HIGHTEST TECHNOLOGY LIMITED

TRAN SERIES INSTRUCTION MANUAL

INDEX

DOCUMENTATION PRECEPTS

The following symbols and messages are used throughout this document and are according to ANSI Z535.6 (Product Safety Signs and Labels).

⚠ WARNING — Indicates a hazardous situation that, if not avoided, could result in death or serious injury

⚠ CAUTION — Indicates a hazardous situation which if not avoided could result in minor or moderate injuries

NOTICE — Indicates information considered important, but not hazard-related (e.g. messages relating to property damage)

SYMBOLS USED ON THE FRONT PANEL OF THE DEVICE

The following symbols are used on the front panel of the device.

Indicates the test cable socket. Follow the instructions while inserting and removing the connector into and out of the socket as explained in section 7 of 'Front Panel Components'.

Indicates the ground connector.

Indicates both USB 2.0/1.1 Standard-A, USB 2.0/1.1 Standard-B ports available on the device for communication purposes.

Indicates Fuse

IMPORTANT SYMBOLS USED ON THE DISPLAY OF THE DEVICE

Following are some important symbols used on the main menu of the display.

Indicates the charge status of the built-in battery.

Indicates the 'Bluetooth' is active on the device.

Indicates when external USB is connected to the flash driver.

GENERAL INSTRUCTIONS

NOTICE

This guide applies to the TRAN, TRAN BLUE, TRAN-B, and TRAN-B BLUE Transformer Analysers (also known as the TRAN Series). The operating procedure is nearly identical for these four models, and any variations between them are clearly described in this manual.

⚠ WARNING

Before turning on the device, please read and follow all instructions. With the purchase of the device, the user assumes full responsibility for its operation. HIGHTEST Technology Ltd. does not assume any responsibility for device misuse or non-compliance with safety precautions.

⚠ CAUTION

All personnel conducting tests with the TRAN Series must be trained and competent to enter substations and possess a comprehensive understanding of the requirements for performing turn ratio and winding resistance tests. Additionally, it is imperative that all personnel involved maintain a safe distance from high voltage equipment, both directly and indirectly, during testing.

⚠ WARNING

DO NOT MODIFY THE TEST EQUIPMENT

To minimize the risk of unknown hazards, as well as potential dangers, it is essential not to make any modifications to the device or use non-original accessories. To ensure the maintenance of all safety features in the design, it is strongly recommended that repairs be performed solely by HIGHTEST factory service personnel or authorized service providers. Unauthorized modifications can pose safety hazards and will void the manufacturer's warranty.

WORK SAFETY

Never assume that equipment is safe to handle without employing the necessary safety precautions. All procedures must comply with local safety regulations. Before use, thoroughly inspect all equipment for any signs of damage. Do not use damaged equipment. It is advisable to avoid conducting tests alone. In the event of an emergency, another person's presence may be crucial.

Ensure that the transformer to be tested is de-energized. Prior to connecting the test cables to a transformer, verify that the grounding input of the TRAN Series is connected to the substation ground. Finally, ensure that the device's power cord is securely plugged into a grounded socket.

NOTICE

There is a risk of electric shock if the device is not properly grounded and/or if the power cord is not connected to a grounded socket. Improper grounding and power connection may result in damage to the instrument and pose a potential risk of injury to test personnel.

⚠ CAUTION

ENVIRONMENT CRITERIA

TRAN Series is designed for both indoor and outdoor operations.

Humidity: Confirm that relative humidity is less than 90% and non-condensing.

Temperature: Confirm that ambient temperature is within the acceptable range as specified in the technical specification.

Altitude: 2000m (6562 ft) to fully safety specifications.

INSTRUMENT CONNECTION AND ACTIVATION

When the internal battery is charged, the HIGHTET device does not need to be connected to a power supply. When the internal battery is not charged the HIGHTET device can be powered by connecting an AC power supply. Use only original power cords supplied with the devices.

- Input Power Supply: 100-240 V (Permissible deviation: ±15%), 47/63 Hz
- Battery: 14.4 V 3.6 Ah
- Power Consumption:100 VA

CONNECTING AC POWER SUPPLY

Verify that the AC power supply meets the HIGHTET device input requirements.

NOTICE

CHARGING INTERNAL BATTERY

Once the AC power supply is connected, the integrated battery will automatically begin charging.

⚠ CAUTION

REPLACING INTERNAL BATTERY AND FUSE

Replacing internal battery and fuse should only be performed either by a HIGHTEST technician or authorised personnel of HIGHTEST. Unauthorised modifications can cause safety hazards and will void the manufacturer's warranty. HIGHTEST Technology Ltd. It assumes no responsibility for the misuse of the device or the compliance of safety precautions.

STORAGE, MAINTENANCE & REPAIRS

Do not store the HIGHTEST device outdoors in extreme weather conditions. The storage temperature must comply with the temperature range specified in Section "Technical Data". Repairs and maintenance should only be performed by a HIGHTEST technician or authorised personnel of HIGHTEST.

CLEANING

Make sure to clean the device front panel in routine basis to avoid the accumulation of dust or dirt on the surface of the device. Use only dry fabric to clean the surface. Do not use any wet tissue on the touch display.

Features

* 3-Phase Turns Ratio Measurement, Excitation Current, Phase Angle, Polarity, Ratio Error (%), Vector group detection, Magnetic Balance; 3-Phase Winding Resistance Measurement
* 7" TFT Colour touch display
* Independent or PC-based control via Data Management Platform (DMP Software)
* Optional Bluetooth interface.
* Instrument and / or PC-based results analysis
* Built-in 2.28-inch Printer
* Optional battery models available
* Multi-language capability
* Tap changer control outputs
* Light, compact and rugged device with an IP protection class of IP67, (case closed)

Scope of Supply

If any of the following content is missing or damaged, please contact your authorized distributor or HighTest Technology Ltd.

Standard Content List

MCS - TRAN-H	5m H Measurement Cable Set for TRAN
MCS - TRAN-X	5m X Measurement Cable Set for TRAN
ECS - TRAN -H	10m Extension Cable Set for TRAN
ECS - TRAN -X	10m Extension Cable Set for TRAN
PWC-01	1.8m Power Cord with Type F plug
GC-01	2.5m Hightest Standard Ground Cable
USB-01	1.8m USB Cable to connect Hightest devices with PCs
USB-02	USB Flash drive (DMP, Manual, Brochure)
TCS-01	1m Tap changer Cable Set
ECS-TC	4m Extension Cable for Tap Changer Cable Set
PP-57	Thermal Printer Paper
SCB-03	Soft Carry Bag for Cables

External/Optional Accessories

The following accessories are not included in the standard box contents. Please contact your authorized distributor or HighTest Technology Ltd.

- Hard Carrying Case

OVERVIEW

The TRAN series of instruments are designed to measure the turns ratio and winding resistance of three-phase and single-phase transformers. Via its user-friendly interface, the TRAN instrument/s provides a fast and accurate assessment of key transformer parameters.

TURNS RATIO MEASUREMENT

The TRAN instrument/s employs elements of performance tests specified in the ANSI/IEEE C57.12.90 standard. With market-leading accuracy, the TRAN instrument has a very wide ratio measurement capability, (0.8 to 50,000) at a precision of 0.08 %. Other features include the measurement of core excitation current, phase angle, polarity, ratio error and magnetic balance.

TRAN instrument can detect vector groups automatically. The instrument has a wide operating range for use on equipment such as high-excitation current transformers and high-power potential transformers in substations. The instrument can generate 1V, 4V, 10V, 40V, 100V, 250V and 430V AC test voltages.

WINDING RESISTANCE MEASUREMENT

Applying up to 20 Amps of direct current allows the TRAN series to measure the resistance of three-phase transformer windings quickly and accurately. TRAN instrument/s are designed to measure the resistance of the primary and secondary transformer windings simultaneously without the need to disconnect and reconnect the test cables.

Starting at 0.1 μΩ, the TRAN series can measure up to 100,000 Ω of resistance. The instrument can also measure the dynamic resistance of on-load tap changers, (OLTCs) simultaneously on all three phases or one phase at a time. The TRAN series can demagnetise the transformer to mitigate the build-up of remanence or residual magnetism due to the testing. The instrument also has a temperature measurement input which when connected to an optional temp sensor allows the TRAN series to perform temperature correction or adjustments to its measurements. In the case of a failure in the current circuit, the TRAN instrument/s intelligent software controls the flow of current to mitigate damage and provide added safety for users.

FRONT PANEL

Power Connector

- TRAN's AC power input
- The input voltage should be between 100-240Vac 47/63 Hz.

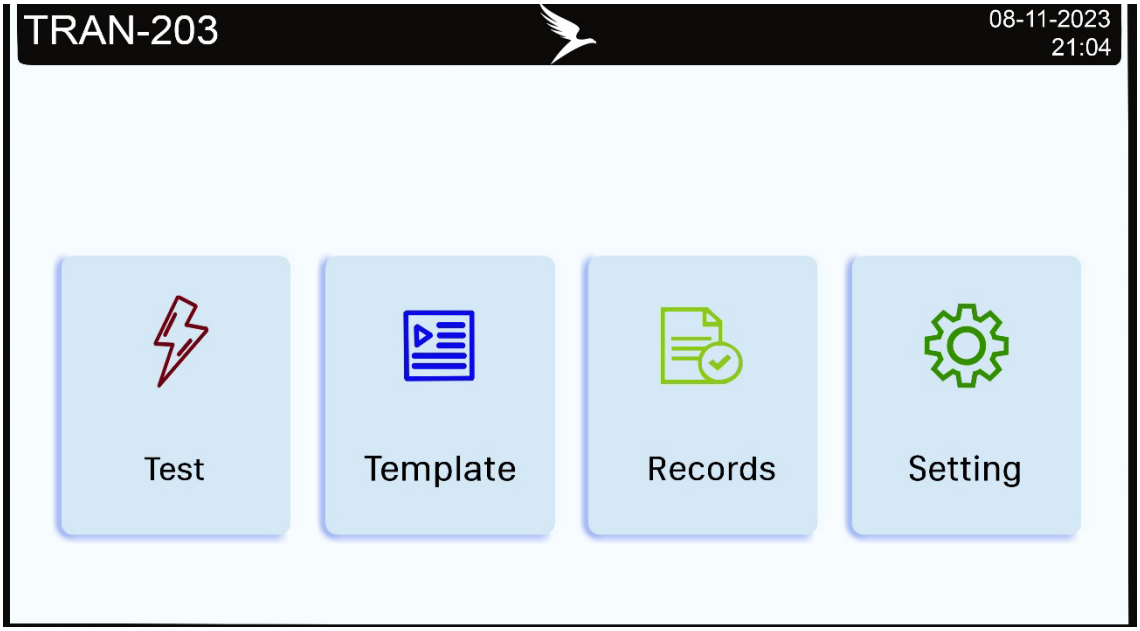
Ground Connector

- Make sure the Ground is connected prior to energising and testing.

Charging Indication LED

- LED flashes while the device is charging.
- If the device is fully charged, the indicator LED stops flashing and stays lit up continuously.

Display



- 7-inch Resistive Touch TFT Display great convenience to users.
- It allows TRAN to show all measurement results on a single screen.
- Visibility in daylight and low light levels
- Able to adjust the brightness level.

Emergency Stop Button

Push the emergency button while testing to stop the ongoing test in an emergency situation. In addition to the designated 'Emergency Button', TRAN's power button will also function as 'Emergency Stop'.

Power Button

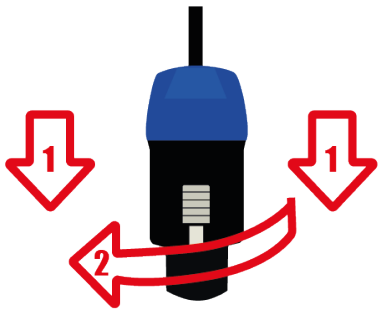
Power Button has some specific tasks apart from the intended purpose.

- To turn ON the device.
- Pressing the power button for 2 seconds while the device is ON will switch off the device automatically. (Display status is negligible.)
- You can switch the device OFF with a single press on the power button while the device is on the main page.
- Can be used as a "**Back**" button on pages other than the home page.
- Can also be used as an "**Emergency Stop**" while performing the test.

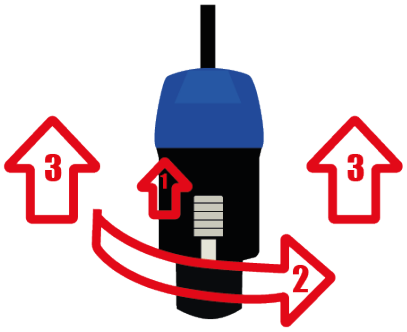
H & X Cable Connector

To connect the test cables to TRAN. Make sure the test cable is properly connected before starting the test.

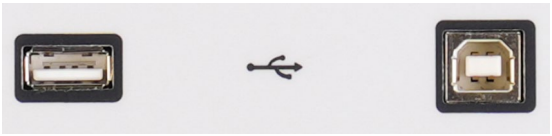
- Snap the test cable into place and turn it clockwise slightly. Check the latch is locked.



- To remove the test cable, hold the latch UP slightly, turn it counterclockwise and pull it out.



USB Connection Port



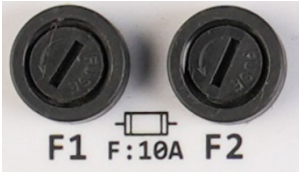
There are two USB ports available on TRAN.

- USB 2.0/1.1 Standard-A, to connect an external USB flash drive to save the test results and to update software.
- USB 2.0/1.1 Standard-B, to control TRAN via computer. The cable to be used should not be longer than 1 meter.

Tap Changer Output

TRAN comes with a built-in Tap Changer Control unit. Users can control the Tap changer with menu available on display while performing the test. You can easily set tap changer contact time or wait time with the available on-screen settings.

Fuse



To provide overcurrent protection for the electrical circuit of TRAN.

Printer

TRAN comes with a 2.28-inch built-in printer which allows the operator to print the measurement results. If the paper is empty, lift the printer cover up to load the new paper roll and close the cover.

Discharge Indication LED

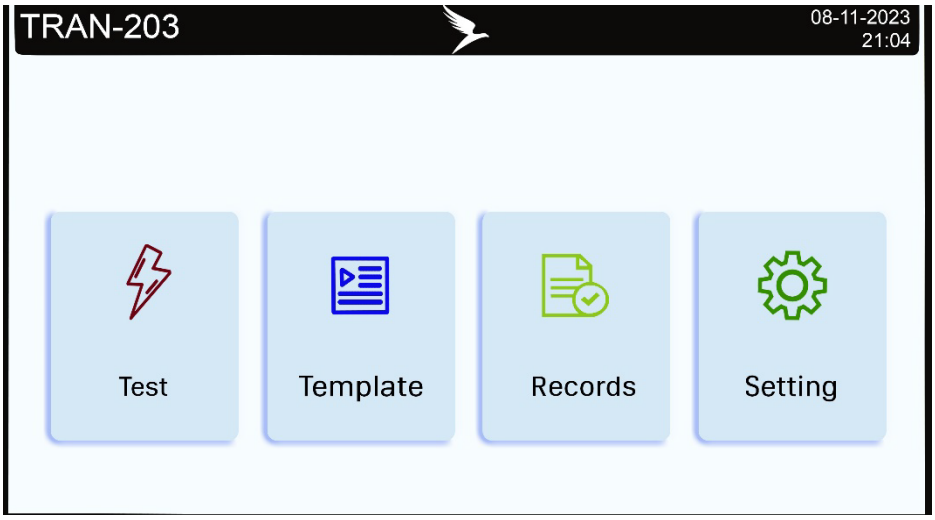
This LED flashes when the TRAN is discharging the stored energy from the transformer. Do NOT disconnect test leads when this light is on. Failure to follow the instructions and warning may cause injury to test personnel and /or damage to the device.

Temperature Sensor Connector

To connect the temperature sensor with TRAN in order to obtain automatic temperature correction.

DISPLAY INTRODUCTIONS

HOME PAGE



- To select test
- To create templates
- To access saved test records
- To add and save test settings
- Indicates the current date and time
- Indicates when Bluetooth is active.
- Indicates when the USB memory is inserted. If it is green, the automatic recording option is active.
- Indicates the battery level and status
- Critical battery warning. The display shows the warning if the battery is at/below 15%. No test can be performed if the battery is at a critical level.

1. SETTINGS

In this menu, the device settings can be altered and necessary settings related to the test to be performed can be made. Settings consist of 5 sections. You can make the following settings under this menu:

1. Device Settings

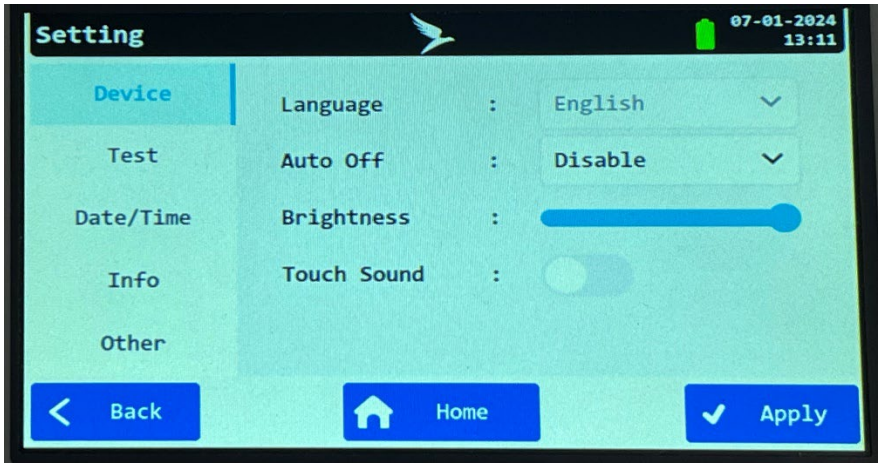
2. Test Settings

3. Date/Time Settings

4. Info Settings

5. Others

Following is the page of 'Setting'



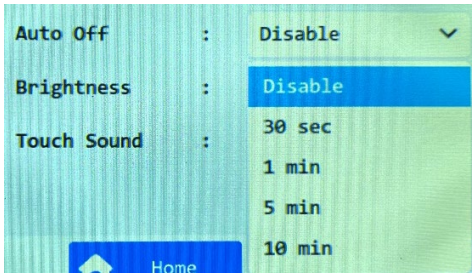
You can use the 'Back' tab to exit the menu, 'Home' tab to view the home page and 'Apply' tab to implement the changes.

1.1 Device Settings

You can make the following settings under the device settings menu:

1.1.1 Language: TRAN series support the language EN (ES, TR, DE, FR and many more will be added soon). If the language button is enabled press the tab to choose the desired language for changing the device's default language.

1.1.2 Auto Off: To set the 'Auto Off' to automatically turn off the display after certain seconds/minutes of inactivity. To turn it on again, press the Power button.



1.1.3 Brightness: The brightness of the display can be set by using the adjustable bar. Keep the screen brightness to a minimum for longer battery life.

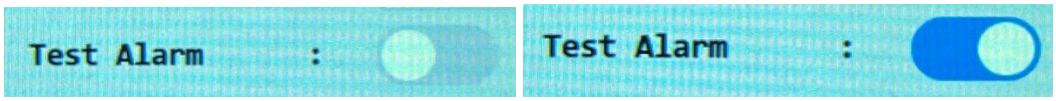
1.1.4 Touch Sound: To turn on the touchpad sound the touch sound button needs to be enabled and to turn it off the button needs to be disabled.

1.2 Test Setting

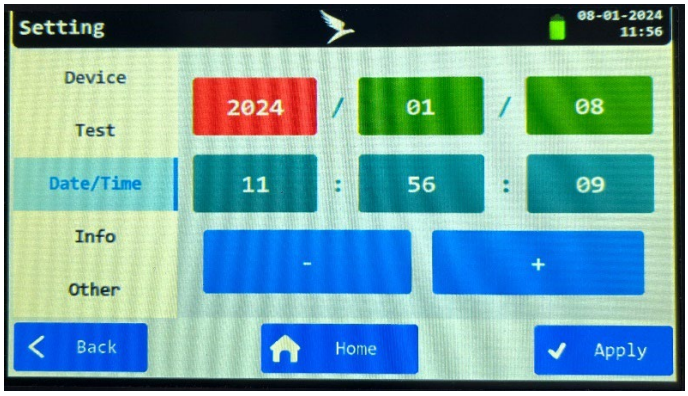
Test setting consists of 2 features. You can make the following settings under this menu:

1.2.1 Standard: To select the standard of test procedure which is designed according to the international standards of the ANSI, IEC and Australian.

1.2.2 Test Alarm: To turn on the 'Test Alarm' sound the test alarm button needs to be enabled which makes the alarm sound run at the beginning of the test and to turn it off the button needs to be disabled.



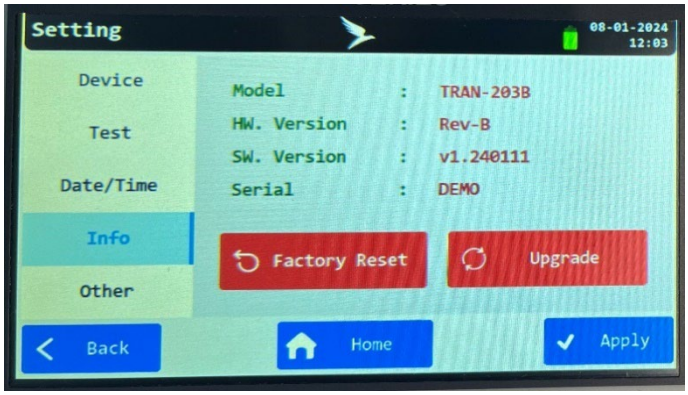
1.3 Date/Time Settings



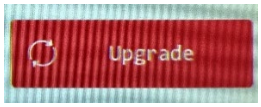
TRAN has a high-accuracy real-time clock.

