HF, RF & Microwave

Precision
Measurement
Technology
for Safety in
Electromagnetic
Fields

narda
Safety Test Solutions
an L3 Communications Company

Narda's
< advanced technology >
turns complex test scenarios into child's play for the user.

Narda Safety Test Solutions holds
< 95% of all patents >
worldwide in the area of electromagnetic field measurement technology.

Your One-Stop Shop for Safety in Electromagnetic Fields

Narda Safety Test Solutions develops and produces a comprehensive line of measuring devices for:

- **Low-frequency fields**
- **HF / RF / microwave fields**
- **Personal safety applications**

Our highly practical user support program includes:

- Equipment and application consultation by our worldwide sales network
- Repair and calibration service
- Expertise on standards and industry developments
- Training and measurement services

"Just power on and measure!"
Simple operation is important when you need dependable results. This requires **< device technologies >** capable of simplifying the highly complex measurements found in EMF applications. With any device you purchase from Narda Safety Test Solutions, the basic tenet is: "Just power on and measure!"

With **< 95 % of all patents >** in electromagnetic field measurement technology, Narda Safety Test Solutions is clearly a powerhouse in its business sector. Its portfolio includes the patent for frequency response shaping which greatly simplifies measurements in a multifrequency environment.

All of our measuring devices hold up well under demanding ambient conditions. The robust design is built to take physical punishment and stand up to a radiation-prone workplace.

The CE mark is another standard feature: All equipment is manufactured in our ISO 9001-compliant production facilities located in Germany and the US.

All Narda Safety Test Solutions products are calibrated and comply with most of the country-specific standards of their users.

The HF / RF / Microwave product line
Like all equipment from Narda Safety Test Solutions, the HF / RF / microwave product line delivers excellent measurement reliability. All of the functions were designed for straightforward and reliable testing.

For all of your applications
Precision measurements of HF / RF / microwave fields are required mainly in the following areas:

- Wireless / telecommunications
- Satellite communications
- Radio / TV broadcasting
- Military
- Industry (particularly in processes involving heating, curing, melting, plastics welding and in semiconductor production)
- Railways / transportation (communications facilities)
- Medicine (particularly diathermy and hyperthermy)
- EMC laboratories

Narda Safety Test Solutions is dedicated to meeting your exact requirements with a comprehensive product line. Whether you are a specialist in charge of **< qualifying >** entire facilities, or a technician who must regularly inspect facilities and/or equipment or make on-site visits to do service work, we have the right test solution.

To view our equipment recommendations for any application area (qualification, inspection or personal safety), please visit our Website at www.narda-sts.com.

