

6. Analyzers for Measuring Low-Frequency Magnetic Fields with regard to human exposure

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The magnetic field measuring sets described in this paper extend the Wandel & Goltermann range of field measurement equipment into the low-frequency sector. In contrast to the high-frequency radiation monitors in the EMR range, the EFA-1 and EFA-2 Field Analyzers are designed for standardized measurement of alternating magnetic fields in the frequency range 5 Hz to 30 kHz. With the EFA range, it is now possible to check the limit values of low-frequency magnetic fields quickly and accurately.

High accuracy, reproducible results and standardized measurement on the one hand, simple operation, easy handling and low-cost on the other hand -- these are the requirements which must be met by modern field measurement equipment. The EFA-1 and EFA-2 measuring sets fulfil all these requirements and offer a range of practical test functions into the bargain.

Measurements simplified by ease of use and clarity of result display

The instruments are menu-driven and have the minimum number of keys needed for operation. This means that even untrained personnel can make rapid and effective use of all of the measurement functions. The large, back-lit LC display allows all measurement parameters to be displayed simultaneously, giving an optimal overview of the measurement in progress. The measured value is displayed in large digits, along with a bargraph for indicating trends in the field strength. The essential information from the measurement can thus be seen at a glance.

Precise measurement and wide dynamic range: Essential for standardized measurements

Field strengths of 10 nT to 10 mT can be measured in 6 ranges to an accuracy of 3% when the external precision B-field probe is used. Since the basic exposure to magnetic fields on a day-to-day basis is around 50 nT to 70 nT, and that WHO (World Health Organisation) considers that continuous exposure to a magnetic field strength of 5 mT (frequency 50 Hz) is dangerous to health, it is clear that these instruments cover all the relevant field strength ranges.

EFA-1 and EFA-2 use fully isotropic detection, calculating the equivalent field strength from the geometric mean of the individual field components. The equivalent field strength can be calculated on the basis of the real r.m.s. value or from the detected peak value. The individual field components are additionally displayed as a percentage of the equivalent field strength to make it easier to determine the direction of the main field strength vector. Unidirectional field detection mode can also be selected. To simplify location of the maximum field strength occurring in a given area, a procedure which is practically essential for demonstrating that specific limit values are not exceeded, the display can be set to MAX HOLD with the bar graph updated continuously.

The instruments are calibrated at Wandel & Goltermann in a reference magnetic field which is traceable to the German PTB standard. The recommended annual recalibration of the instrument is no problem as special calibration software allows the instrument to be calibrated by any calibration laboratory equipped with the necessary equipment.

Wideband or selective ?

The EFA range of instruments allow both wideband and selective measurements of field strength. This feature is unique in instruments of this type. The analyzers have four wideband

ranges with lower frequency limits of 5 Hz and 30 Hz and upper limits of 2 kHz and 30 kHz. Frequency-selective investigations of the magnetic field can be undertaken in the range from 15 Hz to 2 kHz with the aid of digital signal processing which allows interference fields of specific frequency to be suppressed. This means that, for example, 16 2/3 Hz fields can be analyzed in the presence of superimposed 50 Hz fields. Built-in filters for 16.7 Hz, 50 Hz, 60 Hz, 100 Hz and 400 Hz, with their second and third harmonics are provided for this purpose. The required filter is selected by function key and indicated on the display.

The built-in frequency counter is of great assistance when determining fields of unknown frequency. It automatically indicates the frequency of the signal with the highest field strength to an accuracy of 1 Hz when a wideband measurement is made. Fields within the entire frequency range up to 30 kHz can thus be traced and, if required, more precisely investigated in the selective range up to 2 kHz.

Exchangeable field probes for flexibility

The instruments come complete with a built-in isotropic magnetic field probe, allowing magnetic field measurements without external sensors. The traceable accuracy of this probe is 6%, which is very good considering the size and location of the probe. For standardized measurements, an isotropic magnetic field probe with an effective electrical cross-section of 100 cm² which conforms to IEEE 1308/IEC 61786 is available. A small (30 mm), flexible isotropic probe can also be connected to the instruments for determining localized field distributions. Since the induced voltage is directly dependent on the area and mechanical precision of the probe, the most precise measurements (3%) are achieved using the large IEEE 1308/IEC 61786 probe. The type of probe connected is detected by the instrument automatically, and the correction data corresponding to this probe is then applied when calculating the results.

The probes are calibrated during production and are effectively screened against the influence of electrical fields. This ensures that the measurement data obtained is precise and reliable.

Alarm function: Monitors limit values

Workplace safety considerations require that specific limit values are not exceeded. Instruments used for demonstrating this must therefore include a monitoring function. The EFA range of instruments is equipped with visible and audible alarms which are triggered when a programmed threshold is exceeded.

Interfaces: The link to a PC

As well as the interface for the external probe, the instruments are fitted with a serial optical interface which can be configured just like a PC serial interface. The measurement results can be transferred on-line via this interface to a printer or a PC with the aid of a PC Transfer Set consisting of an opto-electric converter and fiber optic cable. Changes in field strength can thus be observed on the PC from a "safe distance".

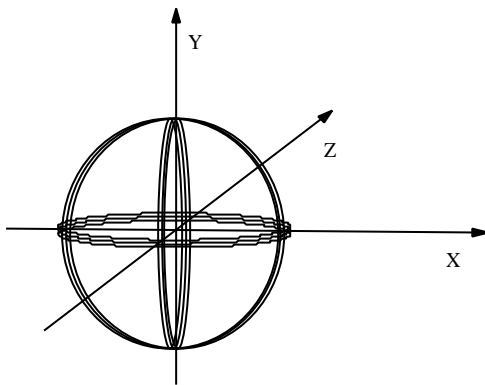
EFA-2: More practical features

In addition to the features of the EFA-1, the EFA-2 includes functions which make it easier to "survey" a magnetic field. Alongside automatic measurement range selection, it is possible to set any filter frequency between 10 Hz and 2 kHz with an accuracy of 0.1 Hz for selective field measurements.

As the magnetic field strength is proportional to the current generating the field, changes in the current are reflected in the field strength. Observing these changes in field strength over a long period of time is often essential if a measurement is to have any meaning. The EFA-2 allows automatic recording of measurement values over a period of up to 24 hours. The measurement parameters of start time, time interval and stop time can be programmed to practically any required value. A maximum of 2000 complete sets of measurement data can

be stored during an automatic measurement. A set of measurement data includes all the parameters relevant to later reconstruction of the measurement. The measurement is controlled by the instrument's built-in clock. The stored results can be transferred to a computer for evaluation using the optical interface.

The EFA-2 can also store four instrument settings for instant recall. The instrument can thus be programmed for certain measurements in advance, so that no time is wasted on-site in setting it up: Simply switch on, select the pre-set, and measure.



Triaxial detector coil geometry. EFA-1 and EFA-2 calculate the equivalent field strength from the geometric mean of the individual field components.

Construction of a new high-voltage power line involves a few hurdles. Once plans are made public, intensive discussion of the project can ensue, given the current sensitivity to issues related to the environment and electromagnetic pollution. During this stage, it helps if the utility company can supply substantial technical data. Once this hurdle is surmounted, procedures for obtaining the necessary right of way and specifying actual plans can begin. This stage sometimes encompasses environmental compatibility testing.