

USER GUIDE

FRAX200 Series

Frequency response analysers

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FRAX200 Series

User Guide

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Please note that the product images in this document are for illustrative purposes only. Actual appearance, accessories, and configurations may vary. Refer to technical specifications and product descriptions for accurate information.

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1. Introduction

Thank you for your trust in Megger.

We have the goal to always offer you a pleasant purchasing experience. The FRAX200-series is developed and manufactured in Sweden by knowledgeable and committed employees. Every day, our team does its best to offer best in class products and services. This document contains information regarding the correct use and handling of FRAX200-series. Keep this document at hand when using the product. Please ensure to consult the chapter 'Safety'. This chapter contains important information for your personal safety. Read the safety regulations attentively before using this device.

The FRAX200 Series, sweep frequency response analyser provides high-resolution measurements for detecting mechanical or electrical faults in power transformer windings and cores. The method is based on swept sinewave injection and response analysis. Designed for field use, the FRAX200 features USB-C and Bluetooth communication, and is supplied with software for detailed comparison and evaluation of measured curves.

With the optional FSX200 switchbox and active clamps, all test phases can be connected simultaneously. This reduces test time and improves safety by minimising ladder climbs and reconnections.

Integrated demagnetisation ensures consistent low-frequency results by eliminating residual magnetism prior to measurement.

- Built-in demagnetisation and automatic ground loop check
- High measurement repeatability with shielded cabling and IEC-compliant grounding
- Battery operation with removable battery pack and flight-mode discharge
- Optional FSX200 switchbox enables one-time connection to all phases
- Active clamps for safe, one-hand bushing connection
- Full sweep with ground check completed in under one minute
- Variable output voltage for alignment with historic data

1.1 Company web site

Occasionally an information bulletin may be issued via the Megger web site. This may concern new accessories, new usage instructions or a software update. Please occasionally check on the Megger website for anything applicable to your Megger instruments.

www.megger.com

1.2 Receiving instructions

- This instrument has been thoroughly tested and inspected to meet rigid specifications before being shipped. It is ready for use when set up as indicated in this user manual
- Check the equipment received against the packing list to ensure that all materials are present. Notify Megger of any shortage
- Examine the instrument for damage received in transit. If damage is discovered, file a claim with the carrier at once and notify Megger, providing a detailed description of the damage

1.3 Service and support

For technical assistance please contact your local representative or direct your request to Megger Sweden.

When sending the instrument, please use either the original crate or one of equivalent strength.

Add the return authorization number to the address label of the shipping container for proper identification and quicker handling.

1.4 Training

For information about training courses contact your local distributor or the Megger Sweden office.






E-mail: support-sweden@megger.com

2. Safety warnings and standards

These safety warnings must be read and understood before the instrument is used. Retain for future reference.

WARNING : Read and comply with the following instructions. Always comply with local safety regulations.

2.1 Safety, hazard and warning symbols on the instrument

Icon	Description
	Caution: Refer to accompanying documents
	Protective conductor terminal
	Equipped with Lithium-ion battery
	Equipment complies with current EU directives
	WEEE, Waste Electrical and Electronic Equipment

2.2 Warnings, cautions and notes

This user guide follows the internationally recognised definition. These instructions must be adhered to at all times.

Description
WARNING : Indicates a potentially dangerous situation which, if ignored, could lead to death, serious injury or health problems.
ATTENTION : Indicates a dangerous situation which, if ignored, could lead to injuries or health problems.
CAUTION : Indicates a situation which could lead to damage of the equipment or environment.
NOTE : Indicates important instructions to be followed to perform the relevant process safely and efficiently.

2.3 Accessories

Only use accessories that are recommended by Megger.

2.4 Cables

Test leads, including clamps, must be in good condition, clean, dry, and free of broken or cracked insulation.

Connecting cables must be routed so that they are not likely to be walked on nor pinched by items placed upon or against them. Do not pull on or tie them together. Pay particular attention to the connectors.

To disconnect a cable:

Unlock retainer (multi-cable) or turn the contact head (BNC contact). Grasp the connector firmly and pull.

If an input or output cable becomes damaged, stop using it. Use of a damaged cable may result in fire or electric shock.

2.5 Placement

The FRAX200- Series must be situated away from any heat sources such as radiators, heat registers, stoves, or

other products that produce heat. Do not place the FRAX200-Series in areas with excessive dust, mechanical vibration or shock.

Do not use the FRAX200-Series near water.

Do not expose the FRAX200-Series to rain or moisture.

Do not touch the charger power cord plug with wet hands. Doing so may result in electric shock.

Cleaning

- Unplug FRAX200-Series before cleaning.
- Do not use liquid cleaners or aerosol cleaners.
- Only use a damp cloth for cleaning.
- Stubborn stains may be removed with a cloth lightly dampened with a mild detergent solution.

2.6 Damaged product

Do not use the FRAX200-Series if the test leads appear damaged.

Do not continue using a damaged FRAX200-Series. Using a damaged FRAX200-Series may result in fire or electric shock.

Damage requiring service

Unplug the FRAX200-Series from all connections and entrust servicing to qualified service personnel under the following conditions:

- If any connector is damaged, including main plug
- If liquid has been spilled into the FRAX200-Series
- If the FRAX200-Series has been exposed to rain or moisture
- If the FRAX200-Series does not operate normally (following the operating instructions)
- If the FRAX200-Series has been dropped or damaged in any way
- If the FRAX200-Series exhibits a distinct change in performance

If the FRAX200-Series begins to emit smoke, smell, or make strange noises, disconnect all power connections immediately and contact your dealer for advice.

2.7 Inputs and outputs

- Do not exceed the specified input voltage limit on any of the FRAX200-Series inputs.
- Do not apply voltage to the outputs.

2.8 Lightning

For added protection of the FRAX200-Series during a lightning storm, unplug it from the AC outlet and from all cables connected to the inputs. This will prevent damage to the FRAX200-Series due to lightning and power supply surges.

Never touch the charger plug and power cord if it begins to thunder. Touching them may result in electric shock.

2.9 Servicing

Do not attempt to service the FRAX200-Series yourself. Opening or removing covers can expose you to dangerous voltage and other hazards.

- Please entrust all servicing to qualified service personnel.
- If you attempt to service the FRAX200-Series yourself, the warranty will no longer be valid.
- In case of return for service, please use either the original transport box or one of equivalent strength.

2.10 Safety warnings

WARNING : It is not possible to eliminate all potential hazards from, and in using, electrical test equipment.

For this reason, every effort has been made to point out in this instruction manual the proper procedures and precautions to be followed by the user in operating this equipment and to mark the equipment itself with precautionary warnings where appropriate

It is not possible to foresee every hazard which may occur in the various applications of this equipment. It is therefore essential that the user, in addition to following the safety rules in this manual, also carefully consider all safety aspects of the test before proceeding.

1. The test set and the specimen to which it is connected are a possible source of high-voltage electrical energy and all persons making or assisting in tests must use all safety practice precautions to prevent contact with energized parts of the test equipment and related circuits.
2. Persons engaged in the test must stand clear of all parts of the complete high-voltage circuit, including all connections, unless the test set is de-energized, and all parts of the test circuit are grounded. Persons not directly involved with the work must be kept away from test activities by suitable barriers, barricades, or warnings.
3. Treat all terminals of high-voltage power equipment as a potential electric shock hazard.

There is always the potential of voltages being induced at these terminals because of proximity to energized high-voltage lines or equipment.

4. Always ground connection points of the test specimen before connecting any leads from the test set. Whenever possible, always keep one side of the test specimen grounded at all times. Always use a safety ground stick to ground any high-voltage conductor.
5. The ground connection on the test set must be the first made and the last removed. Any interruption of the grounding connection can create an electric shock hazard.
6. Make sure that the instrument is properly grounded, both through its AC power cord and through the ground connector. The AC power cord is the disconnecting device.
7. Always disconnect test leads from test specimen before attempting to disconnect them at the test set.
8. High-voltage discharges and other sources of strong electric or magnetic fields may interfere with the proper functioning of heart pacemakers. Persons with heart pacemakers should obtain expert advice on the possible risks before operating this equipment or being close to the equipment during operation.
9. All persons making or assisting in tests must use all practical safety precautions to prevent contact with energized parts of the test equipment and related circuits. Also follow all local and company safety requirements.
10. Safety is the responsibility of the user.
11. Misuse of this high-voltage equipment can be extremely dangerous.
12. The purpose of this equipment is limited to use as described in this manual. Do not use the equipment or its accessories with any device other than specifically described.
13. Before making any connections, make sure that the instrument is de-energized and that all parts of the test circuit are properly grounded.
14. Never connect more than one output at the time. All outputs are energized by the same amplifier and therefore all outputs are energized simultaneously.
15. Operation is prohibited in rain or snow.
16. Do not use the test set in an explosive atmosphere.
17. Refer all servicing to qualified personnel.
18. A qualified operator should attend all times while the test equipment is in operation.

19. Observe all safety warnings marked on the equipment.
20. Corrective maintenance must only be performed by qualified personnel who are familiar with the design and operation of the test set and the hazards involved.

2.11 Important

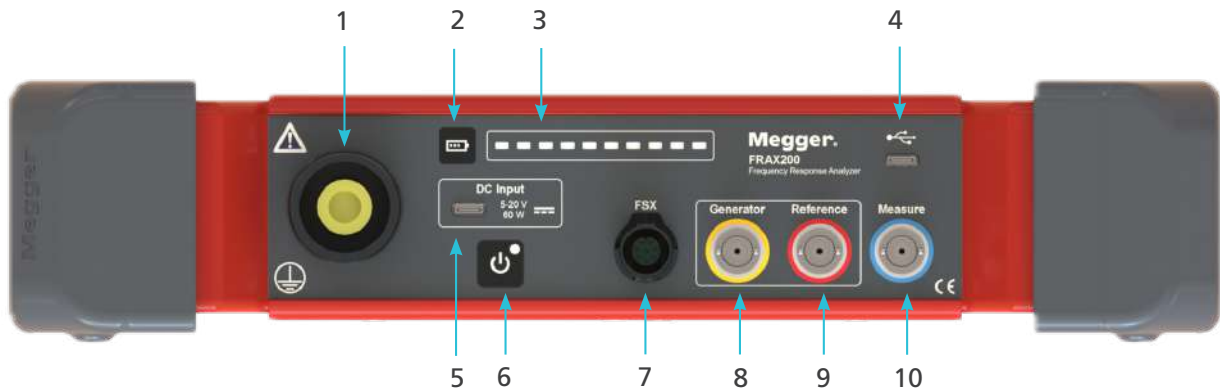
ATTENTION : Disconnect the power adapter before any cleaning or maintenance.

1. Maintenance should be performed only by qualified personnel familiar with the hazards involved with high-voltage test equipment.
2. Refer all servicing to qualified personnel.
3. Routine maintenance is all that is required for these test sets. The cables and connector panel should be inspected frequently to be sure all connections are tight and all ground connections intact.
4. The appearance of the test set can be maintained by occasional cleaning of the case, panel, and cable assemblies.

The outside of the carrying case can be cleaned with detergent and water. Dry with a clean, dry cloth. The control panel can be cleaned with a cloth dampened with detergent and water. Do not allow water to penetrate panel holes, because damage to components on the underside may occur. A household all-purpose spray cleaner can be used to clean the panel. Polish with a soft, dry cloth, taking care not to scratch the display screen cover. The cables and mating panel receptacles can be cleaned with isopropyl or enatured alcohol applied with a clean cloth.

