capabilities

antenna solutions

Enabling Your Success™

ETS·LINDGREN™

An ESCO Technologies Company

Company History

ETS-Lindgren is an innovator of systems and components for the detection, measurement, and management of electromagnetic, magnetic, and acoustic energy. We apply proven engineering principles and adapt new technologies to create value-added solutions for our customers.

Our company began in 1995 when industry leaders EMCO, Rantec, and Ray Proof combined their resources to create EMC Test Systems. While our formation is recent, the roots of each company run deep;

- Ray Proof started as a supplier of medical X-ray shielding in 1932.
- Rantec led in the development of anechoic absorber and microwave chambers for the military during the early 1970's.
- EMCO (The Electro-Mechanics Company) formed as an outgrowth of magnetic field and radio frequency research in the 1960's.

In subsequent years, the company advanced abroad while continuing to grow at home.

- In 1997, EMC Test Systems established its first physical presence in Europe with the purchase of Finnish company Euroshield OY. Euroshield is best known for developing pan-type RF shielding and a unique RF sliding-door technology.
- In 2000, Lindgren RF Enclosures was acquired. The US Company is a world leader in RF and MRI Shielding. The addition of Lindgren doubled the overall company size and added additional offices in the US, UK, France, and Singapore. The company names of EMC Test Systems and Lindgren were merged to form a new company name, ETS-Lindgren.
- Holaday Industries, another US company, was also purchased in 2000. The company is a leader in electromagnetic field sensing (EMF) systems.
- In 2002, ETS-Lindgren purchased Acoustic Systems, a leading US provider of acoustic test and measurement, audiology, and broadcast solutions.
- That same year (2002), Japanese and Chinese acquisitions were also made, providing our first physical presence in Asia, with offices for both manufacturing and sales support.
- In 2006, ETS-Lindgren further expanded its Asian presence with a new office in Taiwan to serve the growing customer base in that country.
- Also in 2006, ETS-Lindgren expanded its headquarters in Cedar Park, Texas, US by 64%, bringing the total office space there to 10,683.5 square meters (115,000 square feet).
- In 2011, ETS-Lindgren added to its European operations with the purchase of EMV, a leading German supplier of EMC and RF measurement and shielding systems.

ETS-Lindgren employs more than 800 professionals in offices and manufacturing facilities around the world. Our employees are supported by more than 60 local, independent representatives and distributors.

ETS-Lindgren is a subsidiary of ESCO Technologies, a leading supplier of engineered products for industrial and commercial markets. ESCO is headquartered in St. Louis, Missouri, and listed of the New York Stock Exchange with symbol ESE.

ETS-Lindgren – Enabling Your Success™

CERTIFIED COMPANY ISO 9001:2008 BEIJING · CEDAR PARK· EURA

CTIA Authorized Test Lab LAB CODE 20021212-00

ilac-MRA A2LA ACCREDITED Testing Laboratory Certificate 1207.02

ilac-MRA A2LA ACCREDITED Calibration Laboratory Certificate 1207.01

NVLAP LAB CODE 100286-0

MEMBER Wi Fi ALLIANCE

WiMAX FORUM MEMBER COMPANY

ANTENNA QUICK FINDER

Icon Descriptions

Antennas-2-Go features our most popular antennas, in stock and available for quick delivery.

Rugged Cases provide a safe way to store and ship our antennas. Page 21 for more details.

We can custom design antennas for your specific needs. Page 20 for more details.

2D antenna patterns provide performance information in the two principal planes.

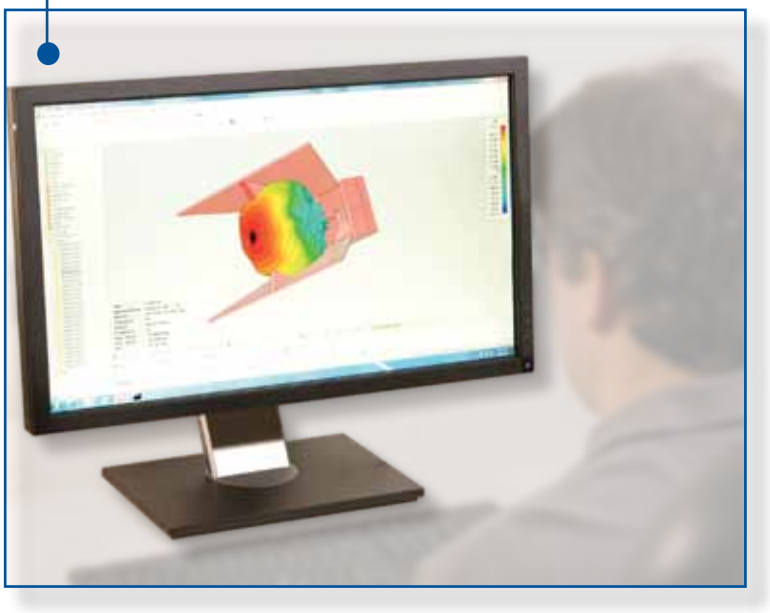
3D antenna patterns provide performance information every 5º in θ and ϕ.

Competitive Advantage

Advanced Computer Modeling

We use state of the art computer modeling to design our antennas. A few of the methods used are Finite Difference Time Domain (FDTD), Finite Element Method (FEM) and Method of Moments (MoM).

After RF modeling is completed, mechanical 3D CAD software is used to help build prototypes for testing. Measured results often match or outperform predicted results. While computers are an important part of the process, we also rely on a staff of experienced RF engineers to guide development. These experts are knowledgeable about current standards and customer requirements, to assure that our antennas meet the needs of our customers.



Precision Manufacturing

For over 40 years we have been developing and manufacturing precision-built antennas. Our capabilities include precise machining of aluminum, brass, steel and dielectric materials such as Teflon™, Kydex™, polycarbonate, Nylon and fiberglass.

Our end-to-end manufacturing capability means we control critical processes that ensure compliance with quality standards. Our commitment to excellence is demonstrated by our certification as an ISO 9001:2008 compliant manufacturer in our Beijing, Cedar Park, and Eura facilities.

