ECKEL UMMS

Universal Magnet Measuring System

Operating Manual

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1. General description of the UMMS

The UMMS is a digital sampling and signal generation system. It is used to measure magnetic properties of soft and hard magnetic samples

All inputs from sensors as coils, Hall probes or temperature sensors are digitally sampled by analog/digital converters. The samples are stored internally during measurement. Sample resolution is 16 bit. Maximum sample speed is 1 MHz. All inputs are sampled simultaneously.

At the same time the digital/analog converter produces the signal for the power amplifier to create the necessary magnetic field. Resolution is also 16 bit at a maximum rate of 1 MHz.

The system is controlled by an 80 MHz signal processor. This processor does not only control the complete measuring procedure but calculates itself necessary changes of the signal for the magnetic field during measurement. Once the measurement is started, the signal processor takes total control until end of measurement.

Some measurements have a simple structure like DC hysteresis measurement needing a triangular change of magnetic field. Other measurements are very complicated as adaptive AC measurements with given secondary voltage. Here the signal processor has to care about primary voltage adaption. The primary voltage must be changed over measurement time until the secondary voltage has the predefined shape. At the same time the signal processor has to care about DC bias of the primary current and the change of ohmic resistance by temperature changes even during measurement.

The power amplifier is necessary for magnetic field generation. Since the Epstein frame as well as Single sheet testers or Ring devices have an ohmic resistance near zero, most of the output power is apparent power. Thus it is necessary to have an amplifier that can handle full power as internal power loss. The phase shift between output voltage and output current at inductive load needs a very rugged amplifier construction.

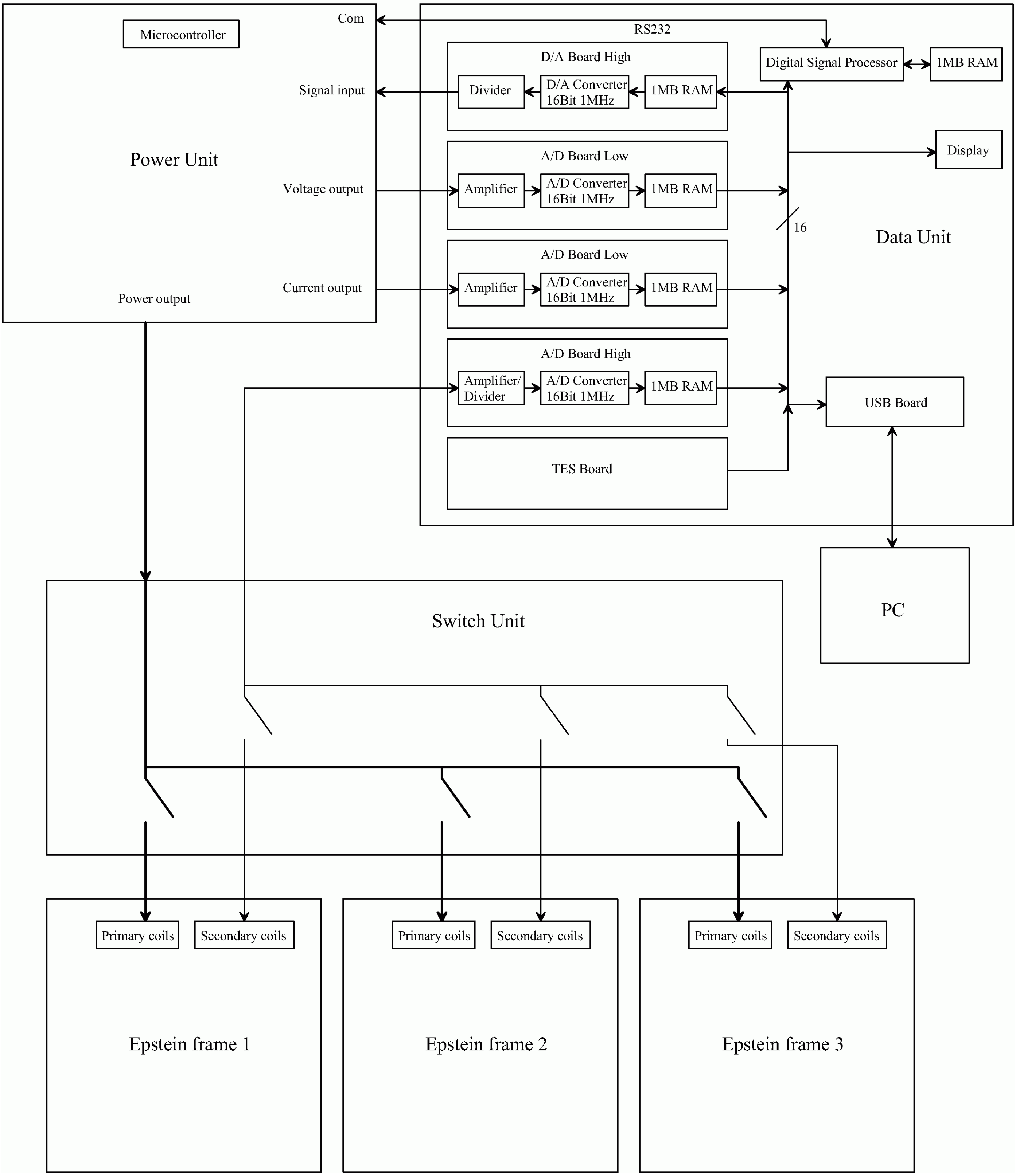
The power amplifier has 4 operating modes. For DC measurements output voltage is near zero. Therefore the amplifier is set to current source mode, controlling current instead of voltage. For AC measurements the voltage source mode is used. Both modes can operate at a maximum voltage of +- 100 V and a maximum current of +-20 A as well as at a maximum voltage of +- 200 V with a maximum current of +- 10 A. Full power bandwidth is 10 kHz.

After measurement is finished, the software on the PC takes all input samples from the Data Unit via USB and the evaluation is made by software. Sorting of the signals, noise filtering, time shift adjustment, integration and offset correction as well as combination of the different signals to get a hysteresis are carried out on the PC. Then all desired numerical results are calculated from the hysteresis by software considering the sample parameters.

Since the UMMS is a complete open system and all functions and signals are defined by software, a large variety of measurements is possible.

The manual alignment of the measuring equipment (e.g. J compensation) is not necessary. All mutual inductances for measuring equipment according to IEC 60404 are not required.

System diagram Universal Magnet Measuring System UMMS



2. Data Unit

The **UMMS Data Unit** provides the signal converters as well as the digital and analogue control of the output stage and also the link to the PC.

The UMMS Data Unit consists of the power supply, motherboard with 10 plug-in slots and a 240x128 pixel graphic display. The motherboard includes an 80MHz signal processor with an own operating system and 1MB RAM. It receives the commands from the PC, controls the functions of all plug-in boards, drives the display, prepares the measuring data and transmits the data to the PC where it is evaluated.

Furthermore, the serial interface to the output stage, a high precision reference source and a test generator are integrated in the motherboard. The UMMS Data Unit automatically configures itself to the plug-in boards installed.

Data Unit

The plug-in boards can be selected to match the required measurements.

All sampling boards have differential inputs and are protected against overvoltage. The sampling rate can be freely selected between 38Hz and 1MHz but maximum sample rate depends on complexity of necessary calculation. For adaptive Epstein frame measurements the maximum sample rate is 190kHz in the moment.

By means of the test generator all sampling boards are synchronised to 2.5ns and fully automatically calibrated by the reference source and also set to zero offset. The sampling board includes 1MB RAM for the storage of measuring data. Up to 524,288 measured values can be recorded by each board during a measurement.

With actual firmware the display of the Data Unit is not used for AC measurements as with the Epstein frame.

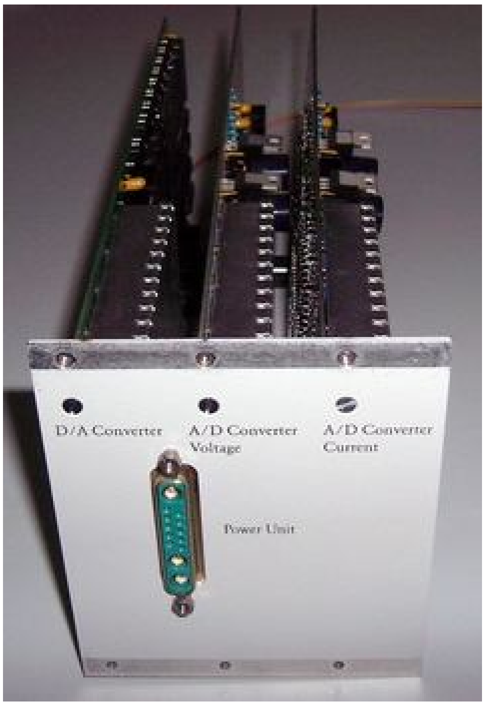
The sampling board with 1MHz, 16-bit analogue/digital converter is installed in two versions:

- As a universal board with an input range for maximum inputs from +/- 5.3mV to +/- 360V.
  This board is used to measure the secondary voltage of the Epstein frame. This input is protected by fuses 50mA Fast.

Universal sampling board 360V

- As a primary current or voltage measurement board with an input range of +/- 5.3mV to +/- 2.75V.
  These boards are directly connected to the output stage.

The D/A converter board includes a 1MHz 16-bit digital/analogue converter and 1MB RAM for signal storage. It is addressed synchronously with the sampling boards and it generates the control signal for the output stage. The control signal can be created as desired. The output frequency limit can be varied from 3 Hz to 44 kHz.



Sampling board for primary signals with D/A converter board

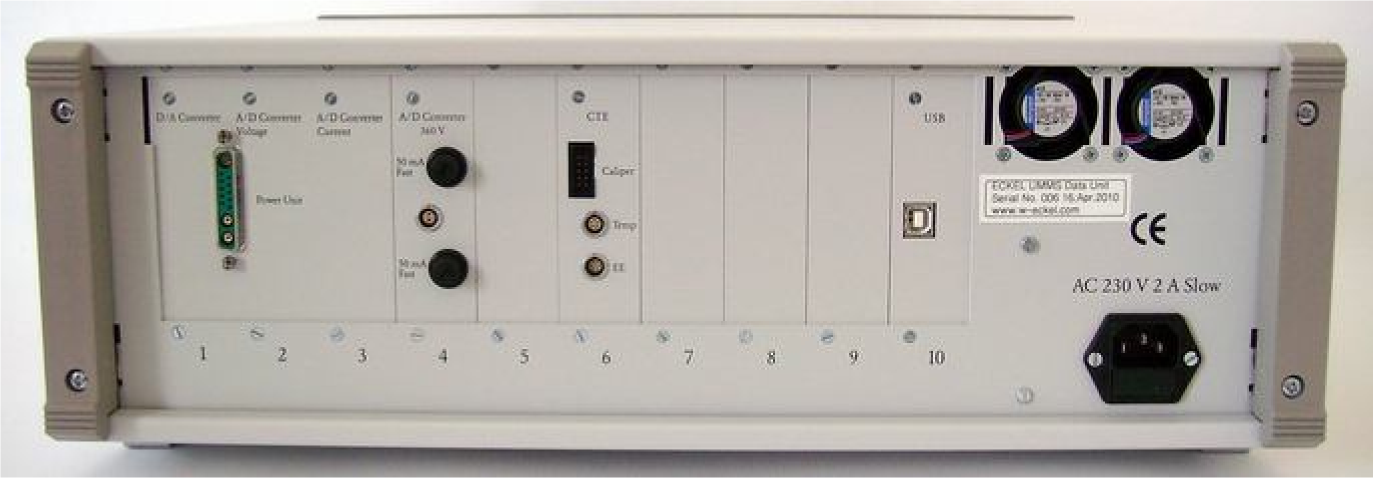
USB board with serial transmission at 12 Mbit/s for connection to the standard USB interface of the PC.

USB board

Parameter board for a digital temperature sensor, an EEPROM for recognizing the measuring equipment and a digital sliding caliper.

Parameter board

If desired a digital temperature sensor can be connected here for temperature compensation.



Plug-in boards in the Data Unit

If it is necessary to change the firmware of the UMMS, pull out the power cable, screw out the 4 screws from the 2 plastic covers at the backside of the unit. Remove the covers and lift up the top cover of the unit.

In the centre there is a special zero-force socket for the EPROM. Lift up the lever at the left side and change the EPROM. Be sure to enter it in correct direction. Then push down the lever again to close the socket.

Program EPROM inside the Data Unit

After switching on the Data Unit the display shows the actual software version.

Switching off the Data Unit also switches off the Power Unit if they are connected by cable.

3. Power Unit

The **UMMS Power Unit** is the output stage that provides the energizing signal for the generation of the magnetic field. It has a power output of 2000 VA. It can be switched between 100V/20A and 200V/10A. Additionally, it can be operated as a current or voltage source.

DC measurements are preferably carried out using the current source. With AC measurements the current source cannot be used, as the AC stability cannot be guaranteed for unknown measuring equipment.

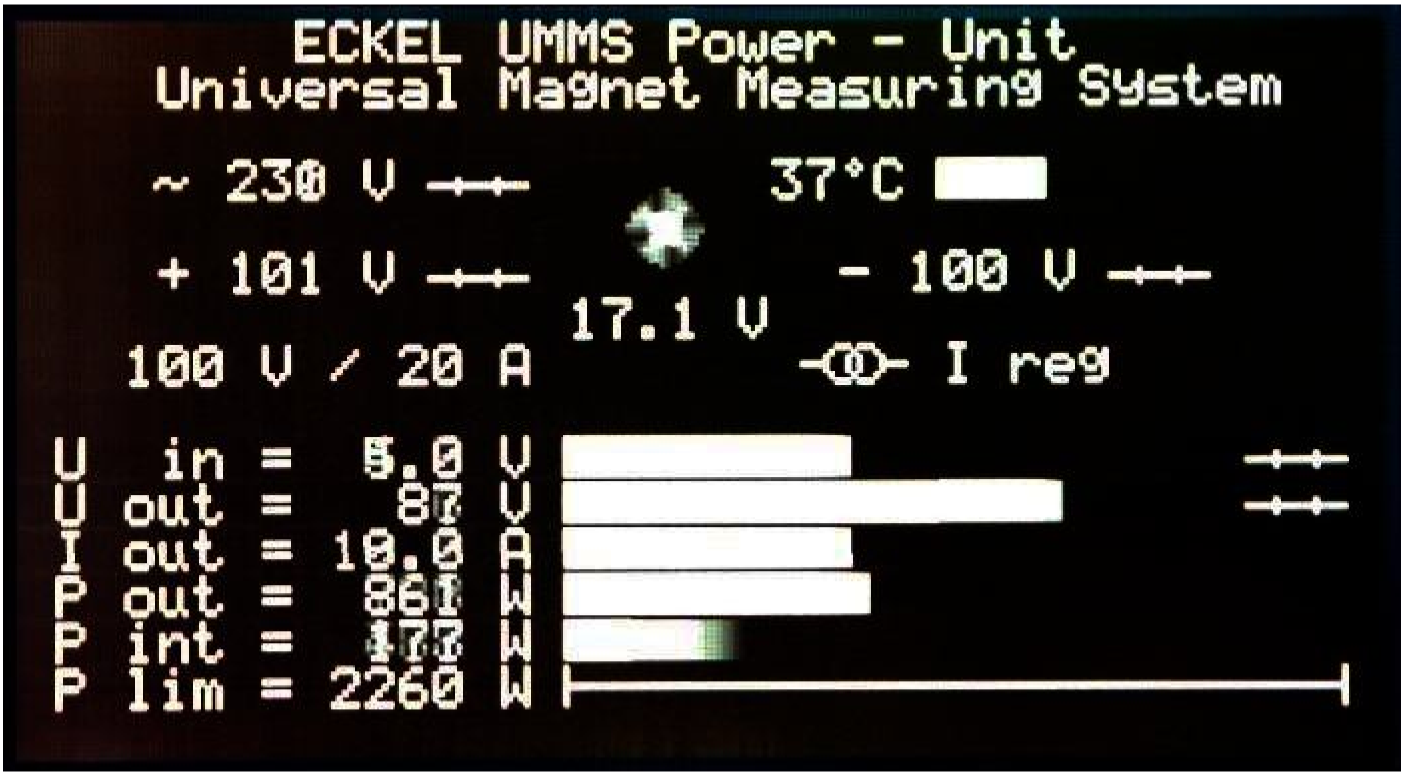
However, it is possible to adapt the primary current as well as the secondary voltage to desired shape by adaptive regulation algorithms and thus measurement can be performed e.g. with sinusoidal field H or sinusoidal induction B or polarisation J. For Epstein frame measurements only sinusoidal polarisation J is enabled yet.

Power Unit

The full power bandwidth is 10 kHz.

The UMMS Power Unit contains a microcontroller and a graphic display. It is short-circuit-proof, forced-draught cooled, thermally controlled and has an automatic emergency cut off. An offset alignment is automatically performed.

The UMMS Power Unit has an EEPROM interface for the read-in of parameters that automatically recognizes the measuring equipment. As a result of the recognition of the measuring equipment the correct software will be automatically loaded.



Display of the Power Unit

The display of the Power Unit shows the following features:
- AC mains input voltage
- Maximum transistor temperature
- Positive and negative internal DC power supply voltage
- Fan speed and fan voltage
- Operating mode
- Peak input voltage from the Data Unit
- Peak output voltage to the Epstein frame
- Peak output power to the Epstein frame
- Peak internal power loss
- Limit of internal power loss depending on transistor temperature

The Power Unit is automatically shut down if:
- Mains voltage is below 200 V or above 245 V
- Internal power supply voltages are below 90/180 V or above 110/215 V
- Transistor temperature is above 80 °C

Measurement is interrupted if:
- Input voltage is above 5.5/11 V
- Output voltage is above 100/200 V
- Output current is above 20.5/10.5 A
- Internal power loss is above power loss limit

An error message will be generated.

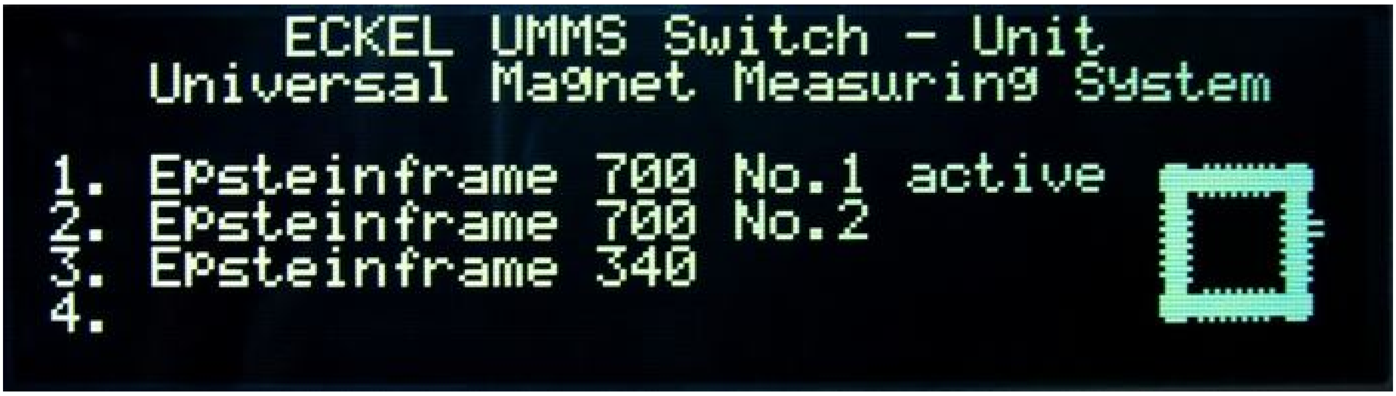
Backside of the Power Unit

The four single fuses 10A Slow are connected to the secondary windings of the power transformer.

4. Switch Unit

To connect a measuring system to several equipments the **UMMS Switch Unit** is used. Thus four measuring equipments can be used alternately without changing cables and plugs.

UMMS Switch Unit



Display of the UMMS Switch Unit

Manual switching by pressing the desired button with automatic device detection or automatic switching by PC when selecting the appropriate measurement are possible.

All relay positions can be programmed separately on the PC, e.g. to allow one temperature sensor to be used for several equipments. Additionally it is possible to add name and icon to every switching position.

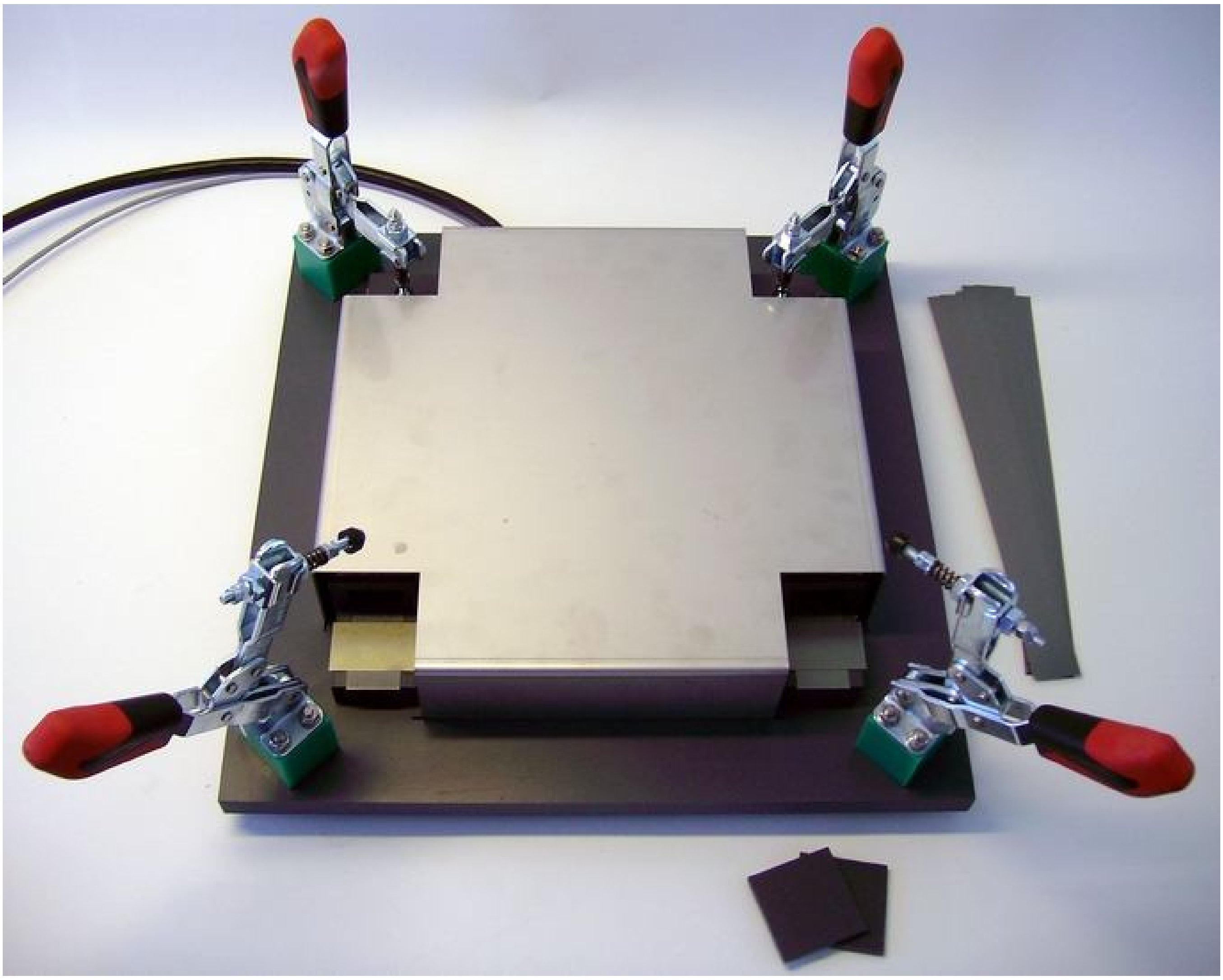
Backside of the UMMS Switch Unit

5.1 Epstein frame

The 25 cm Epstein frame is standardized measuring equipment for measurement of hysteresis curves and losses of soft magnetic sheets of steel according to IEC 60404-2 norm.

The working principle is as a ring transformer. The steel sheets are positioned in a square overlapping at the corners. They are the core of the transformer.
Primary (input) and secondary (output) windings are separated into 4 coils, each with 175 turns. So altogether there are 700 primary as well as 700 secondary windings. The secondary winding is the inner coil and the primary winding is the outer coil.

For higher frequencies it is necessary to reduce the number of turns of the primary winding to reduce inductivity and thus the necessary voltage. Therefore also an Epstein frame with 340 turns is offered. Other numbers of turns are also possible.



Epstein frame

Due to the construction of the Epstein frame there is already some coupling between primary and secondary winding of the empty frame since air flux is measured. This flux has to be compensated since it is an additional signal, independent of the steel sheets and falsifies the result.

This compensation is normally made with a mutual inductor in series but in opposite direction to the Epstein frame, generating exactly the same signal as the empty frame and thus compensating it. This mutual inductor has to be trimmed by hand very exactly.

With the UMMS there is no need for this mutual inductor. The empty Epstein frame is measured, a compensation is calculated, stored as parameter and subtracted from the output signal at every measurement.

It is important to know, that due to the compensation of the air flux of the empty frame also during measurement with steel the air flux is compensated for the complete cross-sectional area. This includes the area filled with the steel sample. Thus the result is not a B-hysteresis (induction) but a J-compensated J-hysteresis (polarisation).

$$\mathbf{J = B - \mu_0 * H}$$

Since the secondary voltage must be sinusoidal, the measurement is made with sinusoidal J and not with sinusoidal B as with a ring measurement. Also maximum induction given for this measurement is not B but J.

Results will not be exactly the same for measurement with B-hysteresis and J-hysteresis though the difference is very small.

With the UMMS it is possible to measure with sinusoidal J as well as with sinusoidal B by reducing the air flux compensation for the part of the steel cross-sectional area. Also DC hysteresis and measurements with given primary voltage and given primary current (H) are possible. These options are not enabled yet.

The steel sheet samples must have a length of 280 to 320 mm and a width of 30 +- 0.2 mm. Length of all samples must be identically to +- 0.5 mm.

For non-oriented steel half of the samples are cut parallel and other half of the samples are cut vertical to direction of rolling. Cut angle must be exact to +- 5°.

For grain-oriented steel the samples are only cut parallel to direction of rolling. Here cut angle must be exact to +- 1°.

Samples must be burr-free.

Total number of samples must be a multiple of 4. A minimum weight of 240 g at a length of 280 mm is required.

If desired frequency cannot be reached with 240 g, a reduction up to only 1 sheet in every coil is possible but accuracy will be reduced.

Before measurement the weight, thickness and width of the samples are measured. There is also the possibility to determine the cross-sectional area from weight, length and density if it is exactly known.

The samples are inserted one sheet to 2 opposite coils and then one sheet to the other 2 coils and so on, so that they overlap alternately. If samples in different direction of rolling are used, all samples of parallel direction are inserted in 2 opposite coils and the vertical samples in the other 2 coils.

