APPLICATION NOTE

Applications of Single-axis Fluxgate Magnetometers

Medical physics

The Magnetic Resonance Imaging (MRI) equipment used in medical physics requires the generation of stable magnetic fields, and is therefore susceptible to interference from external fields. This might be caused by radio frequency interference, lower frequency interference from electrically-operated equipment - such as lifts within the same building - or from electric trains, even at a considerable distance. It is standard practice to survey an area prior to installation of this sensitive equipment to record the variations in the magnetic field, and thereby select a site with the least disturbance, or to establish the level of magnetic shielding required.

Radio frequency interference can usually be reduced sufficiently by shielding. In MRI installations using a closed magnet system the critical magnetic field of MRI equipment is normally along a single axis, so a Mag-01(H) sensor can be used with the probe aligned along this axis where the equipment is to be installed, and the readings monitored manually or by means of a chart recorder over a period of time.

General physics

There are many areas where low magnetic fields are required and the Earth's field needs to be cancelled. This is often done using pairs of Helmholtz Coils to oppose the vertical and horizontal components of the environmental field. In many applications a reduction to 10% of the Earth's field is sufficient, and this can be achieved by applying constant currents to the coils. The Mag-01 single axis magnetometer can be used to monitor vertical and horizontal components in turn while the appropriate coil currents are adjusted to achieve zero field. This technique is known as active shielding with open loop control.

This technique is employed where low energy electrons or ions are used such as in electron microscopes and photo electron spectrometers.

Induced and residual magnetisation

The high permeability of some magnetic materials can concentrate the field in which they are placed by several thousand times. Magnetic materials can be divided into two groups: magnetically soft materials, which show a high-induced field but do not become permanently magnetised, as in transformer core material; and magnetically hard materials, which will remain magnetised, as used for permanent magnets. It is often necessary to detect the presence of magnetic components or any residual field that they may possess. This can be important in instrument and transducer manufacture where magnetic fields play a part in the measurement process, as in flow meters or linear displacement transducers.

The Mag-01 and Mag-01H are ideal instruments for the measurement of induced and residual magnetisation. It is possible

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to determine if a material is magnetic by measuring the magnetisation induced by the Earth's magnetic field. If the magnetometer probe is mounted in a horizontal position with the sensor East-West then the field will be normal to the probe and the magnetometer will read zero. If a sample of magnetic material is then brought close to the East or West end of the probe, the field will be distorted and the magnetometer will measure the component of the field produced along the magnetic axis of the probe. In this way soft magnetic materials can easily be distinguished.

If a component has a residual magnetic field then it will exhibit a North and South pole, and the field will vary positively and negatively about the mean value if the component is rotated close to the probe. For the measurement of weakly magnetised components this measurement should be done within a magnetic shield to eliminate the effects of induced magnetisation. Bartington Instruments can supply magnetic shields for this purpose.

Air transport of magnets or magnetised material

In air transport, an item which has a strong magnetic field can influence the magnetic compass of an aircraft and a measurement of the magnetic field at a distance from any point on the surface of a package is necessary to determine if a package complies with air transport regulations. If a sensor is held in an East-West position and the package is rotated in all directions at a distance along the magnetic axis of the probe, the maximum magnetic field can be determined. For some applications an array of sensors at varying heights with a switch box (available from Bartington Instruments) may be required.

Cryogenics

Cryogenic probes are available for operation down to liquid helium temperatures. These probes have a very low power dissipation and the leads have a soldered connection for connecting through a cryostat or vacuum vessel.

Magnetic shield efficiency and integrity

Metallic magnetic shields are often used to generate a zone of zero magnetic field. Examples are to be found in bioelectromagnetics, palaeomagnetics etc. The Mag-01 is used to quickly and accurately measure the strength of any small background field remaining within the chamber.