Module 1 : ANTENNAS

Types and parameters

Antenna parameters and Basics

THE ANTENNA FUNCTIONS:

- As a transductor, it transforms an electrical signal into an Electromagnetic wave with an specific space orientation.
- In 2-D Radar Systems, among these functions, it determines the azimuth angle of the target.
- In 3-D Radar Systems, it provides the elevation angle of the target.

Antenna parameters

In Transmission

*The antenna, **focus** the energy to the target direction.*

- The **Directivity** (D) or the maximum radiation gain.
- The **antenna gain** (G) related with the antenna radiation efficiency.
- The antenna **radiation efficiency** (η_r), as the looses between the transmitter output power and the radiated power.

In Reception

*The antenna **captures** the energy coming from the target.*

- The **physical area** of the antenna: A_{phys}
- The **effective area** of the antenna, A_{eff} which captures the transmitted power density of the electromagnetic wave.
- The **antenna illumination efficiency** (η_i), or the ratio between the effective and the physical areas of the antenna,

Both roles related through the reciprocity principle

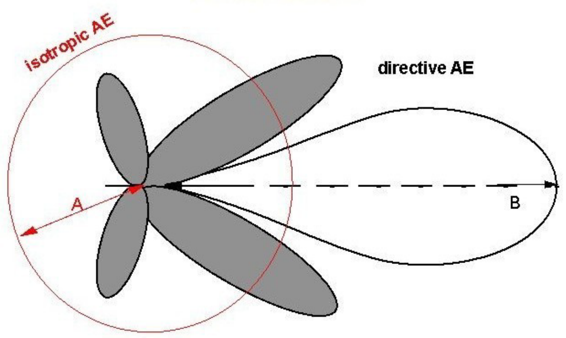
Antenna parameters and Basics

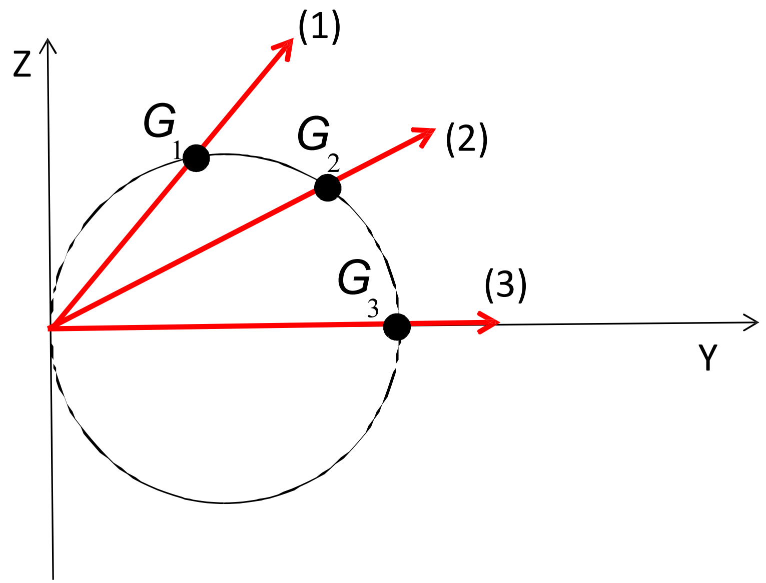
Antenna Directivity

The relationship between the power density radiated in one direction and at a distance R, relative to the power density radiated at the same distance from an isotropic antenna.

$$D(\theta,\phi) = \frac{\mathcal{P}(\theta,\phi)}{P_t / 4\pi R^2}$$

θ: azimuth angle
ϕ: elevation angle





Antenna parameters and Basics

Antenna Directivity

If no direction is specified, the Directivity means the power density radiated in the direction of maximum radiation

$$D = \frac{\mathcal{P}_{max}}{P_t / 4\pi R^2}$$

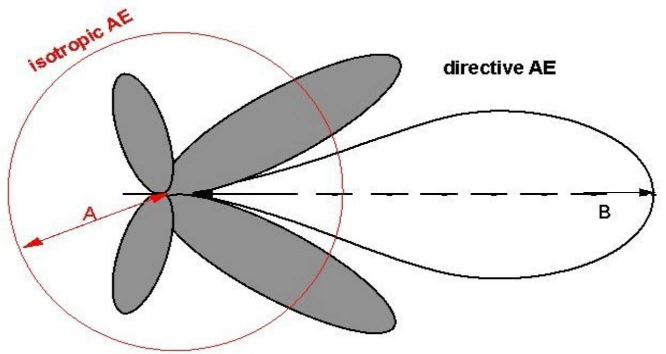
The looses between the transmitter output power and the radiated power are usually computed as the antenna radiation efficiency (η_r), as a reduction of the transmitted power.

Antenna parameters and Basics

Antenna gain:

The relationship between the power density radiated in one direction and at a distance R, relative to the power density radiated at the same distance from an isotropic antenna by the power delivered to the antenna. It takes into account the radiation efficiency η_r (conversion of the the radio-frequency power at antenna terminals into radiated power)

$$G(\theta,\phi) = \frac{\mathcal{P}(\theta,\phi)}{P_{delivered}/_{4\pi R^2}} = \frac{P_{radiated}}{P_{delivered}} \cdot \frac{\mathcal{P}(\theta,\phi)}{P_{radiated}/_{4\pi R^2}} = \eta_r \cdot D(\theta,\phi)$$



NOTE: Some manufacturers utilize dBd (gain relative to a dipole antenna) as a metric, rather than dBi. A dBd is inherently greater, 0 dBd = 2,15 dBi.

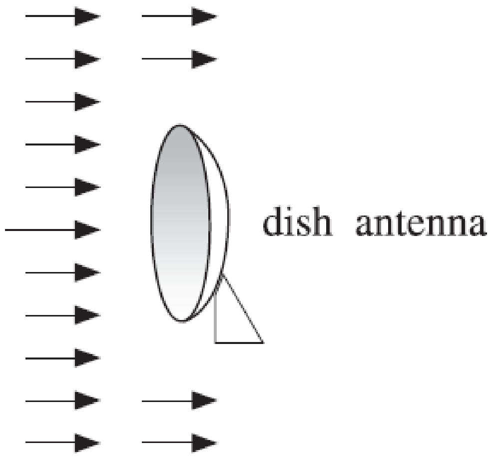
Antenna parameters and Basics

Effective Area

Capacity of the antenna to capture energy. Related with its physical dimensions through the antenna illumination efficiency η_i :

$$A_{eff}(\theta,\phi) = \eta_i A_{phys}(\theta,\phi)$$

$$\frac{\mathcal{P}}{4\pi R^2} \quad (W/m^2)$$



$$P_r = \frac{\mathcal{P}}{4\pi R^2} A_{eff} \quad (W)$$

Antenna parameters and Basics

RELATION BETWEEN GAIN AND EFFECTIVE AREA

Capacity of the antenna to capture energy. Related with its physical dimensions

$$\frac{D}{A_{eff}} = \frac{4\pi}{\lambda^2}$$

λ: *Carrier wavelength* $= \frac{c}{f}$

c: *speed of light* $= 3 \cdot 10^8$ *m/s*

Densitat de potència radiada (EIRP: equivalent isotropic radiated power)

- La **potència isotròpica radiada equivalent (PIRE)** és el resultat del producte de la potència del transmissor pel guany de l'antena transmissora.

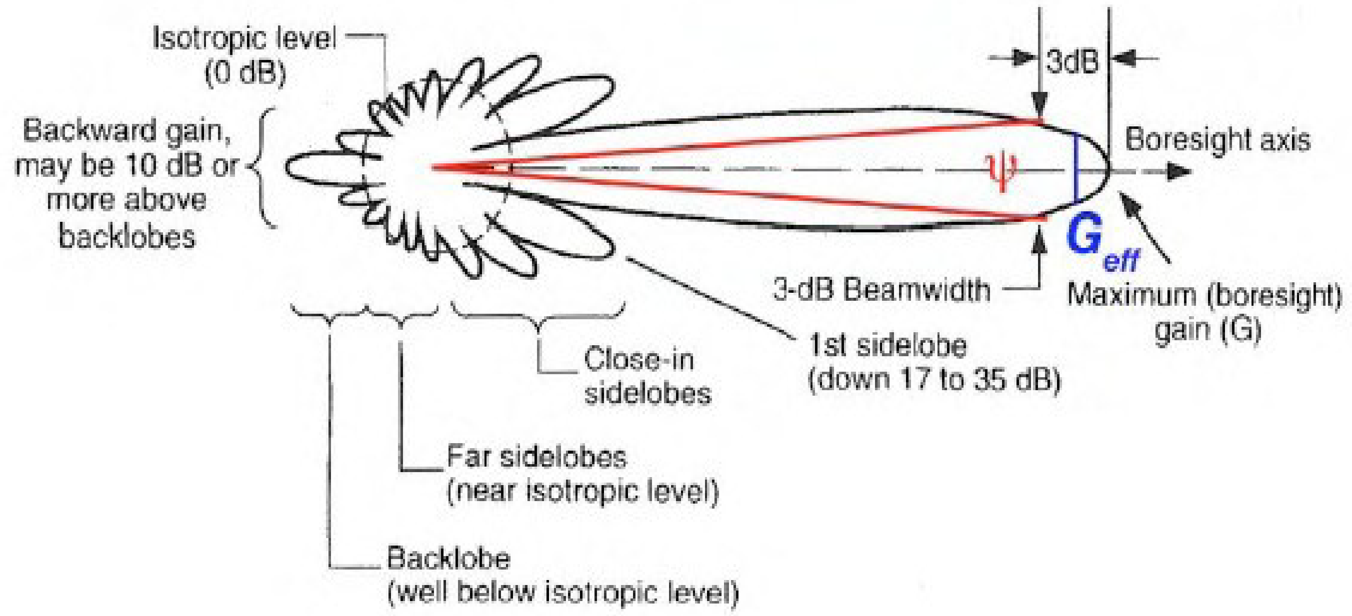
$$PIRE = P_T \cdot G_T \quad (W)$$

- La densitat de potència (power density) $\mathcal{P}$, expressada en watts/m^2 es defineix com el quocient entre la potència isotròpica radiada equivalent (PIRE) i 4π pel quadrat de la distància a l'antena transmissora des d'on mesurem aquesta densitat de potència. Aquesta densitat ***s'atenua*** amb el ***quadrat de la distància*** a l'antena transmissora.

$$\mathcal{P} = \frac{PIRE}{4\pi \cdot R^2} \quad \left(W/m^2\right)$$

Antenna parameters and Basics

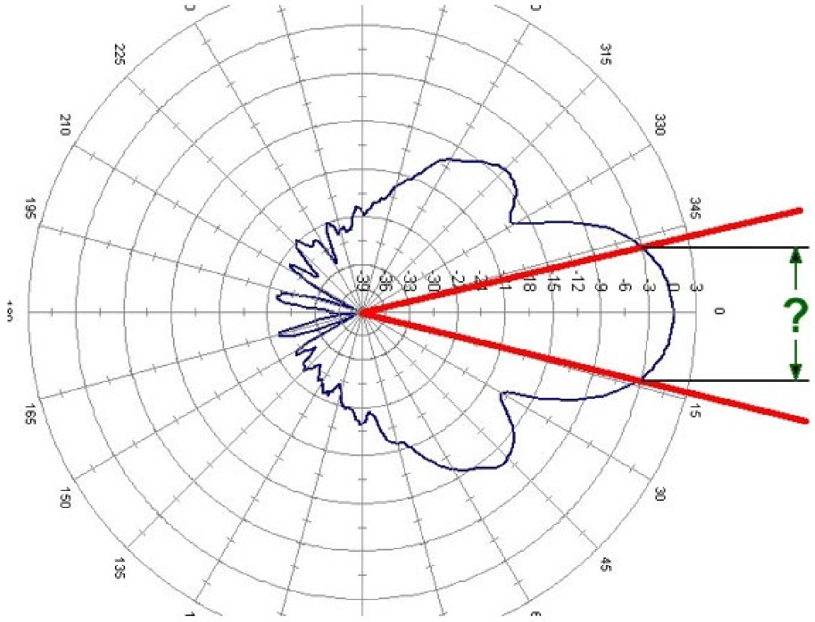
Diagram of radiation



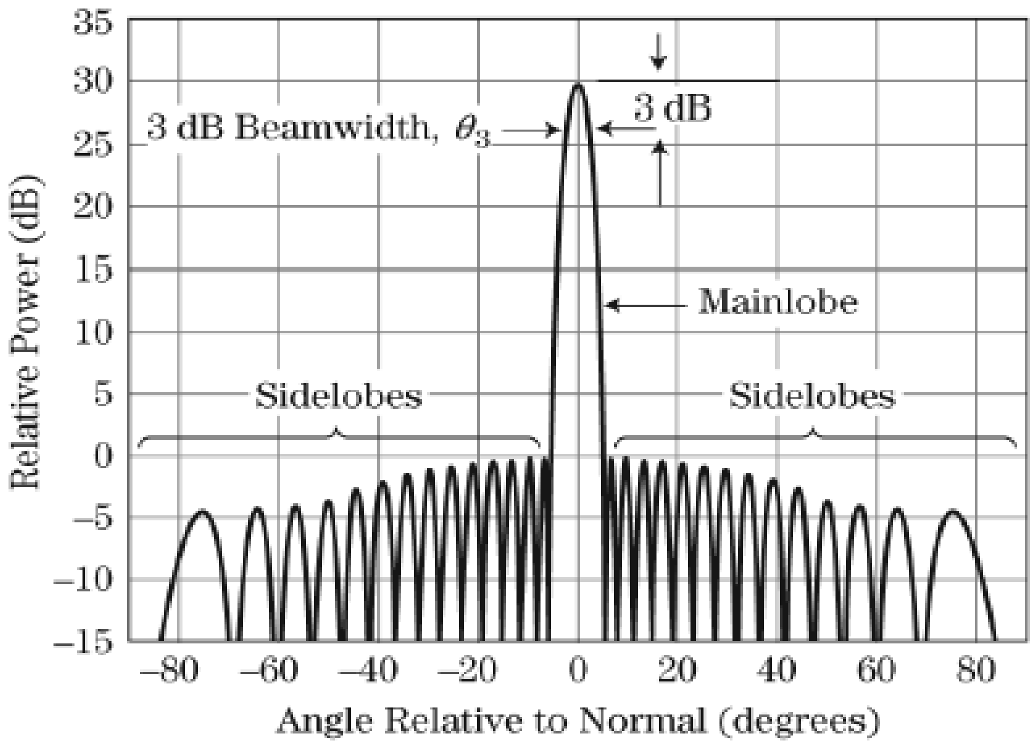
Front to back ratio : he power radiated from the primary (front) lobe and the power radiated 180° in the opposite direction of the primary lobe (in dB)

Antenna parameters and Basics

Diagram of radiation

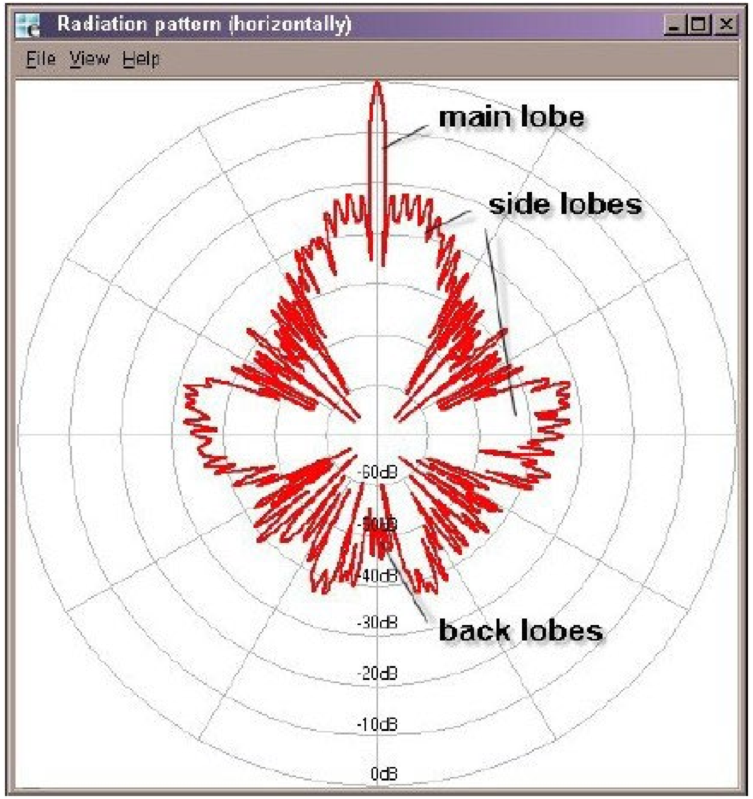


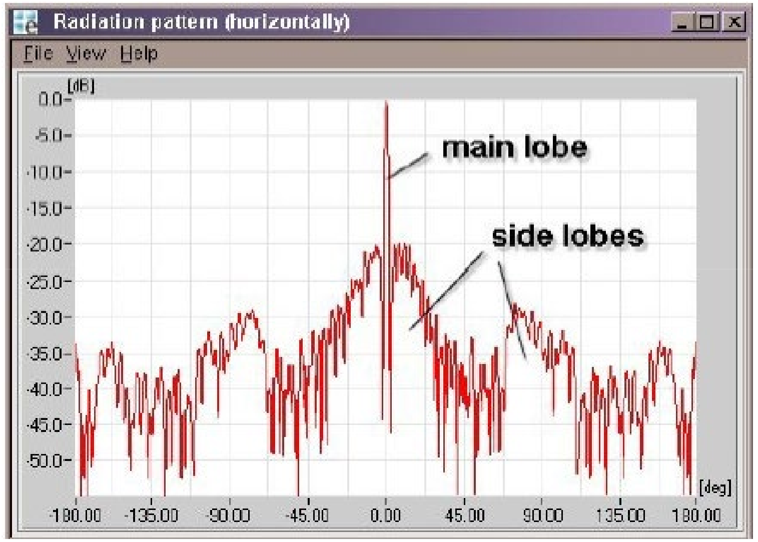
- Beamwidth coverage



Antenna radiation pattern and aperture illumination

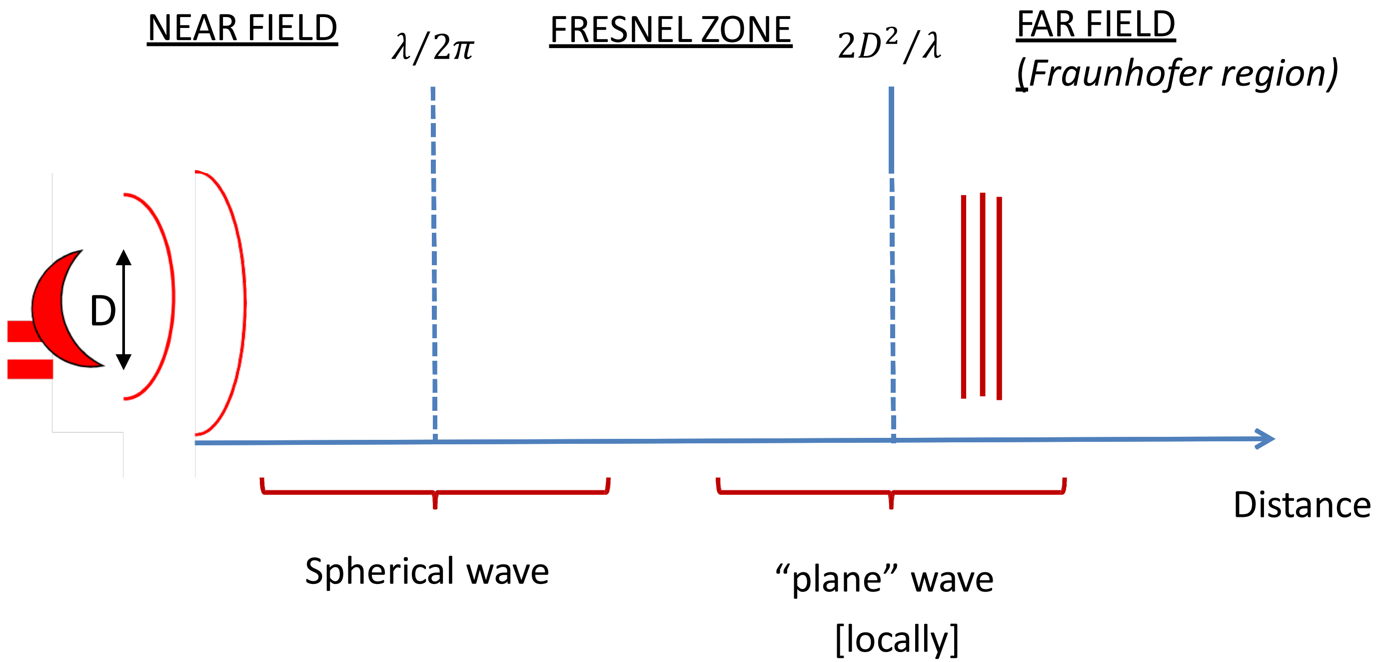
FAR FIELD RADIATION PATTERN



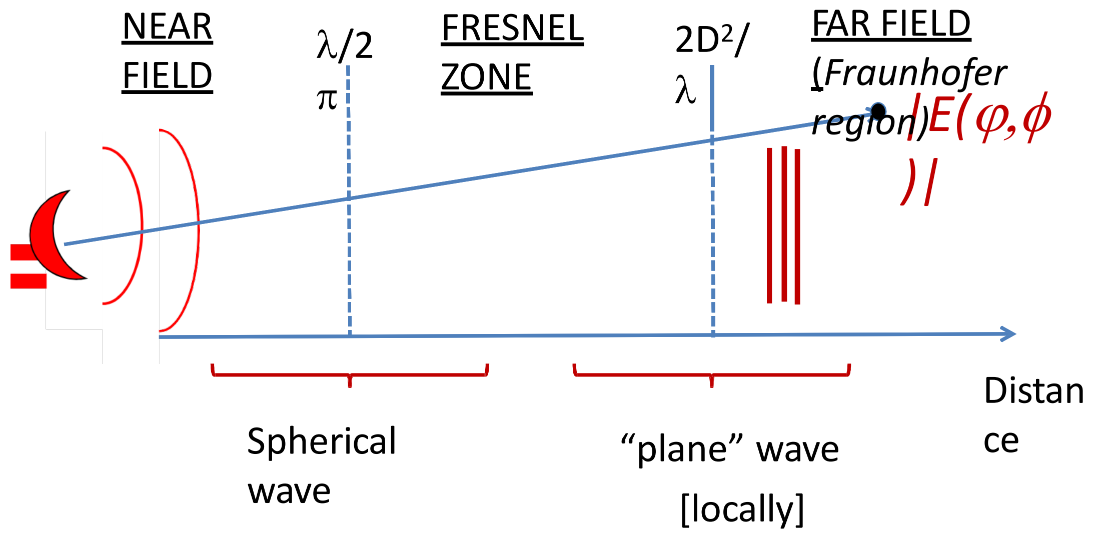


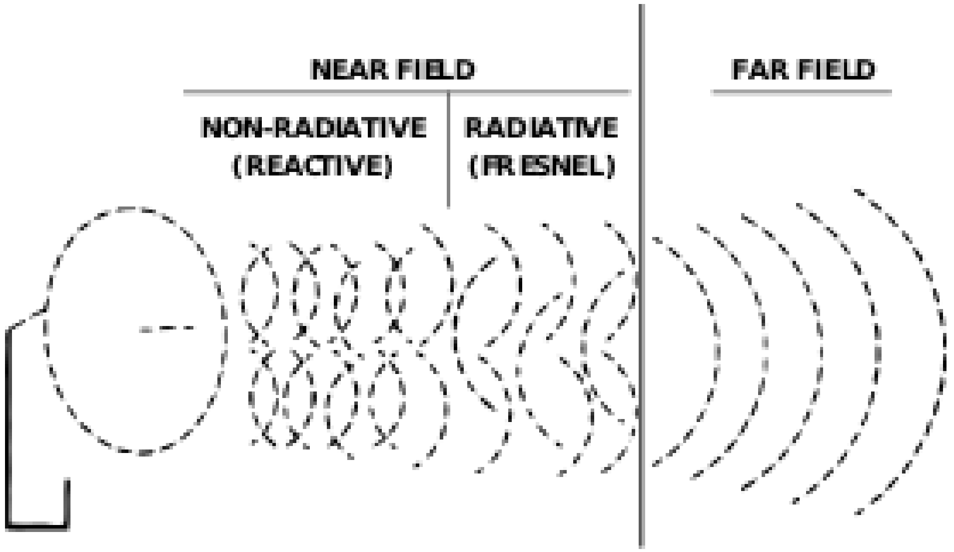
Bidimensional uniform aperture illumination

