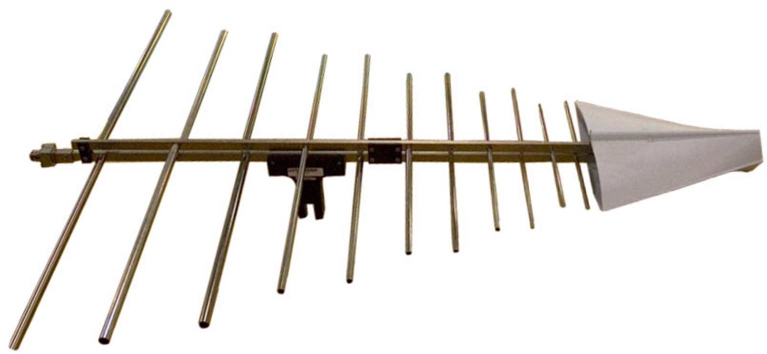
Model 3147

Log Periodic Dipole Antenna

User Manual



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Revision Record

MANUAL 3147 LOG PERIODIC ANTENNA | Part #399160, Rev. G

Revision	Description	Date
A	Initial Release	January, 1999
B	Updated content/branding	October, 2002
C	Edited content, rebranding changes	June, 2008
D	Updated photos	April, 2009
E	Added *Mounting Instructions*	March, 2010
F	Corrected error in *Power Requirements* table; updated part numbers in *Mounting Instructions*	November, 2010
G	Updated calibration information	April, 2020

Table of Contents

Notes, Cautions, and Warnings

	Note: Denotes helpful information intended to provide tips for better use of the product.
CAUTION	**Caution**: Denotes a hazard. Failure to follow instructions could result in minor personal injury and/or property damage. Included text gives proper procedures.
WARNING	**Warning**: Denotes a hazard. Failure to follow instructions could result in SEVERE personal injury and/or property damage. Included text gives proper procedures.

See the ETS-Lindgren *Product Information Bulletin* for safety, regulatory, and other product marking information.

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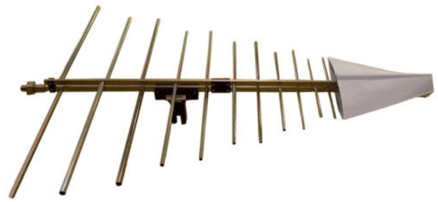
1.0 Introduction

The **ETS-Lindgren Model 3147 Log Periodic Dipole Antenna** is a linearly-polarized broadband antenna designed to operate over the frequency range of 200 MHz to 5 GHz. The antenna was designed with the latest revision to Part 15 of FCC Rules and Regulations in mind. See page 13 for specifications.



The Model 3147 is constructed from 30 elements mounted on two 6.35-mm by 12.7-mm booms. The choice of scaling factors, the various diameters of each element, and the center-to-center spacing of the booms yield excellent VSWR characteristics throughout the operating frequency range (see *VSWR* on page 24). The precise design of the feed and the positioning of the elements on the boom yield an optimum phase relationship. This causes the active region, at any given frequency, to propagate RF energy towards the smaller elements, leaving the elements behind it electrically dead.

The constant gain of the Model 3147 yields an antenna factor which varies linearly with frequency, as shown in *Typical Data* on page 23. The variation is smooth; therefore, accurate interpolation of performance between specified frequency points is simple.

Due to the relatively high upper frequency limit, the small elements on the Model 3147 are very thin. The antenna is equipped with an integral, low dielectric-constant radome to protect the elements from possible damage.

CAUTION **Do not disassemble or drop the antenna or the thin elements may be damaged.**

Because the radome is almost RF-invisible, it has very little effect on the performance of the Model 3147 (see *VSWR* on page 24).

The base of the Model 3147 accepts an ETS-Lindgren or other tripod mount with 1/4–20 threads. Additionally, the antenna is shipped with a support rod. A variety of mounting options are available for the Model 3147. For information, see *Mounting Instructions* on page 15.

Regarding Calibration of Log Periodic Dipole Antennas

The ETS-Lindgren Model 3147 antenna is calibrated based on ANSI C63.5 at a distance of 10 m. Per the requirement of the standard, ETS-Lindgren measures from the midpoint to the midpoint of the log periodic antennas.

Optionally the log periodic antenna can be calibrated per SAE ARP 958 (Society of Automotive Engineers, Aerospace Recommended Practice). The SAR APR 958 requires an antenna spacing of one meter, measured from tip (front of the antenna boom) to tip..

➔ It is important in compliance demonstration testing to measure the spacing from the antenna to the Equipment Under Test (EUT) as it was measured when calibration was performed.

For additional information, contact ETS-Lindgren.

ETS-Lindgren Product Information Bulletin

See the ETS-Lindgren *Product Information Bulletin* included with your shipment for the following:

- Warranty information
- Safety, regulatory, and other product marking information
- Steps to receive your shipment
- Steps to return a component for service
- ETS-Lindgren calibration service
- ETS-Lindgren contact information

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2.0 Maintenance

CAUTION **Before performing any maintenance, follow the safety information in the ETS-Lindgren *Product Information Bulletin* included with your shipment.**

Maintenance of the Model 3147 Log Periodic Dipole Antenna is limited to external components such as cables or connectors. If you have any questions concerning maintenance, contact ETS-Lindgren Customer Service.

Maintenance Recommendations

If the Model 3147 is used outdoors, periodic removal of the antenna cable connection and cleaning of any corrosion may be needed to maintain accuracy of the measurements. An inspection to determine the need for cleaning should be made at least every six months. More frequent inspection may be needed depending on the atmosphere and the environment in which the antenna is used.

Annual Calibration

See the *Product Information Bulletin* included with your shipment for information on ETS-Lindgren calibration services.

Service Procedures

For the steps to return a system or system component to ETS-Lindgren for service, see the *Product Information Bulletin* included with your shipment.

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3.0 Specifications

Electrical Specifications

Frequency Range:	200 MHz–5 GHz
VSWR:	**Average:** 1.25:1 **Maximum:** 1.7:1
Impedance:	50 Ω
Maximum Continuous Input Power:	80 W at 1 GHz 40 W at 5 GHz
Maximum Peak Input Power:	100 W at 1 GHz 50 W at 5 GHz
Connector:	Precision N female

Physical Specifications

Height:	7.62 cm 3.0 in
Width:	88 cm 34.65 in
Depth:	97 cm 38.19 in
Weight:	4.25 kg 9.36 lb

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4.0 Mounting Instructions

CAUTION

Before connecting any components, follow the safety information in the ETS-Lindgren *Product Information Bulletin* included with your shipment.

