

# Isotropic measurement of magnetic fields from 1 Hz to 400 kHz



The new BFD-400-3 magnetic field probe from the Narda FieldMan family is designed for high-resolution magnetic field analysis from 1 Hz to 400 kHz. It supports Weighted RMS (WRM) and Weighted Peak (WPM) assessments in line with IEC/EN 62311 and IEC/EN 62233.

Readings are processed on the FieldMan basic unit or streamed via USB using Narda-TSX software with full access to all modes, including real-time Live Mode.

With its integrated isotropic 3 cm<sup>2</sup> sensor, the BFD-400-3 targets detailed investigations in development, diagnostics, and maintenance—especially in confined or component-dense environments. Applications include source localization in control cabinets, PCB emission analysis, shielding evaluation, coupling path verification near conductors, and interference detection in industrial systems. It also enables coupling factor determination per IEC/EN 62233 Annex B, where spatial resolution is critical for exposure modeling.

Compared to previous 3 cm<sup>2</sup> probes (e.g. ELT 400), the BFD-400-3 offers significant functional upgrades: digital signal processing with real-time FFT, integrated WRM/WPM evaluation, advanced filter options, USB high-speed streaming, and a self-test-capable digital probe interface. While not intended for 100 cm<sup>2</sup> standard area coupling, it delivers unmatched efficiency for targeted EMF diagnostics, design optimization, and quality control.



- › Isotropic (non-directional) measurement with standard-compliant 3 cm<sup>2</sup> sensor
- › Shaped time domain assessment STD (WPM and WRM) for all relevant international standards and regulations such as Directive 2013/35/EU
- › Fast gapless real-time spectral analysis
- › Spectrum mode with displayed limit value curve for all 3 measuring axes
- › Scope mode offers triggered time signal analysis
- › Adjustable selective filters (band pass or band stop)
- › Digital probe interface - no basic unit calibration is necessary
- › Integrated probe self-test at startup
- › Streaming with the probe connected to a PC via USB (no FieldMan basic unit necessary)

## Use and benefit

- › The BFD-400-3 is an innovative probe for measuring exposure to magnetic fields in the workplace and in public spaces. It is designed for health and safety professionals in industry, occupational health and safety associations and service industries.
- › Display of field exposure in percentage of standard limits such as Directive 2013/35/EU for workers
- › Exposure evaluation of arbitrary waveforms in compliance with Weighted RMS (WRM) and Weighted Peak (WPM) methods (IEC/EN 62311 and 62233 compliant)
- › Supports multiple international standards Easy software update for future standard modifications, other limits or new standards
- › In addition to the field strength and exposure values, the Spectrum and Scope modes offer in-depth signal analysis in the frequency and time domain
- › Probe calibration and integrated probe and sensor self-test ensure the highest accuracy and reliability regardless of the frequency range. No basic unit calibration necessary due to digital probe interface

## How it works:

The probe consists of three orthogonally and concentrically arranged coils that detect changes in the magnetic field based on the law of induction. The generated voltage is then amplified and pre-conditioned by electronics, depending on the measurement range or the selected standard. A powerful FPGA handles digital processing to ensure phase-correct signal evaluation, providing accurate readings of both field strength and exposure indices. The data is then transmitted to a receiver via USB, either a FieldMan basic unit or any computing device running the TSX software.

## Applications

Examples of measurement environments are:

- › Industry and production areas (Assessment of workers' exposure acc. FCC, IEEE, ICNIRP or EMF Directive 2013/35/EU)
- › Induction heating and melting (e.g. EN 50519)
- › Household appliances (e.g. IEC/EN 62233)
- › Electric welding equipment (e.g. IEC/EN 62822)
- › Railroad operations (e.g. EN 50500)
- › Automotive operations (e.g. IEC 62764)
- › Energy supply systems (e.g. IEC/EN 62110)
- › Electrical medical devices (e.g. IEC/EN 60601)

## Industry

The BFD-400 is an essential tool for assessing magnetic fields generated by various industrial facilities. In many manufacturing environments, machinery produces non-sinusoidal signals, particularly in resistance welding systems using pulse waveforms and phase angle control within traditional 50/60 Hz systems, as well as in modern medium frequency switching units.

