SENIS AG

MAGNETIC FIELD MAPPING SYSTEM
MMS-1-R
Software version 5

- USER'S MANUAL -

Revision 5.2 (N.M.)
September 2012

Senis GmbH
Grabenstrasse 25
6340 Baar, Switzerland

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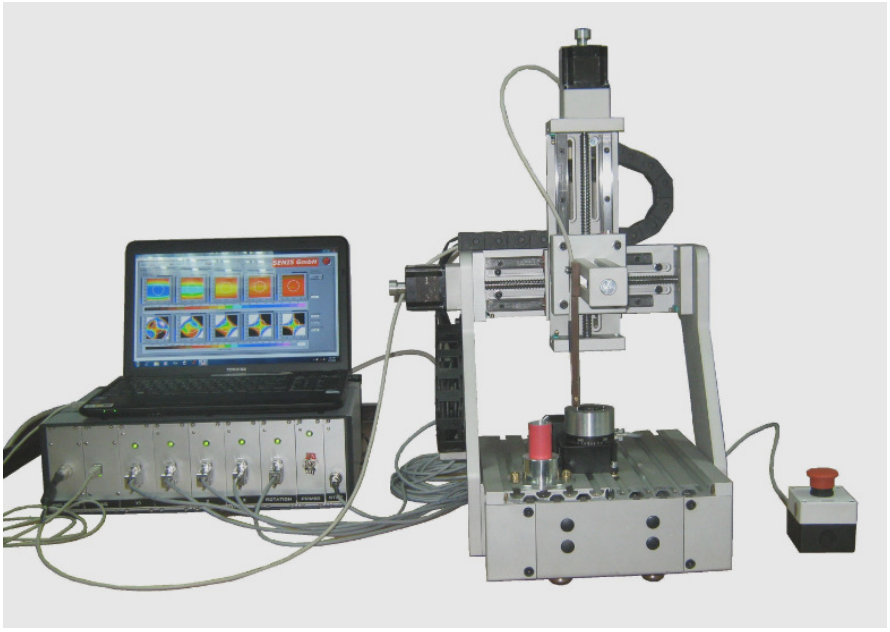


Figure 1: MMS-1-R scanning system

Figure 2: MMS-1-R scanning system with a protective cabinet


SAFETY PRECAUTIONS:

- Do not connect the device to a power source other than the one specified;
- If you discover any abnormalities while checking the device, before operation or during operation, stop using the device immediately;
- Do not disassemble or modify the device. Only manufacturer approved technicians are allowed to repair, disassembly and do device modifications;
- Remove the power plug before carrying out maintenance and checks;
- Do not use any cables other than the ones specified;
- Do not subject the device to impacts;
- Keep the top of the device and inside of the cabinet clear of all objects; only magnets under test allowed inside of the cabinet;
- Use the device in a place where it can be maintained in a horizontal position;
- When moving the device, first lift and then carry, do not move the device by pulling the cables;
- When removing the plug, hold and pull the plug itself; do not remove it by pulling the cable;
- Do not apply undue force to plugs, cables or the sensor;
- Do not unplug any cables while measurement is in progress; always stop the program before unplugging the cables;
- Do not touch the system or magnet under test during the measurement;
- Do not use abrasive means for cleaning the scanning surface;
- Do not scratch the scanning surface;

- **The laptop computer is not supplied with an antivirus program; before inserting any media into the computer, make sure that media is not infected;**

- **Do not open the cabinet door while the system is moving.**

FEATURES AND TYPICAL APPLICATIONS:

❖ Unique features:

- Color coded 3D and 2D isometric representation of the magnetic field;

- Magnetic angle measurement;

-Zeroes and Poles detection;

-User defined scanning path;

- SENIS 3-axis integrated Hall probe with a spatial resolution of 0.1mm;

- Measuring magnetic fields with accuracy better than 0.1%;

- Scanning spatial resolution down to 5µm;

- Easy to use software on any MS Windows platform;

- Direct report generation.

❖ Typical applications:

- Quality control of permanent magnets;

- Quality assessment production tool, for assemblies such as loudspeakers, multi-pole magnets, photocopier rollers and magnetic films;

- Development of magnet systems;

- AC magnetic field mapping;

- Applications in laboratories and in production lines, etc.

CONNECTIONS:

Block diagram of the Magnetic field mapping system is shown on Figure 3:

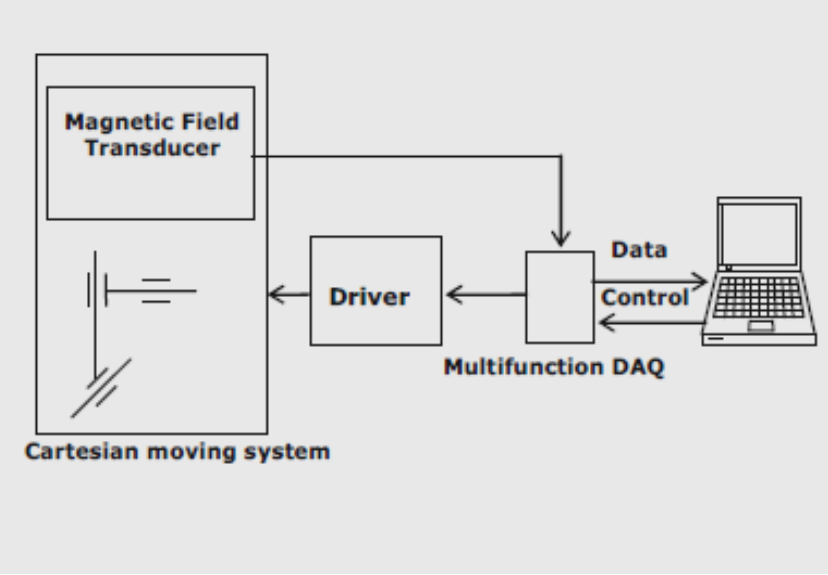


Figure 3: Block diagram of the magnetic field mapping system

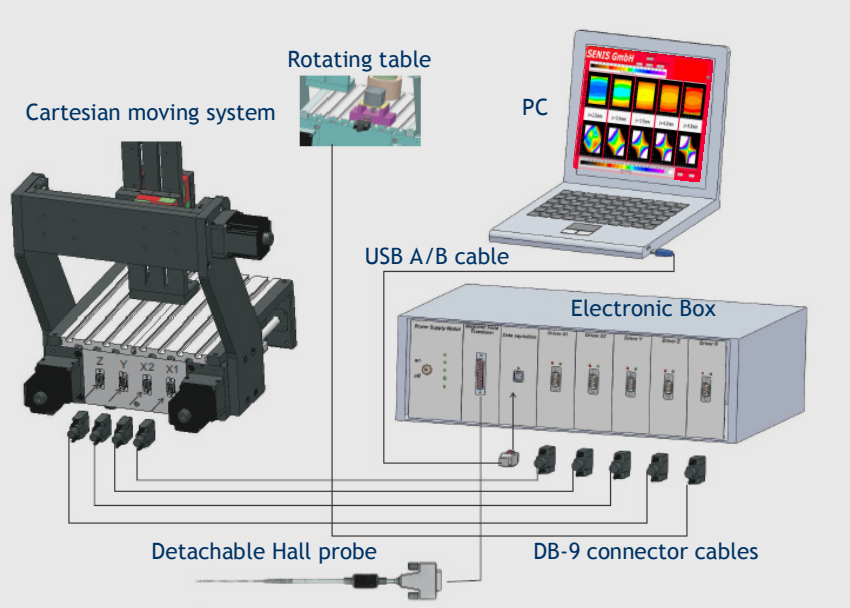


Figure 4: Connection diagram

Since most of the items are already connected inside the Electronic Box, only a few connections are needed to make the system fully operational. A proper way to connect the Electronic Box to the Cartesian

Moving System and to the PC is shown on figure 4 (connector positions on the Electronic Box may differ depending on the system type).

PACKAGE CONTENTS

1) Mechanical Probe Positioning System (MPPS1) includes: Magnetic Mapping System, Probe Holder, Zero Gauss Chamber, Zero Gauss Holder, Rotation Stage, Magnet Holder, Vertical Positioning Tool and Center Positioning Tool.

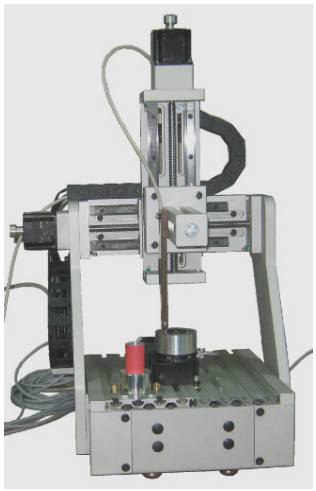


Figure 5: Mechanical Probe Positioning System (MPSS1)

2) Electronic box with a power cord (the front panel may differ depending on the system type).

Figure 6: Electronic Box

3) Computing System includes: a laptop computer with a Windows 7 operating system and a MMS-1-R software installation disk:

Figure 7: Laptop computer

4) Emergency stop:

Figure 8: Emergency stop switch

6) Cables with DB-9 female connectors (5 pieces);

7) USB A/B cable:

Figure 9: USB A/B cable

8) Hall Probe with the appropriate cable.

Make sure that all the cables are properly connected. Falsely connected cables can lead to incorrect measurement results, or can even cause system damage.

PREPARATION FOR USE:

After the system is unpacked, the user should visually inspect all system components. Pay special attention to the border switches located on both sides of each linear module of the mechanical probe positioning system.

POWER SUPLY:

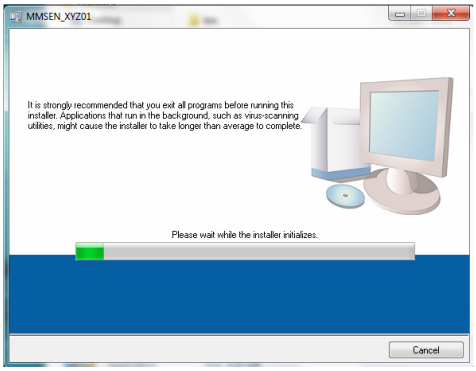
On the rear side of the Electronic Box is the IEC connector along with the electronic fuse (2.5A, 250V AC, 20x5mm). Plug the power cord into the IEC connector and into a wall socket. The laptop computer has its own power supply.

INSTALLING THE SOFTWARE:

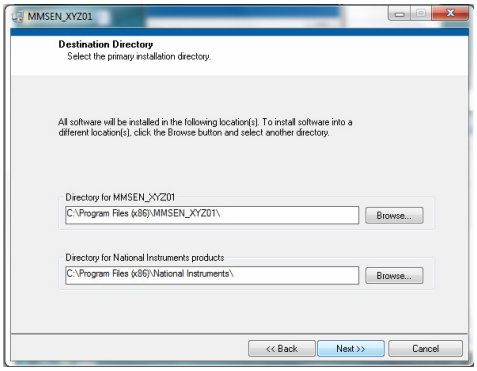
1) Insert the installation CD into the CD-ROM drive;

2) Go to Install -> MMSEN_XYZ01 Installer -> Volume;

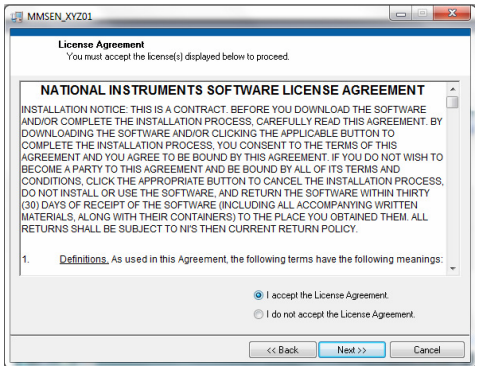
3) Double click on the setup icon;

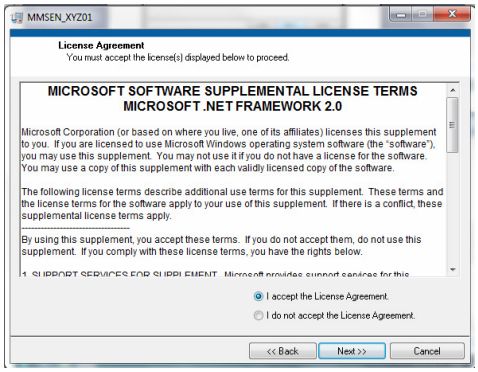


4) Select the destination directory; use the default settings (recommended); click on "Next";

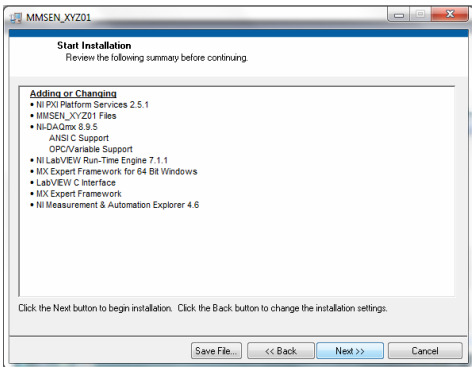


5) Accept both License Agreements; click on "Next";

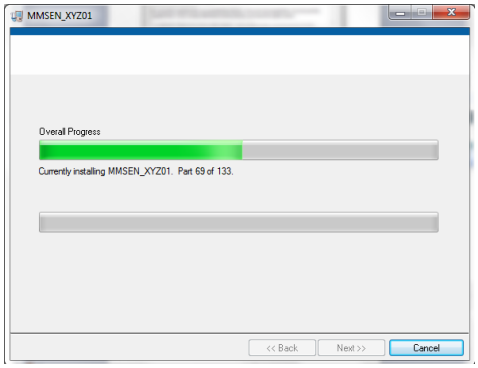


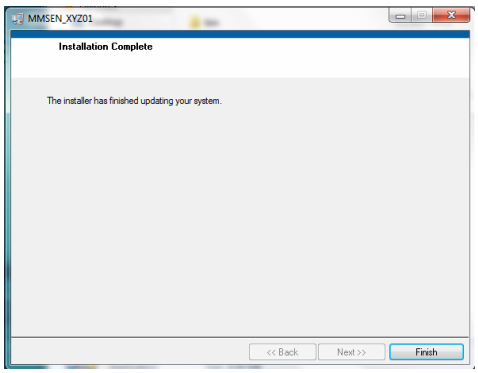


6) Start the Installation; click on "Next". The list of installable products may differ depending on the PC configuration;

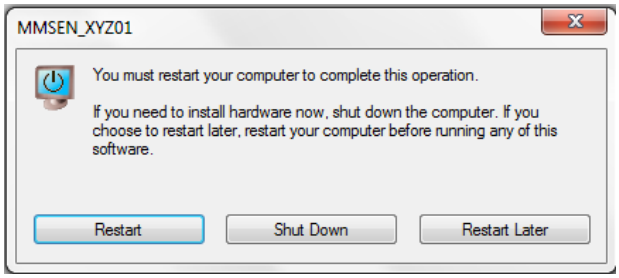


7) Wait until the installation completes; click on "Next"; the number of installed products may differ depending on the PC configuration;





8) After the installation, restart the computer if necessary;



FUNCTIONAL VERIFICATION:

After all the cables are properly connected, the user should perform a functional verification. Turn the computer on but do not start the program before turning on the Electronic Box. The green LED on the DAQ module should start flashing.

