



5 Hz to 32 kHz

EFA-300 Field Analyzer

For Isotropic Measurement of Magnetic and Electric Fields



- ◆ **Evaluation of Field Exposure Compared to Major Standards and Guidances (selectable)**
- ◆ **Shaped Time Domain (STD) – an innovative technique for signal-shape-independent field measurements**
- ◆ **Fast Fourier Transform (FFT) Spectral Analysis**
- ◆ **Peak Value Measurement with Proper Phase**
- ◆ **Large-Capacity Data Storage**
- ◆ **Remote Control**

Applications

The EFA-300 is an ideal field analyzer for measuring magnetic and electric fields in the workplace and in public spaces. It is designed for professional users in the power industry, at municipal utilities, by insurers, and for health and safety professionals in industry. In the low frequency range, it handles virtually any required measurement, simply and precisely. This instrument provides field analysis using an FFT computation in addition to measuring magnetic and electric fields. The innovative STD mode opens up further application areas. With this new mode the measurement results for magnetic and electric field strength are displayed as a Percent of Standard, regardless of the signal shape. This mode enables fast and reliable measurement and evaluation of the typical fields where complex, non-sinusoidal signals are common, e.g., in industrial applications that use resistance welding. Resistance welding issues surface in the traditional 50/60 Hz systems as well as in the newer medium-frequency switching units.

Basic Operation

The EFA-300 has a built-in, isotropic, magnetic field probe. Optional external probes can be used to handle other applications. For example, an isotropic B-field probe with high sensitivity and a large (100 cm²) cross-sectional area is available for the standardized measurement of dissimilar magnetic fields.

For measurements in hard-to-reach places, a miniature 3 cm diameter B-field “sniffer” probe is available.

The EFA-300 includes a cubic-shaped, isotropic, E-field module. This E-field module contains both the sensor and circuitry that allows it to be operated independent of the base unit. The base instrument, or a computer with the EFA-TS remote software, can be used to read results in real-time and control the functions of the module. In the data-logging mode, the E-field module can be operated independently. Stored data can be read and analyzed at a later date using a computer and the EFA-TS software. The major advantage of operating the E-field module remotely is that it greatly reduces the influence of the human body on the electric field you are trying to measure.



EFA-300 Field Analyzer

Operating Modes

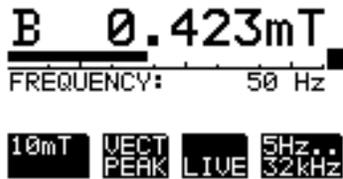
Various standards and guidances take into account the fact that signal shape plays a major role in determining the workplace limit. For example, in Germany the employer's liability insurance association guideline on "Electromagnetic Fields" specifies different evaluation guidelines for different field shapes. Stationary sinusoidal and pulsed fields are differentiated. Occasionally both the RMS value and the peak value, (with proper phase) are critical for assessing exposure in the low-frequency range.

This new generation of equipment greatly simplifies the measurement process. Besides measuring the RMS and peak values with the classic filter technique, the EFA-300 includes the highly innovative mode known as STD (Shaped Time Domain). With this new mode, both instruments achieve a new standard in simple but reliable measurement, even in very complex environments. A standard's variation with frequency can be automatically taken into account and normalized. Field strength results are provided in a "Percent of Standard." Knowledge about the signal shape, frequency, or frequency-dependent limits is no longer needed.

For individual frequency and field strength analysis, a very fast FFT (Fast Fourier Transform) mode, which includes evaluation of harmonics, is available as an option.

Field Strength Mode

Selective and Broadband Field Strength Measurements



In many practical applications, such as proximity to high-voltage lines and transformer stations, this measurement is simple and produces accurate results. If the field under test has essentially a single frequency component, the broadband mode is the best choice. A broadband measurement of the magnetic field in the frequency range from 5 Hz to 32 kHz is made using the built-in isotropic probe. The Model EFA-300 can also be used to measure the electric field with the external, cube-shaped E-field module.

For more precise analysis or multi-frequency fields, band pass and band reject filters are available in the frequency range of 15 Hz to 2 kHz with user-editable filter lists. Operation is configured to allow fast switching between common settings, e.g., broadband and bandpass filter.

