HSMM / 2.4 GHz and Antenna Building Project Night

Brought to you by

The Other Keith (N8XD)

Microwave Topics

- Devices
- Amplifiers
- Locations
- Test Equipment
- Transmission Lines
- Connectors
- Software
- Antennas

2.4 GHz Devices

- Cordless Phones

2.4 GHz Devices

- Video Senders

2.4 GHz Devices

- WiFi

2.4 GHz Devices

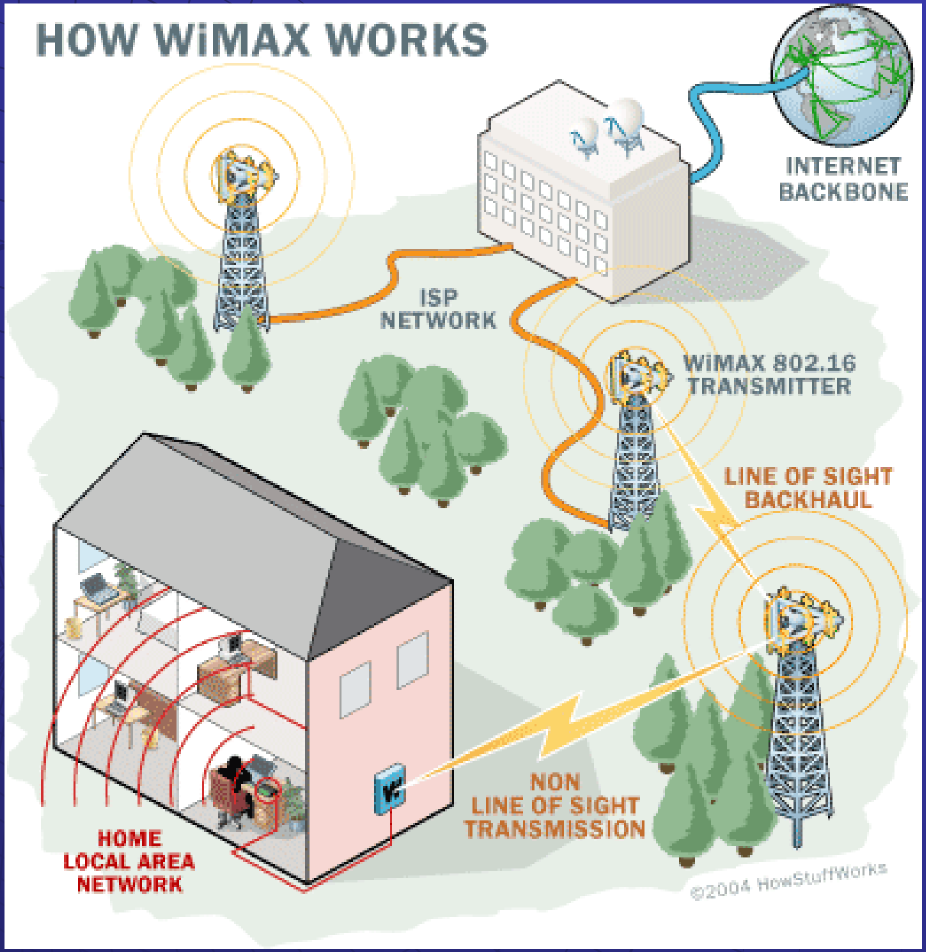
- Bluetooth and ZigBee

2.4 GHz Devices

- Wireless Cameras

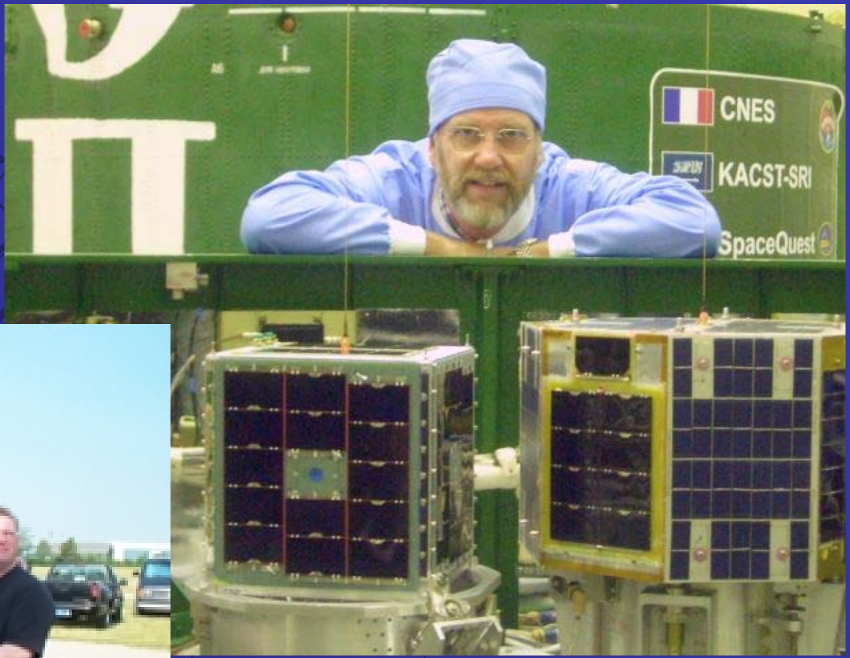
2.4 GHz Devices

- WiMax



2.4 GHz Devices

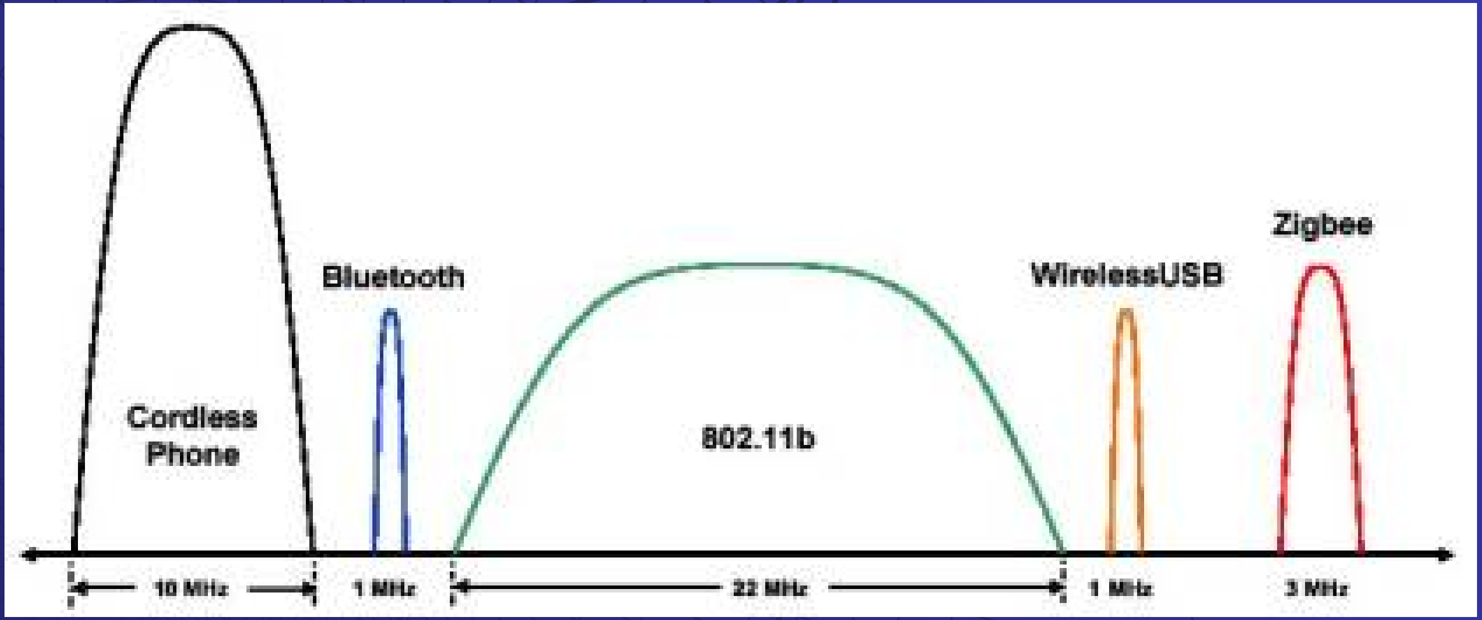
