

#### DESCRIPTION

MMS-1A-RS is the high-end version of the SENIS 3axis Magnetic Field Mapping System that allows users to perform a fast, high resolution mapping of magnetic field around permanent magnets, electromagnets and electronic circuit PCBs. The map of the magnetic field can be presented as color coded 1D, 2D or 3D isometric visual displays and as a table of numerical values of the magnetic field and the geometrical coordinates of measured points. The measured data analysis is performed during the mapping of the magnetic field, so that calculated data required for the analysis can be visualized immediately after the mapping.

**MMS-ANALYSIS** is an additional software module of the MMS-1A-RS magnetic field mapper software that can be used for the on-line (during the mapping) and for the offline analysis of the measured data. It visualizes the measured and calculated 3-axis magnetic field data in various, customized and intuitive color-coded displays, and tables.

Due to unique features of the applied fully integrated **3-axis Hall probe**, all three components of the magnetic field are measured simultaneously at virtually same point (field sensitive area is within a  $150\mu m \times 150 \mu m$ ). The Hall probe can be positioned at a very short distance to the magnet surface (<0.3mm). The mapper computer program and its graphical user interface is an extremely easy-to-use-software built on MS Windows platform and NI LabVIEW. Scanning profiles and measured data visualization are fully customizable.

#### **KEY FEATURES**

- On-line and Off-line (historical) visualization and analysis of the 3-axis magnetic field vector measured around permanent magnets of different sizes and geometries (disc, ring, block, segment and rotors)
- User-friendly customization of the measured data visualization and analysis
- Comparison of multiple measured data sets
- Visualization of all three components of the magnetic field, Bx, By and Bz as well as B<sub>xy</sub> (inplane field distribution), B<sub>Total</sub>, B<sub>max</sub>, B<sub>min</sub>, North-South pole
- Visualization of the slope (Inclination and Declination), magnetic field homogeneity, angle error
- Fourier Analysis (FFT) and visualization of the first 10 harmonics, single and total harmonic distortion
- Visualization of the multipole magnetic field number of poles, min, max, average pole width, pole distribution, pole pitch, pitch error, zero crossing
- Visualization of the cracks and inhomogeneity in the magnetized and non-magnetized parts



Figure 1: Magnetic Field Mapper Software with the optional MMS-ANALYSIS Module

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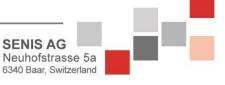
#### **APPLICATIONS – MAPPING OF PERMANENT AND ELECTRO-MAGNETS & PCBs**

Different geometries and sizes of permanent magnets, electromagnets, as well as electronic appliances and PCB's can be easily can be easily positioned and fixed on the mapper table or on the rotary stage to be mapped by an 3-axis Hall probe (magnetic field mapping) or by an eddy-current prob (cracks and inhomogeneity detection) or by a pick-up coil probe (electromagnetic compatibility). The measurement profile, i.e. scanning path, vizualisation and reporting can be setup within minutes using an interactive software graphical user interface and predifined mapping scenarios and commands.



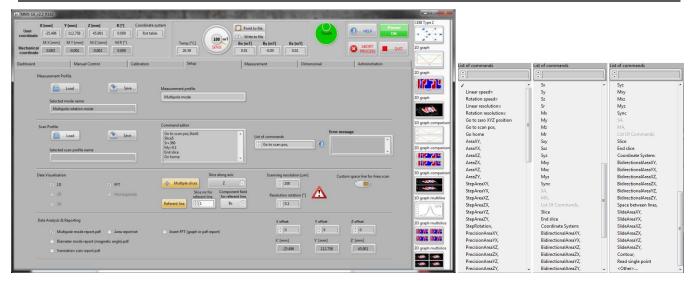
Figure 2: Some samples of permanent magnets, electromagnets, as well as electronic appliances and PCB's that can be easily mapped on SENIS mappers within minutes

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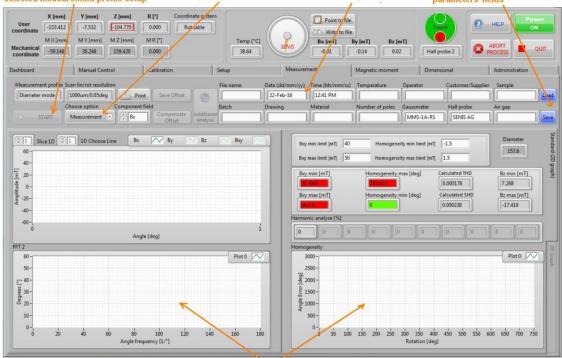


#### **MAGNETIC FIELD MAPPER SOFTWARE**



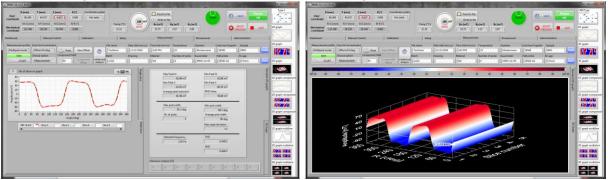
#### Figure 3: Flexible setup of measurement profiles and scan paths using the command set

Start measurement, according to selected presentation mode Measured data & parameters field SaveLoad measured data & parameters fields



Data visualization graphs and measurement data report for selected measurement profile

#### Figure 4: Measurement Tab – Header data set-up and data visualization area



*Figure 5:* Header Data set-up; Measured data and analysis visualization in the Mapper software