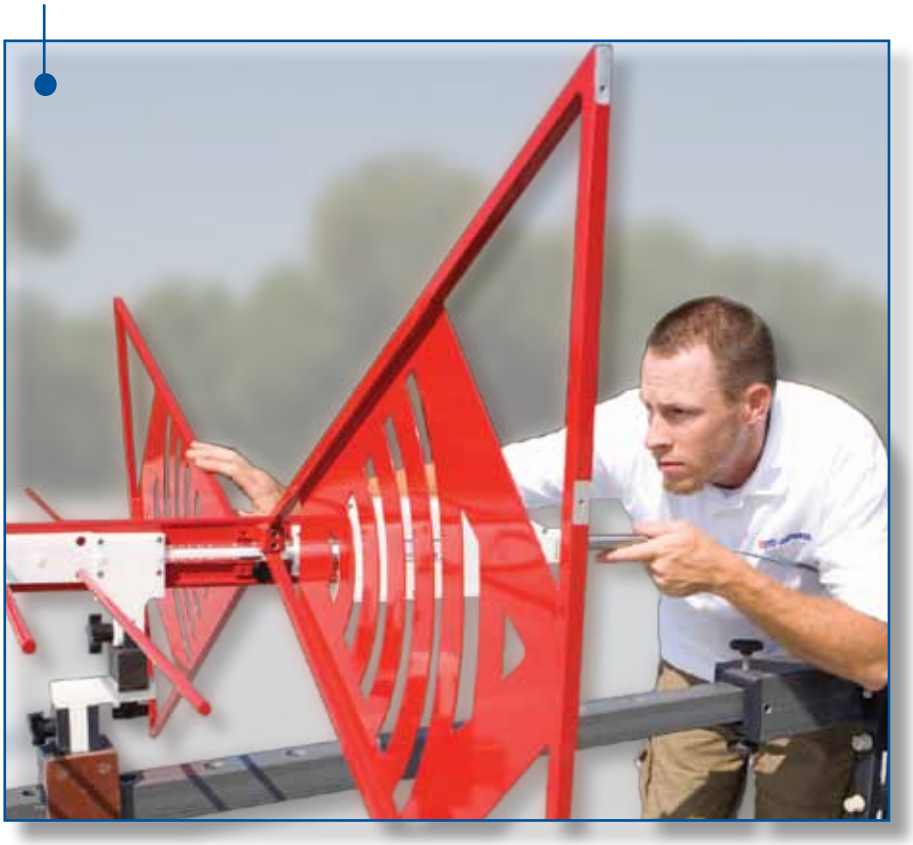
Measured Data

At ETS-Lindgren, we know that low measurement uncertainty values and repeatable results can't be made with unreliable data. That is why we supply actual measured data with our antennas, made with NIST traceable calibrated instruments, in our A2LA antenna calibration lab. Additionally, we publish data for each model on our website, www.ets-lindgren.com.

In-House Antenna Calibration

ETS-Lindgren's calibration lab is accredited by the American Association of Laboratory Accreditation (A2LA).

To increase the precision and accuracy of our calibrations, we use high-end vector network analyzers wherever possible rather than the typical combination of signal/tracking generator/spectrum analyzer.



Network analyzers provide superior linearity, stability, and signal rejection compared to a typical signal generator/spectrum analyzer combination, and provide more frequency points per trace than most spectrum analyzers. The benefit is greater measurement accuracy, less interpolation error, and lower uncertainty values.

Our lab includes an 80 m x 50 m solid-metal outdoor ground plane for calibrating antennas, fully anechoic rectangular and tapered chambers for probe calibrations and cell phone and antenna pattern measurements, GTEM and TEM cells for probe calibrations, and other test fixtures, along with a full complement of NIST traceable instrumentation.

Coils and Loops

Series Frequency: 20 Hz to 50 GHz

Antennas-2-Go
Some Models

Cases Available
Some Models

Series Features

- Magnetic Field Antennas
- For Sensing Low Frequency Signals
- Active (Preamplifier Included) Models Available

Typical Applications

- MIL-STD-461F, ISO 11452 Magnetic Field Test
- RFID Testing at Low Frequencies
- Spectrum Monitoring Below 30 MHz
- Ideal Where Portable Antennas at Low Frequencies are Needed
- Shielding Testing for Magnetic Field

Pattern

- Omnidirectional

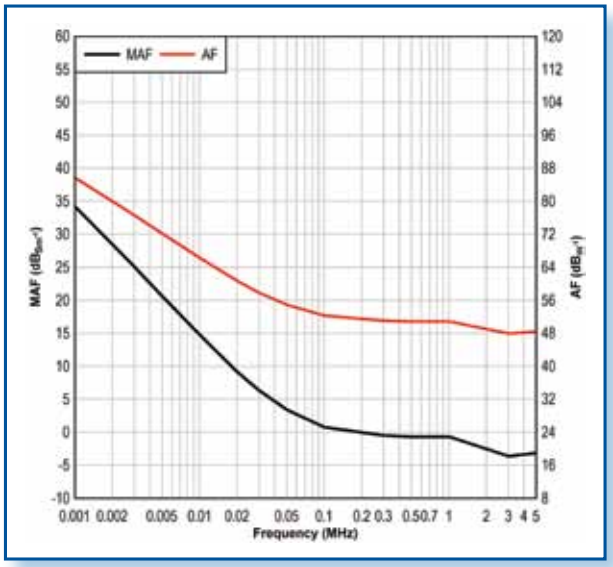
Polarization

- Linear

Mounting

- 1/4” - 20 Threaded Mount

Our Loop & Magnetic Field Coils enable a wide range of magnetic field testing. Some models include active electronics for impedance matching, consistent linear antenna factors, and signal attenuation. Most include a balanced Faraday cage for reduced response to E-Fields.



Typical MAF and Antenna Factor

Monopoles and Rods

Series Frequency: 30 Hz to 50 MHz

Antennas-2-Go
Some Models

Cases Available
Some Models

Series Features

- Low Frequency Wide Band Antennas
- Ideal for Generating or Sensing Electric Fields
- Active (Preamplifier Included) Models Available

Typical Applications

- MIL-STD-461F and Prior Versions, CISPR 25
- EMC Emissions Below 30 MHz
- Spectrum Monitoring
- Shield Testing

Pattern

- Omnidirectional

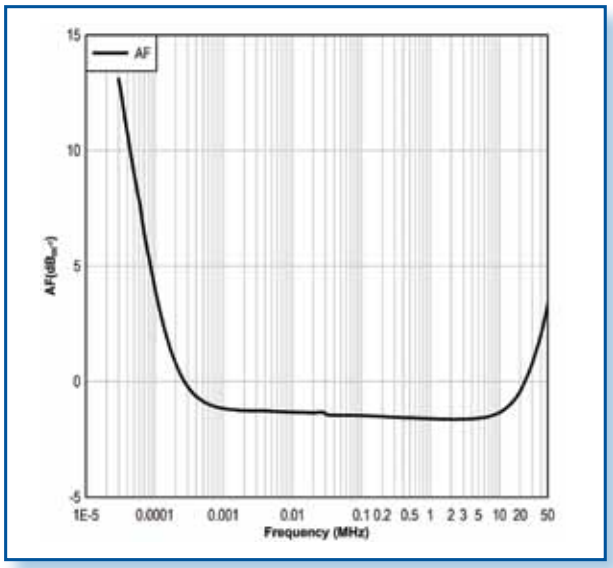
Polarization

- Linear

Mounting

- 1/4” - 20 Threaded Mount

Our Rod Antennas are available individually or as a set. The active Rod is designed to provide reception throughout its frequency range, in a single band, without tuning or bandswitching. Internal attenuators with a saturation indicator are included. The passive Rod antenna has manual bandswitching and accepts power input.



Typical Antenna Factor

Dipoles

Series Frequency: 30 MHz to 6 GHz

Cases Available

Some Models

CUSTOM Solutions Available

Series Features

- Reference Antennas
- Available in:
  - -- Tunable Elements Broadband Balun
  - -- Fixed 1/4 Wavelength Balun Side-fed
  - -- End-fed Sleeve Dipole
  - -- Small Loop (Magnetic Dipole)
- Low VSWR
- Excellent Symmetry on Loops and Sleeve Dipoles

Our Tuned Dipoles provide an accurate standard for precise measurement. Our Fixed Length Balanced Dipoles were designed for AAMI and FDA test requirements, and are frequently used as reference antennas for a transmitting device of the same frequency. Our Precision Sleeve Dipoles are designed to meet the CTIA 0.2 dB symmetry requirement for ripple test measurements.

