Magnetic Field Mapper MMS-xI-CMM integrated in commercially available Coordinate Measuring Machine

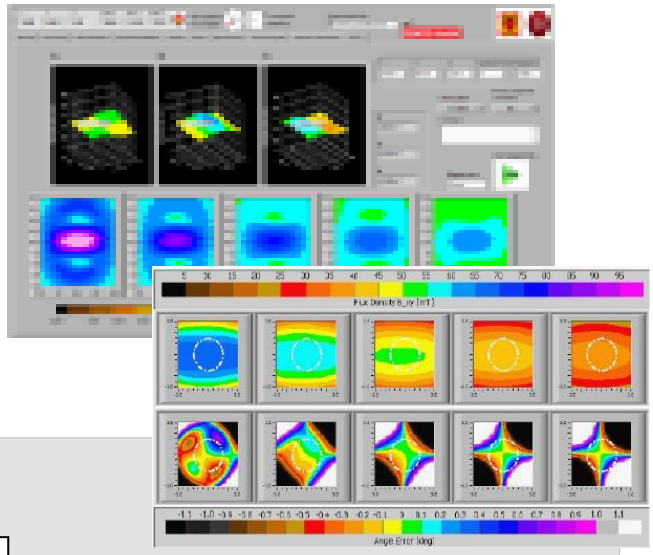
DESCRIPTION:

The Magnetic Field Mapper System MMS-xI-CMM combines commercially available Coordinate Measuring Machine with the SENIS magnetic-field-to-voltage transducer. The SENIS mapper system can be integrated in a newly purchased or in an already existing customer's CMM. The main system components are:

1. Coordinate Measuring Machine (e.g. Carl Zeiss) for automatic positioning of Hall Probes under vector position control and can hence map within a preset distance over a curved concave or convex surface around the permanent magnetic to be characterized.
2. High-resolution magnetic-field-to-voltage transducer, which consists of a 3-axis Hall probes (Bx, By, Bz) and an electronic module for analog signal processing.
3. Multifunction data acquisition system DAQ NI 6212, which receives data from transducer and sends them to a computer. DAQ uses an USB connection to interface the PC.
4. PC that provides reports of the measured magnetic field values together with the corresponding measured coordinates (tables, 2D, 3D isometric displays).

KEY FEATURES:

- **Fast, accurate, three component magnetic field mapping, Bx, By, Bz, with standard CMM vector position control**
- **Mapping volume dimensions are possible up to those offered by commercially available CMM**
- **Permanent magnet and electromagnet fields to +/-2T with frequency response from DC to 2.5kHz**
- **Probe position calibration and mechanical protection is achieved by utilizing standard CMM Touch Probe Holders**
- **Point-to-point and continuous (on-the-fly) magnetic field scanning**
- **Easy to use software, including color coded 2D and 3D isometric representation of magnetic field**