Before turning on the Electronic Box, make sure that the emergency switch is not closed. If this switch is closed, the Electronic Box can't be turned on. To turn on the Electronic Box put the on/off switch in the "on" position. Note that this doesn't turn on the Electronic Box and none of the LED indicators will turn on. When the on/off switch is in "on" position, push the green button to turn the system on. This is a precaution to protect the system. For an example, if there is a power blackout, the system won't turn on by itself after the power is restored, regardless of the switch position. When the system is on, one red and five green LEDs are on.

The Protective Cabinet (only with CE system version) door has a switch which ensures that the door is closed while the system is moving. When the system is turned on, a green switch light is on. When the door is closed, a yellow light starts flashing. If the door is open, the yellow light is off. While the system is moving, the door is locked and can't be opened. In this situation, the yellow light is fully on.

After turning on the system, the software can be started. Each time the program starts, it will check if any of the boundary switches are closed and open them if needed. This way the system is protected from damage. Next, follow the information given on screen.

To continue with functional verification, go to "Manual control" screen by selecting the appropriate tab. You will see eight arrows pointing in various directions, as showed on Figure 10:

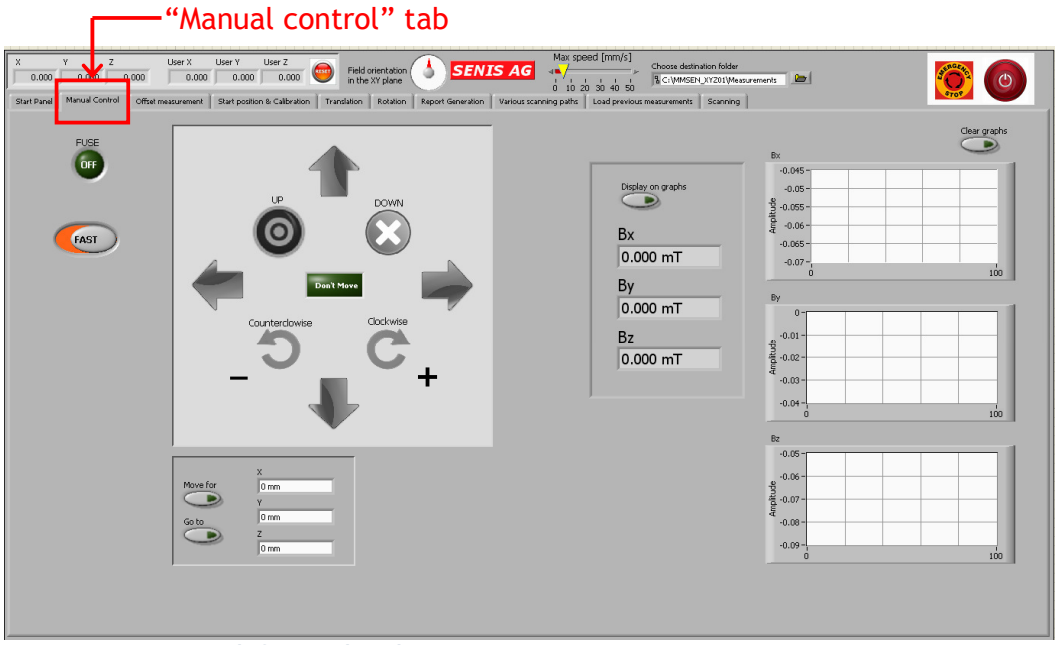


Figure 10: Manual Control Tab

Put the slider in the 5mm/s position. Click and hold on each of these arrow icons and make sure that the system is moving in the appropriate direction. Also, note that each linear module has two boundary switches. These switches are used as position reference, and as system protection. To make sure that the switches are working properly click and hold the each arrow command (except for rotation, because the rotation table has no boundary switches). Hold each arrow until the module moves to the boundary switch. Upon hitting the switch the module will fence off and move 5mm in the opposite direction. The fuse indicator will switch off and any further movement of the system will be disabled. Click on the fuse indicator to turn it on again and repeat the same procedure for the remaining arrow controls. Be very careful not to hit or damage the probe.

Emergency stop is a very important safety aspect and its functionality also needs to be checked. The role of the emergency stop switch is to immediately stop any system movement. Also, this switch terminates the power supply to the system and informs the software that unexpected circumstances have occurred. The system will not work unless the Emergency stop switch is properly connected to the Electronic Box.

To check if the emergency stop is working properly, activate this switch while the system and the software are on. The system will stop moving immediately, and all LEDs (except the flashing green one on the DAQ module) will turn off, indicating that the system has no power supply. Also an image like the one shown in Figure 11 appears on the screen.

Figure 11: On screen display indicating that the emergency stop is activated

To put the system back in the operating conditions release the emergency switch and turn on the system by pushing the green button again (note that the on/off switch is in the "on" position and there is no need to toggle it). After the power is restored, the software will wait for ten seconds at most before confirming the normal operating conditions.

To turn off the system, the user should first exit the program and then turn off the whole device. The only appropriate way to exit the program is by using the "Turn off" icon in the top right corner of the screen. This icon is disabled while any task is in progress.

Figure 12: Turn off icon

After exiting the program, turn off the hardware simply by moving the on/off switch to "off" position.

CALIBRATION:

The system software has few built-in functions for self calibration (such as offset canceling and position calibration). In further text the user can find detailed explanations on how to use these features.

The most important part of the system is the Hall probe, which measures the magnetic field. The Hall probe can be calibrated only by the manufacturer and the recommended calibration period is one year.

INITIAL SYSTEM SET-UP:

It is highly recommended that the system setup is performed by a certified SENIS AG engineer. If this is not the case, SENIS AG will not be held responsible for any system malfunction or damage. The set files on the installation disk will not match your system if the system was disassembled before shipping. Each time any system component is physically moved, the set files must be changed!

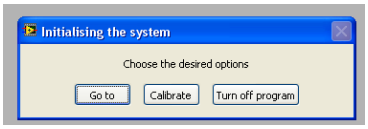
1) The on/off switch on the Electronic Box is used to turn on the system. Note that the system won't simply start by using this switch. When the switch is in the "on" position the user needs to push the green button on the Electronic Box to turn the system on.

2) Start the program MMS-1-R by double clicking on the desktop icon;

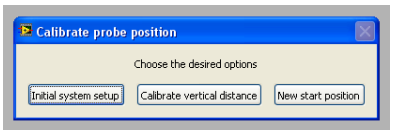
Figure 13: MMS-1-R Start screen

3) In order to prevent system damage, each time the program starts it automatically checks if any of the boundary switch is closed. If a boundary switch is closed, the system moves away from the switch and opens it. Note that the door of the cabinet must be closed in order for this to work. Otherwise, a message will appear on the screen asking the user to close the door.

4) System will give you a few options:



Choose "Calibrate" option. Another dialog box will appear:



Choose "Initial system setup" and continue as shown in this manual.

5) Select the "Manual Control" tab (Figure 14);

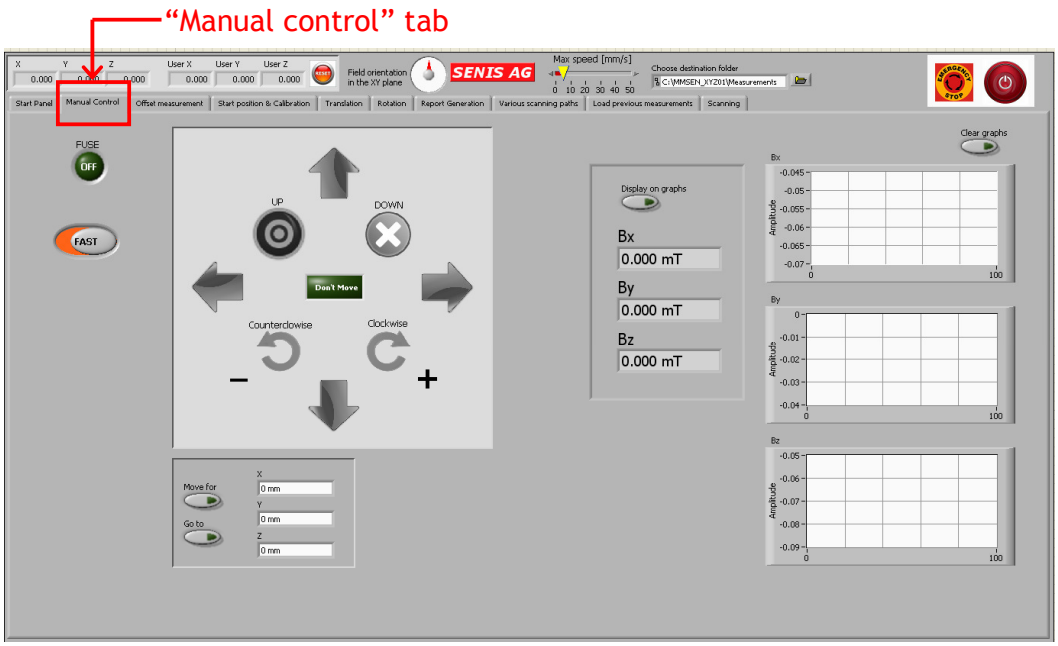


Figure 14: Selecting the "Manual Control" tab

6) The switch in the left of the screen is used for changing the movement speed (Figure 15). If the probe is near any objects, during manual positioning, it is recommended to change the speed to slow. If the switch is in the "Fast" position the probe will move at the speed chosen by the "Max speed" slider. If the switch is in the "Slow" position, the probe will move at the speed 1mm/s.

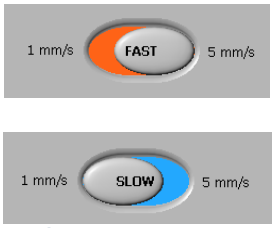


Figure 15: FAST/SLOW toggle switch

PART I: Home position calibration

- Be extra careful while moving the probe. Any impact could damage the system.
- The Cabinet door must be closed while any system movement is in progress.
- While the door is open, all system moving controls will be disabled.

7) Using the arrow icons (Figure 16) position the probe into the Zero Gauss chamber, installed on the table (Figure 17). In order to move the probe, press and hold the appropriate arrow icon. While holding, the arrow will turn green. The whole probe (black part at the tip of the probe holder) should be inside the Zero Gauss chamber;

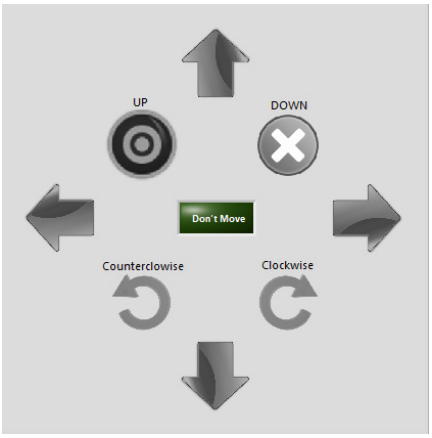


Figure 16: Driving arrow icons

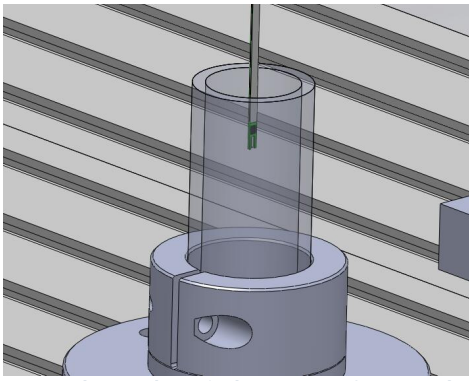


Figure 17: Probe positioned inside of the Zero Gauss chamber

8) Choose "Start position and Calibration" tab.

