narda
Safety Test Solutions®
an L3 communications company

RF RADIATION SAFETY
PRODUCTS AND SERVICES 2010

Model Number Search

2245/301/FFT32

Find

Use Acrobat® Navigational Aids

Make sure Bookmarks are turned on for optimal navigation (View / Navigation Tabs / Bookmarks).

USA:
435 Moreland Road
Hauppauge, NY 11788
Tel (1) 631 231-1700
Fax (1) 631 231-1711
E-Mail NardaSTS@L-3COM.com
www.narda-sts.us

GERMANY:
Sandwiesenstrasse 7
72793 Pfullingen, Germany
Tel +49 (0) 7121-97 32-777
Fax +49 (0) 7121-97 32-790
E-Mail support@narda-sts.de
www.narda-sts.de

ITALY:
Via Leonardo da Vinci, 21/23
20090 Segrate (Milano) ITALY
Tel +39 02 26952421
Fax +39 02 26952406
E-Mail support@narda-sts.it
www.narda-sts.it

About Narda Safety Test Solutions

Narda Safety Test Solutions is the name of the world leader in non-ionizing radiation safety equipment. In February 2000, Narda acquired the Safety Test Solutions business from Wavetek Wandel & Goltermann. To give more focus to the RF safety business and to separate it from Narda's business in components and networks, a new division was formed – Narda Safety Test Solutions – which combines the expertise and complementary product lines of both operations. Narda-STS holds more than 95% of the patents in the industry. Products are now available to accurately measure electromagnetic fields from a few Hertz to over 100 GHz as well as static magnetic fields. RF personal monitors cover 100 kHz to 100 GHz and area monitors detect energy from 50 Hz to 100 GHz.

User Support

Narda-STS User Support Includes:

- Equipment and application consultation by our worldwide sales network
- Repair and calibration service
- Expert advice on standards and recent developments
- Training and measurement services

Just Power-On and Measure

Simple operation is critical when you need dependable results. This requires device technology that simplifies the complex measurements found in EMF (Electro-Magnetic Field) applications. With any device you purchase from Narda-STS, the basic principle is: Just Power-On and Measure.

Quality and Compliance

All Narda-STS measurement products are built for use under demanding environmental conditions. Rugged construction enables them to stand up to high-level fields even as they weather the physical punishment often encountered in on-site locations.

Quality and adherence to international standards are reflected in the CE mark that appears on every Narda-STS product and the ISO 9001-compliant production facilities in Italy, Germany and the US where all equipment is manufactured. All Narda-STS products are calibrated to comply with the country-specific standards of their users.

RF Radiation Safety Training

Narda-STS can provide unequaled educational materials and training for your company. You will find public seminars and courses that address different industries as well as custom corporate training programs using live instruction or CD-, VCR-, and DVD- based content. See our training section beginning on page 5.

Product Sections

We have designed this catalog to give you easy access to information on all our products.

LOW FREQUENCY –
DC STATIC FIELDS (0 Hz) TO 400 kHz

Like all Narda-STS equipment, the low frequency product line delivers excellent measurement reliability. All instrument functions were designed for direct and reliable testing.

Precision measurements of low frequency fields are required in the following industries:

- Power Generation and Delivery (50/60 Hz)
- Electric Railway Lines
- Smelting Furnaces
- Welding Systems
- Medical Systems (e.g., MRI)

THM1176 – This product measures static magnetic fields as well as modulated magnetic fields up to 1 kHz. Ideally suited for medical device and MRI measurements, the sensor can be supplied with or without a PDA to display readings on. Either way, software is provided for direct readout on Netbooks and Computers. See page 19.

EHP-50C – High Precision measurement of E and β fields from 5 Hz to 100 kHz. This field analyzer can operate in a data logging mode or with the supplied software, through a 10m fiber optic cable to display real-time spectrum information on a PC. With it's wide dynamic range and exceptional accuracy, ELF/VLF fields are easily measured. See page 36.

ELT-400 – The first low frequency measurement device that can be used by engineering and safety personnel. This new system measures the magnetic field required for certification of products destined for Europe. Safety personnel can use the ELT-400 to verify magnetic field limits recommended by the new IEEE C95.6 standard. See page 23.

EFA-300 – EFA-300 (Electric and Magnetic) Field Analyzer sets the testing standard for low frequency devices. This unit offers exceptional accuracy and overall performance for testing occupational exposures to ELF/VLF frequencies. See page 29.

RF AND MICROWAVE – 100 kHz TO 100 GHz

Narrowband Meters

EHP-200 – A stand-alone solution for measurements of fields from 9 kHz to 30 MHz is the new EHP-200. This fiber-optically isolated sensor measures both E and H fields over a wide dynamic range and displays them on a computer through a 10-meter cable. This design allows repeatable field measurements thanks to the supplied non-metallic stand, and the EHP-200 also features excellent accuracy. See page 40.

SRM-3006 – Narda's second generation narrowband meter features a full color display, built-in GPS and a frequency range of 9 kHz to 6 GHz. This system is outstanding for determining FCC 5% boundaries and detecting low level signals that broadband equipment can't distinguish. See page 43.

Broadband Meters

8500 Series – Features digital meters and dual-field probes. The 8513 is excellent for measurements on heat sealers and vinyl welders, while the 8511 covers a wider frequency range for testing most semiconductor systems. See page 71.

NBM Series – Narda's new NBM series of meters and probes provide unequalled performance for broadband measurements. Either the NBM-520 or -550 meters can be used with 11 different E or H field probes. This revolutionary system features rugged, lightweight design with incredible displays and intelligent probes. See page 57.

PERSONAL MONITORS

Narda offers two families of RF/microwave personal monitors – The RadMan and Nardalert XT series. These products perform similar tasks in different ways.

RadMan – The RadMan offers broad frequency coverage for both the electric (E) and magnetic (H) fields. Utilizing dipoles (E) and loops (H) with diode-based detection and a housing that allows isotropic detection (when used off the body), this system can be used as more than a monitor. When operating it off the body, its isotropic features allow you to make field strength measurements. Coupled to the optional ESM-TS software and cable package, real-time readings can be displayed on a computer. We also offer the ESM-30 which adds a data logging capability. For utility workers, Narda offers the ESM-30, ELF-Immune model. This unit incorporates special coatings to allow proper RF field detection even while immersed in a 125 kV/m powerline (50/60 Hz) frequency field. Narda recommends the RadMan to technicians and engineers for off-body use. See page 81.

Nardalert XT – The Nardalert XT series was recognized by R&D Magazine as one of the 100 most significant new designs of 2002. Nardalert monitors employ three different detectors, a surface charge sensor, dipole and thermocouple elements. These detectors give the Nardalert a very wide frequency range of operation – 100 kHz to 100 GHz. Updated electronics provide the user with instant knowledge of field levels, thanks to its top-mounted LEDs and audible and/or vibration alarms. The Nardalert XT also has data logging and ELF-Immune models. There is also a high power model to accommodate RF safety clothing. All models allow alarms to be varied through optional software and the rate of data logging can be changed on models with that feature. The Nardalert XT has perfected the RF personal monitor making it an exceptional monitor for wearing on the body. An optional climber pouch keeps it on the body and its sensor technology allows true RMS average detection, even in the presence of pulse-modulated signals. See page 75.

AREA MONITORS

SMARTS II – The SMARTS II monitors feature wideband operation (2 MHz to 100 GHz) that is ideally suited to high power, indoor applications, such as satellite uplink amplifier rooms, industrial process machines employing high power RF, and military system test stands. See page 89.

2600 System – For outdoor applications, the Narda 2600 system is alone in its field. At a height of only 29 inches, and a weight of just 11 lbs., this wireless system can be mounted outdoors for power or communication. Solar panels provide all the energy it needs and the standard GSM modem provides wireless communication capability. With this new design, outdoor environments can be continuously measured down to 1 V/m. When fields that exceed the owner-set threshold are detected, the 2600 can be programmed to call pre-set phone numbers and/or modems to transfer historical field readings. Available sensors include 20 Hz to 3 kHz, 500 kHz to 3 GHz and 1 MHz to 18 GHz. See page 85.

Narrowband Systems – Narda-STS can also supply designs based on the upcoming 8060 Series of narrowband monitors. Contact the factory for more details.

Table of Contents

RF Safety Training

RF Radiation Regulations

Seminars and Courses

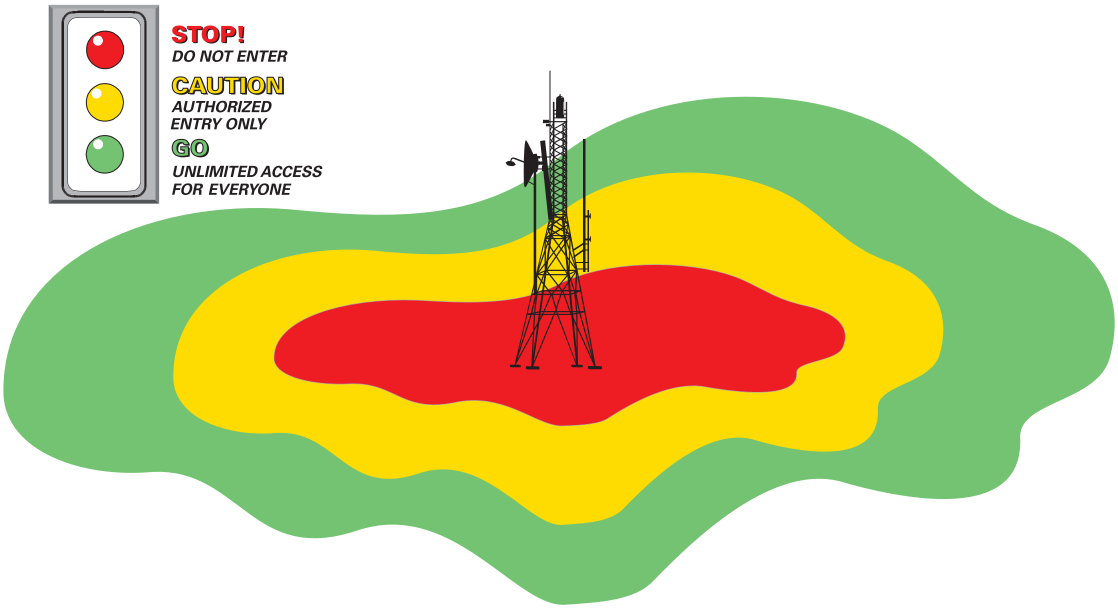
Videos / DVDs

narda Safety Test Solutions
an L3 communications company

The 1996 Telecommunications Act Mandates RF Radiation Regulations

September 1, 2000: the Federal Communications Commission's (FCC) RF Radiation Exposure Regulations became effective for ALL communications sites. These regulations point out several problems that must be solved by each organization in the wireless industry.

Problem	Solution
How will you know what you need to comply to the new regulations?	A written RF Radiation (RFR) Safety Program is all but mandated – it's also the simplest place to begin.
How will you determine and designate potential hazards for your employees?	Using the new FCC regulations as a guide, identify the areas and equipment that carry potential hazards. Once identified, you must make measurements to establish the boundaries of Occupational/Controlled and General Population/Uncontrolled areas.
An Occupational/Controlled classification imposes fewer operational restrictions. How can you get your sites classified as Occupational environment?	In an Occupational environment, informed workers understand and follow well-defined safety procedures. Consequently, restricted areas are smaller. Your sites can be classified Controlled when you have developed and implemented a comprehensive safety program.
Do you need to make field strength measurements at each site?	Possibly. The FCC only requires measurements for certain antenna installations but definitive field strength data for each site may be needed to establish boundaries for employees and to supply local governments.



Problem

What kinds of equipment will you need to make these measurements?

Solution

To measure RFR emissions at today's complex sites, you will need survey instruments – usually a meter and one or more probes – that yield accurate measurements in multi-signal environments.

How will you continue to keep your employees safe between measurements?

Personal RF monitors (worn) and area monitors (mounted at the site) alert you to potentially unsafe situations the moment they occur.

How are you going to protect your employees from other emitters that could be co-located at your sites?

The human body doesn't care who owns the emitter and neither does the FCC. You must protect your employees from energy from all sources at a site. Personal RF monitors are often the ideal solution.

Training is a key element of all safety programs. Where can you get it?

Go to an expert in RF radiation, one that has studied the potential hazards and knows how to manage them.

With 95% of the world's patents in RF radiation safety equipment...

The solution is N a r d a

RF Radiation Safety Training

- Public Three-Day Courses
- Custom Corporate Training Programs
- Training Videos

RF Radiation

You can't see it, smell it, hear it, or touch it. Yet the more we learn about it, the better we are at managing operations and reducing risks. It is referred to by many names – electromagnetic radiation, non-ionizing radiation, radio frequency radiation (RFR), electromagnetic energy (EME), and even "EMFs" (electromagnetic fields).

Recent media interest in very low level sources of non-ionizing radiation – cellular phones, VDT's, appliances, power lines – has reminded us to focus on the possibility of hazardous conditions in occupational areas.

Tens of thousands of occupational situations involve potentially hazardous exposure to non-ionizing radiation – exposure that could be at, near, or above recognized safety standards. Industrial uses outside the electronics industry and the military continue to grow.

RF heat sealers and welders, induction heaters, microwave dryers, and semiconductor processing equipment join communications and radar systems in their use of high power electromagnetic sources.

We must manage these sources with knowledge and responsibility.

Narda is continuously creating and refining instruments to gather the significant data essential for environmental and occupational safety. With accuracy as a benchmark and sensitive to corporate liability issues, Narda has developed a comprehensive approach to non-ionizing radiation safety in the workplace.

The training courses and videos described on the following pages can help you develop a safety program.

Seminars and Courses

DESCRIPTION	LENGTH	LOCATION	FOCUS
Non-Ionizing Radiation Survey Training (page 9)	3 days	Long Island, New York	Evaluation, effects and standards. Emphasis on surveys of all types of emitters
Custom Corporate RF Training Programs (page 10)	1/2 - 3 days	U.S. and Canada	From awareness to in-depth training programs

Training Videos

DESCRIPTION	LENGTH	FOCUS
EME Awareness for Antenna Site Safety (page 14)	20 min	Rooftop and tower sites in the wireless and broadcast industries
RF Field Measurements for Antenna Sites (page 12)	32 min.	Measurement techniques for wireless antenna sites

USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

Non-Ionizing Radiation Survey Training

- **Narda has conducted this comprehensive three-day course once or twice a year since 1992.**
- **The course is designed to train professionals in non-ionizing radiation evaluation and management techniques. Limited class size makes this an ideal hands-on experience.**

Who Should Attend

- Industrial Hygienists
- Safety Professionals
- Engineers
- Insurance Professionals
- Managers in Industry, Government, and Service Organizations

Focus

- Determining compliance with major standards
- Evaluating the risk potential of various sources of non-ionizing radiation
- Setting up a non-ionizing radiation safety program

What You Will Learn

When you complete this training course, you will know how to evaluate and manage potential sources of non-ionizing radiation.

The 1997 FCC Regulation, IEEE C95.1-2005/ANSI C95.1-1992 Standard, Canada's Safety Code 6, and the International Commission for Non-Ionizing Radiation Protection (ICNIRP) are the basis of this course which covers health effects from exposure to non-ionizing radiation from sources operating from 3 kHz to 300 GHz. It provides a broad background in the characteristics and generation of electromagnetic radiation by a variety of sources. Instrument designs, applications, and limitations are discussed in detail.

Survey techniques, calculations, and documentation are emphasized. Several types of emitters provide practical hands-on experience operating a broad variety of instruments.

In a small work-group setting, you will make electric field and magnetic field measurements. A variety of sources are used to give you realistic measurement experience.

Course Outline

DAY ONE

- Introduction
- Theory
- Instrument Overview
- Detector Designs

DAY TWO

- Effects and Definitions
- Standards Overview
- Antenna Designs and Calculations
- Introduction to Surveys

DAY THREE

- Performing Surveys
- Documenting a Survey
- Course Review

CREDITS
The American Board of Industrial Hygiene (ABIH) has approved this course for three certification (CM) points.

PREREQUISITE
A professional background in science, engineering, or environmental health and safety is highly desirable.

Schedule And Registration

To register or to obtain the latest seminar schedule contact:

BY MAIL:	Narda Seminar Center 435 Moreland Road Hauppauge, NY 11788
BY FAX:	(631) 231-1711
BY TELEPHONE:	(631) 231-1700 Ext. 242
BY E-MAIL:	nardaseminar@L-3COM.com

Custom Corporate RF Safety Training Program

- **Standard Seminars and Courses Tailored to Fit Your Application**
- **Custom Programs – Shorter or Longer – to Fit Your Needs**
- **Multiple, Short Employee-Awareness Classes**

Training Options

Narda has conducted many different types of RF safety courses for a broad range of customers. The type of training that would be best for your organization depends on several factors:

- **The RF energy environment –** For example, rooftop or tower communication antenna sites, high power radar systems, manufacturing equipment, semiconductor production. The exposure environment impacts the focus of the training.
- **The background of the personnel to be trained –** engineers and technicians, management, environmental health & safety professionals, manufacturing personnel – all can be accommodated but their backgrounds and job functions must be considered.
- **Training objectives –** from simple awareness to thorough overview to detailed survey (measurement) techniques and procedures – your objectives will dictate the program

One approach that has been used for several organizations is to provide either a half-day or whole-day training program for all personnel and have an additional half-day focus on surveys and measurements. Using this approach, only those who will be involved in making measurements attend the second part of the training program.

Previous Customers

Narda has conducted custom training programs for numerous organizations including:

- AT&T (Cingular)
- SBC
- Chrysler
- Hughes Information Technology
- Motorola
- National Association of Broadcasters
- JPL
- NOAA
- NASA
- SONY
- Texas Instruments
- U.S. Air Force
- U.S. Army
- U.S. Navy

Questionnaire

Use the questionnaire on the next page as a guide to help you determine the type of training program desired. Send the completed questionnaire to the Narda Seminar Center. A training professional from Narda will contact you to review your requirements.

BY MAIL:	Narda Seminar Center 435 Moreland Road Hauppauge, NY 11788
BY FAX:	(631) 231-1711
BY TELEPHONE:	(631) 231-1700 Ext. 242
BY E-MAIL:	nardaseminar@L-3COM.com

RF Safety Training Questionnaire

Organization____

Address____

City______________________________ State______________ Zip__________

Contact Person:______________________________ Title______________ Date________

Tel: ( )______________________________ Fax: ( )______________________

CHECK ALL THAT APPLY:

RF Systems

- ❑ Broadcast
- ❑ Wireless Communications
- ❑ Satellite
- ❑ Radar
- ❑ EMC Test
- ❑ Semiconductor Process
- ❑ Industrial Process (describe)______________

____

Environment

- ❑ Rooftops
- ❑ Towers
- ❑ Antenna Ranges
- ❑ Production Test
- ❑ Production
- ❑ Other (describe)______________

____

____

Personnel to be Trained

- ❑ Electronic Engineers & Technicians
- ❑ Environmental Health & Safety Professionals
- ❑ Management
- ❑ Manufacturing Personnel
- ❑ Other (describe)______________

____

Training Objectives

- ❑ Basic Awareness
- ❑ Full Topic Overview
- ❑ Learn How to Develop an Appropriate Safety Program
- ❑ Learn to Make Basic Measurements
- ❑ Learn Advanced Measurement Techniques

Training will be most convenient for me (approximate date)**:**______________________________

Comments____

____

____

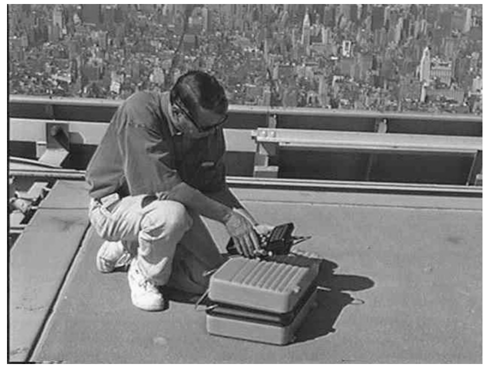
Fax or Mail Questionnaire to:

Narda Seminar Center
435 Moreland Road
Hauppauge, NY 11788

Fax: (631) 231-1711 Tel: (631) 231-1700 Ext. 242

RF Field Measurements for Antenna Sites

This video provides practical advice on making measurements at telecommunications antenna sites from Richard Tell, a highly regarded measurement expert.



Description

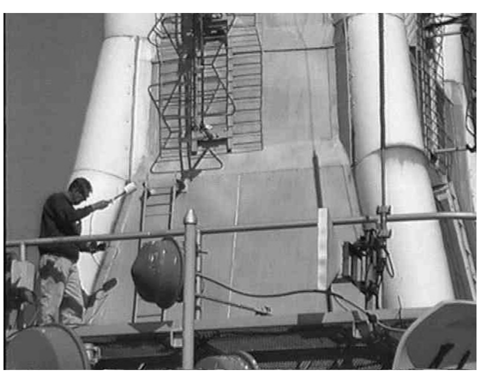
The telecommunications industry is growing rapidly. In the United States, the Federal Communications Commission has issued more stringent regulations for RF radiation. Worldwide, there is an increasing awareness and concern over this issue. The rapid growth of the wireless communications industry has been the focus of many of these concerns.

Finding suitable antenna sites is becoming increasingly difficult due to the proliferation of services and antennas as well as the concerns of the public. Today, it is not uncommon for sites to contain literally dozens of antennas including cellular, PCS, paging, SMR, and traditional two-way radio. In some instances, high power radio and television broadcast antennas may be co-located at the site.

While most of these telecommunications services are not especially high powered, the increasingly common high density of antennas at a site, low antenna mounting heights, and the frequent need for personnel to work in the near vicinity of these antennas too often result in personnel being exposed to high RF fields.

The purpose of this 32-minute video is to provide practical guidance on measuring RF fields at telecommunications antenna sites. The goal is to obtain the most accurate and meaningful data for assessing potential RF exposure levels for certifying site compliance with RF exposure limits.

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us



Topics Covered

- Units of Measure
- Shaped Frequency Response Probes versus Traditional Flat Frequency Response Probes
- Measurement Uncertainty and Correction Factors
- Analog versus Digital Meters
- Connecting and Zeroing the Probe
- Checking Probe Functionality
- Beginning to Make Measurements
- Identifying High Level Areas First
- Spatial Averaging Techniques
- Using the Maximum Hold Feature
- Impact of the Human Body on Field Measurements

Ordering Information

PART NUMBER	LANGUAGE	FORMAT
42945500	ENGLISH	NTSC
42945501	ENGLISH	PAL

Richard (Ric) Tell has been working on issues related to radio frequency (RF) hazards for more than thirty years. During the first twenty years of his professional career, he worked for the U.S. Environmental Protection Agency and served as the Chief of the Electromagnetics Branch. In that capacity, he supported the agency's work program to develop a public exposure standard for RF fields and did extensive work related to RF instrumentation evaluation, computer modeling of antennas and national field studies to measure environmental levels of RF fields. During his tenure at the EPA, his program provided technical support to the Federal Communications Commission (FCC) as the FCC adopted new rules for human exposure to RF fields. More recently, Mr. Tell has pursued his own scientific consulting business related to electromagnetic field exposure assessment. Much of his work has been in helping clients evaluate compliance with applicable standards and establish RF safety programs within their companies including contract support to the FCC and the Cellular Telecommunications Industry Association (CTIA) related to analyzing and evaluating RF fields associated with wireless antenna sites.

Ric earned a B.S. degree in physics and mathematics in 1966 from Midwestern State University in Wichita Falls, Texas, and a M.S. degree in radiation sciences in 1967 from Rutgers University in New Brunswick, New Jersey. He is an elected member of the National Council on Radiation Protection and Measurements and serves as Chairman of Subcommittee 2 of the IEEE Standards Coordinating Committee 28 on RF. He is also Chair of the Risk Evaluation Working Group of Subcommittee 4 which is presently revising the IEEE standard for RF exposure. He is the author of approximately 65 reports, publications, and book chapters related to evaluating electromagnetic fields from a hazards perspective.

EME Awareness for Antenna Site Safety

- This training focuses on RF safety in typical wireless industry environments on rooftops and towers
- Available in English and Spanish
- New DVD Format Available

Application

Motorola developed this 20 minute videotape as part of its Electromagnetic Energy (EME) safety program for its Network Services group. This group manages more than 1000 wireless services sites worldwide. Many of these sites are on rooftops or towers. On rooftops in particular, a great number of people require site access – the engineers and technicians maintaining the communications services equipment, HVAC service personnel, plant maintenance personnel, and window washers among others.

Description

The first half of this tape:

- Describes what electromagnetic energy is and contrasts it with ionizing radiation, differentiating both the sources and health effects.
- Explains the known health effects of EME – tissue heating and shocks and burns – and that it is not cumulative at low levels, as with ionizing radiation.
- Describes the major standards that exist.
- Describes the issues with typical rooftop and tower sites.

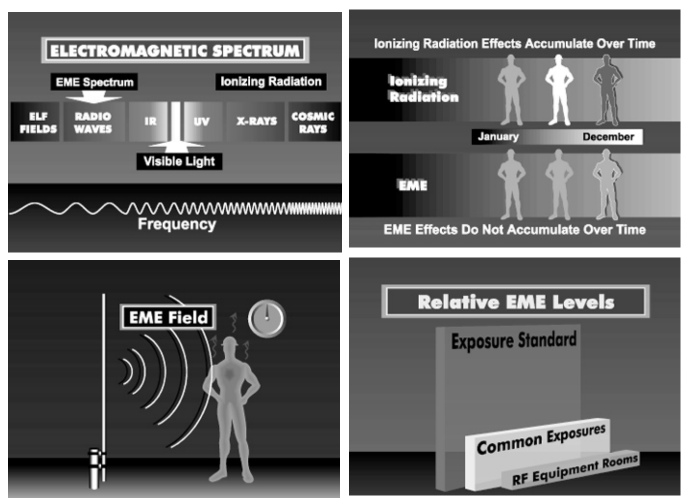
The second half of this tape:

- Explains the ten workplace rules that are referred to as "Guidelines for Working in Radio Frequency Environments."
- After each of the ten points are given and explained, they are repeated in summary form.

Ordering Information

Order by part number from the table below.

PART NUMBER	LANGUAGE	FORMAT
42929000	English	NTSC
42929001	English	PAL
42929002	Spanish	NTSC
42929003	Spanish	PAL
42929008	English	DVD



Instruments and Monitors

Electric and Magnetic Field Measurement

Personal and Area Monitors

Microwave Oven Instruments

narda
Safety Test Solutions
an L3 communications company

Electric and Magnetic Field Instrument Selection Guide

- **Design Features that Impact Application**
- **Product Recommendations for Common Applications**
- **Application Guide**

Design Features that Impact Application

SURVEY SYSTEM CONFIGURATION

Every survey system requires a minimum of one probe (the sensor) and one meter (that displays the measurement data). Systems may include a cable to connect the meter to the probe. In many applications, it is desirable to mount the probe directly on the meter. Similarly, a fiber optic link is sometimes used to provide remote information to a computer, or another meter.

The use of a non-conducting cable to connect the meter to the probe is by far the most common configuration. It allows the probe to be held out away from the body, minimizing interaction with the electromagnetic field which improves measurement accuracy. This separation between the operator and the measurement point can be an important safety issue in certain applications where strong fields exist.

A direct connection between the probe and the meter is useful:

- For one-handed measurements, such as when climbing.
- For making more accurate measurements below 10 MHz (see page 124).

A fiber optic output is useful:

- For making more accurate measurements without human perturbance.
- For making measurements with the system separated from the surveyor by up to 20 meters, or to remote the meter/probe from a computer.

METERS

Meter features to consider:

- Analog or digital readout
- Basic Readout or Instrument with Advanced Features such as:
  - Data logging
  - Multiple-unit readout options
  - Built-in test sources
  - Time and spatial averaging
  - Fiber Optic output capability

CALIBRATION

There are two basic design options:

1. The meter and probe are calibrated as a system with meter. This is a less expensive design because there is less calibration work and an amplifier is not needed inside the probe. The advantage of this approach is that the system can be calibrated as a set, but this may require a larger exposure area to fully simulate field conditions.
2. The probe and meter are calibrated as independent modules. This design approach normally uses a microprocessor to provide calibration information directly to any meter it is connected to. Any meter in the series can be used with any probe in the series without impacting calibration accuracy.

PROBE DESIGN

Most probes are isotropic, or omni-directional, to measure the energy from all directions. Anisotropic, or directional probes, are used primarily for leakage measurements such as with microwave ovens (see page 107). Isotropic probes, such as Narda's 8500 and NBM Series products, employ three mutually perpendicular sensors to provide isotropic response. This configuration results in accurate field measurements independent of the position of the probe or polarization of the incident field.

DETECTION AND UNITS OF MEASURE

All electric field probes detect either the vector electric field, measured in V/m or the mean square of the electric field measured in V^2/m^2. All magnetic field probes in the RF/microwave frequency range detect either the vector magnetic field, measured in A/m, or the mean square of the magnetic field, measured in A^2/m^2. The unit that is displayed is often different from what is actually detected. For example, although no probe actually measures power density, standards may use equivalent power density. The equivalent power density units of mW/cm^2 and W/m^2 are entirely valid in the far field. These units are also useful in the near field for quickly comparing the relative strength of the electric field to the magnetic field since the same unit is used for both fields, even though a far field relationship is assumed. Narda 8500 and NBM Series probes detect the square of the electric field or the square of the magnetic field.

SENSOR TYPE

Electric field probes normally use dipoles with either a diode or thermocouple as a detector. Magnetic field probes normally use current loops with either a diode or a thermocouple as a detector. Isotropic, or omni-directional probes use three sets of dipoles or loops and detectors. One exception is the low frequency EFA-300 that uses an active plate antenna design – in essence a small, almost static field sensor that allows the use of a small antenna despite a long wavelength.

Diodes have the advantage of being rugged and their high output results in little thermal or zero drift. The major disadvantage is that they tend to peak detect pulsed signals and overestimate field levels whenever the signals are amplitude modulated and especially if there are multiple signals. A typical communications site now often contains radio and television antennas plus pagers, emergency services, and cellular systems. A simple diode probe typically overestimates the field strength by 1-2 dB but can overestimate by as much as 10 dB (reads 25-65%, up to 1000% too high). The other major disadvantage is that simple diodes are often overly sensitive to higher, out-of-band signals.

Narda's diode probes are designed with larger square-law regions to remain accurate in most field strength situations that are below human limits. They are recommended for all applications except for pulsed systems, where RMS average levels are sought, but can be employed if the surveyor knows the signal characteristics.

Thermocouples are always true RMS (root mean squared) detectors and yield accurate readings for all signal conditions. Narda's patented designs operate in the traveling wave mode at higher frequencies. The Models EF 5091 and EF 5092 for example, have been proven accurate up to at least 100 GHz. The major disadvantage of thermocouple probes is the zero drift which occurs for several minutes during warmup and can occur if the ambient temperature changes significantly.

Product Recommendations for Common Applications

Select a meter based on the features that you expect to use and the skills of the surveyor. For example, if you plan on simply checking a piece of industrial equipment for leaks, advanced features such as data logging are not needed. Probe selection depends on several factors. Refer to pages 68-70 for details. The following are suggested hardware configurations for some of the most common applications.

WIRELESS AND BROADCAST COMMUNICATIONS

The combination of complex multi-signal environments, frequency dependent exposure standards and regulations for emitters that generate more than 5% of exposure limits, makes the SRM-3000 the ideal choice for the wireless and broadcast industries. The ability to identify important emitters below 3 GHz at these sites, by frequency and level makes it an ideal solution for a better understanding of the site. The broadband NBM meters and probes are also good choices for quick measurements where only the total field strength is needed.

USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www**.narda-sts.us

Electric and Magnetic Field Instrument Selection Guide

MILITARY SYSTEMS

The NBM Series system is ideal because of the broad range of frequencies used by the military. Flat response probes are normally selected because the users have control of the emitters and a shaped response is not required. However, shaped probes are very useful for multiple-emitter flightiness and classified areas. Users performing complex surveys will appreciate the advanced features of the Model NBM-550 Meter. Basic surveys can easily be handled by the very user-friendly NBM-520 Meter.

RADARS

Radar systems normally use microwave frequencies and waveguide. The NBM series, with either the NBM-550 or NBM-520 meter, are appropriate. The probe should employ thermocouple detectors if RMS average results are required (see page 122). The unique averaging and history display available from the NBM-550 is very useful for Radar measurements, while the NBM-520 Meter is ideal for simple waveguide leakage measurements.

WAVEGUIDE SYSTEMS

The NBM-520 and one of four microwave probes with small heads and diode or thermocouple detectors are the most practical choices. The EF1891 and EF 6091 probes use high dynamic range diodes. They are useful for measuring the smallest of leaks from communication waveguides. For Radar (pulsed) waveguides, the EF 5091 or EF5092 are useful because of their thermocouple sensors. Earlier versions of these probes (8721, 8723) have been used by military and air traffic control organizations for years. These four probes are used for leakage detection in densely packaged systems where it is important to distinguish between closely spaced junctions.

SEMICONDUCTOR PROCESS EQUIPMENT

The 8500 Series Industrial Compliance meters are ideal for checking leaks on semiconductor fabrication equipment. The Model 8513 is used by many organizations that operate only at 13.56 MHz. The Model 8511 is a similar unit with a much broader frequency range that also accommodates the 300-500 kHz sources used in some of the newest fabrication equipment.

HEAT SEALERS

The vast majority of heat sealers or vinyl welders operate at the 27.12 MHz ISM band which makes the Model 8513 the perfect solution.

OTHER INDUSTRIAL APPLICATIONS

Industrial heating systems utilizing 915 and 2450 MHz are best covered by the NBM-520 meter and the EF 0391 Electric field probe. This economical and robust design provides exceptional accuracy and ease of use.

USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

Measuring Static Magnetic Fields
ranging from low fields up to 20 Tesla

THM1176 3-Axis Hall Magnetometer

PDA Touch Screen

3 Axis HALL Probe

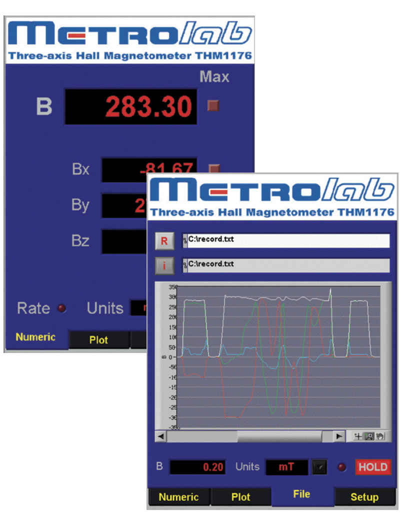
- **Non-Directional Measurement using an Isotropic 3-Axis HALL Probe**
- **Small Sized Field Point for Accurate Measurements in High Gradient Fields**
- **Frequency Range from DC to 1 kHz**
- **USB Probe Interface, Bus–Powered**
- **PC Control Software included for Windows XP and Vista**

THM1176-PDA only

- **Easy Operation by PDA Touch Screen or MS-Windows based PC software (all included)**

Applications

The Three-axis Hall Magnetometer is used to measure the magnetic field (flux density). Its unique, extraordinarily compact design allows it to be used as a portable instrument or directly connected to a PC. The probe is designed for measuring magnetic fields with frequencies from DC to 1 kHz. Measurements on medical equipment (magnetic resonance imaging, MRI), metal production equipment and railway systems are typical applications.



Features

The The total magnetic flux density is provided no matter the orientation of the probe, which greatly facilitates many measurement tasks such as field mapping. Outstanding features are as follows:

- **Three Axes:** Simultaneous measurement of all three axes of the magnetic field provides the total field, no matter the orientation of the probe.
- **Microscopic Field Sensitive Volume:** A sensor size of only 150 x 150 x 10 µm3 provides excellent localization and a self-consistent measurement of the three axes even in highly inhomogeneous fields.
- **Magnetic Fields up to 20 T:** Four measurement ranges – 100 mT, 500 mT, 3 T and 20 T – allow measuring even very strong fields. The standard calibration covers the range up to 3 T. Automatic or manual range setting is provided.
- **Bandwidth of DC to 1 kHz:** The 1 kHz bandwidth allows measuring AC fields generated, for example, by transformers and motors.
- **Graphical Results Display:** Magnetic flux density vs. time can be displayed as a graph. Measurement data can also be recorded to file.

THM1176 3-Axis Hall Magnetometer

Specifications

THM1176 THM1176-PDA				
MEASUREMENT MODES				
Software Functions	- Numerical and graphical display of data (including total field) - Range and units selection - Hold and Maximum - Record to file and recall file			
Record File Format	ASCII tab delimited; compatible with Handheld file format			
MEASUREMENTS				
Ranges	100 mT, 500 mT, 3T, 20T (automatic or manual ranging)			
Data Output	- B_x, B_y, B_z (ASCII or binary, single point or array, calibrated or not) - Temperature (uncalibrated) - Time stamp (10ms resolution)			
Units	Magnetic flux density in T, mT, G, kG, MHz p (NMR frequency of proton)			
Sample Rate				
Immediate Trigger (default)	Approx. 12 kHz (free-running, until internal buffer is full)			
Timed Trigger	0.36 Hz to 2.048 kHz (timer resolution of at least 0.24 ‰; continuous read-out in blocks of 2048 samples)			
Bus Trigger (via USB)	Up to approx. 400 Hz (until internal buffer is full) Note: 1 sample = (B_x, B_y, B_z); Internal buffer size = 2048 samples			
Bandwidth	DC to 1 kHz			
Resolution	100 mT range	500 mT range	3 T range	20 T range
No Averaging	300 µT	500 µT	3 mT	15 mT
Averaging 100 samples	30 µT	50 µT	300 µT	1.5 mT
Accuracy	The greater of ±1% of reading or specified resolution 20 T range specified up to 3 T			
User Offset Correction	To be performed before each series of measurements, in Zero Gauss Chamber supplied			
INTERFACE				
Interface	USB 2.0, full speed (12 Mbps)			
Class / USB Driver	USBTMC (USB Test & Measurement Class) / USB488 DFU (Device Firmware Upgrade)			
Protocol	IEEE 488.2, SCPI (Standard Commands for Programmable Instruments)			
Connector	USB Type A			
Power	USB bus-powered, 4.3V to 5.25V 35 mA min (idle, power-saver on), 90 mA max			
Wake-up Time from Power-Saver	100 ms			
OPERATING CONDITIONS				
Probe				
Operating Temperature	0°C to +40°C			
Storage Temperature	-20°C to +60°C			
Operating Magnetic Field	3 T max. for the instrument electronics (located within the probe cable at 2m distance from the sensor)			
PDA (THM1176-PDA only				
Operating Temperature	0°C to +50°C			
Operating Magnetic Field	1 T max. The PDA may experience forces as high as 50 N. Note: The touch screen of the PDA will cease to function. The power of the PDA must be cycled to restore full operation.			

PDA SPECIFICATIONS (THM1176-PDA only)	
PDA Type	Windows Mobile® 5.0 with USB host interface
PDA Size	(127 x 75 x 21) mm
PDA Weight	230 g with 2600 mAh battery, stylus and USB adapter cable
Display	64K color TFT LCD, 3.5", 240 x 320 pixels
Input Device	Stylus or fingertip
Connectors	- Power jack - 2.5mm audio headset jack - 26 pin connector for ActiveSync, USB 1.1 host and USB 2.0 client - CompactFlash and SDIO expansion slots
Audio	Built-in microphone and speaker
Memory	128 MB SDRAM, 256 MB NAND Flash
Wireless LAN	IEEE 802.11 b/g; internal antenna
Bluetooth	V2.0 + EDR class 1
Battery Life	6 hours min.
Record File Format	ASCII tab delimited
Pre-loaded Software	Acquisition software (same functionality as desktop software) - Word Mobile, Excel Mobile, PowerPoint Mobile - Outlook Mobile, IE Mobile, MSN Messenger Client - Windows Media Player 10.2 Mobile - ActiveSync Client - Socket Mobile Wi-Fi Companion - Programmable Home Screen, Calculator, Utility programs
GENERAL SPECIFICATIONS	
Warranty	2 years
Recommended Calibration Interval	18 months (3-Axis Hall Probe only)
Certification	CE approved
Maintenance	Firmware upgradeable by end user
Accessories (included)	See ordering information
Country of Origin	Switzerland
PROBE HEAD – MECHANICAL DETAILS	
Size:	
- Instrument Electronics	76 x 22.5 x 14 mm^3
- Probe with Housing	113 x 16 x 10 mm^3
Stationary Mounting Point	For M2.5 screw (not included). Note: to avoid breaking the mounting point, use a spacer and do not over-tighten the screw.
Weight	150 g
Size of Field Sensitive Point	150 µm x 150 µm x 10 µm
Sensor Dimensions and Location of Field Sensitive Point	See Figure 1

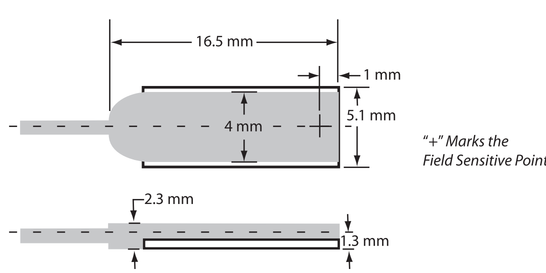


Figure 1: Sensor Dimensions and Location to the Field Sensitive Point

THM1176 3-Axis Hall Magnetometer

Ordering Information

THM1176-PDA	ORDERING NUMBER
THM1176-PDA, 3-Axis HALL Magnetometer with PDA Handheld Computer included *Includes:* - 3-Axis Hall Probe with 3 meter cable - Industrial-quality PDA (pre-installed software, ready to use) - Heavy duty Li-Ion battery (2600 mAh), plus spare (1200 mAh) - AC adapter/charger (100-240 VAC 50/60 Hz) with wall socket adapter plugs for Europe, UK, USA, Australia - USB-Host adapter cable to connect PDA to THM1176 - USB-Device adapter cable to connect PDA to PC - CD with acquisition software for PC (Windows XP/Vista) and PDA (Windows Mobile), LabVIEW source code for all PC and PDA software and user's manual (PDF) - Zero Gauss Chamber - Carrying Case - Certificate of calibration (Full-range calibration on 0.1, 0.5 and 3 T ranges; 20 T range to 3 T)	**2901/101**
THM1176	
THM1176, 3-Axis HALL Magnetometer for Personal Computer (Windows XP/Vista) *Includes:* - 3-Axis Hall Probe with 3 meter cable - CD with acquisition software for PC (Windows XP/Vista), LabVIEW source code and user's manual (PDF) - Zero Gauss Chamber - Certificate of calibration (Full-range calibration on 0.1, 0.5 and 3 T ranges; 20 T range to 3 T *Requires a Personal Computer for operation*	**2901/102**

THM1176-PDA

narda Safety Test Solutions an L3 communications company **USA • Germany • Italy**
USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www**.narda-sts.us

Safety Evaluation within a Magnetic Field Environment

Exposure Level Tester ELT-400

- **Direct Evaluation of Field Exposure Compared to Major Standards (IEEE C95.6)**
- **Automatic Exposure Evaluation for Various Waveforms**
- **Eliminates the Overestimation that Can Occur with FFT-based Evaluation**
- **Ultra-Wide Frequency Range (1 Hz to 400 kHz)**
- **Wide Measurement Range (up to 80 mT, type-dependent)**
- **Isotropic 100 cm^2 and 3 cm^2 Probe (complies with standards)**
- **Three-Channel Scope Output**

Applications

The ELT-400 is an innovative exposure level meter for measuring magnetic fields in the workplace and public spaces. It is designed for health and safety professionals in manufacturing, the insurance business and the service industry. This instrument handles virtually any level measurement in the low and medium-frequency range, simply and precisely. It is comparable to sound level meters commonly used in noise assessment at the workplace.

PRODUCTION AREA

The ELT-400 is ideal for use with diverse manufacturing machinery, including induction heating, melting, and hardening equipment. Also, due to the extremely low frequency limit and high power capability, most magnetic stirrers can be measured. Special demands often occur with machinery in production areas where non-sinusoidal signals are common, e.g., in industrial applications that use resistance welding machinery (pulse waveform, phase angle control) with traditional 50/60 Hz systems as well as in newer medium-frequency switching units.

GENERAL ENVIRONMENT

In public spaces, complex fields occur with several kinds of electronic surveillance systems. Most of the electromagnetic and acousto-magnetic gates are operated in the frequency range of the ELT-400.

EMC TEST HOUSE

Magnetic fields generated by household appliances or other electrical devices are receiving increased attention. Some new standards such as EN 50366 (IEC 62233) describe how to evaluate such products. The ELT-400 is the ideal measuring device for compliance with these standards. Benefits include the perfectly matched frequency range and implementation of the specified transfer function.

ELT-400 Exposure Level Tester

This new generation ELT-400 greatly simplifies the assessment process. With the EXPOSURE STD (Shaped Time Domain) mode, the instrument achieves a new standard in the simple but reliable measurement of magnetic fields, whether straightforward or in complex field environments. Time-consuming and easily-misinterpreted measurements with a spectrum analyzer or a scope are rendered obsolete. Detailed knowledge about the evaluation procedure, field waveform or frequency is no longer needed. The results are reliable and speed and ease of use are significantly improved over all traditional methods.

Basic Operation

The ELT-400 covers the wide frequency range of 1 Hz to 400 kHz which is far beyond the reference limits of common guidelines. This instrument has an external isotropic magnetic field probe with a 100 cm^2 cross-sectional area, making it suitable for standards-compliant measurement even in inhomogeneous fields.

The ELT-400 has a rugged housing and is easy to operate using only six buttons. The instrument settings and measurement results are clearly displayed on a backlit LCD display.

An optional probe extension cable is especially designed for low influence on the frequency response and sensitivity of the instrument. This cable is a good choice in cases where the probe and instrument must be handled separately. The ELT-400 is available with different operating mode combinations, e.g., “Exposure STD” or “Field Strength.” See *Ordering Information* section for details.

Exposure Std (Shaped Time Domain) Mode

SIGNAL-SHAPE-INDEPENDENT FIELD EVALUATION

In EXPOSURE STD mode, the level of the magnetic (B) field is directly displayed as a “Percent of Standard” regardless of the signal shape and frequency. The numeric result clearly reflects the current situation and the remaining safety margin. The implemented method can be compared to sound level meters that are commonly used to determine noise in the workplace.

A standard’s variation with frequency is normalized through an appropriate filter. Knowledge about the frequency or the frequency-dependent limits is no longer needed. The standard is easily selected with a single keypress. Signals with one or more frequencies are no problem. Newer safety standards and guidelines also specify waveform-specific evaluation procedures. For example, stationary sinusoidal and pulsed fields are differentiated. With the ELT-400 the waveform is automatically taken into account. The user no longer needs any knowledge about the waveform or the duty cycle. Pulse signal measurements are also possible. Different evaluation patterns are occasionally specified in the standard for some selected pulse waveforms. These patterns (valid for all imaginable waveforms) are directly handled by EXPOSURE STD mode. This completely eliminates the need to analyze the waveform in the time domain using a scope.

Even when faced with pulses that include DC fields, the EXPOSURE STD method provides valuable results. The ELT-400 covers all the relevant signal components down to 1 Hz so that correct assessments can be made.

Occasionally, both the RMS value and the peak value are critical for assessing exposure in the low-frequency range. Both detector types are provided and are simultaneously activated in the default setting. Depending on the incoming signal and standard selected, the most suitable detector is automatically employed at all times. The necessary weighting factors are also taken into account. The detectors may also be selected independently for further interpretation of the signal.

Detailed knowledge of the field, the test equipment, and other auxiliary conditions are necessary for insight into the degree of exposure when using traditional analysis instruments. The exposure level is derived through extensive calculation. Results can be easily misinterpreted or can have problems. For example – with ICNIRP standard – FFT spectrum analysis tends to overestimate results. The ELT-400 eliminates misinterpretation. It continuously monitors the field and the results are permanently updated. Any change in the field, e.g., due to a power reduction, can be immediately evaluated. Proper evaluation in a personal safety context is achieved quickly and reliably using the STD technique.

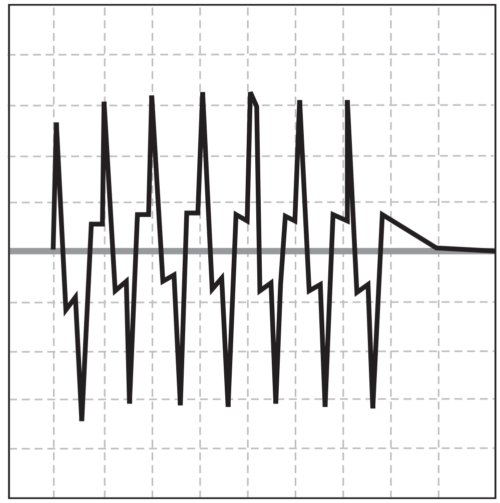
Field Strength Mode

BROADBAND FIELD STRENGTH MEASUREMENTS

If the field under test has essentially a single-frequency component, the broadband mode is also a good choice.

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

The ELT-400 provides an ultra-wideband, flat frequency response. The measurement range can handle extremely high field strength levels. Both RMS and peak detectors are available for broadband measurement. The field strength result is displayed in "Tesla."



Active Field Probe

THREE-AXIS ANALOGUE SIGNAL OUTPUT

In scientific studies or advanced signal-shape / frequency analysis, a scope or an FFT analyzer may be connected to the analog output. The output signal ensures proper phase within the three axes and covers the full bandwidth of the instrument.

The buffered output provides an adequate voltage swing to allow simple operation.

ELT-400 Exposure Level Tester

Specifications [a]

ELT - 400 with 100 cm² Probe						
Frequency Range (-3 dB), selectable	1 Hz to 400 kHz, 10 Hz to 400 kHz, 30 Hz to 400 kHz					
Antenna Type	Magnetic (B) Field					
Sensor Type	Isotropic Coil 100 cm²					
Damage Level RMS	160 mT The damage level reduces linearly with increasing frequency above 77.5 Hz (1/f)					
Damage Level Peak	226 mT The damage level reduces linearly with increasing frequency above 620 Hz (1/f) The damage level (peak) applies for pulse duration ≤15.6 ms and duty cycle ≤1/64					
Measurement Uncertainty [d]	±4% (50 Hz to 120 kHz)					
Mounting Thread	1/4-20UNC-2B (standard thread)					
EXPOSURE STD MODE						
Exposure Evaluation	Comparison with Standard (see Ordering Information)					
MODE [b]	ICNIRP		BGV B11		EN 50366	
RANGE	LOW	HIGH	LOW	HIGH	LOW	HIGH
Overload Limit	160%	1600%	160%	1600%	160%	1600%
Noise Level [c], typical	1%	5%	0.4%	2%	0.4%	2%
Resolution (Range: Low)	0.001%					
Detection, selectable	Automatic according to Selected Standard or RMS (averaging time 1 s) or Peak Value					
Display Mode, selectable	Instantaneous or Max Hold					
FIELD STRENGTH MODE						
Frequency Response	Flat					
MODE [b]	320 µT		8 mT		80 mT	
RANGE	LOW	HIGH	LOW	HIGH	LOW	HIGH
Overload Limit	32 µT	320 µT	800 µT	8 mT	8 mT	80 mT
Noise Level, typical [e]	60 nT	320 nT	1 µT	8 µT	10 µT	80 µT
Resolution (RANGE: LOW)	1 nT					
Detection, selectable	RMS (averaging time 1 s) or Peak Value					
Display Mode, selectable	Instantaneous or Max Hold					
OUTPUT						
Analog Scope Output	Three Channel (X-Y-Z)					
Analog Output Level	The open-circuit analog output voltage is 800 mV when the field strength value corresponds to the overload limit (sensitivity = 800 mV / overload limit) (ELT-400 output impedance = 50 Ω, load impedance ≥ 10 kΩ)					
Interface (Remote Control and Readout)	RS-232 (19200 baud, 8n1, XON/XOFF), 3-Wire, 2.5 mm Stereo Jack					
GENERAL SPECIFICATIONS						
Operating Temperature Range	-10°C to +50°C					
Operating Humidity Range	<95% (30°C) or <29 g/m³, non-condensing					
Weight, Typical	2 lbs. (910 g) with probe					
Dimensions, Typical	7.1 x 3.9 x 2.2 inches (180 x 100 x 55 mm) without probe / probe 11.8 x 4.9 Ø inches (300 x 125 Ø mm)					
Display Type	LCD with Backlight; refresh rate 4 times per second					
Battery	NiMH Batteries (4 x Mignon, AA), exchangeable					
Operating Life, Typical	12 hours					
Charger Unit	100 to 240 V AC / 47 to 63 Hz, fits all AC line connectors					
Charging Time, Typical	2 hours					
Calibration Interval, recommended	24 Months					

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

Specifications (con't) [a]

ELT - 400 with 3 cm^2 Probe						
Frequency Range (-3 dB), selectable	1 Hz to 400 kHz, 10 Hz to 400 kHz, 30 Hz to 400 kHz					
Antenna Type	Magnetic (B) Field					
Sensor Type	Isotropic Coil 3 cm^2					
Damage Level RMS	1500 mT The damage level reduces linearly with increasing frequency above 30 Hz (1/f)					
Damage Level Peak	2121 mT The damage level reduces linearly with increasing frequency above 240 Hz (1/f) The damage level (peak) applies for pulse duration ≤15.6 ms and duty cycle ≤1/64					
Measurement Uncertainty [d]	±6% (50 Hz to 120 kHz)					
Mounting Thread	1/4-20UNC-2B (standard thread)					
EXPOSURE STD MODE						
Exposure Evaluation	Comparison with Standard (see Ordering Information)					
MODE [b]	ICNIRP		BGV B11		EN 50366	
RANGE	LOW	HIGH	LOW	HIGH	LOW	HIGH
Overload Limit	1500%	15,000%	1500%	15,000%	1500%	15,000%
Noise Level [c], typical	10%	50%	4%	20%	4%	20%
Resolution (Range: Low)	0.001%					
Detection, selectable	Automatic according to Selected Standard or RMS (averaging time 1 s) or Peak Value					
Display Mode, selectable	Instantaneous or Max Hold					
FIELD STRENGTH MODE						
Frequency Response	Flat					
MODE [b]	320 µT		8 mT		80 mT	
RANGE	LOW	HIGH	LOW	HIGH	LOW	HIGH
Overload Limit	300 µT	3 mT	7.5 mT	75 mT	75 mT	750 mT
Noise Level, typical [e]	600 nT	3.2 µT	10 µT	80 µT	100 µT	800 µT
Resolution (RANGE: LOW)	1 nT					
Detection, selectable	RMS (averaging time 1 s) or Peak Value					
Display Mode, selectable	Instantaneous or Max Hold					
OUTPUT						
Analog Scope Output	Three Channel (X-Y-Z)					
Analog Output Level *	The open-circuit analog output voltage is 800 mV when the field strength value corresponds to the overload limit (sensitivity = 800 mV / overload limit) (ELT-400 output impedance = 50 Ω, load impedance ≥ 10 kΩ)					
Interface (Remote Control and Readout)	RS-232 (19200 baud, 8n1, XON/XOFF), 3-Wire, 2.5 mm Stereo Jack					
GENERAL SPECIFICATIONS						
Operating Temperature Range	-10°C to +50°C					
Operating Humidity Range	<95% (30°C) or <29 g/m^3, non-condensing					
Weight, Typical	1.9 lbs. (840 g) with probe					
Dimensions, Typical	7.1 x 3.9 x 2.2 inches (180 x 100 x 55 mm) without probe / probe 9.8 x 1.3 Ø inches (250 x 32 Ø mm)					
Display Type	LCD with Backlight; refresh rate 4 times per second					
Battery	NiMH Batteries (4 x Mignon, AA), exchangeable					
Operating Life, Typical	12 hours					
Charger Unit	100 to 240 V AC / 47 to 63 Hz, fits all AC line connectors					
Charging Time, Typical	2 hours					
Calibration Interval, recommended	24 Months					

USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www**.narda-sts.us

ELT-400 Exposure Level Tester

NOTES (for Spec Tables on 2 previous pages)

[a] Unless otherwise stated, these specifications apply for the reference condition: ambient temperature 23±3°C, relative air humidity 40% to 60%, continuous wave signal (CW), RMS detection (frequency range: 30 Hz to 400 kHz)

[b] Type-dependent, see Ordering Information

[c] Detection: automatic according to selected standard

[d] Includes flatness, isotropy, absolute and linearity variations (frequency range: 1 Hz to 400 kHz or 10 Hz to 400 kHz). The uncertainty increases at the frequency band limits (10 Hz, 30 Hz, 400 kHz) to ±1 dB based on the nominal frequency response.

[e] For Frequency Range 1 Hz to 400 kHz and 10 Hz to 400 kHz only

* Preliminary guide values. The overload limit will be specified more precisely to allow specification of the analog output.