- Satellites



2.4 GHz Devices

- Microwave Ovens

Signal Bandwidth



Polarization

- Linear
  - Horizontal
  - Vertical
- Elliptical
  - Left hand
  - Right hand

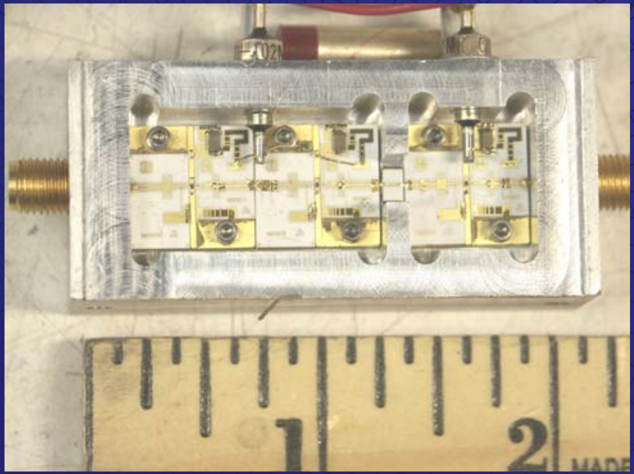
Mis-Polarization

- Linear
  - Horizontal
  - Vertical
- Elliptical (circular)
  - Left hand
  - Right hand

- Horiz. vs Vert. (20db loss)
- Eliptical vs Linear (3db loss)
- Left vs Right (20db loss)

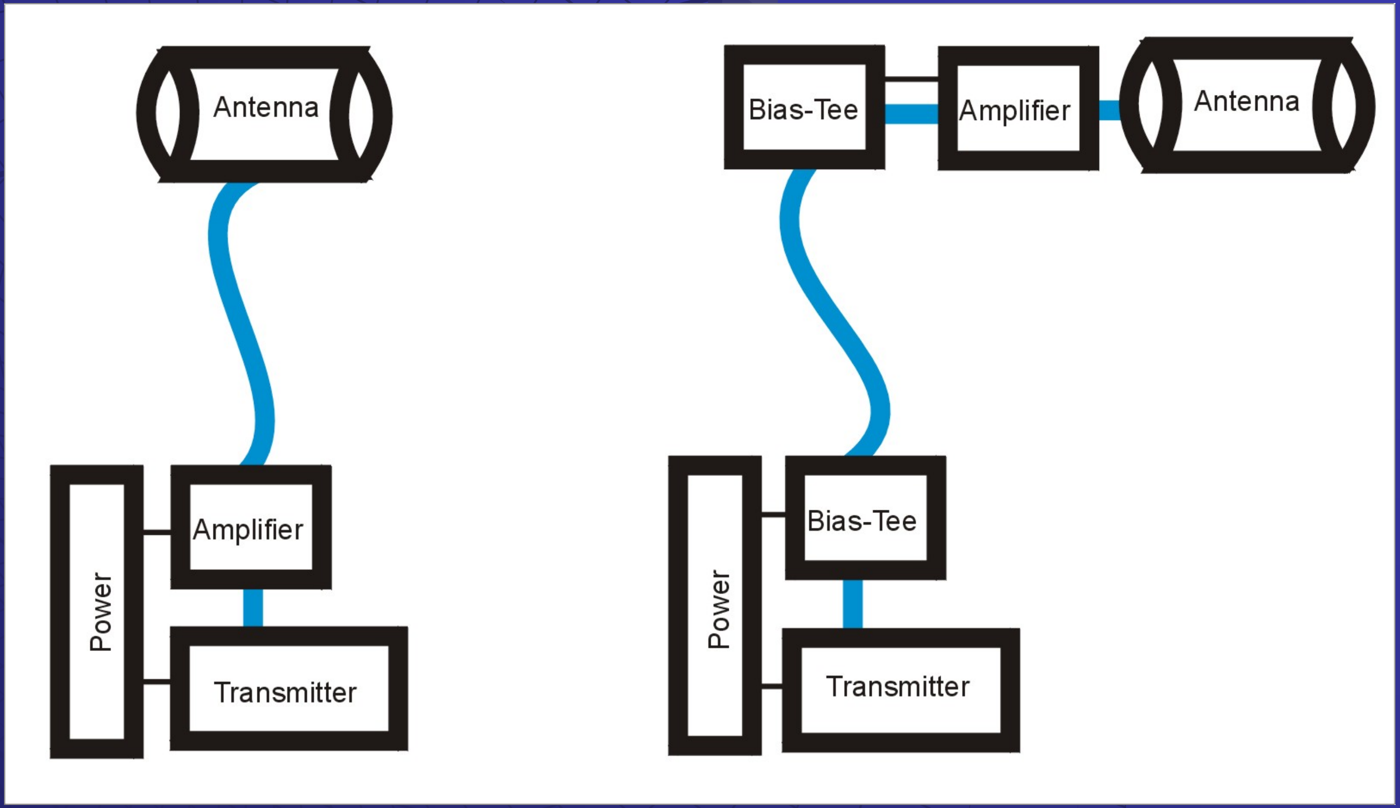
Amplifiers

- RF Amplifiers
  - Low Noise Amplifiers (LNA) for receiving small signals
  - Power Amplifiers for transmitting