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1. DISK AND RIN	NG MAGNETS DIAMETRICALLY MAGNETIZED
Applications: Scanning profile:	Angle and Position Sensors (Automotive, Consumer Industry) Hall probe is positioned at the centre of magnet at the defined height (typically 0.3-0.5mm) and the magnet is rotated by 360° on the rotary stage. The probe can be then positioned at different radii and heights.
Pos. resolution:	0.1°
Mapping duration: Measured data:	
Measured data:	Bx, By, Bxy, Btotal, FFT, Homogeneity (angle error), peak values (N and S)
	By Bx
X [mm] -43.112 Deshboard	
Measurement prof	Analysis, Comparison     Date (dd/mm/yy)     Time (ht/mm/ss)     Temperature     Operator     Customer/Supplier     Sample       Choose option     View component field     Batch     Date (dd/mm/yy)     Time (ht/mm/ss)     Temperature     Operator     Customer/Supplier     Sample       Analisys     Image: All components     Batch     Date (dd/mm/yy)     Time (ht/mm/ss)     Temperature     Operator     Customer/Supplier     Sample       Material     Number of poles     Saussmeter     Hall probe     Air gap
60- 10- 10- 10- 10- 10- 10- 10- 1	Bx, By, Bz, Bxy, Btot       Complete the second secon

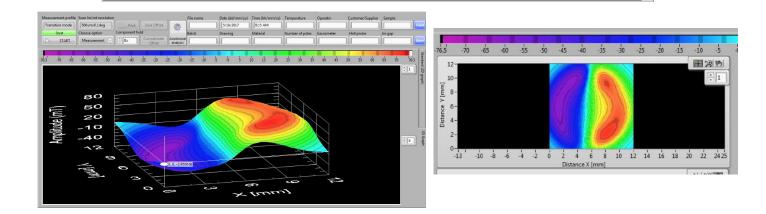


Figure 6: Mapper Software: Visualization of the map around the diametrically magnetized disk and ring magnets

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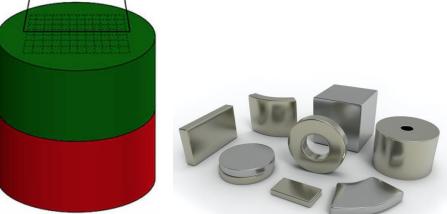
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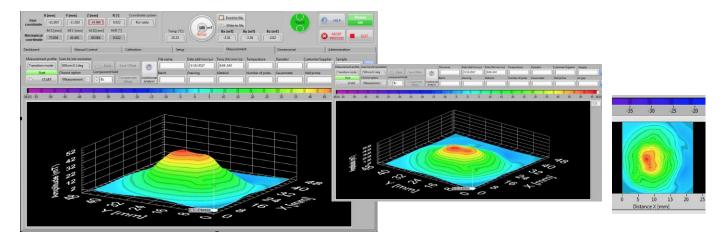
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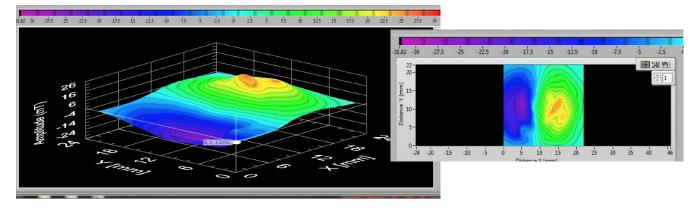


## 2. CYLINDRICAL MAGNETS AXIALLY MAGNETIZED

Applications: Scanning profile:	Angle and Position Sensors (Automotive, Consumer Industry) Hall probe is positioned at the starting position (the corner of the area to be scanned) at the
	defined height (typically 0.3-0.5mm). Then the probe scans the defined area, XY, XZ or ZY. The
	probe can be then positioned at different heights to scan several slices.
Pos. resolution:	0.1mm
Mapping duration:	2min with the positioning resolution of 0.1mm
Measured data:	2D and 3D of Bz magnetic field component







*Figure 7:* Mapper Software: Visualization of the map around the axially magnetized cylindrical magnets

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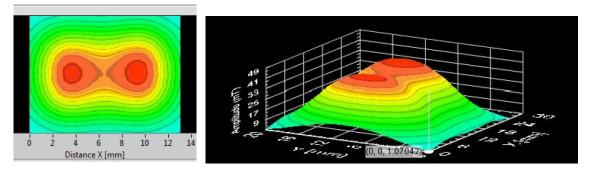


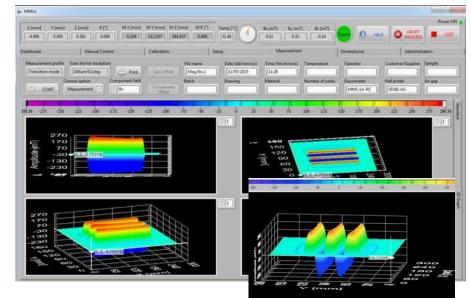


# 3. BLOCK MAGNETS AXIALLY MAGNETIZED

Applications:	Angle and Position Sensors (Automotive, Consumer Industry)		
Scanning profile:	Hall probe is positioned at the starting position (the corner of the area to be scanned) at the defined height (typically 0.3-0.5mm). Then the probe scans the defined area, XY, XZ or ZY. The		
	probe can be then positioned at different heights to scan several slices.		
Pos. resolution:	0.1mm		
Mapping duration:	2min with the positioning resolution of 0.1mm		
Measured data:	2D and 3D of Bx, By and Bz magnetic field components		







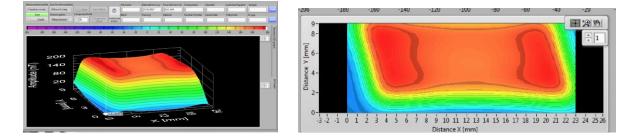


Figure 8: Mapper Software: Visualization of the map around the axially magnetized block magnets