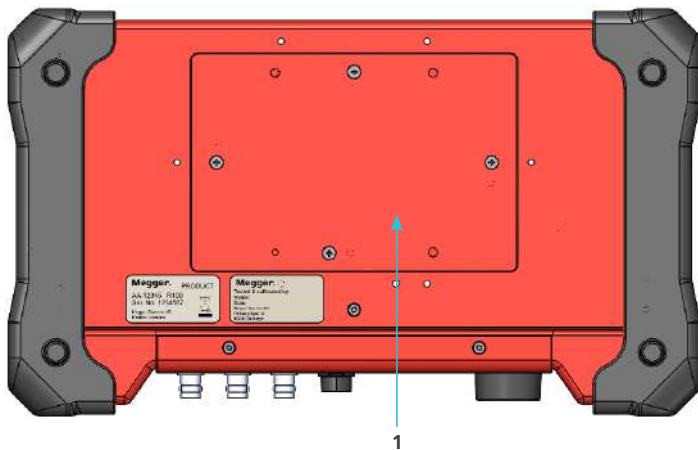
3. Product overview

3.1 FRAX200 Front panel



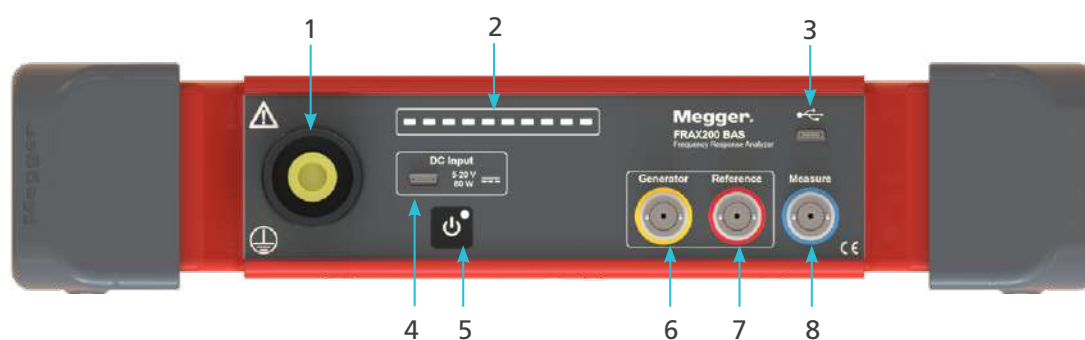
Item	Description	Item	Description
1	Ground (earth) terminal	6	On/Off button
2	Battery charge check push button	7	Switchbox Connector (for FSX200)
3	Device status and battery charge LED indicator	8	Generator (Yellow)
4	USB-C for data transfer	9	Reference input (Red)
5	USB-C for DC-input and charging	10	Measure input (Blue)

3.2 Bottom panel



Item	Description
1	Removable cover for battery replacement

3.3 FRAX200 BAS Front panel



Item	Description	Item	Description
1	Ground (earth) terminal	5	On/Off button
2	Device status and battery charge LED indicator	6	Generator (Yellow)
3	USB-C for data transfer	7	Reference input (Red)
4	USB-C for DC-input and charging	8	Measure input (Blue)

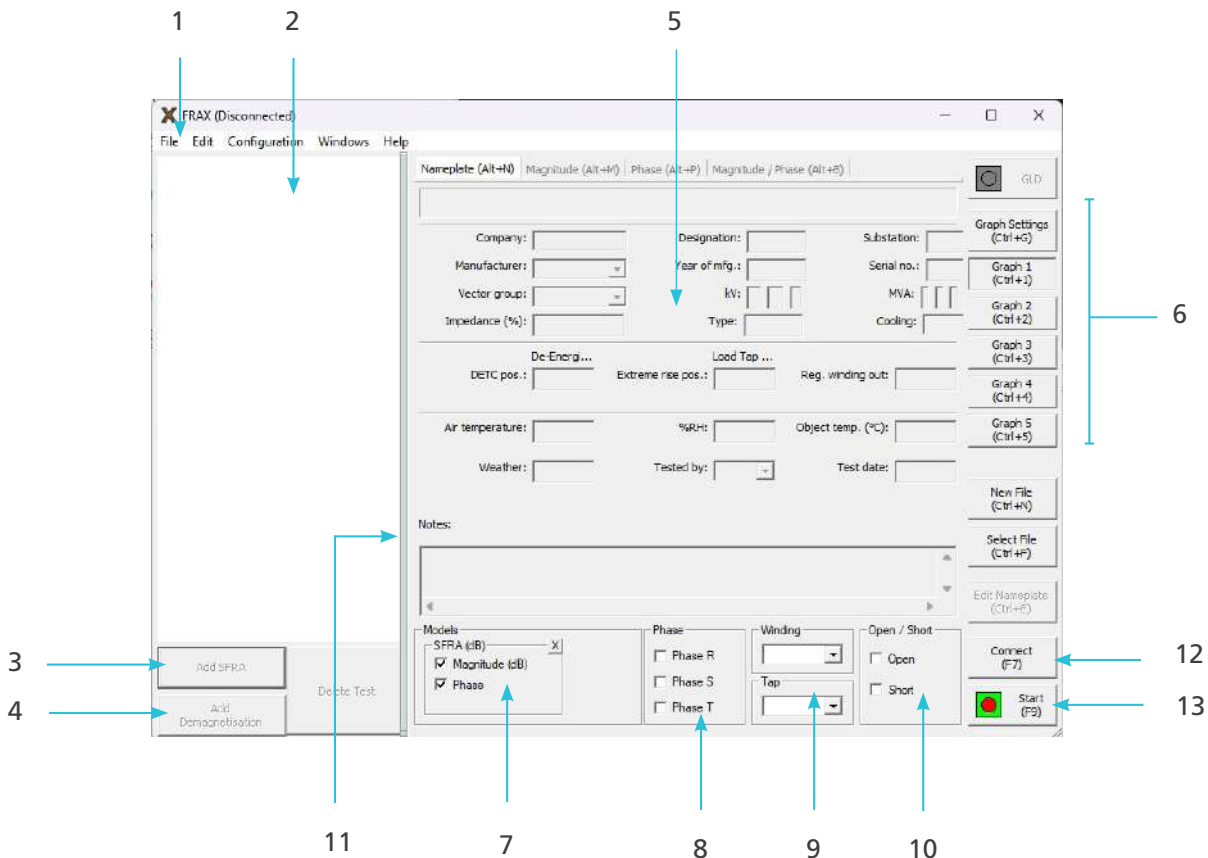
3.3.1 Differences between FRAX200 and FRAX200 BAS

Feature	FRAX200	FRAX200 BAS
Built-in battery	■	—
FSX200 support	■	—
Demagnetisation	■	—
Active clamps	■	—
Upgradable to FRAX200		—

4. Functions Software interface

4.1 Main window

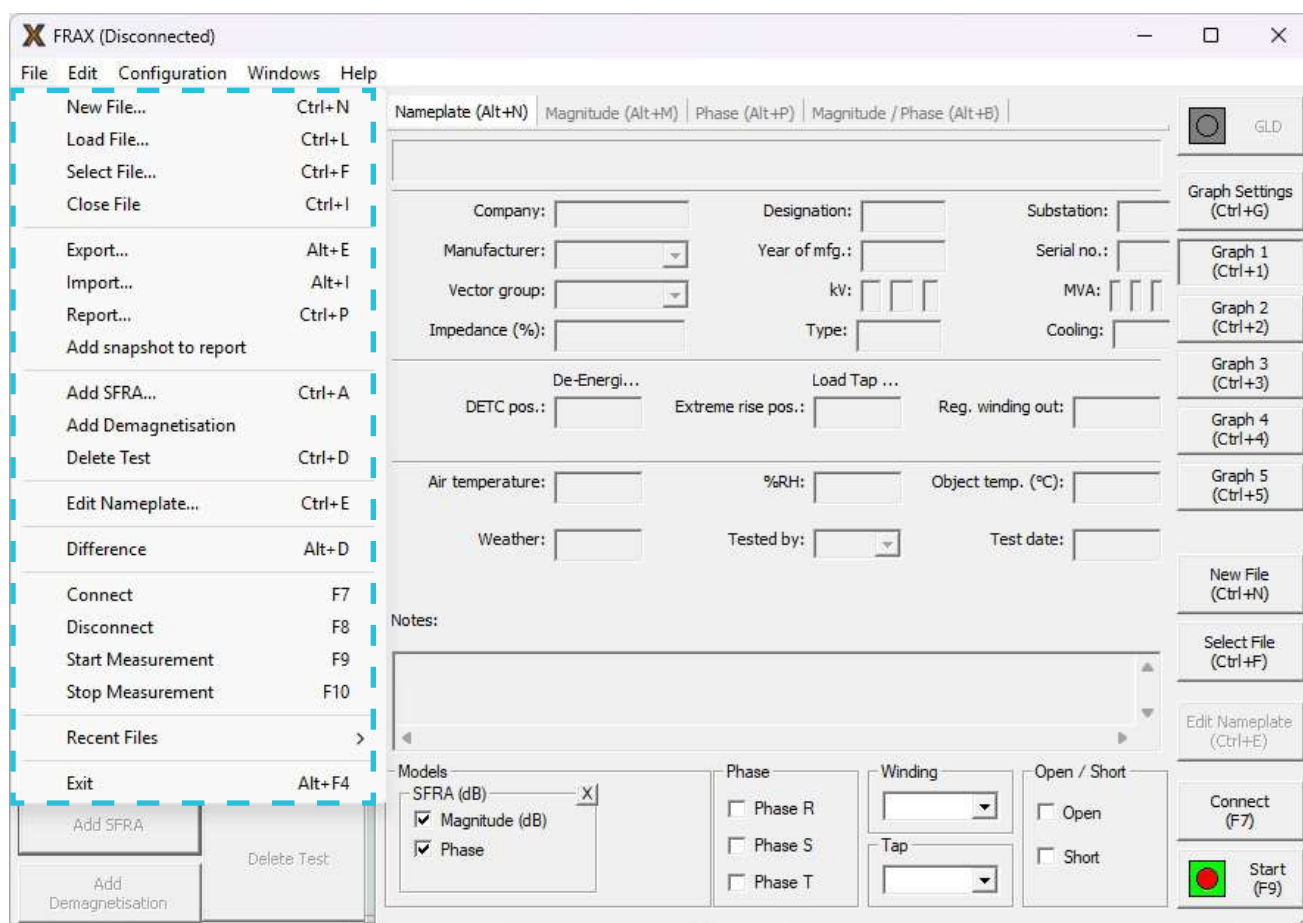
The main window is divided into three sections:



Item	Description	Item	Description
1	Main menu	8	Filters: phases (R, S, T)
2	The test browser or Legend	9	Filters: winding and tap
3	Button "Add SFRA" sweep	10	Filters measurement mode
4	Button "Add demagnetisation"	11	Splitter bar
5	Nameplate	12	Connect/disconnect button
6	Graph options	13	Start/Stop button
7	Models (default model is SFRA)		

- The action buttons to the right can be used with touch screen, or mouse click. They are also assigned to specific keyboard shortcuts and all buttons except Graph 1 to Graph 5 can be selected in the File or Configuration menus.
- The splitter bar can be used to adjust the relative size of the two parts of the window. The resizing is limited to ensure that the program is always usable.

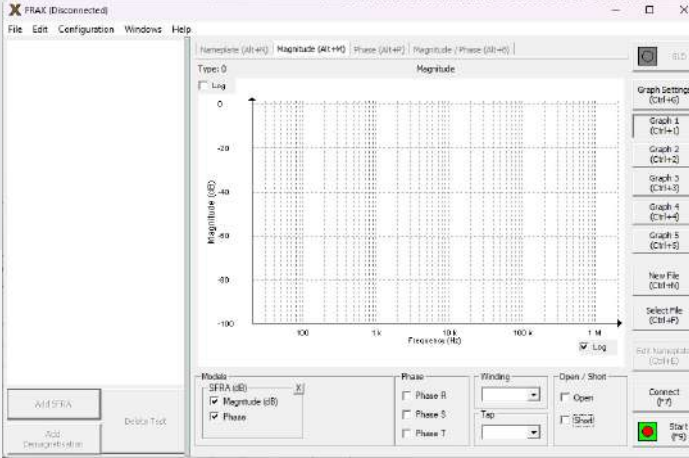
4.2 File menu



Menu action	Shortcut	Description
New file	Ctrl+N	Creates a new measurement file to save data in
Load file	Ctrl+L	Loads a previous performed measurement file
Select file	Ctrl+F	Opens the file database to be able to select one or more files to open
Close file	Ctrl+I	Closes a measurement file
Export	Alt+E	Exports active measurements to a *.csv or *.txt file
Import	ALT+I	Loads files in other file formats
Report	CTRL+P	Creates a simple report in MS Word, pdf and html formats
Add snapshot to report		Adds current graph view to the report
Add test	Ctrl+A	Adds an additional test into a measurement file
Delete test	Ctrl+D	Deletes a test (performed or empty) from a measurement file
Edit Nameplate	Ctrl+E	Opens the measurements file nameplate to allow editing
Difference	Alt+D	Calculates the difference between two tests active in the graph and plot results
Connect	F7	Connects the FRAX software to the FRAX instrument
Disconnect	F8	Disconnects the FRAX software from the FRAX instrument
Start measurement	F9	Starts measurement of selected test in test browser
Stop measurement	F10	Stops active measurement
Recent files		The latest files opened
Exit	Alt+4	Terminates the FRAX Software

4.2.1 Selection between measurement types (New file...)

When creating new file there are two options:

<p>Use Measurement as Template</p>	<p>To use an earlier performed measurement as template for a new measurement.</p>	
<p>Use Templates</p>	<p>Offers a wide range of predefined measurement sequences according to IEC or IEEE standards for different transformers</p>	
<p>If Use Measurement as Template" tab is selected:</p> <p>Select an earlier measurement as template for the new measurement. Press the "Load File" button and load the Measurement file or use "Select File" to find an earlier measurement in the database.</p> <p>The "Test names" in the selected previous measurement are shown. An "X" indicates the tests in the selected file which were successfully performed last time. The tests to be included must be checked and those not included unchecked. Then press "OK". The test names and measurement settings used in the selected file are loaded.</p> <p>The information from the selected file is entered automatically in nameplate of new file, except the test date which is filled using computer system date. It is always possible to add or change information to the "Nameplate" by clicking the Edit Nameplate button. This feature makes it possible to add notes during measurement.</p>		

4.2.2 Loading files (Load File...)

Loads a previously performed measurement into the graph view. The default directory is "My Documents\FRAX" on first start of the software and later the directory used last time.