To ensure worker safety, exposure to magnetic fields must be continuously monitored and evaluated across a broad range of industrial applications. These include, among others, induction heating, welding, melting, electrolysis, and hardening.



## Automotive

The BFD-400 provides a comprehensive solution for measuring and assessing magnetic field exposure in automotive environments, including electric vehicles and their components.

Modern vehicles contain numerous electrical and electronic systems that generate low-frequency magnetic fields, exposing both drivers and passengers to EMF. To safeguard vehicle occupants from excessive exposure, comprehensive assessments are essential. The BFD-400 enables EMF exposure levels to be analyzed in accordance with various industry standards, ensuring compliance with national and international electromagnetic compatibility (EMC) regulations. Automotive manufacturers and international regulatory bodies have established specific guidelines to verify that vehicles meet these safety requirements.



## Electronic Article Surveillance (EAS)

Those systems are widely used in public areas, emitting complex fields.

Most of these technologies operate within the low-frequency range, generating electromagnetic fields that vary depending on the type of surveillance system. Many electromagnetic and magneto-acoustic security gates function within the frequency range covered by the BFD-400, making it a valuable tool for measuring and assessing exposure in such environments.



## Household appliances

Household appliances and other electrical devices generate magnetic fields that must be assessed for compliance with safety standards. Regulations such as IEC/EN 62233 outline procedures for evaluating these products before they enter the market.

With its EXPOSURE STD (Shaped Time Domain) mode, the BFD-400 significantly simplifies the assessment process. This mode sets a standard for reliable magnetic field assessments, even in environments with complex field conditions.

By providing accurate and efficient measurements, the BFD-400 ensures that home appliances meet regulatory requirements before reaching consumers.



# Definitions and Conditions

## Conditions

Unless otherwise noted, specifications apply within the specified environmental conditions and the product is within the recommended calibration cycle.

### Specifications with limits

These describe product performance for the given parameter covered by warranty. Specifications with limits (shown as <, ≤, >, ≥, ±, max., min.) apply under the given conditions for the product and are tested during production, considering measurement uncertainty.

### Specifications without limits

These describe product performance for the given parameter covered by warranty. Specifications without limits represent values with negligible deviations, which are ensured by design (e.g. dimensions or resolution of a setting parameter).

## Typical values (typ.)

These characterize product performance for the given parameter that is not covered by warranty. When stated as a range or as a limit (shown as <, ≤, >, ≥, ±, max., min.), they represent the performance met by approximately 80% of the instruments. Otherwise, they represent the mean value. The measurement uncertainty is not taken into account.

## Nominal values (nom.)

These characterize expected product performance for the given parameter that is not covered by warranty. Nominal values are verified during product development but are not tested during production.

## Uncertainties

These characterize the dispersion of the values attributed to the measurands with an estimated confidence level of approximately 95%. Uncertainty is stated as the standard uncertainty multiplied by the coverage factor k=2 based on the normal distribution. The evaluation has been carried out in accordance with the rules of the "Guide to the Expression of Uncertainty in Measurement" (GUM).