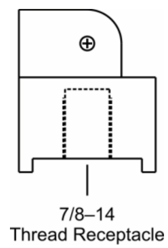
CAUTION

The Model 3147 is a precision measurement device. Handle with care.

Using Included Mounting Adapters

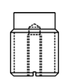
The Model 3147 Log Periodic Dipole Antenna ships with these mounting adapters:

- **100989 Polarizing Mounting Adapter with 7/8–14 thread receptacle**

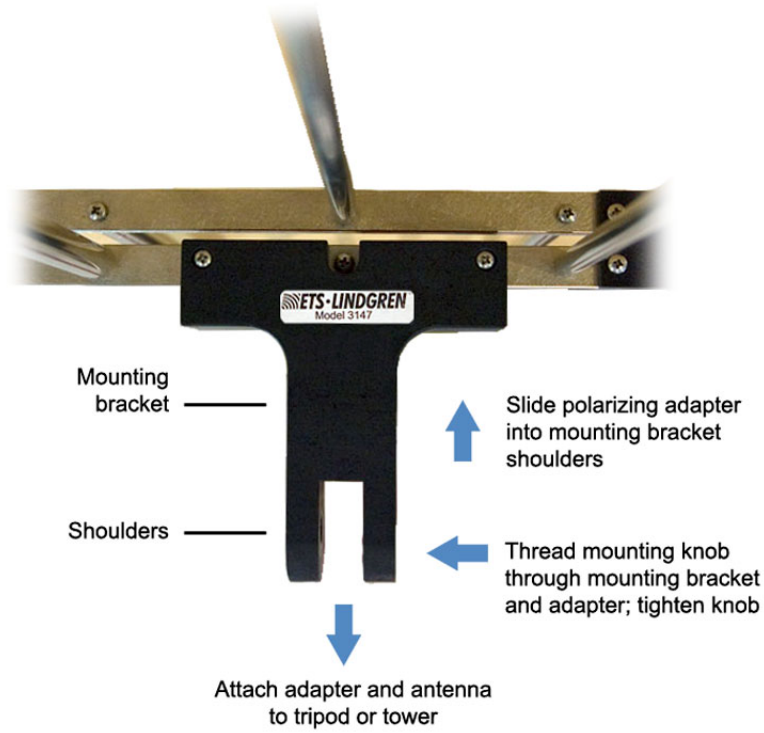


If you need to convert the polarizing adapter to a 1/4–20 receptacle, insert the 1/4–20 thread insert into the polarizing adapter

- **105861 1/4–20 Thread Insert**



To attach the included adapters to the Model 3147:



1. If required, insert the 1/4–20 thread insert into the polarizing adapter.
2. Remove the mounting knob from the mounting bracket on the antenna.
3. Slide the polarizing adapter into the mounting bracket by placing the polarizing adapter placed between the shoulders of the mounting bracket.

4. Thread the mounting knob through the mounting bracket, then through the polarizing adapter, and finally through the hex nut.

➔ Do not cross thread or permanent damage to the adapter could occur.

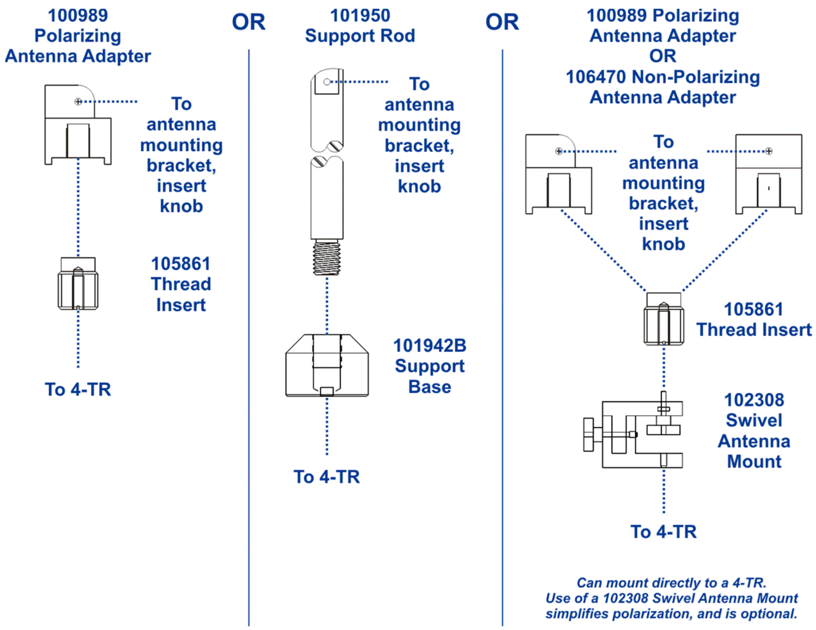
5. Tighten the mounting knob to secure the antenna.

6. Attach the polarizing adapter and antenna to tripod or tower, as required.

Additional Mounting Options

4-TR Mounting Options

Following are additional options for mounting the Model 3147 onto an ETS-Lindgren 4-TR tripod. Contact the ETS-Lindgren Sales Department for information on ordering optional mounting hardware.

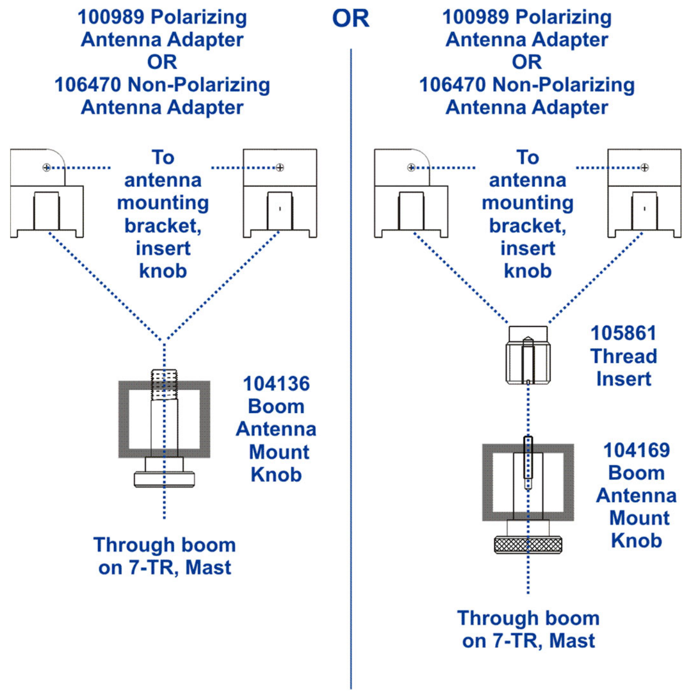


7-TR and Mast Mounting Options

Following are options for mounting the Model 3147 onto an ETS-Lindgren 7-TR Tripod or mast. Contact the ETS-Lindgren Sales Department for information on ordering optional mounting hardware.