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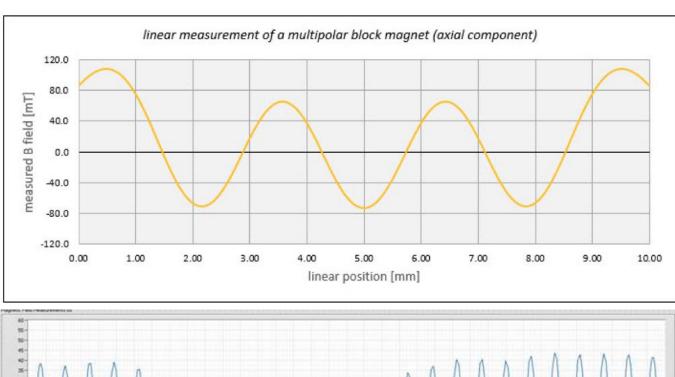
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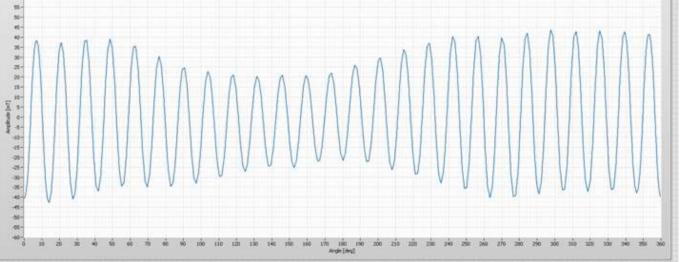
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# 4. LINEAR AND ROTARY ENCODER MAGNETS (SCALES)

Applications: Scanning profile:	Angle and Position Sensors (Automotive, Consumer Industry) Hall probe is positioned at a starting position (edge of the encoder) very close to the magnet surface (0.3mm). The probe is then linearly moved along the encoder length, or the ring magnet is rotated by 360° on the rotary stage.	
Pos. resolution:	0.1mm	
Mapping duration:	: 5sec	
Measured data:	Bz, number of poles, zero-crossings, peak values (N and S), pole disposition, slope	







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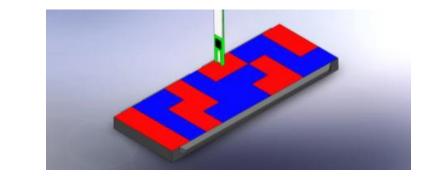
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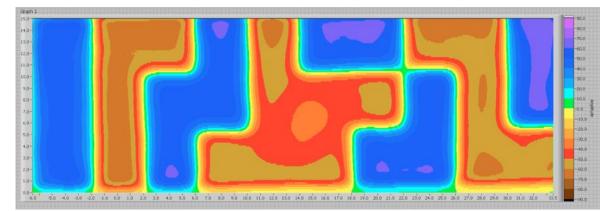




# **5. CODED PLATES**

Applications: Scanning profile:	Position Sensors (Automotive, Consumer Industry) Hall probe is positioned at a starting position (edge of the plate) very close to the magnet surface (0.3mm). The probe is then linearly moved along the plate.
Pos. resolution:	0.1mm
Mapping duration:	5sec (for one line); 3min for the area
Measured data:	Bz, zero-crossings, peak values





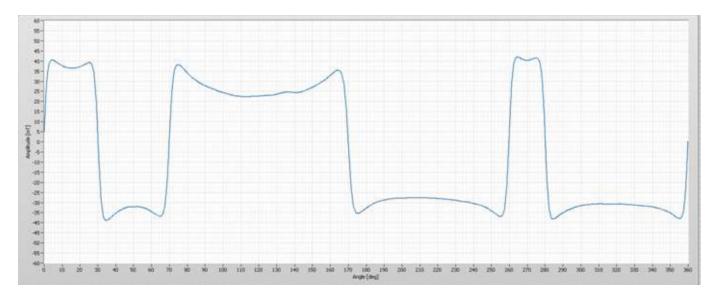
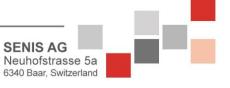


Figure 10: Mapper Software: Visualization of the map above coded plates





#### 6. COMPLEX MAGNETIZATION STRUCTURES – SMART MAGNETS

Applications:Magnets providing spring, latch, align, snap, torque, hold, twist functions for mobile phones,<br/>tablets and industry applications

**Scanning profile**: Hall probe is positioned at the starting position at the defined height (typically 0.3-0.5mm). Then the probe scans the defined XY area in the precision mode. The probe can be then positioned at different heights to scan several slices.

Pos. resolution:high spatial resolution of 10um - 0.1mm (point-by-point and on-the-flight scanning)Mapping duration:5min with the positioning resolution of 0.1mm; hours with positioning resolution of 10umMeasured data:2D and 3D of Bx, By and Bz magnetic field components

