Introduction to Antenna Basics

Week 4: Intro to Planar Antenna Design

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Housekeeping

Multiples of half and quarter wavelength wire resonant antennas

- Will have changes to gain and radiation pattern

Antennas when you don’t want them

- Alligator clips

NanoVNA measurement tutorial coming by June 3

CENOS community licenses for students - free for non-commercial use

Next week’s Hack Chat on June 2 - Satellite Communications

Recap from last class

Dipoles and monopoles are generally low gain, omnidirectional, linearly polarized resonant antennas

Impedance for a λ/2 dipole antenna in free space is 73 Ω

Input impedance for a λ/2 folded dipole antenna is roughly 280 Ω

Balun converts between a balanced (differential) signal (like a λ/2 dipole antenna) and an unbalanced signal (like coaxial line)

Week 4 Class Outline

Slots

Patches

Circularly Polarized Patches

Microstrip Lines

Vivaldis

Slots

Complement to half-wave dipole - λ/2 elongated slot, cut in a conductive plate

length of a slot determines the resonant frequency

width of the slot determines the bandwidth

Linearly polarized - opposite of dipole!

Can also be slotted waveguide (shown)

Ciacho5, Public domain, via Wikimedia Commons

Patches

Popular for arrays

Most commonly square

can be other shapes

Low-profile

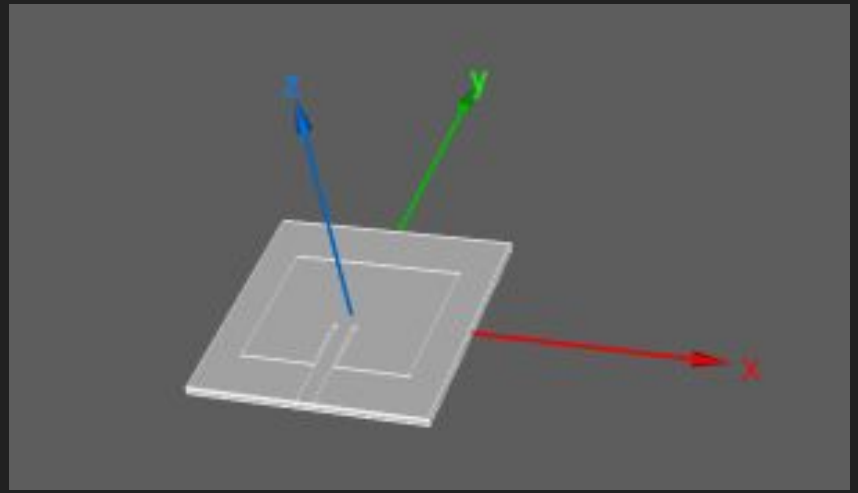
Directional pattern

Gain <8 dBi

Linearly polarized along the width of the patch, able to make circularly polarized

Can be probe or transmission line fed

Narrow bandwidth, low efficiency



S-band template, CENOS software

Calculation Process

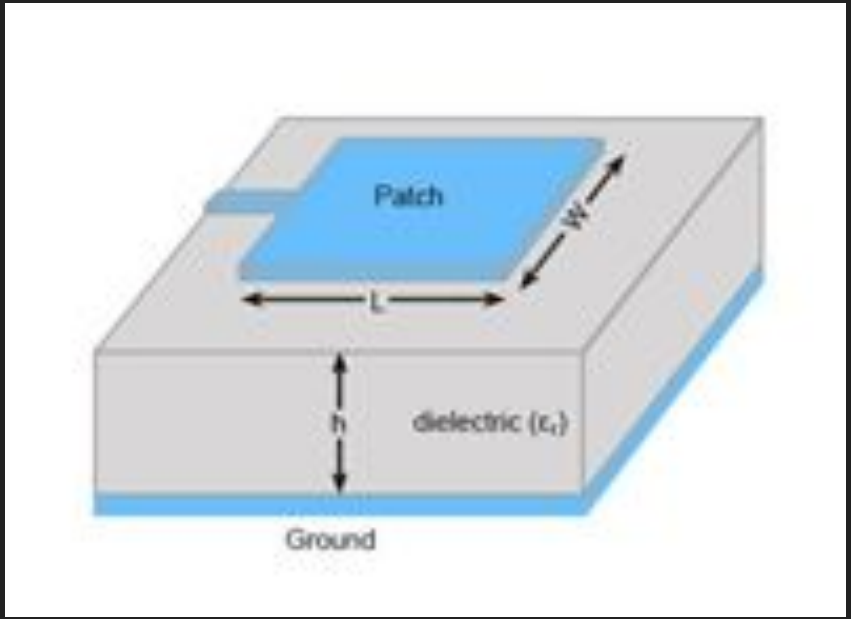
Step 1: Calculation of the Width (W)