Typical Applications

- EMC Emissions
- RFID (ISO TR 18047-6)
- CTIA Ripple Test and Range Calibration Antenna
- Reference Antenna

Pattern

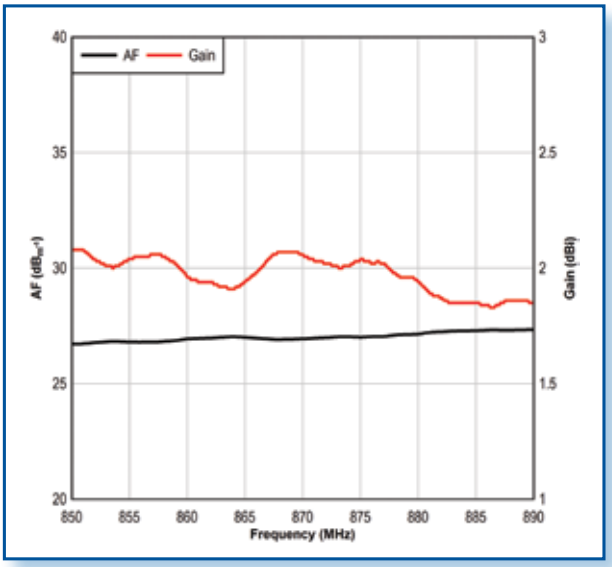
- Omnidirectional

Polarization

- Linear

Mounting

- EMCO and Stinger Mounts (3121D Only)
- CTIA Mount (Loops and Sleeves Only)
- 1/4”- 20 Threaded Mount (3125 Only)



Typical Antenna Factor and Gain

Biconicals and Mini-Bicons

Series Frequency: 30 MHz to 18 GHz

Antennas-2-Go
Some Models

Cases Available
Some Models

CUSTOM
Solutions
Available

2D
Antenna
Patterns
Available

Series Features

- Wide Band Antennas
- Models Available for 15 kW Input Power

Typical Applications

- EMC Emissions:
  - -- CISPR 16
  - -- CISPR 25
  - -- MIL-STD-461
- EMC Immunity:
  - -- Automotive
  - -- MIL-STD
- Harmonics Monitoring for Radiated Immunity
- Spectrum Monitoring
- Chamber and Test Site Validation (CISPR 16) Fully Anechoic Room Validation

Pattern

- Omnidirectional

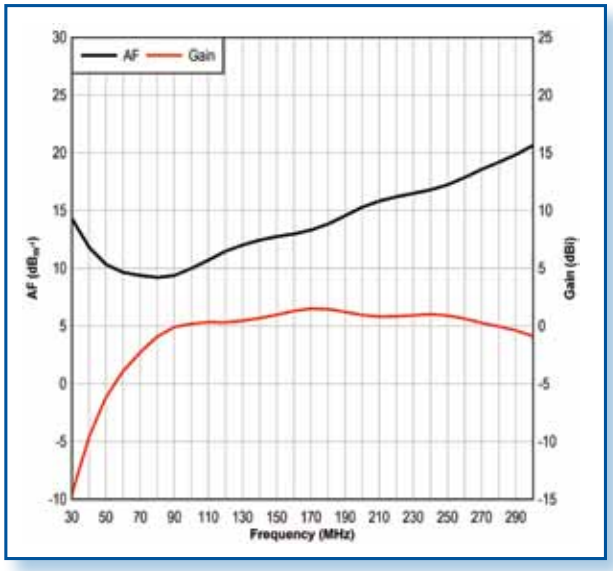
Polarization

- Linear

Mounting

- EMCO Mount
- Stinger Mount (Some Models)
- 1/4”- 20 Threaded Mount (Some Models)
- Custom Mount (Large Immunity Models)

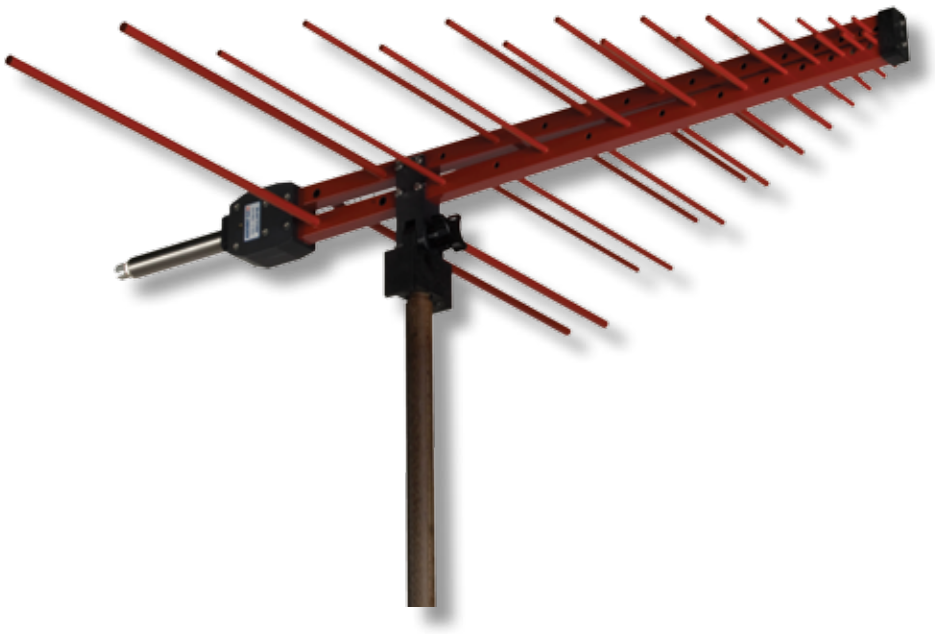
Our Biconical Antennas offer broadband performance in a compact size. Two of our models feature excellent broadband sensitivity for emissions measurements, while another has excellent power handling capability for immunity applications. Model 3183 is specifically designed for CISPR 16-1-4. These small antennas are ideal for spectrum monitoring. Some units are weatherized for continuous outdoor use.



Typical Antenna Factor and Gain

Log Periodic Dipole Array

Series Frequency: 20 MHz to 5 GHz



Antennas-2-Go
Some Models

Cases Available
Some Models

CUSTOM
Solutions
Available

2D
Antenna
Patterns
Available

3D
Antenna
Patterns
Available

Series Features

- Wide Band Directional Antennas
- Power:
  -- Peak: 2.0 kW
  -- CW: 800 W
- Low VSWR
- Excellent Symmetry on Loops and Sleeve Dipoles

Our Log Periodic Antennas exhibit high gain and low VSWR across their broadband frequency range. Precision construction and assembly of the boom contribute to the low VSWR and optimize the phase relationship. Gain is relatively linear across the frequency range, without any sudden dips or bumps.