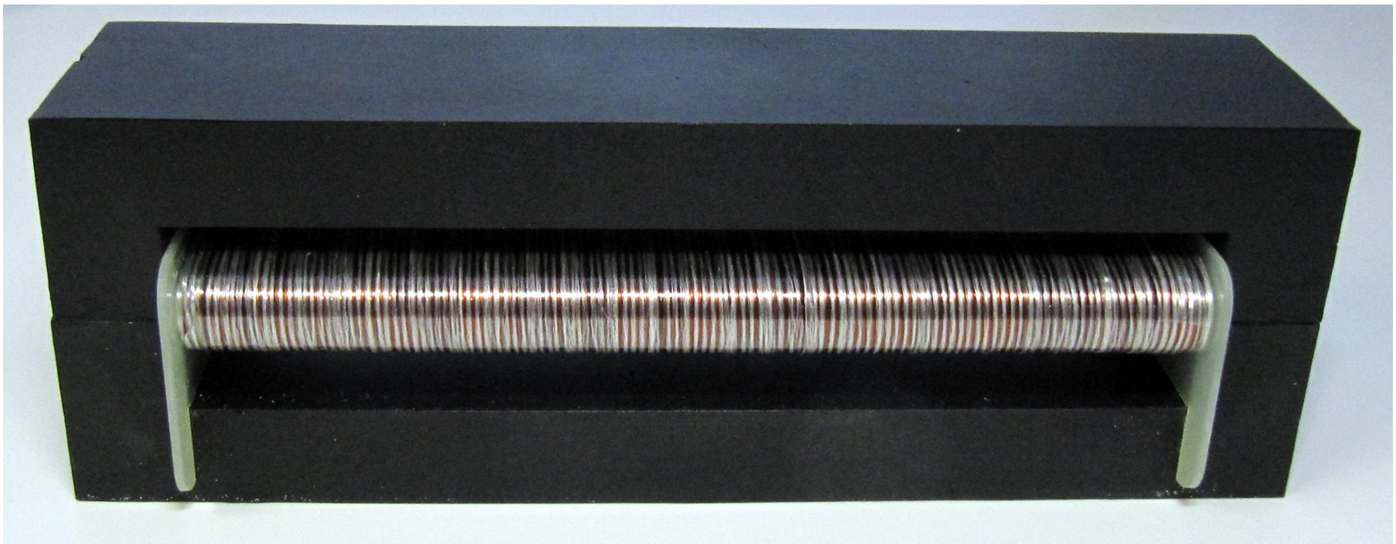
All samples are adjusted to the inner wall of the coils and then the plastic covers are put on the corners and they are fixed with the levers. Adjust the pressure of the levers to low force but enough to have no space between the sheets at the corners. A maximum force of 1 Newton is given in the norm. Often this is not enough to eliminate the space between the sheets. With higher pressure no difference in result has been found.

The Epstein frame is detected automatically when connected to the Power unit.

5.2 Single sheet tester

The single sheet tester is available in different sizes.

Original IEC 60404-3 single sheet tester is for 50cm x 50cm sheets. Since this is too big for many applications, smaller testers are produced depending on customers demand.



Single sheet tester for 30cm x 6 cm stripes

The SST (single sheet tester) consists of 2 C-cores made of several hundred laminated thin steel sheets of grain oriented low loss steel.

In the center there is a coil with an inner (secondary) and an outer (primary) winding. This coil is very similar to one of the 4 Epstein frame coils.

The upper core is lifted by some mechanics or by hand and the sheet is entered to the coil. Then the upper core is lowered again exactly above the lower core. If the sheet is less wide than the coil it is important to place the sheet parallel to coil length and not diagonally.

Different to the Epstein frame measurement only one sheet of steel is entered to the coil and the magnetic circuit is not closed by the sheets in the other 3 coils but it is closed by the 2 C-cores. Theory suggests these cores to have neglectable losses compared to the losses in the sheet. Thus field is presumed to be zero in the core. Active length for measurement is the part of the sheet between the cores. That is 25cm. If the sample is longer than 30cm it does not harm.

Except for different dimensions of the sample measurement is performed exactly as with an Epstein frame since same physical formulas are valid. But some differences have to be observed:

At higher frequencies the cores start to produce more eddy current and thus more losses. So measurement is limited to lower frequencies.

For non oriented steel it is not possible to measure both production directions together. An average of both measurements will not be the same as with an Epstein frame. Also measuring two sheets (one of each production direction) together is not the same as with an Epstein frame. Thus only grain oriented steel will offer comparable results but nevertheless it is standard to calibrate SST measurements by an Epstein frame measurement of the same sample.

The Single sheet tester is detected automatically when connected to the Power unit.

5.3 Ring test device

For testing of rings various configurations are possible.

The ring is wound with a secondary inner coil and a primary outer coil. The ring acts like a transformer, transforming the primary induced voltage to secondary coil by relation of the windings ratio N2/N1.

The IEC 60404-6 defines the secondary air flux to be neglectable, so total flux is inside the iron sheets.
In fact the difference between primary air flux and secondary air flux is most times also neglectable though primary coil is larger than secondary coil.

Ring test device

The necessary number of primary turns depends on the available current, the size of the ring and the desired field strength. Winding ratios up to 1:1 are possible but most time primary coil has no more windings than necessary for measurement. For high permeable rings a measurement with only 1 primary winding is performed to save time for producing the primary coil.

For only 1 primary winding induced primary voltage is in the range of mV to µV. Then it is not possible to adapt a correct sinusoidal primary voltage since it is lost in noise. Therefore resistors (shunts) are added to the primary coil to increase ohmic resistance to get some signal even for low currents. To get a more exact measurement of current, the voltage $U_R = R * I_{In}$ is measured by an external board instead of the standard current board getting signal from the power unit.

According to the different fields and thus different currents, a large number of shunts from 0.1 Ohm to 200 Ohm are selectable in 11 steps. These shunts are selectable by manually turning a knob at the device or, in Remote position, can be set automatically by software.

Ring test device in Remote control

Additionally an external load can be connected to secondary coil either swiched manually or by remote.

Connecting an external load to the Ring test device

Connections at the backside of the Ring test device

The Ring test device is powered by an external 12V power supply and connected to the PC by RS232.

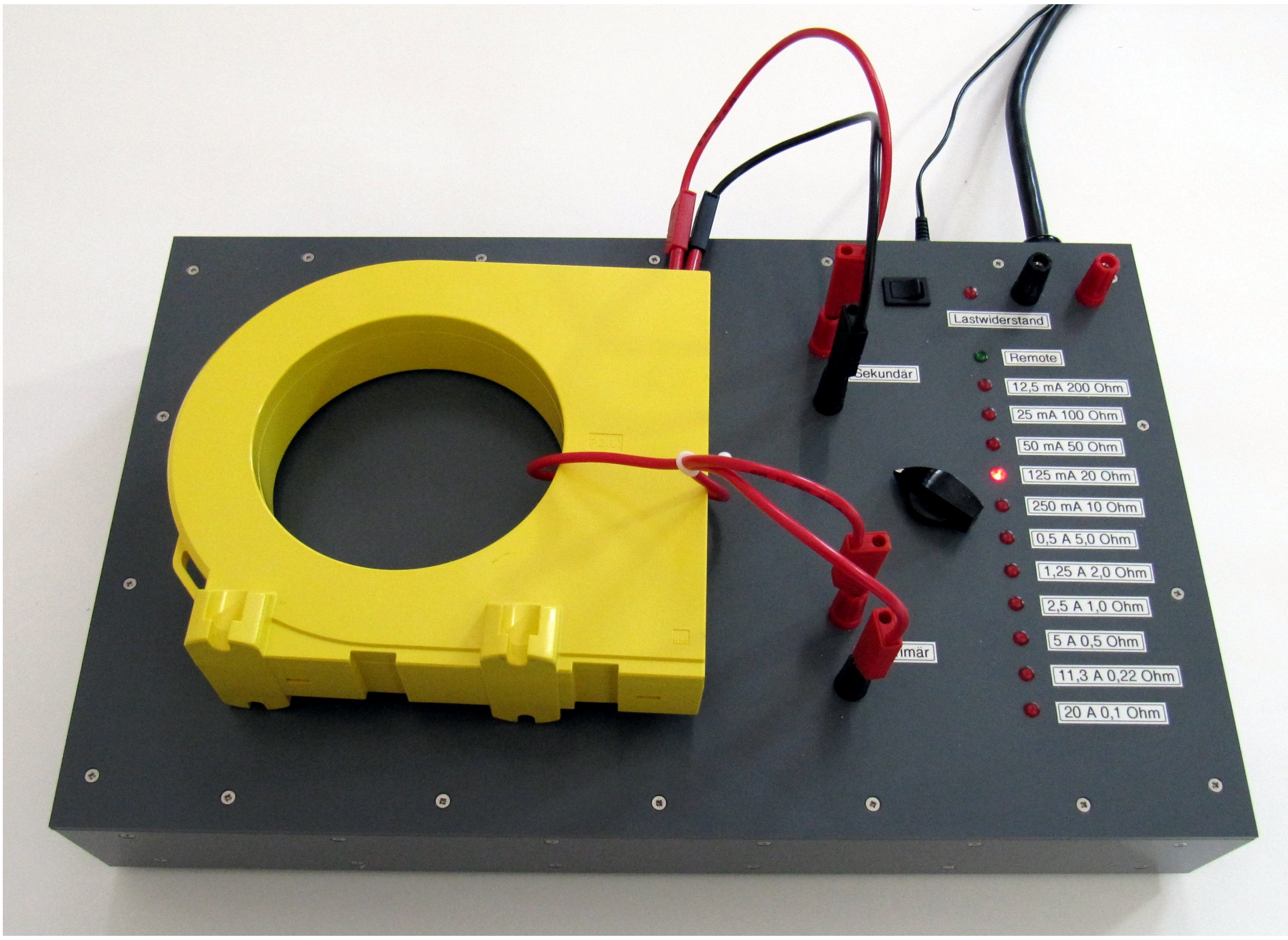
$U_R = R * I_{In}$ and the secondary voltage U_{Sec} are connected to the Data unit.

I_{Pri} (= $U_R = R * I_{In}$) is connected to the sampling board with 2.75V range and the secondary voltage U_{Sec} is connected to the sampling board with 360V range.

The ring test device is detected automatically when connected to the Power unit.

To connect a ring to the ring tester, connect the coil of the ring to the secondary terminals using the 2 short cables.

Pull the longer cable through the ring and use a plastic clip to create one single winding around the ring. Then connect the plugs to the primary terminals. Polarity is not important. It is automatically detected during measurement.



Connecting a ring to the Ring test device

6. Connection of the components

Select a place with free air circulation. Put the Power Unit on the table. Put the optional Switch Unit on the Power Unit and the Data Unit on the Switch Unit.

UMMS Units

Connect Data Unit, Power Unit and Switch Unit to 230 V AC mains voltage. Keep all units in off-state yet. Connect the Data Unit to the Power Unit by the combined RS232/Coaxial Sub-D cable.

Connection Data to Power Unit

Connect the Data Unit to the PC by the USB cable. Do not use USB cables longer than 2 m.

Connection Data Unit to PC

Without Switch Unit:

If there is only 1 test device and no Switch Unit is used, connect the power plug of the test device directly to the Yoke plug of the Power Unit and connect the 1 or 2 sensor cables directly to the appropriate sample board inputs at the Data-Unit.

With Switch Unit:

Connect the Switch Unit to the PC via RS232 cable.

Connection Switch Unit to PC

Connect the Switch Unit with the yoke plug at the cable to the output of the Power Unit.

Connect the input of the A/D converter 360V card in the Data Unit to the input 360 V 1 of the Switch Unit via 2- pole cable with small LEMO plug.

Connection Switch Unit to Power Unit and Data Unit

Connect all Test devices to the Switch Unit using the same number for yoke plug and 360V 1 outputs.

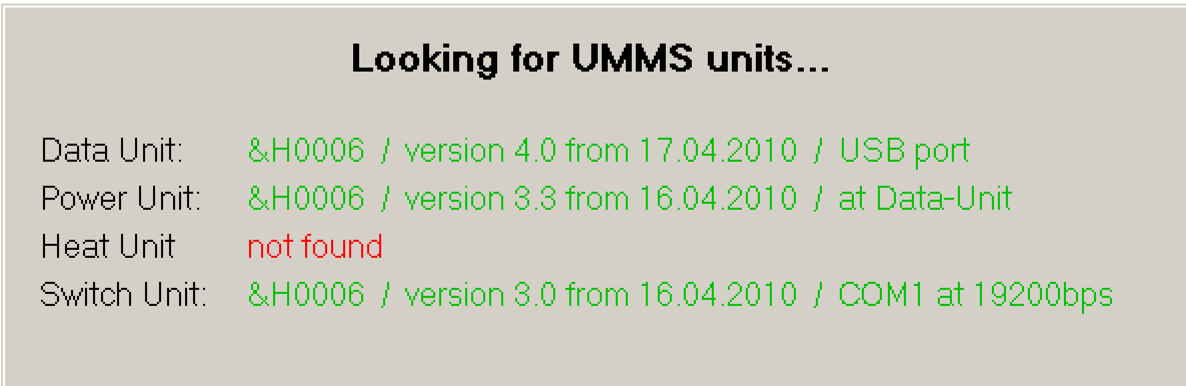
Connection Test devices to Switch Unit

Switch on all units using the power button at the front panel.

Power button

Start the UMMS program on the PC.

Search for all components (see software description). The program must show all components found.



Units found

Select e.g. one Epstein frame at the Switch Unit by pressing the appropriate button. The software must show “Epstein frame”.

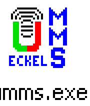
Epstein frame found

7. Software

The software is installed by inserting the UMMS Program CD and executing the Setup.exe program.

For installation of the USB driver it is necessary to connect the Data Unit to the PC and switch it on. The PC will find “Eckel UMMS” USB device and ask for installation of a driver. Go to “Select driver” and select “bulkusb.inf” in the folder “Driver” on the CD.

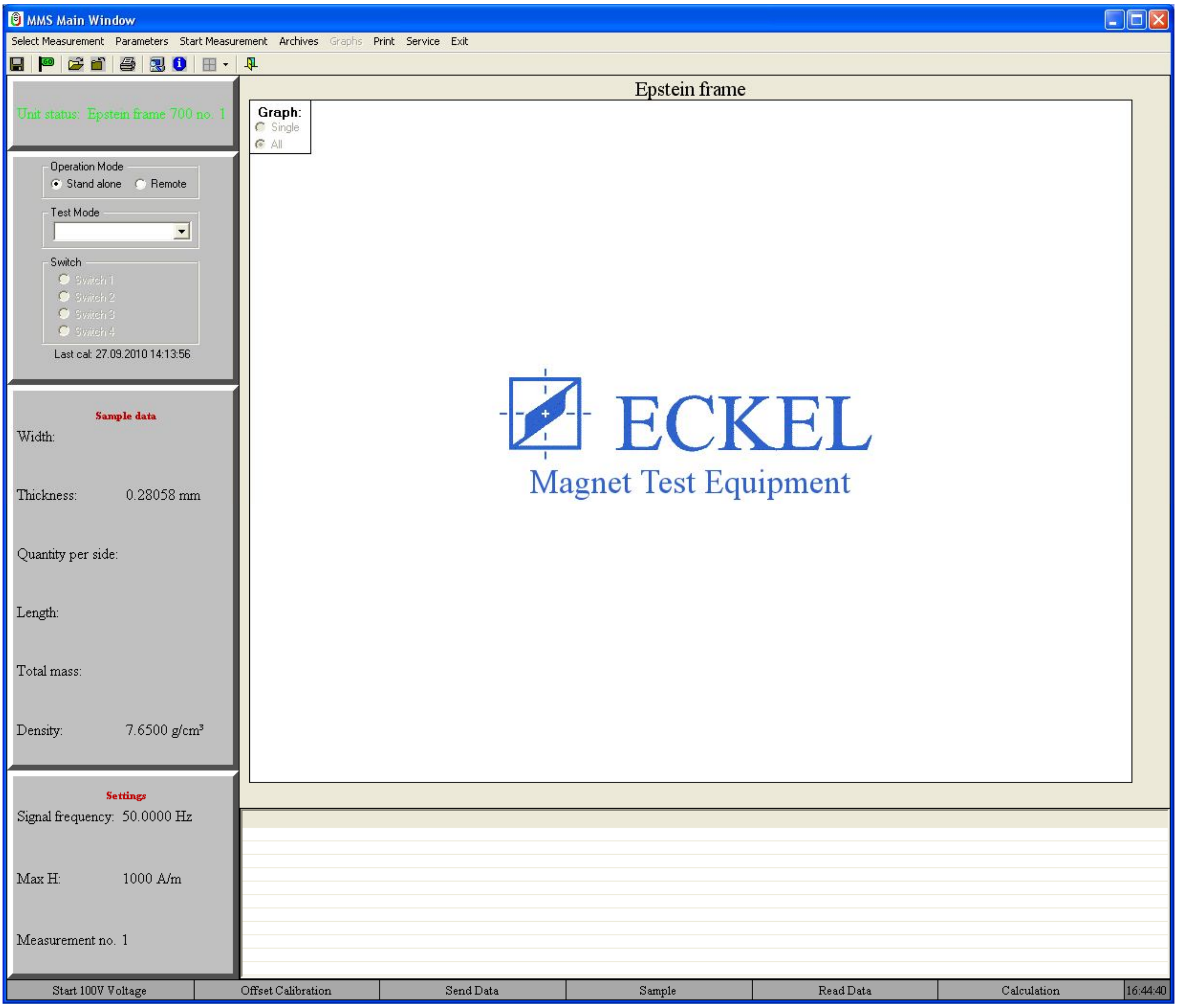
The installation program will create an icon on the desktop. The program is started by double-clicking on this icon.



ECKEL UMMS icon

7.1 Main window

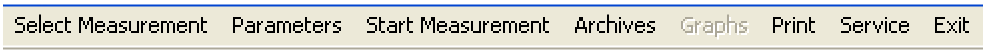
The main window will open.



UMMS main window

The main window is divided in several areas:

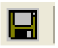
On the top there is the task bar. All features are explained below.



Task bar

Below the task bar there are some icons representing selected features for fast execution

Icons

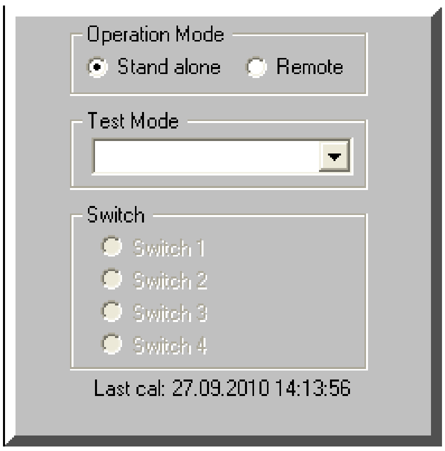
	= Save measurement settings	See chapter 7.2
	= Start measurement	See chapter 7.4
	= Load measurement from archive	See chapter 7.5
	= Save measurement to archive	See chapter 7.5
	= Print	See chapter 7.7
	= Search UMMS	See chapter 7.8
	= Info	See chapter 7.8
	= Select quadrant of graph	See chapter 7.6
	= Exit program	See chapter 7.9

The upper block at the left side shows the Unit status.

Epstein frame found

Here it shows: Epstein frame 700 turns No.1 found.

The second block is a window showing different informations. This window is not visible for all kinds of measurements:

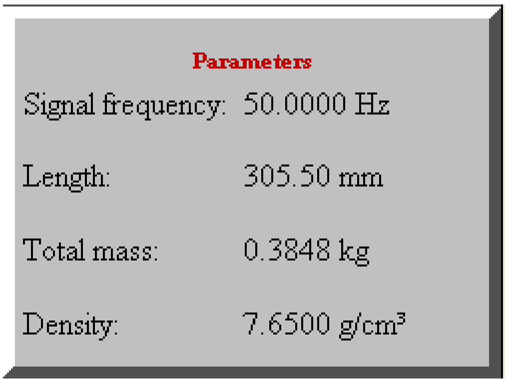


Mode window

Operation Mode allows the selection between **remote** and **stand alone** operation. In stand alone mode the UMMS is operated by this main window. In remote mode all informations necessary for execution of the measurement are sent by external operator to the UMMS PC. As soon as the UMMS PC received this information, measurement is started automatically and the results are sent back to the external operators PC. More information at 7.3. Parameters.

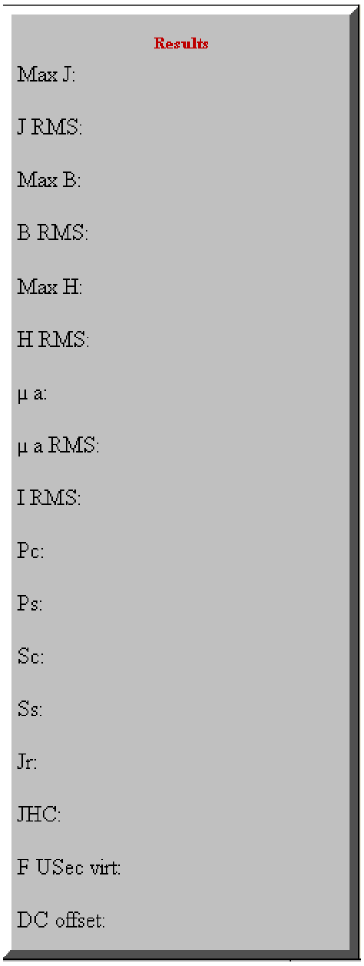
Test Mode shows the name of the actual test program
Switch shows actual status of the Switch unit if available. Also the switch can be set here manually.
Last calibration shows date and time of last UMMS calibration.

The third block shows the measurement and sample **Parameters**. These parameters are selectable at measurement settings. See chapter 7.2.



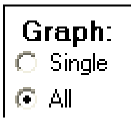
Parameters block

The lowest block shows the **Results**. These results are also selectable at measurement settings.



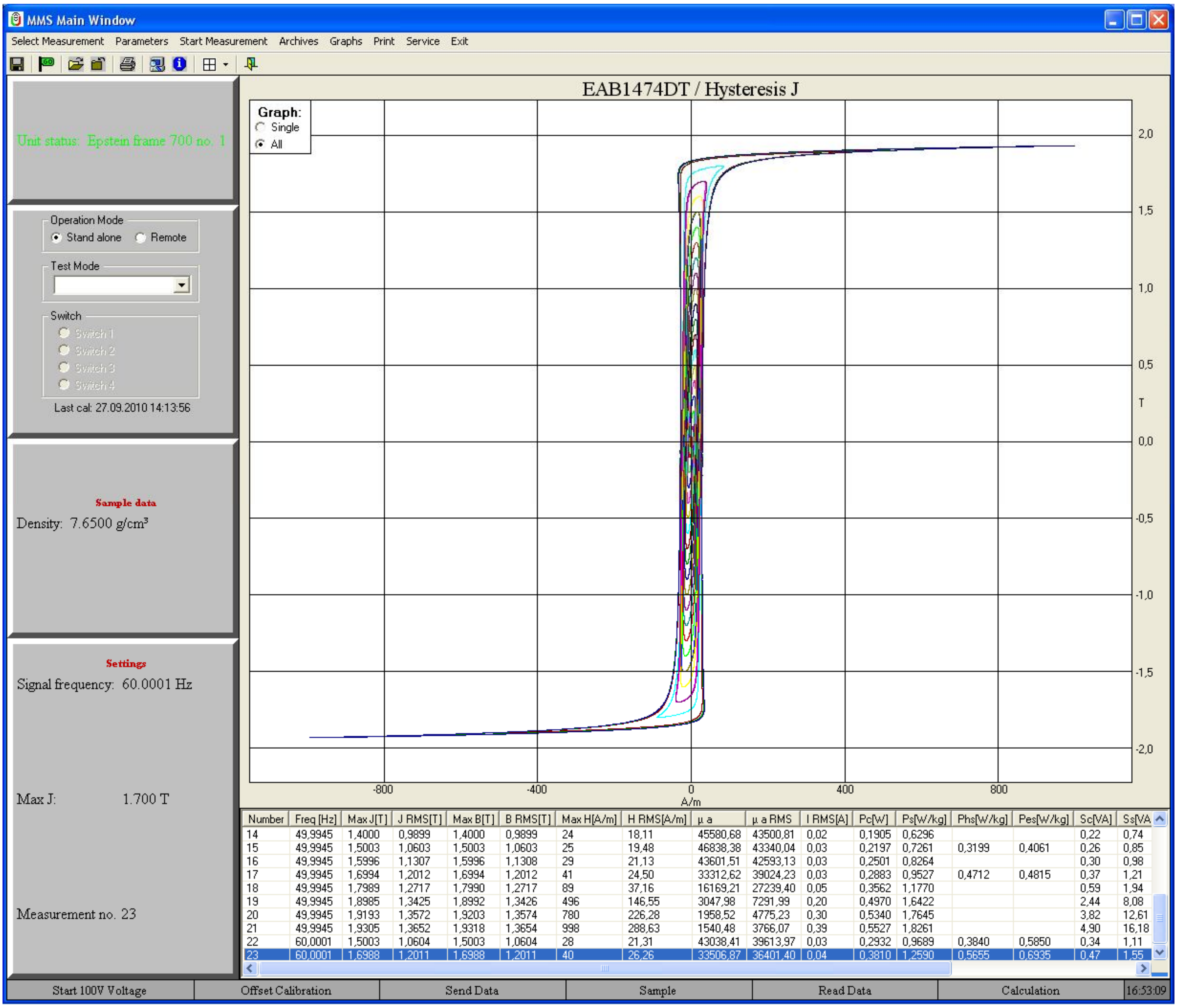
Results block

The big window is divided in a graph and a result area. Depending on the selection **Graph Single** or **All**, only the last measured or all graphs that have been measured in this test mode are shown in different colours. The graph shows the hysteresis. Other graphs are selectable at the task bar.



Graph selection

In the result area a list of results of all consecutive measurements is shown.



All graphs

On the bottom there is a bar showing different steps of measurement. During measurement each step becomes blue during execution, green after execution and red if execution failed.

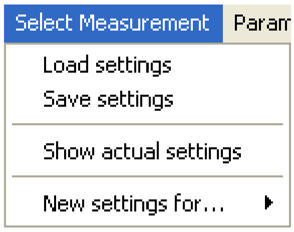
Measurement run bar

The contents of the bar change from operation to operation depending on which steps are necessary for execution.

Task bar features

7.2 Select Measurement

Select Measurement allows loading, saving or entering new settings for the measurements.



Drop down menu

Load settings opens a file selector box. There are listed parameter files for all materials and types of measurements that have been created before. Load the settings suitable for the steel that is to be measured next. These files have the extension **.umo**.

The user should create one complete set of measurement settings for every steel quality and save it for further use. Thus it is guaranteed that measurement is executed with optimum amplifications and best quality.