- Press the 'Date/Time' tab in the 'Setting' menu to change the date or time.
- Choose the parameter to be changed and then use '+/-' tabs to alter it.
- Press 'Apply' after making the necessary changes.

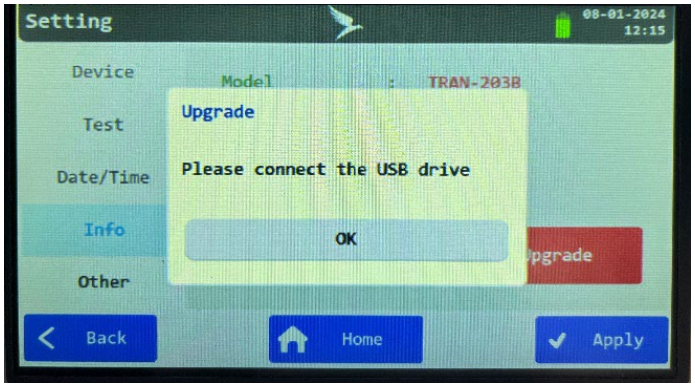
1.4 Info Settings



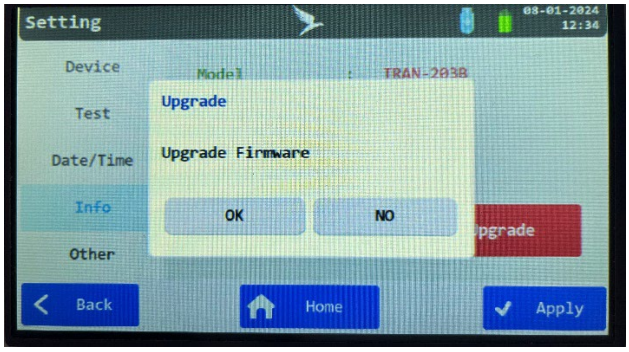
'Info' menu makes it available to reach the information about TRAN.



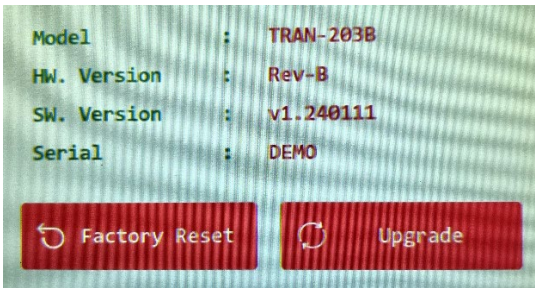
Download the latest version of the software from www.hightest.co.uk for software updates and by using a USB, you can update the device by pressing the 'Upgrade' tab.



If the USB is not connected, the following pop-up will appear on the screen.



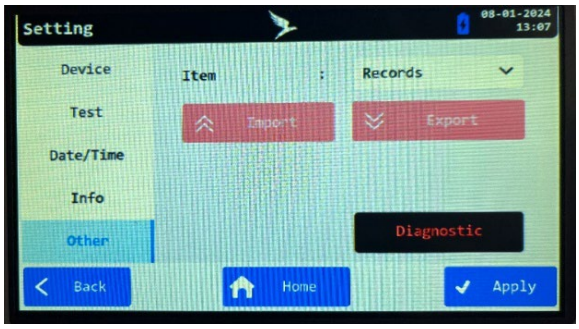
The following window appears after connecting the USB and pressing the 'Upgrade' tab. Press 'Ok' to continue the upgrading process.



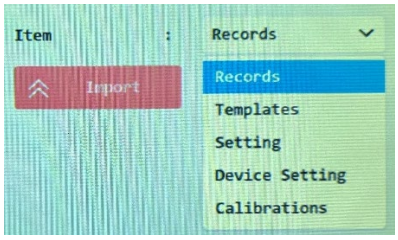
Then the following screen will appear and TRAN's firmware will be updated.

You can use the 'Factory Reset' tab to reset the device to factory default settings. All the saved test results and templates will be permanently deleted.

1.5 Others



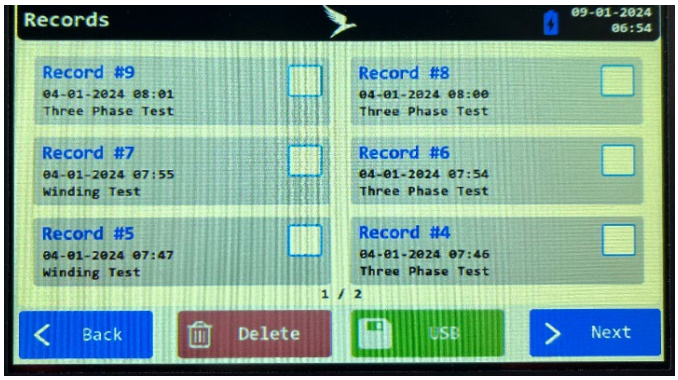
'Other' menu has 'Item' tab which is used with 'Import' and 'Export' buttons.

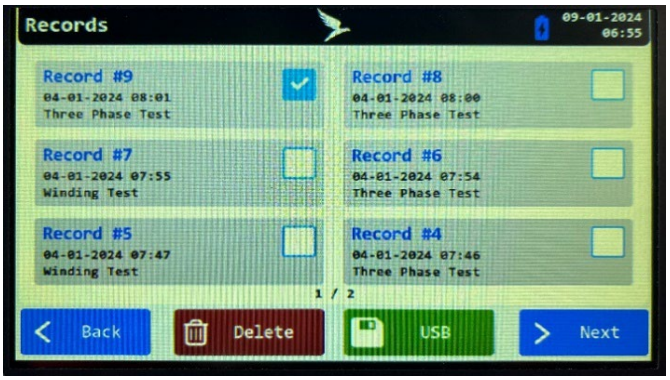


Export provides saving the 'Records' from USB to the device. Import provides saving 'Records, Templates, Setting, Device Setting, Calibrations' both from USB to device and from device to the USB.

'Diagnostic' makes it available to test the channel. It needs a password to enter the menu.

2. RECORD

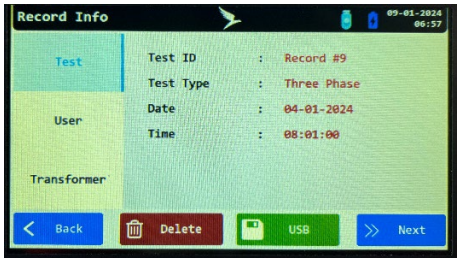


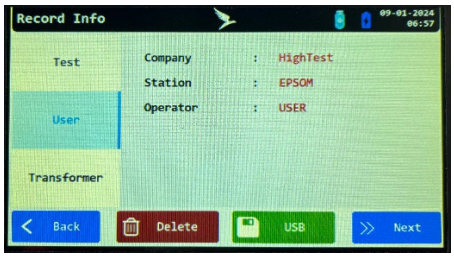


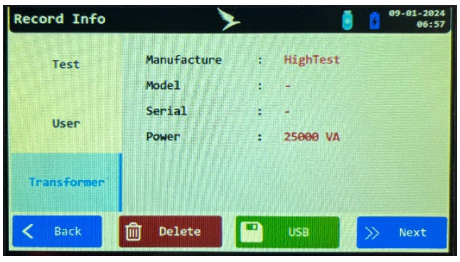
You can access the test results that you have already saved from the 'Record' menu on the home page. You can also quit the tests at some point, and later continue from where you left the test. 'Delete' and 'USB' buttons get enabled when you choose the records you selected.

TRAN can store 100 test results in its internal memory. Each test can have 100 test results, 35 taps, 3 phase and 3 measurements such as ratio, current and phase difference. Therefore, TRAN can hold up to 31500 measurements in total. In addition to the internal memory, TRAN has unlimited extended memory by using an external USB. When a USB is connected, the test records will be saved to USB.

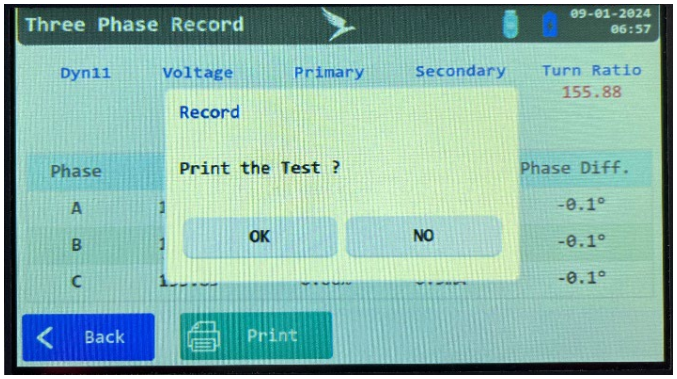
TRAN can store 1000 test results in its internal memory.



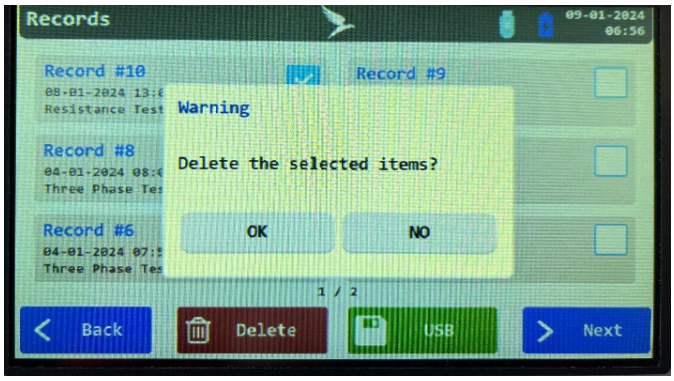


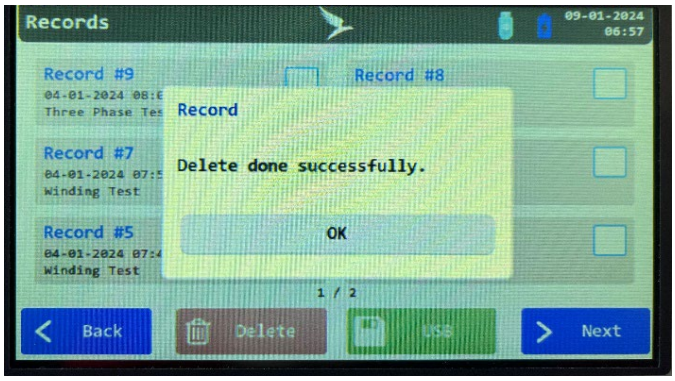


The details of the test records will be displayed as shown in the pictures given above.



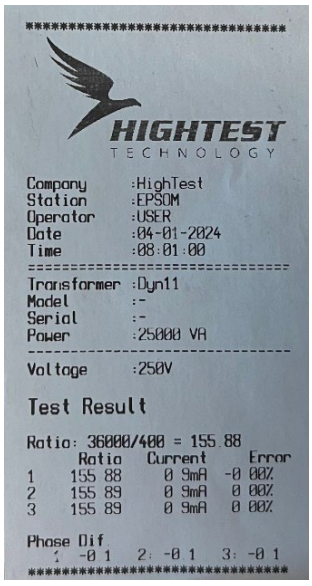
You can print the test using the 'Print' tab.



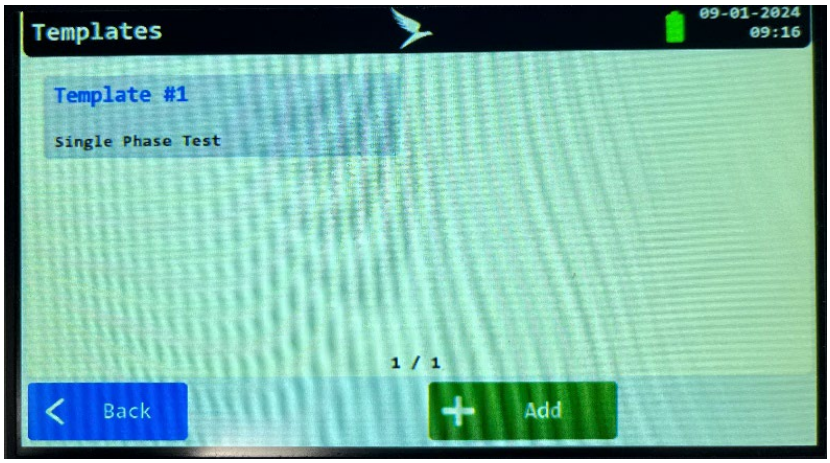


For the completed tests, you can either print results or delete a result from record.

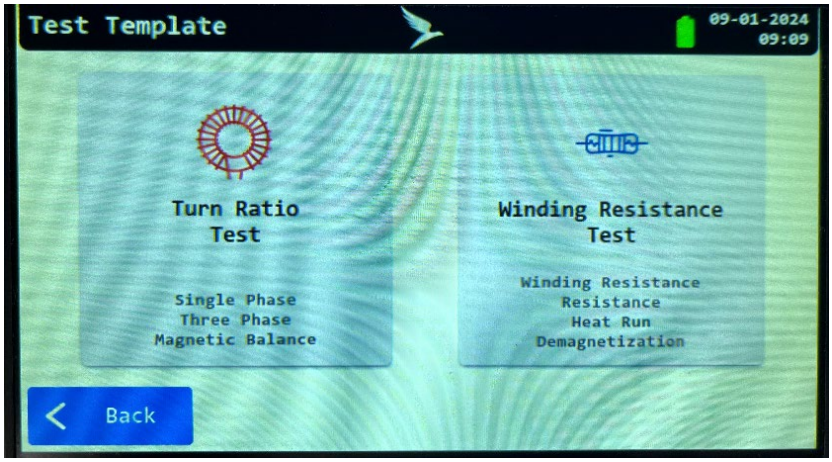
The printed result will be as follows;



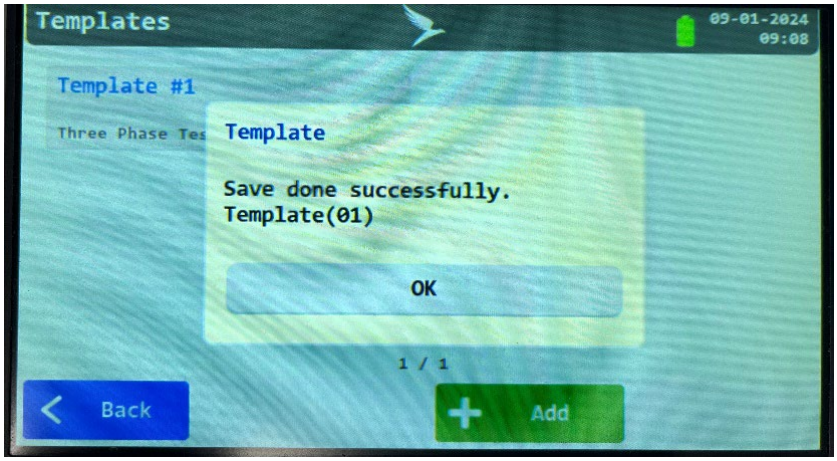
3. TEMPLATE



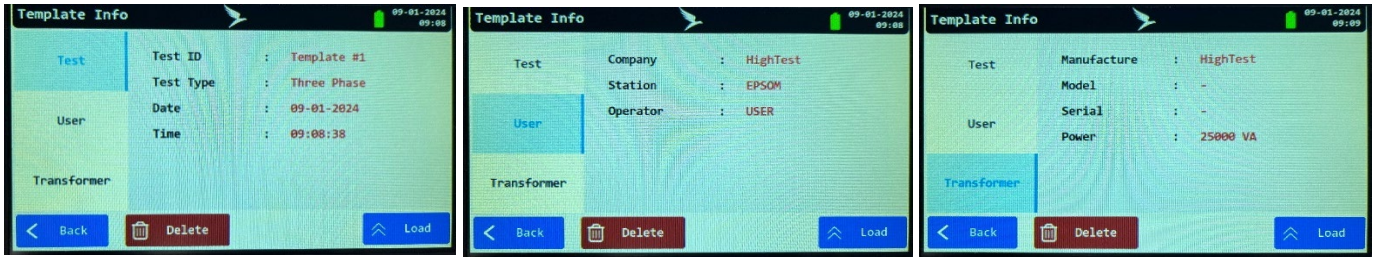
You can both create a template by using the 'Add' tab and access the templates that you have already saved on the device from the 'Template' menu.



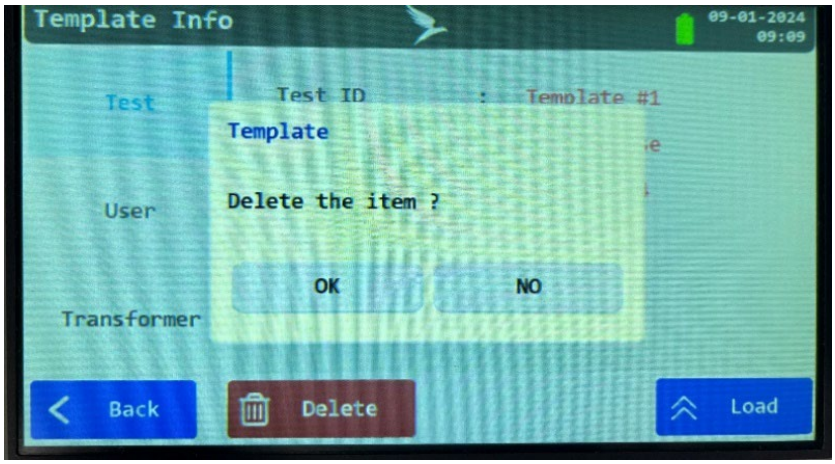
To create a template by using the 'Add' tab, you choose one of the test menus between 'Turn Ratio Test' and 'Winding Resistance Test'. After that you choose the required test category and improve the test settings.



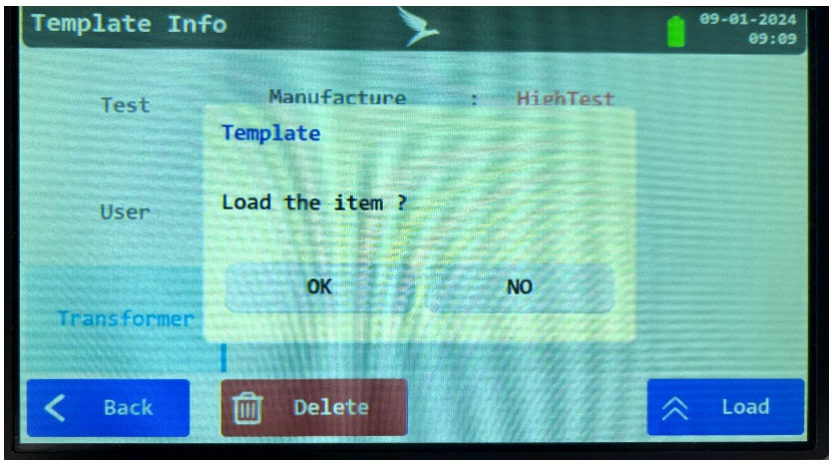
To create the template use the 'Apply' button. You will get the following pop-up appear on the screen.



To see your previously created template choose the related template that you have already saved on the device. To reach the 'Test' informations such as 'Test ID, Test Type, Date, Time' click on the relevant tab. You can access 'Company, Station, Operator' information on the 'User' menu. To see 'Manufacture, Model, Serial, Power' information use the 'Transformer' menu.

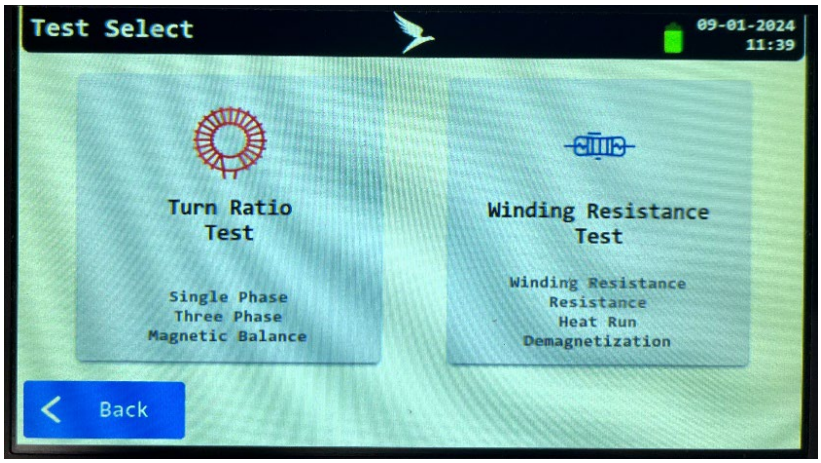


For the previously saved templates, you can delete it by using the 'Delete' tab.



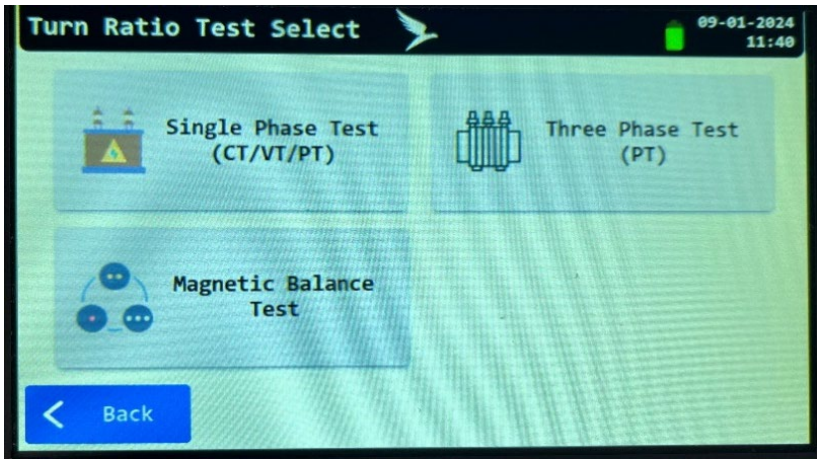
To run a previously saved template, click the 'Load' tab.