Typical Applications

- EMC Emissions
- EMC Immunity
- Spectrum Monitoring
- Light Medium Gain Directional Antennas

Pattern

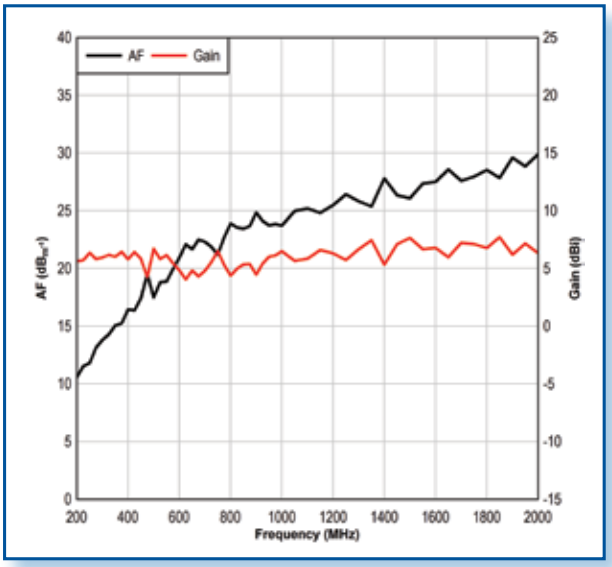
- Directional

Polarization

- Linear
- Dual Linear Polarized Models Available

Mounting

- EMCO Mount
- Stinger Mount (3148B Only)
- Custom Mounts (Large Immunity and Dual Polarized Models Only)



Typical Antenna Factor and Gain

Conical Log Spirals

Series Frequency: 100 MHz to 10 GHz

Antennas-2-Go
Some Models

2D
Antenna Patterns Available

Series Features

- Wide Band Antennas
- Low VSWR

Typical Applications

- EMC Emissions per Previous Versions of MIL-STD
- Communication Antenna
- Spectrum Monitoring
- Antenna Measurements of Circularly Polarized Antennas

Pattern

- Directional

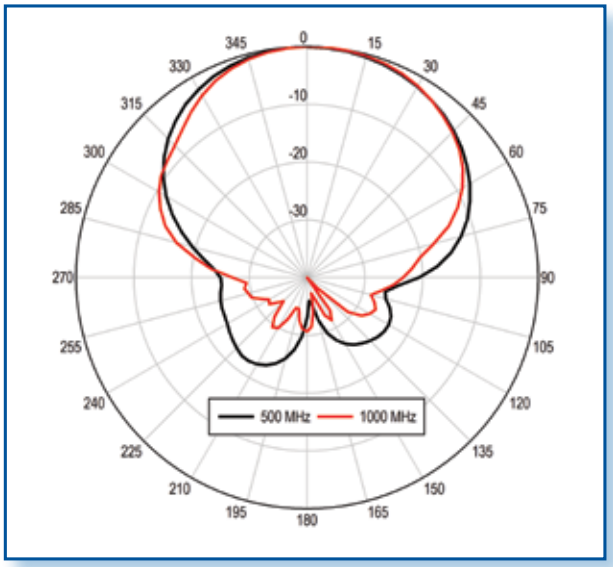
Polarization

- Circular

Mounting

- 1/4”- 20 Threaded Mount

Our Conical Log Spiral Antennas exhibit minimal pattern change over their operating frequency. Received signals can be either linearly or circularly polarized fields. All antennas in this series have moderate gain and low VSWR. Three models offer a choice in size and frequency range. The standard models are left-handed circularly polarized antennas. Right-handed circularly polarized are also available. Please contact ETS-Lindgren for details.



Typical Radiation Pattern

BiConiLog™

Series Frequency: 26 MHz to 6 GHz

Antennas-2-Go
Some Models

CUSTOM
Solutions
Available

2D
Antenna
Patterns
Available

3D
Antenna
Patterns
Available

Series Features

- Ultra-wide Band
- Power:
  -- Peak: 2.0 kW
  -- CW: 800 W
- Low VSWR

Our BiConiLog Antennas sweep their frequency range without stopping for band breaks. This series includes antennas that are optimized for delivering high gain at low frequencies, thus reducing input power requirements.

Typical Applications

- EMC Emissions
- EMC Immunity
- Spectrum Monitoring
- Pre-compliance Sweep Measurements

Pattern

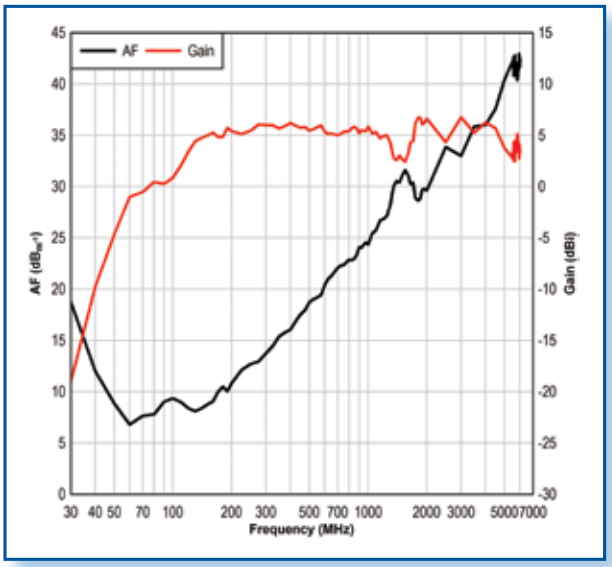
- Omnidirectional (Low End)
- Directional (Upper End)

Polarization

- Linear

Mounting

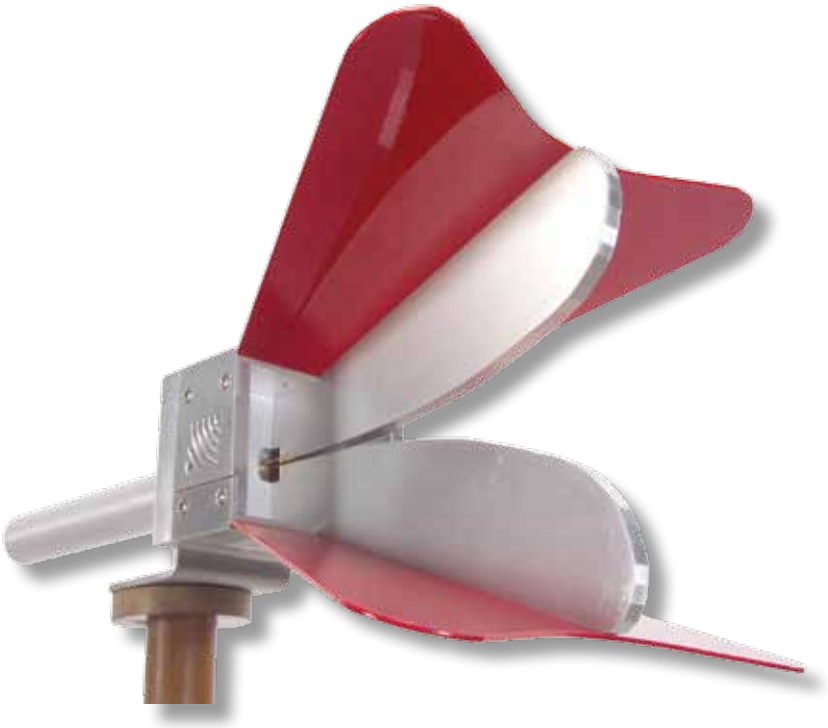
- EMCO Mount
- Stinger Mount (Not Available on 3140B)



Typical Antenna Factor and Gain

Dual Ridge Guide Horns

Series Frequency: 100 MHz to 40 GHz



Antennas-2-Go
Some Models

Cases Available
Some Models

CUSTOM
Solutions
Available

2D
Antenna
Patterns
Available

3D
Antenna
Patterns
Available

Series Features

- Wide Band Antennas
- High Gain
- Low VSWR

Typical Applications

- EMC Emissions
- EMC Immunity
- EMC Standards
  - -- CISPR 16
  - -- ISO 11451
  - -- ISO 11452
  - -- MIL-STD-461
- Antenna Pattern Measurement
- Field Surveying
- Spectrum Monitoring