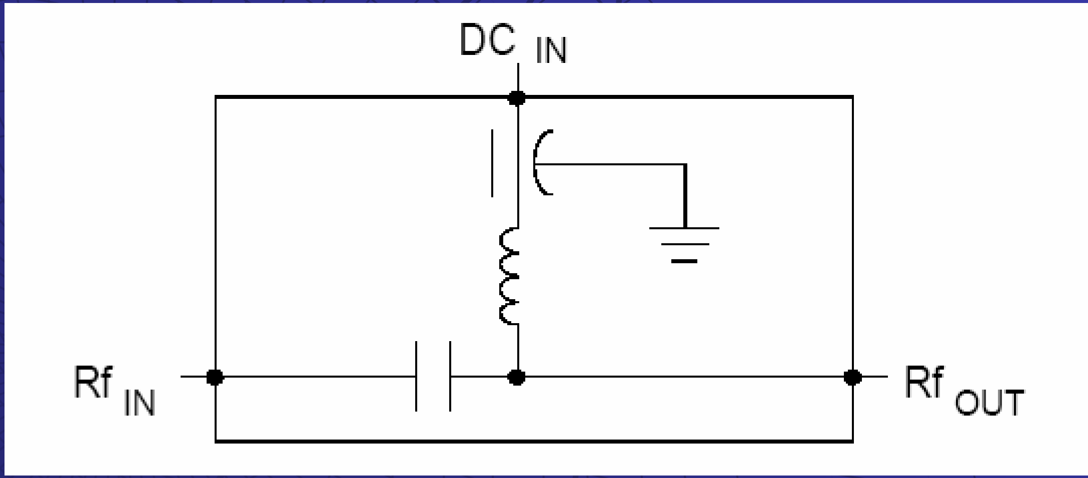
Amplifiers

- Location



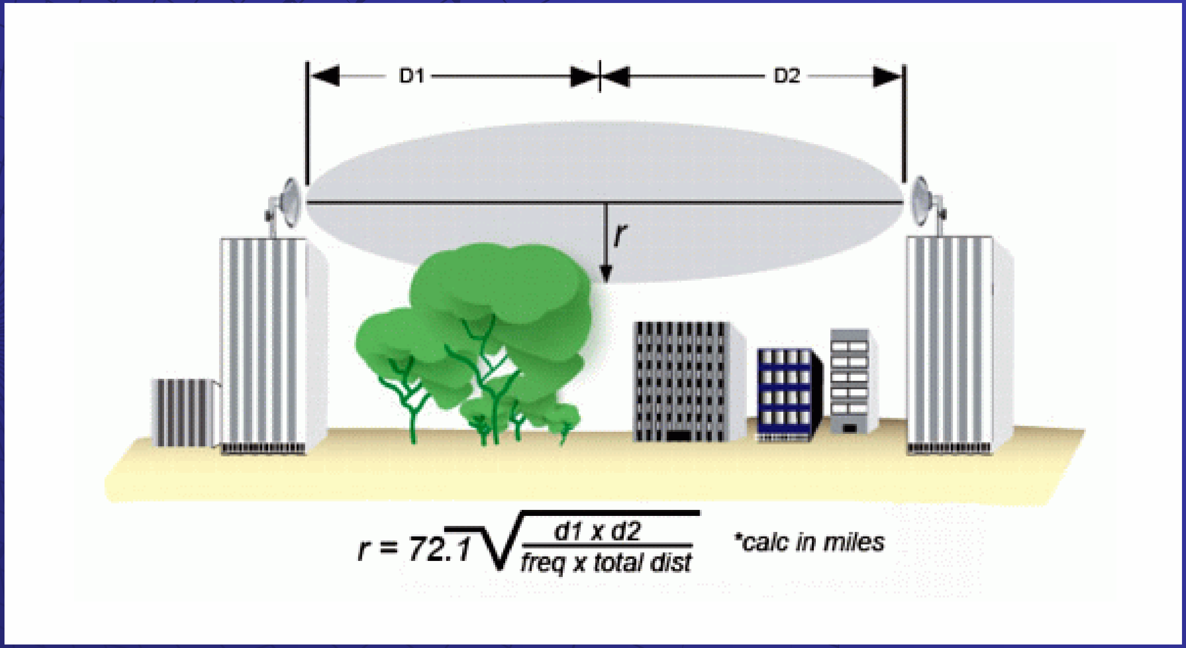
Amplifiers

- Bias-Tee (Power Injector, etc)

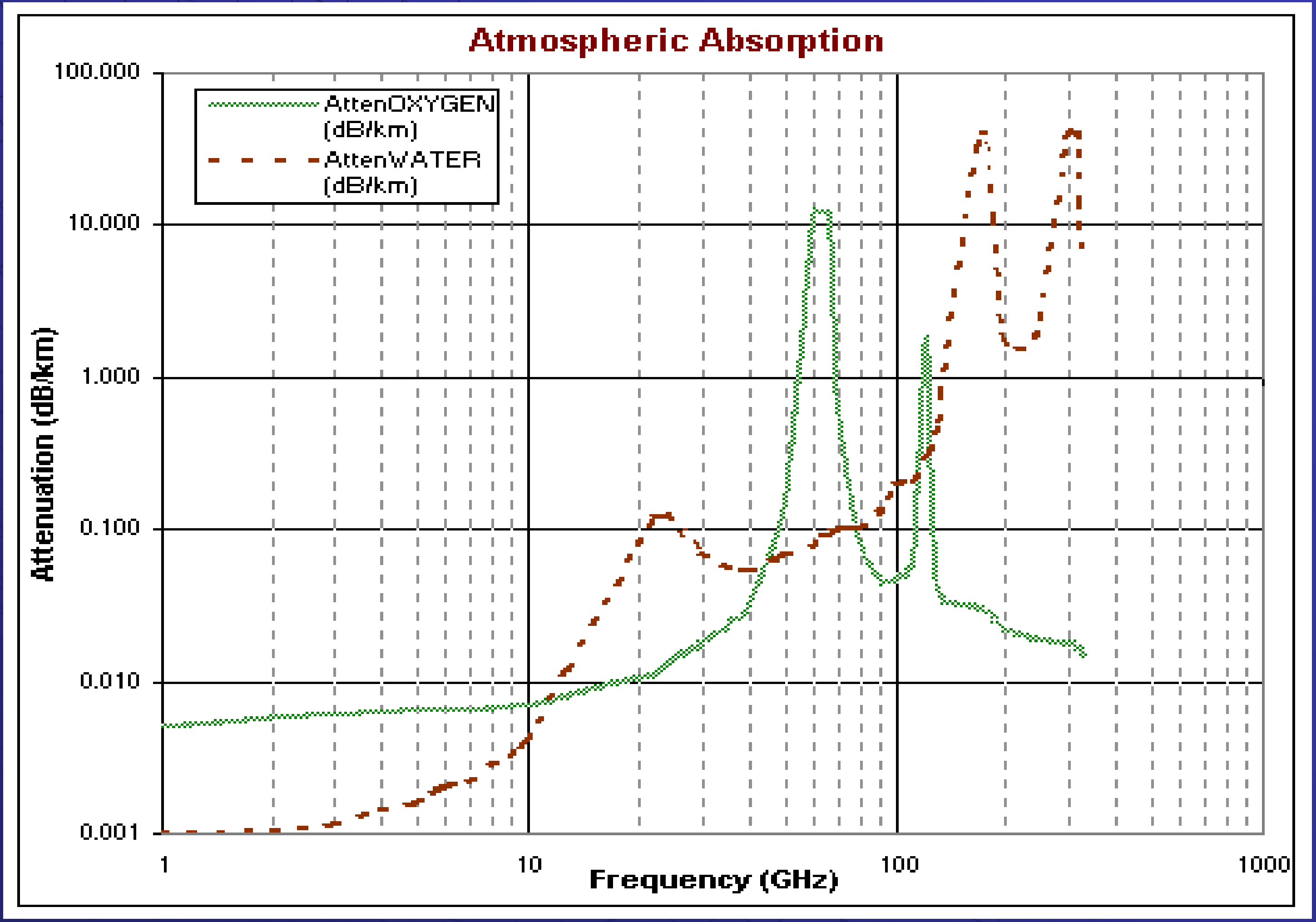


Obstacles at 2.4 GHz

- Anything Solid
  - Trees / Leaves
  - Buildings
  - Water?



Water Vapor



Atmospheric Absorption
AttenOXYGEN (dB/km)
AttenWATER (dB/km)
100.000
10.000
1.000
0.100
0.010
0.001
Attenuation (dB/km)
1
10
100
1000
Frequency (GHz)

Test Equipment

- Wave Meter
- Frequency Counter

Test Equipment

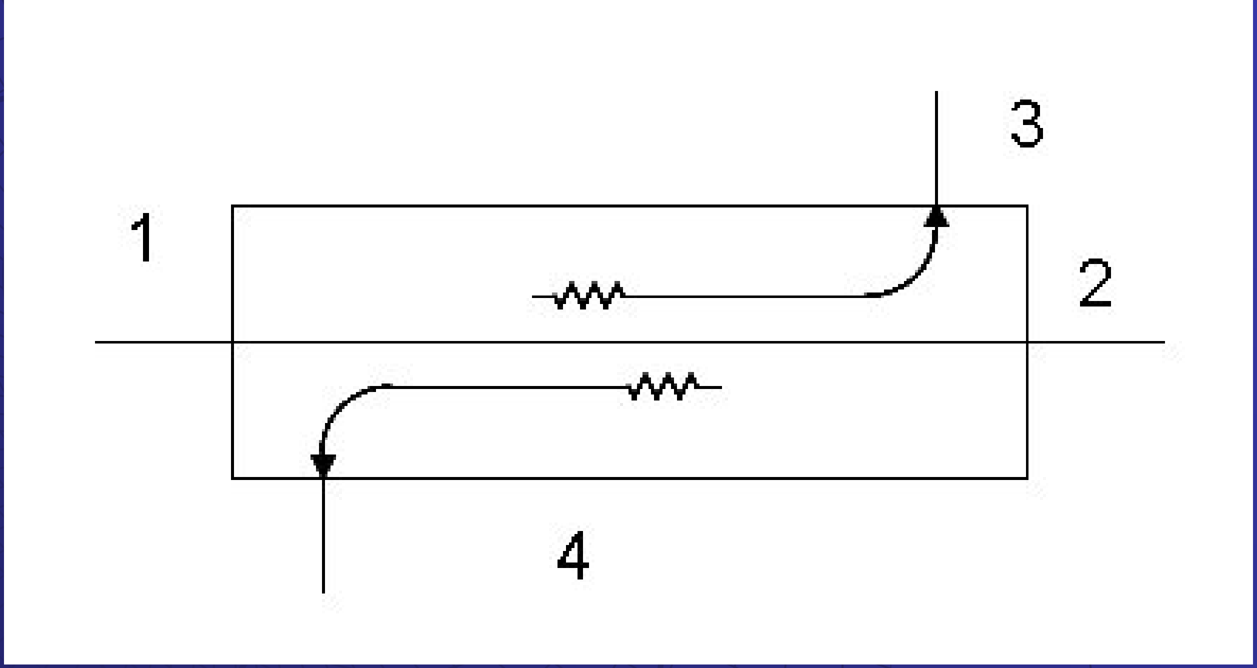
- RF Power Meter

Test Equipment

- Signal Source
  - VCO
  - Harmonic Multiplier
  - Gunn Diode
  - Video Sender
  - Cordless Phone