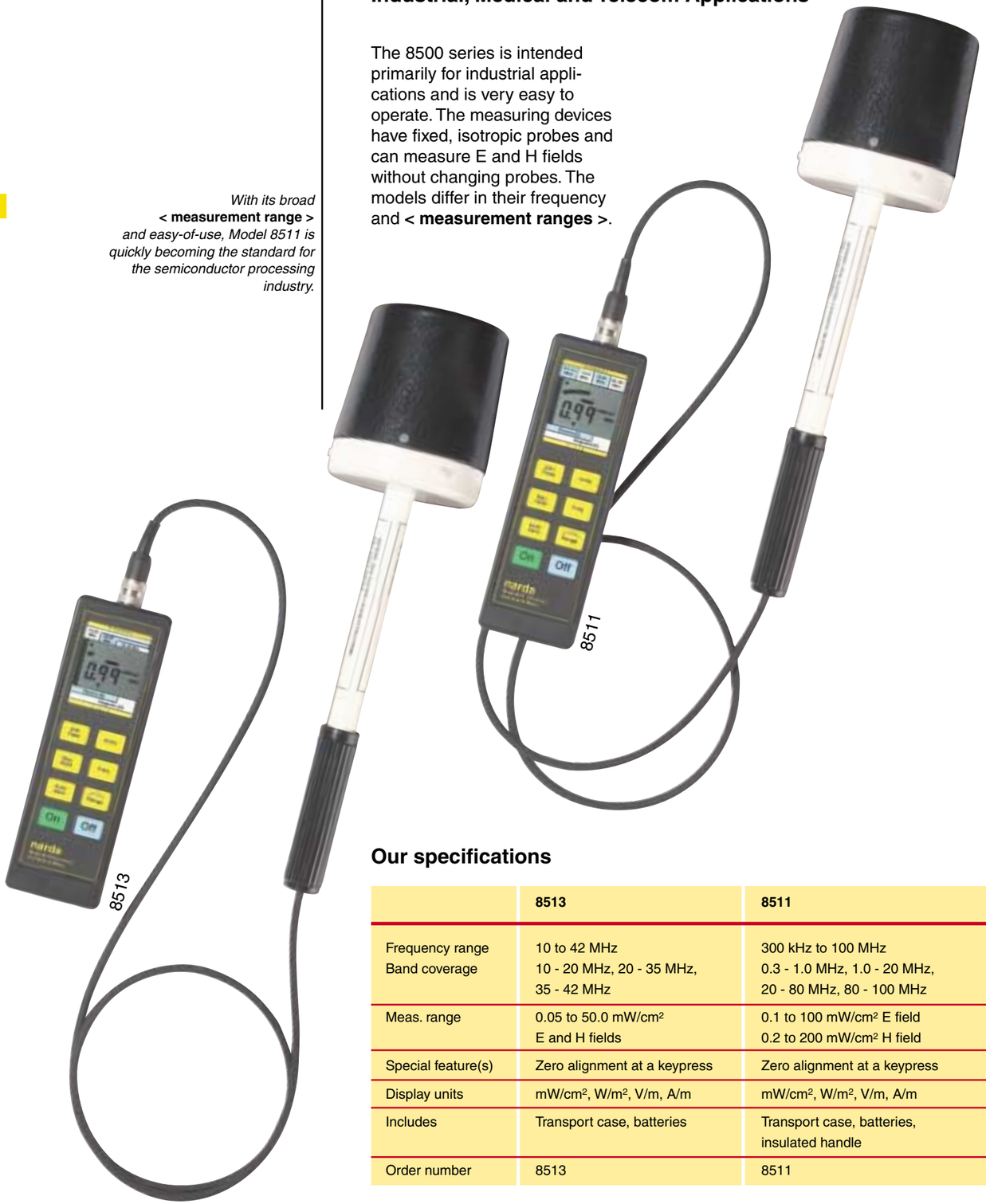
DE-99379-01

< Qualification >,
verification and personal safety: Narda Safety Test Solutions has the right test equipment no matter what your requirements.

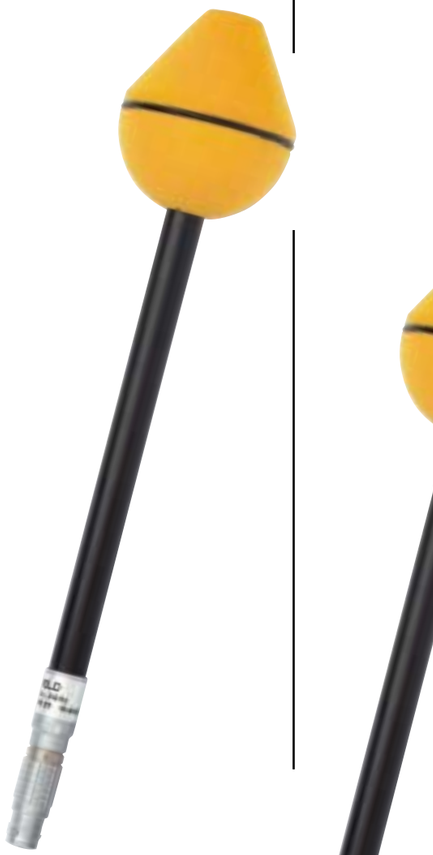
HF / RF / Microwave Measuring Devices for Industrial, Medical and Telecom Applications

The 8500 series is intended primarily for industrial applications and is very easy to operate. The measuring devices have fixed, isotropic probes and can measure E and H fields without changing probes. The models differ in their frequency and **< measurement ranges >**.

With its broad **< measurement range >** *and easy-of-use, Model 8511 is quickly becoming the standard for the semiconductor processing industry.*



The EMR-20C / EMR-21C
Designed primarily for industrial and medical applications, these units are also suitable for getting started in telecommunications applications. The E-field probes make isotropic measurements.
EMR-21C has an exceptionally high sensitivity. Both units offer remote control via the optical RS 232 interface.



