of an uninsulated voltage with enough magnitude to produce an electric shock.

2.2 Safety Precautions

- Stand clear of all parts of the high-voltage circuit, including all connections, unless the device under test is de-energized.
- CTT assembly and live line tool adapters shall be considered non-insulating.
- Keep other people away from test activities with barricades or warnings.
- Treat all terminals of high-voltage power equipment as potential electric shock hazards. Voltages may be induced at these terminals because of proximity to energized high-voltage lines or equipment.
- Do not use the CTT in an area with risks of explosion.
- Wearing rubber gloves is recommended as a routine safety precaution whenever working with the test set.

- Maintenance must be performed by qualified personnel who is familiar with the instrument maintenance, operation and involved hazards. This equipment should be used only by qualified employees, trained in and familiar with the local applicable safety-related work practices, safety rules and other safety requirements associated with the use of this type of equipment.
- These instructions are not intended as a substitute for appropriate work practice training, nor do they cover all details or situations which could be encountered when operating this type of equipment.
- A failure to respect safety precautions could permanently damage the instrument, cause injuries or death.
- Even with all efforts invested in making a safe instrument, it is not possible to remove all potential injury or death risks regarding the use and/or maintenance of this equipment. Also risks of electrocution is inherent in or around high voltage environments and these risks cannot be controlled by ndb Technologies.
- Safety is the user's responsibility. In no event shall ndb Technologies be liable for any direct, indirect, punitive, incidental, special consequential damages, to property or life, whatsoever arising out of or connected with the use or misuse of it's products.
- Use genuine ndb Technologies accessories to ensure system safety and reliable operation. The use of other parts is not permitted and invalidates the warranty.
- Avoid hitting, throwing, crushing, puncturing or bending the instrument.
- Avoid using the CTT in salt fog environments.

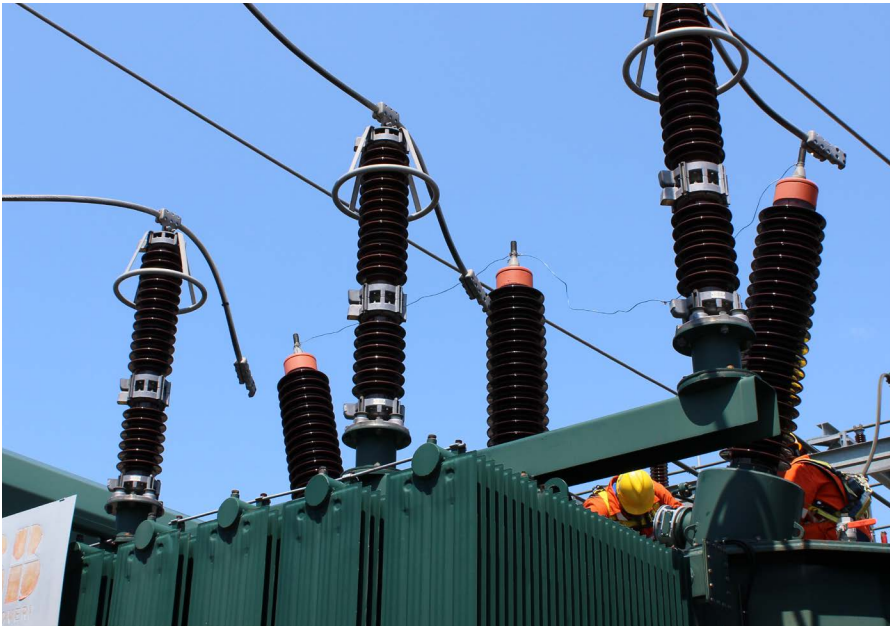
- Do not attempt to disassemble the device or its accessories. Only qualified personnel can perform maintenance.
- Prior to using the CTT, a careful inspection should be made to ensure the unit is free from any contaminants and that there are no apparent physical damages.
- Do not use the device while driving.
- Do not place the device or its accessories in containers with a strong electromagnetic field.
- Do not use the device in an environment with flammable gas, such as a gas station, or put the device in a high temperature place.
- The CTT's internal circuits are set from the factory for either 115V or 230V input voltage and cannot be changed. Therefore, it is important to keep the fuse socket orientation as set by the factory and only use the proper input voltage. Using improper voltage can permanently damage the instrument.
- Keep the device and its accessories away from children.
- High-voltage discharges and strong electric or magnetic fields may interfere with heart pacemakers. If you have a pacemaker, obtain medical advice on the possible risks before getting close to the energized test set.
- The ground connection must be the first made and the last removed.
- Never connect the CTT to energized equipment/transformer.
- Never disconnect the test leads while performing a test.
- Always disconnect test leads from the power equipment before disconnecting them at the test set.
- To remove the test clamps from the transformer’s terminals after a completed test, it is strongly recommended not pull on the cables themselves. Pulling the cables can possibly weaken the internal structure of the cable and cause intermittent readings. Instead, it is recommended to remove the cable by opening the clamps first.

3. Introduction

The CTTx5 and CTTx2 are designed to efficiently perform current transformer testing. The CTT design is focused on providing the results required for commissioning and maintenance of protection class CT's.

Protection class CT's are designed to provide proportional current signal outputs even when sensing large fault type currents. These proportional signals are what the protection relays will require to ensure reliable operation. The CTT performs the following tests: CT excitation voltages and knee points, turns ratio and error %, polarity, phase angle, winding resistance, insulation resistance and also measure the CT's load burden (Ohms/VA). The knee point voltages are calculated for ANSI 10/50, IEEE-30 and IEEE-45.

The CTTx5 differs from the CTTx2 in that it has X1, X2, X3, X4 and X5 test terminals whereas the CTTx2 has X1 and X2 terminals. The CTTx5 provides convenient arrangement for testing any of the 10 possible combinations of a multi ratio current transformer X1 to X5. Up to 10 set of tests can be stored in one test file.



4. Material

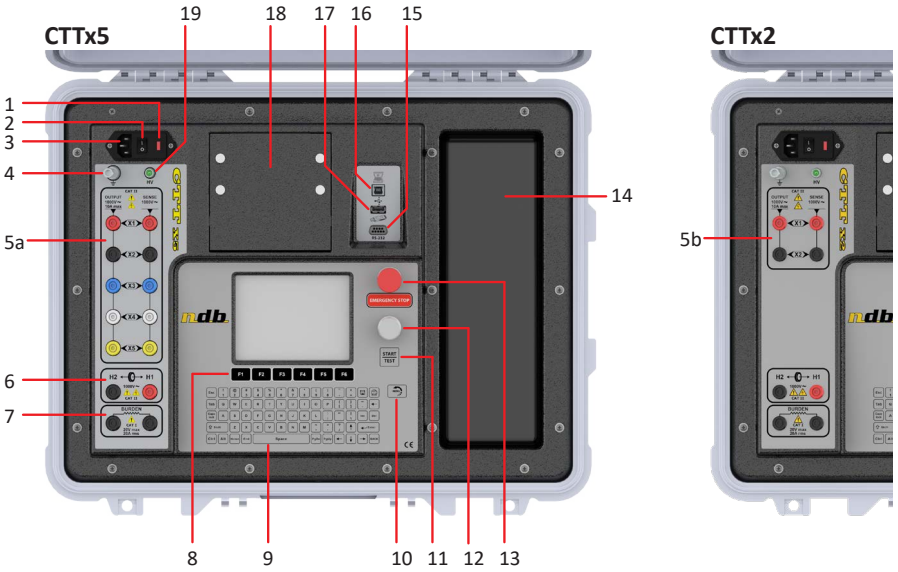
This section shows the CTT instruments and their accessories.

Item	Part number	Description	Illustration
1	CTTx5	Five tap current transformer tester. Configured for either 120V or 240V (cannot be changed).	
2	CTTx2	Two tap current transformer tester. Configured for either 120V or 240V (cannot be changed).	
3	CTT-VX2	Two tap secondary lead. For CTTx2 only.	
4	CTT-VX5 CTT-VX5-35S	Standard secondary lead 6m (20ft) Shielded secondary lead 10.6m (35ft) For CTTx5 only.	
5	CTT-VH1 CTT-VH1-50 CTT-VH1-35s CTT-VH1-50s	Standard VH1 cable 10.6m (35ft) Standard VH1 cable 15.2m (50ft) Shielded VH1 cable 10.6m (35ft) Shielded VH1 cable 15.2m (50ft)	
6	CTT-BURDEN	Burden test lead 5.5m (18ft)	
7	NDB-GND-P	Ground cable 4.5m (15ft)	

8	ACC-054	USB 2.0 A Male to B Male 28/24AWG Cable	
9	ACC-009	DB9 cable male to female 3m (10ft)	
10	ACC-074	4GB USB key drive	
11	NDB-10	Nylon bag for cable set 56 x 41 cm (22 x 16 inches)	
12	PAP-004	Thermal paper roll for built-in printer	
13	WIR-X-012 or WIR-X-036	Power cord WIR-X-012: Euro WIR-X-036: North America	
14	MU016	User manual Download here: https://www.ndbtech.com/downloads/SubstationMaintenance/CTT/	
15	N/a	Calibration report	
16	Report Manager	Download here: https://www.ndbtech.com/downloads/SubstationMaintenance/CTT/	

5. Overview

This section describes the CTTx5 and CTTx2 interface.



1. **Fuse socket***: Contains the main fuse. ⚠ The fuse socket must stay in the orientation set by the factory.

2. **Power switch**: Turns on or off the instrument.

3. **Power input***: Connect to a proper AC source. Only use a non-noisy power source. Lower quality gasoline power generators can induce high levels of noise which can affect measurement accuracy.

4. **Ground post**: Before connecting the CTT instrument to any other cable/ equipment, make sure the ground post is earthed properly using the provided ground cable.

⚠ ***Note**: The CTT's internal circuits are set from the factory for either 115V or 230V input voltage and cannot be changed. Therefore, it is important to keep the fuse socket orientation as set by the factory and only use the proper input voltage. Using improper voltage can permanently damage the instrument.

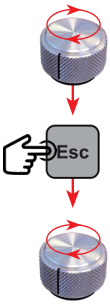
5. **Secondary terminals**: The secondary (X) terminals will apply a voltage to the secondary side of the CT under test and will sense the resulting voltage. Secondary terminals configuration is the main difference between the CTTx5 and CTTx2 models:
    a. **CTTx5 model**: X1, X2, X3, X4 and X5 terminals. Allows to perform tests on up to five taps CTs.
    b. **CTTx2 model**: X1 and X2 terminals. Allows to perform tests on two taps CTs.
6. **Primary terminals**: The primary terminals (H) are connected to the primary side of the current transformer under test and will measure induced voltage.
7. **Burden terminals**: The burden terminals are used as an AC current source to perform CT load burden test.
8. **Task bar buttons**: Press to navigate between the different tabs.
9. **Keypad**: Allows to configure test plans, edit names, write notes, print reports, select test modes, save data, change menus, etc..
10. **Menu key**: Allows to access the control panel of the CTT.
11. **Start Test key**: Allows to start or stop a test.
12. **Navigation knob**: Rotate clockwise or counter clockwise allows to navigate the menus. Pressing the knob allows to select a field or accept a selection. The knob is used to control the voltage output when performing CT testing in manual mode, and current output when performing CT load burden test.
13. **Emergency stop button**: Shuts down the high voltage output of the device in case of an emergency. Rotate clockwise to release.
14. **Storage bin**: Store accessories.
15. **RS232 communication port**: Allows for transferring test data to a computer.
16. **USB-B communication port**: Allows for transferring test data to a computer.
17. **USB-A communication port**: Allows for transferring test data on a USB memory stick.
18. **Thermal printer**: Allows to print test reports.
19. **High voltage indicator**: Turns on when the CTT is applying a voltage to a CT under test.

6. Navigation

6.1 Navigation Knob

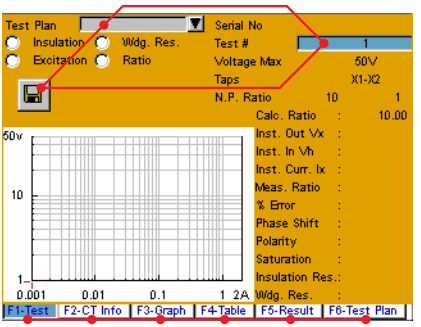
1. **Main screen loop**: Rotate the knob to toggle between the save button, test plan, drop down menu and test number selection field.

2. **ESC key**: Press the ESC key to switch to the tabs loop.



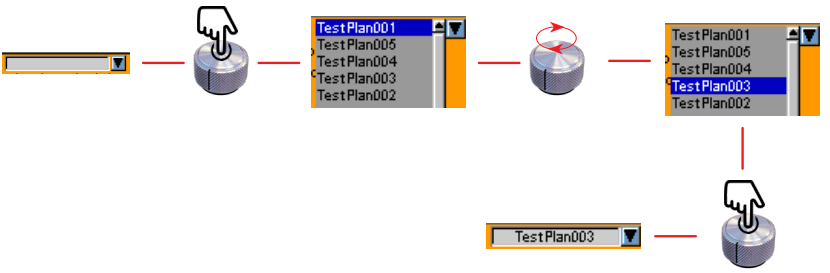
Main screen loop

Tabs loop



3. **Tabs loop**: Rotate the knob to toggle between the tabs 1 to 6 (1 to 5 for CTTx2).