VSWR

- Directional Coupler

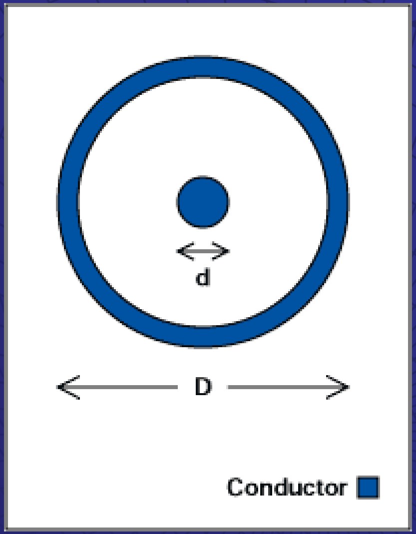


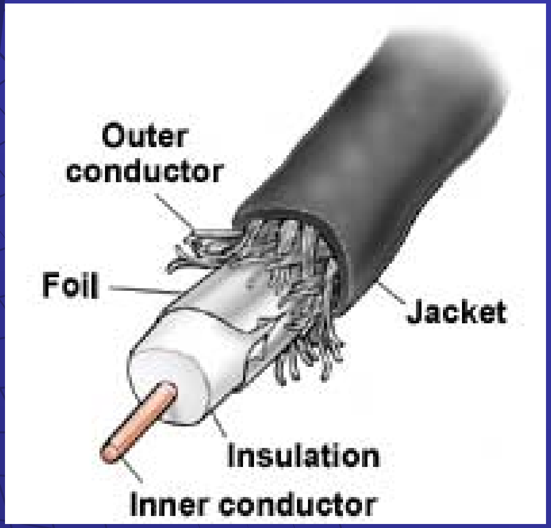
Transmission Lines

- Waveguide

Transmission Lines

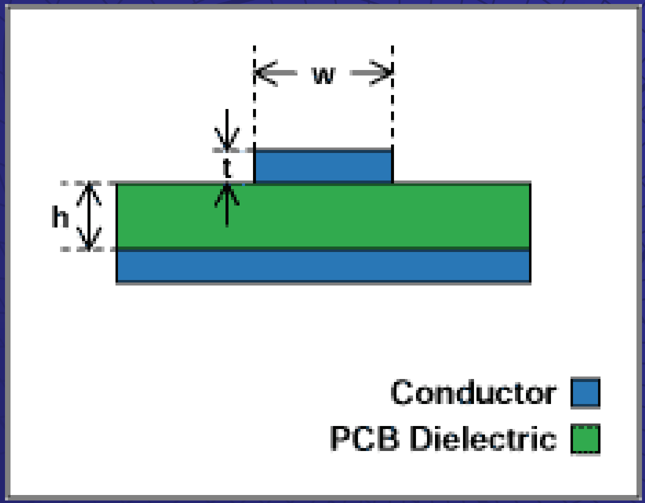
- Coax



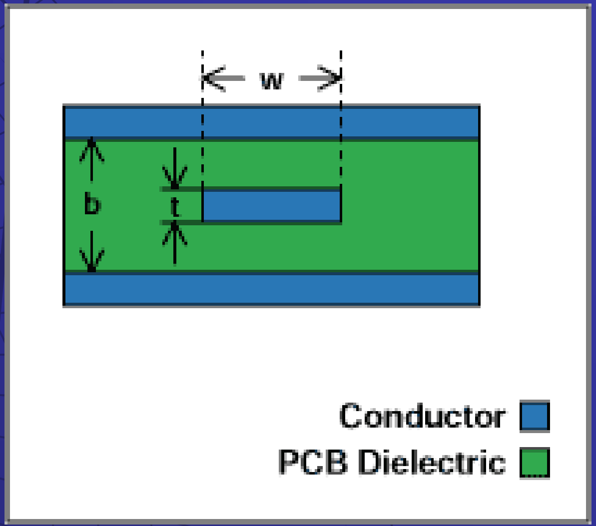


Transmission Lines

- Microstrip



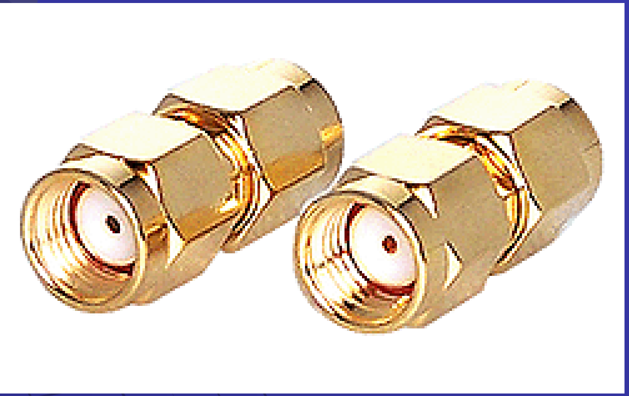
- Stripline



RF Connectors

- SMA

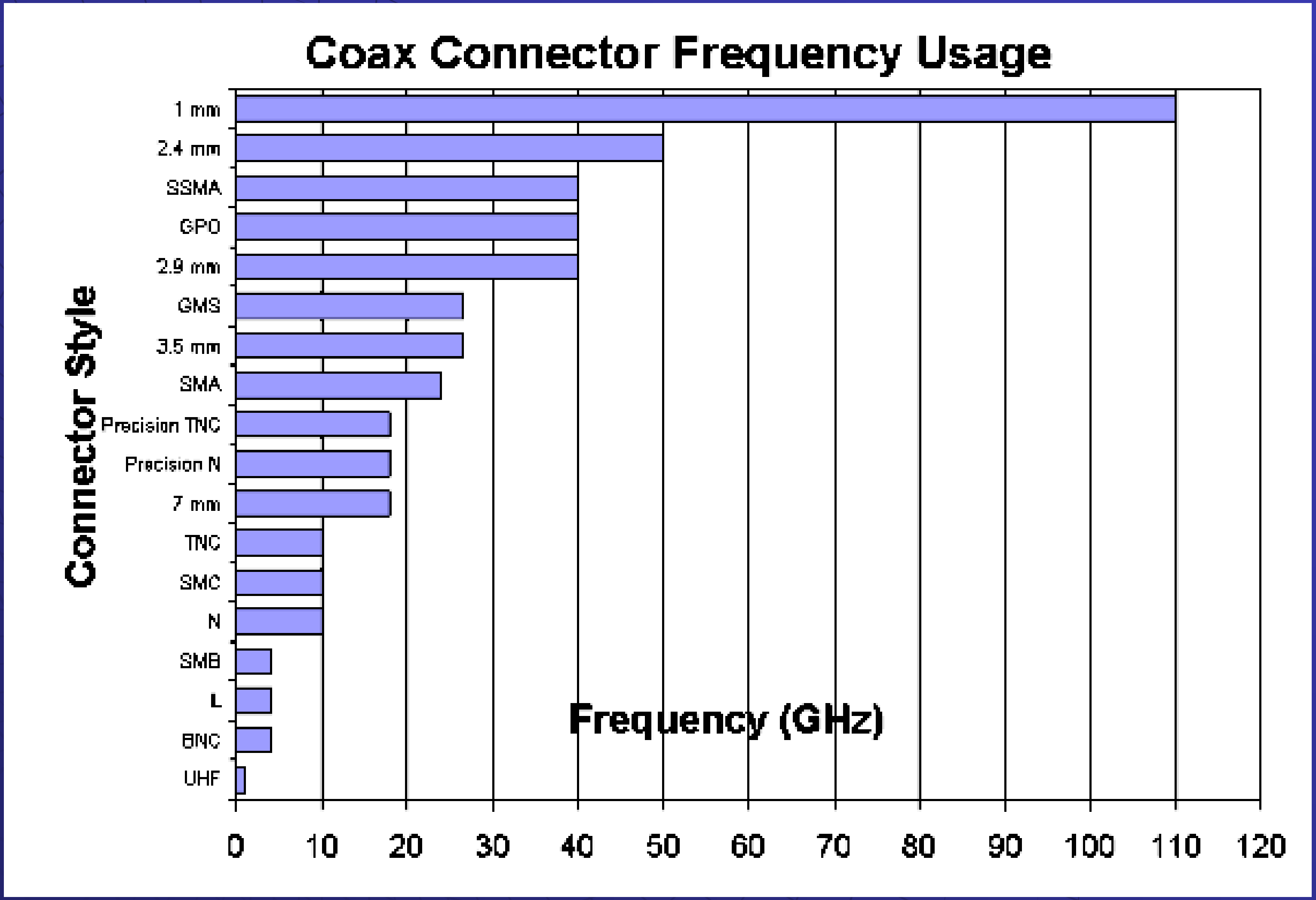
