Microtron
Flexible electronic solutions

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Safety Test Solutions®
an L3 Communications Company

Magnetometer

HP-01

Conforms to EMF Directive 2013/35/EU

Analysis of static and time-variable magnetic fields

- **Field exposure evaluation according to current standards and regulations such as Directive 2013/35/EU for workplaces**
- **Frequency-selective and wideband measurement of magnetic fields from 0 Hz to 1000 Hz**
- **Non-directional (isotropic) measurement with orthogonally arranged Hall sensors**
- **Extremely wide measurement range from 10 µT to 10 T (dynamic range 120 dB)**
- **FFT spectrum analysis and time response display**
- **Narrow band filter for standard compliant measurement in the range 0 Hz to 1 Hz**
- **Optical interface for control by PC or NBM-550 (not yet supported)**

Magnetometer HP-01

APPLICATIONS

The Magnetometer HP-01 is a device for measuring static magnetic fields and time-variable fields of frequencies up to 1000 Hz. Its main application is in the measurement of high static fields with the aim of ensuring the safety of personnel who have access to areas where such fields are present. The possible risks are due to indirect effects, such as the force exerted on ferromagnetic objects. As a consequence, hazards can result from flying objects (projectile effect), or from the force exerted on passive implants, or from functional impairments in active implants. These must be identified and avoided. Risks can also occur due to direct effects when the magnetic flux density is very high and movement of the body within the field results in stimulation of sensory cells or nerve cells. Exposure limit values are laid down in the ICNIRP Guidelines and in the European Directive 2013/35/EU among other regulations. The action levels depend on the source of the hazard, ranging from relatively low values (e.g. 0.5 mT for effects on active implants) up to very large values of several Tesla. Typical areas where high fields are present are:

- Magnetic resonance tomography (MRT)
- Magnetic resonance spectroscopy (MRS)
- Use and production of strong permanent magnets such as lifting magnets
- DC generators, particularly superconducting
- DC motors, e.g. in railroads
- Applications involving electric vehicles
- Large industrial magnetic stirrers
- Electrolysis used in the production of chlorine and aluminum

Figure 1: Particularly high static magnetic fields are generated by magnetic resonance tomography (MRT)

Figure 2: Static magnetic fields are also present in DC powered railroads

FUNCTION

The exposure level limits and action levels specified in guidelines and standards cover a wide range of values. This would usually mean that several different measurement probes would be needed in order to achieve the necessary measurement dynamic range. The HP-01 easily covers all these applications with its built in Hall effect sensors, which have an unusually wide overall dynamic range from 10 µT to more than 10 T. Additional measurement probes are not needed. The orthogonal arrangement of the sensors in the tip of the probe wand ensures that the three spatial axes are captured completely, guaranteeing an isotropic (non-directional) measurement. The sensors are located approximately 7 mm below the tip of the wand and are indicated by a clearly visible groove.

The HP-01 is much more than just a magnetometer probe, however. It includes a very powerful FFT analyzer that allows signal analysis in both the time and the frequency domains. The fast signal processing allows detailed, highly accurate gap-free analysis of the frequency spectrum. The results can be displayed as a live spectrum, as a spectrogram versus time, or as a three-dimensional waterfall diagram.

The “DC – 1 Hz” operating mode is a further special feature that is particularly suitable for standard-compliant measurements according to human safety standards. The limit values are usually specified for static fields and variable fields with frequencies of up to 1 Hz. A finite impulse response (FIR) filter used in the HP-01 captures just these frequency components. The measurement is made using a high sampling rate and delivers the corresponding wideband value for the 0 Hz to 1 Hz range, which is required in order to demonstrate compliance with the limit values. If required, more extensive analysis in the sub-Hertz region can be performed from the time domain display of the instantaneous values. This would not be possible in this way from the FFT analysis.

The HP-01 is operated using the HP01-TS software supplied, which is compatible with all Microsoft Windows ® based PCs running Windows 7 or above. An optical cable with USB adapter links the measuring device to the PC. The measurement can therefore be controlled from a safe distance of up to 10 m. This can be extended to 50 m with cables, available as options.

Figure 3: Connector side of HP-01 with tripod adapter attached

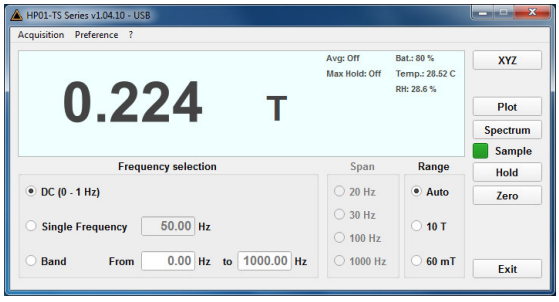

Figure 4: Main window with display of measurement parameters and numerical result