4. Press the knob to either edit a field or open a drop-down menu. Rotate the knob to highlight an item from the drop-down menu and then press it to select the item.



6.2 Shortcuts

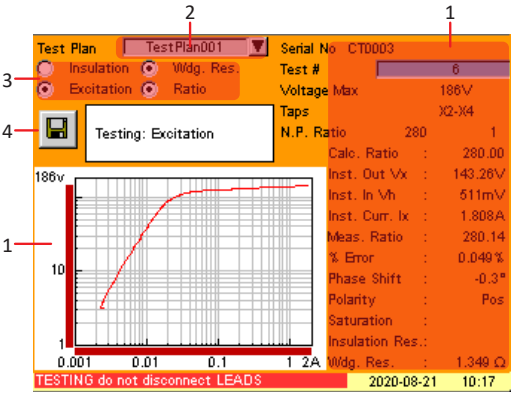
- Activate the manual mode: Hold the *Ctrl* key and press the *M* key.
- Activate the burden mode: Hold the *Ctrl* key and press the *B* key.
- Activate the automatic mode: Hold the *Ctrl* key and press the *A* key.

7. User Interface Overview

7.1 Tabs Overview

7.1.1 F1-Test tab (CTTx5 only)

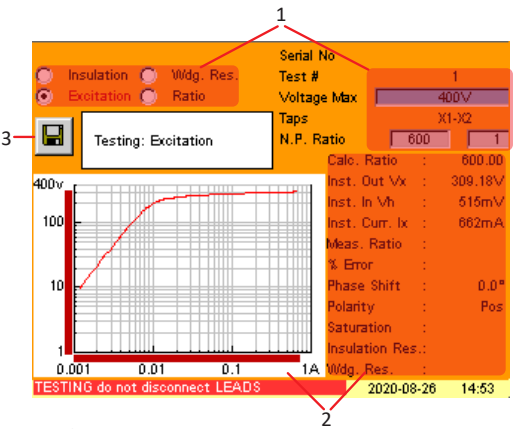
The *F1-Test* tab found on the CTTx5 is where all tests (in automatic mode) will be performed. The operator will select an existing test plan from the list, start the test, consult results as the sequence progresses and finally save to memory.



1. Displays information of the CT under test along with live tests values including saturation graph.
2. List of available test plans.
3. Tests to be performed are checked. The test being performed will flash in red.
4. Saves all tests results to memory. ! Note the *F2-CT Info* tab must be filled prior saving (serial number of the device under test is mandatory).

7.1.2 F1-Test tab (CTTx2 only)

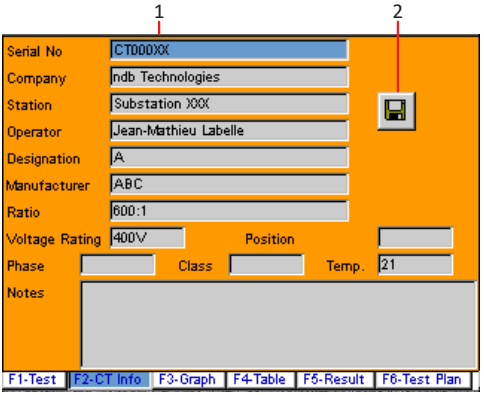
The *F1-Test* tab found on the CTTx2 is where all tests (in automatic mode) will be performed. The operator will configure test parameters, start a test, consult results as the sequence progresses and finally save to memory.



1. Test parameters: (Left) check the test(s) to be performed, (right) type the max test voltage and name plate ratio.
2. Live tests values including saturation graph.
3. Saves all tests results to memory. ! Note the *F2-CT Info* tab must be filled prior saving (serial number of the device under test is mandatory).

7.1.3 F2-CT Info tab

The *F2-CT Info* tab is where the operator fills in the CT's information. Note the serial number field is mandatory prior saving a measurement.

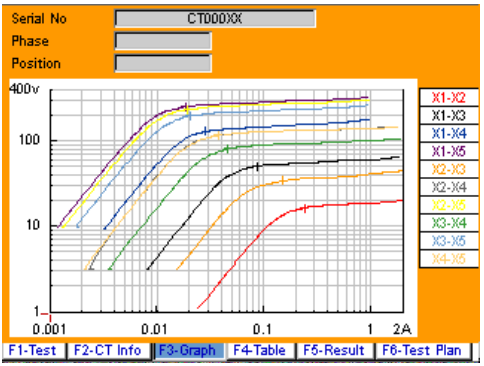


1. Type in all appropriate information about the CT to be tested.

2. Saves all tests results to memory. The *Serial No* field is mandatory prior saving. This save button serves the same function as the one found on tab *F1-Test.*

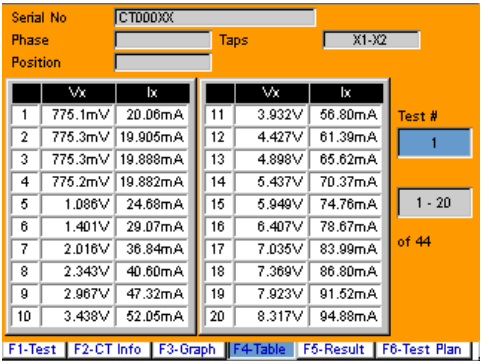
7.1.4 F3-Graph tab

The *F3-Graph* tab displays saturation curves for every ratio combination of a completed test. Serial number, phase and position informations are copied from the *F2-CT Info* tab.



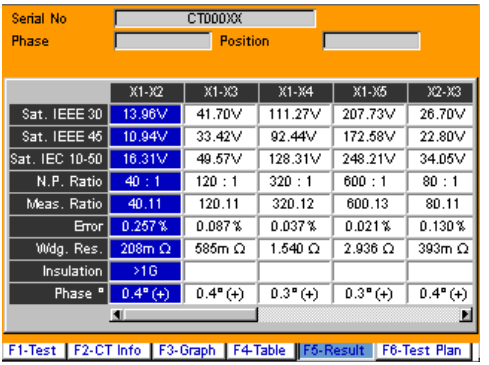
7.1.5 F4-Table tab

The *F4-Table* tab displays every measurement sample (voltage and current) taken while performing the saturation test, for every ratio combination. Serial number, phase and position informations are copied from the *F2-CT Info* tab.



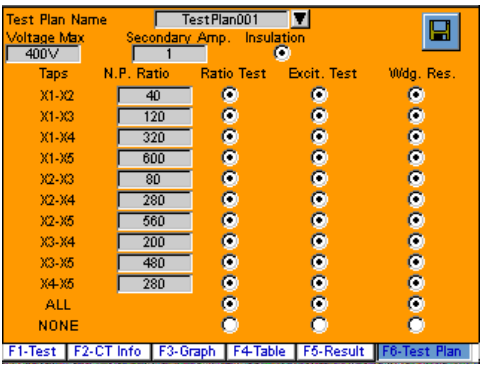
7.1.6 F5-Result tab

The *F5-Result* tab displays every test results of a completed test in a single page. Rotate the knob to scroll.



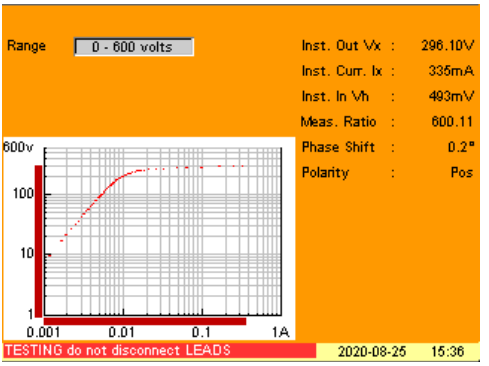
7.1.7 F6-Test Plan tab (CTTx5 only)

The *F6-Test Plan* tab (CTTx5 only) is where a test plan is created prior to testing a CT in automatic mode. The test plan can be saved in memory and recalled later on. Refer to section 8.2.3 for more information on how to create a test plan.



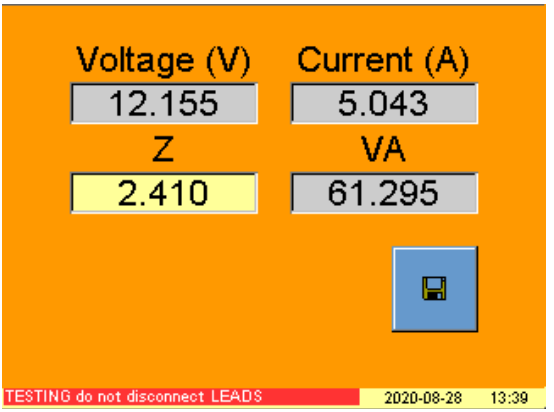
7.1.8 Manual Mode Tab Overview

The CTTx5 and CTTx2 features a manual mode which is helpful for quick CT testing that do not require to be saved, exported or printed. The manual mode is also very useful for CT diagnostic purposes. Refer to section 8.1 for more information on how to operate the manual mode.



7.1.9 Burden Mode Tab Overview (CTTx5 and CTTx2)

The CTTx5 and CTTx2 features a CT load burden (Ohms/VA) mode. Refer to section 8.3 for more information on how to operate the burden mode.



7.2 Configuration Menu Overview

The configuration menu regroups all the parameters of the CTT instrument along with its data exportation and file management features.

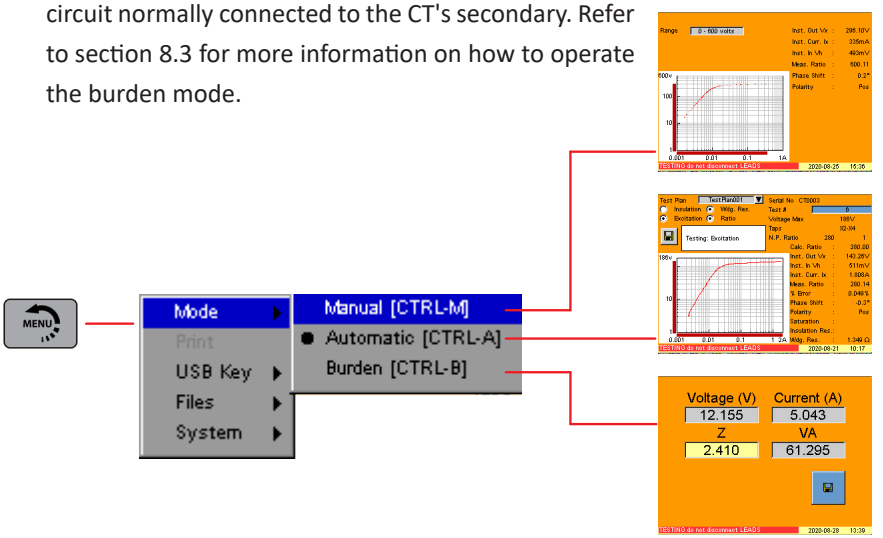
7.2.1 Menu - Operation Mode

The CTTx5 and CTTx2 can be configured in one of the three available modes:

- **Manual Mode**: Helpful for quick CT test that doesn't require to be saved, exported or printed. The manual mode is also very useful for CT diagnostic purposes. Refer to section 8.1 for more information on how to operate the manual mode.

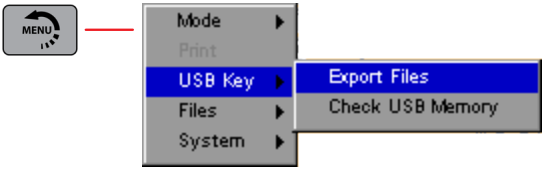
- **Automatic Mode**: Prior going on site, the operator has the possibility to create complete test plans for every CT configuration. A test plan can then be used to test same-spec CTs found in a power transformer for example. When selected, the automatic mode will perform all selected tests (insulation, winding resistance, saturation curves, ratio, polarity and phase shift) on a given CT. The operator can then annotate the CT information and save the report to memory. Refer to section 8.2 for more information on how to operate the automatic mode.

- **Burden Mode**: The burden mode allows to measure the impedance of the circuit normally connected to the CT's secondary. Refer to section 8.3 for more information on how to operate the burden mode.



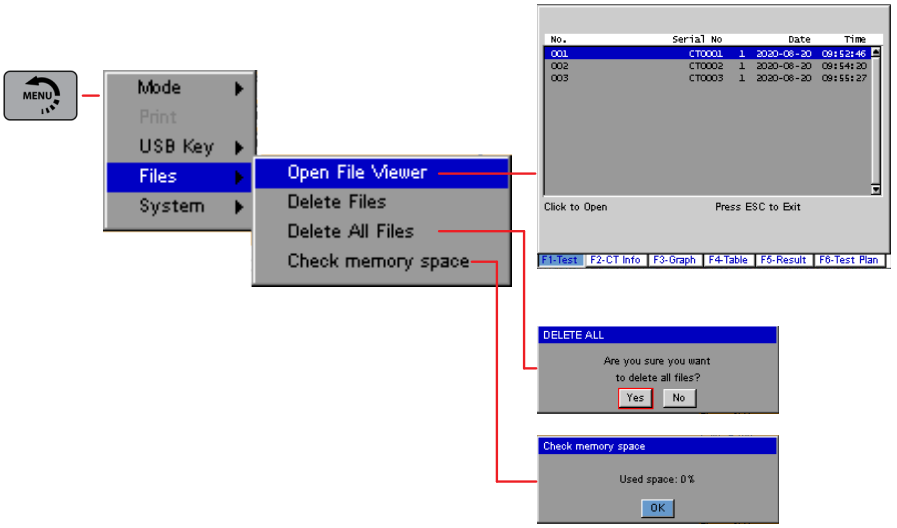
7.2.2 Menu - USB Key

- The CTTx5 and CTTx2 can export test data on a USB key. Not all keys are compatible. Use the *Check USB Memory* feature to validate the compatibility of a USB key. When selected, the *Export Files* feature will copy/paste (and not cut/paste) the files. Refer to section 10.2.3 for more information on how to export test data to a computer.