Antenna parameters and Basics

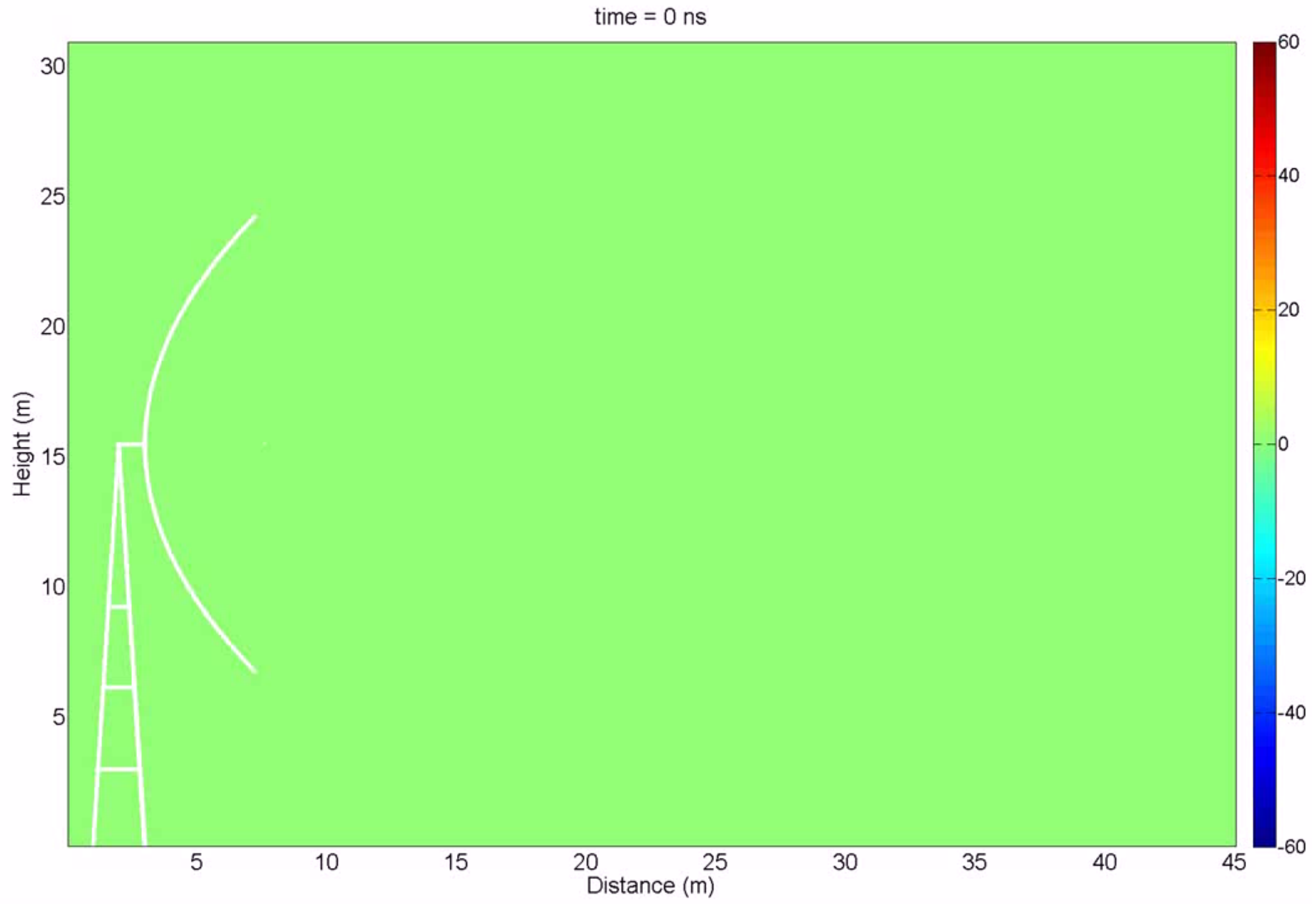


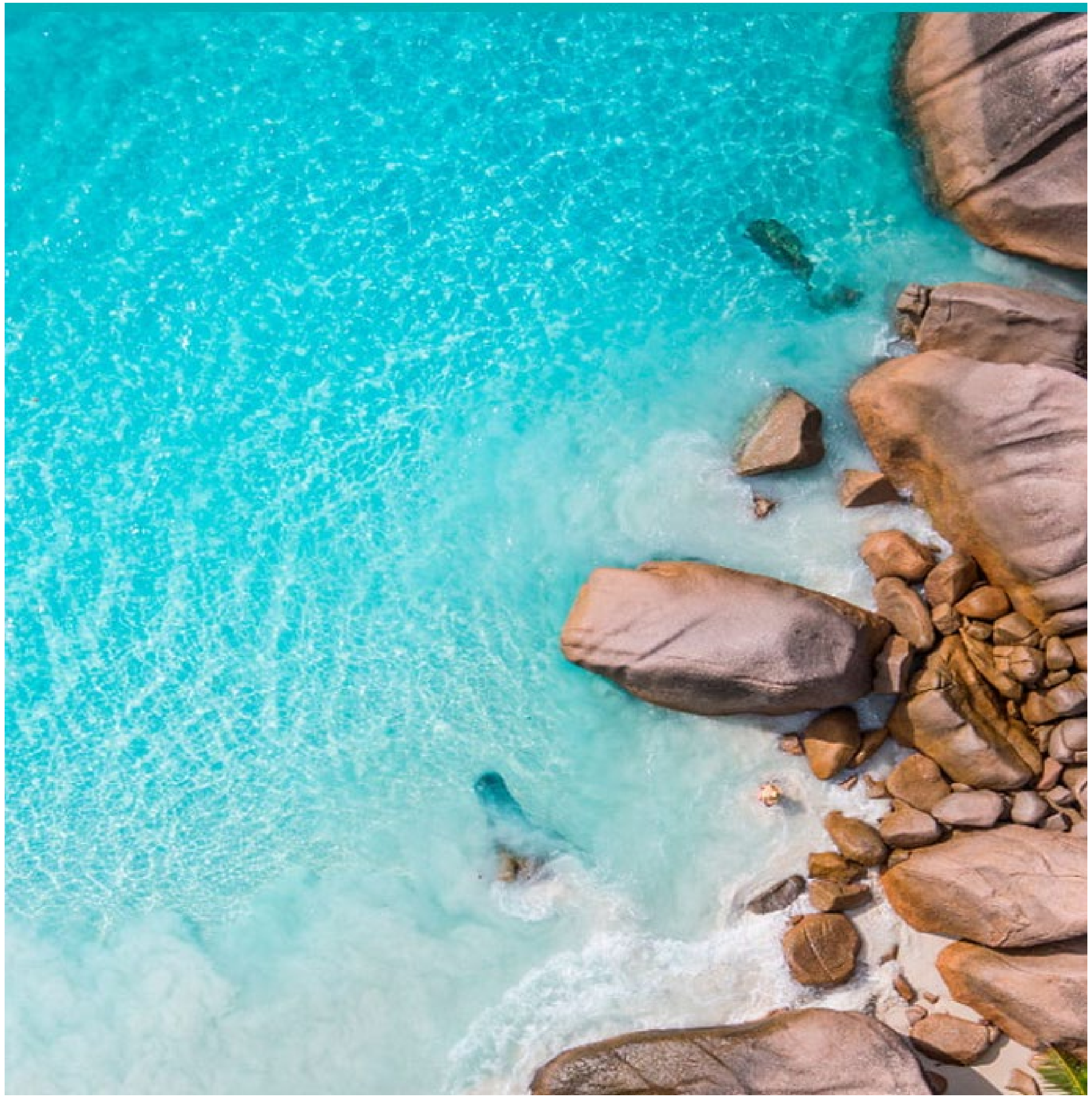
Antenna parameters and Basics





EM wave generation in a parabolic reflector.

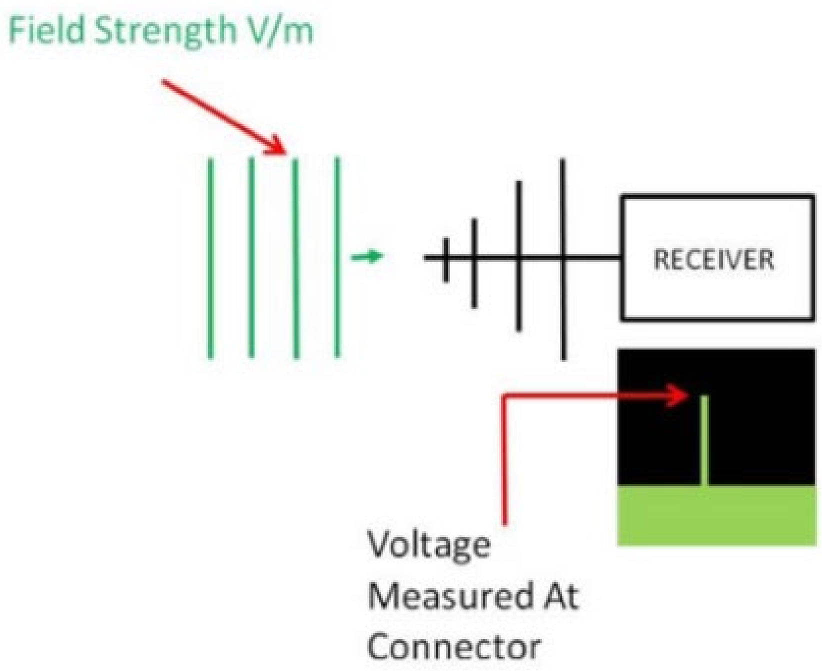





Antenna Factor (EMC / EMI. I.e, to check **CENELEC** , **CISPR, FCC, …** Electromagnetic Compatibility (EMC) limits)

Antenna Factor is defined as the ratio of the incident Electromagnetic Field to the output voltage from the antenna and the output connector. It may include factors such as:

- Loss due to mismatch of impedance between the antenna output and transmission line
- Loss due to attenuation of the transmission line.
- Loss due to VSWR at the and/or the receiver.
- Gain due to a preamplifier located at the antenna.
- Loss due to the mismatch of impedance at the input of the receiver



CENELEC- EMI/EMC

$$AF_{\mathrm{dB/m}} = E_{\mathrm{dBV/m}} - V_{\mathrm{dBV}}$$

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

$$AF = Fa = 10\log\frac{Zo}{Zr} - Gdb - 20\log\lambda + 10\log 4\pi$$

Z_O = Impedance of radiating media (120 π for free space)

Z_r = Receiver input impedance

G = Antenna gain(

If EMC limit is given in dBµA/m,

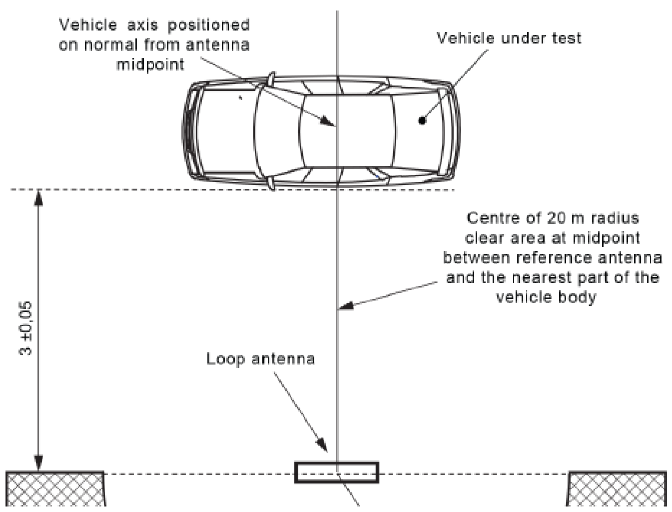
dBµV/m = dBµA/m + 51.5

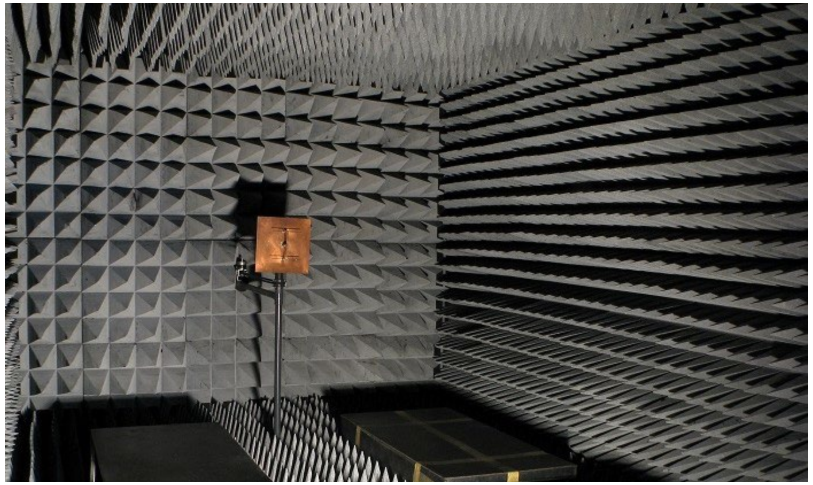
51.5 = 20 log 120π (in free space)

$$Z_0 = \frac{|\mathbf{E}|}{|\mathbf{H}|} \approx 120\pi\ \Omega$$

E → dBµV/m
H → dBµA/m

Example: (CISPR, Comité International Spécial des Perturbations or International special committee on radio interference. It is a technical committee of IEC (*International Electrotechnical Commission*)





– 10 – CISPR 36:2020 © IEC 2020

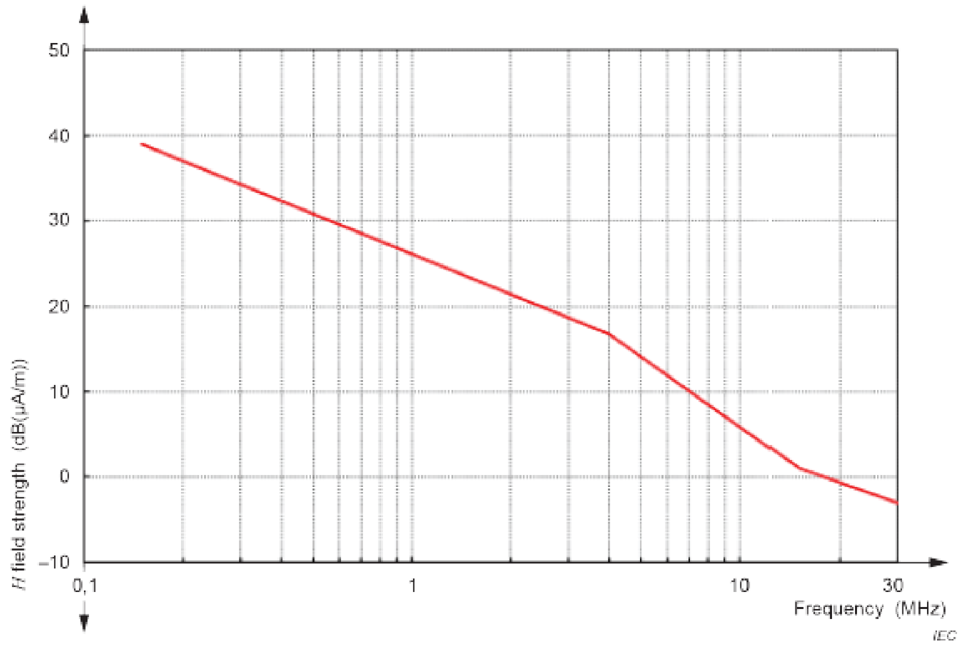


Figure 1 – Limit of magnetic field disturbance (quasi-peak detector) at 3 m antenna distance

Example: Aircraft radiated emissions

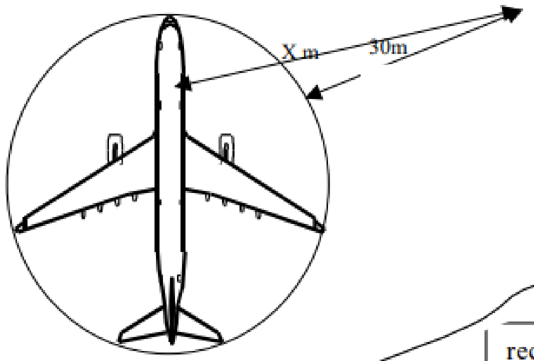
CENELEC

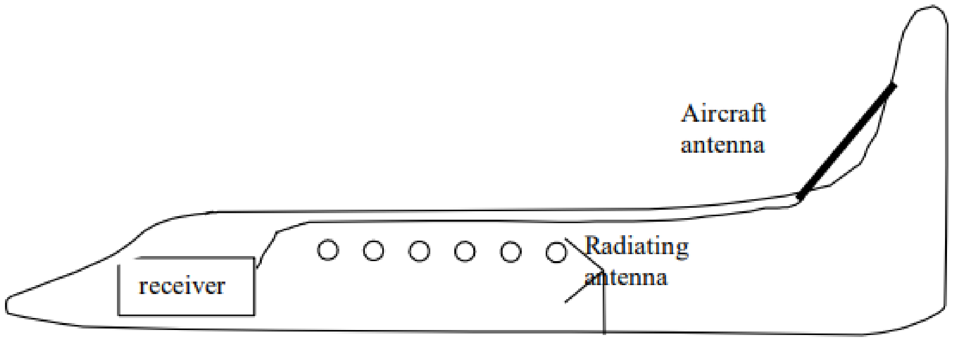
CLC(SG)819

Edition 05

REPORT ON CIVIL AIRCRAFT AND INCORPORATED EQUIPMENT COVERING THE TECHNICAL SPECIFICATIONS AND RELATED CONFORMITY ASSESSMENT PROCEDURES, REGIONAL OR INTERNATIONAL, IN RELATION TO ELECTROMAGNETIC COMPATIBILITY

Issue, 5 October 2000

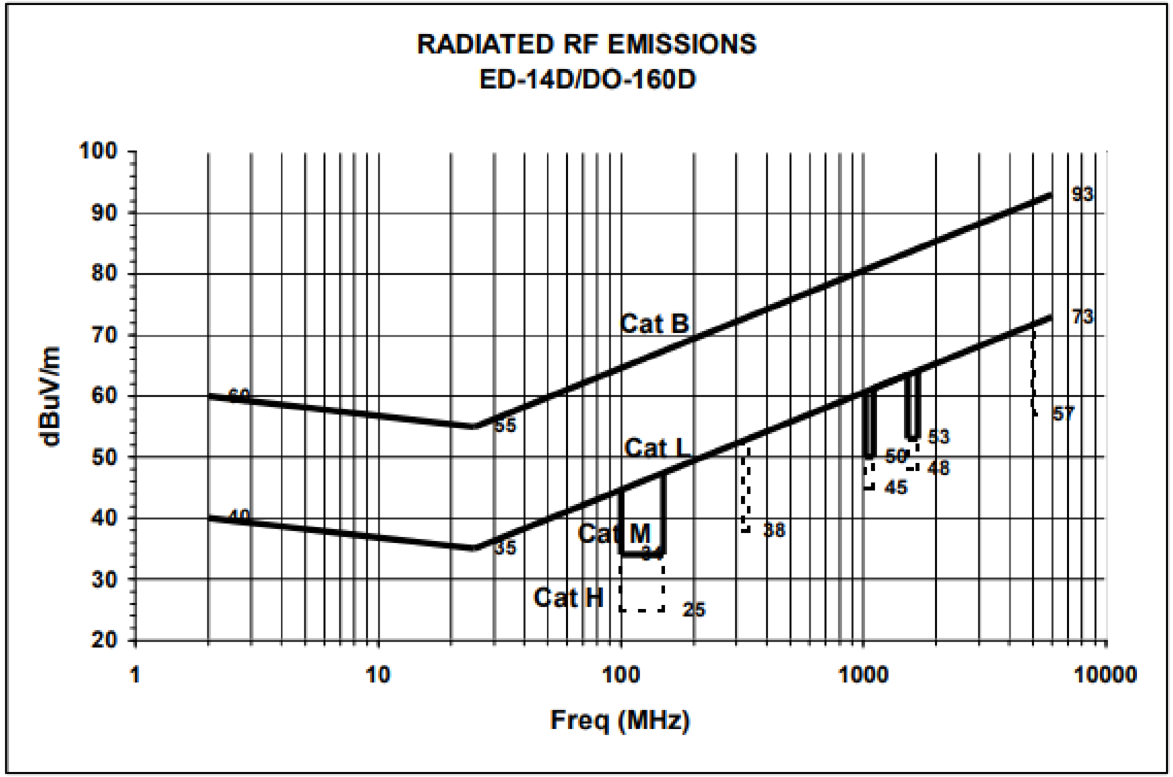




Receiver	Frequency band	Immunity Level dB µV	Means for immunity level assessment
HF Com.	2 MHz - 30 MHz	6 dB µV	From minimum sensitivity and signal/noise EUROCAE requirement (MOPS)
Marker	75 MHz	32 dB µV	From minimum sensitivity and signal/noise ARINC requirement
VHF Com.	118 MHz - 137 MHz	6 dB µV	From test and from minimum sensitivity and signal/noise EUROCAE requirement (MOPS)
ILS-Loc.	108,1 MHz - 112 MHz	-3 dB µV	From test and from minimum sensitivity and signal/noise RTCA requirement (DO199)
VOR	108 MHz - 118 MHz	-3 dB µV	From test and from minimum sensitivity and signal/noise RTCA requirement (DO199)
ILS-G/S	329 MHz - 335 MHz	8 dB µV	From test and from minimum sensitivity and signal/noise RTCA requirement (DO199)
DME	962 MHz - 1,212 GHz	24 dB µV	From test and from minimum sensitivity and signal/noise RTCA requirement (DO199)
ATC/TCAS	1,090 GHz	27 dB µV	Conservative Immunity Level from system analysis
GPS	1575,42 MHz	-19 dB µV	From ARINC requirement
SAT/COM	1530 MHz - 1559 MHz	12 dB µV	From RTCA requirement (DO210 Part A)

Table 6/5

Operational receiving frequency range, Immunity levels of aircraft radio-communication and radio-navigation receivers



ANTENNA NOISE TEMPERATURE

NOISE IN ANTENNAS

TEMPERATURA D'ANTENA

EN EL MARGE DE 100 kHz A 100 MHz.

Temperatura de soroll d'antena degut al soroll còsmic i al soroll atmosfèric.

Font: Jordan-Balmain, "Ondas electromagnéticas y sistemas radiantes."

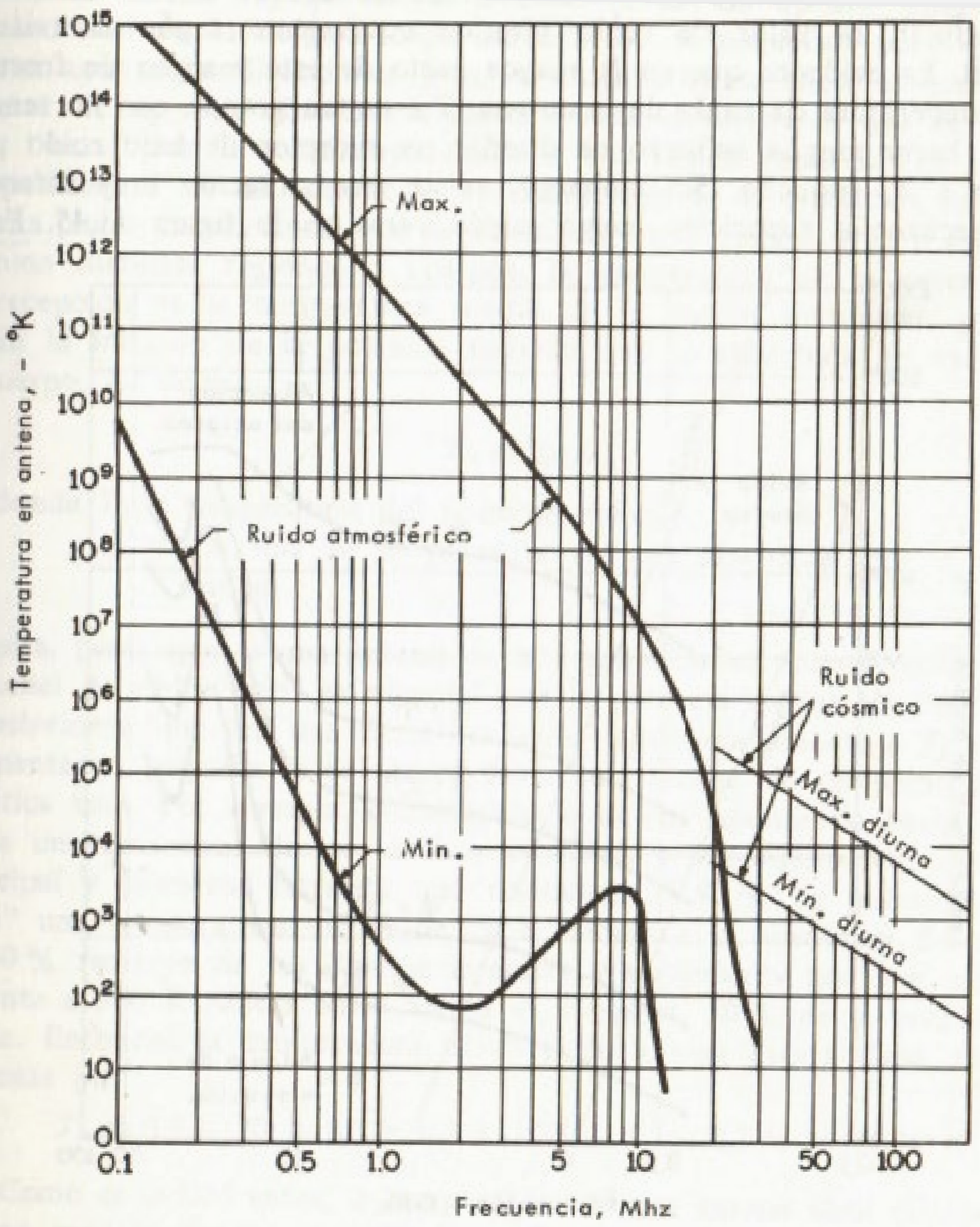


FIG. 11.44. *Temperatura de ruido en frecuencias medias y altas (según E. C. Hayden).*

TEMPERATURA D'ANTENA

EN EL MARGE DE 100 MHz A 100 GHz.

Temperatura de soroll d'antena degut al soroll còsmic i a l'absorció d'oxigen, en funció de l'angle d'elevació per antenes apuntant cap a l'espai exterior.