Pattern

- Directional

Polarization

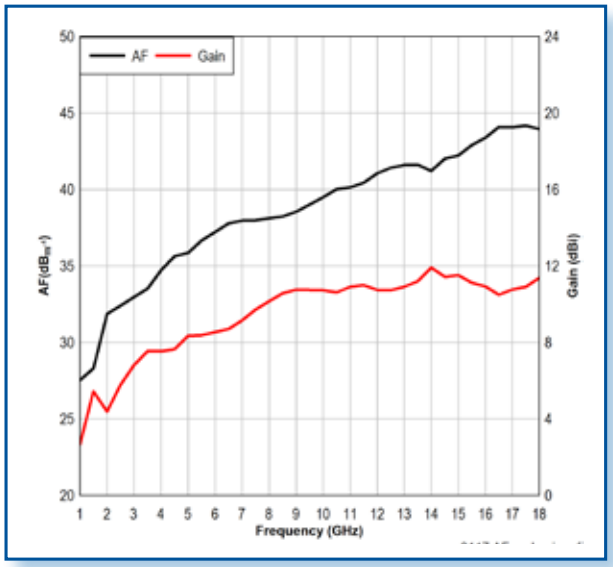
- Linear

Mounting

- Stinger Mount (Some Models)
- 1/4”- 20 Threaded Mount (Some Models)
- Custom Mount (Large Models Only)

Our Dual Ridge Waveguide Horns are linearly polarized with excellent gain and low VSWR over a multi-octave bandwidth. They are effective for generating high fields with modest power input, and receiving low-level signals where high gain characteristics are needed.

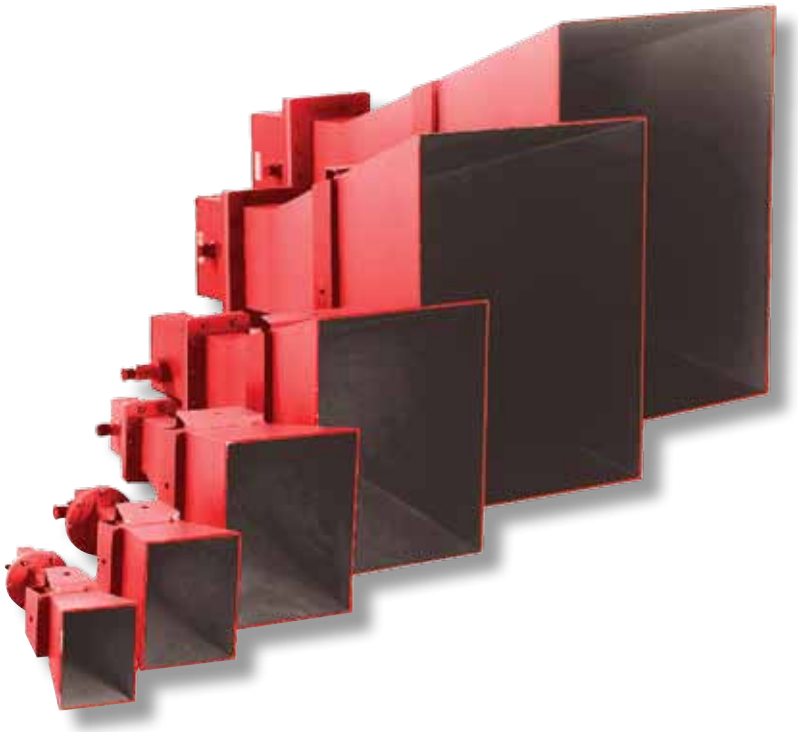
These horns produce a radiation pattern which translates into a smooth gain across the frequency range.



Typical Antenna Factor and Gain

Standard Gain Horns

Series Frequency: 500 MHz to 40 GHz



CUSTOM Solutions Available

2D Antenna Patterns Available

3D Antenna Patterns Available

Series Features

- Reference Antennas
- Calculable Gain
- 16 dB Gain
- High Directivity

Typical Applications

- EMC Emissions
- EMC Immunity
- Antenna Pattern Measurement
- Gain Reference for Any Antenna Measurement

Pattern

- Directional

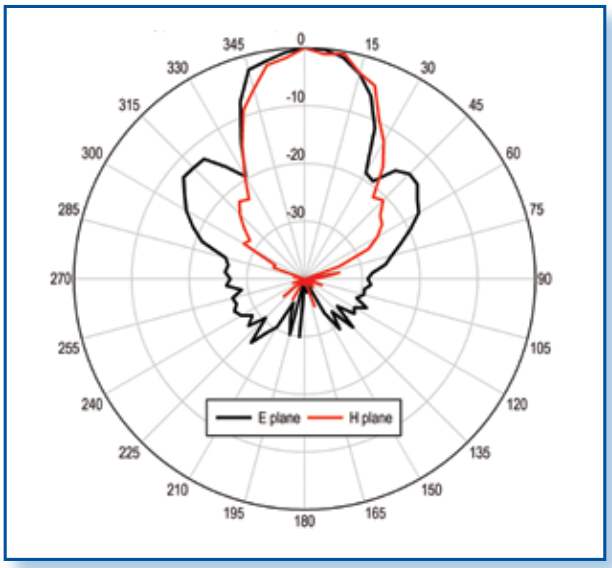
Polarization

- Linear

Mounting

- 1/4”- 20 Threaded Mount

Our Standard Gain Horns are linearly polarized with medium gain, optimal half power beamwidth (equal in both H & V planes), and low VSWR. Antenna factor is constant throughout the entire operating frequency range. Precision manufacturing contributes to the predictable performance of these antennas.



Typical Radiation Pattern

Miscellaneous Horns

Series Frequency: 1 GHz to 26.5 GHz

CUSTOM Solutions Available

2D Antenna Patterns Available

3D Antenna Patterns Available

Series Features

- Pulse Radar Testing Antennas
- Tapered Chamber High Gain Conical Horns
- Low VSWR
- High Directivity

Typical Applications

- EMC Emissions
- EMC Immunity Radar Testing
  - -- GM
  - -- Ford
- 16 dB to 25 dB Conical Horn Sets
- Antenna Pattern Measurements
- Applications Where Small Highly Directive Antennas are Required

Pattern

- Directional

Polarization

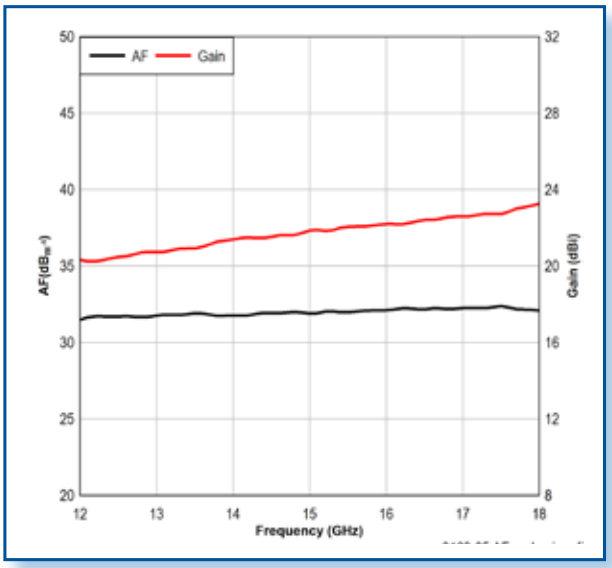
- Linear

Mounting

- Custom Mounts

ETS-Lindgren offers a variety of different horns. Conical horns with high gains are ideal as source antennas for tapered chambers.