Step 2: Calculation of the Effective Dielectric Constant. This is based on the height, dielectric constant of the dielectric and the calculated width of the patch antenna.

Step 3: Calculation of the Effective length

Step 4: Calculation of the length extension ΔL

Step 5: Calculation of actual length of the patch



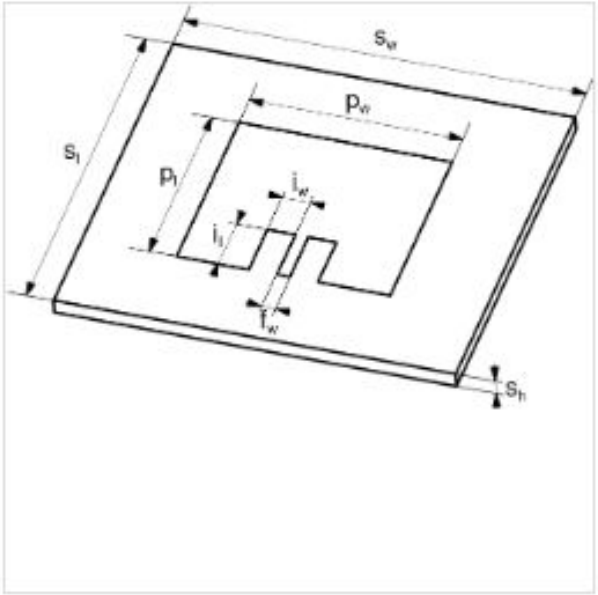
[Microstrip Patch Antenna Calculator]

Properties

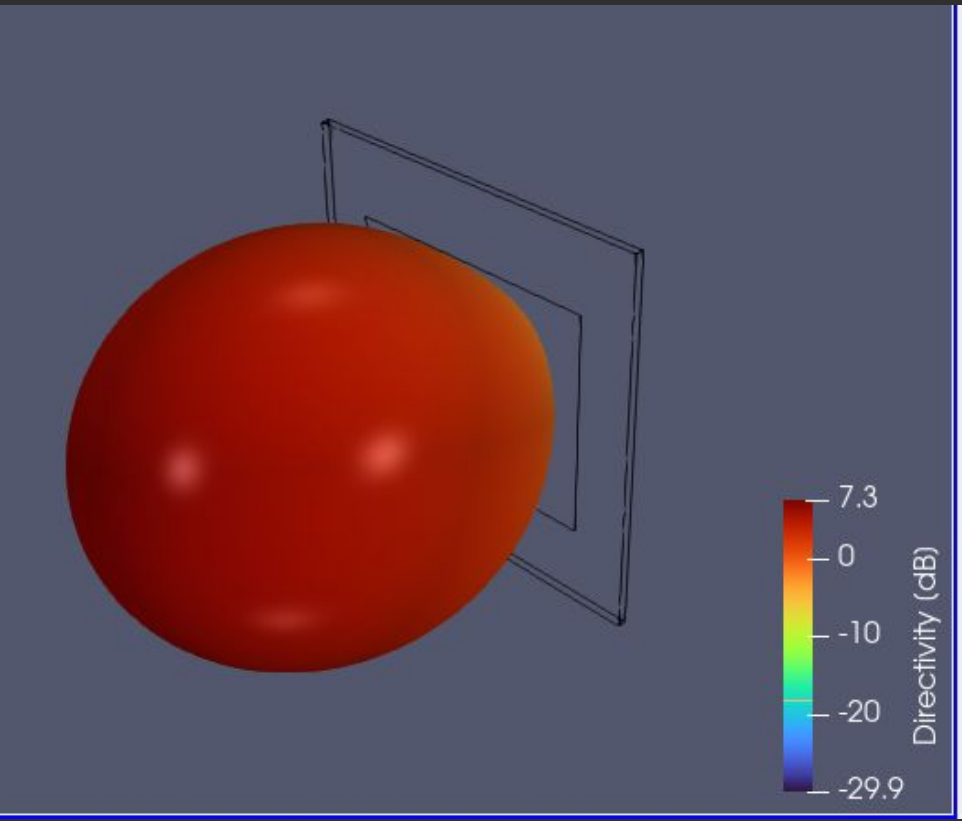
s_w	70	*Substrate width*
s_l	70	*Substrate length*
s_h	1.6	*Substrate height*
p_w	49.4	*Patch width*
p_l	41.3	*Patch length*
w_f	4.95	*Feed width*