4. TEST



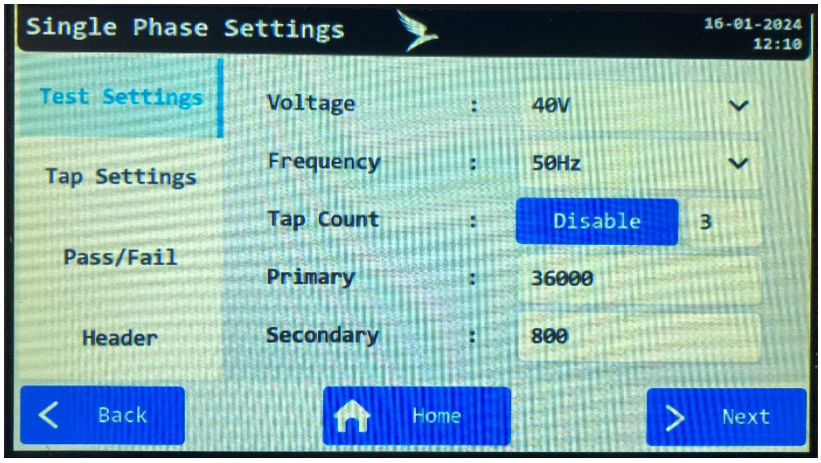
When you choose the 'Test' menu on the home screen, the page above will open. On the 'Test Select' page, you choose a menu between 'Turn Ratio Test' and 'Winding Resistance Test'

4.1 TURN RATIO TEST

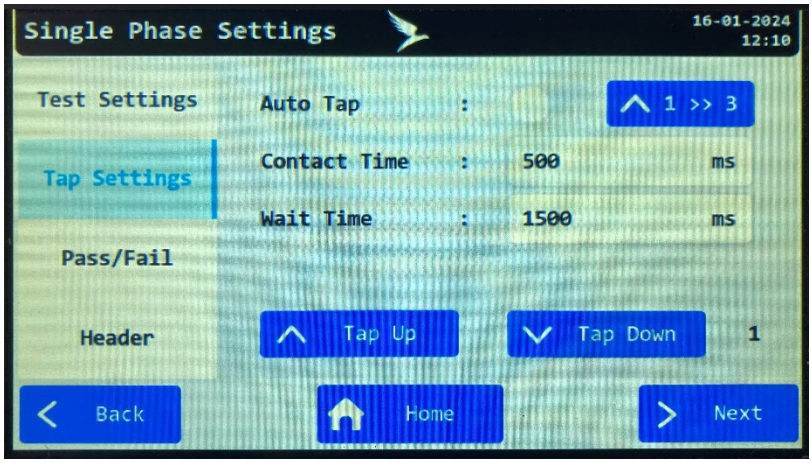


Under the 'Turn Ratio Test' menu, there are three sub-menu to perform; 'Single Phase Test', 'Three Phase Test' and 'Magnetic Balance Test'.

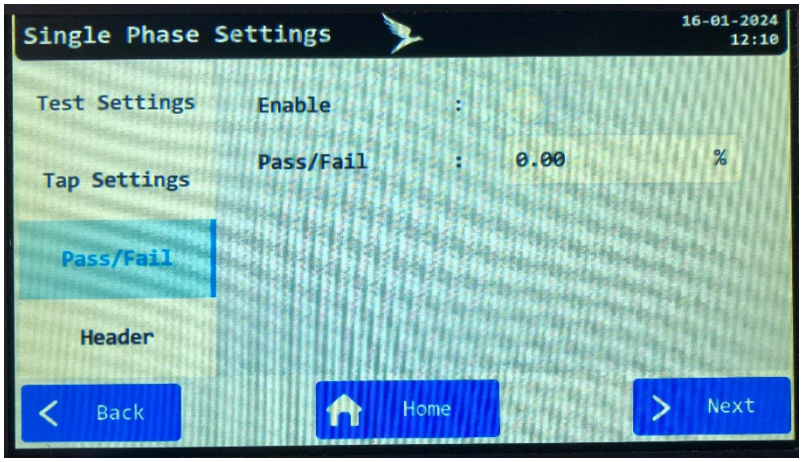
4.1.1 SINGLE PHASE TEST (CT/VT/PT)



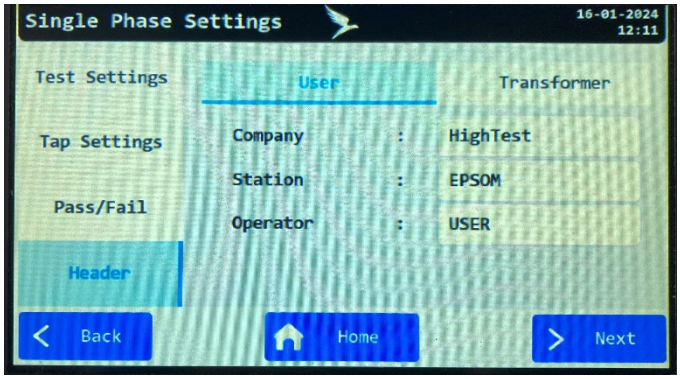
On the 'Test Settings' part, select the appropriate test voltage for your transformer by pressing on 'Voltage' tab on the screen. You can choose from the following menu. To change the frequency, click on the 'Frequency' tab. You can make your selection by clicking on the desired test frequency. 'Tap Count' has 3 options to choose. You can choose 'Primary', 'Secondary' or 'Disable'. If your choice is not Disable, press on Tap Count to enter the number of taps. Users may enter the primary and secondary values of the transformer to be tested by using the device's onscreen keyboard.

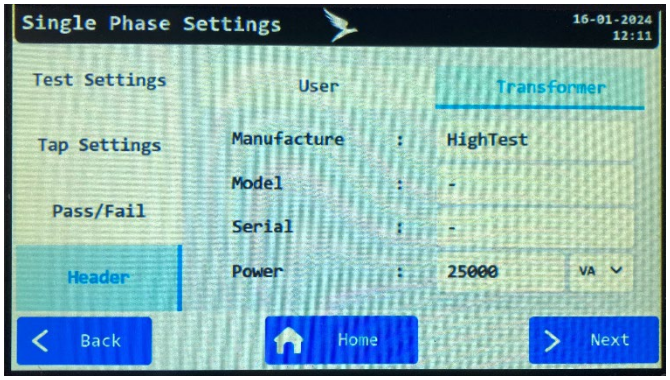


On the 'Tap Settings' part, if the 'Auto Tap' is enabled, TRAN will automatically change the taps. To set the contact time, tap on the space provided to enter 'Contact Time'. Press 'Enter' to save the value and return to the previous page. And to set the wait time, tap on the space provided to enter 'Wait Time'. Press 'Enter' to save the value and return to the previous page.



On the 'Pass/Fail' part, users are able to set pass-fail criteria depending on their requirements.

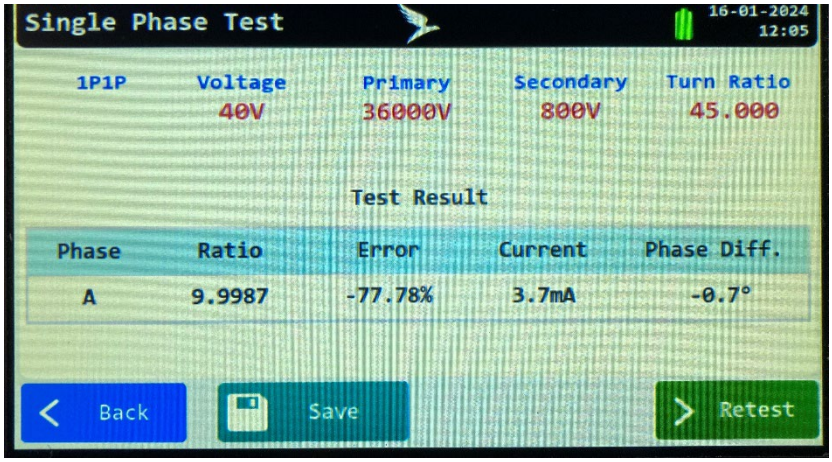




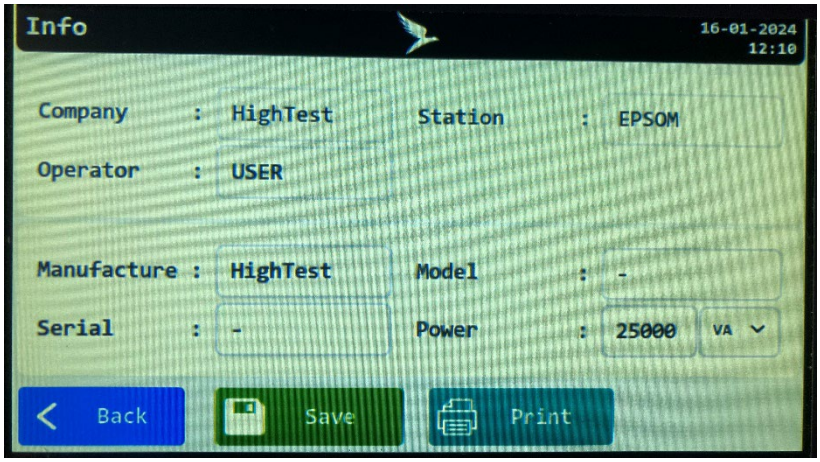
On the 'Header' part, there is 2 sections. By using 'User', you can enter 'Company', 'Station', and 'Operator' informations. Click on the relevant tab to enter data using the on-screen keyboard. By using 'Transformer', you can enter 'Manufacture', 'Model', 'Serial' and 'Power' informations. You can enter new details or can use already existing default details.

CAUTION!

During the test, you can press 'Emergency Stop' button on the front panel or you can touch on the 'Screen' or simply press the 'Power Button' in an emergency situation. The test will be cancelled immediately.



You can repeat the test by pressing 'Retest' or proceed to save the result by pressing 'Save'.

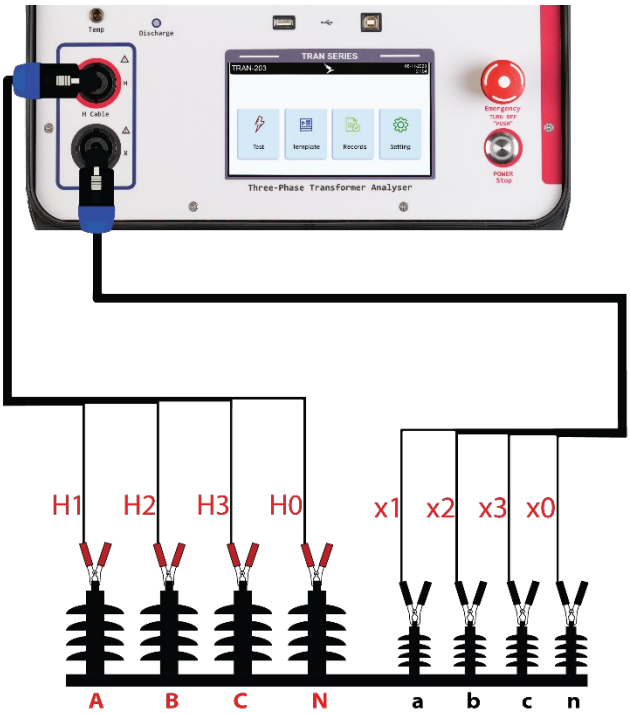


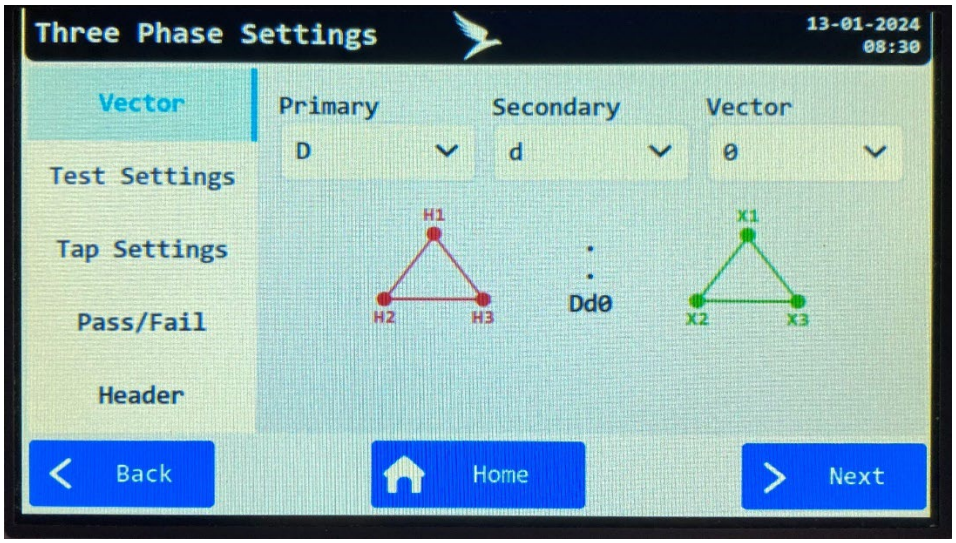
The 'Info' screen is as shown above. You can enter new details or can use already existing default details. Tap on the concerned tab to enter each detail. You can input the details using on-screen keyboard of TRAN. You can 'Save' or 'Print' the test result.

The printed result will look as follows,

4.1.2 THREE PHASE TEST (PT)

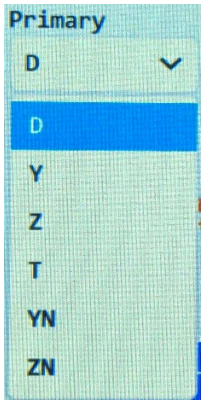
Connection Diagram



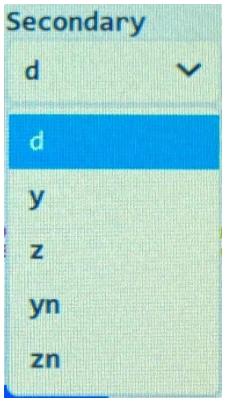


'Three Phase Test' menu has 5 setting sections. Under 'Vector' part, users may choose the vector group and enter information about the transformer to be tested. You can make appropriate selections by pressing on 'Primary', 'Secondary' and 'Vector' tabs.

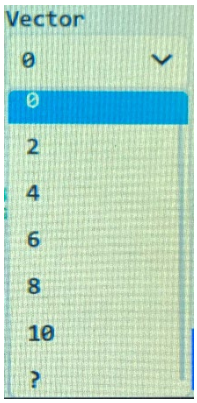
To select the primary connection;

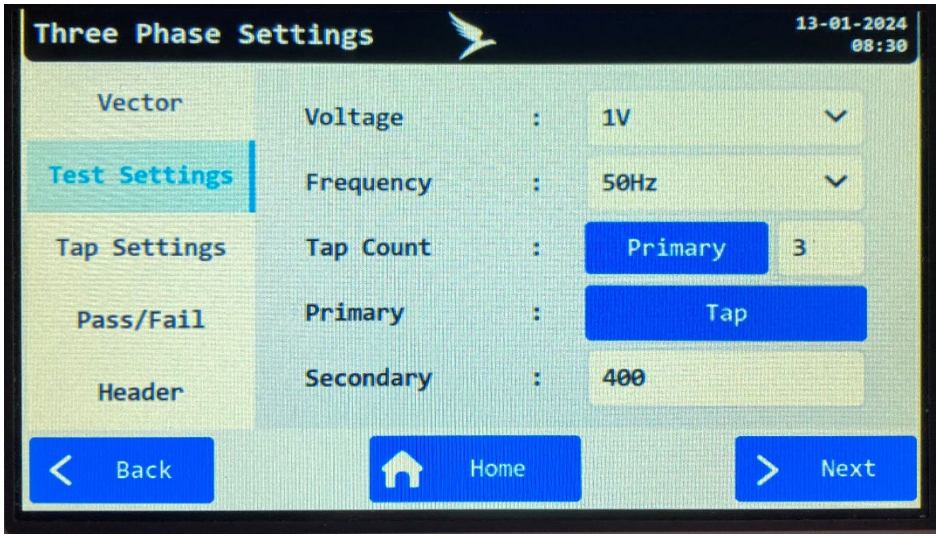


To select the secondary connection;

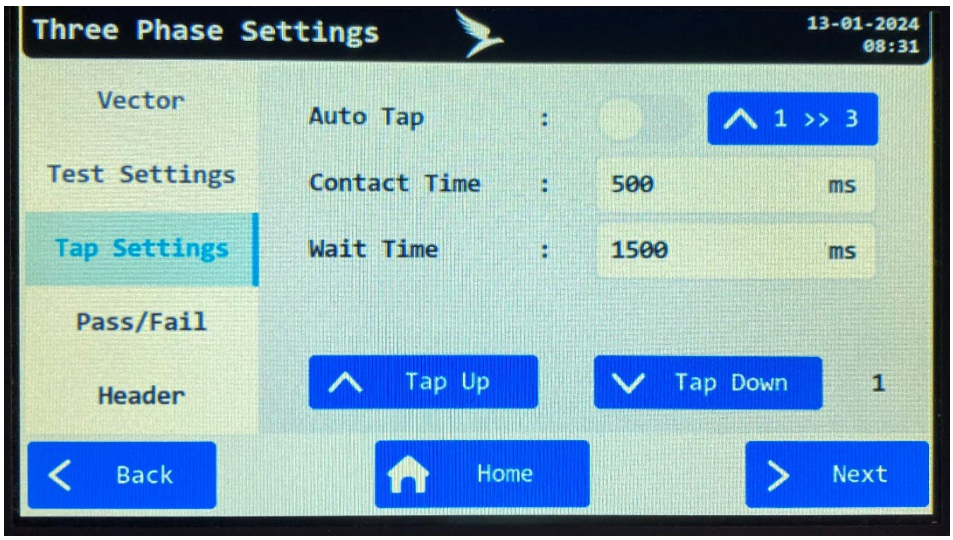


And you can choose the vector number by clicking on the tab 'Vector'.

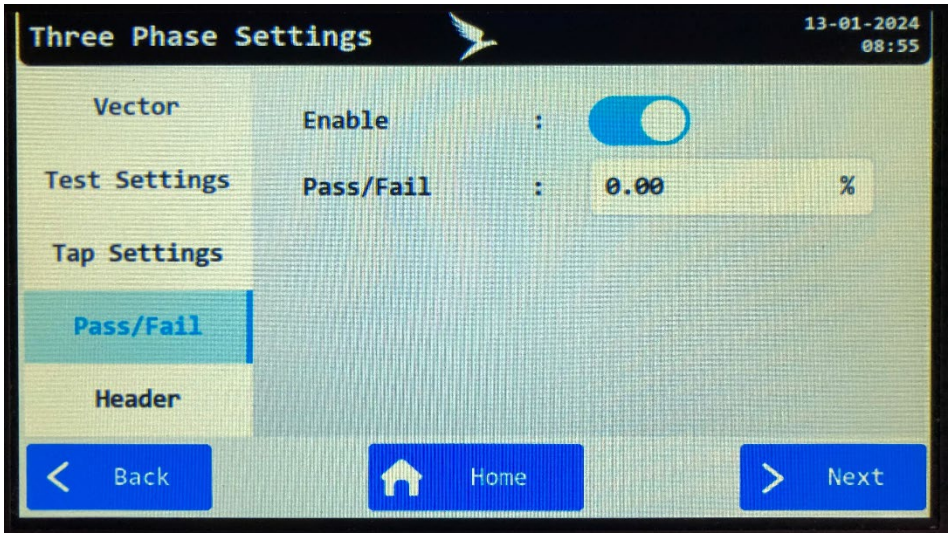




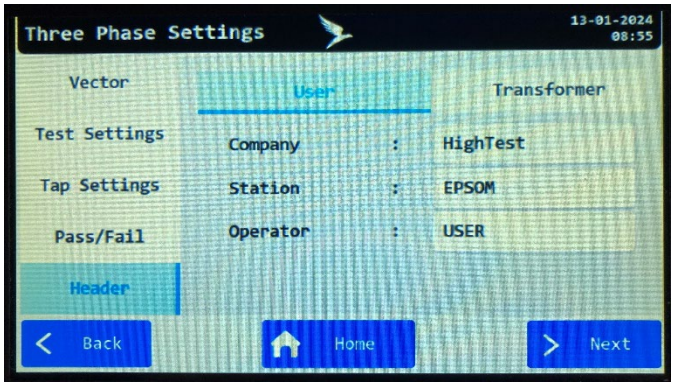
On the 'Test Settings' part, select the appropriate test voltage for your transformer by pressing on 'Voltage' tab on the screen. You can choose from the following menu. To change the frequency, click on the 'Frequency' tab. You can make your selection by clicking on the desired test frequency. 'Tap Count' has 3 options to choose. You can choose 'Primary', 'Secondary' or 'Disable'. If your choice is not Disable, press on Tap Count to enter the number of taps. Users may enter the primary and secondary values of the transformer to be tested by using the device's onscreen keyboard.