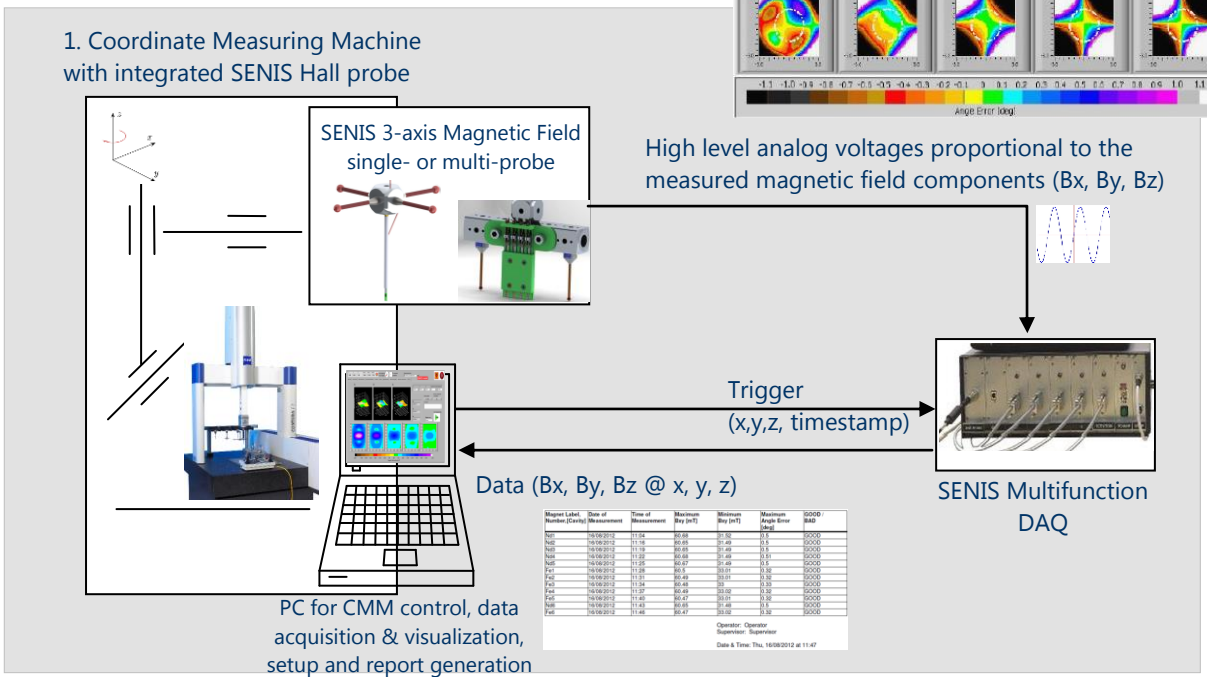


Figure 1: **Block-diagram of the Magnetic Field Mapping System**

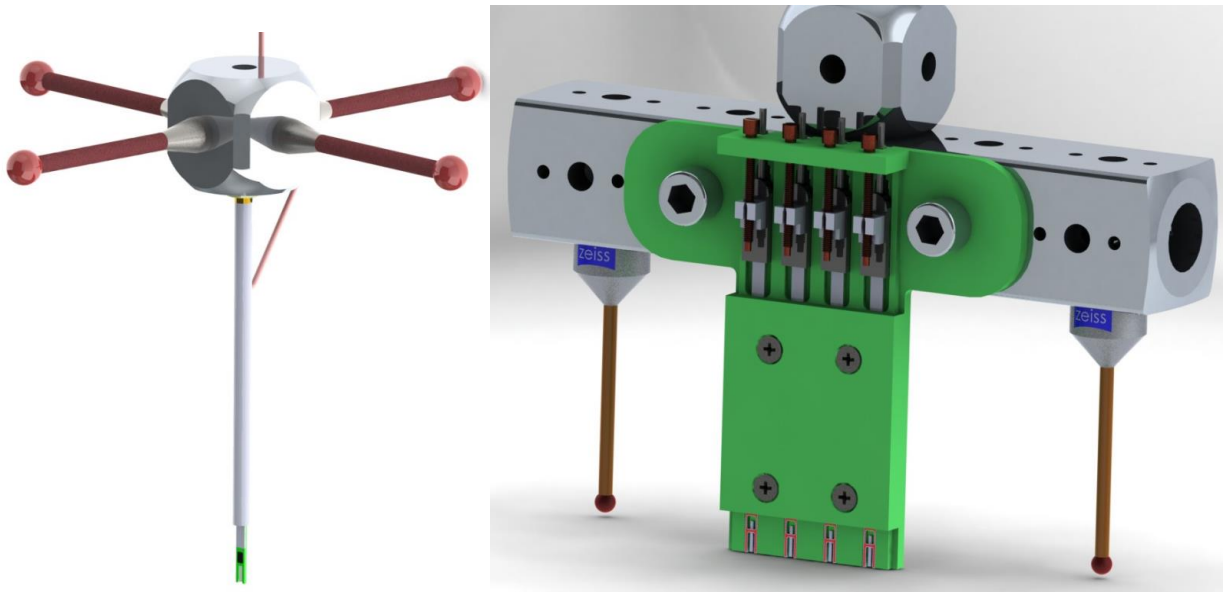


Figure 1. **3-axis single-probe (MMS-1i-CMM) and 3-axis four-probe array (MMS-4i-CMM) mounted on the standard CMM holder together with touch probes**