- RP-SMA



RF Connectors

- N – Connector

RF Connectors

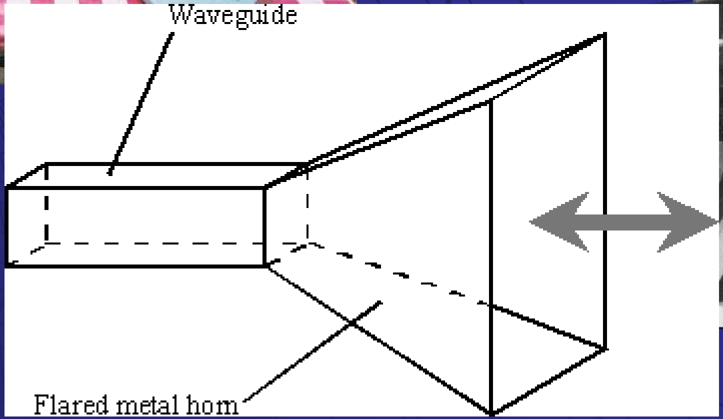


Antennas

- Waveguide Antennas

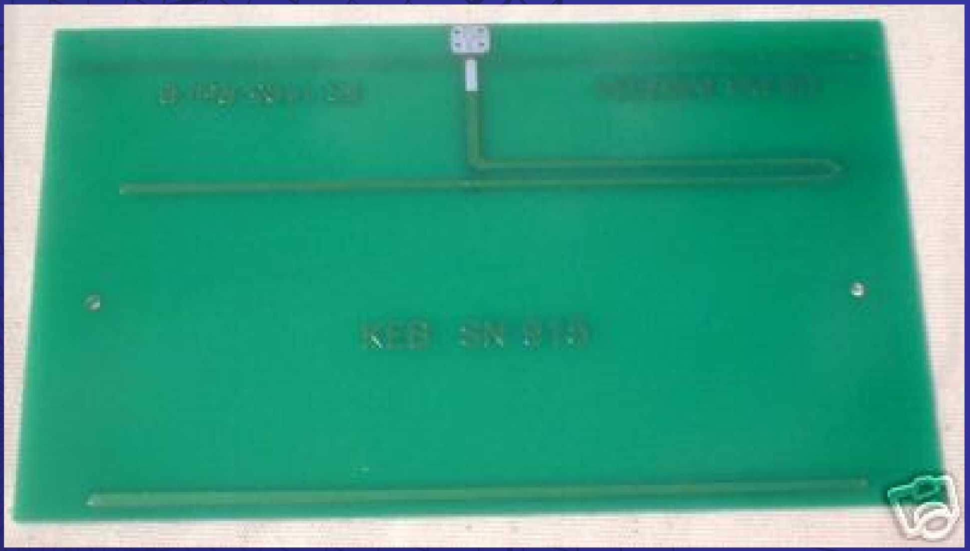
Antennas

- Waveguide Antennas (Horns)



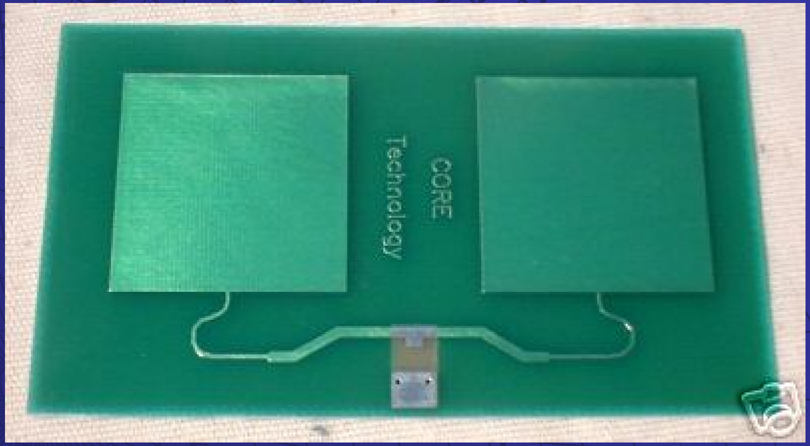
Antennas

- PCB Yagi



Antennas

- PCB Patch



Antennas

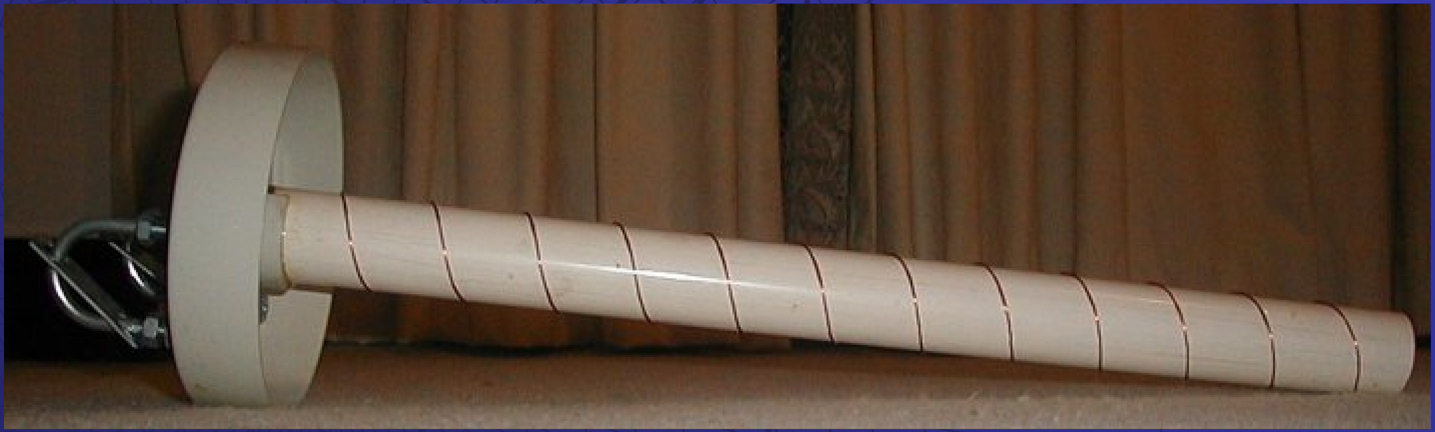
- PCB Log Periodic

Antennas

- 1/4 Wave (31 mm)