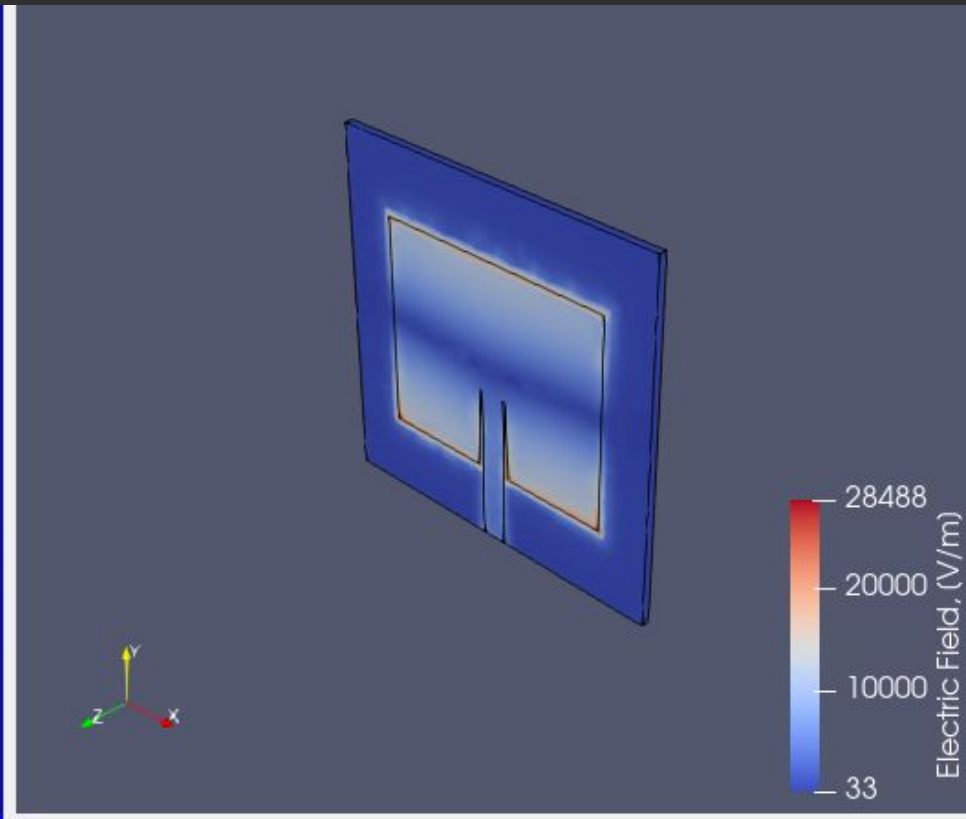
☑ Inset

i_l	15.7	*Inset length*
i_w	0.8	*Inset width*



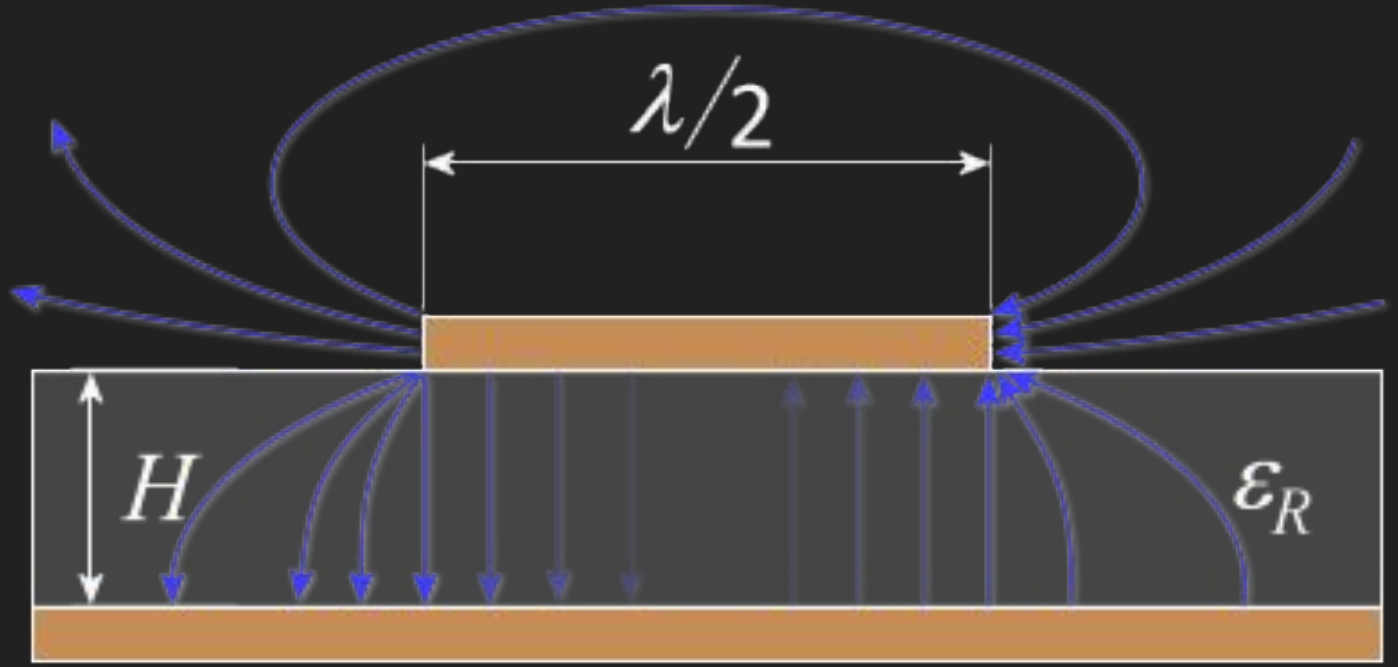
S-band template, CENOS software





S-band template, CENOS software

Field behavior of patch antenna



https://www.radartutorial.eu/06.antennas/Microstrip%20Antenna.en.html

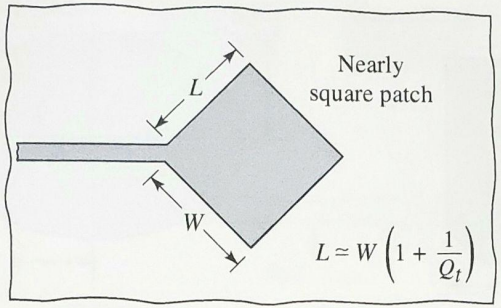