7.2.3 Menu - Files

- The CTTx5 and CTTx2 allows for management of the saved test records. The operator is able to open and review a test record, delete a record, delete all records and check the percentage of used space.



7.2.4 Menu - System

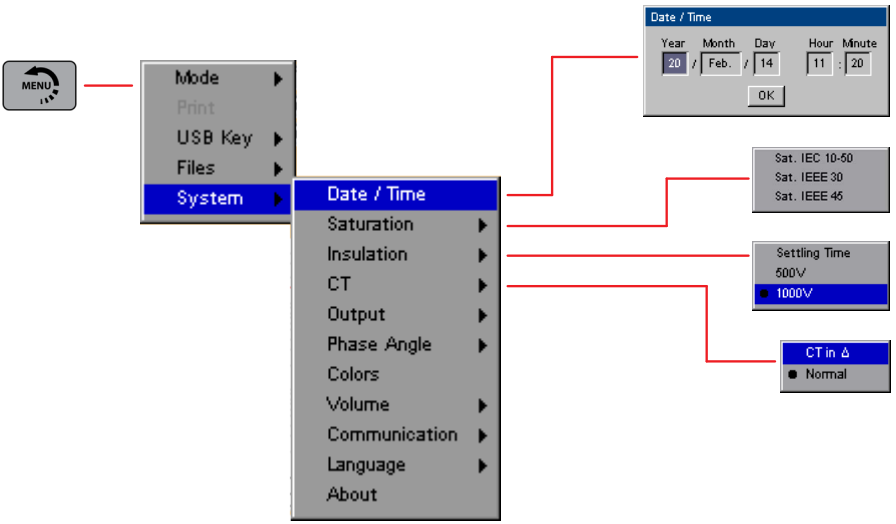
The system menu contains all CTT parameters.

- **Date/Time**: Set the time and date. Time and date will be used to time-stamp a test records when it is saved to memory.

- **Saturation**: The saturation's knee point is the point on the magnetization curve where a 10% increase in flux density (voltage) causes a 50% increase in magnetization force (current) (ANSI / IEC 10/50). The saturation knee point is one of the main health indicators of a CT since it reflects its structural integrity. A drop in the saturation knee point can indicate a deterioration in the material of its core (delamination, cracking, etc...) or a defect in the winding (short-circuit). Several defects arising in a CT can be detected by analyzing the trend of the saturation knee point over time. To ensure that the trend is reliable, the saturation knee point measurements must be constantly accurate. The IEEE 45 and 30 definitions apply to class "C" CTs and refer to the point on the saturation curve where the tangent is 45° (or 30°) from the abyss.

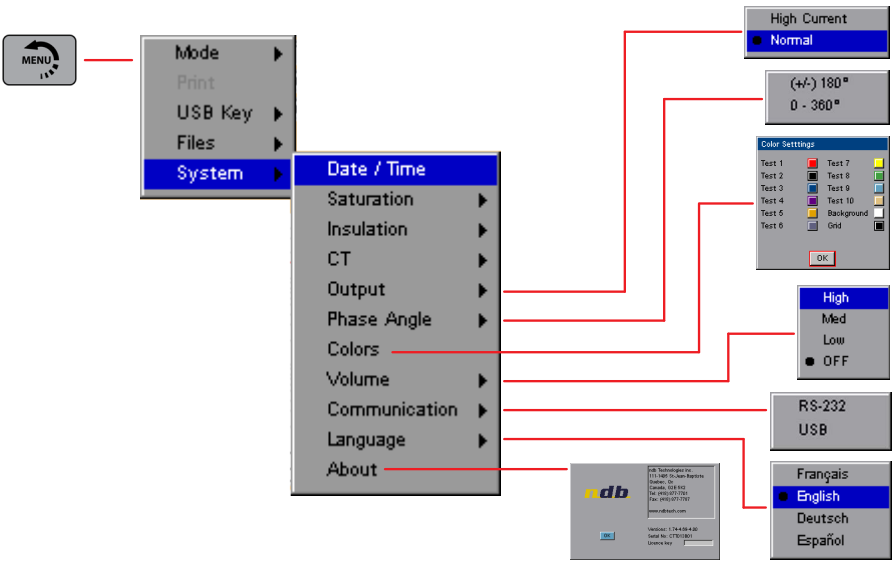
- **Insulation**: Allows to select the insulation test voltage, as well as the stabilization time.

- **CT**: Select "Normal" for any CT not buried in a delta type transformer. Select "CT in Delta" for any CT in series with a winding of a delta type transformer (buried). Error compensation will be applied to correct the reading. Refer to section 9.2 for more details.



7.2.5 Menu - System

- **Output**: Selection of the test output power: Normal or High. For the vast majority of tests, the saturation levels are less than 300mA and by default the *Normal* selection is entirely appropriate. Selecting high current provides higher current for the same saturation voltage levels. The CTT is thus used to the maximum of its capacity. This use should be temporary and not the norm. The *High Current* duty cycle is 5 min on, 5 min off.
- **Phase Angle**: Select the desired phase display between: ±180° and 0-360°
- **Colors**: Select the preferred color for the different saturation curves.
- **Volume**: The CTT will emit an audible warning to alert the operator that the high voltage tests are in progress. Adjust the volume to your preference.
- **Communication**: Data export to a computer can be performed using a USB key, DB9 (RS232) cable or USB cable. Prior to perform data transfer with the DB9 or USB cable, the correct communication must be selected.
- **Language**: Select the preferred language.
- **About**: Displays information of ndb Technologies, software version and the instrument serial number. The factory reset is also performed from the about menu, refer to section 11.4.



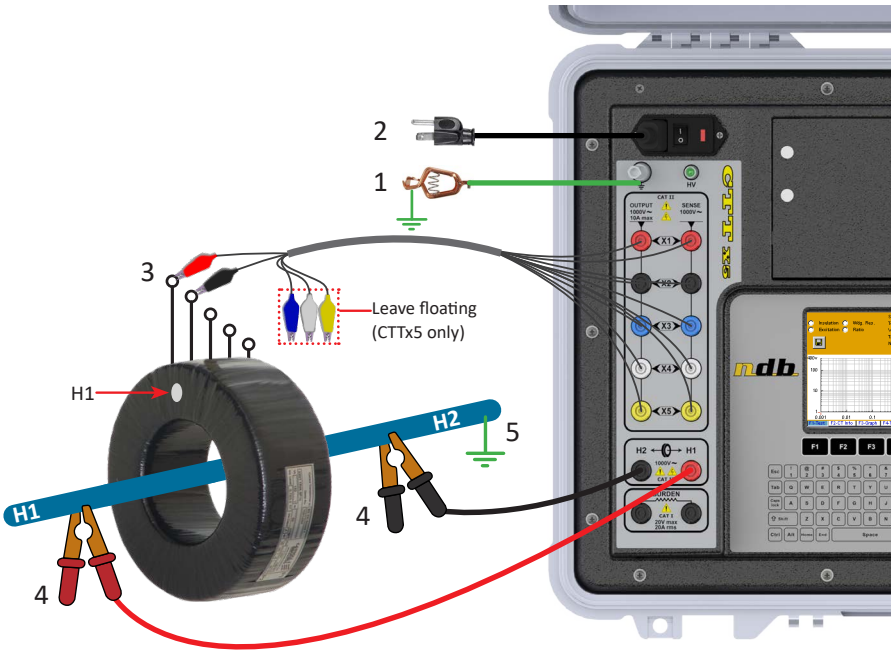
8. Operation

8.1 Manual Mode Operation

This section explains how to operate the CTTx5 and CTTx2 in manual mode. It is assumed the CT under test is not installed in a power transformer, circuit breaker or any other larger system.

8.1.1 Connections

1. Before connecting the CTT instrument to any other cable/equipment, make sure the ground post is earthed properly using the provided ground cable.
2. Connect the CTT to a power source and then turn on the instrument.
3. Connect X1 and X2 clips to the CT's secondary terminals. The manual mode only allows single winding testing at a time and therefore, only X1 and X2 clips are used. Clips X3, X4 and X5 are left floating (CTTx5), or are non-existent in case of a CTTx2.
4. Connect H1 and H2 clamps to the primary side of the CT under test. Make sure to respect the CT polarity. CTs are typically marked with a label on their H1 side.
5. In order to reduce nearby induction effects, the terminal on which is connected the H2 clamp, must be shorted to ground.



8.1.2 Manual mode test sequence

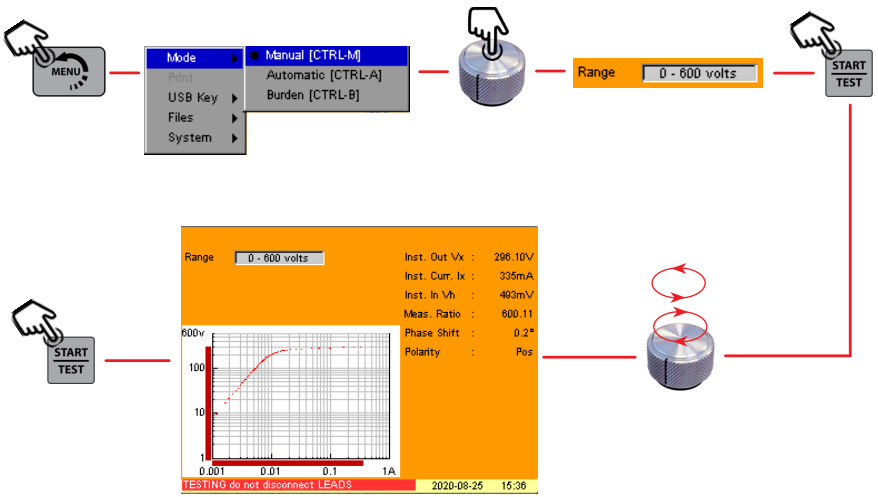
This section describes how to configure the CTT for manual testing of a current transformer.

1. Press the *Menu* key.
2. Select *Mode - Manual*.
3. Press the navigation knob to edit the test voltage range.
4. Rotate the knob to select the voltage range according to the specification of the CT to test. Press the knob to accept. If the maximum voltage is not known, refer to section 11.
5. Press the *Start/Test* key to start the test.
6. Start rotating the knob clockwise one click at a time (allow half a second between each click). The saturation curve will be plotted, and the other results will be displayed on the right side of the screen. The test ends when the CT is fully saturated, or by pressing the *Start/Test* key.

Tip: A more defined saturation curve can be plotted by alternating the ramping up then ramping down of the applied test voltages during the test.

7. When done, re-position X1 and X2 clips on the next winding to be tested.

Note: Tests results in manual cannot be saved, exported or printed. Manual mode is intended for diagnostic purposes.



8.2 Automatic Mode Operation

This section explains how to operate the CTTx5 and CTTx2 in automatic mode. It is assumed the CT under test is not installed in a power transformer, circuit breaker or any other larger system.

8.2.1 Connections

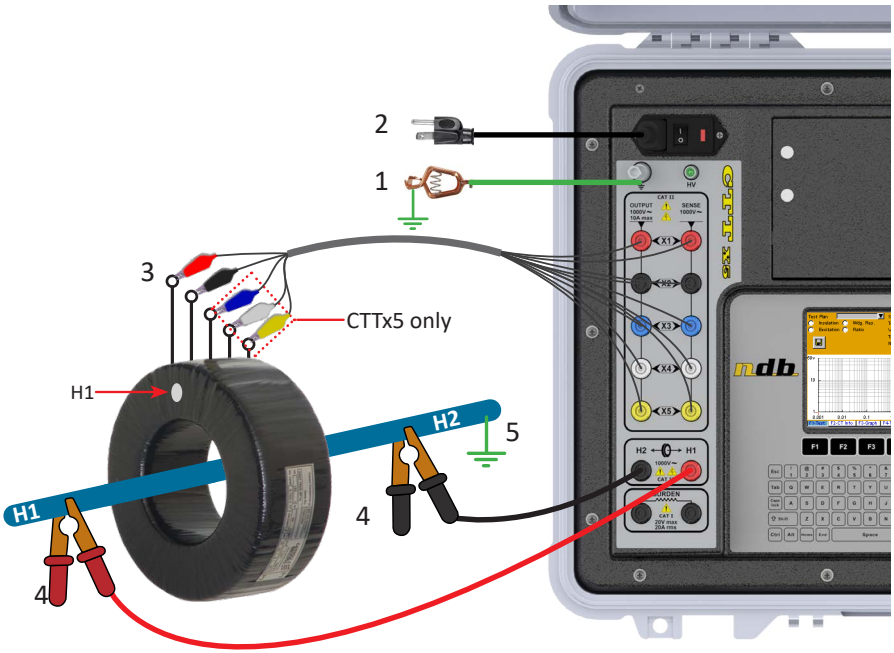
1. Before connecting the CTT instrument to any other cable/equipment, make sure the ground post is earthed properly using the provided ground cable.

