

Antenna Types and Antenna Patterns
 Iulian Rosu, VA3IUL-YO3DAC

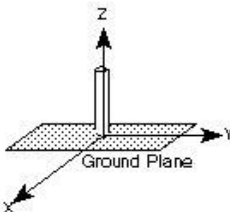
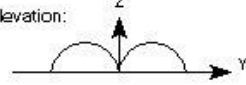
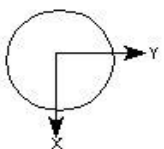
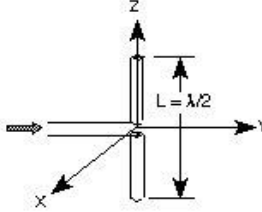
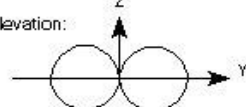
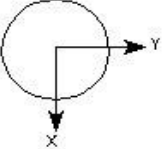
Antenna Type	Radiation Pattern	Characteristics
<p>MONOPOLE</p> 	<p>Elevation:</p>  <p>Azimuth:</p> 	<p>Polarization: Linear Vertical as shown</p> <p>Typical Half-Power Beamwidth 45 deg x 360 deg</p> <p>Typical Gain: 2-6 dB at best</p> <p>Bandwidth: 10% or 1:1:1</p> <p>Frequency Limit Lower: None Upper: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

Figure 1

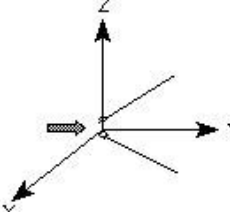

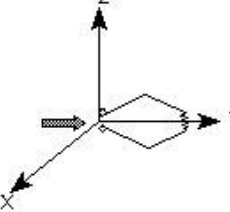

Antenna Type	Radiation Pattern	Characteristics
<p>VEE</p> 	<p>Elevation & Azimuth:</p> 	<p>Polarization: Linear Vertical as shown</p> <p>Typical Half-Power Beamwidth 60 deg x 60 deg</p> <p>Typical Gain: 2 to 7 dB</p> <p>Bandwidth: "Broadband"</p> <p>Frequency Limit Lower: 3 MHz Upper: 500 MHz (practical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

Figure 2

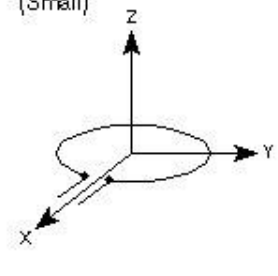
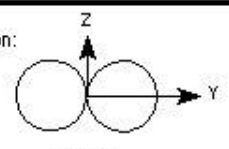
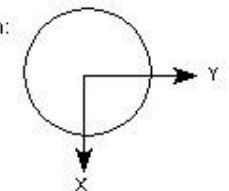
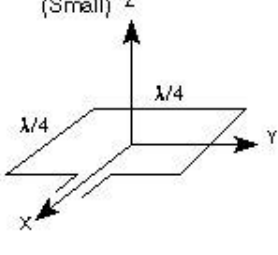
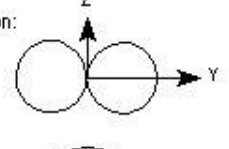
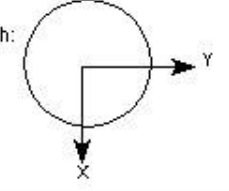
Antenna Type	Radiation Pattern	Characteristics
<p>CIRCULAR LOOP (Small)</p> 	<p>Elevation:</p>  <p>Azimuth:</p> 	<p>Polarization: Linear Horizontal as shown</p> <p>Typical Half-Power Beamwidth: 80 deg x 360 deg</p> <p>Typical Gain: -2 to 2 dB</p> <p>Bandwidth: 10% or 1.1:1</p> <p>Frequency Limit: Lower: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

Figure 3

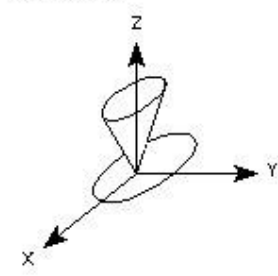
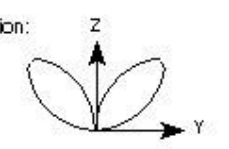
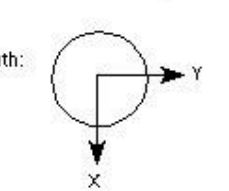
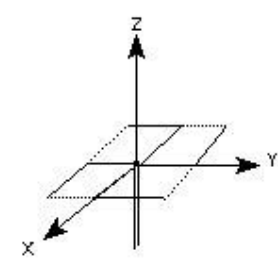
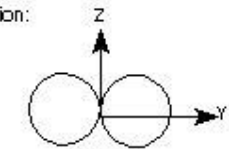
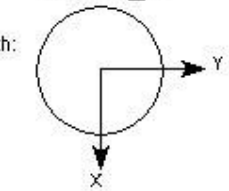
Antenna Type	Radiation Pattern	Characteristics
<p>DISCONE</p> 	<p>Elevation:</p>  <p>Azimuth:</p> 	<p>Polarization: Linear Vertical as shown</p> <p>Typical Half-Power Beamwidth: 20-80 deg x 360 deg</p> <p>Typical Gain: 0-4 dB</p> <p>Bandwidth: 100% or 3:1</p> <p>Frequency Limit: Lower: 30 MHz Upper: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