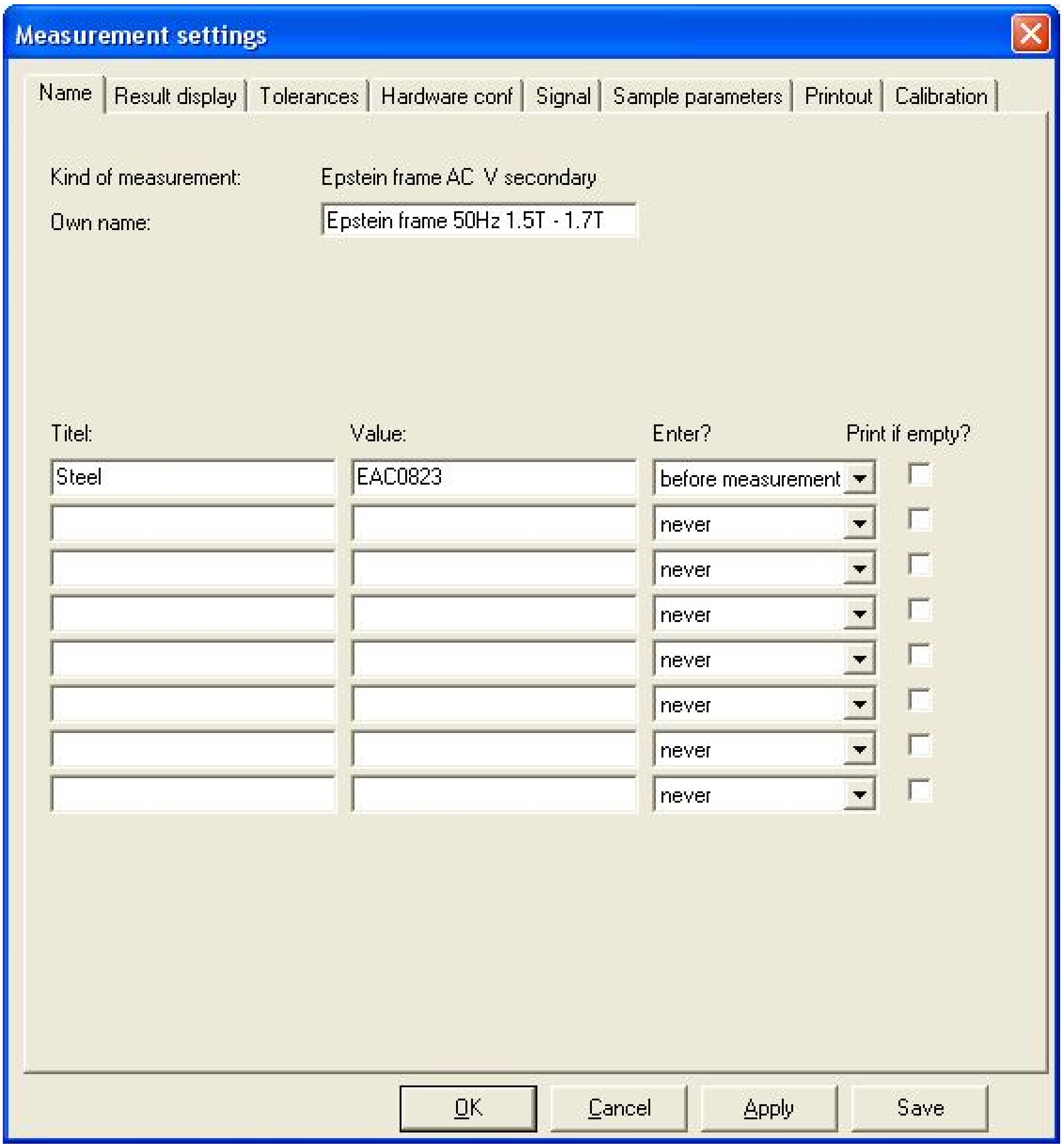
As a minimum one set of settings for non-oriented steel and one set for grain oriented steel must exist.

Save settings opens a file selector box to save the actual settings to the desired place with the selected name. Normally the steel name is taken as measurement settings name.

View actual settings opens the **Measurement settings** window.

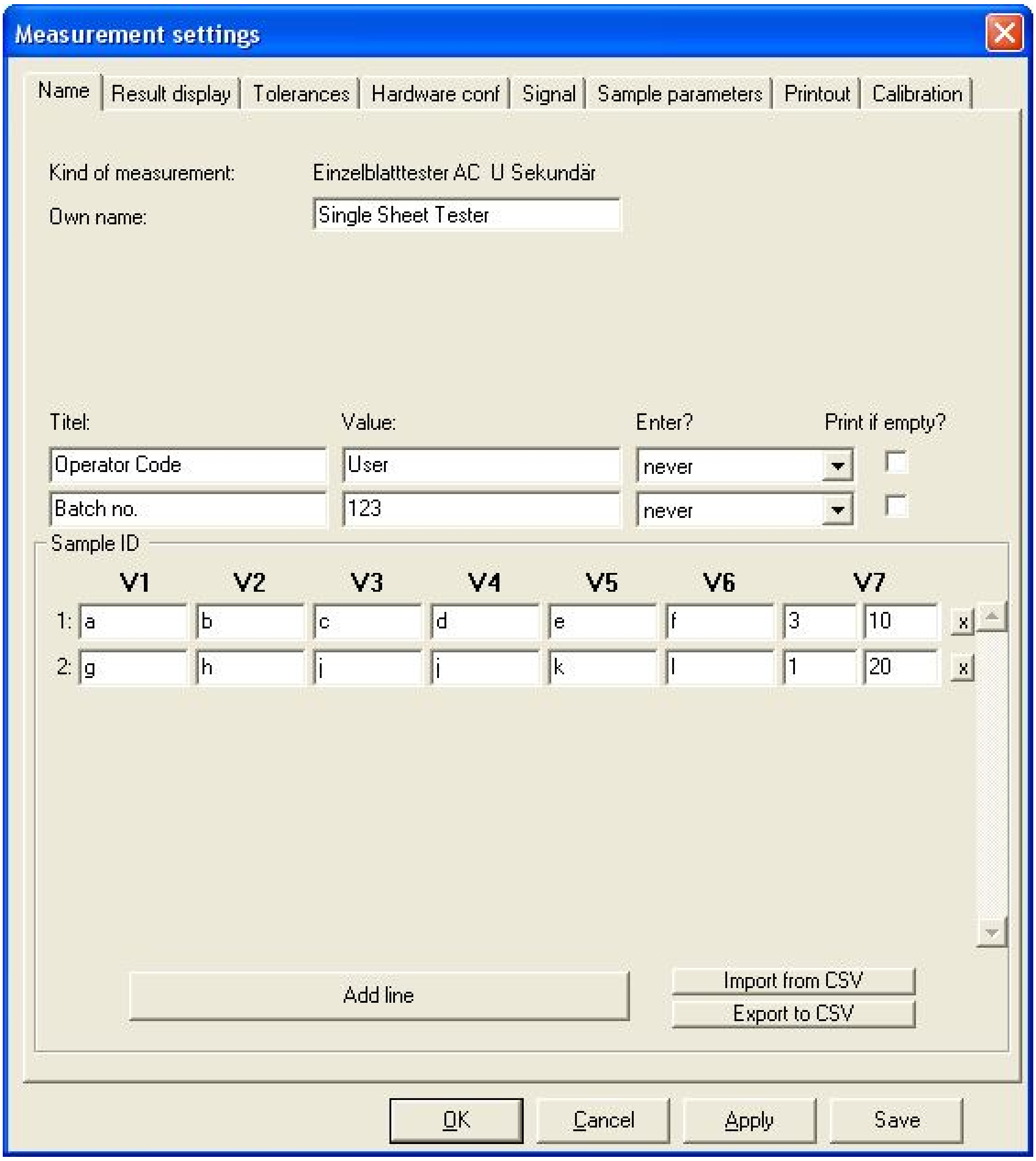
With **Name** the name for measurement can be given for screen and printout.

Also other texts can be entered to be printed on the printout.



Name settings

A special version has been made for robotic single sheet measurements.

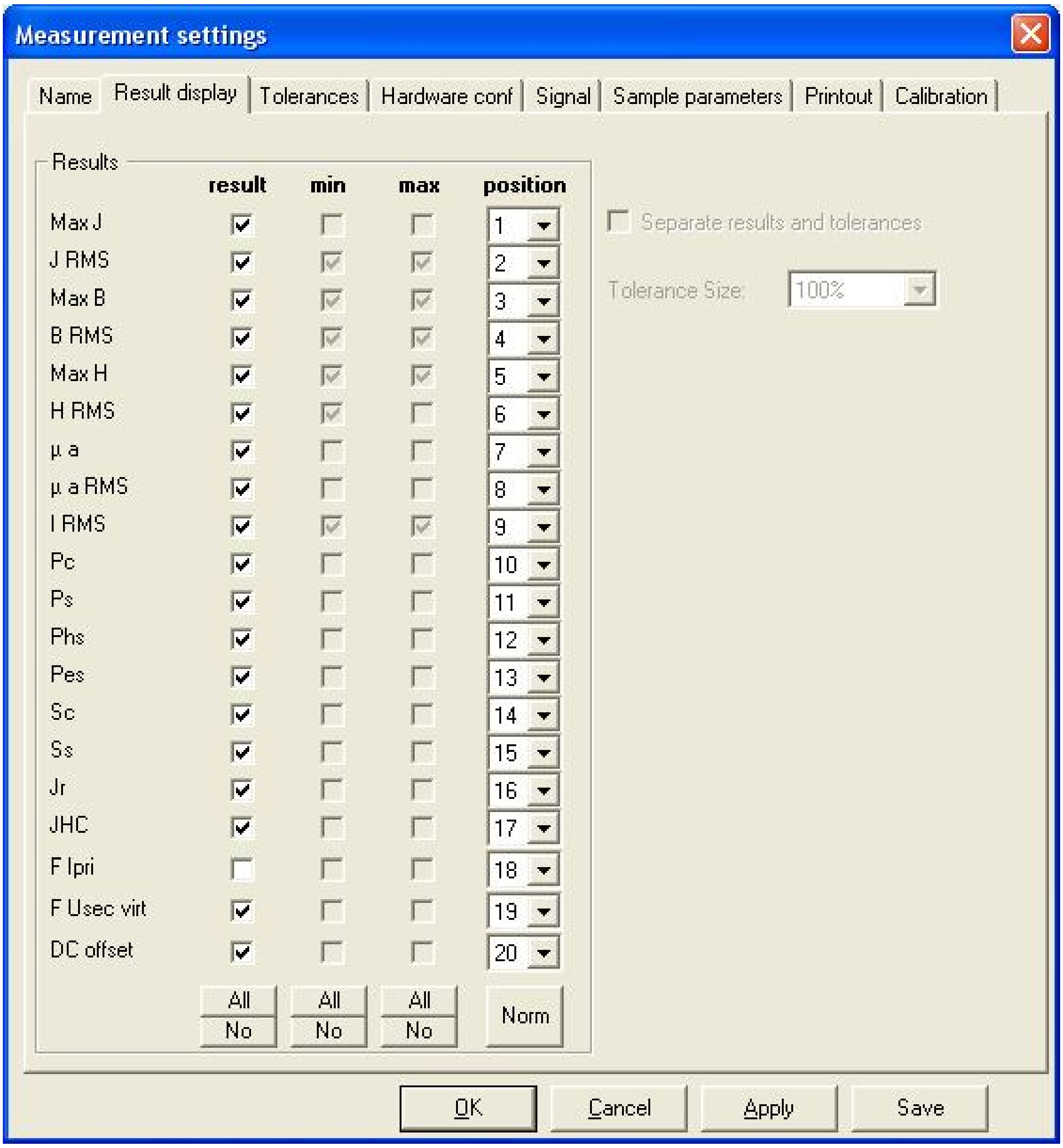


Name settings for robotic single sheet tests

This structure has been created on customer demands.

Automatic storing of results is organized by the sample ID table.

With **Result display** the user can select which results and limits will be shown in the results block on the screen in which order.



Result display settings

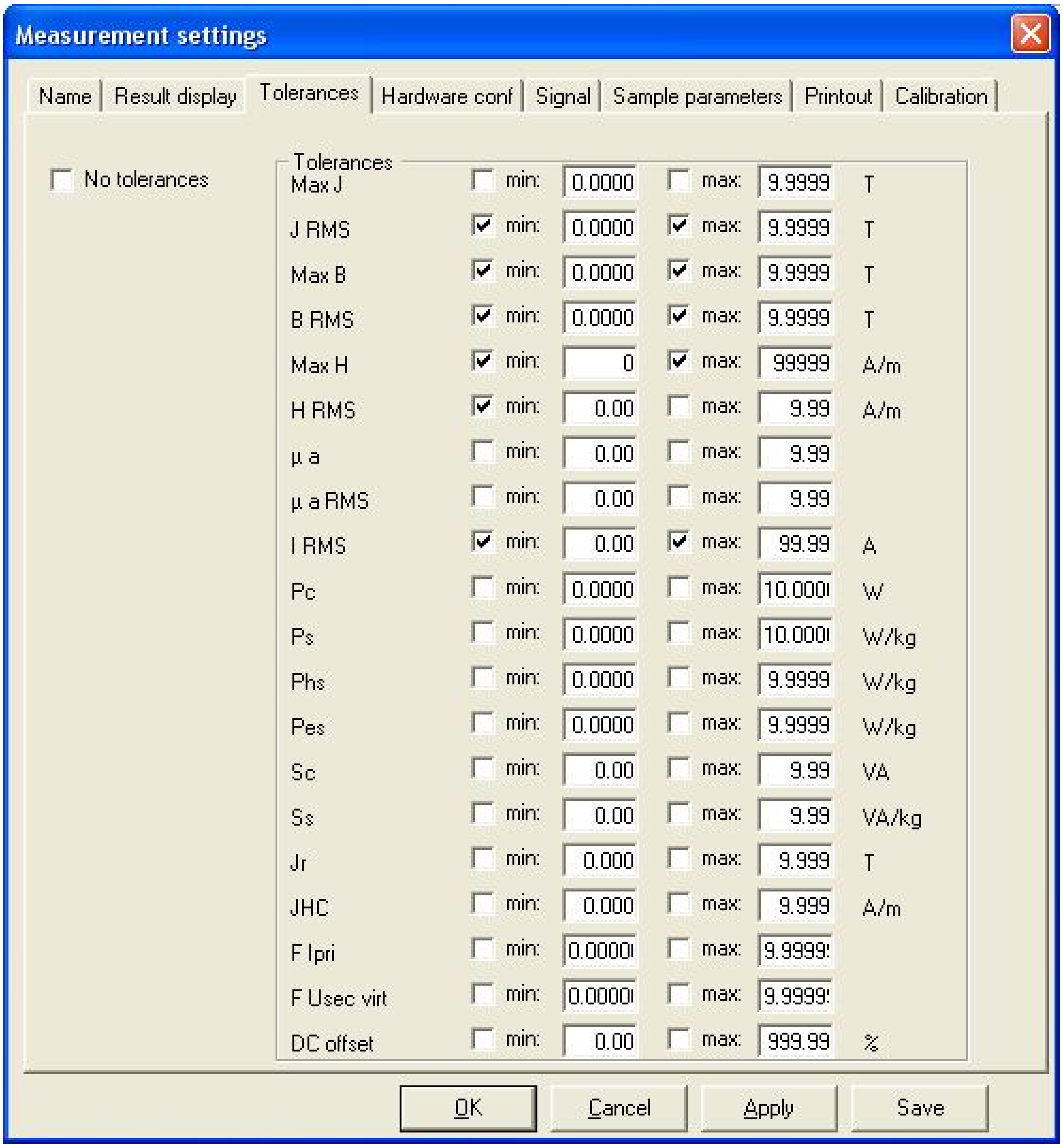
If **Separate results and tolerances** is selected, results will be shown in one block and tolerances in a second block. Normally each result is shown between its tolerances.

With **Tolerance Size** it is possible to show the tolerances smaller than the results.

Description of selectable results:

Max J	=	Peak value of magnetic polarisation
J RMS	=	Effective value of magnetic polarisation
Max B	=	Peak value of magnetic induction
B RMS	=	Effective value of magnetic induction
Max H	=	Peak value of magnetic field strength
H RMS	=	Effective value of magnetic field strength
μa	=	Amplitude permeability
μa RMS	=	Effective value of amplitude permeability
I RMS	=	Effective value of excitation current
Pc	=	Total power loss
Ps	=	Specific total power loss
Phs	=	Specific hysteresis power loss.
Pes	=	Specific eddy current power loss Can only be determined by 2 identical measurements at different frequencies.
Sc	=	Apparent power
Ss	=	Specific apparent power
Jr	=	Remanence of magnetic polarisation
JHC	=	Coercitive field strength of magnetic polarisation
F Ipri	=	Form factor of primary current. Only interesting for current regulation.
F Usec virt	=	Form factor of virtual secondary voltage. This has to be 1.111.
DC offset	=	Difference between I max pos and I max neg in percent

At **Tolerances** the user can enter limits for all results.



Tolerances settings

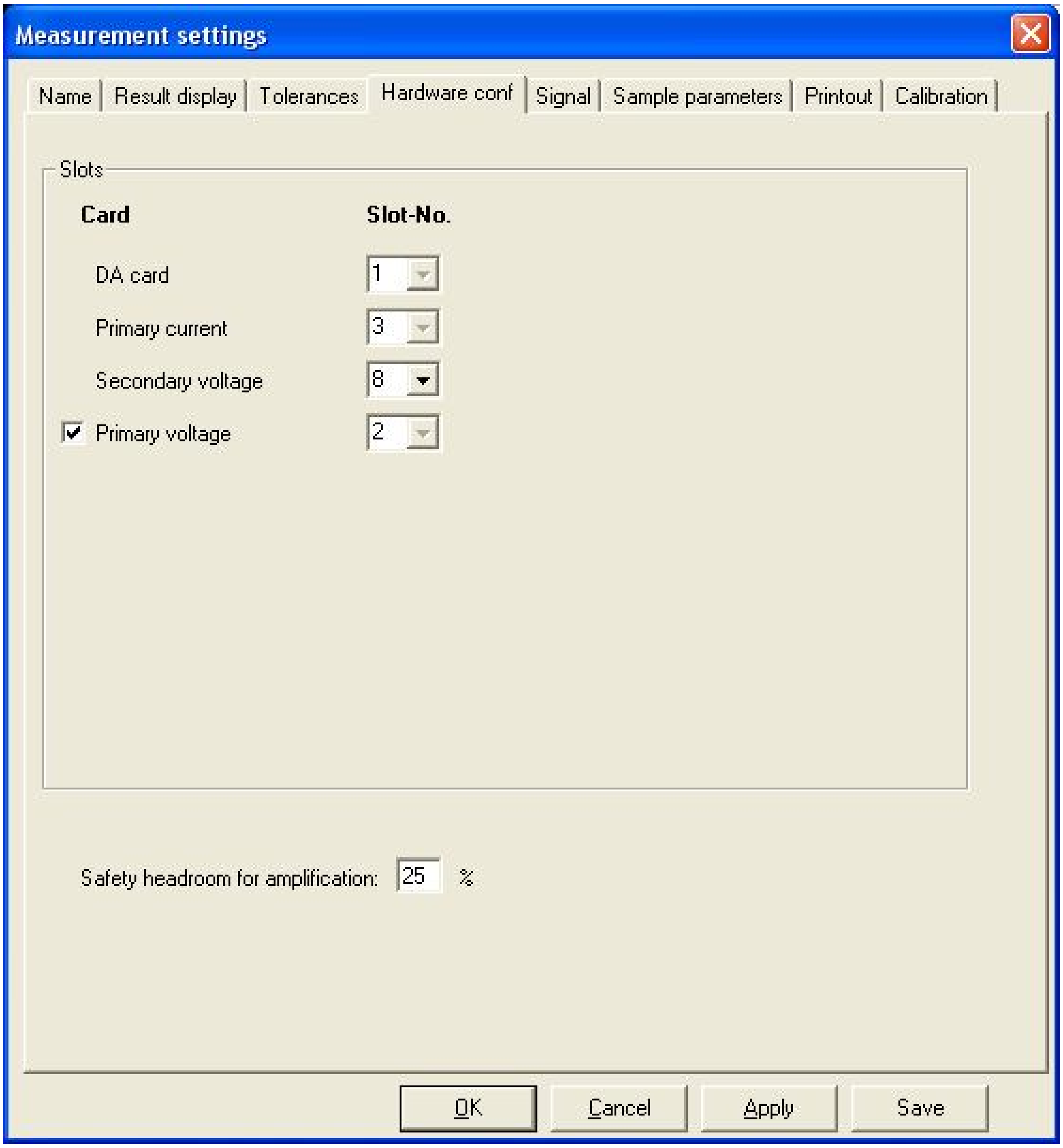
If after measurement the result is below minimum or above maximum, the result is shown in red.

With **No tolerances** all tolerances can be blocked together.

At **Hardware configuration** the user can see the slot numbers of the sample boards. If there is more than one sample board 360V, the user can select which one is used for secondary voltage.

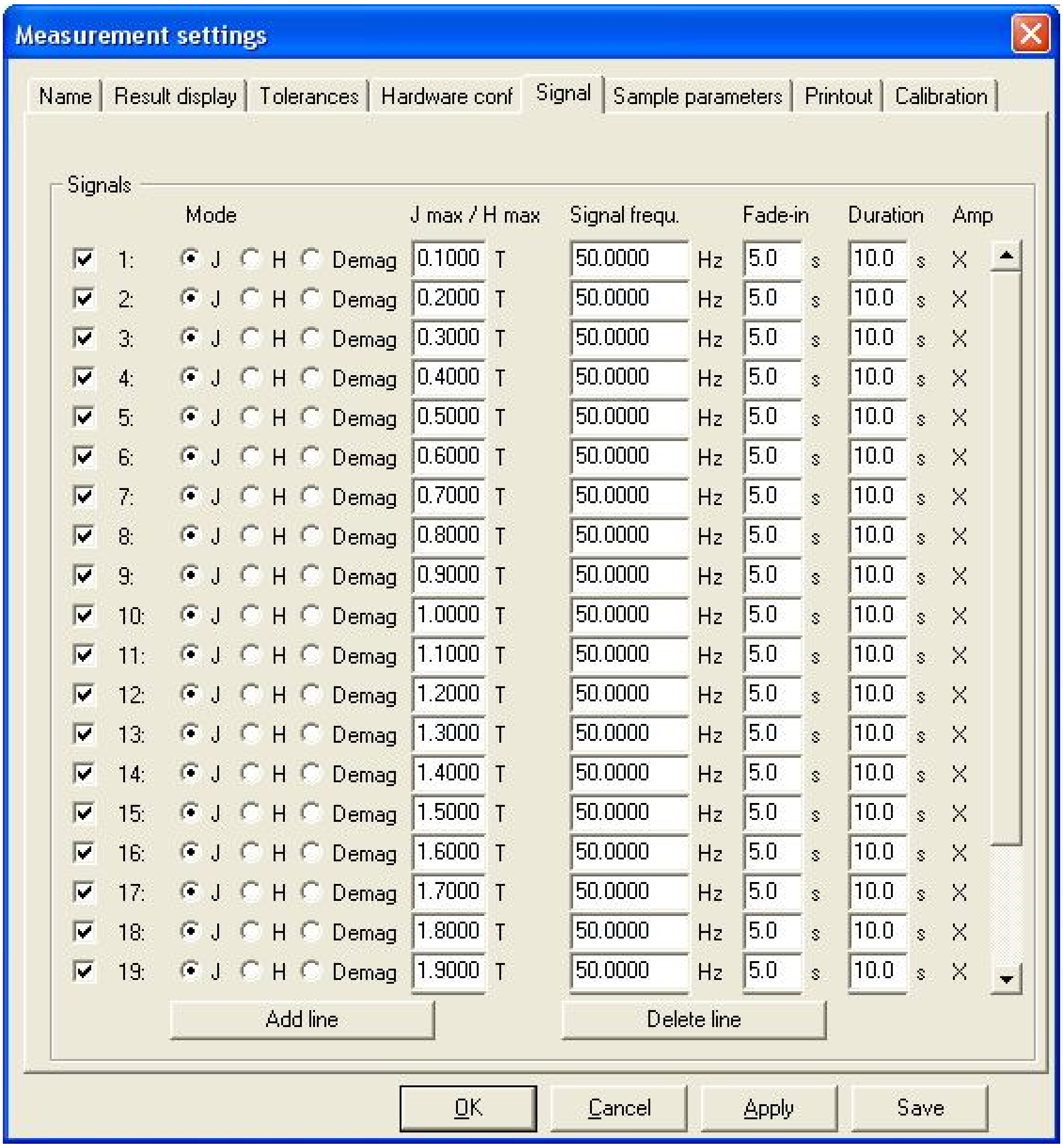
Also the user can select if the primary voltage is recorded or not. Primary voltage is not necessary for measurement but may be viewn for interest.

Safety headroom for amplification is necessary to prevent overload of the sample inputs if the signal becomes larger than estimated. Only change if overload occurs though parameters are correct.



Hardware configuration settings

At **Signal** the user must enter the measurement settings for one or more measurements.



Signal settings

First it is selected if this measurement is executed or not in this run.

Mode selects if it is a measurement with given maximum **J**, given maximum **H** or a **Demag**netisation. Then the appropriate **max**imum is entered. Next the **frequ**ency is selected.