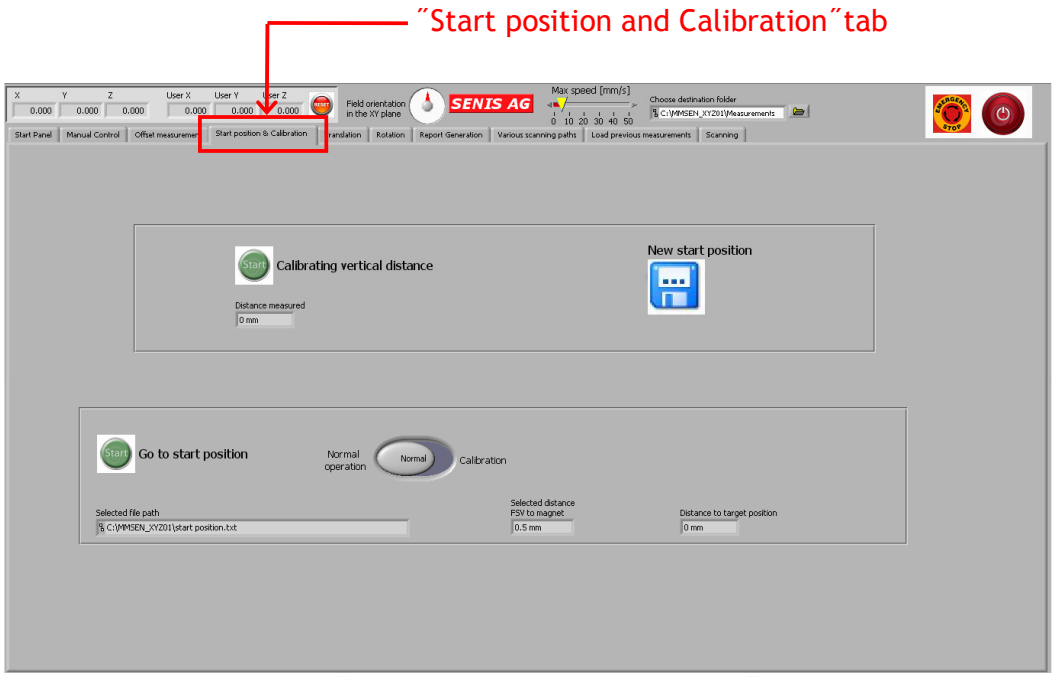


Figure 18: Choosing the "Start position and Calibration" tab

9) Click on the toggle switch in the bottom of the screen (Figure 19) to put it in the "Calibration" position. New controls will appear on the screen.

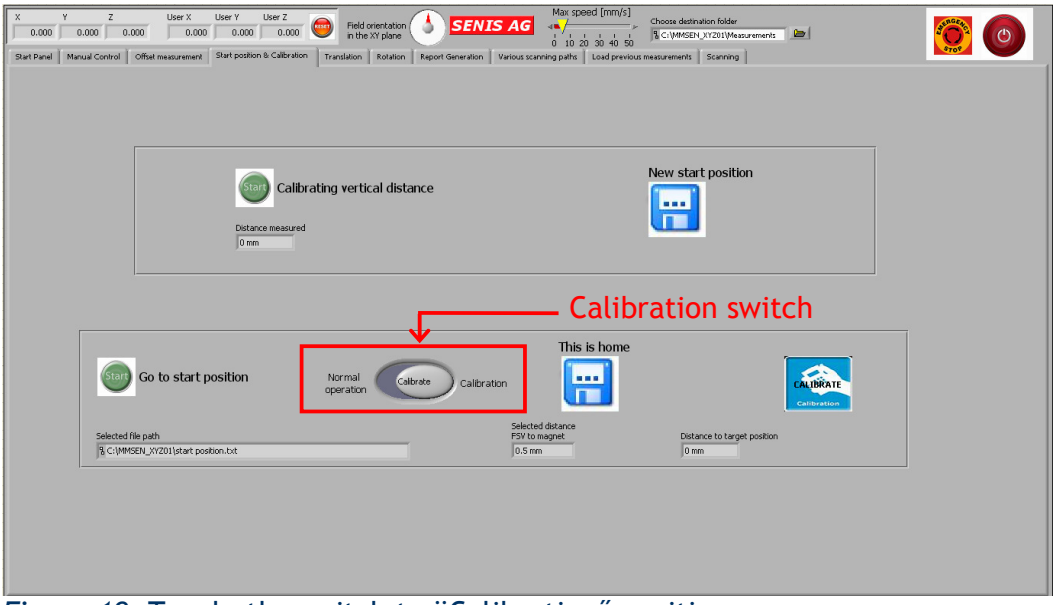


Figure 19: Toggle the switch to ¨Calibration˝ position

10) Click on the "This is home" button (Figure 20). The probe will move to each of the three optical switches while counting steps. After that the software will update the ˝Home position˝ file located on the hardware location C:\MMSEN_XYZ01.

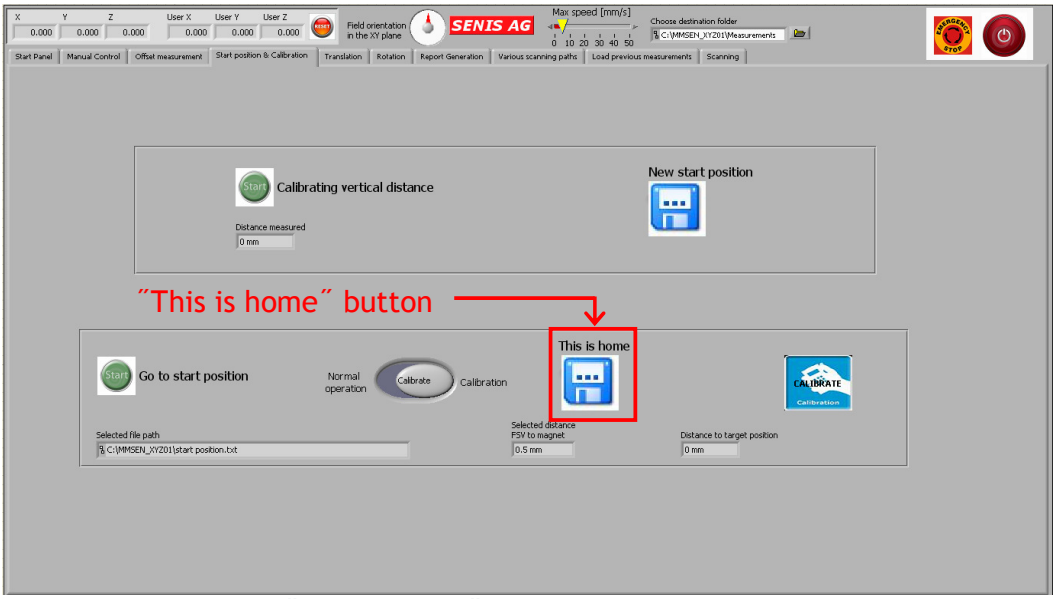


Figure 20: Using the ˝This is home˝ button

11) Select the "Offset Measurement" tab (Figure 21);

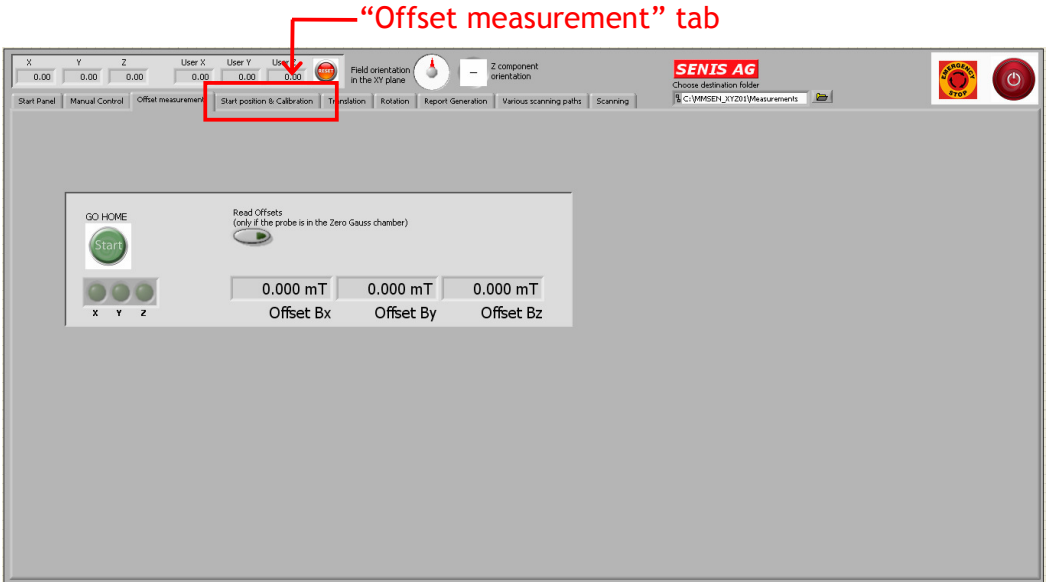


Figure 21: "Offset measurement" tab

After clicking on the "GO HOME" button, closely monitor the probe movement. If the set files are false, there is the possibility that the probe could collide with an object. Before this happens, terminate the program using the "Emergency Stop" button.

12) Click on the "GO HOME" button (Figure 22). The system will move the probe and position it into the Zero Gauss chamber. After the probe is positioned, the readings in the fields "Offset Bx", "Offset By" and "Offset Bz" will change (the probe will read the new offsets).

Figure 22: "GO HOME" button

PART II: "Start position" calibration

Probe position is always defined by tree coordinates X, Y and Z. This coordinates are given in millimeters on the top left of the screen. Reference right coordinate system is placed in the center of the rotation table. When X=0 and Y=0 the probe is in the axis of rotation of the rotation table. Z coordinate displays distance between the probe's FSV and the reference surface. The rotation table is taken to be the default reference surface, but the magnet under test surface can also be taken as reference system. User can define the desirable reference surface.

13) Place the Rotating Tool (Figure 23) on the Rotation Table:

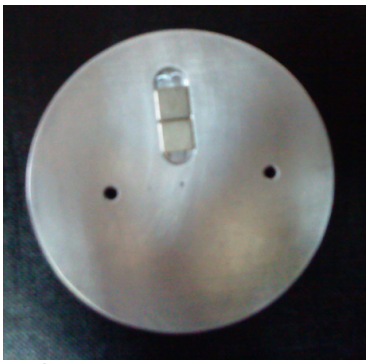


Figure 23: The Rotating Tool

14) Select the "Manual Control" tab (Figure 24);

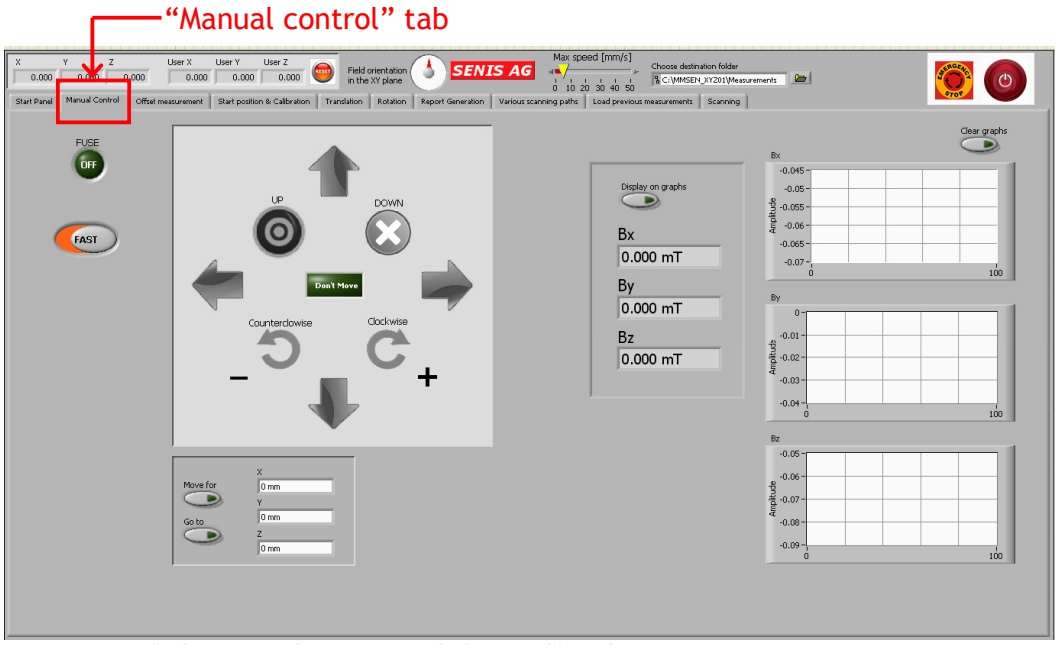


Figure 24: Selecting the "Manual Control" tab

15) Using the arrow icons position the probe approximately above the center of the rotation table, a few millimeters (2-3mm) above the reference magnet surface. Go to ″Start position and Calibration″ tab and click on the ″Calibrate″ button (Figure 25);

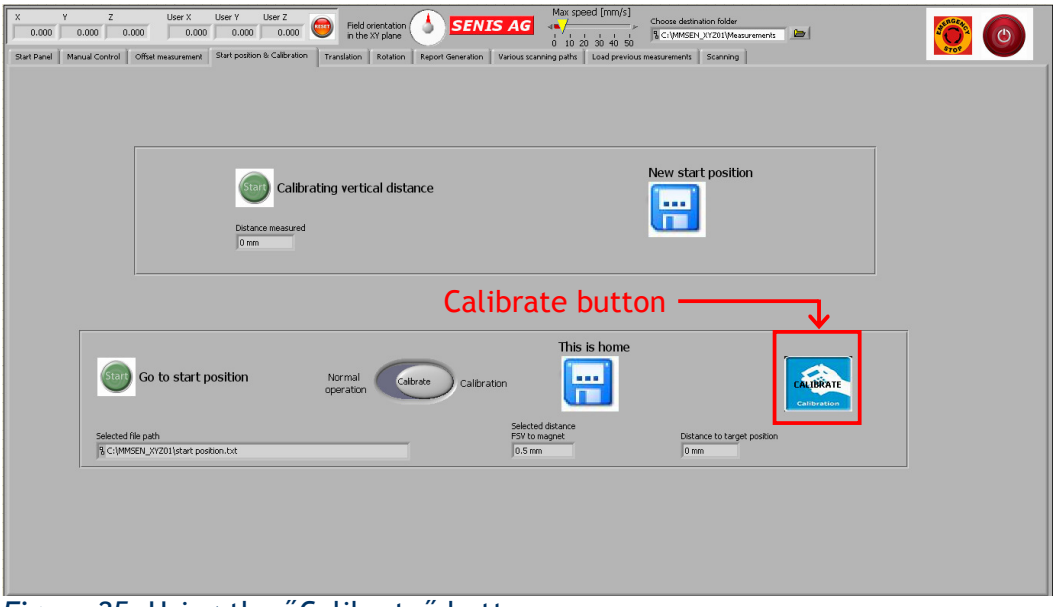


Figure 25: Using the ″Calibrate″ button

Each time you change the magnet type to be scanned you need to reference the vertical distance for the probe, otherwise the probe could hit the magnet surface and get broken.