Mast refers to 2070 Series, 2075, and 2175 Antenna Towers.
7-TR refers to 109042, 108983, and 108507 booms:

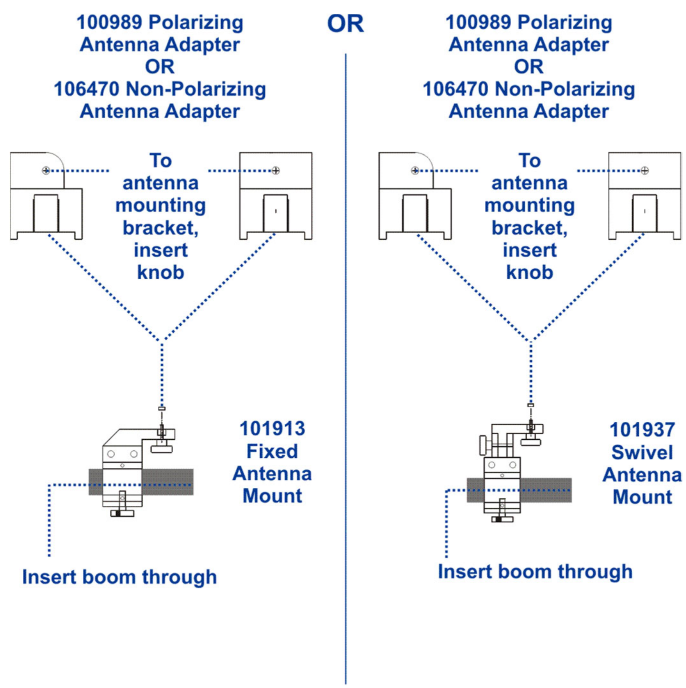
- *109042 boom*—Straight boom; for general antenna mounting on a 7-TR
- *108983 boom*—Offset boom; for general antenna mounting on a 7-TR with pneumatic or manual polarization; can also be used to mount stinger-type antennas



2X2 BOOM MOUNTING OPTIONS

Following are additional options for mounting the Model 3147 onto a 2x2 boom. Contact the ETS-Lindgren Sales Department for information on ordering optional mounting hardware.

2x2 boom refers to a typical 2-inch by 2-inch boom.



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5.0 Operation

CAUTION

Before connecting any components, follow the safety information in the ETS-Lindgren *Product Information Bulletin* included with your shipment.

Model 3147 Assembly Instructions

A variety of mounting options are available for the Model 3147. For information, see *Mounting Instructions* on page 15.

To attach the support rod to the base of the Model 3147 Log Periodic Dipole Antenna:

1. Remove the clamping screw from the mount on the antenna.
2. Insert the support rod.
3. Replace the screw.
4. Place the support rod and base onto a tripod, and then tighten the 1/4–20 screw in the bottom of the base.
5. Remove the red connector cover from the precision N connector.
6. Attach a cable to the precision N connector and to the input of a measuring device.

Model 3147 Use

The Model 3147 may be used for either reception or transmission of electromagnetic energy. The primary design goal is the efficient reception of signals from 200 MHz to 5 GHz for electromagnetic compatibility testing to commercial standards such as CFR 47 Part 15 of the FCC Rules and Regulations. Typical performance data is provided beginning on page 23 to assist with use. Methods of use for radiated emissions measurement are described on page 35.

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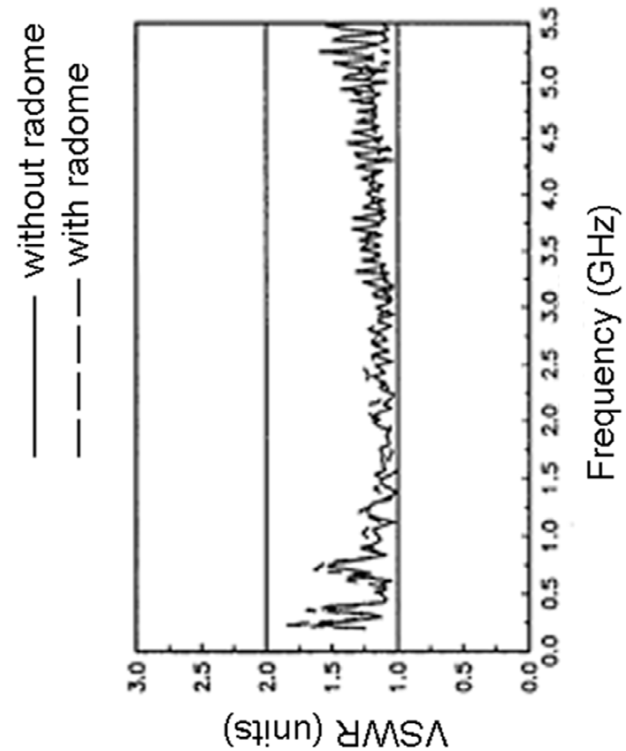
6.0 Typical Data

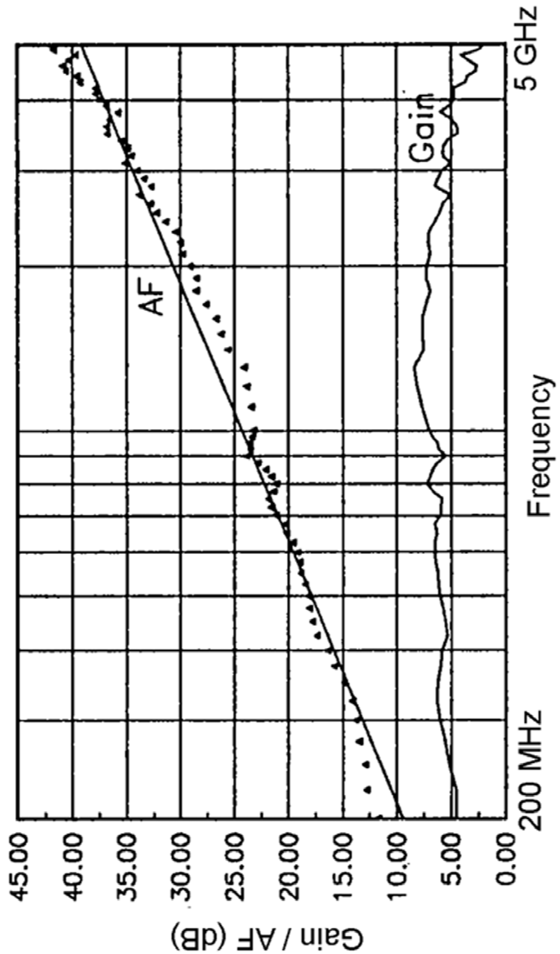
Following are typical measurements for the Model 3147 Log Periodic Dipole Antenna.