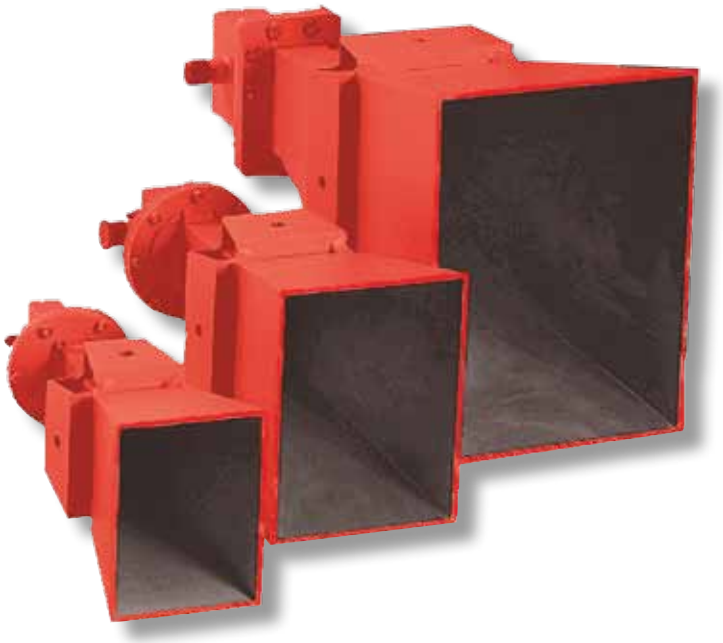
Our Field Generator Horns are pyramidal horns designed for the best performance when used at a one meter test distance.



Typical Antenna Factor and Gain

Octave Horns

Series Frequency: 1 GHz to 8 GHz



CUSTOM Solutions Available

2D Antenna Patterns Available

Series Features

- High Gain
- 16 dB Gain
- Covering an Octave per Antenna
- Low VSWR

Typical Applications

- EMC Immunity
- Applications Matching with Octave Amplifiers

Pattern

- Directional

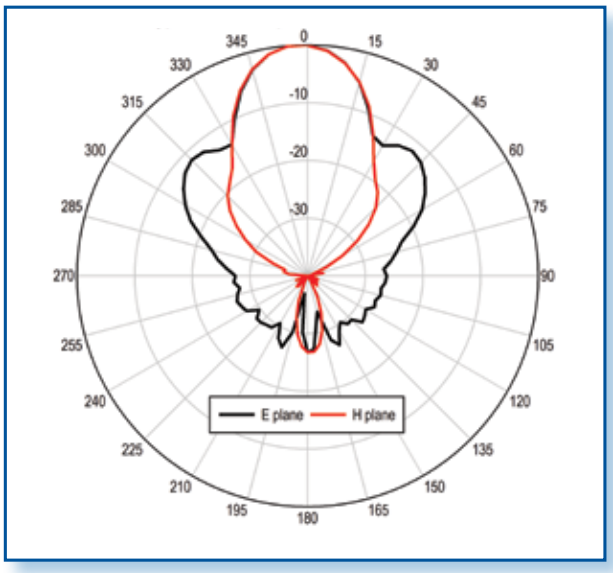
Polarization

- Linear

Mounting

- 1/4”- 20 Threaded Mount

Our Octave Horns are ideal for immunity applications. These horns match perfectly with octave range amplifiers. They have equal half-power beamwidth in the E and H planes and low VSWR.



Typical Radiation Pattern

Open Boundary Quad Ridge Horns

Series Frequency: 80 MHz to 18 GHz

Antennas-2-Go
Some Models

Cases Available
Some Models

CUSTOM
Solutions
Available

2D
Antenna
Patterns
Available

3D
Antenna
Patterns
Available

Series Features

- Wide Band
- Dual Linear Polarization
- Low VSWR

Typical Applications

- EMC Emissions
- Antenna Pattern Measurements
- Field Surveying
- Field Monitoring

Pattern

- Directional

Polarization

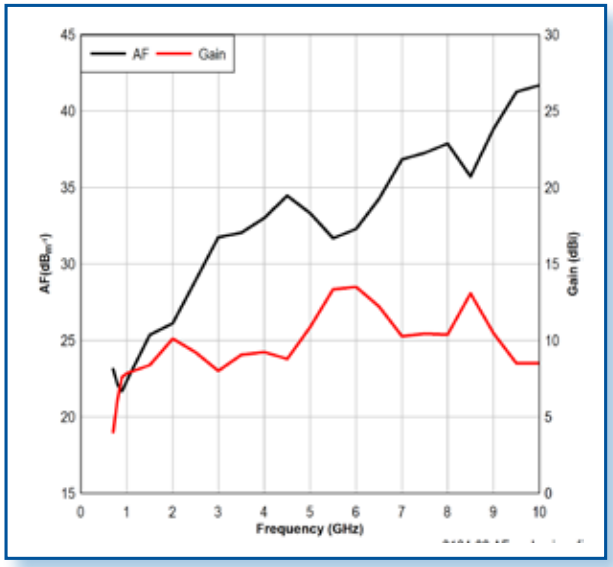
- Dual Linear

Mounting

- 1/4”- 20 Threaded Mount
- Stinger Mount (3164-05 Only)
- Flange Mount for Shielded Enclosures
- Custom Mount (Large Models Only)

Our Open Boundary Quadridge Horns cover all known wireless service frequencies. Two orthogonal placed feeds permit simultaneous measurement in either H or V polarization. Transmit and receive signals can be either linear or circularly polarized fields over a broad frequency range.

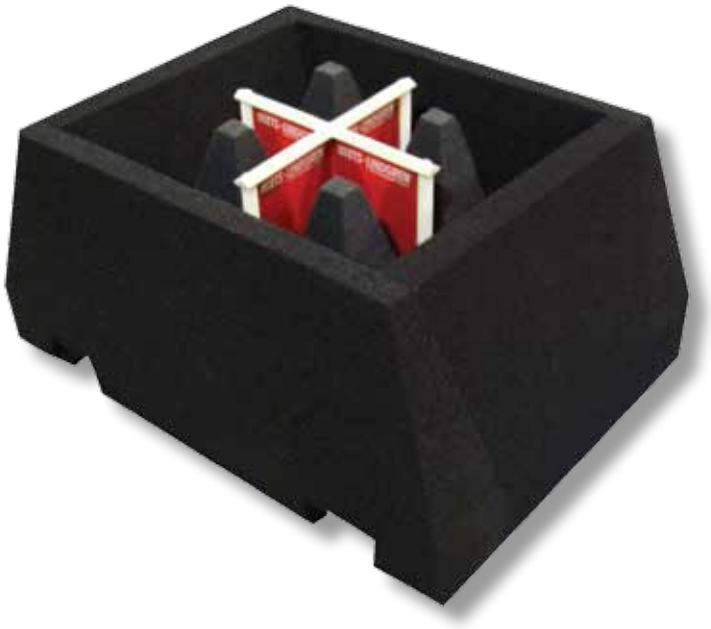
These are also ideal for radar pulse testing and as measuring antennas for Antenna Pattern Measurements.