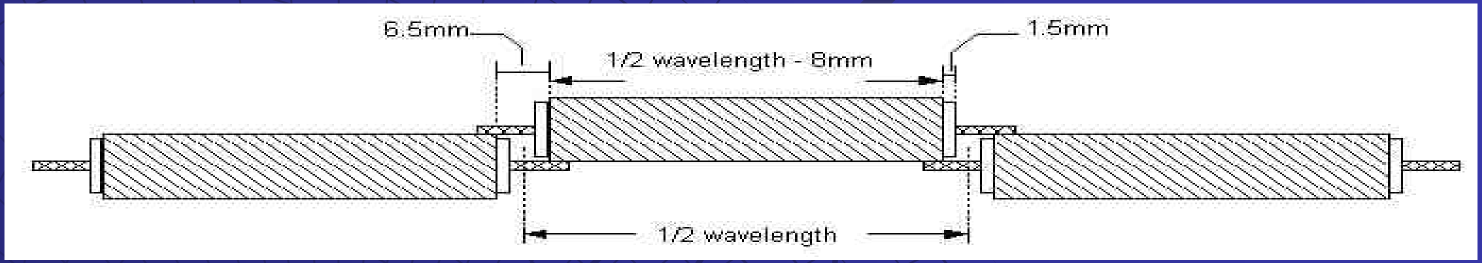
Antennas

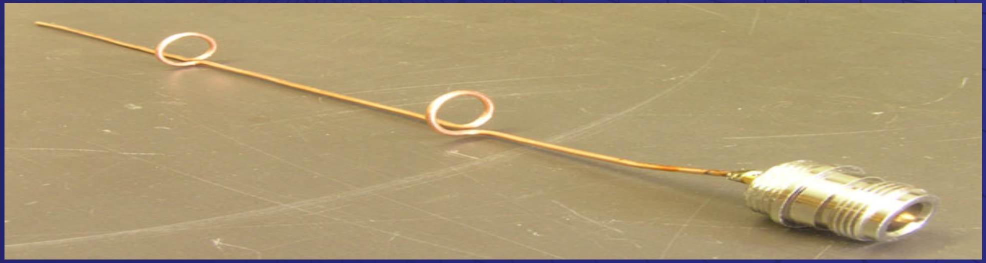
- Helical

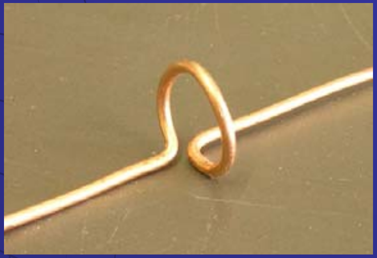


Antennas

- Collinear

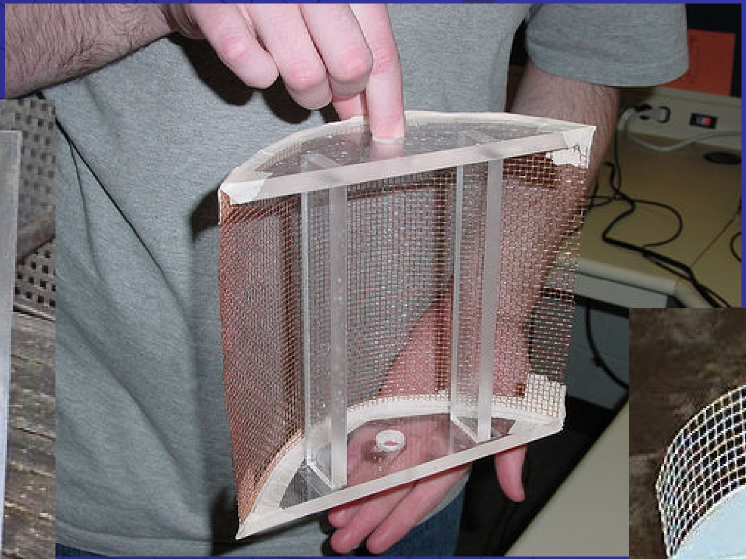






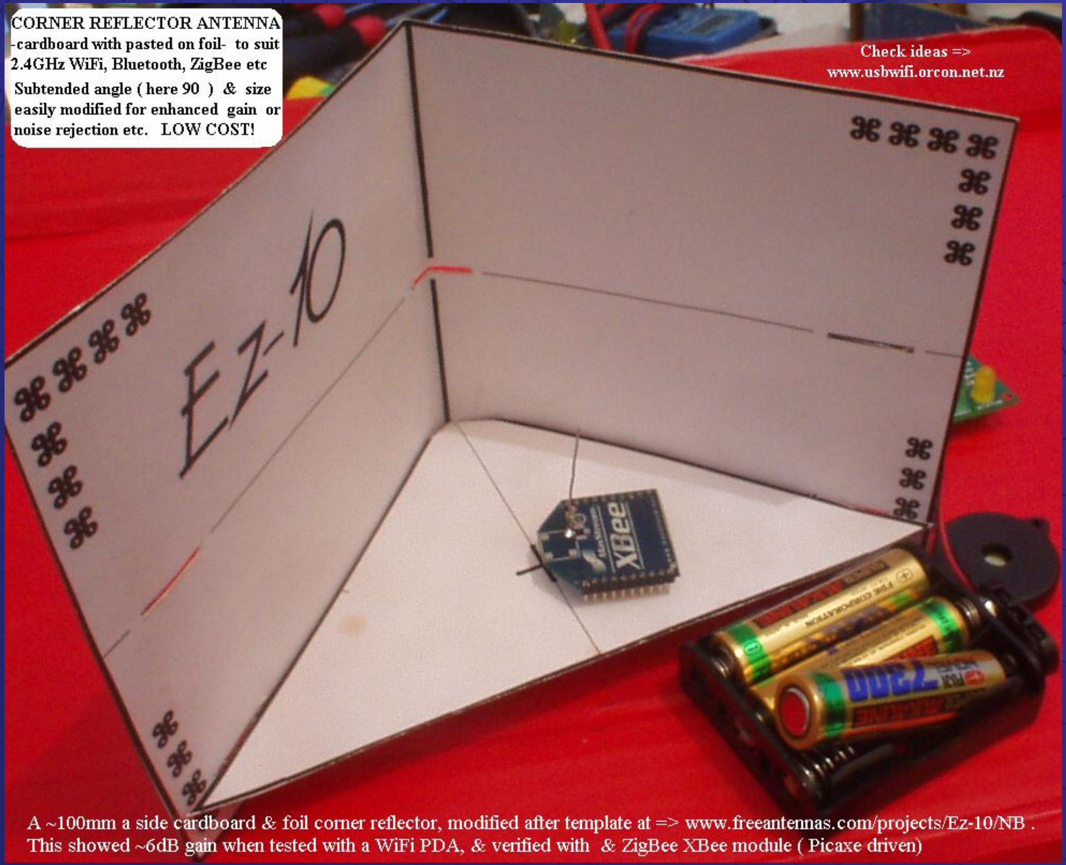
Antennas

- Parabolic Cylinder



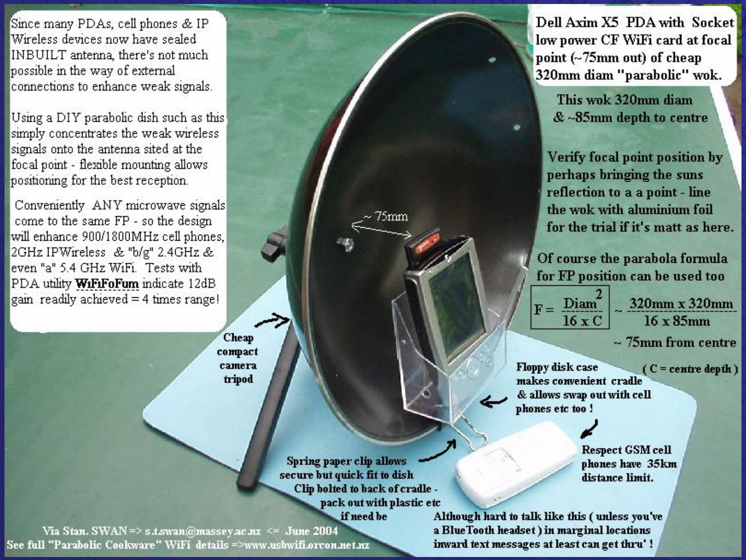
Antennas

- Corner Reflector