Our specifications

	8513	8511	EMR-20C	EMR-21C
Frequency range Band coverage	10 to 42 MHz 10 - 20 MHz, 20 - 35 MHz, 35 - 42 MHz	300 kHz to 100 MHz 0.3 - 1.0 MHz, 1.0 - 20 MHz, 20 - 80 MHz, 80 - 100 MHz	100 kHz to 3 GHz	100 kHz to 3 GHz
Meas. range	0.05 to 50.0 mW/cm² E and H fields	0.1 to 100 mW/cm² E field 0.2 to 200 mW/cm² H field	0.6 to 800 V/m, 0.0001 to 170 mW/cm²	0.2 to 320 V/m 0.00001 to 27 mW/cm²
Special feature(s)	Zero alignment at a keypress	Zero alignment at a keypress	Automatic zero alignment, averaging (time)	
Display units	mW/cm², W/m², V/m, A/m	mW/cm², W/m², V/m, A/m	mW/cm², W/m², V/m, A/m	
Includes	Transport case, batteries	Transport case, batteries, insulated handle	Rechargeable cells, charger	
Order number	8513	8511	2244/70	2244/46

HF / RF / Microwave Measuring Devices for Wireless Applications

The 87xx series is a test system with interchangeable probes for electric and magnetic fields.

The system was designed primarily for applications in the **< wireless and radar >** sectors. A full range of accessories is available for setting up and qualifying facilities. All of the measuring devices have an adjustable alarm threshold.

8718 B unit
- Backlit display
- Results memory
- Internal test sources
- Optical interface for transferring measurement data

8715 unit
- Easy operation
- Spatial averaging
- Time averaging
- Batteries allow > 50 hours operating time

8712 unit
- Like 8715 but without averaging

The **< EMR series >** offers very simple operation and highly dependable results. Zero alignment is automatic – even in the presence of powerful fields. The 3-channel, digital-results processing ensures a wide dynamic range (up to 65 dB). The alarm threshold is user-selectable. The setting for the averaging can be varied from 4 seconds to 15 minutes (default = 6 minutes). The devices have an optical interface to transfer measurement data and for remote control and calibration purposes.

EMR-300
- Flexible system for measuring electromagnetic fields
- Basic device plus wide range of accessories
- Interchangeable measurement probes
- Automatic probe detection
- Remote control / RS 232 interface
- Memory for 1,500 measured values
- Spatial averaging

	8712	8715	8718 B	EMR-300
Display units	mW/cm², W/m², V/m, A/m, % of standard	mW/cm², W/m², V/m, A/m, % of standard	mW/cm², W/m², V/m, A/m, V²/m², A²/m², pJ/cm³, % of standard	mW/cm², W/m², V/m, A/m % of standard
Averaging	—	Temporal and spatial	Temporal and spatial	Temporal and spatial
Power source	Dry battery (E-Block 9V)	Dry battery (E-Block 9V)	Rechargeable cell	Rechargeable cell or dry batteries (type AA Mignon)
Includes	Case, battery, 8744-04 cable,	Case, battery, 8744-04 cable, 8713B zero-field chamber, insulated handle / table-top tripod	Case, rechargeable cell, charger, 8744-04 cable, 8713B zero-field chamber, PC interface cable with software	Case, rechargeable cell, PC transfer set incl. software, table-top tripod, charger
Order number	8712	8715	8718 B	2244/31

Measurement and frequency range see page 8 to 11

Measurement and frequency range see page 8 to 11

Summary of Probes for the 87xx Series

E-field probes

Frequency range	Measurement range		Model	Detection mode	Housing design	Highlights
3 kHz ... 1 MHz	0.1 µW/cm² to 200 mW/cm²	0.61 to 868 V/m	8782D[a]		1	Active antenna
100 kHz ... 300 MHz	100 µW/cm² to 200 mW/cm²	19.4 to 868 V/m	8764D	Compensated diodes	2	
300 kHz...3 GHz	0.05 µW/cm² to 100 µW/cm²	0.5 to 19.4 V/m	8760D	Compensated diodes	2	high measurement sensitivity
300 kHz...3 GHz	10 µW/cm² to 20 mW/cm²	6.13 to 274 V/m	8761D	Compensated diodes	2	
300 kHz...3 GHz	100 µW/cm² to 200 mW/cm²	19.4 to 868 V/m	8762D	Compensated diodes	2	
300 kHz...50 GHz	50 µW/cm² to 20 mW/cm²	13 to 274 V/m	8741D	Compensated diodes and thermocouples	2	Ultrabroadband
300 MHz...50 GHz	10 µW/cm² to 20 mW/cm²	6.13 to 274 V/m	8721D	Thermocouples	3	
300 MHz...50 GHz	50 µW/cm² to 100 mW/cm²	13.7 to 614 V/m	8723D	Thermocouples	3	
300 MHz...50 GHz	50 µW/cm² to 100 mW/cm²	13.7 to 614 V/m	8783D	Thermocouples	4	Flexible probe neck
2 ... 18 GHz	20 µW/cm² to 20 mW/cm²	8.67 to 274 V/m	8781D	Thermocouples	5	Flexible probe neck

[a] Model 8782 must be operated with the model 8747 optical interface and 8718B unit.