In broadband mode, the large, backlit display provides measurement and frequency results simultaneously.

Two plug-in, B-field, probes extend the range of possibilities. The small "sniffer" probe has a 3 cm diameter while the larger, more sensitive probe, has a 100 cm² cross-sectional area.

Users can choose between RMS and peak value measurement from less than 1 nT to 31.6 mT. The EFA-300 can also measure the E-field from less than 1 V/m to 100 kV/m.

STD (Shaped Time Domain) Evaluation Mode

Innovative Technique for Signal-Shape-Independent Field Measurements

In many situations, detailed knowledge of the field, test equipment and other auxiliary conditions are necessary to obtain insight into the degree of exposure when using traditional measurement equipment. Standardized evaluation entails complicated analysis. However, the new and innovative "Shaped Time Domain" technique simplifies the process.



The frequency dependency of standards is automatically incorporated when using shaped-frequency-response measurements. Suitable detectors are provided for measuring the RMS and peak values. The analysis takes into account the phase of the individual components.

The B- or E-field is measured over the entire frequency range up to 32 kHz in real time and displayed as a Percent of Standard.

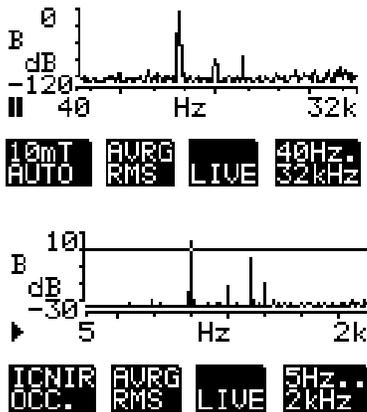
STD analysis is not limited to specific signal shapes. Signals with one or more frequencies and pulsed signals are no problem. Pulsed signal measurements are possible since the time-domain limits (e.g., those specified for selected pulsed signals) can be directly converted into frequency-domain limits. Proper evaluation in a personal safety context is achieved quickly and reliably using the STD technique.

To evaluate the field, six limit curves (standards) are stored in the device. A simple download procedure can be used to update the instrument to cover new standards.

Spectrum FFT Mode (Optional)

Spectrum analysis considerably simplifies the process of quickly evaluating multi-frequency signals up to 32 kHz. All spectral components are evaluated at once.

To provide a spectrum, the signal curve versus time is recorded via the probe and converted into the frequency domain using a mathematical procedure known as "Fast Fourier Transform."



The EFA-300 is so powerful that even transient events ranging up to 2 kHz can be analyzed in real time.

Evaluation is supported by graphics to clearly show the frequency spectrum and by cursor functions with frequency and level indications. The RMS and peak values of the nine most significant frequency components are easy to read.

You can also use this mode to normalize the display to a given standard. The measured value is then displayed relative to its associated standard. In visual terms, the frequency-dependent standard becomes a straight line. This makes it easy to determine the relevancy of each spectral component.

Harmonic Analysis Mode

(Included with Spectrum FFT Mode)

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F1:400.6Hz
B1:1.002uT
K2:0.0912%  K8:0.03339%
K3:0.0426%  K9:0.0222%
K4:0.0414%  KT:0.1303%
K5:0.0387%  KN:3.9004%
K6:0.0773%
K7:0.0222%
    
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This mode enables fast, convenient evaluation of the harmonic spectrum. A table lists the field strengths of the measured fundamental frequency along with up to 8 harmonics.

This feature is very useful for a “hands-off” verification of power quality (“Quality of Service”) in addition to occupational safety applications.

Remote And Data Analysis Software EFA-TS

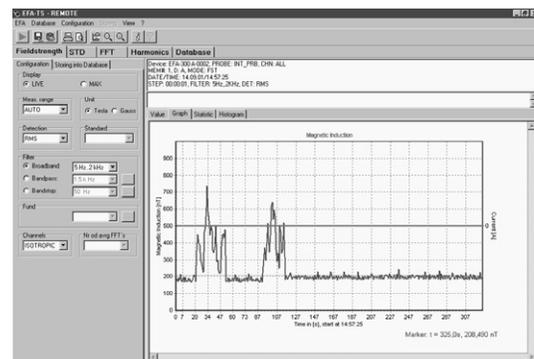
This optional software is used to:

- Provide remote control of the field analyzer and data readout
- Download the data stored in the device
- Save acquired data on the computer

- Analyze the data and provide a graphic representation of the results to support the user in the preparation of measurement reports

FEATURES

- Windows® interface to configure the instrument and/or to control it remotely.
- Graphic representation of data stored in the internal memory of the instrument or in a file:
 - Line diagrams show field strength or Percent of Standard versus time. Can be used in real time.
 - Display of spectrum
 - Bar graph of harmonics
 - 2D-views with import possibility: background maps for Matrix-data sets
 - Graphic tools – zoom, marker, set-up for scale, color/thickness of lines, etc.
- Additional Analysis Functions:
 - Statistics – mean and maximum values, histogram, and number of values over a defined threshold
 - Peak list for spectrums
- Export Functions
 - Data sets as ASCII-files
 - Graphic screen into the clipboard



MINIMUM SYSTEM REQUIREMENTS

- Microsoft® Windows® 95 or Higher
- Windows NT® 4.0 or Higher
- Pentium Processor
- Min. 4 MB RAM
- Graphic card VGA 640/480, 256 colors
- CD-ROM



Specifications

		MAGNETIC (B-) FIELD			ELECTRIC (E-) FIELD
		100 cm ² Probe	Internal Probe	3 cm Probe	
Sensor System		Coil (internal or external)			Plate Electrode
Measurement Axis, selectable		Tri-Axial (Isotropic) or Single Axis			
FIELD STRENGTH MODE					
Frequency Range		5 Hz to 2 kHz, 30 Hz to 2 kHz, 5 Hz to 32 kHz or 30 Hz to 32 kHz			
Bandwidth		Broadband (+0/-3 dB), selectable			
Filter		Band Pass / Band Reject Filter, adjustable			
Detection, selectable		RMS (averaging time 1 sec.) Peak Value (proper phase)			
Measurement Range	Nominal	100 nT to 32 mT	100 nT to 32 mT	100 nT to 32 mT	10 V/m to 100 kV/m
	Damage Level (Peak)	91 mT ^a @ ≤125 Hz	91 mT ^a @ ≤625 Hz	91 mT ^a @ ≤625 Hz	280 kV/m
Damage Level (Peak)	Damage Level (Peak) ^a For magnetic field probes depending on frequency				
Noise Level (RSM), typical	Broadband, 30 Hz to 2 kHz	4 nT	100 nT	20 nT	0.7 V/m
	Broadband, 5 Hz to 32 kHz	10 nT	200 nT	50 nT	4.5 V/m
	Band Pass Filter, 50 Hz to 400 Hz	0.8 nT	25 nT	5 nT	0.14 V/m
Uncertainty, typical ^b	Broadband, 5 Hz to 2 kHz	±3% @ ≥40 nT	±5% @ ≥1 μT	±4% @ ≥200 nT	±3% @ ≥5 V/m
	Broadband, 5 Hz to 32 kHz	±3% @ ≥80 nT	±8% @ ≥2 μT	±5% @ ≥400 nT	±3% @ ≥40 V/m
	Band Pass Filter, 50 Hz to 400 Hz	±3% @ ≥10 nT	±5% @ ≥250 nT	±4% @ ≥50 nT	±3% @ ≥1 V/m

^a The upper limit decreases linearly with increasing frequency above the mentioned frequency.

$$\text{Overload limit for } 100 \text{ cm}^2 \text{ Probe} = \left(\frac{8000 \text{ mT} \cdot \text{Hz}}{\text{Frequency}} \right) \cdot \sqrt{2}$$

$$\text{Overload limit for } 3 \text{ cm and internal Probe } 100 \text{ cm}^2 \text{ Probe} = \left(\frac{40000 \text{ mT} \cdot \text{Hz}}{\text{Frequency}} \right) \cdot \sqrt{2}$$

^b Uncertainty includes all partial uncertainties (absolute, linearity, frequency response, and isotropy) as well as temperature and humidity related deviations. Signal sinusoidal, level >10% of selected measurement range; additional uncertainties apply with the steep frequency band limits.