Typical VSWR for Model 3147

➔ This is a plot of the VSWR showing the antenna with and without a radome. The effect of the radome on the electromagnetic performance of the antenna is minimal.



Typical Antenna Factor and Gain for Model 3147

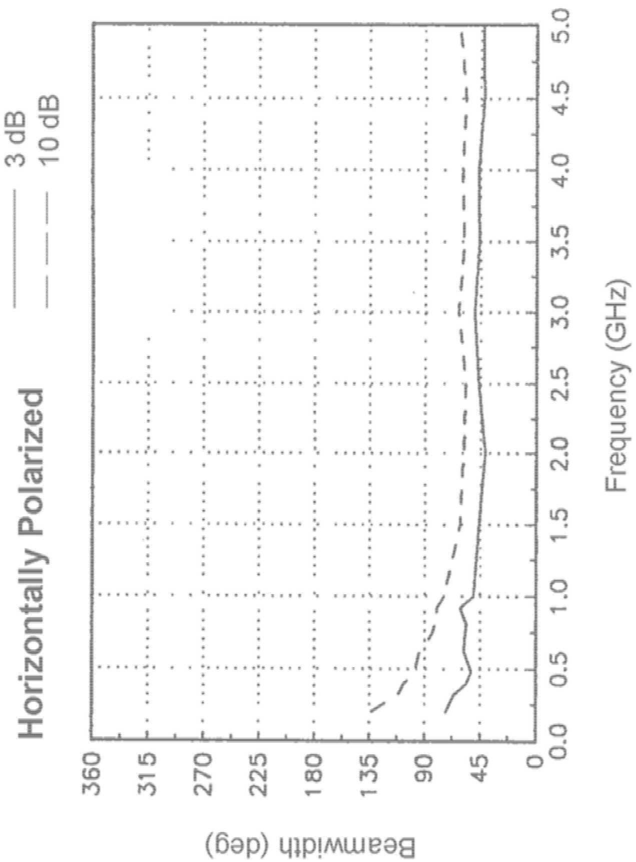

Gain / AF (dB)
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
200 MHz
Frequency
5 GHz
AF
Gain

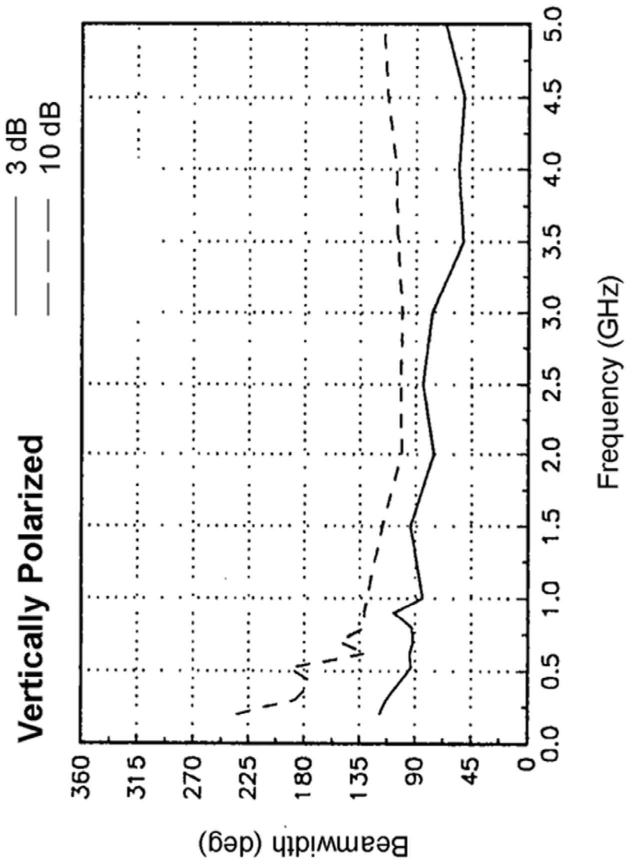
The antenna factor of the Model 3147 (triangles) measured at the distance of three meters as per ANSI C63.5. The standard states that *the spacing R between log-periodic array antennas is measured from the projection onto the ground plane of the midpoint of the longitudinal axis of each antenna*. This midpoint has been marked on the radome and labeled *Reference Point Per ANSI C63.5*. The line shown in the figure is a linear fit to the antenna factor data. The second curve shows the gain of the antenna as computed from the antenna factor by:

$$G(dB) = 20 \log(F_{MHz}) - 29.79 - AF_{dB(m^{-1})}$$

Beamwidth for Horizontally and Vertically Polarized Model 3147

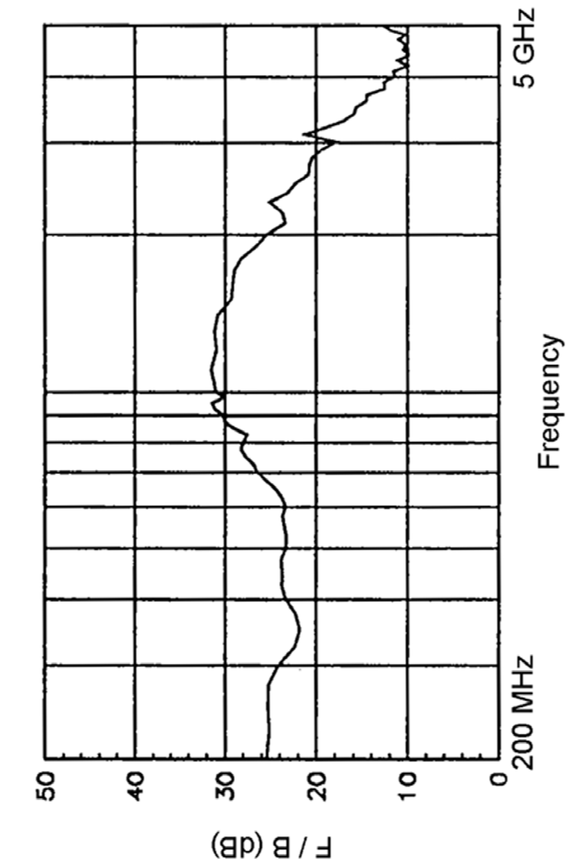
➔ The beamwidth charts show the 3-dB and 10-dB power beamwidth as determined from the antenna patterns taken for both horizontal and vertical polarizations.