Frequency response weighted E-field probes (“shaped probes”)

Frequency range	Measurement range	Model	Detection mode	Housing design	Highlights
300 kHz ... 3 GHz	0.6 to 600 % of standard related to power density	x8742D*	Compensated diode	2	
300 kHz ... 50 GHz	0.3 to 300 % of standard related to power density	x8722D**	Compensated diode and thermocouples	2	Ultrabroadband

* A8742D = FCC 1997 (occupational/controlled)
= Japan RCR-38 (controlled)
B8742D = FCC 1997 (General Population)

** A8722D = FCC 1997 (occupational/controlled)
B8722D = IEEE C95.1-1999 (controlled)
C8722D = Canadian Safety Code 6 (1999 RF/Microwave Workers)
D8722D = ICNIRP 1998 (occupational)
= CENELEC ENV 50166-2. Jan. 1995 (occupational)
= BGV B11, 2001, exposure range 1

H-field probes

Frequency range	Measurement range		Model	Detection mode	Housing design	Highlights
300 kHz...10 MHz	100 µW/cm² to 200 mW/cm²	0.0515 to 2.31 A/m	8752D	Thermocouples	2	
300 kHz... 10 MHz	1 mW/cm² to 2 W/cm²	0.163 to 7.29 A/m	8754D	Thermocouples	2	
10 MHz ...300 MHz	10 µW/cm² to 20 mW/cm²	0.0163 to 0.729 A/m	8731D	Thermocouples	2	
10 MHz ...300 MHz	50 µW/cm² to 100 mW/cm²	0.0364 to 1.64 A/m	8733D	Thermocouples	2	

Frequency response weighted H-field probes (“shaped probes”)

Frequency range	Measurement range	Model	Detection mode	Housing design	Highlights
300 kHz...200 MHz	0.3 to 300 % of standard related to power density	A8732D	Thermocouples	2	

A8732D = IEEE C95.1-1999 (controlled)

Accessories:
For extension cables and connectors, see our detailed data sheets at www.narda-sts.com or contact one of our sales associates.

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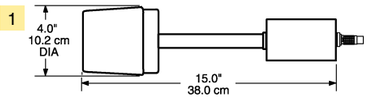

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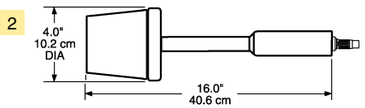

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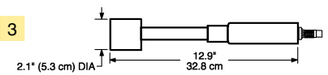

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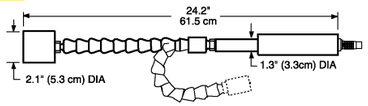

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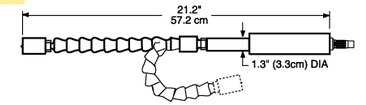
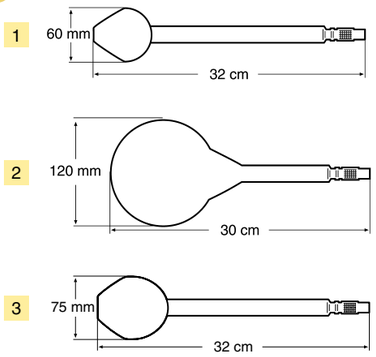


Summary of Probes for EMR-300

E-field probes

Frequency range	Measurement range		Model	Detection mode	Housing design	Highlights
100 kHz ...3 GHz	0.00001 to 42.4 mW/cm²	0.2 to 320 V/m	Type 18C	Diodes	3	High sensitivity
100 kHz ...3 GHz	0.0001 to 170 mW/cm²	0.6 to 800 V/m	Type 8C	Diodes	1	
3 MHz ...18 GHz	0.0002 to 265 mW/cm²	0.8 to 1,000 V/m	Type 9C	Diodes	1	
27 MHz ...60 GHz	0.0001 to 23.9 mW/cm²	0.7 to 300 V/m	Type 11C	Diodes	1	Ultrabroadband
300 MHz ... 50 GHz	0.02 to 100 mW/cm²	9 to 614 V/m	Type 33C	Thermocouples	1	



Frequency response weighted E-field probes (“shaped probes”)

Frequency range	Measurement range	Model	Detection mode	Housing design	Highlights
300 kHz ... 40 GHz	0.2 to 10,000 % of standard related to power density	Type 2xC[a]	Diodes	1	Ultrabroadband