PART III: "Vertical distance" calibration

For each new magnet type that you want to scan you need to reference the vertical distance. Each time you change the magnet type (dimension of the magnets) you change the reference surface position and you need to reference vertical distance again. To do so go to ″Manual control″ tab.

16) Drive the probe toward the magnet surface using the ″Down″ arrow (Figure 26a). When you come near to the magnet surface use step by step moving. To do so, use the ″Move for″ button. Before that, insert zero value in the X and Y control and value -0.005 in the Z control. Value of 5um (0.005mm) is the smallest step that the probe can move for. Minus sign for Z axis drive the probe toward the surface, while the plus sign move the probe away from the magnet surface (Figures 26a and 26b).

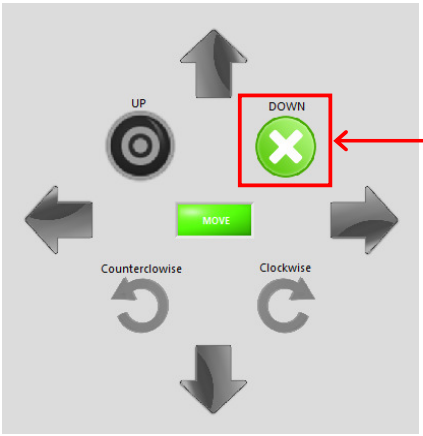


Figure 26a: Moving the probe to touch the top surface of the magnet

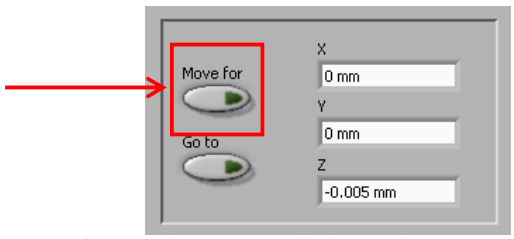


Figure 26b: Moving the probe toward the reference surface for 5um

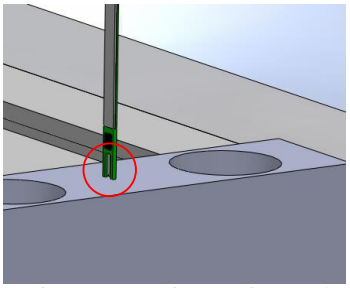


Figure 27: The tip of the probe is touching the reference surface

17) After you have positioned the probe so that it touches the referent surface of the magnet (Figure 27), select the "Start position and Calibration" tab.

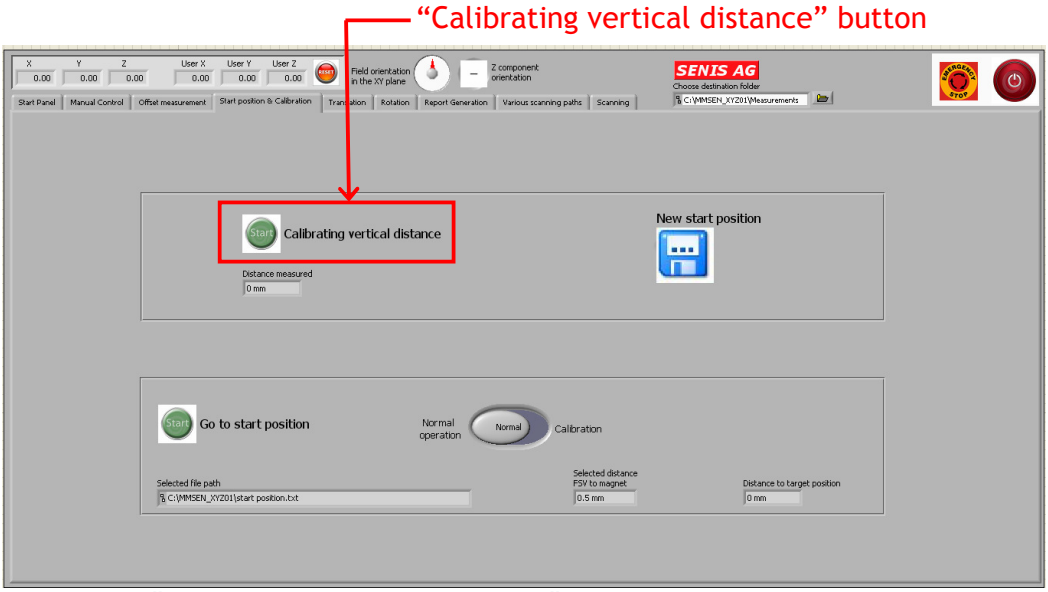


Figure 28: ˝Calibrating vertical distance˝ button

Click on the "Calibrating vertical distance" button (Figure 28). Dialog box will appear asking the user to enter the current distance FSV to magnet. The FSV is not on the same distance from the tip of the probe for different type of the probes. Consult the probe datasheet for this distance (for C type Hall probes this distance is 1mm, while for 3H05 probe this distance is 0.35mm).

Falsely entered value can lead to the damage of the probe.

Probe will move away from the magnet surface and toward the optical switch on the Z axis. After closing the switch, the appropriate value will be calculated and entered in the start position file automatically.

PART IV: Resetting to the initial setup state

If any system components are physically moved, the set files will no longer match the system.

After the calibration, the appropriate values are recorded in the "start position" file. After completing step 17, it is recommended to create a backup copy of the MMSEN_XYZ01 folder. This copy should be preferably saved on an external media. If a system reset is required, follow the steps below to return to the initial setup state:

The laptop computer is not supplied with an antivirus program; before inserting any media into the computer, make sure that media is not infected.

1) Open the backup copy of the MMSEN_XYZ01 folder;

2) Copy the files "Home" and "start position" to the folder C:\MMSEN_XYZ01 (if this folder doesn't exist just start the MMSEN_XYZ01 software and it will be created); overwrite the files if required.

Vertical distance in these set files will be appropriate only for the referent magnet type. If you change the magnet type you need to reference the vertical distance again.

This procedure will reset the system to a state after the step 17. This way, there is no need for setting up the system again, even if the PC or some other system component is replaced. The set files will not match only if some components of the Mechanical Probe Positioning System (MPPS1) are

physically moved from their initial position. In this case it is necessary to redo the whole system setup.

Before measurement starts make sure that:

- The room temperature is stable;
- The system is away from an external magnetic or electric field;
- There are no ferromagnetic objects near the system;
- The system must be fixed, no mechanical vibrations are allowed;
- Not to touch the system while performing a scan;
- Not to pull any cables while performing a scan;
- Not to unplug any cables while scanning;
- The scanning surface is clean, no objects or dust are allowed;
- The Electronic Box is turned on at least 5 minutes before starting the measurement.

SOFTWARE OPERATION BASICS:

Start the MMS-1-R software either by double clicking on the desktop icon or by going to Start/All Programs/MMS-1-R. The start screen will look like the one shown on Figure 29.

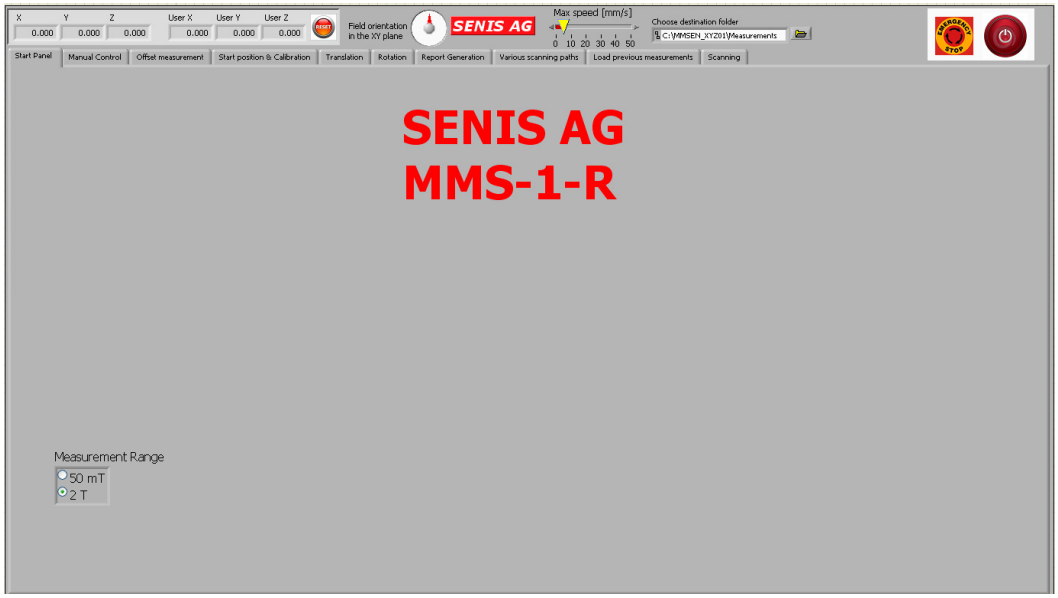


Figure 29: The MMS-1-R software start screen

In the top right corner of the screen is the control table (Figure 30) with basic software commands:

Figure 30: Software control table

The exit button is for closing the program (Figure 31). Note that the exit button is disabled while any program task is in progress (for example if measurements are in progress the user cannot use this button). If you need to terminate the program immediately use the "Emergency Stop" button.

Figure 31: The "Exit" button and the "Emergency Stop" button

The "Emergency Stop" button is used to prevent system damage. For example, if the probe is approaching an obstacle and there is a possibility of impact, press the "Emergency Stop" button, and the program will terminate immediately. The "Emergency switch" has a similar function; it's a hardware switch that stops the hardware immediately after pressed.

The "abort" button is visible only when the system is performing a task. This command terminates all system tasks and immediately stops the system. After clicking this button, the user will be prompted to reference the current probe position by choosing the appropriate start position file.

In the top left corner of the screen there are the coordinate indicators X, Y and Z (Figure 32), which show the current position of the Hall probe. The Z indicator is showing the distance between the probe FSV (Field Sensitive Volume) and the reference surface (FSV is 1mm away from the tip of the probe for C type of probe, white cross on the Figure 33). All values are in millimeters.

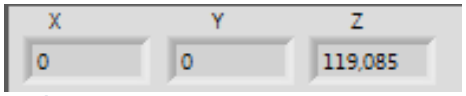
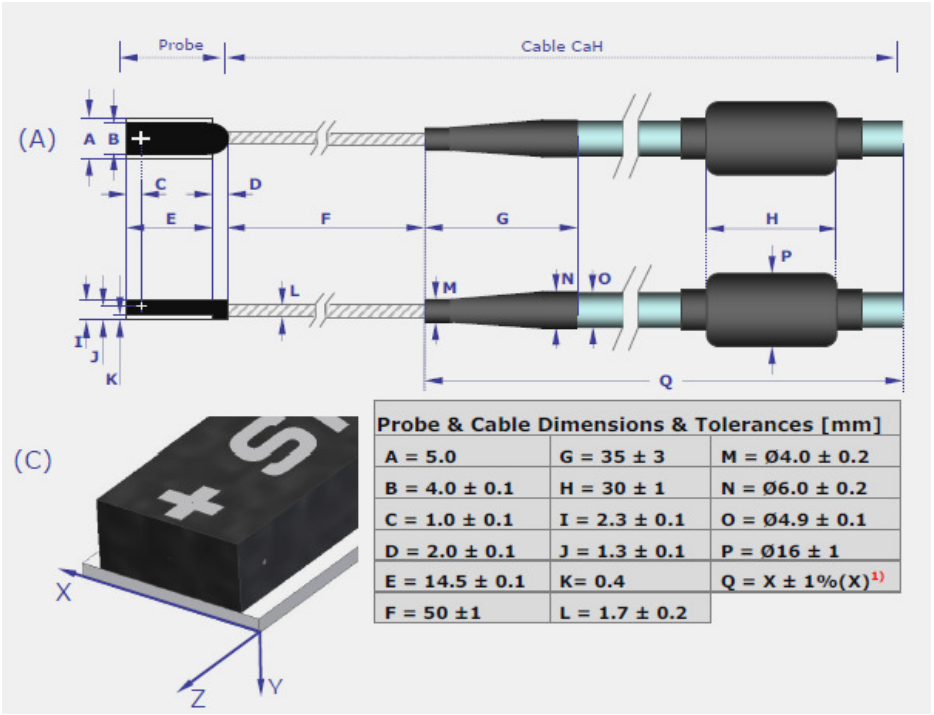


Figure 32: Position coordinates



Probe & Cable Dimensions & Tolerances [mm]		
A = 5.0	G = 35 ± 3	M = Ø4.0 ± 0.2
B = 4.0 ± 0.1	H = 30 ± 1	N = Ø6.0 ± 0.2
C = 1.0 ± 0.1	I = 2.3 ± 0.1	O = Ø4.9 ± 0.1
D = 2.0 ± 0.1	J = 1.3 ± 0.1	P = Ø16 ± 1
E = 14.5 ± 0.1	K= 0.4	Q = X ± 1%(X)[1)]
F = 50 ±1	L = 1.7 ± 0.2	

Figure 33: Distance between the FSV and the tip of the probe

Fields marked User X, User Y and User Z (figure 34), along with the reset button allow the user to reference the probe's position from the desired point in space. By clicking on the reset button, fields User X, User Y and User Z reset their values to zero. All values are in millimeters.