	MAGNETIC (B-) FIELD			ELECTRIC (E-) FIELD
	100 cm ² Probe	Internal Probe	3 cm Probe	
EXPOSURE STD MODE				
Frequency Range (+0/-3 dB)	5 Hz to 32 kHz			
Exposure Evaluation	Compared to Standards Stored in Meter ^c			
Measurement Range / Overload Limit	200%	200%	200%	200%
Noise Level, typical ^d (for ICNIRP Occupational)	<0.4%	<2%	<1%	<5%
Uncertainty, typical (percent of reading) ^b	±4%	±9%	±6%	±4%
SPECTRUM FFT / HARMONICS MODE (Optional)				
Frequency Range	5 Hz to 2 kHz 40 Hz to 32 kHz			
Fundamental Range (HARMONICS only)	10 Hz to 400 Hz 10 Hz to 10 kHz (Option, FFT 5 Hz-32 kHz)			
Resolution by Marker:	2 kHz Range	0.01 Hz		
	32 kHz Range	0.1 Hz		
Frequency Scale, selectable:	2 kHz Range	Full-Scale Logarithmic or 100 Hz Wide Linear Span		
	32 kHz Range	Full-Scale Logarithmic or 1000 Hz Wide Linear Span		
Detection, selectable	RMS, RMS Average, Peak Value or Vector Peak Value (at each single frequency, proper phase)			
Measurement Range	See FIELD STRENGTH MODE			
Noise/ Spurious Level (RSM), typical	See Table 1 (on next page)			
Uncertainty, by marker ^b	See FIELD STRENGTH MODE			
Results Scale, selectable	20 dB to 120 dB (logarithmic)			
Data Acquisition, (start/stop)	2 kHz Range	Continuous and Overlapping / Seamless		
	32 kHz Range	Continuous		
Window Length:	2 kHz Range	1.0 second		
	32 kHz Range	0.1 second		
Result Averaging, selectable	2 kHz Range	1, 2, 4, or 8 seconds		
	32 kHz Range	4, 8, 16, or 32 Spectra		
Graphical Display, selectable (SPECTRUM FFT only)	Result: Absolute or Normalized to Reference Limit of Selected Standard; Marker Displays 9 Highest Peaks within Selected Frequency Range			
Result List, tabular (HARMONICS only)	Result of 2 nd to 9 th Harmonic ^e and Total Distortion (with/within noise), Referenced to the Level of Fundamental Frequency			
MEASUREMENT DATA MEMORY (individual in B- and E- Field unit)				
Capacity, typical (dependent on setting)	3600 Single Values or 22 Spectral Analyses			
Control:	Field Strength & Exposure STD Modes	Manual or Sequence Timer or Sequence Spatial-Assigned		
	Spectrum FFT & Harmonics Modes	Manual Only		

^b Uncertainty includes all partial uncertainties (absolute, linearity, frequency response, and isotropy) as well as temperature and humidity related deviations. Signal sinusoidal, level >10% of selected measurement range; additional uncertainties apply with the steep frequency band limits.

^c Stored standards can be updated by software: e.g. ICNIRP: occupational, general public; BGV B11: Exp. (2 h/d), Exp. 1, Exp. 2; VDE 0848: draft

^d Dependent on selected standard.

^e Limited by selected frequency range



EFA-300 Field Analyzer

General Specifications

		B-FIELD UNIT	E-FIELD MODULE
Display		LCD Dot Matrix 128x64 Pixel with Backlight	Via B-Field Unit
Alarm, Adjustable Threshold		Acoustical, Optical	Via B-Field Unit
Current Documentation (Specific Modes Only)		Input of Prevailing and Reference Current Value; Storage with Measurement Value of Field	N/A
Interface (Remote Control, Data Memory)		Optical, Serial (RS-232)	
Operating Temperature Range		0°C to +50°C	
Humidity		<95% or <29 g/m ³ Occasional Brief Condensation Tolerable	
Operating Interval, typical	Continuous Measurement	10 Hours	
	Programmed Sequence Time	24 Hours	
Calibration Interval, recommended		24 Months	
Battery		NiMH Batteries (5x C-cell), exchangeable	NiMH Batteries, built in
Dimensions, approximate		4.3 x 7.9 x 2.4 inches (110 x 200 x 60 mm)	4.1 x 4.1 x 4.1 inches (105 x 105 x 105 mm)
Weight, approximate		2.2 lbs. (1000 g)	2.2 lbs. (1000 g)