[a] Type 25C: For FCC 96-326, Aug. 1996, occupational
Japan, RCR-STD-38, controlled
Type 26C: For ICNIRP, 1998, occupational
CENELEC ENV 50166-2. Jan. 1995 occupational
BGV B11, 2001, exposure range 1 (formerly: DIN VDE 0848, 1991, exp. 1)
Canada Safety Code 6, 1993, occupational

H-field-probes

Frequency range	Measurement range		Model	Detection mode	Housing design	Highlights
3 kHz ... 3 MHz	1.2 to 2,360,000 mW/cm²	0.18 to 250 A/m	Type 13C	Diodes	2	
300 kHz ... 30 MHz	0.005 to 10,900 mW/cm²	0.012 to 17 A/m	Type 12C	Diodes	2	
27 MHz ... 1 GHz	0.01 to 9,650 mW/cm²	0.018 to 16 A/m	Type 10C	Diodes	1	
80 MHz ...1 GHz	0.001 to 942 mW/cm²	0.006 to 5 A/m	Type 14C	Diodes	1	High measurement sensitivity

Standards-Compliant Measurements with Convenient Test Equipment

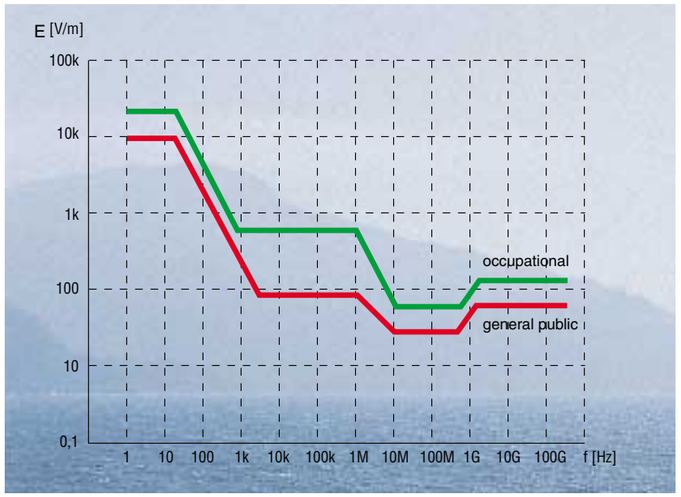
Equipment from Narda Safety Test Solutions was developed especially for applications involving occupational safety and protection of the general public, and includes all of the functions you need to make standards-compliant measurements with ease.

Limits for human exposure to electromagnetic fields are governed by various national and international standards. Many of these standards are based on the recommendations of the **< ICNIRP >.**

< ICNIRP >
is the "International Commission on Non-Ionizing Radiation Protection". For more information, visit www.icnirp.de

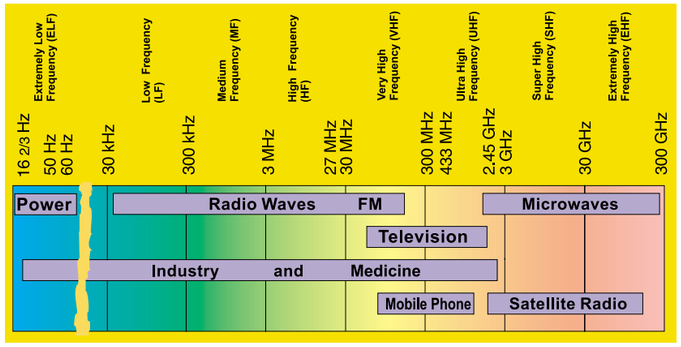
Frequency ranges and application fields
The frequency spectrum is usually broken down into two ranges: Low frequency up to about 30 kHz and high frequency from 30 kHz to 300 GHz (which includes the RF & microwave ranges).

Different applications such as FM radio as well as wireless and satellite communication are associated with certain HF ranges. To monitor the behavior of electromagnetic fields, it is necessary to know the frequency since the limits are frequency-dependent. The one exception to this is when you are measuring with patented **< shaped probes >**. These Narda Safety Test Solutions probes have automatic frequency response weighting so you don't have to worry about frequency ranges. The results are displayed as a % of standard.



Limits for the electric field: ICNIRP, 1998.

< Shaped probes >
greatly simplify measurements in a multifrequency environment.