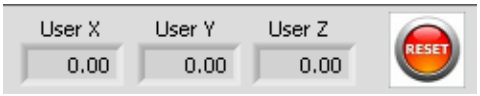


Figure 34: User adjustable position coordinates

The next indicator display magnetic field orientation (figure 35) in the XY plane.

Figure 35: Magnetic field orientation indicators

Slider on the top of the screen allows user to select the maximum speed of the probe during the movement or scanning (for the scanning modes that allow scanning on the fly). To change maximum speed, drag the yellow pointer to desired value (Figure 36).

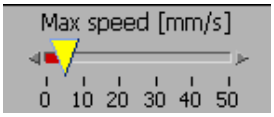


Figure 36: Maximum speed slider

Next to the slider is the save field (figure 37). The save field allows user to select the destination on the hard drive where the measurement file will be saved.

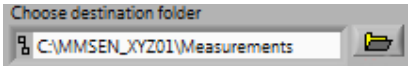


Figure 37: Save field

When the system is performing a task, a new icon becomes visible in the top right corner of the screen, the "abort" button (figure 38).

Figure 38: The "Abort" button

There are nine different tabs in the program (figure 39).A tab can be selected by clicking on the tab name.

Figure 39: Software tabs for different purposes

1) Start panel tab:

The Start panel screen (figure 40) displays the system name (MMS-1-R) and developer name, SENIS AG.

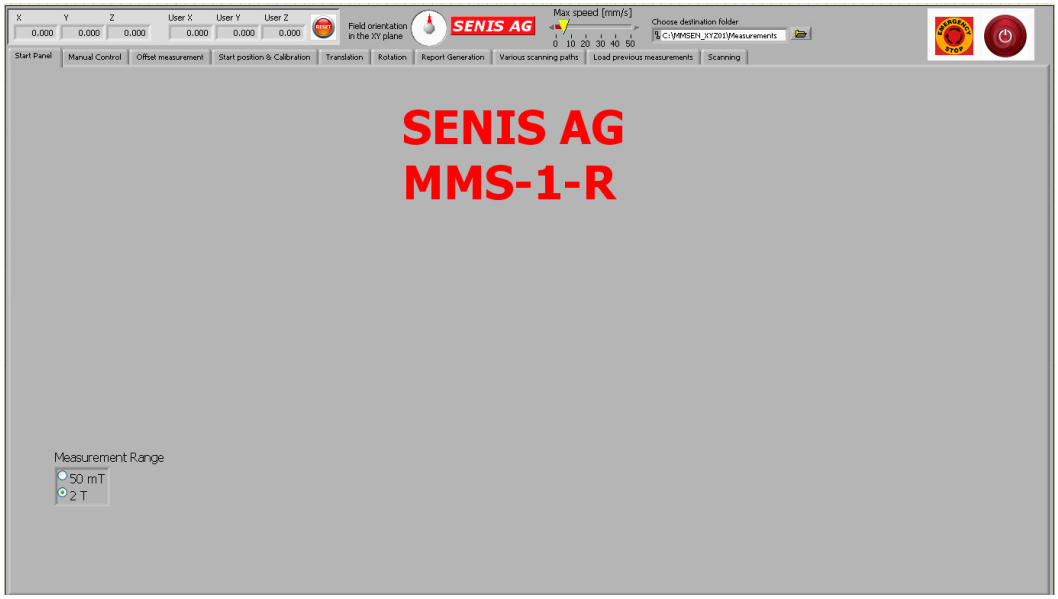


Figure 40: Start panel screen

If the system is supplied with the multi-range probe, the range selector will be also available on the start screen (Figure 41). To select the desired measurement range click in the white circle next to the range label. The calibrating coefficients for chosen range will be loaded into the software automatically.

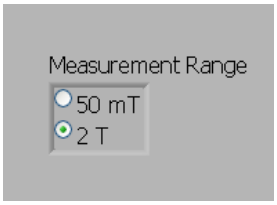


Figure 41: The range selector

2) Manual Control tab:

Be extra careful when moving the probe. Hitting any object could damage the system.

The Manual Control screen (figure 42) allows the user to manually move the probe and position it in a desirable point in space. Placing the mouse pointer over the appropriate arrow icon and holding the left mouse button moves the probe in the direction the arrow is pointing. The "UP" icon moves the probe away from the magnet holder and the "DOWN" icon moves the probe towards the magnet holder. Rotate buttons turn the rotating table in the desired direction, clockwise or counter clockwise. The center indicator changes the state from "Don't Move" to "Move".

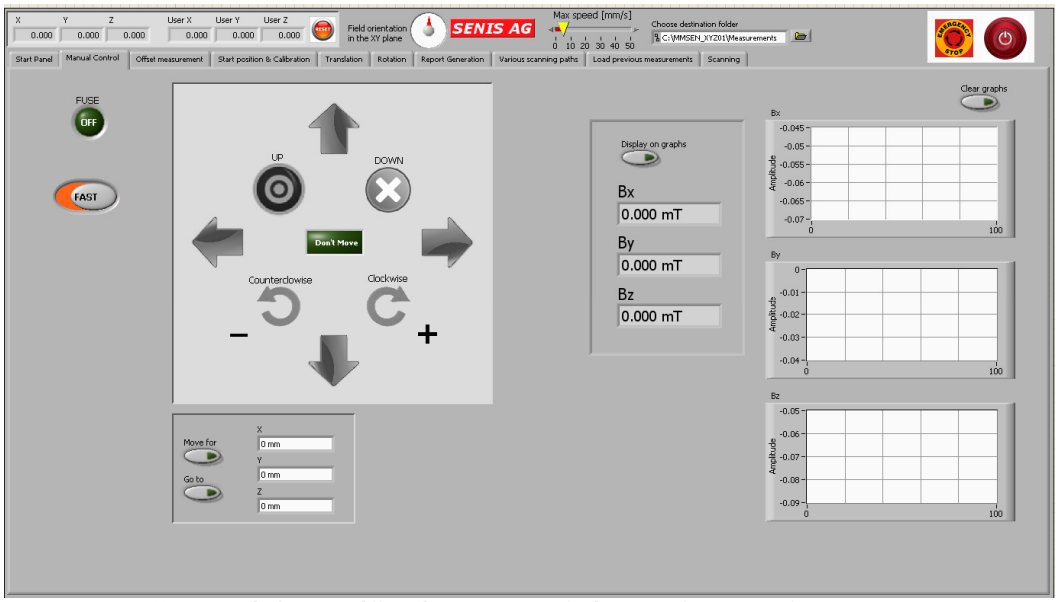


Figure 42: "Manual Control" tab screen of the MMS-1-R software

During the manual movement of the probe by using the arrows, the position coordinates tend to get unadjusted. Starting the measurement or using the ˝Go to˝ command can be very dangerous if the coordinates are unadjusted. A warning will appear on the screen each time you change the tab going away from the ˝Manual control˝ tab asking you to reference the probe position.

When the "FUSE" indicator (figure 43) is off, manual probe movement is disabled. Click on this indicator to turn it on and to enable probe movement. If the probe hits a boundary switch, the FUSE will switch off again, preventing any system damage. If a boundary switch is hit, the probe will fence off, preventing the switch from staying closed.

Figure 43: The "FUSE" indicator

The software switch in the left of the screen is used for changing the movement speed (Figure 44). If the probe is near any objects, during manual positioning, it is recommended to change the speed to slow. If the switch is in the "Fast" position the probe will move at the speed chosen by the "Max speed" slider. If the switch is in the "Slow" position, the probe will move at the speed 1mm/s.

Figure 44: Speed control toggle switch

Magnetic field indicators on the manual control screen (figure 45) show the Bx, By, and Bz components of a magnetic field. All units are in militeslas. These values can be graphically displayed on the screen, using the appropriate option. This option also allows user to see the AC magnetic field in the single point. To delete all graphs use the "Clear graphs" option.

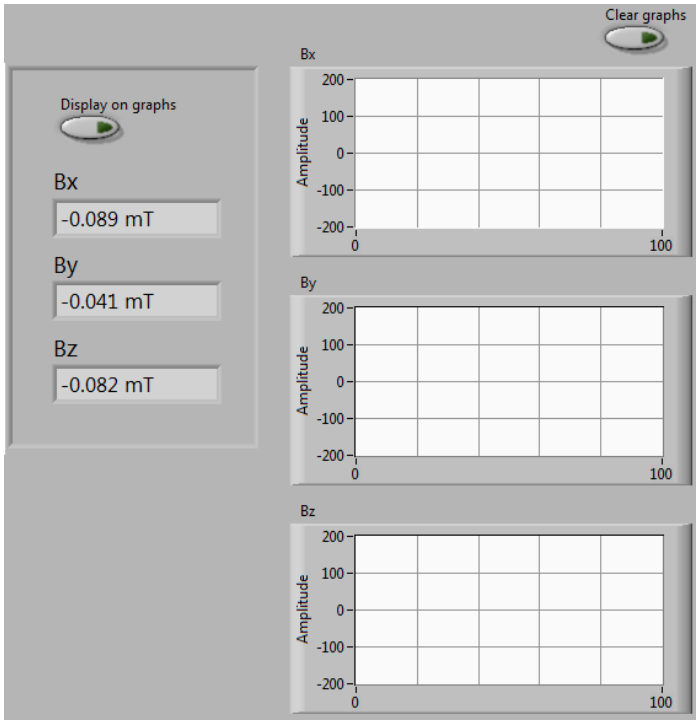


Figure 45: Magnetic field indicators

To automatically move the probe to a specific position use the move controls located on the bottom of the screen (figure 46). Right coordinate system is placed in the center of rotation table, so the point X=0, Y=0 is in the axis of rotation of the rotation stage. Z coordinate shows the distance between the probe FSV and the reference surface.

Do not use the ˝Go to˝ button if you have previously used the arrows for the probe movement. The position coordinates may be wrong, and this could lead to damage of the probe.

The "Go to" button moves the probe to the desired point in the coordinate system. User should enter the desired point's coordinates and click this button. The probe will be moved first in Z direction, than in X and last in Y direction.

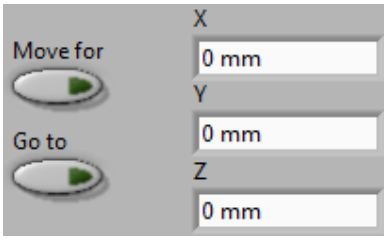


Figure 46: Movement controls

The "Move for" button moves the probe in each direction for the value given in the appropriate control fields. If the probe should be moved in all tree directions, it will be first moved in Z direction, than in X and last in Y direction. If you enter zero in some field, the probe will not move in that direction. This button can be very useful for precise movement of the probe, especially when moving the probe near to the obstacle.

3) Offset measurement tab:

Before starting the measurements it is necessary to cancel all Hall probe's offsets. After turning the Electronic Box on, it is recommended to wait a minimum of five minutes, in order for the components to reach theirs optimal working temperature. The probe must be placed in the Zero Gauss chamber before any offset reading.

After clicking on the "GO HOME" button, closely monitor the probe movement. If the set files are false, there is the possibility that the probe could collide with an object. Before this happens, terminate the program using the "Emergency Stop" button.

To cancel the offsets it is necessary to go to the "Offset measurement" tab (figure 47). The "GO HOME" button positions the probe into the Zero Gauss chamber. After this command is activated the probe starts moving towards the appropriate boundary switches, and upon hitting each switch the appropriate indicator (X, Y or Z) turns on. After all three boundary switches are hit the probe goes into the chamber and all offsets are read. The indicators: Offset X, Offset Y and Offset Z show Hall probe's offset for the appropriate measuring channel. Note, that the next time you start the program these indicators will show the previously read offset values.

"Read offset value" button allows user to read the offsets without going to the Home position (for example, if Hall probe is already into the Zero Gauss chamber). Simply by clicking on this button the offsets will be read. If this button is used while the probe is out of the chamber, the readings will be false and will affect on all further measurements, until the new, correct offset values are read. In order to avoid this, user will be prompted to confirm the offset reading.