Horizontally Polarized
3 dB
10 dB
Beamwidth (deg)
360
315
270
225
180
135
90
45
0
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
Frequency (GHz)

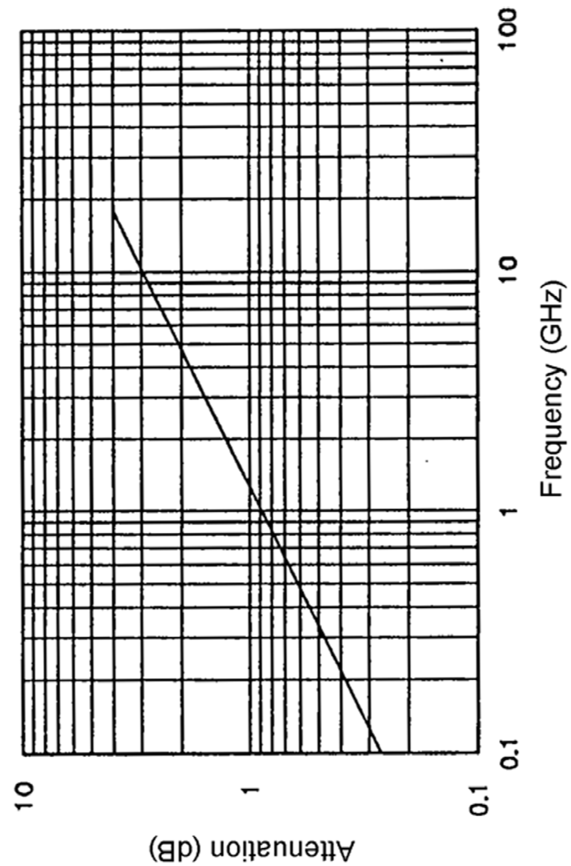

Vertically Polarized
3 dB
10 dB
Beamwidth (deg)
Frequency (GHz)
0
45
90
135
180
225
270
315
360
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0

Front-to-Back Ratio for Model 3147

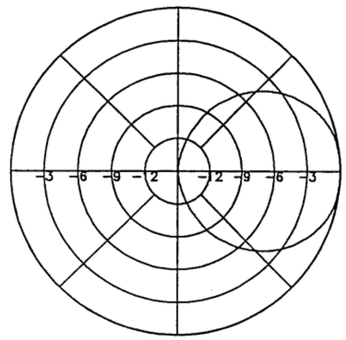
The front-to-back ratio is representative of how well the antenna propagates energy in the end fire direction. The measurement is made by first positioning two identical Model 3147 antennas face-to-face at a 2-meter height and a 3-meter distance. A signal is transmitted through one antenna and received with the other. The transmitting antenna is then rotated 180° in azimuth so that the back is pointed towards the receiving antenna. The difference between the two measurements is taken as the front-to-back ratio.


F / B (dB)
50
40
30
20
10
0
200 MHz
Frequency
5 GHz

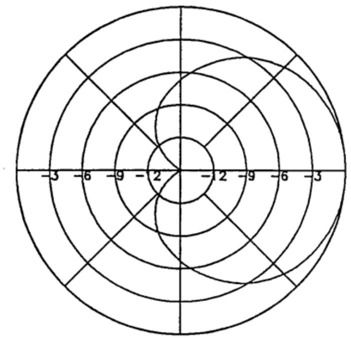
Cable Attenuation (dB) at 20°C for 6-M Cable



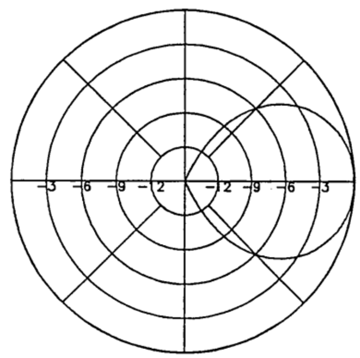
Typical Antenna Pattern for 200 MHz and 300 MHz



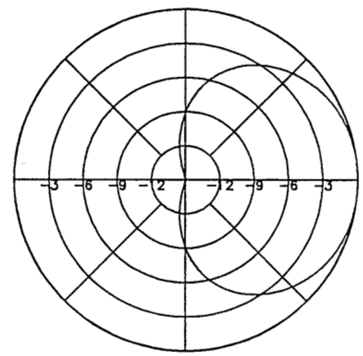
200 MHz, Horizontal Polarization



200 MHz, Vertical Polarization



300 MHz, Horizontal Polarization



300 MHz, Vertical Polarization

This shows a sample antenna pattern taken at selected frequencies of 200 MHz and 300 MHz. Additional antenna patterns are located in *Appendix A* on page 41. These patterns were measured indoors using a separation distance of 1 meter to 1.5 meters between the transmit antenna and the receive antenna.

The antenna patterns in *Appendix A* and the beamwidths on page 28 are useful in determining the size of the Equipment Under Test (EUT) that can be measured with the Model 3147 at a specified distance.

7.0 Radiated Emissions Measurement

CAUTION

Before connecting any components, follow the safety information in the ETS-Lindgren *Product Information Bulletin* included with your shipment.

Ambient field strength values are measured as follows:

1. Install the antenna where measured field strength values are desired.
2. Select the desired orientation of the antenna, both boresite direction and polarization.
3. Connect the antenna output connector to the input of the receiving system using a coaxial cable. These antennas are calibrated for receiving systems having 50-Ω input impedance. Other values of receiving system input impedance will require correction for the differences in input impedance.
4. Select the desired frequency of measurement on the receiving system.
5. Measure the RF voltage, V_a, referenced to the input port of the receiving system. The units of the measurement should be in dB referenced to 1 microvolt, dB(μV). If the units of measurement as displayed by the receiver are not dB(μV), for example, in millivolts, they should be converted to microvolts and then converted to dB(μV) by:

   $V_a = 20 \times \log_{10}$ (RF voltage in microvolts)
   $V_a = 20 \times \log_{10} v_d$

6. To determine the field strength at the frequency of the observation, add the voltage reading from the receiving system in dB(μV) to the value given by the antenna factor chart at that frequency in dB (m^{-1}):

   RF Voltage, dB(μV) + Antenna Factor dB (m^{-1}) = Field Strength dB (μV/m)

   $E_a = V_a + AF$

If a long coaxial cable is used between the antenna and the receiving device, or the frequency of the observation is more than several tens of MHz, the losses in the coaxial cable, A_e, must be included in the computation. In this case the computation is:

RF Voltage, dB(μV) + Cable Loss, dB + Antenna Factor, dB (m^{-1}) = Field Strength dB (μV/m)

$$E_a = V_a + AF + A_e$$

Conversion Factors

Following are some useful conversion formulas.