4.2.3 File selection from indexed directories (Select File...)

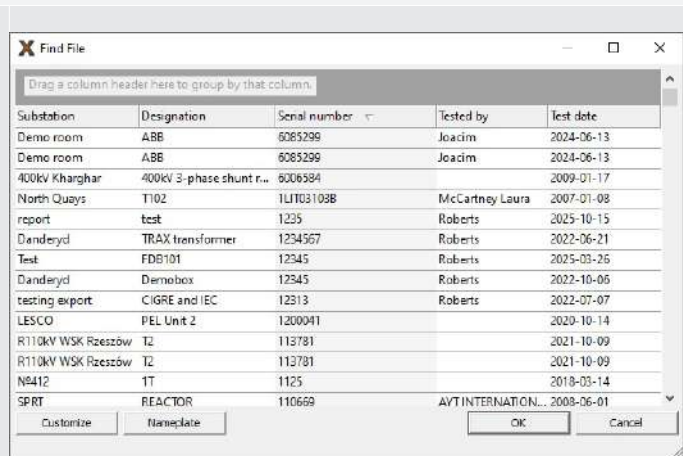
The FRAX software has built-in indexer which works in the background and checks all monitored directories for new or changed files. When a file is opened from a directory that is not indexed the question is presented if this directory shall be indexed.



If it is a directory with valid measurements, user should answer “Yes” if those files are supposed to show up in the Select File database.

Finding a previously performed measurement in the test database and loading it into the graph view is done using a dialog showing the files in the database:

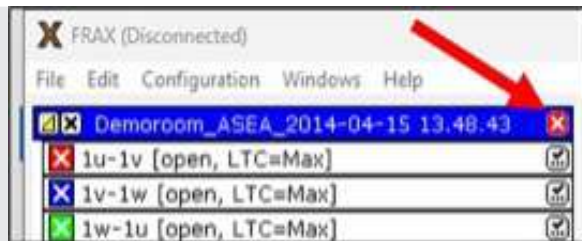
1. By clicking on the column headings (Substation, Designation and so on) it is possible to sort the list alphabetically according to that entry.
2. User can change the order of the columns by dragging the column header to the desired position or drag them away to remove them. To add more headings, click on the Customize button for a list.
3. To see the full nameplate of a test, click the Nameplate button.
4. To group the tests according to any heading by dragging it into the grey area at the top.



4.2.4 Closing files (Close file)

The measurement file that is selected in the test browser is closed if “Close File” in the “File menu”, or Ctrl+I are pressed.

A measurement can also be closed by clicking the right-hand side right corner of the legend. See arrow in picture.



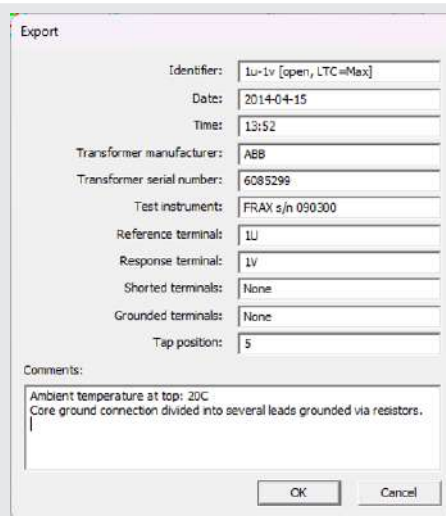
4.2.5 Exporting measurements (Export...)

Export function invokes a "Save As..." dialog to specify where to store the exported data. Type of export can be chosen from drop-down menu, where the following export formats are available:

1. IEC 60076-18
2. CIGRE TB342
3. Doble
4. Column type Excel compatible file ("*.csv" format)
5. Column type text file ("*.txt" format)

IEC 60076-18 (*.xml)

IEC 60076-18 standard recommends saving files in xml (extensible markup language) format. When exporting to this format there is an opportunity to inspect and make changes to information which will be written to the file:



Pay attention to the terminal settings, especially if using custom sweep names that don't use the default sweep names.

CIGRE TB342 (*.xfra)

Export in xfra file format recommended in CIGRE Technical Brochure 342. When exporting to xfra format there is an opportunity to inspect and make changes to information which will be written to the file as with xml format.

Doble export

The Doble export exports the data of the currently selected test to a format (*.sfra) used by Doble SFRA devices. Make sure that correct test is selected for export as only one selected test is exported

4.2.6 Importing files (Import...)

It is possible to load files in various file formats, including::

- XML (e.g., Test1.xml)
- CSV (e.g., Test2.csv)
- Files from several vendors of SFRA devices

The software tries to automatically detect the file format when "All supported files" is selected in the File type list. It is also possible to manually select the file format to import this list.

If importing files from Doble and Omicron:

- The available information will also be displayed in the Nameplate.
- Omicron import will use the same curve colour and thickness as in the Omicron file.

Supported formats

Doble:

- SFRA
- SFRX

Omicron

- FRA
- TFRA

Creating reports

The report function allows a simple direct printout containing the currently selected tab. For example, if the Magnitude Graph View tab is selected then the printout will contain the magnitude curve.

- The printout will also contain a simple list of the nameplate data.
- The printout of nameplate data will be in English only.

Printouts can be generated in the following formats:

- HTML
- PDF
- Microsoft Word

Setting logotype:

- Microsoft Word reports only.
- By default, only content of nameplate is reported.

Adding graphs

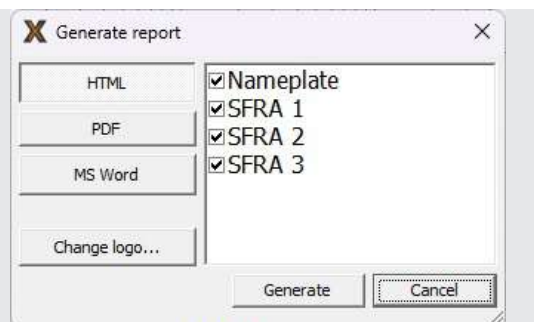
- Use menu "Add snapshot to the report"

For more advanced reports with more options to format the output it is suggested to either use the customised reports using copy functions, i.e., "Copy View", "Copy Legend" or "Copy View + Legend" to copy a screenshot to the clipboard and then paste them into an editing software of choice.

Add snapshot to report

Report creation can be facilitated by creating desired graphs with selected sweeps and adding those to report.

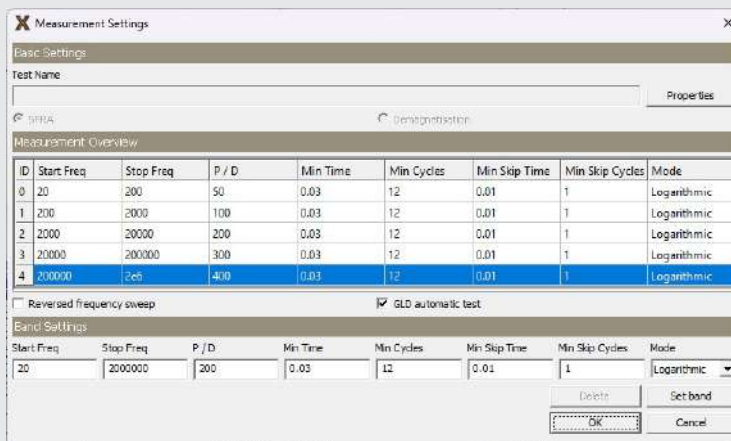
It is possible to add several graphs to the report.



4.2.7 Adding tests to existing measurement (Add SFRA and Add Demagnetisation)

Existing measurement can be expanded with more tests if necessary. Two options are available:

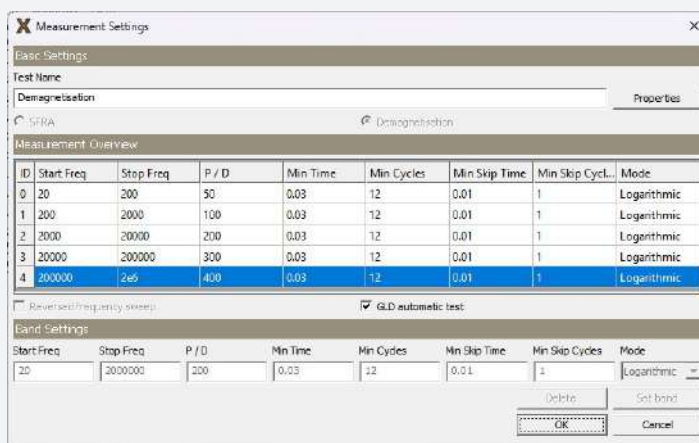
Add SFRA – adding regular SFRA sweep with default settings. User must enter sweep name.



Add Demagnetisation – adding sweep which is configured according to demagnetisation settings.

Default sweep name is “Demagnetisation” but it can be changed.

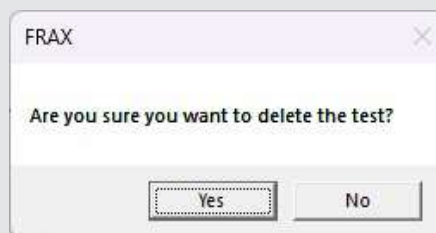
Band settings cannot be changed.



4.2.8 Removing sweeps from measurement file (Delete test...)

Selecting menu command or pressing button “Delete Test” will remove selected sweep from measurement file structure.

User is warned about it, but pressing “Yes” in dialog will permanently remove data from measurement file.



4.2.9 Changing nameplate information (Edit Nameplate...)

Menu command or pressing button “Edit Nameplate” allows for editing the nameplate information of the measurement file.

NOTE : Some of the fields have a drop-down box; if the field is filled in and then pressed enter, the software will ask if the entered text should be saved as a preset choice for next time. It is possible to delete a text from the list by selecting the text and pressing the delete key on keyboard.

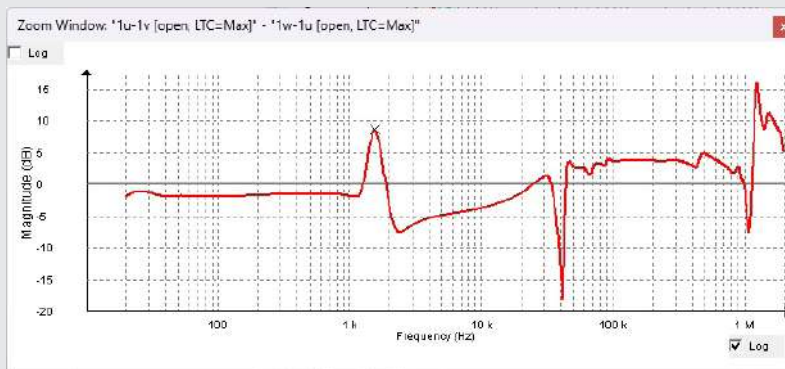
4.2.10 Analysing difference between two sweeps (Difference)

The Difference function calculates and displays curve of difference between two sweeps. This difference is calculated between two highest sweeps in the list. If other sweeps are to be compared, then unnecessary sweeps must be unchecked.

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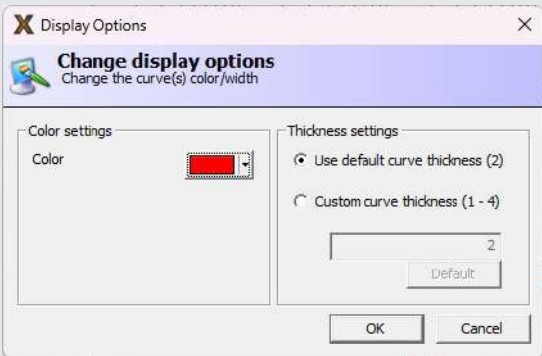
4.2.11 Communication with FRAX200

There are four menu commands and two buttons to communicate with FRAX200.

Menu commands	Shortcut	Description
Connect	F7	Connects the FRAX software to the FRAX instrument using one of available methods of communication – USB or Bluetooth.
Disconnect	F8	Disconnects the FRAX software from the FRAX instrument.
Start measurement	F9	Starts SFRA measurement or demagnetisation process according to selected test.
Stop measurement	F10	Stops active SFRA measurement or demagnetisation procedure (not recommended).
Exit	Alt+F4	Terminates the FRAX software.

4.3 Edit menu

This menu contains commands allowing for creating screenshots for customised reports as well as for changing display options.

Menu commands	Shortcut	Description
Copy View		Copies the current view of active tab into the clipboard.
Copy Legend		Copies the Legend (sweep list) into the clipboard.
Copy View + Legend	(Alt+C)	Copies whole FRAX software window with current View and the Legend into the clipboard.
Change Display Options	(Alt+O)	 <p>This dialog allows for changing the colour and line width of the selected curve and change the thickness of the line.</p> <p>The thickness of the line can either be set as the default or a custom width. It is also possible to set a new default curve for all lines by pressing the “Default” button.</p>

4.4 Configuration menu

Configuration menu commands allow for changing various parameters of the measurement settings and software appearance.