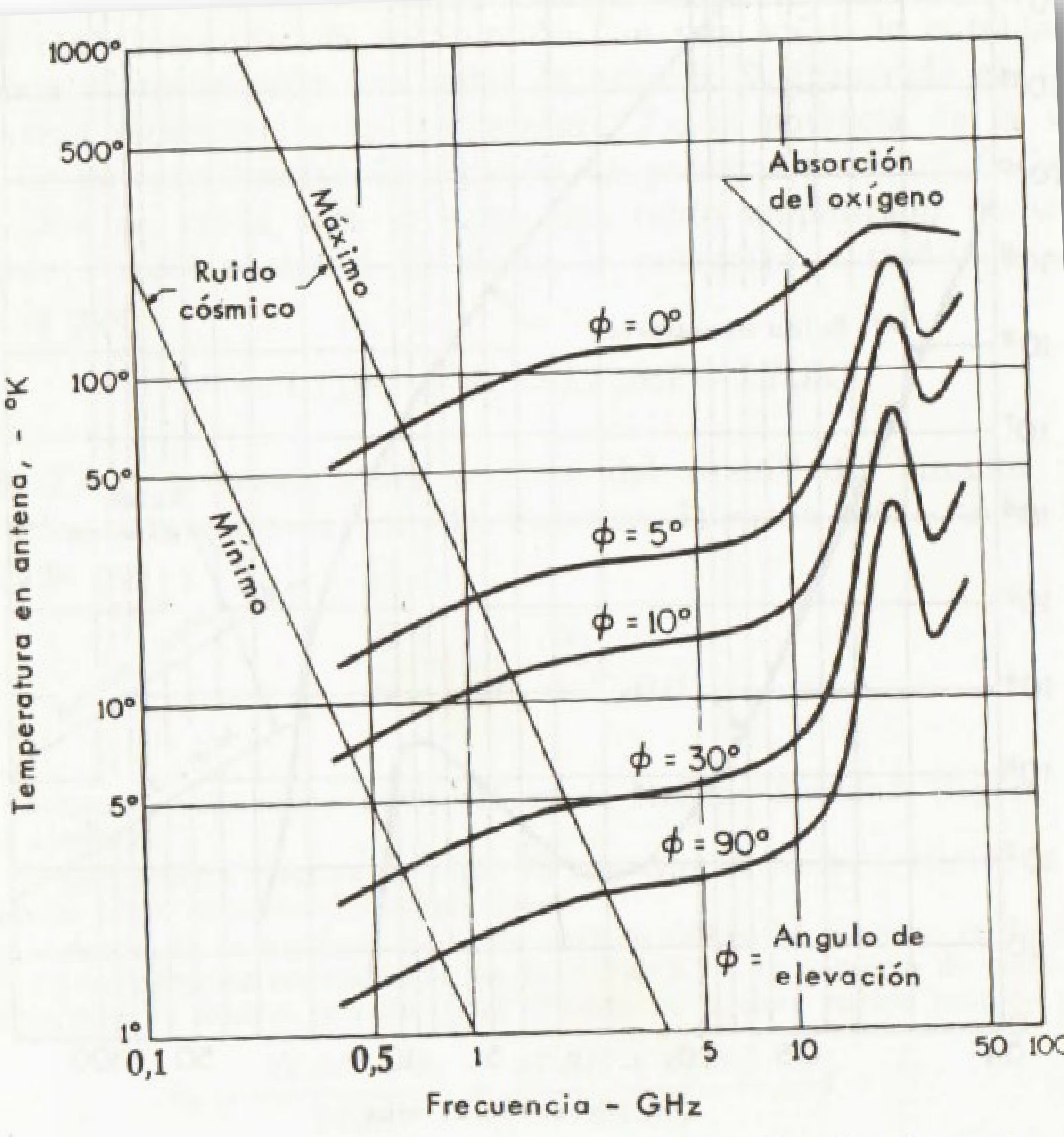
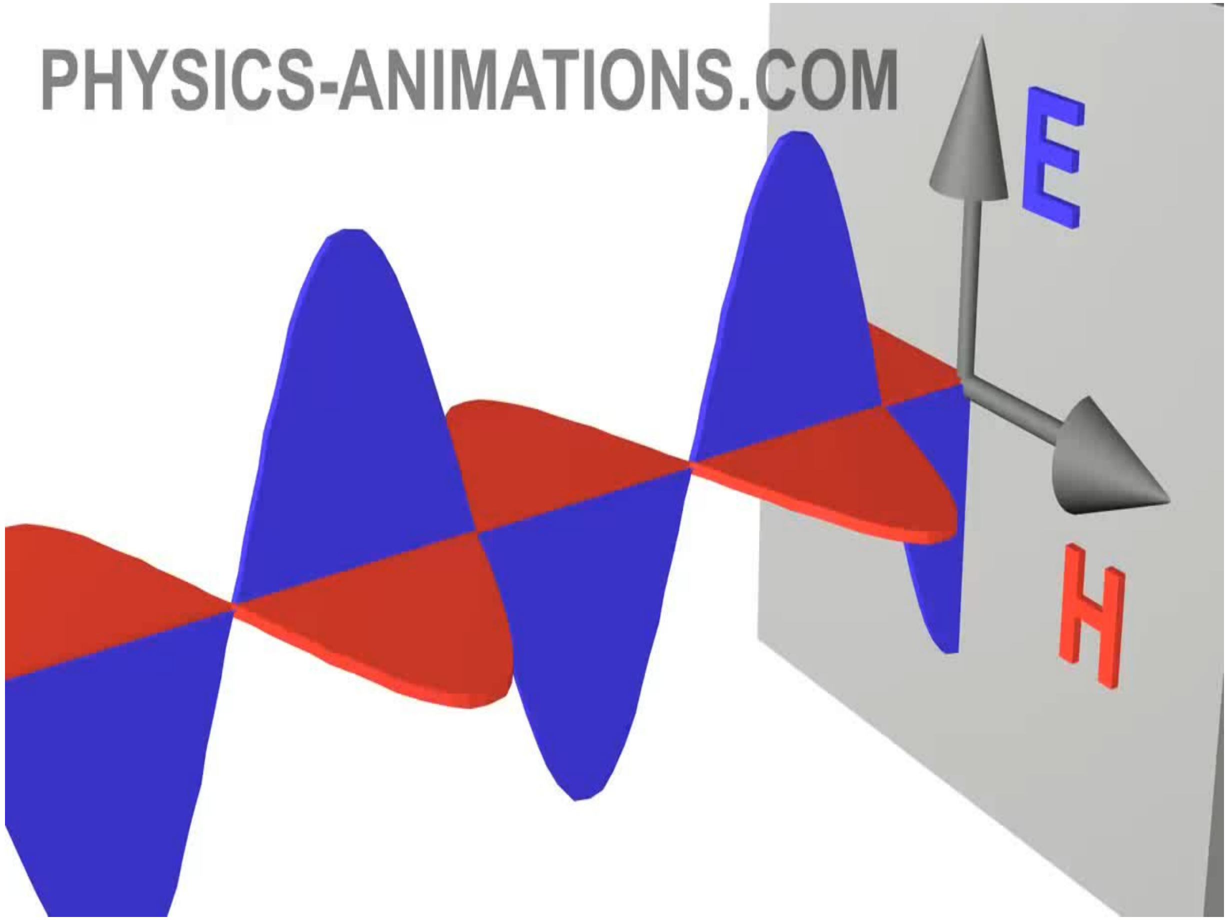


FIG. 11.45. *Temperatura de ruido en frecuencias de microondas (Pierce y Kompfner, según D. C. Hogg).*

Font: Jordan-Balmain, "Ondas electromagnéticas y sistemas radiantes."

Polarization = orientation of the E field of the EM wave.

Plane wave



Polarization linear, circular and elliptical

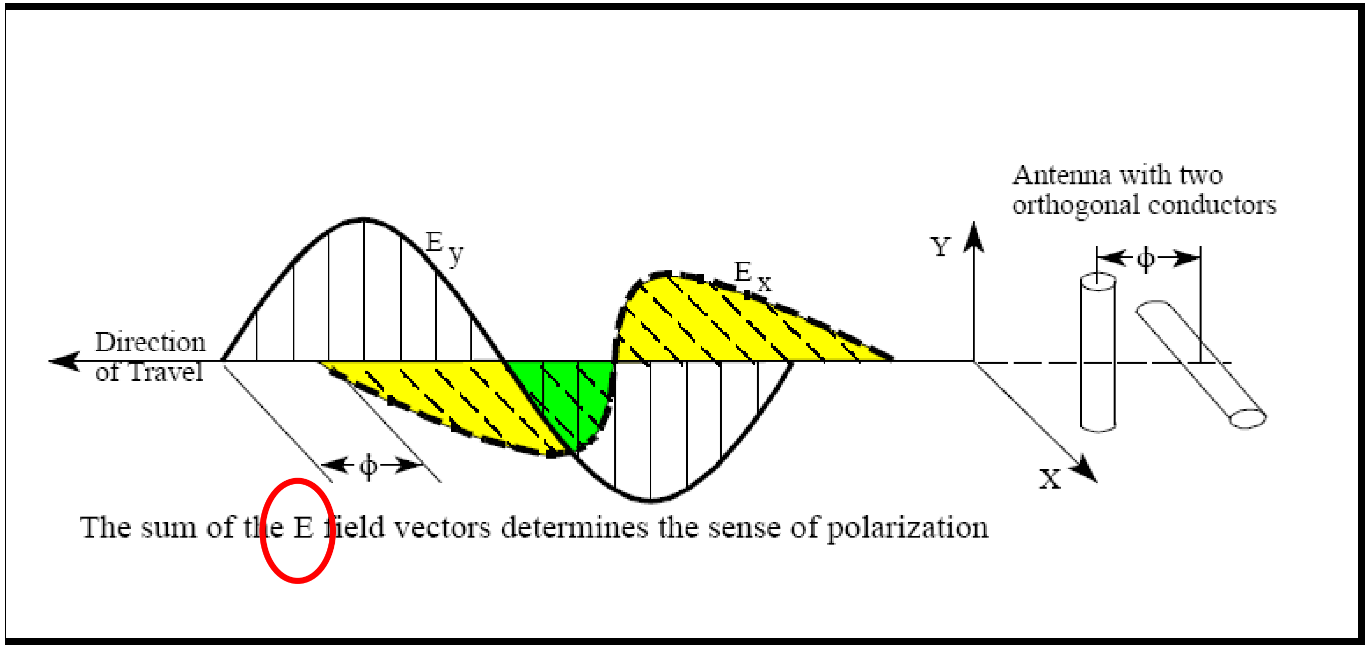
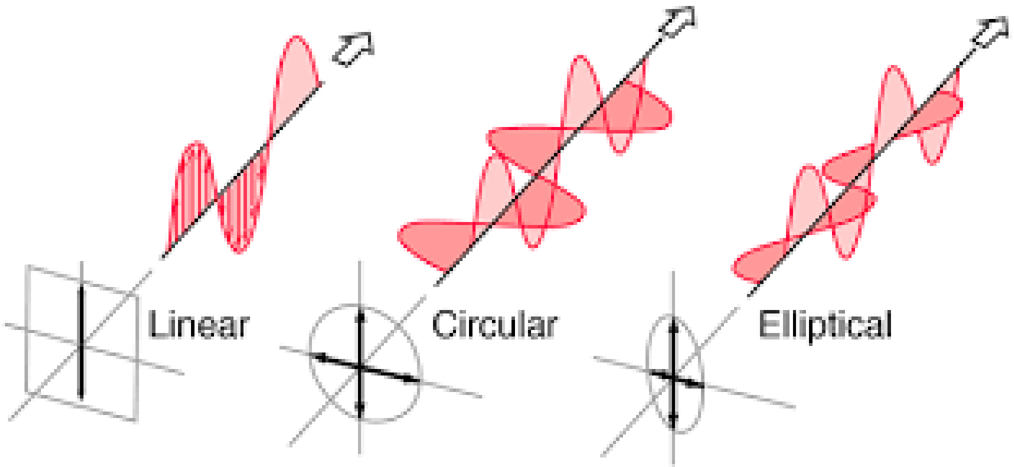
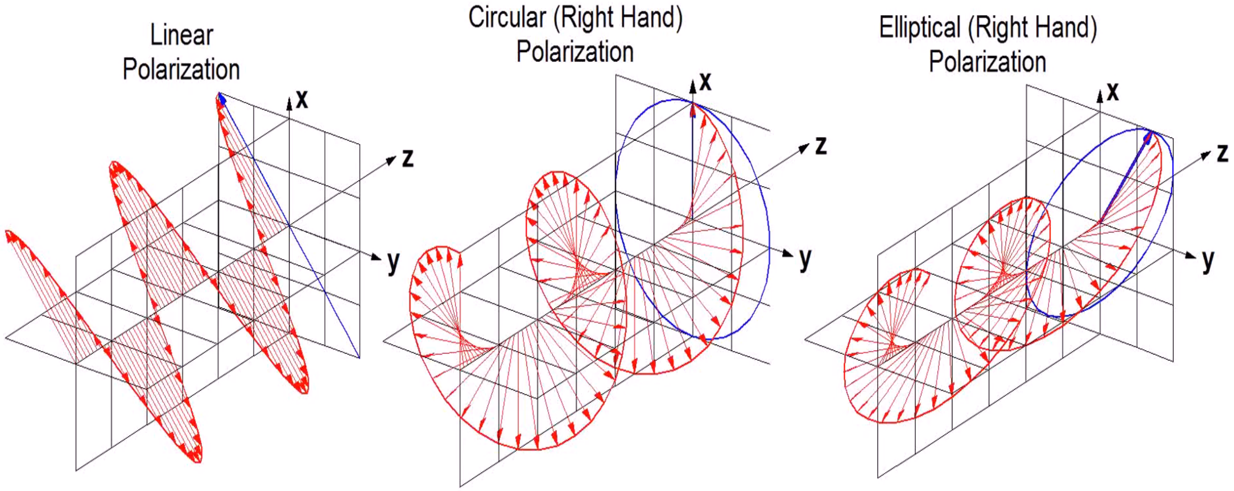
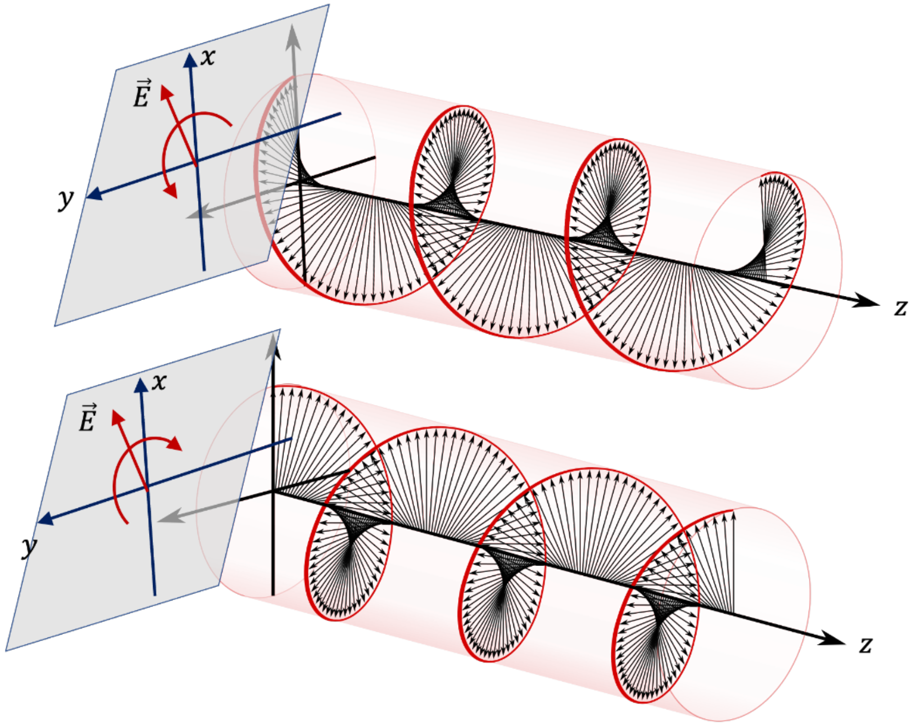


Figure 1. Polarization Coordinates



Polarization linear, circular and elliptical

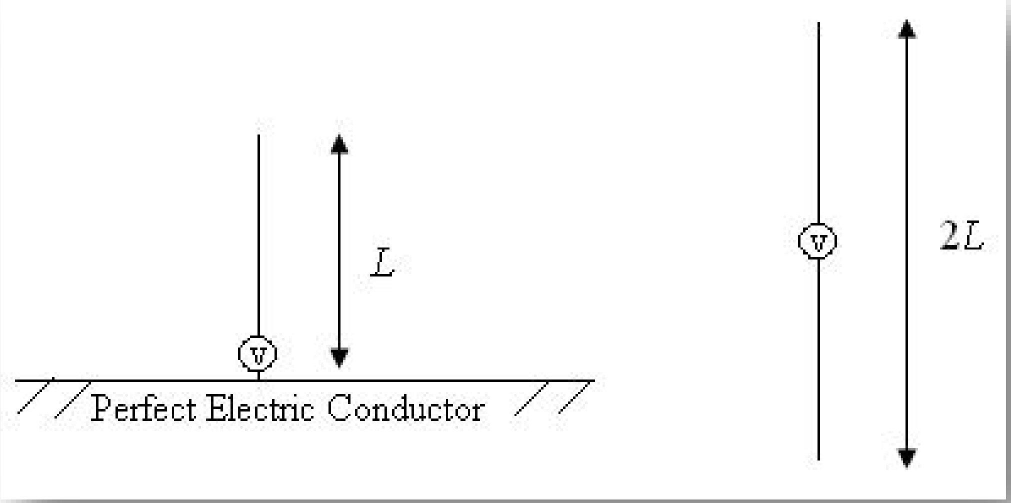




right-hand : sense to the direction of propagation. Clockwise.
left-hand sense: counter-clockwise

https://gifer.com/es/7fXp

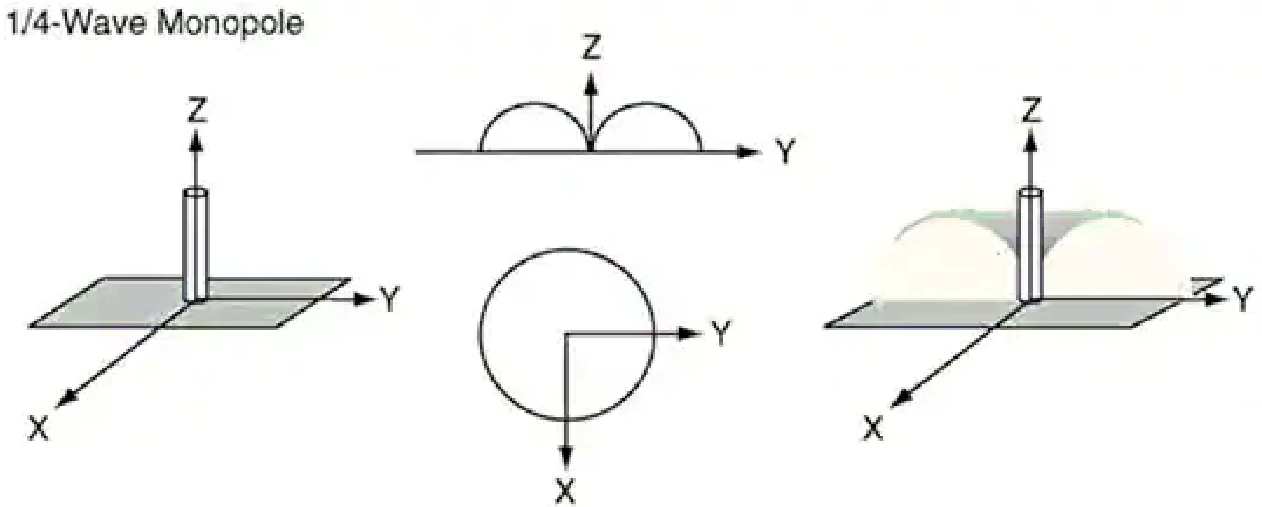
https://www.youtube.com/watch?v=Q0qrU4nprB0
https://www.youtube.com/watch?v=Fu-aYnRkUgg

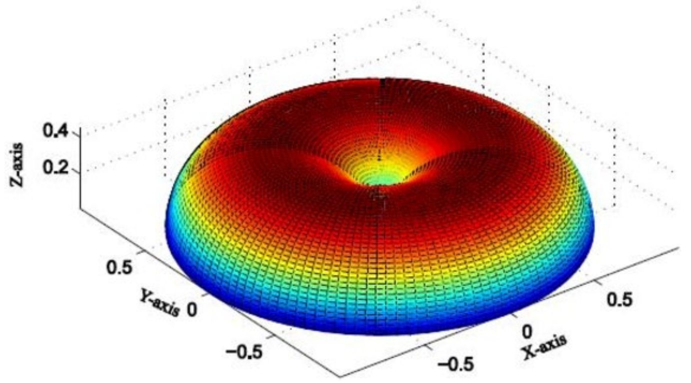


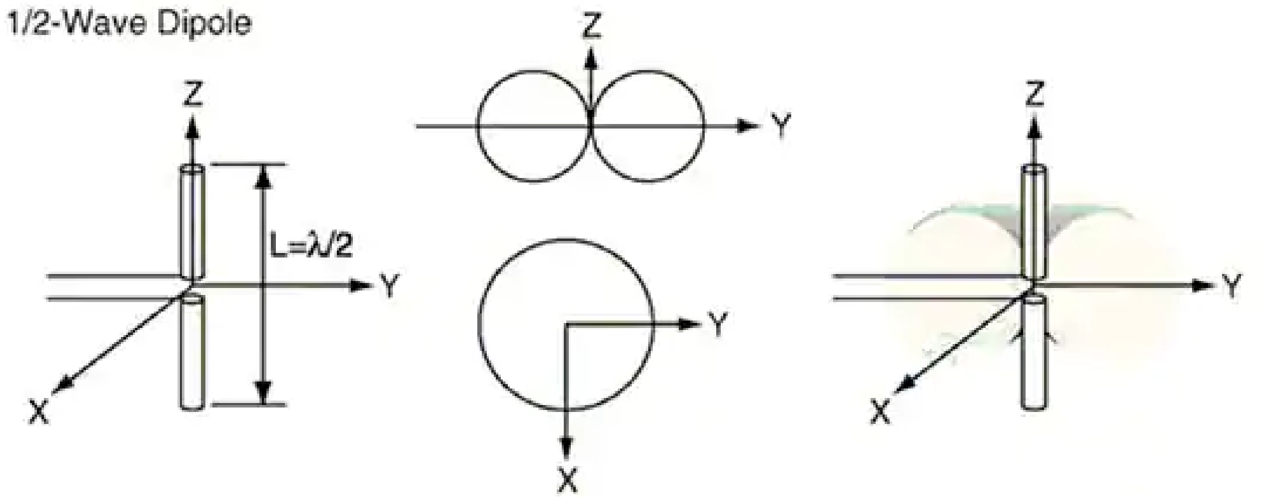
Wire antennas

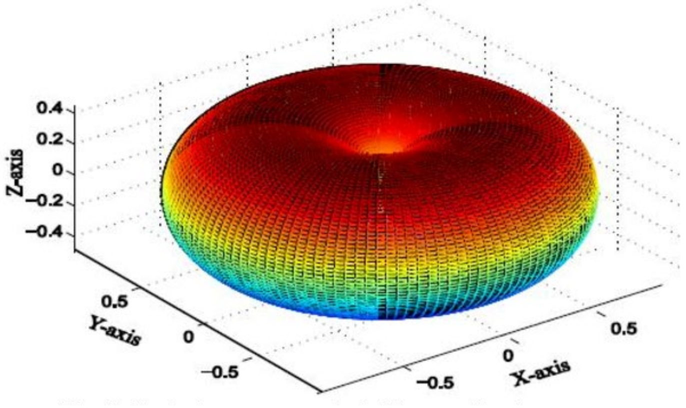
Polarization adjustment required.

Radiation paterns (wire antennas)









Radiation diagrams in function of the dipole length measured in λ.