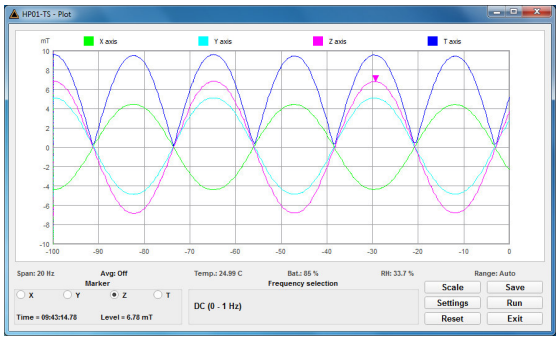

Figure 5: Time response display of a sine wave signal in the sub-Hertz range in DC-1Hz operating mode

MEASUREMENTS USING A PC

The graphical user interface of the HP01-TS PC Software is arranged very clearly and is easy to use. The main window (Figure 4) is displayed when the program starts. The main settings such as measurement range and frequency range are made in this window. The display area continuously shows the numerical value of the magnetic flux density measurement result, separately for the three spatial axes if required. Click on the “Zero” button to trigger a zero adjustment that reduces measurement uncertainty to a minimum. For this, the probe tip is placed in the zero field chamber supplied, to exclude effects due to the earth’s magnetic field or other fields. Three different modes enable selection of frequency ranges for static fields (DC to 1 Hz), or for any single frequency, or for band integration with settable frequency limits.

In addition to the numerical display of the measurement value, the time response of the magnetic flux density can also be shown and evaluated graphically. The graph shows the time response of the RMS value for each of the three spatial axes and the isotropic total value. A constant sine wave signal appears as a continuous horizontal line. In “DC - 1 Hz” mode, the instantaneous value is shown instead of the RMS value, i.e. a sine wave signal is also shown as a sine wave (Figure 5). This means that even the frequency and amplitude of signal components below 1 Hz can be determined.

FFT analysis represents the spectral distribution of the signal as an amplitude spectrum (Figure 6). The spectrums are shown for the three separate axes as well as for the isotropic total value. The frequency range can be adapted in four stages by appropriate selection of the “Span”. Two markers are provided to simplify result evaluation. It is also possible to show the variation in the spectrum over time graphically, either as a spectrogram (Figure 7) or as a waterfall diagram (Figure 8).

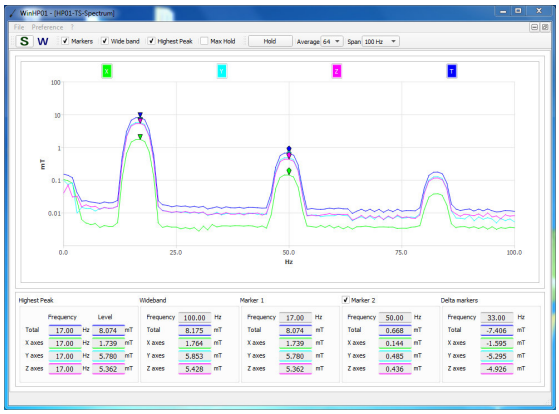

Figure 6: FFT analysis with display of amplitude spectrum

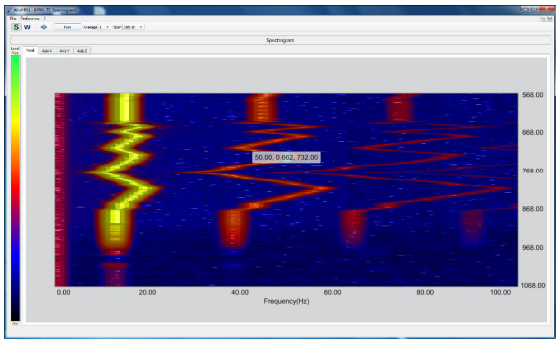

Figure 7: FFT analysis with spectrogram display

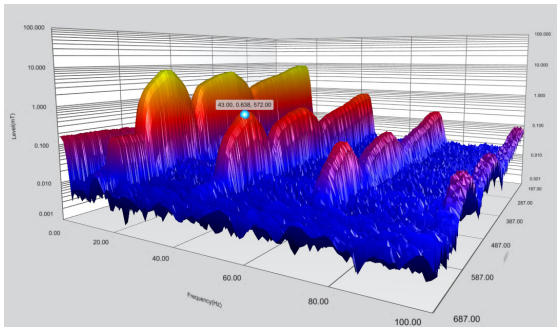

Figure 8: FFT analysis with spectrum displayed as a waterfall diagram

SPECIFICATIONS [a]