Ordering Information

ELT-400 SET	ORDERING NUMBER
Calibrated Basic Unit and B-Field Probe (100 cm^2), Certificate of Calibration, Charger (fits all AC line connectors), Operating/Programming Manual, and Rechargeable Batteries **EXPOSURE STD: EN 50366 (IEC 62233)** **EXPOSURE STD: ICNIRP occ.** **FIELD STRENGTH: 320 µT** **FIELD STRENGTH: 80 mT**	**2304/103/USA**
ACCESSORIES SUPPLIED:	
Probe Extension Cable (length 1 m)	**2300/90.30**
Serial Interface Cable (length 2 m) – Stereo Jack / DB9	**2260/90.51**
Analog Interface Cable (length 3 m) – D-SUB15 / 3xBNC	**2260/90.80**
Transport Case	**2245/90.07**
OPTIONAL ACCESSORIES:	
Tripod, non-conductive (height 1.65 m)	**2244/90.31**
Tripod Extension, non-conductive (height 0.5 m)	**2244/90.45**
B-field Probe 3 cm^2 *(Upgrade required for all ELT 400 with Firmware Version below 2.1 or Serial Number A-0001 til H-9999)*	**2300/90.20**

USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www.**narda-sts.us

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 cm^2) 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

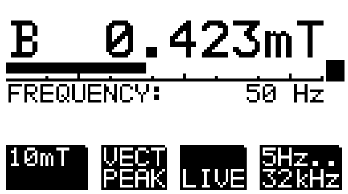
Various standards and guidances take into account the fact that signal shape plays a major role in determining the workplace limit. For example, in Germany the employer's liability insurance association guideline on "Electromagnetic Fields" specifies different evaluation guidelines for different field 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 cm^2 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.

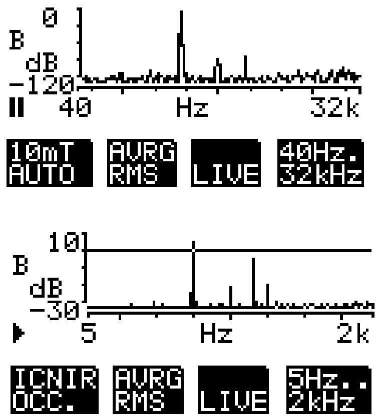
STD analysis is not limited to specific signal shapes. Signals with one or more frequencies and pulsed signals are no problem. Pulsed signal measurements are possible since the time-domain limits (e.g., those specified for selected pulsed signals) can be directly converted into frequency-domain limits. 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)

```
F1:400.6Hz
B1:1.002uT
K2:0.0912% K8:0.0339%
K3:0.0426% K9:0.0222%
K4:0.0414% KT:0.1303%
K5:0.0387% KN:3.9004%
K6:0.0773%
K7:0.0222%
```

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.

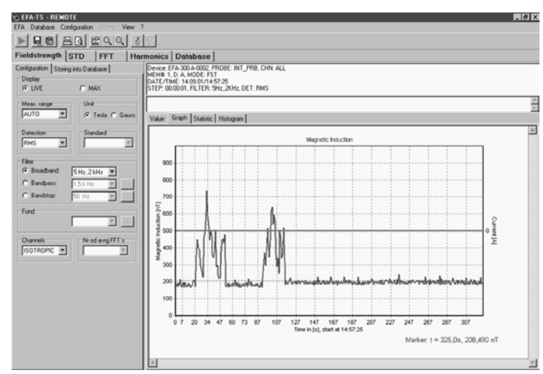
Remote And Data Analysis Software EFA-TS

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

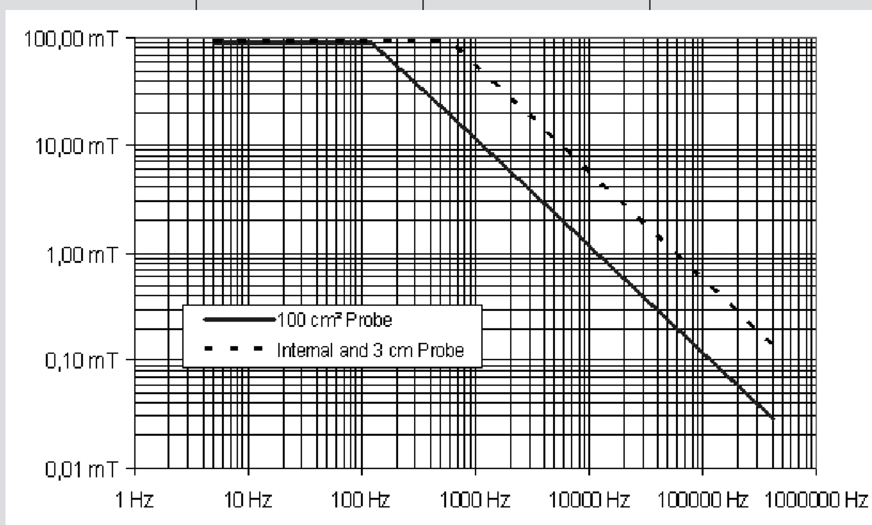


MINIMUM SYSTEM REQUIREMENTS

- 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

EFA-300 Field Analyzer

Specifications

		MAGNETIC (B-) FIELD			ELECTRIC (E-) FIELD
		100 cm² 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	**Broadband (+0/-3 dB), selectable**	5 Hz to 2 kHz, 30 Hz to 2 kHz, 5 Hz to 32 kHz or 30 Hz to 32 kHz			
	Band Pass / Band Reject Filter, adjustable	15 Hz to 2 kHz (resolution 0.1 Hz)			
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)	**Damage Level (Peak)**	91 mT[a] @ ≤125 Hz	91 mT[a] @ ≤625 Hz	91 mT[a] @ ≤625 Hz	280 kV/m
	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% @ ≥1µT	±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.

Overload limit for 100 cm² Probe = $\left(\frac{8000\ \mathrm{mT} \cdot \mathrm{Hz}}{\mathrm{Frequency}}\right) \cdot \sqrt{2}$

Overload limit for 3 cm and internal Probe 100 cm² Probe = $\left(\frac{40000\ \mathrm{mT} \cdot \mathrm{Hz}}{\mathrm{Frequency}}\right) \cdot \sqrt{2}$

[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			
Resolution by Marker: 32 kHz Range	0.1 Hz			
Frequency Scale, selectable: 2 kHz Range	Full-Scale Logarithmic or 100 Hz Wide Linear Span			
Frequency Scale, selectable: 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			
Data Acquisition, (start/stop): 32 kHz Range	Continuous			
Window Length: 2 kHz Range	1.0 second			
Window Length: 32 kHz Range	0.1 second			
Result Averaging, selectable: 2 kHz Range	1, 2, 4, or 8 seconds			
Result Averaging, selectable: 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 2nd to 9th 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			
Control: 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

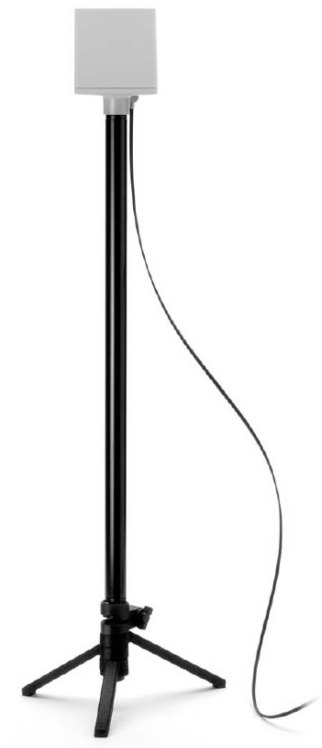
		B-FIELD UNIT	E-FIELD MODULE
Display		LCD Dot Matrix 128x64 Pixel with Backlight	Via B-Field Unit
Alarm, Adjustable Threshold		Acoustical, Optical	Via B-Field Unit
Current Documentation (Specific Modes Only)		Input of Prevailing and Reference Current Value; Storage with Measurement Value of Field	N/A
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	**Part Number**
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**



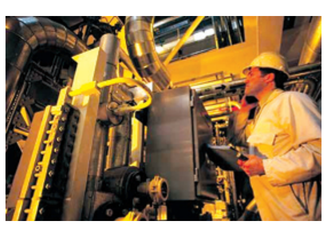
EHP-50C Electric Field and Magnetic Flux Density Analyzer

- Electric Field and Magnetic Flux Density Analysis from 5 Hz to 100 kHz
- Isotropic Measurements with a Dynamic Range of 140 dB
- Small Size and Optical Fiber Connection for Accurate, Repeatable Measurements
- Built-in FFT Spectrum Analysis
- Three (Narrowband, Broadband and Marker) Detection Modes
- Internal Memory for Stand Alone Measurements
- Interfaces to PC and Pocket PC

Measurements of ELF/VLF (Extremely Low Frequency and Very Low Frequency) fields, in an accurate and repeatable manner, have long been a difficult proposition. Interference caused by the proximity of the surveyor has made E-field measurements especially difficult, and most devices have offered only single axis sensors rather than isotropic arrays that only served to further reduce repeatability. With new standards and recommendations (like IEEE C95.6) being introduced and the increase of implanted medical devices, there is an increased need to know what the field levels are in our workplaces and/or around the products we manufacture no matter what their direction or orientation.

The Narda EHP-50C is a new and innovative system that has been designed to offer the highest performance, capabilities and functions, for measurements of low frequency electric and magnetic fields. The EHP-50C performs E and β field measurements in the 5 Hz to 100 kHz range with an unsurpassed dynamic range of > 140 dB and built-in spectrum analyzer function. The EHP-50C, along with a display device (PC or Pocket PC), allows the user to select among three measurement modes: **Wideband**, which measures the contribution of all the frequency components in the selected frequency span; **Highest**, which measures only the highest level found within the Span; and **Spectrum**, with marker functions.

Narrowband spectrum analysis capability of the EHP-50C makes it possible to measure only the contribution from the selected source – e.g. a high voltage line – excluding other nearby additional frequencies.



EHP-50C Electric Field and Magnetic Flux Density Measurement

The EHP-50C's small cubic housing (approx. 4 in.) accommodates everything: three magnetic loops and three plate capacitors orthogonally positioned for sensing fields from any direction. Encased inside the housing is also an A to D converter followed by a powerful DSP (Digital Signal Processor) that performs signal analysis; and the CPU module that controls all the functions; an EEPROM, that stores the calibration data; an optical interface to allow easy connection to external displays via optical fiber link; a high capacity data logger for stand alone continuous acquisition; the control panel with the connections and the ON/OFF switch.

The innovative sensor design, along with the supplied software allows the user to setup measurement parameters beforehand on a PC. During or after a measurement, the software allows displaying, recording and analyzing their values on a PC.

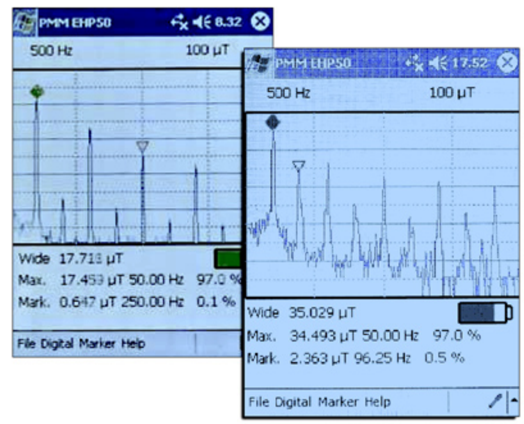
OPERATION WITH POCKET PC

To further improve the flexibility and the portability of the solution provided, the EHP-50C also has dedicated software running on specifically selected Pocket PC's (HP iPAQ Model hx2190 or HP equivalent). Data is received from the EHP-50C through the optical cable and can be easily displayed, analyzed and stored.

The Pocket PC software features digital and analogue reading, span, range and E or β settings, Marker Peak and Delta Peak. It is delivered on a standard 32 MB Secure Digital memory card that can also be used to save the spectra measurements as well as the corresponding numeric values.

STAND-ALONE CONTINUOUS ACQUISITION WITH INTERNAL DATA LOGGER FOR 24 HOURS

If a long monitoring campaign is a must – e.g. when monitoring magnetic fields that might cause interference with implanted medical devices or next to high, medium and low voltage transformers; measuring close to power lines or to machinery, air conditioning systems, large home appliances, etc. the EHP-50C can be used in stand-alone mode without needing a PC, or a Pocket PC connected to it. Once the measurement parameters have been programmed by means of the PC software (supplied), the EHP-50C analyzer can start its acquisition by storing the data over 24 hours in stand-alone mode with a sampling rate of 30 or 60 seconds. After 24 hours the EHP-50C will stop automatically. The data can then be downloaded to the PC. The PC software allows the user to select the measurement field (electric or magnetic), the full scale, the mode (Highest or Wideband), the frequency span and the sampling interval (one minute or 30 seconds).

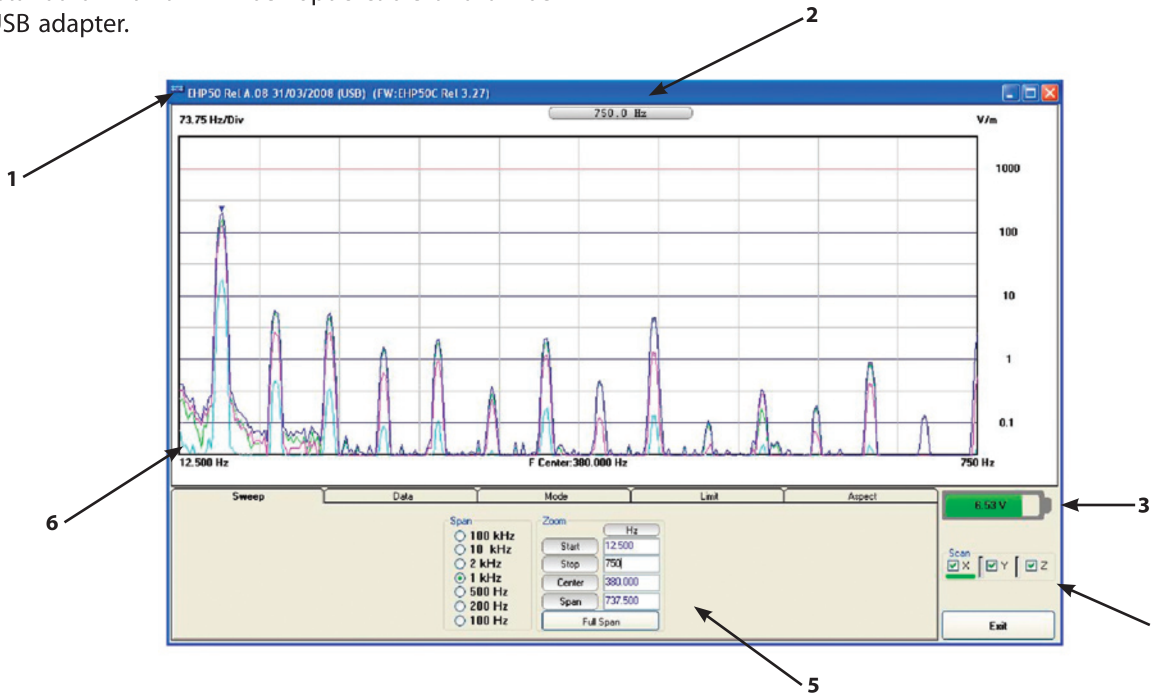


EHP-50C with Pocket PC

EHP-50C Electric Field and Magnetic Flux Density Measurement

PC Software

The supplied software is compatible with Windows™ and allows fast analysis of detected fields in real-time or readings previously stored by the EHP-50C. The EHP-50C is supplied standard with a 2m fiber optic cable and a fiber optic to USB adapter.



DESCRIPTION:

1 – EHP50 software release and firmware of connected analyzer.

2 – Displays frequency while scanning

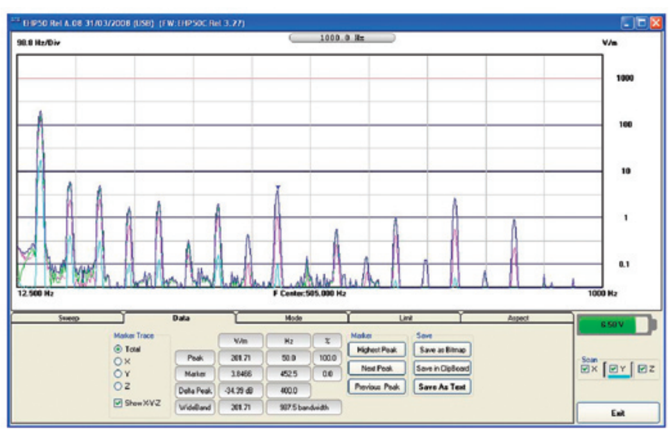
3 – EHP-50C battery status

4 – Scan activation for each axis (default setting: all axis activated)

5 – Control panel

6 – Spectrum analysis display

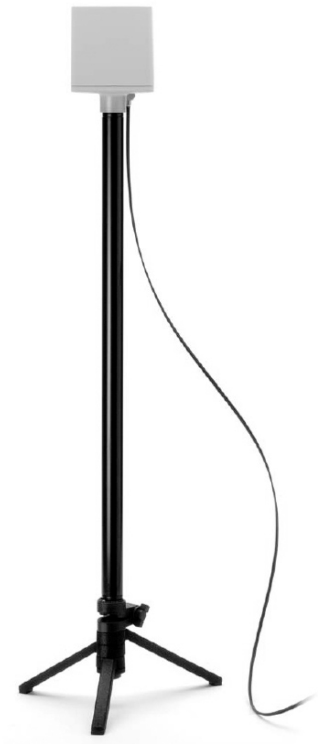
The Control Panel allows you to select the Sweep Span and to Zoom into that span, evaluate Data with automatic peak detection and marker display – and to save plots as graphics or text, Mode selects either E or H fields, instantaneous or "Maximum Hold", Limit allows you to set and save limits, Aspect allows setting of trace colors and label text.



EHP-50C Electric Field and Magnetic Flux Density Measurement

Specifications

EHP-50C E and β Field Analyzer		
FUNCTIONAL SPECIFICATIONS	**Electric Field**	**Magnetic Field**
Frequency range	5 Hz to 100 kHz	
Measuring Ranges	1 kV/m to 100 kV/m	0.1 mT to 10 mT
Overload	200 kV/m @ 60 Hz	20 mT @ 60 Hz
Resolution	0.1 V/m	10 nT
Sensitivity	0.01 V/m	1 nT
Absolute Error	±0.5 dB @ 60 Hz and 1 kV/m	±0.5 dB @ 60 Hz and 0.1 mT
Flatness (40 Hz – 10 kHz)	±0.5 dB	±0.5 dB
Isotropy	±1 dB	
Linearity @ 60 Hz	±0.2 dB (1 V/m to 100 kV/m)	±0.2 dB (200 nT to 10 mT)
SPAN	100 Hz, 200 Hz, 500 Hz, 1 kHz, 2 kHz, 10 kHz, 100 kHz	
Starting Frequency	1.2 % of the SPAN	
Stop Frequency	Equal to the SPAN	
E-Field Rejection	—	> 20 dB
H-Field Rejection	> 20 dB	—
FFT	Real Time FFT Analysis	
Internal Data Logger	1 measurement every 30 or 60 seconds	
Internal memory	1440 data with 1 minute storing, 2880 data with 30 second storing. The data can only be transferred to a PC	
GENERAL SPECIFICATIONS		
Calibration	Internal EEPROM	
Temperature Error (referred to 23°C)	±0.05 dB/°C between -10 and +23°C @ 40% RH ±0.01 dB/°C between +23 and +50°C @ 40% RH	
Humidity Error (referred to 40%)	±0.05 dB between 20% and 50% @ +23°C ±0.05 dB between 50% and 80% @ +23°C	
Internal Battery	Rechargeable NiMH batteries (5 x 1.2 V)	
Operating Time	> 10 hours in normal mode > 150 hours in low power mode 24 hours with internal data logger (SPAN > 200 Hz) in stand alone mode	
Recharging Time	< 4 hours	
External DC supply	10 / 15 V, 200 mA	
Optical Fiber Link and operating Distance	Up to 80 meters	
Firmware Update	Via USB port	
Operational and Storage Temperature	-10°C / 50°C – Storage -20°C / 70°C	
Size and Weight	92 x 92 x 109 mm – 25 g	
Tripod Support	Threaded insert π	
ORDERING INFORMATION		
Part Number	EHP-50C	
Accessories Supplied	0.5m Tripod, Optical Shorting Loop, EHP Software, Operating Manual and Calibration Certificate	



EHP-200
Electric and Magnetic Field Analyzer

- **New solution for Isotropic Measurements in the 9 kHz – 30 MHz Range**
- **Electric Fields from 0.02 to 1000 V/m**
- **Magnetic Fields from 0.6 mA/m to 300 A/m**
- **Built-in Frequency Spectrum Analysis**
- **Built-in Rechargeable Battery**
- **Optical Fiber Connection to PC**

The E-H fields analyzer model EHP-200 has been designed for accurate isotropic measurements of both electric and magnetic fields in the 9 kHz - 30 MHz frequency range, with no or minimum perturbation of the fields that are being measured.

The field sensors and the electronic measuring circuitry are contained in a rugged housing, only 3.6 x 3.6 x 4.3 inches in size. Separate 3-axis and total values (peak and average) are measured with exceptional flatness and linearity of ±0.3 dB. Results are expressed in V/m, A/m, μT, mW/cm^2, W/m^2.

The EHP-200 features built-in spectrum analysis with minimum selectable bandwidth of 1 kHz for detailed measurements of the E and H field intensity vs. frequency, and a dynamic range of 80 dB. The built-in rechargeable Li-Ion battery provides up to 8 hours of continuous operation.

The EHP-200 is controlled by a PC through the optical fiber link, and measurements are displayed in real time. An auxiliary input is available for measuring the frequency spectrum of external applied signals.

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

Applications

BROADCASTING SURVEILLANCE

The EHP-200 is particularly useful in measuring the actual fields generated by long, medium and short wave broadcast transmitters, to ensure safety around the sites of large antennas, to control the transmitted power in the actual radiation direction, to test the functionality of the transmitting antennas and to identify the borders between near and far field regions.

WAVE IMPEDANCE

As a unique feature, the PC program calculates the field wave impedance by dividing the total value of the E-field by that of the H-field. This method is particularly suitable for evaluating the non-linear, scattered near-field region of large broadcast antenna systems.

FIELDS GENERATED BY METAL DETECTORS AND RFID'S

Fields generated by a number of devices using RF to detect the presence of metals, to identify objects, anti-theft systems etc. can now be accurately and easily measured.

EHP-200 Control Software

FOR WINDOWS™ OPERATING SYSTEMS

All measuring functions are user-programmable: Resolution Bandwidth Filter, center frequency and frequency span, preamplifier, measuring units, etc.

The Marker function is used to measure the frequency and amplitude. It features Highest, Next and Previous Peak functions, while the Marker Center function sets the display center frequency at the current marker frequency value.

The Marker also features the Delta Peak function for relative measurements. The Wide Band field value is calculated with reference to the measured frequency span.

To immediately evaluate the measured levels, Limit Lines can be created and displayed on the graphical window. The measured data can be saved as either text or bitmap, and the limits can also be saved and recalled.

Blue Line: total Field / Green Line: X-axis
Cyan Line: Y-axis / Magenta Line: Z-axis

EHP-200 Field Analyzer

Specifications

EHP-200 E AND H FIELD ANALYZER				
RF SPECIFICATIONS	**Electric Field**	**Magnetic Field Mode A**	**Magnetic Field Mode B**	**Auxilllary Input**
Frequency Range	9 kHz to 30 MHz	9 kHz to 30 MHz	300 kHz to 30 MHz	9 kHz to 30 MHz
Measurement Range @ 10 KHz RBW	0.1 to 1000 V/m	0.03 to 300 A/m	3.0 mA/m to 30 A/m	-80 to 0 dBm
@ Preamp ON	0.02 to 200 V/m	6.0 mA/m to 60 A//m	0.6 mA/m to 6 A/m	-94 to -14 dBm
Dynamic Range	>80 dB			
Sensitivity @ 10 kHz RBW	0.1 V/m	30 mA/m	3 mA/m	-80 dBm
@ Preamp ON	0.02 V/m	1 mA/m	0.1 mA/m	0.01 dB
Resolution	0.01 V/m	1 mA/m	0.1 mA/m	0.01 dB
Flatness	±0.5 dB (20 V/m, from 0.1 to 27 MHz)	±0.8 dB (166 A/m, from 0.15 to 30 MHz)	±0.8 dB (53 mA/m, 0.3 to 27 MHz)	±0.4 dB (-20 dBm)
Anisotropy	±0.8 dB at 1 MHz			
Linearity	0.5 dB @ 1 MHz from Full Scale to -60 dB Full Scale			
Typical Accuracy at 1 MHz	±0.8 dB @ 20 V/m	±0.8 dB @ 53 mA/m	±0.8 dB @ 53 mA/m	±0.3 dB@-10 dBm
Maximum Frequency Span	6 kHz to 30 MHz			
Resolution Bandwidths Available	1 kHz, 3 kHz, 10 kHz, 30 kHz, 100 kHz, 300 kHz			
Rejection to E-field	—	> 20 dB		—
Rejection to H-field	> 20 dB	—	—	—
Calibration Errors	Stored in internal EEPROM			
Temperature Error	0.02 dB/ºC			
GENERAL SPECIFICATIONS				
Preamplifier	Selectable ON/OFF, 14 dB gain			
Reading Units	V/m, A/m, mT, mW/cm^2, W/m^2			
Optical Link	Maximum length of 80 m			
Internal Battery	3.7 V, 3.6 Ah, Li-ion, rechargeable			
Battery Operation Time	> 8 hours (recharging time approximately 8 hours)			
External Supply	10 – 15 VDC, 500 mA			
Firmware Update	Via Optical Fiber			
Operating Temperature	-10ºC to +50ºC			
Storage Temperature	-20ºC to +70ºC			
Dimensions and Weight	3.6 x 3.6 x 4.3 inches (92 x 92 x 109 mm), 1.22 lb (550 g)			
ORDERING INFORMATION				
Part Number	EHP-200			
Accessories Supplied	10 meter Fiber Optic Cable (FO-8053/10), Fiber Optic Converter (FO to RS-232, 8053-OC), Soft Carrying Bag (8053-SC), Battery Charger (8053-BC), 50 cm Plastic Pole and Tripod, PC Software, Operating Manual, Calibration Certificate			
Optional Accessories	EHP-200 Palm Kit			

SRM-3006 Selective Radiation Meter

- Complete Solution for Selective Measurement of RF and Microwave Electromagnetic Fields
- Isotropic and Single-Axis Measurements from 9 kHz to 6 GHz
- Excellent Immunity for Operation in High Field Strengths
- Automatic Antenna and Cable Detection
- Results in V/m, A/m, Power Density, or Percentage of Permissible Limit
- Measures strength of single emitters in multiple emitter environments
- Ultra Wide Dynamic Range of 50 µV/m to 200 V/m (E-Field)
- Determines 5% Boundaries for FCC Compliance
- Resolution Bandwidths (RBWs) up to 20 MHz for UMTS and W-CDMA, 32 MHz (Level Recorder and SCOPE Modes)
- Designed for Outdoor Use: rugged, splash proof ergonomic design. Equipped with GPS and voice recorder to simplify survey reports
- Optional SCOPE and UMTS Modes

Features

The Selective Radiation Meter (SRM-3006) is our second generation, hand-held system for performing narrowband analysis of electromagnetic fields. Unlike our NBM series (broadband), the SRM-3006 has the ability to give you results of individual emitters and also generate a total of all emitters. The SRM-3006 allows you to verify compliance with the US FCC's "5% Rule" as well as accurately detect fields well below domestic and international standards. The SRM-3006 also has the ability to measure fields more accurately than broadband equipment and maybe more importantly, it is able to give you more information than just the total – like exactly what emitter or emitters are generating the most of the power.

SRM-3006 Selective Radiation Meter

No other measurement system gives you the information and accuracy that the SRM-3006 does. Narda Safety Test Solutions provides complete calibration information standard with every unit, just as you'd expect from the world leader.

The US version of the SRM-3006 consists of a basic unit (meter) and a 3-axis, E-field antenna. The meter is really an optimized spectrum analyzer covering 9 kHz to 6 GHz and modified to make accurate field strength readings with the help of our antennas. You can operate the meter with any type of antenna for special measurements (direction finding, DTV measurements, "Roberts' dipoles") but you'll be impressed by the performance of Narda's designs. We supply our SRM-3006 with a 3-axis design that covers 27 MHz to 3 GHz that is calibrated at 20 different frequencies and reliably works down to 200 µV/m . This portable, rugged and splash-proof system incorporates a highly readable color display, GPS receiver and microphone for voice recording. Also supplied is our full SRM-TS software package, a 1.5 meter cable to separate the antenna from the meter and charger, manual and other accessories inside a very protective carrying case.

Narda offers additional antennas that you'll find listed at the back of this data sheet. We have lower and higher frequency E-field antennas and some single axis designs that offer even higher accuracy. Narda can also supply single or 3-axis H-field antennas. Each antenna is individually calibrated and its factors are automatically accounted for as soon as the antenna is plugged in. We also offer longer cables for special measurement needs, non-metallic tripods, external or mobile battery chargers with extra battery packs, carrying pouches – basically everything you might need to get the survey done.

Every SRM-3006 has the ability to perform single or multiple measurements that can be averaged and/or stored in the meter for download to a computer. You can set-up the SRM-3006 the way you like and store a complete configuration for later use or repeated uses. You can set up parameters for time controlled storing that only logs the data you want above a certain threshold level. Each system has an embedded GPS receiver and microphone, so every stored reading is supplied with GPS coordinates and can have an audio description added.

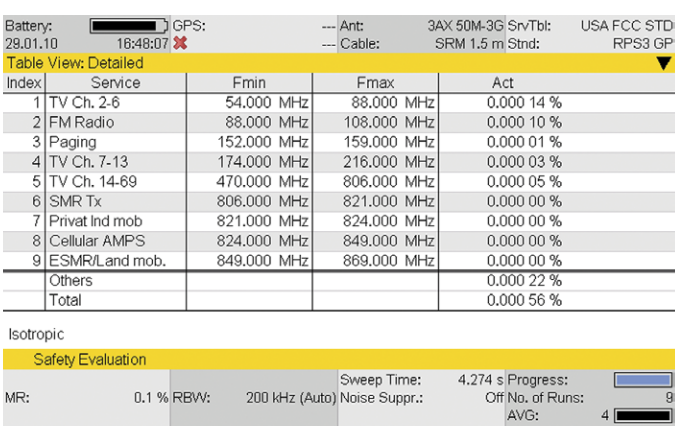
Applications

The SRM-3006 has some special capabilities when it comes to RF safety measurements. In addition we have added some other operational modes (UMTS P-CPICH) for common engineering measurements. But if you simply want to perform safety measurements – the SRM-3006 makes it simple.

SAFETY EVALUATION MODE

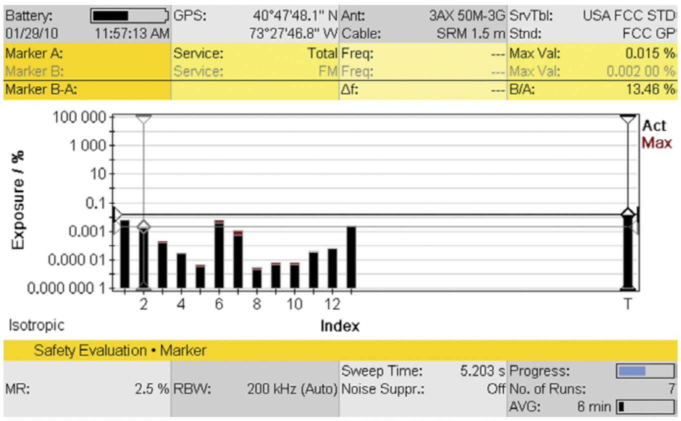
Have you ever made a broadband measurement and wish you really knew what all the emissions all around you were really adding? The Safety Evaluation Mode is a very popular method to make a reading that simply separates emitters the way you would like them displayed. We include multiple sample tables in the meter we deliver to you that you can use as is, or modify for your own geographical area or interest. It's easy to make your own tables that quickly and cleanly show the total level of individual emitters or bands. You can display the results in common field strength or equivalent power density, or the easily understood "% of standard" units shown below. You can easily modify these tables and identify each frequency band or emitter by the name that you choose. You can add or remove entities as you see fit, thereby customizing the display for your area or need. We even offer two different displays, a common tabular listing as well as a bar graph listing, making evaluation of data quick and accurate.

This is a very powerful way to display multiple emitter data in a way that even non-technical persons understand and technical persons can appreciate.

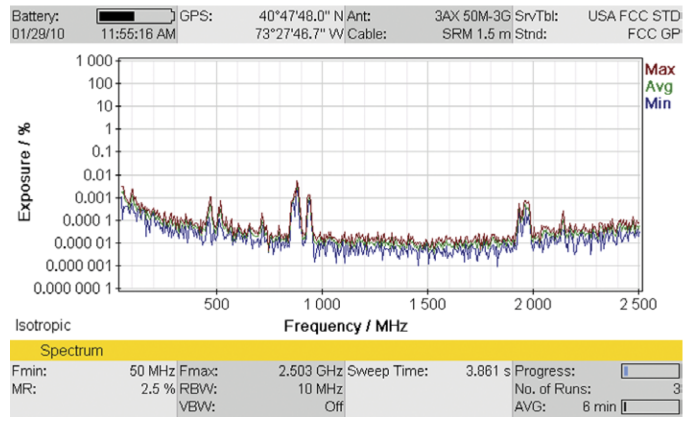


Index	Service	Fmin	Fmax	Act
1	TV Ch. 2-6	54.000 MHz	88.000 MHz	0.000 14 %
2	FM Radio	88.000 MHz	108.000 MHz	0.000 10 %
3	Paging	152.000 MHz	159.000 MHz	0.000 01 %
4	TV Ch. 7-13	174.000 MHz	216.000 MHz	0.000 03 %
5	TV Ch. 14-69	470.000 MHz	806.000 MHz	0.000 05 %
6	SMR Tx	806.000 MHz	821.000 MHz	0.000 00 %
7	Privat Ind mob	821.000 MHz	824.000 MHz	0.000 00 %
8	Cellular AMPS	824.000 MHz	849.000 MHz	0.000 00 %
9	ESMR/Land mob.	849.000 MHz	869.000 MHz	0.000 00 %
	Others			0.000 22 %
	Total			0.000 56 %

Overview with Safety Evaluation: *The services to be checked are recorded in editable tables. There's no complicated evaluation needed in Safety Evaluation Mode. The numerical result shows the individual contributions of the services as well as the overall level in terms of the permitted limit value.*



***Safety Table Entries** can also be displayed as bars on a graph, quickly identifying what service (or frequency) is providing the most power to your selected safety table.*



***Classic Spectrum Analysis:** Result evaluation using markers and delta markers. For example, the integration function can be used to determine the channel power level. Special feature: Service Identification by means of pre-recorded service values.*

SPECTRUM ANALYSIS MODE

Spectrum Analysis Mode makes finding "hidden" or "intermittent" emitters easy. Perhaps you didn't expect a certain frequency to be used in your area, but in this mode that emitter can be quickly and easily identified by the frequency and level it's operating at. This gives you the real story of what is happening right now – when and where you are performing the measurement. The SRM-3006 allows easy settings of frequencies and resolution bandwidths with a powerful "marker" function that lets you see each significant signal, set a marker on it and zoom to it in a rapid manner. When it comes time to save a spectrum view the SRM saves the entire dataset rather than just a picture. With the supplied SRM-TS software you are able to even post-process information thereby enhancing detected data for your survey reports.

When using the SRM-3006 to "direction find" or search out "cable leakage" the Spectrum Analysis Mode with our overall system design makes it a simple, portable task. First is the SRM's capability to add antennas into its memory. You can easily import calibration data of your existing antennas and/or cables and have the SRM account for them in its display.

SPATIAL AVERAGING

FCC license holders will find the built-in spatial averaging feature very powerful. Broadcasters can employ the 1.5m cable along with optional antenna holders and a non-metallic tripod to make accurate and repeatable measurements at their transmitter sites. GPS logs exactly where the measurement was taken and the narrowband performance means you just survey your emissions. Cellular operators can also use the fast time averaging for a quick vertical spatial average sweep, again logging just your emission out and beyond the "5%" distance.

LEVEL RECORDER MODE

Level Recorder Mode allows you to particularly watch one signal or band over a long time period. The display is optimized to give you four results, Maximum Peak, Actual Peak (present reading), Maximum RMS and RMS. RMS Actual is an average over a time that you choose from 0.48 seconds to 30 minutes. This makes long term monitoring of an emitter easy and supplies all the data you might need to fully evaluate its contribution to the overall site levels.

Options

UMTS P-CPICH DEMODULATION

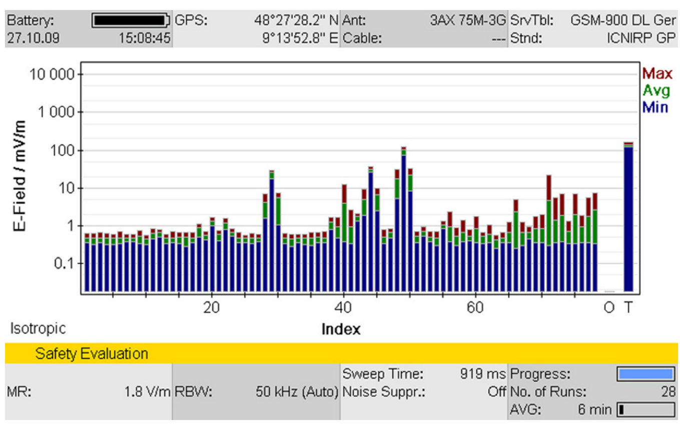
This option is useful for cellular phone companies and their consultants. The SRM-3006 automatically identifies every site and sector that it received a UMTS scrambling code from. The SRM-3006 can then measure the field strength (or power density) of the associated pilot channel (P-CPICH) at the same time. The SRM-3006 also shows the sum of all P-CPICH levels as an overall value (Total). The Analog measured value for the frequency channel is also shown for comparison. You can also set a factor that the SRM can use to extrapolate the field strength that would result if all channels were fully loaded. Therefore, instead of guessing what the UMTS signal is (at measurement time) and how it relates to the maximum possible signal strength that the site could generate, now you can measure and estimate with confidence.

SCOPE MODE

The Scope Mode incorporates a high speed oscilloscope that displays pulse modulated signals down to a resolution of 31.25 µs. This allows high speed characterization of WiMax signals along with any other pulsed signal below 6 GHz. This mode allows the communications engineer and technician an extended and powerful capability in a system that they needed already.

TIME CONTROLLED STORING

The SRM can store measurements under timer control by specifying the start date, start time, measurement duration, and other parameters. MORE TO COME



Safety Evaluation in the UMTS Range: *The individual channels with their channel numbers are shown next to each other in the bar graph display, just like a textbook. The "T" bar on the extreme right shows the total power density. The "O" bar shows the contributions from the frequency gaps (others) between the services*

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

Measurement Functions

Detection of Narda Measurement Antennas	Automatic consideration of antenna parameters after antenna is plugged in: antenna type, serial number, calibration date, and antenna factors (see below) Automatic limitation of the frequency range according to the frequency range of the connected antenna.
Antenna Factors	Used for display in field strength units Saved in all Narda antennas during calibration Antenna factor lists for antennas from other manufacturers can be saved (these lists defined using the PC configuration software *SRM Tools* or *SRM TS*)
Detection of Narda Cables	Automatic consideration of cable parameters after cable is plugged in: cable type, serial number, calibration date, and loss factors (see below) Automatic limitation of the frequency range according to the frequency range of the connected cable
Cable Loss Factors	Used for compensation of the power level display Saved in all Narda cables during calibration Cable loss lists for cables from other manufacturers can be saved (these lists defined using the PC configuration software *SRM Tools* included in delivery)
Units with antenna	% of the standard, V/m, A/m, W/m^2, mW/cm^2, dBVm, dBmV/m, dBA/m, dBµV/m
without antenna	dBV/m, dBmV/m, dBµV/m, dBm
Isotropic Measurements	Automatic switching of the antenna axes, when using Narda's triaxial measurement antenna, followed by computation of the isotropic result Sequential measurements, using single-axis antennas with subsequent computation of the isotropic result are supported Both results are directly displayed as a spectrum curve or as numerical values
Weighted Display	In % of the standard for the following human safety standards: ICNIRP, IEEE, FCC, BGV B11, BImSchV, Safety Code 6 Updating for new human safety standards can be made using the PC configuration software "SRM tools" included in delivery
Correlation of Results with Telecom Services	Definition and editing of service tables in the PC configuration software *SRM Tools* or *SRM TS* i.e., lists of frequency bands (upper and lower limit frequency, name for defined frequency band) Storage of service tables in the basic unit Use of the service tables for automatic correlation of measurement results with defined services based on frequency (marker functions, peak table evaluation function, Safety Evaluation mode)
Setups	Complete device configurations can be saved in the basic unit; up- and downloadable using *SRM Tools* or *SRM TS* Software
Memory Modes	Result stored as: SPECTRUM in Spectrum Analysis mode (SPEC), TABLE in Safety Evaluation mode (SAFETY), VALUES for Level Recorder (LEVEL) and Scope (SCOPE)
Memory Capacity	128 MB
Hold	"Freezes" the display; the measurement continues in the background

SRM-3006 Selective Radiation Meter

Specifications

Basic Unit SRM-3006		
	Frequency Range	9 kHz to 6 GHz
	Modes	Spectrum Analysis; Level Recorder Safety Evaluation; SCOPE UMTS P-CPICH Demodulation
RF FEATURES		
Frequency	Resolution Bandwidths (RBW)	See specifications for each mode
Frequency	Phase Noise (SSB)	10 kHz carrier spacing < -70 dBc (1 Hz) 300 kHz carrier spacing < -100 dBc (1 Hz)
Frequency	Reference Frequency	Initial Deviation < 1.0 ppm Aging < 5.0 ppm over 15 years Thermal Drift < 1.5 ppm (within specified operating temperature range)
Amplitude	Measurement Range Setting (MR)	-30 dBm to +20 dBm (in steps of 1 dB)
Amplitude	Display Range	1 dB above the measurement range
Amplitude	Maximum RF Power Level	+27 dBm
Amplitude	Maximum DC Voltage	50 V
Amplitude	Intrinsic Noise	<MR -100 dB for RBW = 1 kHz and f ≤ 30 MHz <MR -96 dB for RBW = 1 kHz and f ≤ 2 GHz <MR -95 dB for RBW = 1 kHz and f ≤ 4 GHz <MR -90 dB for RBW = 1 kHz and f ≤ 6 GHz
Amplitude	RF Attenuation	0 to 50 dB in steps of 1 dB (coupled with measurement range)
Amplitude	2nd Order Intermodulation Products	≤ -40 dBc for two signals of level 6 dB below MR and a spectral line spacing of more than 1 MHz
Amplitude	3rd Order Intermodulation Products	≤ -60 dBc for two signals of level 6 dB below MR and a spectral line spacing of more than 1 MHz
Amplitude	Extended Level Measurement Uncertainty	< 1.1 dB for the entire frequency band (within the temperature range from 15°C to 30°C) < ±1.2 dB SA and SE Modes only
Amplitude	Spurious Responses (input-related)	< - 60 dBc or MR - 60 dB (whichever is worse)
Amplitude	Spurious Responses (residual)	< -90 dBm or MR -60 dB (whichever is worse) Except the following frequency range: 294 to 306 MHz, where the value is < -85 dBm or MR -55 dB (whichever is worse)
RF Input	Type	N Connector, 50 Ω
RF Input	Return Loss	>12 dB for 1 kHz RBW, f ≤ 4.5 GHz and MR ≥ -28 dBm >10 dB for 1 kHz RBW, f > 4.5 GHz and MR ≥ -28 dBm

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

SPECTRUM ANALYSIS MODE	
Measurement Principle	Spectrum analysis
Resolution Bandwidths (-3 dB)	10 Hz to 20 MHz (in steps of 1, 2, 3, 5, 10) List of available RBWs depends on selected sweep SPAN
Measurement Range Setting (MR Range)	Set individually from a list or using the "MR Search" function for determining the optimum measurement range at a given time
Video Bandwidth	0.2 Hz to 2 MHz (depending on the selected RBW)
Filter **Type** **Shape Factor (-3 dB / -60 dB)**	 Gaussian < 3.8 (for RBW ≤ 100 kHz)
Result Type	ACT: Displays current spectrum MIN: Minimum Hold function MAX: Maximum Hold function AVG: Average over a selectable number of spectra (4 to 256) or a selectable time period (1-30 min) MAX AVG: Maximum Hold function after averaging over the defined number of spectra MIN AVG: Minimum Hold function after averaging over the defined number of spectra STANDARD: Displays limit line of the selected safety standard
Marker Functions	Delta marker on one Result Type or for displaying the difference between two Result Types Highest peak, peak right, peak left, higher peak, lower peak Marker field (frequency, level and service name from selected service table)
Evaluation Functions	Peak Table (list of 50 highest peaks) Integration over a user-specified frequency range
Axis	Isotropic measurement (isotropic result displayed directly) Measurement of X-, Y- or Z- axis (separate measurement of a single axis using the isotropic / three-axis antenna)
Display Functions	Y-scale range 20, 40, 60, 80, 100 or 120 dB Y-scale reference MR -100 dB to MR +20 dB (-130 dB to +40 dB) Screen Arrangement (enlarges the graph window to fill the entire screen area)
Zoom Functions	Zoom Min: Sets the lower frequency limit of the zoom window Zoom Max: Sets the upper frequency limit of the zoom window Zoom Cent: Moves the zoom window along the frequency axis Zoom Span: Changes the scale of the zoom window Execute Zoom: Sets the zoom window limits to the selected frequency values
SAFETY EVALUATION MODE	
Measurement Principle	Spectrum analysis, followed by integration over user-defined frequency bands ("services")
Resolution Bandwidths (-3 dB)	Automatic (Auto), depending on the narrowest user-defined service bandwidth, or user-defined (Manual) for all services, or separately defined for each individual service (individual)
Measurement Range Setting (MR Range)	Set individually from a list or using the "MR Search" function for determining the optimum measurement range at a given time
Filter	See *Spectrum Analysis* mode
Detection	RMS (integration time ≈ $\frac{1}{RBW}$)
Result Type	See *Spectrum Analysis* mode
Axis	Isotropic measurement (for direct display of the isotropic result) Measurement in the direction of the X, Y, and Z axis (separate measurement in one direction using an isotropic / three-axis measuring antenna)
Display	Table view showing service names, field strengths and the corresponding frequency band (up to three columns) Individual Screen Arrangement Sort Function according to various criteria Bar graph of services showing contribution of different Result Types
Noise Suppression	Identifies whether measured values are above the device noise floor by setting a threshold (selectable at 0, 3, 6, 10, 15, or 20 dB relative to device noise floor). Measurement values below the threshold are shown as the absolute threshold value marked with "<" (less than threshold)
Others On/Off	Measurement of services and gaps in the Service Table (Others On) or Measurement of services in the Service Table excluding gaps (Others Off)

SRM-3006 Selective Radiation Meter

LEVEL RECORDER MODE	
Measurement Principle	Selective level measurement at a fixed frequency setting
Detection	Peak RMS (integration time = 480 ms), observation time selectable from, 480 ms up to 30 minutes
Filter Type	Steep cutoff channel filter
Resolution Bandwidth RBW (-6 dB)	40 kHz to 32 MHz (10 steps per decade)
Video Bandwidth (VBW)	4 Hz to 32 MHz (depending on the selected RBW)
Measurement Range Setting (MR)	Set individually from a list or using the "MR Search" function for determining the optimal measurement range at a given time
Result Type	Peak ACT: Displays the current (actual) value Peak MAX: Maximum hold function RMS ACT: Average over a defined time (0.48 seconds to 30 minutes) RMS MAX: Maximum hold function for the averaged values – with RMS detector only SAVG: Spatial averaging (option) in Value display mode
Time Averaging	Selectable from 0.96 seconds up to 30 minutes (0.96 s; 1.2 s; 2.4 s; 3.6 s; 6 s;12 s; 18 s; 30 s; 1 min; 2 min; 3 min; 5 min; 6 min; 10 min; 15 min; 20 min; 30 min)
Axis	Measurement in the direction of the X, Y, and Z axis (separate measurement in one direction using an isotropic / three-axis measuring antenna)
Noise Suppression	Identifies whether measured values are above the device noise floor by setting a threshold (selectable at 0, 3, 6, 10, 15, or 20 dB relative to device noise floor). Measurement values below the threshold are shown as the absolute threshold value marked with "<" (less than threshold). Only applies to the numerical result display (Value)
SCOPE MODE (OPTION)	
Measurement Principle	Selective level measurement at a fixed frequency
Filter Type	Steep cutoff channel filter
Time Span	500 ns to 24 h
Time Resolution	Selectable from 31, 25 ns up to 90 minutes (0.96 s; 1.2 s; 2.4 s; 3.6 s; 6 s; 12 s; 18 s; 30 s; 1 min; 2 min; 3 min; 5 min; 6 min; 10 min; 15 min; 20 min; 30 min)
Resolution Bandwidth RBW (-6 dB)	40 kHz to 32 MHz (10 steps per decade)
Measurement Range Setting (MR Range)	Set individually from a list or using the "MR Search" function for determining the optimum measurement range at a given time.
Video Bandwidth (VBW)	4 Hz to 32 MHz (depending on the selected RBW)
Result Type - Depends on Detector	ACT: Displays the current (actual) value STANDARD: Displays the selected safety standard OR MAX: Maximum value within the time resolution interval (corresponds to peak detector) AVG: Average value within the time resolution interval (corresponds to RMS detector) MIN: Minimum value within the time resolution interval STANDARD: Displays the selected safety standard

narda Safety Test Solutions an L3 communications company **USA • Germany • Italy**
USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www.**narda-sts.us

UMTS P-CPICH DEMODULATION MODE (optional)		
Measurement Principle		Demodulation of the P-CPICH (Primary Common Pilot Channel) as the basis for automatic assignment of measured field strength values to the individual UMTS radio cells (defined as cell name tables)
UMTS Channel Selection		By entering the center frequency (Fcent) By entering the channel number (Chann)
Resolution Bandwidth (-3 dB)		3.84 MHz (fixed)
Measurement Range Setting (MR Range)		Set individually from a list or using the “MR Search” function for determining the optimum measurement range at a given time
Frequency Setting Resolution		100 kHz (for Fcent frequency entry) 0.5 x channel number (for channel entry)
Detection		RMS (integration time = 10 ms)
Filter	**Type**	Root-Raised Cosine (RRC)
	Roll-Off Factor	$\alpha = 0.22$
Demodulation Algorithms		FAST SENSITIVE
Result Types		ACT: Displays the instantaneous value combined with the maximum value MAX (maximum hold function) which occurred since the last reset AVG: Averages over a selectable number of results (4 to 64) or over a specified time period (1 to 30 minutes) combined with Max AVRG (maximum hold function of the average values)
Marker Functions (in Hold mode only) (Bar graph, Mixed and Graph display)		Marker, highest peak, next peak right, next peak left, next highest peak, next lowest peak Display switchable between Value and Max Value
Evaluation Functions		Extrapolation factor settable from 0 to 100 in steps of 0.001
Received / Demodulated Signal		P-CPICH
Axis		Isotropic measurement (for direct display of the isotropic result) Measurement in the direction of the X, Y, and Z axis (separate measurement in one direction using an isotropic / three-axis measuring antenna)
Display		Up to 16 scrambling codes simultaneously Value (instantaneous) and MAX Value (maximum) channel power User-defines cell names (using cell name tables) Number of sweeps since the last reset Selection of individual scrambling codes Extrapolation factor settable from 0 to 100 in steps of 0.001
	Normal Table	Table format: Index, Scrambling Code, Value, Max. Value, Cell Name Total of all ACT (Value) and MAX (Max Value) values (Total) Analog measurement result (Analog)
	Table Ratio	Table format: Index, Scrambling Code, Value, Max. Value, Ratio of Value to Analog Total of all ACT (Value) and MAX (Max Value) values (Total) Analog measurement result (Analog)
	Bar Graph	Bar graph display of selected scrambling codes, with the Total value and the Analog measurement result with maximum values indicated in each case
	Mixed	Total of selected scrambling codes: Value and Max Value shown in enlarged numerical format with graphical display of the history for the last 1 to 60 minutes
	Value	Total of selected scrambling codes Value and Max Value shown in enlarged numerical format
	Graph	Total of selected scrambling codes Graphical display of the history for the last 1 to 60 minutes
Noise Suppression		Identifies whether measured values are above the device noise floor by setting a threshold (selectable at 0, 3, 6, 10, 15, or 20 dB relative to device noise floor). Measurement values below the threshold are shown as the absolute threshold value marked with “<” (less than threshold)

SRM-3006 Selective Radiation Meter

GENERAL SPECIFICATIONS		
Operating Temperature Range		-10°C to +50°C during normal operation 0°C to +40°C when charging
Compliance	Climatic	
	Storage	1K3 (IEC 60721-3) extended to -10°C to +50°C
	Transport	2K4 (IEC 60721-3) restricted to -30°C to + 70°C due to display
	Operating	7K2 (IEC 60721-3) extended to -10°C to +50°C
	Mechanical	
	Storage	1M2 (IEC 60721-3)
	Transport	2M3 (IEC 60721-3)
	Operating	7M3 (IEC 60721-3)
	ESD and EMC	EN 61326-1 : 2006
	Safety	EN 61010-1 : 2004
	EU Guidelines	2003/11/EG 06.02.2003 (PBDE and OBDE) 2002/95/EG 27.01.2003 (RoHS) 2002/96/EG 27.01.2003 (WEEE)
CE (European Community)		Yes
Air Humidity (Operating Range)		<29 g/m^3 (<93% at +30°C)
Weight		6.2 lbs. (2.8 kg) including rechargeable cell
Dimensions		11.7 x 8.4 x 3.1 inches (297 x 213 x 77 mm)
Display	Type	Color Display, TFT-LCD
	Size, Resolution	7 inch, (152 x 91 mm), 800 x 480 pixels
Interface		Optical 115.2 kbaud USB (2.0), Earphone
Power Supply	Rechargeable Cell	Lithium-Ion rechargeable battery - typical 2.5 hour operating time Charged using external power supply
	External Power Supply (12 V DC / 2.5 A)	AC/DC adapter (DIN 45323) Input: 9-15V
Recommended Calibration Interval		24 months

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

Antenna Specifications

ANTENNA	Three Axis E-Field (supplied)	Three Axis E-Field 3502/01	Three Axis H-Field 3581/02	Single Axis E-Field 3531/01	Single Axis E-Field 3531/04	Single Axis H-Field 3551/02
Frequency Range [a]	27 MHz to 3 GHz	420 MHz to 6 GHz	9 kHz to 250 MHz	27 MHz to 3 GHz	9 kHz to 300 MHz	9 kHz to 300 MHz
Antenna Type	E-Field	E-Field	H-Field	E-Field	E-Field	H-Field
Sensor Type	Triaxial design with scanned axes	Triaxial design with scanned axes	Triaxial active magnetic loop design with scanned axes	Single axis passive wide band dipole	Single axis active broadband dipole	Single axis active magnetic loop
Dynamic Range [b]	0.25 mV/m to 200 V/m	0.14 mV/m to 160 V/m	2.5 µA/m to 560 mA/m	90 µV/m to 80 V/m	70 µV/m to 36 V/m	0.4 µA/m to 71 mA/m
CW Damage Level	435 V/m or 50 mW/cm²	435 V/m or 50 mW/cm²	250 A/m / f[MHz]	> 300 V/m or 25 mW/cm²	> 1000 V/m	> 2.65 A/m above 1 MHz
RF Connector [c]	N connector, 50 Ω					
Operating Temperature Range	-10° C to 50° C (same as SRM basic unit)					
Compliance – Climatic						
Storage[d]	1K3 (IEC 60721-3)					
Transport	2K4 (IEC 60721-3)					
Operating	7K2 (IEC 60721-3)					
Compliance – Mechanical						
Storage	1M2 (IEC 60721-3)					
Transport	2M3 (IEC 60721-3)					
Operating	7M3 (IEC 60721-3)					
ESD and EMC	EN 61326:2006					
Safety	EN 61010-1:2004					
CE (European Community)	Yes					
Air Humidity	< 29 g/m³ (< 93% at +30°C)					
Weight	450 g	400 g	470 g	450 g	550 g	450 g
Dimensions	450 mm length, 120 mm antenna head diameter	450 mm length, 120 mm antenna head diameter	450 mm length, 120 mm antenna head diameter	460 mm length, 135 x 90 mm antenna head dimension	460 mm length, 135 x 90 mm antenna head dimension	460 mm length; 43 x 100 mm antenna head dimension
Calibration The SRM applies linear interpolation between reference points.	20 reference points[e] 26, 45, 75, 100, 200, 300, 433, 600, 750, 900 MHz 1, 1.2, 1.4, 1.6, 1.8, 2, 2.2, 2.45, 2.7, 3 GHz	21 reference points[e] 420, 600, 750, 900 MHz 1, 1.2, 1.4, 1.6, 1.8, 2, 2.2, 2.45, 2.7, 3, 3.5, 4, 4.5, 5, 5.5, 5.8, 6 GHz	178 reference points[e]	24 reference points[e] 26, 30, 40, 50, 60, 75, 100, 200, 300, 433, 600, 750, 900 MHz 1, 1.2, 1.4, 1.6, 1.8, 2, 2.2, 2.45, 2.6, 2.8, 3 GHz	183 reference points[e]	183 reference points[e]
Calibration Interval	24 months (recommended)					

NOTES:

a The correction factors determined individually during calibration are stored in an EEPROM and are applied automatically when used in conjunction with the SRM basic unit.
b Typical measurement dynamic range for 10 dB signal to noise ratio (RBW = 1 kHz)
c Typical Values
d Extended to -10°C to +50°C
e The SRM basic unit applies linear interpolation between reference points

SRM-3006 Selective Radiation Meter

Antenna Uncertainty[a]

THREE AXIS E-FIELD ANTENNA (supplied antenna)			
Intrinsic Noise Display in conjunction with the SRM basic unit (separate measurement of a single axis) [a, b]	25 µV/m at 900 MHz with 1 kHz resolution bandwidth (RBW) 40 µV/m at 2.1 GHz with 1 kHz resolution bandwidth (RBW)		
Intrinsic Noise Display in conjunction with the SRM basic unit (for isotropic result) [a]	40 µV/m at 900 MHz with 1 kHz resolution bandwidth (RBW) 70 µV/m at 2.1 GHz with 1 kHz resolution bandwidth (RBW)		
Measurement Range Limit (for single CW signal)	300 V/m, 1000 V/m for f ≤110 MHz		
Max. Measurement Range (in conjunction with the SRM basic unit) [a]	200 V/m (without restrictions for total span of 27 MHz to 3 GHz)		
Damage / Overload Level	≥ 1000 V/m		
Extended Measurement Uncertainty [b] (in conjunction with SRM basic unit and 1.5 m RF cable)	Frequency Range	Single Axis Measurement with Isotropic Antenna	Isotropic Measurement
	27-85 MHz	+2.4 / -3.3 dB	+3.2 / -4.7 dB
	85-900 MHz	+2.4 / -3.4 dB	+2.5 / -3.6 dB
	900-1400 MHz	+2.3 / -3.1 dB	+2.5 / -3.4 dB
	1400-1600 MHz	+2.3 / -3.1 dB	+2.6 / -3.8 dB
	1600-1800 MHz	+1.8 / -2.3 dB	+2.2 / -3.0 dB
	1800-2200 MHz	+1.8 / -2.3 dB	+2.4 / -3.3 dB
	2200-2700 MHz	+1.9 / -2.4 dB	+2.7 / -3.8 dB
	2700-3000 MHz	+1.9 / -2.4 dB	+3.3 / -5.3 dB
Calibration Uncertainty	< 1.5 dB		

THREE AXIS E-FIELD ANTENNA 3502/01			
Intrinsic Noise Display in conjunction with the SRM basic unit (separate measurement of a single axis) [a]	33 µV/m at 900 MHz with 1 kHz resolution bandwidth (RBW) 25 µV/m at 2.1 GHz with 1 kHz resolution bandwidth (RBW)		
Intrinsic Noise Display in conjunction with the SRM basic unit (for isotropic result) [a]	60 µV/m at 900 MHz with 1 kHz resolution bandwidth (RBW) 43 µV/m at 2.1 GHz with 1 kHz resolution bandwidth (RBW)		
Measurement Range Limit (for single CW signal)	200 V/m		
Max. Measurement Range (in conjunction with the SRM basic unit) [a]	160 V/m (without restrictions for total span of 420 MHz to 6 GHz)		
Extended Measurement Uncertainty [b] (in conjunction with SRM basic unit and 1.5 m RF cable)	Frequency Range	Single Axis Measurement with Isotropic Antenna	Isotropic Measurement
	420-750 MHz	+2.1 / -2.9 dB	+2.6 / -3.8 dB
	> 750-1600 MHz	+2.0 / -2.7 dB	+2.2 / -2.9 dB
	> 1600-2000 MHz	+1.7 / -2.2 dB	+1.9 / -2.4 dB
	> 2000-4000 MHz	+1.7 / -2.2 dB	+2.0 / -2.6 dB
	> 4000-4500 MHz	+1.8 / -2.3 dB	+2.2 / -3.0 dB
	> 4500-5000 MHz	+1.9 / -2.5 dB	+2.5 / -3.5 dB
	> 5000-6000 MHz	+1.9 / -2.5 dB	+2.9 / -4.3 dB
Calibration Uncertainty	< 1.5 dB		

THREE AXIS H-FIELD ANTENNA 3581/02			
Intrinsic Noise Display in conjunction with the SRM basic unit (separate measurement of a single axis) [a]	0.3 µA/m with 1 kHz resolution bandwidth (RBW)		
Intrinsic Noise Display in conjunction with the SRM basic unit (for isotropic result) [a]	0.8 µA/m with 1 kHz resolution bandwidth (RBW)		
Extended Measurement Uncertainty [a, b]	Frequency Range	Single Axis Measurement with Isotropic Antenna	Isotropic Measurement
	0.3-30 MHz	2.1 dB	2.4 dB
	30-60 MHz	2.2 dB	2.5 dB
	60-250 MHz	2.3 dB	3.2 dB
Calibration Uncertainty	< 1.5 dB		

Antenna Uncertainty[a] con't.