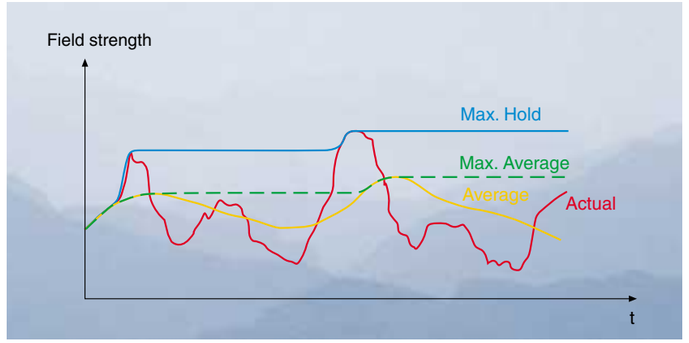
Near and far fields
Electromagnetic fields have an electric field component E [V/m] and a magnetic field component H [A/m]. In the near field, it is necessary to measure the E and H fields separately. However, if the distance from the field source is **< 3 x wavelength >** or greater, we are in the far field. Here, the E and H fields are related by a constant, and we only have to measure one of them.

Conversions in the far field
In the far field, once we measure the H field we can compute the magnitude of the E field and also the power density S (mW/cm² or W/m²), or vice versa. For conversion tables or a converter, visit www.narda-sts.com and click on "Help". When measuring with one of our devices, you can also choose the units of your choice, e.g., V/m, A/m, mW/cm² or W/m².

Zero alignment and the functional test after power-on
To make precision measurements, measuring devices for electromagnetic fields must undergo zero alignment after power-on or when the temperature changes. Depending on the measuring device, this procedure is performed in a convenient, portable, zero-field chamber (85xx and 87xx devices) or using a new automatic technique allowing internal zero alignment – even in the presence of high field strengths (EMR devices).

After the automatic self test, the functional check of the sensors can use the built-in field source (8718B) or an external source.

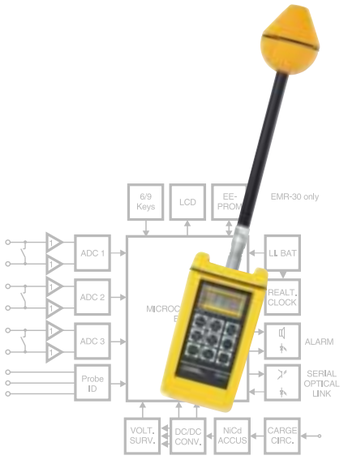
Field distributions in time and space
Since the **< field distribution >** is rarely homogeneous, a field needs to be measured at several points to truly characterize the full-body exposure. Based on these measured values, the quadratic mean is formed. With a measuring device from Narda Safety Test Solutions, this is a single keypress function (spatial averaging). Almost all devices also include an averaging function vs. time to perform a 6-minute average, as stipulated in many standards. The time interval can be varied to meet other requirements.



These four values are present in the EMR devices, regardless of what display mode you choose: Actual Measured Value e.g. in V/m, Max Hold, Average and Max Average.

< 3 x wavelength >
is a simplified form of the equation $R = 0.6\ D^2 : \lambda$

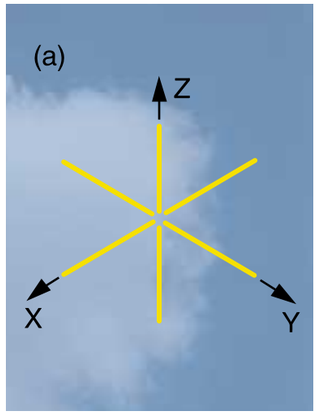
Since the **< field distribution >**
is rarely homogeneous, a field needs to be measured at several points.



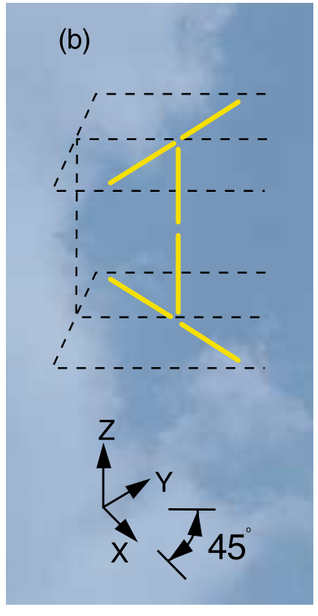
Figs. a to d shows different sensor arrangements for isotropic measurements.

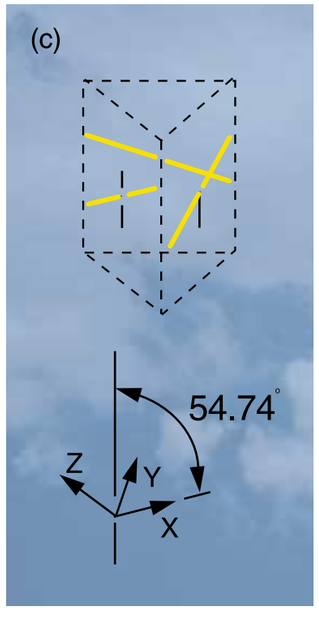
Standardized measurements must be ***< isotropic >****, meaning non-directional:*

$\sqrt{x^2 + y^2 + z^2}$



Non-directional measurements
In a free field, we are usually dealing with multiple sources of electromagnetic radiation. To properly assess the exposure, **< isotropic >** (non-directional) measurements are required. Using a clever sensor arrangement, the correct result is obtained no matter how the device and fields are situated.