Each time the offsets are read, the appropriate values, along with the date and time information, are written in the "Offset log" file. By looking at this file the user can detect any unusual behavior of the Hall probe (large change in offset, offset too large…).

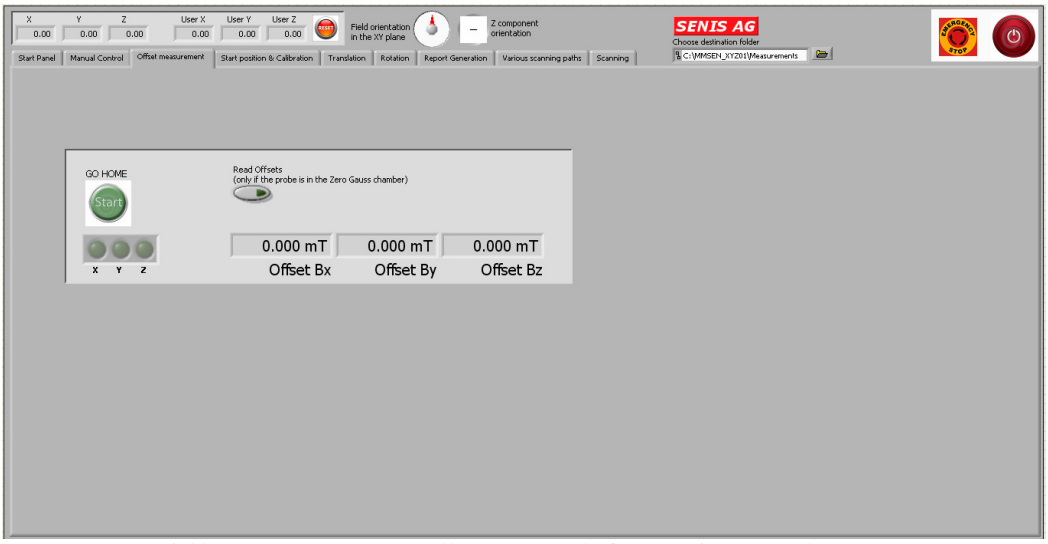


Figure 47: "Offset measurement" screen of the MMS-1-R software

4) Start position & Calibration tab:

"Start position & Calibration" tab (Figure 48) allows the user to place the probe in the appropriate position before starting the measurement. Before starting any type of measurement, it is necessary to place the probe in the start position, and set the vertical distance. If the start position and vertical distance are not correctly set, than the measurements can be faulty or even the probe could be damaged.

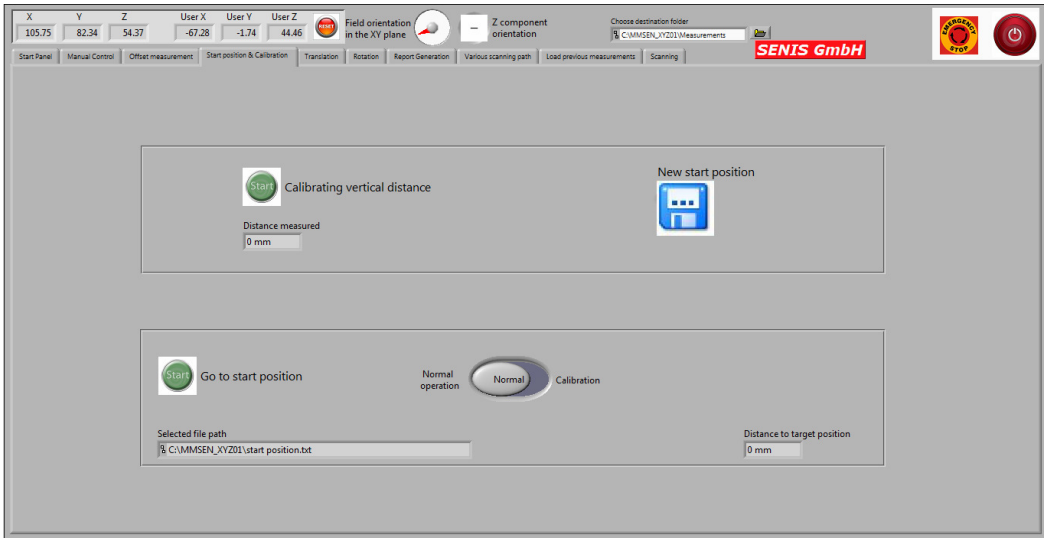


Figure 48: "Start position & Calibration" screen of the MMS-1-R software

Each time when the magnet type is changed, the reference plane is also changed. Because of this, it is necessary to calibrate the vertical distance. To do this (see page 24 of this manual), touch the top plane of the magnet with the tip of the probe, and click the "Calibrating vertical distance" button (Figure 49). The user will be prompted to enter the current vertical distance, which is actually the distance of probe FSV to probe tip.

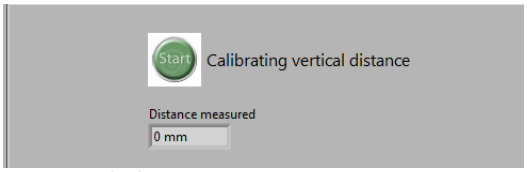


Figure 49: Choosing vertical distance

Failing to reference the vertical distance after the magnet dimensions are changed could lead to probe damage.

User can define the start position for magnet under test. This position can be saved in the file, and used later for the same magnet. To save the start position file, drive to probe to desired position and click the "New start position" button. You will be prompted to enter the file name for the start position file (Figure 50). You can also create a notepad file with the coordinates (for example X=-20; Y=0; Z=5), save the file and use it later as start position file. In the notepad file you should enter following line:
-20 0 5.
Use tabulator key between two values.

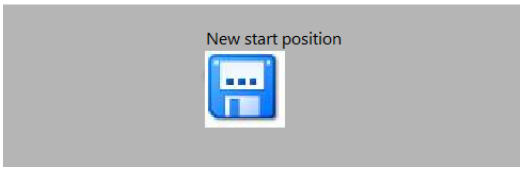


Figure 50: Configure new start position file

To drive the probe to the predefined start position, use the "Go to start position" button (Figure 51). You will be prompted to choose the desired file. If you choose the default start position file from the MMSEN_XYZ01 folder, the probe will be placed in the coordinates X=0, Y=0, Z=5mm. You could also choose any of the start position file you created.

"Distance to target position" indicator shows which distance, in the appropriate direction, will the probe move before it stops. This indicator can help prevent the damage on the probe; if the distance shown is bigger than expected, and there is a possibility that the probe hit some obstacle, terminate the movement immediately.

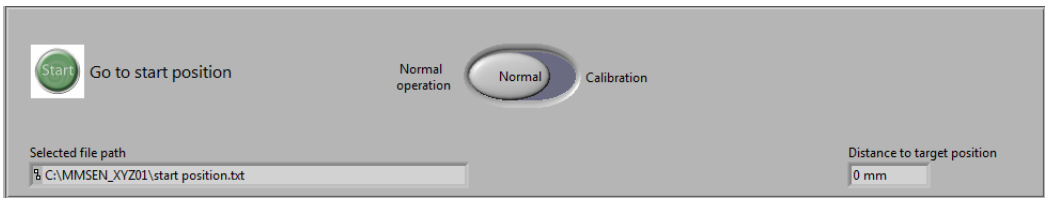


Figure 51: "Go to start position" button

Calibration of the start position is performed during the system initialization. But, it is recommended to perform this procedure at least once a month. For detailed description on these procedure look-up the "Initial setup" section.

5) Translation tab:

During the translation measurement, the probe moves above the magnet, while the magnet is fixed. The probe starts measuring from a point on the rotation axis of the rotation stage, and continues along the spiral path. The step, between the two measurements, is defined by the user (x/y [mm] - default scan resolution is 0.5mm). The area to be scanned is defined with the ″Scan area side parameter″ and it is square area.

Figure 51: Translation scan parameters I

User can also define the starting vertical distance for scanning; system uses the coordinate indicator Z as the reference for the current position of the probe and moves the probe in Z direction in order to position it on the distance entered in ˝Starting vertical distance˝ control (Figure 52). This value should not be less then 0.5mm for 3H05 type of the probe or 1.5mm for C type of the probe. Number of layers to be scan and distance between the layers can also be defined.

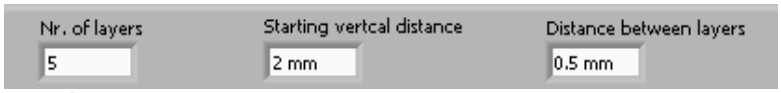


Figure 52: Translation scan parameters II

If you have previously used the manual movement of the probe the coordinates could be false and this could lead to a damage of the probe. To avoid this create the start position file for each measurement type and position the probe using the ˝Go to start position˝ while choosing the appropriate start position file.

On the translation measurement screen (figure 53) there are ten graphic measurement representations. A group of five graphs in the top row represent the flux density. Five graphs in the bottom row represent measured angle error. Each row of graphs has the appropriate legend. The graphs are arranged so that the first one on the left represents measurements when the probe's FSV is closest to the magnet's surface. The first one on the right represents measurements when the probe's FSV is farthest away from the magnet surface. The distance between the two measured planes is adjustable (z [mm] - Distance between layers), the default value is 0.5mm. If you choose more than five layers all the graphs would move to the left and newest graph would appear on the right.

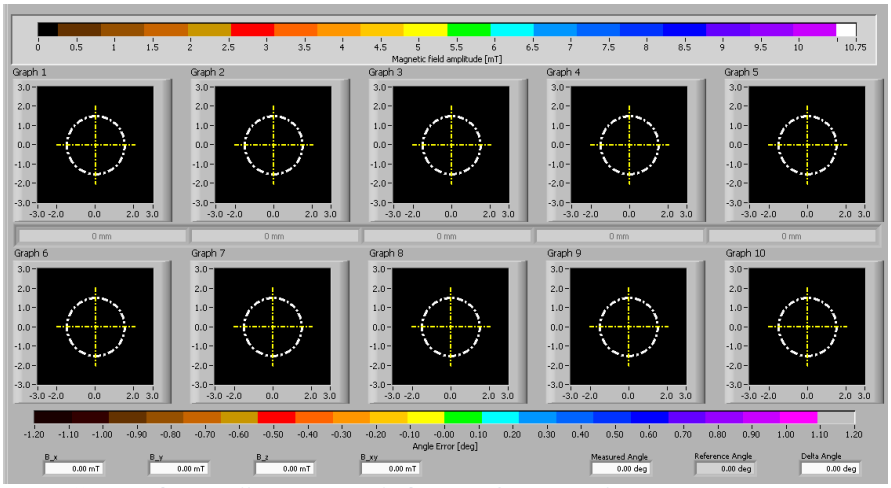


Figure 53: "Translation" screen of the MMS-1-R software

On the bottom right of the screen, there are fields that give the information on the magnet. Also, the "Magnet sample" file will be the name of the file with the measured values.

In the top right corner of the screen are graph display controls. Select the desired graph from the dropdown menu. A horizontal slider enlarges the graph. The reset button resets the graph to its original appearance (Figure 54).

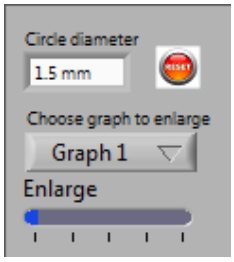


Figure 54: Graph display controls

On the bottom of the screen are the values of measured parameters of the current measuring point.

If the probe is not in the appropriate position before starting the measurement, there is a risk of damaging the system.

Before clicking on the "START" button, make sure that the probe is positioned in the appropriate position (the probe should be placed 20 mm left from the rotation axis), and at the appropriate vertical distance. If this is not the case, go back to the "Start position & Calibration" tab, click on "Go to start position" and select the appropriate file. If the probe is not in the expected position before the measurement, the measurement results can be faulty and there is even a risk of damaging the system. Also, make sure that the magnet is in the appropriate position. Recommended start position is (X=-20; Y=0; Z=5).

When the measurement procedure starts, the probe will first move 20 mm to the right, positioning itself on the rotation axis and adjust vertical distance. In the first scan, the probe's FSV is closest to the magnet's surface. After this scan is finished, the probe moves away, to a next selected distance, from the magnet and continues the scan. This process will be repeated the number of times you entered in the ˝Nr of layers˝ control. After all the layers are scanned, the probe positions itself back to the start position, so there is no need for setting the start position or vertical distance again. Place another magnet on the holder and click on the "START" button.

Before proceeding to the next magnet, the measuring results should be saved otherwise new measurement results will overwrite the old ones. To save the results see the "Report Generation" tab section. For the example representing the measured results see Figure 62a of this manual.

6) Rotation tab:

During the rotating measurements, the probe is fixed and the magnet is rotating. There are four different probe positions during this type of measurement, and the current position of the probe is shown in the top right corner of the screen (Figure 55).

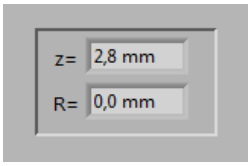


Figure 55: Actual Hall probe position

The "z" parameter shows the current vertical distance between the probe FSV and the magnet's surface. The "R" parameter shows whether the probe is on the rotating axis (R=0.0 mm), or out of the rotation axis (R=xx mm).

User can choose two scanning distances, z1 and z2, and how much the probe should go out of the center during the scan (figure 56).