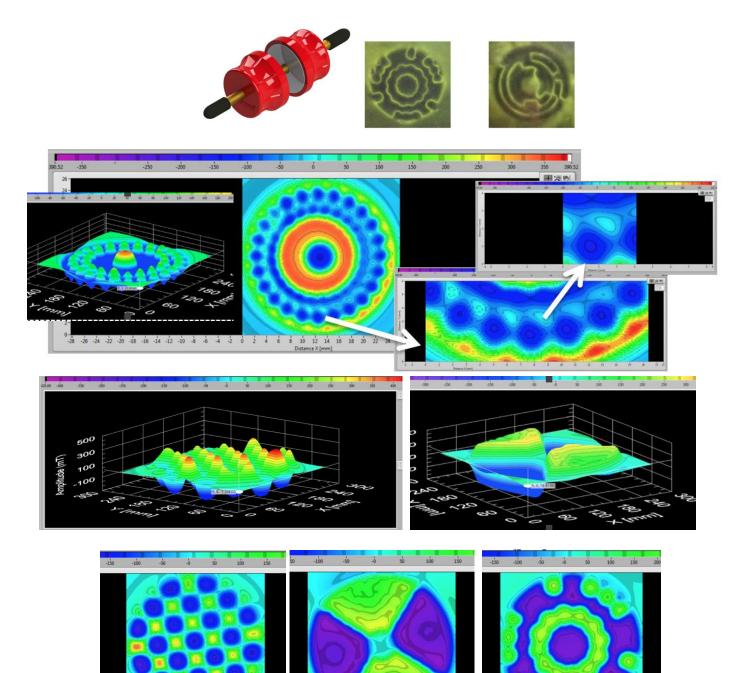


Figure 11: Mapper Software: Visualization of the map above the complex micro structures

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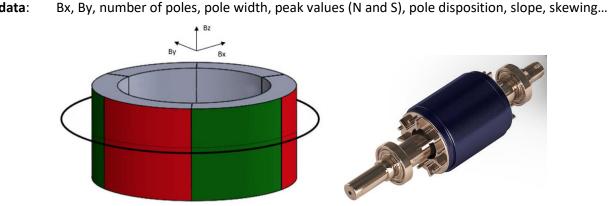
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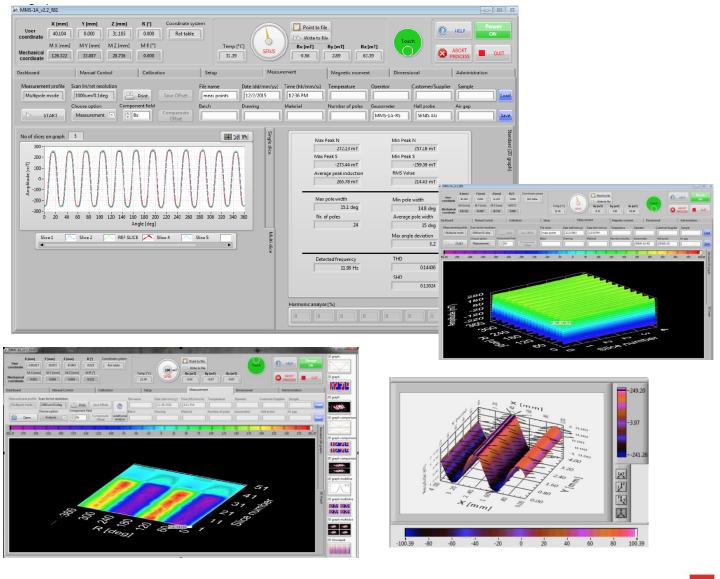


# **7. ROTOR MAGNETS**

Applications:Actuators, Motors (Automotive, Consumer Industry)Scanning profile:Hall probe is positioned next to the rotor at the defined distance (typically 0.3mm) and the<br/>magnet is rotated by 360°. The probe can be then positioned at different heights (slices) to<br/>cover the whole rotor surface.Pos. resolution:0.1°

Mapping duration: 20sec Measured data: Bx, By





#### Figure 12: Mapper Software: Visualization of the map around rotor magnets

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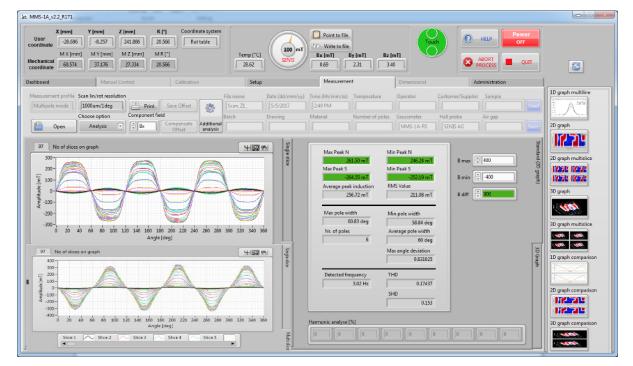


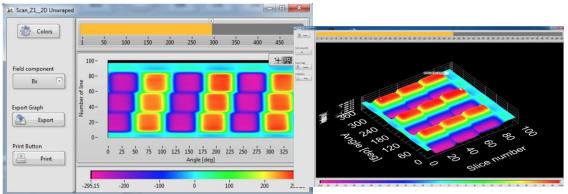
8. MOTORS	
Applications: Scanning profile:	Actuators, Motors (Automotive, Consumer Industry) Hall probe is positioned next to the motor at the defined distance (typically 0.3mm) and the motor is rotated by 360°. The probe can be then positioned at different heights (slices) along the z-axis to cover the whole rotor surface. At the end, the probe can scan the sensor (control) magnet from the top, to calculate the phase shift to the rotor poles.
Pos. resolution:	0.1° - 1°

Mapping duration: 60sec

Measured data: Bx, By, number of poles, pole width, peak values (N and S), pole disposition, slope, skewing...