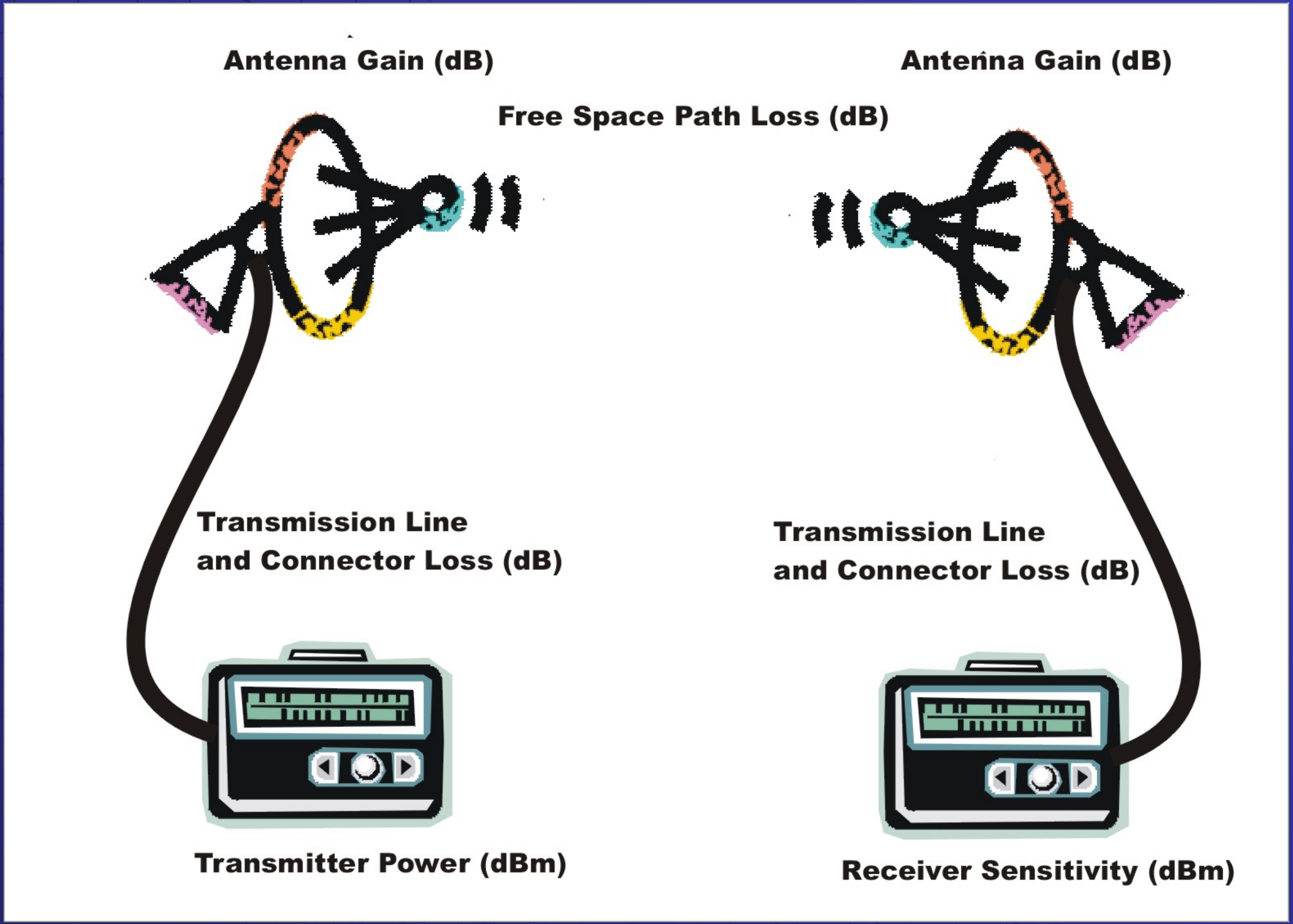


Antennas

- Dish

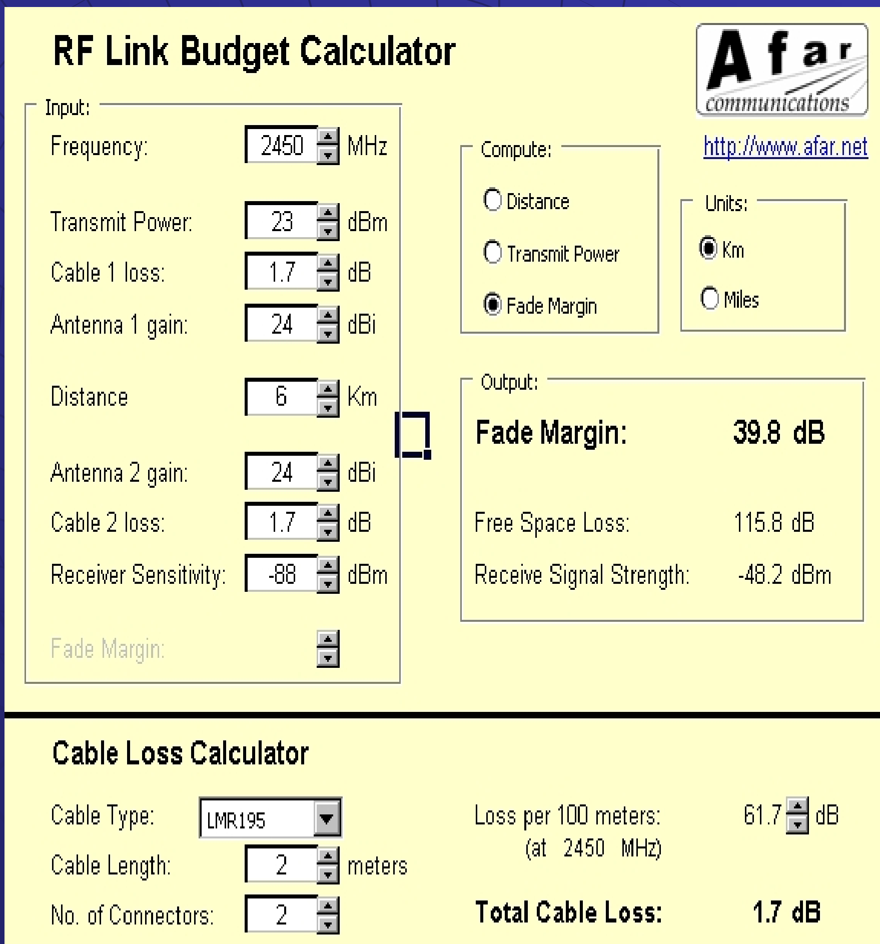


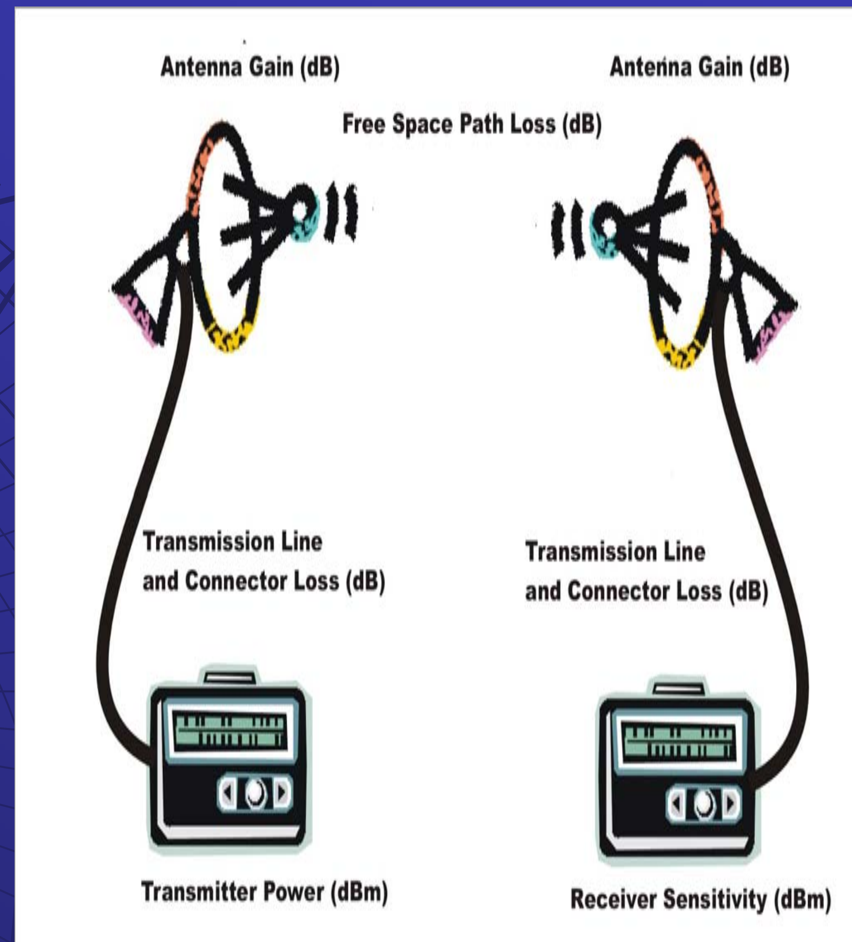
Link Budget



Antenna Gain (dB)
Antenna Gain (dB)
Free Space Path Loss (dB)
Transmission Line
and Connector Loss (dB)
Transmission Line
and Connector Loss (dB)
Transmitter Power (dBm)
Receiver Sensitivity (dBm)