Change Language...	Selecting one of the available languages will change language in menus and dialogs in the FRAX software. A software restart is required to activate the changes after the new language is selected.
Change Standards...	SFRA measurement can be done according to standardised practices, which regulates connection of reference and response terminals, tap changer positions as well as terminal abbreviations. Available standards are IEC and IEEE. A software restart is required to activate the changes after the new standard is selected.
Connection Settings...	FRAX200 instrument supports two options to communicate with the computer – either Bluetooth Low Energy (BLE) or a serial port via USB. If serial port is chosen as a communication channel the FRAX software will try to find an active/free COM-port and provide suggestions if no FRAX200 instrument was found. COM-ports marked with green indicate that a FRAX200 instrument was found on that COM-port. Red means that no FRAX instrument was found. If FRAX200 was recently connected to computer, then pressing Refresh button FRAX software will search again for port with FRAX200 connected.

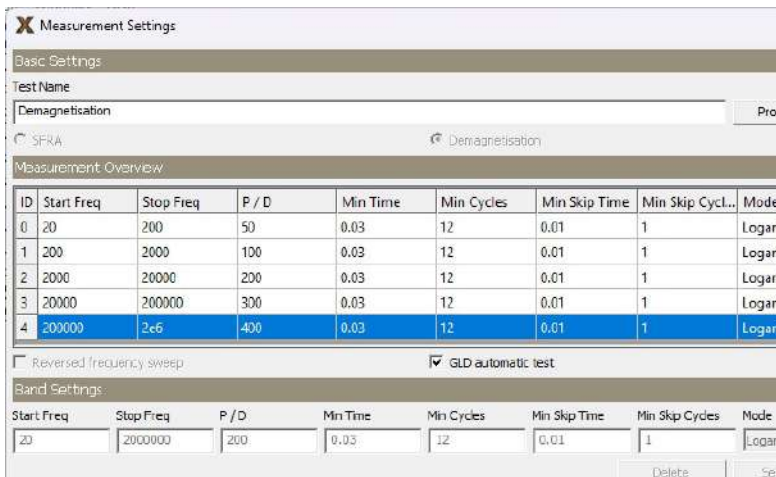


Bluetooth communications can be enabled after clicking on button “Switch to BLE”. Now FRAX software can connect to FRAX200 using BLE when “Connect” button is pressed. The dialog “Connect” appears, where FRAX200 can be selected. Connection will be established after clicking on button OK.

4.4.1 Measurement Settings... (Ctrl+M)

The default measurement settings are specified in this dialog. All new measurement sweeps except sweeps based on “Use Measurement as Template” will have these settings initially.

A measurement sweep can consist of one or more (max 15) measurement bands with different settings. Normally the frequency settings are set in such a way that the next band continues the previous band. The default settings are shown in the picture.



Explanations of measurement settings:

Measurement settings	Description	Example
Start Freq and Stop Freq	Frequency limits of the given band.	
P / D.	Points per decade. This is the number of measurement points, equally spaced in a logarithmic or linear scale, per decade. Using less than 10 P / D is not recommended.	In logarithmic scale 200 P/D between 10 Hz and 1000 Hz results in 400 measurement points logarithmically distributed between 10 Hz to 1000 Hz (two decades).
		In a linear scale, "P / D" is the total number of measurement points, linearly distributed. 200 P / D from 10 Hz to 1000 Hz results in 200 measurement points linearly distributed.
Min time and Min cycles	Defines the time and the number of cycles in measurement of one point. Depending on the current frequency either one is used to start measurement at next frequency.	If a measurement is performed at 100 Hz where "Min time" = 0.1s and "Min cycles" = 12. Since 12 cycles is greater than 10 cycles = 0.1s, the system measures at 100 Hz using 12 cycles. Same settings at 1000 Hz means that the system measures 100 cycles since 0.1s = 100 cycles is greater than 12 cycles.
Min skip time and Min skip cycles	Define the time and the number of cycles applied before a data point starts to be measured at given frequency	

If it is necessary to perform the measurement faster, the low frequency range can be modified by decreased number of measurement points and/or lower the integration time ("Min Cycles").

Examples of various sweeps:

Measurement settings	P/D	Freq bands (Hz)	Meas points	Approx. meas. time (s)
Default	50	20-200	50	
	100	200-2k	100	
	200	2-20k	200	
	300	20-200k	300	
	400	200k-2M	400	
			Total: 1050	64
Fast	40	20-200	40	
	60	200-2k	60	
	80	2-20k	80	
	100	20-200k	100	
	160	200k-2M	160	
			Total: 440	37
Fixed P/D set- tings				
Example	100	20-2M	500	
Omicron default	160	20-2M	800	76
Doble default	200	20-2M	1000	93
Omicron max	320	20-2M	1600	145
Double max	360	20-2M	1800	163
Frax max	6400	20-2M	32000	

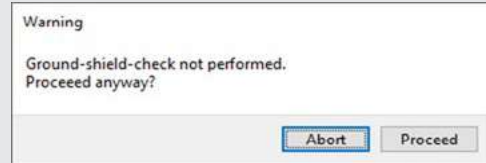
Functions Software interface

Using FRAX200 the test can be set to be performed in reverse frequency order, i.e., to measure from the highest frequency to the lowest. This is a single setting for all bands.

By default, FRAX200 performs ground loop detection test automatically for all channels. Unchecking the automatic GLD checkbox allows for skipping this test in newly created tests. User is warned about omitted GLD test:

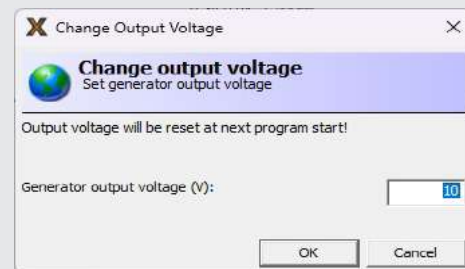
To enable automatic GLD test user is required:

- check in the automatic GLD checkbox in each sweep properties,
- enable GLD in Measurement settings and create a new file again.



4.4.2 Output voltage

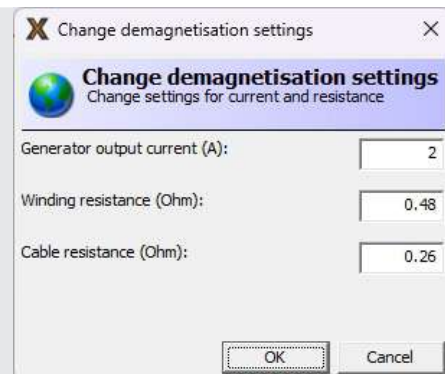
The voltage output of FRAX200 can be adjusted within range of 0,1 to 12Vpeak. The default value of output voltage is 10Vpeak. The changes made during measurement session will be reset back to default 10Vpeak when the software is terminated.



4.4.3 Demagnetisation settings

In this dialog the settings affecting demagnetisation procedure can be changed. Default current is 2A. Winding as well as cable resistances are set to 0 Ohm by default.

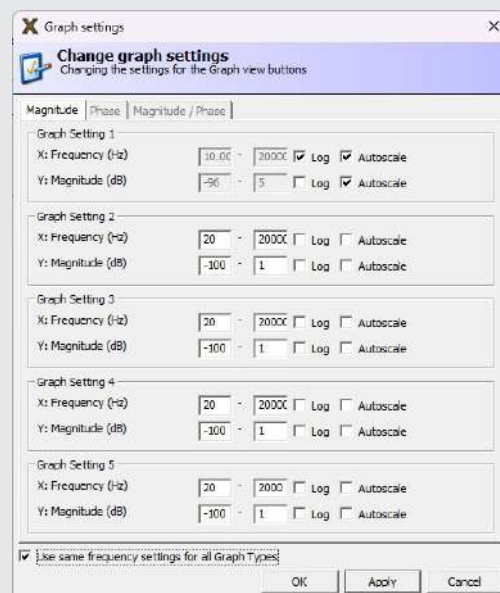
NOTE : 1. If battery is absent in FRAX200 the maximum demagnetisation current is limited to 1,2 A.



NOTE : 2. Demagnetisation is not available in FRAX200 BAS.

4.4.4 Graph Settings... (Ctrl+G)

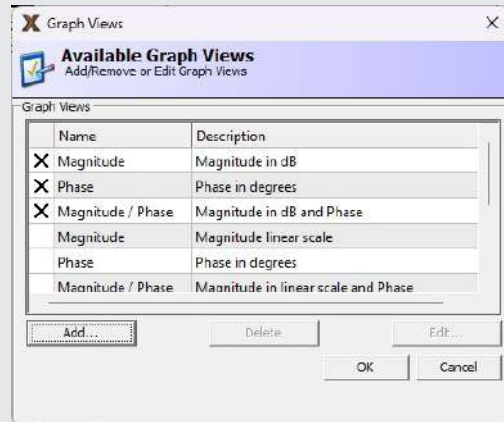
In the Graph settings dialog auto scale or range and spacing for the axis can be set. The Dialog has one tab for Magnitude and one tab Phase, as well as a tab for the combination of combined Magnitude and Phase. At the bottom there is a check box that makes changes that affect all graphs.



4.4.5 Graph Views...

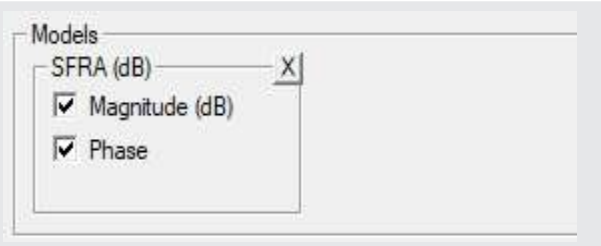
In the Graph Views dialog, it is possible to configure which graphs are accessible as separate tabs. The default selections include Magnitude, Phase, and Magnitude / Phase.

1. To select a graph, check or uncheck the box to the left of its name.
2. To edit or delete a custom graph, select the graph in the list and then click the Delete or Edit... buttons. To add a custom graph, click the Add... button, and the following dialog is shown.
3. To add a graph type, type a name and a description in the box, and click the Add button.
4. Enter a description and a number in the Graph Type box. The number is used as a unique ID for this graph. It is also possible to use pre-defined types via the Get... button.



4.4.6 Models

In the Models dialog, it is possible to select which models to use when a graph is plotted. In the dialog below, the SFRA (dB) model is selected which is the most used model. Selected models are shown below the graphs in the main window and can be selected and deselected by clicking the small check box.



NOTE : All standard models display phases in degrees, but in custom models defined below phases are in radians (1 radians = 180 pi / degrees).

If "Reference" voltage is Ch0 and Measure voltage is Ch1, the following equations are used in calculations of models:

SFRA (dB)	Magnitude = 20 x log10 (Ch1 / Ch0) Phase = Phase(Ch1/Ch0) = Phase(Ch1) – Phase(Ch0)
SFRA (Linear)	Magnitude Ch1/Ch0 Phase = Phase(Ch1/Ch0) = Phase(Ch1) – Phase(Ch0)
Impedance	$Z = U/I = (Ch0 - Ch1)/I = 50 \times (Ch0 - Ch1)/Ch1$ Phase = Phase(Z)
Admittance	$Y = 1/Z = Ch1/(50 \times (Ch0 - Ch1))$ Phase = Phase(Y) = - Phase(Z)

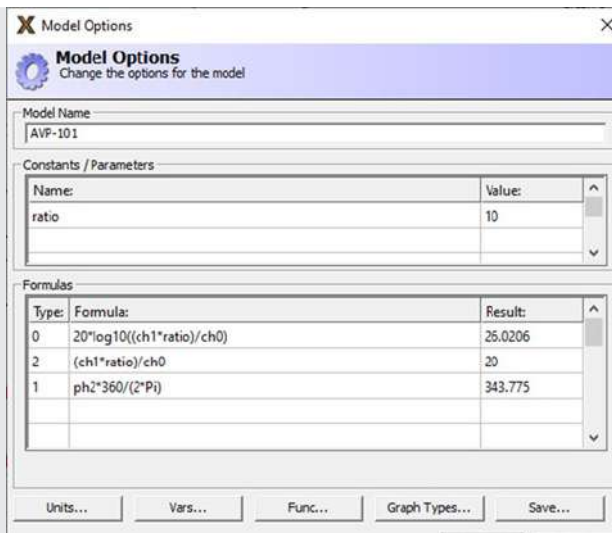
Two additional models are available and that is R and L model that plots its results in Impedance view. The R and L models are very useful evaluate why curve deviates at low frequencies in short-circuit measurements, increase of R at lowest frequencies may be a poor contact, whereas change of L may be a winding movement.

Also comparing R when frequency increase, typically in the range 50-400 Hz may give valuable information; this is also called FRSL (Frequency Response of Stray Losses).

Functions Software interface

To create a custom model, check “Custom Model” in the “Models” dialog as shown above.
Click “OK”

Then, click the button named “...” in the “Custom Model” frame in the main window. This brings up a window called “Model Options”.



The Model Options depicted above, with the custom model designed by Megger for the Active Voltage probe AVP-101, illustrates some of the features of Custom Models.