2. Connect the CTT to a power source and then turn on the instrument.

3. Connect X1, X2, X3, X4 and X5 clips (CTTx5) to the CT's secondary terminals to test (X1 and X2 for CTTx2).

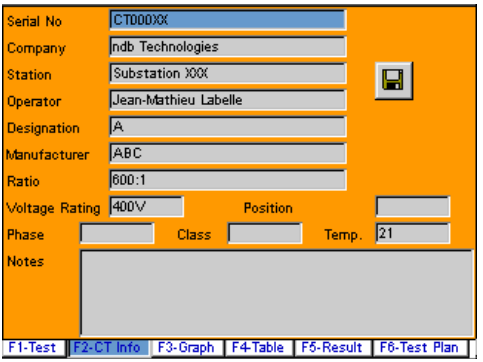
4. Connect H1 and H2 clamps to the primary side of the CT under test. Make sure to respect the CT polarity. CTs are typically marked with label on their H1 side.

5. In order to reduce nearby induction effects, the terminal on which is connected the H2 clamp, must be shorted to ground.



8.2.2 Device under test information

1. Press the *Menu* key.
2. Selection *Mode - Automatic*.
3. Go to the *F2-CT Info* tab.
4. Fill in the CT's information. Note the *Serial No* field is mandatory for saving a test report to memory.

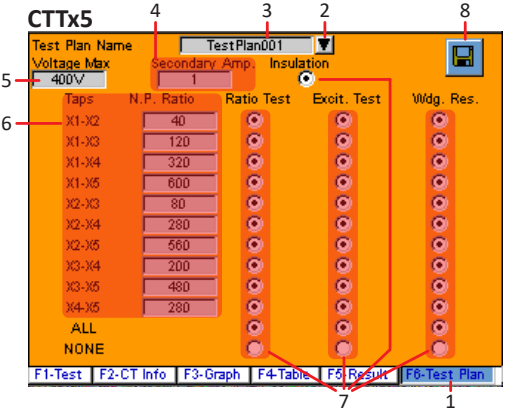


8.2.3 Create a test plan

8.2.3.1 CTTx5 test plan

Creating a test plan is mandatory when using the automatic mode. All test parameters of a test plan can be saved to memory. A test plan can be created, saved, edited later and re-saved under a new name.

1. Go to *F6-TestPlan* tab.
2. From the drop-down menu, select *Blank* to create a new test plan.
3. Select the *Test Plan Name* field, type a name under which the test plan will be saved.
4. Set secondary current, typically 1 or 5 Amps.
5. Set the maximum test voltage either by rotating the knob, or by typing in the voltage. The max voltage must be set according to the specification of the CT's largest winding, typically X1-X5. Refer to section 11 for more information on how to set the max voltage.



6. For each tap to be tested, adjust the ratio either by rotation the knob, or by typing in the ratio value. **Do not leave a ratio value in an unused field. This could result in improper voltage distribution across ratio tests. Type "1" in each unused ratio field to disable.**

7. Select tests to be performed for each individual tap. While the ratio, saturation and winding tests can be performed on every tap, the insulation test is performed between X1 and ground. Taps with no test selected will be left untested.

8. Select and press the save button to save the test plan to memory.

8.2.3.2 CTTx2 test setup

1. Press the *Menu key*.

2. Select *Mode - Automatic*.

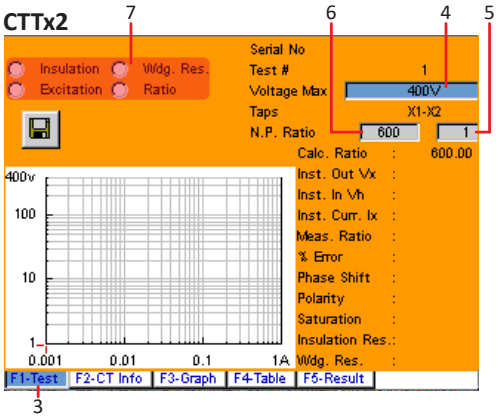
3. Go to *F1-Test* tab.

4. Adjust the maximum test voltage range according to the specification of the CT under test. Refer to section 11 for more information on how to set the max voltage.

5. Set secondary current, typically 1 or 5 Amps.

6. Set the ratio.

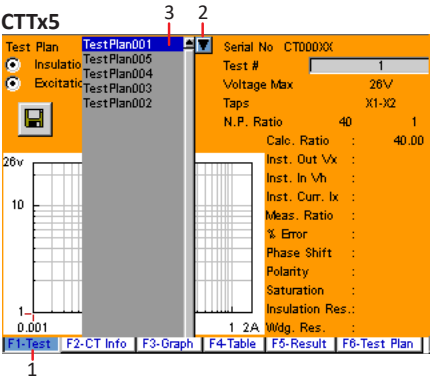
7. Select the tests to perform.



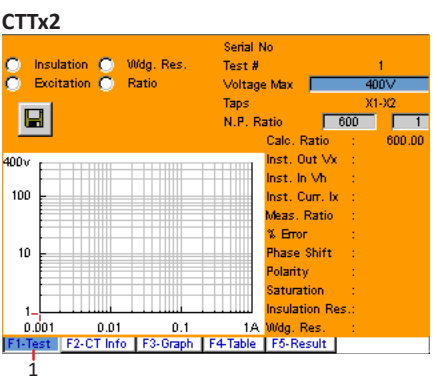
8.2.4 Run a test

1. Go to *F1-Test* tab.
2. Open the drop-down menu (CTTx5 only).
3. Select the appropriate test plan (CTTx5 only).
4. On the CTT, press the *Start/Test* key.

CTTx5

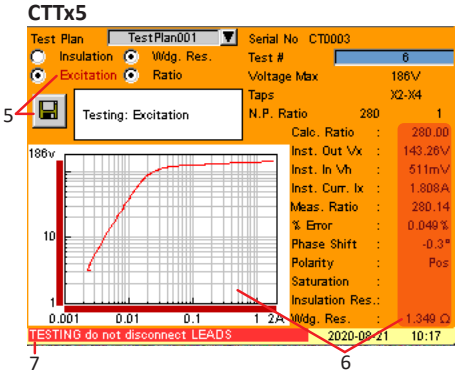


CTTx2

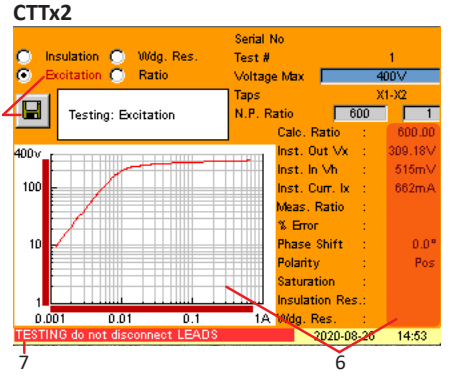


5. The instrument will run all selected tests. The test being performed will flash in red, and a test box will be displaying the name of test being performed.
6. Live test values will be displayed on the right side of the screen. Saturation curve(s) will be displayed in the left side graph.
7. A status message will be displayed at the bottom left of the screen.
8. If for any reason the test needs to be stopped before the end of the sequence, press the *Start/Test* key. Alternatively, the emergency stop button can be used.

CTTx5

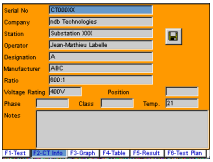


CTTx2

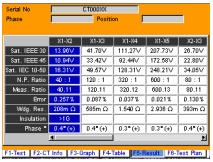


8.2.5 Save a test

1. When a test sequence is completed, the operator can choose to save the results to memory.
2. Start by reviewing all test results found on tabs *F3-Graph, F4-Table* and *F5-Results*.
3. Make sure the tab *F2-CT Info* is duly filled as the informations found in this tab will be saved along with test results. The *Serial No* field is mandatory prior saving.
4. When ready, press either the keypad save key or the save icon found in tab *F1-Test* and *F2-CT Info*. The test file will be saved to memory and will be accessible here: *Menu-Files-Open File Viewer*

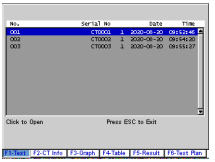

CT information

+


Test Results

+

=


Saved in memory

8.3 Burden Mode Operation

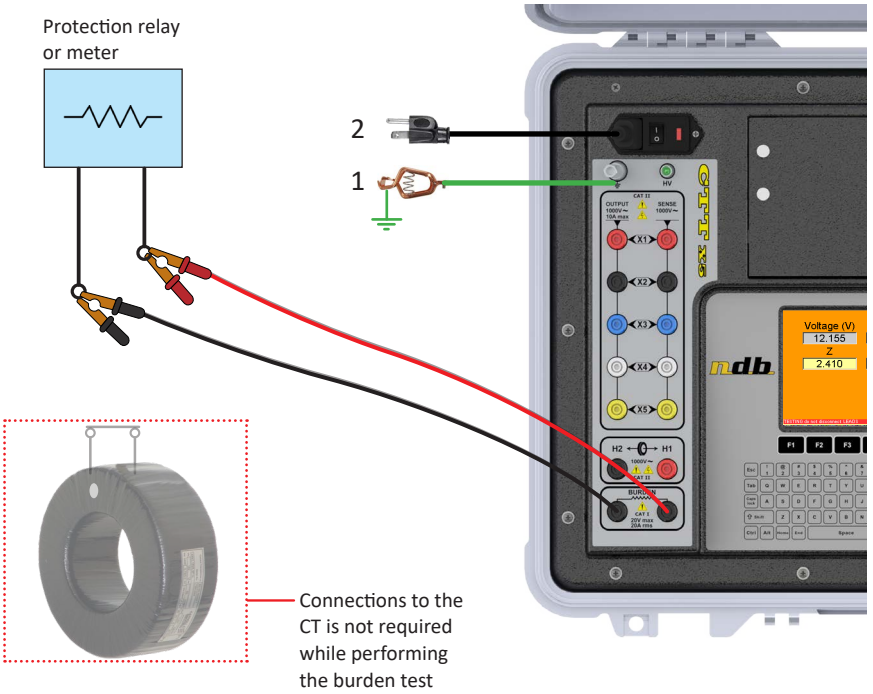
This section explains how to operate the CTTx5 and CTTx2 in burden mode.

8.3.1 Connections

1. Before connecting the CTT instrument to any other cable/equipment, make sure the ground post is earthed properly using the provided ground cable.

2. Connect the CTT to a power source and then turn on the instrument.

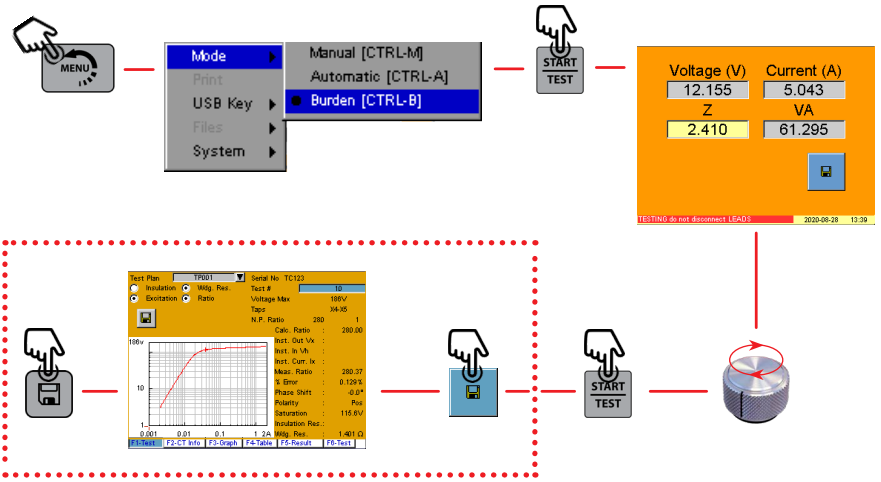
3. Connect the CTT's burden terminals to the CT's burden (i.e. cables, relay etc..). These burdens would be connected to the CT's secondary winding under normal operation. The current transformer does not require to be connected to the CTT instrument for this burden test.



8.3.2 Burden mode test sequence

The burden test can be performed on its own, but some operators may find convenient to attach the burden test results to an actual CT test report. In order to do that, make sure a CT test has been completed in automatic mode, but wasn't saved yet. Then follow the steps below.

- Press the *Menu* key, then select *Mode- Burden*.
- Press the *Start/Test* key to activate the CTT's AC current source.
- Rotate the navigation knob clockwise to increase the current injected into the load to the desired value.
- Voltage, current, impedance (Z) and VA will be displayed.
- When completed, press the *Start/Test* key to stop the test.
- Select the save button. *F1-Test* tab will now appear.
- When in *F1-Test* tab, press the save button. CT tests and burden test results will be saved into memory (See File Viewer, tab *F2-CT Info*, see the *Notes* field).



Optional: Attaches the burden test results to the CT test results.