SINGLE AXIS E-FIELD ANTENNA 3531/01		
Intrinsic Noise Display in conjunction with the SRM basic unit [a, c]	30 µV/m from 100 MHz to 2.1 GHz with 1 kHz resolution bandwidth (RBW)	
Measurement Range Limit (for single CW signal) [a]	160 V/m	
Extended Measurement Uncertainty [a, b] (in conjunction with SRM basic unit and 1.5m RF cable)	Frequency Range	Single Axis Measurement
	27-300 MHz	2.1 dB
	300-433 MHz	2.4 dB
	433-1600 MHz	2.2 dB
	1600-3000 MHz	1.9 dB
Calibration Uncertainty	< 1.5 dB	
SINGLE AXIS E-FIELD ANTENNA 3531/04		
Intrinsic Noise Display in conjunction with the SRM basic unit [a]	20 µV/m in the range from 100 MHz to 300 MHz with 1 kHz resolution bandwidth (RBW)	
Measurement Range Limit (for single CW signal) [a]	50 V/m	
Extended Measurement Uncertainty [a, b] (in conjunction with SRM basic unit and 1.5 m RF cable)	Frequency Range	Single Axis Measurement
	0.1-300 MHz	2.0 dB
Calibration Uncertainty	< 1.2 dB	
SINGLE AXIS H-FIELD ANTENNA 3551/02		
Intrinsic Noise Display in conjunction with the SRM basic unit [a]	0.12 µA/m for each frequency > 10 MHz with 1 kHz resolution bandwidth (RBW)	
Measurement Range Limit (for single CW signal) [a]	100 mA/m	
Extended Measurement Uncertainty [a, b] (in conjunction with SRM basic unit and 1.5 m RF cable)	Frequency Range	Single Axis Measurement
	0.1-300 MHz	2.0 dB
Calibration Uncertainty	< 1.2 dB	

NOTES:

a Typical Values

b Typical value k=2 (k=extrapolation or correction factor for determining the assessment value); +15°C to +30°C

c Intrinsic noise increases by 0.5 dB per 100 MHz above 2 GHz

SRM-3006 Selective Radiation Meter

Ordering Information

SRM-3006	ORDER NUMBER
Set comprising: Selective Radiation Meter SRM3006, basic unit, calibrated Triaxial antenna, E-field, 27 MHz to 3 GHz, calibrated 1.5 meter SRM RF cable, 9 kHz to 6 GHz, 50 Ω Carrying strap for SRM-3006 (basic unit) Operating manual Power supply 12.0 VDC, 100 – 240 VAC, universal AC line connector SRM-3006TS - Configuration, Evaluation and Remote Control Software USB 2.0 Cable - Master/Slave, 3 m DB9 / DB9 Cable for serial interface, 3 m Transport Hard Case	3006/127/USA
OPTIONS	
UMTS P-CPICH Demodulation	3701/04
SCOPE	3701/05
OPTIONAL ANTENNAS	
Three-axis E-Field Antenna, 420 MHz to 6 GHz	3502/01
Three-axis H Field Antenna, 9 kHz to 250 MHz	3581/02
Single-axis E-Field Antenna, 27 MHz to 3 GHz	3531/01
Single-axis E-Field Antenna, 9 kHz to 300 MHz	3531/04
Single-axis H-Field Antenna, 9 kHz to 300 MHz	3551/02
OPTIONAL ACCESSORIES	
5 meter SRM RF cable, 9 kHz to 6 GHz, 50 Ω	3602/02
Antenna holder for single axis and triaxial antennas	3501/90.01
Antenna holder for triaxial antennas (horizontal/vertical)	3501/90.02
Additional battery pack, rechargeable, 7.4 V / 4 A/h	3001/90.01
External charger set for SRM battery pack	3001/90.07
Tripod, non conductive, 1.65 m, with carrying bag	2244/90.31
Softcase with wheels	3001/90.05
O/E converter, RP-02/USB	2260/90.07
Cable, Fiber Optic Duplex, RP-02, 2 m	2260/91.02
Cable, Fiber Optic Duplex, RP-02, 20 m	2260/91.03

Electric and Magnetic Field Measurements
from RF to Microwave

NBM-550 Broadband Field Meter

- **Available with Isotropic Probes to cover 100 kHz to 60 GHz**
- **Large Graphical Display**
- **Intelligent Probe Interface with Automatic Probe Parameter Detection**
- **Fully Automatic Zeroing**
- **Extensive Memory for Logging of up to 5000 Results**
- **GPS Interface and Mountable Receiver for Positioning Data Documentation (Optional)**
- **Voice Recorder for Adding Comments (Optional)**

Description

The NBM-500 Series is the most accurate non-ionizing radiation survey system available. It provides the broadest frequency coverage of electric and magnetic fields. Both flat response probes and probes shaped to international standards are available. All NBM probes have a non-volatile memory containing device parameters and calibration data. Probes are calibrated independently of the meter. Any NBM probe can be used with any NBM-500 Series meter and still maintain total calibration.

Applications

Precision measurement of electric or magnetic field strength for personal safety at work where high radiation levels are present, such as:

- General RF Safety program measurements
- Service work on transmitting and radar equipment
- Service work on mobile antennas, broadcasting and satellite communication systems
- Working with heating and packaging machines in the food industry
- Working with heating and hardening machines in the automotive industry
- Operating diathermy equipment and other medical instruments producing short-wave radiation
- Drying equipment in the tanning and timber industries

NBM-550 Broadband Field Meter

Features

DISPLAY

- Backlit Monochrome LCD; readable even in bright daylight
- Graphical User Interface (GUI) with selectable languages

OPERATION

- Simple-to-Use 9 button keypad
- Hold button soft key for "freezing" measurement display during readings
- User defined setups can be saved for repetitive survey needs
- Keypad can be locked to guard against inadvertent inputs
- User selectable "auto-off" feature to save battery life

READINGS DISPLAYED

- 5 Types of results can be displayed - actual, minimum, maximum, average and maximum average
- History Mode – history memory operates continuously in the background, allowing you to display past readings at any time, up to 8 hours
- Selectable Units – V/m, A/m, W/m^2, mW/cm^2 and "% of Standard" when using shaped frequency response probes
- Stored standards and guidances in the NBM's memory allow you to simultaneously display readings as a "% of Standard" if frequency is known
- Data memory for up to 5000 measurements

AVERAGING FUNCTIONS

- Time Averaging – 4 seconds to 30 minutes, in 2-second intervals
- Spatial Averaging – discrete or continuous

AUDIBLE ALARM

- Variable alarm threshold setting
- Audible indication of increasing or decreasing field strength

PROBE INTERFACE

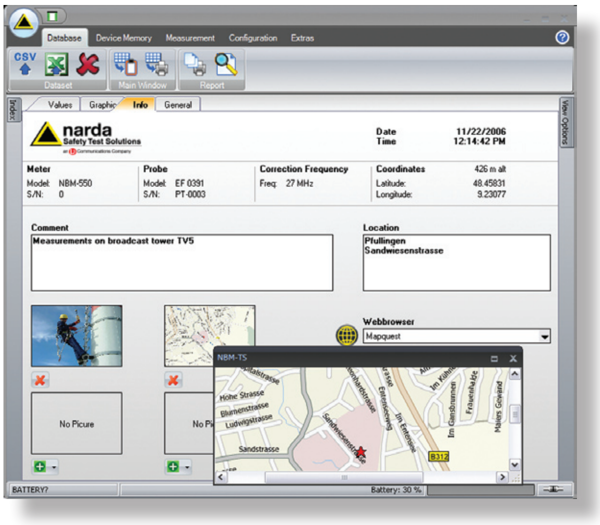
- Automatic detection of probe type and calibration information
- Fully automatic and variable zero adjustment interval times
- Additional optical input for separating probe from meter

REMOTE CONTROL

- PC connection via USB or Optical interface
- Trigger input for externally initiating readings to be taken
- NBM-TS software enables remote controlled measurements
- Screenshots can be downloaded to PC

Rugged and lightweight housing, designed for easy one-hand operation

narda **Safety Test Solutions** an L3 communications company **USA • Germany • Italy**
USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www**.narda-sts.us



NBM-TS Software (supplied with NBM-550)

The supplied NBM-TS software provides for convenient data management, documentation of results and future evaluation. It also provides you the capability to remotely control the NBM and perform firmware upgrades. This innovative software package also allows you to link the optional GPS data with actual pictures from mapping programs like Google Earth™, making field survey data take on more relevance with the reader. And, to ensure it will be viable for years to come, this software was designed with Microsoft's Vista™ operating system in mind.

NBM Option Set

Consider the Option Set for the NBM-550 and how it can simplify your survey reports – a major advantage. This Option Set adds a GPS receiver and conditional logging. It also allows you to add voice storage to stored readings via our built-in microphone. By adding the power and versatility of audible comments to stored readings, you will not have to remember the particulars of when and where readings were taken – imagine that!

THE NBM-550 OPTION SET INCLUDES:

- GPS Receiver, cable and mounting hardware
- Audio Recorder for adding voice comments to stored readings
- Conditional Logging – data can be logged when threshold is exceeded (upper or lower), outside of a user-defined level "window," or only store first and last time readings that cross conditional boundaries

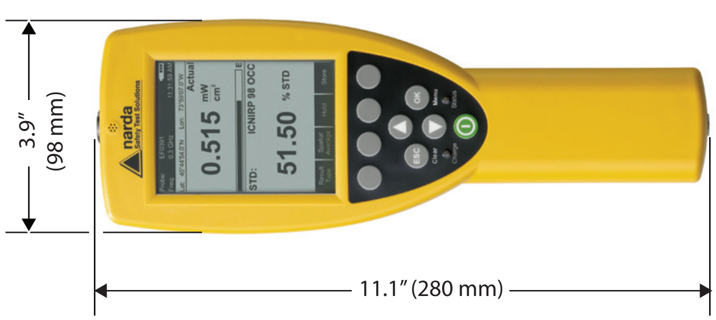
The Option Set is field (or factory) installable, so it can be added any time you choose, without having to return it to the factory.

***NOTE:** Narda strongly recommends that an optional check source be used to verify operation of the NBM Series. Any device capable of generating an upscale indication at microwave frequencies is acceptable, as well as Narda P/N 8699.*

NBM-550 Broadband Field Meter

Specifications

NBM-550	
DISPLAY	
Display Type	Transflective LCD, monochrome
Display Size	10 cm (4 inch), resolution 240 x 320 dots
Backlight	White LEDs, selectable illumination time (OFF, 5s, 10s, 30s, 60s, PERMANENT)
Refresh Rate	200 ms for bar graph and graphics, 400 ms for numerical results
MEASUREMENT FUNCTIONS	
Result Units	mW/cm^2, W/m^2, V/m, A/m, % of Standard
Display Range, Fixed Triads	0.0001 to 9999 for all units (4 digits)
Display Range, Variable Triads	0.01 V/m to 100 kV/m 0.027 mA/m to 265.3 A/m 0.265 $\mu W/m^2$ to 26.53 MW/m^2 0.027 nW/cm^2 to 2.653 kW/cm^2 0.0001% to 9999%
Result Types (Isotropic, RSS)	Actual (ACT), Maximum (MAX), Minimum(MIN), Average (AVG), Maximum Average (MAX AVG)
Result Types (X-Y-Z mode)	Actual X, Actual Y, Actual Z (requires a probe with separate axes)
Averaging Time	Selectable, 4 seconds to 30 minutes (2 second steps)
Spatial Averaging	Discrete or continuously
Multi-position Spatial Averaging	Averaging of up to 24 spatially averaged results, each position and total will be stored
History View	Graphical display of actual results versus time (span of 2 minutes to 8 hours)
Frequency Correction	1 kHz to 100 GHz or OFF (direct frequency entry, interpolation between calibration points)
Hot Spot Search	Audible indicator for increasing and decreasing field strength (result type Act or Max)
Alarm Function	2 kHz audible signal (4 Hz repetition), adjustable threshold
Timer Logging	Start time pre-selection: up to 24 hours or immediately Logging duration: up to 100 hours Logging interval: 1 second to 6 minutes (in 11 steps)
RESULTS MEMORY	
Physical Memory	12 MB non-volatile flash memory for measurement results and voice comments
Storing Capacity	Up to 5000 results (including test parameters, time stamp and GPS data when available)
INTERFACES	
Remote Control	Via USB or optical RS-232 interface (selectable)
USB	Serial, full duplex, 460 kBaud (virtual COM port), multi-pin connector
Optical Interface	Serial, full duplex, 115 kBaud, no parity, 1 start and 1 stop bit
Earphone	3.5 mm TRS, > 16 ohms (mono), for voice recorder option only
External Trigger (to store results)	Uses the multi-pin connector. Interface cable with BNC connector available as an option, triggers when contacts shorted.
External GPS Receiver	Uses the multi-pin connector. GPS receiver with interface cable is available as an option
Probe Interface	Plug-and-play auto detection, compatible with all NBM series probes



Environmental Specifications

NBM-550	
Recommended Calibration Interval	24 months
Battery	NiMH rechargeable batteries, 4 x AA size, 2500 mAh
Operation Time	20 hours (backlight off, no GPS) 12 hours (permanent backlight, no GPS) 10 hours (GPS receiver connected, no backlight)
Charging Time	2 hours
Battery Level Display	100%, 80%, 60%, 40%, 20%, 10%, low level (< 5%)
Humidity	5 to 95%, non condensing ≤29 g/m^3 absolute humidity (IEC 60721-3-2 class 7K2)
Temperature Range Operating Non-Operating (Transport)	 -10°C to +50°C -30°C to +70°C
Size (h x w x d)	11.1 x 3.9 x 1.8 inches (280 x 98 x 45 mm) without probe and GPS receiver
Weight	20 oz. (550 g) without probe and GPS receiver
Supplied Accessories	Transit case for meter and up to 4 probes, NBM-TS PC Transfer Software, USB interface cable, rechargeable batteries, power supply, shoulder strap, bench-top tripod, manual, certificate of calibration

Option Set (Ordering Number 2401/40/USA)

CONDITIONAL LOGGING	
Logging Conditions	Selectable, - On upper threshold: Storing when measurements exceed the adjustable threshold - Out of gap: Storing when measurements are higher than the upper or lower than the lower threshold
Logging Range	Selectable, - Store all (as long as the condition is true), sampling rate 5 Hz - Store first and last event (when the condition was true)
VOICE RECORDER	
Microphone	Integral microphone at the top side of the instrument near the Narda logo
Recording Level	Fix level, VU-meter displayed when recording for level monitoring
Recording Length	30 seconds max. length per voice comment, 1 voice comment stored with relevant result
Recording Format	8-bit PCM mono, stored as WAV file (approx. 240 kB per 30 seconds)
Output	External earphone (adjustable output level) or via NBM-TS PC Software
GPS POSITION LOGGING	
Receiver Type	12-channel satellite tracking, DGPS capability, WAAS / EGNOS compatible
Displayed Position Data	Latitude (Lat) and Longitude (Long), selectable unit: DMS (degrees, minutes, seconds) / MinDec (decimal minutes) / DegDec (decimal degrees)
Geodetic System	WGS84 / NAD83
Position Accuracy	< 3 m (DGPS, WAAS), <15 m (SPS), high precision mode indicated by the NBM-550
Update Rate	1 second
Acquisition Time	2 seconds (reacquisition) up to 5 minutes (no data known)
Receiver Size/ Weight	2.4 inches (61 mm) in diameter, .8 inches (19.5 mm) in height 2.2 oz. (62 g) — approx. 3.5 oz. (100 g) with mounting plate
Receiver Mounting	Uses the tripod thread on the underside of NBM-550, mounting plate included

NBM-550 Broadband Field Meter

Ordering Information

NBM-550	Ordering Part No.
NBM-550 Narda Broadband Field Meter System Includes: NBM-550 Basic Unit (2401/01) Transit Case, holds field meter and up to 4 probes (2400/90.06) Power Supply / Charger 100 VAC to 240 VAC Input, 9 VDC Output (2259/92.06) NBM-TS Software and PC Transfer (2400.93.01) USB Interface cable for NBM, 2 m (2400/90.05) Bench-top Tripod, 0.16 m, non-conductive 2244/90.32) Shoulder Strap, 1 m (2244/90.49) Operating Manual Certificate of Calibration ***Probes are NOT included***	**2400/101**
Option Set for NBM-550 (GPS Interface and Receiver, Voice Recorder, Conditional Logging)	**2401/40/USA**
PROBES	
Probe EF 0391, E-Field, 100 kHz – 3 GHz, Isotropic	**2402/01**
Probe EF 0392, E-Field, 100 kHz – 3 GHz, Isotropic	**2402/12**
Probe EF 0691, E-Field, 100 kHz – 6 GHz, Isotropic	**2402/14**
Probe EF 1891, E-Field, 3 MHz – 18 GHz, Isotropic	**2402/02**
Probe EF 5091, E-Field, Thermocouple, 300 MHz – 50 GHz, Isotropic	**2402/03**
Probe EF 5092, E-Field, Thermocouple, 300 MHz – 50 GHz, Isotropic	**2402/11**
Probe EF 6091, E-Field, 100 MHz – 60 GHz, Isotropic	**2402/04**
Probe HF 3061, H-Field, 300 kHz - 30 MHz, Isotropic	**2402/05**
Probe HF 0191, H-Field, 27 MHz – 1 GHz, Isotropic	**2402/06**
Probe EA 5091, Shaped E-Field, FCC, 300 kHz - 50 GHz, Isotropic	**2402/07**
Probe EB 5091, Shaped E-Field, IEEE, 3 MHz - 50 GHz, Isotropic	**2402/08**
Probe EC 5091, Shaped E-Field, SC6, 300 kHz - 50 GHz, Isotropic	**2402/09**
Probe ED 5091, Shaped E-Field, ICNIRP, 300 kHz - 50 GHz, Isotropic	**2402/10**
ACCESSORIES	
Test-Generator 27 MHz, Hand-Held	**2244/90.38**
Tripod, Non-Conductive, 1.65 m with Carrying Bag	**2244/90.31**
Tripod Extension, 0.50 m, Non-Conductive (for 2244/90.31)	**2244/90.45**
Handle, Non-Conductive Extension 0.42m	**2250/92.02**
Cable, Coaxial Multi-pin / BNC for NBM-550 External Trigger, 2 m	**2400/90.04**
Cable, Fiber Optic Duplex (1000 µm) RP-02, 2 m	**2260/91.02**
Cable, Fiber Optic Duplex (1000 µm) RP-02, 20 m	**2260/91.03**
Cable, Fiber Optic Duplex FSMA / RP-02, 0.3 m	**2260/91.01**
O/E Converter RS-232C (RP-02/DB-9)	**2260/90.06**
O/E Converter USB (RP-02/USB)	**2260/90.07**
Cable, Adapter, USB 2.0 - RS-232, 0.8 m	**2260/90.53**

narda **Safety Test Solutions** an L3 communications company **USA • Germany • Italy**
USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www**.narda-sts.us

Rugged and Lightweight Housing designed for easy one-hand operation. Interchangeable plug-and-play probes, no need for configuration.

NBM-520 Broadband Field Meter

- **Available with Isotropic Probes to cover 100 kHz to 60 GHz**
- **Plug-and-Play Probe Interface with Automatic Probe Parameter Detection**
- **Fully Automatic Zeroing**
- **Extra Small and Lightweight**
- **Easy 4 Button Operation**
- **Remote Operation via Optical Link**
- **Interoperability with NBM-550 (Controller)**

Description

The NBM-500 Series is the most accurate non-ionizing radiation survey system available. It provides the broadest frequency coverage of electric and magnetic fields. Both flat response probes and probes shaped to international standards are available. All NBM probes have a non-volatile memory containing device parameters and calibration data. Probes are calibrated independently of the meter. Any NBM probe can be used with any NBM-500 Series meter and still maintain total calibration.

Applications

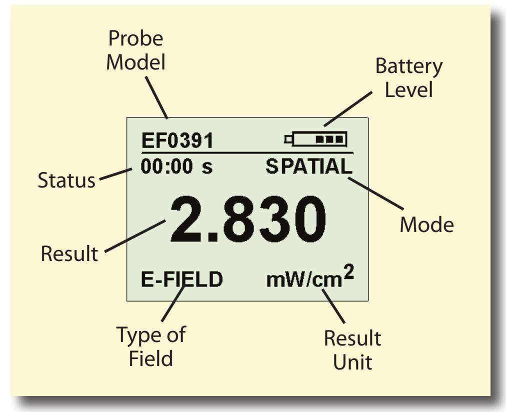
Precision measurement of electric and magnetic field strength for personal safety at work where high radiation levels are present, such as:

- General RF Safety program measurements
- Service work on transmitting and radar equipment
- Service work on mobile antennas, broadcasting and satellite communication systems
- Working with heating and hardening machines in the industry
- Operating diathermy equipment and other medical instruments producing short-wave radiation
- Drying equipment in the tanning and timber industries

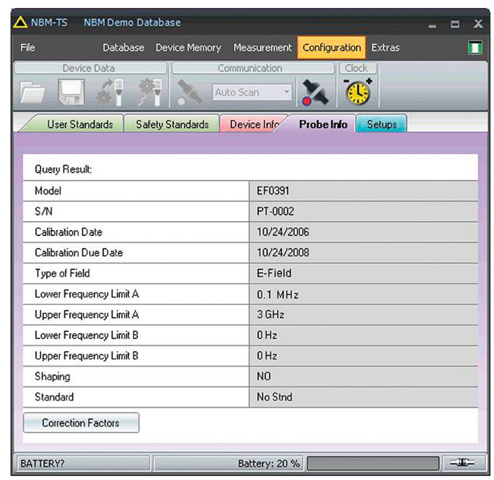
NBM-520 Broadband Field Meter

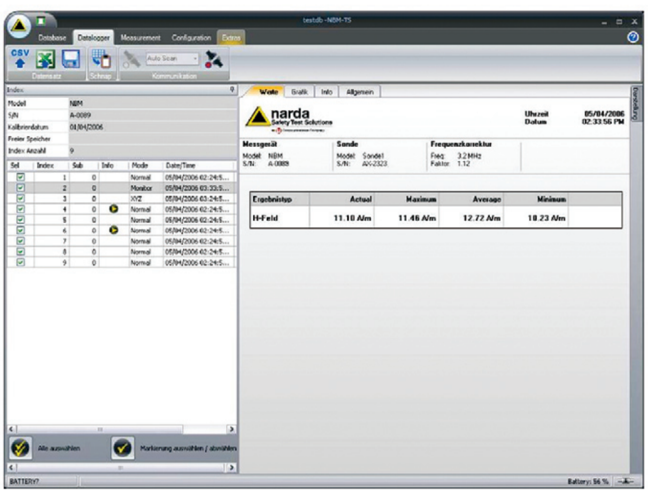
Features

- Easiest 4 button operation
- Automatic probe type recognition
- Intelligent probes (automatic probe data transfer)
- Audible alarm function (threshold adjustable by PC software)
- Auto-Zeroing (time interval adjustable by PC software)
- Time Averaging (time adjustable by PC software)
- Spatial Averaging (discrete samples or continuously)
- Maximum Hold display function
- Calibration Due Date check by PC software
- LCD Backlight (adjustable illumination time by PC software)
- Auto Power-Off (adjustable time by PC software)
- Selectable unit (V/m, A/m, mW/cm^2 or W/m^2, % for shaped probes)
- Hold key to freeze the current display
- Optical link to connect to a PC
- Remote control via optical link
- Interoperability with NBM-550 (NBM-550 controls NBM-520)
- PC software included for instrument setup and remote testing



NBM-520 LCD Display Description





PC Software

The NBM-TS transfer software is used for:

- changing instrument settings
- controlling firmware updates
- performing remote controlled measurements

Specifications

NBM-520	
DISPLAY	
Display type	Transflective LCD, monochrome
Display Size	3.8 cm (1.5”), 128 x 64 dots
Backlight	White LEDs, selectable illumination time (OFF, 5s, 10s, 30s, 60s, PERMANENT)
Refresh Rate	400 ms
MEASUREMENT FUNCTIONS	
Result Units	mW/cm^2, W/m^2, V/m, A/m, % of Standard (“%” for shaped probes only)
Display Range	0.0001% to 9999% for all units (4 digits)
Result Types (isotropic, RSS)	Actual (ACT), Maximum (MAX), Average (AVG), Spatial Average (SPATIAL)
Averaging Time	4 seconds to 30 minutes (2 second steps), selectable by PC software
Spatial Averaging	discrete or continuously, selectable by PC software
Alarm Function	2 kHz audible signal (4 Hz repetition), threshold adjustable by PC software
INTERFACES	
Optical Interface	Used for remote operation and instrument configuration, Serial, full duplex , 115 kBaud, no parity, 1 start and 1 stop bit
Probe Interface	Plug-and-play auto detection, compatible with all NBM series probes
GENERAL SPECIFICATIONS	
Recommended Calibration Interval	24 months
Battery	NiMH rechargeable batteries, 2 x AA size (Mignon), 2500 mAh
Operation Time	22 hours (backlight off) 16 hours (permanent backlight)
Charging Time	2.0 hours
Battery Level Display	100%, 80%, 60%, 40%, 20%, 10%, low level (< 5%)
Humidity	5 to 95%, non condensing ≤29 g/m^3 absolute humidity (IEC 60721-3-2 class 7K2)
Temperature Range Operating Non-Operating (Transport)	 -10° C to +50° C -30° C to +70° C
Humidity	5 to 95%, non condensing ≤29 g/m^3 absolute humidity (IEC 60721-3-2 class 7K2)
Size (h x w x d)	1.5 x 2.0 x 7.7 inches (38 x 52 x 195 mm) without probe
Weight	10.6 oz. (300 g) without probe
Accessories (included)	NBM-TS PC Transfer Software, rechargeable batteries, power supply, shoulder strap, O/E converter RS-232, fiber optic cable 2m, manual, certificate of calibration, transit case

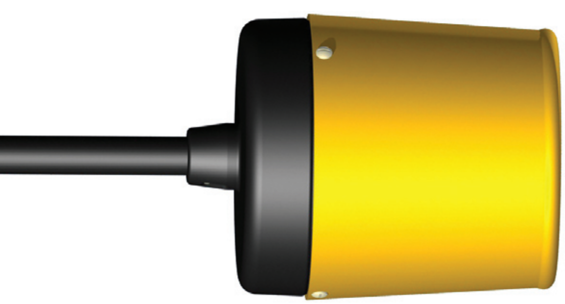
***NOTE:** *Narda strongly recommends that an optional check source be used to verify operation of the NBM Series. Any device capable of generating an upscale indication at microwave frequencies is acceptable, as well as Narda P/N 8699.**

NBM-520 Broadband Field Meter

Ordering Information

NBM-520	Part Number
NBM-520 Narda Broadband Field Meter System Includes: NBM-520 Basic Unit (2403/01) Transit Case, Holds Meter and up to 2 Probes (2400/90.07) Power Supply / Charger 100 to 240 VAC Input, 9VDC Output (2259/92.06) 2 NiMH "AA" Rechargeable Batteries Shoulder Strap, 1m (2244/90.49) Cable, Fiber Optic Duplex (1000 µm) RP-02, 2m (2260/91.02) Fiber Optic to USB Converter (RP-02/USB) (2260/90.07) Software, NBM-TS, PC Transfer Software (2400/93.01) Operating Manual, NBM-520 Certificate of Calibration ***Probes are NOT included***	**2400/102**
PROBES	
Probe EF 0391, E-Field, 100 kHz – 3 GHz, Isotropic	**2402/01**
Probe EF 0392, E-Field, 100 kHz – 3 GHz, Isotropic	**2402/12**
Probe EF 0691, E-Field, 100 kHz – 6 GHz, Isotropic	**2402/14**
Probe EF 1891, E-Field, 3 MHz – 18 GHz, Isotropic	**2402/02**
Probe EF 5091, E-Field, Thermocouple, 300 MHz – 50 GHz, Isotropic	**2402/03**
Probe EF 5092, E-Field, Thermocouple, 300 MHz – 50 GHz, Isotropic	**2402/11**
Probe EF 6091, E-Field, 100 MHz – 60 GHz, Isotropic	**2402/04**
Probe HF 3061, H-Field, 300 kHz - 30 MHz, Isotropic	**2402/05**
Probe HF 0191, H-Field, 27 MHz – 1 GHz, Isotropic	**2402/06**
Probe EA 5091, Shaped E-Field, FCC, 300 kHz - 50 GHz, Isotropic	**2402/07**
Probe EB 5091, Shaped E-Field, IEEE, 3 MHz - 50 GHz, Isotropic	**2402/08**
Probe EC 5091, Shaped E-Field, SC6, 300 kHz - 50 GHz, Isotropic	**2402/09**
Probe ED 5091, Shaped E-Field, ICNIRP, 300 kHz - 50 GHz, Isotropic	**2402/10**
ACCESSORIES	
Test-Generator 27 MHz, Hand-Held	**2244/90.38**
Tripod, Non-Conductive, 1.65m with Carrying Bag	**2244/90.31**
Tripod Extension, 0.50m, Non-Conductive (For 2244/90.31)	**2244/90.45**
Handle, Non-Conductive Extension 0.42m	**2250/92.02**
Cable, Fiber Optic Duplex (1000um) RP-02, 20m	**2260/91.03**
Cable, Fiber Optic Duplex (1000um) FSMA/ RP-02, 0.3m	**2260/91.01**
O/E Converter USB (RP-02/USB)	**2260/90.07**
Cable, Adapter, USB 2.0 - RS-232, 0.8 m	**2260/90.53**

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us



NBM Series Probes

- New Rugged Construction
- Imbedded EEPROM Stores Details
- Lightweight, Accurate
- Flat or Shaped Response
- Electric or Magnetic Fields
- Fully Interchangeable

Description

Narda's new NBM Series of probes provide Electric or Magnetic and Flat or Shaped response coverage. Detection is performed by diode, thermocouple or compensated diode with thermocouple for the highest accuracy obtainable. New to this series is the addition of an internal eeprom to each probe to identify the probe to the meter and provide all calibration and measurement range data.

We've combined the best solutions from the EMR and 8700 series of probes and developed our new generation by building on past success. All probes are more rugged in their design and feature improved specifications. Unlike previous designs that incorporated a preamplifier in the handle to minimize cable flex variations, the NBM series removes that measurement variable and always operate directly connected to the meter. This new design improves low-level stability, reduces weight and improves reliability.

For uses where the probe needs to be separated from the meter, Narda offers the NBM-520 meter's fiber optic output to connect to the NBM-550, or directly to a computer. The following pages will give you a better understanding of our current offerings of probes for the NBM series.

Applications

Narda probes measure the mean-squared field strength, so that no matter what units you use they maintain their accuracy in the near or far fields. Below is a partial list of their uses;

- Radar Measurements
- Satellite Uplinks
- Wireless Communication Sites
- Television and Radio Broadcast
- Industrial Heating or Vinyl Heating
- Semiconductor Processing
- Induction Heating

NBM Series Probes

Specifications

Probe Model No.	Probe Ordering No.	Frequency Range [a]	Measurement Range	Linearity	Frequency Sensitivity [c, d]
Probe EF 0391, E-Field, Flat	2402/01	100 kHz to 3 GHz	0.2 to 320 V/m	±0.5 dB (1.2 to 200 V/m) ±0.7dB (200 to 320 V/m)	±0.5 dB (100 kHz to 100 MHz) ±1.4 dB (100 MHz to 3 GHz)
Probe EF 0392, E-Field, Flat	2402/12	100 kHz to 3 GHz	0.8 to 1300 V/m	+2/-3 dB (1 to 2 V/m) ±1 dB (2 to 4 V/m) ±0.5 dB (4 to 400 V/m) ±1 dB (400 to 1300 V/m)	±1 dB (1 MHz to 1 GHz) ±1.25 dB (1 to 2.45 GHz)
Probe EF 0691, E-Field, Flat	2401/14	100 kHz to 6 GHz	0.35 to 650 V/m	±0.5 dB (2 to 400 V/m)	±1.5 dB (1 MHz to 4 GHz)
Probe EF 1891, E-Field, Flat	2402/02	3 MHz to 18 GHz	0.8 to 1000 V/m	±3 dB (0.8 to 1.65 V/m) ±1 dB (1.65 to 3.3 V/m) ±0.5 dB (3.3 to 300 V/m) ±0.8 dB (300 to 1000 V/m	±1.5 dB (10 to 100 MHz) ±2.4 dB (100 MHz to 8 GHz) ±3.0 dB (8.0 to 18 GHz)
Probe EF 5091, E-Field, Flat	2402/03	300 MHz to 50 GHz	8 to 614 V/m	±1 dB (8 to 27 V/m) ±0.3 dB (> 27 V/m)	+1.25 / -3 dB (0.3 to 1.0 GHz) ±1.25 dB (1 to 50 GHz)
Probe EF 5092, E-Field, Flat	2402/11	300 MHz to 50 GHz	18 to 1370 V/m	±1 dB (18 to 61.4 V/m) ±0.3 dB (> 61.4 V/m)	+1.25 / -3 dB (0.3 to 1.0 GHz) ±1.25 dB (1 to 50 GHz)
Probe EF 6091, E-Field, Flat	2402/04	100 MHz to 60 GHz	0.7 to 300 V/m	±3 dB (0.7 to 2 V/m) ±1 dB (2 to 250 V/m) ±2 dB (250 to 400 V/m)	+3.0 / -7.0 dB (100 MHz to 60 GHz) ±3 dB (300 MHz to 40 GHz)
Probe HF 3061, H-Field, Flat	2402/05	300 kHz to 30 MHz	0.017 to 16 A/m	±3 dB (0.017 to 0.033 A/m) ±1 dB (0.033 to 0.068 A/m) ±0.5 dB (0.068 to 3 A/m) ±1 dB (3 to 16 A/m)	±0.5 dB (500 kHz to 30 MHz)
Probe HF 0191, H-Field, Flat	2402/06	27 MHz to 1 GHz	0.026 to 16 A/m	±3 dB (0.026 to 0.05 A/m) ±1 dB (0.05 to 0.1 A/m) ±0.5 dB (0.1 to 3 A/m) ±1dB (3 to 16 A/m)	±0.5 dB (27 to 300 MHz) ±0.65 dB (300 to 750 MHz) ±1.2 dB (750 MHz to 1 GHz)
Probe EA 5091, E-Field, Shaped FCC	2402/07	300 kHz to 50 GHz	0.5 to 600% of FCC "Occupational/Controlled" limits	±3 dB (0.5 to 6%) ±1 dB (6 to 100%) ±2 dB (100 to 600%)	±2.0 dB from Standard
Probe EB 5091, E-Field, Shaped IEEE	2402/08	3 MHz to 50 GHz	0.5 to 600% of IEEE C95.1-2005 for People in Controlled Environments		
Probe EC 5091, E-Field, Shaped SC 6 Canada	2402/09	300 kHz to 50 GHz	0.5 to 600% of Safety Code 6 for People in Controlled Environments		
Probe ED 5091, E-Field, Shaped ICNIRP	2402/10	300 kHz to 50 GHz	0.5 to 600% of ICNIRP Recommendations for Occupational Exposures		

NOTES:

[a] Cutoff frequency at approximately -3 dB (-6 dB for EF 6091)

[b] Pulse Length 1 μsec., duty cycle 1:100 (1:1000 for EF5091 and EF 5092)

[c] Frequency Sensitivity can be compensated for by the use of correction factors stored in the probes' memory.

[d] Accuracy of the fields generated to calibrate the probes is 1 dB (<400 MHz), 1.5 dB (400 MHz to 1.8 GHz), 1 dB (≥1.8 GHz).

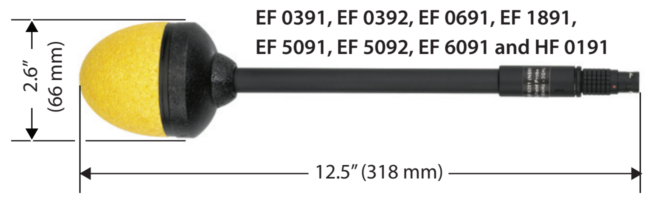
[e] Uncertainty due to varying polarization (verified by type approval test for meter with probe). Ellipse ratio included and calibrated for each probe.

[f] Frequencies above 30 MHz.

Unless otherwise noted, specifications apply at reference condition: device in the far-field of source, ambient temperature 23 ±3°C, relative humidity 25 - 75%, sinusoidal signal

Probes Model Numbers beginning with EF or HF are flat frequency response and employ diode sensors, except EF 5091 and EF 5092, which employ thermocouple sensors

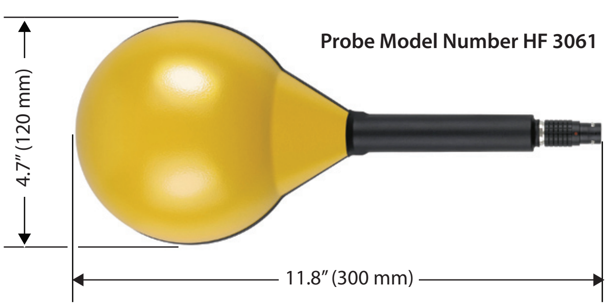
Probe Model Numbers:
EF 0391, EF 0392, EF 0691, EF 1891, EF 5091, EF 5092, EF 6091 and HF 0191



NBM Series Probes

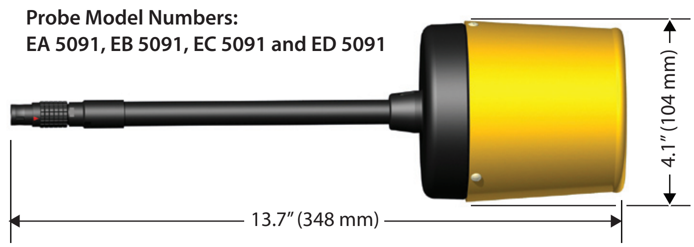
Specifications

Isotropic Response [e]	CW Overload	Peak Overload [b]	Calibration Frequencies	Thermal Response	Humidity	Weight
±1 dB for f > 1 MHz	170 mW/cm^2	17 W/cm^2	0.1, 0.2, 0.3, 1.0, 3.0, 10, 27.12, 100, 200, 300, 500, 750, 1000, 1800, 2450, 2700, 3000 MHz	+0.2 / -1 dB	5 to 95% RH @ ≤ 25°C	3.2 oz., 90 gms.
±1 dB	1000 mW/cm^2	100 W/cm^2	0.1, 0.2, 0.3, 1.0, 3.0, 10, 27.12, 100, 200, 300, 500, 750, 1000, 1800, 2450, 2700, 3000 MHz	+0.2 / -1.5 dB (±0.025 dB/K @ 10 to 50° C)	5 to 95% RH @ ≤ 25°C	3.2 oz., 90 gms.
±1 dB	265 mW/cm^2	26 W/cm^2	0.1, 0.2, 0.3, 1.0, 3.0, 10, 27.12, 100, 200, 300, 500, 750, 1000, 1800, 2450, 2700, 3000, 4000, 5000, 6000 MHz	+0.2 / -1 dB	5 to 95% RH @ ≤ 25°C	3.2 oz., 90 gms.
±1.5 dB (10 MHz to 8 GHz) ±2.0 dB (f > 8 GHz)	700 mW/cm^2	70 W/cm^2	3, 10, 27, 100, 200, 300, 500, 750 MHz 1.0, 1.8, 2.45, 3.0, 4.0, 5.0, 6.0, 7.0, 8.2, 9.3, 10, 11, 18 GHz	+0.2 / -1.5 dB (±0.025 dB/K @ 10 to 50° C)	5 to 95% RH @ ≤ 28°C	3.2 oz., 90 gms.
±0.75 dB	600 mW/cm^2	200 W/cm^2	300, 750 MHz, 1.0, 1.8, 2.45, 4.0, 8.2, 9.3, 10, 11, 18, 26.5, 40, 45.5 GHz	±0.0 dB	5 to 95% RH @ ≤ 25°C	3.2 oz., 90 gms.
±0.75 dB	1500 mW/cm^2	600 W/cm^2	300, 750 MHz, 1.0, 1.8, 2.45, 4.0, 8.2, 9.3, 10, 11, 18, 26.5, 40, 45.5 GHz	±0.0 dB	5 to 95% RH @ ≤ 25°C	3.2 oz., 90 gms.
±1.0 dB	680 mW/cm^2	1 W/cm^2	27, 50, 80, 100, 200, 300, 500, 750 MHz 1.0, 1.7, 2.45, 3.0, 4.0, 5.0, 6.0, 7.0, 8.2, 10, 11, 18, 26.5, 40, 45.5, 60 GHz	±0.9 dB (-0.03 dB/K)	5 to 95% RH @ ≤ 25°C	3.2 oz., 90 gms.
±1.0 dB	> 35 A/m	> 350 A/m	0.1, 0.15, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.2, 1.5, 2.0, 3.0, 4.0, 5.0, 10, 15, 20, 25, 27.12, 30 MHz	+0.2 / -0.8 dB (±0.025 dB/K @ 10 to 50° C)	5 to 95% RH @ ≤ 28°C	6.7 oz., 190 gms.
±1.0 dB	> 20 A/m	> 200 A/m	10, 15, 20, 27.12, 30, 35, 40, 50, 60, 70, 80, 90, 100, 120, 150, 180, 200, 250, 300, 400, 433, 500, 600, 700, 800, 900, 1000 MHz	+0.5 / -0.8 dB (±0.025 dB/K @ 10 to 50° C)	5 to 95% RH @ ≤ 28°C	3.2 oz., 90 gms.
±2.0 dB[f]	3000% of Standard	32 dB above Standard	0.3, 3.0, 10, 30, 100, 300, 750 MHz, 1.0, 1.8, 2.45, 4.0, 8.2, 10, 18, 26.5, 40, 45.5 GHz	±0.5 dB	5 to 95% RH @ ≤ 25°C	7.3 oz., 206 gms



Probe Model Number HF 3061

Probe Model Numbers:
EA 5091, EB 5091, EC 5091 and ED 5091



USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www**.narda-sts.us

NBM Series Probes

Shaped Probes

The goal in designing and manufacturing a traditional, "flat" frequency response probe is to make the probe equally responsive to energy at every frequency within its rated frequency range. In contrast, Narda's patented shaped frequency response probes are designed and manufactured so that their sensitivity mirrors a particular standard (or guidance) as closely as possible. For example, many of the major guidances and standards in the world set E-field limits for maximum human exposure at 614 V/m (1000 W/m^2) at lower frequencies (~1 MHz). At frequencies of 10 to 400 MHz the limits are typically much less, 61.4 V/m (10 W/m^2), a difference of 20 dB (100 times the power). A shaped frequency response probe designed for such limits is 100 times more sensitive in the 100 MHz region, than at 1 MHz.

If you were performing a survey of a site with a flat frequency response probe that has both of the above frequency ranges and your survey indicated 137 V/m (or 50 W/m^2), it would be difficult to determine if the site was out of compliance without turning one of the emitters off. Again, given the example above, the site could be generating anywhere from 5% to 500% of the human exposure limit. There are many sites with multiple emissions (rooftops, flight lines, broadcast towers) that have emitters at different exposure limits.

If your interest is general safety measurements, to know if you comply with an exposure limit or not, you will find shaped probes easy to use in any environment. The display of total field strength with shaped probes is not in terms of V/m or W/m^2, it is "% of Std." So at a multiple emitter site, a result of 15% is simple to understand. The total detected field strength of each emitter (to its limit, at its frequency) has added up to 15%. An additional use of these probes is for Military (classified) environments, since you no longer have the "need to know" the frequency when using a shaped probe.

Probe Selection Guide

Frequency Range	100 kHz – 3 GHz		100 kHz – 6 GHz	100 kHz - 6 GHz	3 MHz -18 GHz	300 MHz – 50 GHz		100 MHz – 60 GHz	300 kHz – 30 MHz	27 MHz – 1 GHz	300 kHz – 50 GHz
Type of Field	E	E	E	E	E	E		E	H	H	E Shaped
Probe Model*	**EF 0391**	**EF 0392**	**EF 0691**	**EF 0691**	**EF 1891**	**EF 5091**	**EF 5092**	**EF 6091**	**HF 3061**	**HF 0191**	**EX 5091**
Mobile/ Telecommunication	♦		♦		♦				♦	♦	♦
Broadcasting	✧	♦	♦		♦				♦	♦	♦
Satellite Communication						♦	✧	♦			✧
Radar Signals						✧	♦	♦			✧
Industry Heating and Hardening	♦		✧						♦		
Industry Plastic Welding	✧	♦	✧						♦		
Industry Semiconductor Production	♦		♦						♦		
Medicine Diathermy / Hyperthermia	✧	♦	✧								✧
Leak Detection			✧		♦	♦		♦			✧
General Public Exposure Levels	♦		♦		♦	♦	✧	♦	♦	✧	✧
Occupational Exposure Levels		♦	✧		♦	♦	♦	♦	♦	♦	♦

♦ = best use for ✧ = partially suitable for

* Probe Ordering Number listed on preceeding page.

8500 Series
Industrial Compliance Meters

- **Complete Measurement System: Meter and Dual Electric and Magnetic Field Probe**
- **Covers Most Industrial Equipment**
- **Extremely Easy to Use**
- **Low Cost, Compact, and Lightweight**
- **High Overload Tolerance**
- **RMS Detection**

Applications

- **RF or High Frequency Heat Sealers, Vinyl Welders**
- **Semiconductor Process Equipment: Etchers, Sputterers, Ashers, and Glass Deposition**
- **RF Induction Heating**
- **Dielectric Dryers and Heaters**
- **Plasma Generation Systems**

Description

The Narda Models 8511 and 8513 combine an unprecedented ease of operation with powerful measurement capabilities. It provides the industrial plant manager and safety professional with an accurate and inexpensive solution for proving compliance with regulations that cover exposure to RF radiation. Both models provide a complete measurement system comprised of an extremely easy to operate meter and a probe that contains sensors to measure both the electric (E) and magnetic (H) field components of an electromagnetic wave.

8500 Series Compliance Meters

Operation

The 8511 and the 8513 were designed to make measurements a simple process that does not allow the most common mistakes to happen.

NO CHANGING PROBES TO MEASURE THE ELECTRIC AND MAGNETIC FIELDS - the probe contains two sets of sensors that separately measure each field. Simply press the **E/H Field** key to change the field that you are measuring.

NO RANGE CHANGES - the meter automatically displays a numeric value over the probe's entire measurement range.

NO CONFUSING SCALES - simply read the digital display, including the unit of measure.

NO DIFFICULT ZEROING - just touch the **Auto Zero** key.

NO FORGETTING THAT YOU ARE IN THE MAXIMUM HOLD MODE - the meter clearly displays the word "Max" when you are in the maximum hold mode. The digital display shows the maximum value while the bar graph continues to indicate the instantaneous value.

Application

Major safety standards worldwide require that both the electric and the magnetic field components (E and H fields) be measured for equipment operating below 300 MHz. Most high power industrial equipment operates at one of the frequencies allocated for Industrial, Scientific, and Medical (ISM) applications. Two ISM frequencies - 27.12 MHz and 13.56 MHz - are used extensively. The majority of heat sealers and induction heaters operate at 27.12 MHz while most semiconductor processing equipment operates at 13.56 MHz. The 8513 operates from 10 MHz to 42 MHz and is calibrated at the three ISM frequencies within this range: 13.56 MHz, 27.12 MHz and 40.68 MHz. The 8511 has a much broader sensor that operates from 100 kHz to 100 MHz and covers most induction heaters.

RF energy can cause the body to be heated beyond its ability to thermally regulate itself. Since 1987 OSHA has had the authority to cite employers for exceeding the limits specified by "state-of-the-art, scientific standards." OSHA has chosen the IEEE C95.1-2005 Standard for enforcement of non-ionizing radiation safety. This IEEE standard includes many changes from earlier standards and is considerably more complex. The Maximum Permissible Exposure (MPE) limits for Controlled Environments are:

Frequency	E Field (mW/cm^2)	H Field (mW/cm^2)
13.56 MHz	4.89	54.4
27.12 MHz	1.22	13.6
40.68 MHz	1.00	6.04

Technical Description

The Models 8511 and 8513 are unique in several ways that are important to the user. The most important is that both the electric and magnetic fields can be measured separately with a single probe. Changing field detection is as simple as pressing the **E/H Field** key on the meter. Measured field levels are displayed on the large-character, liquid crystal display (LCD). A bar graph makes it easy to determine trends during the measurement process. The **Max Hold** key makes it easy to lock in the maximum value on the digital display while still using the bar graph to indicate instantaneous values and trends. Small frequency deviations that are inherent in all electromagnetic field probes are automatically compensated for by selecting the correct frequency range before beginning to make measurements.

The probe's unique, patented design incorporates three orthogonal loops for the magnetic (H) field having a center that corresponds to the approximate vertex of the three orthogonal dipoles for the electric (E) field. The electric field dipoles respond only to the electric fields and the magnetic field loops respond only to the magnetic field. The diode detectors are operated in their square law region in order to provide RMS average detection. RMS average detection is important when similar industrial equipment is nearby. Cross coupling caused by re-radiated fields is virtually eliminated. Performance testing of this design was conducted by establishing various impedance fields in a TEM (Transverse Electromagnetic) cell. The cast aluminum meter housing provides a high level of shielding for the electronic circuitry. Feed-through capacitors are used for exit and entry leads. Static charges are eliminated by using special carbon-loaded filler between the shield and insulated conductors. Operating time is approximately 50 hours from a standard 9 volt alkaline battery.

Maintenance

Both 8500 series meters are very easy and inexpensive to maintain. The entire unit is calibrated together at a cost much lower than a meter and two separate probes. Users that have the ability to establish precise field levels will be able to calibrate the instrument using the meter's built-in calibration program.

Probe

- Dual Sensor probe measures electric and magnetic fields independently

Audio Alarm

- Alarm sounds if input exceeds probe's measurement range

Display

- Large, bright seven-segment numeric display
- Analog bar graph
- Custom legends indicate unit of measure, battery status, maximum hold mode, etc.
- Arrows indicate:
  – whether the electric field or the magnetic field is being measured
  – the current frequncy range setting

Shape

- Easy to hold and well balanced
- No Sharp corners

Keypad

- Positive, tactile feel keys

Housing

- Rugged, cast aluminum housing
- Fully shielded against strong electromagnetic fields

Battery

- Operates about 50 hours from a standard 9 V battery

8500 Series Compliance Meters

Specifications

MODEL	8513	8511
Frequency Range **Bands**[a]	10 to 42 MHz Three: 10-20 MHz, 20-35 MHz, & 35-42 MHz	300 kHz to 100 MHz[b] Four: 0.3 - 1.0 MHz, 1.0 - 20 MHz, 20 - 80 MHz, 80 - 100 MHz
Measurement Range	Single Range, 0.05 to 50.0 mW/cm^2 Bar Graph Auto Ranges or Select One of Three 10 dB (10:1) Ranges	Single Range, 0.1 to 100 mW/cm^2 E-field 0.2 to 200 mW/cm^2 H-field Bar Graph Auto Ranges or Select one of Three 10 dB (10:1 Ranges)
Display **Type** **Digital Output** **Bar Graph** **Units**	Custom Liquid Crystal Display 3½ Digits, .44 inch (11 mm) Character Height 18 Segments Custom Legends	
Controls	8 Key Membrane Keypad	
Zeroing	One Touch Auto Zero	
Units	mW/cm^2, W/m^2, V/m, A/m	
Audible Alarm	Probe Overload Warning	
Accuracy **(frequency response and meter)**	Calibrated precisely at three ISM frequencies. Accuracy at other frequencies within each of the three user-selectable frequency bands is ±0.75 dB for the E-field and ±1.0 dB for the H-field, plus one digit.[c]	Calibrated precisely at four frequencies. Accuracy at other frequencies within each of four user-selectable bands is ±1.5 dB for both the E-field and the H-field, plus one digit.[c]
Isotropic Error (max)	± 1.00 dB	
Ellipse Ratio (max)	± 0.75 dB	
Calibration Frequencies	13.56 MHz, 27.12 MHz, 40.68 MHz	500 kHz, 13.56 MHz, 27.12 MHz, 90 MHz
Calibration Accuracy	±0.5 dB	
Probe Overload	>50 W/cm^2	
Battery **Type** **Life (approx)**	9V alkaline 50 Hrs.	
Weight **Meter** **Probe**	1.35 lbs. (0.61 kg) 0.60 lbs. (0.46 kg)	
Size (LxWxD) **Meter** **Probe** **Cable (approx)**	7.8 x 2.5 x 1.8 inches (19.8 x 6.4 x 4.6 cm) 16 inches (41 cm) long 44 inches (112 cm) long	
Temperature **Operating** **Non-operating**	-20°C to +50°C -20°C to +70°C	
Humidity	0% to 90%, Non-Condensing	
Accessories Supplied	Battery, Manual, Shielded Storage Case[d]	Battery, Manual, Shielded Storage Case[d], Insulated Handle

NOTES

a The probe always detects energy over its entire measurement range. The "bands" are used to provide greater accuracy by automatically compensating for frequency response deviation.

b To use the 8511 to make measurements from 100 kHz to 300 kHz, set the meter to the **0.3 - 1.0 MHz** range. The indicated measurement for the electric field will be high (ranging from a small error up to a maximum of 2:1). The indicated measurement for the magnetic field will be low. To obtain a more accurate value, multiply the number displayed by a correction factor using the formula 300/f (f = frequency in kHz).

c There is an additional uncertainty due to traceability, i.e., the fields generated to calibrate the models 8511 and 8513 are accurate within ± 0.5 dB.

d The heavy duty storage case is foam-lined and shielded to protect the meter and the probe in storage and in transit. It is approximately 17.6 in X 12.6 in x 5.0 in (44.7 cm x 32.0 cm x 12.7 cm).