Typical Antenna Factor and Gain

Vivaldi

Series Frequency: 700 MHz to 6 GHz



CUSTOM Solutions Available

2D Antenna Patterns Available

Series Features

- Low Reflectivity
- Low VSWR
- High Directivity

Typical Applications

- MIMO
- Wireless
- Antenna Pattern Measurements

Pattern

- Directional

Polarization

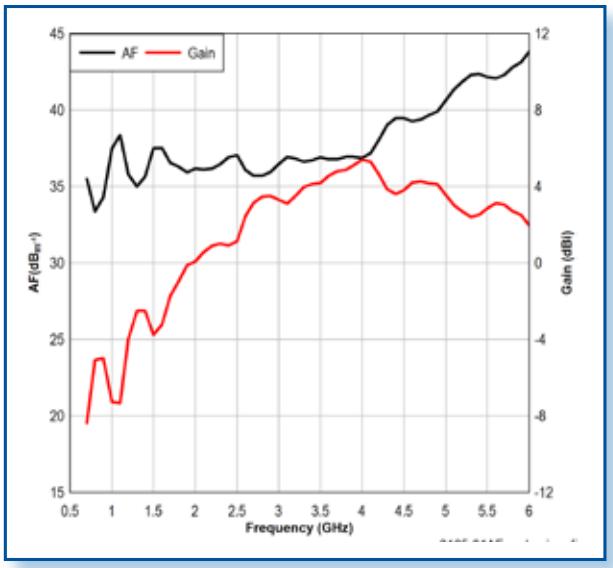
- Dual Linear

Mounting

- Custom Mount

Our Vivaldi Antenna is designed for applications where source antenna effects must be minimized, such as chambers where the device under test (DUT) is illuminated from different directions.

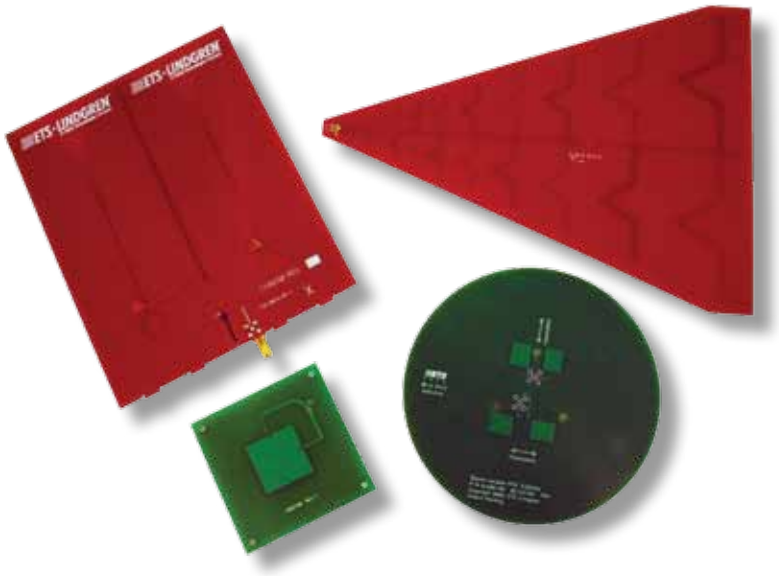
The antenna can also be used without the surrounding absorber in any application where a light-weight directive antenna is required.



Typical Antenna Factor and Gain

Printed and Patch

Series Frequency: 433 MHz - 6 GHz



CUSTOM Solutions Available

2D Antenna Patterns Available

Series Features

- Low Profile, Low Weight
- Narrow and Wide Band

Typical Applications

- Wireless
- Medical Product Testing at 433 MHz
- Low Profile Narrowband Applications

Pattern

- Directional

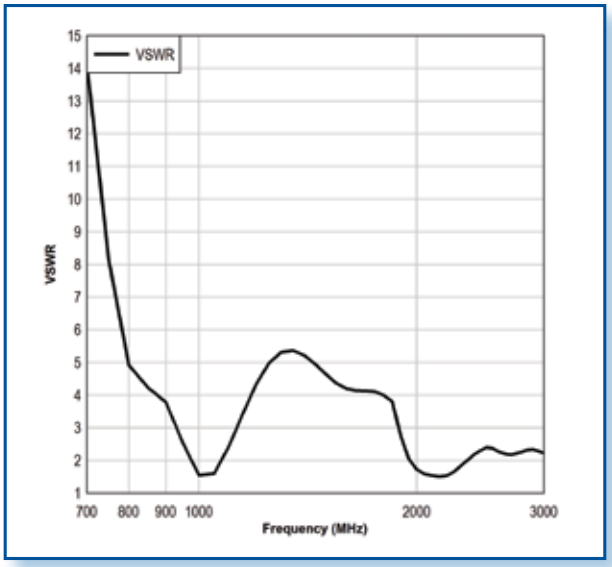
Polarization

- Linear
- Dual Linear
- Circular

Mounting

- Custom Mount

ETS-Lindgren also offers printed and microstrip patch antennas for use in small shielded rooms and test boxes to perform functionality test of wireless and medical devices.



Typical VSWR Data for Printed Dipole

E/H and E-Field Generators

Series Frequency: 10 kHz to 30 MHz

CUSTOM Solutions Available

Series Features

- Self-standaing and Chamber Supported (1 kW to 10 kW Models)
- Vertical Field and Vertical/Horizontal Field Generation
- Low VSWR
- Up 200 v/m of Field

Typical Applications

- EMC Immunity
- Full Vehicle or Large EUT Immunity
- EMC Standards
  - -- Belcore Standard
  - -- MIL-STD-461
  - -- ISO 11451-2 and Equivalents

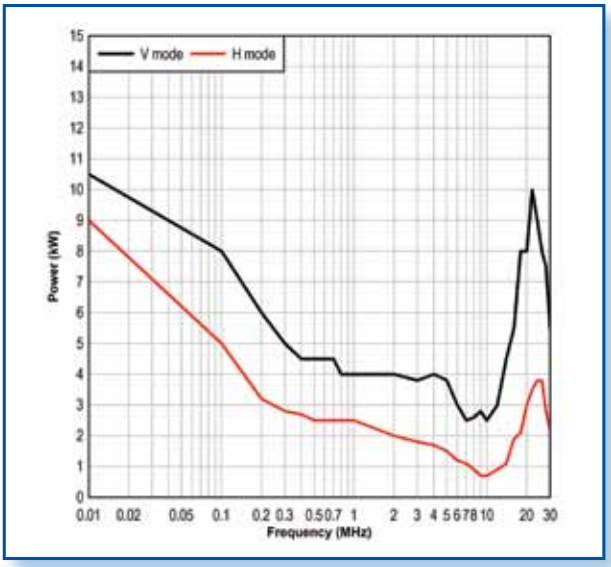
Polarization

- Dual Linear

Mounting

- Chamber Supported
- Self-Supported

At frequencies below 30 MHz, antennas become physically too large to fit inside chambers. Our E/H and E-Field Generators provide the means of performing radiated immunity testing by using TEM transmission lines. Several self standing models and chamber supported models are available.