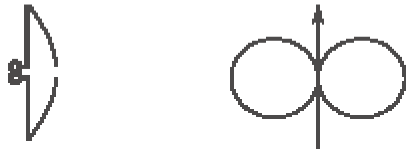
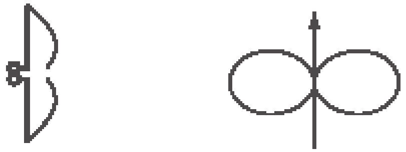
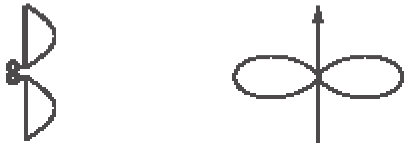
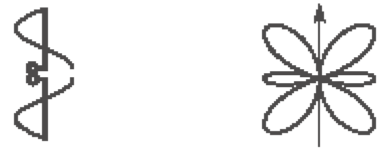
	$H = \lambda/4$	$\Delta\theta_{-3dB} = 78^o$	$R_r = 73\ \Omega$ $D = 1{,}64$
	$H = 3\lambda/8$	$\Delta\theta_{-3dB} = 64^o$	$R_r = 360\ \Omega$ $D = 1{,}94$
	$H = \lambda/2$	$\Delta\theta_{-3dB} = 48^o$	$R_r = \infty\ \Omega$ $D = 2{,}41$
	$H = 5\lambda/8$	$\Delta\theta_{-3dB} = 33^o$	$R_r = 210\ \Omega$ $D = 3{,}33$
	$H = 3\lambda/4$	$\Delta\theta_{-3dB} = 33^o$ $\theta_{max} = 43^o$	$R_r = 99{,}5\ \Omega$ $D = 2{,}17$
	$H = \lambda$	$\Delta\theta_{-3dB} = 27^o$ $\theta_{max} = 57^o$	$R_r = \infty\ \Omega$ $D = 2{,}52$

Tabla 4.1 Parámetros de dipolos de diferentes longitudes

Slotted Antennas

(Antenas de Ranura) (Antenes d’escletxa)

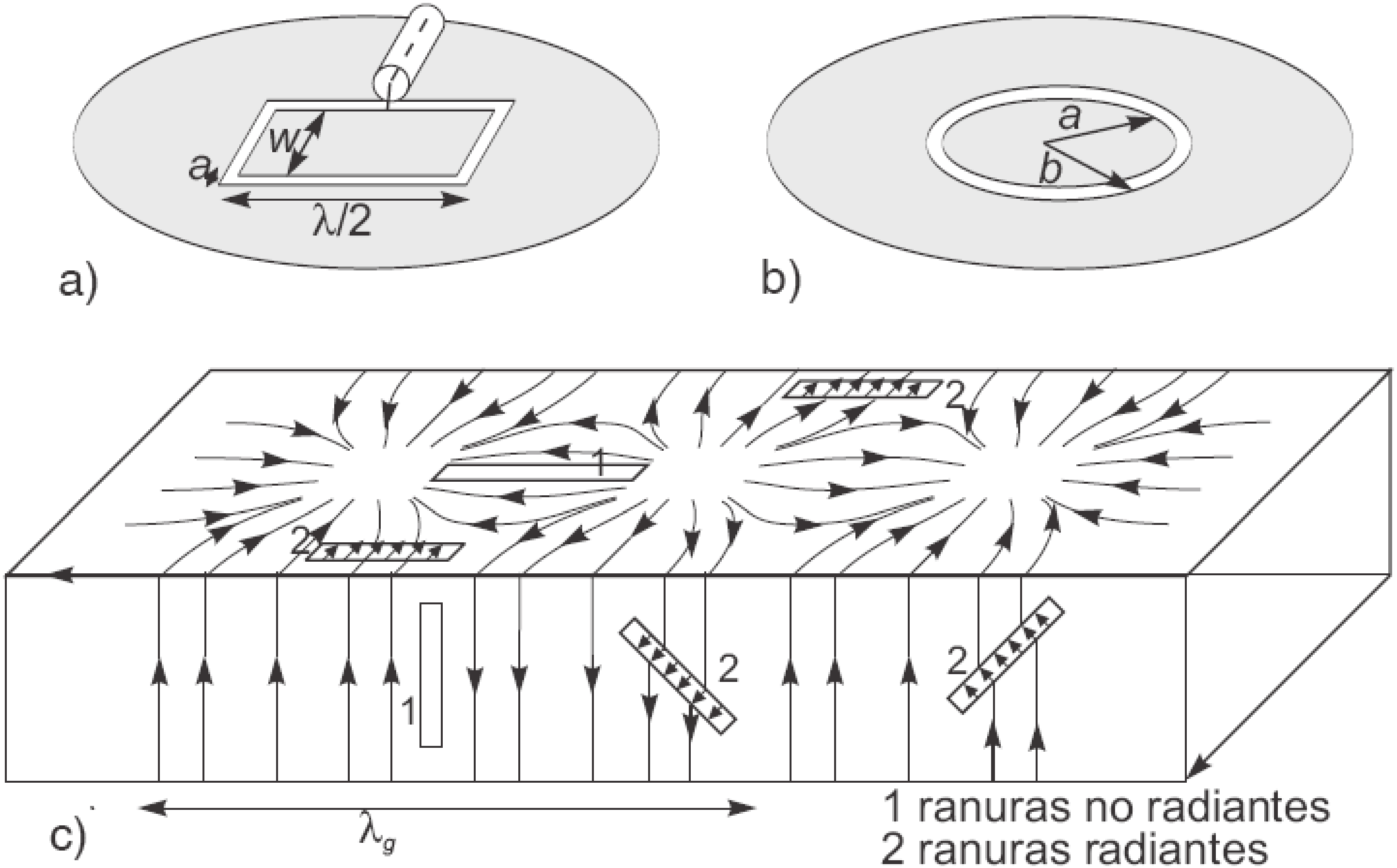
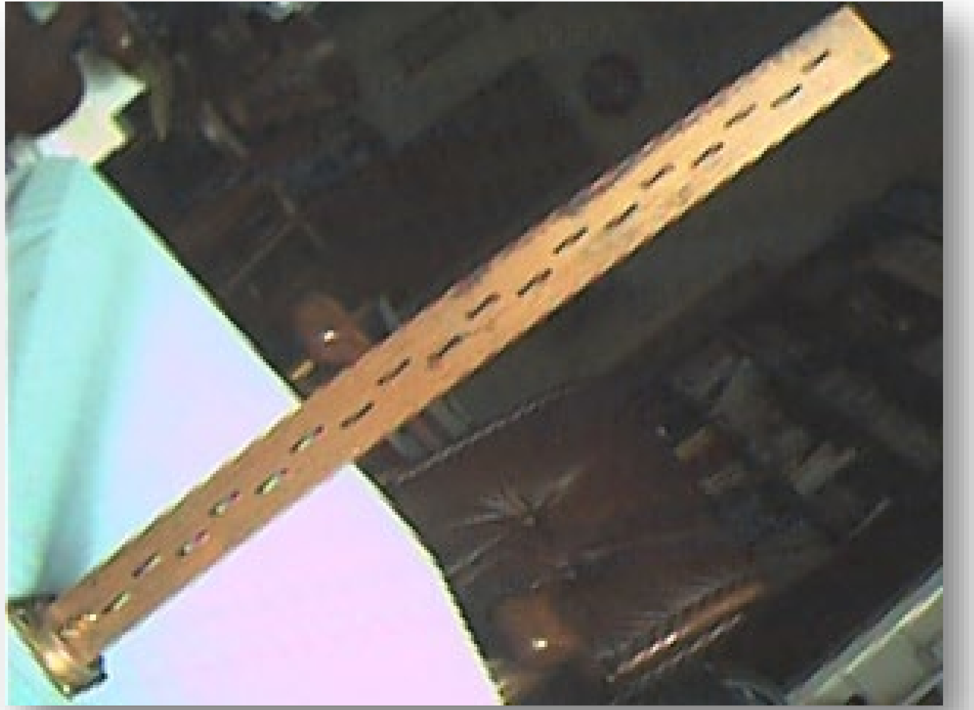
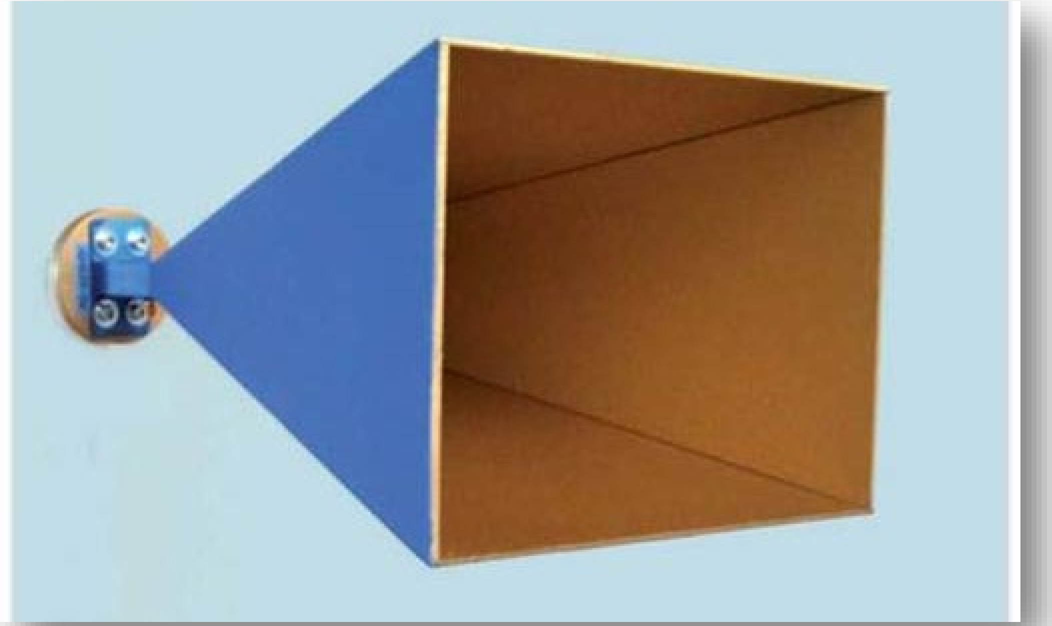


Fig. 6.21 Realizaciones habituales con ranuras: a) ranura doblada, b) coaxial abierto en un plano conductor y c) guía rectangular ranurada





Aperture antenna

Horn Antennas

(antenes de botzina)

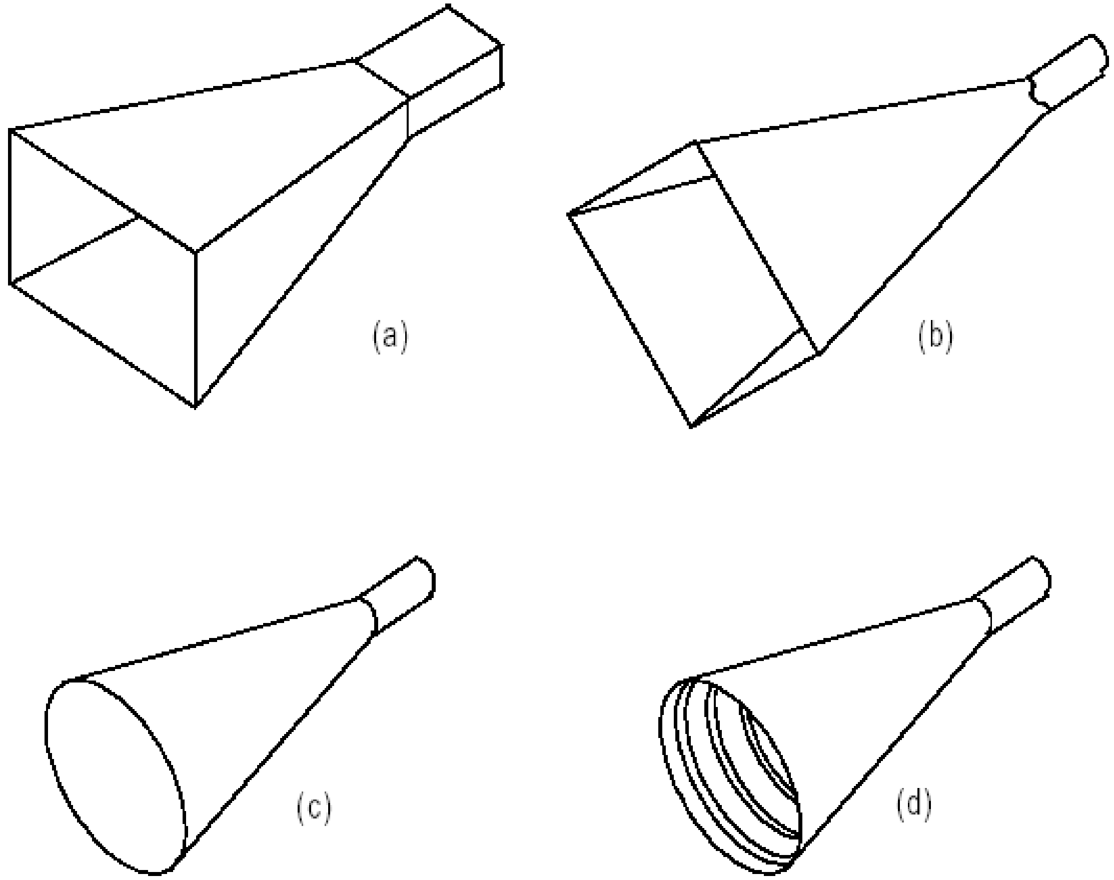


Figure A59 Common types of horn antennas: (a) pyramidal horn; (b) diagonal horn; (c) conical horn; (d) corrugated horn (after Currie, 1987, Fig. 12.12, p. 539).

Reflectors

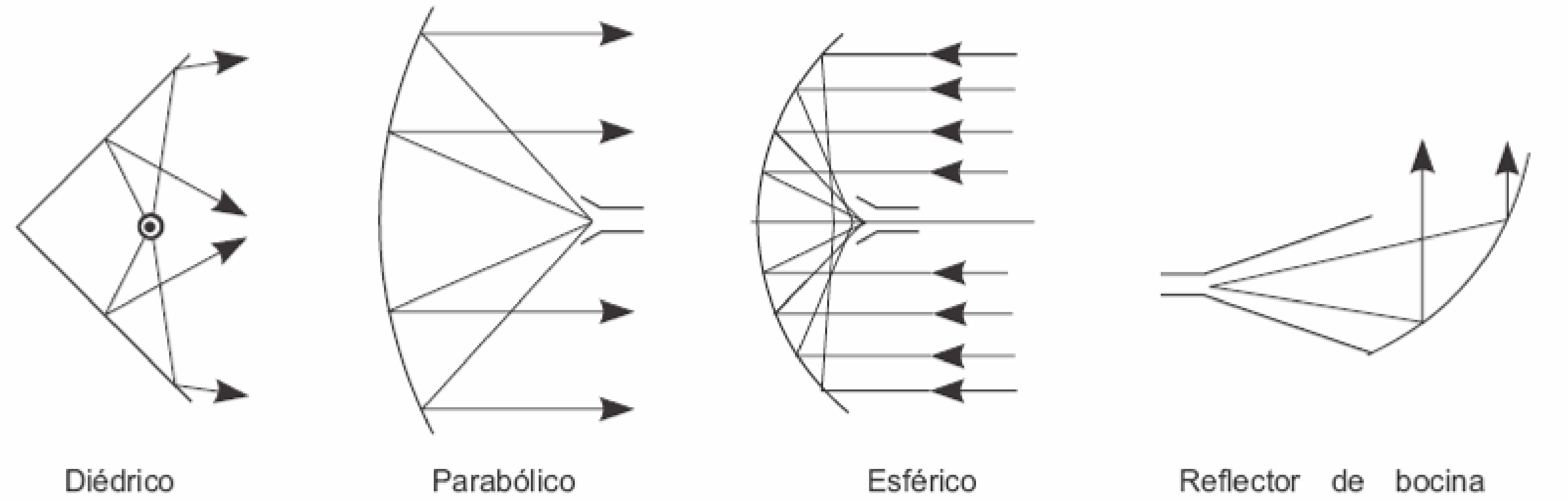
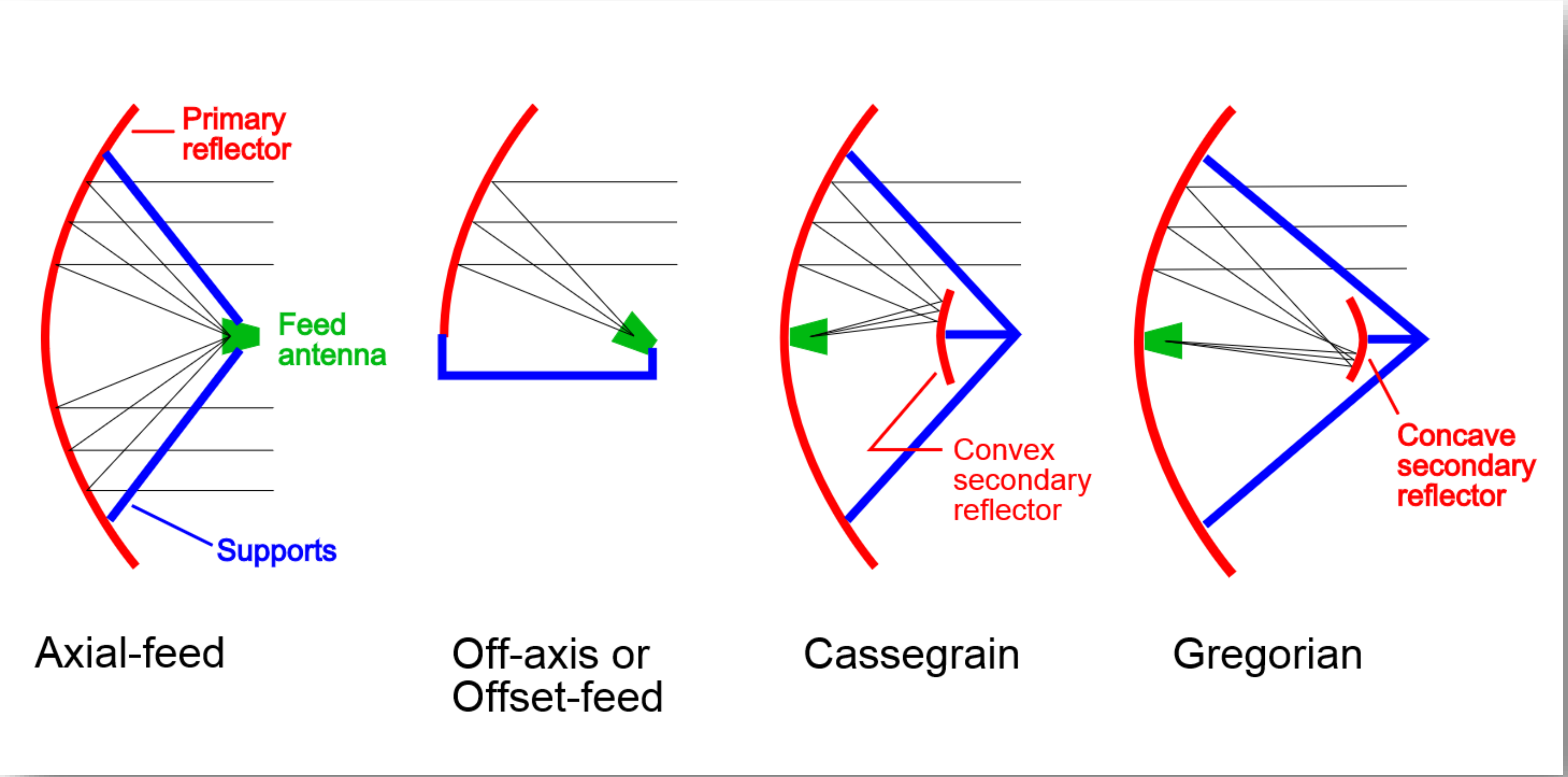


Fig. 6.23 Distintas geometrías de reflector

Kinds of parabolic reflectors



Ref.: Johnston (1979), p. 58.

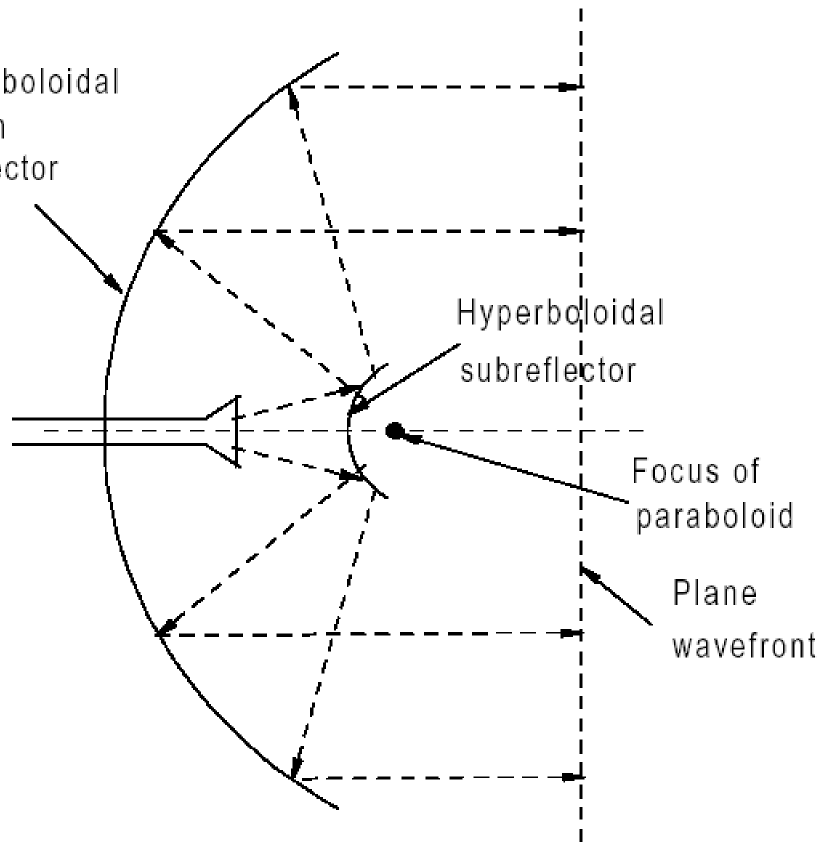


Figure A56 Geometry of the Cassegrainian dual-reflector antenna.

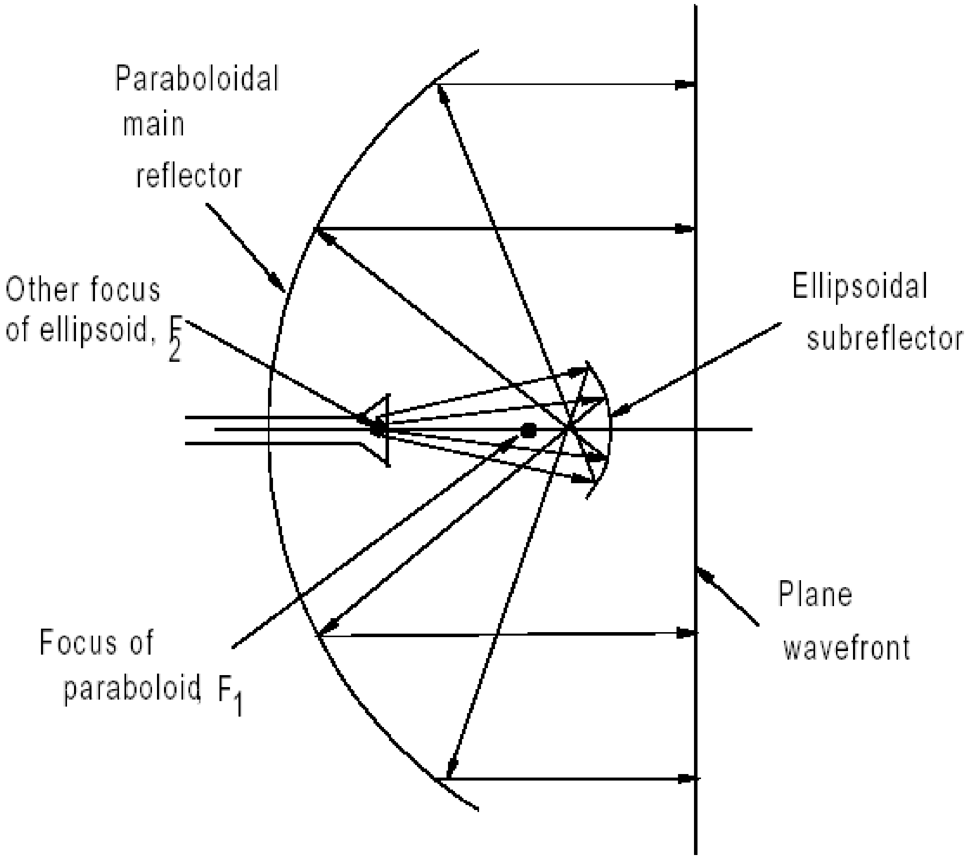
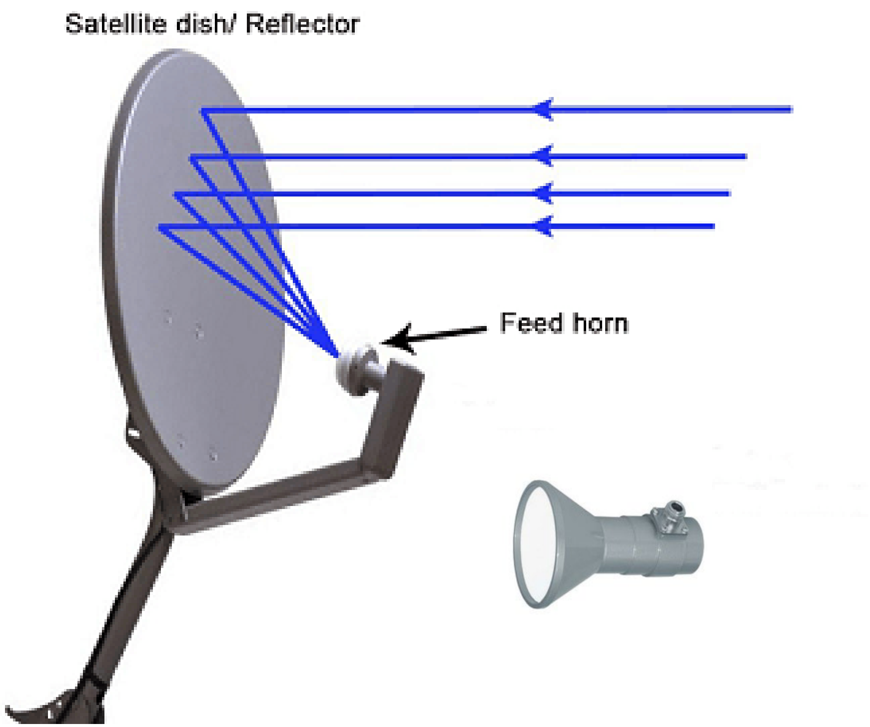
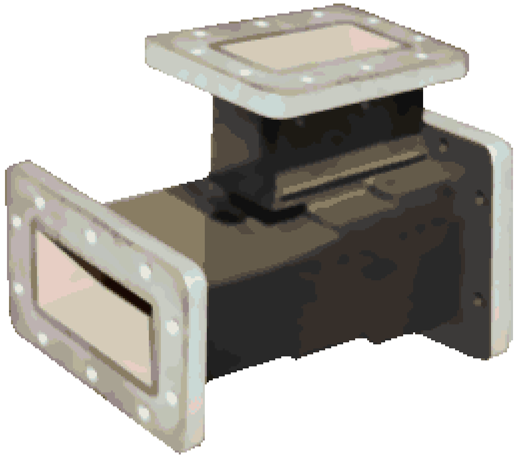


Figure A57 Dual-reflector Gregorian antenna.