#### Figure 13: Mapper Software: Visualization of the map around motors

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# 9 MADDING IN THE MOTOR AIR GAD BETWEEN POTOR AND STATOR

9. MAPPING IN	THE MOTOR AIR GAP, BE	TWEEN ROTOR AND STAT	FOR		
Applications: Scanning profile:	the motor is rotated by 360° along the z-axis to cover the (control) magnet from the to	stry is positioned in the air gap bet . The probe can be then positic whole rotor surface. At the en op, to calculate the phase shift	oned at different heig d, the probe can sca	ghts (slie	ces)
Pos. resolution:	1°				
Mapping duration: Measured data:		e width, peak values (N and S),	note disposition, sta	na cka	vina
Measureu uata.	bx, by, number of poles, pole	e width, peak values (N and S),	pole disposition, sio	je, skev	wing
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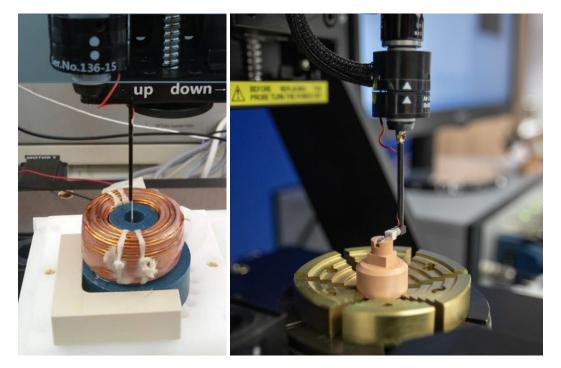
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# 10. AC MAGNETIC FIELD OF ELECTROMAGNETS AND COILS WITH HALL OR INDUCTIVE PROBE

Applications: Consumer Industry / AC magnetic field (MHz)	
Scanning profile:	High-frequency Hall probe or Inductive pick-up coil probe is positioned at the starting position
	at the defined height. Then the probe scans the defined XY area.
Pos. resolution:	0.1mm
Mapping duration:	60min with the positioning resolution of 0.1mm
Measured data:	2D and 3D of Bx, By and Bz magnetic field components down to 100pT



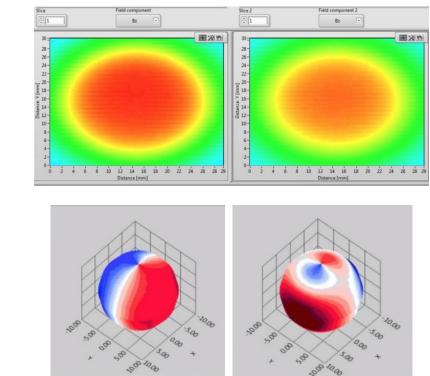


Figure 15: Mapper Software: 2D and 3D Visualization of the AC map around the electromagnet and microcoils

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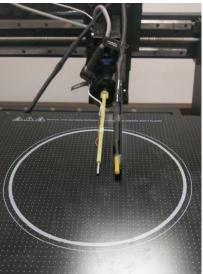


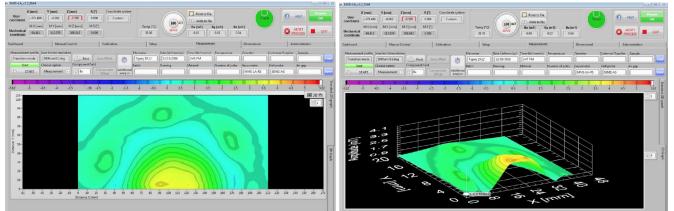


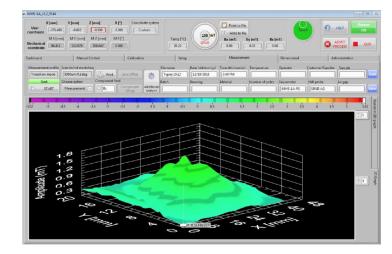
# **11. HIGH FREQUENCY AC MAGNETIC FIELD MAPPING**

Applications:	Inductive heaters, cookers for AC magnetic fields of <b>up to 75kHz</b>		
Scanning profile:	High-temperature, High-frequency Hall probe is positioned at the starting position at the defined height. Then the probe scans the defined XY area. The probe has to be cooled during the mapping due to high temperature generated by heater.		
Pos. resolution:	1mm		
Mapping duration:	15min with the positioning resolution of 1mm		
Measured data:	2D and 3D of Bx, By and Bz magnetic field components		











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#### **12. SMARTPHONES, TABLETS**

Applications: Scanning profile:

#### Smart phones, tablets

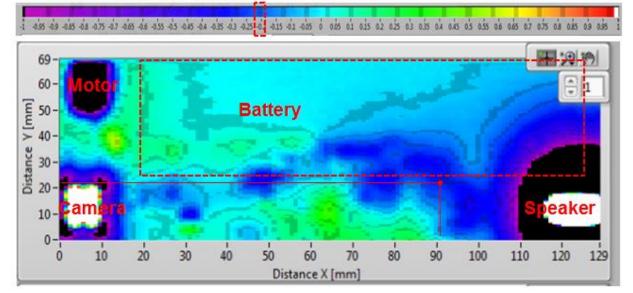
Hall probe is positioned at the starting position at the defined height (typically 0.3-0.5mm). Then the probe scans the defined XY area in the precision mode. The probe can be then positioned at different heights to scan several slices.