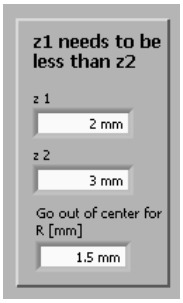


Figure 56: Scanning parameters

If you have previously used the manual movement of the probe the coordinates could be false and this could lead to a damage of the probe. To avoid this create the start position file for each measurement type and position the probe using the ˝Go to start position˝ while choosing the appropriate start position file.

On the rotation measurement screen (Figure 57) there are two graphs of the measurement results. On each graph, there are two dashed red border lines. If the parameters stay within their range the magnet is declared "GOOD". Four different lines appear during measurements and show results for each probe's position. The color legends are on the right side of the graphs.

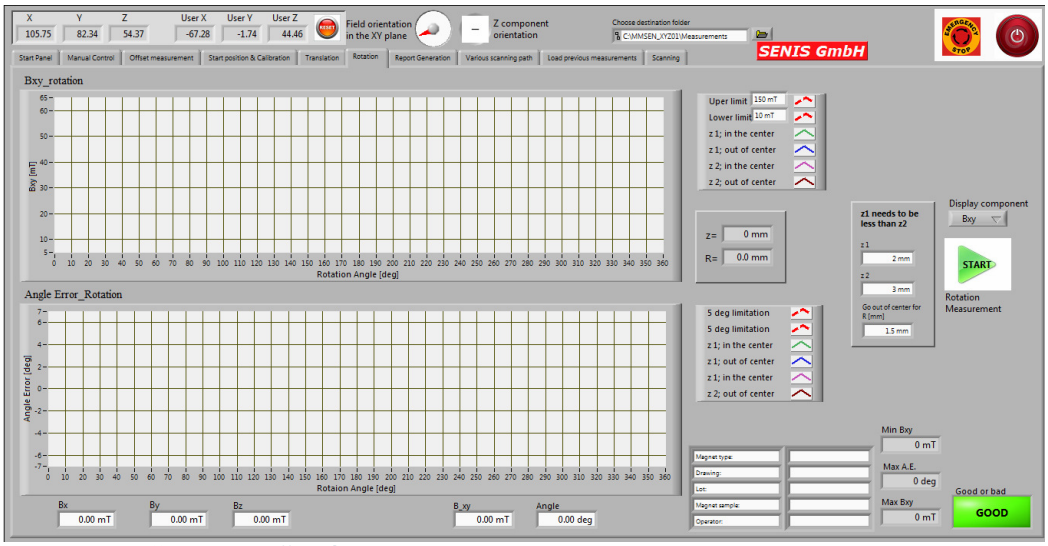


Figure 57: "Rotation" tab screen

The top graph shows the flux density as a function of the rotating angle, while the bottom graph shows the angle error as a function of the rotating angle. On the right side of the screen are the indicators showing the measurement results for the actual measurement point.

There are fields for labeling magnets, including magnet type, drawing, lot, magnet sample and operator. Before the measurement, the operator enters these values for each magnet under test. All this data can be viewed in the report, along with measured data for the appropriate magnet.

If the probe is not in the appropriate position before starting the measurement, there is a risk of damaging the system.

Before clicking on the "START" button, make sure that the probe is positioned in the appropriate position (the probe should be placed 20 mm left from the rotation axis), and at the appropriate vertical distance. Recommended start position is (X=-20; Y=0; Z=5). If this is not the case, go back to the "Start position & Calibration" tab, click on "Go to start position" and select the appropriate file. If the probe is not in the expected position before the measurement, the measurement results can be faulty and there is even a risk of damaging the system. Also, make sure that the magnet is in the appropriate position.

When the measurement procedure starts, the probe will first move 20 mm to the right, positioning itself on the rotation axis, and position the probe at appropriate vertical distance, and then start measuring. After the magnet rotates a full circle, the probe positions itself in the next measuring position, and the magnet starts rotating again. When the scan is finished for all 4 positions of the probe, four indicators will appear: maximum measured field, minimum measured field, maximum angle error and GOOD/BAD indicator. The most important one is the GOOD/BAD indicator. If all the criteria are fulfilled (max field<Upper limit, min field>Lower limit, max error<5 deg) then the indicator will display "GOOD". If any of the criteria are exceeded the indicator will display "FALSE". The range limits can be adjusted.

The graph based report from the rotating measurements, along with the characteristic values, is generated automatically. The user is only required to enter the .pdf file name to save the report. Also, there is an option to save all the characteristic values for all the measured magnets from the program start, to do this click on the ″Save table″ button in the bottom right corner of the screen (see the "Report Generation" tab section for details).

After scanning each magnet (for all the 4 probe positions), the probe moves back to the start position, and there is no need for setting the start position or the vertical distance again. Just place another magnet on the holder, enter label and number, and click on the "START" button.

7) Report Generation tab:

In order to save different types of measurement results go to the "Report Generation" screen (Figure 58). This screen is divided into two separate entities, for each report type. Each type includes date and time of the report.

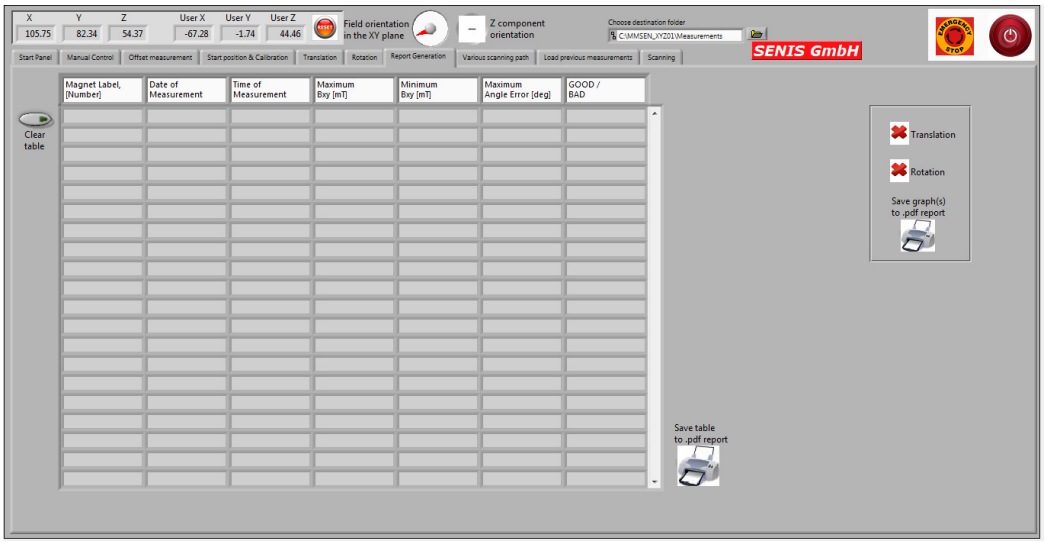


Figure 58: "Report Generation" tab screen

On left part of the screen (Figure 58) is a table with the characteristic values, measured in the rotation measurement procedure. During this measurement, all characteristic values are automatically entered in the appropriate table cells. Each row represents a different magnet. To delete all cells click on the "Clear table" button. When you exit the program all the cells entries are automatically deleted. Magnet label, number and cavity in this table, are the same as those entered in the appropriate fields on the "Rotation" program screen.

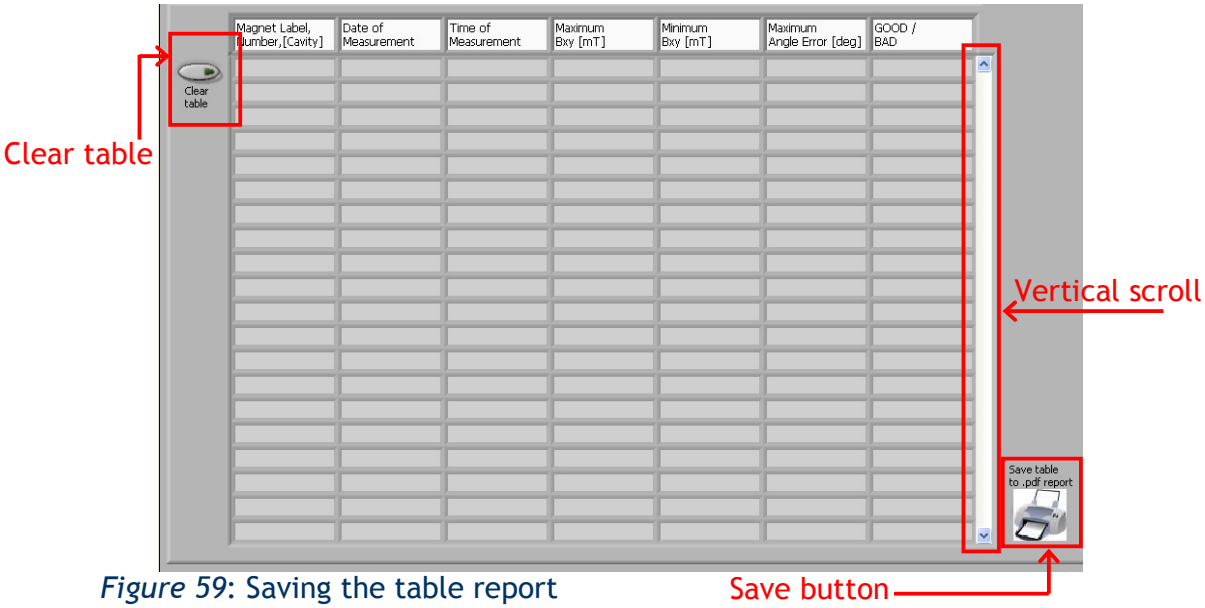
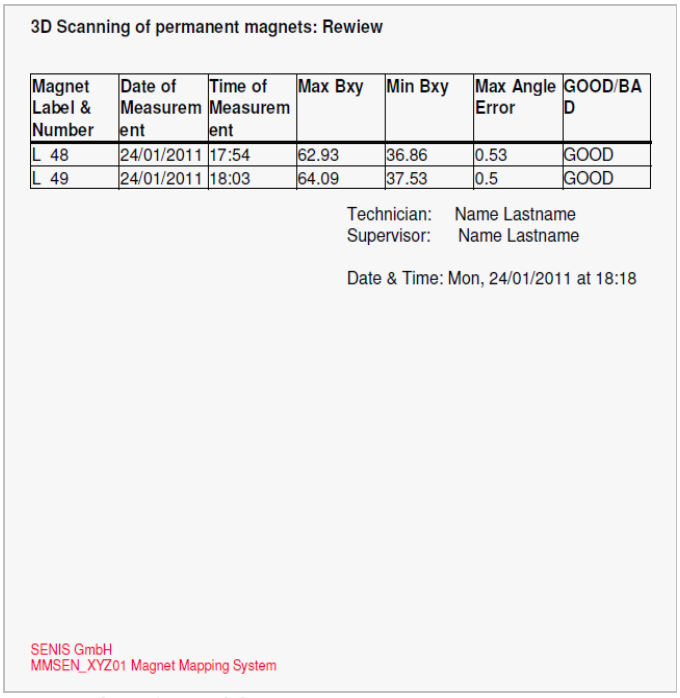


Figure 59: Saving the table report

There are 20 rows displayed on the screen. To see the other values use the vertical scroll on the right side of the screen.

To save the table, click on the "Save Table to .pdf report" button. A pop-up window will appear asking for the file name and the location where to save the file. A report example is shown on Figure 60.



3D Scanning of permanent magnets: Rewiew

Magnet Label & Number	Date of Measurement	Time of Measurement	Max Bxy	Min Bxy	Max Angle Error	GOOD/BAD
L 48	24/01/2011	17:54	62.93	36.86	0.53	GOOD
L 49	24/01/2011	18:03	64.09	37.53	0.5	GOOD

Technician: Name Lastname
Supervisor: Name Lastname

Date & Time: Mon, 24/01/2011 at 18:18

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MMSEN_XYZ01 Magnet Mapping System

Figure 60: An example of a table report

The controls on the right side of the "Report Generation" screen (figure 61), allows user to generate another report type. This type of report saves the measured values as graphs. The saved graphs are the ones displayed on "Translation" and "Rotation" screens. Unlike the table report, here, each new data from the same scanning procedure will overwrite the old one. Therefore, it is necessary to save the data before starting the same scanning procedure. If the same magnet is scanned with two different scanning procedures (Translation and Rotation) new data won't overwrite the old one.

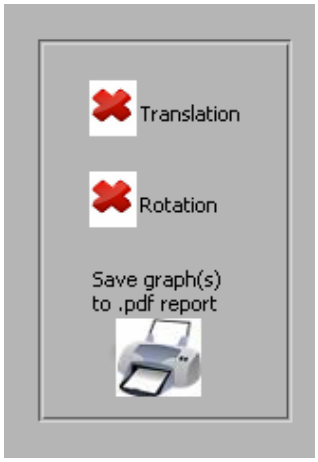

Figure 61: Graph report generation

To save the translation measurement graphs, make sure the "Translation" button is on, and click on the "Save graph(s) to .pdf report" button. A pop-up window will appear asking for file name, and the location where to save the file. An example of a report is shown in Figure 62a (one page report).

To save the graphs from the rotation measurement graphs, make sure the "Rotation" button is on, and click on the "Save graph(s) to .pdf report" button. A pop-up window will appear asking for file name, and the location where to save the file. An example of a report is shown in Figures 62b and 62c (two pages report).

To save both graphs types, from the translation and the rotation measurements, make sure that the "Translation" and "Rotation" buttons are on and then click on the "Save graph(s) to .pdf report" button. A pop-up window will appear asking for file name, and the location where to save the file. An example of the report is shown in Figures 62a, 62b and 62c (three pages report).