9. Applications

This section of the user manual describes how to connect the CTT instrument in various test configurations.

Important safety note (Applies to all applications described in this section): CT's secondary leads should not be left opened when the CT is installed and not in use. A current transformer is designed to circulate a current proportional to the turns ratio through a certain load/burden. If this burden is an open circuit (infinite resistance) then the primary current of the transformer will try to "push" the relative secondary current through very large resistance and therefore generate very large voltage across the secondary leads, limited by the turns ratio and core saturation limits. This could equate to voltages of several thousands of volts. For this reason it is always good practice to short the secondary terminals of CT's that are installed and not in use (using shorting bars) or to leave them connected to their respective burdens.

9.1 CT in a Power Transformer

This section explains how to connect the CTTx5 and CTTx2 to test a current transformer installed on the bushing of a power transformer.

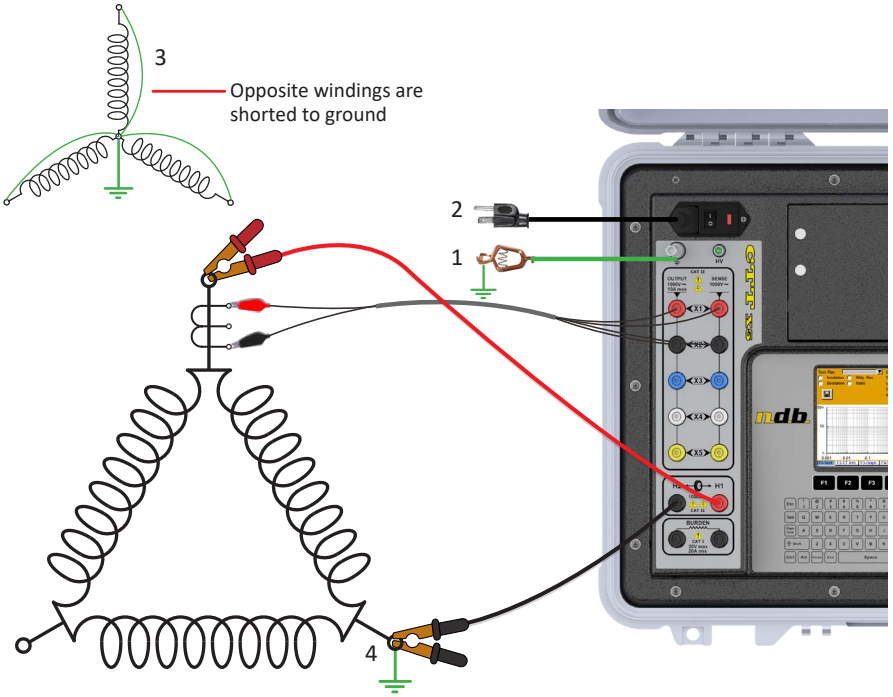
9.1.1 Connections

1. Before connecting the CTT instrument to any other cable/equipment, make sure the ground post is earthed properly using the provided ground cable.

2. Connect the CTT to a power source and then turn on the instrument.

3. In order to mitigate the CT ratio measurement errors due to the voltage divider circuit composed of the CT impedance and the transformer winding impedance(s), it is necessary to magnetically cancel the transformer winding(s) impedance by shorting the opposite winding(s). For example, if the CT under test is on the primary side of the power transformer, short all secondary windings together and then to ground. If the CT under test is on the secondary side of the power transformer, short all primary windings together and then to ground. Refer to next figure.

However, if the CT under test is in the "Buried in Delta" configuration, do not short. Refer to section 9.2.



4. In order to reduce nearby induction effects, the bushing on which is connected the H2 clamp, must be shorted to ground.

5. At this step, either refer to section 8.1 for manual mode operation, or section 8.2 for automatic mode operation.

9.2 Buried CT in Delta Winding

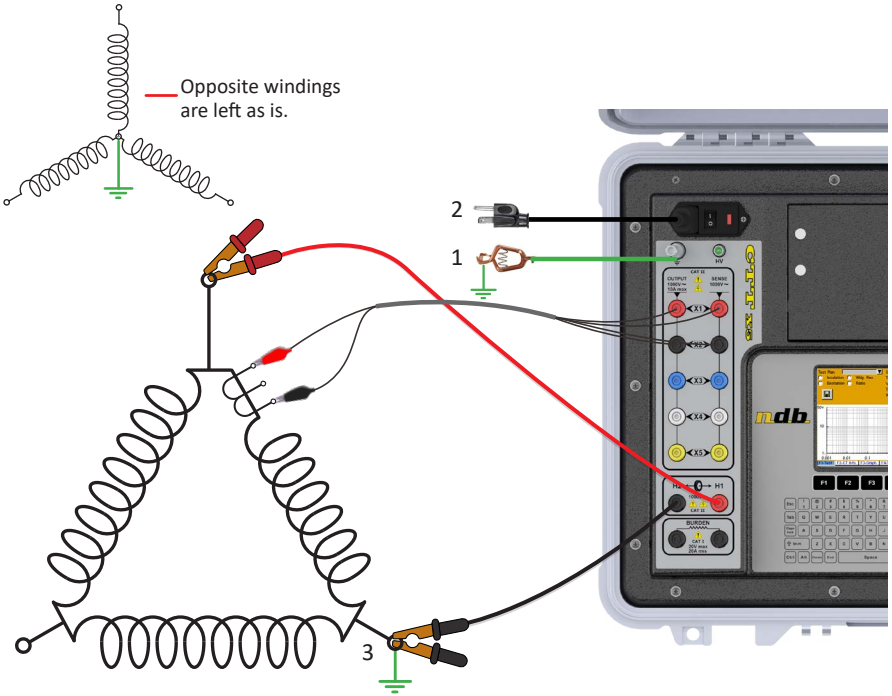
This section explains how to connect the CTTx5 and CTTx2 to test a current transformer installed within the windings (buried) of a delta configuration of a power transformer.

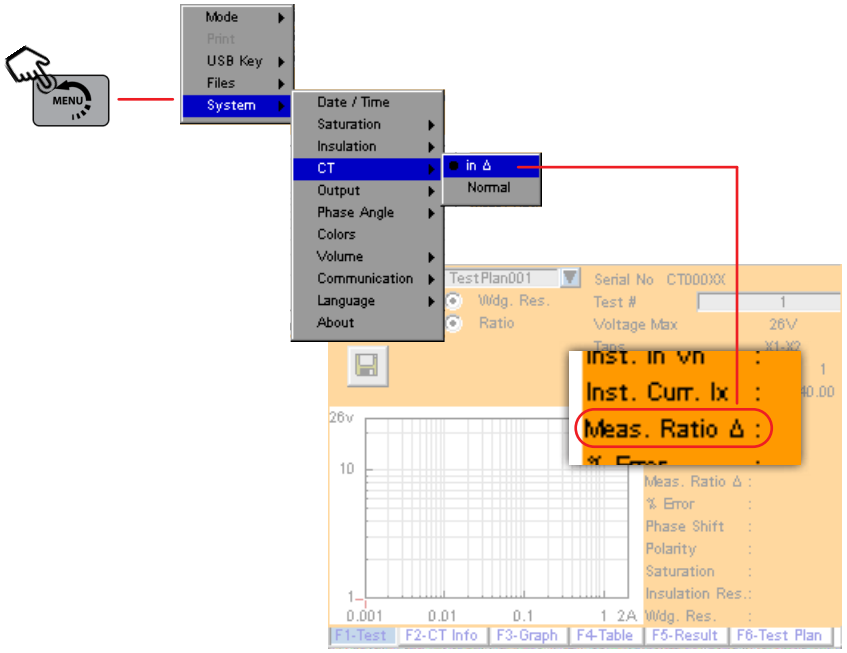
9.2.1 Connections

1. Before connecting the CTT instrument to any other cable/equipment, make sure the ground post is earthed properly using the provided ground cable.

2. Connect the CTT to a power source and then turn on the instrument.

3. In order to reduce nearby induction effects, the bushing on which is connected the H2 clamp, must be shorted to ground.





4. Since the CT is buried in the transformer's windings, it is necessary to activate the "Buried in Delta" mode from the *Menu*. From the *F1-Test* tab, a delta icon is now present to indicate the proper compensation is applied to the ratio measurement.

Note: The CTT transformation ratio test is performed dividing the voltage applied to the CT secondary terminals by the voltage induced at the CT primary, Ratio = Vs / Vp. The voltage induced at the CT primary is measured between the H1-H2 terminals of the power transformer. This measurement is actually a fraction (2/3) of the total voltage induced at the CT primary. The terminals H1 + H2 gives us 1/3 + 1/3 = 2/3, Ratio = Vs / Vp therefore, Ratio = Vs / Vp (2/3) finally: (3/2) Ratio = Vs / Vp

5. At this step, refer to section 8.2 for automatic mode operation.

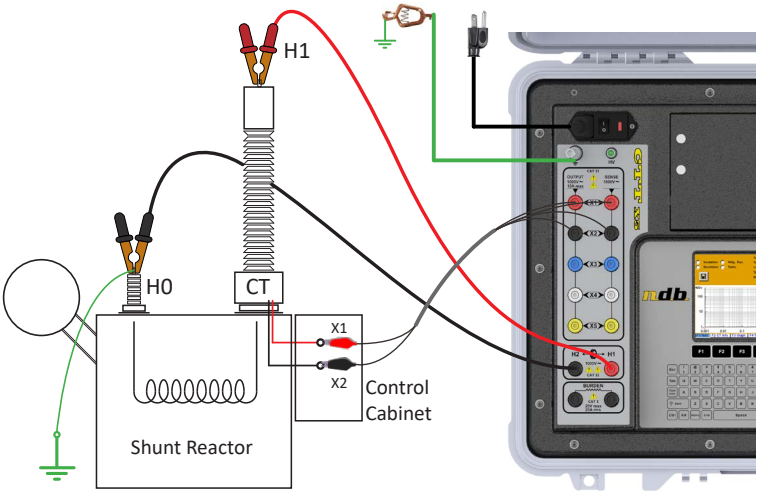
9.3 Testing CT's in Shunt Reactor

This section explains how to connect the CTTx5 and CTTx2 to test a current transformer installed in a high voltage shunt reactor. When performing tests on CT's located on power transformer bushings, we use magnetic short-circuiting of power transformer winding impedances. Essentially canceling power transformer winding impedances. For CT's on shunt reactor bushings, unfortunately there are no opposite windings we can magnetically short circuit. Therefore an error in ratio measurements is expected. The following steps explain an alternative test method that does not require to physically disassemble the shunt reactor to install a cable on the primary side of the CT to test.

9.3.1 Step 1 - General Tests

This section describes the first steps in testing a CT located in a shunt reactor. All tests will be conducted, but ratio test results will be discarded and covered in the next section.

1. Before connecting the CTT instrument to any other cable/equipment, make sure the ground post is earthed properly using the provided ground cable. Connect the CTT to a power source and then turn on the instrument.
2. Connect the H1 and H2 tests leads to the primary side of the CT under test. Connect X tests leads to the secondary side of the CT under test.
3. In order to reduce nearby induction effects, the bushing on which is connected the H2 clamp, must be shorted to ground.
4. At this step, either refer to section 8.1 for manual mode operation, or section 8.2 for automatic mode operation. CT ratio test results must be discarded. All other tests are considered valid. Expect a minor error for the polarity test result.



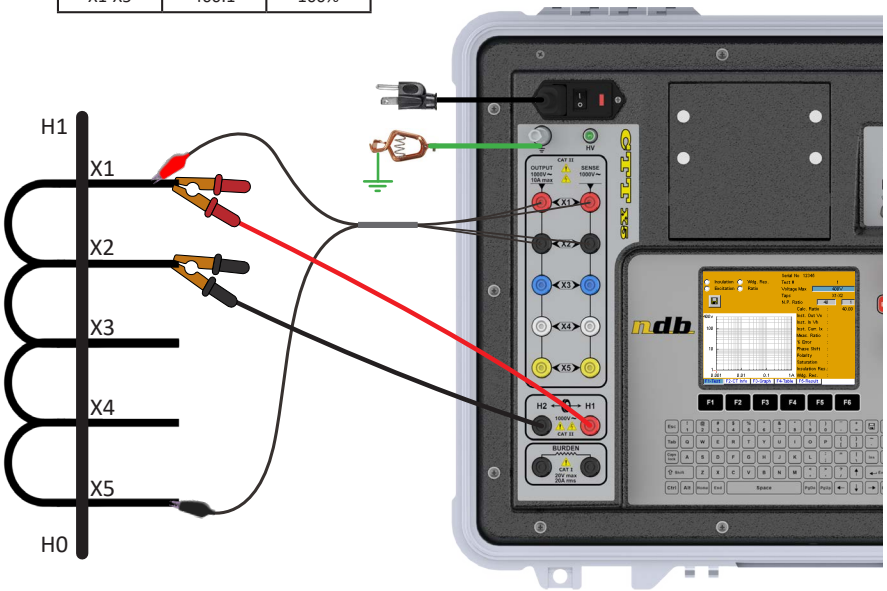
9.3.2 Step 2 - Ratio Test

This section describes how to perform ratio tests of a CT installed on a shunt reactor. The ratio tests will be performed on the secondary side of the CT only. The table below shows an example of a CT with four secondary windings to test. Each winding's ratio percentate is shown (for example X1-X2 has a ratio of 80:1 which is 20% of the full winding of 400:1). A ratio test will be necessary on each winding for a total of four tests.