dBm = dB(μV) – 107
dB(mW/m²) = dB(μV/m) – 115.8
dB(μV/m) = dB(μV) + AF
$V/m = 10^{\frac{dB(\mu V/m) - 120}{20}}$
dB(μA/m) = dB(μV/m) – 51.5
$A/m = 10^{\frac{dB(\mu A/m) - 120}{20}}$
dB(W/m²) = 10 log(V/m A/m)
dB(mW/m²) = dB(W/m²) + 30
dB(pT) = dB(μA/m) + 2.0

The constants that appear in the above equations are obtained as follows:

In the first equation, the power is related to the voltage via the system impedance as:

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

In a 50-Ω system, the above equation becomes:

$$10 \log_{10} P = 20 \log_{10} V - 10 \log_{10}(50)$$

Converting from dB to dBm for power and from dB(V) to dB(μV) for voltage, the added constant becomes:

$$30 - 120 - 10 \log_{10}(50) = -107$$

The constant in the second equation is obtained by considering the pointing vector which relates the power density in (W/m^2) to the electric field density in (V/m) by:

$$P = \frac{|E|^2}{\eta}$$

Where η is the free space characteristic impedance equal to 120π Ω. Transforming the previous equation to decibels and using the appropriate conversion factors to convert dB(W/m^2) to dB(mW/m^2) for power density and dB(V/m) to dB(μV/m) for the electric field, the constant becomes:

$$30 - 120 - 10 \log_{10}(120\pi) = -115.8$$

For the constant in the fifth equation, the magnetic field density is related to the electric field density via the characteristic impedance of free space. When the transformation is made to decibels, the constant becomes:

$$20 \log_{10}(120\pi) = 51.5$$

In the last equation, the magnetic flux density **B** in (T) is related to the magnetic field density **H** in (A/m) the permeability of the medium in (H/m). For free space the permeability is $\mu_o = 4\pi 10^{-7}$ H/m. Converting from (T) to (pT) and from (A/m) to (μA/M) and taking the log, the constant becomes:

$$240 - 120 + 20 \log_{10}(4\pi x 10^{-7}) = 2.0$$

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8.0 Power Requirements

The Model 3147 Log Periodic Dipole Antenna may also be used as a transmitting antenna. Please note the maximum power specification in the specification table on page 13. The power needed to generate a given field strength in free space can be estimated according to the transmission equation:

$$\text{Power transmitted} = \frac{(\text{field strength})^2(\text{distance in meters})^2}{(30 \times \text{Numeric Gain})}$$

$$Pt = \frac{|E|^2R^2}{30\ g}$$

where E is the field strength (in V/m), R is the distance from the transmit antenna. g is the antenna gain (in linear unit). The power limitation is 80 Watts maximum continuous power for frequencies below 1 GHz and 40 Watts maximum continuous power above 1 GHz.. As an example, to generate a 20 V/m electric field at a given frequency, the measured antenna factor is 23.2 dB(m^{-1}). The gain in dB is computed using:

$$G(dB) = 20 \log_{10}(F_{MHz}) – 29.79 – AF$$

$$G(dB) = 20 \log_{10}(1000) – 29.79 – 23.2 = 7.0$$

Converting this value to obtain numeric gain:

$$g = 10^{0.7} = 5.0$$

Applying the formula for the power transmitted, at 3 m distance from the antenna boresight,

$$P_t = \frac{20^2 3^2}{30 \times 5} = 24\ W$$

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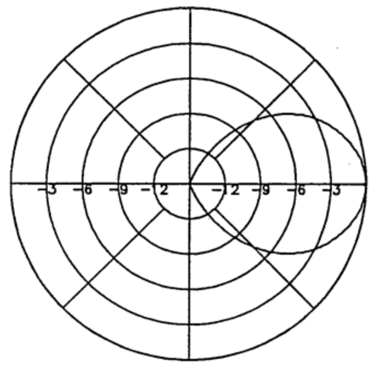
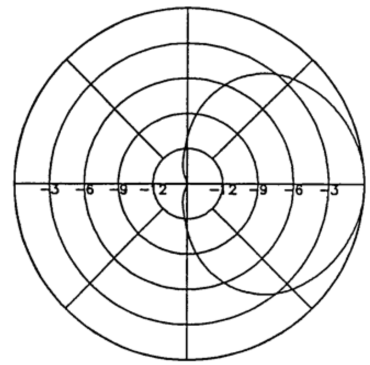
Appendix A: Typical Antenna Patterns