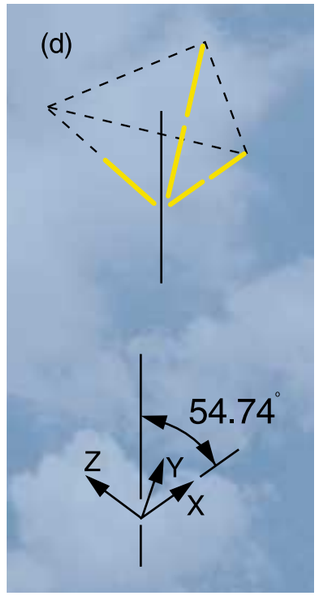


The right sensor and detector for every measurement
An E field is normally measured with a dipole sensor or a surface-area sensor, while an H field requires a coil.

Surface-area sensors are used in the Nardalert XT personal monitor, for example. Their design minimizes the bodily influence on the E field in the low frequency range.

Depending on the application, diodes and thermoelements are used as detectors.

Thermocouple probes should be used for most radar measurements. they always yield true RMS average measurements regardless of



pulse width. The **< dynamic range >** is limited to approximately 30 dB so diode probes must be used for extremely low level measurements. Diode probes can also be used to measure peak levels.

Frequency response weighted probes for convenient testing
There are different personal safety limits at different frequencies. “Shaped probes” take care of the frequency

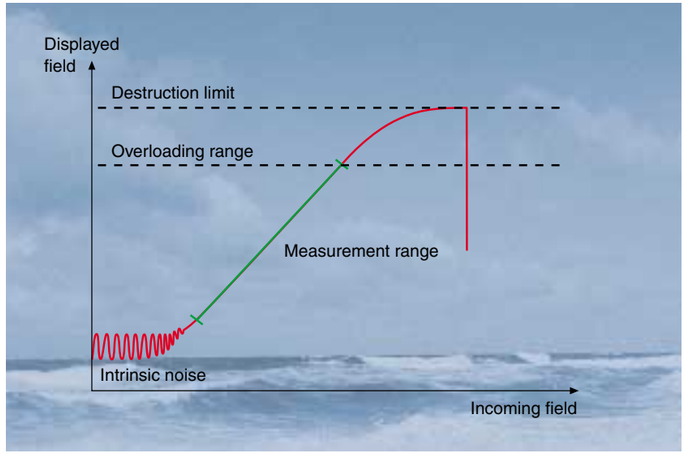
Frequency response weighted probes for convenient testing

issues for you, providing an easy-to-read display as a % of standard. You don’t have to deal with the actual field strength limits or frequencies, enabling quick and simple measurements even under complex ambient conditions. Narda Safety Test Solutions is the only supplier for shaped probes. Why? We hold the patent for this feature.

Modulation type: How does it influence the measurement?
The customary modulation types such as amplitude modulation (AM, low modulation factor), frequency modulation (FM) and digital modulation (GSM) have minimal influence on the measurement result. However, this is not the case with the pulsed signals found in radar applications, which generally have an extreme pulse/pause ratio. Here, thermocouples are beneficial (see sensor types).

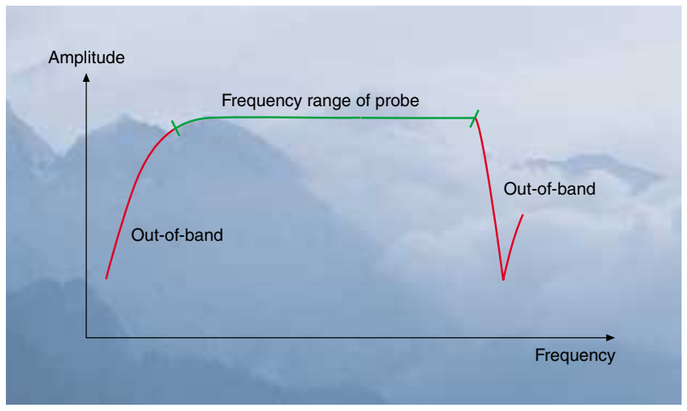
< Dynamic range >
is measured in dB and is a logarithmic power or voltage ratio, e.g., a voltage ratio of 10 : 1 corresponds to 20 dB.