Circularly Polarized Patches

Diagonal feed point

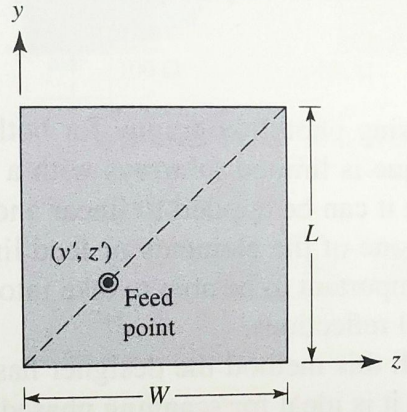
Diagonal slots

Trimmed square

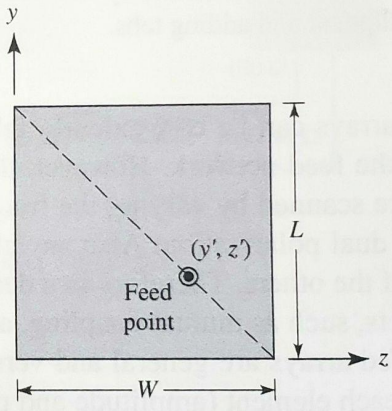
Dual feed



(a) Nearly square patch



(b) Left-hand circular (LHC)



(c) Right-hand circular (RHC)

Figure 14.35 Single-feed arrangements for circular polarization of rectangular microstrip patches.