Type 0 represents the SFRA(dB) Magnitude graph and since the AVP-101 has a ratio of 10, the equation becomes $20 \cdot \log_{10}((ch1 \cdot \text{ratio})/ch0)$.

The phase is just the phase, but since all phase variables (Vars...) come in radians and we want to plot in degrees we multiply the phase by $360/(2 \cdot \text{Pi})$, $ph2 = ph1 - ph0$.

The buttons Units, Vars, Func, and Graph Types provide lists with available units, variables, mathematical functions, and graph types that can be used within formula.

A formula only affect one graph type. That is, a type must be unique for each formula, and two or more formulas cannot share the same type.

Click the Save button to save the model. The model is listed as “User defined” in the Models dialog for later use.

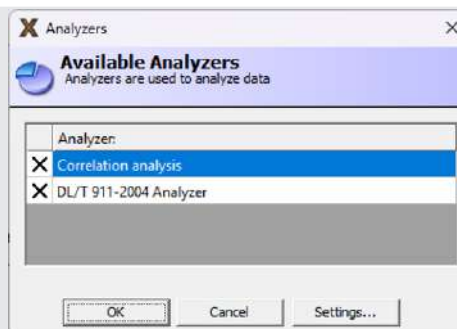
4.5 Analysers...

Two analysers are available for evaluation of the measurement results and can be invoked from Configuration menu:

- Correlation analysis
- DL/911-2004 Analyser

Correlation analysis includes three separate statistical techniques:

1. Cross-correlation
2. DL/T 911-2004 (Rxy) approach
3. NCEPRI evaluation



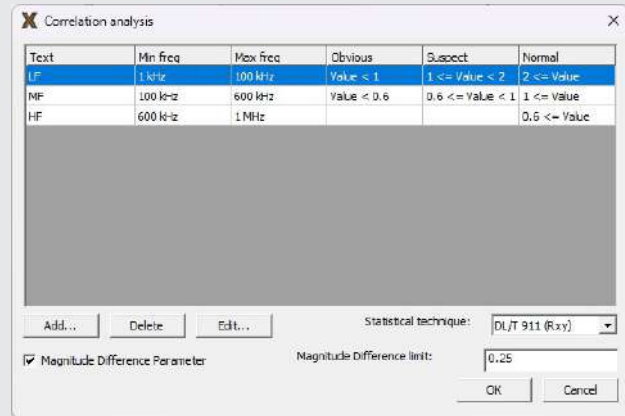
These techniques can be selected under “Settings...” button. The frequency regions and limits for all these techniques can be adjusted in “Correlation analysis” dialog window.

“Correlation analysis” dialog window.

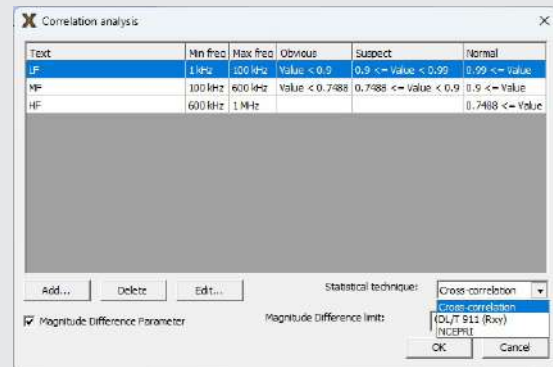
Analysing data will only very briefly be described in this manual. Please refer to relevant guides and standards such as:

- IEC 60076-18
- IEEE PC57.149
- CIGRE Brochure 342
- Chinese standard DL/T 911-2004
- NCEPRI algorithm

Detailed interpretation of results is not covered in this user manual. Analysers built-in FRAX software can be used to help understanding the data.

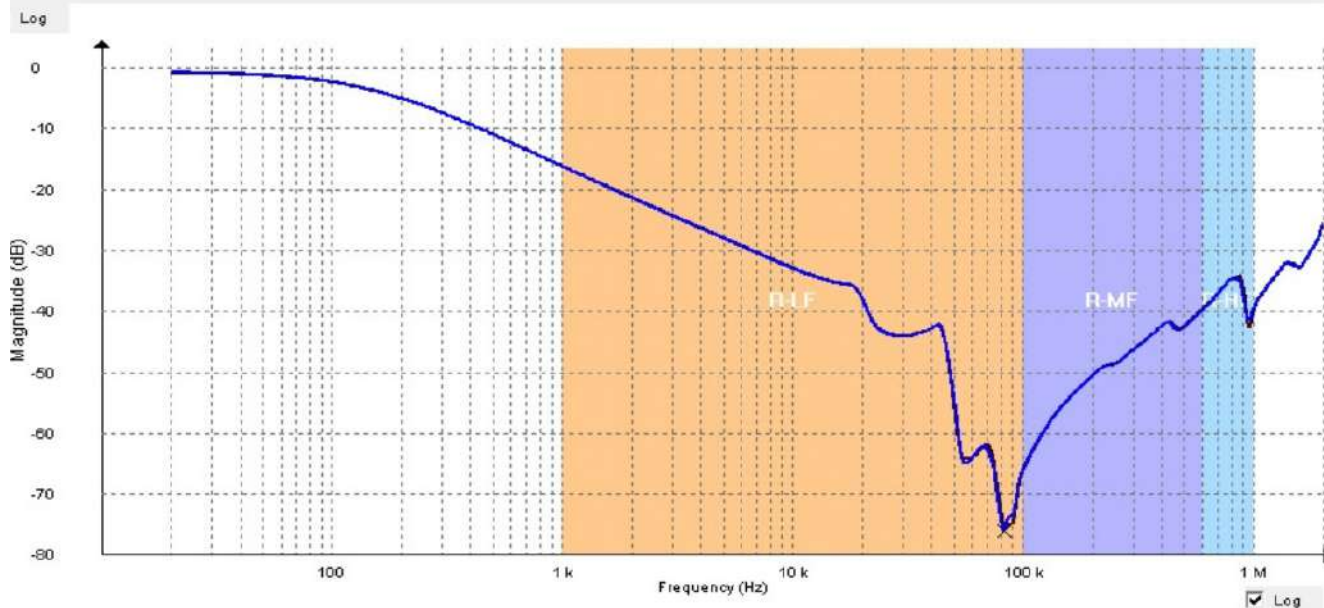


The desired analysis technique can be selected from drop-down menu "Statistical techniques". Frequency ranges and limits can be adjusted under "Edit..." button.



4.5.1 Using DL/T 911-2004 Analyzer

1. Use the Test Browser to select the two sweeps to compare.
2. The results for the combinations of the first three selected sweeps are shown in a table at the top of the window.
3. If more than three sweeps are selected, only the first three are displayed by the analyzer. The calculations are performed automatically, and the Conclusion is shown in the table above the graph. To view the curves and details for a specific combination, select them in the table above the graph.
4. The analyzer calculates Rxy values for three frequency ranges: 1 kHz–100 kHz, 100 kHz–600 kHz, and 600 kHz–1 MHz.



Interpretation according to DL/T 911-2004, China 2005-06-01
 Frequency response analysis on winding deformation of power transformers

	Value	Severe Distortion	Obvious Distortion	Light Distortion	Normal
-LF (1kHz - 100kHz)	3.38	R-LF < 0.6	0.6 <= R-LF < 1	1 <= R-LF < 2	2 <= R-LF
-MF (100kHz - 600kHz)	4.41		R-MF < 0.6	0.6 <= R-MF < 1	1 <= R-MF
-HF (600kHz - 1MHz)	1.65				0.6 <= R-HF

The DL/T 911-2004 Analyzer calculates the relative factor Rxy for three frequency ranges according to formulas below. Each calculated value is assigned a corresponding Winding Deformation Degree, and the final Conclusion is based on the worst resulting degree.

NOTE : RHF < 0.6 is not assigned to any **Winding Deformation Degree**.

Standard variance

Calculate the standard variance of the two sequences.

$$D_X = \frac{1}{N} \sum_{k=0}^{N-1} \left[X(k) - \frac{1}{N} \sum_{k=0}^{N-1} X(k) \right]^2 \quad D_Y = \frac{1}{N} \sum_{k=0}^{N-1} \left[Y(k) - \frac{1}{N} \sum_{k=0}^{N-1} Y(k) \right]^2$$

Covariance

Calculate the covariance of the two sequences.

$$C_{XY} = \frac{1}{N} \sum_{k=0}^{N-1} \left[X(k) - \frac{1}{N} \sum_{k=0}^{N-1} X(k) \right] \times \left[Y(k) - \frac{1}{N} \sum_{k=0}^{N-1} Y(k) \right]$$

Normalized covariance factor

Calculate the normalized covariance factor of the two sequences.

$$LR_{XY} = C_{XY} / \sqrt{D_X D_Y}$$

Relative factor Rxy

Calculate the relative factor Rxy according.

$$R_{XY} = \begin{cases} 10 & 1 - LR_{XY} < 10^{-10} \\ -\log(1 - LR_{XY}) & \text{others} \end{cases}$$

Winding deformation degree

Judge the degree of transformer winding deformation according to table below.

Winding deformation degree	Relative factors R
Severe deformation	RLF < 0.6
Obvious deformation	1.0 > RLF 0.6 or RMF < 0.6
Slight deformation	2.0 > RLF 1.0 or 0.6 RMF < 1.0
Normal winding	RLF 2.0, RMF 1.0 and RHF 0.6

RLF represents the relative factor in the low-frequency band (1 kHz–100 kHz).

RMF represents the relative factor in the medium-frequency band (100 kHz–600 kHz).

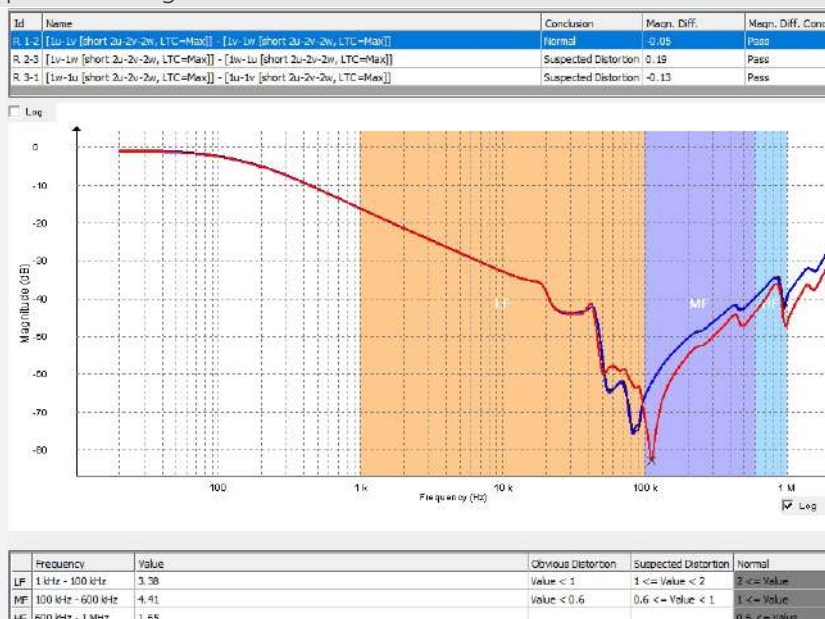
RHF represents the relative factor in the high-frequency band (600 kHz–1 MHz).

Using Correlation Analysis

The Correlation Analyzer is based on the DL/T 911-2004 Analyzer and uses the same calculation method. Unlike the standard analyzer, it allows the user to define custom frequency ranges, limits, and evaluation methods.

Step 1 : Select curves to compare

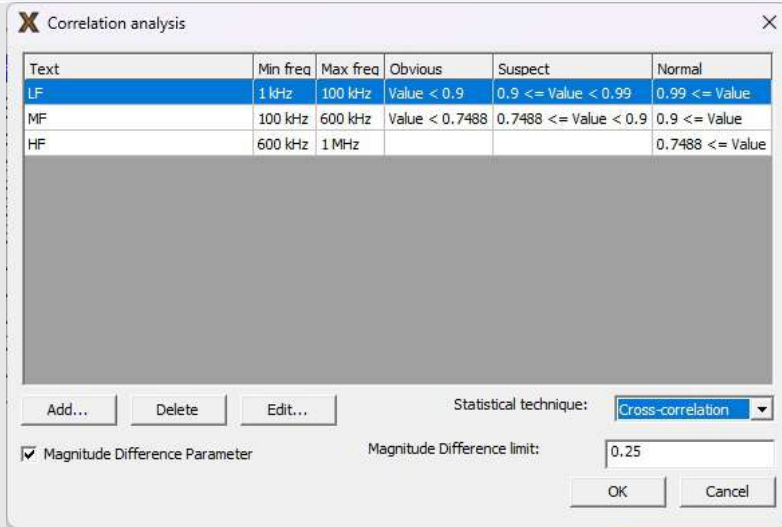
Use the Test Browser to select the curves to compare. If more than three curves are selected, only the first three are displayed. The calculations are performed automatically, and the Conclusion is shown in the tables above graphs. The Magnitude Difference Conclusion is also shown.