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

Nardalert XT Personal Monitor

- 100 kHz to 100 GHz
- Shaped Frequency Response Matched to Your Standard
- Data Logger Records Continuously – more than 30,000 data points
- Five High-Intensity LED Level Indicators
- Tri-Sensor Handles All Types of Fields
- Two Adjustable Audio Alarms
- Adjustable Vibrator Alarm
- Long Battery Life
- Patented Design

U.S. Patents 6,154,178
5,600,307 5,168,265
International Patent 1008856

Description

The Nardalert XT family of RF personal monitors is designed to satisfy the needs of virtually all individuals who use an RF personal monitor.

- Models are available that closely conform to all major worldwide standards.
- The adjustable alarm feature allows one alarm to be set at a level equal to the upper tier of two-tier standards, such as the "Occupational" or "Controlled" limits, while the second alarm can be set to the lower tier, such as the "Action" or "General Population" limits.
- The ultra-broadband sensors cover almost the entire usable RF spectrum in a single monitor.
- The unique tri-sensor design handles every possible signal format, from complex multi-signal communication environments to military platforms with both communications and radar signals.
- The five flashing high-intensity LED level indicators can be seen while wearing the monitor, even outdoors in the sun.
- There are four different ways to wear the monitor – pocket clip, belt clip, soft case with belt clip (optional) and soft case for climber's harness (optional).
- The audio alarm has two distinct sounds that are associated with the two different alarm thresholds. Both alarm thresholds can be adjusted using the optional Interface Kit.
- The user can select an audio alarm, a vibrator alarm, both audio and vibrator, or an optional remote vibrator. The remote vibrator can be used in areas with high ambient noise when the user is wearing heavy clothing that would prevent the detection of the internal vibrator.

Nardalert XT Personal Monitor

- The data logger is always on. The logging interval can be adjusted using the optional Interface Kit. At the default setting, the average field strength is logged every five seconds with the data logger retaining more than 40 hours of information before it starts to write over the oldest data.
- Either one or both of the two LEDs that indicate the lowest levels (10% of Standard and 20% of Standard) can be deactivated using the optional Interface Kit for applications where it is desirable to indicate only higher field strengths.

The pocket clip supplied with the monitor allows you to wear the monitor inside your shirt pocket while maintaining the top of the monitor near the top of the pocket, regardless of pocket size. This allows you to view the LED level-indicators.

Applications

Nardalert XTs are usable over their entire rated frequency range when worn on the body as an RF personal monitor. The patented sensor design detects the electric field over an extremely broad frequency band regardless of signal format or polarization.

- The low frequency sensor is a low impedance, surface-area sensor designed to detect the radial fields that are characteristic of low-frequency communication systems. The compensated diode detector yields accurate results even in highly complex, multisignal environments.
- The diode-dipole design complements the low frequency sensor in the UHF region by detecting vertically polarized fields. The combination of the two sensors detects all polarizations.
- The microwave band sensor uses thermocouple detectors. Thermocouple arrays function primarily as dipole antennas up to about 10 GHz. At higher frequencies, the sensor increasingly functions in the traveling-wave mode of detection. This enhances the sensor's sensitivity and allows it to function accurately up to 100 GHz and beyond. Thermocouple detectors are always true RMS detectors and yield accurate results even with extremely narrow radar pulses.

The 8861 Series is specifically designed for use in strong ELF fields, such as where wireless antennas are mounted on towers that carry high voltage 50/60 Hz utility power. The 8860 and 8862 Series Nardalert XT models are not designed for this environment and false alarms may occur.

The 8864 Series is specifically designed to be worn on the outside of RF protective suits since monitors do not function properly when worn underneath these suits. RF protective suits generally provide a minimum of 10 dB (10:1) protection. The 8864 Series monitors sound an alarm at high field levels to warn the wearer that they are in an area where the RF protective suits may not be sufficient protection.

The belt clip supplied with the monitor snaps on the monitor case in place of the pocket clip. It has a strong spring and retaining hook that makes an accidental detachment from your belt unlikely.

Model 8865 Interface Kit

The Model 8865 Interface Kit, although not required, allows Nardalert XT users to perform two important functions:

- Adjust several monitor parameters, such as alarm-threshold settings and data-logging rate
- Download and analyze logged data

The Nardalert XT is ready to use upon receipt. If you want to take advantage of these additional features all you need is one Interface Kit per location. For example, if your New York office has 30 Nardalert XTs, all you need is one Interface Kit. Of course, if you also have monitors in another city, then you will probably want a kit for every city.

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

The Model 8865 Interface Kit is comprised of:

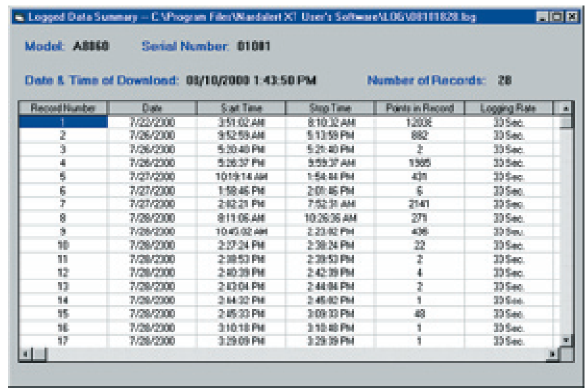
- A small electronic module that connects the Nardalert XT to any Windows® compatible personal computer
- The Nardalert XT User's Software (CD)
- A cable to connect the module and the PC (RS-232)
- A cable to connect the module and the monitor
- A plastic storage box

The User's Software is very easy to use. Although a complete manual is included on the CD and is available from the help menu, few users ever need to refer to the manual. A "tool tip" appears for every control and window when you pause the cursor near the control. Anyone familiar with Windows programs has seen the words "Cut" or "Paste" appear in other programs.

Data

Logged data is downloaded. Once it is downloaded you can:

- Analyze it on screen with a variety of tools. For example, even though the data is collected in terms of five-second average exposure (default setting), the User's Software allows you to smooth the data and average it over longer periods of time
- Create reports
- Export the data to other programs such as word processors, spreadsheets, or data bases.



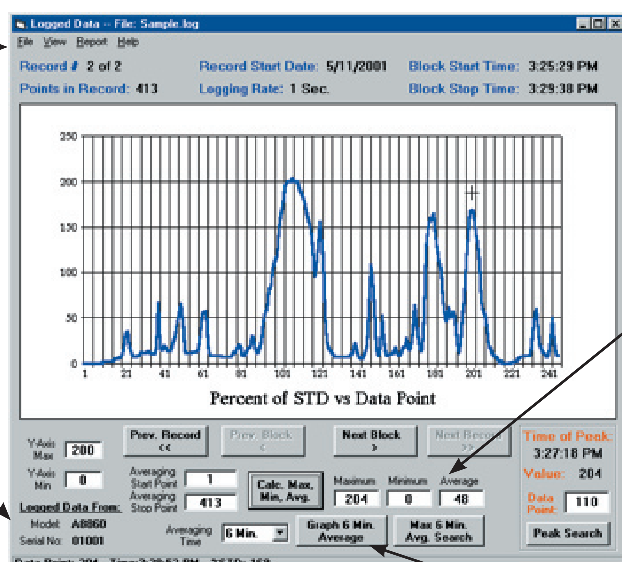
Logged Data Summary -- C:\Program Files\Nardalert XT User's Software\LOG\08101828.log

Model: A8860 Serial Number: 01081

Date & Time of Download: 08/10/2000 1:43:50 PM Number of Records: 28

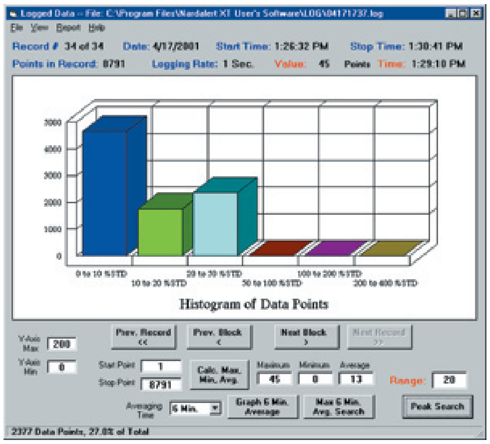
Record Number	Date	Start Time	Stop Time	Points in Record	Logging Rate
1	7/22/2000	3:51:02 AM	8:10:32 AM	12008	33 Sec.
2	7/26/2000	9:52:59 AM	5:13:59 PM	882	33 Sec.
3	7/26/2000	5:20:40 PM	5:21:40 PM	2	33 Sec.
4	7/26/2000	5:26:37 PM	9:59:37 AM	1585	33 Sec.
5	7/27/2000	10:19:14 AM	1:54:44 PM	431	33 Sec.
6	7/27/2000	1:58:46 PM	2:01:46 PM	6	33 Sec.
7	7/27/2000	2:02:21 PM	7:52:31 AM	2141	33 Sec.
8	7/28/2000	8:11:06 AM	10:26:36 AM	271	33 Sec.
9	7/28/2000	10:45:02 AM	2:23:02 PM	436	33 Sec.
10	7/28/2000	2:27:24 PM	2:38:24 PM	22	33 Sec.
11	7/28/2000	2:38:53 PM	2:39:53 PM	2	33 Sec.
12	7/28/2000	2:40:39 PM	2:42:39 PM	4	33 Sec.
13	7/28/2000	2:43:04 PM	2:44:04 PM	2	33 Sec.
14	7/28/2000	3:44:32 PM	2:45:02 PM	1	33 Sec.
15	7/28/2000	2:45:33 PM	3:09:33 PM	48	33 Sec.
16	7/28/2000	3:10:18 PM	3:10:48 PM	1	33 Sec.
17	7/28/2000	3:29:09 PM	3:29:39 PM	1	33 Sec.

A new record is created every time the monitor is turned on. This screen makes it easy to find any record.

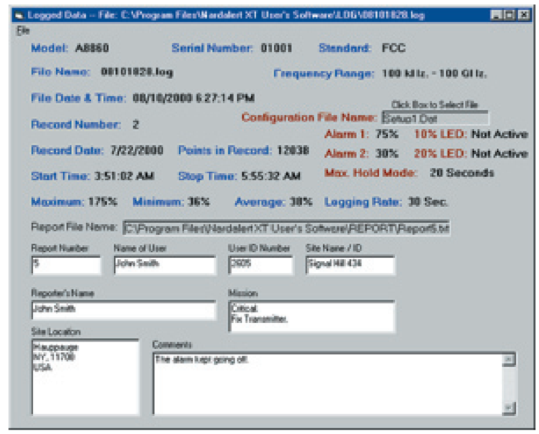


Nardalert XT Personal Monitor

Data Reports



The histogram shows the distribution of data points



Configure a report to print directly or for export to a word processor.

Monitor Settings

The User's Software allows you to change seven parameters to tailor the Nardalert XT's operation:

PARAMETER	DEFAULT	OPTIONS
Alarm 1 Threshold	50% of Standard[a]	10% to 100%
Alarm 2 Threshold	200% of Standard[a]	20% to 200%
10% LED[a]	Active	Inactive
20% LED[a]	Active	Inactive
Logging Rate	Every five seconds[b]	1 second to 6 minutes
Maximum Hold	Off	Highest One-Second Average; Highest Average (10 seconds to 6 minutes)[c]
Time & Date	Greenwich Mean Time (GMT)	Local Time & Date

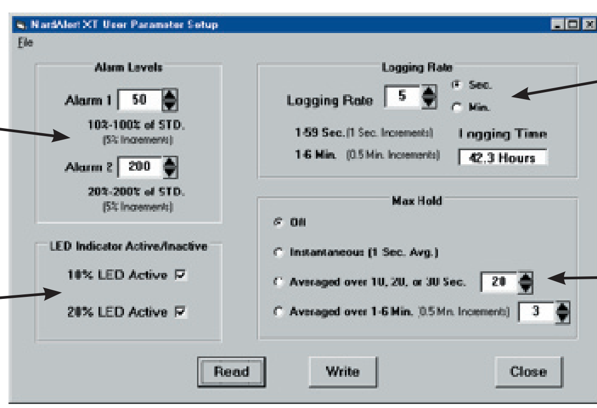
[a] Values for 8864 Series are five times higher

[b] Averaged over the interval

[c] The maximum hold feature indicates the highest exposure since the monitor was turned on. It can be based on a one-second average or a longer averaging period ranging from ten seconds to six minutes.

Change one or both alarms to fit your needs

Turn one or two LED Indicators off so that low field levels are not indicated



Change the logging rate to get either more data points or a longer logging time

The monitor can be set to indicate the highest peak field or the highest average field

The User Parameter setup screen makes it easy to set the monitor to meet your needs

Model Selection

There are four series of Nardalert XT RF monitors. Within each series, the specifications are essentially identical except for the sensor "shaping." Each specific standard or guidance requires some differences in the sensor design and calibration. The four Nardalert XT series are:

8860 SERIES
This is the full-featured, Nardalert XT series that includes all the user-adjustable parameters plus the ability to log more than 30,000 data points automatically whenever the monitor is turned on. The data-logger feature can be used to analyze personnel exposures in order to improve operations. Or it can be used in the way a Flight Data Recorder is used on board an aircraft – the logged data can be reviewed whenever there is a need to determine an individual's level of exposure.

8861 SERIES
The 8861 Series is designed for applications where the user will be in close proximity to strong ELF fields, such as from 50/60 Hz power lines. These monitors are very similar to the standard, full-featured series except that the inside of the housing has a special conductive coating that blocks the ELF signals. The low frequency range of these monitors is reduced by the coating.

8862 SERIES
This series is identical to the full-featured 8860 Series except they do not include the data-logging capability.

8864 SERIES
This series is identical to the full-featured 8860 Series with one exception: these high power monitors function at field levels five times higher than all other model series.

Soft cases are recommended for use by climbers and in severe weather: (l. to rt.) climber-harness case; case front; belt-clip case

Model Selection Guide

STANDARD / GUIDANCE	NARDALERT XT MODELS			
	8860 SERIES	8861 SERIES	8862 SERIES	8864 SERIES
ACGIH	B8860	B8861	B8862	—
AS/NZ 2772.1 (1998, draft) Occupational	D8860	D8861	D8862	D8864
Canada Safety Code 6 (2009) Controlled	C8860	C8861	C8862	C8864
DIN VDE 0848, Part 2, October 1991 Area 1 Occupational	D8860	D8861	D8862	D8864
ENV 50166-2 Occupational	D8860	D8861	D8862	D8864
FCC 1997 Occupational / Controlled	A8860	A8861	A8862	A8864
ICNIRP 1998 Occupational	D8860	D8861	D8862	D8864
IEEE C95.1-2005 Controlled	B8860	B8861	B8862	—
Japan RCR-38 Controlled	A8860	A8861	A8862	A8864
NATO STANAG 2345	B8860	B8861	B8862	—

Nardalert XT Personal Monitor

Specifications

SERIES	8860	8861	8862	8864
Frequency Range	100 kHz to 100 GHz	10 MHz to 100 GHz	100 kHz to 100 GHz	100 kHz to 100 GHz 30 MHz to 100 GHz (C8864 & D8864)
Alarm Accuracy[a] (Frequency Sensitivity and Polarization Uncertainty)	+6.0 / -3.0 dB (100 kHz to 2.3 GHz) +4.5 / -2.5 dB (2.3 to 30 GHz) +2.5 / -6.0 (30 to 50 GHz) +2.5 / -6.0 dB (50 to 100 GHz, Typical)			
Sensors (All E-field)	Low-band surface area detector, diode / Mid-band dipole, diode / High-band thermocouple			
Alarm Indicators				
LEDs	Five High Intensity Flashing, 2 Yellow, 3 Red			
Audio Alarm 1	Steady Tone			
Audio Alarm 2	Variable Tone			
Vibrator, Internal and Remote[b]	Continuous			
Alarm Threshold[c]				
Alarm 1, Default Setting	50% of Standard			250% of Standard
Range of Adjustment[d]	10% to 100% of Standard in increments of 5%			50% to 500% of Std. in inc. of 5%
Alarm 2, Default Setting	200% of Standard			1000% of Standard
Range of Adjustment[d]	20% to 200% of Standard in increments of 5%			100% to 1000% of Std. in inc. of 5%
Vibrator, Internal and Remote[b]	Same Threshold as Alarm 1			Same Threshold as Alarm 1
LED Indicators	10%, 20%, 50%, 100% and 200% of Standard			50%, 100%, 250%, 500% and 1000% of Standard
CW Overload	3000% of Standard or Guidance			
Peak Overload	32 dB above Standard or Guidance			
Memory[e]				
Number of Data Points	31,263		—	31,263
Logging Interval, Default	5 sec.			5 sec.
Range[d]	1-60 sec. in 1 sec. inc. 1.5-6.0 min. in 0.5 min. inc.			1-60 sec. in 1 sec. inc. 1.5-6.0 min. in 0.5 min. inc.
Logging Time @ rate of 12/min	42.3 hrs			42.3 hrs
Maximum Hold Modes[d]	Off, Instantaneous (1 sec. avg.), Averaged up to 6 Minutes			
ELF Immunity	6,000 V/m	100,000 V/m	6,000 V/m	6,000 V/m
Battery Type / Life (approx.)	1 x AA Alkaline / 1500 hrs. with LEDs and Alarms OFF			
Temperature: Operating	-10°C to +55°C			
Non-operating	-20°C to +55°C			
Humidity	0 to 95%, non-condensing			
Weight (including battery)	5.5 oz. (157 g.)			
Size	4.12" H x 3.0" W x 1.37" D (10.5 cm H x 7.6 cm W x 3.5 cm D)			
Color	Gray			
Accessories Supplied	Pocket Clip, Belt Clip, Plastic Storage Box, Battery, User's Guide			
Optional Accessories	Model 8865 Interface Kit, Soft Case with Belt Clip (P/N 21847600), Soft Case for Climber's Harness (P/N 21847700) and Remote Vibrator (P/N 11110100)			

NOTES: [a] Accuracy specified as the mean of the radial and vertical orientations (10 to 1600 MHz) and mean of the vertical and horizontal orientations (1600 MHz to 50 GHz).
[b] Remote vibrator, P/N 11110100, is available as an option. It operates from its own battery.
[c] Percent-of-Standard percentages are in terms of equivalent plane-wave power density relative to the Standard or Guidance.
[d] The Interface Kit is required to make adjustments to the monitor settings and/or to download logged data.
[e] 8862 Series monitors do not include memory.

RadMan / RadMan XT
RF Personal Monitors

- 1 MHz to 40 GHz
- Shaped Frequency Response Matched to Your Standard
- Multi-Function Tool – Personal Monitor, Leakage Detector, Simple Measurement Instrument
- Simultaneous E- and H-Field Measurement
- Data Logger Records Continuously (Radman XT)
- Four LED Level Indicators
- Isotropic Response when used Off the Body
- Optical Interface can be used "Real Time"
- Patented Design

Description

All RadMan monitors share the same compact housing, dual electric (E) and magnetic (H) field detection, and wideband shaped frequency response. The "shaped" frequency response means that the monitor has frequency-selective sensitivity that matches your standard – all major standards are supported. The alarm criteria and the output information are incorporated in the "Percent of Standard."

Narda Safety Test Solutions' latest RF personal monitor is the Series ESM-30 RadMan XT. This "Extended Technology" monitor is very similar to the ESM-20 Series monitors that have been available since 1997 with one very important difference: the RadMan XT continuously records the field strength that it measures. Since the monitor has both electric and magnetic (E and H) field sensors, it records six different values for every data point: Maximum, Minimum, and Average values during the averaging period for both the E field and the H field. The time and date of each data point is also stored. This data may be retrieved at any time using the optional ESM-TS Interface Set which includes a fiber optic cable, adapter circuit, and software. The software permits the user to download the data that the monitor has collected, analyze the data, and set the monitor's internal clock. The data logger is always on – it simply stores the newest data in place of the oldest data.

All RadMan monitors are multi-function tools. With the RF absorber cap off, the RadMan functions as a simple instrument with isotropic detection and four level indicator LEDs that provide an approximate indication of field strength. The RadMan can also be used as a simple area monitor. The fiber optic interface and available software can be used to continuously monitor the detected field strength levels from both the electric field and magnetic field sensors.

RadMan Personal Monitors

Applications

RadMan RF monitors are generally usable over their entire rated frequency range with one limitation:

Standard RadMan monitors are not recommended for use with radar signals. "Fast" RadMan monitors are available for applications where peak detection of radar signals is desired. See Detecting Peak Radar Signals on the next page.

There are two series of RadMan RF monitors. Within each series, the specifications are essentially identical except for the sensor "shaping." Each specific standard or guidance requires some differences in the sensor design and calibration. The specified frequency range of each model can vary depending on the difficulty in shaping the frequency response of the monitor to match the standard. The two RadMan series are:

RADMAN XT
This is the full-featured RadMan monitor. It operates over the maximum frequency range and contains both E and H field sensors. Monitors are generally shaped to match the higher level of two-tier standards, i.e., the "Controlled," "Occupational," or "RF Worker" limits. The data-logger can log more than 1,600 sets of data that can be used to analyze personnel exposures in order to improve operations. Or it can be used in the same way a Flight Data Recorder is used on board an aircraft – the logged data can be reviewed whenever there is a need to determine an individual's level of exposure.

RADMAN
This series is identical to the full-featured RadMan XT except they do not include the data-logging capability.

Detecting Peak Radar Signals

Most RadMan XT and RadMan monitors use a one-second averaging time for their alarm criteria. "Fast" Radman models (see Model Selection Guide) have a 30-millisecond averaging period for the electric field sensor. These monitors detect the peaks of sharp, narrow radar pulses. The ICNIRP standard, for example, requires peak detection when the ratio of peak to average power is greater than 30 dB.

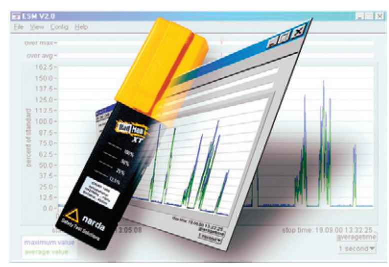
RadMan PC Interface Set

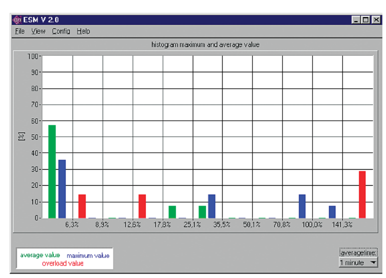
Allows you to monitor both E and H fields in real time via fiber optic cable when monitor is used off the body. You can download and analyze logged data from RadMan XT monitors.

Interface Set ESM-TS includes:

- Windows® compatible User's Software
- Interface Module that connects directly to the COM port of your PC
- Fiber optic cable to connect module to RadMan

ONE TRANSFER KIT PER LOCATION IS RECOMMENDED (P/N 2251/90.50)





Model Selection Guide

Select the model based on standard/guidance and the product series (RadMan XT or RadMan). The frequency rating is for the E-field sensor. The H-field sensor is rated 1 MHz to 1 GHz for most models. Exceptions are noted.

STANDARD / GUIDANCE	RADMAN XT	RADMAN
BGV B11, 2001, Exp. 1 Occupational	**2251/01 (2251/51 fast)** E-Field 1 MHz to 40 GHz H-Field 1 MHz to 1 GHz	**2250/51 (2250/01 fast)** E-Field 1 MHz to 40 GHz H-Field 1 MHz to 1 GHz
Canada Safety Code 6 (2009) Controlled	**2251/10** E-Field 1 MHz to 40 GHz H-Field 1 MHz to 1 GHz	**2250/60 (2250/10 fast)** E-Field 1 MHz to 40 GHz H-Field 1 MHz to 1 GHz
ENV 50166-2 Occupational	**2251/04** E-Field 1 MHz to 40 GHz H-Field 27 MHz to 1 GHz	**2250/54 (2250/04 fast)** E-Field 1 MHz to 40 GHz H-Field 27 MHz to 1 GHz
FCC 96-326 Occupational / Controlled	**2251/02** E-Field 3 MHz to 40 GHz H-Field 3 MHz to 1 GHz	**2250/52 (2250/02 fast)** E-Field 3 MHz to 40 GHz H-Field 3 MHz to 1 GHz
ICNIRP 1998 Occupational	**2251/06 (2251/56 fast)** E-Field 1 MHz to 40 GHz H-Field 27 MHz to 1 GHz	**2250/56 (2250/06 fast)** E-Field 1 MHz to 40 GHz H-Field 27 MHz to 1 GHz
ICNIRP 1998 General Public (E-Field Only)	**2251/16** E-Field 1 MHz to 40 GHz no H-Field	—
IEEE C95.1-2005 Controlled	**2251/05** E-Field 3 MHz to 40 GHz H-Field 3 MHz to 1 GHz	**2250/55 (2250/05 fast)** E-Field 3 MHz to 40 GHz H-Field 3 MHz to 1 GHz
Japan RCR-38 Controlled	**2251/03** E-Field 3 MHz to 40 GHz H-Field 3 MHz to 1 GHz	**2250/53 (2250/03 fast)** E-Field 3 MHz to 40 GHz H-Field 3 MHz to 1 GHz

RadMan Personal Monitors

Specifications

SERIES	RADMAN XT	RADMAN
Frequency Range	See Model Selection Guide	
Type of Frequency Response	Shaped	
LED Indicators	12.5%, 25%, 50%, and 100% of Standard[a]	
Alarm Threshold	50% of Standard[b]	
CW Overload	20 dB above standard but not more than 10 kV/m or 26.5 A/m	
Peak Overload	40 dB above standard for pulse widths < 10 µsec	
Sensors	E and H Field (no H field for General Public versions) Diode based design	
Directivity	Isotropic (Tri-axial)	
Sensitivity[c]	6% of Standard	
Frequency Sensitivity (Typical)		
H-field	±3 dB	
E-Field	±3 dB (up to 3 GHz) +4/-3 dB (3 GHz to 10 GHz) +6/-3 dB (10 GHz to 18 GHz) +6/-10 dB (18 GHz to 40 GHz)	
Isotropic Response[d]	+4/-2 dB (27 MHz to 500 MHz)	
ELF Immunity	1 kV/m	
Memory		—
Number of Data Points (six values per data point)[e]	1638	—
Logging Intervals[f]	1 sec., 2 sec., 5 sec., 10 sec., 1 min., 3 min. (default: 1 min.)	—
Logging Time @ rate of 1/min	27.3 hrs.	—
Calibration Frequency	100 MHz (200 MHz for IEEE versions /05, /55)	
Recommended Calibration Interval	36 months	
Battery Type	2 x AAA Alkaline	
Battery Life	200 hrs. with LEDs and Audio Alarm OFF	
Temperature Operating	-10°C to +55°C	
Temperature Non-operating	-40°C to +70°C	
Humidity	5 to 95%, non condensing ≤29 g/m³, absolute humidity (IEC 60721-3-2 class 7K2)	
Weight (including cap and batteries)	4.6 oz. (130 g.)	
Size without cap	1.0 x 1.4 x 6.2 inches (26 x 36.4 x 157 mm)	
Size with cap as absorber	1.5 x 1.6 x 6.4 inches (37 x 41 x 163 mm)	
Size with cap as handle	1.5 x 1.6 x 7.8 inches (37 x 41 x 197 mm)	
Accessories Supplied	Earphone, Operating Manual, Soft Case, Batteries	
Optional Accessories	PC Transfer Set[f], Extension Rod for Hand-Held Use (BN 2250/92.02), Hard Case (BN 2250/92.03) and Tripod (BN 2244/90.31)	

Notes:

[a] The percent of standard ratings refer to equivalent power density.
[b] The alarm threshold is set to 50% of Standard ±1 dB at the calibration frequency.
[c] This value is only significant for data logging and online measurements.
[d] Uncertainty due to varying polarization (verified by type approval test). Ellipse ratio included.
[e] Each record includes the maximum, minimum and average values for both the E field and the H field (optional, P/N 2251/90.50).
[f] The logging interval can be selected via the ESM-TS software (optional)

Remote Monitoring of Electromagnetic Fields

2600 Series Area Monitor System

- **50 Hz to 18 GHz Range – dependent on probe selected**
- **Stable, Reliable Results – even at very low levels**
- **Continuous Monitoring Results Stored – 18-month memory capacity**
- **Remote Unit Automatically Communicates Alarm Condition**
- **2600 Software**
  - **Allows automatic system operation with user-defined settings**
  - **Supports individual configuration of each 2600 Station in your system**
- **Powered by Solar Panel and Integrated Back-Up Batteries**
- **Bi-Directional Communication via GSM Network**

Description

The 2600 Series provides a complete solution for the remote monitoring of electromagnetic field strength at any location. Typically positioned near antenna installations, the system consists of one or more 2600 Station field monitors, an electric or magnetic field probe that matches your application for each monitor and the associated 2600 Software running on a PC.

2600 Station

The 2600 Station unit monitors the field strength over a wide frequency band. A variety of isotropic probes is available to meet the frequency and level range requirements of your application.

DATA ACQUISITION AND MEMORY

The actual field strength is continuously monitored. The time-averaging may be set according to common standards. All results are internally stored for further processing. The oversized memory capacity allows a storage period up to 18 months. Programmable text "bookmarks" can be used to identify individual sub-sets of these results.

ALARM

A flexible alarm circuit permanently checks the field strength results as well as the station's status. Two field strength limits may be set independently. Whenever an alarm condition is met, the remote unit can automatically establish a link to initiate further actions.

The implemented SMS function allows direct calls to a set of predefined cellular phone users, for example, to the safety- or site-manager. Also included is a daily result and status report for the 2600 Station unit.

2600 Series Area Monitor System

COMMUNICATION

The bi-directional link is provided via the GSM phone network. The communication protocol is optimized for reliable operation. Results are usually downloaded automatically and periodically, e.g. every 24 hours depending on the individual setting. The maximum field strength in a given period of time may be sent to any phone as a brief report.

CONFIGURATION

Various parameters of the 2600 Station monitor may be configured by the 2600 Software. These settings include two adjustable field-strength thresholds, the detection mode, the average time, and the internal memory storage rate. All messages from the 2600 Station may be enabled or disabled. A subset of these configuration parameters may be directly set by any cellular phone via SMS messages.

OPERATION

The 2600 Station monitor operates autonomously. It is powered by a combination solar panel and integrated back-up batteries. Typically, the monitor will be mounted on a mast which is available as an accessory.

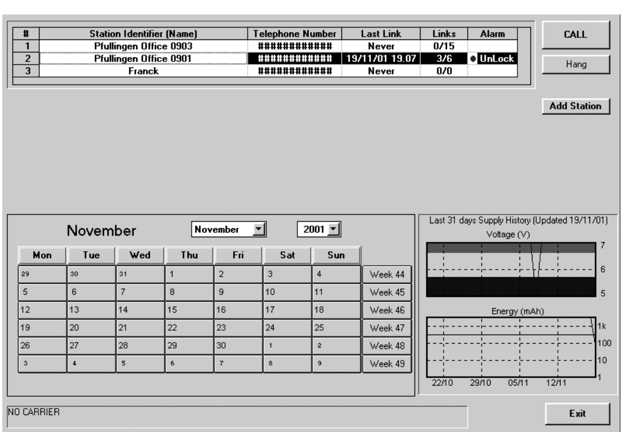
2600 Software

The 2600 Software provides full remote control of the system's operation. Programmable schedules may be set separately with each 2600 monitor to control the periodic data transfer.

After downloading the results, a powerful display tool allows a graphic display of every available result. Results acquired during GSM modem activities are highlighted to avoid misleading interpretation. In addition to receiving automatically programmed data, the user may query each monitor to download stored data manually or to monitor the instantaneous existing field strength.

DATA VALIDATION AND DOCUMENTATION

The integrated post-averaging tool allows calculation of an averaged result over six minutes based on the downloaded data.



Easy-to-operate zoom and marker functions allow a complete examination of the results. Diagrams may be printed and copied to different documents. For further processing and presentation, all information is stored in individual folders for every remote unit. Data is easily distinguished by date or week at any time by activating the system's calendar feature. This data may be exported to other applications, e.g., into powerful databases. Possible applications could include reporting and internet presentation (not included).

CONFIGURATION SECTION

The 2600 Software supports complete and individual configuration of every 2600 Station monitor in the system. The set of parameters is included in the 2600 Station section on the next page.

Specifications

2600 STATION	
Sensor	Diode based, isotropic
Frequency/Measurement Range	Depending on probe Refer to Ordering Information
Detection Mode, selectable	Average Peak (extra) X, Y, Z (extra) Update Rate: 1 / second
Average Time, programmable	1 minute to 10 minutes
Storage Rate, selectable	5 seconds to 6 minutes
Memory Capacity	45 hours to 18 months Depending on Storage Rate and Detection Mode Selected
ALARM SECTION	
Alarm-criteria, selectable	Field Strength exceeds and/or falls below thresholds Internal Temperature High Battery Low Probe Malfunction Case Open Dual Field Strength threshold, adjustable separately
Alarm Notification, selectable	To Computer (data) Data: to one out of 10 computers
DATA SECTION	
Data Download to Computer, selectable	Automatic (periodical) Event Triggered (alarm) Individual – Scheduler Programmable
Result & Status Report to cellular phone	Automatic (periodical) – To a maximum or 10 cellular phones, simultaneously Individual – Scheduler Programmable
GENERAL	
Modem, implemented	GSM Dual Band, WiFi Bands according to Ordering Information
SIM Card	Data-Service: incoming, outgoing SMS-Service: incoming, outgoing Note: not included with delivery
Power Supply	Solar Panel, Buffered by Internal Battery Pack On Request: External Power Supply
Operating Time	7 days (approx.) in darkness
Operating Temperature Range	-10°C to +50°C
Self Test	Automatic during Power-On Periodically every 7 days
Calibration Interval	24 months recommended

USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www**.narda-sts.us

2600 Series Area Monitor System

2600 Software Specifications

CONFIGURATION / DOWNLOAD SECTION	
Parameter Setting	Meter & Result Storage mode Alarm Criteria & Notification mode Scheduler Phone Number Bookmarks, Plot Colors Individual for each 2600 Station
Download Management, programmable	Date, time From last download, until now Between bookmarks Refer to Data Section
EVALUATION & DOCUMENTATION SECTION	
Result Presentation	Line Diagram
Special Feature	Marker Zoom Data highlighted if acquired during modem activity
Export Format	File: ASCII table Clipboard: bitmap
STATUS SECTION	
On Screen Display	Alarm status from last communication Battery voltage, solar energy history of last month
GENERAL	
Dimensions	29”H x 8”W x 8”D (73.6 cm H x 20.3 cm W x 20.3 cm D) 11 lbs. (5 kg)
Result Database Capacity	Restricted by computer’s hard disk capacity
Operating Language	English
Hardware Requirements	Pentium processor, Microsoft® Windows® 95 or above, 16 MB RAM, 10 MB hard disk, data modem

Ordering Information

Narda Area Monitor 2600 Software	**2600/01**
Narda Area Monitor 2600 Station including: GSM 900/1800 modem, solar panel, battery charger, operating manual, accessory Note: SIM card required for GSM communication, not included with delivery	**2600/11**
Probe* (select one)	
E-field probe, Type 330 500 kHz to 3 GHz 0.3 V/m to 300 V/m	**2600/90.20**
E-field probe, Type 309 1 MHz to 18 GHz 0.8 V/m to 800 V/m	**2600/90.22**
H-field probe, Type 305 20 Hz to 3 kHz 10 nT to 40 µT	**2600/90.48**
Accessory (optional) Fiberglass pole (height 2 meters), including base	**2600/91.01**

*Other probes on request

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

Ultra-Wideband

Smarts II™ Area Monitors

- **Ultra-Wideband Smarts II™ Area Monitors**
- **2 MHz to 100 GHz in a Single Monitor**
- **Shaped Frequency Response Matched to Your Standard**
- **Continuous, Automatic Monitoring – No Operator Required**
- **Audible, Visible, and Remote Alarms**
- **Recorder Output**
- **Battery or Low Voltage DC Operation**
- **Adjustable Alarm Threshold**
- **Weatherproof Housing Option**

Description

Narda's latest design in the popular SMARTS™ family of RF area monitors introduces several new features. Like earlier SMARTS models, the SMARTS II area monitors provide continuous detection of RF radiation within a specific area. The SMARTS II uses the latest, ultra- wideband sensor technology of the Nardalert™ RF personal monitors. The result is an area monitor that covers most of the usable RF spectrum in a single monitor with "shaped" frequency-dependent sensitivity that matches the standard used to determine compliance. The dual sensor design accurately detects all types of electric fields from 2 MHz to 100 GHz. The microwave portion of the sensor employs thermocouple detectors so that radar signals are accurately converted to true RMS values while the patented diode design used for the lower frequencies provides RMS detection even in very complex, multi-signal environments. SMARTS II monitors respond equally to all polarizations and cover an entire hemisphere. They can even be mounted on a metallic wall. There is a SMARTS II model shaped to match each of the major standards.

The SMARTS II operates from a common nine-volt battery or a 12-volt or 24-volt DC supply. Every monitor has an audio alarm. An alarm condition causes both a voltage transition to occur and a SPDT relay to operate. Either the TTL signal or the relay contacts can be used to provide remote alarms, a record of alarm conditions, and/or automatic shutoff of equipment.

The SMARTS II area monitors can be used outdoors by installing the monitor in a NEMA weatherproof enclosure.

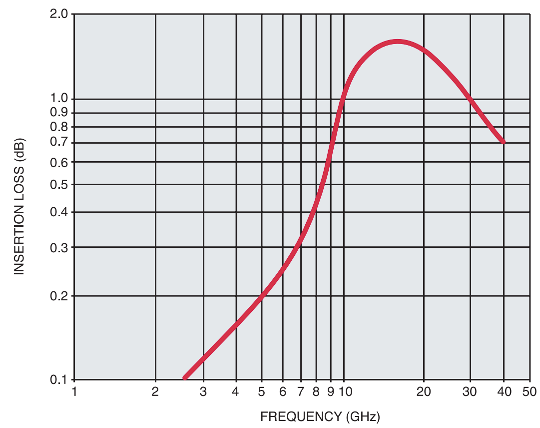
Smarts II™ Area Monitors

Operation

SMARTS II monitors operate like common household smoke detectors. When operating normally, the alarm LED flashes approximately every 40 seconds. If operating under battery power and the battery needs replacement, a "chirp" accompanies the LED flash. A continuous audible and visual alarm occurs when the SMARTS II detects RF radiation at its preset level or higher. Both an electronic signal and a relay closure are provided during alarm conditions. Either of these indications can be used to activate various user-supplied remote circuitry and systems. The SMARTS II goes into a continuous alarm mode if the battery drops below a critical level or if the detector fails.

Operation can be verified at any time by depressing the TEST button that activates a full-system test. The ENABLE input can be used in situations where the standard operating procedure produces RF field levels in excess of the threshold and exposure to people is possible (e.g., in an anechoic chamber or on the deck of a ship). The ENABLE input can be tied to a motion sensor or an interlock switch. Under these conditions, the SMARTS II activates its alarms only when two conditions are satisfied: (1) high levels of RF are present and (2) motion is detected or a door is open.

The alarm threshold is field adjustable from 10% of standard to 50% of standard. The user can easily switch from battery operation to an external, low voltage DC supply.



Insertion Loss of SMARTS II* Weatherproof Housing

*Approximate insertion loss of weatherproof housing under dry conditions with the SMARTS II facing the source of energy (normal to the Poynting vector).

Outdoor Installations

An all-plastic weatherproof housing is available that permits operation of the SMARTS II in virtually any environment. This housing is rated NEMA class 4X, which is the equivalent of IEC Publication 529, Type IP66 or CSA Standard C22.2, No. 94. Connections to the housing are made through a MIL-type, multi-pin, circular connector (the mating connector is supplied). Installation of the SMARTS II into the weatherproof housing could not be simpler: remove the housing cover, plug the internal cable into the SMARTS II, then attach the monitor with two screws. Put the cover of the housing back on and attach the external cabling. Since standard visual and audio signals are masked by the weatherproof housing, status and alarm information plus low voltage DC are sent via a user-supplied external, shielded cable.

The insertion loss of the weatherproof housing starts to become significant at about 8 GHz, thus reducing the monitor's sensitivity. Losses are greater in the rain, especially if the weatherproof housing is mounted horizontally which allows water to collect on it. Depending on the frequency, the insertion loss from the housing can be up to 2 dB under dry conditions and up to 10 dB in the rain. The adjustable threshold feature of the SMARTS II can be used to compensate for the insertion loss of the weatherproof housing.

Model Selection Guide

STANDARD OR GUIDANCE	TIER	SMARTS II™ MODEL
ACGIH	—	B8830
Canada Safety Code 6 (2009)	Controlled	C8830
FCC 1997	Occupational / Controlled	A8830
ICNIRP 1998	Occupational	D8830
IEEE C95.1-2005	Controlled	B8830
NATO STANAG 2345	—	B8830

Monitor Specifications

PARAMETER	SPECIFICATION
Model Number	A8830 through D8830[a]
Frequency Range	2 MHz to 100 GHz
Frequency Sensitivity[b]	+6.0 / -3.0 dB (2 MHz to 2.3 GHz) +4.5 / -2.5 dB (2.3 to 30 GHz) +2.5 / -6.0 (30 to 50 GHz) +2.5 / -6.0 dB (50 to 100 GHz, Typical)
Calibration Frequencies	100 MHz, 4 GHz
Alarm Threshold	10%, 25%, 35%, or 50% of Standard[c]
Maximum CW Power Density	3000% of Standard
Maximum Peak Power Density	32 dB above Standard
Battery[c]	9 volt alkaline
External Power Requirements[d, e]	12 Vdc ±10%, 50 ma max / 24 Vdc ±10%, 50 ma max
STATUS signal levels	-4 Vdc standby, +4 Vdc alarm (nominal)
Status Relay	SPDT
Recorder Output Level	-1 Vdc full scale (approximate)
Temperature: Operating	-10°C to +55°C
Non-operating	-20°C to +55°C
Size	9.4" L x 8.1" W x 5.0" H 23.9 cm x 20.6 cm x 12.7 cm
Weight (approximate)	26 oz / 0.74 kg
Color	White
Accessories Supplied	Mating 9-pin connector, Battery, Operation Manual

NOTES:

a Use Selection Guide to determine the SMARTS II shaped to your standard or guidance.

b Accuracy specified as the mean of the radial and vertical orientations (10 to 1600 MHz) and mean of the vertical and horizontal orientations (1600 MHz to 50 GHz).

c Determined by DIP switch setting inside battery compartment. There is an additional ±1 dB uncertainty in the alarm threshold when the SMARTS II is set to 10% of Standard.

d A switch inside the battery compartment determines whether the battery or an external supply powers the monitor.

e Voltage choice (12 Vdc or 24 Vdc) determined by wiring of cable that connects to 9-pin connector. The external power supply must be floating (not grounded).

Weatherproof Housing Specifications

PARAMETER	SPECIFICATION
Part Number	11081900
Construction	All plastic
Rating	NEMA class 4X[a]
Size	11.8" L x 11.8" W x 7.2" H 30.0 cm x 30.0 cm x 18.3 cm
Weight (approximate)	45 oz / 1.3 kg
Color	Light Gray
Accessories Supplied	Mating Weatherproof Connector

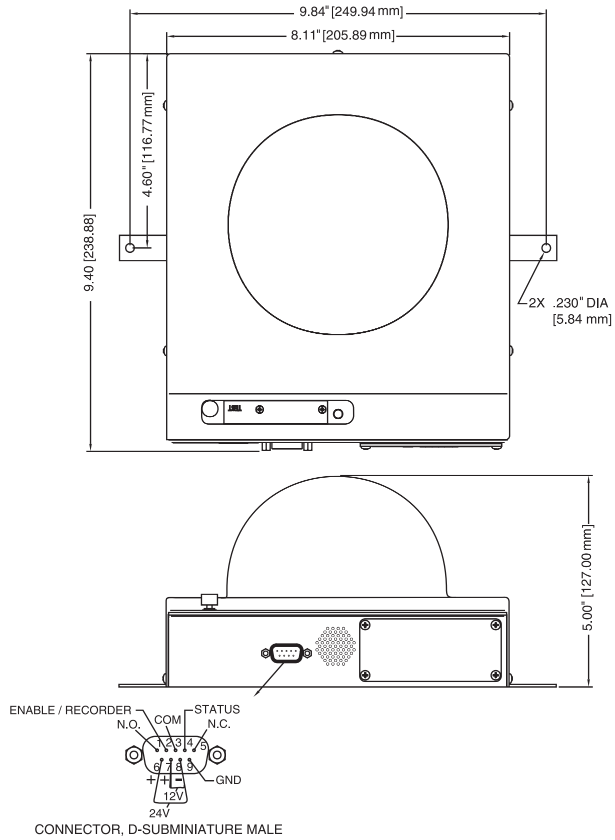
NOTE:

a Equivalent to IEC Publication 529, Type IP 66 or CSA Standard C22.2, No. 94.

Smarts II™ Area Monitors

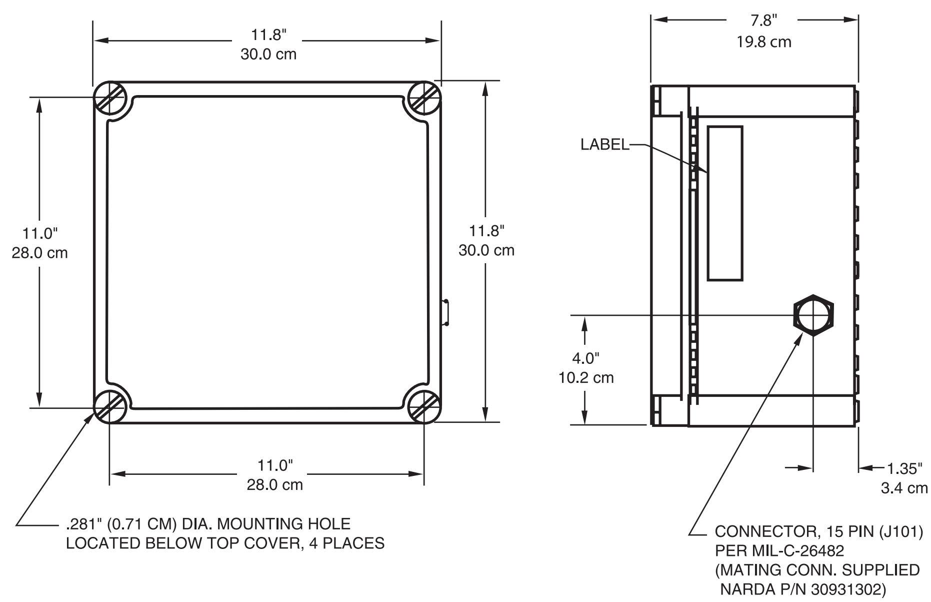
Outline Drawings

SMARTS II™



WEATHERPROOF HOUSING

PIN	DESCRIPTION
B	+24V – FLOATING
A	+12V – FLOATING
K	-V – FLOATING
G	N.C. – RELAY CONTACTS
H	COM – RELAY CONTACTS
J	N.O. – RELAY CONTACTS
P	GND
C	ENABLE / RECORDER
E	STATUS



Model 8217

Microwave Oven Survey Meter

- **Compact and Easy to Use**
- **0.5 to 10.0 mW/cm^2**
- **Includes Thermometer, Beaker and Case**

Description

Narda's Model 8217 is the least expensive, accurate microwave oven survey instrument available. The mid-scale reading (5 mW/cm^2) of the single 0 to 10 mW/cm^2 range corresponds to the allowable limit for ovens used in the United States, Canada, and most of Europe. The 8217 is extremely easy to use. Its detection circuitry uses a patented spiral antenna design. It comes complete with a beaker and thermometer to measure the output power of the oven in addition to its leakage. The meter, beaker, thermometer, and manual store in a rugged, foam-lined carrying case.

Specifications

PARAMETER	SPECIFICATION
Calibration Frequency	2450 MHz
Measurement Range	0.5 to 10.0 mW/cm^2
Accuracy	±1.0 dB
Meter Type Size Scale	 D'Arsonval 1.4" (3.6 cm) 0 to 10 mW/cm^2
Measurement Mode	Instantaneous
Zero Control	Front Panel Knob
Battery Type Life	 Standard 9V 200 hrs (approx.)
Sizes Meter Case	 5.7" x 3.2" x 1.5" (14.5cm x 8.2cm x 3.8cm) 13.5" x 8.0" x 5.5" (34.3cm x 20.3cm 14.0cm)
Weight	0.4 lb. (0.2 kg)
Temperature Operating Non-operating	 0°C to +50°C -40°C to +75°
Humidity	0% to 95%, non-condensing
Accessories Supplied	Battery, Operating Manual, 600 ml Beaker, Thermometer, Carrying Case[a]

[a] The carrying case is foam lined to protect the meter in transit and in storage. The meter, manual, beaker, and thermometer are stored in the case.

Model 8201

Microwave Oven Survey System

- **Two Interchangeable Probes**
- **Readings from 10 µW/cm² to 100 mW/cm²**
- **Accuracy ±0.75 dB**
- **Three Measurement Ranges**
- **Separate Probe and Meter**
- **Portable and Lightweight**

Description

The Model 8201 Survey System is designed to provide maintenance, repair, and safety personnel with a small, completely portable instrument for measuring radiation leakage levels of commercial and industrial microwave ovens. These anisotropic probes measure emissions from a single direction. A spacer cone maintains the 5 cm distance from the leakage point which is the measurement distance standard for consumer ovens. The mid-scale readings for the two probes are 1mW/cm² and 5 mW/cm². In the United States, these values correspond, respectively, to the maximum leakage values for ovens at manufacture and the maximum leakage over the life of the oven. A standard system is comprised of the meter, one probe, a spacer cone, and a carrying case.

Ordering Information

To order an 8201 system:

Order the Model 8211 meter, the Model 8140B spacer cone, and one or two probes (Models 8221 and 8223).

NSN for Model 8201 system with Model 8221 probe: 6625-01-142-5468

Specifications

PARAMETER	SPECIFICATION
Calibration Frequency	2450 MHz
Measurement Ranges	
Model 8221 Probe	10 µW/cm² to 20 mW/cm²
Model 8223 Probe	50 µW/cm² to 100 mW/cm²
Probe Overload	
Model 8221	40 mW/cm²
Model 8223	300 mW/cm²
Accuracy	±0.75 dB
Meter	
Type	D'Arsonval
Size	2.2" (5.6 cm)
Scales	Two linear, marked 0-2 and 0-10
Measurement Mode	Instantaneous
Zero Control	Front Panel Knob
Batteries	
Type	Two 6.0 volt NEDA 1410M
Life	300 Hrs (approx)
Sizes	
Meter	5.7" x 3.2" x 1.5" (14.5 cm x 8.2 cm x 3.8 cm)
Probe	11" long x 3/4" diameter (27.9 cm long x 1.9 cm diameter)
Cable , coiled	6" (15 cm)
Cable, extended	43" (109 cm)
Case	15.3" x 9.4" x 3.0" (38.9 cm x 23.9 cm x 7.6 cm)
Weight, Meter & Probe	1.3 lb (0.6 kg)
Temperature	
Operating	0°C to +50°C
Non-operating	-40°C to +75°C
Humidity	0% to 95%, non-condensing
Accessories Supplied[a]	Batteries, Operating Manual, and Carrying Case[b]

[a] The basic 8201 system is comprised of the Model 8211 meter, one probe (either Model 8221 or Model 8223), the Model 8140B spacer cone and the accessories supplied with the meter.

[b] The carrying case is foam lined to protect the meter and probes in transit and in storage. The meter, manual, spacer cone, and two probes can be stored in the case.

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

Calibration and Maintenance

Customer Service

Xpress Cal

Replacement Parts

Accessories

Upgrade Options

narda Safety Test Solutions

an L3 communications company

Customer Service

- Calibration
- Repairs
- Replacement Parts

Services Provided

While it is neither practical nor possible to service some very old models, Narda continues to calibrate almost all the radiation safety products that it has built since 1980. The most common services provided are calibration, repair, and the supply of spare parts.

The following pages describe capabilities and procedures. The section *How To Obtain Service* is important. Please follow the guidelines in that section – they allow Narda to provide you with the quickest possible service.

Please use the form on page 99 to expedite service.

Capabilities

Narda Safety Test Solutions, Hauppauge, New York

Narda can calibrate any model RF safety product it has ever built. We also provide calibration services for a limited number of competitive models. We can usually repair almost any damaged unit providing that parts are available. Parts availability is rarely an issue for any item that is less than 15 years old (see Repair Categories).

Narda can calibrate probes under CW conditions at the following frequencies:

3 kHz to 1100 MHz (any frequency)

1700 MHz to 40 GHz (any frequency)

At 45.5 GHz

Narda Safety Test Solutions
435 Moreland Road
Hauppauge, NY 11788
Attention: Customer Service

Tel. 631-231-1700
Fax. 631-231-1711

Narda Safety Test Solutions, Pfullingen, Germany

Narda Safety Test Solutions
Sandwiesenstr 7
D-72793 Pfullingen
Germany
Tel. 49-7121-9732-777
Fax. 49-7121-9732-790
support@narda-sts.de

UK Service Center

Narda's UK Service Center is located at Link Microtek in the UK. The calibration and repair of Narda's RF safety products is co-ordinated from this Service Center. The Center has the ability to calibrate most of the 8700 series and some 8600 series probes, any meter model and all Nardalert personal monitors.

Calibration and repair of other special probe models and special instruments (such as the induced body current devices) can be coordinated by the service center.

Narda Service Center
Link Microtek
Intec 4.1, Wade Road
Basingstoke, Hants R624 8NE
Hampshire, UK

Tel. 44 1256 355771
Fax. 44 1256 355118
sales@linkmicrotek.com

How To Obtain Service

The most important thing you can do to receive the best calibration and repair service in the quickest time, is to use the following procedure:

1. **Contact the appropriate service facility**
   Customers located in the United States and all international customers, other than those located in Europe, should contact Narda in New York. Customers located within the European community should contact our service facilities in England and Germany.
2. **Obtain RMA (Return Material Authorization) Number** You will be asked to provide a list of the equipment. Model numbers, serial numbers, and a description of the services required will be needed. For example, if you anticipate requiring only calibration, state that. If there indications that the equipment requires repairs, please describe the symptoms.
3. **Pack the equipment well.** Meters and probes should be shipped in the original instrument case whenever possible. The instrument should then be packed inside a cardboard box. Probes, in particular, should be packed very carefully if they are not being shipped in an instrument case.
4. **Authorize the calibration and/or repair charges in advance.** Narda has established fixed prices for 99% of calibration and repair work. This allows us to process your order immediately. Ideally, authorizations are not to exceed (NTE) value equal to a minor repair charge. See *CALIBRATION PROCEDURES* and *REPAIR CATEGORIES.*
5. **Specify the type of calibration service required.**

Most customers request our standard service. ANSI Z540 service (see below) is available at an additional charge. *Priority Calibration* service provides five business-day calibration (not repairs) at an additional charge.

Equipment that is received via an RMA number and with the charges authorized will be worked on immediately. Simply returning equipment without contacting us (i.e., without both an RMA number and authorization to perform the work) will result in delays.