# Specifications <sup>1,3</sup>

Key Product Features	
Frequency range <sup>2</sup>	1 Hz to 400 kHz
Damage Level	1500 mT (see Figure 1)
Filters	Low-pass, High-pass filters, 6 <sup>th</sup> order band-pass and band-stop filters (see Figure 2 and 3)
Implemented Standards	2013/35/EU, ICNIRP1998, ICNIRP2010, EMFV2016, GB8702, TREMF, IEEE C95
Integrated real time FFT	up to 4096 points
Raw data streaming	Flat (Field) and shaped (WPM) waveforms up to 1.024 MSps with direct link to PC
Sensor type	Isotropic coils (3-axis) for magnetic (B) field (sensor area 3 cm <sup>2</sup> )
Spatial assessment	3 separate axes
Self-test	Signal path and coil functional test

Operating Modes		
Mode description	Field Strength	Broadband field measurements. Numerical results with time curve or bar graph display.
	Spatial Average	Procedure of broadband measurements over several measurement positions.
	Timer Logging	Time-controlled broadband measurement of the field strength in a definable period.
	Spectrum	FFT analysis with spectrum display, marker evaluation and display of the broadband level.
	Shaped Time Domain	Time domain assessment (WPM, WRM) with digital filtering related to a selected safety limit.
	Scope	Triggered measurement of the field curve over time with pre-trigger feature.

<sup>1</sup> Unless otherwise noted specifications apply at reference conditions: Ambient temperature 23±3 °C; relative humidity 25% to 75 %

<sup>2</sup> Cutoff frequency at typ. -3 dB.

<sup>3</sup> All values are measured with sinusoidal fields

Field Strength					
Measurement	Frequency Span	1 kHz, 10 kHz, 100 kHz, 400 kHz			
	Range	80 $\mu$ T	800 $\mu$ T	8 mT	80 mT
	Overload (typ., single axis)	160 $\mu$ T <sub>RMS</sub>	1.6 mT <sub>RMS</sub>	16 mT <sub>RMS</sub>	160 mT <sub>RMS</sub>
	Noise level (typ., RSS)	120 nT <sub>RMS</sub> (10 Hz - 400 kHz)	380 nT <sub>RMS</sub> (10 Hz - 400 kHz)	3.2 $\mu$ T <sub>RMS</sub> (10 Hz - 400 kHz)	43 $\mu$ T <sub>RMS</sub> (10 Hz - 400 kHz)
	Resolution (4 digits)	0.1 nT	0.1 nT	0.1 $\mu$ T	0.1 $\mu$ T
	Detectors	RMS, Peak			
	Detector time constant	1 s (integration time for RMS, hold time for Peak)			
	Units	Tesla, Gauss			
	Low Cut Filters	1 Hz, 10 Hz, 30 Hz (digital filters, see Figure 3), Butterworth, 6 <sup>th</sup> order			
	Band pass/ Band Stop filters	Bessel characteristic (digital filters, see Figure 2)			
	Time Span (Interval)	4 min (1 s between consecutive data points) to 24 h (360 s between consecutive data points)			
	Averaging Time	1 s to 24 h			

Spatial Average		
Measurement	Detector	RMS
	Measurement Time	Manual, 5 s to 360 s
	All other corresponding Parameters	According to Field Strength mode

Timer Logging		
Measurement	Storage Interval	1 s to 360 s
	All other corresponding Parameters	According to Field Strength mode

Spectrum (real-time FFT)					
Measurement	Frequency Span	1 kHz	10 kHz	100 kHz	400 kHz
	Resolution (FFT Point setting: High)	0.625 Hz	6.25 Hz	62.5 Hz	250 Hz
	Range	According to Field Strength mode			
	Noise Level	According to Field Strength mode			
	Frequency Scale	Linear, Logarithmic			
	FFT Points	Low=1024, Medium=2048, High=4096			
	Detectors	RMS, Peak			
	Detector Time	1 s (integration time for RMS, hold time for Peak)			
	Units	Tesla, Gauss, A/m			
	Result Types	Actual, Maximum, Average			
	Low Cut Filters	1 Hz, 10 Hz, 30 Hz			
	Number of Averages	4, 8, 16, 32, 64			