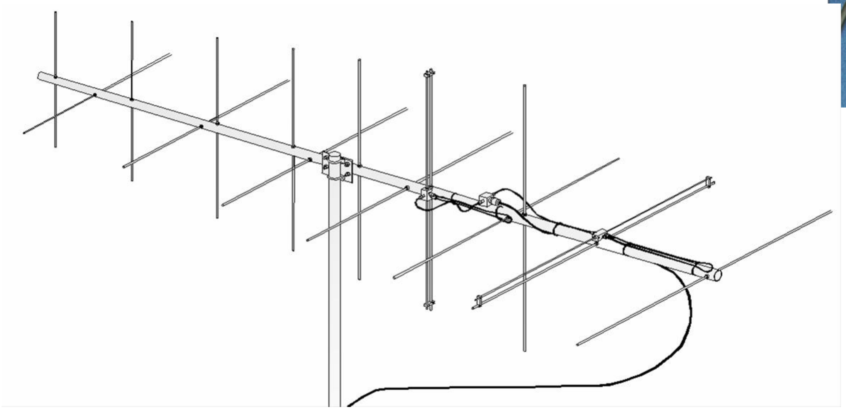
Parabolic: Polarization determined by the feeder of the antenna (circular, orhogonal,…)



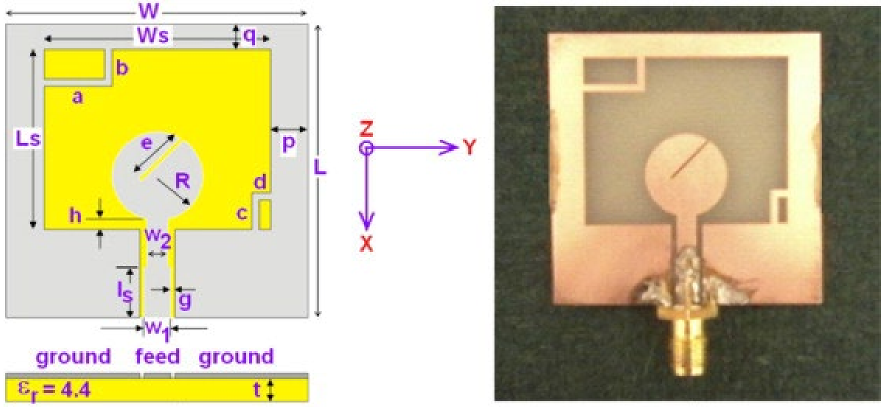
Orthomode transducer (OMT): It serves to separate or combine two guided waves of the same frequency with linear polarization, whose polarization planes are orthogonal to each other.



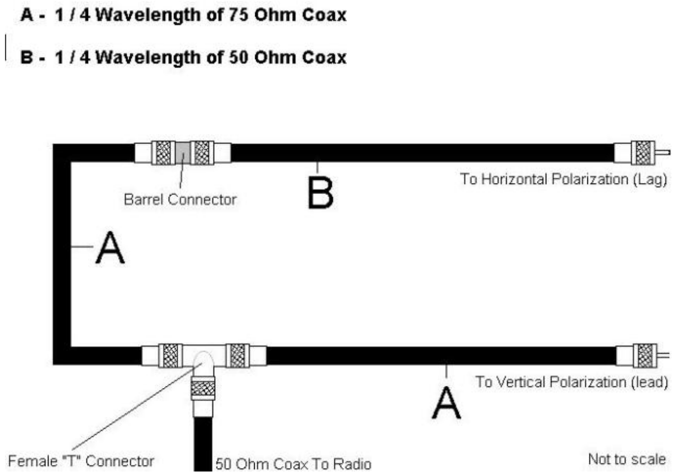
Circular polarization (no orientation adjustment is required; multipath: RHCP vs LHCP)

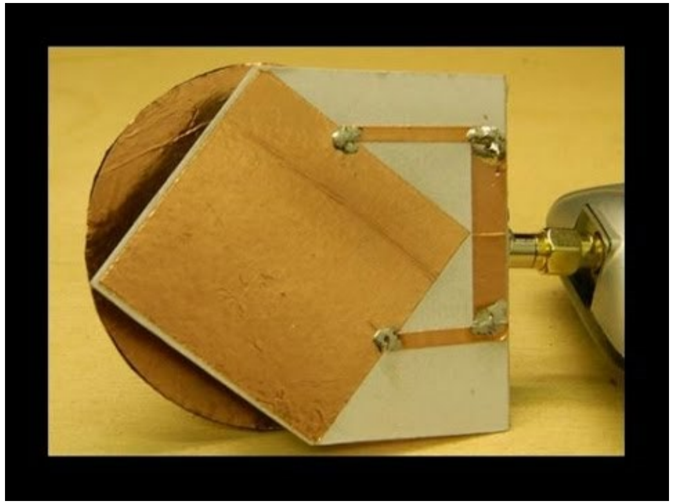


Circular polarization

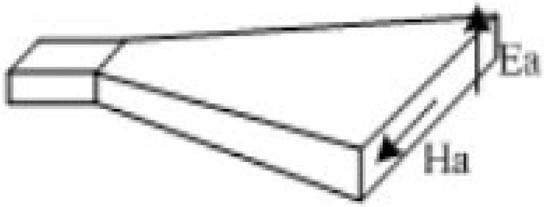


(a) (b)

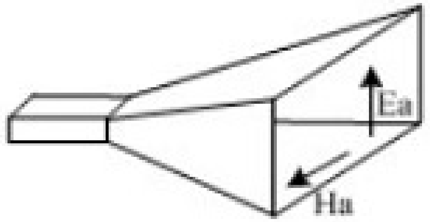




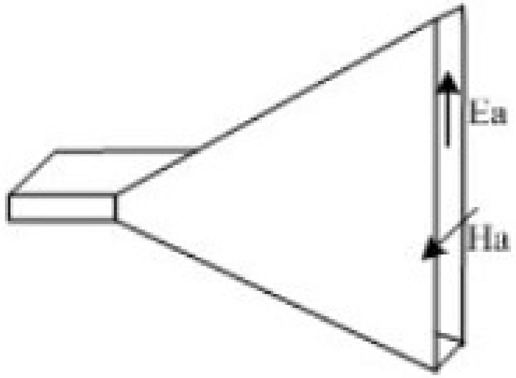
DIFFERENT TYPES OF HORN ANTENNA



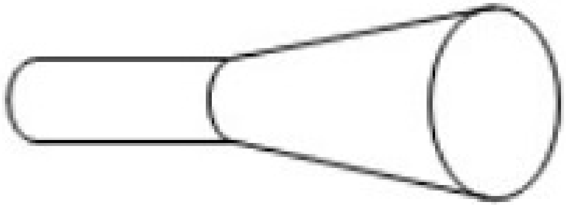
H-plane sectoral horn



Pyramidal horn

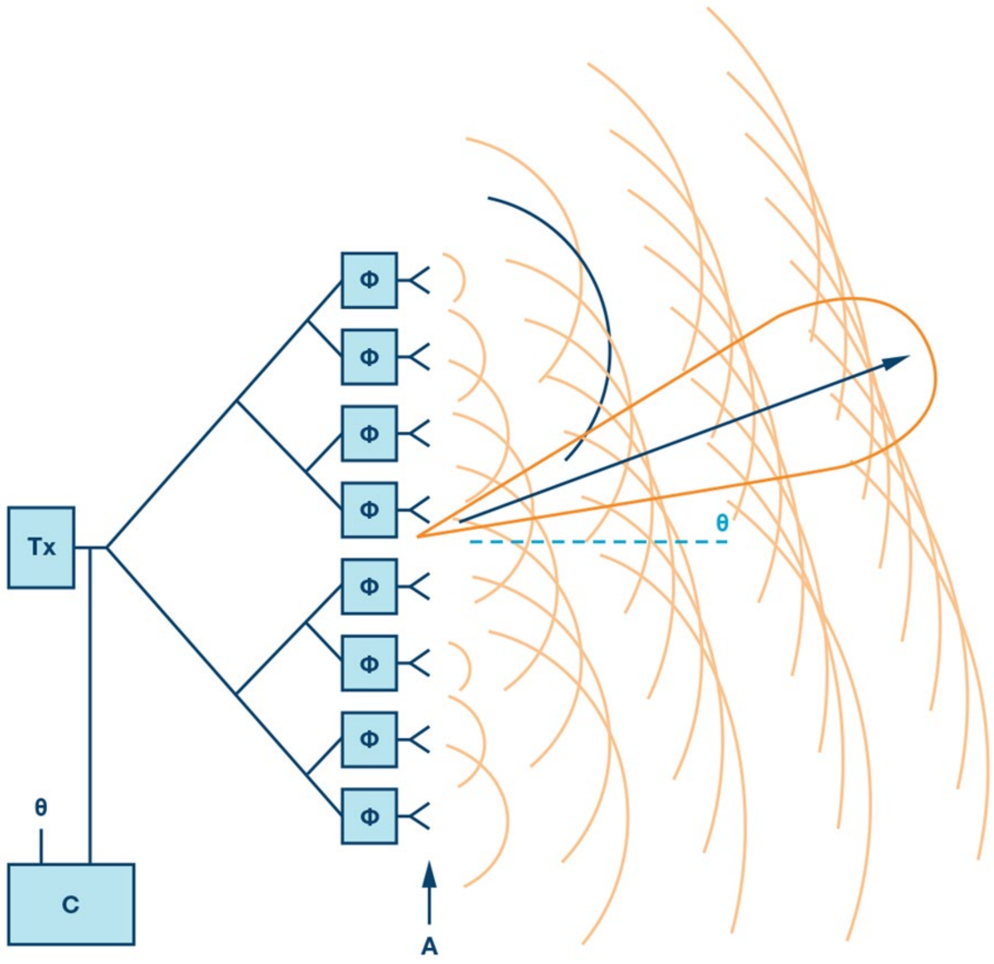


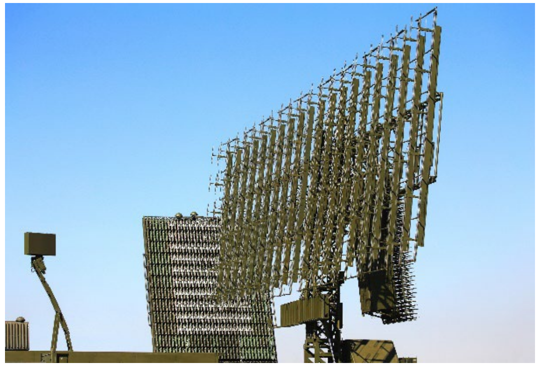
E-plane sectoral horn

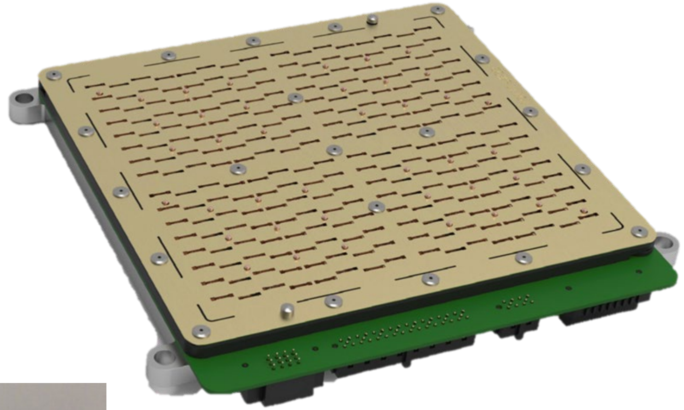


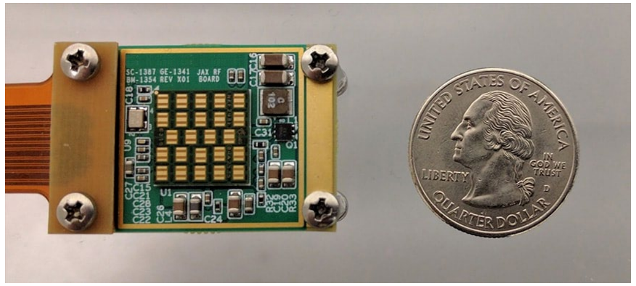
Conical Horn Antenna

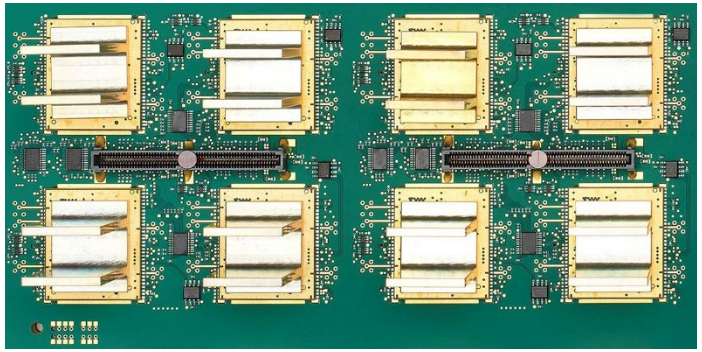
Phased Array Beamforming











Radiation diagrams

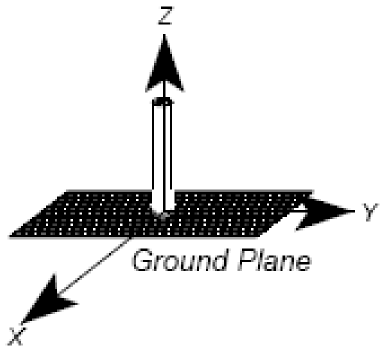
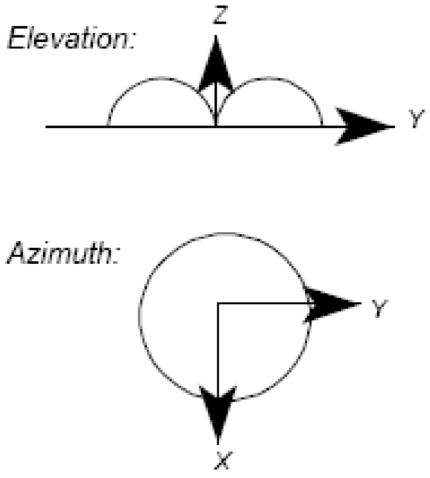
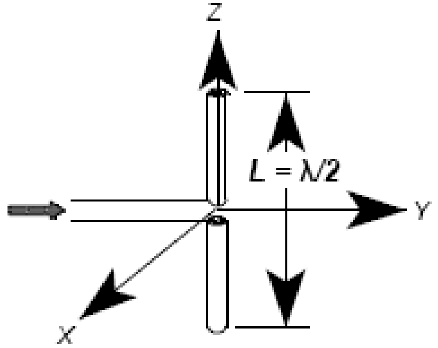
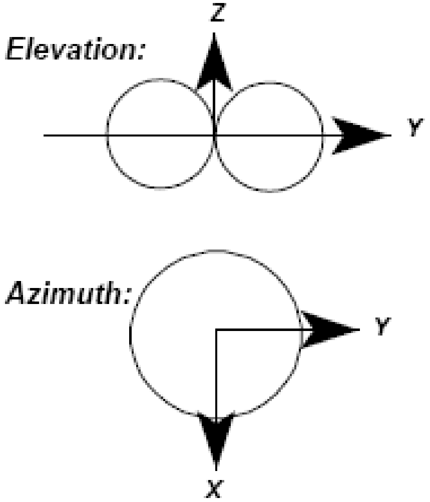
Antenna Type	Radiation Pattern	Characteristics
MONOPOLE 		**Polarization: Linear** *Vertical as shown* **Typical Half-Power Beamwidth** *45 deg x 360 deg* **Typical Gain:** *2-6 dB at best* **Bandwidth:** *10% or 1.1:1* **Frequency Limit** **Lower:** *None* **Upper:** *None* **Remarks:** *Polarization changes to horizontal if rotated to horizontal*
λ/2 DIPOLE 		**Polarization:** *Linear* *Vertical as shown* **Typical Half-Power Beamwidth** *80 deg x 360 deg* **Typical Gain:** *2 dB* **Bandwidth:** *10% or 1.1:1* **Frequency Limit** **Lower:** *None* **Upper:** *8 GHz (practical limit)* **Remarks:** *Pattern and lobing changes significantly with L/f. Used as a gain reference < 2 GHz.*

Figure 1

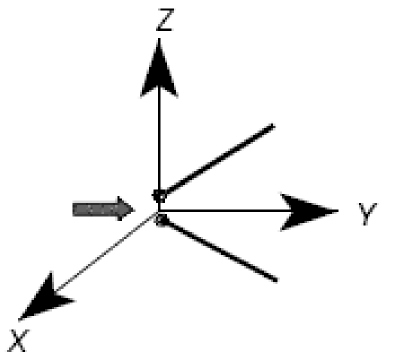
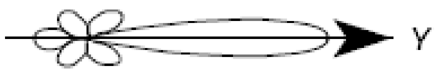
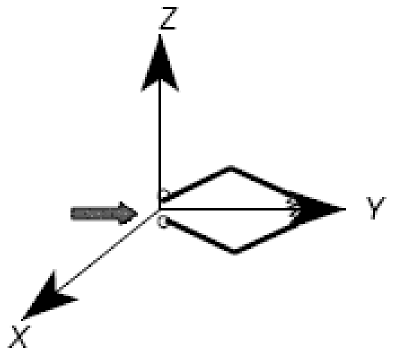
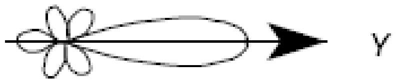
Antenna Type	Radiation Pattern	Characteristics
VEE 	**Elevation & Azimuth:** 	***Polarization***: *Linear* *Vertical as shown* ***Typical Half-Power Beamwidth*** *60 deg x 60 deg* ***Typical Gain:*** *2 to 7 dB* ***Bandwidth:*** *"Broadband"* ***Frequency Limit*** ***Lower:*** *3 MHz* ***Upper:*** *500 MHz (practical limits)* ***Remarks:*** *24KHz versions are known to exist. Terminations may be used to reduce backlobes.*
RHOMBIC 	**Elevation & Azimuth:** 	***Polarization***: *Linear* *Vertical as shown* ***Typical Half-Power Beamwidth*** *60 deg x 60 deg* ***Typical Gain:*** *3 dB* ***Bandwidth:*** *"Broadband"* ***Frequency Limit*** ***Lower:*** *3 MHz* ***Upper:*** *500 MHz* ***Remarks:*** *Termination resistance used to reduce backlobes.*

Figure 2

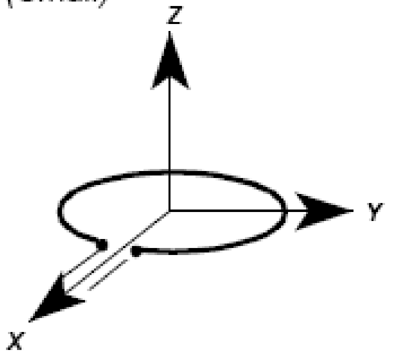
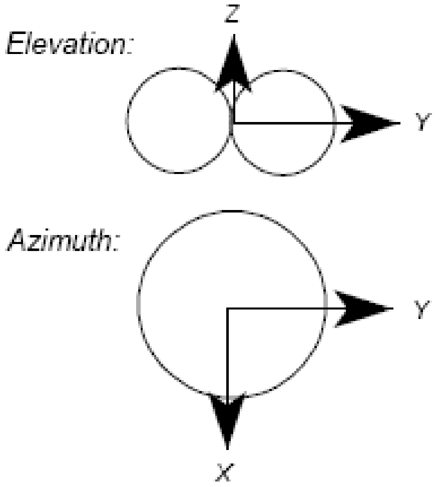
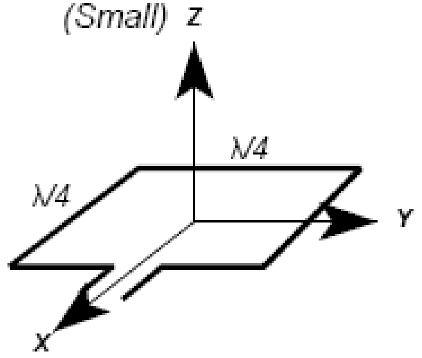
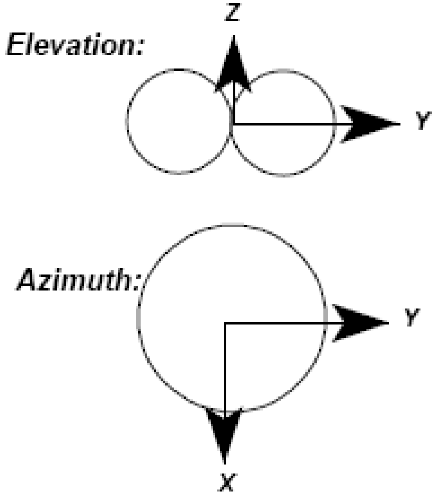
Antenna Type	Radiation Pattern	Characteristics
CIRCULAR LOOP (Small) 		**Polarization:** Linear Horizontal as shown **Typical Half-Power Beamwidth:** 80 deg x 360 deg **Typical Gain:** -2 to 2 dB **Bandwidth:** 10% or 1.1:1 **Frequency Limit:** **Lower:** 50 MHz **Upper:** 1 GHz
SQUARE LOOP (Small) 		**Polarization:** Linear Horizontal as shown **Typical Half-Power Beamwidth:** 100 deg x 360 deg **Typical Gain:** 1-3 dB **Bandwidth:** 10% or 1.1:1 **Frequency Limit:** **Lower:** 50 MHz **Upper:** 1 GHz

Figure 3

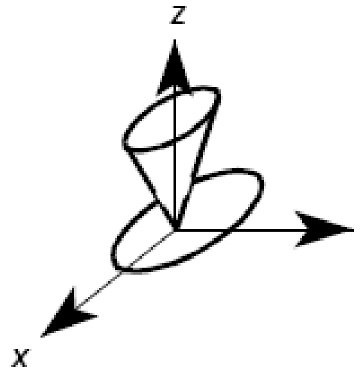
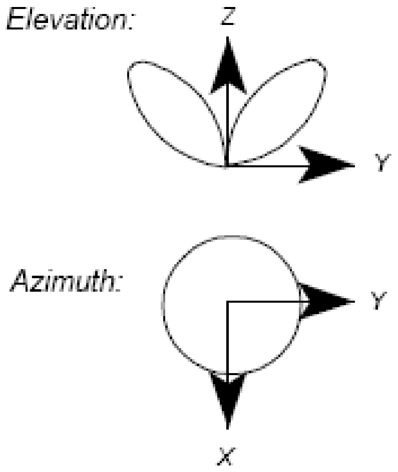
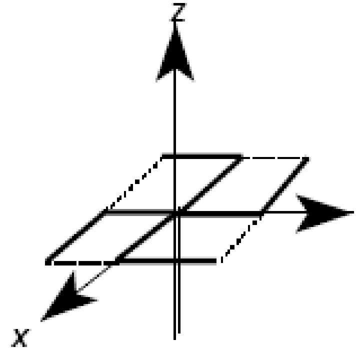
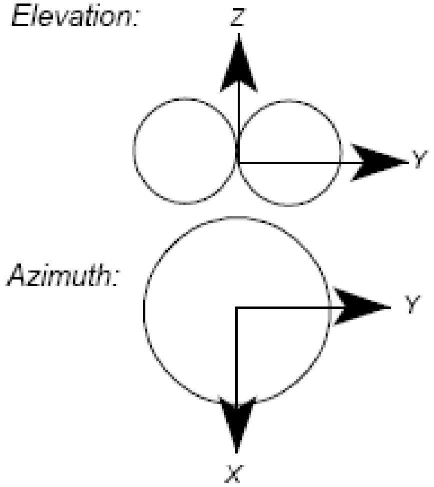
Antenna Type	Radiation Pattern	Characteristics
DISCONE 		**Polarization:** *Linear Vertical as shown* **Typical Half-Power Beamwidth:** *20-80 deg x 360 deg* **Typical Gain:** *0-4 dB* **Bandwidth:** *100% or 3:1* **Frequency Limit:** **Lower:** *30 MHz* **Upper:** *3 GHz*
ALFORD LOOP 		**Polarization:** *Linear Horizontal as shown* **Typical Half-Power Beamwidth:** *80 deg x 360 deg* **Typical Gain:** *-1 dB* **Bandwidth:** *67% or 2:1* **Frequency Limit:** **Lower:** *100 MHz* **Upper:** *12 GHz*