400 MHz

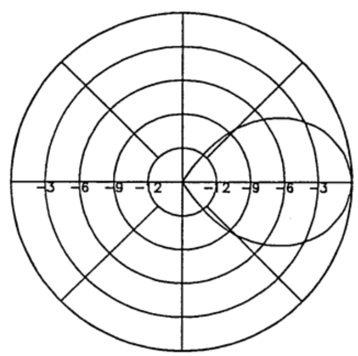


400 MHz, Horizontal Polarization

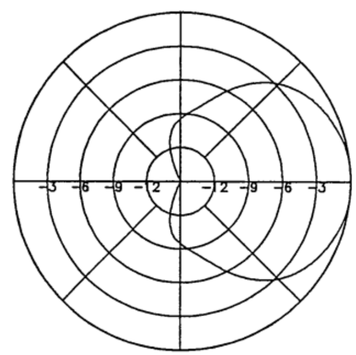


400 MHz, Vertical Polarization

500 MHz

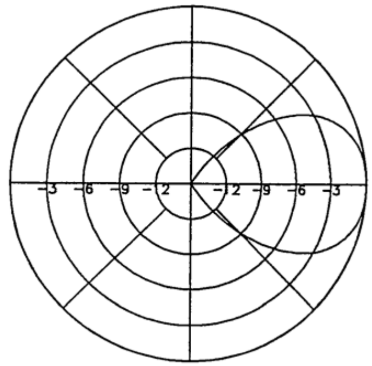


500 MHz, Horizontal Polarization

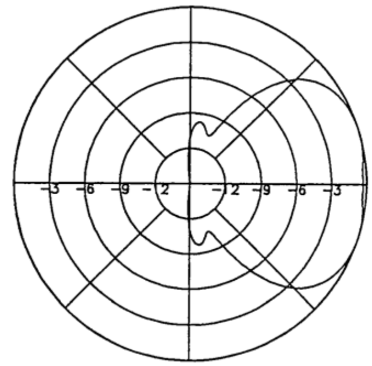


500 MHz, Vertical Polarization

600 MHz

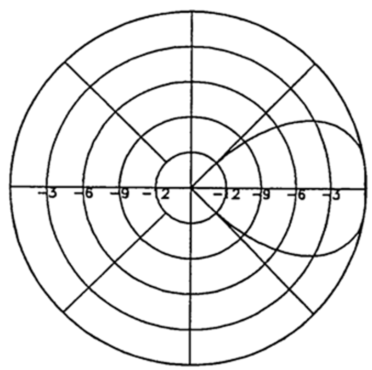


600 MHz, Horizontal Polarization

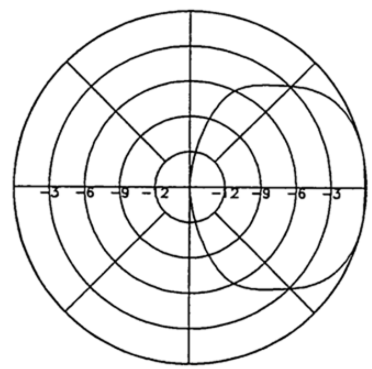


600 MHz, Vertical Polarization

700 MHz

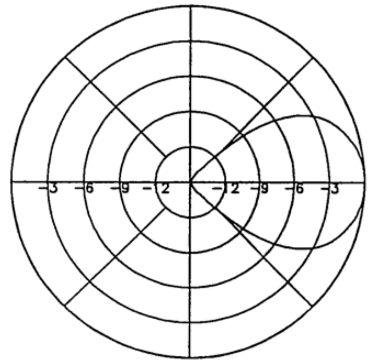


700 MHz, Horizontal Polarization

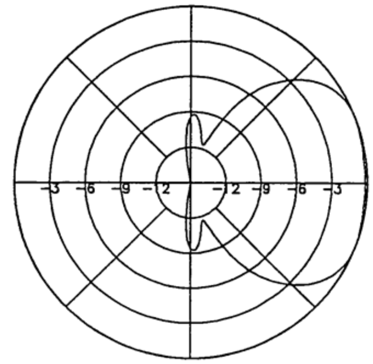


700 MHz, Vertical Polarization

800 MHz

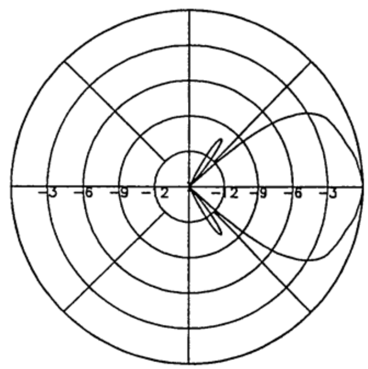


800 MHz, Horizontal Polarization

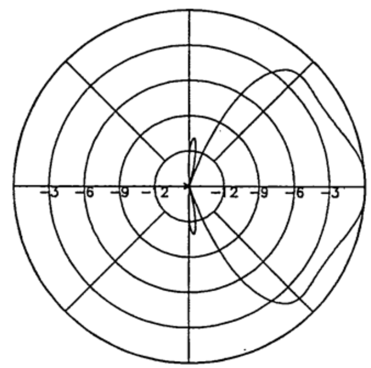


800 MHz, Vertical Polarization

900 MHz

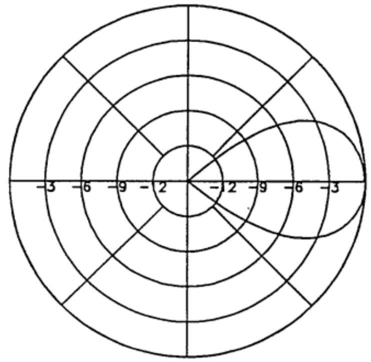


900 MHz, Horizontal Polarization

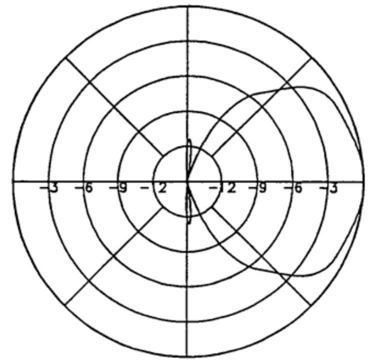


900 MHz, Vertical Polarization

1.0 GHz

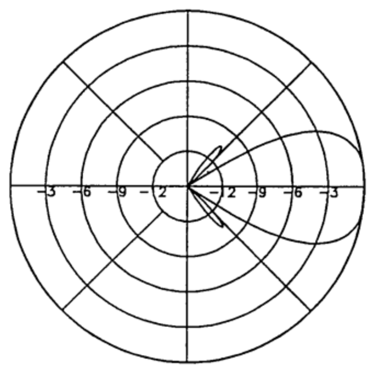


1.0 GHz, Horizontal Polarization

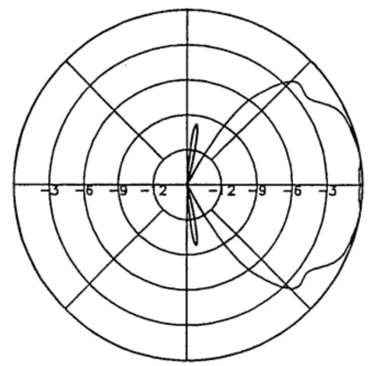


1.0 GHz, Vertical Polarization

1.5 GHz

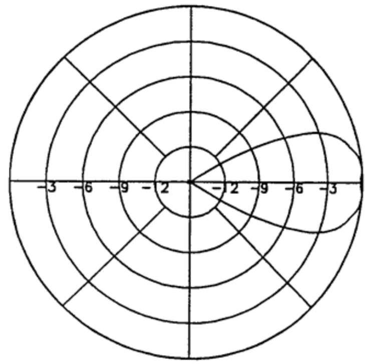


1.5 GHz, Horizontal Polarization

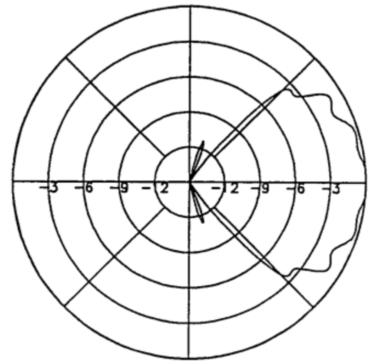


1.5 GHz, Vertical Polarization

2.0 GHz

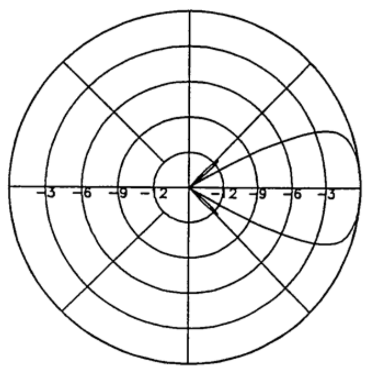


2.0 GHz, Horizontal Polarization