Calibration Procedures

Most Narda survey instruments are designed so that the meter and probes are calibrated independently of each other. The 8100, 8200, 8600, and 8700 series equipment can have probes and meters interchanged within the same series without in any way affecting calibration. The 8500 series alone is supplied as a single probe and meter that are calibrated as a set. Personal monitors and area monitors are calibrated as separate units.

Meters (except the 8500 series) are calibrated by using a precise DC voltage that relates to the full scale measurement range of the probes in that series.

Probes are calibrated by placing them in precise RF fields using either TEM cells, waveguide fixtures, or free field environments. The RF field strength is normally established to be equal to 5.0% of the full scale rating of the probe. For example, to calibrate a model 8721 electric field probe, which is rated at 20 mW/cm^2 , an electric field equal to 1.0 mW/cm^2 is established at each calibration frequency. If the probe were perfectly flat, it would then produce an output that reads 1.0 mW/cm^2 at every frequency. In practice, the probes are not perfect and some error is expected. If the probe indicates 1.1 mW/cm^2, a calibration factor of 0.91 would be marked on the handle. Multiplying the calibration factor times the indicated rating provides the true value (0.91 x 1.1 +0.999). The actual procedure is to calibrate at every frequency and then to set the gain of the amplifier to center the frequency response for "best fit".

Probes that are obviously damaged will not zero properly. Occasionally, a probe will appear to function properly but cannot be calibrated successfully. This can occur when some form of internal damage or malfunction in the RF sensor results in certain frequencies not being measured accurately. This problem necessitates some type of repair of the sensor. It is for this reason that, occasionally, a probe that appears to require calibration only, will require minor repairs (see *REPAIR CATEGORIES*).

Personal monitors and area monitors are calibrated in a similar manner to probes. Since there is no readout, they are normally calibrated at a limited number of frequencies (sometimes only one).

ANSI Z540 Calibration

Narda's standard calibration procedures are similar to the procedures used for new equipment. The product is adjusted as required so that it is well within specification. ANSI Z540-1-1994 (similar to the now obsolete MIL-STD-45662A) requires that the equipment to be calibrated must first be measured to determine how it is reading *before* adjustment. These values are then compared to the values that the particular meter or probe was originally set to. Customers are advised in writing if a unit has changed by more than ±1.5 dB since it was last calibrated. The equipment is then calibrated in the normal manor. Equipment calibrated under these procedures receive special calibration labels and certificates. This is obviously a more involved procedure than a standard calibration and the costs are higher.

Repair Categories

Narda uses several terms to define repair categories. They are:

- **Standard or NIST Calibration:** This is Narda's standard calibration service that is traceable to the U.S. National Institute of Standards and Technology.[1]
- **ANSI or MIL Calibration:** See *ANSI Z540 CALIBRATION* above.
- **Minor Repair:** This category of repairs covers the majority of typical repairs for most models of equipment. Meters alone have separate pricing for common repair items such as replacing meter movements and rechargeable batteries. Virtually all other items to be repaired are classified as minor or major repairs. There is a fixed price for the minor and major repair of each model. Minor Repairs typically cost 25-40% more than a standard calibration.
- **Major Repair:** Although a probe may look like it is beyond repair, it may still be salvageable and would fall under the Major Repair category. Otherwise, it will be classified Beyond Economic Repair (BER). Major Repairs typically cost 40-50% of the price of a new unit.
- **Beyond Economical Repair (BER):** Narda classifies a piece of equipment as BER if either (1) the cost of repair and calibration will be more than 50% of the cost of a new unit or (2) it is a very old unit and parts may be unavailable or impractical to obtain.
- **Return As Is (RAI):** Narda occasionally will return a piece of equipment without calibrating or repairing it at the discretion of the customer or if it is classified as BER. *An evaluation fee is charged for equipment Returned As Is.*
- **Evaluation Fee:** Narda charges a modest fee for each item that is evaluated and returned without performing a repair or calibration.

[1] Microwave oven instruments are calibrated based on comparisons with FDA

Narda XPRESS CAL™

♦ **GUARANTEED 10-DAY TURNAROUND*
for all catalog model RF safety products**

HERE'S HOW IT WORKS:

1. Contact us to get an RMA number –
   so we know your unit is coming
2. Mark your package and shipping papers with your RMA number –
   so we can identify it when it gets here
3. Give us pre-approval for calibration with your P.O. or credit card –
   so we're not calling you for paperwork
4. Specify the type of calibration required –
   Standard Commercial or MIL-type?

How Often Should You Calibrate Your Probes, Meters, and Monitors?

The only measurement worth having is an accurate one. For such precision, we recommend annual calibrations for most probes and meters.

* XPRESS CAL™ service available from Narda New York only.

* In the interest of the environment, Narda works a 9/80 schedule (80 hours in 9 days with every other Monday off). Narda is also closed Christmas week and traditional national holidays.

Rechargeable Battery Management Program

Certain models of Narda RF Safety Equipment contain a rechargeable nickel-cadmium battery which must be recycled or disposed of in compliance with applicable federal, state, or local environmental regulations.

In keeping with our highly proactive policy on environmental protection and conservation of natural resources, Narda maintains a rechargeable battery management program which we offer as a service to our customers. At the end of this product's effective life cycle, it may be returned to us for proper disposal.

For information, please call Narda's Environmental Health and Safety Department at (631) 231-1700.

Request for Calibration or Repair RF Safety Products

Instructions:

1. Use this form to obtain an RMA Number
2. Pack a copy of the form (with RMA Number) with the product

RMA No:

Narda Safety Test Solutions
435 Moreland Road
Hauppauge, NY 11788
Attention: Customer Service
Tel. 631-231-1700
Fax. 631-231-1711

Narda Safety Test Solutions
Sandwiesenstr 7
D-72793 Pfullingen
Germany
Tel. 49-7121-9732-777
Fax. 49-7121-9732-790
support@narda-sts.de

Narda Service Center
Link Microtek
Intec 4.1, Wade Road
Basingstoke, Hants R624 8NE
Hampshire, UK
Tel. 44 1256 355771
Fax. 44 1256 355118
sales@linkmicrotek.com

From

Organization: ______________________________

Address: ______________________________

____

____

Name: ____________________ Tech. Contact: ____________________

Title: ____________________ Tel: ____________________

Tel: __________ Fax: __________ Email: ____________________

Reason For Request:

Calibration Only ❑ Standard ❑ ANSI Z540

Repair and Calibration ❑ Standard ❑ ANSI Z540

Special Calibration Frequencies: ______________________________

If for Repair, Describe Trouble: ______________________________

____

____

Is Trouble Localized? ❑ Yes ❑ No

If so, How and Where? ______________________________

____

____

Is Trouble Intermittent? ❑ Yes ❑ No

Was Factory Consulted Earlier: ❑ Yes ❑ No If YES, Person Contacted __________

Model Number(s)	Serial Number(s)	Calibration Date

Replacement Parts

- Batteries
- Instrument Cases

Batteries for Narda Meters, SMARTS™, Nardalert™

Instrument Model Number	Description	Part/Model Numbers Narda	NEDA	IEC
SMARTS™ Circuit Fail-Safe	9.0 V Lithium[a] 3.0 V Lithium	88020000 88025000	1604LC —	— Note b
Nardalert™ Circuit LED[d]	12.0 V Alkaline 1.5 V Alkaline	88021000 88022000	1811A 135SO	Note c SR41
8699	6.0 V Carbon	88016000	908AC	—
8217, 8512, 8520, 8711	9.0 V Alkaline	88017000	1604A	6LR61
8616	+12.5 V, -12.5 V NiCad[g]	88011000	—	—
8716[d], 8719[d], 8850, 8870	8.4 V NiCad[g]	88018000	—	—
8718, 8718B	8.4 V NiCad[g]	21760000	—	—
8745, 8746, 8747, 8748	15.0 V NiCad[g]	88024000	—	Note e
8211[d,f], 8611[d,f]	6.0 V Alkaline	88012000	1410M	4MR52
8110B	+15 V, -15 V NiCad[g]	88010000	—	—

NOTES:
- a 9.0V Alkaline can be substituted but must be replaced more often.
- b Renata 320A
- c Duracell MN21, Eveready A23, Ronson VR22, and GP23A
- d Requires two batteries
- e Motorola NLN-4462B
- f Duracell PC164A
- g Dispose of properly. See page 98 for details of Narda's Rechargeable Battery Management Program.

Instrument Cases

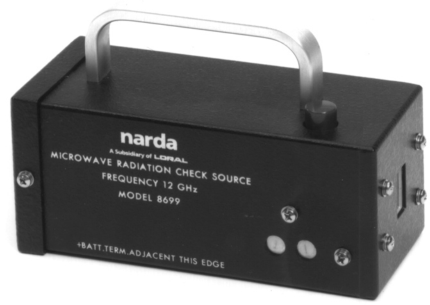
Meter Model	Narda Part Number
8718, 8718B	32542703
8712, 8715	32542709
8511, 8513	32542708
8716, 8719, 8616, 8711	32542704
8512, 8520	32542702
8850, 8850B	32542701
8870	32542700
8110B	32542705

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

Model 8699

Check Source

- **Portable, Lightweight**
- **Common Replacement Batteries**
- **12 GHz Output Checks Electric Field Probes, Microwave Band SMARTS and SMARTS II™**



Description

The Model 8699 Check Source provides a convenient, portable means to verify operation of NBM Series microwave electric field probes. The check source can also be used to verify the operation of the models 8820, 8820-DC, 8820-WP* and 8825 SMARTS™ area monitors.

*Weatherproof cover must be removed.

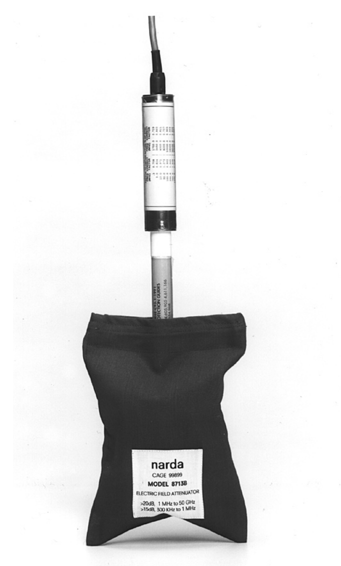
Specifications

Model	8699
Frequency (approx.)	12 GHz
Power Output (approx.)	Equivalent of 1 mW/cm^2 field at surface
Battery	6.0 V Carbon
Size (approx. w/o handle)	3.0" x 3.0" x 6.7" (7.8 cm. x 7.8 cm. x 17.0 cm.)
Weight	36 oz. (1 kg.)

Model 8713B

Electric Field Attenuator

- **Provides "Zero" Density for Electric Field Probes**
- **Portable and Lightweight**



Description

The Model 8713B Electric Field Attenuator provides a convenient and rapid way to create a "zero" density field for Narda electric-field probes. Electric fields are attenuated by at least 25 dB and the non-conductive fabric does not interfere with the probe test points. Operation is as simple as slipping the Model 8713B over the probe head and performing the zeroing procedure. Measurements in a low level RF/microwave environment can be quickly confirmed by covering and uncovering the probe. Hook and loop fasteners close the opening around the neck of the probe. The fabric-based construction makes the Model 8713B easy to carry and store. The durable fabric is both washable and rugged.

Insulated Handle / Tripod

- **Mounts directly to Models 8712, 8511 and 8513**
- **Mounts to Model 8718B when used with Adapter**
- **Improves isolation between the operator and the meter when making low frequency (<10 MHz) measurements**
- **Can be used as a benchtop tripod**

Description

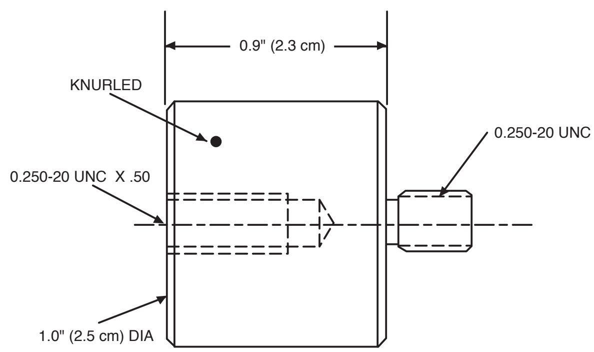
This insulated handle/tripod, P/N 21797900, significantly improves measurement accuracy when making measurements at lower frequencies. Problems with reflections off the body that begin to appear at about 300 MHz increase as you move into lower frequencies and are especially a problem below 10 MHz (see page 124). The basic insulated handle, which can also function as a short tripod, isolates the human body from the meter.

Tripod Adapter

for Model 8718B

Description

The adapter, P/N 32595900, is used to extend the mounting hole of the Model 8718B below the bottom of the meter. This stainless steel part is used with the insulated handle P/N 21797900 and large tripods



Adaptor, P/N 32595900

RF Radiation Safety Signs

- **UV-Resistant for Outdoor Use**
- **Comply with Major Standards for RF Radiation Safety Signs**

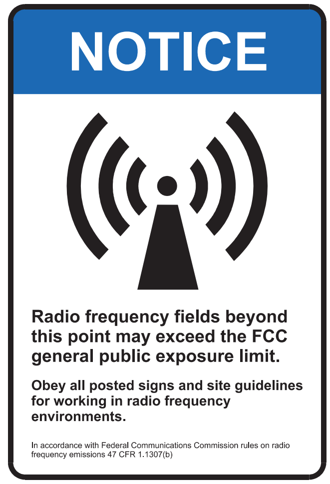
RF radiation safety signs should be a key component of any RF safety program. They are designed to assist the safety professional in restricting access to those areas where moderate to high level RF fields are present.

Narda offers four RF radiation signs. Signs A, B, and C conform to ANSI guidelines for antenna sites subject to the United States Federal Communications Commission (FCC) RF safety Regulations. Three signs – NOTICE, CAUTION and WARNING – are designed for use in different areas. These three terms, NOTICE, CAUTION and WARNING follow ANSI standards and have a progressively stronger meaning. Signs A, B and C are all painted aluminum with a UV resistant coating.

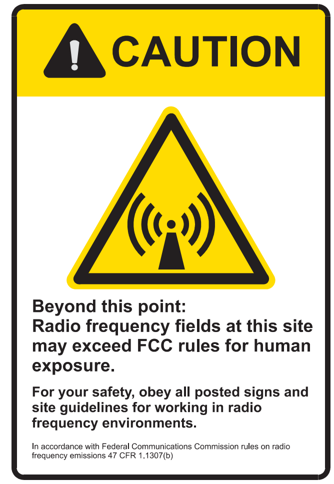
Sign D is a more general-purpose sign that uses the most common RF radiation symbol. This sign is constructed of non-conductive fiberglass and has a UV-resistant coating. It is available in two sizes.

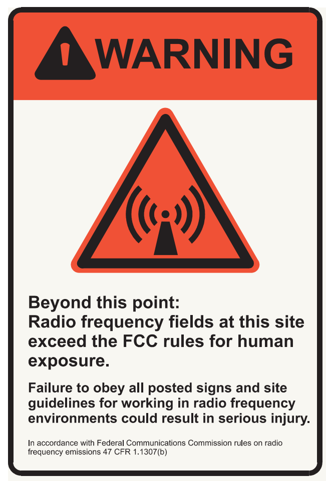
All signs have four mounting holes in the corners.

Sign A



Sign B





Sign C

Sign D

PART NUMBER	STYLE	SIZE	CONSTRUCTION	COLORS (ALL HAVE WHITE BACKGROUNDS)
42942900	A	12″ x 18″ (31 cm x 46 cm)	Painted Aluminum	Black Marking, Blue Band
42942901	B	12″ x 18″ (31 cm x 46 cm)	Painted Aluminum	Black Marking, Yellow Band & Triangle
42942902	C	12″ x 18″ (31 cm x 46 cm)	Painted Aluminum	Black Marking, Red Band & Triangle
21726400	D	7″ x 10″ (18 cm x 25 cm)	Fiberglass with UV-Resistant Coating	Black Marking, Yellow Triangle
21726401	D	10″ x 14″ (25 cm x 36 cm)	Fiberglass with UV-Resistant Coating	Black Marking, Yellow Triangle

Upgrade Options

- **8718 → 8718B Firmware**
- **8712 → 8715**
- **8700 Probes → 8700D Series Connector**
- **8745/8746 Fiber Optic Link → 8747/8748 Fiber Optic Link**

Narda now offers several cost-effective upgrade options for owners of older Model 8700 Series products.

8718 Meter Upgrade

Your Model 8718 can be upgraded to operate with most of the new features of the Model 8718B. The 8718 Meter Upgrade will:

- Upgrade main circuit board to 8718B configuration
- Install Version 3.0 Firmware
- Supply Version 3.0 Interface Software
- Supply 8718B *Users' Guide*
- Test and calibrate meter

How will your upgraded 8718 differ from a new model 8718B?

- It will still have the same screw-on type "A" probe connector
- It will continue to use the same charger
- The marking will not change other than the firmware version that shows on the display during boot-up

8712 Meter Upgrade

Your Model 8712 Meter can be upgraded to the mid-level Model 8715 meter configuration. The two major upgrade features of the 8715 are spatial averaging and six-minute time averaging.

The 8712 Meter Upgrade will:

- Upgrade 8712 meter hardware and firmware to 8715 configuration
- Supply 8715 *Operations Manual*
- Test and calibrate meter

The upgraded meter will be identical to a new Model 8715. The only items not included are:

- The Model 8713B Electric Field Attenuator and the Insulated Handle/Tripod, included with a new 8715, will not be supplied. They may be purchased separately as accessories.
- The yellow instrument case will not be altered or replaced.

Probe Upgrade

Older-style 8700 Series Probes featured the screw-on type "A" connector, and usually included a cable. These probes can be upgraded to a configuration that features the same quick-release, type "L" connector as the 8700D Series Probes. Probes upgraded in this way are referred to as 8700N-style probes. This upgrade is most cost-effective when performed while the probe is at Narda for routine calibration.

The N-type Probe Upgrade includes:

- Change to quick-release connector style connector configuration
- Calibration of probe

Not included in the price of the probe upgrade are:

- Any repairs not associated with the connector or probe cable
- The 8743 or 8744 style probe extension cable that is required to connect an "N" style probe to any of the 8700 series meters.

Fiber Optic Link Upgrade

Older style fiber optic transmitter Models 8745T and 8746T feature the same "Type A" screw-on connector as the older style 8700 Series Probes. The current fiber optic transmitter models 8747 and 8748 feature the quick-release "Type L" connector. The 8700D Series Probes and older probes upgraded to this connector (referred to as 8700N Series, see above) plug directly into the new fiber optic transmitters. This connector provides both electrical connection and mechanical support.

The fiber optic transmitter upgrade includes:

- Change to quick-release, connector-style connector and new label
- Calibration of fiber optic transmitter

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

TECHNOLOGY

Technology and Products

Definitions and Glossary

Application Notes

narda Safety Test Solutions
an L3 communications company

Narda's Unique Technology and Patented Designs Insure Accuracy

Narda holds nearly forty patents in non-ionizing radiation safety equipment, which represents more than 95% of the world's total. The preferred choice of knowledgeable individuals, Narda equipment is relied on for accurate mesurements in any signal environment.

Narda is continuously creating and refining instruments to gather the significant data essential for environmental and occupational safety. **Accuracy under all conditions is our goal.**

Significant Narda Patents for Electric and Magnetic Field Survey Instruments

- Shaped frequency response probes (two patents). Sensitivity varies over the frequency band at the point of detection which allows output to be quantified in Percent of Standard.
- Thermocouple detectors that function as both detector and dipole at the same time.
- Thermocouple detectors that function as dipoles at lower frequencies and operate in the traveling wave mode at higher frequencies. Models EF 5091 and EF 5092 probes have correction factors of <10% at 94 GHz.

Significant Narda Patents for Personal and Area Monitors

- Microwave frequency area monitor that accurately detects electric fields even when mounted on conductive, metallic surfaces.
- Personal monitor for microwave frequencies that can be worn on the body and accurately detects the electric field.
- Shaped response communication frequencies, magnetic field personal monitor design.
- Flat response communication frequencies, magnetic field personal monitor design.
- Displacement current sensor design for accurate measurement of electric field on the body at lower frequencies.

Significant Narda Patents for Induced and Contact Current Measurement Instruments

- Induced Current Monitor/Workmat.
- Contact Current Meter
- Human Equivalent Antenna for induced current measurements.ield.

narda Safety Test Solutions an L3 communications company **USA • Germany • Italy**
USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www**.narda-sts.us

What equipment do you need?

Getting the Right Equipment

Several factors should be considered before you decide what type of equipment you need. Start by answering the question "Do I want to make a measurement or do I simply want to detect potentially hazardous levels?" In many cases you may decide to do both.

SURVEY EQUIPMENT

- provides accurate measurements and can be used to determine the level of compliance to a particular standard
- requires a reasonable level of training before it can be used with confidence
- does not provide continuous monitoring against sudden equipment failure

In contrast . . .
MONITORING EQUIPMENT

- is not designed for – nor should it be used to make – measurements
- requires only very limited training of personnel
- provides continuous monitoring in an area or for an individual

Frequency

Determine the operating frequency or frequencies of all the emitters, or sources, that may be present where you are going to make measurements or monitor. Don't forget to include any sources that belong to another organization – they may be contributing some energy to the environment that you will be in. If any of the frequencies are below 30 MHz, you will probably have to measure both the electric (E) field and the magnetic (H) field. The survey system or monitor should be capable of accurately detecting all the relevent frequencies.

NARROWBAND vs BROADBAND

For use between 100 kHz and 3 GHz, Narda offers narrowband or broadband survey systems. Generally narrowband equipment is more useful in unknown, outdoor environments - like rooftops. Broadband equipment is easier to employ indoors or when you know the frequency of the systems that you're planning to survey. Narrowband also has much higher sensitivity to measure levels that are well below human safety limits but could still interfere with sensitive communication systems.

Microwave Ovens versus All Other Sources

(Directional versus Omnidirectional Measurement)

All major standards around the world are ***human exposure*** standards. Therefore, you need to monitor or measure the energy from all directions and polarizations. The ***isotropic*** probes used in Narda survey systems have sets of three internal sensors so that they pick up from all directions. Most oven monitoring probes contain two sensors so that they are sensitive to the energy polarized in a plane. These directional, or ***anisotropic***, probes meet the needs of the ***leakage*** regulations for microwave ovens but do not satisfy any other standards. Occasionally, microwave oven type instruments are used to locate leaks in industrial equipment that operate at the same 2450 MHz frequency as microwave ovens (915 MHz for very old ovens). These simple, inexpensive units can be used to find leaks but should not be used to quantify the amount of human exposure.

Determine the Type of Detection Required

Start by reviewing the discussion of sensor types that begins on page 16 of this catalog. In summary:

- Radar systems should only be measured with thermocouple sensors or detectors.
- Multi-signal environments require RMS detection – either thermocouple or compensated diode detectors. Refer to the application note that begins on page 139.
- AM modulated signals require RMS detection – either thermocouple or compensated diode detectors.
- Complex, multi-signal environments, where the operating frequencies have different exposure limits, are most easily measured with Narda's patented, shaped frequency response probes. Refer to the application note that begins on page 139.
- Microwave ovens should be measured with anisotropic, or directional, sensors or probes.

Narrowband vs Broadband Measurements

Narda offers both narrowband (SRM) and broadband (NBM) survey systems. Generally, broadband survey equipment is a good choice for indoor measurements where you know frequencies being emitted, while the SRM-3000 is a more powerful solution for outdoor measurements at rooftop and tower sites where unknown emitters may be present. Another consideration is what type of levels are expected. Broadband survey equipment measures down to ~ 1 V/m, while the narrowband SRM can measure down to 25 mV/m. The SRM-3000 can also decode UMTS signals for wireless company applications, and it's present maximum frequency is 3 GHz. Users looking to measure Radar and higher frequency satellite uplinks will be better served by the NBM's top frequency of 50 or 60 GHz

Electric Field versus Magnetic Field Measurement

In the "far field" the electric and magnetic fields are at right angles to each other and to the direction of propagation and their magnitudes have a specific relationship. Therefore, measuring either field under these conditions is all that is required. Since the boundaries of the far field are largely related to the number of wavelengths, which decreases as the frequency increases, microwave frequency measurements are invariably far field measurements. The major standards usually use 300 MHz as the upper limit for measurement of both fields. Although you could measure either the electric or magnetic field component under far field conditions and yield the same result, higher frequency probes are almost always designed to measure the electric field because of design considerations.

Units of Measure

The power density units of mW/cm^2 and W/m^2 are really only applicable in the far field. No commercial instrument actually measures power density – they measure the square of either field. However, plane wave equivalent power density units are often convenient even in the near field because using a common unit makes it easy to see which field contains the most energy. The **Unit Conversion Tables and Formulas** section that begins on page 154 contains the information that you need to make conversions. Narda's latest microprocessor-based instruments allow you to make readings in any appropriate unit of measure with the same probe without needing to make any calculations.

Low Frequency Measurements

Low frequency electric field measurements (particularly below 30 MHz) are well served by our new NBM series. Both electric and magnetic field probes are directly connected to the meter and can be remotely read out on a computer via optional fiber optic cables. Or users can connect the probes directly to the NBM-520 and use fiber optic isolation between the NBM-520 and the NBM-550, which allows remote readings without a computer. Both approaches produce repeatable readings devoid of human body perturbance or exposure.

For Detailed information, Refer to:

Definitions and Glossary of Terms

action level The values of the electric and magnetic field strength, the incident power density, contact and induced current, and contact voltages above which steps should be initiated to protect against exposures that exceed the upper tier, specifically, implementation of an RF safety program.

amplitude The maximum value of the electric field, E_o, or of the magnetic field, H_o. For waves travelling in free space, E and H are mutually orthogonal and are in phase, i.e., maxima and minima occur at the same point in time and space. The units of E are volts/meter and for H, amperes/meter.

antenna A means of radiating or receiving Radio Frequency Radiation (RFR).

antenna gain The ratio of the power gain of an antenna referred to a standard antenna, which is usually an isotropic emitter of RF energy. Gain is a measure of the directionality of an antenna. It may be expressed in decibels or as a pure number.

average power The transmitter power available averaged over a modulation cycle – the power actually available to do work. In a pulsed system, average power is the peak power multiplied by the duty factor. In CW systems, average power is the rated power output, corrected for any transmission line losses.

average (temporal) power (P_{avg}) The time-averaged rate of energy transfer.

averaging time (T_{avg}) The appropriate time period over which exposure is averaged for purposes of determining compliance with a Maximum Permissable Exposure (MPE). For exposure durations less than the averaging time, the MPE′, in any time interval equal to the averaging time is found from where T_{exp} is the exposure duration in that interval expressed in the same units as T_{avg} (seconds or minutes).

$$MPE' = MPE \left[\frac{T_{avg}}{T_{exp}}\right]$$

basic restrictions Exposure restrictions that are based on established adverse health effects that incorporate appropriate safety factors and are expressed in terms of the in situ electric field (3 kHz to 5 MHz), specific absorption rate (100 kHz to 3 GHz), or the incident power density (3 GHz to 300 GHz).

beam width In a plane containing the main beam of the antenna, the beam width is the angle between the two directions in that plane in which the radiation intensity is some fraction (usually one half or 3dB) of the maximum value of the main beam intensity.

biological effect A biological effect is an established effect caused by, or in response to, exposure to a biological, chemical or physical agent, including electromagnetic energy. Biological effects are alterations of the structure, metabolism, or functions of a whole organism, its organs, tissues and cells. Biological effects can occur without harming health and can be beneficial. Biological effects also can include sensation phenomena and adaptive responses.

continuous exposure Exposure for durations exceeding the corresponding averaging time. Exposure for less than the averaging time is called short-term exposure.

controlled environment An area where the occupancy and activity of those within is subject to control and accountability as established by an RF safety program for the purpose of protection from RF exposure hazards.

CW system A system designed to produce its output in continuously successive oscillations (continuous waves). Rated output is normally average power.

decibel (dB) The unit to express a numerical ratio. For power considerations the decibel is equal to 10 times the logarithm of a power ratio expressed by the following:

$$dB = 10 \log_{10} (P_1)/(P_2)$$

where P_1 and P_2 are two amounts of power. Power ratios in decibels can be added or subtracted like ordinary numbers.

duty factor The ratio of pulse duration to the pulse period of a periodic pulse train. A duty factor of 1.0 corresponds to continuous-wave (CW) operation. In pulsed systems, the ratio of the pulse width to the pulse period of a periodic pulse train. Mathematically, the duty factor is the product of the pulse width multiplied by the pulse repetition frequency (PW x PRF = DF).

electric field strength (E) A field vector quantity that represents the force (F) on a positive test charge (q) at a point divided by the charge.

$$E = \frac{F}{q}$$

Electric field strength is expressed in units of volts per meter (V/m).

ellipse ratio The variation in response when a field sensing probe is rotated about the axis of its handle, or when a wearable monitor is placed vertically or horizontally in a constantly polarized field. Usually specified in dB.

energy density (electromagnetic field) The electromagnetic energy contained in an infinitesimal volume divided by that volume.

exposure Exposure occurs whenever and wherever a person is subjected to electric, magnetic, or electromagnetic fields or to contact currents other than those originating from physiological processes in the body and other natural phenomena.

exposure, partial-body Partial-body exposure results when RF fields are substantially nonuniform over the body. Fields that are nonuniform over volumes comparable to the human body may occur due to highly directional sources, standing waves, re-radiating sources or in the near field (see *RF "hot spot"*).

far-field region That region of the field of an antenna where the angular field distribution is essentially independent of the distance from the antenna. In this region – also called the free space region – the field has a predominantly plane-wave character, i.e., locally uniform distributions of electric field strength and magnetic field strength in planes transverse to the direction of propagation (see *Fraunhofer region*).

field A mathematical specification, in terms of position variables and time, of a physical quantity such as the electric charge density for a *scalar* field and the electric field for a *vector* field. An electrostatic field is produced by stationary charges (such as a common magnet) and an electromagnetic field by moving charges.

Fraunhofer region The electric and magnetic fields are perpendicular to each other, thus making it possible to make measurements of one field and calculate the other (see *far field region*).

frequency (f) The number of wave cycles per second passing a fixed point along the direction of propagation. One cycle is represented as the period in which the magnitude of the electric field vector varies from zero, through its maximum value, back through zero to its minimum value, and finally back to zero. The unit of frequency is Hertz, or 1 cycle per second.

Hertz (Hz) The unit for expressing frequency, (f). One hertz equals one cycle per second.

intermediate field region That portion of the Fresnel region of an antenna where the power density is decreasing at a near linear rate (1/r) with range. Not usually used in safety calculations.

isotropic antenna A hypothetical antenna radiating or receiving equally in all (4π) directions. In the case of electromagnetic waves, isotropic antennas do not exist physically but represent convenient reference antennas for expressing directional properties of actual antennas. An isotropic antenna would have a gain of 1.

magnetic field strength (H) A field vector that is equal to the magnetic flux density divided by the permeability of the medium. Magnetic field strength is expressed in units of amperes per meter (A/m).

magnetic flux density (B) A field vector quantity that results in a force (F) that acts on a moving charge or charges. The vector product of the velocity (*v*) at which an infinitesimal unit test charge, *q*, is moving with β, is the force that acts on the test charge divided by *q*.

$$\frac{F}{q} = (v \times \beta)$$

Magnetic flux density is expressed in units of tesla (T). One T is equal to 10^4 gauss (G).

maximum permissible exposure (MPE) Derived limits in RF exposure standards for time averaged and peak exposures to ambient electric (E) and magnetic (H) fields, e.g., the root-mean-square (rms) or peak electric and magnetic field strengths, their squares, or the plane-wave equivalent power densities associated with these fields, and the induced and contact currents and contact voltages to which a person may be exposed without harmful effect due to the effects identified in the standard, and with an acceptable safety factor for protection from such effects as described in the standard.

mixed frequency fields The superposition of two or more electromagnetic fields of differing frequency.

near-field region A region generally close to an antenna or other radiating structure, in which the electric and magnetic fields do not have a substantially plane-wave character, but vary considerably from point to point. The near-field region is further subdivided into the *reactive near-field region,* which is closest to the radiating structure and contains most or nearly all of the stored energy, and the *radiating near-field region* where the radiation field dominates the reactive field, but lacks substantial plane-wave character and is complicated in structure.

near-field region, radiating That region of the field of an antenna where the power density is not inversely proportional to the distance from the source. It is sometimes called the Fresnel region. In this region the power density increases irregularly with range to a maximum level, then decreases at a near linear rate to the onset of the far-field region. It is convenient and adequate from a personnel-hazard viewpoint to consider the power density in the radiating near field to be constant with range and equal to four times the average power density calculated at the antenna aperture itself. Such a power density profile has proven accurate when compared to measured results.

near-field region, reactive That region of the field immediately surrounding the antenna where the reactive energy of the electromagnetic field is recovered and re-emitted during sucessive oscillations. True reactive near field conditions exist only to a distance of less than one-half wavelength of the emitted radiation from the radiator.

non-ionizing radiation Any electromagnetic radiation incapable of producing ions directly or indirectly.

penetration depth For a plane electromagnetic wave incident on the boundary of a medium, the distance from the boundary into the medium along the direction of propagation in the medium, at which the field strengths of the wave have been reduced to 1/e (36.8%) of the boundary values.

permeability (μ) The ratio of the magnetic flux density produced in a material to the magnetic field strength which produced it. The units of μ are the Henry/meter; 1 H = 1 volt/(amp-sec). The permeability of free space μ_o has a value of 1.257×10^{-6} H/m.

permissible exposure level (PEL) See maximum permissible exposure (MPE).

permittivity (ε) The ratio of the electric flux density in a medium to the electric field strength producing it. The units of ε are the farad/meter = coulomb/ (volt-meter) = $C^2/nt\text{-}m^2$. The permittivity of free space ε_o has a value of 8.855×10^{-12}F/m. The dielectric constant, K (sometimes also given as E_r), is the relative permittivity of a particular medium as compared to free space, $= \varepsilon/\varepsilon_o$.

polarization Polarization of an electromagnetic wave is characterized by the oscillatory behavior and orientation of the electric field vector. A wave referred to as being linearly polarized means that the electric field vector varies in amplitude in only one direction as it travels. It is conventional to describe polarization in terms of the electric field only, not the magnetic field. An electromagnetic wave may exhibit linear, circular, elliptical, or random polarization (such as in a light bulb). A receiver of electromagnetic radiation must have the same sense of polarization as the incoming wave for it to be detected most efficiently.

Poynting's vector (P) For an electromagnetic wave the power density at any point may be calculated from the vector product of the electric and magnetic field strength vectors, i.e., E x H = P. P is called Poynting's Vector and represents the power density and the direction of energy propagation. Note that if E has dimensions of V/m and H is in units of A/m, the dimensions of P are W/m^2.

power density, average (temporal) The instantaneous power density integrated over a source repetition period.

power density (S) or electromagnetic power flux density Power per unit area normal to the direction of propagation. This is usually expressed in units of watts per square meter (W/m^2), milliwatts per square centimeter (mW/cm^2), or microwatts per square centimeter ($\mu W/cm^2$). For plane wave power density, electric field strength (E) and magnetic field strength (H) are related by the impedance of free space, i.e., 377 ohms. In particular,

$$S = \frac{E^2}{377} = 377H^2$$

where E and H are expressed in units of V/m and A/m, respectively, and S in units of W/m^2. Although many survey instruments indicate power density units, the actual quantities measured are E or E^2 or H or H^2.

power density, peak The maximum instantaneous power density occurring when power is transmitted.

power density, plane-wave equivalent A commonly-used term associated with any electromagnetic wave, equal in magnitude to the power density of a plane wave having the same electric (E) or magnetic (H) field strength.

pulse-modulated field An electromagnetic field produced by the amplitude modulation of a continuous wave carrier by one or more pulses.

pulse-repetition frequency (PRF) In pulsed systems, the number of output pulses per unit time, usually expressed in Hertz (sec^{-1}).

pulse width In pulsed systems, the amount of time that each output pulse or burst of energy is on. In radar systems, pulse width is measured in microseconds (10^{-6} sec).

pulse systems A system designed to produce its energy in short pulses or bursts, repeated at regular intervals (see pulse width, duty factor, and pulse repetition frequency). Applications include most radars and are distinct from CW systems.

radiation The emission or transfer of energy in the form of electromagnetic waves.

radio frequency (RF) Although the RF spectrum is formally defined in terms of frequency as extending from 0 to 3000 GHz, for purposes of this document, the frequency range of interest is 3 kHz to 300 GHz.

re-radiated field An electromagnetic field resulting from currents induced in a secondary, predominantly conducting object by electromagnetic waves incident on that object from one or more primary radiating structures or antennas. Re-radiated fields are sometimes called "reflected" or, more correctly, "scattered fields." The scattering object is sometimes called a "re-radiator" or "secondary radiator" (see *scattered radiation*).

RF "hot spot" A highly localized area of relatively intense radio-frequency radiation that manifests itself in two principal ways:

(1) The presence of intense electric or magnetic fields immediately adjacent to conductive objects that are immersed in lower intensity ambient fields (often referred to as re-radiation), and

(2) Localized areas, not necessarily immediately close to conductive objects, in which there is a concentration of radiofrequency fields caused by reflections and/or narrow beams produced by high-gain radiating antennas or other highly directional sources.

In both cases, the fields are characterized by very rapid changes in field strength with distance. RF hot spots are normally associated with very nonuniform exposure of the body (partial body exposure). This is not to be confused with an actual thermal hot spot within the absorbing body.

rf safety program An organized system of policies, procedures, practices and plans designed to protect against hazards associated with RF fields, contact voltage, and contact and induced currents. Radio frequency safety programs shall be documented in writing.

root mean square (RMS) The effective value, or the value associated with joule heating, of a periodic electromagnetic wave. The RMS value is obtained by taking the square root of the mean of the squared value of a function.

scalar A quantity, such as temperature or energy, having a magnitude only.

scattered radiation An electromagnetic field resulting from currents induced in a secondary object (conducting or dielectric) by electromagnetic waves incident on that object from one or more primary sources.

short-term exposure Exposure for durations less than the corresponding averaging time.

specific absorption (SA) The quotient of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume (dV) of a given density (ρ).

$$SAR = \frac{d}{dt}\left[\frac{dW}{dm}\right] = \frac{d}{dt}\left[\frac{dW}{rdV}\right]$$

The specific absorption is expressed in units of joules per kilogram (J/kg).

specific absorption rate (SAR) The time derivative of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of given density (P).

$$SA = \frac{dW}{dm} = \frac{dW}{rdV}$$

SAR is expressed in units of watts per kilogram (W/kg).

threshold limit value (TLV) See maximum permissible exposure (MPE).

uncontrolled environment Any area other than a controlled environment. The uncontrolled environment includes locations where persons are non-occupationally exposed and are not made fully aware of the potential for exposure by the owner, operator or party responsible for the source or cannot, or do not understand how to, exercise control over their exposure. These exposures may occur in residential or work locations where there are no expectations that RF exposure levels may exceed the exposure limits for the lower tier of a two-tier standard, including those for induced currents.

vector A quantity, such as velocity or force, having both magnitude and direction. A vector is denoted by a symbol in bold type.

velocity The velocity of wave propagation, υ, represents the speed at which the wave advances. In free space υ is at right angles to both E and H and in the same direction as the Poynting Vector. In a vacuum, where the speed of an electromagnetic wave is *c*, the speed of light, $c = \lambda\upsilon$.

wavelength (λ) The wavelength (λ) of an electromagnetic wave is related to the frequency (f) and velocity (υ) by the expression $\upsilon = f\lambda$. The velocity of an electromagnetic wave in free space is equal to the speed of light, i.e., approximately $3x10^8$m /s (meters per second).

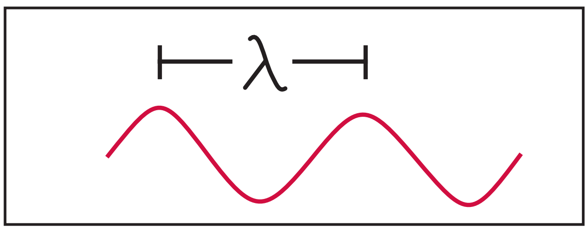
Non-Ionizing Radiation

General Information

What is Radiation?

Radiation is a form of energy that arises when electric charges are accelerated. These moving electric charges induce an electromagnetic field within the region surrounding the charge source. This oscillation generates an electromagnetic wave that radiates energy from the region surrounding the charges, much like the expanding waves that are created when a rock is tossed into a body of water.

An electromagnetic wave consists of coupled electric and magnetic fields that oscillate at the same frequency as the charge source. Frequency is the term used to describe the rates at which these charges move from zero to maximum charge, back through zero to minimum charge, and finally back to zero. This action describes one complete cycle.



Wavelength (λ)

FREQUENCY VS. WAVELENGTH

The energy that is formed by the moving charges move at the velocity of light, which in free space is a distance of approximately 299.79 x 10^6 meters per second. Therefore, a single cycle per second, or one cps, would have a wavelength of almost 300 million meters or over 186 thousand miles.

Simply put, the *wavelength* is determined by dividing 299,790 kilometers per second by the frequency. By dividing 299,790 kilometers by the wavelength (λ), one arrives at the frequency. In other words, this determines how many complete cycles are required for the radio waves to travel 299,790 kilometers. As the frequency increases, the wavelength decreases, because velocity is constant in free space (see the figure below).

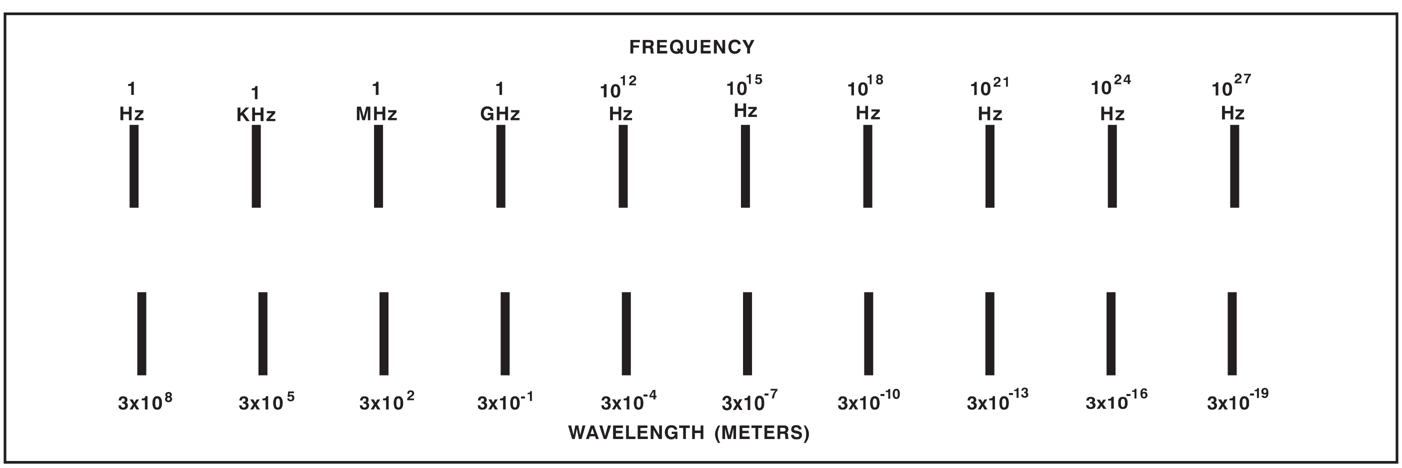
The term "Hertz" is synonymous with cycles per second. Instead of using the term "kilo cps" (1000 cycles per second), it is more commonly described as kHz (kilohertz). One million cycles per second is similarly described as one megahertz (MHz).

What is the Difference Between Ionizing and Non-Ionizing Radiation?

Electromagnetic waves caused by moving electric charges all carry energy. These are commonly called photons. Their energy level increases at higher frequencies and is measured in electron volts, or eV (referred to as Plancks constant, Energy = hf, where h is equal to 6.63 x 10^{-34} joule second and f = frequency).

At a frequency of approximately 2420 million MHz, the photon energy levels are approximately the same 12.4 eV as the energy binding electrons to atoms. At this energy level, water molecules can be ionized, therefore, at this part of the frequency spectrum, the energy is classified as "ionizing."

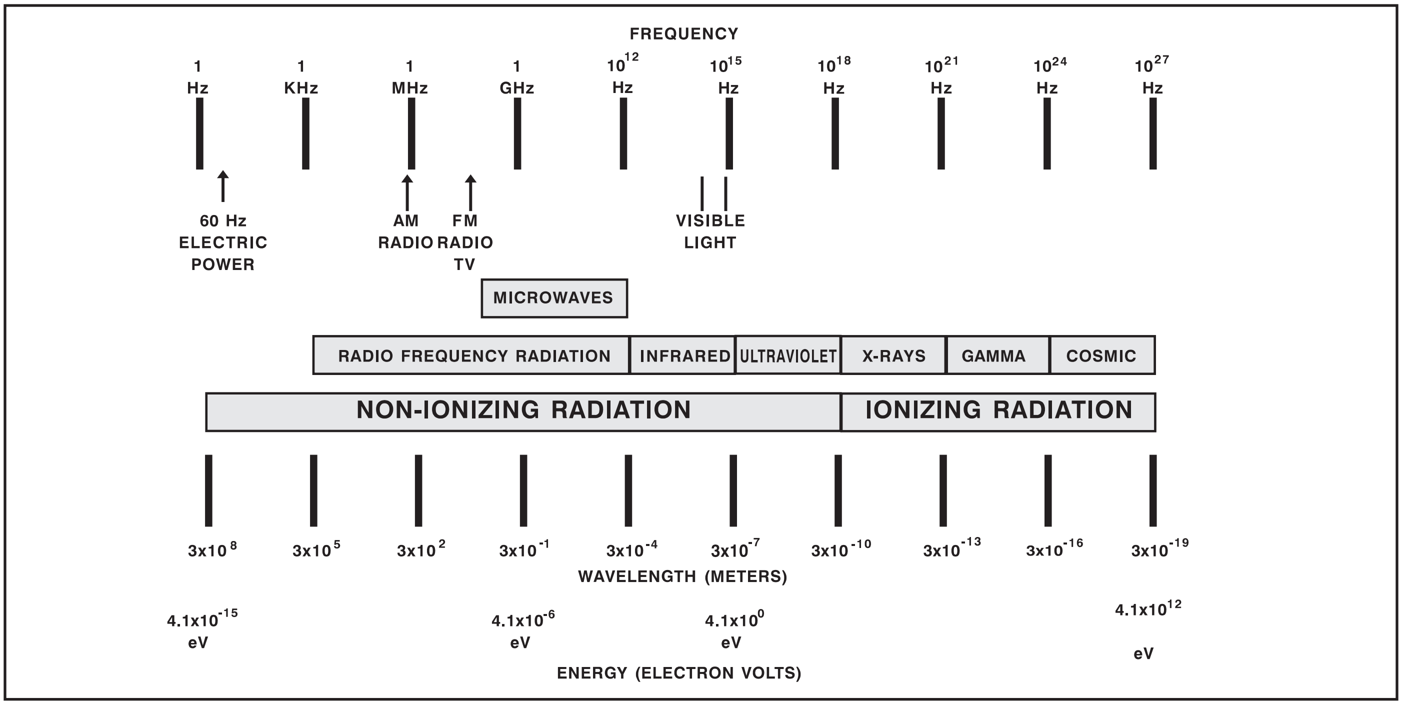
Microwave frequency photons carry considerably less energy (.001 eV) than the weakest chemical bonds and are therefore classified as "non-ionizing."



Frequency vs Wavelength

USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www.**narda-sts.us

Non-Ionizing Radiation



Electromagnetic Spectrum

What Generates Non-Ionizing Energy?

For millions of years, the principal generators of non-ionizing energy have been terrestrial sources such as lightning and extraterrestrial sources such as the sun. Even the human body generates thermal energy in the non-ionizing spectrum totalling approximately 0.3 µW/cm^2.

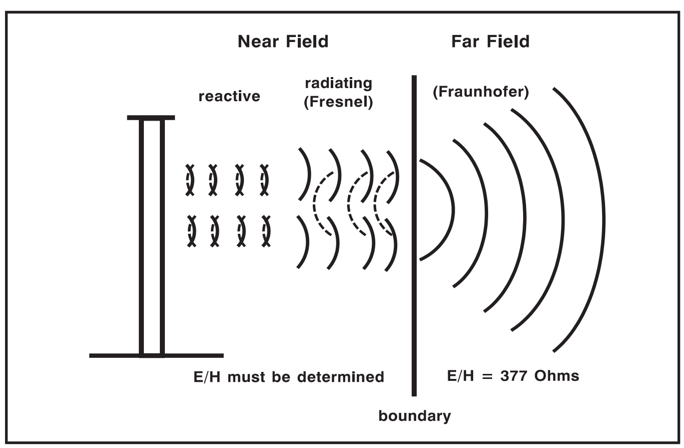
In the last century, a tremendous increase in man-made sources of non-ionizing energy has greatly increased the life quality – and even lifespan – of human beings. Medical systems such as diathermy, Magnetic Resonance Imaging (MRI) and electrosurgical devices use non-ionizing energy. Weather forecasting would be nearly impossible without satellite systems and weather radars and no one could be warned of emergency weather conditions without communications like TV or radio.

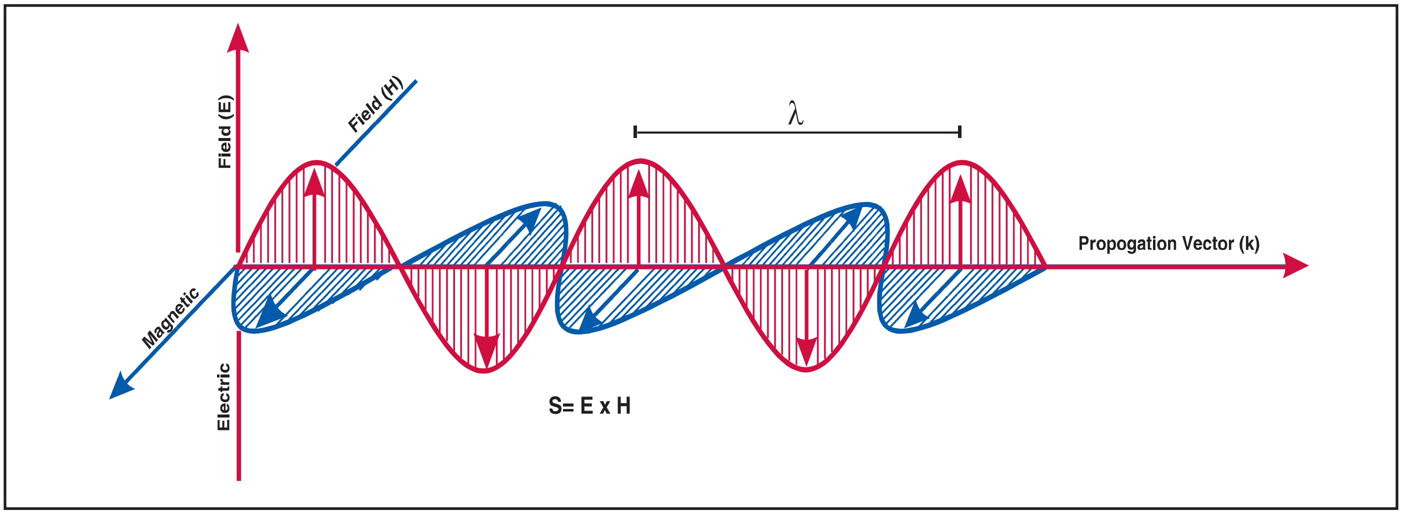
Man-made energy sources use devices such as klystrons, magnetrons and semiconductors to generate the non-ionizing energy required to communicate over long distances or to provide thermal energy.

How Does Electromagnetic Radiation Travel (Propagate) Through Free Space?

Electromagnetic waves that are generated by man-made devices usually travel along two conductor (coaxial) cables or hollow piping called waveguide. A device called an antenna or applicator is used at the end of the coaxial or waveguide lines to transmit the energy into free space. Moving electron charges on the surface of the antenna mostly propagate outward, forming an electromagnetic wave that travels through free space.

If we could freeze the motion of an electromagnetic wave traveling in free space, it would look like the waveform above when it is in the "far field" or "Fraunhofer" region. The electromagnetic field in the far field is very consistent. The electric field is always perpendicular to the direction of propagation and the magnetic field is always perpendicular to both





Far Field Electromagnetic Wave

the electric field and the direction of propagation. The two regions very close to the antenna are called the *reactive near field* and the *radiating near field*. In the reactive near field energy does not radiate, it is recovered and re-emitted during successive oscillations. In the radiating near field, energy is both stored and radiated. While the strength dissipates over distance in the far field, it may increase – or even stay the same – until the distance from the antenna approaches the far-field region.

Free space has a resistance to electromagnetic radiation, otherwise no forms of radio or TV communication could exist. When a plane-wave condition exists, the impedance is a constant value of 377 ohms. In the near field, the impedance will vary with the ratio of the E (electric) to H (magnetic) fields. A higher impedance indicates a stronger E field while a lower impedance indicates a stronger H field, and neither may be constant until the distance approaches the far field. When performing measurements in the near field you must measure both field components separately while in the far field you need to measure only one (usually the E field). Standards used to determine compliance may also specify what measurements are to be made. IEEE C95.1-2005 specifies 30 MHz as the crossover point between measuring both fields or only one. More information on calculating field strengths is contained in the Narda Survey Application Note.

How is Electromagnetic Radiation Characterized?

FREE SPACE IMPEDANCE CALCULATION

The magnitude of the power density in a wave can be calculated from the vector product:

$|E \times H| = |E|\,|H| \sin\theta$

For angle of 90°, as is the case in the far field (sin 90° = 1):

$|E \times H| = |E|\,|H|$

When we look at our free space electromagnetic wave where the ratio of electric to magnetic fields is the free space impedance, we can say:

$Z_o = |E/H|$

Z_o is the impedance as a ratio of E to H and is independent of their magnitudes. Free space has a resistance to electromagnetic radiation. It has a permeability (ratio of magnetic flux density produced in a medium to the magnetic field strength that produced it) and a permittivity (ratio of electric flux density in a medium to the electric field that produced it), therefore via Maxwell's equations:

$Z_o = \sqrt{\mu_o/\varepsilon_o}$

$Z_o = \sqrt{1.257 \times 10^{-6}\ \text{F/m} / 8.855 \times 10\text{-}12\ \text{H/m}}$

$Z_o = \sqrt{141953.6985}$

$Z_o = 376.767$

The characteristic impedance of free space is, therefore, 377 ohms.

Since we have already seen that the electric and magnetic field intensities are related through the impedance of space (Z_o), which is 377 ohms, we can say:

(E)/(H) = 377 ohms

S = (E) x (H), S = W/m^2 (10 W/m^2 = 1 mW/cm^2)

S = (W/m^2) = 377 x H^2 S(mW/cm^2) = 37.70 x H

S = (W/m^2) = E^2/377 S(mW/cm^2) = E^2/3770

RMS AVERAGE

The power density of an electromagnetic wave is related to the electric and magnetic intensities in that it is the product of the two. When we speak about power density, we use the RMS average, which is the root mean square of the maximum amplitude of the field multiplied by $1/\sqrt{2}$ (.707) thus:

$W = H_o / \sqrt{2} \times E_o / \sqrt{2} = E_o H_o / 2$

POWER AND FIELD INTENSITY

An electromagnetic wave represents a flow of energy in the direction of propagation. The intensity, or strength, of an electromagnetic field depends on the transmitter's power level, the antenna used, and the distance from the antenna. The field is specified by its intensity that passes through a unit area. Electric (E) fields are usually expressed in Volts per meter (V/m) or its mean squared value (V^2/m^2).

Similarly, the magnetic (H) field is specified in A/m (or A^2/m^2). The product of the two is the power density (voltage times current equals power per Ohms law). The resulting units are watts per meter squared (W/m^2) or, more commonly, milliwatts per centimeter squared (mW/cm^2). There are instruments available that can display field levels in field strength, mean squared field strength, or equivalent power density. At this time, units that display power density actually measure mean squared field strength. A true measurement of power density would require separate amplitude and phase information for each axis (X, Y and Z). Equipment to measure true power density does not exist commercially.

When using a meter that displays equivalent power density to measure both fields, the amplitude and field must be specified (i.e., 12 mW/cm^2 E field and 5 mW/cm^2 H field). Readings may be converted to field strength – or mean squared field strength – by using the equations above for comparison to a particular standard.

In this way, meters that display equivalent power density, but measure mean squared field strength, are usable in the near field as well as the far field.

If a source radiates power uniformly in all directions, the power density at a distance *r* from the source will be the total radiated power (P) divided by the area (A) of the sphere(s):

$W = P/As = P/4\pi r^2$

Looking at the above equation, it can be said that the power density decreases as the distance to the source increases, and that the power density is inversely proportional to the square of the distance from the source.

This is the inverse square law of radiation. It is true for an emitter that radiates in all directions, or for an emitter that radiates over a limited portion of a sphere.