Figure 4

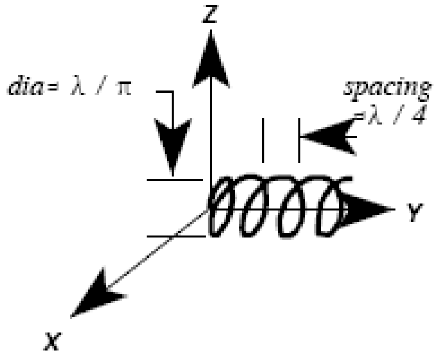
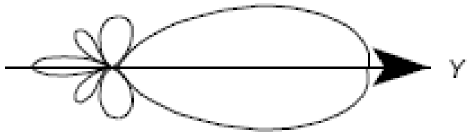
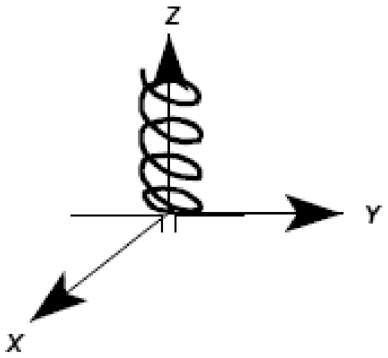
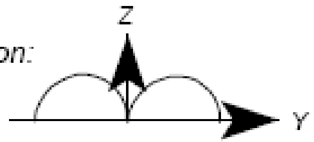
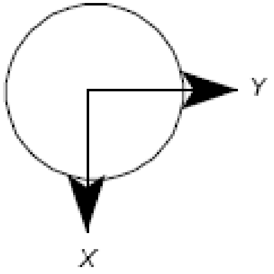
Antenna Type	Radiation Pattern	Characteristics
AXIAL MODE HELIX 	Elevation & Azimuth 	**Polarization:** Circular Left hand as shown **Typical Half-Power Beamwidth:** 50 deg x 50 deg **Typical Gain:** 10 dB **Bandwidth:** 52% or 1.7:1 **Frequency Limit** **Lower:** 100 MHz **Upper:** 3 GHz **Remarks:** Number of loops >3
NORMAL MODE HELIX 	Elevation:  Azimuth: 	**Polarization:** Circular - with an ideal pitch to diameter ratio. **Typical Half-Power Beamwidth:** 60 deg x 360 deg **Typical Gain:** 0 dB **Bandwidth:** 5% or 1.05:1 **Frequency Limit** **Lower:** 100 MHz **Upper:** 3 GHz

Figure 5

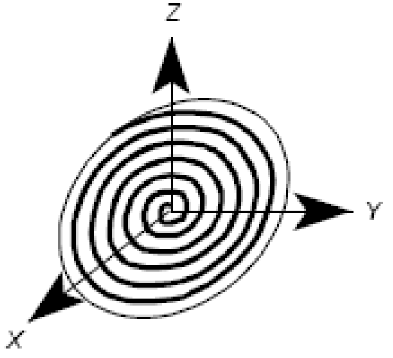
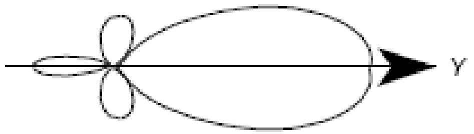
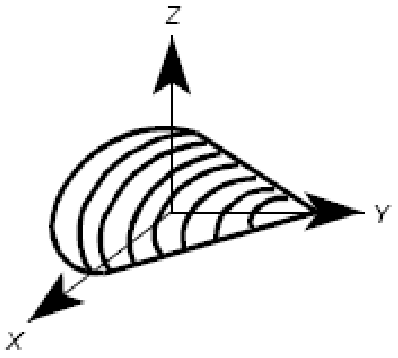
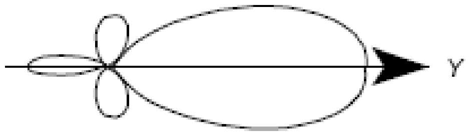
Antenna Type	Radiation Pattern	Characteristics
CAVITY BACKED SPIRAL (Flat Helix) 	*Elevation & Azimuth* 	***Polarization:*** *Circular Left hand as shown* ***Typical Half-Power Beamwidth:*** *60 deg x 90 deg* ***Typical Gain:*** *2-4 dB* ***Bandwidth:*** *160% or 9:1* ***Frequency Limit:*** ***Lower:*** *500 MHz* ***Upper:*** *18 GHz*
CONICAL SPIRAL 	*Elevation & Azimuth* 	***Polarization:*** *Circular Left hand as shown* ***Typical Half-Power Beamwidth:*** *60 deg x 60 deg* ***Typical Gain:*** *5-8 dB* ***Bandwidth:*** *120% or 4:1* ***Frequency Limit:*** ***Lower:*** *50 MHz* ***Upper:*** *18 GHz*

Figure 6

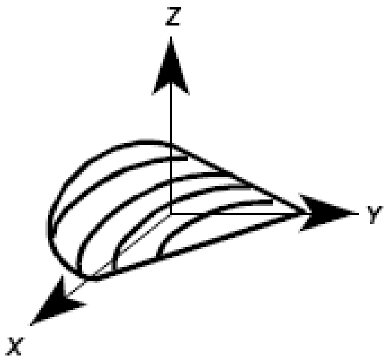
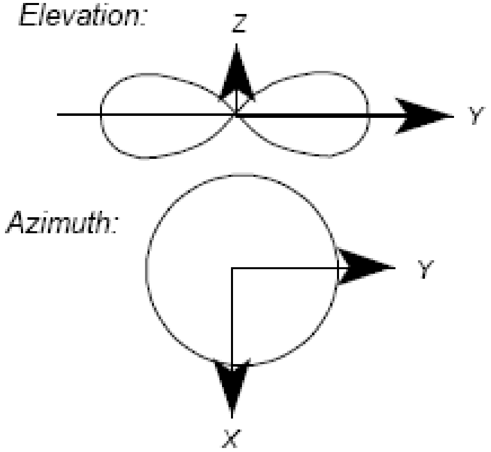
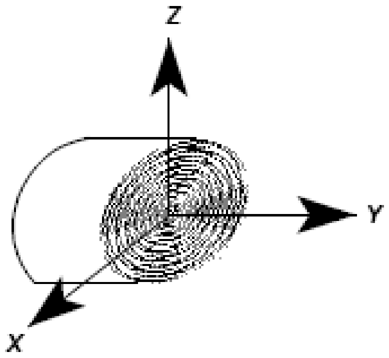
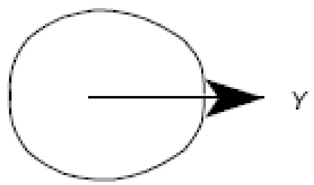
Antenna Type	Radiation Pattern	Characteristics
4 ARM CONICAL SPIRAL 		**Polarization:** *Circular Left hand as shown* **Typical Half-Power Beamwidth:** *50 deg x 360 deg* **Typical Gain:** *0 dB* **Bandwidth:** *120% or 4:1* **Frequency Limit:** **Lower:** *500 MHz* **Upper:** *18 GHz*
DUAL POLARIZED SINUOUS 	**Elevation & Azimuth** 	**Polarization**: *Dual vertical or horizontal or dual Circular right hand or left hand with hybrid* **Typical Half-Power Beamwidth:** *75 deg x 75 deg* **Typical Gain:** *2 dB* **Bandwidth:** *163% or 10:1* **Frequency Limit:** **Lower:** *500 MHz* **Upper:** *18 GHz*

Figure 7

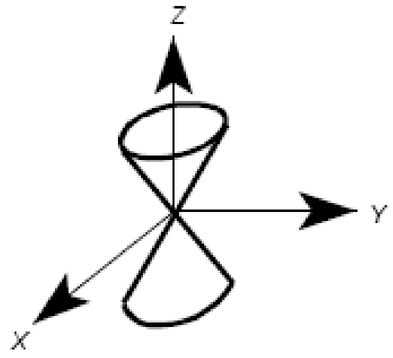
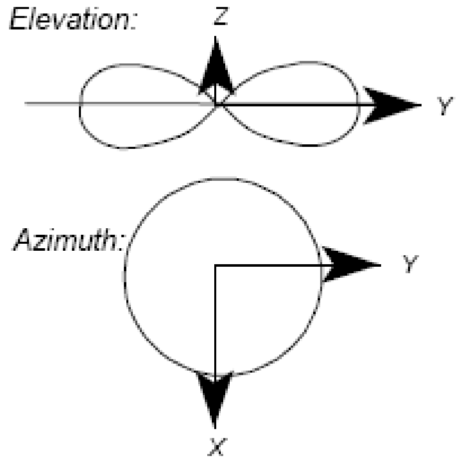
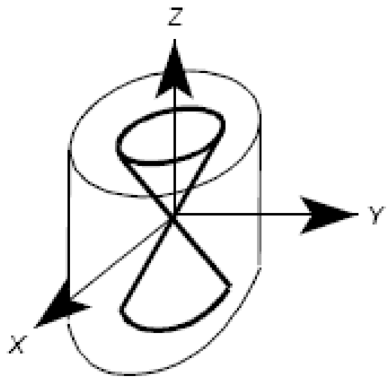
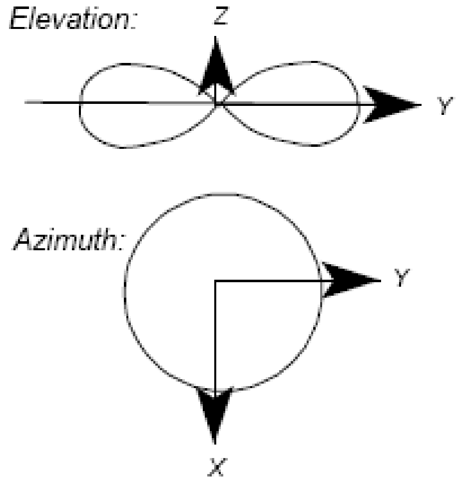
Antenna Type	Radiation Pattern	Characteristics
BICONICAL 		**Polarization:** Linear, Vertical as shown **Typical Half-Power Beamwidth:** 20-100 deg x 360 deg **Typical Gain:** 0-4 dB **Bandwidth:** 120% or 4:1 **Frequency Limit:** **Lower:** 500 MHz **Upper:** 40 GHz
BICONICAL W/POLARIZER 		**Polarization:** Circular, Direction depends on polarization **Typical Half-Power Beamwidth:** 20-100 deg x 360 deg **Typical Gain:** -3 to 1 dB **Bandwidth:** 100% or 3:1 **Frequency Limit:** **Lower:** 2 GHz **Upper:** 18 GHz

Figure 8

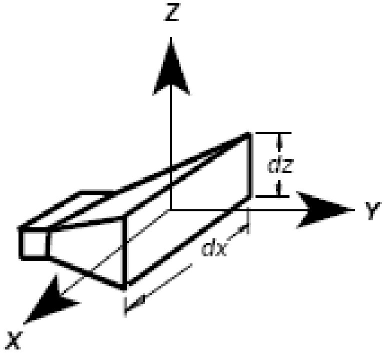
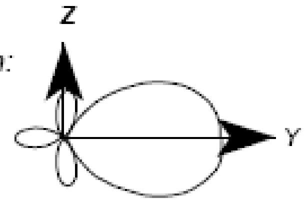
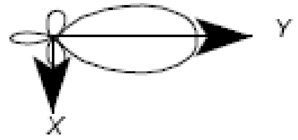
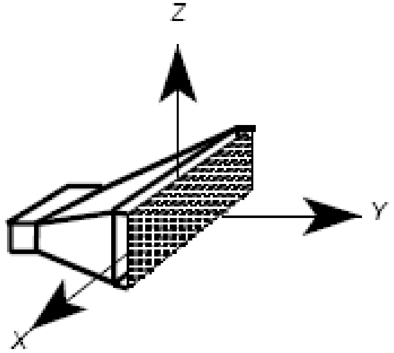
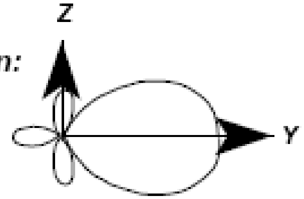
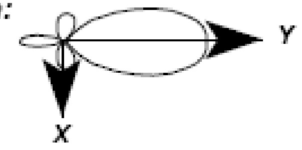
Antenna Type	Radiation Pattern	Characteristics
HORN  	*Elevation:*  *3 dB beamwidth = 56 λ°/dz* *Azimuth:*  *3 dB beamwidth = 70 λ°/dx*	***Polarization:*** *Linear* ***Typical Half-Power Beamwidth:*** *40 deg x 40 deg* ***Typical Gain:*** *5 to 20 dB* ***Bandwidth:*** *If ridged: 120% or 4:1* *If not ridged: 67% or 2:1* ***Frequency Limit:*** ***Lower:*** *50 MHz* ***Upper:*** *40 GHz*
HORN W / POLARIZER  	***Elevation:***  ***Azimuth:***  	***Polarization:*** *Circular,* *Depends on polarizer* ***Typical Half-Power Beamwidth:*** *40 deg x 40 deg* ***Typical Gain:*** *5 to 10 dB* ***Bandwidth:*** *60% or 2:1* ***Frequency Limit:*** ***Lower:*** *2 GHz* ***Upper:*** *18 GHz*

Figure 9

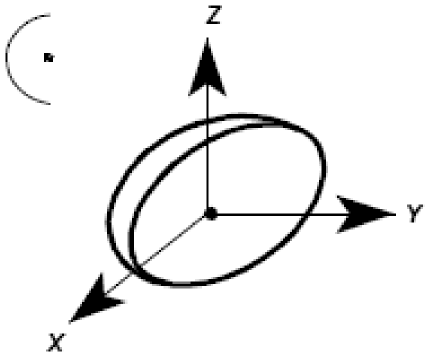
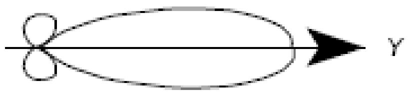
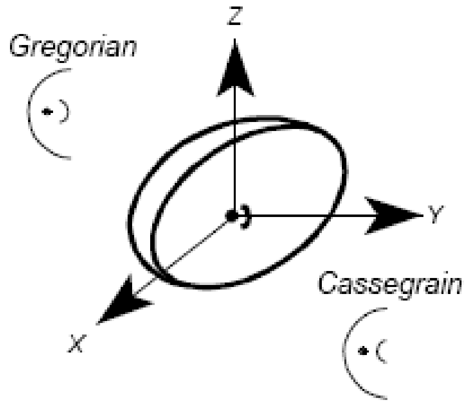
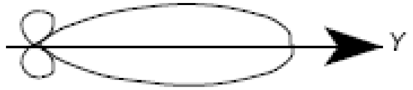
Antenna Type	Radiation Pattern	Characteristics
PARABOLIC (Prime) 	**Elevation & Azimuth** 	***Polarization:*** *Takes polarization of feed* ***Typical Half-Power Beamwidth:*** *1 to 10 deg* ***Typical Gain:*** *20 to 30 dB* ***Bandwidth:*** *33% or 1.4:1 limited mostly by feed* ***Frequency Limit:*** ***Lower:*** *400 MHz* ***Upper:*** *13+ GHz*
PARABOLIC 	*Elevation & Azimuth* 	***Polarization:*** *Takes polarization of feed* ***Typical Half-Power Beamwidth:*** *1 to 10 deg* ***Typical Gain:*** *20 to 30 dB* ***Bandwidth:*** *33% or 1.4:1* ***Frequency Limit:*** ***Lower:*** *400 MHz* ***Upper:*** *13+ GHz*

Figure 10

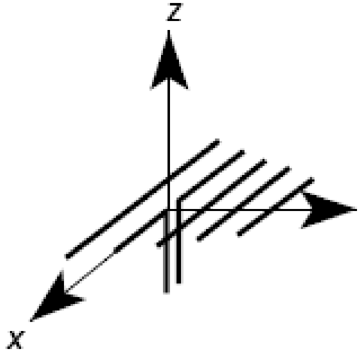
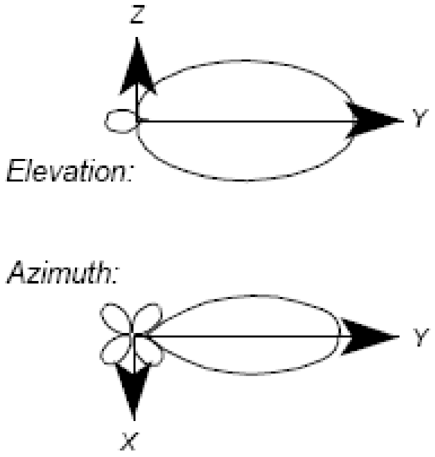
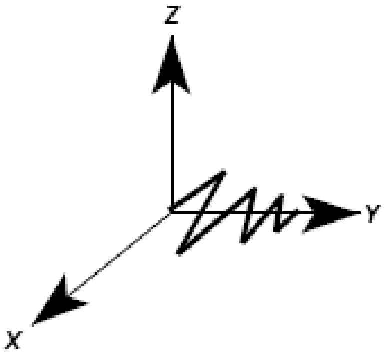
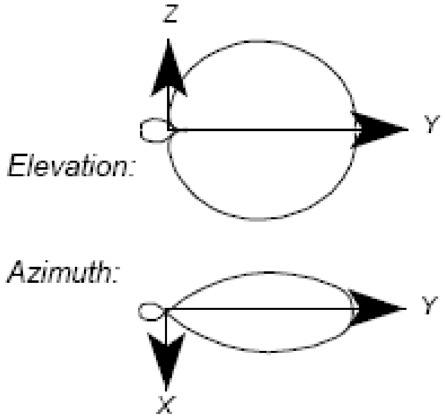
Antenna Type	Radiation Pattern	Characteristics
YAGI  	 	**Polarization:** *Linear Horizontal as shown* ***Typical Half-Power Beamwidth*** *50 deg X 50 deg* ***Typical Gain:*** *5 to 15 dB* ***Bandwidth:*** *5% or 1.05:1* ***Frequency Limit:*** ***Lower:*** *50 MHz* ***Upper:*** *2 GHz*
LOG PERIODIC  	 	***Polarization:*** *Linear* ***Typical Half-Power Beamwidth:*** *60 deg x 80 deg* ***Typical Gain:*** *6 to 8 dB* ***Bandwidth:*** *163% or 10:1* ***Frequency Limit:*** ***Lower:*** *3 MHz* ***Upper:*** *18 GHz* ***Remarks:*** *This array may be formed with many shapes including dipoles or toothed arrays.*

Figure 11

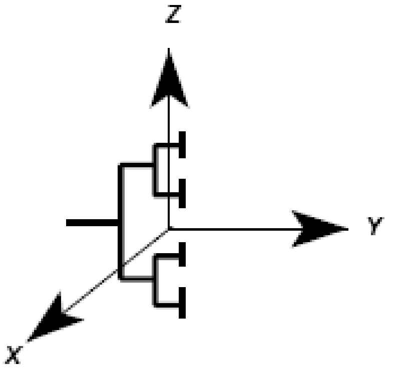
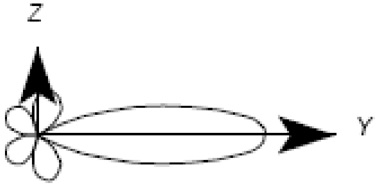
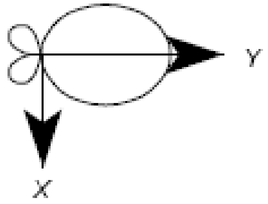
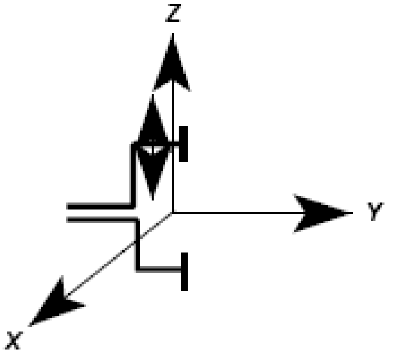
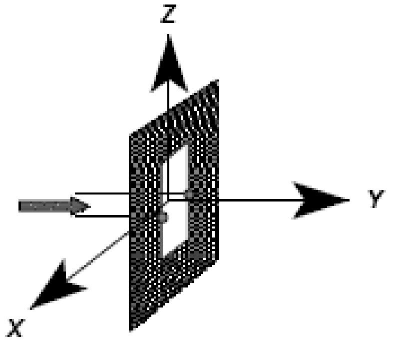
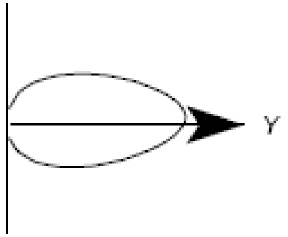
Antenna Type	Radiation Pattern	Characteristics
LINEAR DIPOLE ARRAY *(Corporate Feed)* 	*Elevation:*  *Azimuth:* 	***Polarization:*** *Element dependent Vertical as shown* ***Typical Half-Power Beamwidth:*** *Related to gain* ***Typical Gain:*** *Dependent on number of elements* ***Bandwidth:*** *Narrow* ***Frequency Limit:*** ***Lower:*** *10 MHz* ***Upper:*** *10 GHz*
APERTURE SYNTHESIS 	***Elevation & Azimuth*** 	*All characteristics dependent on elements* ***Remarks:*** *Excellent side-looking, ground mapping where the aircraft is a moving linear element.*

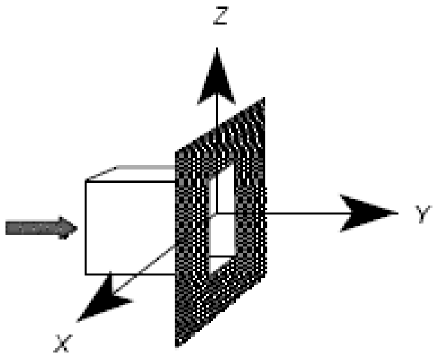
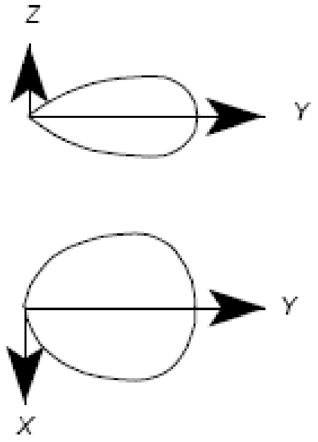
Figure 12

<table>
<tr><th>Antenna Type</th><th>Radiation Pattern</th><th>Characteristics</th></tr>
<tr><td>CAVITY BACKED
CIRCUIT FED SLOT
(and Microstrip Patch)
</td><td>Elevation & Azimuth
</td><td>Polarization: Linear, vertical as shown

Typical Half-Power Beamwidth:
80 deg x 80 deg
Typical Gain: 6 dB

Bandwidth: Narrow

Frequency Limit: Lower: 50 MHz
Upper: 18 GHz

Remarks: The feed line is sometimes separated from the radiator by a dialetric & uses capacititive coupling. Large conformal phased arrays can be made this way.</td></tr>
<tr><td>GUIDE FED SLOT
</td><td>Elevation:
Azimuth:
</td><td>Polarization: Linear,

Typical Half-Power Beamwidth
Elevation: 45-50°
Azimuth: 80°

Typical Gain: 0 dB

Bandwidth: Narrow

Frequency Limit:
Lower: 2 GHz
Upper: 40 GHz

Remarks: Open RF Waveguide</td></tr>
</table>

Figure 13

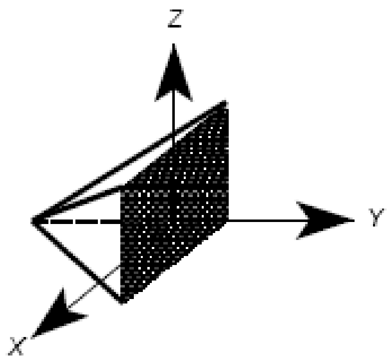
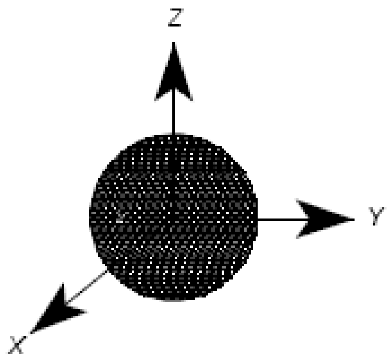
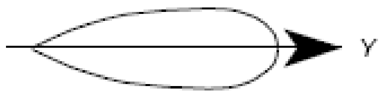
Antenna Type	Radiation Pattern	Characteristics
CORNER REFLECTOR 	Elevation: (Z-Y) Azimuth: (X-Y) Dependent upon feed emitter	***Polarization:*** *Feed dependent* ***Typical Half-Power Beamwidth*** *40 deg x variable* ***Typical Gain:*** *10 dB above feed* ***Bandwidth:*** *Narrow* ***Frequency Limit*** ***Lower:*** *1 GHz* ***Upper:*** *40 GHz* ***Remarks:*** *Typically fed with a dipole or colinear array.*
LUNEBURG LENS Also "LUNEBERG" 	Elevation & Azimuth 	***Polarization:*** *Feed dependent* ***Typical Half-Power Beamwidth:*** *System dependent* ***Typical Gain:*** *System dependent* ***Bandwidth:*** *Narrow* ***Frequency Limit*** ***Lower:*** *1 GHz* ***Upper:*** *40 GHz* ***Remarks:*** *Variable index dielectric sphere.*

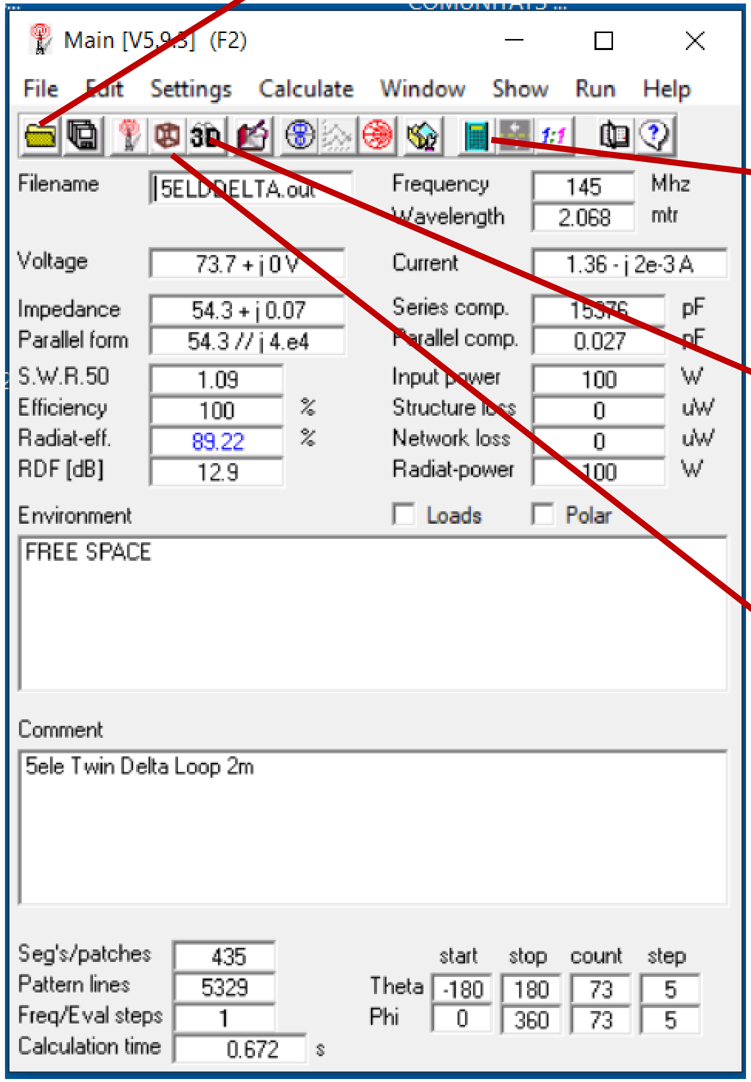
Figure 14

4nec2

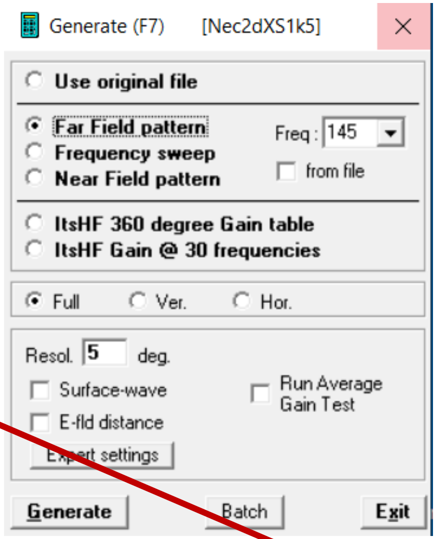
https://www.qsl.net/4nec2/

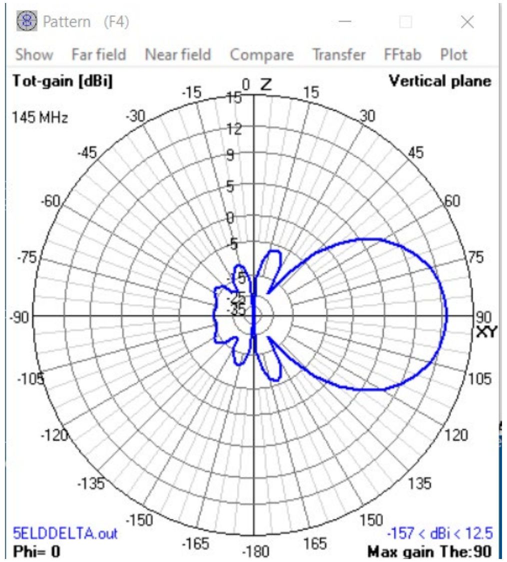
https://www.nec2.org (tutorials,...)