Step 2 : Change the analysis settings (if needed)

To change the analysis settings, click the Settings button in the analyser selection dialog.

This opens a dialog box where the settings can be adjusted. In the bottom-right corner, user can select the evaluation variable: the correlation coefficient (LR_{xy}), the R_{xy} factor according to DLT 911, or analysis using the NCEPRI algorithm. User can also add or remove frequency ranges, and modify the frequency settings and interpretation criteria..



Magnetisation impedance

For End-to-End (Short) measurements, the low-frequency region reflects the leakage impedance. Even a small deviation in this region (> 0.25 dB) may indicate severe winding deformation.

4.6 Magnitude difference parameter

This parameter shows the result of an automatic analysis of the magnitude difference between phases. The frequency range used for the analysis is 110 Hz to 2 kHz.

Default Filename Settings

The default filename settings used in the New File Save As dialog can be changed with this command.

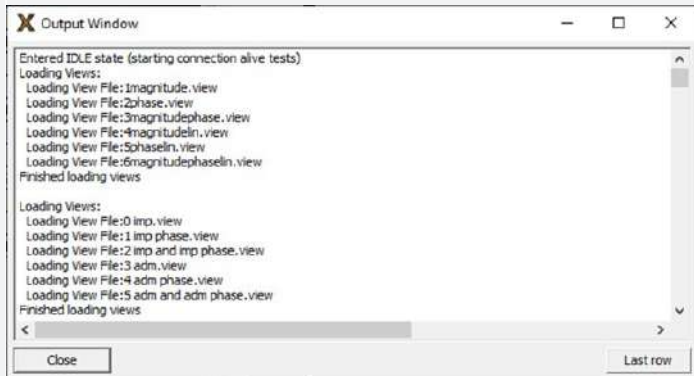
Option	Description	
Date time format (YYYY-MM-DD hh.mm.ss)	Generates a filename in the format YYYY-MM-DD hh.mm.ss.txt based on the system time of the PC.	
According to nameplate	Generates a filename based on the data entered in the nameplate, in the format. substation_designation_date time.frax.	
Number format (Dxxxxxxx)	Generates a filename starting with the number entered in the edit field. Each time a new file is created, the number is incremented automatically. The starting number can be selected freely.	

4.7 Windows menu

The Window menu contains a single command for opening a window that shows the command sequences sent to and received from the FRAX200.

Output window (Ctrl+O)

Opens a small window that displays all communication between the PC and the FRAX instrument. Clicking the Last row button keeps the latest lines visible as new entries are added during continuous communication.



4.8 Help menu

Help

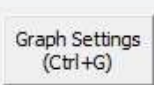
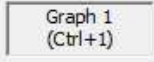
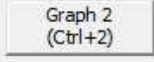
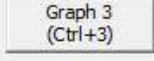
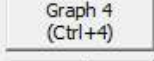
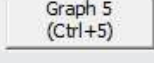
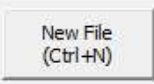




Selecting this command opens the User's Manual in PDF format.

About FRAX

This command opens a dialog box showing the software version and, if connected, the hardware version.





4.9 Action buttons

The action buttons provide quick access to commonly used functions.

Item	Button	Description	Function
Graph settings		Same as the menu item Graph Settings	(Ctrl+G)
Graph view settings	    	These five buttons control the graph views defined in the Graph Settings dialog box	
New File		Same as the menu item New File	(Ctrl+N)
Select File		Same as the menu item Select File	(Ctrl+F).
Edit Nameplate		Same as the menu item Edit Nameplate This button is enabled only when a file is selected in the Legend	(Ctrl+E).
Connect		Same as the menu item Connect ()	(F7)
Start			(F9)

Start

The Start button is multifunctional. It can be pressed at any time, and the application will suggest the next appropriate action. This is useful if you are unsure what to do next.

Icons	Description
	This icon indicates that the FRAX instrument is not connected to the system. <ul style="list-style-type: none"> No file is selected in the Legend
	<ul style="list-style-type: none"> No sweep is selected in the Legend The selected sweep has already been measured
	A measurement is currently in progress.
	The system is ready to start a measurement.

4.10 Legend

The Legend, or Test Browser, is where most work is performed. Here, the measurement settings can be changed and the graphs controlled.






If many tests are shown, or if several files are open at the same time, a scroll bar appears on the right side of the Legend, making it possible to scroll up and down to view all tests.

It is also possible to change the order of the tests in a file. Click and hold a test, drag it to the desired position, and then release it to drop it into place.



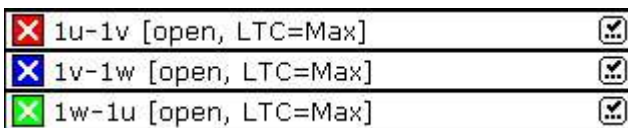
4.11 File description





The file header contains three function buttons and the file name.

File function button	Description
 or 	Hides or shows inactive tests in the file.
 or 	Enables or disables tests in the file.
	Closes the file.

4.12 Test description

The test contains two function buttons and the name of the test. Below is a list of different tests with different attributes.



Test function button	Description
 or 	Enables or disables the test. The color and line width can be set individually for each test. To change the color or line width, right-click the icon.
 or 	Indicates whether the test has been measured or is empty. Clicking this icon changes the measurement settings for the test.

5. Operations

5.1 Preparatory procedures

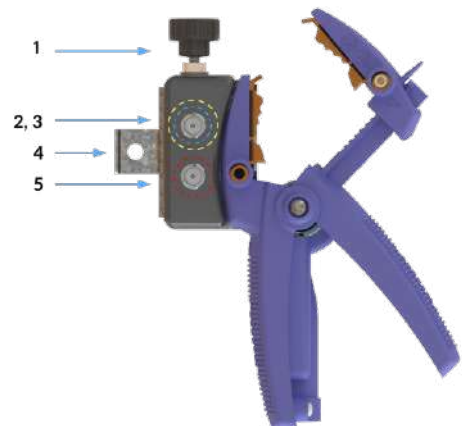
1. The transformer must be disconnected from the net, which means that any connection to the transformer bushings including neutral(s) must be disconnected.
2. The transformer tank must be properly grounded.
 - If the transformer is equipped with a On-Load Tap Changer (OLTC), the position of the OLTC will influence the SFRA measurement. The recommendation is to put the OLTC in the position to include all tap windings in circuit ("Extreme Raise" or "Max" position) and note that this OLTC position is used. When making measurements at several tap positions, make sure to note each tap position.
 - If the transformer is equipped with a De-Energized Tap Changer (DETC), the position of the DETC will influence the SFRA measurement. The recommendation is to leave it at the nominal tap position unless otherwise specified. Make sure to note the DETC position in the Nameplate section of the software.
3. Connect the FRAX instrument to station earth/ground near the power transformer to be measured using the separate earth/ground wire (at bottom of transformer if instrument is operated beside the transformer, at another good connection to transformer at top of transformer if instrument is used on top of transformer). The separate earth/ground wire should be the first connection made and the last removed.
4. Connect the test lead BNC connectors to the FRAX200 instrument, Generator (yellow), Reference (red) and Measure (blue).
5. Connect the AC/DC Adapter to the FRAX200 and a power source that meets local safety regulations and the AC/DC Adapter specifications or use built-in battery supply.
6. Connect the USB-C cable to the FRAX200 and computer if not using Bluetooth.
7. Turn on the FRAX200

5.2 Connecting the test leads

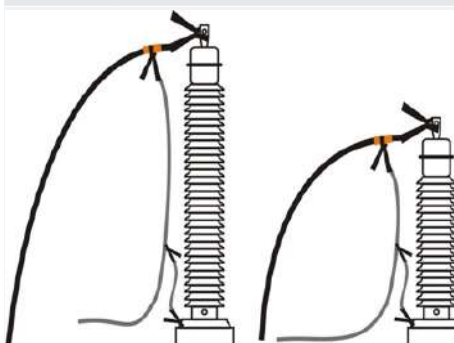
The FRAX200 clamp provides secure connections and repeatable test results. It supports both round and flat connectors and can be attached easily to any bushing. The adjustable jaw opening accommodates a wide range of bushing and busbar thicknesses.

The clamp includes all required connections in one unit: BNC, ground braid and cable strain relief.

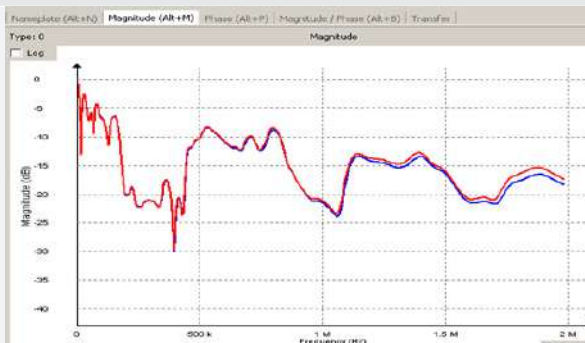
Item	Description
1	Ground braid
2, 3	Cables from FRAX200 Generator (Yellow) or measurement (Blue)
4	Strain relief
5	Reference (Red)



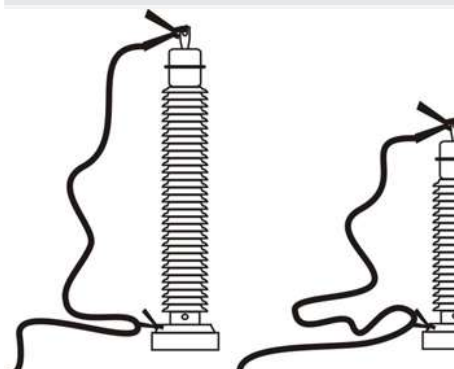
1. Connect the ground braid from the top clamp to the bottom of the bushing using the shortest possible path. Good grounding is essential, as poor grounding may affect the curve at higher frequencies.



Good grounding practice



Good ground connection



Poor grounding practice



Bad connection can affect the curve at higher frequencies

WARNING : Always use strain reliefs for all FRAX cables. If strain reliefs are not used, there is a risk that the BNC connectors may be pulled partially or completely off the cable. A damaged cable may still appear intact, even though the conductor or shield inside may be broken. Measurements made with a damaged cable are invalid.

CAUTION : Always follow local safety regulations. Local safety regulations will normally require all bushing connections to be earthed/grounded when work is carried out on the transformer, for example when connecting the FRAX test leads.

2. Remove any paint and/or rust from the nuts or bolts on the flange to ensure a proper measurement ground connection.
3. Connect the yellow and red leads (generator and reference) to the top of the first bushing, and connect the corresponding ground braid to the base of the bushing. Ensure that the braid does not touch any conductive part at the top of the bushing.
4. Connect the blue lead (measure) to the top of the second bushing, and connect the corresponding ground braid to the base of the bushing. Ensure that the braid does not touch any conductive part at the top of the bushing.
5. Remove any existing ground connections from the tops of the bushings, in accordance with local safety regulations.
6. Use a simple and repeatable cable arrangement to ensure reliable SFRA results.

NOTE : Test connection polarity is important. Reversed polarity will produce different results, so a consistent polarity convention must always be used. In this software, it is assumed, and recommended, that H1-H0 means that the red/yellow connectors (source and reference) are connected to H1, and the blue connector (measure) is connected to H0.

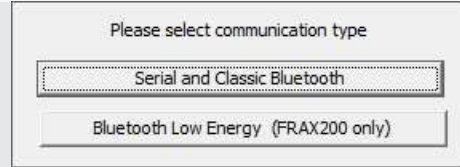


Photograph the connections before starting the measurement. This helps ensure that the same setup can be repeated

5.3 Establishing communication

1. Start FRAX software.
2. Connect to FRAX200 by selecting "Connect" from menu File, by clicking "Connect" button on the right-hand side of software window or by using F7 key.

3. Choose between Serial or Bluetooth Low Energy communication protocols from dialog window below.



4. Press "Connect" button again.

NOTE : Serial and Classic Bluetooth connection can be used also to connect to FRAX99/101/150.

5.3.1 Serial (USB) connection

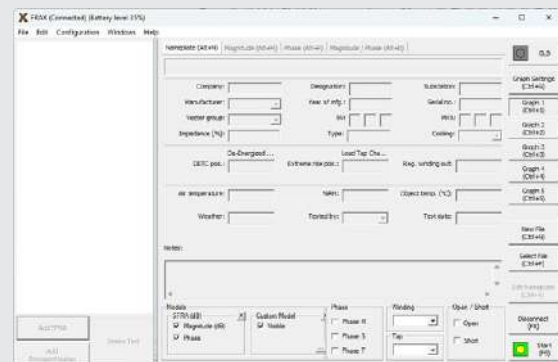
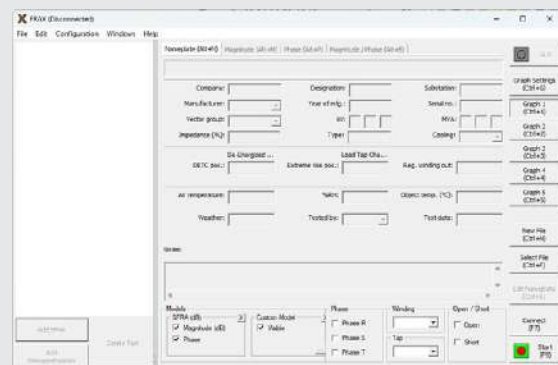
If Serial communication is selected FRAX software will automatically find the port FRAX200 is connected and show it in green colour.