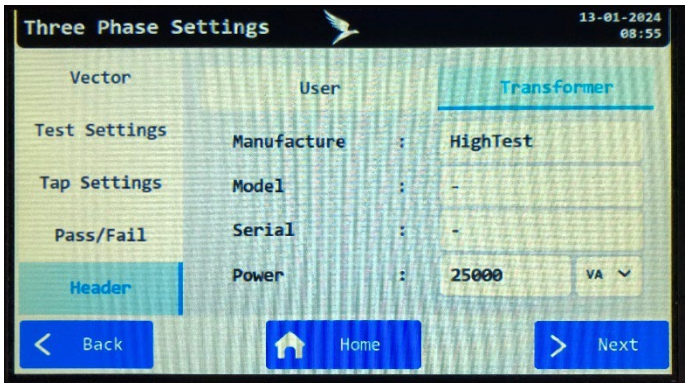


On the 'Tap Settings' part, if the 'Auto Tap' is enabled, TRAN will automatically change the taps. To set the contact time, tap on the space provided to enter 'Contact Time'. Press 'Enter' to save the value and return to the previous page. And to set the wait time, tap on the space provided to enter 'Wait Time'. Press 'Enter' to save the value and return to the previous page.



On the 'Pass/Fail' part, users are able to set pass-fail criteria depending on their requirements.

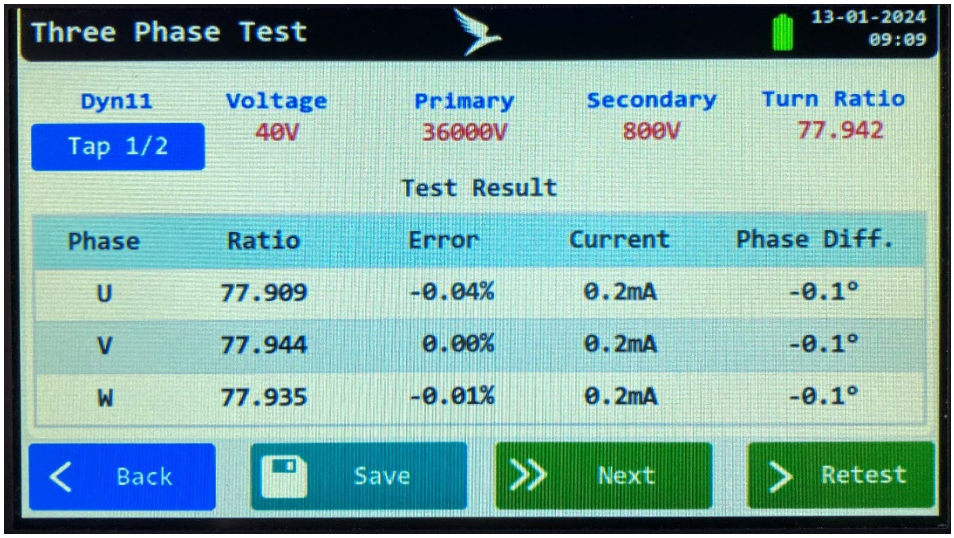




On the 'Header' part, there is 2 sections. By using 'User', you can enter 'Company', 'Station', and 'Operator' informations. Click on the relevant tab to enter data using the on-screen keyboard. By using 'Transformer', you can enter 'Manufacture', 'Model', 'Serial' and 'Power' informations. You can enter new details or can use already existing default details.

CAUTION!

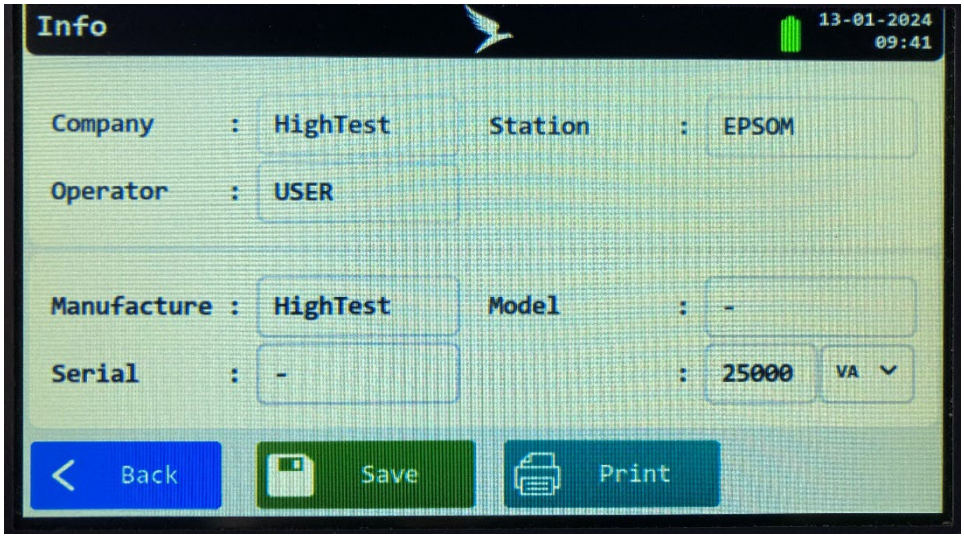
During the test, you can press 'Emergency Stop' button on the front panel or you can touch on the 'Screen' or simply press the 'Power Button' in an emergency situation. The test will be cancelled immediately.



On the result screen, following details are shown;

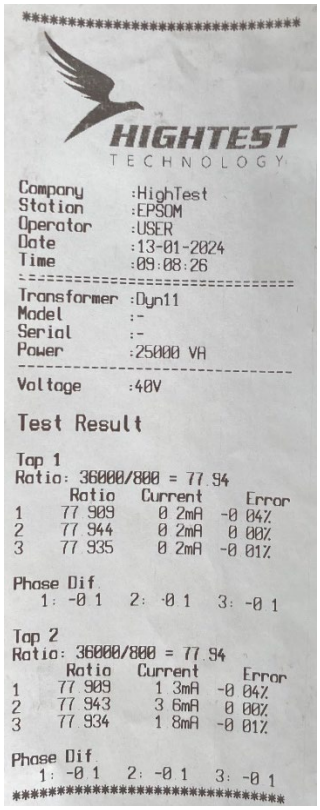
- Measured ratio,
- Percentage error of measured ratio according to calculated ratio,
- Excitation current,
- Phase Angle difference between primary and secondary.

If you want, you can repeat the test for that phase after each result screen has been reached by using 'Retest' button, or you can move to the next 'Tap' with the 'Next' tab. Once the test gets completed, you can save the test results to the device memory, USB memory and print the test using TRAN's built-in printer.



You can repeat the test or proceed to save the result by pressing 'Next'. The 'Info' screen is as shown above. You can enter new details or can use already existing default details. Tap on the concerned tab to enter each detail. You can input the details using on-screen keyboard of TRAN. You can 'Save' or 'Print' the test result.

The printed result will look as follows,



HIGHTEST
TECHNOLOGY

Company :HighTest
Station :EPSOM
Operator :USER
Date :13-01-2024
Time :09:08:26

Transformer :Dyn11
Model :-
Serial :-
Power :25000 VA

Voltage :40V

Test Result

Tap 1
Ratio: 36000/800 = 77.94

	Ratio	Current	Error
1	77.909	0.2mA	-0.04%
2	77.944	0.2mA	0.00%
3	77.935	0.2mA	-0.01%

Phase Dif.
1: -0.1 2: -0.1 3: -0.1

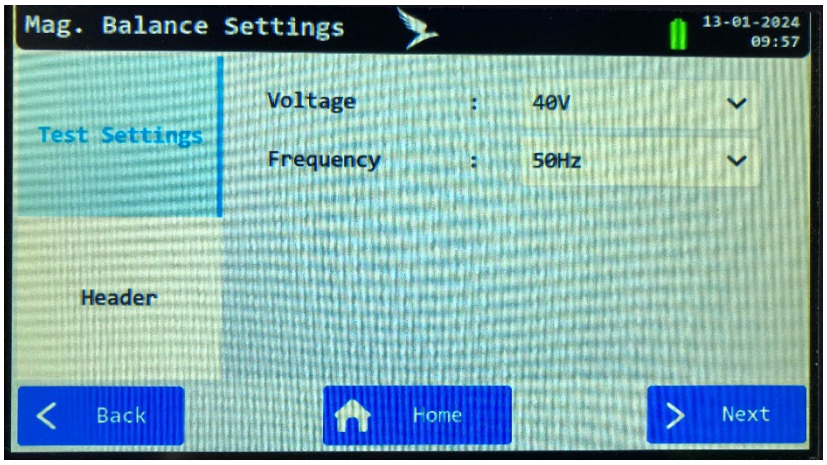
Tap 2
Ratio: 36000/800 = 77.94

	Ratio	Current	Error
1	77.909	1.3mA	-0.04%
2	77.943	3.6mA	0.00%
3	77.934	1.8mA	-0.01%

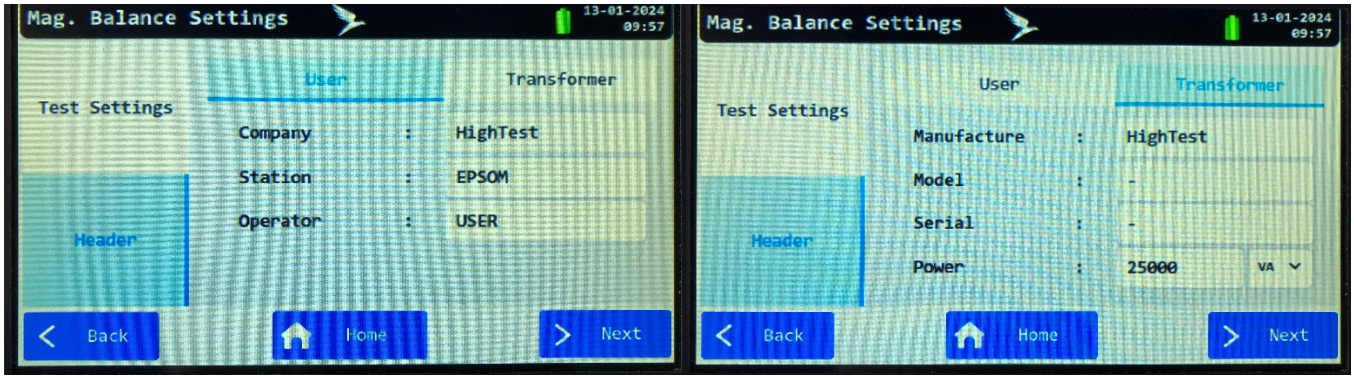
Phase Dif.
1: -0.1 2: -0.1 3: -0.1

4.1.3 MAGNETIC BALANCE TEST

Magnetic Balance tests are performed to figure out the magnetic imbalance of the core of the transformer to be tested. There is no accurate result for Magnetic Balance Tests and can only interpret with another transformer test like Winding Resistance measurement.



On the 'Test Settings' part, select the appropriate test voltage for your transformer by pressing on 'Voltage' tab on the screen. You can choose from the following menu. To change the frequency, click on the 'Frequency' tab. You can make your selection by clicking on the desired test frequency.



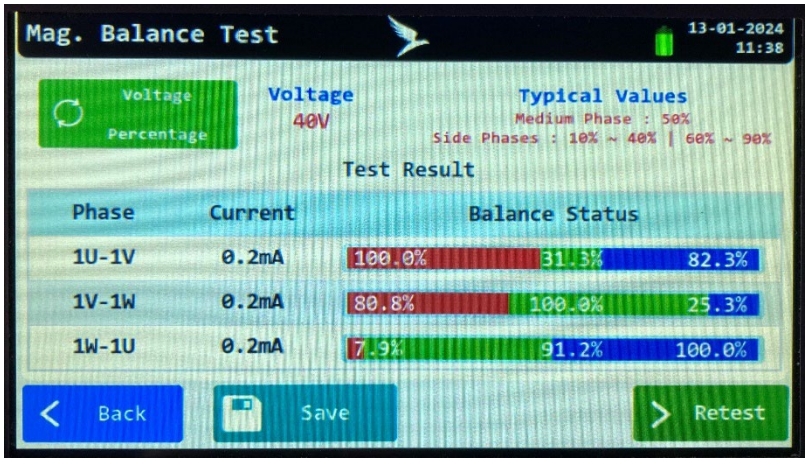
The user and transformer information screen is as the other 'Header' parts. By using 'User', you can enter 'Company', 'Station', and 'Operator' informations. Click on the relevant tab to enter data using the on-screen keyboard. By using 'Transformer', you can enter 'Manufacture', 'Model', 'Serial' and 'Power' informations. You can enter new details or can use already existing default details.

Make the connections and after assigning the test voltage, press 'Next'.

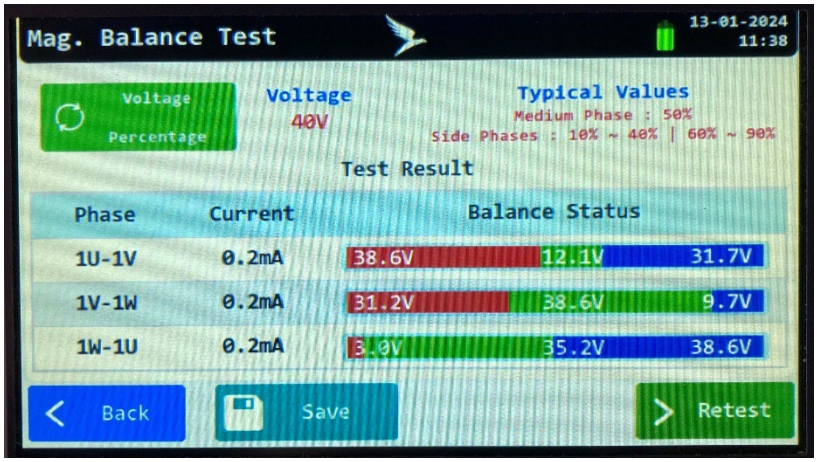
CAUTION!

During the test, you can press 'Emergency Stop' button on the front panel or you can touch on the 'Screen' or simply press the 'Power Button' in an emergency situation. The test will be cancelled immediately.

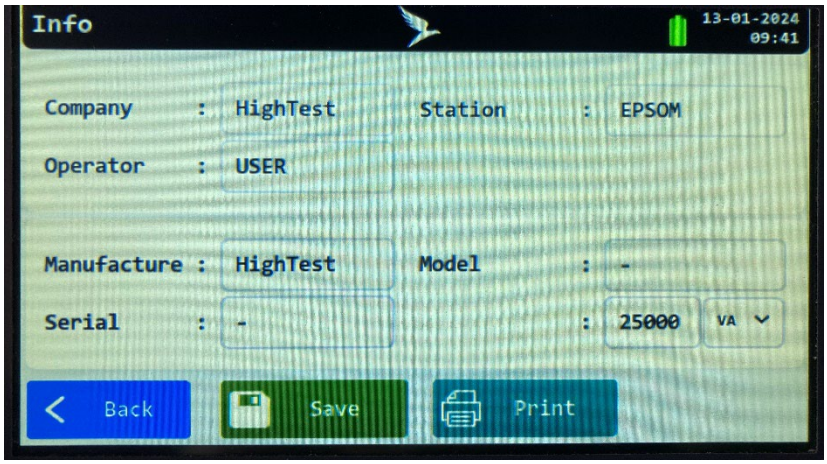
The result page will appear as follows,



You can also view the results in terms of voltage. For that, press on the 'Voltage - Percentage' tab.

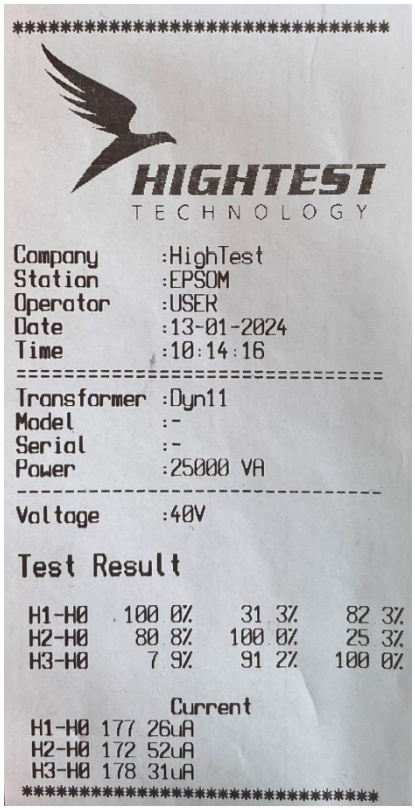


If you want, you can repeat the test for that phase after each result screen has been reached by using 'Retest' button, or you can move to the next 'Tap' with the 'Next' tab. Once the test gets completed, you can save the test results to the device memory, USB memory and print the test using TRAN's built-in printer.



You can repeat the test or proceed to save the result by pressing 'Next'. The 'Info' screen is as shown above. You can enter new details or can use already existing default details. Tap on the concerned tab to enter each detail. You can input the details using on-screen keyboard of TRAN. You can 'Save' or 'Print' the test result.

The printed result will look as follows,



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HIGHTEST
TECHNOLOGY

Company :HighTest
Station :EPSOM
Operator :USER
Date :13-01-2024
Time :10:14:16

==========

Transformer :Dyn11
Model :-
Serial :-
Power :25000 VA

Voltage :40V

Test Result

H1-H0	100.0%	31.3%	82.3%
H2-H0	80.8%	100.0%	25.3%
H3-H0	7.9%	91.2%	100.0%

Current

H1-H0 177.26uA
H2-H0 172.52uA
H3-H0 178.31uA

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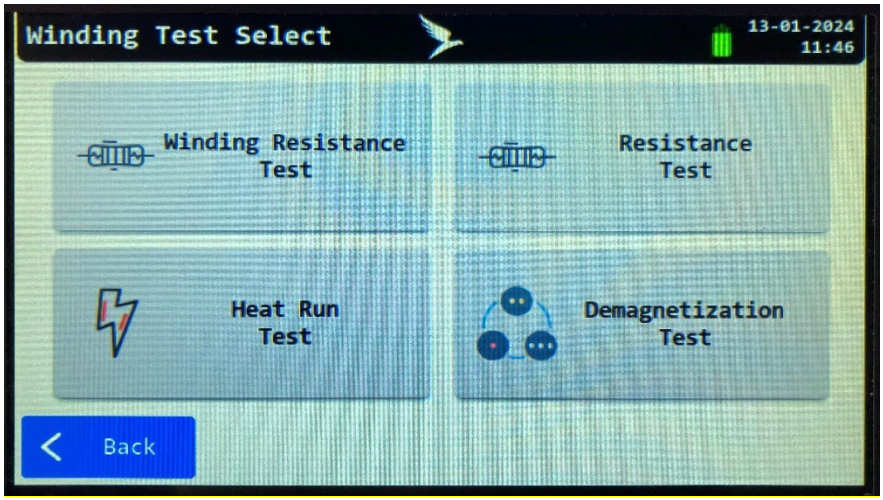
4.2 WINDING RESISTANCE TEST

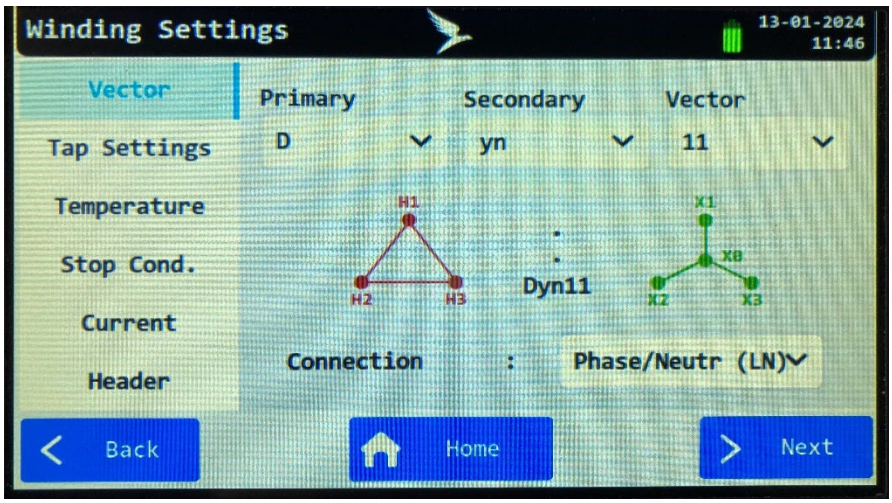
You can carry out the following tests using this menu;

1. Winding Resistance Test
2. Resistance Test
3. Heat-Run Test
4. Demagnetization Test

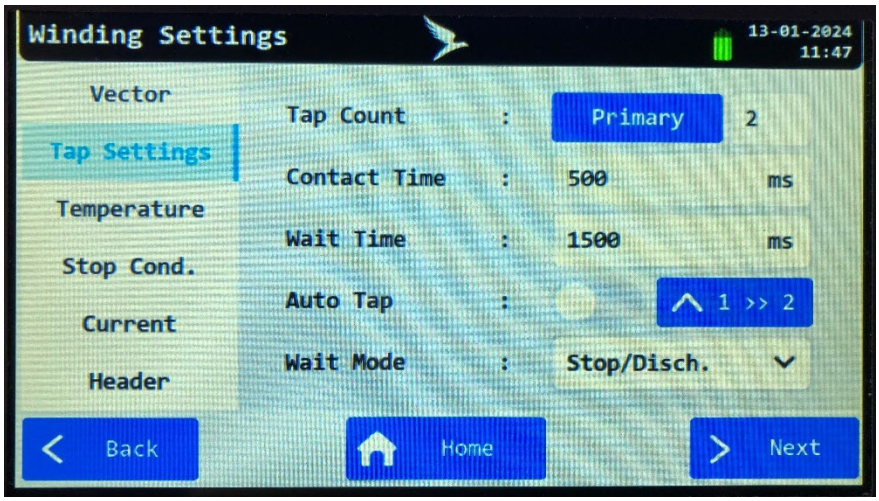


4.2.1 WINDING RESISTANCE TEST

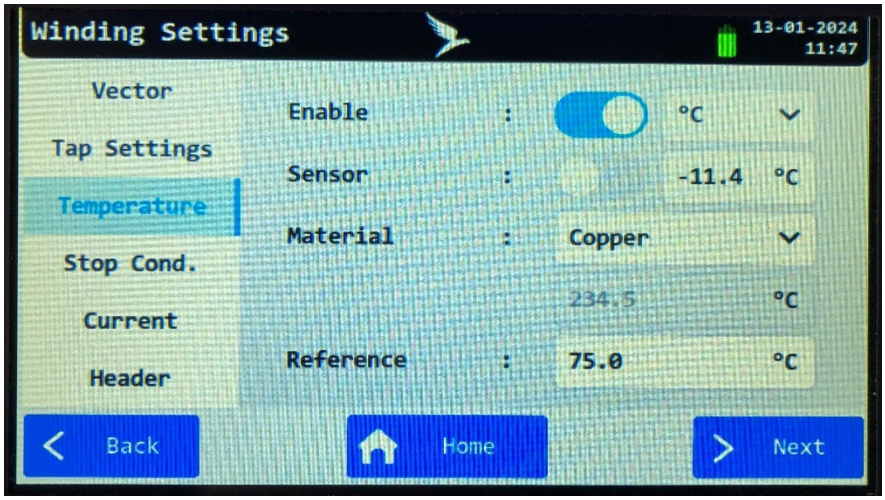
Winding test is performed to confirm each circuit is wired properly and connections are tight. Press the 'Winding Resistance Test' tab to perform the wind test. Press on the corresponding tabs to choose test details.