How is RF Energy Absorbed into the Body?

There are many factors involved in determining how RF energy is absorbed into the body, such as:

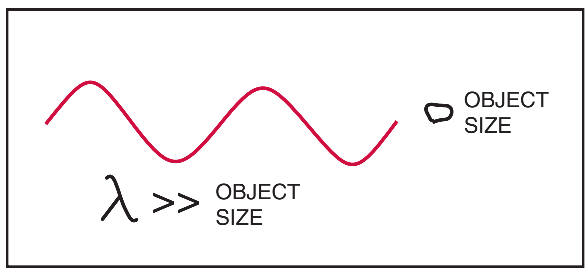
1. Dielectric composition
2. Size of the body
3. Shape and orientation of the body and the polarization of the field
4. Complexity (near field) of the RF field

1. DIELECTRIC COMPOSITION

Absorption characteristics vary for different parts of the body. As a general rule, RF energy passes through fatty tissue and is deposited in the muscle or brain tissue with the depth of penetration varying inversely with frequency.

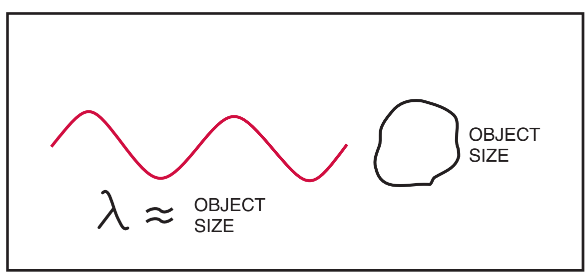
2. BODY SIZE

Although we have previously discussed frequency and wavelength, this section focuses on the different absorption characteristics of the human body vs. wavelength. Three scenarios are examined: (1) where the body is less than the size of the wavelength, (2) where they are roughly equal, and (3) where the body is larger. In instances where the size of the body is less than the wavelength, there is little absorption and a uniform, or equal, distribution of energy. In this range, the body becomes increasingly resistive as frequency is decreased.



Subresonant Region

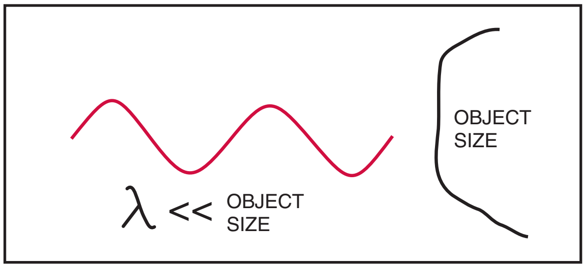
When the wavelength is roughly equal to the size of the body, there is the highest absorption with unequal distribution of the energy. Consequently, "hot spots" may be generated.



Resonant Region

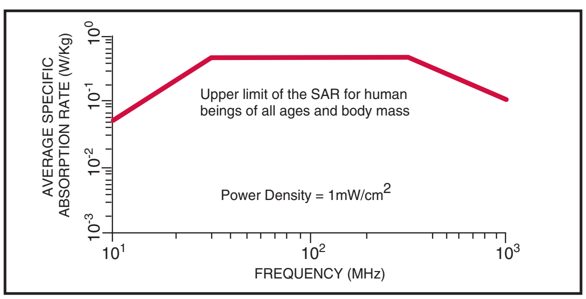
narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

Where the wavelength is less than the size of the body, there is lower absorption and the heating is confined to the irradiated area.



Quasi-Optical Region

Specific Absorption Rate (SAR) is the basis of most safety standards. It is the rate of energy absorption per unit of body mass. At an absorption level of 4 W/kg, *reversible* behavioral disruption has been noted. Levels above 5 W/kg have resulted in *permanent* adverse effects. Therefore, most standards have been based on SARs of 0.4 W/kg to conservatively limit exposures to 1/10th of these levels to account for biological uncertainty and to add an additional safety factor. The rate of energy absorption is not constant over varying frequencies and wavelengths.

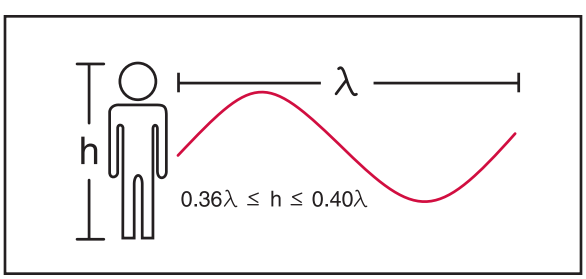


SAR vs Frequency

An example of this is the *whole body human resonance region* where the human body is close in size to the wavelength. You can approximate your own resonant frequency (ungrounded) by using 114 divided by your height in meters. For a person who is 5'9", the frequency would be:

5'9" = 69" x 0.0254 = 1.75 meters

114 divided by 1.75 = 65.1 MHz
(divide in half for grounded resonance)



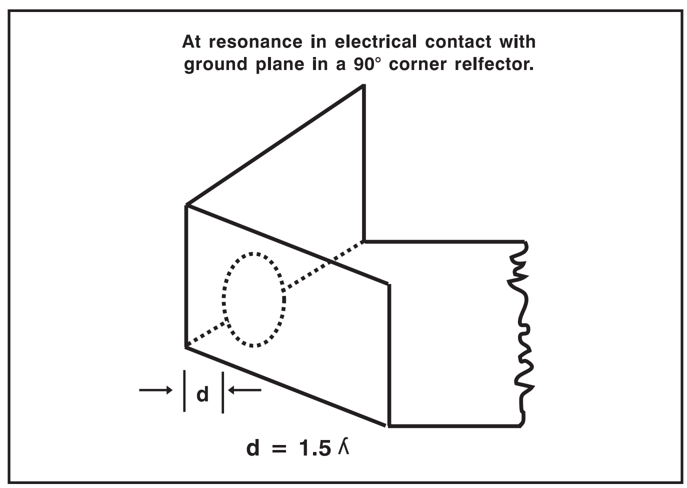
Human Resonance Region

If you were to input the height of a newborn child and that of a very tall adult person – and factor in whether they are grounded – you would begin to see where the highest absorption takes place for a general population (as a function of frequency only). For example, the human resonance region according to IEEE C95.1-2005 is from 30 MHz to 300 MHz.

3. SHAPE, ORIENTATION, AND POLARIZATION

Absorption varies with the shape and orientation of the body in the field. A human standing in the vicinity of a vertically polarized field absorbs much more energy (10 times) than the same person standing in front of a horizontally polarized signal.

Workplace exposure conditions can be difficult to calculate. In a metallic shelter or screen room, the RF energy may be focused at a particular point or area. Experimental measurements on a spheroid model of man immersed in a 10 mW/cm^2 field have shown considerable increases in the Specific Absorption Rate. At the resonant frequency and while standing in the corner of a shielded room (in contact with the ground plane) at a distance of 1.5 wavelengths, models have been calculated to be absorbing as much as 116 W/kg. Standards usually allow no more that 1 mW/cm^2 in this resonance range, but in focused environments there is still the potential to exceed the SARs the standards are based on.



Focussing Effect in a Metallic Room

4. Field Complexity

Most standards are based on the far field plane wave relationships and their interaction on the body. As discussed previously in this document, the near field is complex in its energy distribution and nearly impossible to calculate. When you add this to the three factors that determine absorption, the total variables become staggering.

USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

How Are Field Levels Calculated?

To perform calculations, information should be obtained from engineering personnel or the manufacturer concerning the following:

1. Operating Frequency
2. Transmitter Power
3. Modulation Characteristics, if any (AM, FM, Pulsed)
4. Number of Sources
5. Spurious Frequencies or Harmonics
6. Intermittence of Output (may be scanning, or direction finding)

Just as important are the propagation characteristics:

1. Distance to Source
2. Type of Antenna (Size, Gain, Beamwidth, Orientation)
3. Polarization of E and H field
4. Existence of Absorbing or Scattering Objects

When calculating the distance to the source, determine if measurements are to be made in the near field or far field. For circular antennas, the near field extends to approximately $D^2/4\lambda$ and for other types, it typically extends to $G\lambda/4\pi^2 n$ (where G is the gain of the antenna and n is the efficiency factor). As stated previously, if measurements are to be made in the near field, both E and H fields need to be measured. The reactive near field can become important when monitoring resonant "Whip", or "Dipole" antennas (to name two) at frequencies below 100 MHz and at power levels of only a few watts. The reactive near field typically extends out to a distance of $\lambda/2\pi$ to $\lambda/2$ wavelengths, depending on the antenna.

At frequencies above 300 MHz, most standards assume you are in the far field. Therefore, only one field needs to be measured – almost always the electric field.

CALCULATIONS

Calculations are useful when performing a survey in the far field region. For those instances where a survey will be performed in the near field, calculations are not normally accurate. The survey should start in the far field region at a position calculated to be well within safe limits. It is also recommended that the electric field be measured first in order to minimize any shock or burn hazard.

Antenna gain is defined as the power density at a spot in front of an antenna divided by the power density at the same spot if the antenna were radiating in all directions, or isotropically. For any well-matched circular antenna, where all of the energy supplied to it is transmitted, the ratio of G to A is:

$G = 4\pi A/\lambda^2$

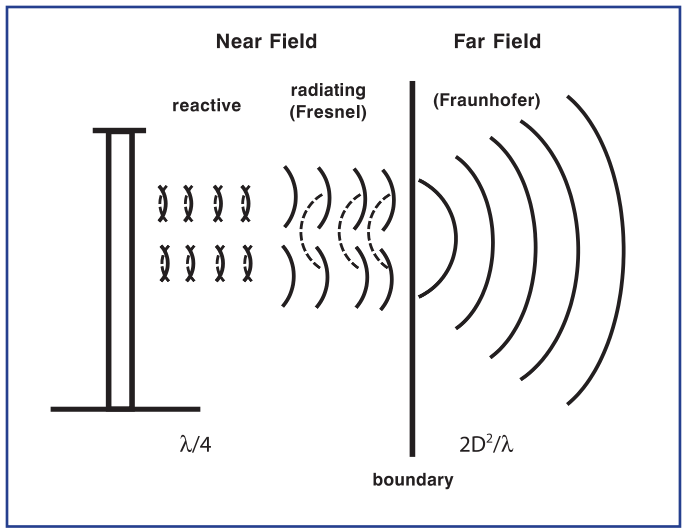
where G = Numerical Gain
A = Area (meters)

NOTE: All equations use numerical gain, G

Below is a table of typical antenna gains listed logarithmically and numerically G_{num} = (G dB/10) antilog:

LOGARITHMIC VS. NUMERICAL GAIN

dB	Numerical	dB	Numerical	dB	Numerical
1.0	1.26	11.0	12.59	21.0	125.89
2.0	1.58	12.0	15.85	22.0	158.49
3.0	2.00	13.0	19.96	23.0	199.53
4.0	2.51	14.0	25.12	24.0	251.19
5.0	3.16	15.0	31.62	25.0	316.23
6.0	3.98	16.0	39.81	26.0	398.11
7.0	5.01	17.0	50.12	27.0	501.19
8.0	6.31	18.0	63.10	28.0	630.96
9.0	7.94	19.0	79.43	29.0	794.33
10.0	10.00	20.0	100.00	30.0	1000.00



Near Field / Far Field

Far field power density is calculated from the Friis free-space formula:

$W = GP/4\pi r^2$

where G = Numerical Gain
P = Power input to antenna (Watts)
r = Distance away from antenna (meters)
W = Result in W/m^2

It is convenient to use the above equation as long as the distance (r) is a far-field distance. The far field would begin at a distance of:

$r = 0.6\ D^2/\lambda$

for a circular antenna. For these antennas, the effective area is less than the actual area, usually on the order of 50% to 80%. If the gain of a circular antenna is not known, it can be approximated by:

$G = 4\pi An / \lambda^2$

where *n* would be on the order of 0.5 to 0.8 in order to account for the actual area used. Equations are also available to estimate power density at a certain distance from an antenna. This is calculated from the output power measured at the input to the antenna, and the known antenna gain (G).

$$D = \sqrt{\frac{P_{avg} \times G_{num}}{4\pi \ (W/m^2)}}$$

Where D = distance in meters, P_{avg} = Avg. Power in Watts

The result is in W/m^2 (Remember 1 mW/cm^2 = 10 W/m^2)

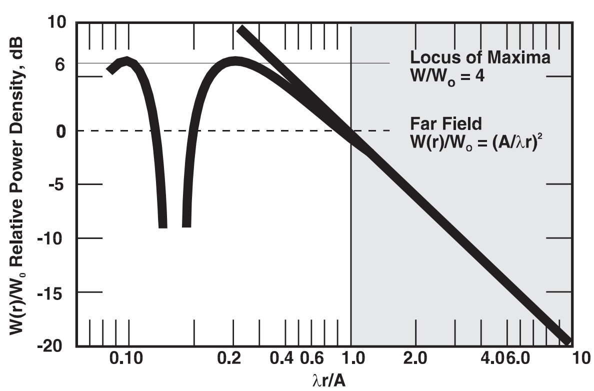
Why is a Survey Required?

A survey is required to have a real understanding of the RF environment. Calculations can only provide an estimate of the field strengths involved, and are merely a starting point. Caution must be employed for the surveyor's safety and to protect expensive surveying equipment from excessively high field levels. Performing the survey is the only way to truly know the field levels and to implement the correct strategy that is the most cost effective.

Before performing the survey, it is important to know what instruments will be needed. To determine this, you must familiarize yourself with the measurement area and match instrument capability to the environment in this area.

For more information on performing surveys, refer to the Narda's application note on surveys.

POWER DENSITY vs. DISTANCE ALONG AXIS FROM ANTENNA APERTURE FOR SQUARE, ROUND OR RECTANGULAR APERTURES



REFERENCES

Biological Effects of Radiofrequency Radiation
edited by D.F. Cahill and J.A. Elder
Environmental Protection Agency
Report No. EPA-600/8-83-026F, 1984.

IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Fields, 3 kHz to 300 GHz. New York: The Institute of Electrical and Electronics Engineers, Inc., IEEE C95.1-2005 (for copies, phone 800-678-IEEE).

Leonowich, John A., Ph.D.
"Sources of Microwave/Radiofrequency Radiation," 1987
"Fundamentals of Electromagnetics," 1987.

Osepchuk, John M., Ph.D.
1992 Book Review of *Nonionizing Radiation Ques*tions and Answers, by M.G. Yost.

Questions and Answers About Biological Effects and Potential Hazards of Radiofrequency Radiation
Federal Communications Commission,
FCC OET Bulletin No. 56, 3rd Edition, 1989.

Radio Frequency and Microwave Radiation
prepared by R.T. Hitchcock
American Industrial Hygiene Association, 1988.

Yost, Michael G.
Nonionizing Radiation Questions and Answers
San Francisco: San Francisco Press, 1988.

Surveys

Table of Contents

Disclaimer

Why Do You Need to Perform Surveys?

Surveys are performed for various reasons, such as: new or modified installations, changes in the previously surveyed environment, changes in the levels of emitted power or limits, and at the request of personnel or management.

A survey is required to have a real understanding of the RF environment. Calculations are necessary to ensure you choose the correct equipment to perform the task, minimize the potential hazard to the surveyor, and protect the equipment that you choose to employ. Calculations can provide an estimate of the field strengths involved, but this is only a starting point.

Two basic types of surveys are performed. The first one is near a known, or intentional, emitter such as an antenna. The second type of survey is near an unintentional emitter to detect a suspected leak (e.g., from waveguide that transfers the RF from an amplifier to an antenna). Both types of surveys are covered in this document.

I. Surveying Intentional Emitters

A. EMITTER CHARACTERISTICS

Before beginning a survey, it is important to obtain information about the system you are going to test. This includes the following information:

1. **Frequency**
2. **Power Level**
3. **Modulation Characteristics**
4. **Number of Sources**
5. **Spurious Frequencies or Harmonics**
6. **Intermittence of Output**
7. **Antenna Information** (e.g., size, beamwidth, gain, orientation)
8. **Previous Survey Results** (if available)

B. SITE CHARACTERISTICS

A drawing of the site characteristics is important to determine a plan of action that will minimize your potential exposure, allow you to perform the best survey with a minimum of site interruption, and will be used in your final report. Visiting the site before the date of the survey is very important and preferable to viewing a picture or drawing. However, pictures and/or drawings are helpful in explaining your reasons for choosing particular measurement positions and results. Items to consider in your site drawing should include:

1. **Structures** (such as buildings, fences, towers, etc.).
2. **Areas Normally Occupied by People** (work areas, walkways, etc.)
3. **Barriers, Interlocks, Signs, and Visual or Audible Alarms**
4. **External Areas** (such as parking lots, residential areas or any other "uncontrolled areas" that may receive lower, but measurable emissions)
5. **Topographical Information** (such as contour height from surveys)

For directional emitters like parabolic antennas, it is necessary to obtain beam elevation angles. This information is used to plot worst-case results if there are no mechanical means to stop the beam from illuminating people in the area.

C. PRE-SURVEY CALCULATIONS

Antennas come in various shapes and sizes but they all operate in the same way. They receive electromagnetic energy from a transmitter through coaxial or waveguide transmission line. Antenna design is dependent on the application and frequency range of operation. The table below gives some of the characteristics of the two major types of antennas – *wire* and *aperture*.

ANTENNAS

Wire Types	Aperture Types
Radiation from currents induced in conductors	Radiation from fields reflected off a surface
Static	Rotating
Low Directivity	High Directivity
Broad Beamwidth	Narrow Beamwidth
Dimensions on the order of one wavelength or less	Dimensions on the order of many wavelengths

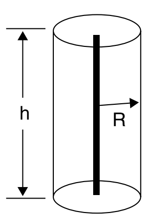
Aperture antennas come in several forms. Examples include: arrays of low directivity elements, aperture horns, and a shaped reflector or lens illuminated by a broad beam radiator.

There are three distinct areas in front of an antenna that you need to be familiar with. These areas are the reactive near field, the radiating near field, and the far field. All antennas operate as a point source once you are beyond the "Raleigh distance." The "Raleigh distance" is that point where the field strength decreases inversely with the distance and the equivalent power density decreases with the square of the distance.

1. Lower Frequency, Omni-Directional Antennas

For lower frequency (<1 GHz) antennas, i.e., non-directional "whip" or "rod" type antennas, the following sample calculations may be used:

NEAR FIELD: The reactive near field will be approximately 10% of the radiating near field at a distance of $\lambda/2\pi$, and the far field may not begin until a distance of $2D^2/\lambda$. For those instances where a survey will be performed in the near field, you can estimate certain antennas by using the following near field estimates. For Omni-directional wire type antennas the following calculation could be used:



The Cylindrical Model

$$S = \frac{P}{2\pi Rh}$$

H would be height in meters and R would be an imaginary radius, or distance away from the antenna (to form an imaginary cylinder), P is power in Watts. This equation yields a result in W/m^2. Arbitrary phases and amplitudes of both fields are present in the near field. Measurements should be made with isotropic probes.

GAIN: Typically 8 dB; 20 dB or more for antenna arrays

FAR FIELD: Power density can be calculated using the following calculation:

$S\ (W/m^2) = PG/4\pi d^2$ where

P= Average Power at antenna

G= Numerical Gain = (Gain dB/10) antilog

d = Distance from antenna (meters)

2. Higher Frequency, Directional Antennas

NEAR FIELD: For Aperture (electrically large, usually many wavelengths) antennas like parabolic reflector, microwave antennas you can estimate the near field power density by using the formula: $4P/A$

where P is the power input to the antenna in Watts, and A is the area of the antenna in meters. This equation would yield a result directly in W/m^2. At distances greater than lambda /2pi (for omni antennas) or $2D^2$ (where D is diameter in meters and wavelength is in meters) for parabolic antennas, you are most likely in the far field and can start using far field calculations.

GAIN: Usually expressed in dB (typically 25dB to 45dB) which can be converted from logarithmic to numerical gain by using the conversion shown above or, by using Table 1. Gain can be estimated from the formula:

$G = 4\pi A_n/\lambda^2$ where

A= Area of Antenna

n= Efficiency Factor (Typ. 0.5 to 0.8)

λ= Wavelength

TABLE 1. LOGARITHMIC VS. NUMERICAL GAIN

dB	Numerical	dB	Numerical	dB	Numerical	dB	Numerical
1.0	1.26	11.0	12.59	21.0	125.89	31.0	1258.93
2.0	1.58	12.0	15.85	22.0	158.49	32.0	1584.89
3.0	2.00	13.0	19.96	23.0	199.53	33.0	1996.26
4.0	2.51	14.0	25.12	24.0	251.19	34.0	2511.89
5.0	3.16	15.0	31.62	25.0	316.23	35.0	3162.28
6.0	3.98	16.0	39.81	26.0	398.11	36.0	3981.07
7.0	5.01	17.0	50.12	27.0	501.19	37.0	5011.87
8.0	6.31	18.0	63.10	28.0	630.96	38.0	6309.57
9.0	7.94	19.0	79.43	29.0	794.33	39.0	7943.28
10.0	10.00	20.0	100.00	30.0	1000.00	40.0	10000.00

The near field can extend to a distance of $D^2/4\lambda$ where D is the antenna diameter.

The power density in the radiating near field can be estimated to be 4P/A. In other words, the maximum power in the near field could be four times the average power over the nominal antenna area. This relationship is shown in the following figure.

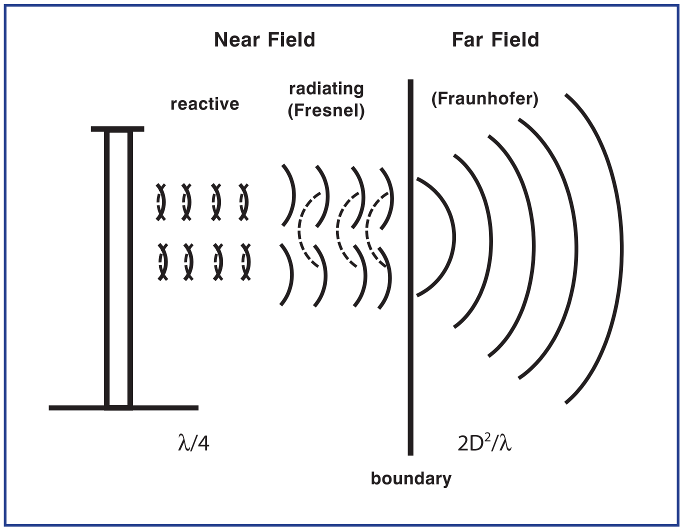


Figure 1

D. INSTRUMENTATION

Instruments are available to cover from 0 Hz to over 100 GHz. ELF and VLF frequency bands are measured by other types of instruments which are not covered in this document. Highlights of instrumentation traits are as follows:

1. General A survey instrument usually contains three distinct parts: Meter, Probe and Cable (or leads). The meter displays the detected levels on an analog or digital display. Meters may include features such as storage of detected levels, audible alarms and built-in test sources. With few exceptions, meters do not form part of the measurement circuit, that is, they do not determine what frequencies or levels are detected. Probes, however, *are* part of the system that determines what may be measured. Probes are available in designs that detect from one direction (anisotropic) or from all directions (isotropic). Frequencies detected may be very few (narrow bandwidth) or very many (ultra-broadband, e.g., 300 kHz to 50 GHz). Dynamic ranges average 30 dB or more and usually only one field component (electric or magnetic) is measured at a time. Cables transmit information from the probe to the meter assemblies. Theses cables are either shielded copper wires, or (at lower frequency ranges) fiber optic cables. Some low frequency designs exclude cables to maintain accurate readings. Before performing a survey, certain characteristics need consideration, including:

2. Field Detection All probes available measure either the electric (E) or magnetic (H) fields. At higher frequencies (300 MHz) some standards require that only one field component be measured (usually E) while at lower frequencies both field components might need to be measured. Additionally, you need to determine if surveys are to be performed with *isotropic* or *anisotropic* probes. Isotropic probes are usually preferred because mistakes can be made when detecting fields from only one direction. Reflections are not as readily found and can result in considerable measurement errors. When measuring in the near field areas, an isotropic probe may be the only accurate solution because the phase relationship varies rapidly near the antenna.

3. Frequency Range: The instrument you choose must cover the frequency or frequencies of the emission. Some emissions may have large harmonics (or multiples) of the main signal, which a narrowband detector may not respond to.

4. Measurement Range: Calculations give you an estimate of the field strengths to expect. Most likely, you will want a probe that measures levels both above and below the calculated levels.

5. Detection: Probes usually employ either *diode-based* or *thermocouple-based* detection. A diode is a non-linear device, which means that over its measurement range it may change from an average detector to a peak detector. As long as the emission is not modulated and it is a single-frequency emission there will not be a large error. If there is a compensating circuit that varies the detector's operation to maintain it in "square law," it will allow the diode to remain accurate in almost any environment. Thermocouple detection is also used at lower (<300 MHz) frequencies. Antenna arrays made up entirely of thermocouple junctions are available for use at higher (1 GHz) frequencies. Thermocouples are linear devices. This means that they will always give true RMS average results, even when used in multiple-emitter applications. Thermocouple array probes operate on energy deposition across their numerous junctions. In this way, they always generate an output that is proportional to the average energy, no matter how narrow the pulse's width. This is why thermocouple detectors are usually used for measurements on pulse modulated emissions. The major drawback of thermocouples has been an inefficiency when compared to diode detectors, meaning that the diode provides a larger output voltage for an equivalent field strength. A thermocouple detector, therefore, exhibits "zero drift" which may be a significant part of a low level reading. Another consideration is that the diode can usually withstand a higher overload level than the thermocouple. This amplifies the need for performing pre-survey calculations, which helps guard against overloading either type of detector.

If, after reviewing literature, you have any questions about how equipment will operate in a specific environment, consult the manufacturer. It is imperative that your questions be answered before any equipment is purchased to ensure that such equipment will meet present and future needs.

E. MEASUREMENT METHODS AND SURVEY HINTS

1. Basic Survey Methods

Before beginning the survey, allow time to warm up and check out the equipment. When using thermocouple-based probes, it is advisable to allow the probe to stabilize to the ambient temperature. Allowing the probe to raise or lower its temperature to the ambient temperature helps minimize "zero drift." If this cannot be accomplished in an area of low field levels, it is recommended that a device equivalent to the Narda Model 8713B Electric Field Attenuator be used to guard against probe overload.

CAUTION

Thermocouple probes can be overloaded even when they are not in use!

Ensure that the meter's batteries are charged enough to complete the survey and, if check sources are available, use them to verify operation of the entire system.

Sites with multiple emitters are considerably more complex than single-emitter sites. Mobile emitters can be moved, further complicating site measurements and future survey validity. Additionally, time may be a major factor, both in the survey time required and coordination with people who will be required to operate the equipment. Such surveys require careful planning to ensure minimal site disruption.

Begin the survey from a distance well beyond the calculated hazard distance. Always begin a survey with the meter set on its highest measurement range. While surveys are usually conducted to seek out the highest field levels, more meaningful results will be obtained if field readings are compared to calculated values at certain distances.

The probe should be held at the maximum distance from your body. If the direction to the emitter is not known, or if there are multiple emitters, the probe should be held at a 45 degree angle. If there is a single emitter, the probe should be pointed directly at the source to minimize isotropic errors. Accuracy can be further improved by taking the mean reading while rotating the probe about its main axis. Results should be conservatively rated. If the system error is 2 to 3 dB, then results should assume worst cases. In other words, multiply your readings by (in this case) 1.6 to 2.0. An antenna reflection can increase the field strength by a factor of 4 and you may wish to include this factor in your result.

Field levels are normally averaged over the whole body. The IEEE/ANSI C95.1 standard allows time averaging, but not whole body averaging, for exposures to the eyes and male testes' body areas. Again, you may want to use a worst case example in your final data.

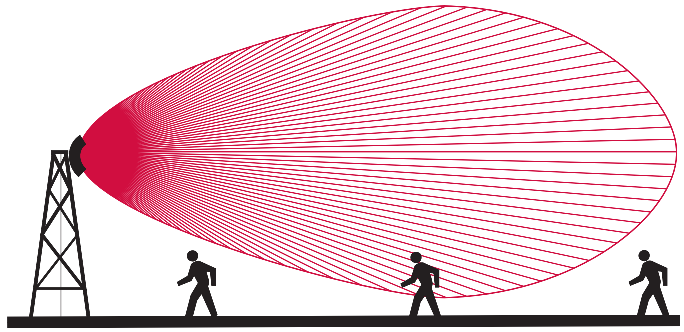


Figure 2

2. Microwave Frequency Surveys

Rotating radars and other scanning sources present additional monitoring requirements. You may wish to make time-averaged measurements of scanning sources. Some surveyors choose not to time-average these sources if there are no provisions to disable the emissions should the motor or scanning software fail. In this instance, the scanning should be disabled when performing the measurements.

Also, consider the diagram *Field Strengths in Front of an Antenna* in Figure 2. Being closer to the antenna may not result in higher readings due to the radiation pattern. Make sure you are in the beamwidth for measurable levels.

3. Radio Frequency Surveys (50 to 300 MHz)

When surveying in this frequency range, readings may be affected by the distance between your body and the survey equipment. The NBM series allows the probe to be connected directly to the meter to effectively eliminate cable pickup issues. Readings can be further enhanced by using either meter's fiber optic outputs to remove the surveyor from the field also. Additionally the NBM-520 with a probe can be connected through fiber optic cables to the NBM-550 meter or to a computer. Both meters can transfer readings directly to a computer with optional 20 meter cables and accessories. For best results, you should still minimize field perturbance caused by the surveyor by using a stand to support the system.

For most standards, both E-field and H-field readings will be made separately and compared with standard, or guidance, limits. Antennas are normally omni-directional in their radiation patterns, so measurements will be made around the entire area in question. Metallic structures may re-radiate and/or reflect the energy present thereby complicating the survey. In the United States the IEEE/ANSI standard also includes limits for induced and contact currents, at frequencies below 100 MHz.

Once you are within a distance of $\lambda/2\pi$ to the antenna, the reactive field components may be greater than 10% of the radiating components, leading to errors of greater than 1 dB. Although the reactive components do not form part of the radiating field strength, they are real and can generate heating effects and/or induced currents.

4. Radio Frequency Surveys (3 kHz to 50 MHz)

The problems with reflections off the body that begin to appear at 300 MHz (see *Radio Frequency Surveys – 50 to 300 MHz* above) become increasingly significant as you move into even lower frequencies. Below 10 MHz, the equipment is affected also. For accurate readings, you must do one of two things: (1) Place NBM meter and probe down on a non-metallic stand and use fiber optic cables with adapter to read levels out remotely, or (2) connect the probe to the NBM-520 and use fiber optic cables to read out field level on NBM-550.

For low frequency antennas that employ guy wires, there will normally be a field radiated from them that should be measured. The level of the reading will be greatly affected by the measurement distance you use. The IEEE/ANSI C95.1 standard recommends a minimum measurement distance of 20 cm from any passive re-radiator and 5 cm from an active radiator. Most other standards and guidances list distances of 5 centimeters.

Contact current hazards may be present when there are low (<100 MHz) frequency transmitters and conductive objects that may be touched by personnel. Ungrounded objects may store energy that will be discharged through a person's body when that object is touched. When in doubt, you should check the metallic objects near the antenna.

F. POST-SURVEY REPORTING

Your post-survey report is going to contain more than field readings. Valuable knowledge can be obtained from a complete listing of steps taken before, during and after the survey.

1. **Emitter Information**
2. **Emitter Purpose**
3. **Site Map**
4. **Operational Procedures**
5. **Field Readings**
6. **Induced and/or Contact Current Hazards**
   (if emissions are <100 MHz)
7. **Outline of Hazardous Areas**
8. **Existence of Ionizing Radiation**
9. **Control Procedures**
   (Lockout-Tagout, Permit to Work, etc.)
10. **Existence of any other Hazards**
    (Fuel Storage, Ordinance, etc.)

After-the-survey steps may include:

1. **Calculations Performed Before the Survey**
   (If readings do not match calculations, this should be explained)
2. **Hazard Areas**
3. **Field Readings at Areas Normally Accessible by People**
4. **Hot Spots**
5. **Existence and Adequacy of Engineering Controls and Warning Signs**
6. **Use of and Operating Procedures to Control Exposures**
7. **Attitudes of Workers Related to RF Radiation**
8. **Drawings, Sketches or Photographs of Area**
9. **Conclusions and Recommendations**

If your survey uncovers potentially hazardous areas, you may want to also provide information, such as:

1. **Placement of Warning Signs**
2. **Engineering Controls**
3. **Antenna Restriction Devices**
4. **Use of Terminations or Dummy Loads when Testing**
5. **Use of Barriers, Interlocks and Visual/Audible Alarms**
6. **Area or Personal Monitors that Continually Monitor for Excessive Fields**
   (should any of the above measures fail)

II. Surveying Unintentional Emitters

Leakage surveys vary considerably from surveys involving known emitters such as antennas. In most cases there are no field calculations that can be performed before the survey.

This section concentrates on the most common types of leakage surveys. The three types of surveys are: (A), Microwave Ovens, (B), Industrial Equipment and, (C), Transmission Line leakage.

A. MICROWAVE OVENS

Microwave oven standards regulate the permissible leakage around the perimeter of an oven door, not human exposure. This leads to a difference in the basic design of the survey equipment. The instruments required to measure this leakage are one-directional or anisotropic. This design helps ensure that only the oven is being tested, rather than having measurements potentially disturbed by other sources in the immediate area.

The U.S. Code of Federal Regulation (CFR) 21 part 1030, specifies the maximum amount of leakage from the oven at distances of 5 cm – 1.0 mW/cm^2 before the oven is sold and

5.0 mW/cm^2 throughout its operating life. Similar standards are used in other countries.

1. Presurvey Inspections

Microwave ovens have built-in safety features that should be checked before surveying for leakage. Visual inspections of the door hinges, door seals and latch mechanism should be performed. The latch mechanism can be checked by insuring the oven stops operation when the door is opened. Excessive food around the door gasket can increase leakage, so ovens need to be kept clean.

2. Oven Surveys

Microwave ovens are normally tested when operating on their highest power level, and with a load of water (approximately 275 ml.). The test equipment is scanned about any surface of the oven, paying close attention to the area of the door seal while holding the probe horizontally. Most survey equipment will have a 5 cm spacer to allow you to hold the probe against a surface. Response time for oven meters is usually around one second, but can be up to 3 seconds, so you need to scan the surface at an appropriate speed. The Narda Model 8217 can perform additional testing, allowing you to test the output power of the oven by monitoring the temperature rise of the water load.

B. INDUSTRIAL EQUIPMENT

Industrial equipment that is used for heating, drying, and sealing is very common in the workplace. These systems can operate from a few Hertz, as in the case of induction heating at foundries, up to hundreds of kilohertz. Sputtering and plasma equipment usually operate at 13.56 MHz and heat sealing or vinyl welding devices usually operate at 27.12 MHz. Before beginning your survey, the emission frequency should be checked with a frequency counter, spectrum analyzer, or manufacturer-supplied data. Spectrum analysis is also useful for determining if equipment is generating multiple emissions, or harmonics, when operated at its highest power level.

With industrial surveys it is important to consider both whole-body averaging and time averaging. Most processes use high power for a short period, which allows for considerably lower-averaged exposure levels. When surveying, it is normally beneficial to use a “story pole” that will allow you to mark various survey heights and repeatably measure at the same point. The Narda Models 8511 and 8513 Industrial Compliance Meters are unique in their ability to measure electric and magnetic fields without changing probes, which can greatly reduce survey time. High power handling is also worth mentioning here. When surveying a device that operates at 27.12 MHz, you will most likely be in the near field. The wavelength at this frequency is approximately 11 meters, which means that, because of the proximity to the source, power may vary greatly with only a slight change of probe position.

A sample survey sheet – *Heat Sealer Record* – is shown on page 151. This form can be modified for other industrial surveys.

Australia, Canada, the United Kingdom and the United States have limitations on contact current. In the U.S. there are also limitations on induced body currents. Such limitations should be considered when planning to perform low frequency (<100 MHz) surveys. In a document published in 1989, the U.S. National Institute of Occupational Safety and Health (NIOSH) stated that measuring the induced body current may provide the most direct indication of absorbed energy. Compliance measurements at frequencies below 100 MHz now include both field and current measurements. If field measurements approach standard or guidance limits, you should measure currents.

C. TRANSMISSION LINE LEAKAGE

A common example of leakage measurements is testing waveguide flanges. Waveguide flanges and bends are likely points of leakage in high power systems. Gaskets in flanges may deteriorate after being cycled over temperature many times. Bends also tend to form stress cracks from temperature and mechanical stress. When testing waveguide systems, most people will probe as closely as possible to the suspected areas. Normally, defective flanges can be tightened, while bends have to be removed from the system for repair or replacement.

In many systems the waveguide may be positioned so close it will be difficult to test certain points. In the past it was common to use a waveguide antenna to search for leaks. This approach is often difficult and time consuming because of the amount of equipment available. A new, and safer method is to use the Narda RadMan and extension handle which has a very small detector housing. Its long length keeps your hands away from the high voltage that is normally present in high power amplifiers.

REFERENCES

E.E. Aslan. “Non-Ionizing Radiation – Measurement Methods and Artifacts,” Proceedings, 39th Annual Broadcast Engineering Conference, National Association of Broadcasters, pp. 645-655. Las Vegas: 1985.

Biological Effects of Radiofrequency Radiation,
edited by D.F. Cahill and J.A. Elder
Environmental Protection Agency:
Report No. EPA-600/8-83-026F, 1984

Guide to the Practical Safety Aspect of the use of Radio Frequency Energy. U.K. Defence Standard 05-74/Issue 1, 9 Jan. 1989. HMSO Publications Centre, London

R.C. Johnson and H. Jasik. *Antenna Engineering Handbook, Second Edition*. New York: McGraw Hill, 1984.

A Practical Guide for Establishing an RF Safety Program

The topic of RF safety is important to every organization that either uses RF and microwave energy to deliver an end product such as a wireless service or employs it to perform an industrial function such as packaging, cooking, and drying of materials or products. Maintaining a safe environment for employees as well as the general public is not simply a good idea – it's the law, and it is being enforced more rigorously every year. An RF safety program is the key to establishing and maintaining an environment that offers personal protection and is legally defensible. The thought of establishing such a program often strikes fear into the hearts of organizations, bemoaning yet another layer of bureaucracy, endless paperwork, and the need to learn about RF and microwave technology.

Fortunately, a credible RF safety program for many organizations is often not complicated, but does require a long-term corporate commitment, discipline, and yes, some difficult work. However, the time is well spent, since even the step of determining if a program is required answers the question of where the organization falls in the "RF safety spectrum," something many companies simply do not know – but should.

Narda Safety Test Solutions created this RF Safety Guide to provide the basic information needed to create an RF safety program. It assumes only that the reader knows that his or her organization employs electromagnetic (EM) energy, which to a wireless carrier is obvious but to a manufacturer sometimes is not. The guide is not intended to be a complete treatise on the subject, but rather an overview that covers the elements of RF safety necessary to begin the implementation of an RF safety program. Additional information is available in the guidances and standards and other resources referenced at the end of the RF Safety Guide. Narda-STS can also provide assistance with RF safety equipment and measurements, and conducts training sessions on RF safety training and measurements throughout North America every year.

Specifically, this guide can help organizations that employ equipment generating EM energy to understand the RF safety environment, assist them in determining if their facilities require an RF safety program, and provide basic guidelines about how one should be constructed. In many cases an RF safety program may not even be required, but the only way to determine this is to thoroughly evaluate facilities where EM energy is present. All of these steps can be aided by using this RF Safety Guide as an outline and help from consultants who specialize in this area. However, it is essential that every affected organization have employees who are tasked with the responsibility of learning the regulatory, technical, and procedural aspects of RF safety, rather than resorting exclusively to outside sources.

The Importance of RF Safety

The use of RF and microwave technology is pervasive throughout the world, and its incorporation into more and more types of devices is growing every year. As a result, more and more people are becoming aware that EM energy is employed in consumer products and the infrastructure used to support them, in medical devices such as magnetic resonance imaging (MRI) systems, and within industrial equipment at the workplace such as RF heaters, dryers, induction welders, and vinyl welders.

While the question of whether or not electromagnetic energy at extremely weak levels can cause bodily harm continues to elude a conclusive answer, the situation is different when the body is exposed to EM energy at high levels at certain frequencies. In the latter case, heating of the body by EM energy is known to cause harm. When compared to other

DISCLAIMER: The information and forms contained in this document are intended to provide general guidelines for RF radiation safety and to aid individuals intending to implement an RF safety program. However, every situation in which RF energy is encountered is unique, as are the requirements for administrative and engineering controls, and the depth and breadth required of the RF safety program. In addition, state, country, provincial, and other regulations, as well as regional interpretations must often be considered along with the national and international standards discussed in this guide. Consequently, the information presented here should not be relied on exclusively or in place of legal advice relating to the circumstances of a specific situation. Forms in this document are intended only as a teaching tool and before use must be modified or expanded to accommodate the needs of a particular situation.

"controlled hazards", it is not as visible and it is easily possible to be exposed to levels in excess of established limits without knowing it.

Together, the uncertainty about low-level exposure and the demonstrated effect of EM energy at high levels have produced exposure limits contained in international regulations to which all organizations must adhere in order to protect workers and the general public from potential bodily harm. In the US, federal regulations dictated by the Federal Communications Commission (FCC) have the force of law, as do regulations from the Occupational Safety and Health Administration (OSHA).

The requirements of these standards, guidances, and regulations must be addressed when employees work around EM fields, whether at broadcast sites (such as cellular, paging, public safety, paging, TV and radio, etc.) or in industrial or medical environments. RF safety programs, when effectively administered, can help ensure companies that their facilities are legally defensible in the face of claims made to the contrary. In short, if employees must work around RF energy, it is important to know what the levels are and how to construct a basic RF safety program if one is needed.

The RF Saety Environment

Only 20 years ago, hardly anyone paid much attention to EM energy, except RF and microwave equipment manufacturers, satellite communications providers, and the aerospace and defense community. This is certainly not the case today, since "wireless" capabilities are highly desirable for virtually any product traditionally tethered to a wired connection, and advances in semiconductor and other technologies have brought them to a bewildering array of products – with many more to follow.

The explosive growth of the cellular telephone industry in the 1990s sparked interest in the possible health effects of EM energy, as millions of people became "glued" to their phones. The result of this attention was a media frenzy culminating in books on the subject, headlines in the most respected newspapers and magazines, and television news stories, as "experts" provided their opinions on the merit of various scientific studies. All of this resulted in little more than arousing the public and boosting the careers of those involved. Industry-sponsored studies were conducted that not surprisingly largely concluded that EM energy either has no effect at the miniscule levels to which cellular phone users are exposed or has some possible effect, the extent of which that would require further study. That study continues today at a muted level and the headlines are gone, essentially because unless conclusive proof (supported by multiple undisputed studies) is presented, the ubiquity of wireless technology, along with the beneficial uses of EM energy in medical and industrial applications, will render moot the question of the hazards of low-level EM exposure.

A POINT TO REMEMBER

Nevertheless, from a legal standpoint, it simply does not matter whether "proof positive" of bodily harm does or does not exist. Challenges to employers can come from unlikely places, not just the underfunded, understaffed government agencies charged with protecting workers and the general public. A classic example of the truth of this claim comes from recent US court rulings. In 2007, the Alaska State Supreme Court upheld a lower court ruling awarding temporary total disability and medical benefits to an employee who was exposed to levels greater than allowed, but below thermal "thresholds of harm". This type of court ruling is important because it directly challenges the popular notion of standards.

In Orchitt v. AT&T Alascom[1] (a satellite communications provider), John Orchitt, an employee of AT&T, was accidently exposed in 1998 to RF radiation emitted by a leaky waveguide feeding a satellite communications uplink antenna while working at a satellite communications terminal. The transmitter serving the antenna was supposed to have been turned off, but another was mistakenly turned off instead. Consequently, the transmitter serving the waveguide Orchitt was working near was delivering about 90 W of power at 6 GHz. Orchitt later filed for workers' compensation benefits claiming he had suffered head, brain, and upper body injuries as a result of overexposure to EM radiation. AT&T disagreed, but after a contested hearing, the Alaska Workers' Compensation Board awarded him temporary total disability and medical benefits.

AT&T unsuccessfully appealed in superior court, alleging that procedural irregularities deprived it of due process and that the board's decision was not supported by competent scientific evidence. AT&T then appealed to the state supreme court, which ruled that substantial evidence supported the compensation board's findings and --because the board's procedural decisions did not deprive AT&T of due process --the superior court's judgment that affirmed the compensation board's ruling should stand.

The lesson here is that while the disability benefits themselves were not huge in monetary terms, the case resulted in a string of expert witnesses on both sides, eight years of litigation, tens of thousands of dollars (or more) in legal fees for AT&T — and still the company lost. Even if AT&T had won, the costs of victory would still have been substantial, perhaps not so much to a Fortune 500 company, but certainly to a small manufacturer without deep pockets. This precedent should be a warning to any company that believes RF safety cannot cost them dearly and that the threat comes only from government agencies directly involved with RF safety.

Step 1: Choose the Right Standard

An organization's important first step is to decide which standard or guidance to follow. In the discipline of RF safety, standards continue to evolve and differ from one another at lower frequencies -- below 100 MHz. However, there is general agreement between them in the microwave region of the spectrum, above about 300 MHz. Most major standards accept a basic Maximum Permissible Exposure (MPE) level of 0.4 W/kg of Specific Absorption Rate (SAR), but do not always agree on the EM field levels needed to create that energy level in the body.

For some organizations there is no decision to be made about standards: FCC licensees must follow FCC limits and the U.S. military usually follows IEEE Standard C95.1: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz[2]. However, all other organizations have a choice. In fact, there are many guidelines adopted by countries throughout the world[3]. The four shown in Table 1 are highly regarded because of the effort expended by the participants in their standards committees or the governments that sponsored them. Any of these standards can be used for establishing an RF Safety Program.

One guideline surprisingly out of date is OSHA's CFR 1910.97, and employers are cautioned that this document employs EM field limits specified by the American National Standards Institute (ANSI) in 1966. Obviously, enormous regulatory and scientific changes have taken place since this time, not only in MPE limits but in recommended engineering and administrative controls as well. Consequently, even though it is an official document of a government agency, it should not be used as a definitive resource.

UNDERSTANDING CONTROLLED AND UNCONTROLLED ENVIRONMENTS

After the FCC issued its latest RF safety rules that took effect in 2000, licensees informed the commission that no standard was available that provided specific guidelines about how an RF safety program should be conducted. This resulted in creation of IEEE Standard C95.7-2005 "IEEE Recommended Practice for Radio Frequency Safety Program, 3 kHz to 300 GHz4, which is now the primary resource that contains all of the elements of an RF safety program for all types of organizations – not just those falling under the jurisdiction of the FCC. Like all standards it is somewhat "dense" in its treatment of the subject and while providing a tremendous amount of useful information, leaves lots of room for interpretation.

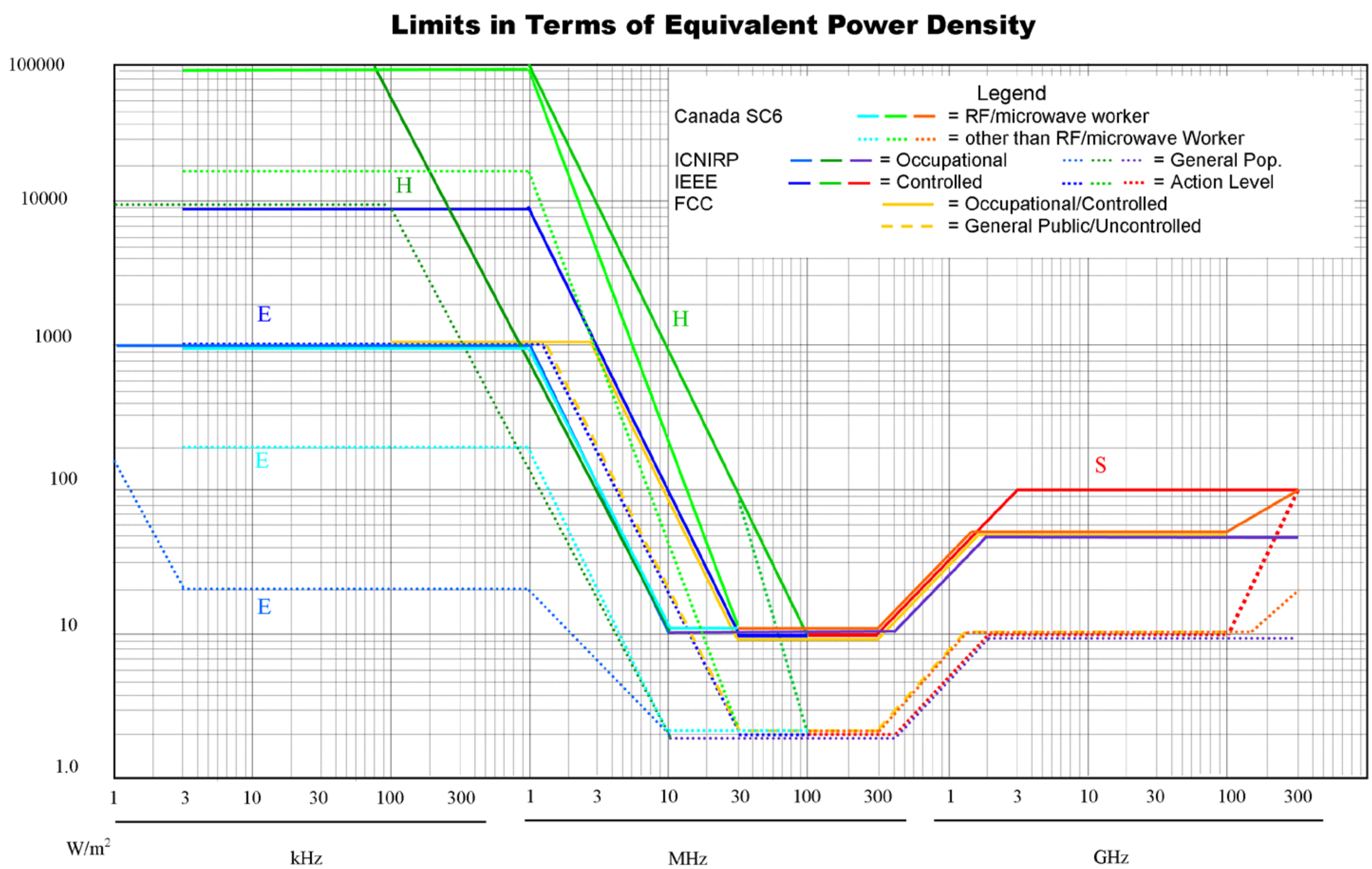


Table 1

Nevertheless, it should be consulted early when an RF safety program is being considered.

IEEE C95.7 is also an essential tool because it is consistent with all standards and guidance's that employ two tiers of exposure: "Occupational/Controlled" and "General Population/ Uncontrolled" (which can be simplified as "Controlled" and "Uncontrolled"). The two differ by the amount of knowledge and control a person has over his or her ability to be overexposed. The more stringent "uncontrolled" rules or guidelines are designed for the public or untrained worker who is assumed to have no control over his or her exposure or any technical knowledge about RF radiation, so permissible exposure levels are more restrictive. "Controlled" exposure levels are less restrictive since trained workers who encounter RF energy in their work know (or should know) what is not safe and how to avoid overexposure. A site at which no RF safety program is in place is considered uncontrolled regardless of the RF levels present, but by adding an RF safety program becomes a controlled environment, raising the acceptable exposure levels to the "Controlled" range.

Controls	Category		
	2	3	4
Engineering			
Site Configuration	✧	✧	✗
Physical Barriers	✧	✦	✦
Administrative			
Signs	✦	✦	✦
Safe Work Practices	✗	✧	✦
Lock-Out / Tag-Out	✗	✧	✦
Control of Source Power	✗	✧	✧
Time Averaging	✧	✧	✗
Personal or Area Monitors	✧	✦	✦
Personal Protective Equipment			
RF Suits, Gloves	✗	✧	✧
Training			
General RF Safety Awareness	✧	✦	✦
Exposure Limits	✧	✦	✦
RF Controls	✧	✦	✦
RF and Medical Devices	✧	✦	✦
Overexposure Incidents	✗	✦	✦
Electro-Explosives	✧	✦	✦
Sources of Additional Info.	✗	✧	✧
Program Audit			
Implementation	✦	✦	✦
Adequacy	✦	✦	✦
Assess Ancillary Hazards	✧	✧	✧

Table 2: Categories of RF Exposure
Legend - ✦ required | ✧ optional | ✗ not applicable

The recommended practice also establishes four categories, into one of which all facilities will fall (Table 2). A Category 1 location contains only RF sources that cannot produce fields that exceed the MPE and do not require an RF safety program. As a general rule, this includes devices emitting 5 Watts or less of RF power because this RF power level is not high enough to produce levels of EM radiation that exceed MPE limits. Categories 2 through 4 are locations that require an RF safety program with increasing levels of controls required depending on their field strength level. As Table 2 shows, the elements required in a safety program increase in direct proportion to the exposure levels likely to be encountered at the location. Items marked as optional muddy the waters somewhat, since their use is left to the discretion of the organization implementing the program.

Step 2:
Perform an Inventory of EM Emitters

The next step is to prepare a detailed list of all the emitters of EM energy at a facility over which the organization has control. Broadcasters must also inventory not just their own emitters at sites they occupy, but also those at these sites over which they have no control (more on this later). Narda Safety Test Solutions has developed a simple, inventory form that can be modified to meet specific situations (Attachment 1).

There are essentially two types of emitters that must be considered: intentional emitters and unintentional emitters. As its name implies, an intentional emitter is one that intentionally emits EM energy as its end product. A broadcast antenna is a perfect example. An unintentional emitter is not intended to emit RF energy but can do so unintentionally because it employs EM energy to perform one or more of its functions. An unintentional emitter could also be a re-radiator on a rooftop or a waveguide carrying high levels of RF power that leaks and sends high levels of EM energy into the environment. While it is relatively easy to calculate fields around a properly-functioning antenna (an intentional emitter), it is much more difficult to calculate the potential effect of a waveguide or heat sealer shield that has failed (an unintentional emitter).

In industrial and medical environments, the task of identifying emitters is less clear cut, since some sources of EM energy may not appear to be emitters at all. For example, induction heaters and welders, vinyl welders, sputtering, and ashing equipment employ high levels of RF or microwave energy to perform their intended functions, but since the RF and microwave functionality is embedded in the equipment, its use is often not readily apparent. Medical equipment such as diathermy machines or electro-surgical devices also radiates EM energy, as do other types of medical diagnostic and surgical equipment. If in doubt about whether a particular device or piece of industrial equipment generates RF energy (and how much), a call to the manufacturer should quickly provide the answer.

STEP 3: Make Measurements

Obviously, an RF safety program cannot be implemented until the areas are identified where potentially hazardous conditions exist and their levels are measured. That's the job of RF safety measurement equipment. Calculations can be effective for establishing a basic idea of EM energy levels that are present, but they are limited because in many environments (like a rooftop), some of the emitters may be controlled by other organizations and calculations cannot be made without information about each one.

For the purposes of selecting the best type of measurement equipment, the facility potentially requiring an RF safety program can be placed into two categories:

Broadcast: Cellular, paging, public safety, broadcast infrastructure, radar, satellite communications uplinks, or other transmitting sites.

Industrial: Primarily manufacturing facilities in which equipment is employed that uses EM energy for some purpose.

While the two types of measurement equipment, narrowband and broadband, can be used in either application, narrowband instruments are increasingly used in broadcast environments, while broadband equipment is generally best suited to industrial applications. The reasons will become clear once the measurement environments and equipment characteristics are described.

CONSIDERATIONS FOR BROADCAST APPLICATION

Making EM field measurements until the early 1980s was a comparatively simple procedure. Standards during this time specified a single MPE level for all frequencies, so antennas employed by EM measurement equipment were equally sensitive at all frequencies and rather simple. To make the measurements, a technician or engineer simply measured the total field strength at various places around the site, and assuming the total was below that mandated by the current applicable standard, compliance was assumed.

If the total field strength was above the specified maximum level, the accepted procedure was "last on-first off", a matter of seniority. That is, the most recent company to add its transmitter to the site was deemed the "problem" and had to remedy the situation. This could mean that the company had to uproot its transmitting facilities and find another location. Of course, since there were fewer multi-emitter sites at that time, only one organization -- the sole occupant of the site – would be affected.

Later in the 1980s, standards became frequency-dependent, reflecting the fact that the human body absorbs radiation more readily at some frequencies than others. This complicated the measurement process because a more complex "shaped" probe (antenna) was required whose sensitivity mirrored the requirements of a particular standard. For example, many standards and guidances then (as now) set E-field MPE limits at 614 V/m (100 mW/cm2) below 1 MHz and 61.4 V/m (1.0 mW/cm2) from 30 to 300 MHz – a difference of 20 dB or 100 times the power at the higher frequencies. To accommodate this, today's shaped probes are 100 times more sensitive in the 100 MHz region than at 1 MHz. As noted earlier, the latest standards have two sets of maximum permissible exposure (MPE) limits instead of one. In addition, a factor called the "5% rule" must be accommodated by FCC licensees. The ability to determine compliance is compounded by the proliferation of sites with multiple emitters, each owned by different organizations.