9.3.2.1 X1-X2 Test

1. Connect the test leads as shown on the figure below.
2. Run a ratio test.
3. Using the name plate information where we have the full winding (X1-X5) that has 400 turns ratio divided by (X1-X2) 80 turns, the expected result is 5.
4. Divide 1 by the result (1/5).
5. The result must be equal to the percentage of ratio previously calculated: 1/5 = 20%

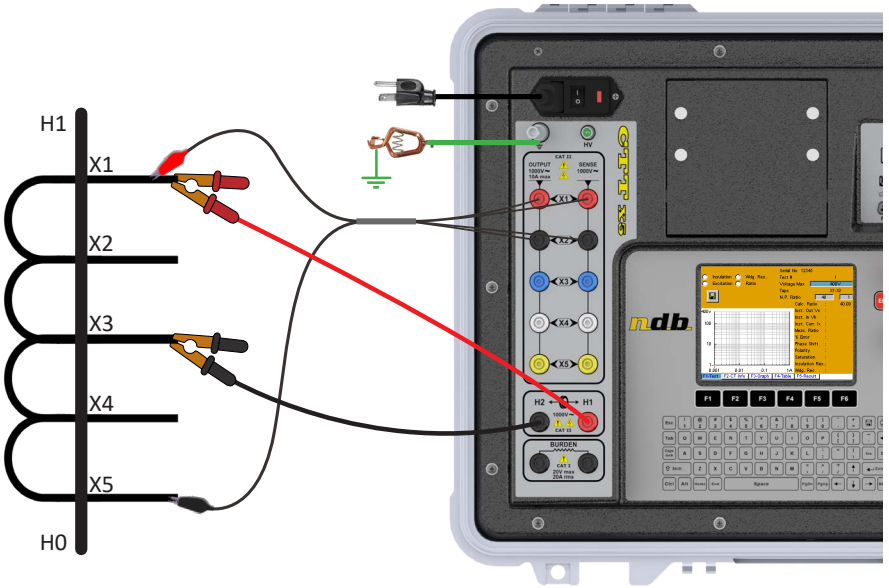
Winding	Ratio	Ratio %
X1-X2	80:1	20%
X1-X3	240:1	60%
X1-X4	300:1	75%
X1-X5	400:1	100%



9.3.2.2 X1-X3 Test

1. Connect the test leads as shown on the figure below.
2. Run a ratio test.
3. Using the name plate information where we have the full winding (X1-X5) that has 400 turns ratio divided by (X1-X3) 240 turns, the expected result is 1.666.
4. Divide 1 by the result (1/1.666).
5. The result must be equal to the percentage of ratio previously calculated: 1/1.666 = 60%

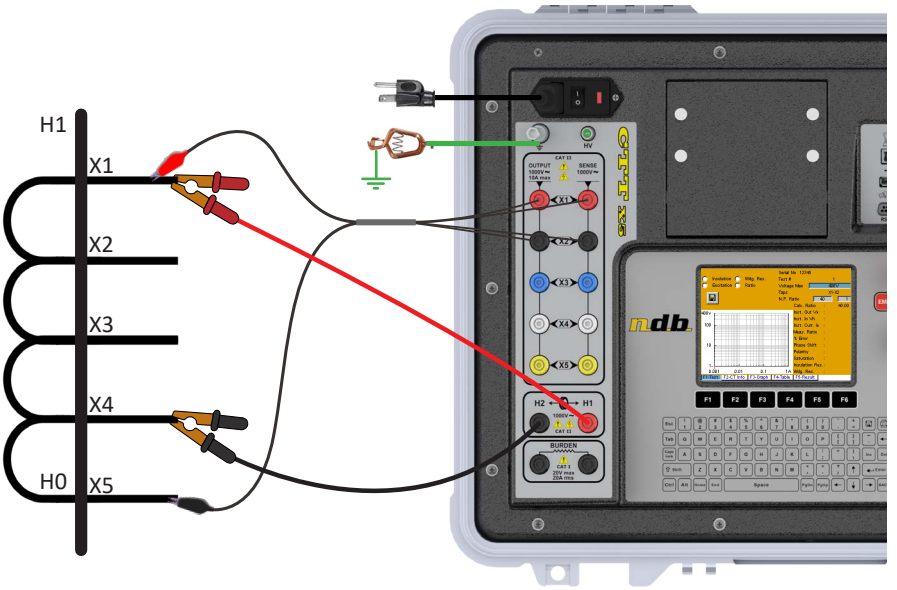
Winding	Ratio	Ratio %
X1-X2	80:1	20%
X1-X3	240:1	60%
X1-X4	300:1	75%
X1-X5	400:1	100%



9.3.2.3 X1-X4 Test

1. Connect the test leads as shown on the figure below.
2. Run a ratio test.
3. Using the name plate information where we have the full winding (X1-X5) that has 400 turns ratio divided by (X1-X4) 300 turns, the expected result is 1.333.
4. Divide 1 by the result (1/1.333).
5. The result must be equal to the percentage of ratio previously calculated: 1/1.333 = 75%

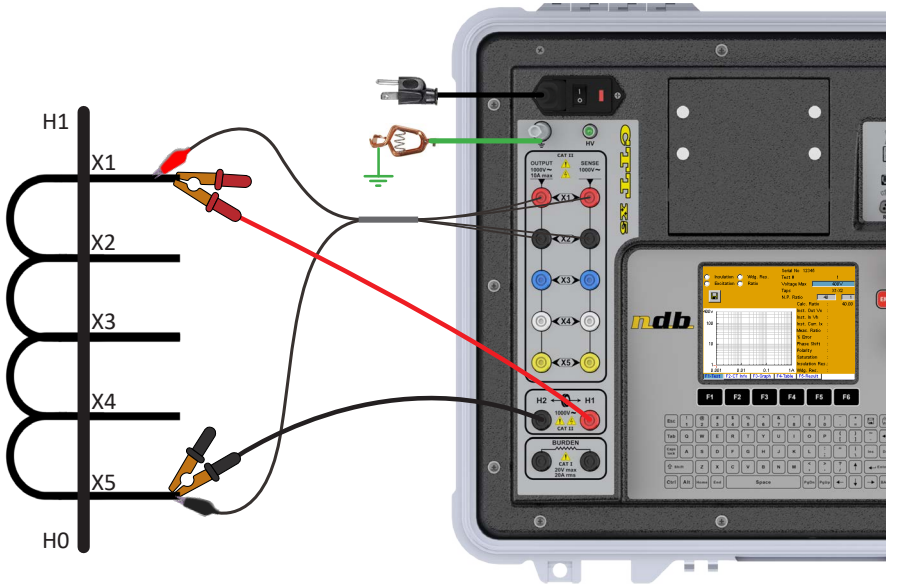
Winding	Ratio	Ratio %
X1-X2	80:1	20%
X1-X3	240:1	60%
X1-X4	300:1	75%
X1-X5	400:1	100%



9.3.2.4 X1-X5 Test

1. Connect the test leads as shown on the figure below.
2. Run a ratio test.
3. Using the name plate information where we have the full winding (X1-X5) that has 400 turns ratio divided by (X1-X5) 400 turns, the expected result is 1.
4. Divide 1 by the result (1/1).
5. The result must be equal to the percentage of ratio previously calculated: 1/1 = 100%

Winding	Ratio	Ratio %
X1-X2	80:1	20%
X1-X3	240:1	60%
X1-X4	300:1	75%
X1-X5	400:1	100%



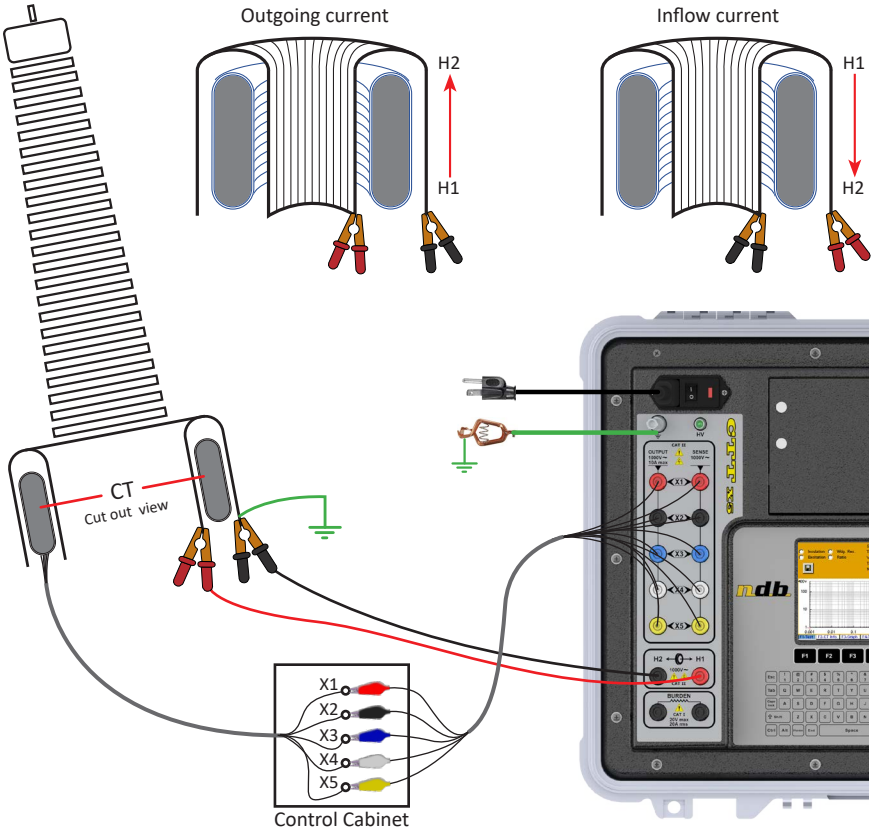
9.4 CT in Circuit Breaker

This section shows how to connect the CTTx5 or CTTx2 to test a current transformer installed on a circuit breaker.

9.4.1 Cover Method

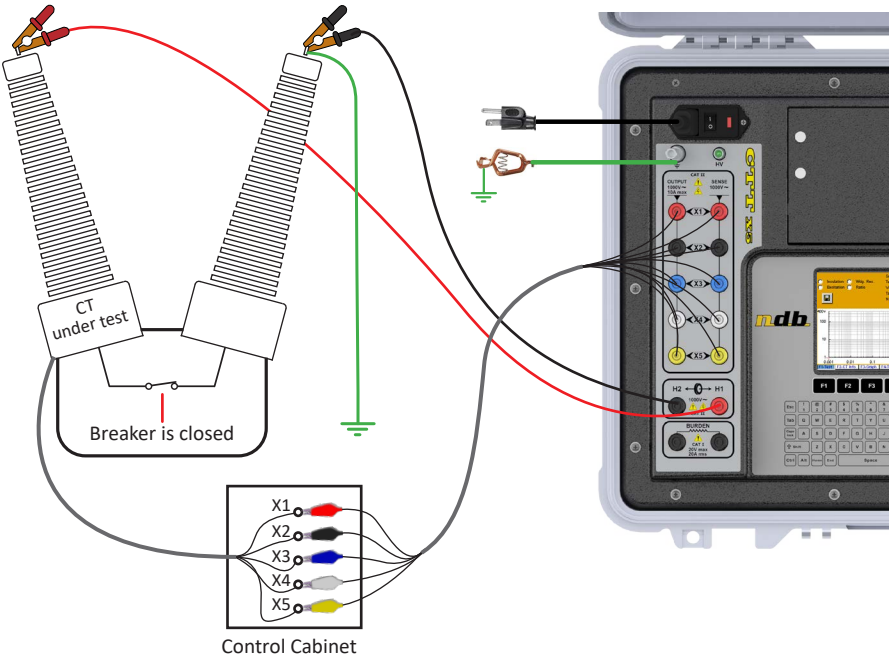
If the circuit breaker bushings have a metal protective cover housing the CT's, it is possible to use that cover for the primary connections. Connect H1 and H2 clamps according to the CT's polarity*. In order to reduce nearby induction effects, the cover part on which is connected the H2 clamp, must be shorted to ground if not already. Either refer to section 8.1 for manual mode operation, or section 8.2 for automatic mode operation.

***Note**: Outgoing current configuration requires the H1 clamp (red) installed on the inner part of the cover, and H2 clamp (black) installed on the external part of the cover to ensure correct polarity reading. Reverse for inflow current configuration.