Figure 4

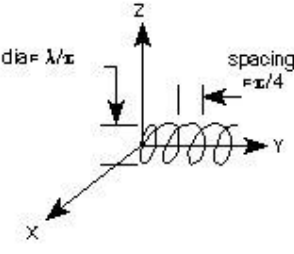

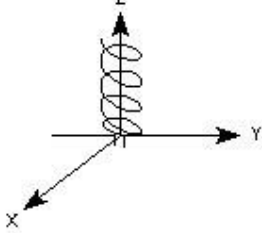
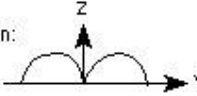
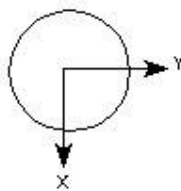
Antenna Type	Radiation Pattern	Characteristics
<p>AXIAL MODE HELIX</p> 	<p>Elevation & Azimuth</p> 	<p>Polarization: Circular Left hand as shown</p> <p>Typical Half-Power Beamwidth: 50 deg x 50 deg</p> <p>Typical Gain: 10dB</p> <p>Bandwidth: 52% or 1.7:1</p> <p>Frequency Limit Lower: 100 MHz Upper: 3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

Figure 5

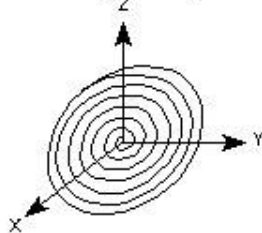

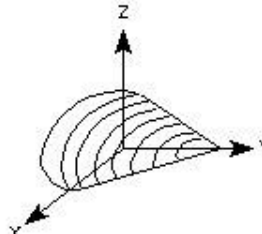

Antenna Type	Radiation Pattern	Characteristics
<p>CAVITY BACKED SPIRAL (Flat Helix)</p> 	<p>Elevation & Azimuth</p> 	<p>Polarization: Circular Left hand as shown</p> <p>Typical Half-Power Beamwidth: 60 deg x 90 deg</p> <p>Typical Gain: 2-4 dB</p> <p>Bandwidth: 160% or 9:1</p> <p>Frequency Limit Lower: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

Figure 6

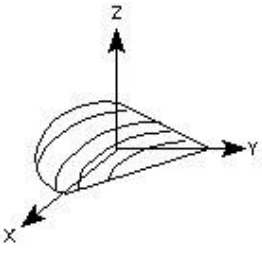
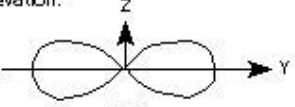
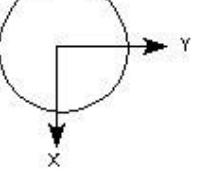
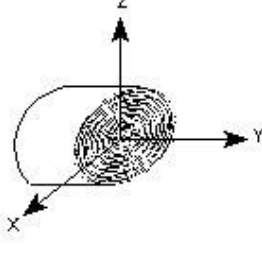
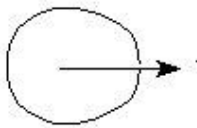
Antenna Type	Radiation Pattern	Characteristics
<p>4 ARM CONICAL SPIRAL</p> 	<p>Elevation:</p>  <p>Azimuth:</p> 	<p>Polarization: Circular Left hand as shown</p> <p>Typical Half-Power Beamwidth: 50 deg x 360 deg</p> <p>Typical Gain: 0 dB</p> <p>Bandwidth: 120% or 4:1</p> <p>Frequency Limit Lower: 500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