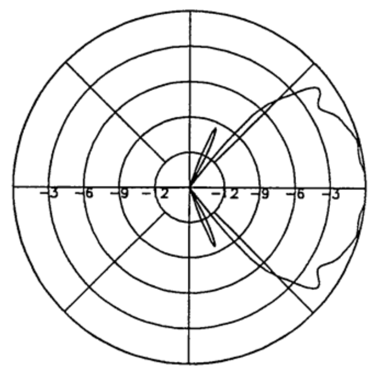


2.0 GHz, Vertical Polarization

2.5 GHz

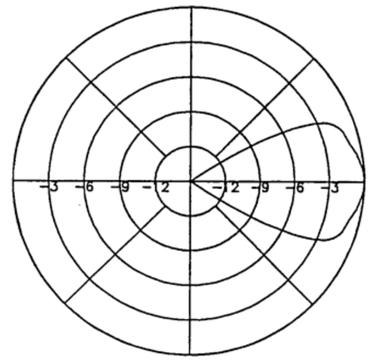


2.5 GHz, Horizontal Polarization

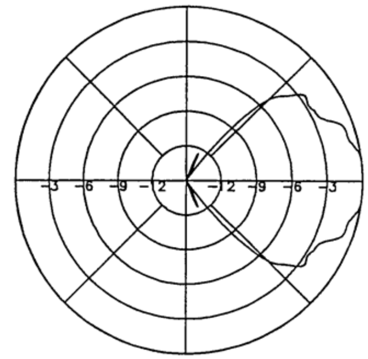


2.5 GHz, Vertical Polarization

3.0 GHz

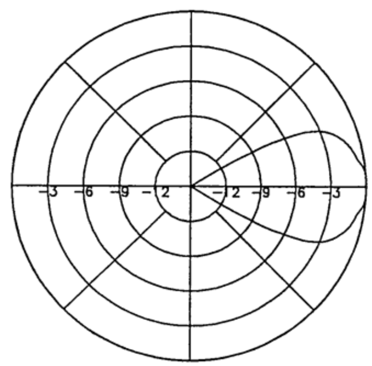


3.0 GHz, Horizontal Polarization

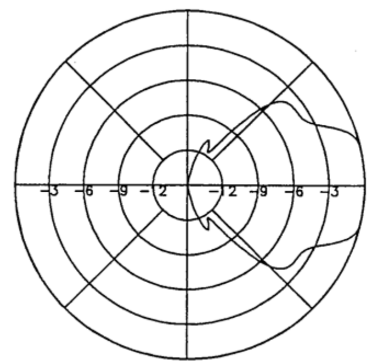


3.0 GHz, Vertical Polarization

3.5 GHz

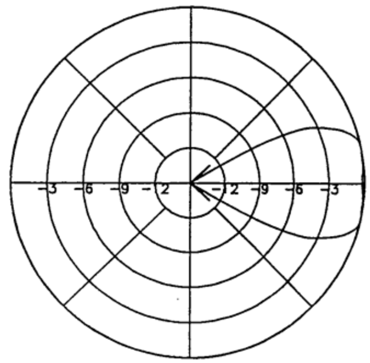


3.5 GHz, Horizontal Polarization

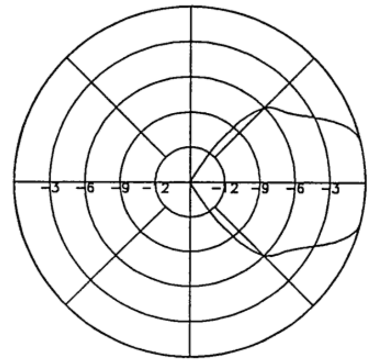


3.5 GHz, Vertical Polarization

4.0 GHz

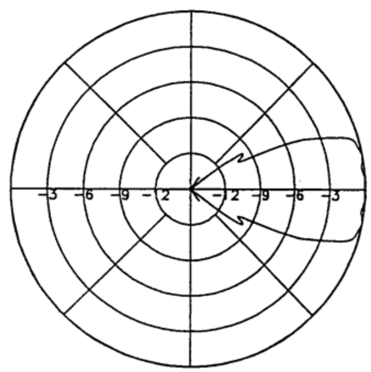


4.0 GHz, Horizontal Polarization

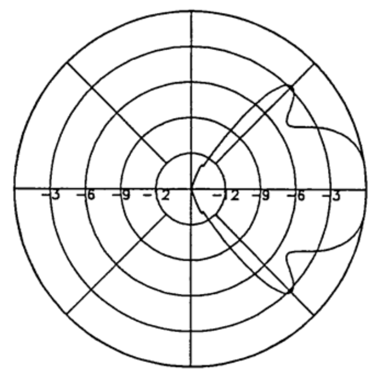


4.0 GHz, Vertical Polarization

4.5 GHz

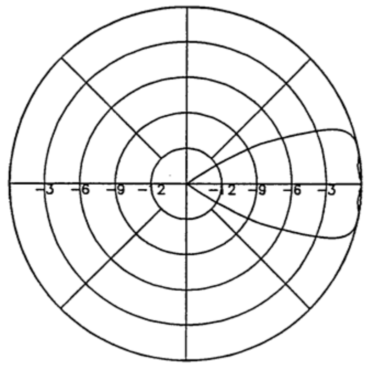


4.5 GHz, Horizontal Polarization

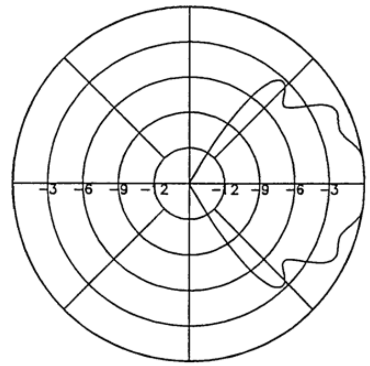


4.5 GHz, Vertical Polarization

5.0 GHz



5.0 GHz, Horizontal Polarization



5.0 GHz, Vertical Polarization

Appendix B: Warranty

➔ See the *Product Information Bulletin* included with your shipment for the complete ETS-Lindgren warranty for your Model 3147 Log Periodic Dipole Antenna.

DURATION OF WARRANTIES FOR MODEL 3147

All product warranties, except the warranty of title, and all remedies for warranty failures are limited to two years.

Product Warranted	Duration of Warranty Period
Model 3147 Log Periodic Dipole Antenna	2 Years