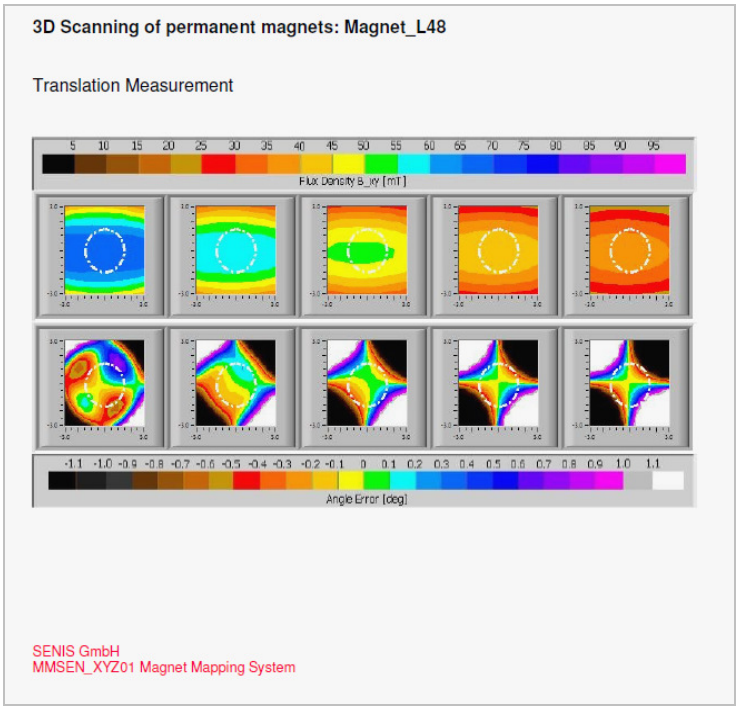

Figure 62a: An example of a translation measurement report

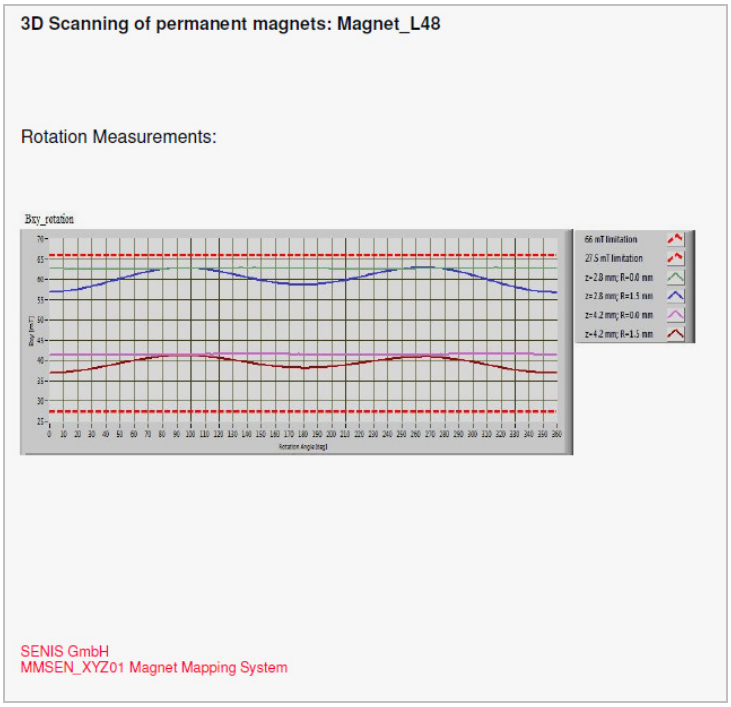

Figure 62b: An example of a rotation measurement report

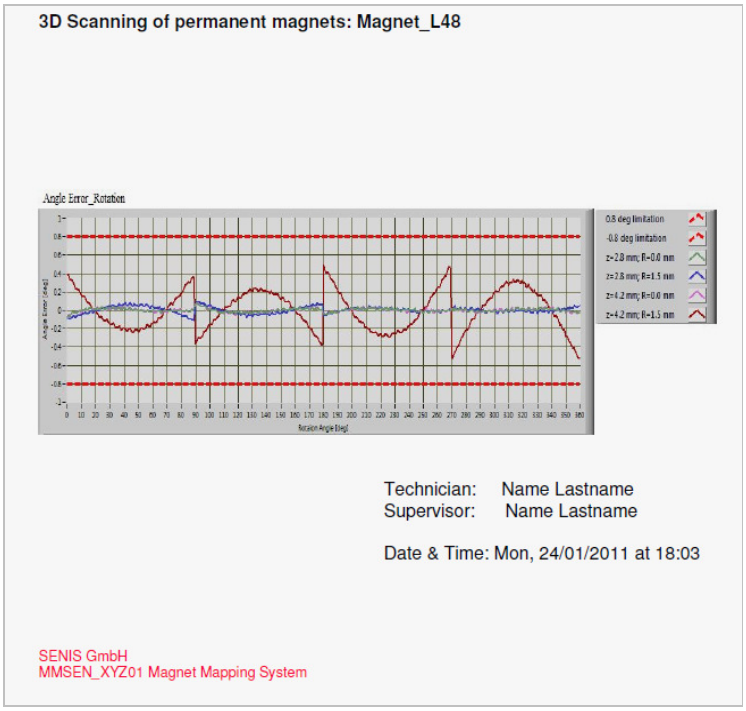

Figure 62c: An example of a rotation measurement report

8) Various scanning paths tab

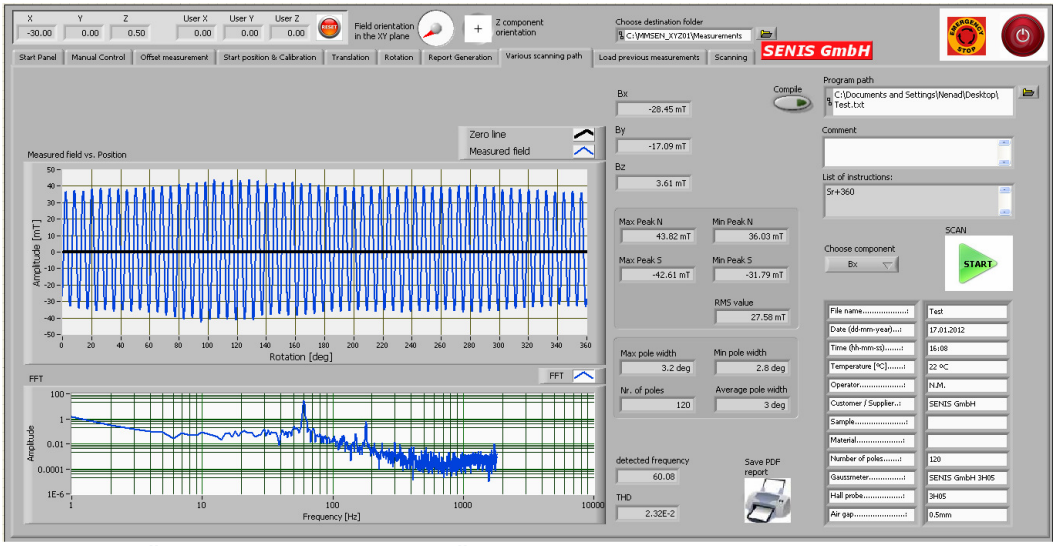

Figure 63: ″Various scanning path″ tab screen

"Various scanning path" screen allow user to define the path of the probe during the scans. To do so, user needs to write the commands in the txt file. To load the file, click on the browse icon at

the far right of the screen, select the file, and click the "compile" icon. If the syntax in the file is not good, the user will get the error message. Each command needs to be written in the new line or it will be ignored.

The syntax for defining the scanning path is as follows:

Ab±distance

A - Represents the type of wanted operation and can be M for Move and S for Scan, only capital letters. If the entered letter is "M", the probe will move but will not scan. If the entered letter is "S", the probe will scan while moving.

b – This shows along which axis the probe should move. It can be "x", "y", "z", or "r" for rotation.

± - Shows the direction in which the probe should be moved along the given axis. The direction applies to right coordinate system, and the rotation table rotates clockwise for "+" sign, and counterclockwise for "-" sign.

Distance – Shows how many millimeters the probe should move in the given direction, or how many degrees the rotation table should rotate in given direction.

For example, if the text file contains a command Sx+100, the probe will scan 100mm along the x-axis.

This measurement type is the most appropriate for scanning the multi-pole magnets that rotate. As the result, the user can see the number of poles, distribution of poles and zeros and RMS value of the field. Also there is a FFT of the measured signal and THD value.

9) Scanning tab

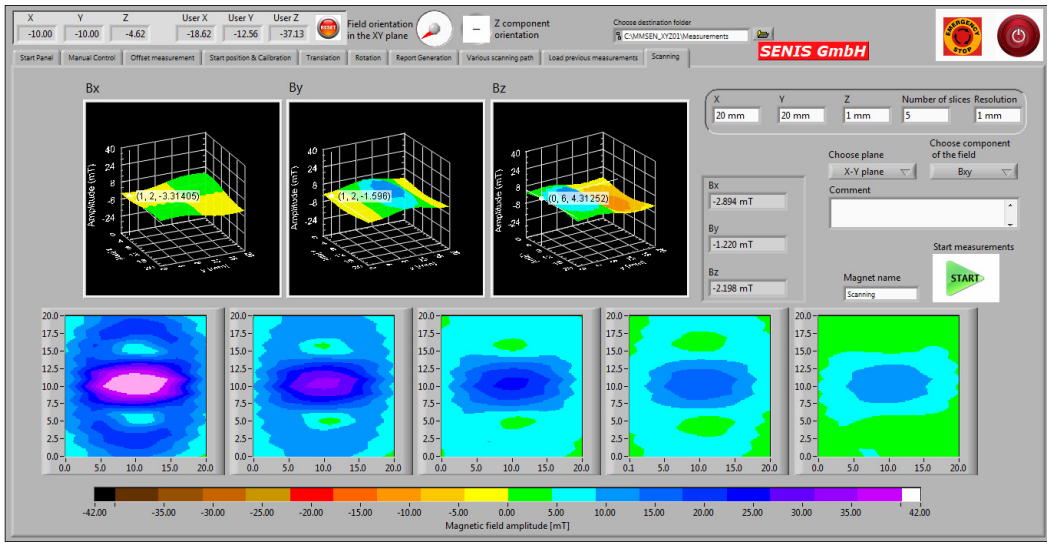

Figure 64: Scanning screen

This tab allows user to choose the desired scanning plain and area. Also on this tab the user can see the 3D and 2D presentation of the measured field and the appropriate color legend.

From the drop down menu named "Choose plain" user can choose the desired scanning plain. From the "Chose component of the field" drop down menu, user can choose which component of the field will be displayed on the 2D graphs. Measurement file name is the same as the name of the magnet you entered in the "Magnet name" field. If the same file already exists, program will ask you to enter another magnet name.

In the "Number of slices" control, user can enter the desired number of slices to be scanned. Since there is three dimensions that the user can choose: X, Y and Z, two dimensions define the scanning area and the third number defines the distance between two scanning plain. If the number of slices is one, third dimension is ignored.

For example, if X-Y plain is chosen, and X=3, Y=5, Z=1, X and Y controls define the scanning area (3 mm x 5 mm). Further, if chosen number of slices is two, the probe will scan the area 3 mm x 5 mm in the X-Y plain, move back to the starting point and away from the magnet surface for 1 mm in the Z axis direction, and scan another 3 mm x 5 mm. This way the probe has scanned the area 3 mm x 5 mm in the two parallel plain with 1 mm distance between these plain. Graphical presentations of the results will appear from left to right for each new plain.

After the scan is finished, the probe will always move back to the starting point for the first plain. This way you can repeat the measurements, or put another magnet for testing, without adjusting the probe position.

Scanning resolution is also user selectable. Keep in mind that better resolution means longer scanning time. The best resolution that can be chosen is 0.02 mm, but it is not recommended to use better scanning resolution than 0.1 mm because it would take too much time to finish, except for the very small scanning area. Keep in mind that both area sides must be divisible with the scanning resolution. Otherwise you will get the message to change either the area dimensions or scanning resolution.

After the scan is finished, the program will save the measurements in the ASCI file and save the graphs in the PDF file. The dialog box will appear asking the user to choose the file name for the PDF report.

SYSTEM SPECIFICATIONS:

Mechanical Specifications:	
Parameter	***Values***
Dimensions of the mechanical part of the scanner	*400 mm x 350 mm x 650 mm*
Total system weight	• *Mechanical part: 26 kg* • *Electronic module: 7 kg* • *Personal Computer: 2 kg*
Maximum scan area (standard)	*100 mm x 100 mm x 100 mm*
Distance between the FSV (Field Sensitive Volume) and the magnet	*Minimum: 1.1 mm* *Maximum: 100 mm*
Maximal scanning speed	*50 mm/s*
Minimal distance between two measuring points	*5 µm*
Hall Probe positioning precision	*10 µm*
Start-up time from cold start till availability for measurement	*< 3 min*
Shut down time	*< 1 min*
Recovery time from an emergency stop	*< 1 min*

Magnetic Field Measurement Specifications:	
Parameter	***Values***
Magnetic field measurement range (full scale)	*±50mT / ± 200mT / ±2T*
Magnetic measurement resolution	*better than 0.1% of the measurement range (full*
Accuracy of the magnetic field measurement	*better than 0.1%*
Measurement sampling rate	*> 40 kSamples/sec, for 3-channels acquisition* *> 120 kSamples/sec, for 1-channel acquisition*