Typical Power Requirements for 200 v/m Generation

Custom Solutions

Series Frequency: 10 kHz to 40 GHz

CUSTOM Solutions Available

Series Features

- Solutions for Complex Requirements
- Broadband
- High Power
- Pulse Immunity

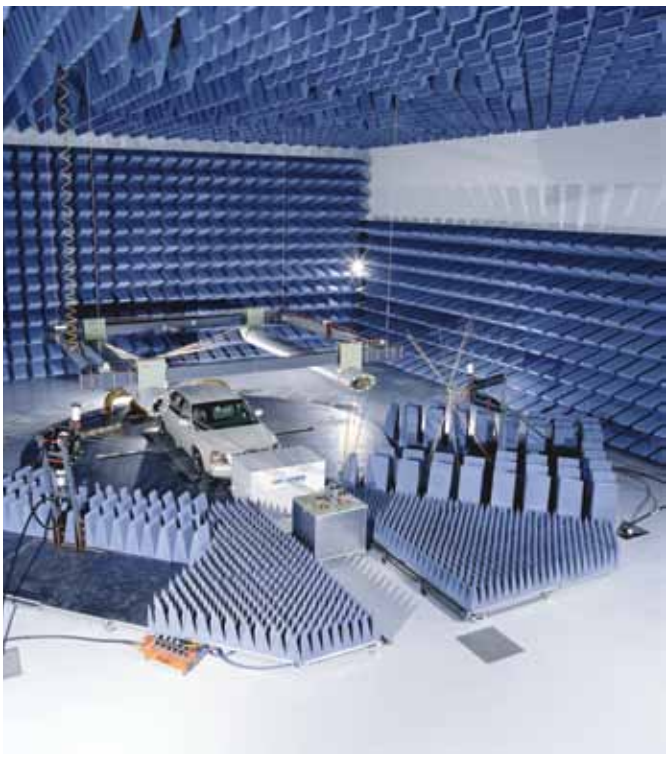
Typical Applications

- Customized to Meet Your Specific Applications

Mounting

- Custom Mount

ETS-Lindgren specializes in antenna solutions for testing wireless, military and automotive products. We have the experience and the tools to design any specialized antenna to meet your specific application.



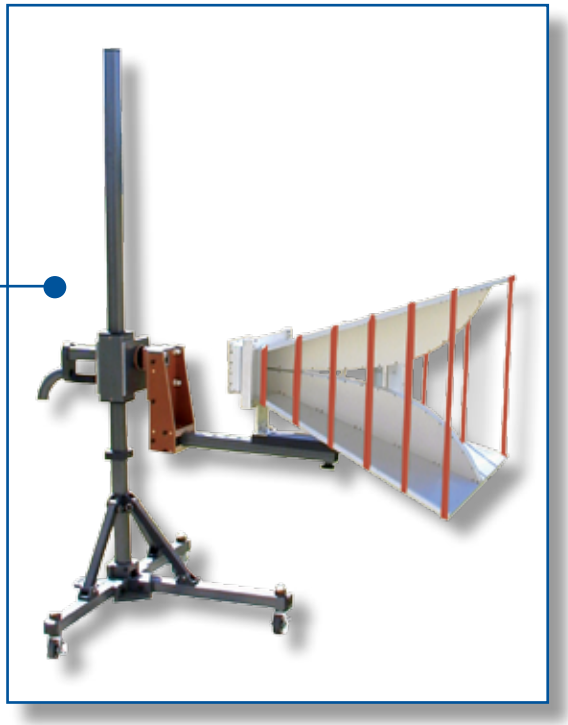
Accessories

Antenna Towers

ETS-Lindgren antenna towers were the first commercially available towers for the EMC market. We now offer a wide variety of compact and full-size antenna towers with features including centerline air polarization, variable speed operation and bore site capability.

Tripods

ETS-Lindgren tripods are constructed of non-metallic, non-reflective materials that will not distort measured data. For ease of use, these tripods have easy-adjust controls which allow for precise height adjustments. To ensure long-life, our tripods are constructed of the highest-quality materials possible and can be used at both indoor and outdoor test sites.



Rugged Antenna Cases

ETS-Lindgren cases provide a safe way to store and ship delicate equipment. Designed for multiple transportation cycles, these cases are uniquely designed to have uniform wall strength and thick, reinforced corners. Additionally, these cases are moisture and chemical resistant, allowing for safe and secure transport of sensitive electronics.

Antenna Equations

For additional reference material including white papers, please see our website at www.ets-lindgren.com.

Antenna Factor

The ratio of field strength at the location of the antenna to the out voltage across the load connected to the antenna.

$$AF = \frac{E}{V}$$

where:

AF = Antenna Factor, meters $^{-1}$

E = Field Strength, V/m or μV/m

V = Load Voltage, V or μV

Converting to dB (decibel) notation gives:

$$AF_{dB(m^{-1})} = 20 \log \left(\frac{E}{V}\right)$$

The antenna factor is directly computed from:

$$AF = \frac{9.73}{\lambda \sqrt{g}} \ (m^{-1})$$

where:

λ = Wavelength (meters)

g = Numeric Gain

In the same sense, for magnetic fields, loop antennas:

$$AF_{H\,dB(S/m)} = H_{dB(A/m)} - V_{dB(V)}$$

In terms of flux density (B-Field)

$$AF_B = AF_H + 20 \log (\mu)$$

$$AF_B = AF_H - 118, \ T / V$$

Loop antennas are sometimes calibrated in terms of equivalent electric field, where:

$$AF_{E\,dB(m^{-1})} = AF_{H\,dB(S/m)} + 20 \log (120\,\pi), \text{ or}$$

$$= AF_{H\,dB(S/m)} + 51.5 \text{ dB}$$

where:

η = the Impedance of Free Space

= 120 π Ω

Relationship of Antenna Factor and Gain in a 50Ω System

$$G_{dB} = 20 \log \left(f_{MHz}\right) - AF_{dB(m^{-1})} - 29.79$$

Conversion of Signal Levels from mW to μV in a 50Ω System

Voltage and power are equivalent methods of stating a signal level in a system where there is a constant impedance. Thus:

$$P = \frac{V^2}{R}$$

$$V_{dB(\mu V)} = P_{dBm} + 107$$

Power Density to Field Strength

An alternative measure of field strength to electric field to power density:

$$P_d = \frac{E^2}{120\,\pi}$$

Friis Transmission Formula

The Friis Transmission formula describes power received by an antenna in terms of power transmitted by another antenna.

$$P_r = \frac{P_t G_t G_r \lambda^2}{(4\,\pi\,r)^2}$$

where:

P_r = Power Received (W)

P_t = Power Transmitted (W)

G_r = Numeric Gain of Receiving Antenna

G_t = Numeric Gain of Transmitting Antenna

r = Separation Between Antennas (meters)

λ = Wavelength (meters)

Electric Field vs. Power Transmitted (Far Field)

The electric field strength at a distance from a transmitting antenna such that the electric and magnetic field values are related by the impedance of free space is:

$$E_{V/m} = \frac{\sqrt{30 P_t G_t}}{r}$$

where the terms are as defined above.

For more complex antennas having higher gain values, far field conditions exist when:

$$r \geq \frac{2D^2}{\lambda}$$

where

D = Maximum Dimension of the Antenna (m)

GLOBAL SOLUTIONS

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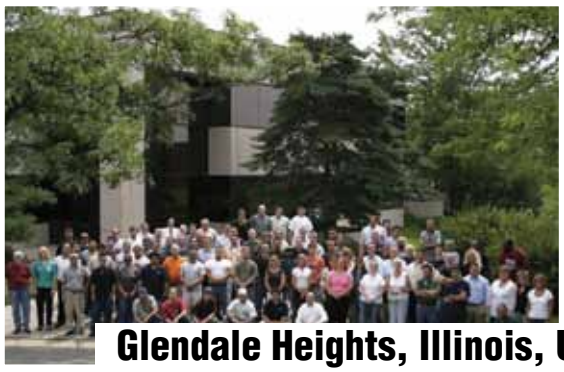

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