Shaped Time Domain			
Method	WPM-TD Weighted Peak Method (acc. IEC/EN 62311) WRM-TD Weighted RMS Method (acc. IEC/EN 62233)		
Standards/Limits	Measurement Range <sup>(4)</sup>	Typ. Noise WRM	Typ. Noise WPM
	2013/35/EU/ LAL	700 %	0.18 %
	2013/35/EU/ HAL	700 %	0.18 %
	2013/35/EU/ Limbs	700 %	0.15 %
	EMFV 2016 LAL	800 %	0.18 %
	EMFV 2016 HAL	800 %	0.18 %
	EMFV 2016 Limbs	700 %	0.14 %
	GB 8702-2014 GP	1700 %	1.30 %
	ICNIRP 1998 GP	1200 %	0.60 %
	ICNIRP 1998 Occ	1200 %	0.60 %
	ICNIRP 2010 GP	2500 %	0.80 %
	ICNIRP 2010 Occ	700 %	0.18 %
	IEEE 2019 Unrest NS	800 %	0.22 %
	IEEE 2019 Restrtd NS	1000 %	0.30 %
	TREMF NF	1200 %	0.40 %
Measurement	Time Span (Interval)	4 min (1 s between consecutive data points) to 24 h (360 s between consecutive data points)	
	Detectors (Method)	WPM-TD (IEC/EN 62311), WRM-TD (IEC/EN 62233) – for pulsed fields consider measurements according to IEC/EN62311 as underestimation of the exposition may occur when using WRM-TD.	
	Units	%	
	Low Cut Filter	1 Hz, 10 Hz, 30 Hz	
	Frequency Span	400 kHz (-3 dB)	
	All other corresponding Parameters	According to Field Strength mode	

Scope		
Measurement	All other corresponding Parameters	According to Field Strength mode
	Sample counts	128, 256 and 512 (menu setting “low”, “medium” and “high”)
	Trigger Type	Free run, Single, Multiple
	Trigger Modes	Positive transition, negative transition
	Trigger Level	0.1 $\mu$ T – 3 mT (depending on measurement range)
	Trigger sources	Scope channel (either x, y or z)
	Pre-Trigger	25 % (fixed)
	Recording Time	1 ms to 30 s

<sup>4</sup> The measurement range is the minimum value in the entire frequency range from 1 Hz to 400 kHz with the field in direction of one single coil. Due to the frequency shaping of the specific standards the device can display much higher values.

Raw Data Streaming (not yet available)	
Interface	USB 2.0, 480 Mbit/s (Probe directly connected to PC)
Data transfer rates	1.28 kSps, 2.56 kSps, 25.6 kSps, 256 kSps, 1024 kSps
Frequency Span	According to Field Strength mode According to Field
Range	Strength mode

Uncertainty <sup>5)</sup>	
Field Strength, Shaped Time Domain	5 Hz ... 400 kHz: 5.0 %
Linearity deviation (nominal) 56 Hz	1.0 %
Isotropy deviation	5 Hz ... 400 kHz: 5.0 %
E-field immunity (nominal) 50 Hz	0.03 nT / (V/m)