Figure 7

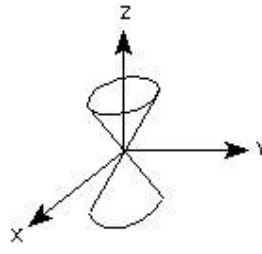
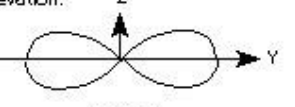
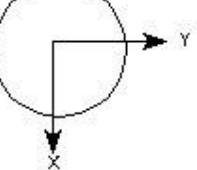
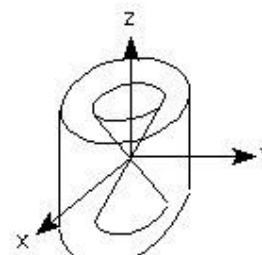
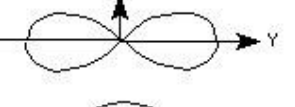
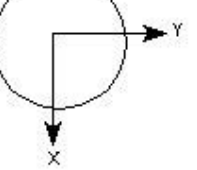
Antenna Type	Radiation Pattern	Characteristics
<p>BICONICAL</p> 	<p>Elevation:</p>  <p>Azimuth:</p> 	<p>Polarization: Linear, Vertical as shown</p> <p>Typical Half-Power Beamwidth: 20-100 deg x 360 deg</p> <p>Typical Gain: 0-4 dB</p> <p>Bandwidth: 120% or 4:1</p> <p>Frequency Limit Lower: 500 MHz Upper: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

Figure 8

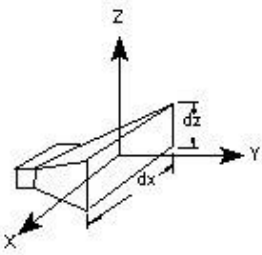
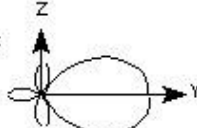
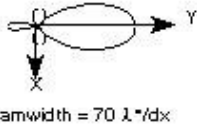
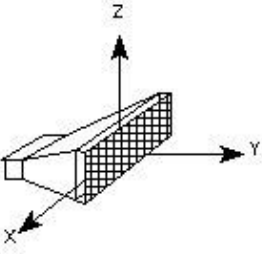
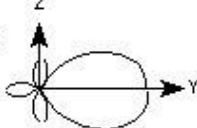
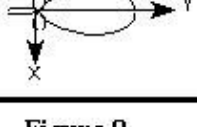
Antenna Type	Radiation Pattern	Characteristics
<p>HORN</p> 	<p>Elevation:</p>  <p>3 dB beamwidth = $55 \lambda / dz$</p> <p>Azimuth:</p>  <p>3 dB beamwidth = $70 \lambda / dx$</p>	<p>Polarization: Linear</p> <p>Typical Half-Power Beamwidth: 40 deg x 40 deg</p> <p>Typical Gain: 5 to 20 dB</p> <p>Bandwidth: If ridged: 120% or 4:1 If not ridged: 67% or 2:1</p> <p>Frequency Limit: Lower: 50 MHz Upper: 40 GHz</p>
<p>HORN W / POLARIZER</p> 	<p>Elevation:</p>  <p>Azimuth:</p> 	<p>Polarization: Circular, Depends on polarizer</p> <p>Typical Half-Power Beamwidth: 40 deg x 40 deg</p> <p>Typical Gain: 5 to 10 dB</p> <p>Bandwidth: 60% or 2:1</p> <p>Frequency Limit: Lower: 2 GHz Upper: 18 GHz</p>

Figure 9

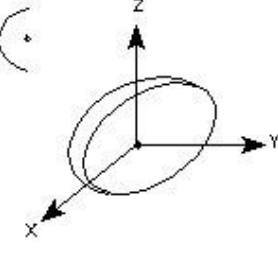

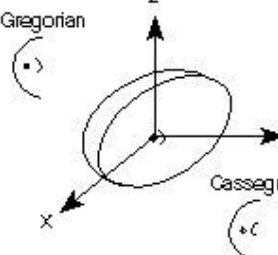

Antenna Type	Radiation Pattern	Characteristics
<p>PARABOLIC (Prime)</p> 	<p>Elevation & Azimuth</p> 	<p>Polarization: Takes polarization of feed</p> <p>Typical Half-Power Beamwidth: 1 to 10 deg</p> <p>Typical Gain: 20 to 30 dB</p> <p>Bandwidth: 33% or 1.4:1 limited mostly by feed</p> <p>Frequency Limit: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