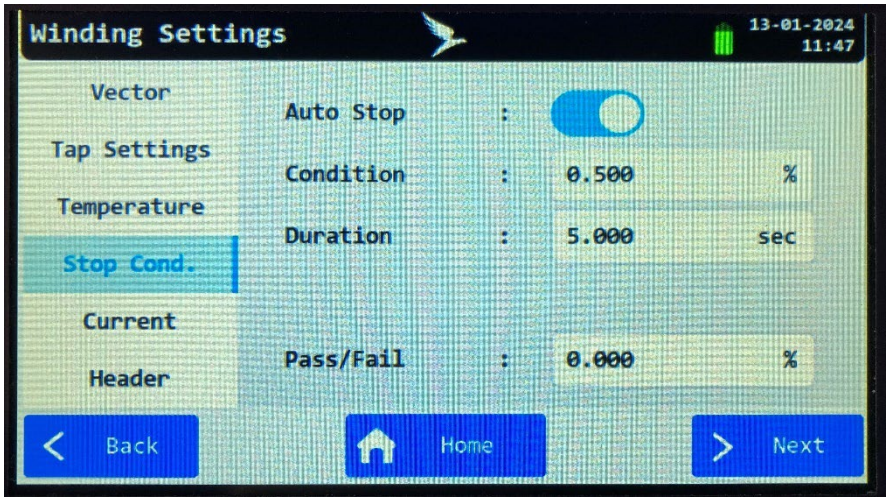
Under 'Vector' part, users may choose the vector group and enter information about the transformer to be tested. You can make appropriate selections by pressing on 'Primary', 'Secondary', 'Vector' and 'Connection' tabs. You can choose the connection type as 'Phase to Phase (LL)' or 'Phase to Neutral (LN)'. Click on the tab for connection type to switch between 'Phase to Phase' and 'Phase to Neutral'.



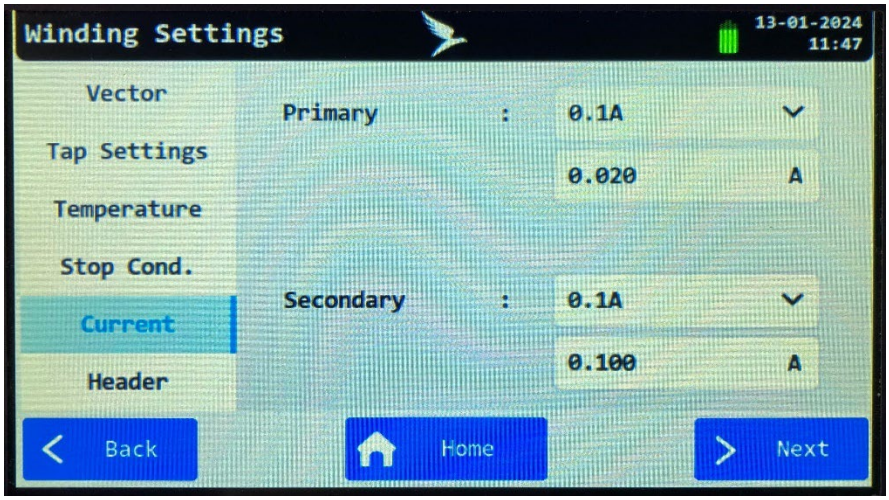
On the 'Tap Settings' part, if the 'Auto Tap' is enabled, TRAN will automatically change the taps. To set the contact time, tap on the space provided to enter 'Contact Time'. Press 'Enter' to save the value and return to the previous page. And to set the wait time, tap on the space provided to enter 'Wait Time'. Press 'Enter' to save the value and return to the previous page.



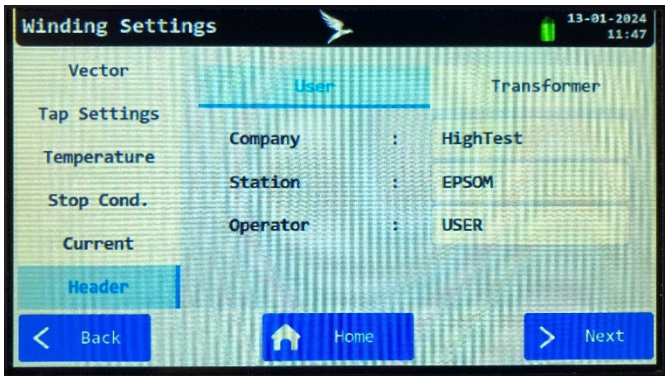
On the 'Temperature' part, press on the Press on the 'Enable' button to activate and alter the temperature settings for the test. Users can choose units of temperature among '°Celsius', 'Kelvin' and '°Fahrenheit' according to their convenience. Hit on the related tab to switch between these units. You can use an optional temperature 'Sensor' with TRAN or you can enter the temperature value manually by pressing on the related tab. You can choose the heating coefficient of winding 'Material' from the options given 'Copper', 'Aluminium' or you can enter the value manually by pressing the 'Custom' option. And you can manually set the 'Reference' temperature by pressing the related tab.

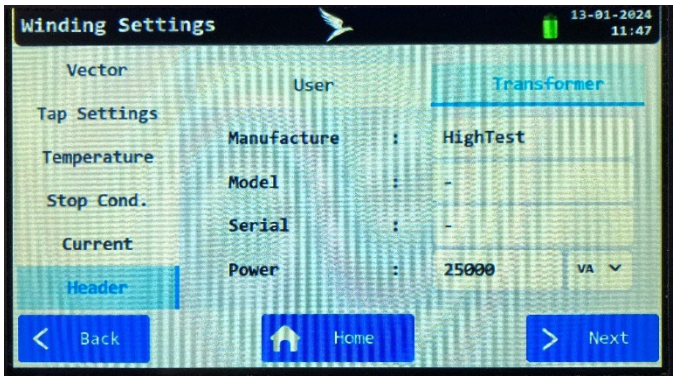


On the 'Stop Cond.' part, users can choose whether the test should be stopped automatically or manually. Press on the 'Auto Stop' to enable or disable it. You can set stability limit percentage by pressing on the 'Condition' tab and enter the limit by using onscreen keyboard. Similarly, you can set the stability time by pressing on the 'Duration' tab and enter the time by using onscreen keyboard. For the 'Pass/Fail' part, users are able to set pass-fail criteria depending on their requirements.



On the 'Current' part, press on the corresponding tabs to enter/choose test details. You can easily choose the primary current from predefined values or you can enter custom values by pressing 'Primary' tab with onscreen keyboard. Similarly, press on the 'Secondary' and repeat the same steps as 'Primary' to enter the secondary test current value.

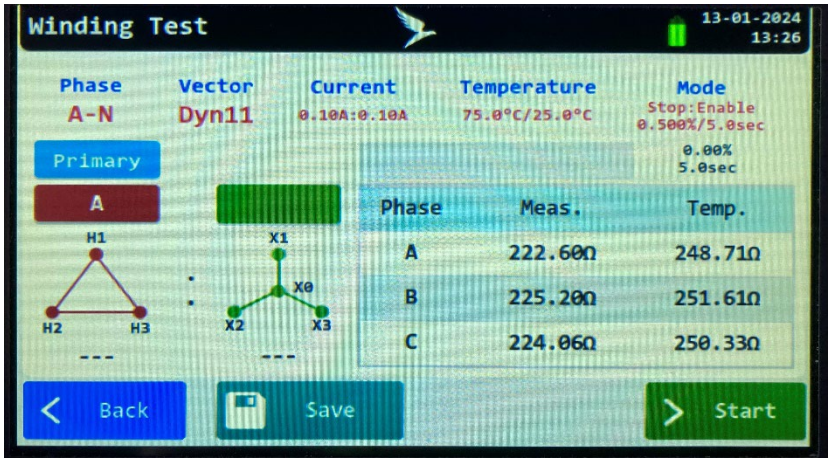




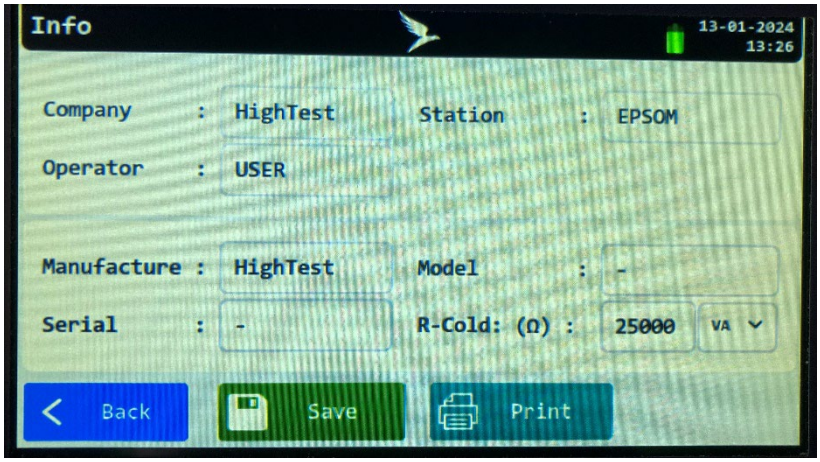
On the 'Header' part, there is 2 sections. By using 'User', you can enter 'Company', 'Station', and 'Operator' informations. Click on the relevant tab to enter data using the on-screen keyboard. By using 'Transformer', you can enter 'Manufacture', 'Model', 'Serial' and 'Power' informations. You can enter new details or can use already existing default details.

After making all necessary settings, you can proceed to test by pressing the 'Next' tab.

The result page will appear as follows,

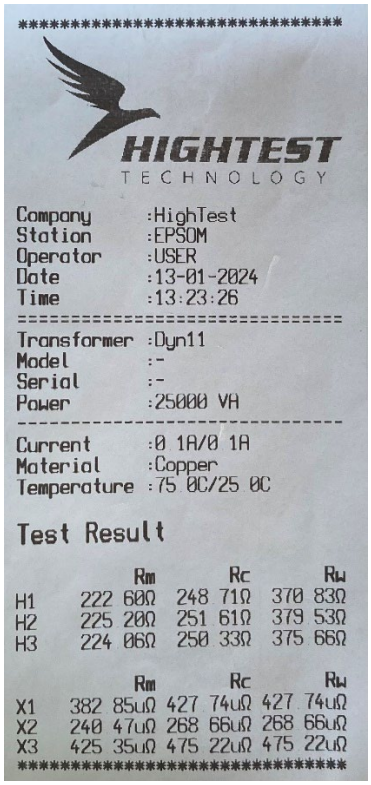


Once the test gets completed, you can save the test results to the device memory, USB memory and print the test using TRAN's built-in printer.



The 'Info' screen is as shown above. You can enter new details or can use already existing default details. Tap on the concerned tab to enter each detail. You can input the details using on-screen keyboard of TRAN. You can 'Save' or 'Print' the test result.

The printed result will look as follows,



HIGHTEST
TECHNOLOGY

Company :HighTest
Station :EPSOM
Operator :USER
Date :13-01-2024
Time :13:23:26

Transformer :Dyn11
Model :-
Serial :-
Power :25000 VA

Current :0.1A/0.1A
Material :Copper
Temperature :75.0C/25.0C

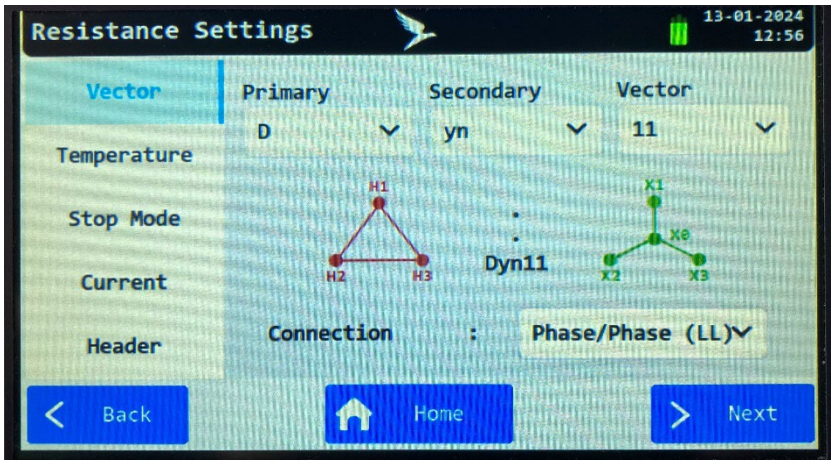
Test Result

	Rm	Rc	Rw
H1	222.60Ω	248.71Ω	370.83Ω
H2	225.20Ω	251.61Ω	379.53Ω
H3	224.06Ω	250.33Ω	375.66Ω

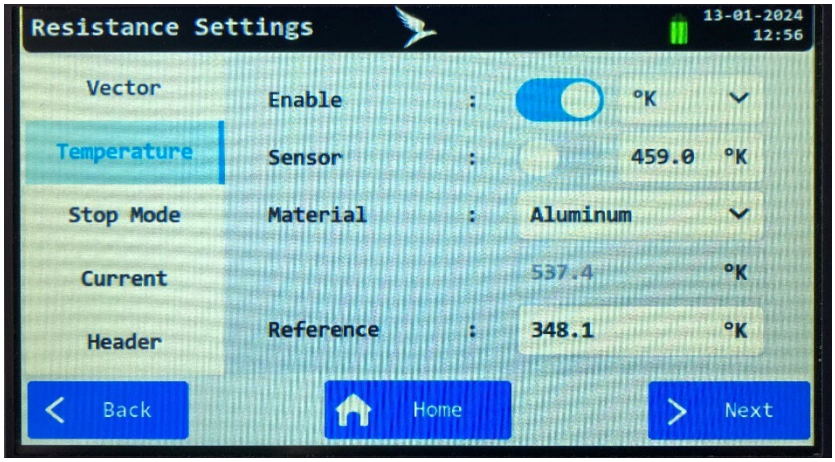
	Rm	Rc	Rw
X1	382.85uΩ	427.74uΩ	427.74uΩ
X2	240.47uΩ	268.66uΩ	268.66uΩ
X3	425.35uΩ	475.22uΩ	475.22uΩ

4.2.2 RESISTANCE TEST

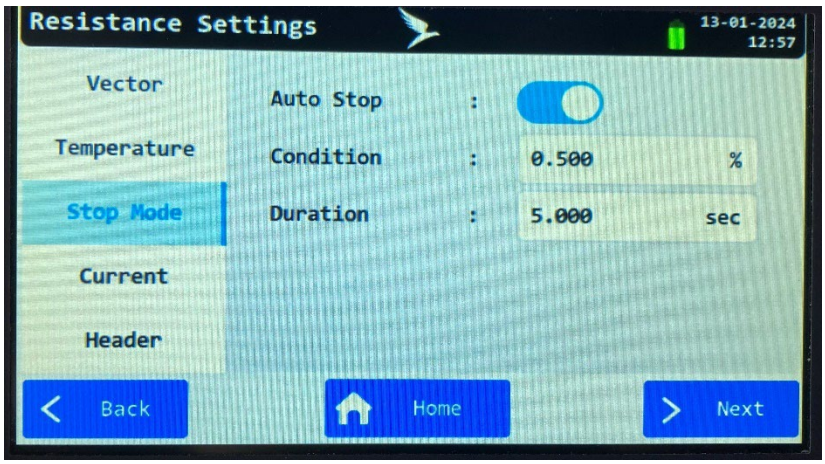
Press the 'Resistance Test' for a quick resistance test on a single phase of the transformer to be tested or to test a shunt resistance.



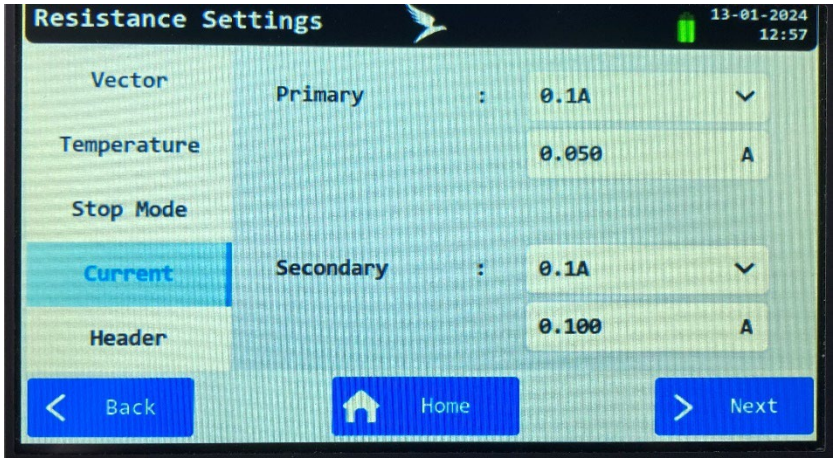
Under 'Vector' part, users may choose the vector group and enter information about the transformer to be tested. You can make appropriate selections by pressing on 'Primary', 'Secondary', 'Vector' and 'Connection' tabs. You can choose the connection type as 'Phase to Phase (LL)' or 'Phase to Neutral (LN)'. Click on the tab for connection type to switch between 'Phase to Phase' and 'Phase to Neutral'.



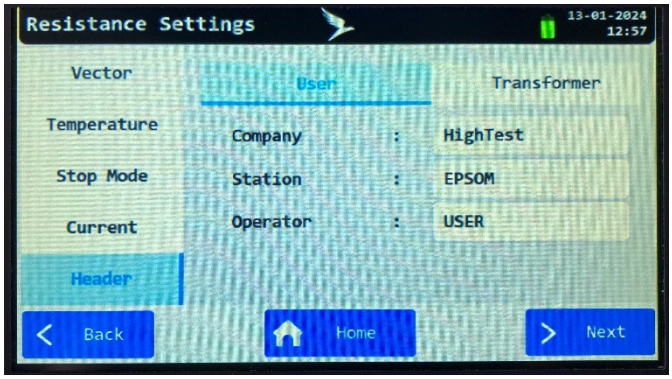
On the 'Temperature' part, press on the Press on the 'Enable' button to activate and alter the temperature settings for the test. Users can choose units of temperature among '°Celsius', 'Kelvin' and '°Fahrenheit' according to their convenience. Hit on the related tab to switch between these units. You can use an optional temperature 'Sensor' with TRAN or you can enter the temperature value manually by pressing on the related tab. You can choose the heating coefficient of winding 'Material' from the options given 'Copper', 'Aluminium' or you can enter the value manually by pressing the 'Custom' option. And you can manually set the 'Reference' temperature by pressing the related tab.

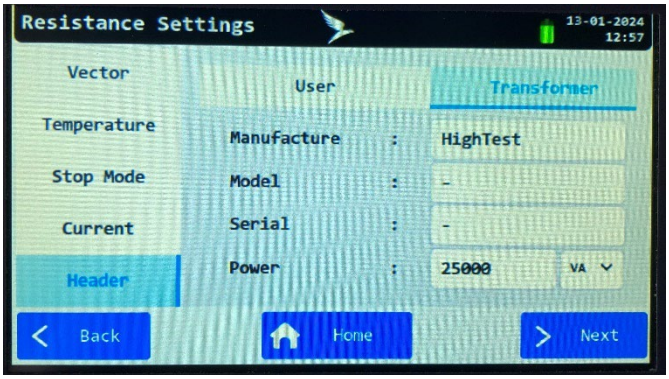


On the 'Stop Mode' part, users can choose whether the test should be stopped automatically or manually. Press on the 'Auto Stop' to enable or disable it. You can set stability limit percentage by pressing on the 'Condition' tab and enter the limit by using onscreen keyboard. Similarly, you can set the stability time by pressing on the 'Duration' tab and enter the time by using onscreen keyboard.