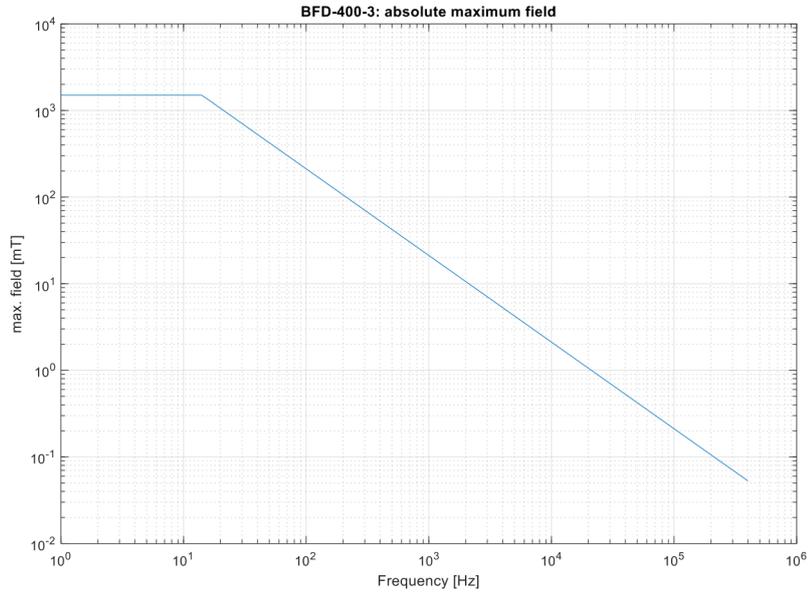
General Specifications		
Accredited calibration (not yet available)	DAkKS, ILAC-MRA (DIN EN ISO/IEC 17025, IEC Std. 61786) For measurands outside the scope, factory calibration is performed.	
Recommended calibration interval	24 months	
Operating temperature	-20 °C to +50 °C	
Humidity	< 29 g/m <sup>3</sup> (< 93 % RH at +30 °C), non-condensing	
Ingress Protection	IP54 (probe attached to FieldMan or Cable)	
Climatic conditions	Storage	-40 °C to +70 °C
	Operation	-20 °C to +50 °C
Size	246 mm x 33 mm Ø	
Weight	100 g	
Country of origin	Germany	

<sup>5)</sup> The systematic error of -3 dB and the slope of the low pass filter at the band edge is not part of this error.

# Characteristics

## Damage field level

The damage level is determined by the power dissipation of internal components and is therefore frequency dependent. Figure 1 illustrates this relationship. For the BFD-400-3, the electrical damage threshold is lower than the thermal threshold; hence, only the electrical damage level is shown. Pulses must remain within the specified limits.



*Figure 1: Damage field level versus frequency*

## Bandpass and Bandstop Filters

Band-pass filters are min. 4<sup>th</sup> order Bessel characteristic filters with a bandwidth that is 10 % of the center frequency. Band-stop filters are min. 4<sup>th</sup> order Bessel characteristic filters with a bandwidth that is app. 5 % of the center frequency. Figure 2 shows the frequency response of the 1 kHz band-pass and band-stop filter.