Fortunately, the introduction of narrowband measurement equipment allows the required measurements to be made regardless of how many services are located at a site. These instruments complement the standard broadband types that were previously the only type available. Nevertheless, broadband instruments may still be a viable option in some cases, so it is important to know when to use each one.

If there is only one emitter at a site, a broadband instrument is obviously the most cost-effective choice because control of the transmitter rests with a single organization and its frequency is known. A broadband instrument may even be acceptable when there are several emitters at a site. For example, a site may have five emitters owned or controlled by a single organization, so their specifications – especially service types and operating frequencies – are known, and the authority to selectively turn each one on and off probably resides with a single person or group.

In other cases, particularly "multi-emitter-multi-operator" situations, a narrowband instrument is really the only practical choice. At a five-emitter site where each emitter is owned and operated by a different organization, there can be several important unknowns, such as the type of service and frequency of operation. In some cases, the owners and operators of these systems also may not be known. Even once information is be obtained, it will generally be extremely difficult or even impossible for a single organization to gain the authority to turn all transmitters on and off for measurement purposes. A narrowband instrument thus makes it possible for any organization wishing to know its contribution and the contributions of others at the site to quickly evaluate compliance.

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

CONSIDERATIONS FOR INDUSTRIAL SITUATIONS

Industrial environments are considerably different from their broadcast counterparts. The equipment emitting RF energy is almost invariably controlled by a single organization, which eliminates the problem faced by broadcasters of isolating specific emitters operated by multiple organizations. In addition, industrial environments, while not static, tend to change far more slowly, as new equipment is added less frequently.

In addition, the measurements required in industrial requirements need not be as detailed as those in broadcast environments because only gross levels of RF emissions need to be considered. As a result, broadband measurement equipment is well suited to these situations. It provides a high level of accuracy and like its narrowband counterpart provides information about the percentage of an applicable standard that an emitter is producing. The narrowband and broadband instruments also share the ability to allow measurement data to be offloaded to a PC where it can be stored and used to perform trend analysis that can identify equipment whose emission levels are gradually increasing over time.

The measurements obtained by both types of instruments will provide definitive information about RF emission levels that will in most cases directly dictate the level of controls that must be instituted.

STEP 4: Identify Exposure Potential and Risk

Once the inventory has been completed and measurements have been made, the risk potential of intentional emitters should be evaluated first, since they emit the highest power levels and pose the greatest exposure potential. This risk assessment can be made considerably easier when the basic principles of failure analysis are applied using Failure Mode, Effects and Criticality Analysis (FMECA). This results in a risk priority number (RPN) that is assigned to the emitters, which provides a starting point for implementing changes or controls. FMECA is not included in IEEE Standard C95.7-2005 but this should be considered only an omission, since FMECA is an extremely valuable in assessing risk at any industrial or broadcast facility. When thoughtfully employed, it provides not only the basis for determining risk, but the rationale for why every element of an RF safety program was established.

THE VALUE OF FMECA

FMECA allows the probability that a failure mode will occur to be charted along with the severity of its consequences. It is an extension of traditional Failure Mode and Effects Analysis (FMEA) that is widely utilized for conducting reliability analyses in virtually industry. FMEA and FMECA may be familiar

<table>
<tr><th>FMECA</th><th>Emitter</th><th>1</th><th>5</th><th>10</th></tr>
<tr><td rowspan="2">Detectability</td><td>Intentional</td><td>Always aware of operation, signs present</td><td>Sometimes aware of operation, signs not always present</td><td>Never aware of operation, hidden antenna, no signs or safety program</td></tr>
<tr><td>Unintentional</td><td>Multiple interlocks or shielding</td><td>Single Interlock or passive shielding</td><td>No Interlocks, signs, shielding or awareness of failures</td></tr>
<tr><td rowspan="2">Severity</td><td>Intentional</td><td rowspan="2">Low (< action) exposure level potential</td><td rowspan="2">Medium (> action) exposure levels</td><td rowspan="2">Can or will expose persons to higher than allowed limits</td></tr>
<tr><td>Unintentional</td></tr>
<tr><td rowspan="2">Occurrence</td><td>Intentional</td><td>Emitter is only used < 10% of the time or not normally accessible</td><td>Emitter is accessible to persons sometimes, during maintenance</td><td>Emitter is mounted in an accessible area with minimal barriers or restriction to access</td></tr>
<tr><td>Unintentional</td><td>System rarely exposes persons due to design</td><td>System has failed in the past or may fail without any other notice</td><td>System has failed in the past and no design changes have been implemented</td></tr>
</table>

Table 3 Suggested Multipliers for RPN

to any organization that has been through the certification process for ISO 9001, QS 9000, ISO/TS 16949, or Six Sigma, or when implementing FDA Good Manufacturing Practices (GMPs), since it is a fundamental task required by each one. FMECA builds on FMEA by focusing on the level of criticality (severity) and probability of occurrence that is assigned to each probable failure mode.

The goal of using FMECA is to reduce or eliminate failure modes with high severity and probability. It lets an organization identify the areas of an industrial or wireless facility that have the greatest potential for overexposure to EM energy. Equally important, FMECA allows the places where remedial actions will provide the greatest benefit. A FMECA analysis can be recorded on a simple paper form, in an Excel spreadsheet, or with commercial software designed specifically for the purpose. The level of detail in a FMECA analysis depends on the complexity of the system being analyzed and in some cases can be very complex. Fortunately, this is rarely the case when used in creating an RF safety program.

To perform an analysis using FMECA, values for Detectability (D), Severity (S), and Occurrence (O) are calculated on a 10 point scale of increasing importance and an RPN is obtained by multiplying them. The first question many people ask is how these values are obtained, since on first inspection the process may seem completely arbitrary. In truth, the process is to some degree arbitrary. However, the more that is known about a particular emitter and the modes that can potentially allow it to cause harm, the less arbitrary the process becomes. Armed with the failure scenarios for the identified intentional and unintentional emitters, it is relatively easy to apply a value to for Detectability, Severity, and Occurrence with a high degree of confidence. Table 3 includes some suggested multipliers that can be used to calculate RPN.

A waveguide system operating at 10 GHz with 50 Watts of power is a good example. At this power level, a leak can be felt, so Detectability could arguably be 5, a middle value that does not reflect other factors such as pressurization (or the lack of it). In addition, Severity would be 10 because 50 Watts is enough power to potentially overexpose someone close by. Occurrence could be assigned a value of 5 if the waveguide is of the flexible type and mounted outside where it is exposed to the elements and potential tampering or unintentional damage.

However, if the waveguide is unpressurized there is an inherently greater level of risk because a leak in a pressurized system will be detected by the system's sensors and will send an alert to someone who can provide a remedy – assuming the system is correctly designed. An unpressurized system can leak for a long time without being noticed since there is no inherent method of detection. Consequently, a Detectability value higher than 5 would be assigned to an unpressurized system, and a lower value to a pressurized system, since it inherently provides a level of control.

Reducing the RPN that results from assignment of the initial values of Detectability, Severity, and Occurrence can be accomplished with administrative controls, engineering controls, or both. For example, if the area around either type of waveguide is protected from unauthorized entry or posted with clearly-labeled signage, this would reduce the value for Occurrence. Pressurizing an unpressurized waveguide system would allow the Detectability element of the RPN to be lowered. In addition, employing an area RF monitor with battery backup that sends an alert to someone when specific EM field levels are exceeded would further reduce the RPN. The use of administrative and engineering controls is discussed in detail later in the RF Safety Guide.

STEP 5: Initiate a Program

If an RF safety program is required, several basic activities must be performed to create its framework. First and foremost, it is essential to understand that from a legal perspective an RF safety program does not exist if its presence cannot be documented. The first thing any inspecting agency or attorney will ask for is proof that such a program exists. The program must not only be documented but must be continually updated with notations about all activities or events that occurred after it was established. In Table 2, which identified program elements according to the safety program categories, the check list covers everything from administrative details to performing an inventory of potential hazards, exposure assessment, administrative and engineering controls, measurements, training, the use of protective equipment, and periodic auditing of the program.

An RF safety program involves employees at several levels of the organization. It must be endorsed and made mandatory by corporate-level management, understood by all managers whose direct reports and vendors are exposed to EM energy in their work, by the RFSO (Radio Frequency Safety Officer) whose job it is to administer the program, by the RF safety committee (optional) that works together with the RFSO to ensure the program is carried out, and most important, by all employees of the company who could potentially be exposed to EM energy in their work.

The duties of the RFSO are not trivial, since he or she is responsible for administration of the entire program, which can include facilities in multiple locations and potentially hundreds or thousands of employees. This requires comprehensive training in RF safety awareness and a reasonable understanding of all elements of RF exposure. This level of training is available from consulting organizations as well as from Narda Safety Test Solutions. Once the RFSO has been trained, the process of training the others involved in safety program administration and ultimately the employees themselves can begin. In organizations with the greatest number of affected facilities, it is often wise to increase the members of the RF safety committee proportionately to ensure the program is properly administered.

Once the program has been created, it must be periodically audited to ensure it still reflects the current situation, is it still needed, or if it should be improved. This is especially important in broadcast (cellular, paging, public safety) "co-located" environments with multiple licenses. Changes to the equipment at these sites can change without notice to the organizations with antennas there, so periodic inspection (and proof that it was performed) are essential. Every licensee at the site must have an RF safety program that will pass muster by the FCC or other government agency at any time.

In every case, the most important ingredient in assuring the success of an RF safety program is discipline. Without it the program will fail to provide the required level of protection to employees and will not hold up under scrutiny if the organization is challenged in court.

STEP 6: Institute Controls

The next step will be to implement controls, the level of which is determined by the level of risk assigned to the facility. Two major types of controls are typically employed: engineering and administrative. Engineering controls are changes or modifications designed into the system. An example of an engineering control would be raising an antenna or moving it to the edge of the roof where people cannot normally get in front of it. Pressurizing waveguide is an engineering control, as are system interlocks designed into vinyl welder shields. Engineering controls are almost always favored over administrative controls because they provide definitive "engineered" solutions.

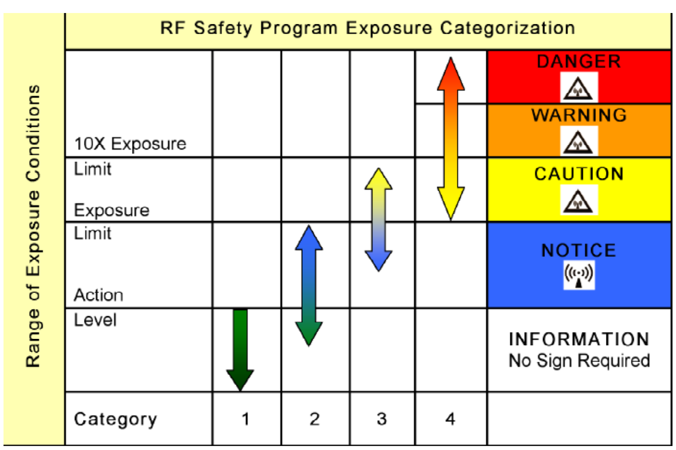


Table 4 Signage vs Exposure Levels

Administrative controls include signs, barriers, and RF monitors (personal and area). They can be used where engineering controls are not possible, such as when local zoning restricts antenna height. In this case, there may be no choice but to erect barriers and post signage in front of the antennas in order to control the areas directly in front of them. However, be careful posting signs without a clear plan and good reasons for their location and what they say. Table 4 shows the level of sign verbiage and graphics required at various RF exposure levels. To be effective, signs must be deployed consistently, and it is as detrimental to "over-sign" as it is to "under-sign" a location.

The IEEE standard allows an organization to insert its own text under the warning symbol, which is a great advantage in some complicated environments. Custom signs are widely available from vendors on the Web that can include site-specific safety procedures in multiple languages. These specialized signs can significantly improve an RF safety program with clear, consistent messages. Common practice on a rooftop with RF emitters is to place a "NOTICE" sign at the entrance(s) to the roof and "CAUTION" sign(s) where needed to "educate" the user as to what areas of the roof should not be entered.

If this practice was undertaken and updated on every rooftop containing RF emitters, everyone would have the knowledge required to avoid overexposure. However, this is generally not the case when multiple wireless licensees occupy a rooftop, since someone would have to take the responsibility of providing the signs on behalf of all parties. Consequently, many wireless carriers require their employees and contract workers to wear personal RF monitors, since they have no idea how well signs on a rooftop depict the actual situation, and they have no control over or knowledge of the rationale for their placement. A wearable RF monitor's purpose is to immediately alert the wearer when he or she approaches an area in which high levels of EM energy are present. An RF area monitor is mounted near a probable leakage source, continuously monitors for excess leakage, and alerts via remote control if conditions change or an event occurs.

When implementing a safety program for a Category 3 or 4 emitter such as a broadcast tower, multiple controls should be employed, beginning with signs on the tower where EM energy levels warrant. Standard RF monitors that alarm at or below the limits of permissible exposure are not effective controls because they will continuously alarm. An alternative is RF clothing and RF monitors that alarm at a higher threshold. However, it may be easier to simply restrict access to those areas of the tower where high levels of EM energy are present. The RF safety program can also specify certain areas of the tower that can be approached when the main antenna is being used and other areas that can be accessed when a standby antenna is in use. Commonly-accepted "lock-out/tag-out" procedures are an effective safety control for sites emitting the highest power levels.

Table 2 provides typical controls that can be implemented based on specific EM energy levels. Engineering controls such as barriers are well suited for wireless licensees that exceed the exposure limits because FCC rules must be met, even though the IEEE standard calls the controls "optional". For that reason, they are labeled in the table as "required" for Category 3 emitters.

Training

Training is a fundamental, essential element of every RF safety program, without which no program can be successful. Unfortunately, the quality of training provided to employees is directly related to the quality of the trainer. Many "trained" employees are either taught the wrong information or simply do not get any useful information at all. Training should include basic information about EM radiation, potential health effects, standards, and information about the controls to be employed, such as signs and personal RF monitors, and what to do when personal monitors alarm. Employees also need to know what to do when they suspect they have been exposed to high levels of EM energy and that they should let the RFSO know if they have implanted metal or medical devices.

Summary

After reading this far, it should be apparent that RF safety is an important issue for any organization in which EM energy is employed, both to protect employees, contractors, and the public, and the organization itself. The most technically difficult task in creating an RF safety program is the process of selecting the category into which the organization falls because in most cases it cannot be done without making comprehensive RF field measurements and interpreting the results.

The most challenging task overall is implementing the program, from assigning and training the RFSO through creating the administrative procedures, and training employees. However, in the long term, the most daunting task for most organizations is ensuring that the program is properly administered, which takes discipline and a corporate commitment to RF safety. Nevertheless, even though this commitment may never be challenged, it only takes a single accident to drive home the point that the effort was worthwhile.

To become more knowledgeable about RF and microwave technology, RF safety programs, standards and guidances, and other related topics, the resources in the References and For Further Reading sections provide a wealth of information. In addition, Narda Safety Test Solutions, which has been intimately involved in the field of RF safety for more than 40 years, can answer any questions about these or any other topics.

References

1. Supreme Court of the State of Alaska: AT&T Alascom v. John Orchitt and The State Of Alaska, Department Of Labor And Workforce Development, Division Of Workers' Compensation, http://www.emrpolicy.org/litigation/case_law/docs/att_alascom_v_orchitt.pdf.

2. IEEE Standard C95.1-2005: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, http://ieee.org/web/standards/home/index.html.

3. "Index of EMF Standards," World Health Organization, http://www.who.int/docstore/peh-emf/EMFStandards/who-0102.

4. IEEE Standard C95.7-2005: IEEE Recommended Practice for Radio Frequency Safety Programs, 3 kHz to 300 GHz, http://ieee.org/web/standards/home/index.html.

FOR FURTHER READING

FCC Office of Engineering and Technology, Bulletin 65, 08/1997, http://www.fcc.gov/oet/info/documents/bulletins/#65.

Attachment #1

Electromagnetic Applications Questionnaire

Organization Profile

Organization ____

Address ____

City ____________________________ State ______________ Zip Code ________________

Individual Completing Form

Name __________________________________ Title ______________________________

Phone Number (____) ____________________ Ext. ________ Fax (____) ________________

E-mail ____

Number of Employees ______________

Brief description of organization (products, services, etc.)

____

____

____

Number of completed forms enclosed: Form A __________
Form B __________

Date questionnaire completed ______________________

A Practical Guide for Establishing an RF Safety Program

FORM A MANUFACTURING

1. Person completing form:
   - Organization ____________________
   - Name____________________
   - Title/Dept. ____________________
   - Telephone/ Ext. ____________________
   - E-mail ____________________
   - Date Completed ____________________

2. Does your facility utilize any of the following devices?

	YES	NO
a. Flow solder machines	____	____
b. Induction Heaters	____	____
c. Plasma etching or cleaning	____	____
d. Heat Sealers, Vinyl Welders or High Frequency Welders	____	____
e. Matcal soldering irons	____	____
f. Sputtering Equipment	____	____

3. If yes to any questions above, have the systems been surveyed for electromagnetic leakage at any time?
   If so, when and by whom? (Attach report if available)

____

____

4. Do you know if you have any other systems that may generate electromagnetic fields, or if you have any devices you are unsure of, please list them below.

____

____

FORM B:
ENGINEERING, RANGE MAINTENANCE, OPERATION, TEST, CALIBRATION/METROLOGY AND Q.A.

1. Person completing form:

Organization ______________________________

Name ______________________________

Title/Dept. ______________________________

Telephone/ Ext. ______________________________

E-Mail ______________________________

Date Completed ______________________________

2. Is your department involved in the Engineering, Range Maintenance/Operation, Test or Quality Assurance of any of the following types of systems?

	YES	NO
a. RF or microwave amplifiers (Power out > 5 Watts)	____	____
b. Radar Systems	____	____
c. Elec. Warfare (EW) systems	____	____
d. Telemetry Systems	____	____
e. Navigation	____	____
f. Communications (Power out > 5 Watts)	____	____
g. EMC Immunity or Susceptibility (> 10 V/m)	____	____

3. If yes to any question above, please give a brief description and nomenclature, if applicable (if classified, list "classified").

____

____

FORM B continued

4. Emitters: Please fill in a line for each source of RF energy with greater than 5 watts of output power. Attach additional forms if required.

Emitters	Frequency Range (Check all that apply)				Power Range		
	< 30 MHz	**30 to 300 MHz**	**0.3 to 3 GHz**	**> 3 GHz**	**5 to 100W**	**0.1 to1 kW**	**> 1 kW**
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

5. Do you know if you have any other systems that may generate electromagnetic fields, or if you have any devices you are unsure of, please list them below.

narda Safety Test Solutions an L3 communications company **USA • Germany • Italy**
USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www**.narda-sts.us

Measuring RF Levels at Multisignal Sites

The FCC's rules concerning acceptable levels of RF emissions require new measurement techniques and RMS detection to ensure compliance in complex multitransmitter signal environments.

Anguish is a familiar response to FCC rulings, and industry concerns were in ample supply when the FCC issued its guidelines for human exposure to RF emissions back on Aug. 1, 1996. The release was first greeted with silence and then with a cacophony of comments ranging from general acceptance to disagreement with specific elements of the guidelines.

That is not surprising, considering the difficulty that today's multi-emitter transmission sites present to accurate RF emissions measurements. Multiple emitters dramatically complicate the measurement process, and it is quite easy to make measurements that appear accurate but are, in fact, quite the opposite. However, the shaped response probe, when used with an accurate RF radiation measuring instrument, provides true RMS detection and allows the operator to quickly determine compliance with FCC radiation exposure standards.

A Complex Situation

The human body is a thermal entity that responds proportionally to RMS energy levels. The major human exposure standards used throughout the world, such as IEEE C95.1-2005 and National Council on Radiation Protection (NCRP) Report 86, are based on controlling the RMS level of exposure an individual receives. This level is averaged over the whole body during a period of time, typically six minutes. The FCC originally planned to adopt the IEEE standard but essentially adopted the NCRP standard instead.

The instruments used to make these measurements increasingly rely on digital circuitry, relegating the RF (analog) portion of the measurement only to the probe. Both in appearance and ease of use, these instruments are a vast improvement over their analog predecessors. However, it is easy to assume that because they display values in digits rather than with an analog meter, they are fundamentally more accurate.

In practice, the digital display portion of the instrument is the smallest contributor to measurement uncertainty. Performance of the probe, which is the signal gathering portion of the instrument, is the true determinant of overall accuracy. As a result, the probe is the most crucial part of an RF radiation measurement system, and its characteristics have more impact on data quality than any other element. The probe's importance becomes even more crucial when employed in dense signal environments.

The fact that data gathering must be conducted in the field at sites where there are other transmitting systems besides the one to be measured compounds measurement difficulties. The emitters may also operate at different frequencies, invoking more than one level of acceptable exposure as defined by today's frequency-dependent standards. The person making the measurement must accurately determine the contribution of the individual signals, total the energy from all emitters, and weigh the resulting information according to its relevance to the standard. If there are many emitters, this can take a long time.

The antennas for these systems are usually located within a stone's throw of each other. Without the ability to discriminate among signals, it is almost impossible to determine the radiation level of a specific emitter. In addition, diode detectors that have often been used for electric and magnetic field measurements in the broadcast industry have characteristics that make their accuracy questionable in these applications.

The Need for True RMS Detection

The easiest way to design a probe to measure electric field intensity in the broadcast and communications bands below 3 GHz is to use simple diode detectors coupled to a dipole antenna. Most instrument manufacturers use three sets of detectors to build an isotropic, or omnidirectional, field probe. The measurement practices standard, IEEE C95.3 2005, requires that measurements be made independent of polarization, preferably with isotropic probes.

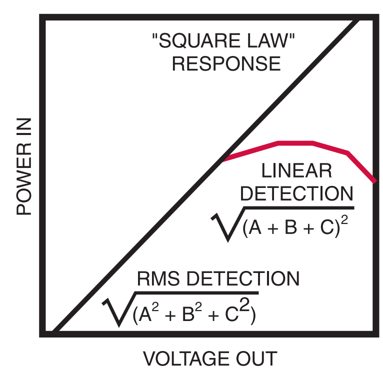


Figure 1. RMS vs Linear Detection

A peculiar characteristic of diode detectors used in isotropic probes is that they can become linear, or rather, stop functioning as an RMS detector, at high input levels as shown in Figure 1. Some manufacturers of RF radiation measurement systems use squaring circuits to compensate for the diode operating in the linear region. This design approach can greatly overestimate actual field strength in multisignal environments. The greater the number of emitters, the greater the error. This error is typically 1 dB to 2 dB when there are two or three emitters; however, when many emitters are present (an increasingly common occurrence), these probes can indicate field strengths as much as 10 dB greater than are actually present. This is especially true when the signals are of the same magnitude.

The implication of such gross errors is significant:

- The cost of correcting the phantom problem can be high.
- Implementing operational limits is at the least undesirable, and at worst unacceptable.
- It is possible to believe that a given transmitter is out of compliance when it is not.

It is essential, therefore, that the measurement system have the ability to make true RMS measurements. Some Narda probes use a patented technique in which the diode detectors are always kept in the square law region without the use of squaring circuits. This design is referred to as compensated diode detection.

Frequency Dependent Standards

An accurate RMS measurement of the total emissions level, with all emitters operating at maximum power, provides an accurate quantitative value but may not yield the answer to the most important question: whether the level is compliant with a given exposure standard. This problem occurs because maximum permissible exposure (MPE) limits in the major standards vary by 20 dB over the communications bands as shown in Figure 2.

If the measured value is below the most restrictive level, which normally occurs in the 30 MHz to 300 MHz band, a true RMS measurement from a conventional "flat response" probe will provide all the required information; however, if the measured value is greater than this limit, the site or area may still be compliant, depending on the relative contributions from signals outside this human resonance region. It depends on how much energy is contributed by each emitter.

For example, a site with AM, FM, and UHF pager signals simultaneously broadcast may produce a level of 5 mW/cm^2 in the instrument. Assuming a relatively small portion of the energy is from the FM antenna, and most of the energy is contributed by the AM antenna, then the overall value of 5 mW/cm^2 may still be in compliance, even though the limit for 30 MHz to 300 MHz is typically only 1 mW/cm^2.

This effect is demonstrated by comparing the signal levels shown in Figures 2 and 3. In each figure, a total power of 5 mW/cm^2 was measured, but Figure 2 shows a level of 71% of the standard, while Figure 3 shows 169% percent of the standard.

But how can the portion of the energy produced by each emitter be determined? Traditionally, there have been two solutions to this problem. The first is to turn off all of the emitters except one and make measurements of each emitter; however, cost constrictions have forced engineers to abandon Sunday night maintenance sessions conducted when traffic is light, so selectively turning off emitters becomes less of an option. In addition, today's competitive communications marketplace makes complete emitter shutdowns intolerable at any time.

The second solution involves making measurements with narrowband equipment like Narda's new SRM-3000 system. Used by government agencies to correctly detect strengths of individual signals, the SRM-3000 allows fast, portable and accurate measurements. The SRM can perform spatially averaged measurements in accordance with FCC requirements, a first for narrowband systems.

Shaped Probes

The introduction of shaped frequency response probes reduces the chance for error in making RF radiation measurements in multisignal environments, and simplifies the measurement procedure.

All probes are defined by whether they measure the electric or magnetic field, their frequency range, their power measurement rating, and whether their frequency response curve is flat or shaped. A shaped probe is a sensor with a frequency response curve that is "shaped" to mimic the requirements of a major standard, such as IEEE C95.1-2005 or ICNIRP. In contrast, a conventional probe is designed to have a flat frequency response throughout a broad operating range to ensure that its response is the same at all frequencies.

In the shaped probe shown in Photo 1, the energy of all the signals is weighted in accordance with the requirements of the standard, and the results are displayed as a Percent of Standard. The only considerations when using a shaped probe are ensuring that all systems at the site are operating at or near maximum power and that the probe is shaped to the correct standard.

A typical shaped probe has a full-scale range of "300% of standard." In IEEE C95.1-2005, this means the probe can measure three times the MPE that the standard allows in controlled environments. As a result, it requires 300 mW/cm^2 from an AM radio station (where the standard allows 100 mW/cm^2) to generate the full scale output from the probe. In contrast, it takes only 3 mW/cm^2 at VHF television or FM radio frequencies to generate the same output. The shaped probes are calibrated at several frequencies in the same manner as flat response probes.

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

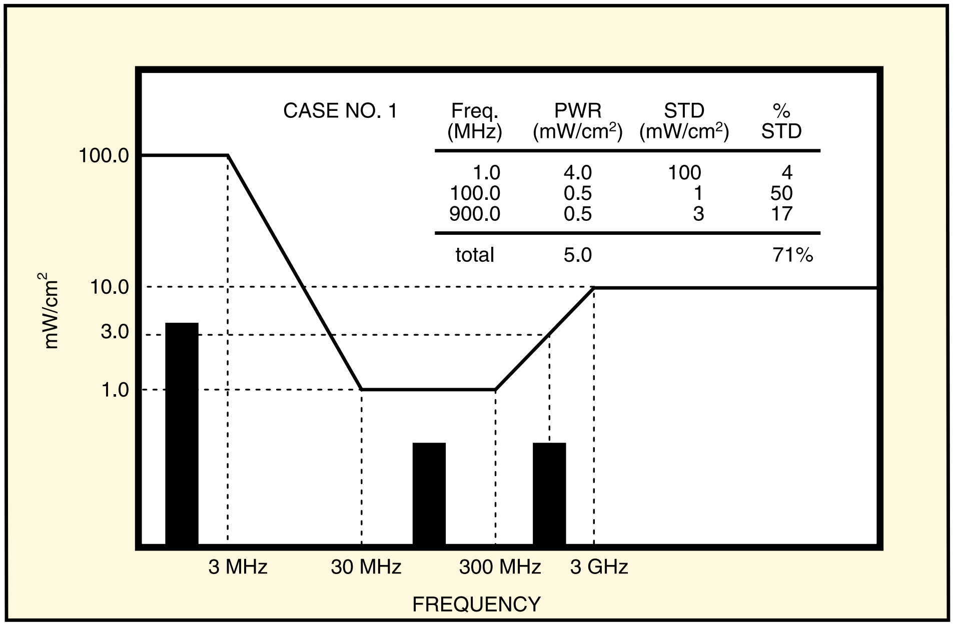


Figure 2.

In this example, three emitters combined to have a total field strength of 5 mW/cm^2 which equals 71% of the standard.

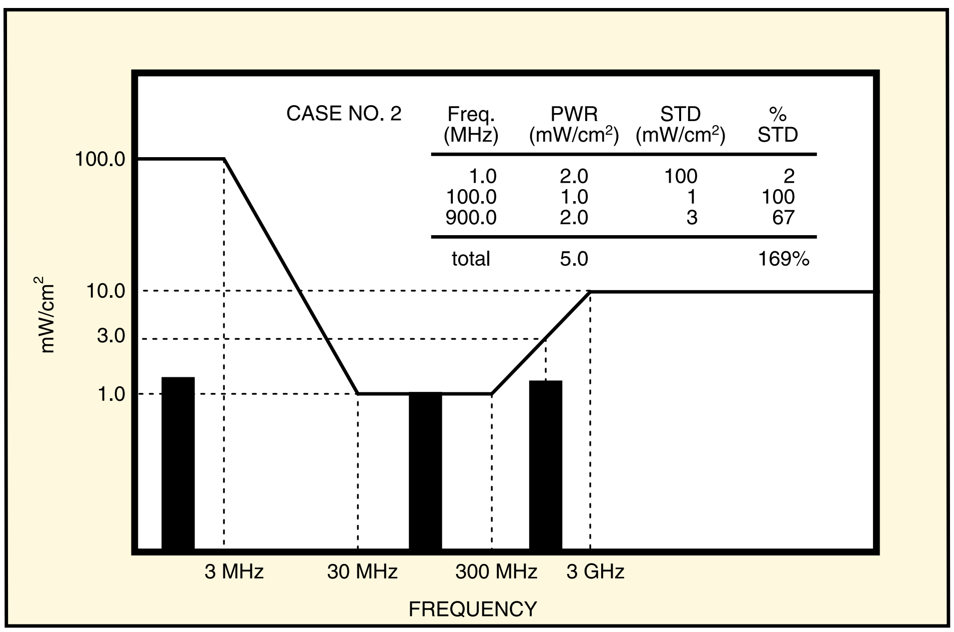


Figure 3.

This example shows the same three emitters as in Figure 2 with the same total field strength. However, this energy distribution results in 169% of the standard.

Photo1.

A shaped probe is physically a little larger than a standard NBM Series isotropic probe. The difference between the two lies in the shaped probe's frequency response curve, which is "shaped" to mimic the requirements of a major standard.

Measurement Uncertainty

Several factors contribute to measurement uncertainty. The first is frequency response, which is typically ±1 dB to ±2 dB (±25% to ±55%). Every probe has a certain amount of frequency response deviation, which is the amount of deviation from the correct measured value that a probe yields at various frequencies.

The smaller the deviation, the greater the accuracy. In a flat response probe, the amount of frequency response deviation is compared to the ideal (a straight line), where a shaped probe is evaluated by how far it deviates from the standard it is designed to mimic. A certain amount of frequency deviation is unavoidable, so it is important to calibrate the instrument at as many frequencies as possible.

Frequency response errors can be minimized by using a correction factor. Correction factors cannot be universally employed. They can be used when there is only one emitter being surveyed, when there are multiple emitters operating at the same frequency (encountered when measuring industrial equipment) and when there are multiple emitters operating at frequencies close to each other in the spectrum (assuming the nearest calibration frequencies have similar correction factors).

When the frequencies of the emitters are diverse, however, there is no way to determine the distribution of energy from the various emitters. So a correction factor should not be used because it could compound the error.

Ellipse ratio is the ratio of readings that occur when the probe is rotated around the axis of its handle, and is typically ±0.75 dB. Narda probes are calibrated in this manner, by rotating the probe about its axis and using the mean value for the correction factor. The correction factors are included on the handle of the probe.

Calibration uncertainty adds another 0.5 dB, and the meter itself varies no more than 3%. Isotropic response is the error that occurs when the probe is pointed in different directions and includes the ellipse ratio and some additional uncertainties. The isotropic response is generally no greater than the ellipse ratio, as long as the probe is pointed toward the source. A good rule of thumb is that the total uncertainty is no greater than ±3 dB, without the use of factors (the worst case).

With a shaped probe, which has a frequency response of ±2 dB, an indication of less than 50% of standard is certain to be compliant, while an indication of greater than 200% is certain to be out of compliance. In actual practice, the areas that fall into this window of uncertainty are quite small. In the worst case, narrowband measurement techniques can be employed to resolve the problem if these narrow areas are deemed operationally important. A good method of mapping the area where compliance is guaranteed is to set the meter to alarm at 50% of standard and quickly map the area. In this manner, the resultant plot can be used to determine compliance.

Summary

The density of systems operating from a single tower or rooftop location is increasing every year. This complex signal environment makes it extremely difficult to accurately determine whether the radiation present at the overall site is in compliance with standards such as IEEE C95.1-2005 and NCRP Report 86, in which MPE limits vary with frequency.

Probes with shaped frequency response curves, along with RMS detection, make compliance with FCC guidelines more accurate in complex multisignal measurement environments. Together with a well-administered RF radiation safety program, they allow regulatory compliance to be confidently demonstrated.

narda Safety Test Solutions an L3 communications company **USA • Germany • Italy**
USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www**.narda-sts.us

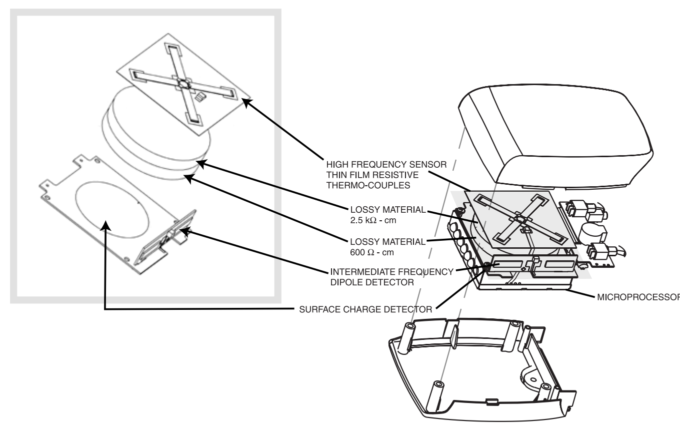
Ultra-Wideband

Electromagnetic Radiation Monitor

This paper was presented by Edward Aslan at the Bioelectromagnetic Society (BEMS) annual meeting in St. Paul, MN, June 2001. It describes the development of the Nardalert XT personal monitor.

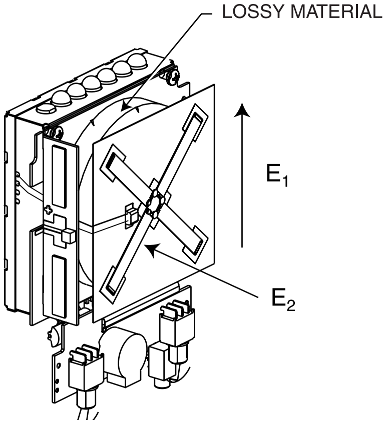
Abstract

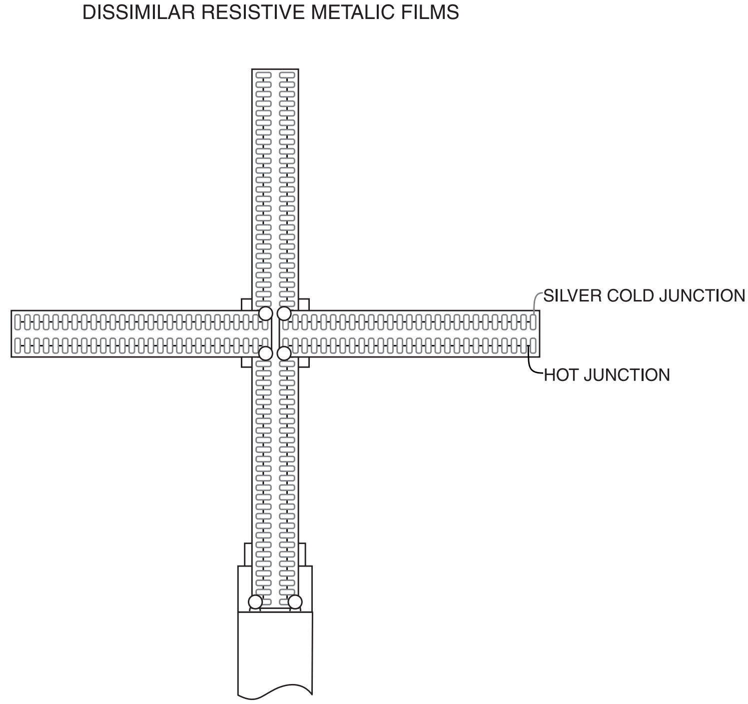
Personal radiation monitors of the prior art are effective only within a kilohertz, megahertz, or a gigahertz range, a predetermined high frequency range, or a predetermined low frequency range. Attempts to fabricate radiation monitors with a capability of detecting electromagnetic radiation in two or more of these ranges have met with great difficulty in the past. This problem is primarily due to interference between various high and low frequency components of the monitor that detect different bands of frequency within the desired bandwidth. This problem has been solved by designing a monitor that includes a low frequency surface charge sensor, a planar array of thin film thermocouples comprising the high frequency sensor, and a lossy material sandwiched between the two sensors. The surface charge sensor responds to electromagnetic radiation from 100 kHz to 1 GHz. The high frequency sensor responds to frequencies from 300 MHz to 100 GHz. The low frequency sensor, in addition to the surface charge sensor, has a vertical dipole. This dipole functions over the range of 10 MHz to 1 GHz for operation in vertically polarized fields. Horizontally polarized fields are monitored by the surface charge sensor when the wearer turns and the field is perpendicular to the sensor disc surface. The monitor functions as a protection device for horizontal, vertical and radial fields below 1 GHz. Above 1 GHz the sensitivity to radial fields is reduced, even with the 90 degree rotation of the wearer. Radial fields above 1 GHz are not significant as a potential hazard, since they predominate for less than 1/6 of a wavelength from the radiator. The frequency response of the monitor is shaped to the MPE of one of the exposure standards. Both sensors operate in their square law region. The alarm threshold varies with frequency and is appropriate for each standard independent of frequency or the number of signals. The control circuit incorporates a microprocessor that permits data logging, dual thresholds, and the ability to adjust both alarm levels, and logging rate.



The assembly drawing shows the complete sensor assembly. It consists of three independent sensors. The low frequency region (0.1-1000 MHz) is monitored by a surface charge sensor responsive to radial E fields. The radial E field at short distance from the radiator predominates to a distance of 1/6 of a wavelength or has a magnitude of the same order as the tangential field. The surface charge sensor also responds to horizontal polarized fields when the sensor is oriented at right angles to the Poynting vector.

Soft cases used by climbers and in severe weather





The surface charge sensor functions when the electric field is perpendicular to the surface of the sensor. This produces a time varying charge on the parallel surfaces of the sensor, with a resultant current which correlates with the rate of change of the electric field in the dielectric between the conductive surfaces of the sensor.

In the 10 MHz to 1000 MHz region, the vertically oriented dipole will respond to vertically polarized fields. The dipole and the surface charge sensor have filter networks or shaping circuits positioned between their outputs and their detector diodes. These circuits alter the frequency response to correspond to the exposure standard.

The high frequency region, 1 to 100 GHz, is monitored by the thin film thermocouple dipole antenna, which is both antenna and detector.

The surface charge sensor is separated from the high frequency thermocouple sensor by layered lossy material, having resistivities of 600 ohms - cm and 2500 ohms - cm.

For the E field parallel to the lossy material (E_1), loss and dissipation in the material will be far greater than the loss and dissipation for the E field (E_2) that is perpendicular to the lossy material.The lossy material at low frequencies is virtually transparent.

The high frequency elements are thin film high resistance dipoles normal to the E field that is to be sensed by the surface charge sensor. As such, they too will appear transparent.

At higher frequencies the lossy material will be effective and dissipate energy, reducing the scattering from the surface charge sensor.

The entire unit has a high resistance coating in the order of 300 k ohms/square. This prevents false triggering due to electrostatic discharge, but will not affect the frequency response.

The equivalent circuits of the three sensors each contain shaping circuits to adjust sensitivity over the frequency range to conform to the FCC standard, or any other standard such as the IEEE, or ICNIRP.

The lumped equivalent circuit of the thin film thermocouple appears as a low “Q” resonant circuit. Adjusting the element resistance determines where the low frequency roll-off will occur. Each dipole of the element is made of a series of resistive thermocouples. The cold junctions are conductive silver films having a geometry equal to a fraction of a square. They will not dissipate any RF energy, and will therefore remain cold. The hot junctions are fabricated of resistive dissimilar metallic films. They will dissipate energy with a resultant increase in temperature and the generation of a thermoelectric voltage. The hot and cold junctions are separated by a distance of less than one millimeter and therefore will be independent of ambient conditions.

In the surface charge sensor, sensor R8 provides the roll- off in the frequency response of the monitor above 1000 MHz. The combination of resistor R1, capacitor C2 and the parallel

narda Safety Test Solutions an L3 communications company USA • Germany • Italy
USA TEL: (1) 631 231-1700 • FAX: (1) 631 231-1711 • E-MAIL: NardaSTS@L-3COM.com • www.narda-sts.us

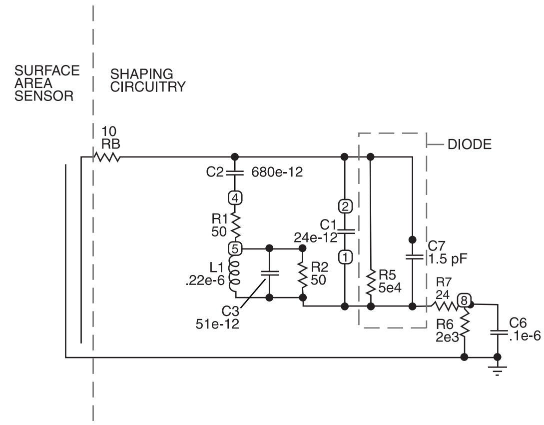
arrangement of capacitor C3, L1 and resistor R2 provides the low frequency roll-off below 30 MHz. Capacitor C1 across the detector diode provides the flat response between 30 and 300 MHz. The flat response below 3 MHz is determined by C2. The dipole mid-frequency sensor is a resistive dipole that contains circuitry to mirror the FCC standard.

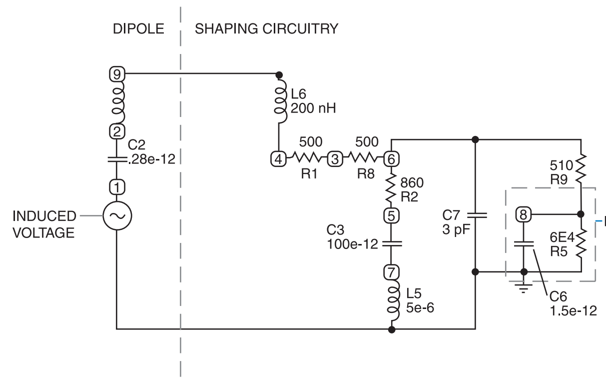
The dipole resistances R1 and R8 together with capacitor C7 provide the high frequency roll off. Components R2, C3, and L5 provide the required frequency response from 3 MHz to 30 MHz of 20 dB per octave. The flat response from 30 MHz to 300 MHz is provided by capacitor C7 and the dipole capacitance C2.

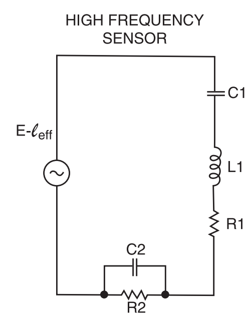
The frequency response of the monitor is shown with the FCC standard and the +1/-3 dB tolerance bracketing the response curve. The theoretical useful measurement range extends to about 140 GHz. Its performance at 94 GHz was confirmed at Brooks AFB in San Antonio, Texas (see application note "Making Measurements from 50 GHz to 100 GHz").

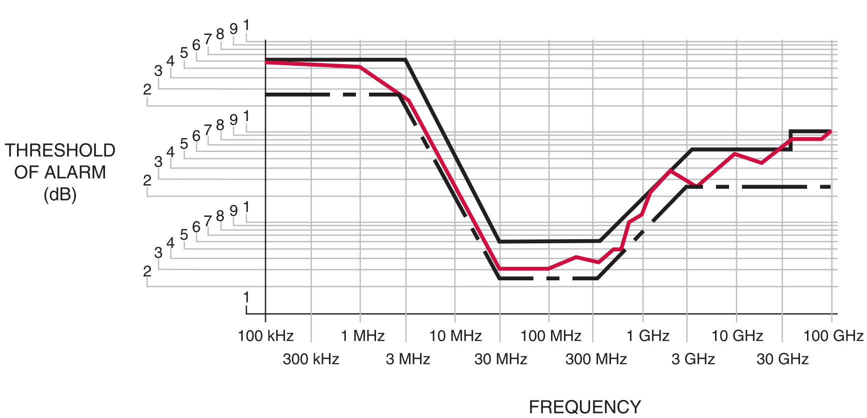
The internal circuits operate from a 3-volt regulated supply powered by an AA battery. A separate 1.5 volt button cell powers the real time clock circuit. The audio and vibrator alarms, which draw the most current, operate directly from the AA battery.

The two sensor inputs feed two low noise operational amplifier circuits. The output of these two circuits are calibrated in terms of Percent of Standard. The monitor makes 32 measurements per second. The entire system operates on a one-second basis. The two, one-second average percentages are summed by the microprocessor. The total Percent of Standard is used throughout the monitor to determine which indicator LEDs are illuminated, whether an alarm is activated, and which values are stored as a part of the data logging function. Data is stored in a non-volatile memory in blocks of 256 bits of information. This is made up of 249 data points plus seven bits of "header" information. Each header includes: date, time, Alarm 1 level, Alarm 2 level, and the logging interval.

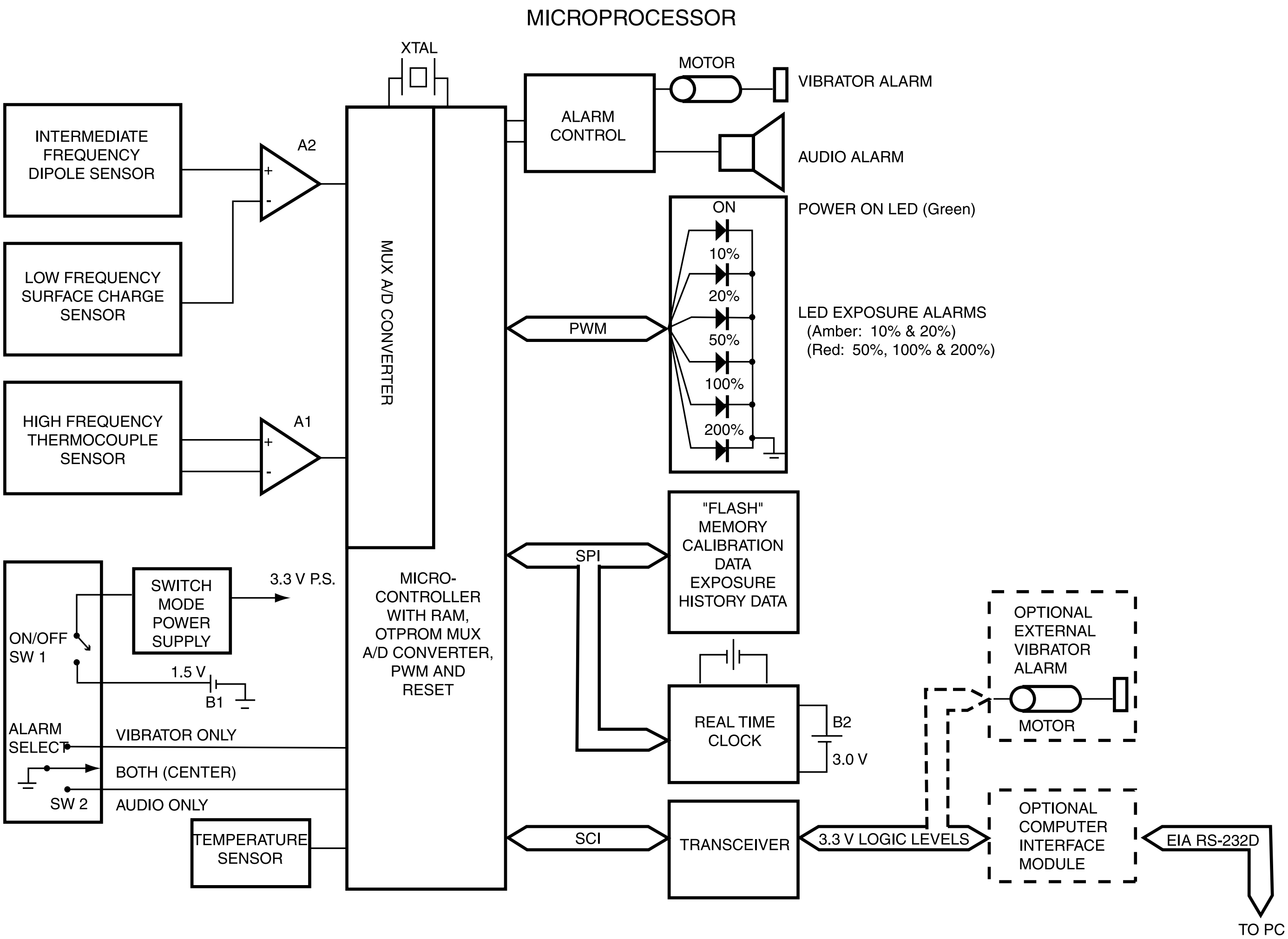








Electromagnetic Radiation Monitor



BIBLIOGRAPHY

1. Aslan, E. "*Radiation Hazard Detector,*" U.S. Patent No. 4,611,166, Sep. 9, 1986.
2. Wolf, F.A. "*Antenna Analysis,*" John Wiley & Sons, NY, 1966, p 27.
3. FCC OET Bulletin 65, Aug. 1997, Washington DC, 20554.
4. IEEE C95.1 "*IEEE standard for safety levels with respect to human exposure to radio frequency electromagnetic fields, 3 kHz to 300 GHz,*" IEEE, NY, 1999.
5. ICNIRP, "*International Commission on Non-Ionizing Radiation Protection Guidelines for Limiting Exposure to Time Varying Electromagnetic Fields (up to 300 GHz),*" Health Physics, Vol. 34, Nov. 1998.
6. Canada, Safety Code 6, "*Recommended Safety Procedures for the Installation and Use of Radio Frequency and Microwave Devices in the Frequency Range, 3 kHz - 300 GHz,*" Dept of National Health and Welfare, Ottawa, Canada.
7. Aslan, E. "*Personal Electromagnetic Radiation Monitor,*" U.S. Patent No. 5,168,265, Dec. 1, 1992.
8. Aslan, E. "*A Personal Monitor Using A Surface Area Sensor,*" IEEE Transactions on Broadcasting, Vol. 43 #1, March 1997.
9. Aslan, E. "*Ultra Wideband Personal Electromagnetic Radiation Monitor,*" U. S. Patent No. 6,154,178, Nov. 28, 2000.
10. "*Making Measurements From 50 GHz to 100 GHz,*" Technical Note No. 1, Narda Microwave East, Hauppauge NY, 11788.

EDWARD ASLAN

The measurement of electromagnetic energy had its beginnings in 1968 when Ed Aslan accepted the FDA's (U.S. Food and Drug Administration) challenge to come up with a device to measure leakage from microwave ovens. Model 8100 met that challenge and brought the first of 57 patents (32 are U.S. patents). A three-time recipient of the Industrial Research 100 Award, IMPI Fellow since 1995, and IEEE Fellow since 1998, this father of the industry has earned more than 95% of the world's patents relating to the detection of RF radiation that define Narda as the recognized leader in non-ionizing radiation safety equipment.

Electromagnetic Radiation Safety and RF Heat Sealers

The properties of electromagnetic energy have always lent themselves well to sealing plastics. Just as a microwave oven heats food, an RF heat sealer heats a plastic part to the point at which it can bond with another plastic part or to another surface. The technique is faster and cleaner than conventional thermal welding, and produces a stronger bond as well. It's not surprisingly that there are more than 100,000 RF heat sealers in operation in the US throughout many industries.

As with any system that generates high levels of electromagnetic energy, there are potential safety problems associated with their operation. When designed, operated, and maintained properly, the systems produce extremely low levels of radiation in the vicinity of the operator, well within the guidelines set forth in the non-ionizing (electromagnetic) radiation safety standard – IEEE C95.1-2005 – which has been adopted by many regulatory agencies and the American National Standards Institute (ANSI).

However, if the shields designed to protect the operator from overexposure conditions are not properly deployed, if the shields are in some way defective, or if the design of the heat sealer does not pay attention to shielding, the level of radiation to which the heat sealer operator may be exposed can be *orders of magnitude* higher than that considered safe. Clearly, the potential for severe overexposure exists (see *The Impact of Shield Failure, page 149)*.

The Exposure Environment

During most of the time that RF heat sealers have been used, little attention paid to workers' overexposure to RF radiation. However, much more is known today about the effect of RF radiation on the human body at certain levels of exposure.

Unlike the alleged damage caused by exposure to the minuscule levels of RF radiation produced by computer monitors and display terminals, exposure to the potentially immense radiation emitted by a faulty RF heat sealer will very likely produce heating of tissue.

To put these different levels in perspective, the amount of power generated by a video display terminal (VDT) might be several microwatts (millionths of a watt). The power generated by an RF heat sealer is between 1500 W to more than 60,000 W – the same level as produced by many radio and television broadcast transmitters. While the power radiated by a broadcast antenna is emitted at a point far from human contact, the RF heat sealer generates its power within a few inches of the operator.

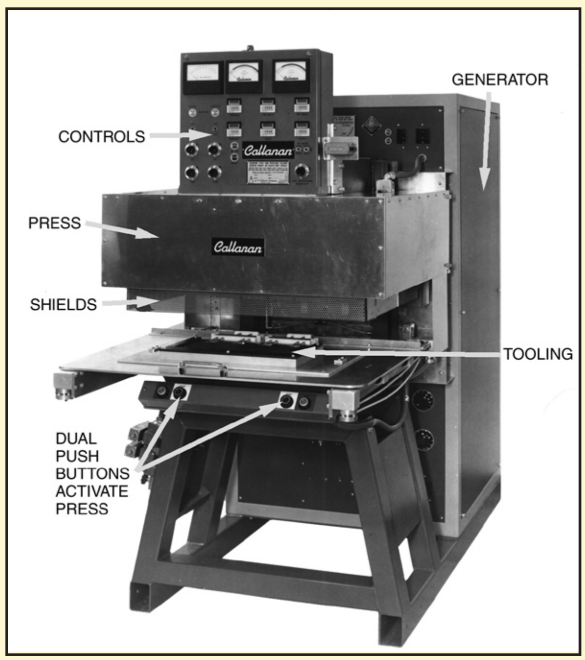
Compounding the problem is that many RF heat sealers in use today could not meet IEEE C95.1 even if operating as designed. This is because such equipment was designed and manufactured before strict attention was paid to nonionizing radiation in the workplace. Sadly, even some new RF heat

How RF Heat Sealers Work

RF heat sealers are relatively large industrial machines that have an RF generator within them. The generator is comprised of three basic components – a power supply, oscillator, and controls. The power supply converts the line power source into high-voltage direct current.

The oscillator circuit converts this power into RF energy, generally at a frequency of 27.12 MHz, although other frequencies are sometimes used. This frequency is one of the Industrial, Scientific, and Medical (ISM) frequencies designated by the Federal Communications Commission (FCC) for unlicensed operation. The controls regulate and monitor the operation of the sealer as it heats the seal area. The RF is applied to the work via an applicator, which is generally an air-operated press with interchangeable electrodes that vary in shape with the area to be sealed.

The operator typically places the item to be sealed on the applicator and then begins the sealing process by simultaneously pressing two switches. The two switches are used to ensure that the operator's both hands are free of the press. Once the switches are activated, the press and shields begin to close. Once the press has applied the proper amount of pressure, the RF generator comes on and the heating cycle begins. Heating time is typically a few seconds. Then, the generator is shut off, the press and shields open, and the sealer is ready to accept another part.



sealers currently being sold will also not comply with the exposure limits imposed by IEEE C95.1-2005.

Finally, even the best of the new equipment can still produce serious overexposure should the shields fail. They are mechanical and must be removed or adjusted with every change of tooling. In some work environments, in which the operators are paid by the piece, it is not uncommon for operators to remove the shields that have just been inspected by a supervisor or health and safety professional in order to increase their production rates. When this is done, the operator is subject to severe overexposure conditions.