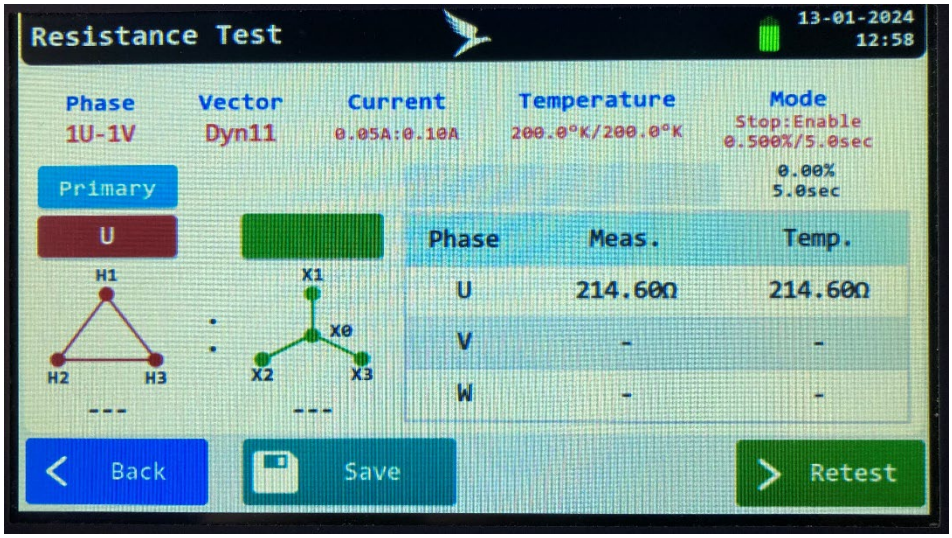


On the 'Current' part, press on the corresponding tabs to enter/choose test details. You can easily choose the primary current from predefined values or you can enter custom values by pressing 'Primary' tab with onscreen keyboard. Similarly, press on the 'Secondary' and repeat the same steps as 'Primary' to enter the secondary test current value.





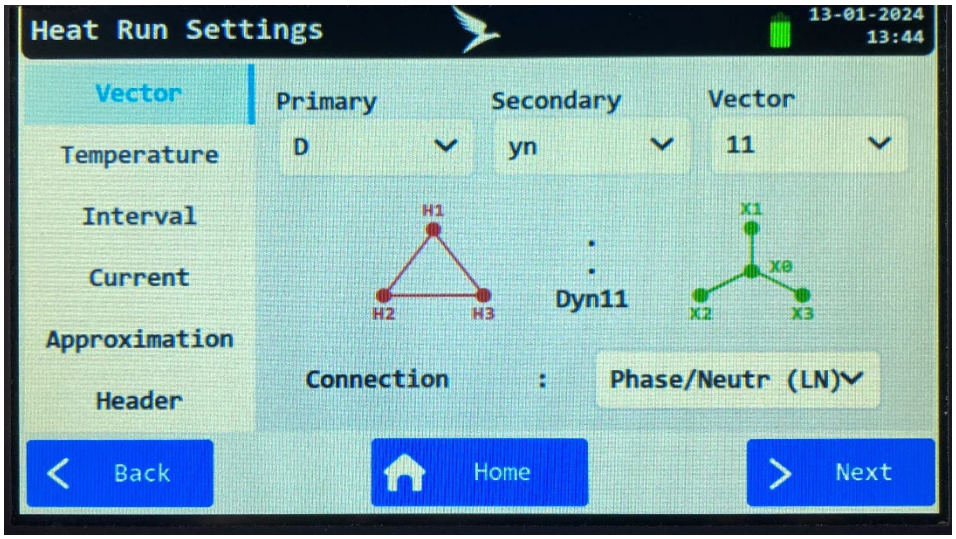
On the 'Header' part, there is 2 sections. By using 'User', you can enter 'Company', 'Station', and 'Operator' informations. Click on the relevant tab to enter data using the on-screen keyboard. By using 'Transformer', you can enter 'Manufacture', 'Model', 'Serial' and 'Power' informations. You can enter new details or can use already existing default details.



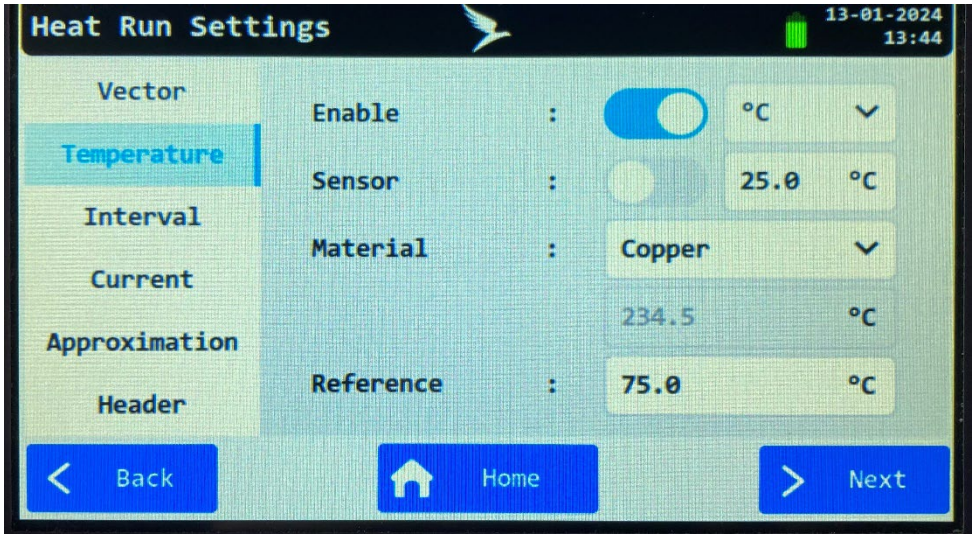
After making all necessary settings, you can proceed to test by pressing the 'Next' tab. The details of the test results will be displayed as shown in the picture given above. You can repeat the test or proceed to save the result by 'Save' button.

4.2.3 HEAT RUN TEST

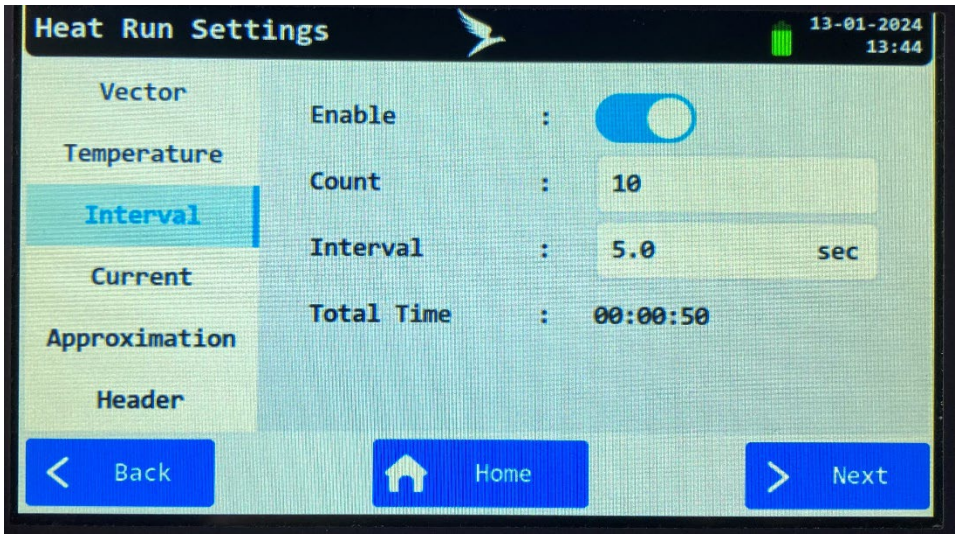
Heat Run Test is one of the type tests on power transformer. It's also called temperature rise test. This test reproduces conditions of continous rated load and the temperature rise occuring during the load.



Under 'Vector' part, users may choose the vector group and enter information about the transformer to be tested. You can make appropriate selections by pressing on 'Primary', 'Secondary', 'Vector' and 'Connection' tabs. You can choose the connection type as 'Phase to Phase (LL)' or 'Phase to Neutral (LN)'. Click on the tab for connection type to switch between 'Phase to Phase' and 'Phase to Neutral'.

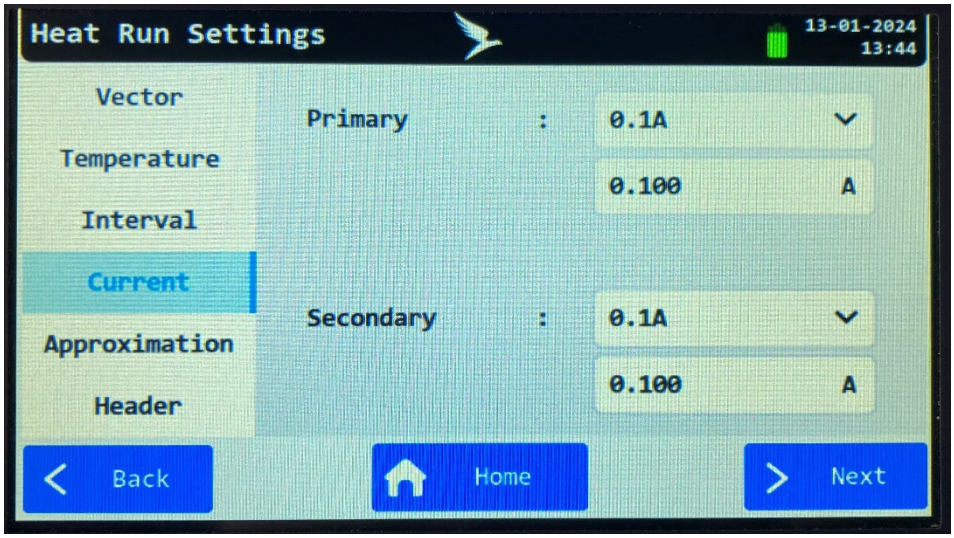


On the 'Temperature' part, press on the Press on the 'Enable' button to activate and alter the temperature settings for the test. Users can choose units of temperature among '°Celsius', 'Kelvin' and '°Fahrenheit' according to their convenience. Hit on the related tab to switch between these units. You can use an optional temperature 'Sensor' with TRAN or you can enter the temperature value manually by pressing on the related tab. You can choose the heating coefficient of winding 'Material' from the options given 'Copper', 'Aluminium' or you can enter the value manually by pressing the 'Custom' option. And you can manually set the 'Reference' temperature by pressing the related tab.

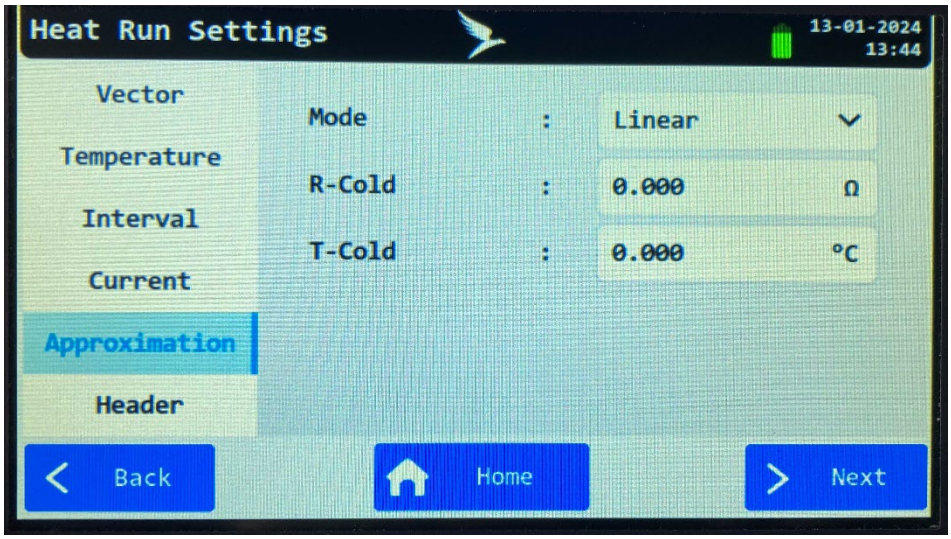


On the 'Interval' part, press on the related tab to set an interval for the heat-run test. In these test settings above, TRAN will continuously check it for 00:50 seconds as the 'Count' is chosen as 10 and the 'Interval' is 5 sec.

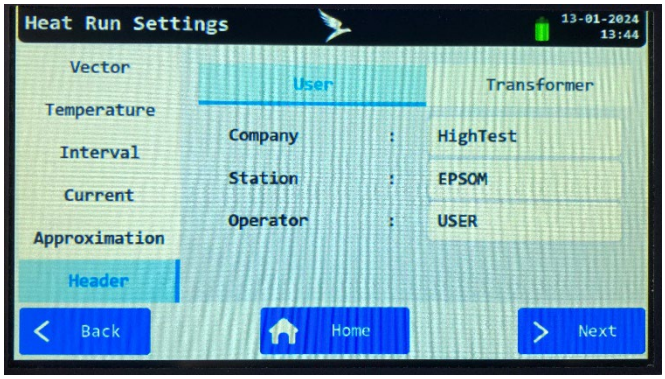
Note: The minimum value for the interval is 5 sec. Users can set this value according to their requirement (starting from 5 sec). And the maximum value for the count is 250.

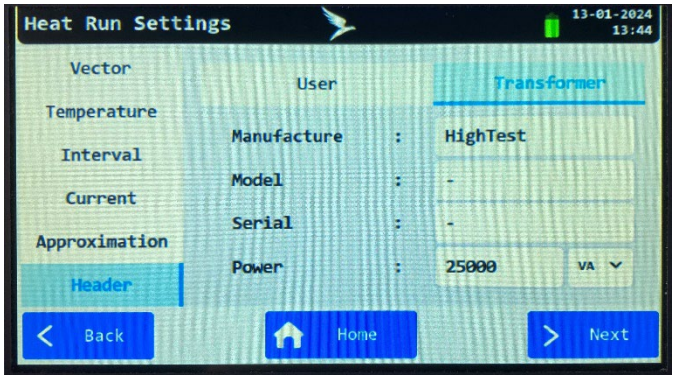


On the 'Current' part, press on the corresponding tabs to enter/choose test details. You can easily choose the primary current from predefined values or you can enter custom values by pressing 'Primary' tab with onscreen keyboard. Similarly, press on the 'Secondary' and repeat the same steps as 'Primary' to enter the secondary test current value.



On the 'Approximation' part; you can set the heat run calculation approach, 'R-Cold' and 'T-Cold' parameters separately by clicking on the respective tab.



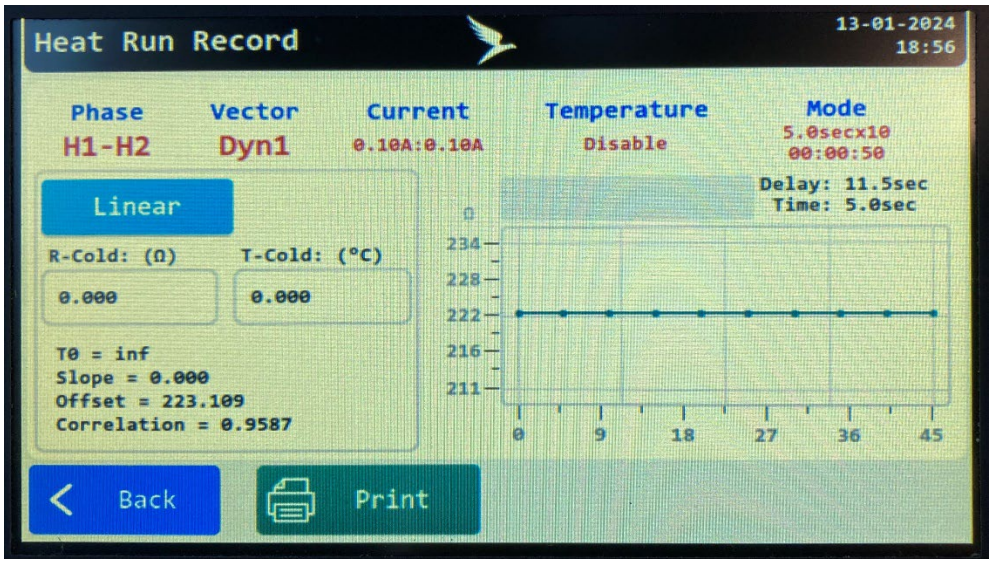


On the 'Header' part, there is 2 sections. By using 'User', you can enter 'Company', 'Station', and 'Operator' informations. Click on the relevant tab to enter data using the on-screen keyboard. By using 'Transformer', you can enter 'Manufacture', 'Model', 'Serial' and 'Power' informations. You can enter new details or can use already existing default details.

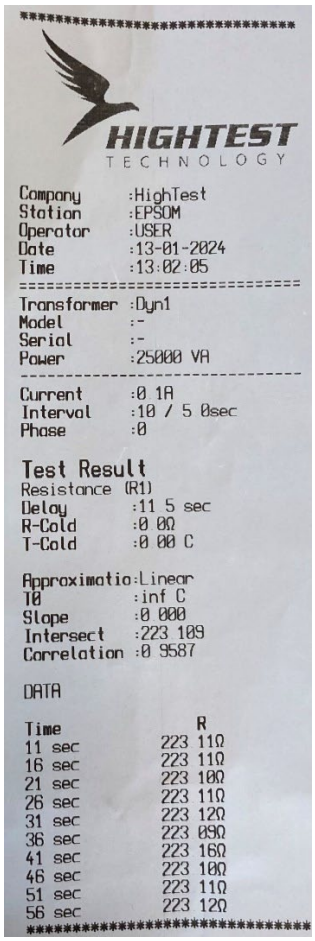
Press 'Next' to proceed to test and then press 'Next' to proceed to print or save the result.

CAUTION!

During the test, you can press 'Emergency Stop' button on the front panel or you can touch on the 'Screen' or simply press the 'Power Button' in an emergency situation. The test will be cancelled immediately.



You can instantly print the result with TRAN built-in printer or save to internal memory for further reference. A sample of printed result for Heat-Run Test is given below;



HIGHTEST
TECHNOLOGY

Company :HighTest
Station :EPSOM
Operator :USER
Date :13-01-2024
Time :13:02:05

Transformer :Dyn1
Model :-
Serial :-
Power :25000 VA

Current :0.1A
Interval :10 / 5 0sec
Phase :0

Test Result
Resistance (R1)
Delay :11.5 sec
R-Cold :0.0Ω
T-Cold :0.00 C

Approximatio:Linear
1Ø :inf C
Slope :0.000
Intersect :223.109
Correlation :0.9587

DATA

Time	R
11 sec	223.11Ω
16 sec	223.11Ω
21 sec	223.10Ω
26 sec	223.11Ω
31 sec	223.12Ω
36 sec	223.09Ω
41 sec	223.16Ω
46 sec	223.10Ω
51 sec	223.11Ω
56 sec	223.12Ω

4.2.4 DEMAGNETIZATION TEST

Demagnetization on transformers is performed in order to remove remnant magnetism. It is caused due to several ways;

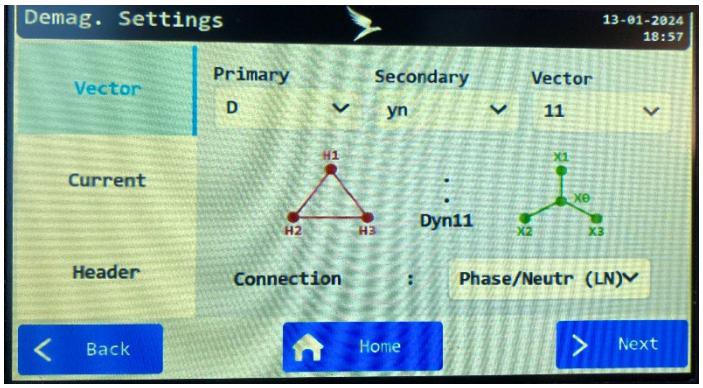
- DC winding resistance measurement,
- Taking the transformer out of service,
- Clearing high fault current

It can cause several problems in the energy sector such as;

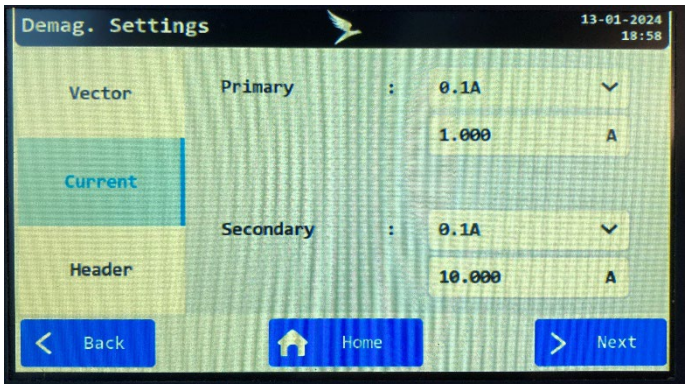
- Incorrect operation of relays,
- Mechanical damage to transformer active parts
- Disturbance and power quality problems

- Incorrect diagnostic test results etc.

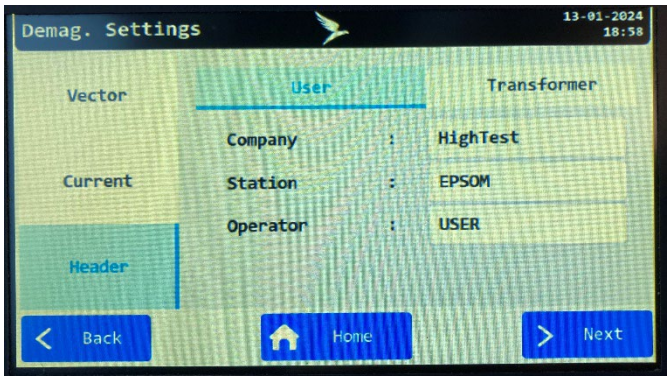
So 'Demagnetization' is highly recommended after every winding test.