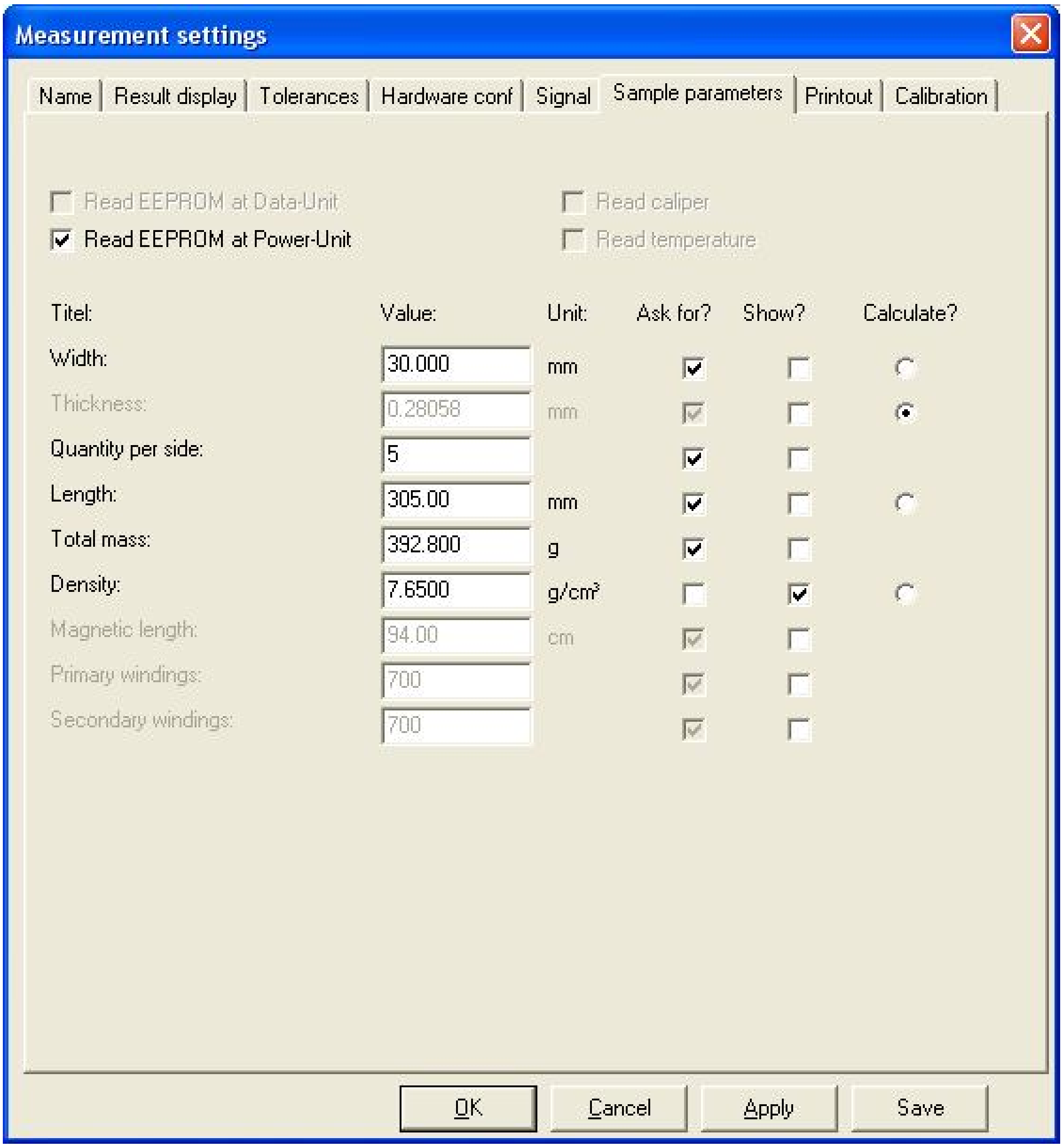
For measurements a **Fade-in** and a **Duration** must be given in seconds.
Fade-in is the time while the signal is increased from zero to final amplitude. Best time depends on measurement and is a matter of experience. Too short time can result in overringing of the signal since regulation did not have time to react. If time is too long it is only a loss of time.
Duration is the time after fade-in. The algorithm needs some time to change the signal shape to the final optimum. If duration is too short, the form factor or DC offset will not be OK.

Amp is the indicator whether the UMMS knows correct amplification for this measurement. At first time the UMMS may repeat measurement until best amplification is used. Then amplification is known and next time only one try is needed.

All measurements in this list will be executed in one run with **Start Measurement**.

Add line and **Delete line** will change the number of lines in this list.

At **Sample parameters** the user must enter the sample parameters.



Sample parameters settings

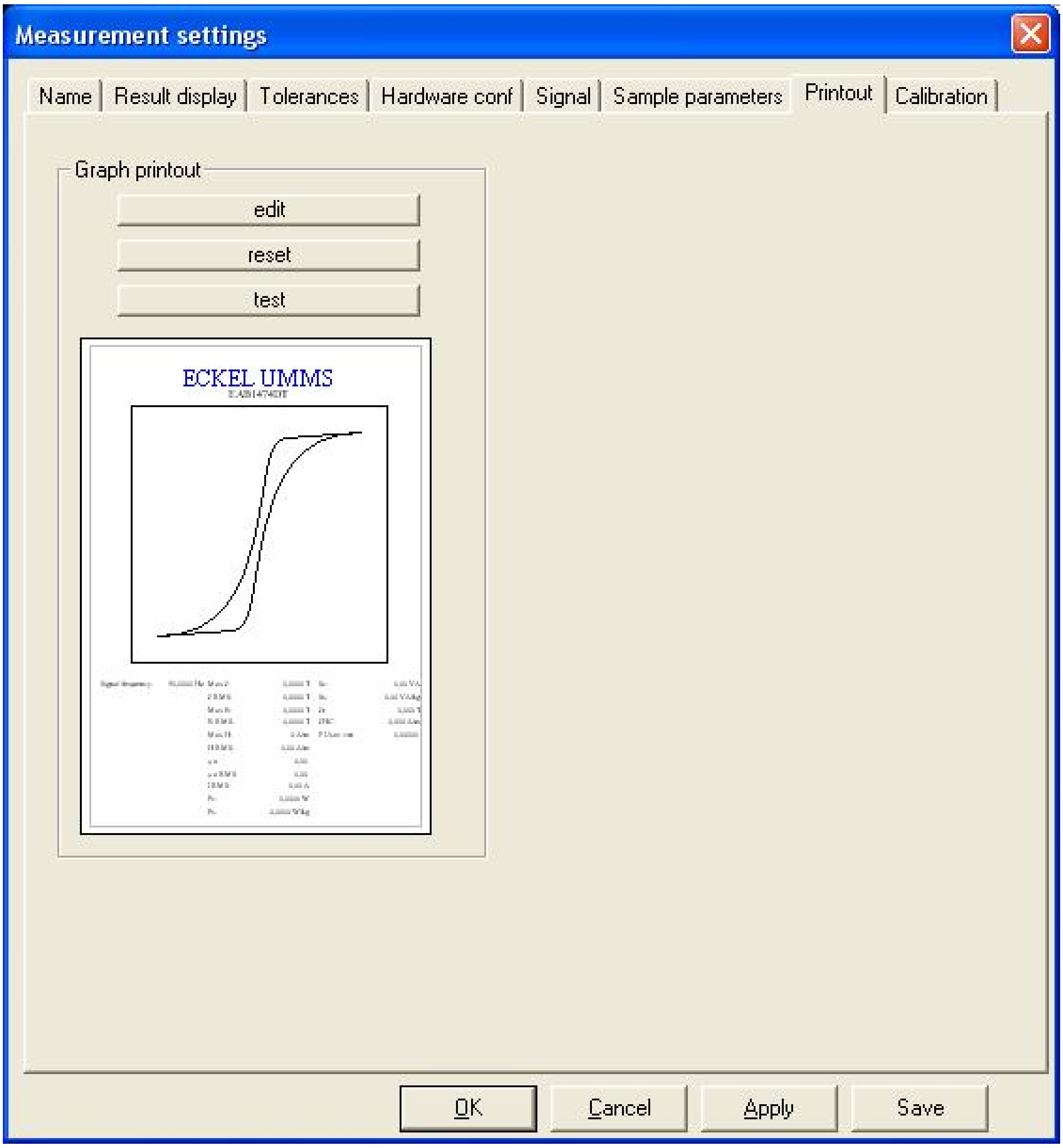
If selected, the **EEPROM** of the Epstein frame is read and magnetic length and number of windings is taken.

If desired, parameters can be selected to be **ask**ed **for** before measurement. It may be necessary to reduce the quantity of sheets for higher frequencies.

Parameters can be **show**n on the screen in the parameters block.

Length and **Total mass** must be entered. Standard is to enter also the material **Density**. Then one of the sample parameters **Width** or **Thickness** can be **calculate**d from the others. If density is not entered, it can be calculated from the other values.
To measure and enter the thickness will most time result in a calculated density that is not correct. If measured, thickness will always contain the isolation film on the steel. Even though it is most times only some hundreds of a millimeter it may change results for several percent.

At **Printout** the user can configure the printout.

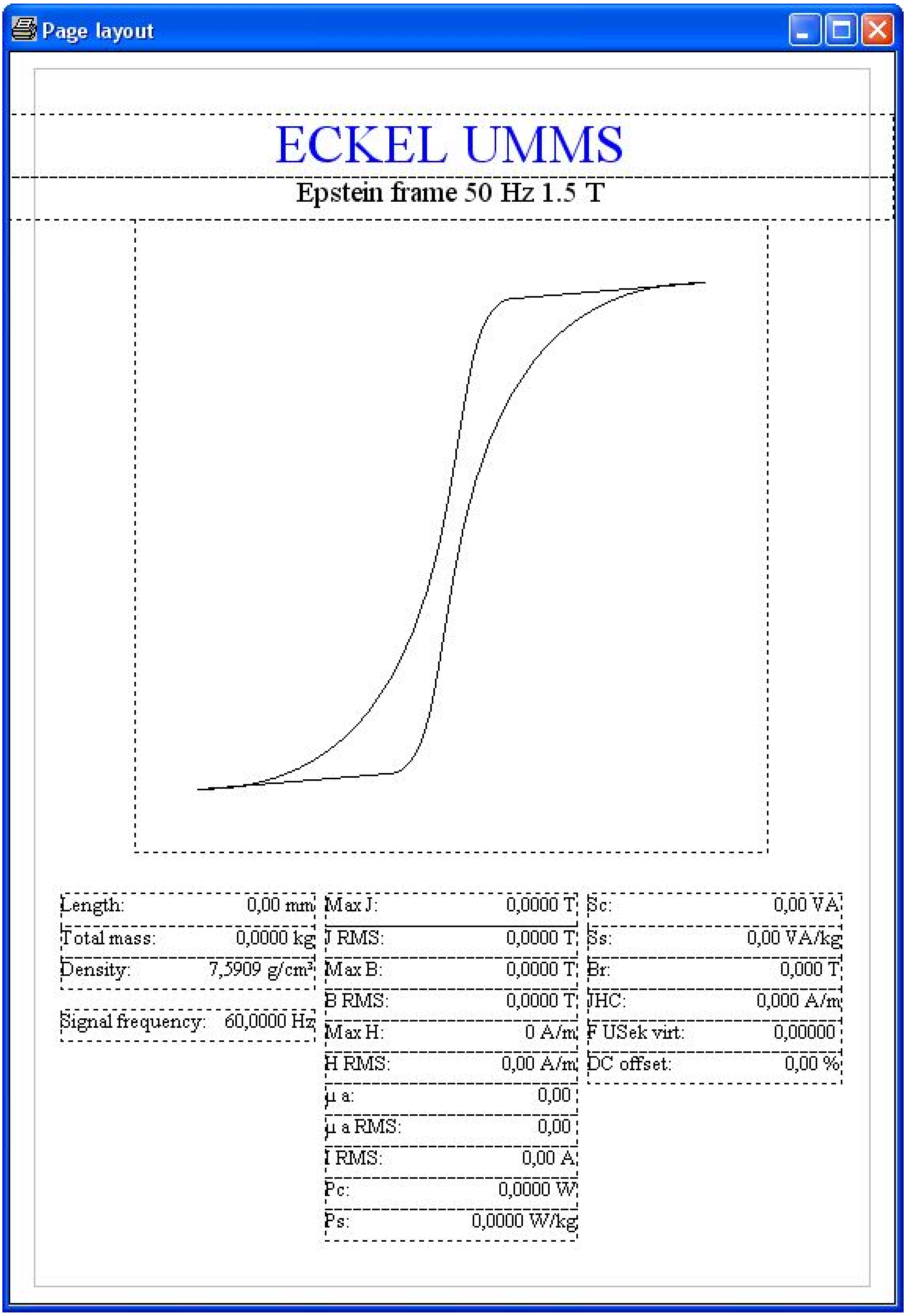


Printout settings

At **edit** a preview window will open that allows setting and moving the graph and all desired results and parameters. See next page.

Reset sets the print layout to standard values. All results selected to be shown on the screen will also be used for printout.

At **test** a test print will be generated. The program always prints to the predefined standard Windows printer.

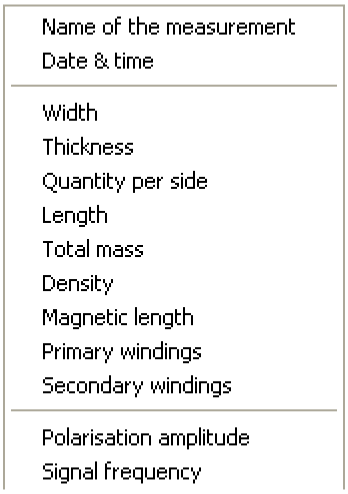


Preview window for print layout defining

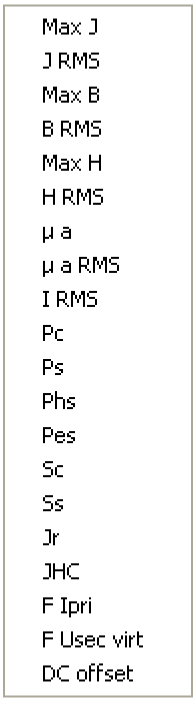
All elements can be moved and changed in size using the mouse.

By right mouse click on an empty place a menu opens to add new features.

Add new features



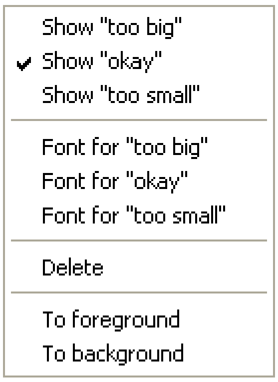
Parameter text to add



Results to add

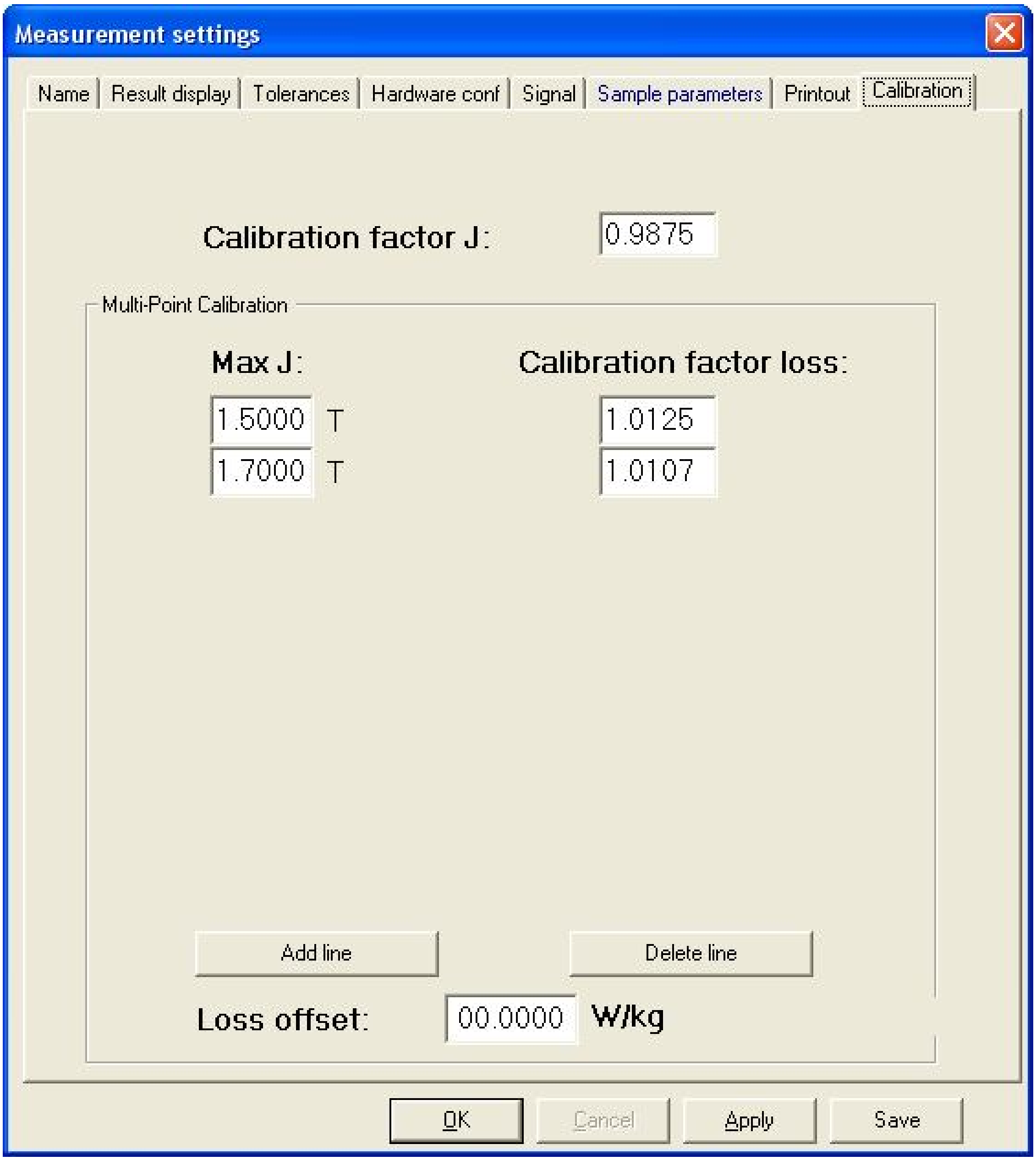
By right mouse click on an existing feature a menu opens to modify this features.

Here different font types can be selected for conditions “too big”, “okay” and “too small” if the results are compared to limits.



Modify menu

At **Calibration** the user must enter calibration values for polarisation J and losses.



Calibration factors

The UMMS is self calibrating and very exact. But if the user wants to adapt results to some standards it may be necessary to change the factor.

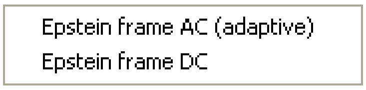
First perform a measurement with given H. Then divide standardized J_{max} by J_{max} result of the measurement. This factor has to be entered in **calibration factor J** field. Accept this value by OK.

Then perform a measurement with selected J_{max} and divide the standardized loss by the loss result of the measurement. This factor has to be entered in **calibration factor loss** field.

Repeat this step for several J_{max} if desired. The number of points for multi-point calibration is selectable by **Add line** and **Delete line**.
If no calibration is necessary, enter 1.0000 to both fields.

Loss offset allows the user to add a certain loss value to the result. This can be used to adapt results to values of other instruments.

Here **New parameters** are only available for Epstein frame.



Measurement selection

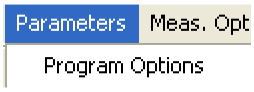
Epstein frame AC (adaptive) and **Epstein frame DC** can be selected.

This will open a measurement settings window with standard preselected settings.
These settings can be changed and stored with a new name.

The differences between Epstein frame AC (adaptive) and Epstein frame DC are explained in chapter 9.

7.3 Parameters

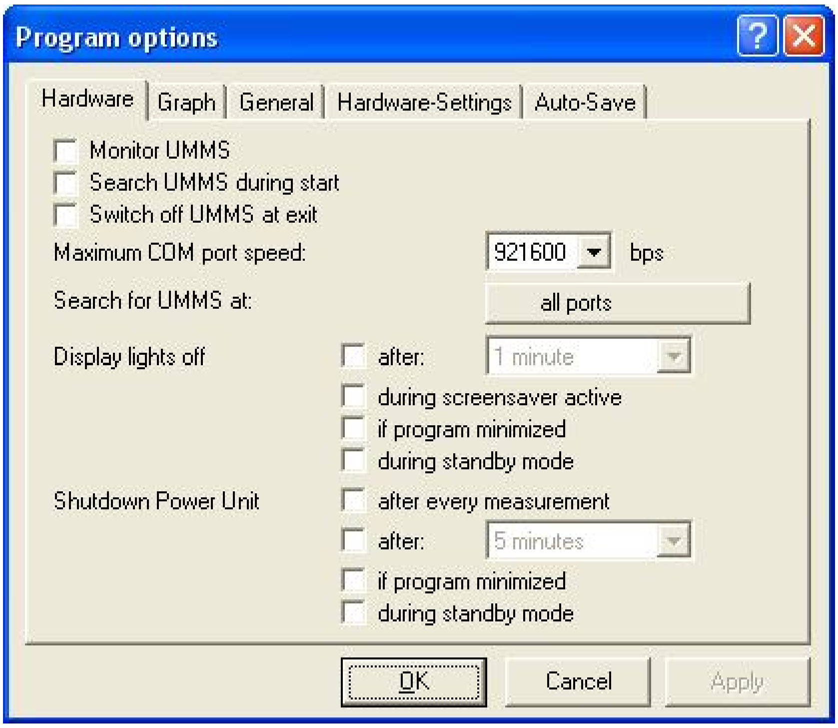
Parameters enables the setting of hardware and system parameters.



Drop down menu

Clicking on **Program Options** opens the Options window.

Hardware Options:



Hardware Options

Monitor UMMS always shows the UMMS status (e.g. online) on the screen.

Search UMMS during start automatically searches at program start even if no measurement is performed.

Switch off UMMS at exit switches off the units if the program is closed.

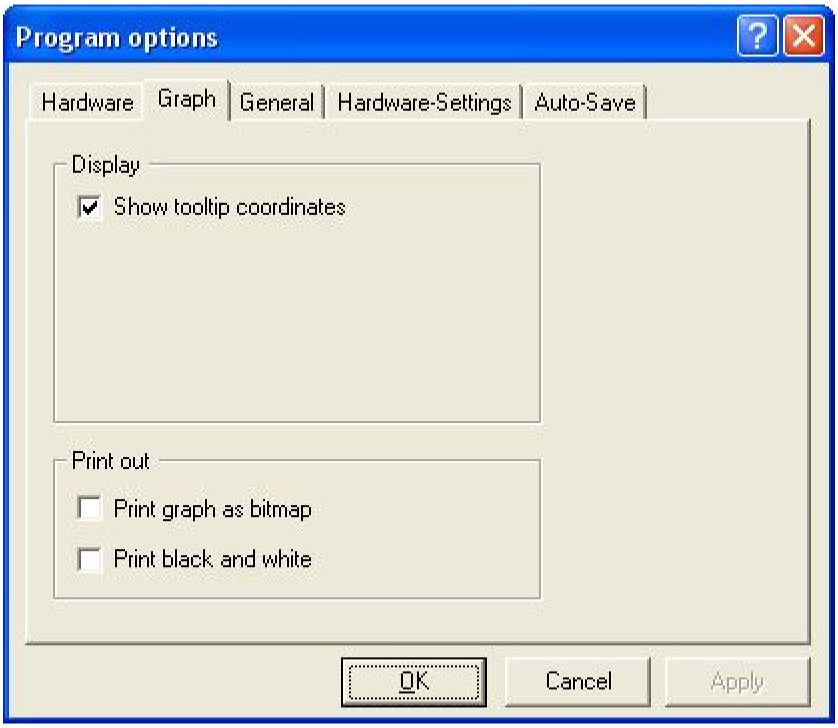
Maximum COM port speed for serial interface (RS232). This is the maximum speed for searching units. Most computers are not able to use more than 115200 bps. To search the UMMS Switch Unit only 19200 bps are necessary.

Search UMMS at specifies where the components are searched. This can save time for useless search.

Display lights off shows different options for automatic turn off. Display light has a limited lifetime. Thus it is useful not to use it all the time. It will be switched on automatically when a measurement is started.

Shut down Power Unit also shows different options. It is useful to switch it off if no measurement is started for a longer time. It will be automatically reactivated at measurement start.

Graph Options:



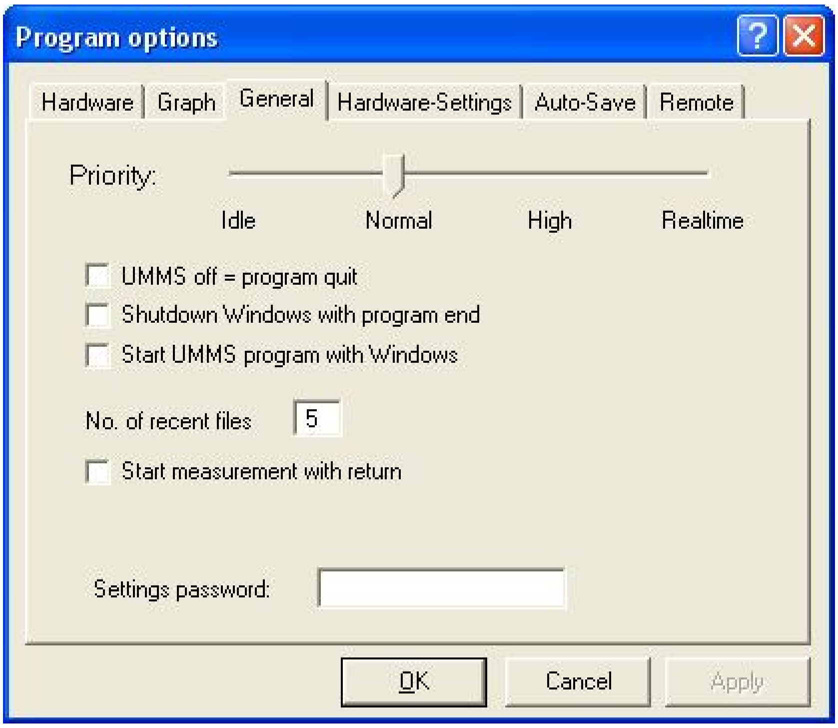
Graph Options

Show tooltip coordinates shows actual coordinates of the mouse position in respect to the actual graph in a small window.

Print graph as bitmap can be used if normal graph printing operation is not working due to some driver problems. This is only used if necessary since graph quality is reduced and printing time is longer.

Print in black and white is used for b/w printers. Otherwise some graphs in brighter colours may not be good visible.

General Options:



General Options

Priority sets program execution priority. **Idle** executes program only if the PC is free of other work. **Normal** shares the PC with other programs. At **Realtime** other programs may not be executed.
With today's standard PCs Normal is always OK.

UMMS off = Program quit will close the UMMS program when the Units are switched off.

Shutdown Windows with program end will end Windows and shut down the PC if the UMMS program is closed.

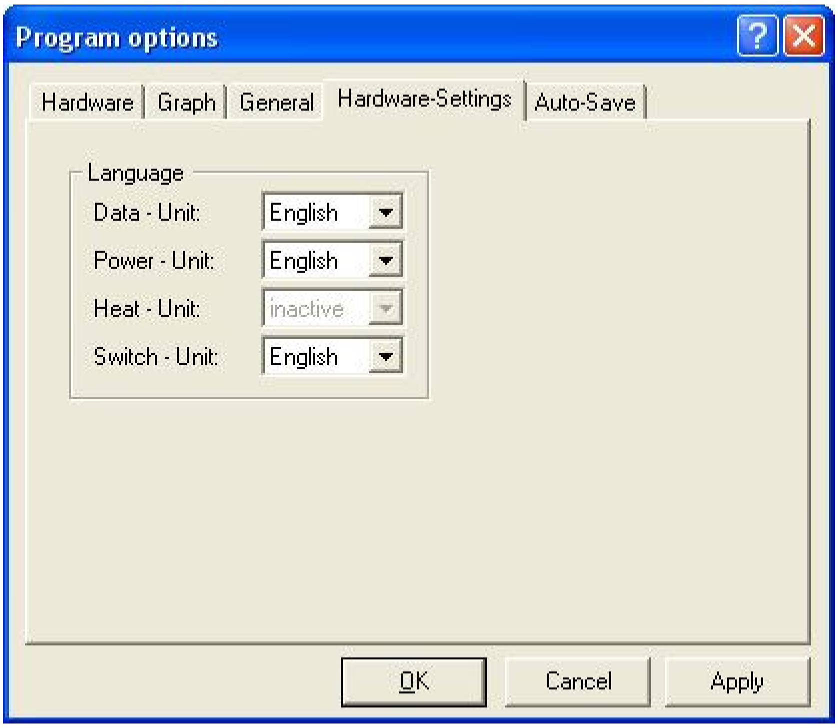
Start UMMS program with Windows start will start the UMMS program automatically after the PC is switched on and Windows has been loaded.

Number of recent files sets the maximum number of recent files shown in the task bar for direct selection without file selection box.