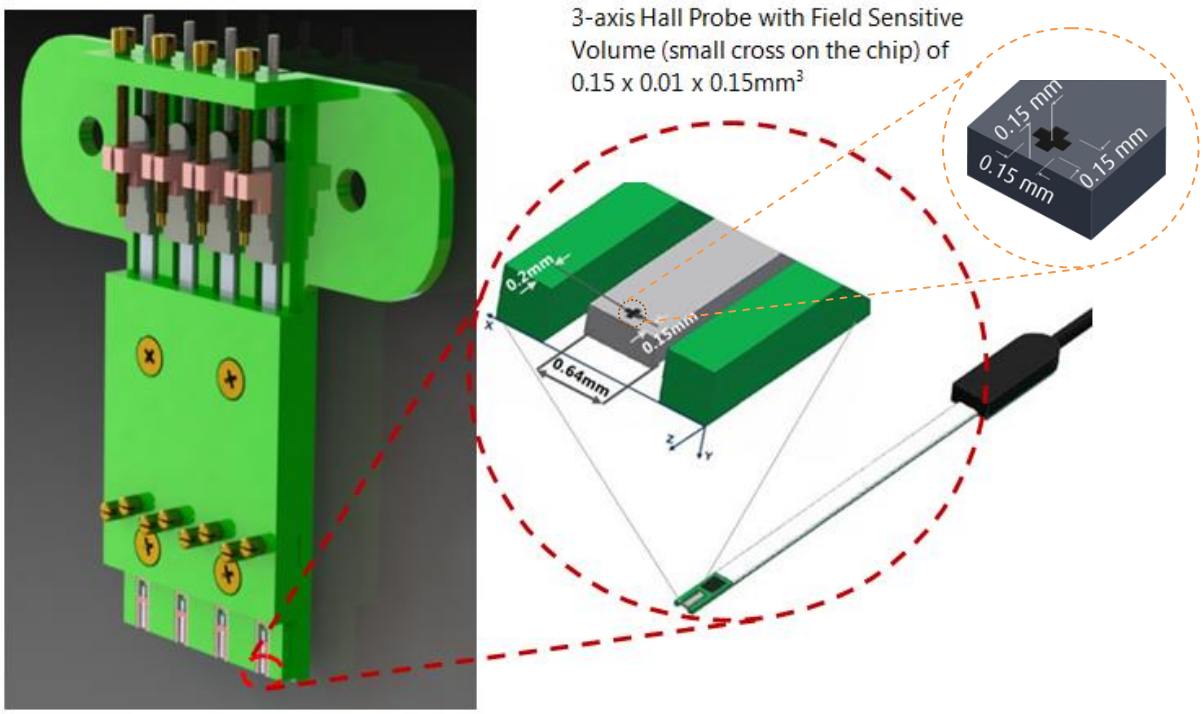


Figure 2. **MMS-4I-CMM Four-Probe Array with four 3-axis fully integrated Hall Probe. The Magnetic Field Sensitive Area can be as close to the measured surface as 0.3mm**

Either a single Hall Probe or a Multi-Probe Array MMS-**x**I-CMM (number of 3-axis Hall probes x = 1, 2, 3, … n) can be used for magnetic field mapping. The geometry of Multi-Probe Arrays can be customized (distance between sensors, sensor disposal, etc.).
Using the fine screws at the top part of the multi-probe array, all probes in the array are vertically aligned, so that their Magnetic Field Sensitive Volumes are colinear. Using the fine screws at the side part of the multi-probe array, all probes can be horizontally adjusted (in x- and y-axis).

While driving the SENIS Probe, the CMM will trigger the magnetic field measurements at SENIS Probe and will acquire analog voltage signals through a National Instruments' NIDAQ acquisition card.

CMM's software generates and exports a table with the measured values - all three position coordinates (X, Y, Z) of the sensitive area of Hall Probe, associated with the three components of the measured magnetic field (Bx, By, Bz) obtained from the Hall Probe.
Standard magnetic field mapper software allows an offline view of the magnetic field maps.

HALL PROBE SPECIFICATIONS:

The fully integrated Hall Probe is a single-chip integrated 3-axis Hall-Probe System. The core of the device represents a silicon sensor chip (based on CMOS technology), which contains Hall elements, biasing circuits, amplifiers, and a temperature sensor. The probe gives a high-level analogue voltage output for each of the three components of the measured magnetic flux density and an analogue voltage output for the chip temperature.
There are a number of different geometries/dimensions of Hall probes available, in order to fulfill a wide range of customer's application requirements.

The unique advantages of the fully integrated probe include:

- **3-axis fully integrated CMOS Hall probe (Bx, By, Bz) with the spatial resolution (By: 0.03 x 0.005 x 0.03mm3; Bx and Bz: 0.15 x 0.01 x 0.15 mm3) and high angular accuracy (orthogonality error less than 0.1°)**
- **Up to four selectable magnetic field measurement ranges**
- **Accuracy of magnetic field measurement: better than 0.1%**
- **Measurement Ranges: ± 20 mT, 50 mT, 100 mT, 200 mT, 500 mT, 1T, 2T**
- **Magnetic Resolution:**
  better than 0.02% for measurement range ≥200mT
  better than 0.05% for measurement range ≤100mT
- **DC and AC field measurements from DC to 2.5kHz (-3dB point); option: up to 25kHz for 3-axis probe and 75 kHz for 1-axis probe**
- **High disturbance immunity**
- **Negligible inductive loops**
- **Virtually no planar Hall effect**

For Probe selection, please see Hall Probes Sections at www.senis.ch

SOFTWARE:

The user-friendly software, based on LabVIEW on MS Windows platform, offers the following features:

- Automatic color coding of magnetic field with appropriate legend
- Report generation
- Measurement range selection
- User defined scanning area and resolution
- Zoom and rotate 2D and 3D image
- Movable cursor displaying X and Y coordinates and corresponding magnetic flux density value
- Calibration Mode

... and much more.

TYPICAL APPLICATIONS:

- Measurement of all three components of magnetic field (Bx, By, Bz), magnetic angle measurement, etc.
- Quality assessment tool in production, for magnet system assemblies
- Development of magnet systems
- AC magnetic field mapping
- Application in laboratories and in production lines, etc.

RECOMMENDED ACCESSORIES:

- Zero Gauss Chamber (ZGC)
- Tools for an in-filed calibration of the Hall probe magnetic field sensitive area position and for the precise determination of the probe's geometry.
  Calibration tool consists of current conducting filament and a CMM touch probe (stylus). The calibration is achieved by mapping of the well-defined magnetic field over the current conducting filament. The obtained positions of magnetic field zero-crossings are then compared to the precisely measured mechanical dimensions of the current conducting filaments; and to the touch probe (stylus). The difference between measured values is used in the software for the automatic Hall probe calibration.