Application Note PE011

Field control of an electromagnet with current source and PID controller

Electromagnets are usually powered by a power source. Air coils also have a linear relationship between the current and the magnetic flux density. However, if the magnet has an iron core, the resulting flux density depends on the magnetization characteristic and the remanence of the iron. There is a non-linear relationship between the current and the magnetic flux density. The "prehistory" of the iron core in the form of the remanence ensures that the resulting flux density is additionally dependent on the direction of the current change. Furthermore, the flux density is subject to a temporal change, since the Weiss' districts, the elementary magnetic particles, do not all align themselves immediately. Even minutes after a change in current, Weiss' districts are still reversing.

All these problems can be avoided by superimposing a magnetic field control on the current control. A Hall probe in the air gap of the magnet measures the flux density in the air gap. A PID controller in the magnet's power supply compares the actual value from the analog output of the teslameter with the setpoint, which is e.g. delivered from a PC.

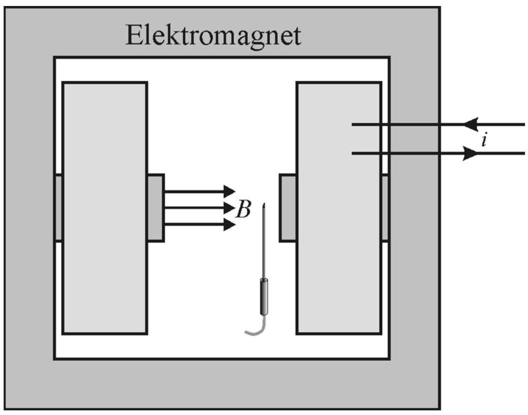

Figure 1 Electromagnet with probe for field control

With this method, the current is no longer specified. The setpoint is used to directly specify the flux density in the air gap of the magnet. As a first approximation, the linearity is only dependent on the teslameter. In the case of the FM 205 with AS-NTM probe, the linearity error is a maximum of 0.5%. For higher requirements, we recommend the FM 3002 with a linearity error of 0.01% and a temperature coefficient of <10 ppm / K.

In principle, all Tesla meters from the company Projekt Elektronik GmbH are suitable for this type of field control, since all devices are equipped with a "fast" analogue output.

Since every field value, including field value 0, can be compensated with this method, our Teslameter FM 205 with AS-UAP probe has a special task. The device measures not only small magnetic DC and low-frequency alternating fields, but with the field control can also compensate for interference fields. This method improves e.g. the sharpness of electron beam microscopes.

Compensation of interference fields

In high-precision magnetometers or electron microscopes, the influence of external magnetic fields is disturbing. This can be the Earth's magnetic field, but also the interference field generated by railway systems, machines, tools, etc. With the help of compensation coils, these interference fields can be compensated. The coils are used to set up a magnetic field directed against the interference magnetic field. In order to be able to correct the compensation coils correctly, it is necessary to be able to react to the smallest possible field changes in the vicinity of zero. With our Teslameter FM 205 with AS-UAP probe, you can measure disturbances that range from approx. 100 nT to several µT. The coils are regulated via the analog output of the FM 205 basic unit.

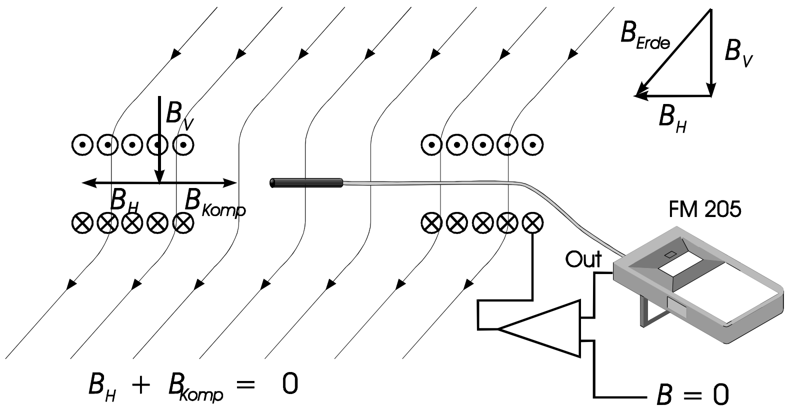

Figure 2 Compensation of an external magnetic field

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