Correction characteristics for ICR magnetic near-field microprobes

Type ICR HV/HH from the company of Langer-EMV Technik GmbH

1. Introduction

ICR near-field microprobes are subjected to a quality test before delivery. Different measurements are carried out on reference set-ups and the resultant correction characteristics generated. Three different types of correction characteristics are determined:

1) Standardized correction characteristic
2) Magnetic field correction characteristic
3) Current correction characteristic

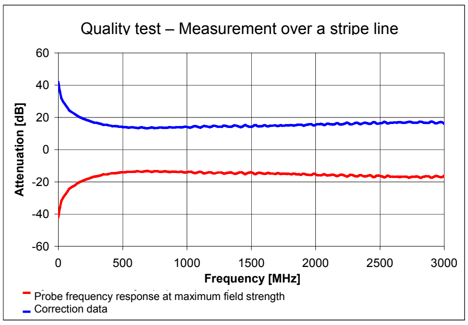
The following provides information on how to measure the characteristic curves and use the correction values for measurement purposes.

2. Measuring the near-field microprobes on a stripe line – probe-specific correction characteristic

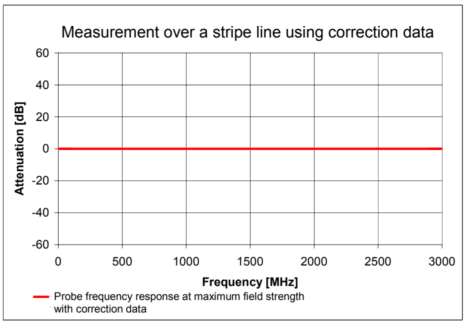
Since the near-field microprobes are characterised by a varying frequency response within a type series due to their design and extreme miniaturisation, they have to be measured over a reference object. The microprobes are thus measured over a stripe line. This allows the frequency response at pre-defined values to be determined.

- Distance between the probe and stripe line
- Design of the stripe line
- Value of the incoming tracking generator voltage at the stripe line
- Setting of the spectrum analyzer

The resultant transfer function is applied to the incoming tracking generator voltage. The result is the 'standardised correction curve'. The data of the correction characteristic can be added to the currently measured data during subsequent measurements. The result from this addition is a relative result relating to the reference measurement. This result can then be compared to the measurements of other microprobes of the same type series.



1st diagram: Transfer function and correction file



2nd diagram: Measured result and correction file over the same reference object

3. Measuring the magnetic field strength – magnetic field correction characteristic

The following describes how to determine the magnetic field correction characteristic for the near-field microprobes which in turn allows the magnetic field strengths to be calculated.
A magnetic field probe outputs a voltage signal U_{Sonde} which is divided into a spectrum by a spectrum analyzer. The characteristic curve of the near-field microprobe's internal amplifier has to be subtracted from this voltage signal and based on the physical correlations the associated magnetic field H_{RF} is determined. The correction factor K_H is defined which describes the correlation between the voltage signal U_{Sonde} and the magnetic field H_{RF}.

The magnetic field strength H_{RF} in the probe coil can be determined based on the voltage signal from the magnetic near-field microprobe U_{Sonde} using the correction factor K_H. In each case of application the correction factor of the near-field microprobe is independent of the measuring geometry, i.e. the probe can be guided at any distance and angle to the current conductor without causing a correction error (Fig. 2). The result obtained is the mean magnetic field which is enclosed by the probe coil (Fig. 1).

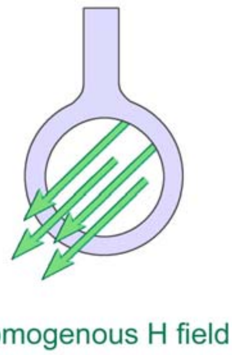


Figure 1: Field strength distribution in the probe coil

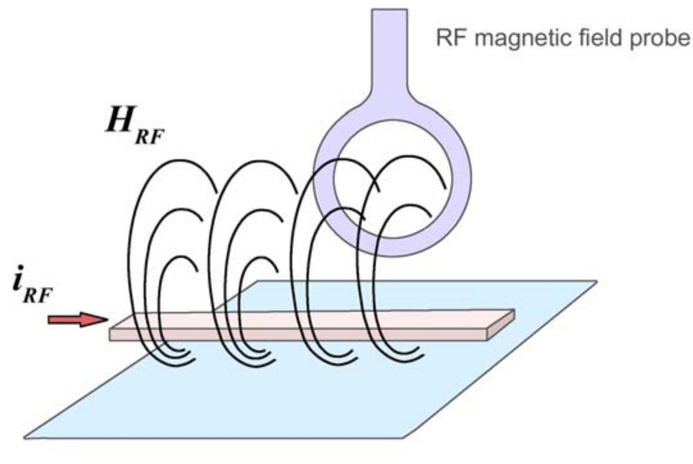


Figure 2: General application set-up

Use of the correction factor K_H in the customized magnitude equation:

$$H_{RF}\left[dB\mu\frac{A}{m}\right]=U_{Sonde}\left[dB\mu V\right]+K_H\left[dB\frac{A}{Vm}\right]$$

Example of how the magnitude equation is used (Fig. 3):

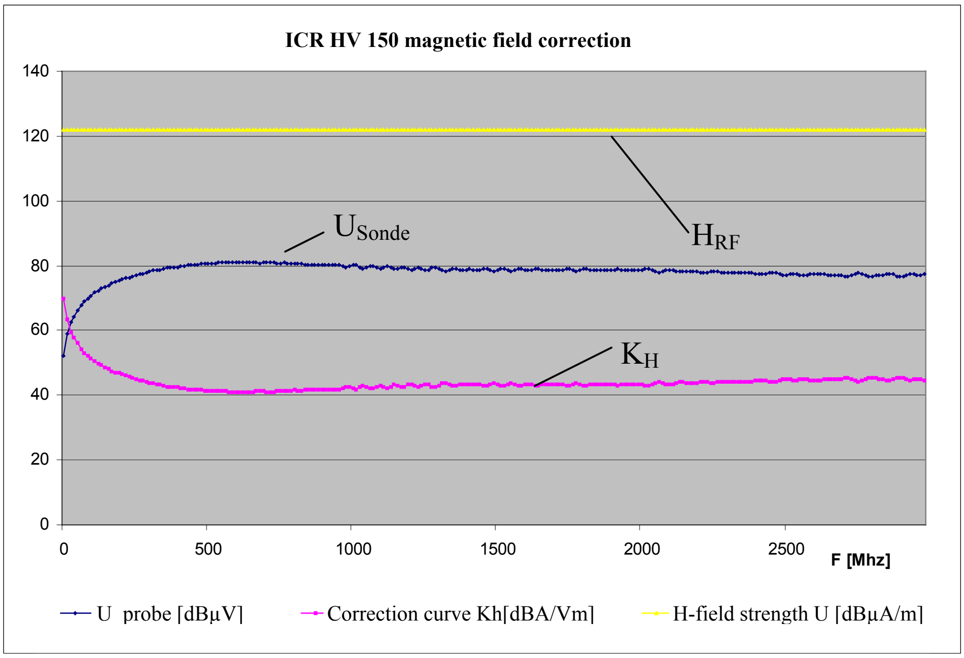


Figure 3: Example of how the magnetic field correction characteristic is used on an ICR HV150

In Fig. 3, the magnetic near-field microprobe is arranged in a magnetic field which is constant over the frequency range of 0 to 3 GHz. Due to the coupling factor and specific probe parameters, the voltage induced in the probe is not constant. The coupling factor mediates between the measured voltage $\boldsymbol{U_{Sonde}}$ and the mean magnetic field strength. The actual magnetic field strength is determined by adding the correction factor to the measured voltage $\boldsymbol{U_{Sonde}}$ (log magnitude equation).

This magnitude equation can then be used to determine the mean magnetic field strength $\boldsymbol{H_{RF}}$ from the measurement curve $\boldsymbol{U_{Sonde}}$ and the correction characteristic $\boldsymbol{K_H}$. The result is shown in Fig. 3.

Interactions which influence the measured result may occur between the probe and the measurement object in certain situations.

4. Measuring the current flowing through a conductor (IC pin) – Current correction characteristic

There is a fixed correlation between the magnetic field $\boldsymbol{H_{RF}}$ and current $\boldsymbol{I_{RF}}$ which depends on the geometry of the current conductor arrangement. The given correction factor $\boldsymbol{K_I}$ thus refers to a defined reference set-up.