Table 1: Spectrum FFT Sensitivity (Noise / Spurious)

	MAGNETIC (B-) FIELD			ELECTRIC (E-) FIELD
	100 cm ² Probe	Internal Probe	3 cm Probe	
2 kHz Range	<45 nT @ ≤48 Hz <4 nT @ >48 Hz <0.05 nT @ noise floor	<400 nT @ ≤48 Hz <42 nT @ >48 Hz <2 nT @ noise floor	<260 nT @ ≤48 Hz <23 nT @ >48 Hz <0.2 nT @ noise floor	<0.3 V/m @ ≤48 Hz <0.1 V/m @ >48 Hz <0.02 V/m @ noise floor
32 kHz Range	<2 nT @ <200 Hz <0.3 nT @ 200 Hz to 20 kHz <0.6 nT @ >20 kHz <0.07 nT @ noise floor	<22 nT @ <200 Hz <11 nT @ 200 Hz to 20 kHz <11 nT @ >20 kHz <1.5 nT @ noise floor	<10 nT @ <200 Hz <2 nT @ 200 Hz to 20 kHz <3 nT @ >20 kHz <0.3 nT @ noise floor	<0.1 V/m @ ≤20 kHz <3 V/m @ >20 kHz <0.05V/m @ noise floor



Ordering Information

EFA-300 ELECTRIC AND MAGNETIC FIELD ANALYZER	Part Number
Basic Unit (EFA-300, EM Field Analyzer System, 5 Hz-32 kHz), Calibrated Mode: FIELD STRENGTH, EXPOSURE STD, HARMONIC ANALYSIS Hard case for EFA-300, O/E Converter ORSD-9 Universal Cable, Fiber Optic Duplex (1000 µm), 2m Software, EFA-300 Tools, Power Supply 9 VDC, 100 V-240 VAC, all Plugs Operating Manual EFA--300	2245/301
PROBE, ELECTRIC FIELD, FOR EFA-300	
E-Field-Probe 5 Hz-32 kHz for EFA-300, Calibrated Power Supply 9VDC, 100 V-240 VAC, all Plugs, Cable, Fiber Optic Duplex (1000 µm), 10m Tripod, Non-Conductive, 1.65 m with Carrying Bag	2245/302
SET	
EFA-300, EM Field Analyzer Set (2245/301 with Electrical Field Probe 2245/302)	2245/30
EFA-300, EM Field Analyzer Set (with Electrical Field Probe) and Option FFT 32 kHz	2245/30/FFT-32
EFA-300 with Option FFT 32 kHz	2245/301/FFT32
Probe, Electric Field for EFA-300 with Option FFT 32 kHz	2245/302/FFT32
OPTIONS	
Option, FFT 5 Hz-32 kHz - Please provide S/N of EFA-300 and Probe	2245/95.15
Option, FFT 2 kHz-32 kHz - Please provide S/N of EFA-300 and Probe, only with Option, FFT 5 Hz-2 kHz	2245/95.19
OPTIONAL PROBES	
Probe, B-Field, A=100 cm ²	2245/90.10
Probe, B-Field, D=30 mm	2245/90.20
PC SOFTWARE	
Software, EFA-TS, Remote and Data Analysis Software	2245/93.56
ACCESSORIES	
Cable, Probe Extension 1.25 m	2244/90.35
Tripod, Non-Conductive, 1.65 m with Carrying Bag	2244/90.31
Tripod Extension, 0.50m, Non-Conductive	2244/90.45
Cable, Fiber Optic Duplex F-SMA, 10 m	2260/90.42
Cable, Fiber Optic Duplex F-SMA, 30 m	2260/90.44
Cable, Fiber Optic Duplex F-SMA, 50 m	2260/90.46
Cable, Fiber Optic Duplex F-SMA, 100 m	2260/90.48
Cable, Adapter USB 2.0 - RS232, 0.8 m	2260/90.53