1.- Select antenna



3.- Calculate (ie, far field, and freq)

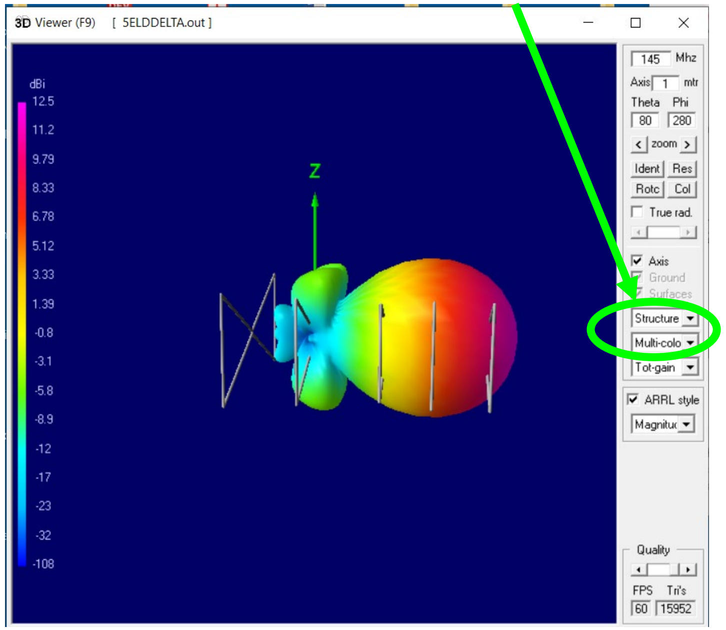




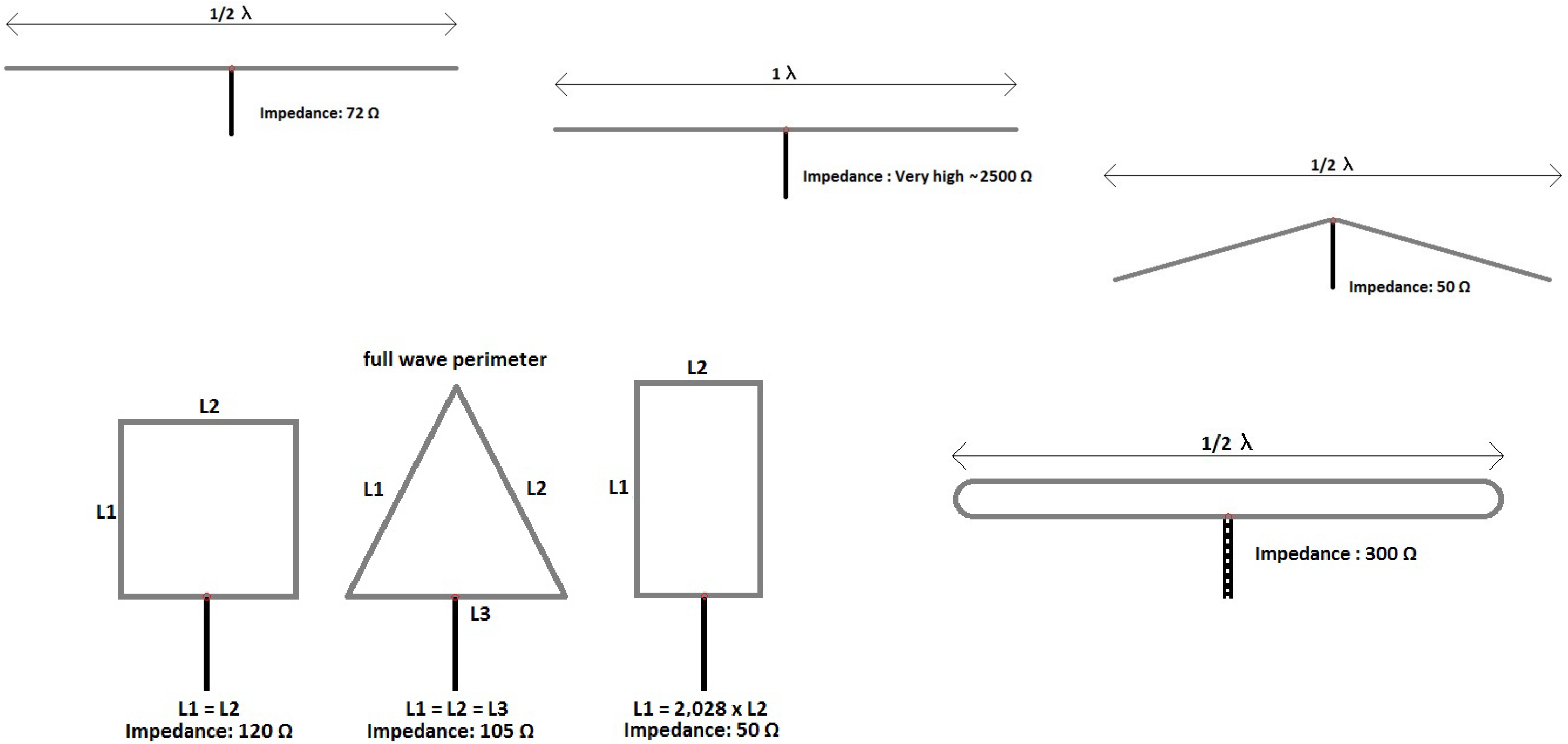
Show pattern

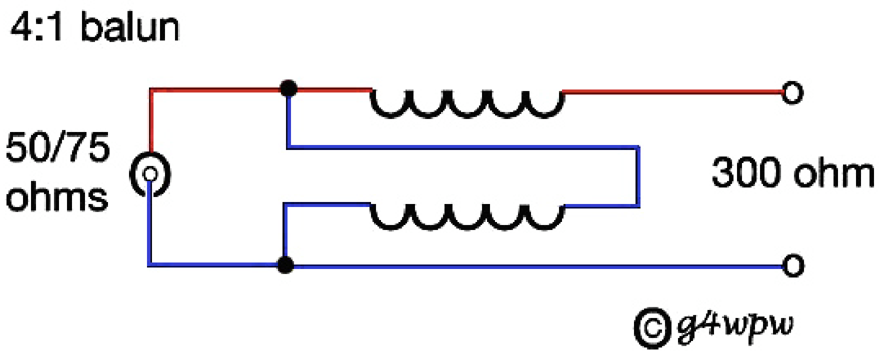
2.- Geometry

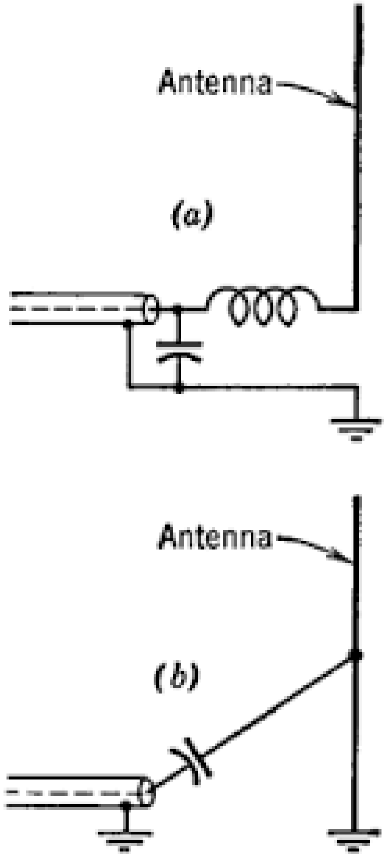
4.- 3D

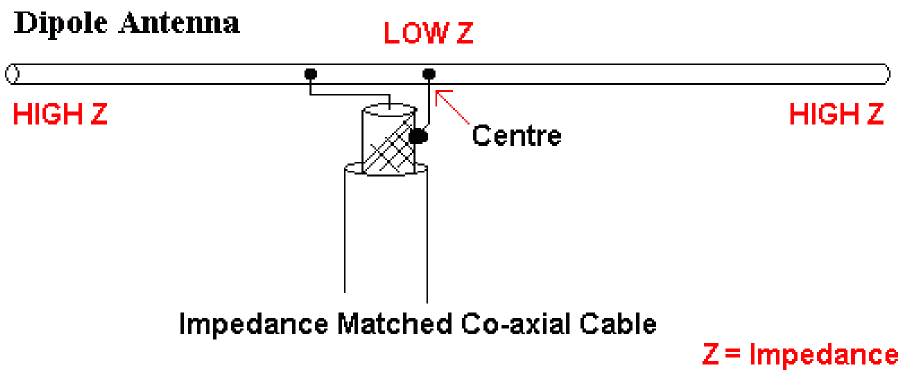


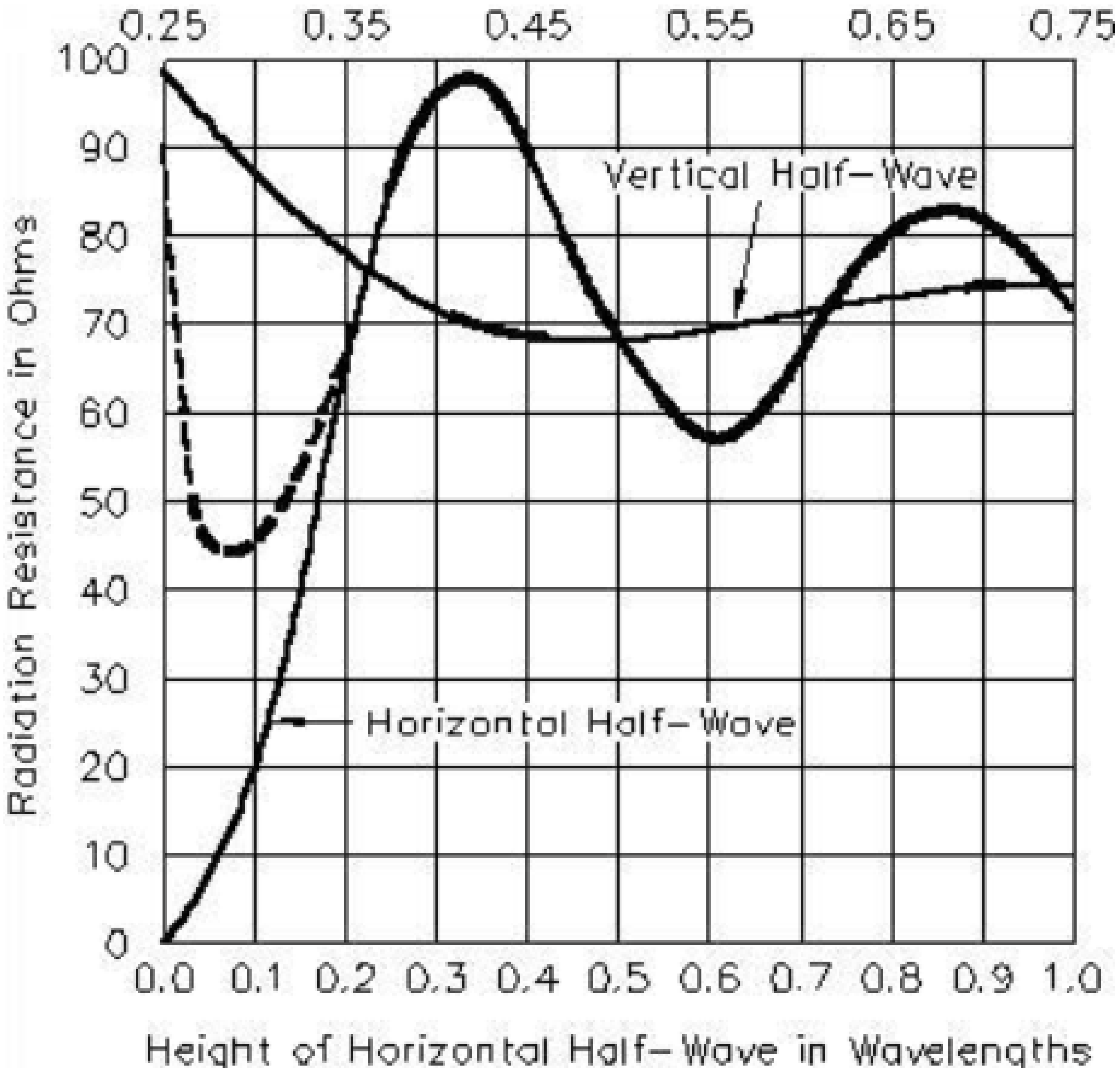
Antenna impedance


1/2 λ
Impedance: 72 Ω
1 λ
Impedance : Very high ~2500 Ω
1/2 λ
Impedance: 50 Ω
full wave perimeter
L2
L1
L1 = L2
Impedance: 120 Ω
L1
L2
L3
L1 = L2 = L3
Impedance: 105 Ω
L2
L1
L1 = 2,028 x L2
Impedance: 50 Ω
1/2 λ
Impedance : 300 Ω


4:1 balun
50/75 ohms
300 ohm
©g4wpw


Antenna
(a)
Antenna
(b)


Dipole Antenna
LOW Z
HIGH Z
Centre
HIGH Z
Impedance Matched Co-axial Cable
Z = Impedance



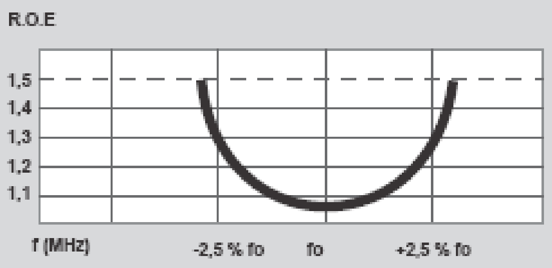
radiation resistance of vertical and horizontal half-wavelength dipoles at various heights above ground

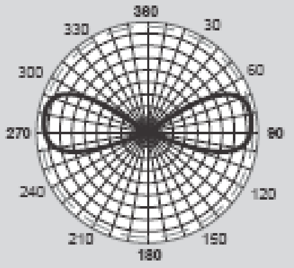
Commercial antennas

UNIPOLO PLEGADO λ/2 G.P. Ref 6522/91/71

CARACTERISTICAS TECNICAS/ TECHNICAL SPECIFICATIONS

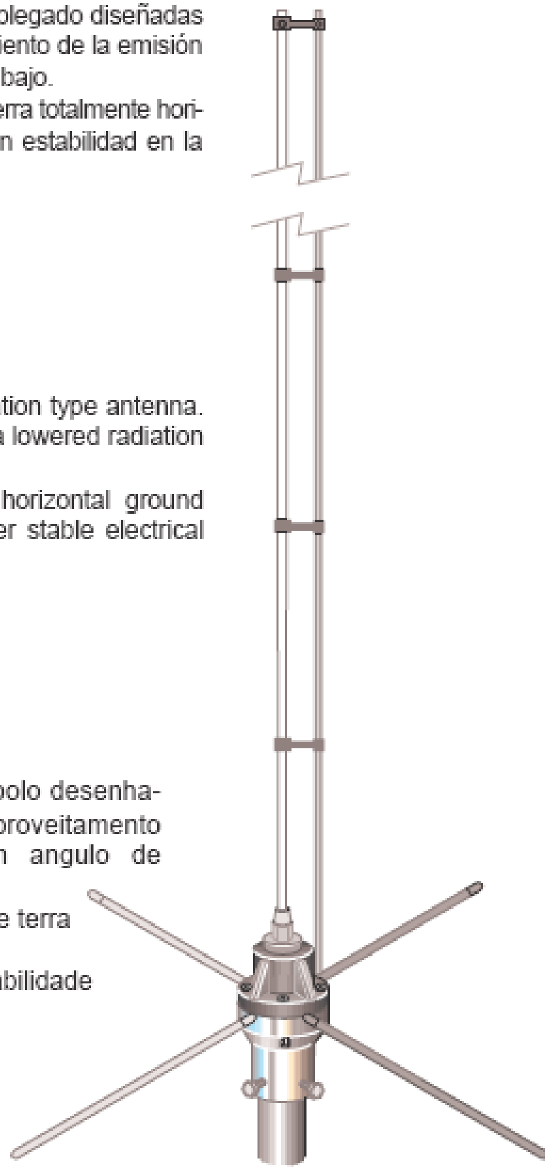
Referencia/ Reference		6522	6591	6571
Frecuencia/frequency	(MHz)	66-88	86-142	142-235
Ganancia/ Gain	(dBi)	2,1	2,1	2,1
Ancho de banda /Bandwidth	(MHz)	3	4	5
Potencia máxima/Max power	(Weff)	2500	2000	1500
Impedancia / Impedance	(Ω)		50	
Longitud radiante/Rad. length	(mm)	1150	775	425
Long. elem. rad./Rad. elem.length	(mm)	1050	840	505
Ø mástil /Mast Ø	(mm)	40	40	40
Peso / Weight	(grs)	2000	1600	1300





Antenas de tipo monopolo plegado diseñadas para un mejor aprovechamiento de la emisión con un ángulo de radiación bajo.

- Incorporan un plano de tierra totalmente horizontal, obteniéndose gran estabilidad en la respuesta eléctrica.



Folded monopole base station type antenna. These references feature a lowered radiation pattern .
They incorporate a fully horizontal ground plane thus obtaining higher stable electrical response.

- Antenas do tipo monopolo desenhadas para um melhor aproveitamento da emissão com um angulo de radiação baixo.
- Incorporam um plano de terra toatalmente horizontal, obtendo-se grande estabilidade de resposta eléctrica.

DM C50-17 VHF ANTENNA

The DM C50-17 Series VHF Communication Antennas have incorporated design improvements to enhance corona threshold, corrosion protection, and drag characteristics.

The DM C50-17 Series provides the lightest weight and strongest blade antenna at lower cost for current use on commercial jet aircraft.

In addition to its low initial price, further cost reductions are realized due to the weight and drag reduction of the antenna. The fuel saving per shipset is calculated to be 160.5 gallons per aircraft per year.

The DM C50-17 antenna has been selected as original equipment for the Boeing 757 and 767, and 777 aircraft. Other models in the DM C50-17 Series can also be used on Boeing 707, 727, 737, 747; Douglas DC-8, DC-9, and DC-10; Aerospatiale A300 Series; and other commercial aircraft. Many of the DM C50-17 Series are interchangeable with other types of antennas presently in use.

SPECIFICATIONS

ELECTRICAL	Frequency Range	116 – 156 MHz
	VSWR	2.0:1
	Power	1 KW CW
	Impedance	50 Ohms
	Polarization	Vertical
	Radiation Pattern	Omnidirectional (Equivalent to a vertical stub)

DESCRIPTION:

The VHF coaxial dipole is a vertically polarized omnidirectional antenna suitable for civil aviation and for mobile and semi stationary applications specially on ships.

This antenna has a high suppression of current flow on the outside cables.

SPECIAL FEATURES:

- Broadband: 118 ÷ 137 MHz
- Nr. input: 1
- Omnidirectional radiation
- High power: 100 W
- Protected against lightning
- Very rugged construction

Electrical Specifications	
Frequency Band (MHz)	118 ÷ 137
Impedance (Ω)	50
VSWR	< 1.5
Polarization	linear vertical
Gain (dBi)	2
Pattern Horizontal Plane Vertical Plane (degree)	 omni ± 0.5 dB 80 ± 5
Continuous Max Power (W)	100
Op. Temp. Range (°C)	- 40 ÷ 70
Lightning Protection	DC grounded

Mechanical Specifications	
Connector	Nf
Dimensions (mm) Length Radome diameter	 780 Ø 40
Colour	RAL 7035 (grey)
Weight (Kg)	2.5
Wind load @ 150 Km/h (N)	23
Radome	Fiberglass
Mounting	on pole Ø 40÷60 mm

6'High Performance Pathfinder 10KW Open Array Antenna. Includes Pathfinder series compatible interconnect cable.