Start measurement with return allows the start of measurement using the Return key.

Settings password allows selection of a password for change of measurement settings. If no password is entered the password function is switched off.

Hardware Settings Options:

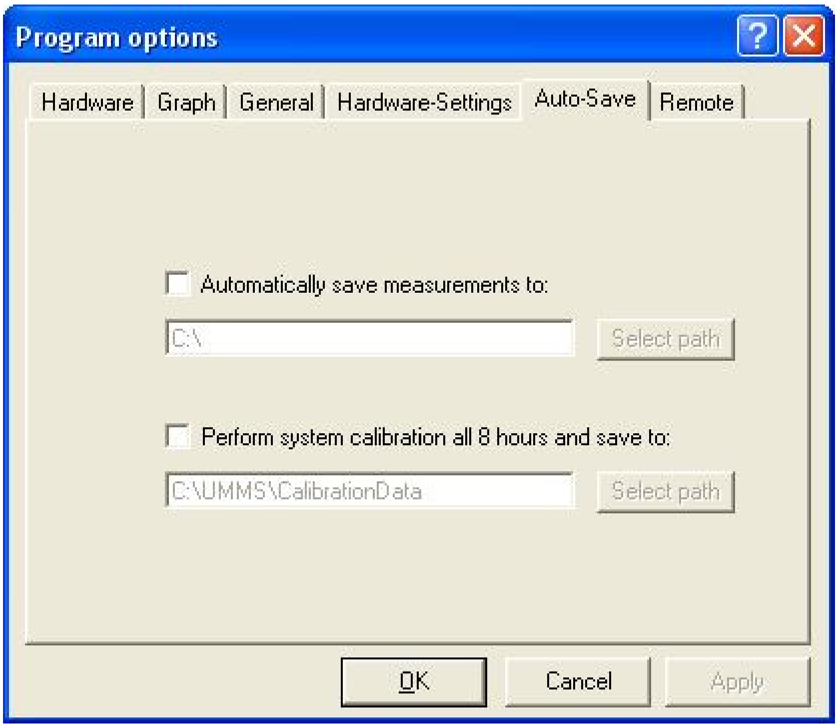


Setup Options

Language sets the display language of the units.

Auto-Save Options allows the automatic archiving of all measurements to a predefined path. This path can be anywhere in the network.

Perform system calibration allows the automatic calibration all 8 hours.



Auto-Save Options

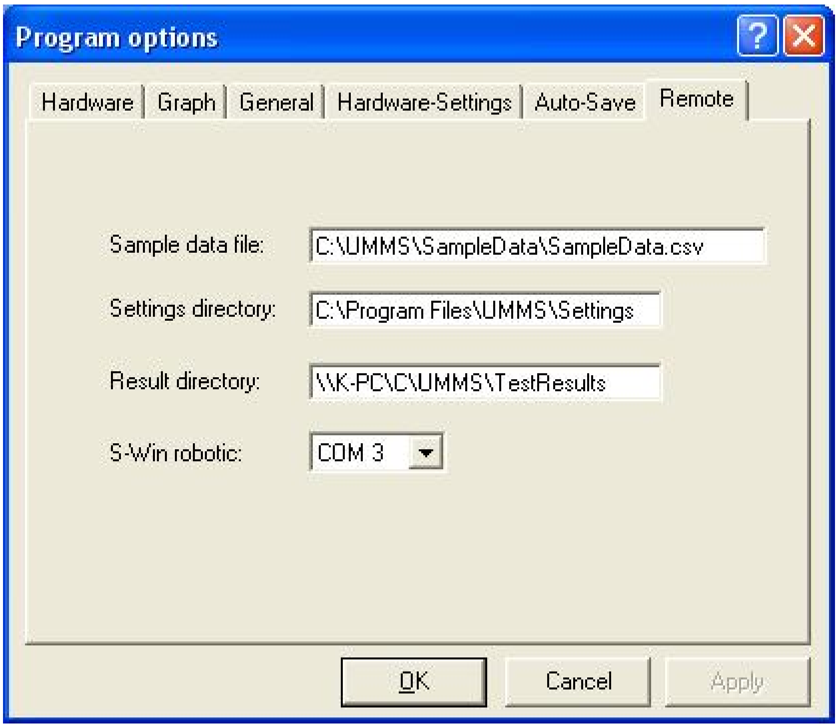
Remote operation needs some specified paths:

Sample data file is the path where the remote operator sends the informations about sample and settings.

Settings directory is the path where the UMMS has stored all different settings.

Result directory is the path where the results are sent to the external operators PC.

S-Win robotic defines the interface for communication with an external robotic PC for data exchange.



Remote Options

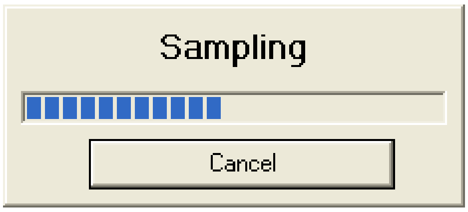
7.4 Start Measurement

Start Measurement will start the selected measurement or series of measurements. If selected at Parameters, measurement can also be started by Return key.

Start Measurement

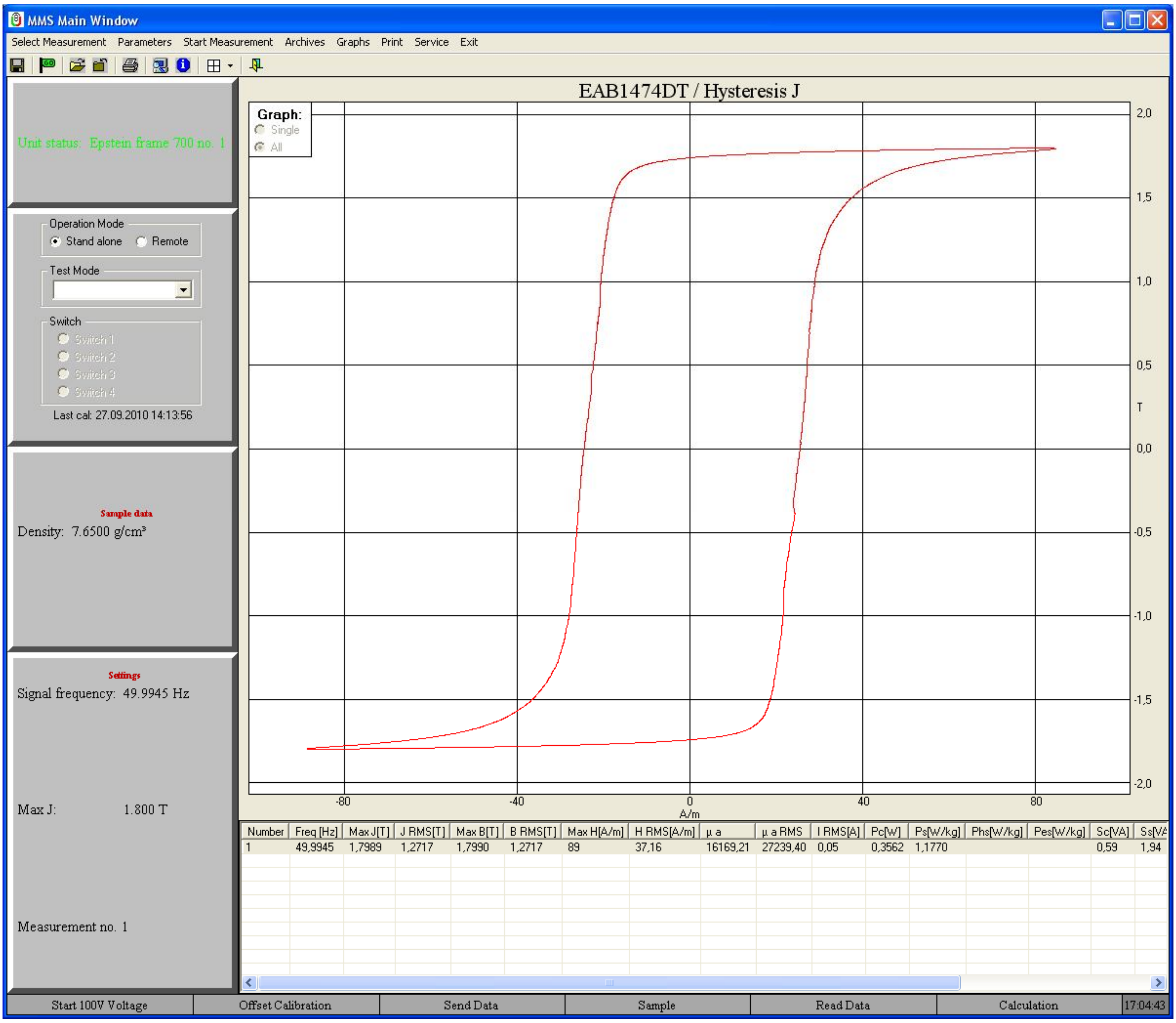
If necessary the PC will search the UMMS and/or power on the Power Unit before measurement.

During measurement a processing bar is visible. Measurement can be interrupted by “Cancel”



Processing bar

After measurement the result is shown on the screen.



Result of a 50 Hz measurement

7.5 Archives

Archives is used to load or save measurements.

Archives menu

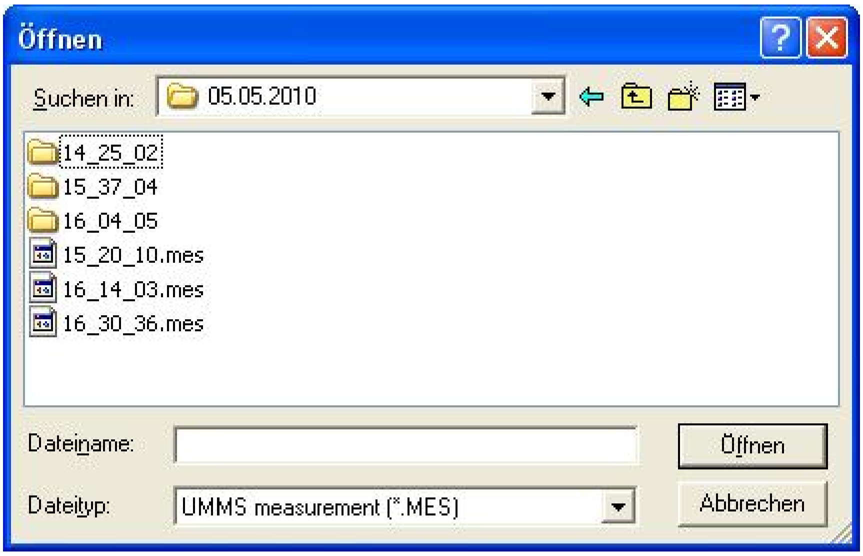
Load and save open a file selector box. The files have the extensions **.mes**.
As standard the data files are stored under the folder “name” (see measurement settings: Name) and the sub-folder “date”.

Measurements are stored as single measurements or groups of measurements, depending on the way they have been measured.

The file name of a single measurement is “time”.mes.

The folder name of a group of measurements is “time of last measurement”. This folder cannot be loaded directly but must be opened and some or all measurements can be selected together. Then all results of all measurements in this folder are shown together.

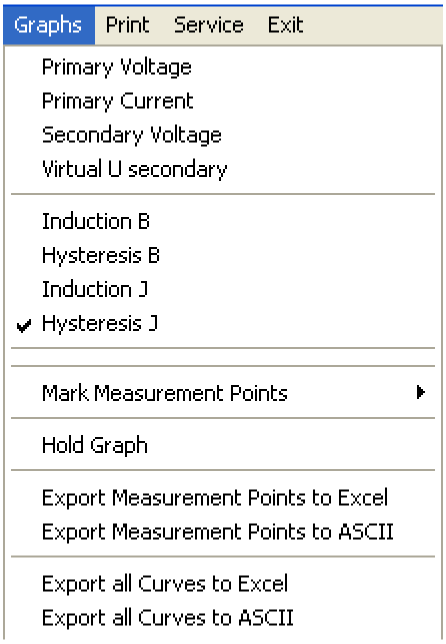
Of course also free names can be given for single and groups of measurements at the file selector box.



Groups and single measurements named “time” in the folder “date”

7.6 Graphs

At **Graphs** different graphs can be selected.



Graphs menu

Hysteresis J is always predefined.

The graph is **automatically scaled**. By drawing a window on the graph, using the **left mouse** button, this part will be **increased** to full screen. Pressing the right mouse button **resets** scale to full graph.

Mark Measurement Points sets dots on the graph at selectable distances of samples.

Mark measurement points menu

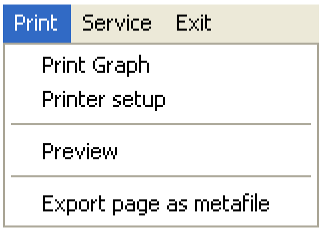
Auto will set dots on every sample as soon as the graph is increased enough to separate the sample dots visually.

Hold Graph prevents the graph from being deleted before next measurement. Thus after next measurements 2 graphs are shown and so on. All graphs are shown in different colours.

Different **Exports** of data can be selected. A file selector box will open to specify destination.

7.7 Print

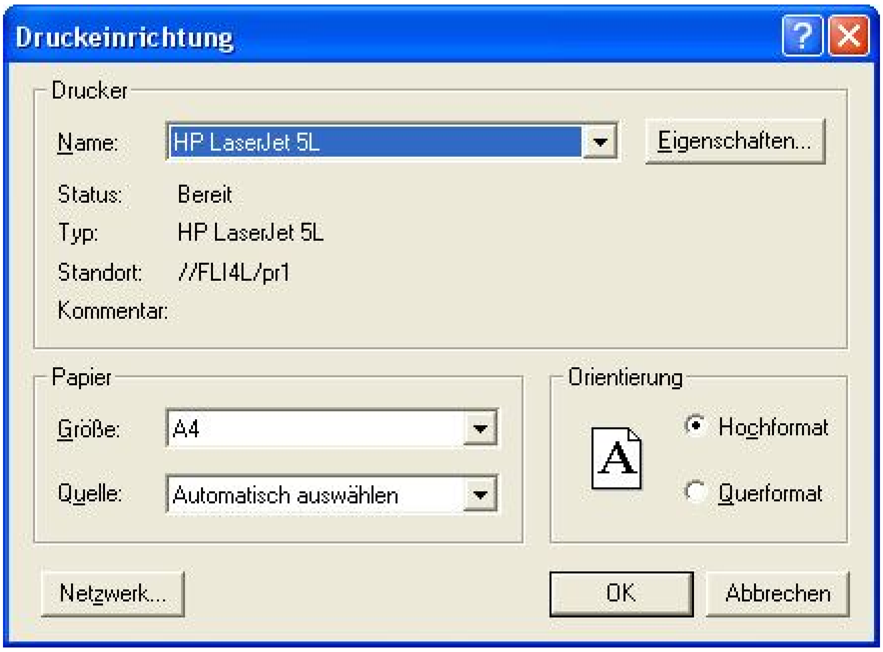
Print will open the print menu.



Print menu

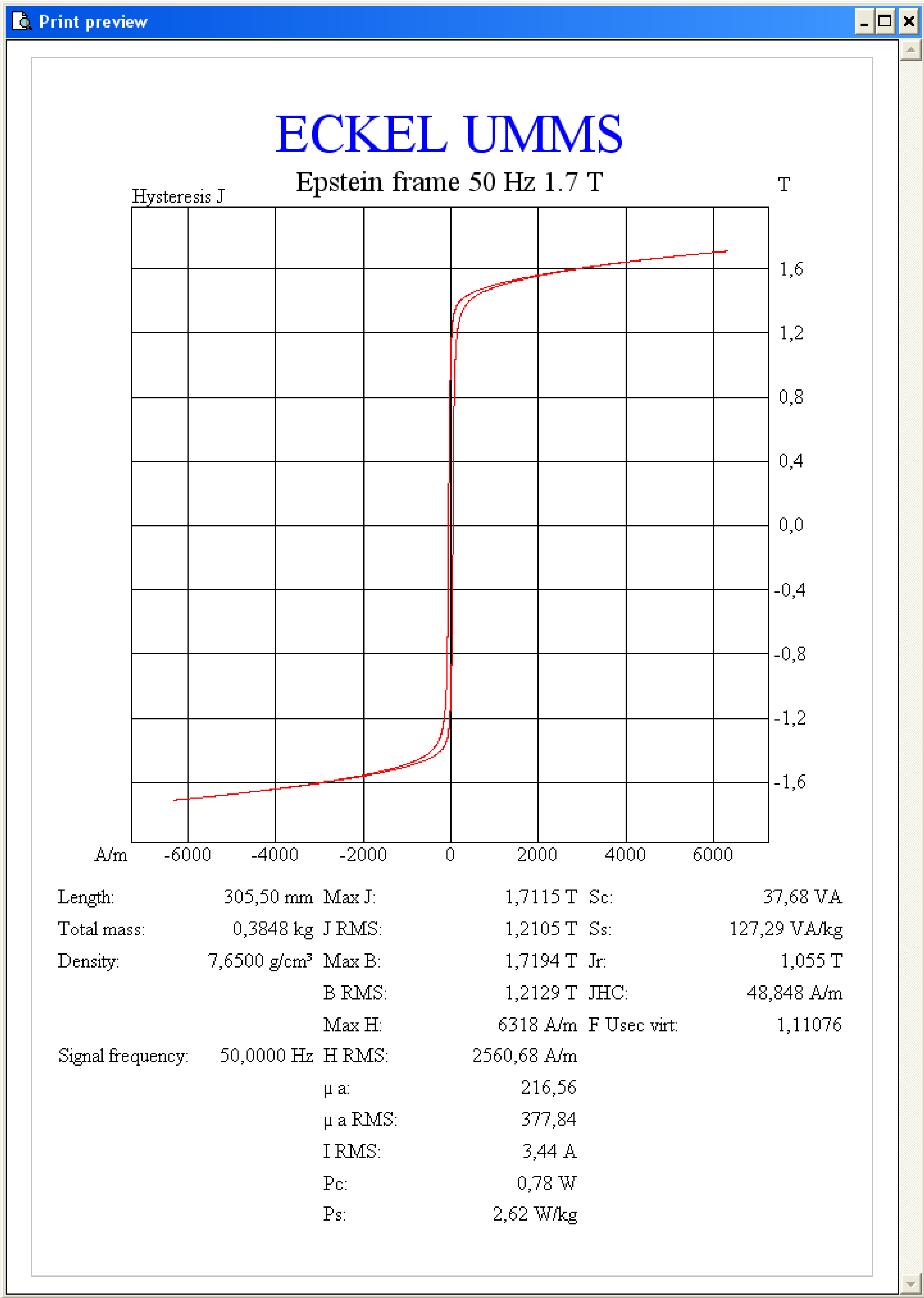
Print Graph starts the print like preselected at printout options on the printer selected at Printer setup. Always the graph on the screen in actual resolution will be printed.

At **Printer Setup** the printer and its properties can be selected.



Printer setup

Preview opens a print preview window.

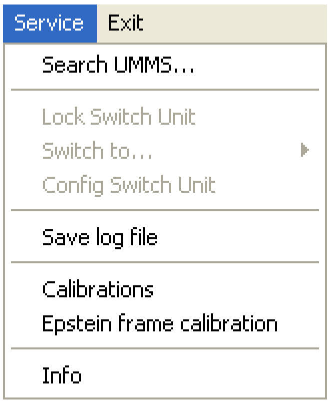


Print preview

It is also possible to **export** the page as enhanced metafile .emf.
A file selector box will open to specify destination.

7.8 Service

Service opens the service menu.

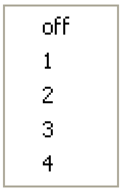


Service menu

Search UMMS searches all units of the UMMS at all possible interfaces of the PC.

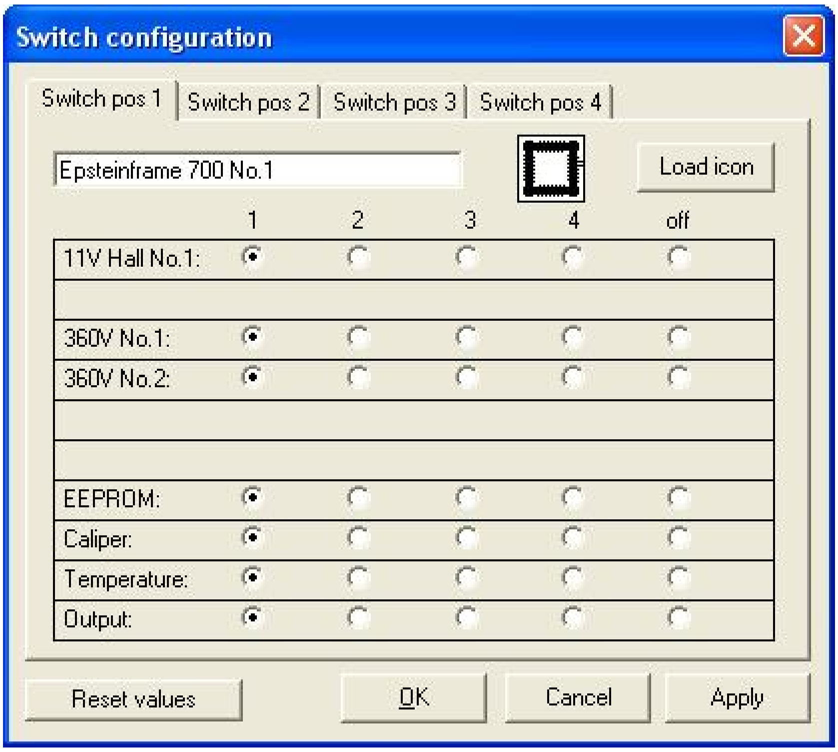
Lock Switch Unit locks the manual switches of the switch unit. Switching can only be done by software then.

Switch to… switches the switch unit.



Switch the switch unit to…

Config Switch Unit allows the configuration of every single switch.

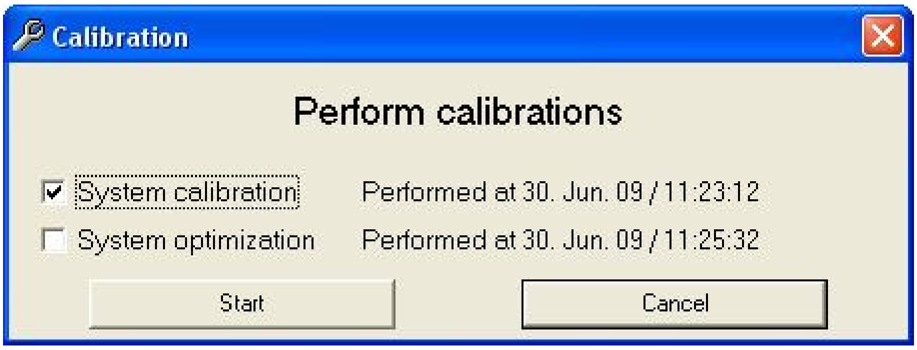


Switch configuration

Also the text for every position can be entered and an icon with 32 x 32 dots can be loaded. This icon should be black and white but a colour icon will be transformed to b/w.

Save log file will save a file “error.log” to the UMMS main folder. This is useful if error messages occurred and it is necessary to send this information to us for analyzing.

Calibrations opens the calibration window.



Calibration window

System calibration and **System optimization** must be performed once after installation and after every change of the boards of the UMMS Data Unit.

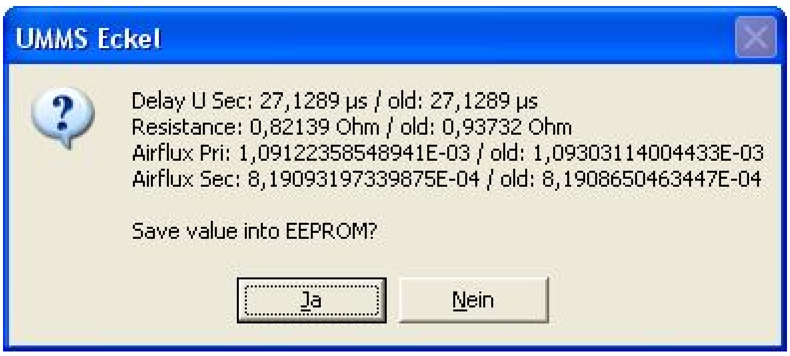
The UMMS will generate a warning if calibration has to be repeated.

Epstein frame calibration determines the parameters of the actual connected Epstein frame. These parameters have been determined before delivery. **Do not execute this program unless something seems to be wrong with these parameters!**

The frame <u>must</u> be empty for this calibration!

Epstein frame calibration

Calibration measurement will start immediately. Then a results window opens.

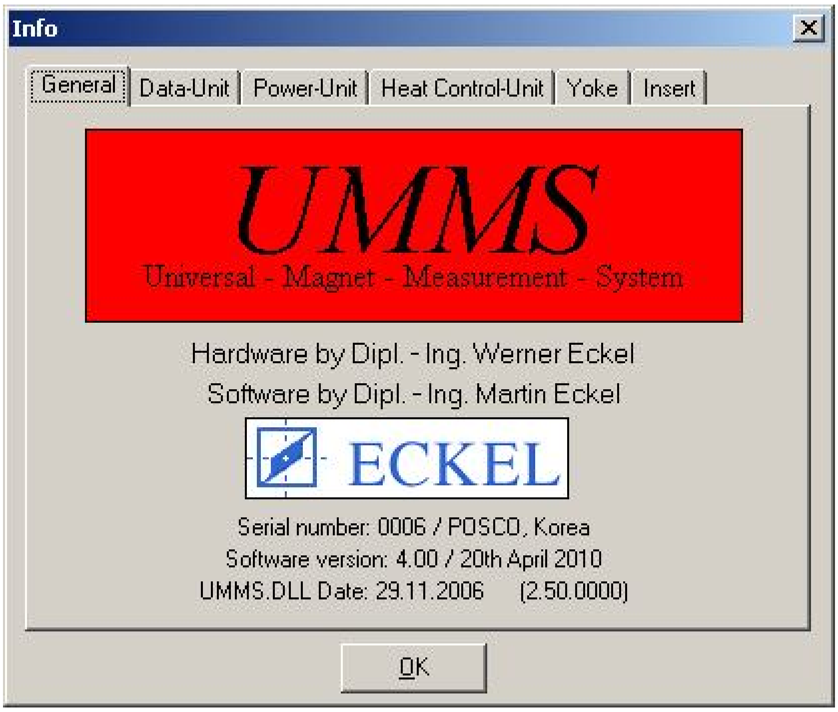


Epstein frame calibration results

If results differ much from old results, a warning will be given before saving.