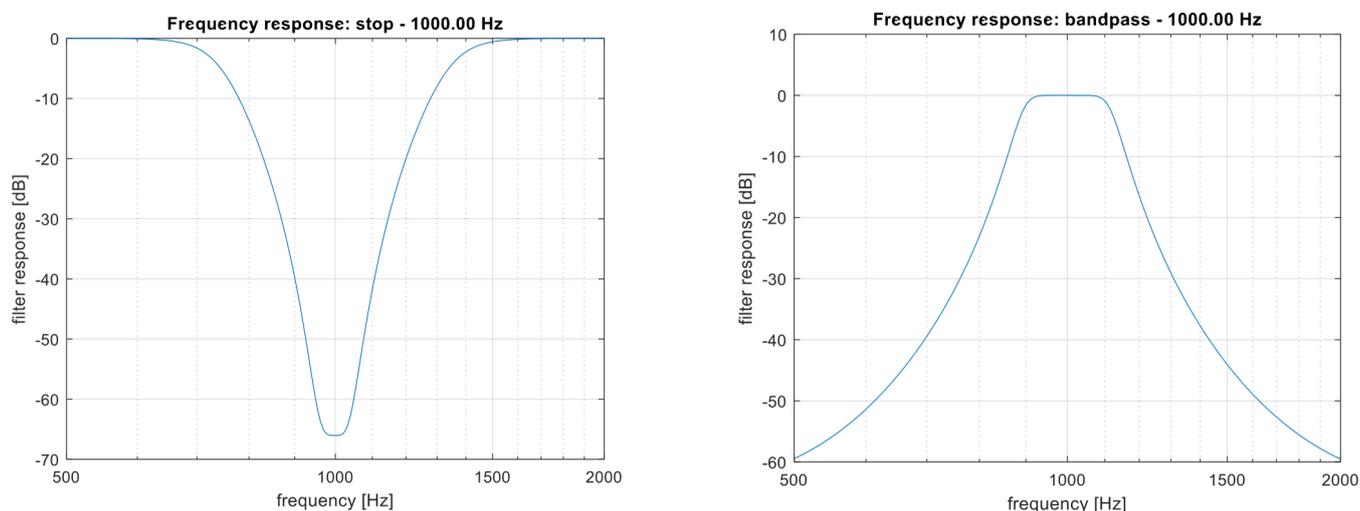


Figure 2: Example frequency response of the digital band-stop and band-pass filters

## Low-Cut Filters

Low cut filters are 6<sup>th</sup> order Butterworth filters. See Figure 3 for example frequency responses.

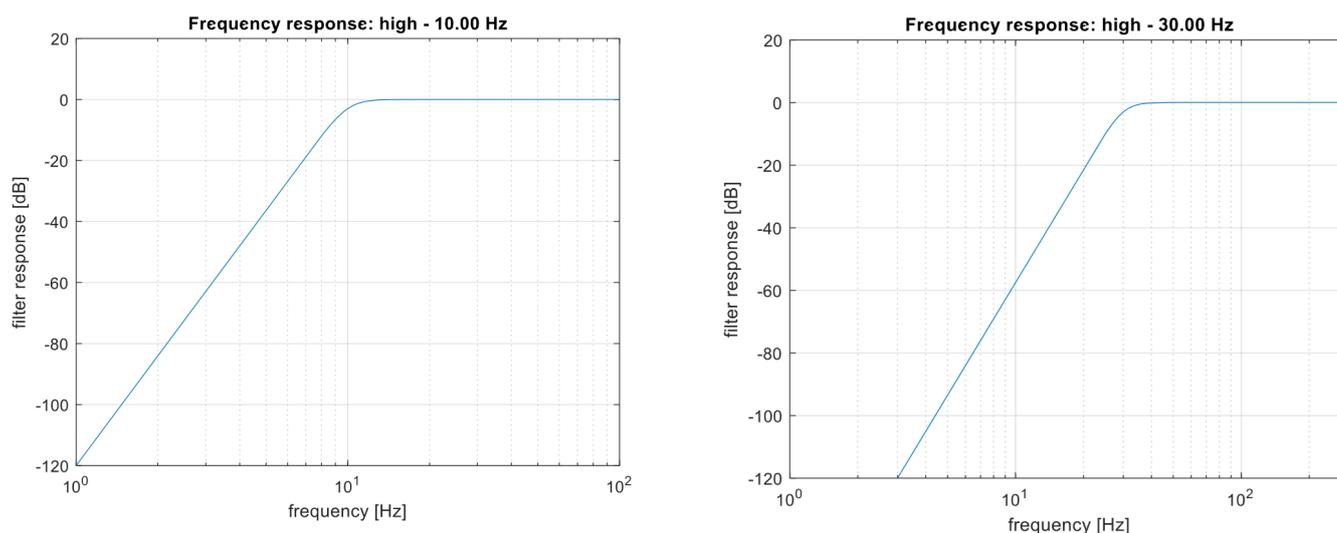


Figure 3: Example frequency response of Low-cut filters

# Ordering information

Your local Narda sales representative can provide further information and will be pleased to offer advice.

Digital Low Frequency	Part number
Probe BFD-400-3, B-Field, 3 cm <sup>2</sup> , 1 Hz – 400 kHz, selective	2463/02

Optional Accessories	Part number
Cable, Digital Probe Extension, 2 m	2460/90.02
Cable, Digital Probe to USB 2.0, 3 m	2460/90.03
Cable, Digital Probe to USB 2.0, 5 m	2460/90.08
Narda-TSX Live Measurement	2460/95.01

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