HP-01 Magnetometer						
Frequency range		DC (0 Hz) to 1000 Hz				
Probe type		Magnetic (B) field				
Field sensor		Triaxial orthogonal Hall effect devices (temperature compensated) Simultaneous triaxial acquisition Sensor area approx. 0.6 mm x 0.6 mm (10 T), approx. 0.15 mm x 0.15 mm (60 mT)				
Measurement range [b]	Auto Range	±10 µT to ±10 T	(units: mT, T, G, kG)			
	60 mT	±10 µT to ±60 mT	(units: mT, G)			
	10 T	±0,010 T to ±10 T	(units: T, kG)			
Overload		20 T				
Dynamic range (after zeroing)		120 dB (Auto Range)				
Resolution	60 mT range	100 nT (Span 20 Hz and 30 Hz), 1 µT (Span 100 Hz and 1000 Hz)				
	10 T range	100 µT (Span 20 Hz and 30 Hz), 1 mT (Span 100 Hz and 1000 Hz)				
Displayed average noise level (DANL) [c]		10 µT				
Flatness of frequency response		0.5 dB (typ.)				
Expanded measurement uncertainty [d]		±1 %				
Temperature response		0.05 % / °C typ. (@ 0 Hz referred to 23°C)				
Temperature and humidity meter		Internal sensor, temperature: -20 °C to + 55 °C, humidity: 5 % to 95 % RH				
DC MODE						
Frequency range		0 Hz to 1 Hz				
Filter		FIR filter, cut-off frequency 1.0 Hz (-3 dB)				
Result display		Numerical result display and time plot (instantaneous value vs. time)				
Reading update time		67 ms				
Result type		Instantaneous value, maximum hold, averaging (linear)				
FFT MODE						
Spectrum analysis		Real-time gapless [e] FFT				
SPAN (selectable)		20 Hz	30 Hz	100 Hz	1000 Hz	
	Frequency range	0 – 20 Hz	0 – 30 Hz	0 – 100 Hz	0 – 1000 Hz	
	Resolution	0.2 Hz	0.3 Hz	1 Hz	3 Hz	
	RBW (-3 dB)	0.8 Hz	1.2 Hz	4 Hz	10 Hz	
Result display		• Spectrum (full Span), spectrogram, waterfall (3D) • Numerical broadband value with selectable cut-off frequencies, time plot (RMS vs. time) • Single frequency and time plot (RMS)				
Reading update time		< 350 ms				
Result type		Actual value (RMS), maximum hold, averaging (RMS)				
OPERATION						
Measurement control and display		Via PC (not included) and supplied software HP01-TS or via NBM-550 (this function is not yet available)				
Supported operating systems		Microsoft Windows® 7, 8/8.1, 10				
Data interface		Serial optical interface (115200 Baud) with optical converter to USB				

a Unless otherwise stated, these specifications apply for the reference condition: ambient temperature 23 °C, relative air humidity 50 %
b For each single axis. Positive and negative at static fields (DC)
c After zeroing. DANL is frequency and SPAN depending. The specified performance is referred to 0 Hz and SPAN 20 Hz
d At static fields (DC)
e Overlapping for Span 20 Hz, 30 Hz and 100 Hz

GENERAL SPECIFICATIONS		
Fastening thread		1/4-20UNC-2B (tripod thread on underside of device)
Power supply	Battery	Li-Ion, rechargeable (3.7 V / 250 mAh)
	Operating time	6 hours
	AC/DC charger	100 to 240 V AC / 47 to 63 Hz, 12 V / 1.5 A, fits all AC line connectors
	Charging time	2.5 hours (typ.)
Temperature range	Operating	-20 °C to +55 °C
	Charging	0 °C to +40 °C
	Storage	-30 °C to +75 °C
Humidity range	Operating	5 to 95 % relative humidity, non-condensing
Size	Basic unit	Sensor stick: Ø 9 mm, L 143 mm; Main body: Ø 43 mm, L 57 mm; Overall length: 200 mm
	Carrying case	120 mm x 365 mm x 305 mm
Weight		Basic Unit: 100 g; Complete set with carrying case: 1.65 kg
Recommended calibration interval		24 months
Country of origin		Italy

ORDERING INFORMATION

HP-01 Magnetometer		Part number P/N
HP-01 Magnetometer Set DC-1kHz Includes: - HP-01 Basic Unit - Zero Gauss Chamber - AC/DC Battery Charger - Cable, FO Duplex (1000 µm) RP-02, 10 m - Cable, FO Duplex (1000 µm) RP-02, 25 cm - O/E Converter USB, RP-02/USB - Conical Tripod Support - HP-01 / NBM Adapter - Software CDROM including User's Manual - Certificate of Calibration - Carrying Case		**2405/101**

OPTIONAL ACCESSORIES	
Tripod, Non-Conductive, 1.65 m with Carrying Bag	**2244/90.31**
Tripod Extension, 0.50 m, Non-Conductive	**2244/90.45**
Cable, FO Duplex (1000 µm) RP-02, 2 m	**2260/91.02**
Cable, FO Duplex (1000 µm) RP-02, 5 m	**2260/91.09**
Cable, FO Duplex (1000 µm) RP-02, 20 m	**2260/91.03**
Cable, FO Duplex (1000 µm) RP-02, 50 m	**2260/91.04**

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