The Ramifications

From a liability standpoint, the potential damage to employees from overexposure to high levels of radiation emitted from RF heat sealers can be menacing. This is especially true today, when more and more people are becoming aware of rights in the workplace and sensitivity to workplace hazards is increasing.

To ensure compliance with current standards as well as to provide employees with a safe working environment, several steps must be taken. None of these steps is necessarily expensive or requires large amounts of time. However, all require a consistent, long-term commitment to something called an RF Radiation Safety Program. These programs are more important than ever because IEEE C95.1-2005 is much more restrictive than earlier standards and essentially makes a high percentage of RF heat sealers now in service dangerous and obsolete (see *Putting the Heat On Sealers*, page 150).

The Elements of an RF Protection Program

An RF Radiation Safety Protection Program serves several purposes. First, it establishes the company as being concerned about the health and safety of its employees. While it does not eliminate liability, a well-administered, well-documented program goes a long way toward creating a safe environment for employees, potentially reducing liability in case of litigation, and appeasing OSHA and state and local government agencies.

However, it is important to note, that a poorly-planned, sloppily-administered program may be as bad as having none at all, or sometimes worse, since it produces a tale of indifference. OSHA inspectors and lawyers may know just what questions to ask in order to determine the efficacy of any RF Radiation Safety Program.

Simply constructing a program, producing documentation, and then ignoring it, is a waste of time and money, and ultimately worthless, or worse yet a liability, from a legal perspective. In contrast, a quality program, fully and continuously documented, could be spotted just as fast by OSHA inspectors.

An RF Radiation Safety Program, regardless of the specific operating environment it is designed to serve, has several basic elements:

- An initial survey of the heat sealer and its operating environment
- Written documentation of the program
- Employee training
- Adoption of administrative and engineering controls
- Someone who is responsible for administration and enforcement of the program

INITIAL SURVEY

When creating an RF Safety Program, assume nothing when conducting an initial survey. Make measurements to determine areas that exceed, or could exceed maximum permissible exposure levels (MPE). If needed, these services are available from consulting engineering organizations.*

Most experts would agree that a program needs to be initiated when exposures approach, or exceed, uncontrolled or "action" levels. Once the baseline study is complete, the next steps can be accurately assessed. These steps may include modification or even replacement of RF heat sealers, depending on their age and likelihood of creating an acute overexposure situation.

ADOPTION OF ADMINISTRATIVE AND ENGINEERING CONTROLS

These two types of controls are very different in their scope and end result. An administrative control is an action, such as placement of signs in areas where high levels of radiation are present or writing a policy covering RF equipment, that is not generally implemented in hardware. Engineering controls include fences, barriers, gates, locks and other physical impediments to human presence that are implemented with some type of hardware solution. Sensors that automatically shut off the heat sealer should the shields fail are a pure engineering control that is highly regarded by regulatory agencies such as OSHA.

WRITTEN DOCUMENTATION OF THE PROGRAM

Creation and publication of the RF Radiation Safety Program is an essential element and not simply an administrative detail. This document clearly states the program's goal, its procedures, and shows how the organization is addressing employee safety. It is as valuable for subjective reasons as it is for simply "getting it all down on paper."

The documentation should clearly describe all procedures, who is responsible for conducting them, when they are to be conducted, who to contact if a problem is detected, and many other areas. A complete guide to establishing an RF Radiation Safety Program is available from IEEE C95.7-2005.

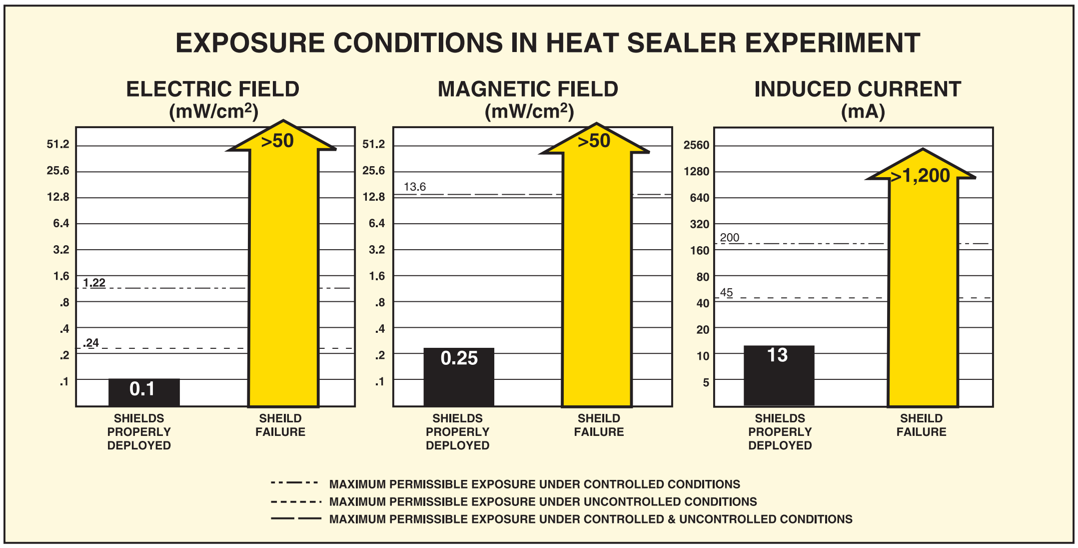
* *For help in selecting a consulting engineer, contact Narda Safety Test Solutions, 631 231-1700*

EMPLOYEE TRAINING

Every employee whose work is in any way connected with operation, maintenance, or inspection of the RF heat sealer must be trained, thoroughly, about the program. All new employees who meet these work criteria should also be trained as part of the initial indoctrination. If changes are made to the program, they must be communicated, in text form and verbally, to the employees. Periodic review of the program must be conducted by the program administrator.

ASSIGNMENT OF SOMEONE TO ADMINISTER THE PROGRAM

Administration of an RF Radiation Safety Program does not require large amounts of time or money. However, the person in charge must report on a regular basis the status of the program, and the program itself must be continually documented.



The Impact of Shield Failure

An experiment was conducted using a modern 12 kW (12,000 W) RF heat sealer operating at a reduced power output of 8 kW. Since the RF power output of heat sealers typically ranges from 1.5 kW to more than 60 kW, this is an average condition. Obviously, the impact of shield failure is less significant with smaller sealers than with those that have higher output powers.

In this experiment, measurements were made at the normal position of the operator with the shields functioning as designed, and with the shields opened only 1 in. above the "safe" position on the operating platform. Completely removing the shields would result in far higher levels of radiation. The values obtained are compared in the table to controlled and uncontrolled Maximum Permissible Exposure levels (MPEs) specified in IEEE/ANSI C95.1-2005. The exact intensity of the electric and magnetic fields with shield failure is not known because radiation levels exceeded the measurement limits of the instrument.

The new standard allows the value of electric and magnetic field levels to be reduced by multiplying the obtained value by the duty cycle of the equipment (typically 10 to 50 percent). However, the new standard limits the value for induced current to a 1 second maximum exposure. Consequently, induced current is now the critical requirement to meet in order to be compliant.

In general, the results show that with shields operating as designed, radiation is well controlled and within the limits set by the standard. However, with shield failure, radiation levels exceeded by more than 40 times the maximum levels considered acceptable, and they were only moved 1 in. from the "safe" position.

Ensuring Compliance with RF Radiation Monitoring

One of the most fundamental elements of ensuring compliance is monitoring, with precision instruments, RF radiation in the critical areas around the heat sealer.

The equipment discussed here is manufactured by Narda Safety Test Solutions, and is designed to serve different needs. The products are designed to:

- Continuously monitor and protect the heat sealer operator
- Provide protection for maintenance personal
- Make compliance measurements

PERSONAL PROTECTION

Narda's personal monitors are an excellent tool for people who must perform maintenance on any part of the heat sealer, not only in the press area but around the generator as well. About the size of a pack of cigarettes it fits in a jacket or shirt pocket. Monitors provide wearable protection against overexposure to non-ionizing radiation in models that cover 100 kHz to 100 GHz, which covers all RF heat sealers. Narda monitors have visual and audible alarms and operate on batteries for up to 1500 hours.

COMPLIANCE MEASUREMENTS

The Model 8513 industrial compliance meter is designed for use by industrial plant managers and safety professionals who must prove compliance on a routine basis. It is ideal for quickly checking the shields and cabinet doors for leaks whenever they have been adjusted or opened.

It is also the only instrument that can measure both magnetic (H) and electric (E) fields with one probe that is permanently attached to the meter, eliminating the need to change probes with each type of measurement.

Putting the Heat on Sealers

The new IEEE standard, entitled *The IEEE Standard for Safety Levels With Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz*, was first published in the spring of 1992. It was adopted by ANSI without change a year later. It is also quickly becoming the de facto US standard for radiation from RF fields. The US Department of Defense has based its new standard on the new IEEE/ANSI standard. The Federal Communication Commission's 1997 Regulations are based on a similar but somewhat more restrictive standard. OSHA is beginning to use it as the basis for enforcement as well.

The Standard

The new IEEE/ANSI standard is far more complicated than its predecessor and differs in several important ways that will impact manufacturers of RF heat sealers:

- Radiation levels are no longer advisory, but are now stated in terms of Maximum Permitted Exposure (MPE) levels.
- The two tiers of exposure limits - are for persons in "controlled" environments and "Action level" (when a safety program is unavailable). The action levels are about 20 percent of the controlled levels at common heat sealer frequencies.
- Induced and contact current are now included. In general, RF heat sealers with E-field radiation levels that hover around the MPE will exceed the induced current MPE value. RF heat sealer operators have always been able to apply the sealer's duty cycle (typically 10 to 50 percent) to reduce electric field level. Induced current has a 1-second maximum, not a 6-minute average, like previous standards. This significantly increases the difficulty of compliance, especially for heat sealers.
- Magnetic field limits have now been relaxed below 100 MHz.

OSHA

OSHA has already cited and fined organizations for exceeding the new standard, even though OSHA's official stance remains unchanged since 1978. OSHA has the right to enforce based on a consensus of scientifically-based standards under its general duty clause. OSHA's interpretation of the implications of controlled and controlled environments are defined in that agency's reply comment to the FCC.

Factoring in the loss of duty cycle averaging, one NIOSH official has stated that even at the controlled levels, the new standard is about 10 times more restrictive for heat sealers than its predecessor. Without an RF safety Plan, OSHA appears more than willing to enforce uncontrolled levels that are five times more restrictive than the controlled levels. The development of a meaningful RF safety plan appears to be the first step for heat sealer operators.

Heat Sealer Survey Record

1. SEALER LOCATION	2. SEALER DESCRIPTION
A. AREA	A. MFR./MODEL No.
B. BLDG. No./NAME	B. SERIAL No./YR.
C. ROOM/SECTION	C. REGISTRATION No.

3. USER INFORMATION	
A. USER ORGANIZATION	C. PHONE
B. USER REPRESENTATIVE	D. MAIL CODE/STOP

4. SURVEY INFORMATION		
❑ INITIAL	❑ FOLLOW UP	SURVEY DATE
❑ REINSPECTION	❑ SPECIAL	SURVEY BY

5. PRE-SURVEY CALCULATIONS

This section is for calculating the duty factor of the sealer. You will need to obtain the RF seal time and the number of cycles per minute the sealer is operating at. Example:

Cycles per minute = 51 cycles per 6 min.
51 cycles x 1.5 sec. = 76.5 sec. per 6 min. (360 sec.)

RF seal time of 1.5 sec. per cycle
Duty factor = 76.5/360 = 0.21

1. Cycles per minute (C/m)	
2. Cycles per 6 minutes (C/m x 6) = (Tc)	
3. Seal time per cycle (St)	
4. Seal time per 6 minutes (Tc x St) = (Ts)	
5. Duty factor (Ts/360) = Df	

6. SURVEY

Survey must be performed without the operator, in the position the operator would normally occupy.
Minimum measurement distance is 20 cm (in the U.S.), or 5 cm from the sealer.

Survey Height or Position	Electric Field (E)	Magnetic Field (H)
A. Head*		
B. Neck		
C. Chest		
D. Waist		
E. Groin*		
F. Thigh		
G. Calf		
H. Ankle		
Total (Add A through H)	Total E Field	Total H Field
Whole Body Average (Divide totals by 8)		
Time and Whole Body Average (Multiply WBA by Df)		

*IEEE C95.1-2005/ANSI C95.1-1992 limits Head and Groin area reading multiplied by the duty factor to a maximum of 1.22 mW/cm^2 (E. Field)

USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www**.narda-sts.us

Making Measurements from 50 GHz to 100 GHz

There is a growing trend worldwide to use increasingly higher frequencies for many applications of high power RF energy. Certainly, it is the military that has led the way in using the millimeter band. MILSTAR communications systems operate from 43.5 GHz to 45.5 GHz and at a similar narrow band around 94 GHz. Millimeter band radars, fire control systems, and numerous other systems are in use around the world. The frequencies are largely classified. There are also several commercial applications either in use or being planned.

Detection at Millimeter Frequencies

Narda's 8600 series probes were originally designed to operate up to 18 GHz and later to 26.5 GHz. These probes all use thermocouple detectors that function as dipoles. The sensitivity starts to decrease above 26 GHz, which limits the useful frequency range.

Narda made a patented breakthrough with the introduction of the models 8621D and 8623D in 1983 that dramatically increased the upper frequency range. This new design was carried forward into the NBM Series.

The ultra broadband characteristics of these probes are obtained by distributing resistive dipoles along the length of detector elements.

The spacing of the dipoles is less than a quarter wavelength of the highest rated frequency. This eliminates the possibility of any resonance within the rated frequency range. Technically, one of these probes may be viewed as a group of series-connected, small resistive dipoles or as a very low Q resonate circuit. The dipoles are oriented along the Poynting Vector which results in a traveling wave effect beginning to occur above 26 GHz. The traveling wave effect increases with frequency which offsets the natural loss in sensitivity from the dipoles. This results in a probe with an extremely flat frequency response throughout most of the millimeter region.

Frequency Response

The theoretical, useful measurement range of the Models EF 5091 and EF 5092 probes extends up to about 140 GHz. The rated frequency response of these models is 300 MHz to 50 GHz . However, these probes have a virtually flat frequency response from 700 MHz to 100 GHz. Narda has long theorized that the useful frequency range was far above the 40 GHz rating of the earlier models but lacked the testing capability to confirm the calculations.

Verification

A U.S. Department of Defense (DoD) funded calibration effort undertaken several years ago indicated that these probes were usable at 94 GHz. Questions concerning the accuracy of the method used still left some doubts. A DoD funded program in 1994 verified accuracy from 40 GHz to 46 GHz to answer questions concerning measurements of MILSTAR systems. The probes proved to be flat (± 0.25 dB) in this region. Narda has now acquired a high power source to calibrate at 45.5 GHz (the upper end of the lower MILSTAR band) and has increased the frequency range of several probe models to 60 GHz.

The United States Air Force and Narda combined efforts to check the frequency response of several Narda probes and monitors at 94 GHz in late 1994. The results were published in a USAF sponsored *RF Radiation and Ultra Wide Band Measurements Symposium* in February 1995. A major U.S. defense contractor verified the results of this test program using their own facilities in 1996.

This 94 GHz measurement program was undertaken at the Air Force's Armstrong Laboratory located on Brooks AFB in San Antonio, Texas, the USAF's center for non-ionizing radiation research. The U.S. Navy and the U.S. Army have now relocated their non-ionizing radiation research facilities to Brooks AFB. The experiments were carried out in an anechoic chamber fed by a 45 W tunable Klystron transmitter located just outside the chamber. The antenna was a 2.54 cm diameter horn and all experiments were carried out in the far field. The accuracy of the facility had recently been verified by two separate outside organizations.

The probes were positioned precisely and the electric field was established to be equal to a five percent of the full scale measurement range of the probe.* This is standard practice for calibrating Narda probes because it results in a minimal linearity error. As expected, Models 8621D, 8623D, 8721 and 8723 had virtually no loss in sensitivity at 94 GHz. The ultra-broadband Models 8741 and 8722 plus the very high power Model 8725 did show a loss of sensitivity. This was expected due to the somewhat different design of the detectors. Two personal monitors and one area monitor were also checked for accuracy.

MODEL	S/N	CORRECTION FACTOR	ELLIPSE RATIO
8723	8010	1.06	±0.2 dB
8723	8011	1.06	±0.8 dB
8721	13037	1.07	±0.4 dB
8721	13031	0.96	±0.8 dB
8725	07004	1.6	±0.4 dB
8725	07003	1.4	±0.8 dB
8623D	35044	0.96	±0.6 dB
8623D	32029	1.26	±0.3 dB
8623D	36009	1.06	±0.4 dB
8741	11021	2.4	±0.2 dB
8722	10005	2.3	±0.2 dB

* The Model 8725, which is rated at 1000mW/cm^2, was checked at 0.5% of rated power. One of the Model 8721 probes was checked at half power to verify that there were no linearity problems.

Application

Probe Models 8621D, 8623D, 8721, 8723, 8721D, 8723D, and the new EF 5091 and EF 5092 can be used with confidence to make accurate measurements up to 100 GHz. This assumes that the probe has been recently calibrated over its normal rated frequency range. These probes have extremely close unit-to-unit frequency response characteristics which is largely determined by the dimensions of the thermocouples. They are manufactured using a sputtering technique that results in virtually identical detectors.

There is only a single gain adjustment on the probe amplifier. Therefore, if a probe is properly adjusted at the lower frequencies and is within its rated frequency response at all frequencies, accuracy at frequencies up to 100 GHz is virtually guaranteed. A failure of any component that could alter the frequency response characteristics of the probe would certainly be evident during calibration at frequencies below 40 GHz.

The EB 5092 shaped frequency response series have two sets of sensors. Microwave frequencies are measured with thermocouple detectors but these detectors lose 3-4 dB in sensitivity at 94 GHz. They are quite accurate up to 50 GHz. Again, these characteristics are quite repeatable unit-to-unit so that by applying a 4 dB correction factor at 94 GHz, these models can be used to provide an approximate field strength reading.

The 8840 and 8841 series of Nardalert personal monitors indicated a 2-4dB loss in sensitivity. Narda now rates the Model 8840D-1 up to 100 GHz because even a 6 dB loss of sensitivity would result in the monitor sounding the alarm at levels no higher than 4mW/cm^2. The vast majority of the standards in the world limit exposure in the millimeter range to either 5mW/cm^2 or 10mW/cm^2. Later testing, performed in 2003, showed the Nardalert XT (B8860) models to have less than 3 dB of loss. As before, an alarm of 50% will provide ample notification for almost any environment.

The Model 8825 SMARTS (replaced by Model B8830) area monitor indicates a loss of less than 2dB at 94 GHz. Given the many variations of monitor location, personnel location, and the site of the leak, this loss in sensitivity should not be critical.

Conversions of Power Density in mW/cm^2 to Other Parameters Based Upon Free Space Conditions

mW/cm^2	$\frac{V^2}{m^2}$ $\frac{(volts)^2}{(meter)^2}$	$\frac{A^2}{m^2}$ $\frac{(ampere)^2}{(meter)^2}$	$\frac{pJ}{cm^3}$ $\frac{pico\ Joules}{cm^3}$	$\frac{watt}{m^2}$ $\frac{watts}{Meter^2}$
Power Density (S)	**Mean Squared Electric Field Strength**	**Mean Squared Magnetic Field Strength**	**Total Energy Density**	**Power Density (S)**
1000	3,769,900	26.53	33.33	10,000
500	1,885,000	13.26	16.66	5,000
200	753,980	5.305	6.67	2,000
100	376,990	2.653	3.333	1,000
50	188,500	1.326	1.667	500
20	75,398	.5305	.6667	200
10	37,699	.2653	.3333	100
5	18,850	.1326	.1666	50
2	7,539.8	.05305	.06667	20
1	3,769.9	.02753	.03333	10
.5	1,885.0	.01326	.01667	5
.2	753.98	.005305	.006667	2
.1	376.99	.002653	.003333	1
.05	188.50	.001326	.001667	.5
.02	75.398	.0005305	.0006667	.2
.01	37.699	.0002653	.0003333	.1
.005	18.850	.0001326	.0001667	.05

$S = E \times H$

$E = Z_o \times H$

$H = E / Z_o$

Where Z_o = Free Space Impedance = 377Ω

$$mW/cm^2 \times 10 = \frac{Watts}{(Meter)^2} = \frac{W}{(M)^2}$$

$$mW/cm^2 \times 3769.9 = \frac{(Volt)^2}{(Meter)^2} = \frac{(V)^2}{(M)^2}$$

$$mW/cm^2 \div 37.699 = \frac{(Amperes)^2}{(Meter)^2} = \frac{(A)^2}{(M)^2}$$

$$mW/cm^2 \times .03333 = \frac{Pico\ Joules}{(cm)^3} = pJ/cm^2$$

$$\sqrt{mW/cm^2 \times 3769.9} = \frac{Volts}{Meter} = \frac{V}{M}$$

$$\sqrt{mW/cm^2 \div 37.699} = \frac{Amperes}{Meter} = \frac{A}{M}$$

$1\ pJ/cm^2 = 1 \mu J/m^3$

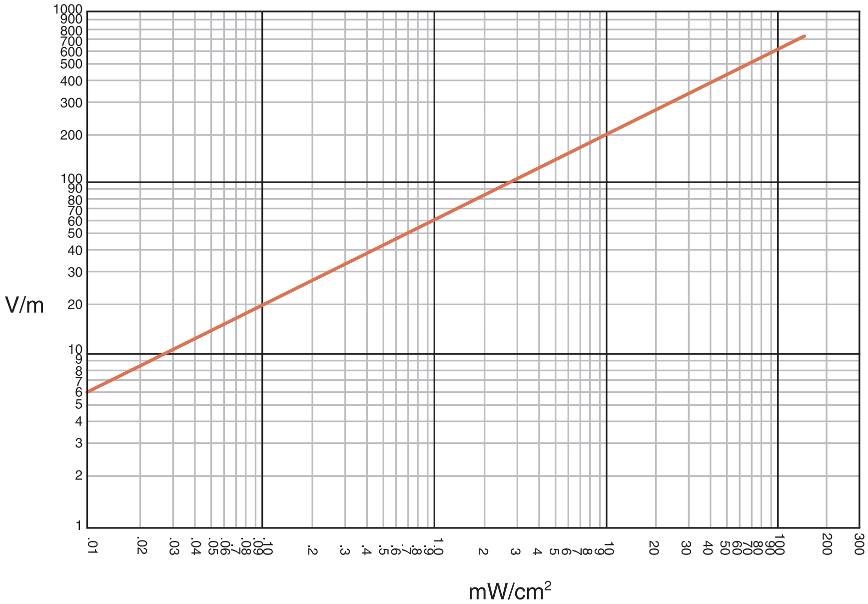
pT	nT	mG	dBmG	µT	Gauss	mT	Tesla	dBT	A/m	V/m	W/m^2	mW/cm^2
10^5	100	1	0	0.1	0.001	10^{-4}	10^{-7}	-140	0.08	30	2.4	0.24
2×10^5	200	2	6	0.2	0.002	2×10^{-4}	2×10^{-7}	-134	0.16	60	9.6	0.96
3×10^5	300	3	10	0.3	0.003	3×10^{-4}	3×10^{-7}	-130	0.24	90	21.6	2.16
4×10^5	400	4	12	0.4	0.004	4×10^{-4}	4×10^{-7}	-128	0.32	120	38.4	3.84
5×10^5	500	5	14	0.5	0.005	5×10^{-4}	5×10^{-7}	-126	0.40	150	60	6.0
6×10^5	600	6	16	0.6	0.006	6×10^{-4}	6×10^{-7}	-124	0.48	180	86	8.60
7×10^5	700	7	17	0.7	0.007	7×10^{-4}	7×10^{-7}	-123	0.56	210	118	11.8
8×10^5	800	8	18	0.8	0.008	8×10^{-4}	8×10^{-7}	-122	0.64	240	154	15.4
9×10^5	900	9	19	0.9	0.009	9×10^{-4}	9×10^{-7}	-121	0.72	270	194	19.4
10^6	1000	10	20	1	0.01	0.001	10^{-6}	-120	0.8	300	240	24.0
10^7	10^4	100	40	10	0.1	0.01	10^{-5}	-100	8	3000	2.4×10^4	2400
10^8	10^5	1000	60	100	1.0	0.1	10^{-4}	-80	80	3×10^4	2.4×10^6	2.4×10^5
10^9	10^6	10^4	80	1000	10	1.0	0.001	-60	800	3×10^5	2.4×10^8	2.4×10^7
10^{10}	10^7	10^5	100	10^4	100	10	0.01	-40	8000	3×10^6	2.4×10^{10}	2.4×10^9
10^{11}	10^8	10^6	120	10^5	1000	100	0.1	-20	8×10^4	3×10^7	2.4×10^{12}	2.4×10^{11}
10^{12}	10^9	10^7	140	10^6	10^4	1000	1.0	0	8×10^5	3×10^8	2.4×10^{14}	2.4×10^{13}

NOTES: pT = picoTesla, nT = NanoTesla, mG – milliGauss, dBmG = dB above 1 mG, µT = microTesla, Gauss = 10^{-4} Tesla, mT = milliTesla, T = Tesla, dBT = dB above 1 Tesla, A/m – amperes/meter, $A/m = B_T/(4\pi \times 10^{-7}) = B_{mG}/4\pi mG = 0.08 \times B_{mG}$

To convert A/m to V/m and power density, valid only for free space, $Z_o = E/H = (\mu_o/\varepsilon_o)^{1/2} = [(1.257 \times 10^{-6}\ H/m)/(8.85 \times 10^{-12}\ F/m)]^{1/2} = 377$ Ohms, $W/m^2 = E \times H$, $mW/cm^2 = W/m^2/10$

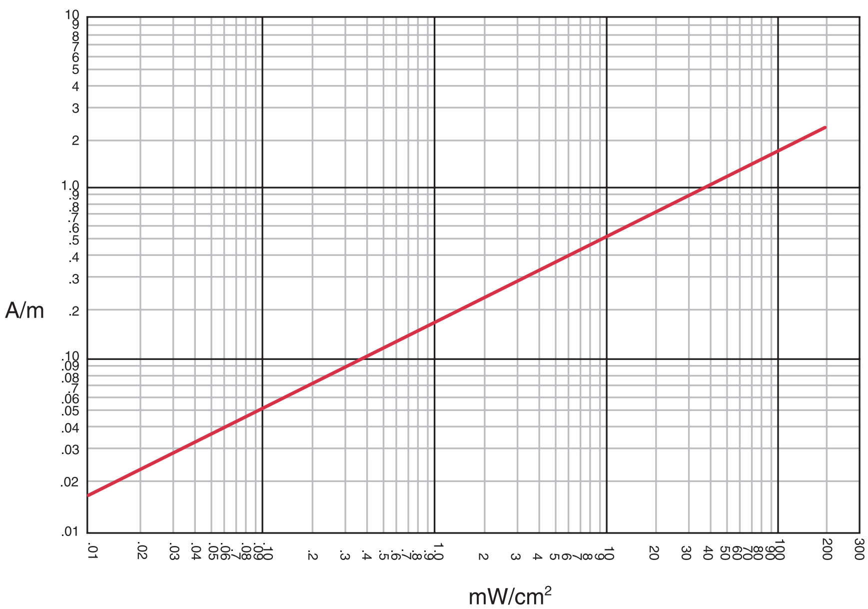
Power Density vs Field Strength

Power Density to Electric Field Strength



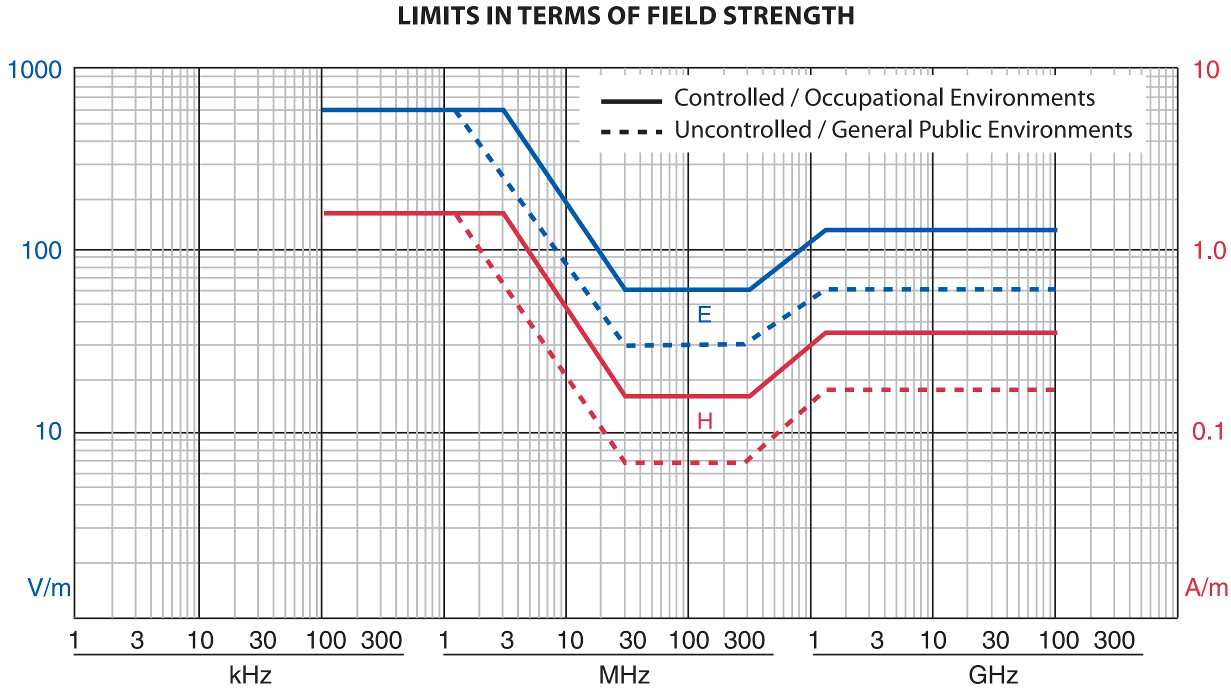
Power Density mW/cm² (S)	Electric Field Strength Volts/meter (E)
1000.00	1,940.00
500.00	1,372.00
200.00	867.60
100.00	613.50
50.00	433.80
20.00	274.00
10.00	194.00
5.00	137.00
2.00	86.70
1.00	61.30
.50	43.40
.20	27.40
.10	19.40
.05	13.70
.02	8.67
.01	6.13
.005	4.34

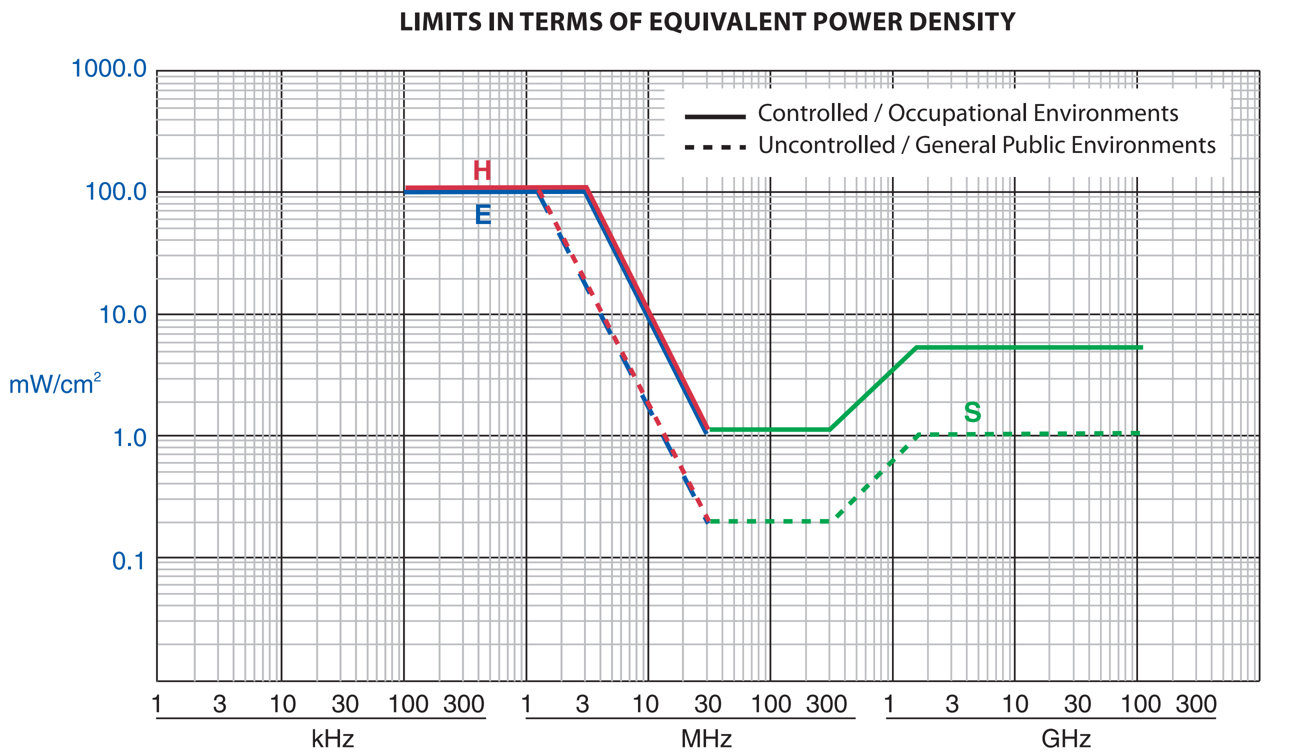
Power Density to Magnetic Field Strength (Free Space)



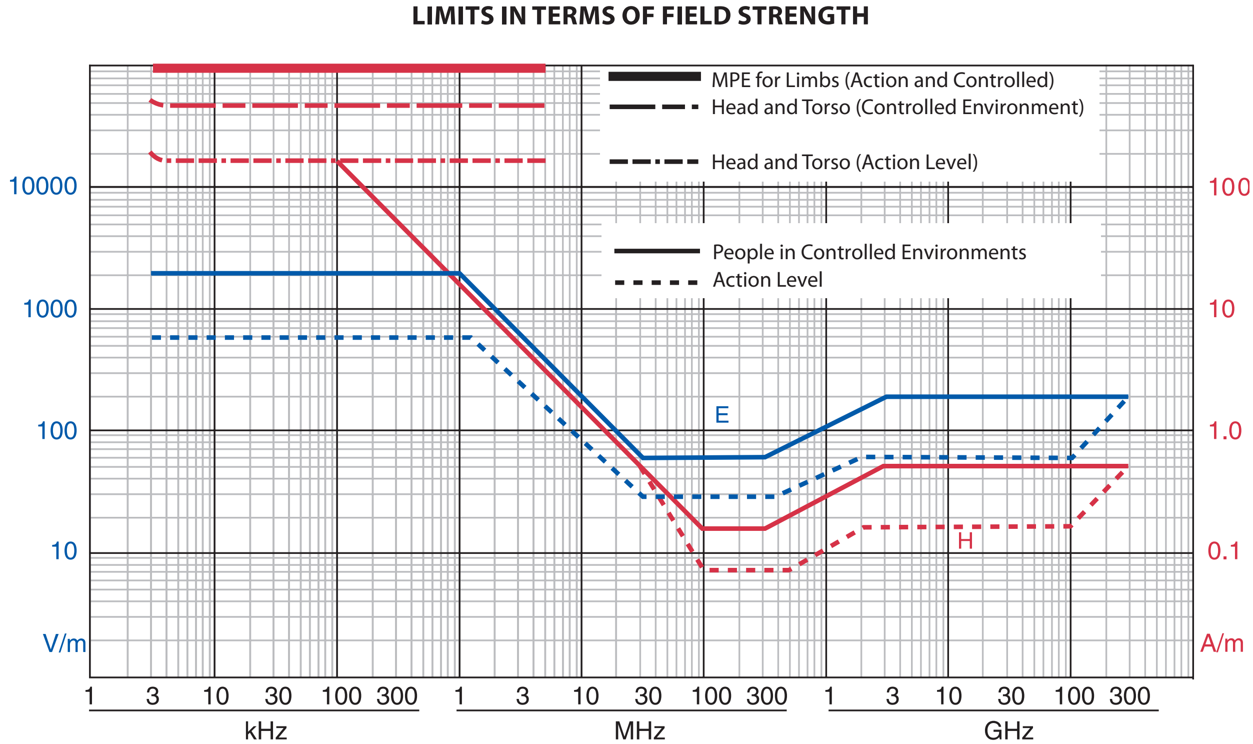
Power Density mW/cm² (S)	Magnetic Field Strength Amperes/meter (H)
1000.00	5.1550
500.00	3.6440
200.00	2.3050
100.00	1.6300
50.00	1.1520
20.00	.7290
10.00	.5155
5.00	.3644
2.00	.2305
1.00	.1630
.50	.1152
.20	.0729
.10	.0515
.05	.0364
.02	.0230
.01	.0163
.005	.0115

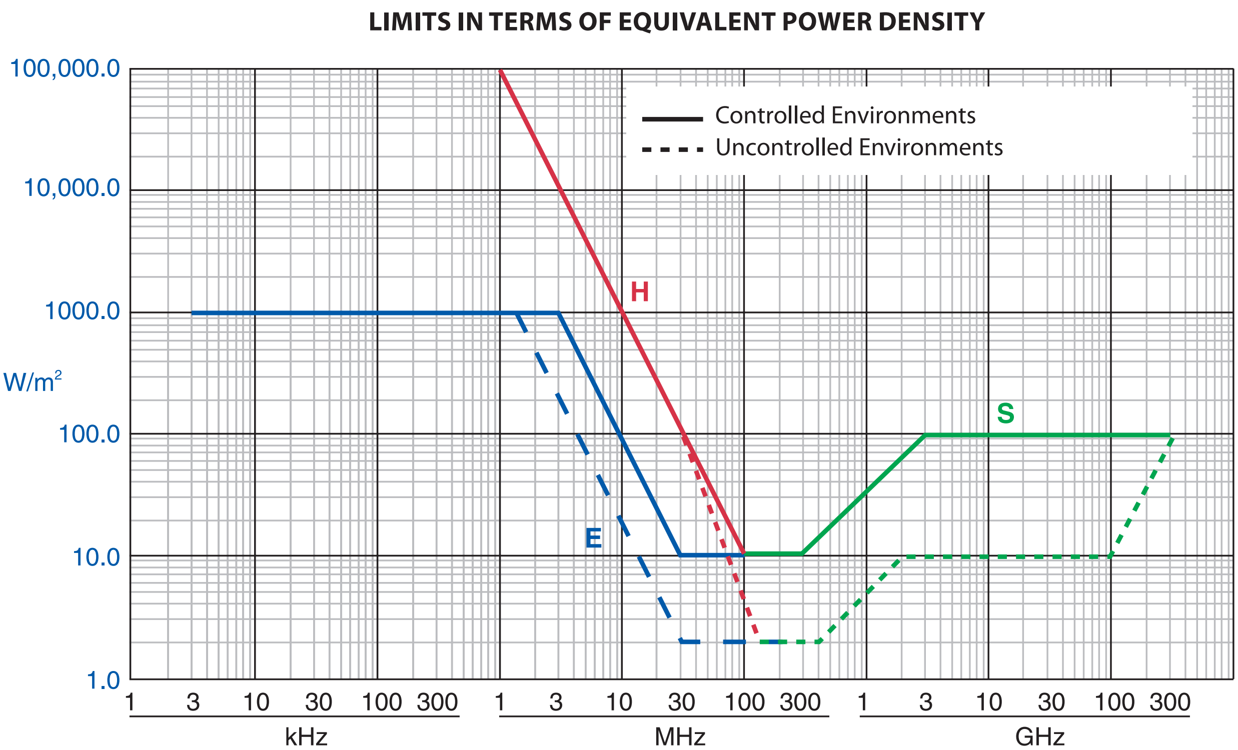
U.S. FCC MPE Limits – 47 CFR § 1.1310





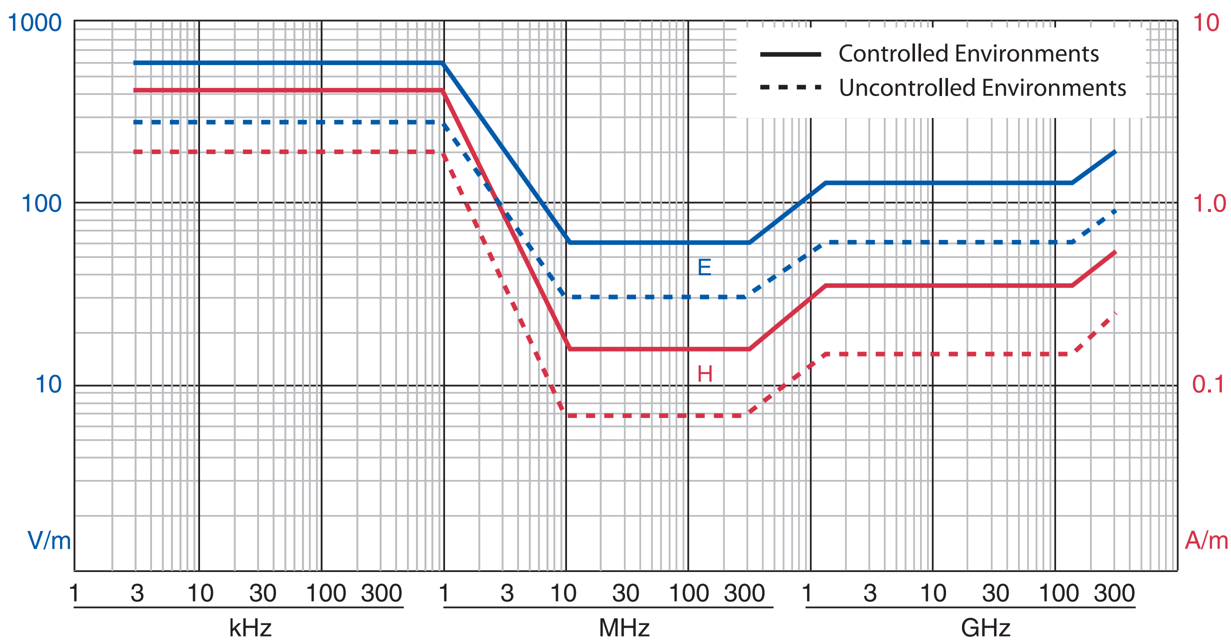
IEEE C95.1-2005 Electric and Magnetic Fields



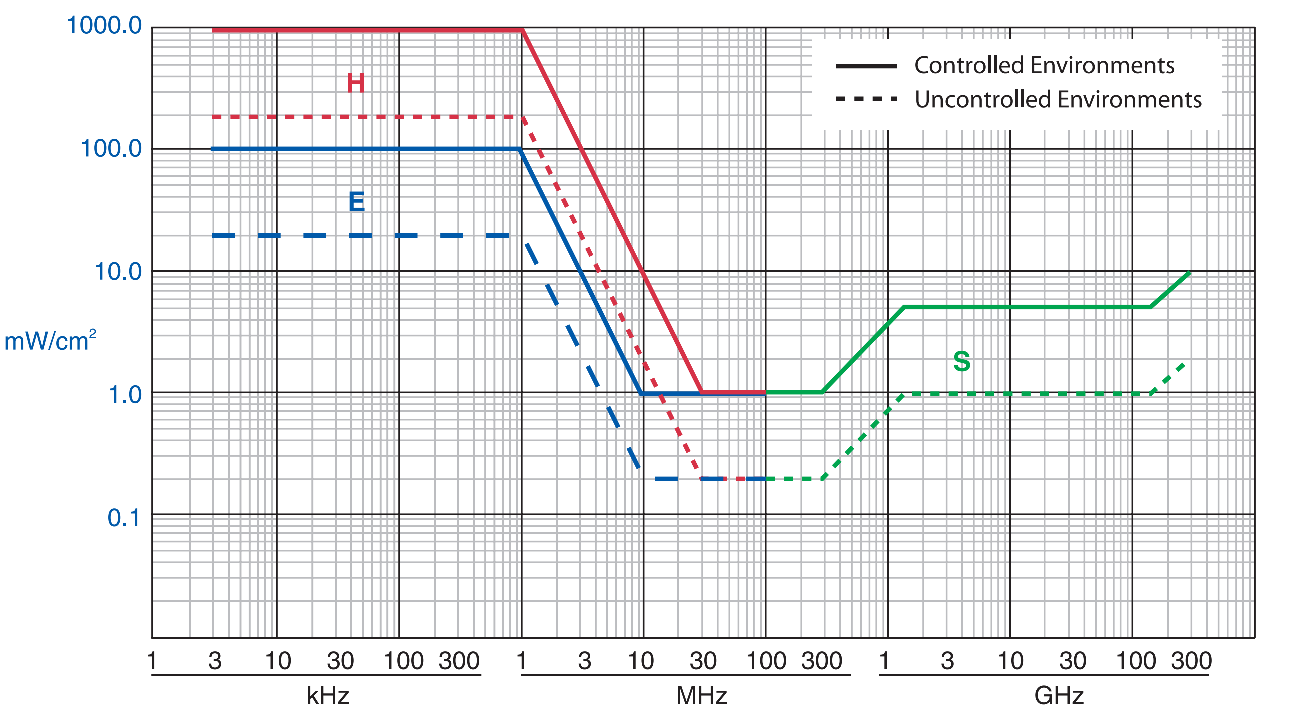


Canada Safety Code 6 (2009)

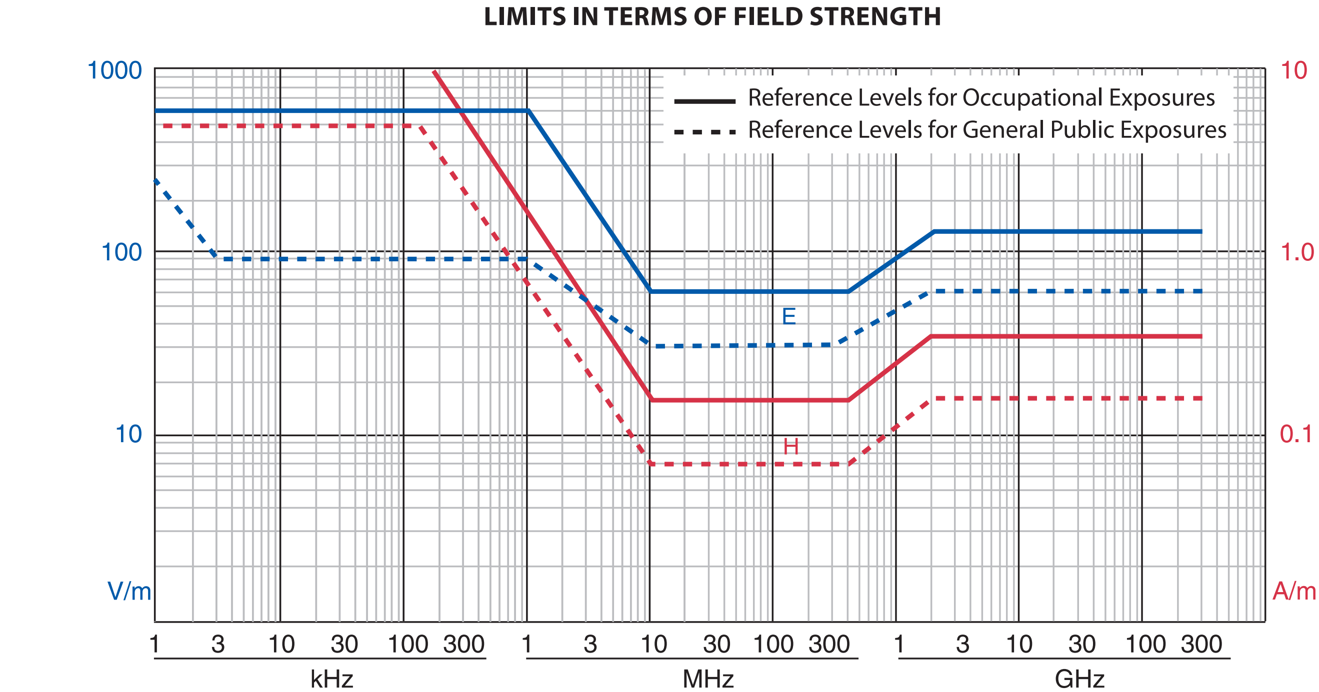
LIMITS IN TERMS OF FIELD STRENGTH

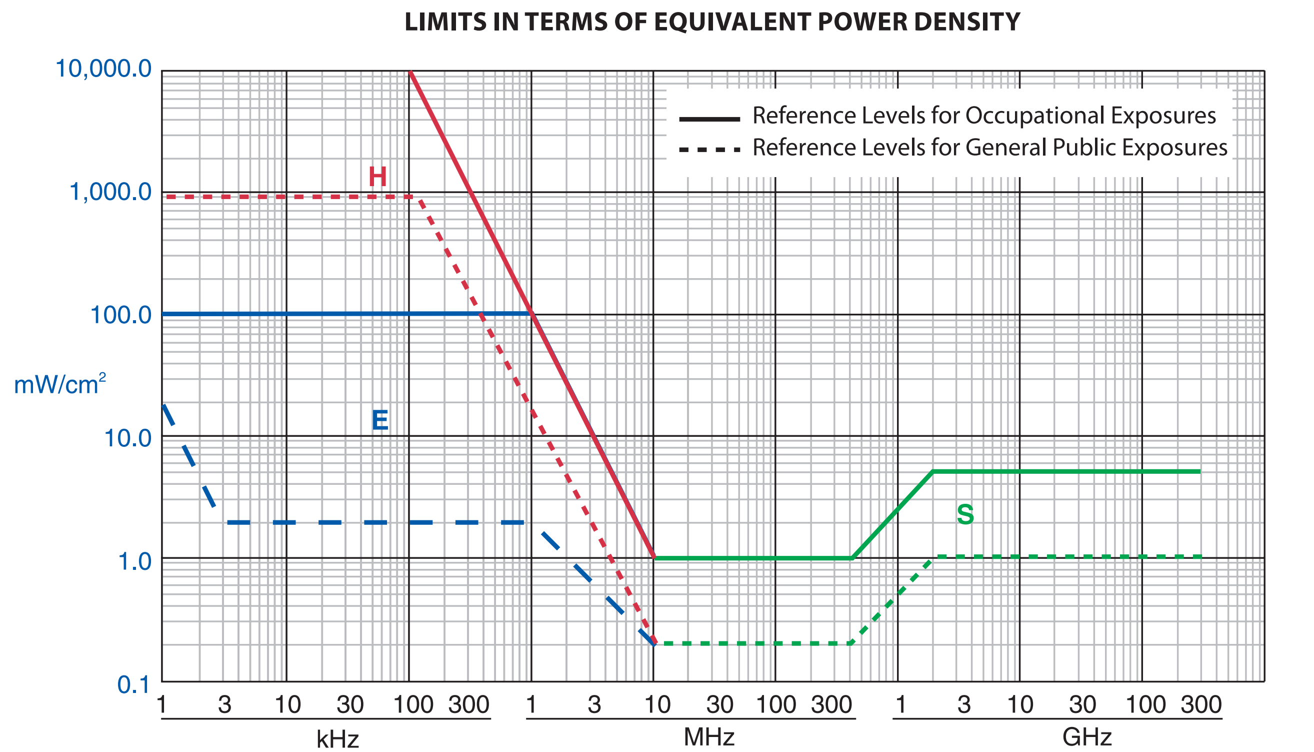


LIMITS IN TERMS OF EQUIVALENT POWER DENSITY



ICNIRP Reference Levels 1998 for Time-Varying Electric and Magnetic Fields





HOW TO ORDER

The information in this catalog will, in most cases, be sufficient for you to select a particular Narda Safety Test Solutions (Narda STS) product. In those instances where additional information is required, a telephone call to your local Sales Representative will provide you with price, availability, and delivery information.

When placing your order, please include model number, product name, government prime contract with classification level, and all shipping instructions. For example,

Model A8862 Nardalert Personal Radiation Monitor

If any non-standard features are desired, they must be fully described to avoid any misunderstanding.

Address Orders, Contracts, and Checks to

NARDA Safety Test Solutions

USA: 435 Moreland Road
Hauppauge, NY 11788
Telephone: (1) 631 231-1700
FAX: (1) 631 231-1711
E-mail: NardaSTS@L-3COM.com

GERMANY: Sandwiesenstr. 7
72793 Pfullingen Germany
Telephone: +49-7121-9732-777
FAX: +49-7121-9732-790
E-mail: support@narda-sts.de

or in care of our Sales Representative in your area (see page 161).

Orders will be accepted via FAX or phone, pending confirmation on your standard Purchase Order Form.

DOMESTIC TERMS

Net 30 days, Ex-works, unless otherwise specified. Shipments are made to unrated firms, C.O.D. unless credit has been established or on receipt of advance payment. Visa and MasterCard are also accepted.

EXPORT TERMS

Full payment in advance of shipment or against irrevocable letter of credit confirmed by a United States bank. All prices Ex-works unless otherwise specified.

SHIPPING INFORMATION

All sales are considered Ex-works unless otherwise specified. Any damage incurred during shipment should be settled between the customer and the carrier. Shipments from the point of origin will normally be made by Parcel Post, UPS, Federal Express, or Air Freight. Narda STS will choose the most appropriate means of transportation unless otherwise specified by the customer.

QUOTATIONS AND PRO FORMA INVOICES

Destination prices and shipping information required for pro forma invoices or FAS, CIF or C&F quotations and importation assistance can be quickly obtained from your local Sales Representative or from the factory directly.

CERTIFICATE OF CONFORMANCE

A Certificate of Conformance is available upon request at the time of purchase. This certification states:

"This material was produced in accordance with all applicable drawings and specifications and meets the contractually applicable quality specifications. All inspections and/or tests have been performed using equipment calibrated in accordance with the requirements of ANSI/NCSL Z540-1. Documentary evidence in the form of the test data and/or reports and inspection records are on file and available for examination."

CHANGE ORDERS AND CANCELLATIONS

Change Orders regarding price, delivery or any conditions not specified on the original order will be considered in effect after mutual agreement has been affirmed in writing between the customer and Narda STS.

Cancellation of any accepted order can only be made after written consent of Narda STS. All cancellations will be dependent upon customer's agreement to satisfy all charges incurred by Narda STS. Narda STS will endeavor to stop work promptly upon notification of cancellation.

REPAIRS/RETURNS

Repairs or recalibration of Narda STS instruments are made at the factory. Before returning any instrument, however, please contact Narda STS for a Return Material Authorization (RMA). When requesting an RMA, you will need to provide the model number, serial number and as much information as possible about the nature of the difficulty or reason for return. Once a repair or return has been approved, it will be issued an RMA number which must accompany the unit being returned. Estimates of repair charges are submitted to the customer before any work is done, unless otherwise directed. Returns must be shipped prepaid to:

NARDA Safety Test Solutions

USA: 435 Moreland Road
Hauppauge, NY 11788
Telephone: (1) 631 231-1700
FAX: (1) 631 231-1711
E-mail: NardaSTS@L-3COM.com

GERMANY: Sandwiesenstr. 7
72793 Pfullingen Germany
Telephone: +49-7121-9732-777
FAX: +49-7121-9732-790
E-mail: support@narda-sts.de

APPLICATION ENGINEERING

Convenient local support is provided through Sales Representatives (see page 161). They are equipped to provide you with any product assistance you may require.

Narda STS's staff also includes engineers who have extensive RF engineering experience and are available to help you with your special requirements and applications.

PRODUCT AND PRICE CHANGES

Although all information in this catalog was current at the time of publication, Narda STS's continuing product improvement program makes it necessary to reserve the right to change specifications and prices without notice.

NOTE: Minimum acceptable order: $100.00.

Warranty

Narda Safety Test Solutions (Narda STS) warrants each product to be free from any defect in material and workmanship for a period of two years after delivery to, and return by the original purchaser. All warranty returns, however, must first be authorized by a factory office representative.

The limit of liability under this warranty shall be to repair or replace any product, or part thereof, which proves to be defective after inspection by Narda STS. This warranty shall not apply to any Narda STS product that has been disassembled, modified, physically or electrically damaged or any product that has been subjected to conditions exceeding the applicable specifications or ratings.

Narda STS shall not be liable for any direct or consequential injury, loss or damage incurred through the use, or the inability to use, any Narda STS product.

Narda STS reserves the right to make design changes to any Narda STS product without incurring any obligation to make the same changes to previously purchased units.

This warranty is the full extent of obligation and liability assumed by Narda STS with respect to any and all Narda STS products. Narda STS neither makes, nor authorizes any person to make, any other guarantee or warranty concerning Narda STS products.

Sales Representatives

For North American Sales Representatives visit the Narda website at:

http://www.narda-sts.us

Click on **"CONTACTS"** and select your state or province (http://www.narda-sts.us/contacts/reps.php).

If you need additional information or assistance please contact the factory direct at 631-231-1700.

Alphabetical Index

Model Number Index

narda **Safety Test Solutions** an L3 communications company **USA • Germany • Italy**
USA TEL: (1) 631 231-1700 • **FAX:** (1) 631 231-1711 • **E-MAIL:** NardaSTS@L-3COM.com • **www.**narda-sts.us