Pos. resolution: Mapping duration: Measured data:

high spatial resolution of 10um - 0.1mm (point-by-point and on-the-flight scanning) 1: 5min with the positioning resolution of 0.1mm; hours with positioning resolution of 10um 2D and 3D of Bx, By and Bz magnetic field components



#### Scan Area: 130mm x 70mm



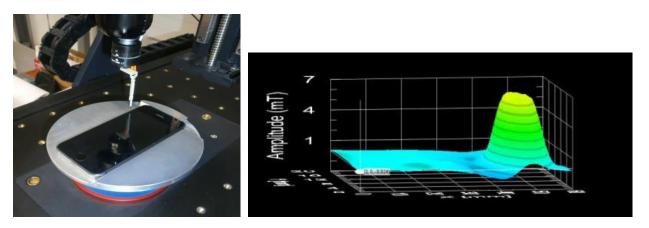


Figure 17: Mapper Software: Visualization of the map above a smartphone

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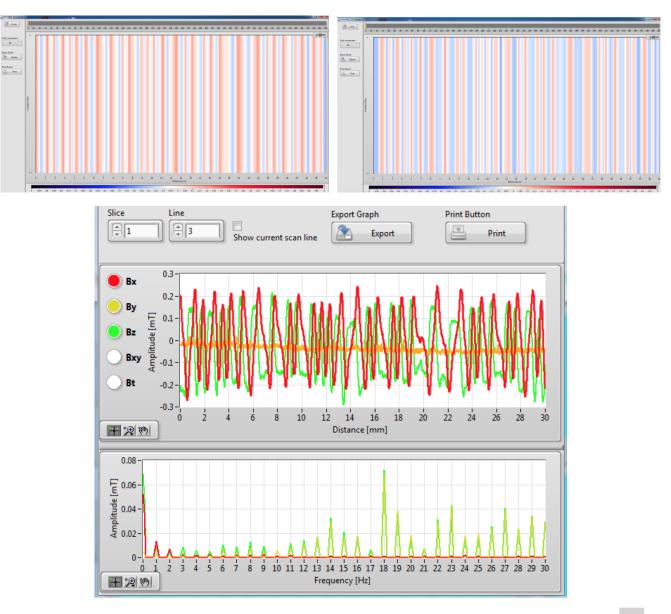
#### 13. LOW-FIELD, HIGH RESOLUTION MAGNETIC FIELD MAPPING

Applications:	Credit cards, barcode strips, low-field coded plates	
Scanning profile:	Hall probe or AMR probeis positioned at the starting position at the defined height (typically	
	0.3). Then the probe scans the defined area, XY.	

**Pos. resolution:** high spatial resolution of 10um - 0.1mm

Mapping duration:2min with the positioning resolution of 0.1mm; 60min with positioning resolution of 10umMeasured data:2D and 3D of Bx, By and Bz magnetic field components





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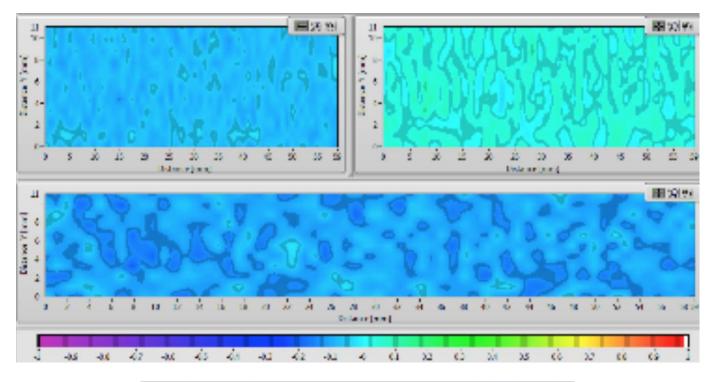
Figure 18: Mapper Software: Visualization of the map above the credit card stripe





## 14. ENVIRONMENTAL MAGNETIC FIELD MAPPING FOR OFFSET CANCELATION

Applications: Scanning profile:	Cancelation of the environmental magnetic field Hall probe or AMR probe is positioned at the starting position without object under test. The defined scanning profile is run and the map of the environmental magnetic field is obtained. This map can be then subtracted as an offset from the map with the object under tes.t	
Pos. resolution:	0.1mm	
Mapping duration:	several minutes	
Measured data:	2D and 3D of Bx, By and Bz magnetic field components	



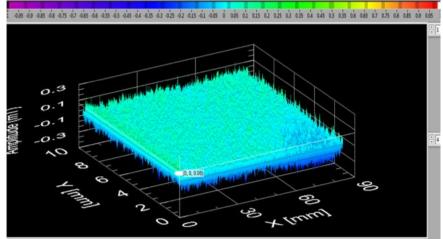


Figure 19: Mapper Software: Visualization of the map of the environmental magnetic field to be used as the offset cancelation

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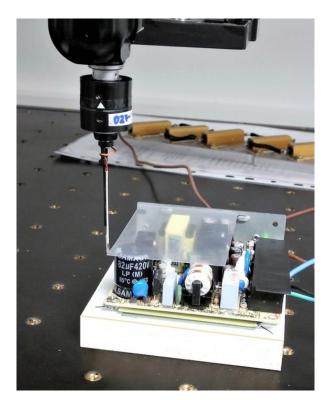


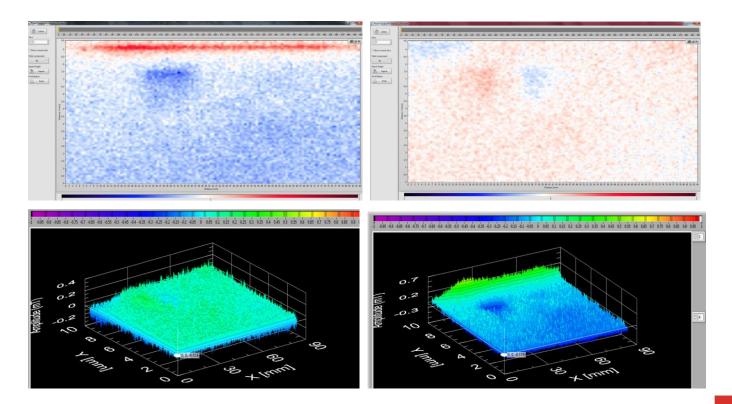




# **15. AC MAGNETIC FIELD AROUND ELECTRONIC PCBs - EMC**

Applications:Consumer Industry / AC magnetic field, EMCScanning profile:High-frequency Hall probe or a miniaturized inductive probe (pick-up coil) is positioned at the starting position at the defined height. Then the probe scans the defined XY area.Pos. resolution:0.1mmMapping duration:15min with the positioning resolution of 0.1mmMeasured data:2D and 3D of Bx, By and Bz magnetic field components