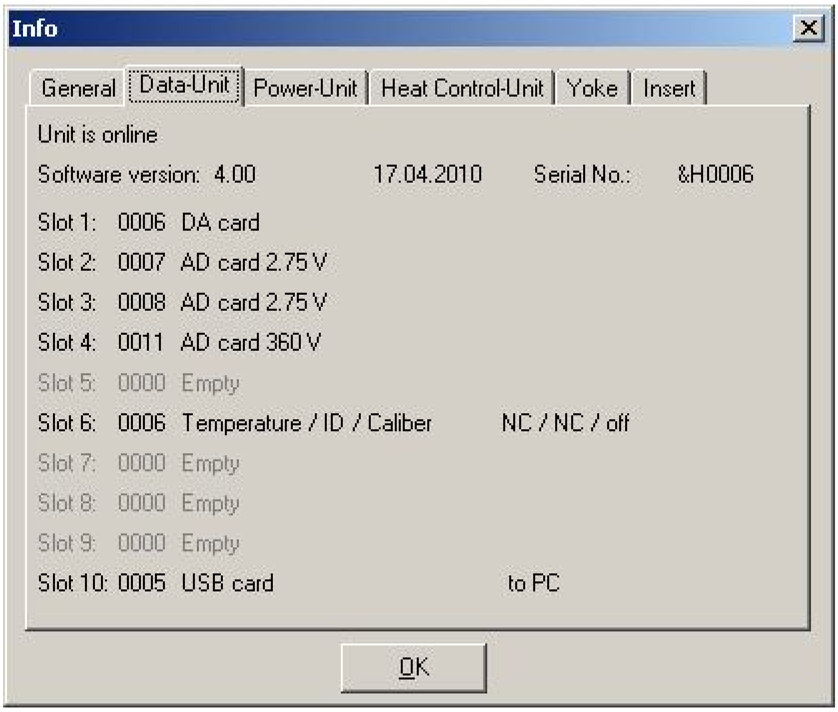
Info opens the Info window:

General shows the serial number of the software and the licensed user, the software version and date and date and version of the actual UMMS.dll.



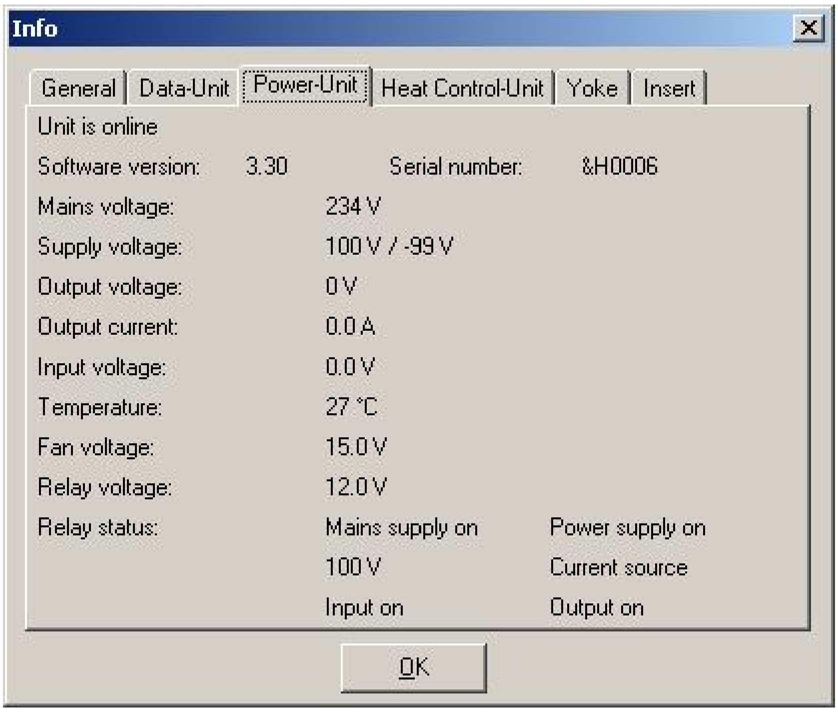
Info window General

Data Unit shows the firmware version, firmware date and serial number of the Data Unit.
Below all detected boards are shown including their serial numbers. For this the Data Unit must be online and connected.



Info window Data Unit

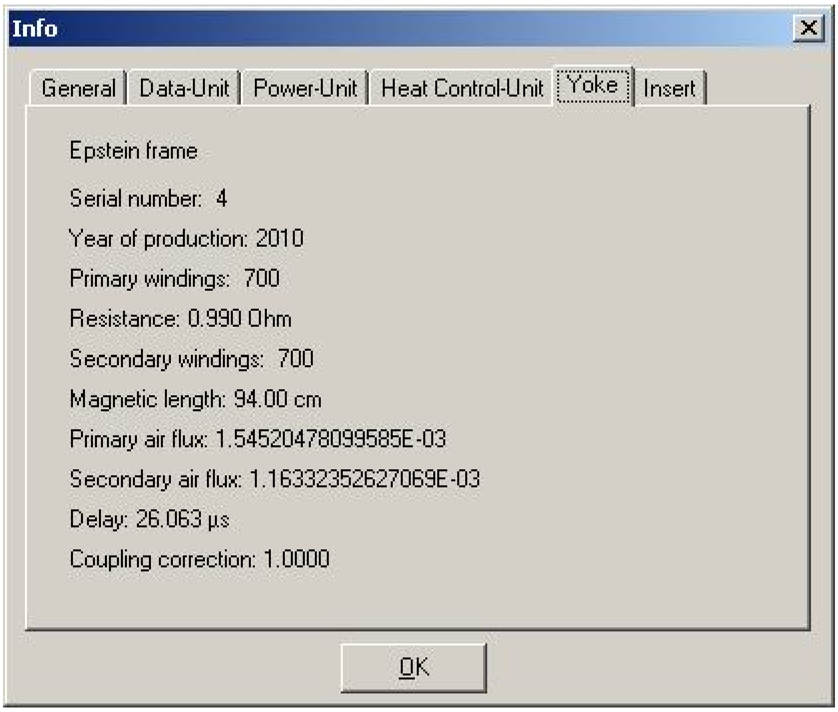
Power Unit shows the firmware version and serial number of the Power Unit.
Below the status of all important internal values are shown. For this the Power Unit must be online and connected.



Info window Power Unit

Heat Control Unit does not exist here.

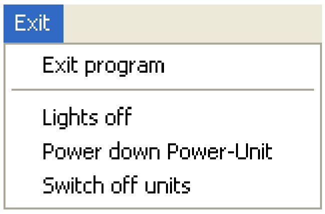
Yoke shows the connected measurement device. In this case it is an Epstein frame.
Serial number, year of production and the parameters of the Epstein frame are shown. These parameters are needed for signal adaption for sinusoidal polarisation.



Info window Yoke

7.9 Exit

Exit opens the exit menu.



Exit menu

Exit program ends and closes the program.

Lights off switches off the lights at the units. The CCFL lights have a limited lifetime. When a measurement is started the lights are switched on again.

Power down Power Unit switches off the power amplifier of the power unit. The power unit itself will stay powered on.

Switch off units switches off all connected Units of the UMMS.

8. IEC 60404-2/-3 Standard measurement: Sinusoidal polarisation

8.1 Theory of operation

Measurement with sinusoidal polarisation is the standard measurement for steel sheets in an Epstein frame. Since with a standard Epstein frame polarisation is relative to the integrated output (secondary) voltage, output voltage also must be sinusoidal.

A standard Epstein frame needs a mutual inductor to compensate the influence of the air flux. The mutual inductor increases the maximum voltage necessary on the input and also increases the part of the input voltage that has a higher gradient than the nominal measurement frequency. Thus the amplifier needs to generate more voltage of higher frequencies though bandwidth of the amplifier is limited. If the amplifier cannot generate the correct signal anymore, measurement will not reach sinusoidal polarisation.

With mutual inductor output voltage is

$U_{out} = n^* (-d\Psi/dt)$ (1)
$\Psi = \Phi - \mu_0{*}H{*}a_A = J{*}a_S$ (2)

With:
Ψ = polarisation flux inside the steel sheets
Φ = total flux inside the secondary coil of the Epstein frame
J = polarisation inside the steel sheets
a_A = total area inside the secondary coil of the Epstein frame
a_S = cross-sectional area of the steel sheets

Unfortunately output voltage of the Epstein frame is not identical to input voltage. Thus some regulation is needed. It is also not useful to regulate the input current since input current for sinusoidal polarisation has an unknown non sinusoidal shape and depends on steel properties.

For input side the following formula is given:

$U_{in} = U_{sin} + I_{in} * R_{inE} + I_{in} * R_{inM} + F_{AIE} * (-dI_{in}/dt) + F_{AIM} * (-dI_{in}/dt)$ (3)

With:
U_{sin} = sinusoidal output voltage needed for sinusoidal polarisation
I_{in} = input current
R_{inE} = ohmic input resistance Epstein frame
R_{inM} = ohmic input resistance mutual inductor
F_{AIE} = air flux input factor Epstein frame
F_{AIM} = air flux input factor mutual inductor
dI_{in}/dt = change of input current over time

The air flux factor depends on number of turns and the area of the coil windings.

The output voltage of the Epstein frame is

$U_{outE} = U_{sin} - I_{out} * R_{outE} + F_{AOE} * (-dI_{in}/dt)$ (4)

With:
U_{outE} = output voltage of the Epstein frame

I_{out} = output current
R_{outE} = ohmic output resistance of the Epstein frame
F_{AOE} = air flux output factor Epstein frame

The output voltage of the mutual inductor is

$U_{outM} = F_{AOM} * (-dI_{in}/dt) - I_{out} * R_{outM}$ (5)

With:
U_{outM} = output voltage of the mutual inductor
I_{out} = output current
R_{out} = ohmic output resistance mutual inductor
F_{AOM} = air flux output factor mutual inductor

First of all it is necessary that the output voltage is measured with a high ohmic instrument. Then $I_{out} = 0$.

Then the outputs of Epstein frame and mutual inductor are connected in series with opposite direction.

$U_{out} = U_{outE} - U_{outM} = U_{sin} + F_{AOE} * (-dI_{in}/dt) - F_{AOM} * (-dI_{in}/dt)$ (6)

Now the mutual inductor has to be trimmed to
$F_{AOE} = F_{AOM}$ (7)

Then the output voltage has directly the desired shape if input voltage has a shape according to (5).
$U_{out} = U_{sin}$ (8)

To regulate the input voltage to get a sinusoidal output voltage, output voltage is compared in shape and amplitude to a given sinusoidal voltage by an operational amplifier. The output of the operational amplifier gives the input to the power amplifier. The regulation is limited by noise, slew rate and nonlinearity of the operation amplifier as well as signal quality of the sinusoidal voltage for compare. The sinusoidal voltage is typically generated by a sinus generator and thus cannot change shape to other signals than sinus.

For testing the accuracy of regulation the form factor of U_{out} is calculated. The form factor is the quotient of r.m.s. value of U_{out} and average value of rectified U_{out}. The IEC norm gives a value of 1.111 though real value is 1.1107 for sinusoidal voltage. A deviation of 1% is allowed. Thus form factors from 1.09989 to 1.12211 are accepted.

It must be said that also other signal forms than sinus can reach a form factor of 1.111. Thus form factor test is not perfect. But as long as the signal mainly is a sinus, deviations from perfect sinus will be detected.

One more point is of interest: To get a symmetric signal ($H_{max} = -H_{min}$) it is extremely important to regulate the DC offset of the input voltage to zero in the same time as shape regulation is active. Since the input resistance of an Epstein frame is very low, even small deviations from zero voltage can result in large deviations of symmetry. U_{out} cannot be used for DC regulation since DC errors do not have any effect on U_{out}.

With the UMMS the regulation is complete digital. The UMMS performs a parametric adaption of the input signal. This means that U_{in}, I_{in} and U_{out} are recorded by analog/digital converters and then used for regulation of the input signal according to physical formulas.

F_{AIE} and F_{AOE} are constant over amplitude and frequency since air flux is linear. Thus they can be determined by test measurement. Then there is no need for a mutual inductor. No trimming is necessary.

Without mutual inductor formula (3) changes to

$U_{in} = U_{sin} + I_{in} * R_{inE} + F_{AIE} * (-dI_{in}/dt)$ (9)

With:
U_{sin} = sinusoidal output voltage needed for sinusoidal polarisation
I_{in} = input current
R_{inE} = ohmic input resistance Epstein frame
F_{AIE} = air flux input factor Epstein frame
dI_{in}/dt = change of input current over time

With $I_{out} = 0$ formula (4) becomes

$U_{outE} = U_{sin} + F_{AOE} * (-dI_{in}/dt)$ (10)

With:
U_{outE} = output voltage of the Epstein frame
F_{AOE} = air flux output factor Epstein frame

Two differences are important:
- U_{in} is smaller than with mutual inductor. Thus with the same power amplifier higher polarisations or higher frequencies can be reached.
- U_{outE} is not sinusoidal for sinusoidal polarisation

The firmware of the Data Unit mainly has to care about two problems:
- U_{in} must be calculated according to formula (9) by measuring I_{in} and calculating dI_{in}/dt. Of course I_{in} changes by regulating U_{in}. Thus parametric adaption changes the signal shapes until finally a stable situation has been reached. Then regulation is finished and signals have the desired shape and polarisation is sinusoidal and of desired amplitude.
- $F_{AOE} * (-dI_{in}/dt)$ must be subtracted from U_{outE} to get a virtual $U_{outEv} = U_{sin.}$

Next problem is the input resistance R_{inE} of the Epstein frame. To get a good result R_{inE} must be known very exactly. Unfortunately R_{inE} is not constant but temperature dependent. Temperature coefficient is about 0.4%/°C and temperature can change fast during measurement due to high current. Thus it is necessary to adjust R_{inE} during measurement to real value.

Concrete procedures cannot be published here since we must keep them secret from competitors.

As with analog regulation it is necessary to regulate the DC bias of U_{in} by comparing the positive and negative maxima of I_{in} to get a symmetric signal in H.

Also, as with analog regulation, it is useful to blow up the signal slowly from zero to desired amplitude to give regulation enough time to react.

Formulas (9) and (10) are also valid for any other waveform. So it is possible to adapt any other signal like signals with higher harmonics, but some algorithms like finding I_{max} have to be modified. This will follow soon.

Using the same formulas it is also possible to adapt any waveform of I_{in} and thus controlling the field H instead of polarisation J. This will also be available soon.

DC measurement does not use adaption but directly uses control of H by switching the amplifier to current source and controlling I_{in}. Normally a triangular low frequency current signal is used for DC measurement.

8.2 How to perform a measurement

The units are powered on and the software is running.

Datas of samples like weight, length and density are known.

It is known whether the samples are grain oriented or not and which quality they have.

Samples are entered to the Epstein frame as described in chapter 5.

Switch the Switch Unit to the desired frame by hand or by software as described in chapter 7.8. All parameters of the frame will be read from the frame EEPROM.

Load measurement settings for these samples as described in chapter 7.2. Everything will be set as it was when these settings were saved and the same measurements will be made.

If no adequate settings have been saved before, select **New settings for Epstein frame** as described in chapter 7.2.

If necessary change selections of **Name**, **Result display**, **Tolerances, Archive** and **Printout** at **Measurement settings** as described in chapter 7.3.

Go to **Measurement settings Sample parameters**. Enter the sample parameters as described in chapter 7.3.

If necessary go to **Measurement settings J/H** and adjust the relation between J and H as described in chapter 7.3.

If necessary go to **Measurement settings Signal** and chose the desired run of measurements from the table or if necessary enter new values to the table as described in chapter 7.3.

Go to **Start measurement** and the complete run of measurements will be executed.

After every measurement the graph and results will be updated and shown according to selection of view as described in chapter 7.1.

Type of view and type of graph can be changed after measurement as described in chapter 7.6.

If preselected the complete run of measurements is saved automatically in a path as described in chapter 7.3. **Measurement settings Archive**. If not preselected, the results can be archived by hand as described in chapter 7.5.

If desired the results can be printed. Single measurement or group measurement print is possible. Always the graph visible on the screen will be printed. See chapter 7.7.

8.3 Limits of measurement

If the UMMS finds by calculation that it is not possible to reach the desired polarisation or field strength at desired frequency for actual sample datas with available current and voltage, an error message will be generated and measurement is not started.

If during measurement any of the sample boards gets an overload due to wrong parameters, measurement is interrupted and an error message is generated. If parameters are correct but input current measurement gets an overload, the J/H relation must be adjusted to set current measurement to a higher range for this polarisation. Then try again.

Maximum possible frequency is depending on maximum primary voltage, J_{max}, sample cross-sectional area and number of primary turns. Peak voltage is about $2*\pi*frequency*turns*J_{max}*area$.

Example: $2*\pi*50Hz*700turns*1.9T*0.03m*0.0005m = 6.27V$.

Depending on current needed to reach 1.9T some voltage for $I_{in} * R_{inE} + F_{AIE} * (-dI_{in}/dt)$ has to be added.

Also not only voltage but maximum current has to be checked.
It is no use to calculate the voltage needed for 2T if the sample is non-oriented steel. Then the maximum field of 14900A/m at 20A is not enough to reach this polarisation.
The same calculation for grain oriented steel may be OK.

The measurement is not only limited by voltage and current but also by the maximum bandwidth of the power amplifier. While U_{sin} is sinusoidal, for higher currents $I_{in} * R_{inE}$ contains parts of higher frequencies. $F_{AIE} * (-dI_{in}/dt)$ has even higher frequencies than $I_{in} * R_{inE}$. Especially if the base frequency is already high and current is high, even more for grain oriented samples, these additional voltages meet the limits of the power amplifier earlier than expected. In this case it is not possible to get sinusoidal polarisation.

8.4 DC measurement IEC 60404-2 and -3

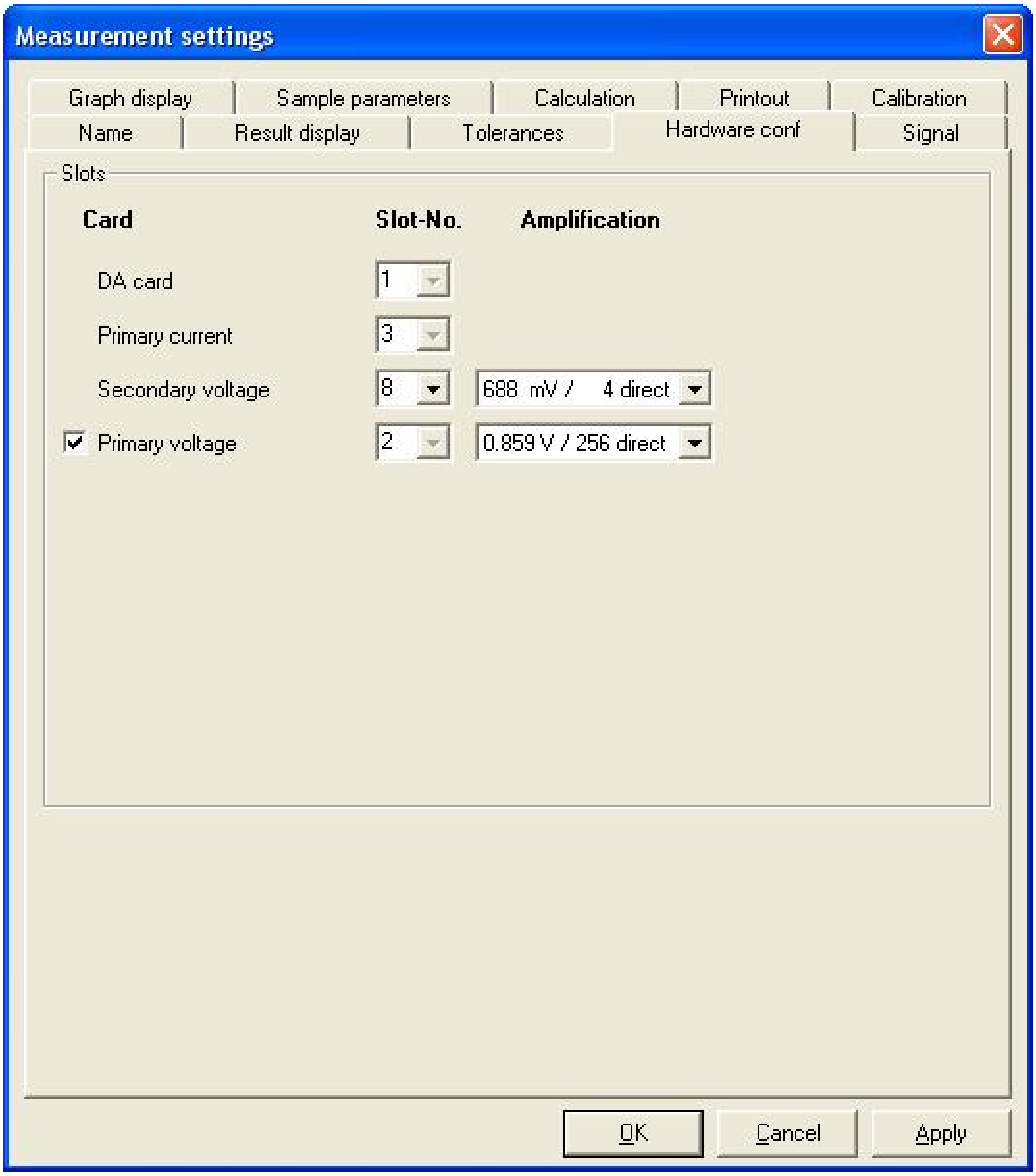
DC measurement measures the hysteresis at very low frequency. Of course a measurement with a frequency of zero is not possible since it would last forever. Also output voltage of secondary coil becomes lower relative to frequency. Real frequency is about 0.2 Hz.

The DC measurement is performed under current control using a triangular signal. Thus the power stage is switched to current source. Eddy current losses are presumed to be zero.

Most parts of the measurement settings are the same as with AC measurement.

There are differences in **Results** and **Tolerances** since some results do not exist for DC measurement.

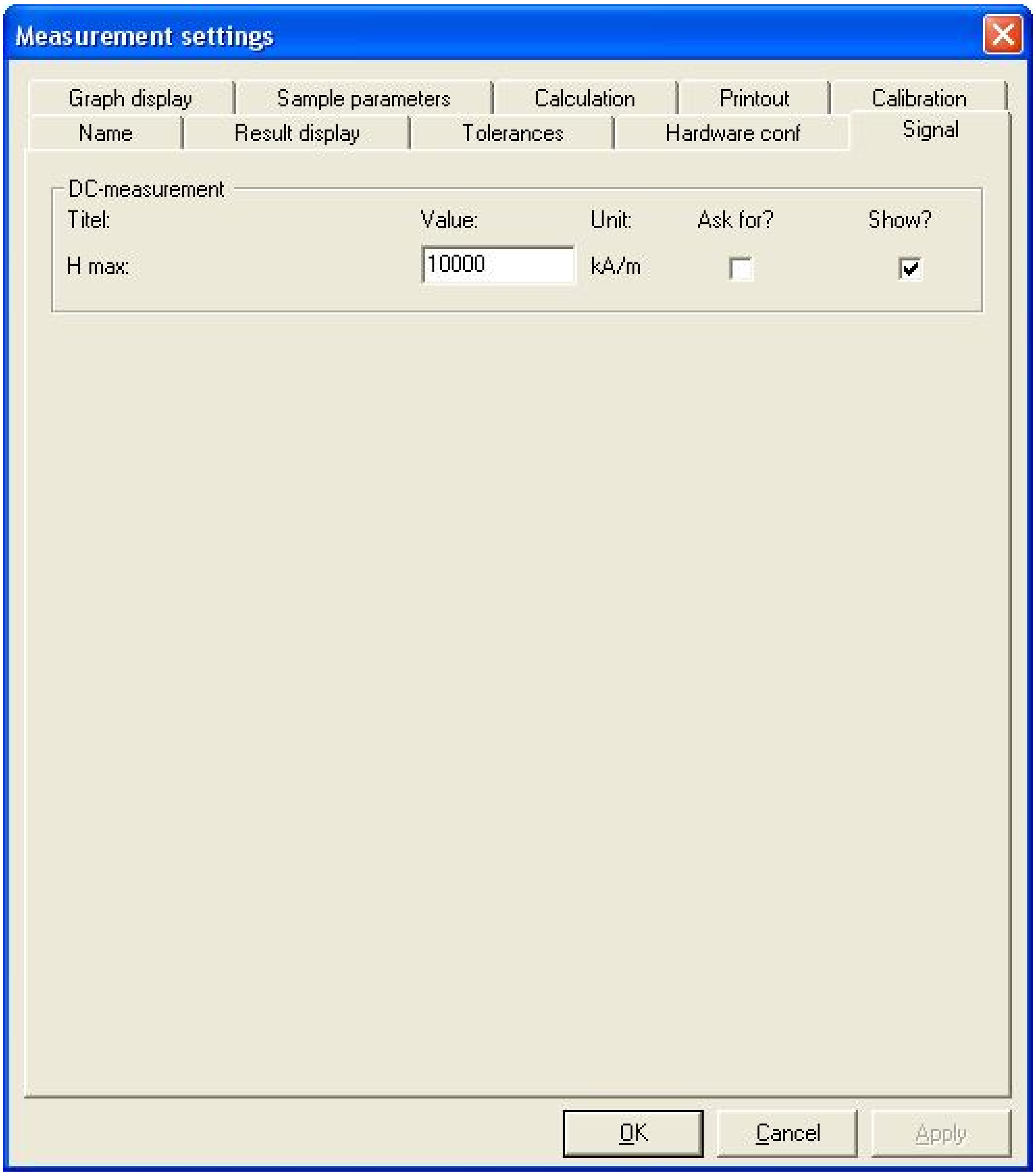
There are also differences in **Hardware configuration**:



Hardware configuration settings DC

Since maximum output voltage is unknown, the user has to select the input amplification here. If amplification is set too low, after measurement a warning will be given, asking the user to set other amplification and maybe repeat the measurement to achieve better resolution and lower noise.

And there are differences in **Signal**:



Signal settings DC

Here only one measurement is possible. Maximum field strength **H max** has to be entered here.

9. IEC 60404-6 ring measurement:

9.1 Theory of operation

With the Ring test device in general 2 different measurements are possible:
- Measurement with given H (field) signal.
- Measurement with given B (induction) signal.

Measurement with given H signal is performed with sinusoidal H but other signal shapes are possible. Since field strength H is relative to primary current I_{Pri}, a sinusoidal I_{Pri} is needed. As parameter the maximum field H_{Max} is given.

Measurement with given B signal is performed with sinusoidal B but other signal shapes are possible. Since field strength B is the integral of secondary voltage U_{Sec}, a sinusoidal U_{Sec} is needed. As parameter the maximum field H_{Max} or the maximum induction B_{Max} are given.

The special situation of using only 1 primary winding leads to the problem of having an ohmic resistance of nearly zero as well as an induced voltage of only some mV or even µV. These small voltages cannot be regulated with sufficient resolution and also these voltages are disturbed by noise of the power stage which is also in the range of mV.

To increase the voltage in the system, the ring test device has selectable resistors in primary path of 0.1 to 200 Ohms. These resistors are also used as shunt resistors for more accurate primary current measurement. The shunts are set to get a voltage of 1.25 to 2.5 V at expected current.

Now the measurement system always fulfils the conditions of the following formula:

$$U_{Pow} = I_{Pri} * R_X + I_{Pri} * R_{Sh} + U_{Pri}$$

With
U_{Pow} = Output voltage of the Power unit
R_X = Unknown resistance of plugs and cables
R_{Sh} = Shunt resistance
U_{Pri} = Primary induced voltage = $U_{Sec} * N_1/N_2$
N_1 = Number of primary turns = 1
N_2 = Number of secondary turns

For a given I_{Pri} the UMMS signal processor must create a D/A signal (that is relative to U_{Pow}) of such a shape that the formula is fulfilled. This is done by parametric signal adaption.