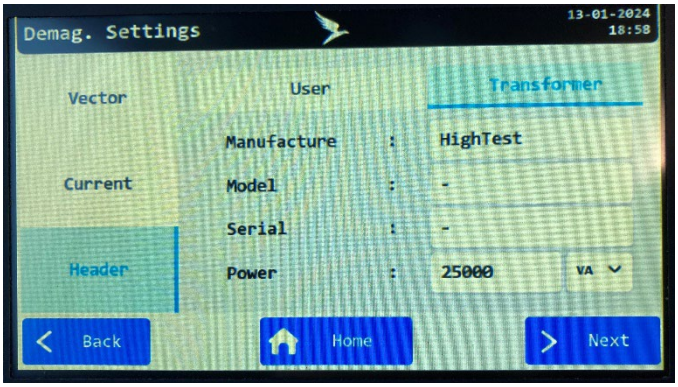


Under 'Vector' part, users may choose the vector group and enter information about the transformer to be tested. You can make appropriate selections by pressing on 'Primary', 'Secondary', 'Vector' and 'Connection' tabs. You can choose the connection type as 'Phase to Phase (LL)' or 'Phase to Neutral (LN)'. Click on the tab for connection type to switch between 'Phase to Phase' and 'Phase to Neutral'.

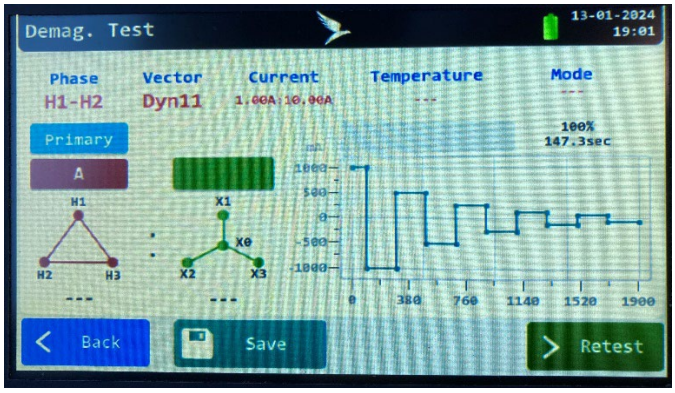


Press the tab 'Current' to select the test current. You can either choose a test current from predefined values or you can add custom value by pressing the section below it and can enter test current values manually using the onscreen keyboard of TRAN.





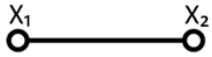
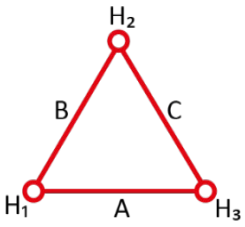
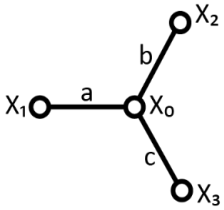
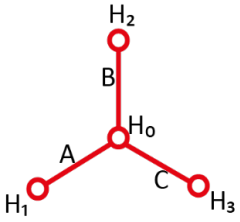
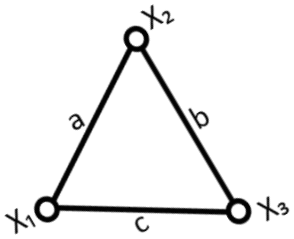
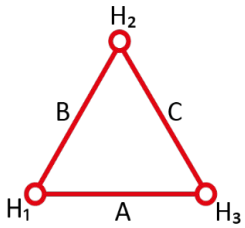
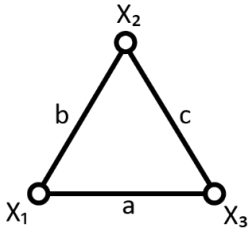
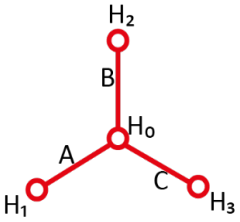
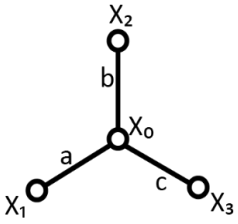
On the 'Header' part, there is 2 sections. By using 'User', you can enter 'Company', 'Station', and 'Operator' informations. Click on the relevant tab to enter data using the on-screen keyboard. By using 'Transformer', you can enter 'Manufacture', 'Model', 'Serial' and 'Power' informations. You can enter new details or can use already existing default details.

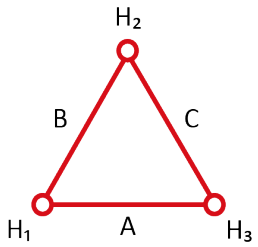
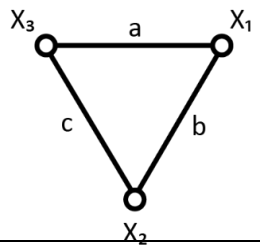
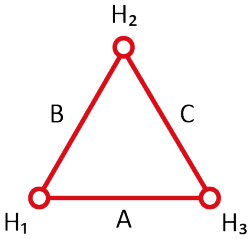
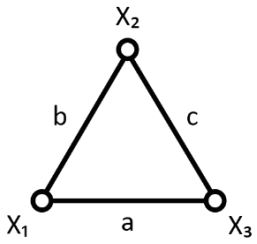
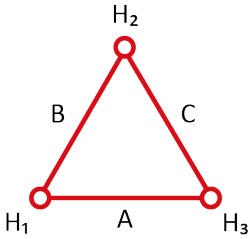
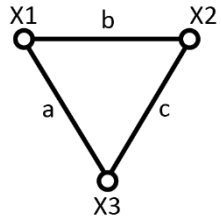
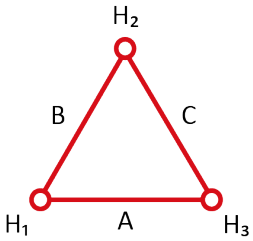
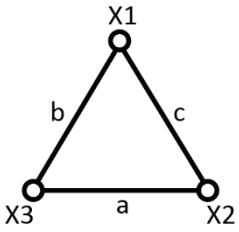
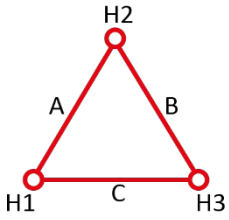
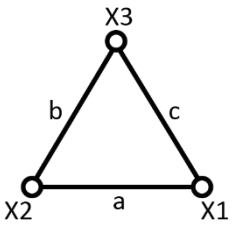
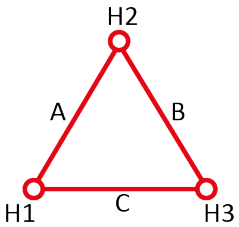
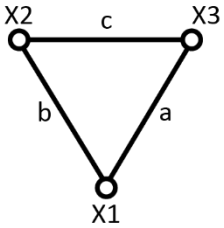


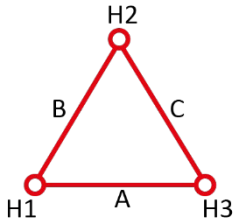
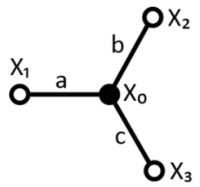
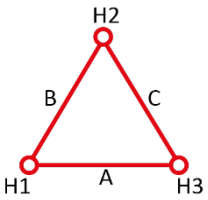
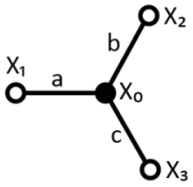
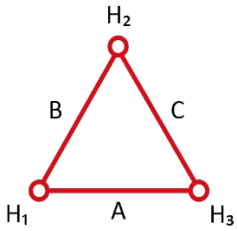
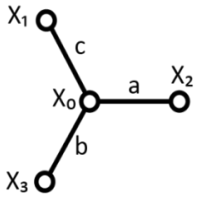
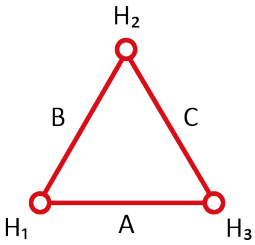
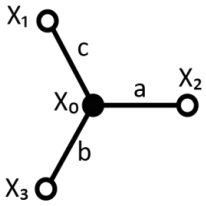
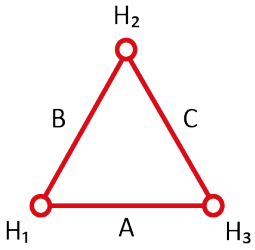
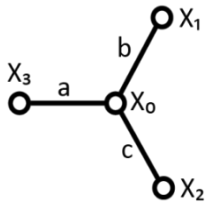
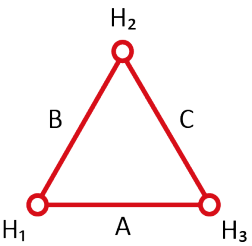
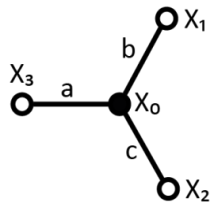
Press 'Next' to proceed to test. You can repeat the test by pressing 'Retest'.

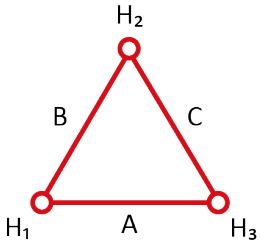
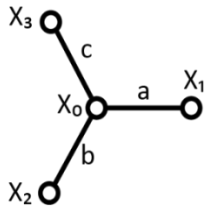
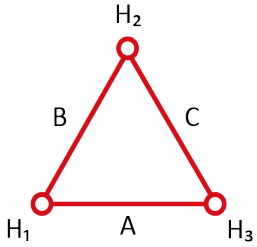
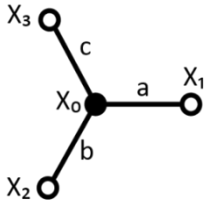
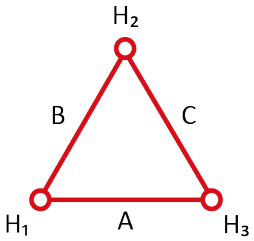
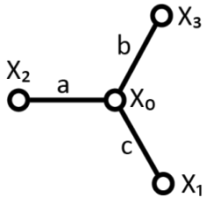
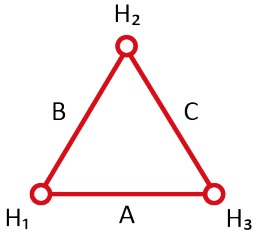
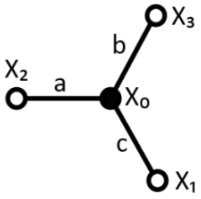
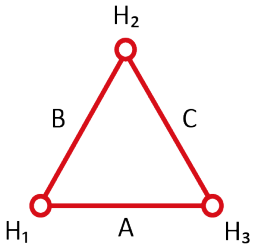
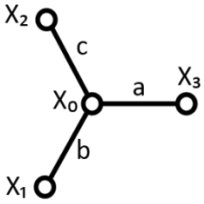
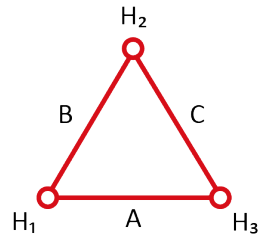
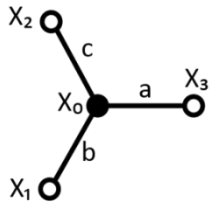
You can instantly print the result with TRAN built-in printer or save to internal memory for further reference. A sample of printed result for Demagnetization Test is given below;

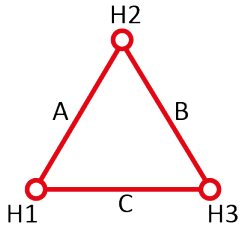
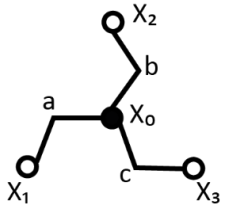
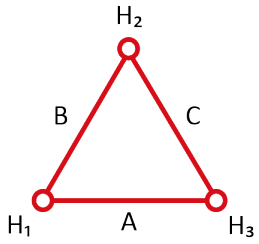
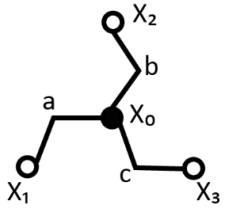
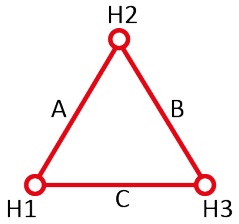
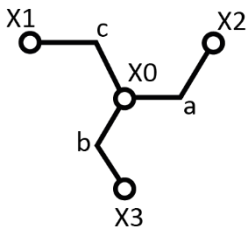
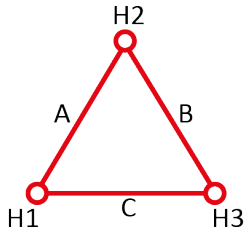
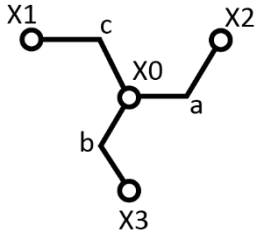
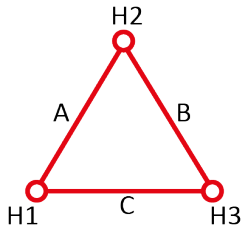
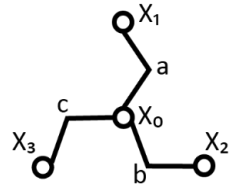
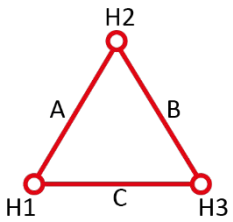
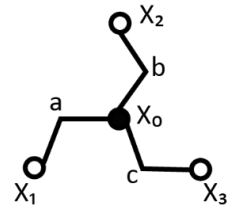
APPENDIX A – ANSI Transformer Winding Phase Relationships

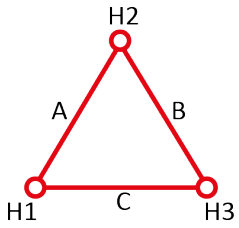
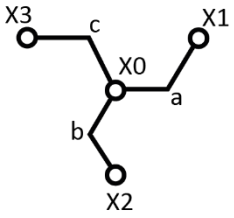
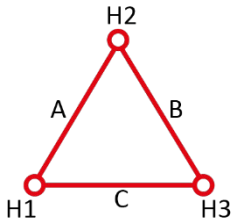
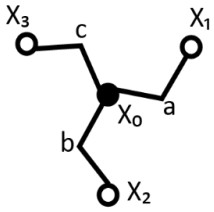
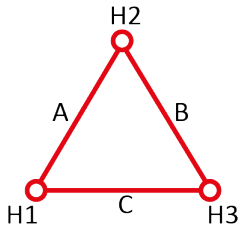
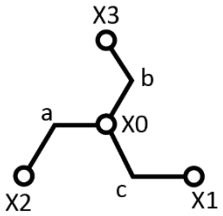
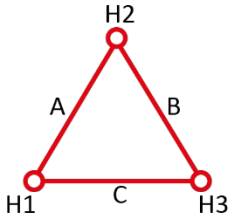
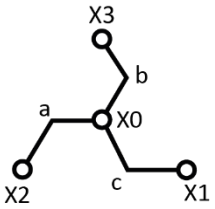
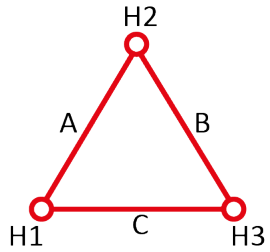
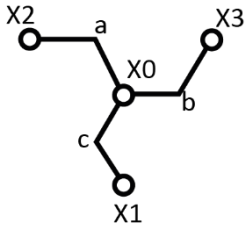
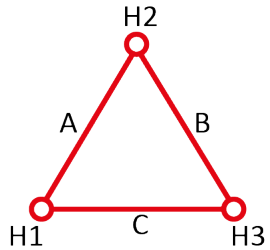
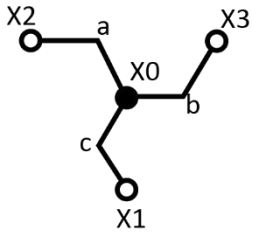
Vector Group	TRANSFORMER CONFIGURATION				WINDING TESTED		Turns Ratio Calculations
	High-Voltage Winding (H)	High-Voltage Winding (X)	JUMPER	PHASE	High-Voltage Winding	High-Voltage Winding	
1ph0				1Φ	H1-H2	X1-X2	V_H/V_X
Dyn1				A	H1-H3	X1-X0	
				B	H2-H1	X2-X0	(VH *√3)/VX
				C	H3-H2	X3-X0	
YNd1				A	H1-H0	X1-X2	
				B	H2-H0	X2-X3	$V_H/(V_X*\sqrt{3})$
				C	H3-H0	X3-X1	
Dd0				A	H1-H3	X1-X3	V_H/V_X
				B	H2-H1	X2-X1	
				C	H3-H2	X3-X2	
YNyn0				A	H1-H0	X1-X0	V_H/V_X
				B	H2-H0	X2-X0	
				C	H3-H0	X3-X0	

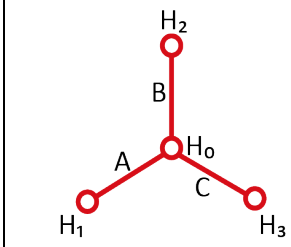
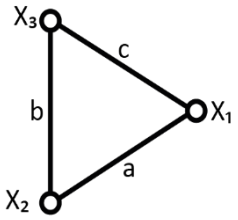
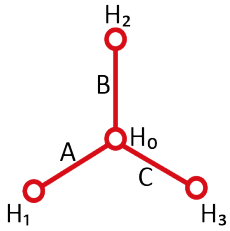
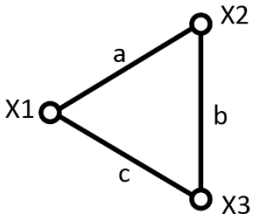
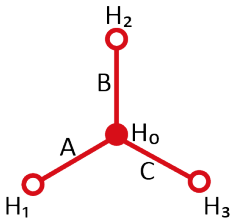
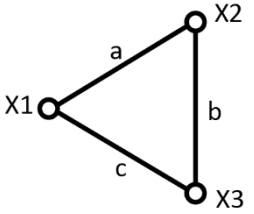
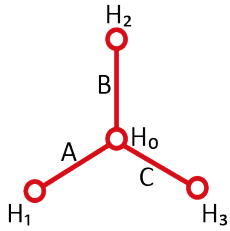
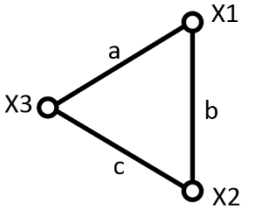
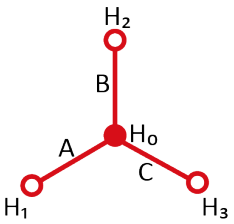
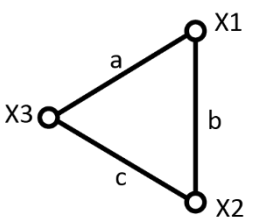
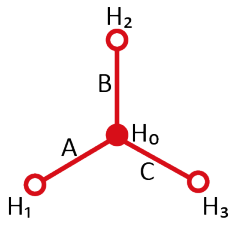
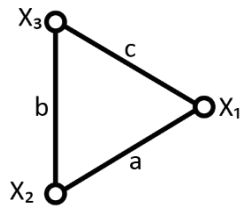
Dd6				A	H1-H3	X3-X1	V_H/V_X
				B	H2-H1	X1-X2	
				C	H3-H2	X2-X3	
Dd0				A	H1-H3	X1-X3	V_H/V_X
				B	H2-H1	X2-X1	
				C	H3-H2	X3-X2	
Dd2				A	H1-H3	X1-X2	V_H/V_X
				B	H2-H1	X2-X3	
				C	H3-H2	X3-X1	
Dd4				A	H1-H3	X3-X2	V_H/V_X
				B	H2-H1	X1-X3	
				C	H3-H2	X2-X1	
Dd8				A	H1-H3	X2-X1	V_H/V_X
				B	H2-H1	X3-X2	
				C	H3-H2	X1-X3	
Dd10				A	H1-H3	X2-X3	V_H/V_X
				B	H2-H1	X3-X1	
				C	H3-H2	X1-X2	