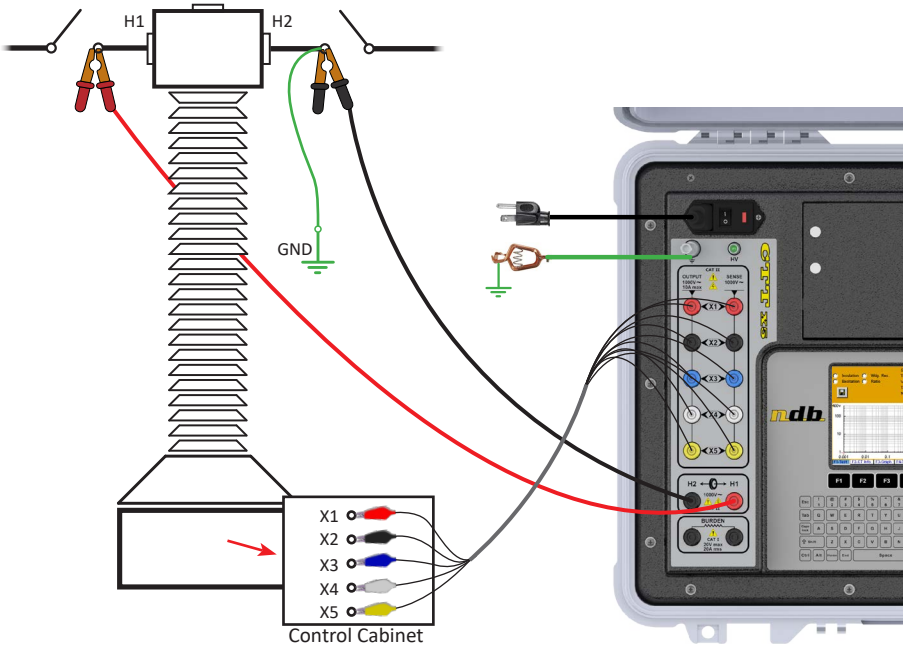
9.4.2 Bushing Terminal Method

In order to test a CT installed in a circuit breaker, install the H1 clamp on the bushing (H1 side of the CT), and the H2 clamp on the second bushing (H2 side of the CT). Make sure the breaker circuit is closed. In order to reduce nearby induction effects, the terminal on which is connected the H2 clamp, must be shorted to ground. Either refer to section 8.1 for manual mode operation, or section 8.2 for automatic mode operation.



9.5 Top Core CT

This section shows how to connect the CTTx5 or CTTx2 to test a top core current transformer. Make sure to isolate the CT from the network. In order to reduce nearby induction effects, the terminal on which is connected the H2 clamp, must be shorted to ground. Either refer to section 8.1 for manual mode operation, or section 8.2 for automatic mode operation.



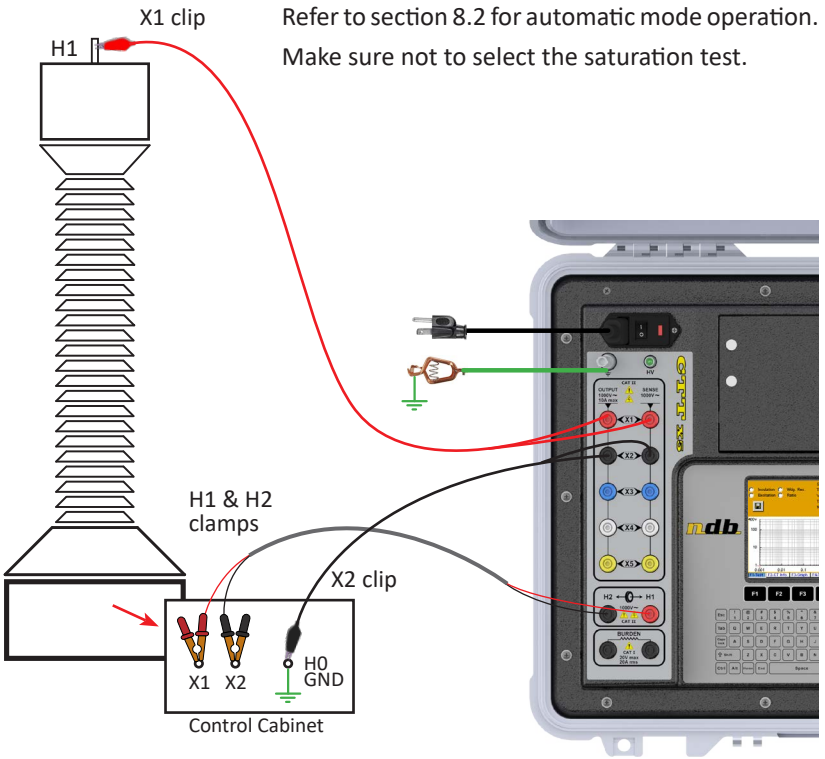
9.6 Potential Transformer (PT, VT)

This section explains how to connect the CTTx5 or CTTx2 to test a potential transformer (PT or VT).

The CTT is able to perform the following tests on a voltage transformer: Insulation resistance, winding resistance, polarity, phase deviation and ratio. Since PTs are not designed to handle saturation due to the lower voltage in comparison with the PT's nominal voltage ratings, it is expected that the saturation curves will not display any inflection or knee point.

To test a PT using the CTT, the operator of the instrument must remember one important physical character of CTs vs PTs:

- CTs will step down currents from the primary to the secondary. Therefore CTs will step up voltage from the primary to the secondary.
- PTs will step down voltage from the primary to the secondary. Therefore PTs will step up current from the primary to the secondary.



10. Test Report

10.1 Local Print

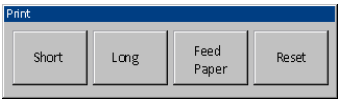
The CTT instrument allows for test report printing from its built-in thermal printer.

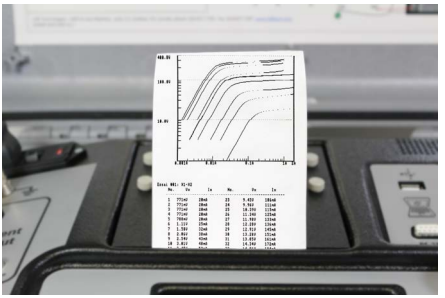
10.1.1 Print an unsaved test

1. When a test was just completed, press the keypad print key to print a test report on the built in thermal printer (available from any of the *F1-Test, F2-CT Info, F3-Graph, F4-Table or F5-Results* tab).
2. Use the knob to select either a short print or a long print.

10.1.2 Print a saved test

1. Press the menu key, then select *Files* and then select *Open File Viewer*.
2. Select a test report to print.
3. Once the test report is opened, press the menu key and then select *Print*.
4. Use the knob to select either a short print or a long print.





10.2 File Transfer

The CTT instrument allows for file transfer to a PC computer for backup purposes and also for test report generation.

10.2.1 RS232 Cable File Transfer

The RS232 method allows a transfer of up to 255 files. If the instrument contains more than 255 files, it is suggested to use the USB key method instead.

- Connect the CTT instrument to a Windows PC using the provided RS232 cable and a RS232 to USB converter.
- On the CTT instrument, press the menu key  .
- Select *System – Communication – RS232*.
- On a computer, start *Report Manager* PC software.
- Select *Files – General Settings – Data File Path* and select the folder in which to save data files.
- Select *Files – Data transfer – Download*.
- The software will scan communication port and display the instrument's serial number when found. If the instrument cannot be found, it is possible to check the assigned port number from the *Control Panel - Device Manager - Ports (COM&LPT)*. ! If the assigned port is higher than 16, the instrument might not be detected. In this case, assign a port number between 1 and 16.
- Click the *Transfer Files* button to start copying all files found in the instrument to the computer. The files stored in the instrument are not modified in any way by this process.

10.2.2 USB Cable File Transfer

The USB cable method allows a transfer of up to 255 files. If the instrument contains more than 255 files, it is suggested to use the USB key method instead.

- Connect the CTT instrument to a Windows PC using the provided USB cable.
- On the CTT instrument, press the menu key  .
- Select *System – Communication – USB*.
- On a computer, start *Report Manager* PC software.
- Select *Files – General Settings – Data File Path* and select the folder in which to save data files.
- Select *Files – Data transfer – Download*.
- The software will scan communication port and display the instrument's serial

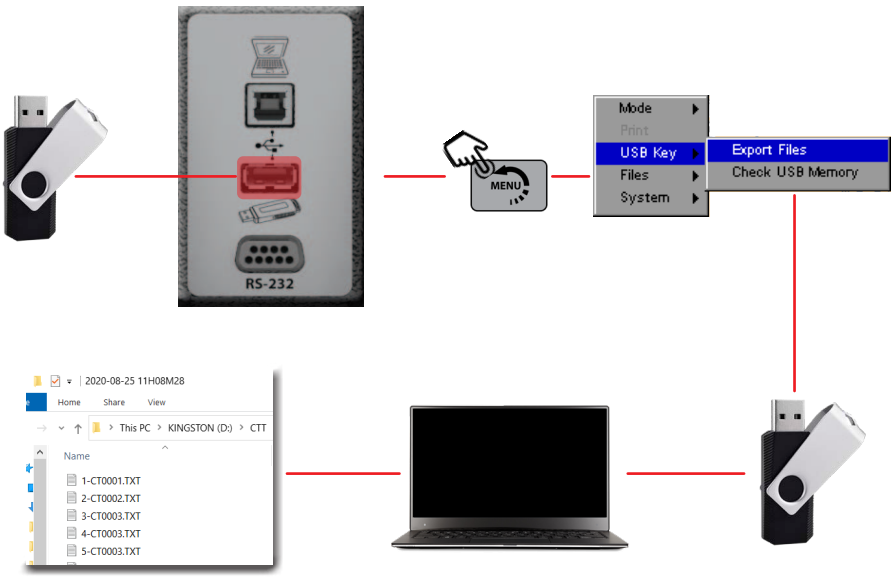
number when found. If the instrument cannot be found, it is possible to check the assigned port number from the *Control Panel - Device Manager - Ports (COM&LPT)*. ⚠ If the assigned port is higher than 16, the instrument might not be detected. In this case, assign a port number between 1 and 16.

- Click the *Transfer Files* button to start copying all files found in the instrument to the computer. The files stored in the instrument are not modified in any way by this process.

10.2.3 USB Key File Transfer

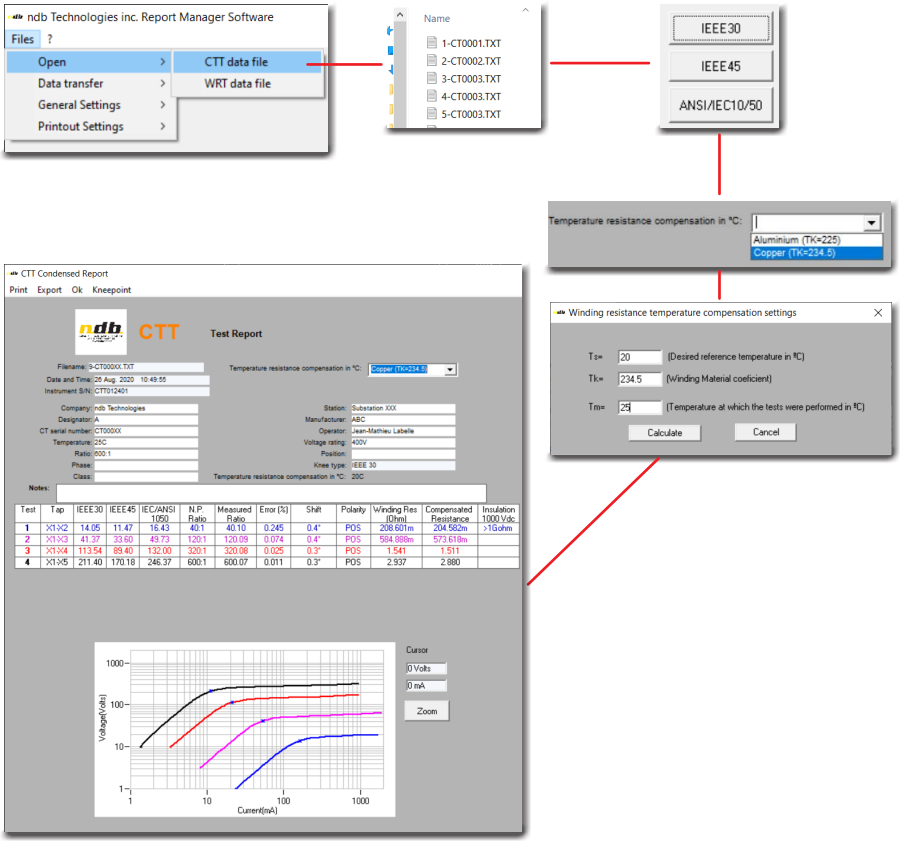
The USB key method allows to transfer up to 400 files (maximal storage is 400 files). The USB key must be formatted with FAT standards.

- Connect the provided USB key to the instrument's type A USB port.
- On the CTT instrument, press the menu key  .
- Select *USB Key - Check USB Memory*.
- The instrument will test the USB key to confirm compatibility.
- Press the menu key  , select *USB Key*, and then select *Export Files.* All test reports will be copied on the USB key. The files stored in the instrument are not modified in any way by this process.
- Connect the USB key to a PC computer to access the files.



10.3 Test Report in Report Manager

1. On a PC computer, start Report Manager.
2. Click *Files - Open - CTT data files*.
3. Browse and select a test file.
4. Select the knee point standard required for the final test report.
5. Select the transformer's winding material, and then set the winding resistance temperature compensation settings (Celsius only).
6. Test report will be displayed with all test values. Edit or add notes, if required.
7. To print the report, select *Print* and the desired printer. To export a PDF file, select a "print to PDF" printer.
8. To export test values to MS Excel, select the *Export* button.