The determined current values $\boldsymbol{I_{Korr}}$ are only correct if the geometric parameters in the respective probe application correspond to the reference set-up. The current values $\boldsymbol{I_{Korr}}$ deviate in case of deviations from this set-up. The calculated current value $\boldsymbol{I_{Korr}}$ can then only be used as an orientation value. Appropriately, the current correction characteristics are only determined for the vertical magnetic field probes.

The reference set-up has the following geometric parameters (Fig. 4 and 5):

- Measurement over the pin of a TQFP housing
- Pin width of 0.4 mm and pin distance of 0.8 mm
- Distance of 0.2 mm between the measuring probe and the pin

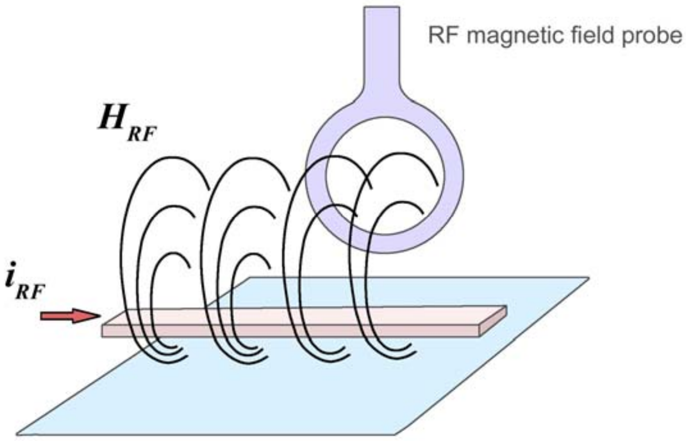


Figure 4: Schematic diagram of the measurement set-up for magnetic field probes

Use of the correction factor K_I in the customized magnitude equation:

$$I_{Korr}[dB\mu A] = U_{Sonde}[dB\mu V] + K_I[dB\Omega]$$

The example was based on a current which is constant over the frequency range (Fig. 5). This current induces a voltage in the magnetic near-field microprobe which is measured as U_{Sonde} by the spectrum analyzer. The frequency-dependent correction factor is added (logarithmically) to the voltage characteristic to maintain the current flow in the conductor. I_{Korr} is the current flowing in the conductor of the reference set-up in dBµA.

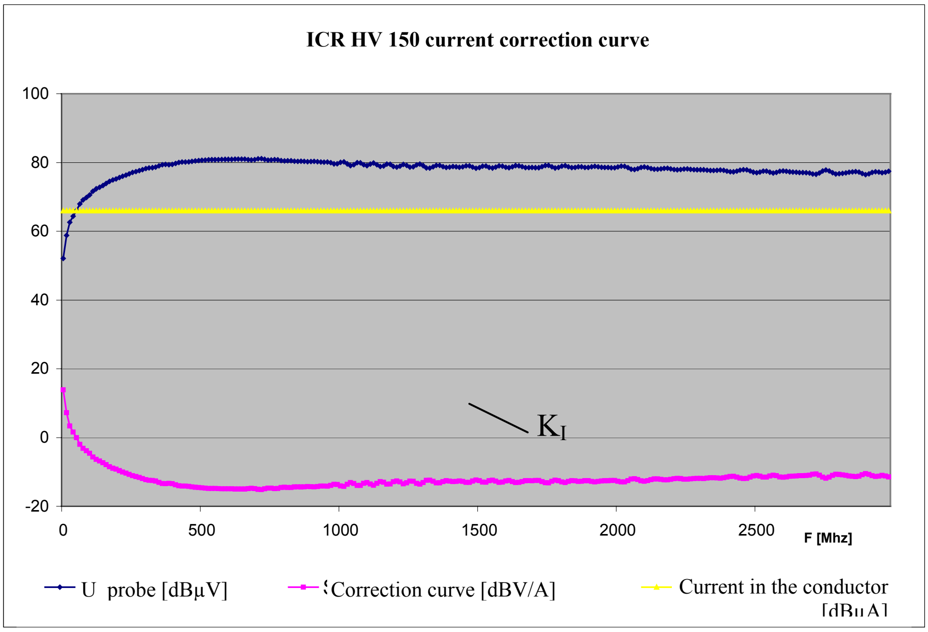


Figure 5: Current correction curve example for ICR HV150

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