Press OK if Serial communication is to be used. Otherwise, it is possible to switch to Bluetooth Low Energy (BLE) communication here as well.

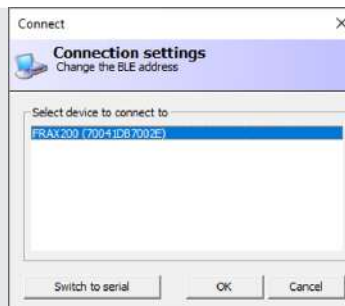


- If connection is successful, the FRAX software window name will change from "FRAX (Disconnected)" to FRAX (Connected)
- The "Connect" button will change name to "Disconnect"
- FRAX200 front panel LED strip will change colour to bright green



5.3.2 BLE connection

If BLE communication is selected FRAX software will automatically find the FRAX200 and list it in the dialog window below. Select it and press OK. Otherwise, it is possible to switch to Serial communication here as well.



- If connection is successful, the FRAX software window name will change from "FRAX (Disconnected)" to FRAX (Connected)
 - The "Connect" button will change name to "Disconnect"
- FRAX200 front panel LED strip will change colour to blue

5.4 Creating new test

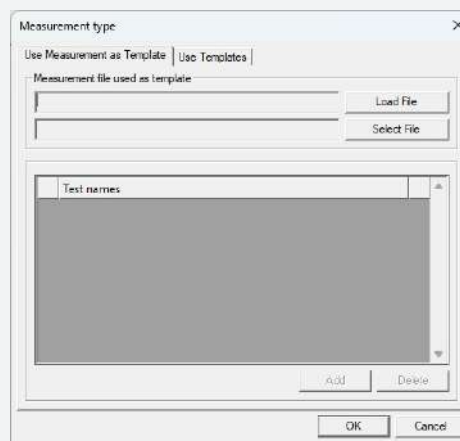
A test starts by creating a sequence of sweeps and deciding where to save the measurement data.

1. Use the command "New File" from the File menu or use of Ctrl+N or use of the button "New File".



2. The "Measurement type" window will appear.

In "Measurement type" window, select the tab of choice:



Use Measurement as Template

Makes it possible to use an earlier measurement as template for a new measurement. Useful if measurements are made on many transformers of the same type.

Use Templates

Offers a wide range of predefined measurement sequences according to IEC or IEEE standards for different transformers.

Depending on chosen tab:

- If "Use Measurement as Template" is used then the Nameplate contains the information from Template Nameplate by default, except the "Test Date" that is automatically added from PC system.
- If "Use Templates" tab is selected there will be given a choice of different predefined templates for different transformer designs. Select suitable template and desired tests to make and press OK.

NOTE : Note that it is always possible to add new sets of tests with different names.

Operations

3. Enter Nameplate information as needed and press "OK".

A "Save As..." dialog appears where the file structure and a name of choice can be selected. The default directory will be "My Documents\FRAX" on first start and then the directory used last time.

The file name will be formatted as selected in default filename settings.
Click "Save" to save the file.

NOTE : Information can always be added to the "Nameplate" at any time. This feature makes it possible to add notes during the measurement.

5.5 Making SFRA measurement

Measurement execution can be started by selecting a sweep from the list at the left side. However, before making SFRA measurement it is advisable to perform demagnetisation procedure to minimise influence of magnetised core on SFRA results. The demagnetisation can be started by selecting corresponding sweep in sweep list.

5.5.1 Demagnetisation procedure

It is recommended to ensure that before SFRA measurements the transformer core has as low as possible remaining remanence after disconnection from network. Other measurements like winding resistance can also magnetise core and thus negatively affect SFRA measurements, i.e. making them more difficult to compare with previous or reference measurements.

Demagnetisation with FRAX200 is performed by injecting an alternating and decreasing DC voltage / current to magnetise the core in two directions. Starting current is normally selected as about the same as the last performed winding resistance test if possible but it is limited at 2 A when using FRAX200.

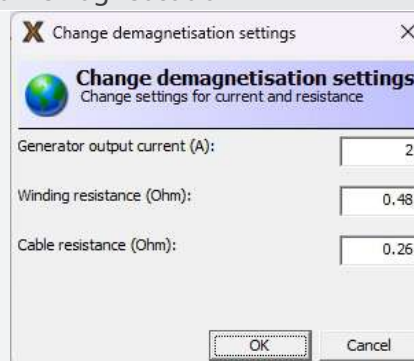
Demagnetisation is normally done on the HV side of the transformer and on the connection with the lowest excitation current (the middle leg for a YN configuration). For configurations without neutral, demagnetisation connection is terminal-terminal.

The predefined templates in FRAX200 software includes a demagnetisation sweep but since demagnetisation is not always necessary the sweep is deactivated by default. It can be activated when measurement file is created. If activated demagnetisation sweep appears at the beginning of SFRA sweep list with names of terminals where FRAX200 shall be connected.

NOTE : It is always possible to add demagnetisation sweep at later stage by pressing "Add Demagnetisation" button or from menu "File" selecting "Add Demagnetisation".

The starting or target current for demagnetisation is by default set to 2 A.

This value can be changed from menu "Configuration" and "Demagnetisation settings..."



In this dialog also winding and cable resistances can be entered to increase the performance of demagnetisation algorithm.

The winding resistance can be obtained from winding resistance measurements while cable resistance for different lengths of FRAX200 cables are listed in table below:

Cable length (m)	Resistance (Ohm)
9	0,13
18	0,26

By default, both winding and cable resistances are set to zero. The resistance values are reset back to zero after closing the software.

During active demagnetisation process FRAX200 front panel LED pattern changes to sweeping red LED from side to side.

WARNING : Before demagnetisation procedure is initiated:

- Check that all BNC cables are securely connected to FRAX200 and FSX200 output connectors. Make sure that all BNC contacts sit in the grooves and cannot be pulled off.
- If using FSX200 make sure that multi-cable between FRAX200 and FSX200 is securely connected with audible click at both ends.
- Check that all clamps are securely connected to cables and bushings.

WARNING : When demagnetisation procedure is in progress (indicated by LED bar on FRAX200 front panel side to side sweeping red light):

- Do not alter any connections to bushings or FRAX200 or FSX200.
- Do not switch off FRAX200.
- Wait until red sweeping light in LED bar turns either to green or blue.

5.5.2 Ground loop verification

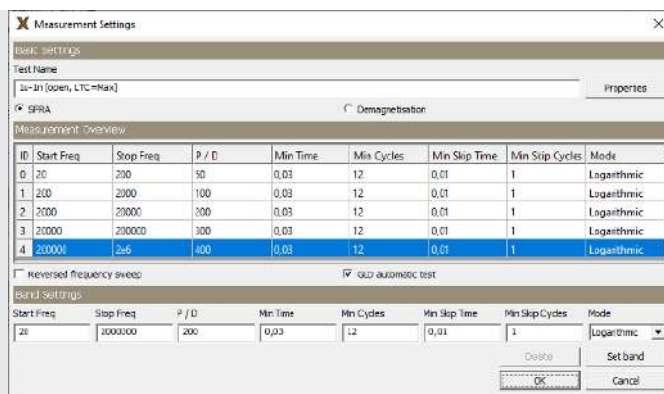
Embedded 'Ground Loop Detector' in FRAX allows for both manual and automatic verifying the test setup and assures that all connections including the grounding braids are properly connected.

The setup can be checked manually using GLD button in FRAX software.

The green/red ("Pass/ Fail") button colour shows the user about the status of the ground loop. In the case of "Fail" signal (red button), the connections must be checked and mistakes rectified. "Pass" signal (green button) guarantees that the measurement results can be reproducible.

The ground loop test is also automatically performed before each sweep.

This feature can be disabled by purposely clearing the GLD automatic test checkbox for given sweep.



NOTE : It is not possible to disable GLD test globally.

Operations

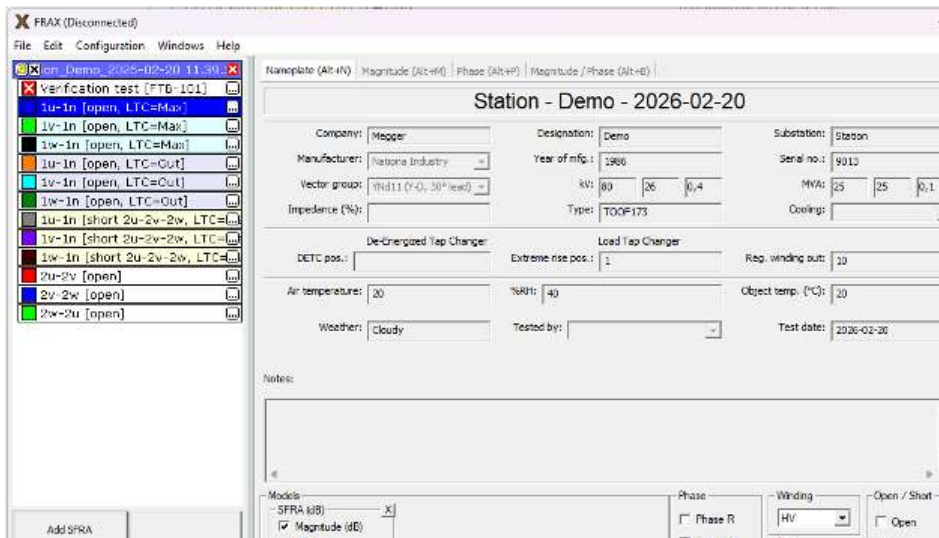
5.5.3 Verification test

Before starting SFRA measurements it is recommended to perform FRAX system test using supplied verification box FTB101.



5.5.4 Starting SFRA sweep

Measurement is started by selecting a sweep from the list on the left-hand side. In the example below, the blue highlight indicates that "1u-1v (open, LTC=Max)" is selected. Ensure that the tap changer is in the maximum position for the transformer being tested.

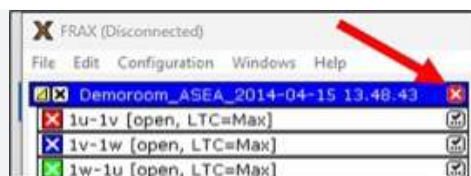


1. Start the measurement by pressing the "Start" button, (F9)-key or by selecting "Start" in the "File" menu.



2. Select tab "Magnitude" and observe the measurement progress.
3. When current sweep is finished, select next sweep and reconnect FRAX200 clamps according to terminal abbreviations in sweep name.
4. Change tap changer position corresponding to sweep requirements.
5. Start the measurement.

- When all measurements are finished, disconnect from FRAX200 using "Disconnect" button.

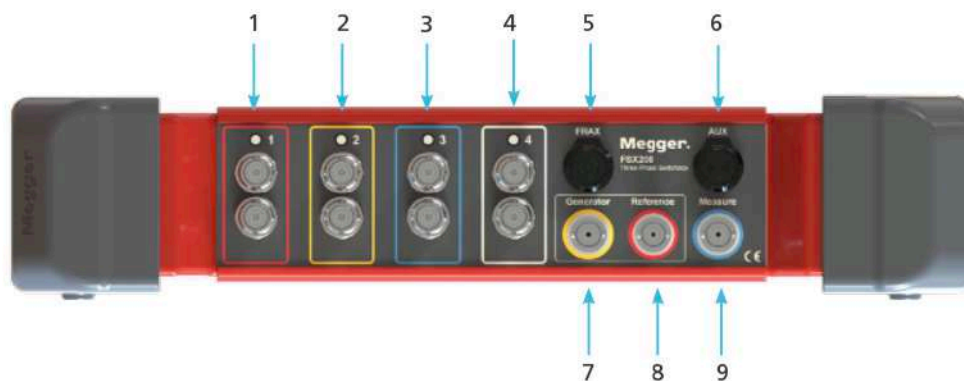


6. Switchbox

6.1 Description

FSX200 is an external switchbox to FRAX200 only, which enables a single hook-up session to test a complete three-phase power transformers. Each measurement channel (1 to 4) can be used as Generator/Reference or Measure channel.

6.1.1 Instrument overview FSX200



Item	Description	Item	Description
1	Measurement channel 1	6	Connector for auxiliary shorting clamps
2	Measurement channel 2	7	Connector for Generator (Yellow) connection between FSX200 and FRAX200
3	Measurement channel 3	8	Connector for Reference (Red) connection between FSX200 and FRAX200
4	Measurement channel 4	9	Connector for Measure (Blue) connection between FSX200 and FRAX200
5	Connector for multi-cable between FSX200 and FRAX200		

6.2 Connection to FRAX200

FSX200 connects to FRAX200 using a multipole cable that carries power and communication data over one cable. The measurement connections from FRAX200 to FSX200 are made using short coaxial cables between “Generator”, “Reference” and “Measure” connectors on both devices.