For measurement with sinusoidal B the adaption becomes much more complicated.
With given H_{Max} only the peak value but not the shape of I_{Pri} is known. U_{Pri} must be of sinusoidal shape but amplitude is unknown.
With given B_{Max} neither the peak value nor the shape of I_{Pri} are known. U_{Pri} must be of sinusoidal shape with known amplitude, but since at the beginning of adaption U_{Pri} is not sinusoidal, it is necessary to integrate U_{Pri} (or U_{Sec}) internally to calculate actual B.
Additionally U_{Pri} is extremely small and full of noise. Thus a direct parametric adaption of U_{Pri} is not possible.
Therfore the new method of direct hysteresis adaption has been developed. This method is very powerful.

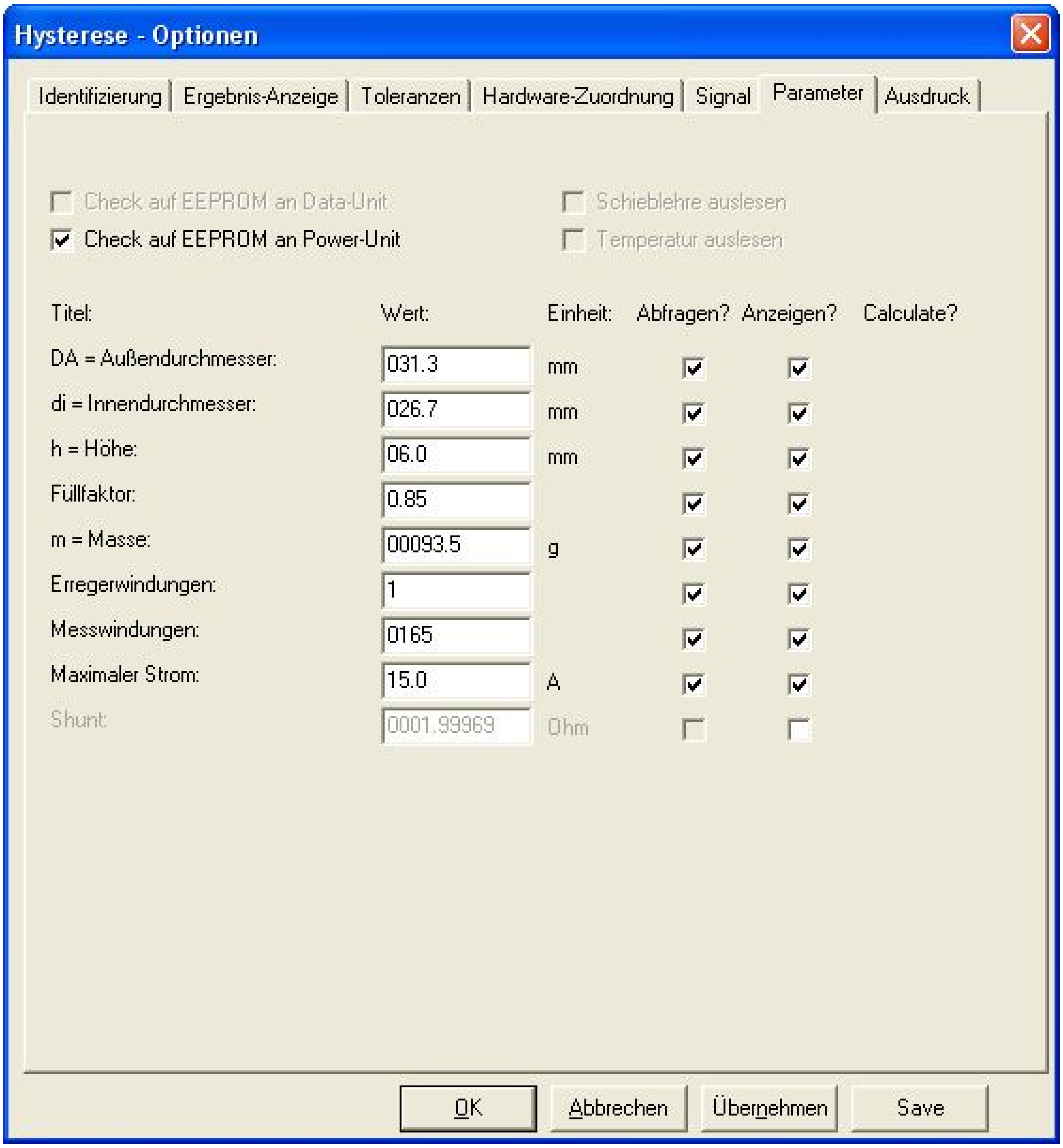
9.2 How to perform a measurement

Look at **7.2** to load settings or create new settings.

If all settings are known and have been tested before, measurement can be started immediately by **Start Measurement**.

To control or change settings select **Show actual settings**. This opens the measurement settings. Most cards of the settings are the same as in chapters before. Please look there for more information. Special settings of the Ring test device are explained in the following:

First of all the ring **parameters** must be entered:



Parameters of the test ring

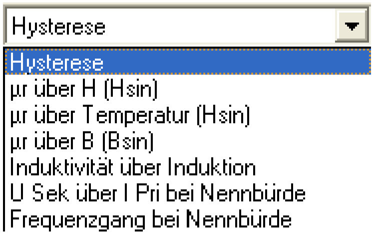
Mechanical values of the ring as outer diameter, inner diameter, height, fill factor, weight and number of turns of secondary coil for measurement are entered.

The number of primary windings is normally 1. Only for very large rings where 20 A may not be enough to create the desired field a value of 2 or 3 may be entered. Be sure to really use the entered number of turns.

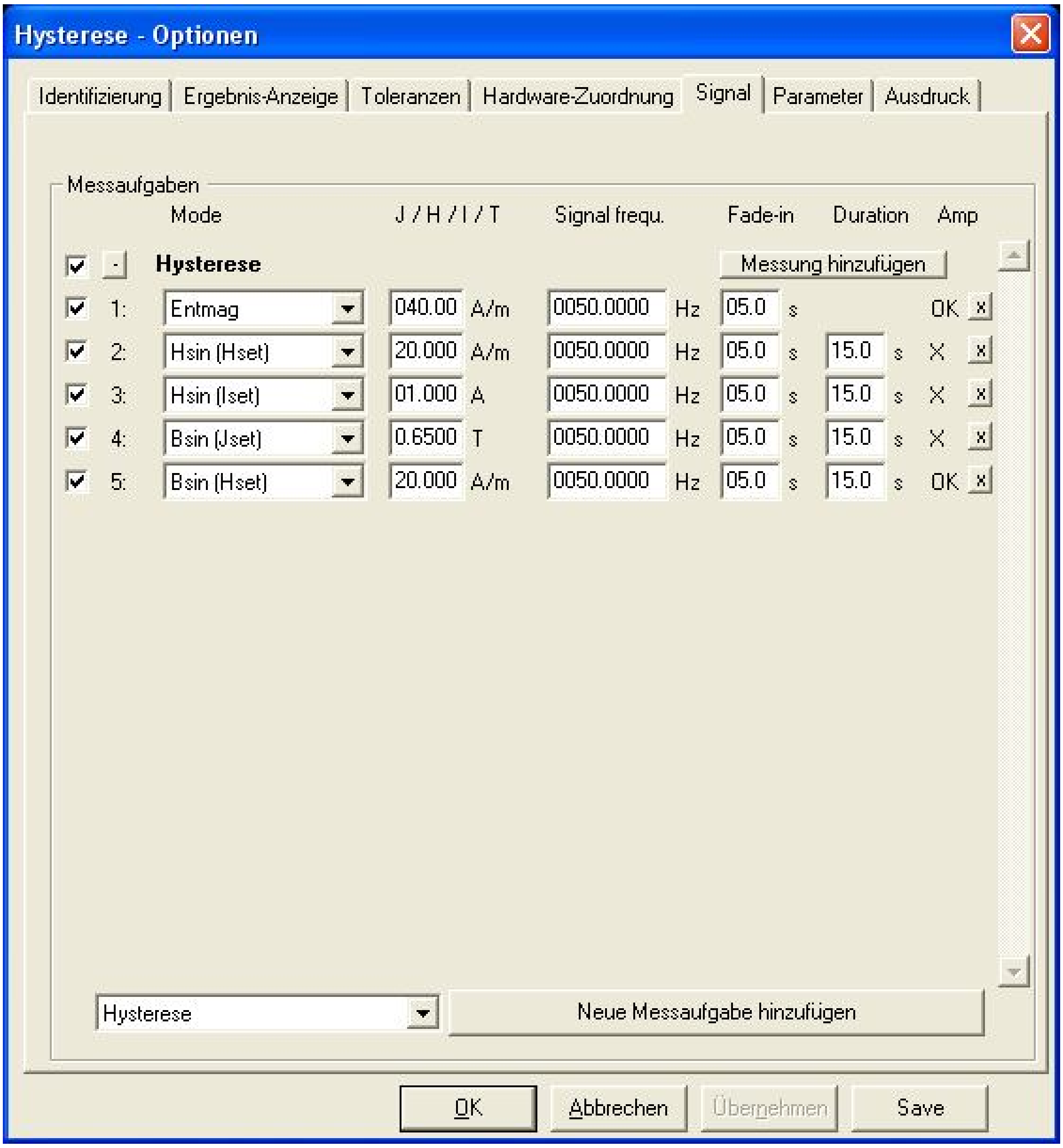
The maximum current is entered for safety reasons. If a B_{Max} is given, that is not reachable under actual conditions, the UMMS will try to reach this B by increasing the current until this maximum current value is reached.

Ask for? will open an input window before measurement to enter these values by hand.
Show? will show these values as parameters on screen.
Here also the shunt used during measurement can be shown.

The **signal** card defines all measurements that will be performed in one run with this ring.
Several different types of measurements and evaluations can be predefined.
To create the list, measurements can be added by **Add new measurement**.



Add new measurements



List of measurements to be performed with the ring

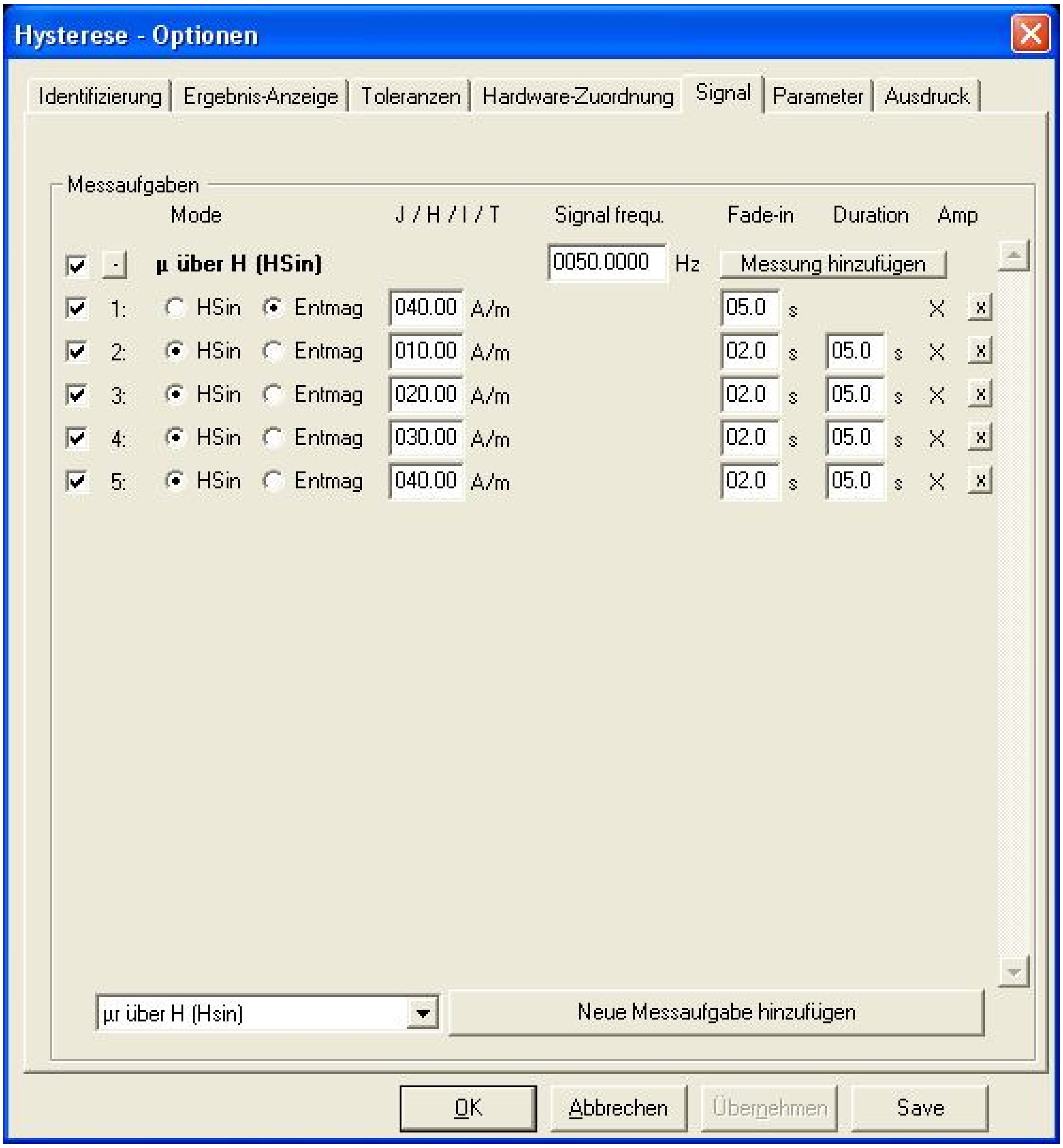
With **Hysteresis** different single measurements are created that are not evaluated as a group.
Possible choices are:

Demagnetisation is a sinusoidal signal fading in from zero to selected amplitude at selected frequency. After fade in the signal fades out to zero with same speed.
The maximum field, signal frequency and duration of fade in are entered.

Hsin is a hysteresis with sinusoidal H signal. Given H_{Peak} or given I_{Peak} can be selected and entered. Fade in time to reach amplitude and duration for signal adaption are entered. Accuracy of adaption depends on time. To find the best compromise between measurement duration and accuracy of the result may need some experience and tests.

Bsin is a hysteresis with sinusoidal B signal. Given J_{Peak} or given H_{Peak} can be selected and entered. Fade in time to reach amplitude and duration for signal adaption are entered.

Amp OK or **X** shows if the UMMS knows which amplification is necessary for U and I sample inputs or not. If amplitude is unknown, the UMMS may repaeat this measurement once or several times until perfect amplitude has been selected. This selection is stored to start the measurement with correct amplifications next time.

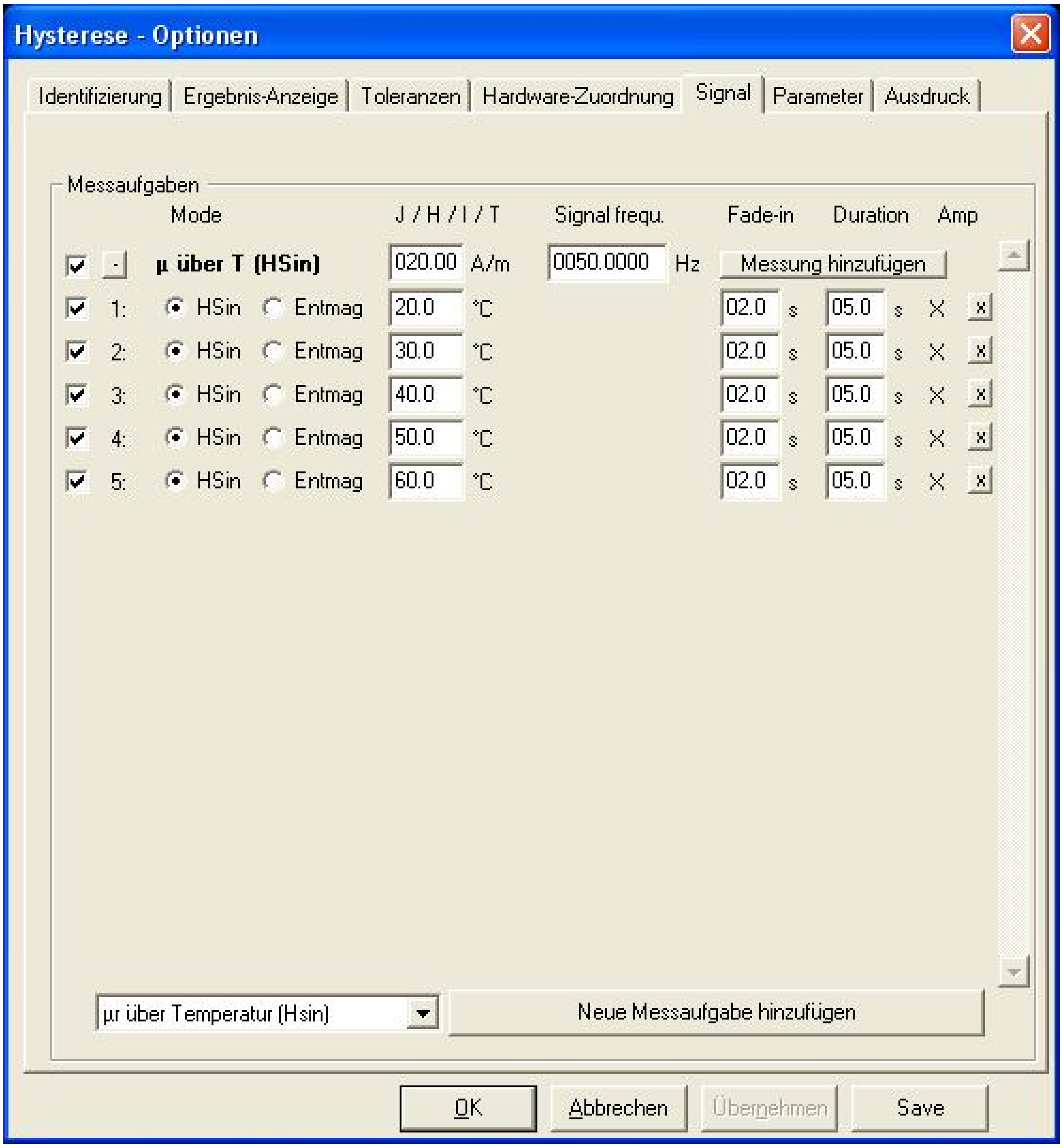


Measurements µ over H (Hsin)

μ over H (Hsin) creates a group of measurements with the same frequency and the special evaluation for μ_r at maximum field of each hysteresis. As a special result a graph showing μ_r over H of this complete group of measurements will be shown.
It may be necessary to select a demagnetisation before first hysteresis.

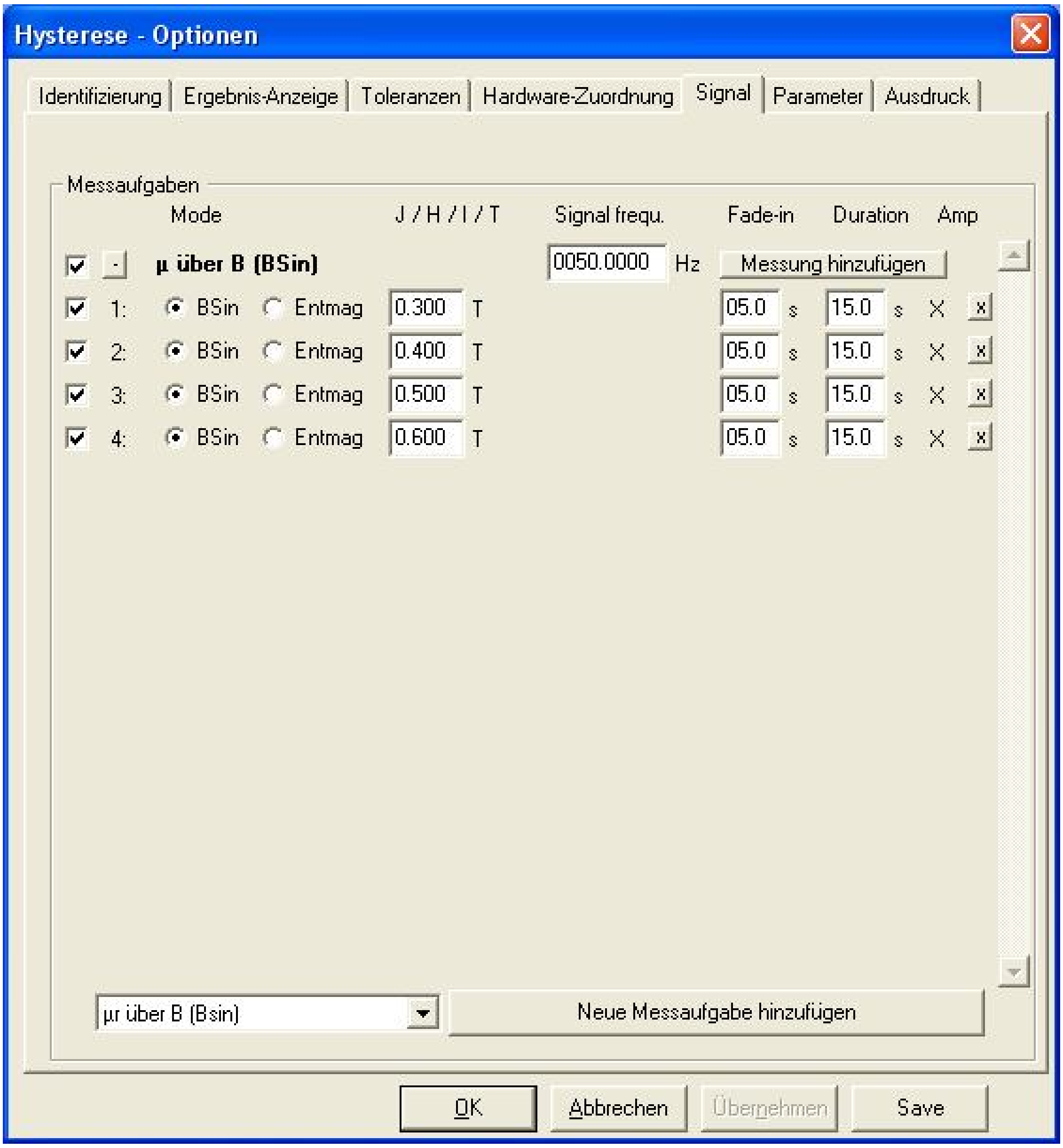
μ over T (Hsin) creates a group of measurements with the same frequency and amplitude but at different temperatures with the special evaluation for μ_r at maximum field of each hysteresis. As a special result a graph showing μ_r over T of this complete group of measurements will be shown.
It may be necessary to select a demagnetisation before first hysteresis.

This measurement is not finally implemented yet since communication and control of temperature still has to be dicussed.



Measurements μ over T (Hsin)

µ over B (Bsin) creates a group of measurements with the same frequency and the special evaluation for μ_r at maximum induction of each hysteresis. As a special result a graph showing μ_r over B of this complete group of measurements will be shown.
It may be necessary to select a demagnetisation before first hysteresis.

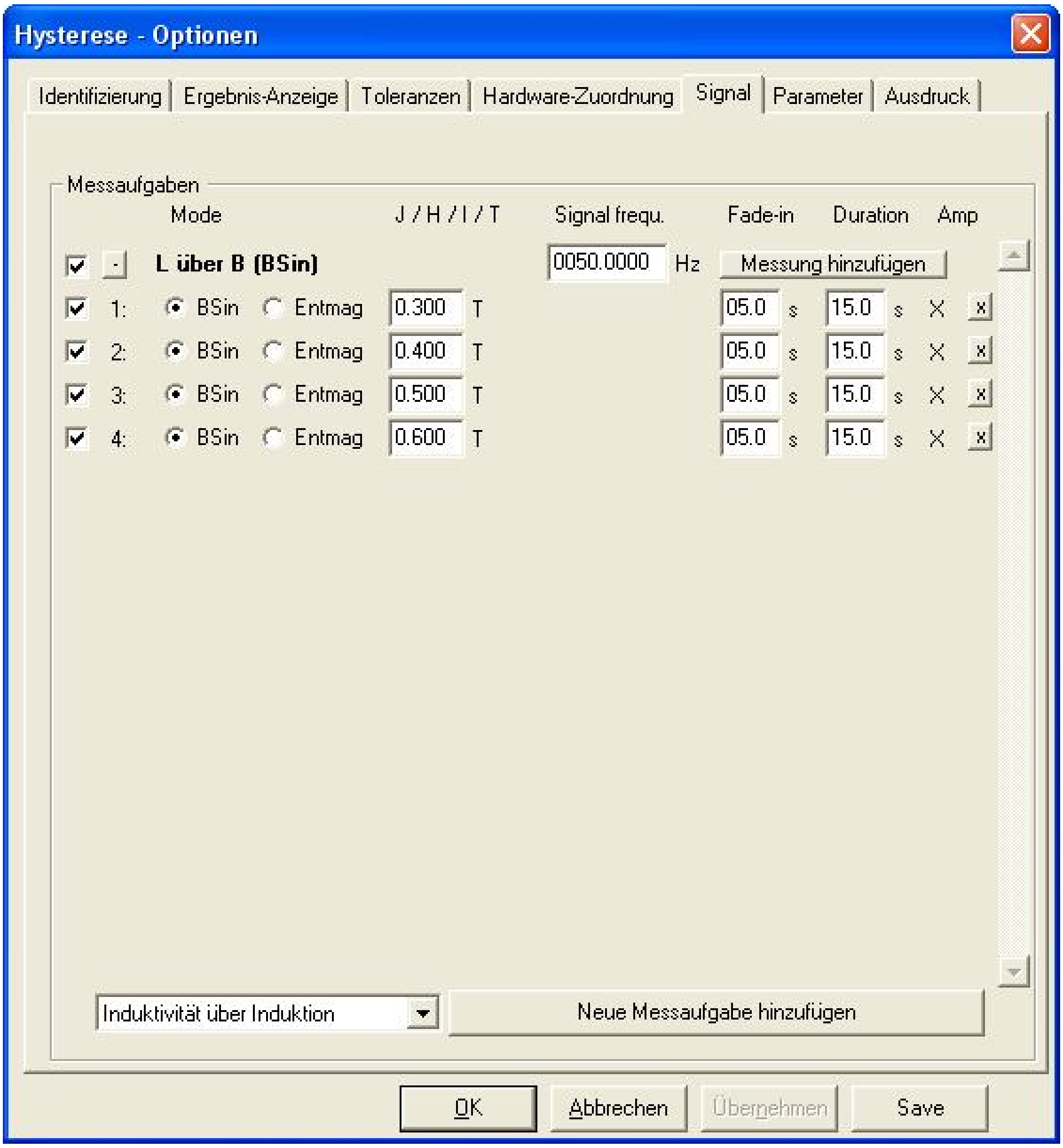


Measurements µ over B (Bsin)

L over B (Bsin) creates a group of measurements with the same frequency and the special evaluation for inductivity L of each hysteresis. L is the inductivity seen from the single primary winding.