Carrying a ***< personal monitor >*** *is a good idea for anyone who has to work at facilities where HF, RF, and/or microwave fields are present.*



How much exposure can measuring devices stand?
Every measuring device has its own unique measurement range. The sensitivity of the device determines the lower limit of the range. Device overloading determines the upper limit. When making measurements in unknown fields, always start out with the least sensitive probe to avoid destroying the sensors! With almost all probes, the overloading / destruction limits lie well above the personal safety limits. In some cases you might choose to increase sensitivity by changing probes. It's a good idea to have an initial look at field conditions using a ***< personal monitor >*** which you should carry with you to avoid exposure to hazardous radiation (see the separate Narda Safety Test Solutions brochure on personal safety applications).

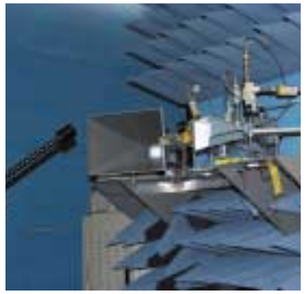
Measurement deviation due to out-of-band measurements
Within the defined frequency range, frequency response deviations of the probes can be minimized using calibration factors. If you are measuring outside of the defined frequency range, the measuring device will still work, but its sensitivity will decrease significantly. For example you can use probe type 8 at lower frequencies than the specified limit of 100 kHz.



If you are interested in more details and practical information on this very complex topic, consider our HF / RF / Microwave training program.

Measurements of high field strengths and long-term measurements with data memory and evaluation
Narda Safety Test Solutions measuring devices designed for qualification work have a data memory. If you need to measure high field strengths or make long-term measurements, you should consider transferring the measured values to a PC and/or printer using the optical interface included in the devices and the transfer set. Most of the devices can be remotely controlled via this same interface.

We have sites for calibration and service work in the **< US and Germany >**.



Two Sites for Calibration and Repair

Narda Safety Test Solutions measuring devices and probes are calibrated prior to delivery to the customer. The calibration data are traceable to national and international standards.

We can recalibrate these same devices and probes in the **< US and Germany >**.

The American site also offers an express calibration service (within 10 days). If you are interested in this service, please request an RMA number. Visit www.narda-sts.com for details.

If a device requires repair, send it to the calibration site, or contact your sales associate for assistance.

Seminars, Courses and HF /RF / Microwave Training

The American and German sites both offer comprehensive occupational safety training as well as training for HF / RF / Microwave. Participants will become familiar with:

- Basic fundamentals
- Individual measurement techniques
- Guidelines for an overall safety concept.

If you want customized training, please contact your sales associate or Narda Safety Test Solutions in the US or Germany. **< Seminars >** are given in the local language of the country where they take place.

Video-based training
We also offer safety training and measurement training on video cassettes. Contact your sales associate for details.

For current information about our **< seminars >**, *visit www.narda-sts.com*

Why Make Your Own Measurements? Let Our EMS Measurement Service Take Charge!

Narda Safety Test Solutions Germany offers a **< full-featured measurement service >** with quotes, specialists to make the measurements and fully standards-compliant documentation.

We use the latest technology, which is calibrated and traceable to national standards.

Upon request, we will qualify and inspect (for low frequency and/or high frequency) any of the following:

- Systems and equipment
- Workplaces
- Areas open to the general public

This can include both indoor and outside spaces.

Your benefits: You save personnel and training costs, not to mention the investment and maintenance expense for state-of-the-art measuring devices. We can also provide regularly-scheduled monitoring of your facilities. To order the EMS measurement service, contact Narda Safety Test Solutions Germany directly.

The EMS measurement service is your **< full-featured measurement service >**.

Accessories for EMR Products

1. PC Transfer Set
(included with EMR-300)
Order no. 2244/90.36

2. Small case for EMR-20C/21C
Order no. 2244/90.08

3. Aluminum Storage Case
(included with EMR-300)
Order no. 2244/62

4. Table-Top Tripod
(included with EMR-300)
Order no. 2244/90.32

5. Tripod plus Transport Bag
Order no. 2244/90.31

6. Test Generator
(27 MHz)
Order no. 2244/90.38

7. Handle
420 mm long
Order no. 2250/92.02

8. Extension Cable for Probes
Order no. 2244/90.35

Accessories for 87xx and 85xx Products

1. Zero-Field Chamber
Order no. 8713B

2. Table-Top Tripod, also serves as Handle for Measuring Device
Order no. 21797900

3. Extension Cable for Probes

4. PC Transfer Set
(for 8718B, included with device)

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