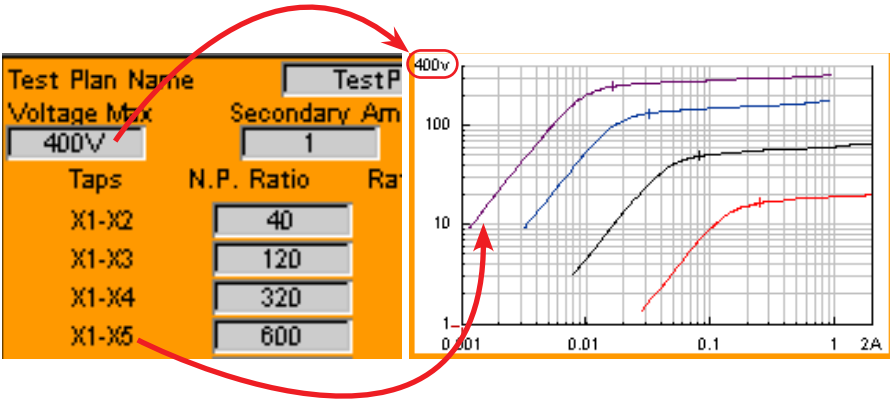
11. Annexes

11.1 Max Test Voltage Setting

This section describes how to select the appropriate max voltage for a CT saturation test, and what are the problems associated with improper test voltage setting. All of the below information applies to the CTTx5 and CTTx2, in automatic or manual mode. When performing the ratio and saturation test, the CTT will saturate the core of the CT. The maximal test voltage setting basically tells the instrument where to stop (example: up to 2000V). The picture below shows an example where the maximal test voltage is 400V. This maximum test voltage is in relation to the full winding specification of the CT (typically X1-X5). In the case of a CTTx5 testing a multi-ratio CT, the instrument will automatically apply the correct test voltage for other ratios entered by the user. For example:

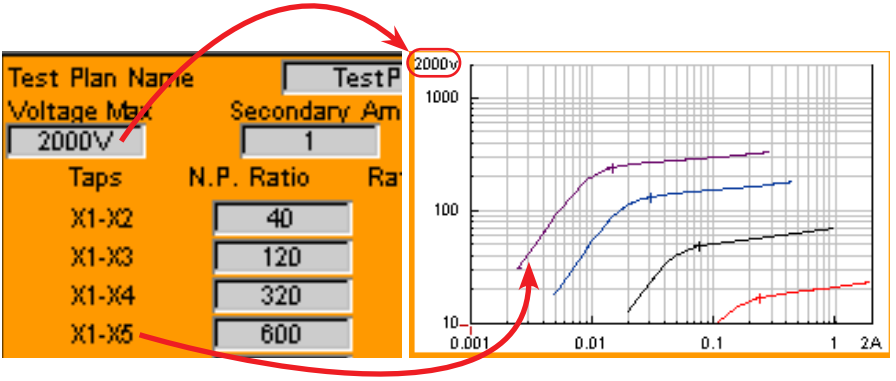
- X1-X5: this ratio (600:1) will get up to 400V.
- X1-X4: this ratio (320:1) is 53% of the full X1-X5 ratio, therefore 53% of the voltage will be injected (up to 213V).
- X1-X3: this ratio (120:1) is 20% of the full X1-X5 ratio, therefore 20% of the voltage will be injected (up to 80V).
- X1-X2: this ratio (40:1) is 6.67% of the full X1-X5 ratio, therefore 6.67% of the voltage will be injected (up to 26.67V).

Note: The maximal voltage is applied to ratio X1-X5 by default. Typing "1" in a ratio field disables this ratio and the maximal voltage would be applied to the previous ratio. For example: If testing a CT where the largest ratio is X1-X4, type the "1" in the X1-X5 field. The max voltage will then be applied to the X1-X4 ratio.



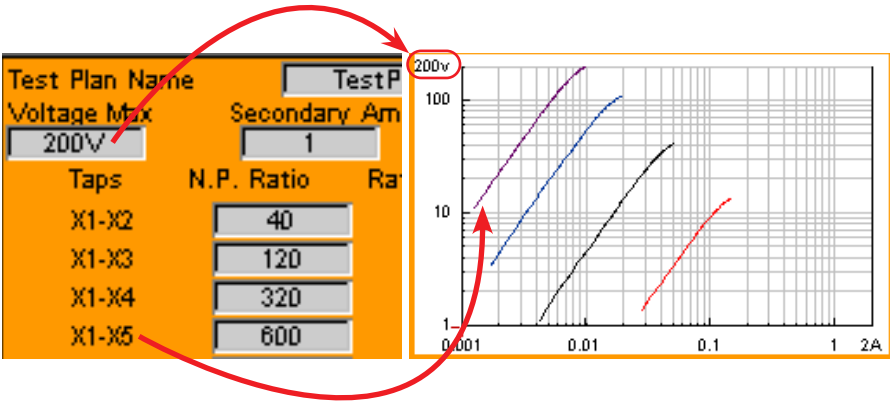
11.1.1 Voltage Set Too High

Using the same example CT requiring only 400V to saturate its largest ratio, only this time max test voltage was set to 2000V. This has for effect of reducing the instrument's accuracy while plotting the saturation graph. This lack of resolution will influence the accuracy of the ratio readings. It is worth noting this will not damage the CT or the CTT instrument in any way, because the CTT has a built-in distortion/crest factor detection circuit that will limit the test voltage output to prevent applying excessive voltages and risking over saturation of the CT.



11.1.2 Voltage Set Too Low

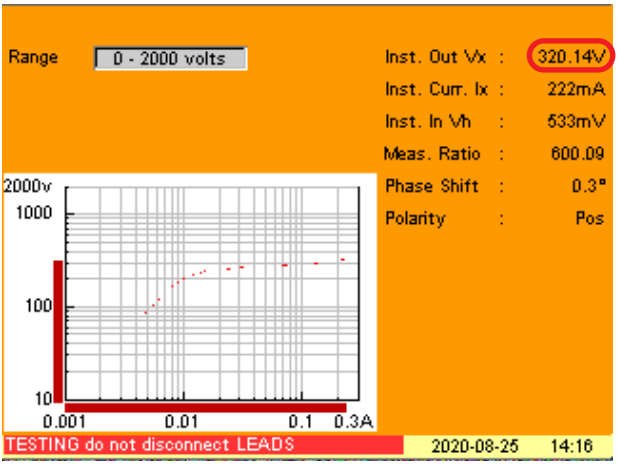
Using once again the same example CT requiring 400V to saturate its largest ratio, only this time max test voltage was set to only 200V. This has for effect of reducing the range of voltage in which the instrument is able to saturate the CT. In this example, the instrument wasn't able to saturate the CT for any of the ratios. The ratio test and saturation tests are then invalid. It is worth noting this will not damage the CT or the CTT instrument in any way, only the test results will be altered.



11.1.3 Determining Max Voltage

If maximal voltage to use isn't known, it is recommended to use the manual mode to perform a quick saturation test.

- Start with the maximal voltage of 2000V.
- Perform the saturation test slowly and stop just before full saturation.
- The instantaneous voltage will be indicated in the top right corner. In the example below, the maximal voltage is 320.14V.
- If a complete test sequence was required in automatic mode, a max voltage of 320.14V + 10% = ~350V would be appropriate.



11.2 Induction Mitigation

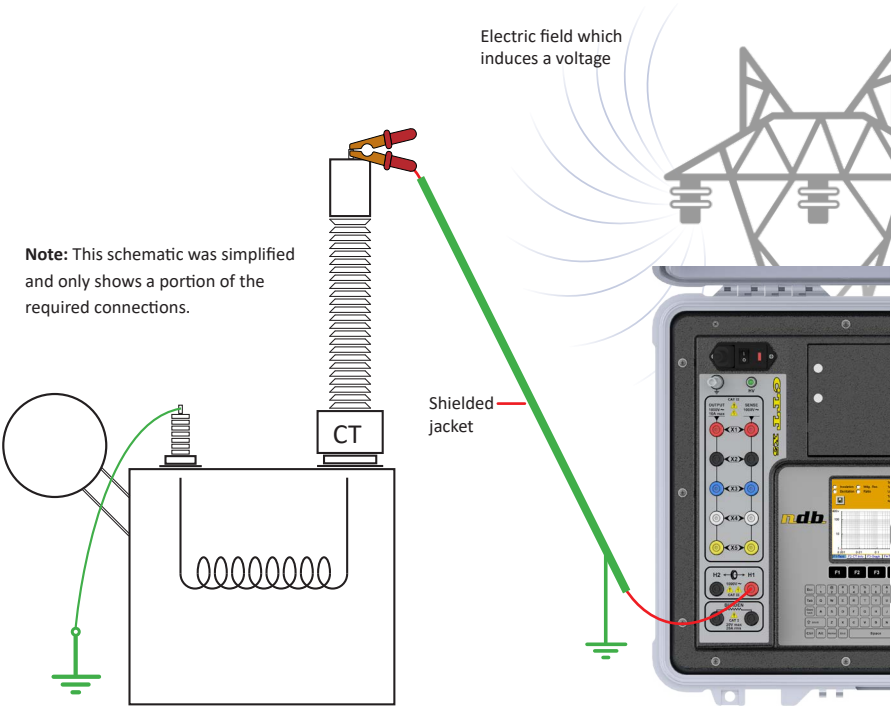
Nearby high-voltage electric fields can force current to flow through the loop of the measurement circuit (depending on their strength, distance, and geometry). The larger the exposed (unshielded) part of this loop, the larger the area sensitive to induced currents.

Optional shielded test leads are available:

- CTT-VH1-35S (10m / 35ft)
- CTT-VH1-50S (15m / 50ft)
- CTT-VX5-35S (10m / 35ft)

These will effectively limit the influence of the induction, substantially reducing the total exposed area of the measurement loop.

The transformer's bushing remains unshielded, and therefore this surface of the loop remains exposed to electric fields. A certain influence on the precision of the result of the transformation ratio can possibly be observed.



11.3 Auto-Transfo Effect

This section explains what is the auto-transformer effect and how the CTT protects from it. The CTT has a built in protection against any voltages higher than 2700 VAC on its input X connectors.

Multi-ratio CT's with large ratio difference can create high induced voltage from a low ratio to a high one.

For example, a CT with ratios:
X1-X2 = 500:1
X1-X3 = 1000:1
X1-X4 = 2000:1
X1-X5 = 3000:1

The turn ratio difference between X1-X2 and X1-X5 is 6 (3000/500). The instrument would normally have all X1 to X5 test leads hooked up on the CT. Now let's say we are testing the saturation voltage of X1-X2 and needed 500V, then, because of the auto-transformer effect, we would have 3000V induced on X5 (6 x 500V) which would normally flash over and damage the testing unit. The CTT has a high speed over-voltage detection system that will turn off the output of the unit when more than 2700V is detected on any of the terminals from X1 to X5. In these cases, X1 through X5 must be tested individually.

11.4 Factory Reset

The factory reset erases all stored files (test reports and test plans).

1. Press the *Menu* key.
2. Select *System - About*.
3. Rotate the knob to select the *License key* field.
4. Press the knob to edit the field.

Note: All data will be lost and won't be recoverable.

5. On the keypad, type the word "factory". Note, the letters will not appear in the field.
6. The factory reset process will start automatically and may take a few moments.

12. Technical Specifications

This section contains technical specifications for the CTTx5 and CTTx2 instruments.

Note the specifications can change without notice.

	CTTx5 and CTTx2 Technical Specifications
Power input	115 VAC or 230 VAC 50/60Hz grounded neutral
Fuse rating	15A or 8A , 250 VAC, Type F
Voltage output	0-50V @ 2A; 0-200V @ 2A; 0-600V @ 2A; 0-1200V @ 1.5A; 0-2000V @ 1.2A
Voltage reading	100mV ±0.2%, 1V ±0.1%, 50V ±0.1%, 1000V ±0.1%
Current reading	0-1.9999 A rms, ±0.5%
Ratio and accuracy	0.8-1000:1 @ ±0.5%; 1000-2000:1 @ ±0.5%; 2000-5000:1 @ ±1%; 5000-10000:1 @ ±1%
Measurement method	ANSI/IEEE C57.13.1: IEC-60044-1
Phase angle	±180 Degrees / 0.0 to 359.9 degrees @ ±1 degree
Winding resistance	0-1.9999Ω @ ±1%; - 19.999 Ω @ ±1%;
Insulation resistance	2M-1GΩ @ ±3%
Current source	0-20A @ 0-20V cont.
Load burden display	19.999 A rms ±1% / 19.999V rms ±1% / 400VA / Z: 1mΩ to 1kΩ
Data storage	Up to 172 files with ten excitation curves per file, or up to 400 files with one curve each
X inputs	CTTx5: Five X inputs / CTTx2: Two X inputs
Display	120mm x 90mm (4¾ x 3½ inches) bright color LCD display
Printer	40 characters, 80mm (3.12 inches)
Operating temperature	-10 to 50°C (14 to 122°F)
Storage temperature	-20 to 80°C (-4 to 176°F)
Dimensions	46.8 x 35.5 x 19.3cm (18.4 x 13.8 x 7.5 inches)
Weight	24.94kg (55lbs)
Approvals	EN61010:2001 EN61326-1:1997