#### Figure 20: Mapper Software: Visualization of the AC map around the electronic PCB of a switching power supply

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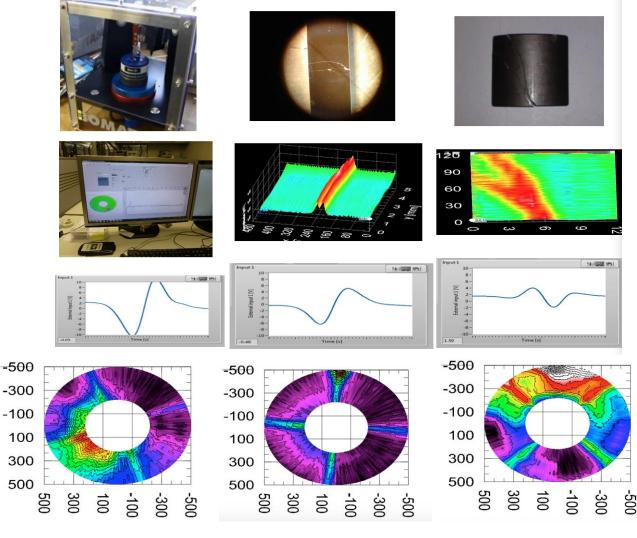


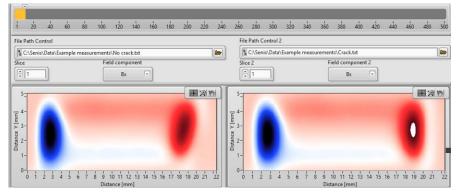
#### **16. CRACK AND MATERIAL INHOMOGENEITY DETECTION**

Applications: Scanning profile: Cracks and material inhomogeneity detection in magnetized and non-magnetized blanks **Eddy-Current probe** is positioned at a starting position very close to the magnet surface (0.2mm). The probe is then linearly moved along the object, or the object is rotated by 360° on the rotary stage.

Pos. resolution:0.1mmMapping duration:5secMeasured data:Eddy-cu

Eddy-current distribution in the measured object that provides the information on cracks or inhomogeneity presence





*Figure 21:* Crack Analysis: Detection and location of cracks and material inhomogeneity in the magnetized and non-magnetized parts by comparing to the eddy-current probe measured data of a reference (GOOD) part

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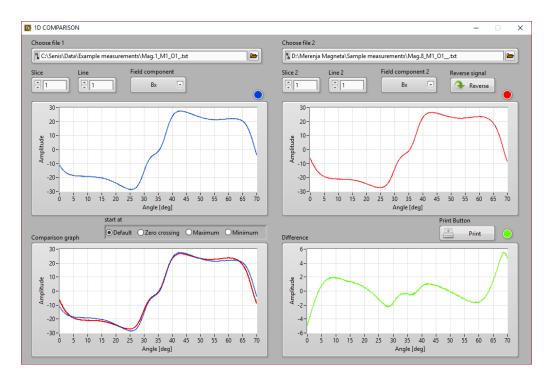
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# **17. MAP ANALYSIS, COMPARISSON**

MMS-1A-RS Magnetic Field Mapper Software includes an ANALYSIS module that allows customized on-line (during the mapping) and the offline visualization and analysis of the measured data. It visualizes the measured and calculated 3-axis magnetic field data in various, customized and intuitive color coded displays, and tables. This software module allows a measured data comparison of several magnetic field maps.



*Figure 22:* **1D Graph Comparison - App: Two or more measurement data-sets are compared, by showing each data separately, then both measured data consolidated on the same graph and the difference between them** 

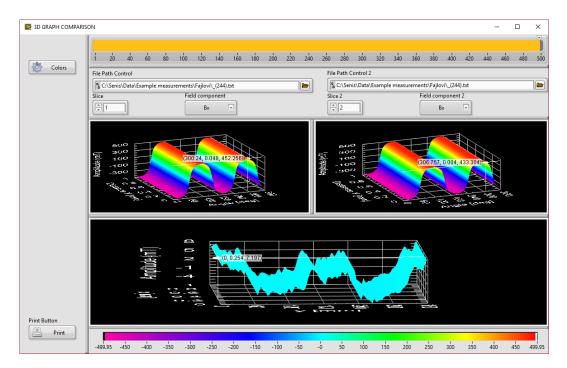


Figure 23: 2D and 3D Graph Comparison - App: Two measurement data-sets are compared, by showing each data separately and by showing the difference between two measurements