Figure 10

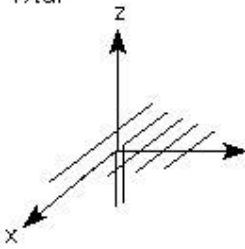
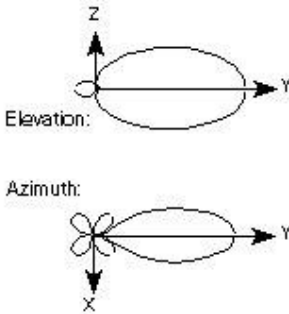
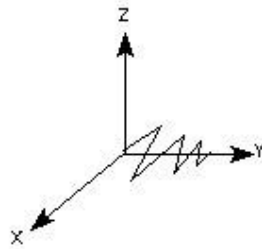
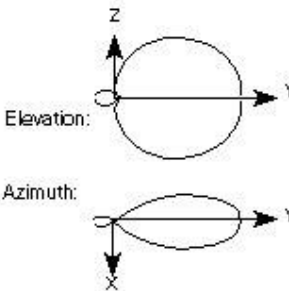
Antenna Type	Radiation Pattern	Characteristics
<p>YAGI</p> 		<p>Polarization: Linear Horizontal as shown</p> <p>Typical Half-Power Beamwidth: 50 deg X 50 deg</p> <p>Typical Gain: 5 to 15 dB</p> <p>Bandwidth: 5% or 1.05:1</p> <p>Frequency Limit: Lower: 50 MHz Upper: 2 GHz</p>
<p>LOG PERIODIC</p> 		<p>Polarization: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

Figure 11

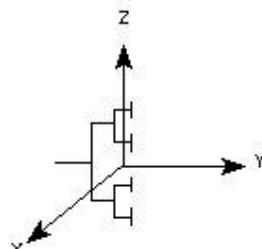
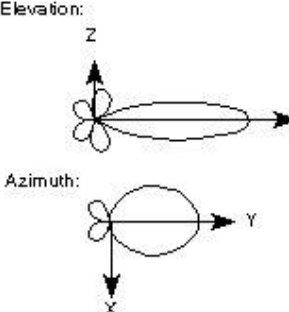
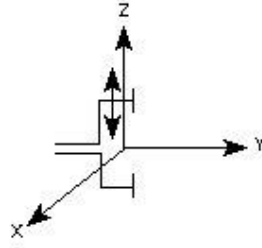
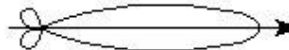
Antenna Type	Radiation Pattern	Characteristics
<p>LINEAR DIPOLE ARRAY (Corporate Feed)</p> 		<p>Polarization: Element dependent Vertical as shown</p> <p>Typical Half-Power Beamwidth: Related to gain</p> <p>Typical Gain: Dependent on number of elements</p> <p>Bandwidth: Narrow</p> <p>Frequency Limit: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

Figure 12

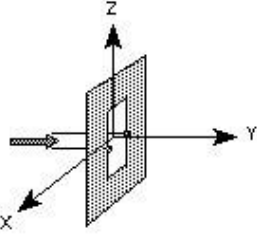
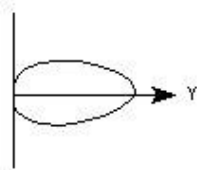
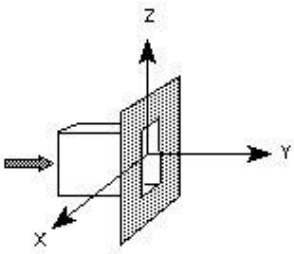
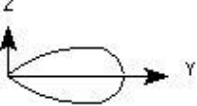
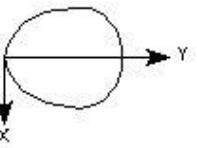
Antenna Type	Radiation Pattern	Characteristics
CAVITY BACKED CIRCUIT FED SLOT (and Microstrip Patch) 	Elevation & Azimuth 	Polarization: Linear, vertical as shown Typical Half-Power Beamwidth: 80 deg x 80 deg Typical Gain: 6 dB Bandwidth: Narrow Frequency Limit Lower: 50 MHz Upper: 18 GHz Remarks: The feed line is sometimes separated from the radiator by a dielectric & uses capacitive coupling. Large conformal phased arrays can be made this way.
GUIDE FED SLOT 	Elevation:  Azimuth: 	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

Figure 13

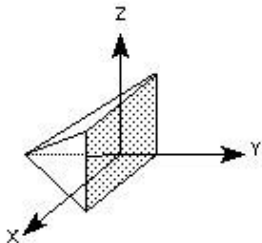
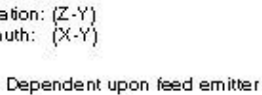
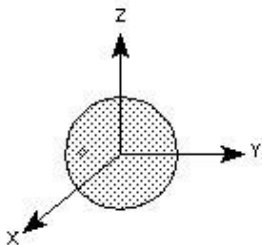
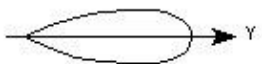
Antenna Type	Radiation Pattern	Characteristics
CORNER REFLECTOR 	Elevation: (Z-Y) Azimuth: (X-Y) Dependent upon feed emitter 	Polarization: Feed dependent Typical Half-Power Beamwidth 40 deg x variable Typical Gain: 10 dB above feed Bandwidth: Narrow Frequency Limit Lower: 1 GHz Upper: 40 GHz Remarks: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