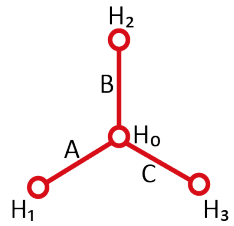
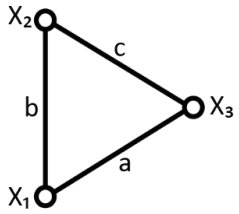
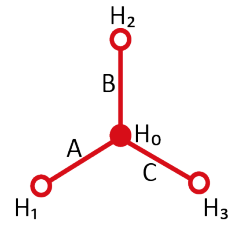
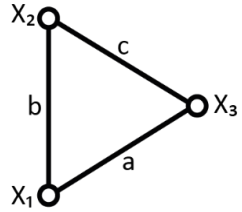
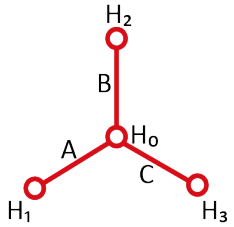
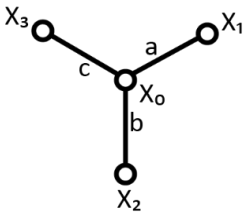
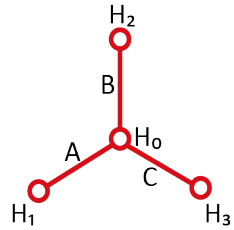
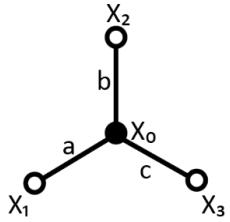
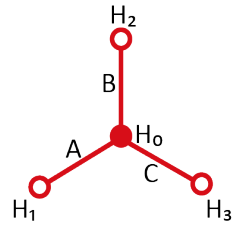
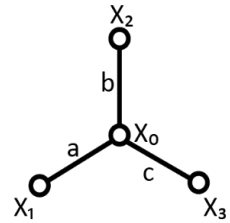
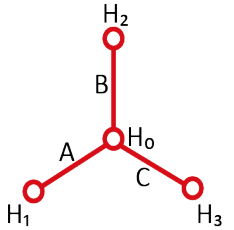
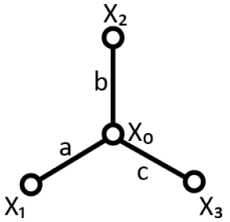
Dyn1				A	H1-H3	X1-X0	
				B	H2-H1	X2-X0	(VH*√3)/VX
				C	H3-H2	X3-X0	
Dy1			H1-H2	A	H1-H3	X1-X3	
			H2-H3	B	H2-H1	X2-X1	(VH*√3)/VX
			H3-H1	C	H3-H2	X3-X2	
Dyn3				A	H1-H3	X0-X2	
				B	H2-H1	X0-X3	(VH*√3)/VX
				C	H3-H2	X0-X1	
Dy3			H1-H2	A	H1-H3	X1-X2	
			H2-H3	B	H2-H1	X2-X3	(VH*√3)/VX
			H3-H1	C	H3-H2	X3-X1	
Dyn5				A	H1-H3	X3-X0	
				B	H2-H1	X1-X0	(VH*√3)/VX
				C	H3-H2	X2-X0	
Dy5			H1-H2	A	H1-H3	X3-X2	
			H2-H3	B	H2-H1	X1-X3	(VH*√3)/VX
			H3-H1	C	H3-H2	X2-X1	

Dyn7				A	H1-H3	X0-X1	
				B	H2-H1	X0-X2	(VH*√3)/VX
				C	H3-H2	X0-X3	
Dy7			H1-H2	A	H1-H3	X3-X1	
			H2-H3	B	H2-H1	X1-X2	(VH*√3)/VX
			H3-H1	C	H3-H2	X2-X3	
Dyn9				A	H1-H3	X2-X0	
				B	H2-H1	X3-X0	(VH*√3)/VX
				C	H3-H2	X1-X0	
Dy9			H1-H2	A	H1-H3	X2- X1	
			H2-H3	B	H2-H1	X3-X2	(VH*√3)/VX
			H3-H1	C	H3-H2	X1-X3	
Dyn11				A	H1-H3	X0-X3	
				B	H2-H1	X0-X1	(VH*√3)/VX
				C	H3-H2	X0-X2	
Dy11			H1-H2	A	H1-H3	X2-X3	
			H2-H3	B	H2-H1	X3-X1	(VH*√3)/VX
			H3-H1	C	H3-H2	X1-X2	

Dzn0			H2-H3	A	H1-H2	X1-X0	$3/2(V_H/V_X)$
			H1-H3	B	H2-H3	X2-X0	
			H1-H2	C	H3-H1	X3-X0	
Dz0				A	H1-H3	X1-X3	V_H/V_X
				B	H2-H1	X2-X1	
				C	H3-H2	X3-X2	
Dzn2			H2-H3	A	H1-H2	X0-X2	$3/2(V_H/V_X)$
			H1-H3	B	H2-H3	X0-X3	
			H1-H2	C	H3-H1	X0-X1	
Dz2				A	H1-H2	X3-X2	V_H/V_X
				B	H2-H3	X1-X3	
				C	H3-H1	X2-X1	
Dzn4			H2-H3	A	H1-H2	X3-X0	$3/2(V_H/V_X)$
			H3-H1	B	H2-H3	X1-X0	
			H1-H2	C	H3-H1	X2-X0	
Dz4				A	H1-H2	X2-X1	V_H/V_X
				B	H2-H3	X2-X3	
				C	H3-H1	X1-X3	

Dzn6			H2-H3	A	H1-H2	X0-X1	$3/2(V_H/V_X)$
			H1-H3	B	H2-H3	X0-X2	
			H1-H2	C	H3-H1	X0-X3	
Dz6				A	H1-H3	X3-X1	V_H/V_X
				B	H2-H1	X1-X2	
				C	H3-H2	X2-X3	
Dzn8			H2-H3	A	H1-H2	X2-X0	$3/2(V_H/V_X)$
			H1-H3	B	H2-H3	X3-X0	
			H1-H2	C	H3-H1	X1-X0	
Dz8				A	H1-H2	X2-X3	V_H/V_X
				B	H2-H3	X3-X1	
				C	H3-H1	X1-X2	
Dzn10			H2-H3	A	H1-H2	X0-X3	$3/2(V_H/V_X)$
			H1-H3	B	H2-H3	X0-X1	
			H1-H2	C	H3-H1	X0-X2	
Dz10				A	H1-H2	X1-X3	V_H/V_X
				B	H2-H3	X2-X1	
				C	H3-H1	X3-X2	

YNd7				A	H1-H0	X2- X1	
				B	H2-H0	X3-X2	VH/(VX*√3)
				C	H3-H0	X1-X3	
YNd1				A	H1-H0	X1-X2	
				B	H2-H0	X2-X3	VH/(VX*√3)
				C	H3-H0	X3-X1	
Yd1			H3-H2	A	H1-H3	X1-X2	
			H1-H3	B	H2-H1	X2-X3	(VH/VX)(√3/2)
			H2-H1	C	H3-H2	X3-X1	
YNd5				A	H1-H0	X3-X1	
				B	H2-H0	X1-X2	VH/(VX*√3)
				C	H3-H0	X2-X3	
Yd5			H3-H2	A	H1-H3	X3-X1	
			H1-H3	B	H2-H1	X1-X2	(VH/VX)(√3/2)
			H2-H1	C	H3-H2	X2-X3	
Yd7			H3-H2	A	H1-H3	X2- X1	
			H1-H3	B	H2-H1	X3-X2	(VH/VX)(√3/2)
			H2-H1	C	H3-H2	X1-X3	

YNd11				A	H1-H0	X1-X3	
				B	H2-H0	X2-X1	VH/(VX*√3)
				C	H3-H0	X3-X2	
Yd11			H3-H2	A	H1-H3	X1-X3	
			H1-H3	B	H2-H1	X2-X1	(VH/VX)(√3/2)
			H2-H1	C	H3-H2	X3-X2	
YNyn6				A	H1-H0	X0-X1	
				B	H2-H0	X0-X2	V_H/V_X
				C	H3-H0	X0-X3	
YNy0			H2-H0	A	H1-H0	X1-X2	
			H3-H0	B	H2-H0	X2-X3	V_H/V_X
			H1-H0	C	H3-H0	X3-X1	
Yyn0			X3-X0	A	H1-H3	X1-X0	
			X1-X0	B	H2-H1	X2-X0	V_H/V_X
			X2-X0	C	H3-H2	X3-X0	
YNyn0				A	H1-H0	X1-X0	
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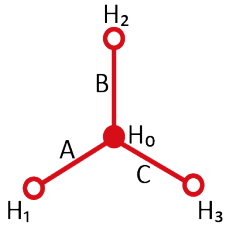
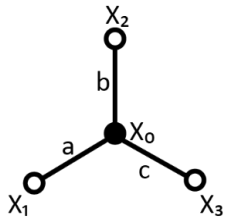
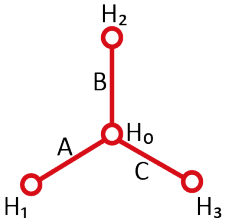
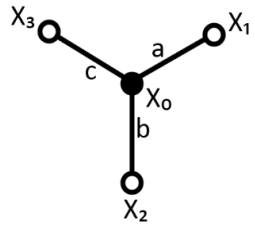
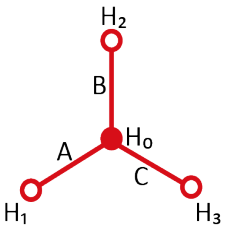
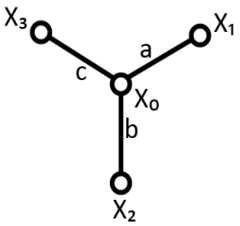
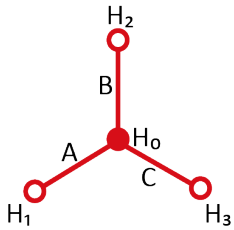
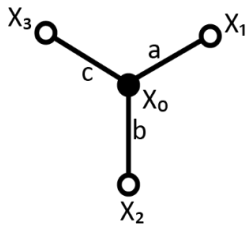
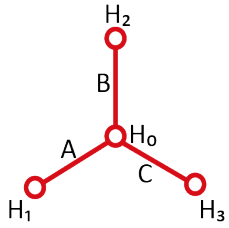
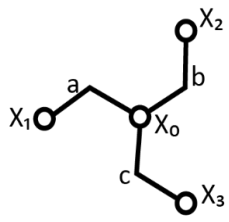
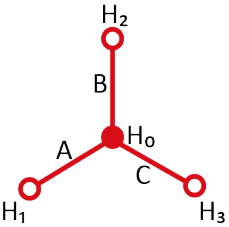
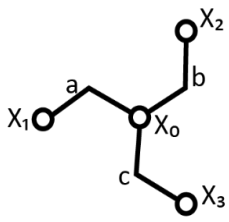
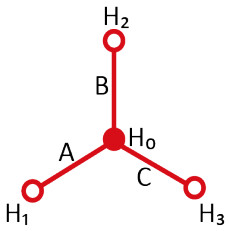
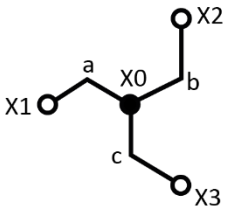
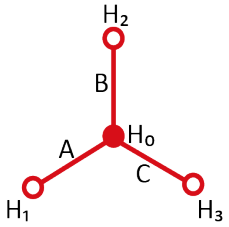
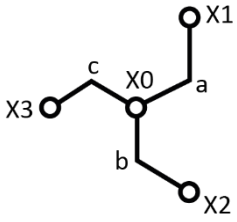
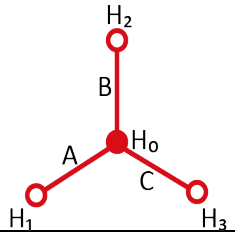
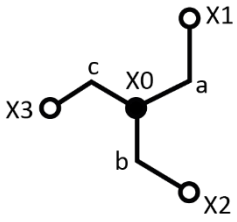
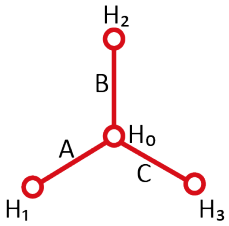
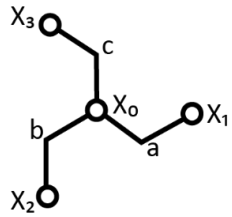
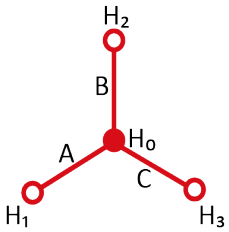
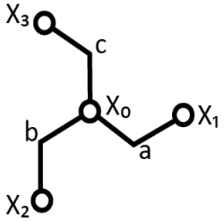
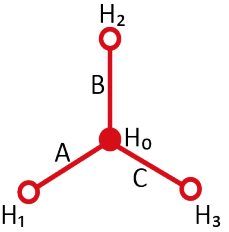
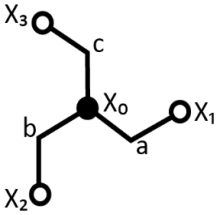
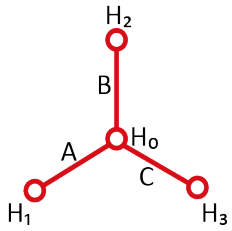
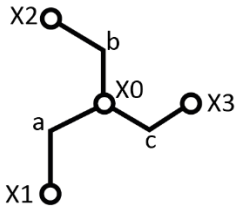
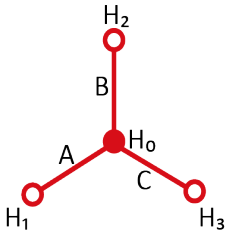
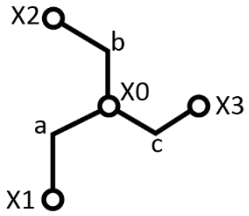
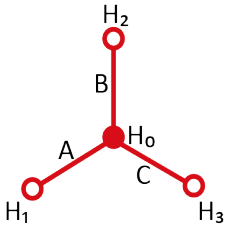
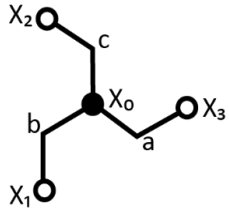
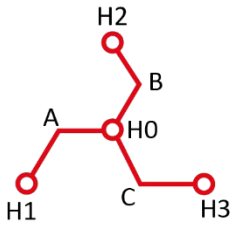
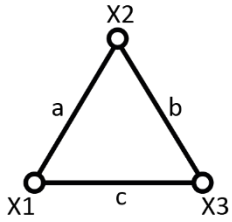
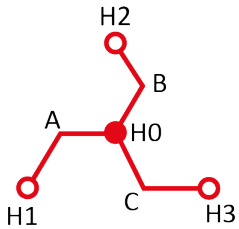
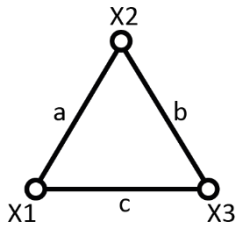
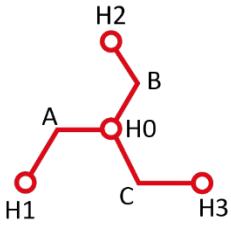
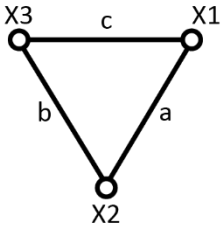
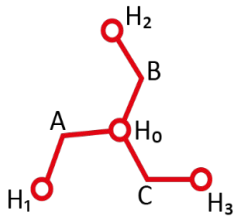
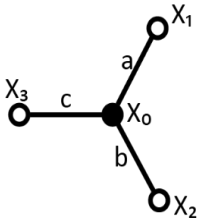
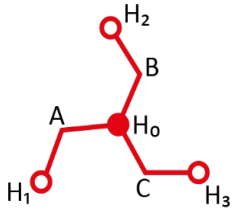
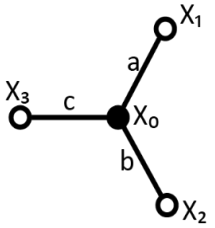
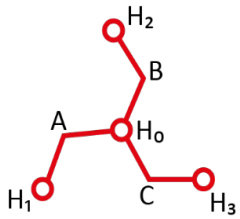
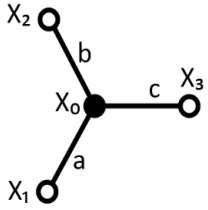
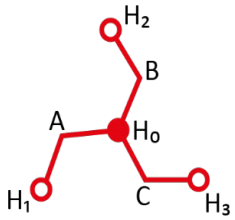
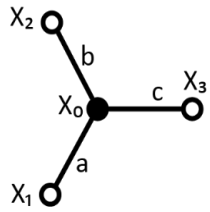
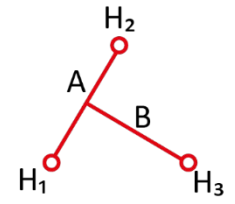
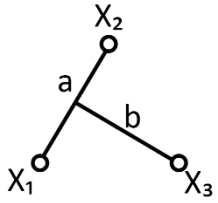
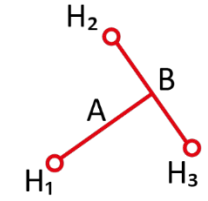
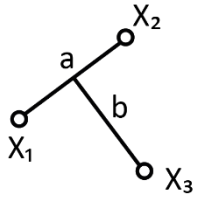
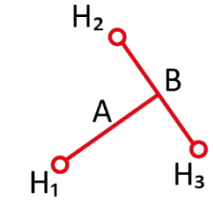
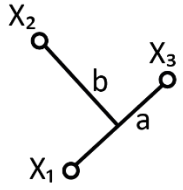
				C	H3-H0	X3-X0	

Yy0				A	H1-H2	X1-X2	V_H/V_X
				B	H2-H3	X2-X3	
				C	H3-H1	X3-X1	
YNy6			H2-H0	A	H1-H0	X2- X1	V_H/V_X
			H3-H0	B	H2-H0	X3-X2	
			H1-H0	C	H3-H0	X1-X3	
Yyn6			X3-X0	A	H1-H3	X0-X1	V_H/V_X
			X1-X0	B	H2-H1	X0-X2	
			X2-X0	C	H3-H2	X0-X3	
Yy6				A	H1-H3	X3-X1	V_H/V_X
				B	H2-H1	X1-X2	
				C	H3-H2	X2-X3	
YNzn1				A	H1-H3	X1-X0	
				B	H2-H1	X2-X0	(VH*√3)/VX
				C	H3-H2	X3-X0	
Yzn1				A	H1-H3	X1-X0	
				B	H2-H1	X2-X0	(VH*√3)/VX
				C	H3-H2	X3-X0	

Yz1			H3-H2	A	H1-H3	X1-X2	
			H1-H3	B	H2-H1	X2-X3	(VH/VX)(√3/2)
			H2-H1	C	H3-H2	X3-X1	
Yzn5				A	H2-H1	X1-X0	
				B	H3-H2	X2-X0	(VH*√3)/VX
				C	H1-H3	X3-X0	
Yz5			H3-H2	A	H1-H3	X3-X1	
			H1-H3	B	H2-H1	X1-X2	(VH/VX)(√3/2)
			H2-H1	C	H3-H2	X2-X3	
YNzn7				A	H1-H3	X0-X1	
				B	H2-H1	X0-X2	(VH*√3)/VX
				C	H3-H2	X0-X3	
Yzn7				A	H1-H3	X0-X1	
				B	H2-H1	X0-X2	(VH*√3)/VX
				C	H3-H2	X0-X3	
Yz7			H3-H2	A	H1-H3	X2- X1	
			H1-H3	B	H2-H1	X3-X2	(VH/VX)(√3/2)
			H2-H1	C	H3-H2	X1-X3	

YNzn11				A	H2-H1	X0-X1	
				B	H3-H2	X0-X2	(VH*√3)/VX
				C	H1-H3	X0-X3	
Yzn11				A	H2-H1	X0-X1	
				B	H3-H2	X0-X2	(VH*√3)/VX
				C	H1-H3	X0-X3	
Yz11			H3-H2	A	H1-H3	X1-X3	
			H1-H3	B	H2-H1	X2-X1	(VH/VX)(√3/2)
			H2-H1	C	H3-H2	X3-X2	
ZNd0			X2-X3	A	H1-H0	X1-X2	$(2/3)*(V_H/V_X)$
			X3-X1	B	H2-H0	X2-X3	
			X1-X2	C	H3-H0	X3-X1	
Zd0				A	H1-H2	X1-X2	V_H/V_X
				B	H2-H3	X2-X3	
				C	H3-H1	X3-X1	
ZNd6			X2-X3	A	H1-H0	X2- X1	
			X3-X1	B	H2-H0	X3-X2	$(2/3)*(V_H/V_X)$
			X1-X2	C	H3-H0	X1-X3	

ZNy5				A	H1-H0	X3-X1	
				B	H2-H0	X1-X2	VH/(VX * √3)
				C	H3-H0	X2-X3	
Zy5			H3-H2	A	H1-H3	X3-X1	
			H1-H3	B	H2-H1	X1-X2	(VH/VX)(√3/2)
			H2-H1	C	H3-H2	X2-X3	
ZNy11				A	H1-H0	X1-X3	
				B	H2-H0	X2-X1	VH/(VX * √3)
				C	H3-H0	X3-X2	
Zy11			H3-H2	A	H1-H3	X1-X3	
			H1-H3	B	H2-H1	X2-X1	(VH/VX)(√3/2)
			H2-H1	C	H3-H2	X3-X2	
T-T			H1-H2	A	H1-H2	X1-X2	V_H / V_X
0			X1-X2	B	H1-H3	X1-X3	
T-T			H2-H3	A	H1-H3	X1-X2	(VH/VX)(√3/2)
30 Lag			X1-X2	B	H2-H3	X1-X3	(VH/VX)(2/ √3)
T-T			H2-H3	A	H1-H3	X1-X3	(VH/VX)(√3/2)
30 Lead			X1-X3	B	H2-H3	X2-X1	(VX/VH)(2/ √3)

HIGHTEST Technology Ltd. is a leading manufacturing company based in the UK that produces high precision test equipment. Our focus is on the development, manufacture, and marketing of Transformer test and measurement equipment.

We have been designing and manufacturing high-end test equipment for many years and we supply our instruments worldwide to Transformer manufacturers, Electrical utilities, general contractors and service companies. Our test equipment is designed and produced according to the most widely adopted international standards and our experienced team provides excellent after-sales support and technical assistance as we endeavour to uphold customer satisfaction at all times.

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HighTest Technology Ltd.
Unit 14, First Quarter, Blenheim Road,
Epsom, Surrey, KT19 9QN, United Kingdom.
Tel: +44 203 900 2710, +44 203 287 2302
Email: info@hightest.co.uk, sales@hightest.co.uk
Web: www.hightest.co.uk