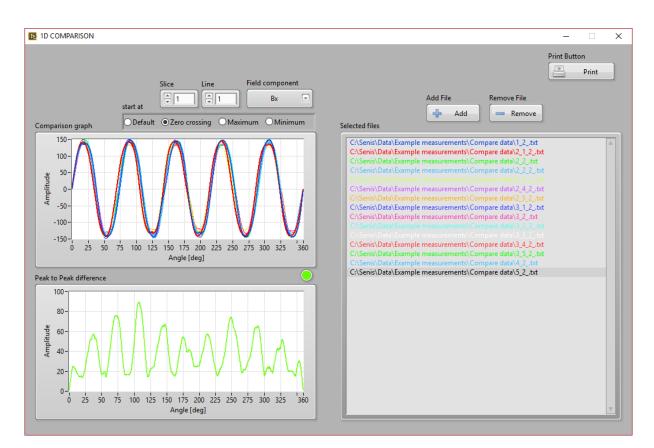
Ref.No.:DS.400.MAPMENU.17
<b>Rev.1.7,</b> 07.02.2019.
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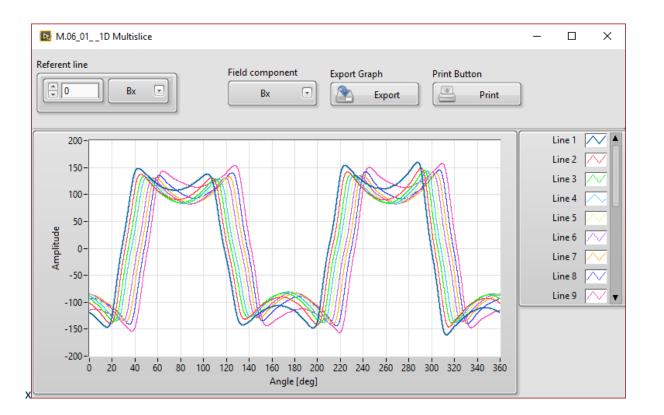
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*Figure 24:* Multi-Graph Comparison - App: Multi-measurement data-sets are compared, by showing each data-set in different colors on the common graph and by showing the largest peak-to-peak difference



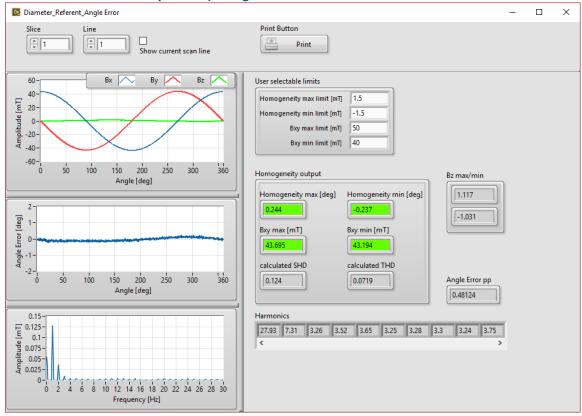
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# Figure 25: Multislice Analysis - App: Analysis of the magnetic field distribution (selectable magnetic field components) along selected number of scanned lines



# *Figure 26:* **Dipole Magnet Analysis - App: GOOD/BAD Analysis based on the thresholds of Angle Error** (Homogeneity), Min/Max values of the magnetic field components and Fourier Analysis

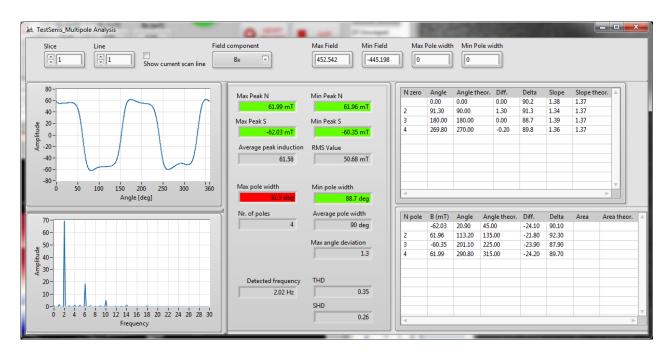


Figure 27: Rotor and Multipole Magnet Analysis - App: GOOD/BAD Analysis based on the magnetic poles distribution and Min/Max values in North/South pole







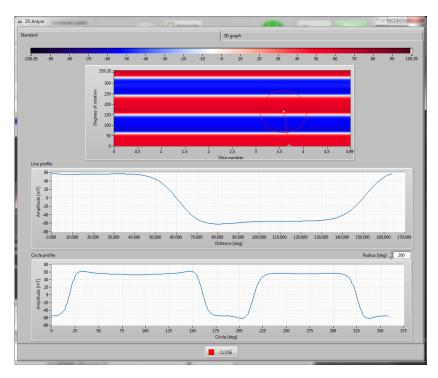
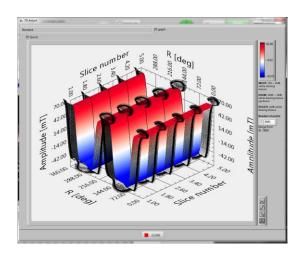
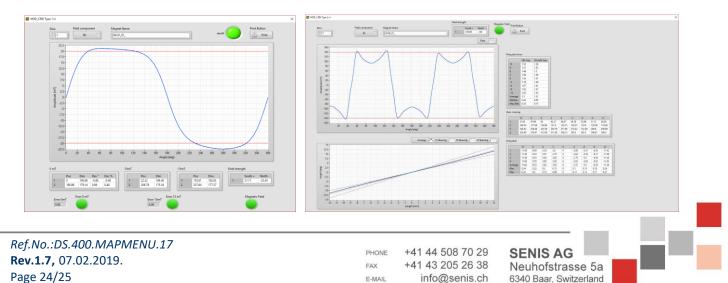


Figure 28: Magnetic Field Analysis - App: Analysis of the magnetic field distribution along a customer-defined line or circle in the unwrapped map







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*Figure 30:* Customized Analysis - App: Analysis of the magnetic field in set points, pole pitch and pitch angle, zero crossing and more