L is nonlinear and thus different over the hysteresis. Here L is defined as $U_{rms} / (2*\Pi*f*I_{rms})$.
Thus L is the effective inductivity drawing at this frequency and this voltage the same current as a linear inductivity L would do.

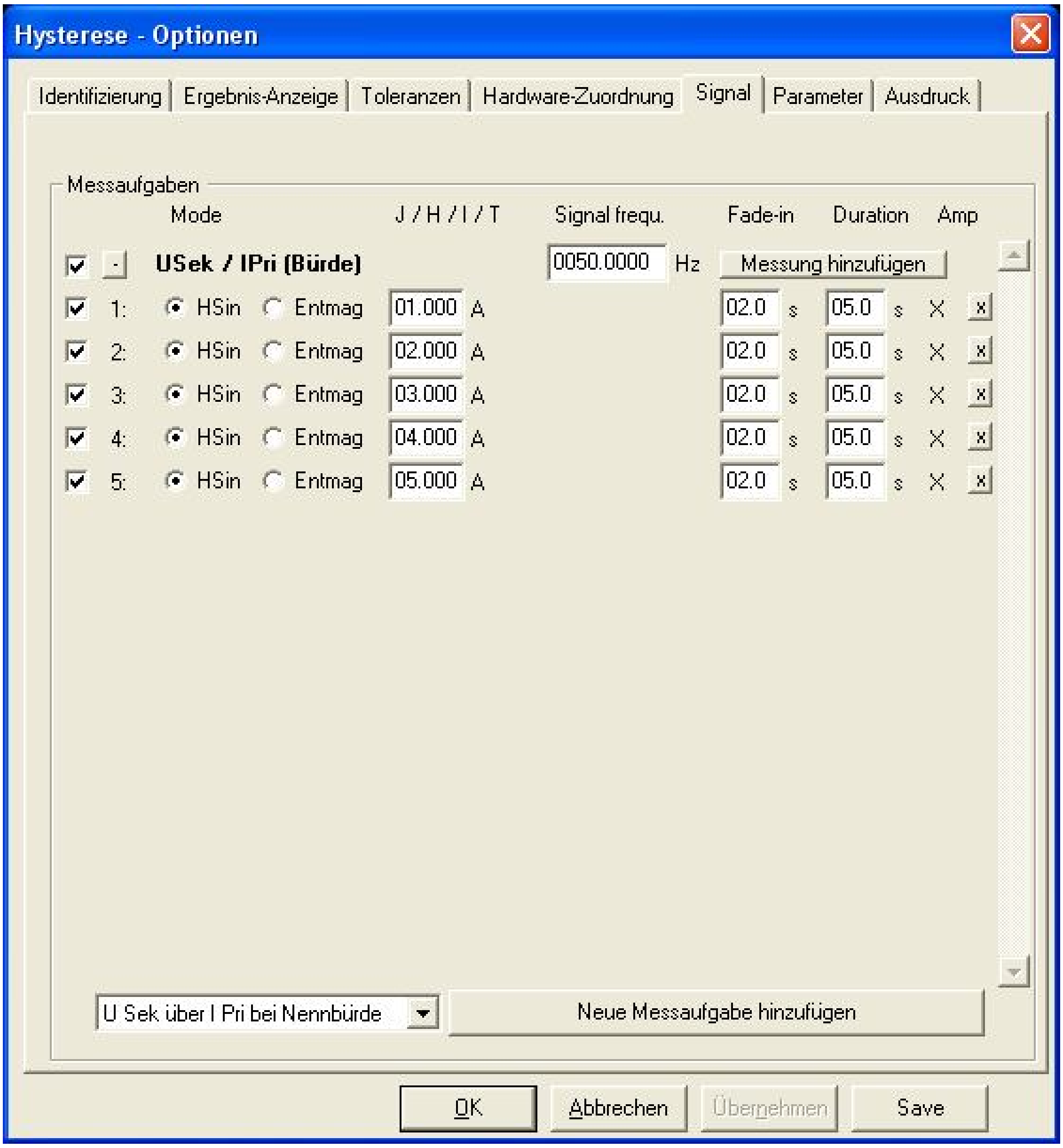
As a special result a graph showing L over B of this complete group of measurements will be shown.
It may be necessary to select a demagnetisation before first hysteresis.



Measurements L over B (Bsin)

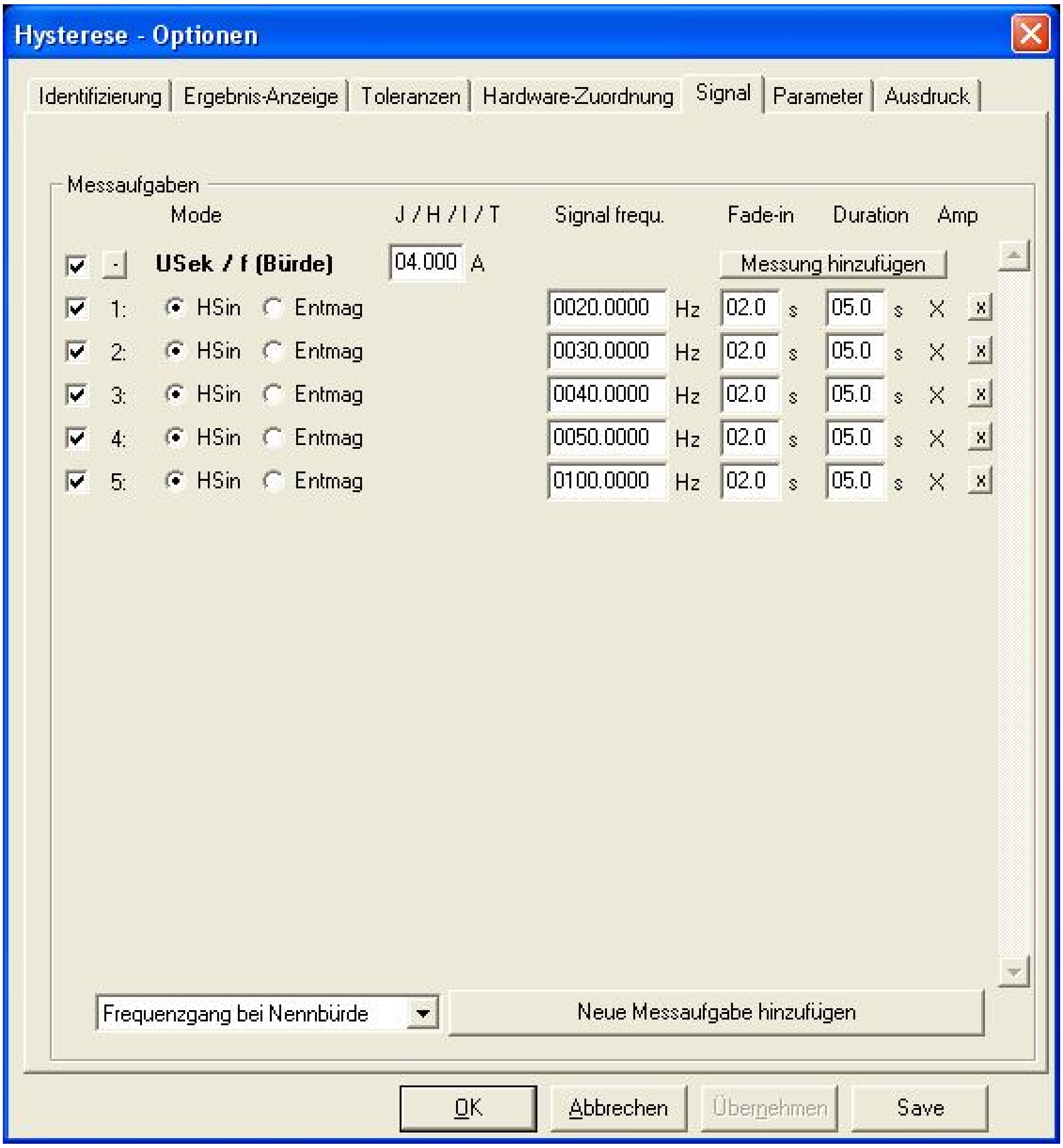
U_{Sec} over I_{Pri} (Load) creates a group of measurements with the same frequency and the special evaluation for peak of U_{Sec} of each hysteresis. Special condition is a load of an ohmic resistor at secondary coil. This load results in a current in the secondary coil reducing the induction B and U_{Sec}.
For this measurement the relay is set to connect the secondary coil to the load terminals.

As a special result a graph showing U_{Sec} over I_{Pri} of this complete group of measurements will be shown.



Measurements U_{Sec} over I_{Pri} (Load)

U_{Sec} over f (Load) creates a group of measurements with the same current but different frequencies and the special evaluation for peak of U_{Sec} of each hysteresis. Special condition is a load of an ohmic resistor at secondary coil. This load results in a current in the secondary coil reducing the induction B and U_{Sec}.
For this measurement the relay is set to connect the secondary coil to the load terminals.



10. Error sources

Accuracy of measurement:

At normal measurements all results should be within 0.2% repeatability. Form factor must be within 1%. Absolute accuracy should always be within 1%.

But it is not possible to predict certain accuracy for a special measurement under all conditions.

Operating range is very large. Since for grain oriented steel at 100mT maybe a maximum of 5A/m (7mA) is needed, other measurements are made with nearly 15.000A/m (20A). This is a range of factor 3000. Of course noise is larger relative to signal size with the smaller signal. Thus accuracy is reduced.

On the other hand measurements with large signals or high frequencies can meet the limits of the amplifier, making it impossible to reach the desired accuracy of regulation.

If the J/H curve is not set correctly in settings and thus amplification is not set to optimum value, accuracy will be reduced.

At small polarisations voltages are very small. If measurement is performed at 50Hz and mains voltage is also 50Hz, some 50Hz noise may be induced to the coil resulting in 2 visible distortions of the hysteresis. Then try to keep more distance to mains cables.

Some special measurements are more critical.

If at grain oriented steel maximum J is set to the polarisation where saturation just starts to be visible at the hysteresis, this measurement is very sensible to DC offset errors. The current overall is still small but very small changes of DC voltage will change current very much. So it is difficult to get a symmetric hysteresis.

At higher frequencies the sheets start to swing mechanically with measurement frequency. This produces remarkable sound. At special frequencies this can lead to a mechanical resonance effects. In this case the movement of the sheets induces an unwanted voltage to the coils that in worst case can corrupt the measurement. There is not much to be done against it.

Most important error messages:

Actual measurement settings not saved! *Open new settings nevertheless?* *Yes No*	At opening new settings
Actual measurement settings not saved! *Load new settings nevertheless?* *Yes No*	At loading settings
No printer installed! *Install new printer now?* *Yes No*	At printing
Amplification of the last measurement is different to the settings. *Use last amplification?* *Yes No*	Only for DC measurement

Copy last amplifications to the settings? *Yes No*	Only for DC measurement
No EEPROM at Power Unit! *OK*	Epstein frame not connected or switch not set
Wrong yoke at Power Unit! *Ok*	Measurement device is not an Epstein frame
Measurement active! *Ok*	Measurement started during measurement. Error not correctly handled. Close program and start again.
Offset calibration error! *Ok*	Could not calibrate Power unit offset at amplification 512
Air flux factor too big! *Ok*	At measurement start. Contact manufacturer
U Sec factor too big! *Ok*	At measurement start. Contact manufacturer
Card placement changed! *Perform new calibration!* *Ok*	After changing a board inside the Data unit
Card placement changed! *New calibration is recommended!* *Ok Cancel*	After changing a board inside the Data unit
No calibration available! *Perform calibration!* *Ok*	Calibration file not found
Read error EEPROM Data Unit! *Ok*	EEPROM at TES board not readable
Read error EEPROM Power Unit! *Ok*	EEPROM at yoke connector not readable
Not able to connect to the Data-Unit at USB port! *Ok*	USB found but no data transmission. Close program and exit program. Start again.
Failure to get card positions! *Ok*	Internal Error of Data Unit. Contact manufacturer
Not able to read icon! *Ok*	Configuration Switch Unit. Check file type and accessibility

11. Technical data

Data Unit
Basic system: Signal processor controlled digital signal generation and sample system.
1 MB basic-RAM, D/A-converter 16 Bit / 1 MHz, 1MB D/A RAM.
Graphic display, 19", 3 height units, 230 V 400W
Weight: 11.5 kg
Additional boards:
2 x A/D card low, 16 Bit / 1 MHz, 1MB A/D RAM for primary current and voltage
1 x A/D card high, 16 Bit / 1 MHz, 1MB A/D RAM for secondary voltage
1 x USB card USB 1.1 10 Mbit/s for connection to PC
1 x Parameter card (Temperature, EEPROM, Caliper)

Power Unit
4 quadrant amplifier for field generation. 200 V / 10 A or 100 V / 20 A switchable.
Voltage source or current source (DC measurements) switchable.
Digitally controlled, short circuit proof, temperature regulated.
Full power bandwidth 10 kHz.
Graphic display, 19", 4 height units, 230 V 2200W
Weight: 42 kg

Switch Unit
Automatic switch for up to 4 measurement equipments.
Weight: 10 kg

Epstein frame according to IEC 60404-2 but with an internal height of 2 cm.
Without mutual inductor.
Magnetic length: 94 cm
Weight: 14.5 kg

Epstein frame according to IEC 60404-2 but with 340 primary and 340 secondary windings.
Without mutual inductor
Magnetic length: 94 cm
Weight: 13.5 kg

ECKEL UMMS

Universal Magnet Measuring System

Maintenance Manual

Index

At normal use the UMMS doesn’t need much maintenance. The UMMS is designed for long life maintenance free operation.

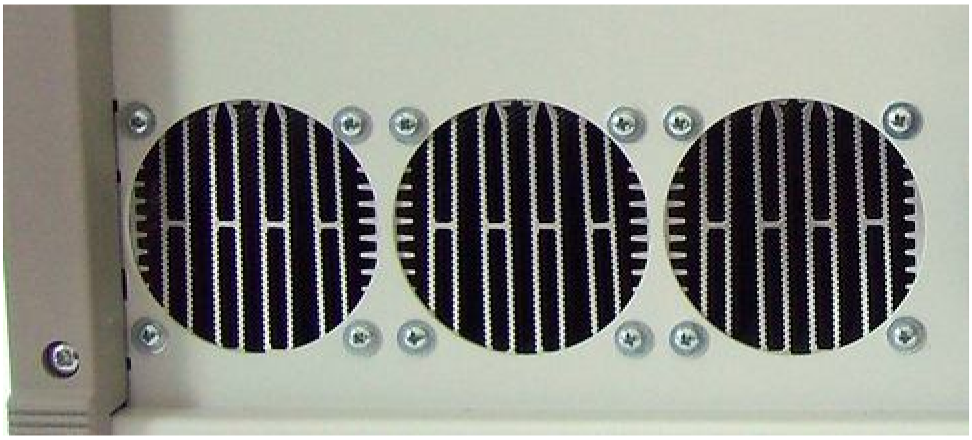
Anyway sometimes it may be necessary to care about some problems.

Cleaning the Units:

If necessary the units can be cleaned. Disconnect the mains power connection before cleaning. Use a soft slightly humid cloth to clean. Do not use aggressive liquids or abrasive materials for cleaning.

Take care not to let water or metal parts enter the units by ventilation slots.

If air is very dusty, it may be necessary to clean the inside of the heat sink of the Power Unit.
If temperature of the Power Unit increases more than normal, it is an indication that cleaning is necessary.
For cleaning switch off the Power Unit and disconnect the mains cable. Then blow compressed air directly in the hot air exit at the backside of the unit.



Air exit at the backside of the Power Unit

Also look at the 2 small fans at the backside of the Data Unit. If dust is visible inside the fans, also clean them softly by compressed air.

Fans at the backside of the Data Unit

Adjustment of the pressure force at the Epstein frame:

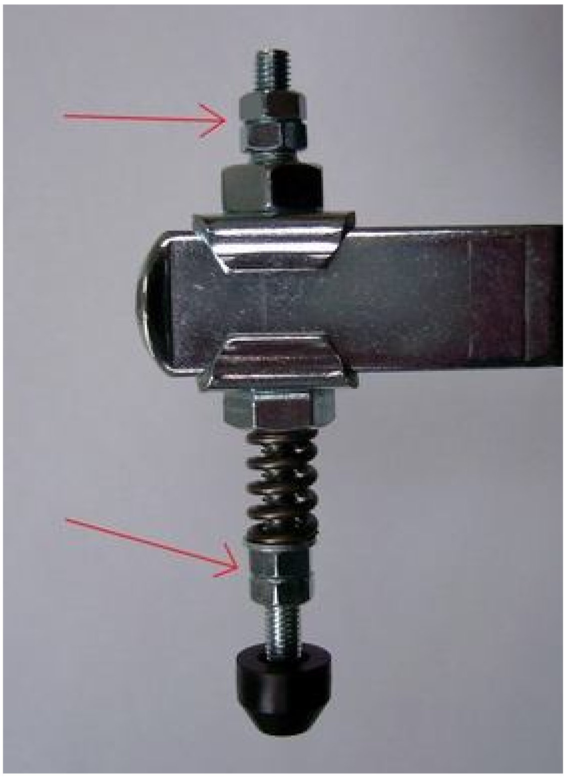
After some time or if always more then 500 g of steel are used for measurement, it may be necessary to adjust position and pressure of the levers at the Epstein frames.

By changing the position of the lower nuts upwards, more pressure will be generated. Please remember that the IEC 60404 norm allows only 1 N of pressure though slightly higher pressure does not affect the measurement.

Anyway pressure must be high enough to ensure full contact of the steel sheets inside the frame.

Changing the position of the upper and lower 2 nuts in the same way changes position of the punch without changing the pressure force.

Be sure to fix the nuts properly.

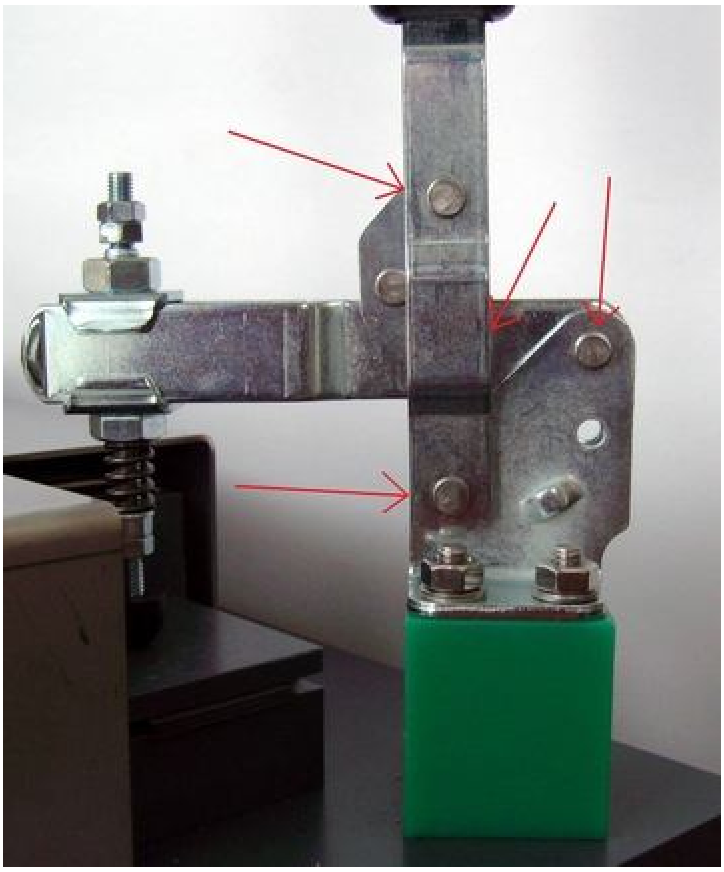


Adjustment of position and pressure

Oiling the levers at the Epstein frame:

After longer use it may be useful to oil the levers of the Epstein frame at the marked positions.

Use some high quality fine machine oil.



Adjustment of position and pressure

Changing the firmware:

If it is necessary to change the firmware of the UMMS, pull out the power cable, screw out the 4 screws from the 2 plastic covers at the backside of the unit. Remove the covers and lift up the top cover of the unit.

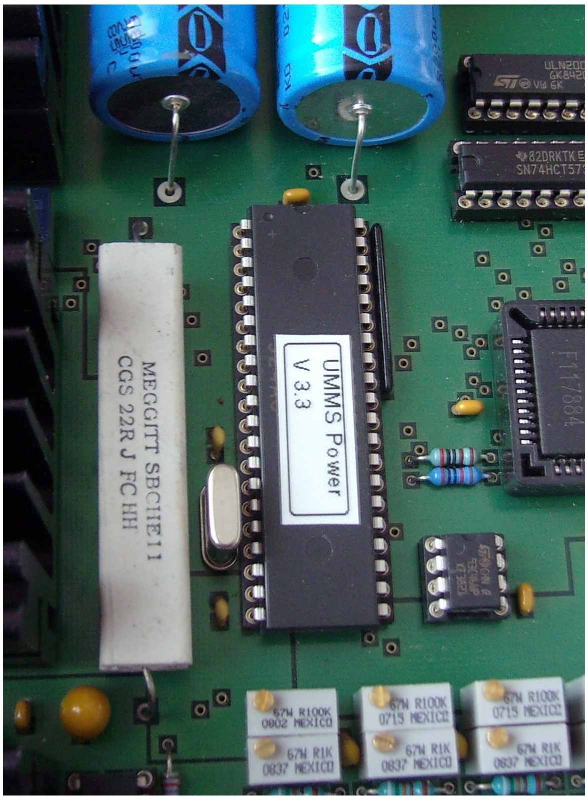
Screws for opening the units

Data Unit:
In the centre of the UMMS Data Unit there is a special zero-force socket for the EPROM. Lift up the lever at the left side and change the EPROM. Be sure to enter it in correct direction. Then push down the lever again to close the socket.

Program EPROM inside the Data Unit

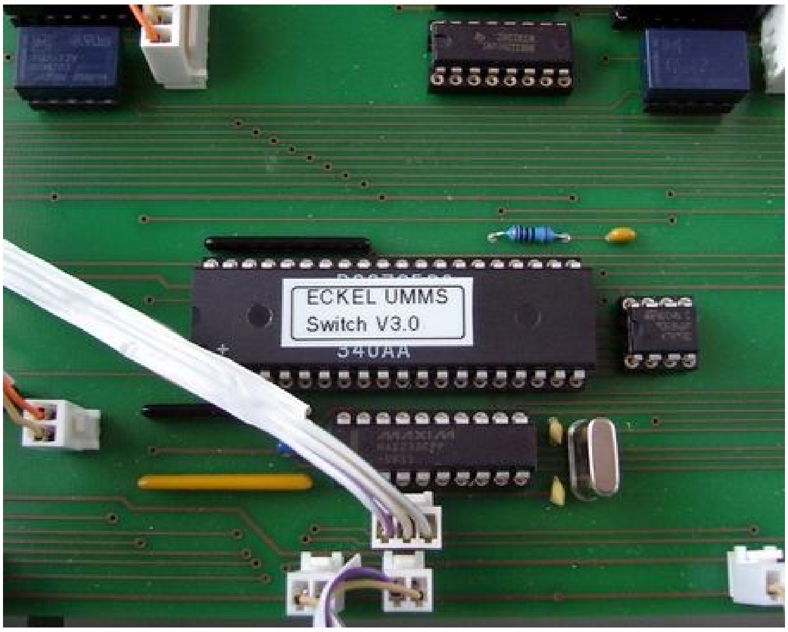
Power Unit:

The Power Unit does not have a zero-force socket since changing the firmware of the Power Unit is not expected. Anyway it is possible to change the processor. Therefore the processor must be pulled out from the socket without damaging the board. Then enter the new processor in the same direction. Be sure that all legs are correctly entered in the socket and carefully apply enough pressure to push the processor down until contact with the socket.



Processor inside the Power Unit

Switch Unit:
For the Switch Unit it is the same procedure as for the Power Unit.



Processor inside the Power Unit

Replacing Fuses:

Data Unit:

The fuses of the A/D Converter board protect the input amplifier. They can be blown if the divider on the board is not set but input voltage is higher than 36 V. Normally this will not happen since the Software always calculates before measurement if the divider is necessary or not.

If the fuses are blown, always replace them with the same value 50 mA Fast 5 x 20 mm. Serious damage may occur if fuses are not able to protect the input due to higher values.

Fuses at the A/D converter board

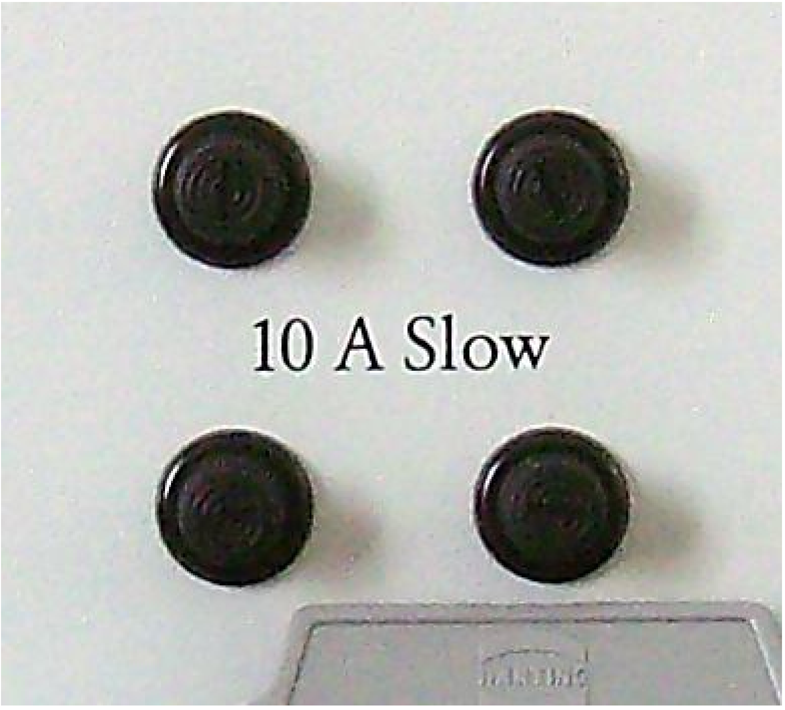
View of a fuse

The mains input is protected by an inbuilt fuse. Fuse value is 2 A Slow. Pull out the drawer at the mains input to replace the fuse. There is a spare fuse in the front part of the drawer. Only the fuse at the backside of the drawer is active. A hardware defect is expected if one of the fuses is blown.

Mains input with fuse drawer

Power Unit:

The Power Unit has 4 single fuses at the backside. These fuses protect the 4 outputs of the power transformer. If a fuse is blown the power unit will not start due to a lack of power voltage. The fuse can be replaced with the same type 10 A Slow but a hardware defect is expected if one of the fuses is blown.



Fuses at the backside of the Power Unit

The mains input is protected by an inbuilt fuse. Fuse value is 10 A Slow. It is the same procedure as for the Data Unit.

Mains input with fuse drawer

Switch Unit:

The mains input is protected by an inbuilt fuse. Fuse value is 2 A Slow. It is the same procedure as for the Data Unit.

Mains input with fuse drawer