Product Number: T52014

Add to My Wish List

General Specifications

Approvals	CE – conforms to 89/336/EEC (EMC), EN60945:1997 FCC – conforms to Part 80 (47CFR) and Part 2 (47CFR)
Dimensions: Array	1829 mm(72in) length
Dimensions: Pedestal	427 x 296 x 406mm (16.8 x 10.5 x 16in)
Environmental	Waterproof to CFR46 Temperature range: -10^{0} to $+55^{0}$C Humidity limit: up to 95% at 35^{0}C Maximum wind speed for satisfactory operation: 100Kts
Input voltage	20– 44 V DC (from display unit)
	A 12Volt to 24Volt rectifier is required for vessels equipped with 12volt DC systems
Maximum Range Scale	72 nm
Power consumption	11 W Standby 80 W Typical operation in light winds 117 W Max. operation in 50 Kt winds 179 W Max. operation in 100Kt winds
Weight: Array	6kg(13.2lbs)
Weight: Pedestal	24kg(53lbs)

2D 18 in. 2kW

Products

- All Products
- A-Series
- Multifunction
- C-Series
- E-Series
- Raymarine H6
- Marine Radar
  - hsb2 Radar Displays
  - SL Series Radars
  - CRT Displays
  - LCD Radar Comparison Chart
  - Open Array Antennas
  - Scanner Options
  - **Radome Antennas**
  - *hsb2*
  - hsb2 Upgrades
  - Heading Sensors
  - MARPA
  - Radar/Chart Overlay
  - Raychart Option
- GPS and Chartplotters
- RayTechRNS
- Autopilots
- Instruments
- Fishfinders
- Communications
- Marine Cameras
- Satellite Television
- LifeTag
- Brochure Download
- Photo Galleries

Request a Brochure

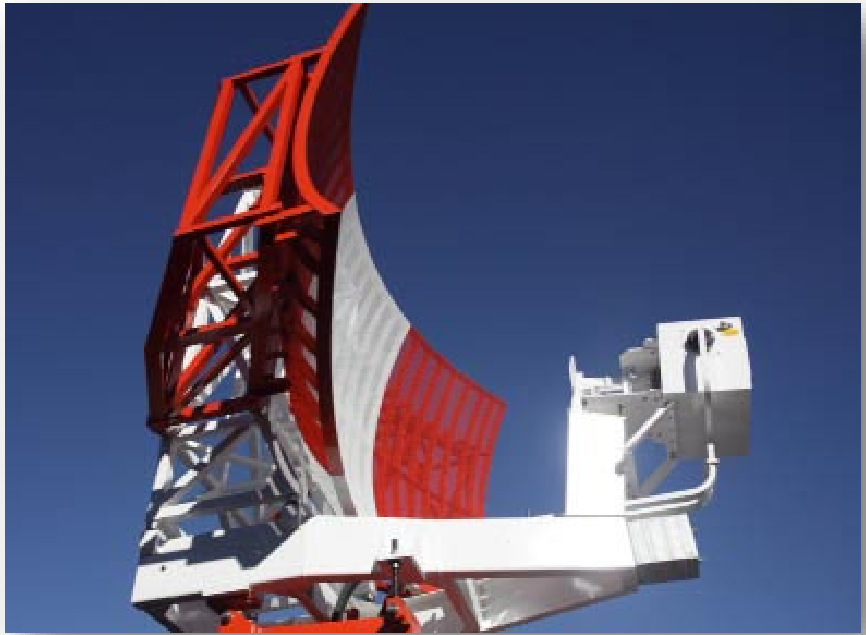
Compact 18" High Performance Pathfinder 2KW Radome Antenna

Product Number: M92650-S

Add to My Wish List

General Specifications

Antenna Type	Radome incorporating patch antenna
Approvals	CE – conforms to 89/336/EEC (EMC), EN60945:1997 FCC – conforms to Part 80 (47CFR) and Part 2 (47CFR)
Dimensions	468mm x 227mm (18.4" x 8.9")
Environmental	Waterproof to CFR46 Temperature range: -10^{0} to $+55^{0}$C Humidity limit: up to 95% at 35^{0}C Maximum wind speed for satisfactory operation: 100Kts
Horizontal Beamwidth	5.2°
Input Voltage	10.7 - 32 VDC
Maximum Range Scale	24 nm
Maximum Wind Load	100 kts
Operating Temperature	-10°C to +55°C. Humidity limit: Up to 95% at 35°C
Power Consumption	9W standby, 28W transmit
Rotation Speed	24 rpm
Vertical Beamwidth	25°
Weight	6.5kg (14.3 lbs)

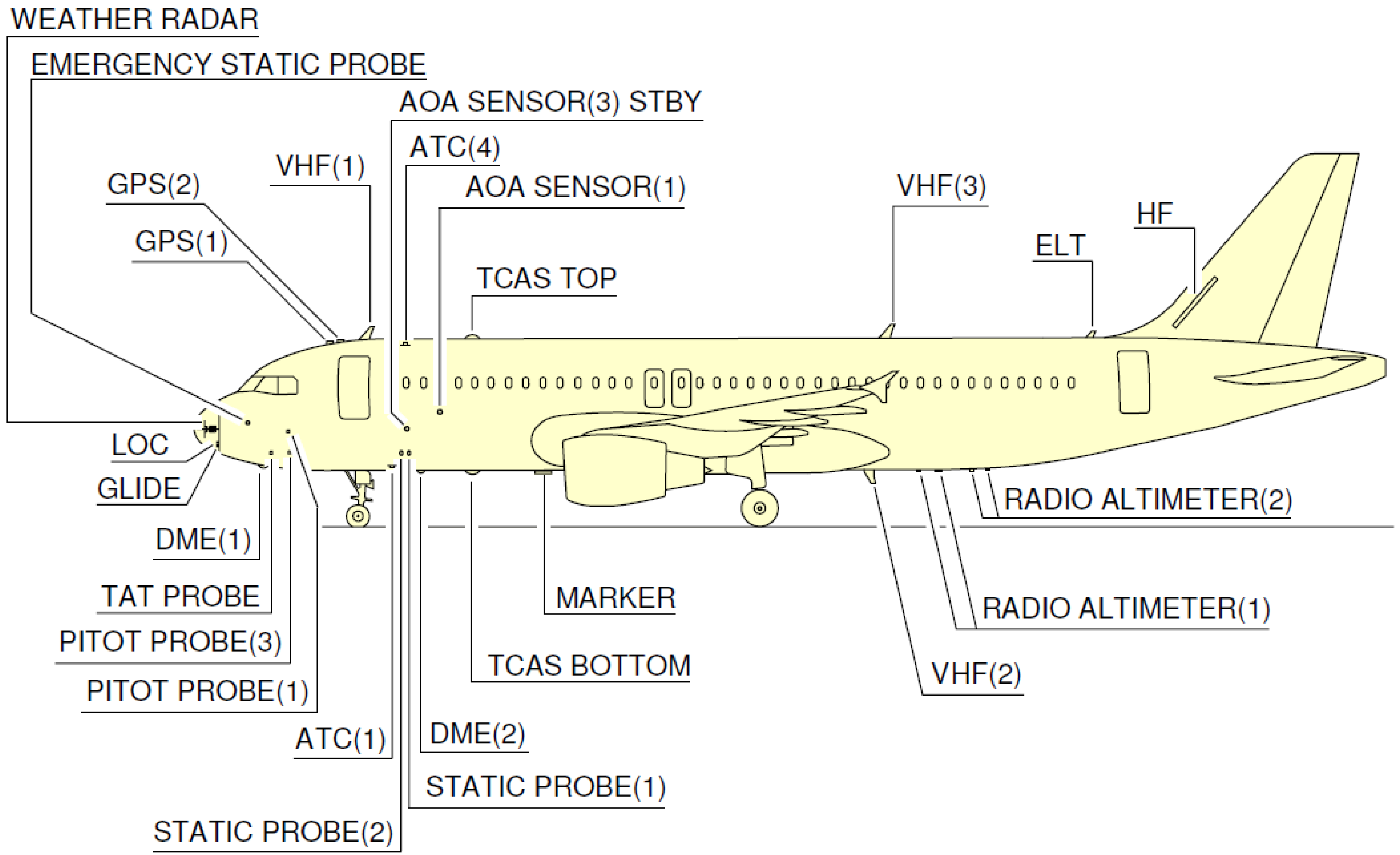


AIRBUS 320

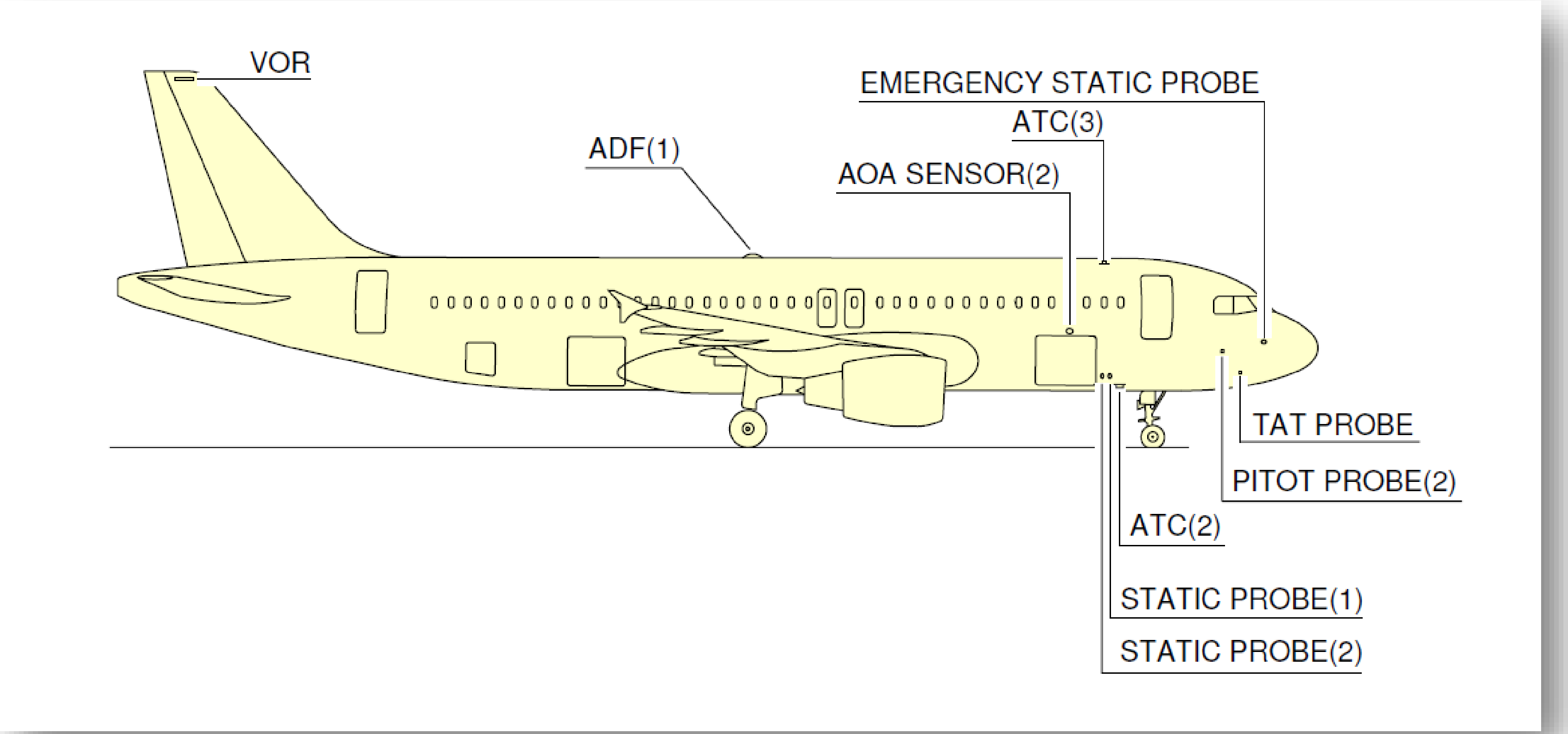
Antenes

AIRBUS

A320/A320NEO



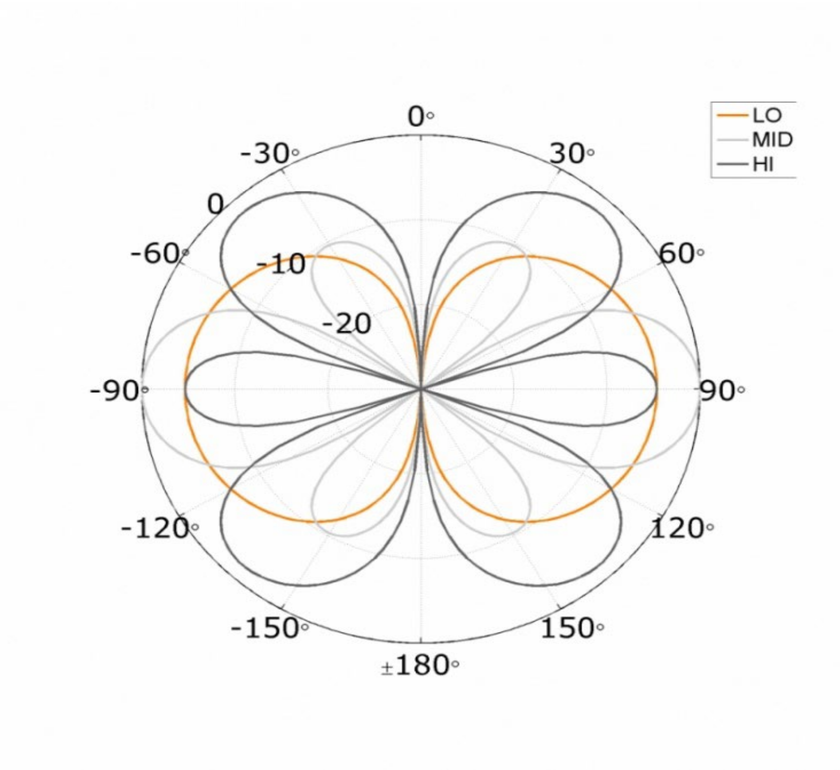
WEATHER RADAR
EMERGENCY STATIC PROBE
AOA SENSOR(3) STBY
ATC(4)
AOA SENSOR(1)
VHF(1)
GPS(2)
GPS(1)
TCAS TOP
VHF(3)
HF
ELT
LOC
GLIDE
DME(1)
TAT PROBE
PITOT PROBE(3)
PITOT PROBE(1)
ATC(1)
STATIC PROBE(2)
DME(2)
STATIC PROBE(1)
TCAS BOTTOM
MARKER
VHF(2)
RADIO ALTIMETER(1)
RADIO ALTIMETER(2)


VOR
EMERGENCY STATIC PROBE
ATC(3)
ADF(1)
AOA SENSOR(2)
TAT PROBE
PITOT PROBE(2)
ATC(2)
STATIC PROBE(1)
STATIC PROBE(2)

4G & 5G Base Stations

4G & 5G Base Stations

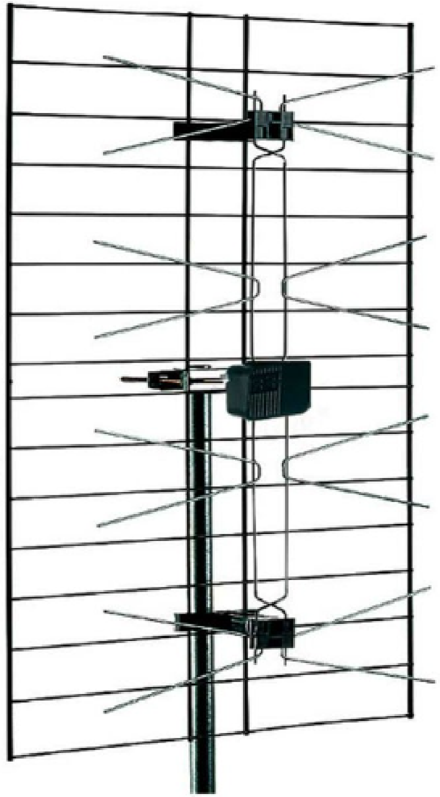
1/2 λ dipole

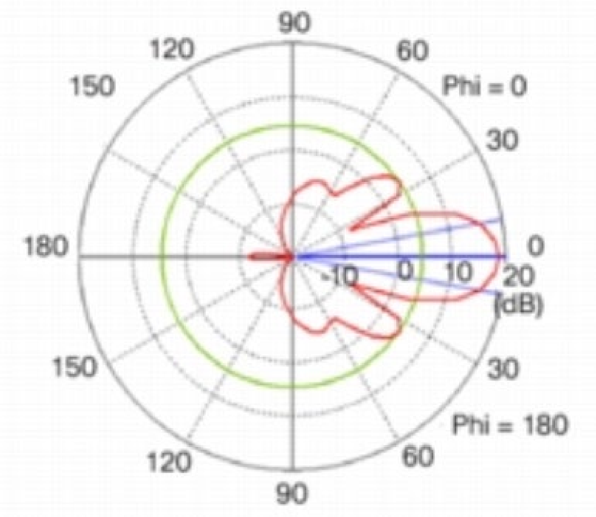


698-960 MHz: 0 dBd, 2.15 dBi
1427-1518/1710-2170 MHz: 3 dBd, 5.15 dBi
2300-2690/3300-3800 MHz: 7 dBd, 9.15 dBi

4G & 5G Base Stations

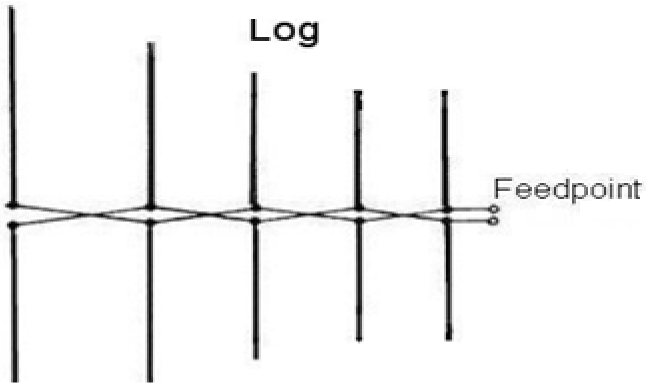
Panel Antenna

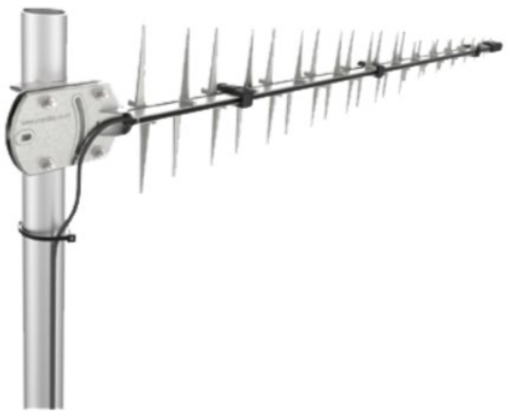


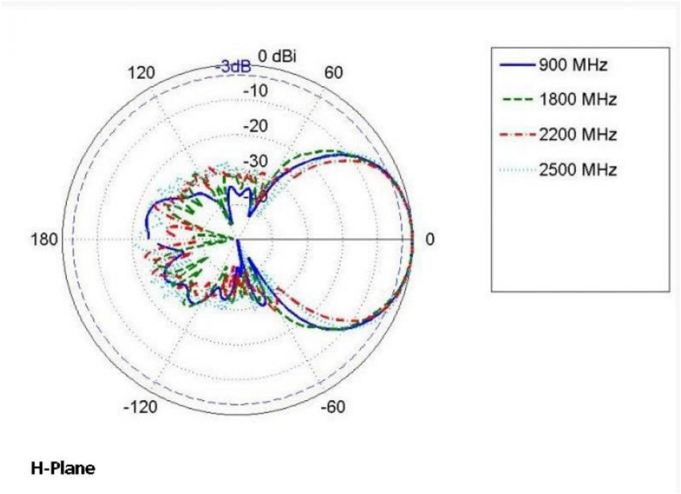


4G & 5G Base Stations

Yagi Logaritm: every horizontal element is a receiving one (not only “directors”)

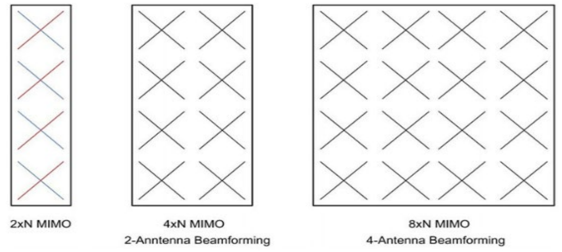


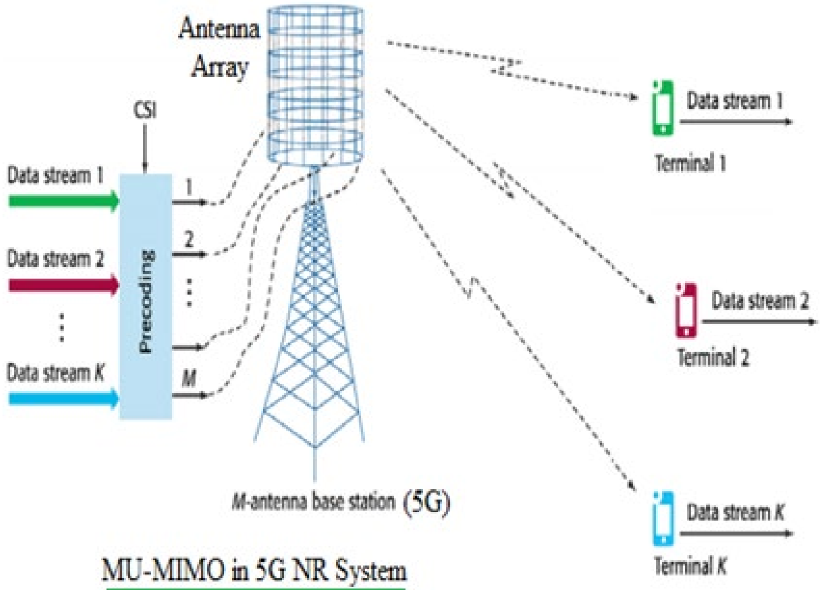




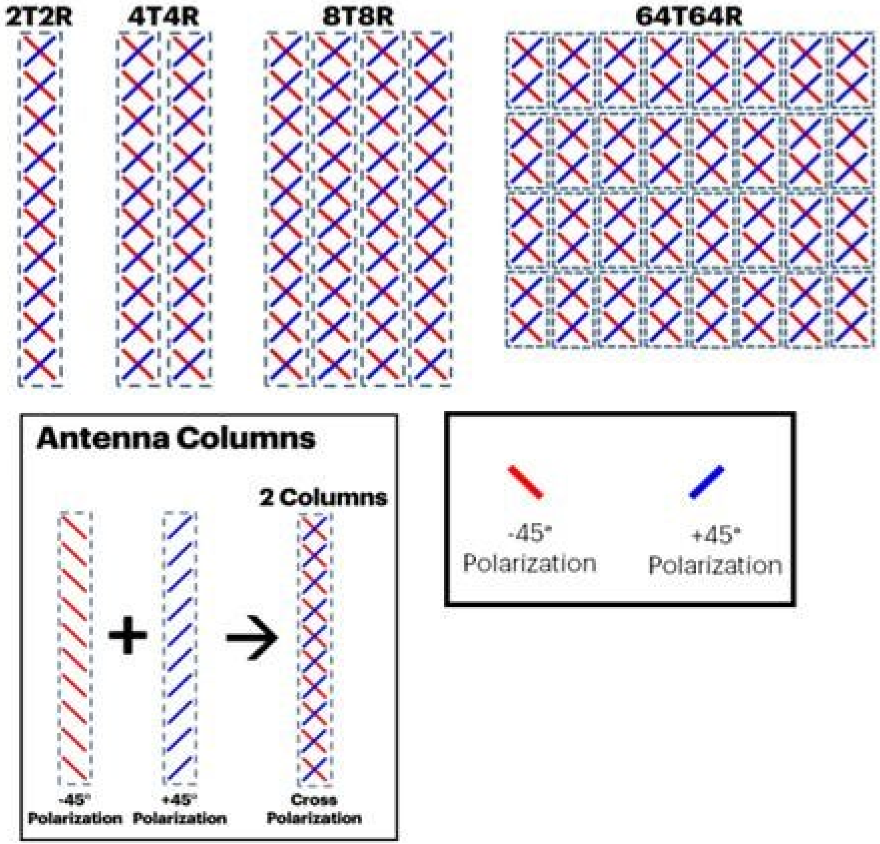
4G & 5G Base Stations

Cross Polarized MIMO Antenna (beamforming)



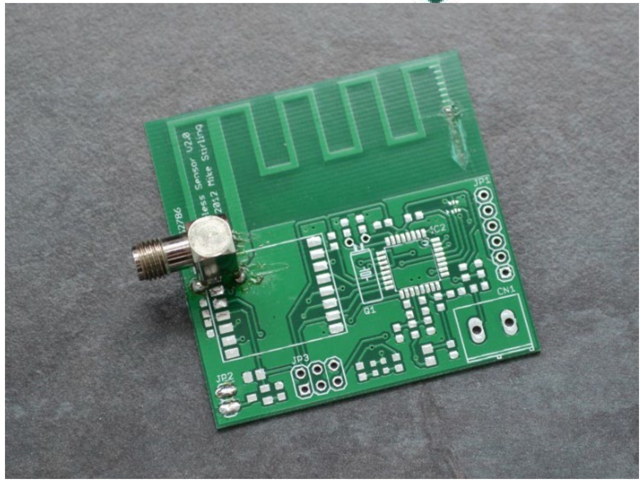
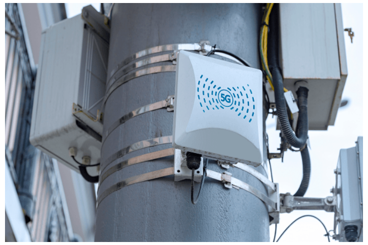


MU-MIMO in 5G NR System

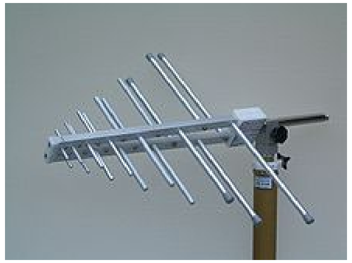
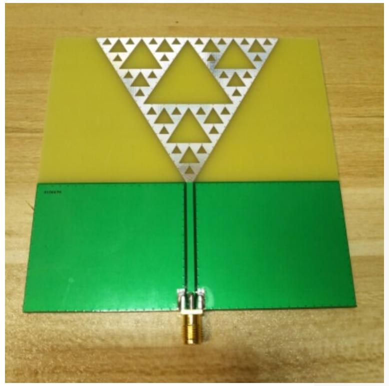


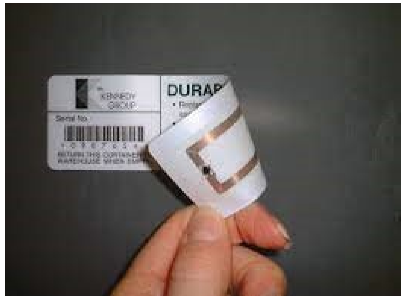
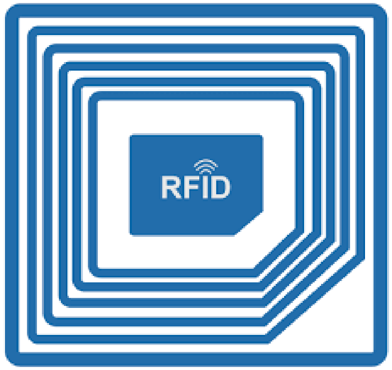




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