6.3 Connections to power transformers

FSX200 is connected to power transformer using dual cables and active clamps. Depending on power transformer design and number of bushings at measurement side the measurement channels are connected to respective bushings of highest voltage side according to the intended order:

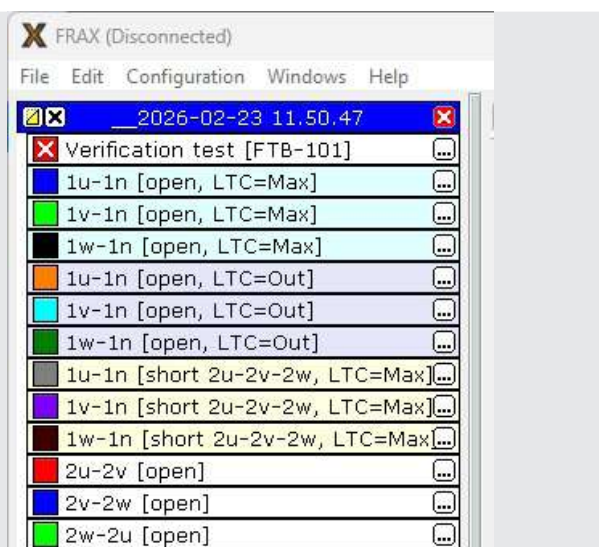
Measurement channel	Y-connection with neutral	D-connection and Y-connection without neutral
1	A, 1U, H1	A, 1U, H1
2	B, 1V, H2	B, 1V, H2
3	C, 1W, H3	C, 1W, H3
4	N, 1N, H0	Not connected

Shorting clamps are connected to secondary or low voltage side of the transformer. Between shorting clamps, a suitable low resistance wire or supplied grounding braid is connected. When sequence calling for short-circuit in secondary side is started, the shorting clamps automatically make short circuit by means of attached wire or grounding braid.

6.4 Making measurements

The measurement procedure is essentially the same as without the switchbox, except that all three phases are measured in a sequence. After one sequence is finished, user shall select next one and press "Start" button again to proceed with the next sequence. The sequences are colour marked for easier identification:

When using FSX200 the GLD functionality is now moved from the circuitry inside the FRAX200 to an extended GLD circuit in the switchbox.



7. Troubleshooting

1	When shutdown due to high temperature has been performed and charger is connected, it is not possible to turn on the system again with ON button until the charger has been disconnected.
2	If it is not possible to turn on the unit with power ON button, battery could be empty. Connect the charger, the LEDs should start to pulsate when charger is connected.
3	If power LED is blinking during usage the unit is overheated. Unit should be turned off and cooled down.
4	If charging does not start (LEDs start to pulsate) when charger is connected, it could be that temperature is outside allowed charging interval. Check specification section and ensure that the unit is inside the valid temperature range for charging the battery.
5	Power LED is off. If unit does not respond to power ON or battery buttons. If charging the unit has been tried without succeeding to get the unit to power on, remove the charger and try to do a force shutdown of the unit by holding the power off button pressed for at least 10 seconds.
6	Power LED is on. If unit does not respond to power OFF or battery buttons. Remove the charger and try to do a force shutdown of the unit by holding the power off button pressed for at least 10 seconds.
7	LED bar is blinking 5 times during start of the unit in white colour. The unit is in overheat, ensure that the unit is in valid temperature range and try again
8	LED bar is blinking 10 times during start of the unit in white colour. Something essential for starting up failed, if it happens repeatedly, the unit needs to be sent to a Megger service centre.
9	LED bar is blinking 15 times during start of the unit in white colour. Something hardware/ software related failed during starting up, if same behaviour happens repeatedly the unit needs to be sent to a Megger service centre.

8. Maintenance

8.1 General maintenance

Test leads should be checked before use for damage and continuity.

Ensure the unit is kept clean and dry after use.

8.2 Cleaning







Disconnect from mains power / charger.

Wipe the instrument with a clean cloth dampened with either water or isopropyl alcohol (IPA).



NOTE : There are no user replaceable parts within this product.

9. Accessories and Equipment


9.1 Included accessories

Picture	Part Number	Description	FRAX200	FSX200	FRAX200 + FSX200	FRAX200 BAS
		Active clamp				
	GC-80054	Yellow	1		1	
	GC-80056	Blue	1		1	
	GC-80052	Red		1	1	
	GC-80059	White		1	1	
		FRAX generator cable				
	GC-30040	Red/Yellow, 9 m (30 ft)	1		1	1
	GC-30044	Yellow/Yellow, 9 m (30 ft)		1	1	
	GC-30046	Blue/Blue, 9 m (30 ft)		1	1	
	GC-30049	White/White, 9 m (30 ft)		1	1	
	GC-30042	Red/Yellow, 18 m (60 ft)	1		1	1
	GC-30054	Yellow/Yellow, 18 m (60 ft)		1	1	
	GC-30056	Blue/Blue, 18 m (60 ft)		1	1	
	GC-30059	White/White, 18 m (60 ft)		1	1	
GC-30043	Red/Yellow, 30 m (100 ft)	1		1		
		FRAX measure cable				
	GC-30050	9 m (30 ft)	1		1	1
	GC-30052	18 m (60 ft)	1		1	1
GC-30053	30 m (100 ft)	1		1		
	GC-80010	C-clamp				2
	GC-80060	Ground clamp	2	2	4	2
	GC-30033	Ground braid insulated, 3 m (10 ft)	2	2	4	2

	GC-30036	Ground braid extension, 3 m (10 ft)	2	2	4	2
	GC-30037	Ground braid 0.3 m (1 ft) with clamp	2	2	4	2
	GA-00925	Switchbox interconnection cable, 0.3 m (1 ft)		1	1	
	GA-30025	BNC cable 0.25 m RG58		3	3	
	GA-00935	Cable, AUX > Shorting clamp 3 m (10 ft)		2	2	
	GA-00945	Cable, AUX > Shorting clamp 10 m (33 ft)		1	1	
	GC-80070	FSX200 Shorting clamp		3	3	
	GC-30080	Ground cable, green/yellow 10 m (33 ft)	1		1	1
	HC-04290	AC/DC Adapter, USB-C, 60 W	1		1	1
	HG-00240	USB-C cable	1		1	1
	AA-00015	IEC 60320 C7 mains lead	1		1	1
	AC-90060	FRAX Field Test Box FTB-101	1		1	1
	GD-30000	Transport case FRAX200 maxi *Depending on FRAX200 + FSX200 combination	1		1*	

	GD-30005	Transport case FRAX200 mini *Depending on FRAX200 + FSX200 combination	1		1*	
	GD-30015	Transport case FSX200 mini *Depending on FRAX200 + FSX200 combination	1		1*	
No image available	GD-30025	Transport case FRAX200 BAS				1
	2012-180	Cable backpack		1	1	1
No image available	SA-AC101	PC software for FRAX	1		1	1

9.2 Optional accessories

Picture	Part Number	Description	FRAX200	FSX200	FRAX200 + FSX200	FRAX200 BAS
	AC-90050	FRAX demo box FDB101	1		1	1

10. Battery

WARNING : Always set the instrument to Off and remove the test leads before the battery is removed or installed.

CAUTION : This product is not intrinsically safe. Do not use in an explosive atmosphere.

CAUTION : Old batteries must be disposed of in accordance with local regulations.

CAUTION : Only use approved batteries as defined below.

WARNING : Switch off the instrument and remove any connection before removing the battery cover.

10.1 Battery status

Battery charging state can be controlled by pressing small battery icon left from the LED bar. Each LED corresponds approximately 10 percent of battery charge.

10.1.1 Battery charging

When charging the Li-Ion rechargeable battery, only use the power supply provided by Megger. The Megger power supply is designed to preserve the functions and accuracy of the FRAX200. The FRAX200 can be used while charging.

10.2 Battery replacement and warranty

ATTENTION : To maintain warranty compliance, replacement batteries must be supplied through authorized Megger service centers only. Using non-approved batteries will void the warranty and may compromise safety and performance.

10.3 Preparing the instrument for shipping

When shipping the FRAX200, follow these guidelines to comply with dangerous goods regulations:

Option 1 (Preferred): Remove the battery completely before shipping to avoid dangerous goods classification.

Option 2: Discharge the battery to approximately 30% state of charge (SOC) before shipping. The instrument must be packaged and labelled according to current IATA dangerous goods regulations.

WARNING : Performing measurements whilst charging can be dangerous when using a third-party charger.

10.4 Preparation for shipment

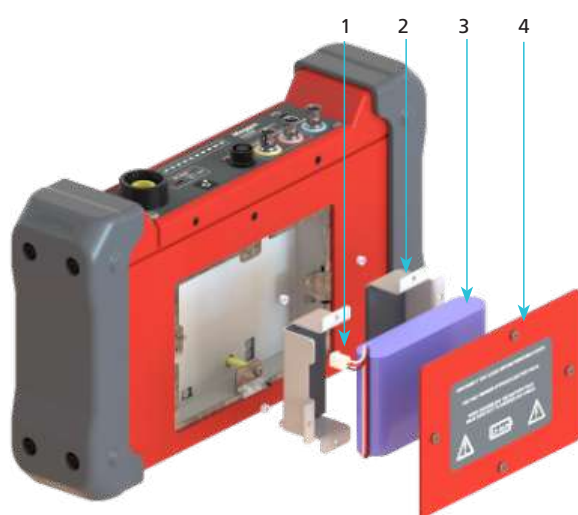
1. Turn on FRAX with ON/OFF button. FRAX200 turns on normally.
2. Hold down the battery button for 20 seconds.
3. Prepare for shipping starts.
4. Indication: blinking ON/OFF button, display charge level on LED-bar.
5. FRAX200 shuts down automatically, when battery is discharged below required limit.

10.5 Battery removal procedure

1. Unscrew the four screws that secure the battery cover. Carefully lift the battery cover. The battery is attached to the cover, so lift the cover and battery together.
2. Disconnect the battery connector from the FRAX200 mainboard.
3. Unscrew the locking nuts, and remove the battery supports.
4. Remove the battery.

NOTE : If battery is replaced use Megger approved battery only

5. Refit the battery supports, and tighten the locking nuts.
6. Connect the battery to the FRAX200 mainboard.
7. Carefully place the battery cover back into the FRAX200 enclosure.
8. Tighten the four screws that secure the battery cover.



1. Battery connector
2. Battery supports
3. Battery
4. Battery cover

Fig 1: Battery assembly

11. Calibration, repair and warranty

Megger operates fully traceable calibration and repair facilities to make sure your instrument continues to provide the high standard of performance and workmanship that is expected. These facilities are complemented by a worldwide network of approved repair and calibration companies, which offer excellent in-service care for your Megger products.

For service requirements for Megger instruments contact your local Megger representative.

11.1 Calibration and repair

For assistance please contact your local Megger representative.

The instrument is calibrated before leaving the factory. Calibration should be performed minimum every third year, but yearly calibration is a general recommendation for test instruments. It is also recommended to perform regular tests to verify the integrity of the complete test system, including:

The following tests can be performed:

Open test	Generator and Reference cables attached to FRAX200, but not connected to any device.
Short test	Cables connected to FRAX200 and connected to each other in the clamp end.
FTB test	Measurement with the Field Test Box (FTB101), which shall give a smooth "hockey stick" shaped curve from -100 dB to -20 dB in frequency range 20 Hz to 2 MHz.

11.2 Warranty

Products supplied by Megger are warranted against defects in material and workmanship.

Our liability is specifically limited to replacing or repairing, at our option, defective equipment.

This warranty does not include batteries, lamps, or other expendable items, where the original manufacturer's warranty shall apply.

We make no other warranty. The warranty is void in the event of negligence abuse (failure to follow recommended operating procedures) or failure by the customer to perform specific maintenance as indicated in this manual.

For service requirements for Megger instruments contact your local Megger representative.

11.3 Returning equipment

Before returning equipment for calibration, warranty repair, or standard repair, please contact your local Megger representative for assistance. If a return is necessary, the equipment must be shipped prepaid and insured. Include all relevant information, such as a description of the issue or the requested service. Please also provide the serial number of the unit.

11.3.1 Shipping with battery

ATTENTION : The FRAX-series contains batteries, so make sure that current Dangerous Goods Regulations are complied with.

12. Decommissioning

12.1 WEEE Directive



The crossed out wheeled bin symbol placed on Megger products is a reminder not to dispose of the product at the end of its life with general waste.

Megger is registered in the UK as a Producer of Electrical and Electronic Equipment. The Registration No is WEE/ HE0146QT.

For further information about disposal of the product consult your local Megger company or distributor or visit your local Megger website.

12.2 Battery disposal



The crossed out wheeled bin symbol placed on a battery is a reminder not to dispose of batteries with general waste when they reach the end of their usable life.

For disposal of batteries in other parts of the EU contact your local Megger branch or distributor.

Megger is registered in the UK as a producer of batteries (registration No.: BPRN00142).

For further information see www.megger.com

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