Link Budget Software

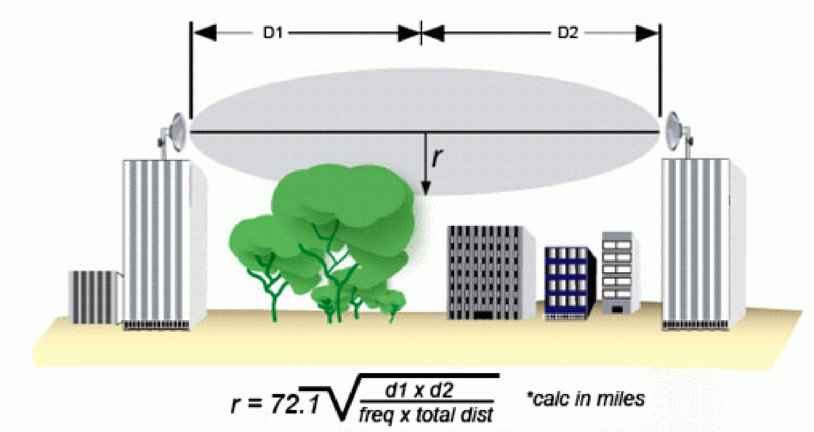




Software

- Fresnel Zone (60%)

FRESNEL ZONE CLEARANCE CALCULATOR



Distance A (D1) in Km

[1] (Km)

Distance B (D2) in Km

[1] (Km)

Frequency in GHz

[2.4] (GHz)

Convert It

[Convert]

Equals

The 1st Fresnel Zone is

[7.9]

meters across to radius.

[25.9]

feet across to radius.

60% of 1st Fresnel Zone is

[4.7]

meters across to radius.

[15.6]

feet across to radius.

Construction

- Measurements for a 3-1/4” diameter
  - Probe Length = 1.21” (31mm)
  - Set 2.49” from back of can (63mm)

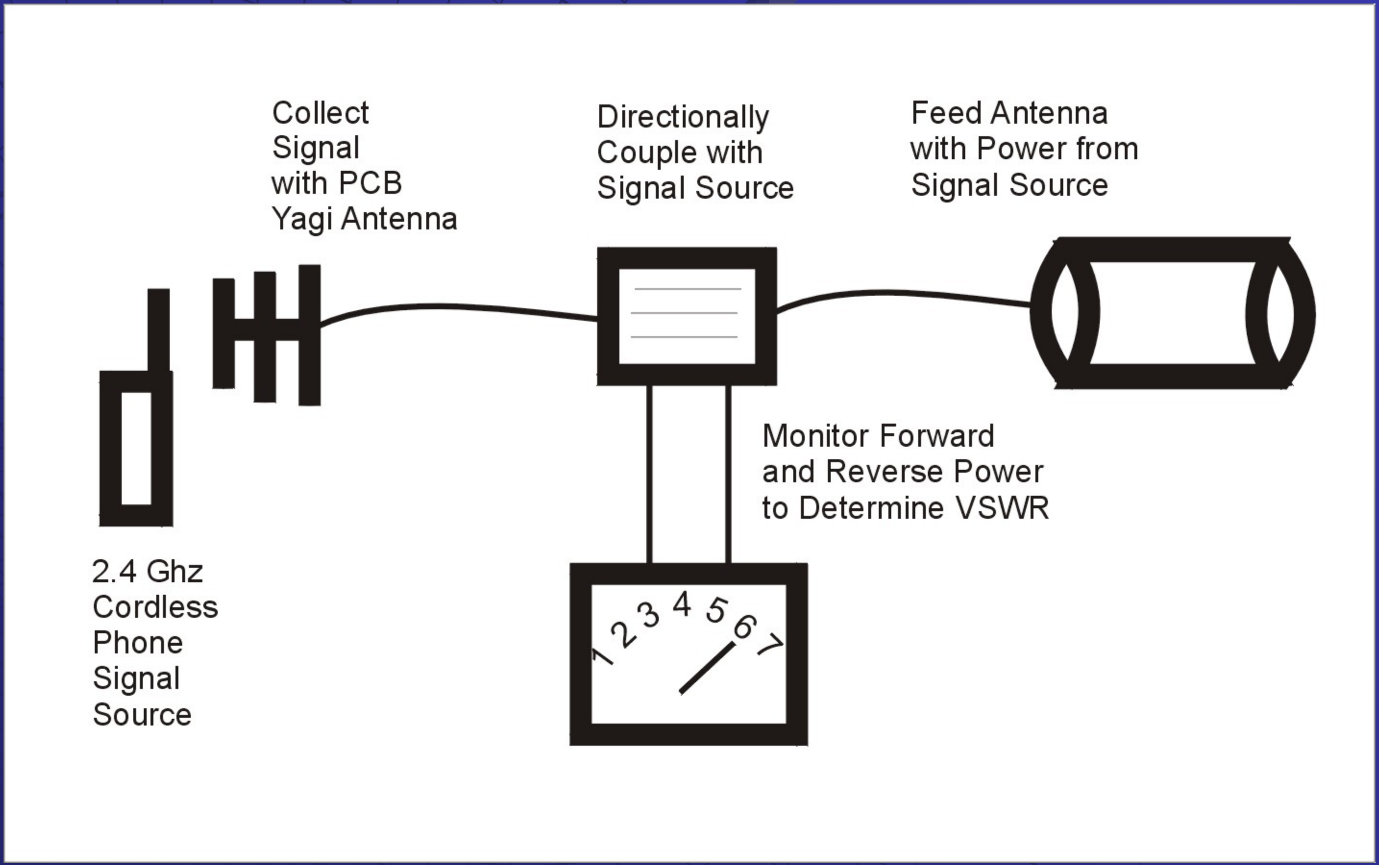
Multimedia Software

- Conf (NetMeeting)
  - Windows Start Button
  - Find “Run” on the menu
  - Type in “conf” and press enter

- Sends Voice and Video over a network – in this case, wireless.

Testing Methods

- VSWR



Testing Methods

- VSWR Measurement
  - FP = Forward Power
  - RP = Reverse Power

$$\text{VSWR} = \frac{1+\text{sqr}(RP/FP)}{1-\text{sqr}(RP/FP)}$$

Definition: impedance mismatch between transmission line and load

Testing Methods

- VSWR Measurement Example
  - FP = .18 mW
  - RP = .05 mW

$$\text{VSWR} = \frac{1+\text{sqr}(.05/.18)}{1-\text{sqr}(.05/.18)} = 3.25:1$$

Testing Methods

- VSWR Mismatch Effects

VSWR	Antenna Impedance Ω	Gain Reduction	Gain Reduction (10 dB antenna)
1.0:1	50	0.00%	0 dB
1.5:1	75, 33	4.00%	.20 dB
2.0:1	100, 25	11.10%	.51 dB
3.0:1	150, 16.67	25.00%	1.28 dB
5.0:1	250, 10	44.50%	2.59 dB
10.0:1	500, 5	67.00%	4.81 dB