Antenna Theory, Analysis and Design, Balanis, pg 833

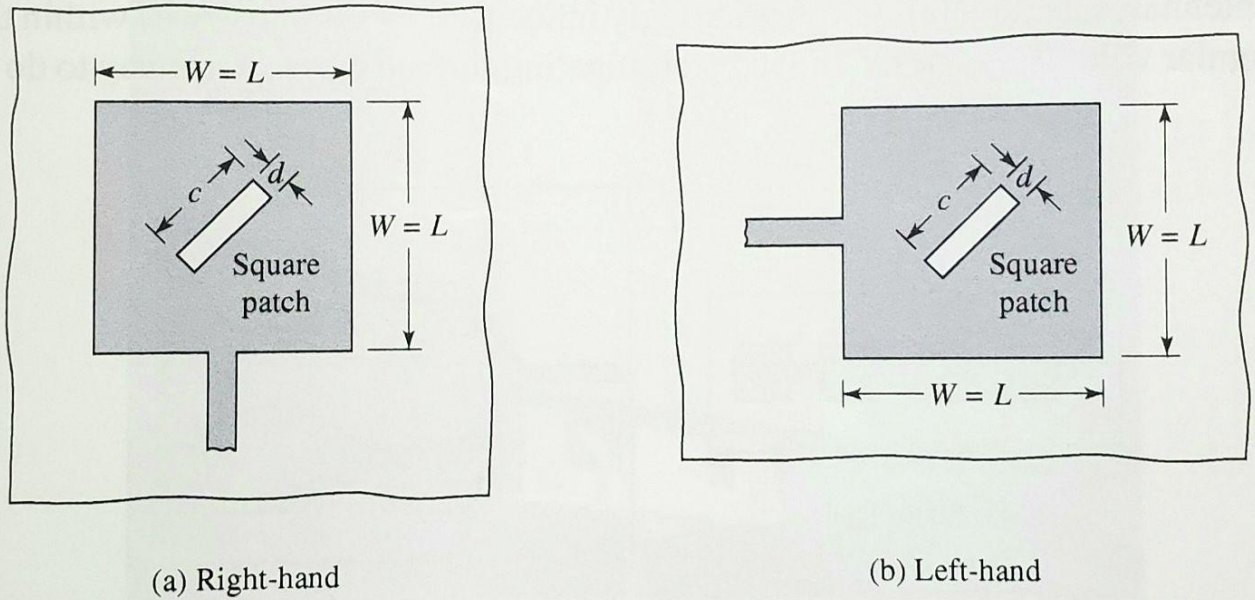
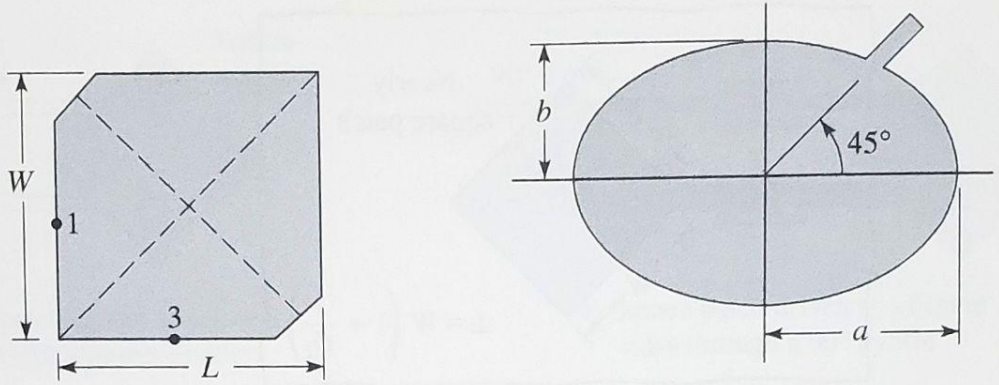


Figure 14.36 Circular polarization for square patch with thin slots on patch ($c = W/2.72 = L/2.72$, $d = c/10 = W/27.2 = L/27.2$).

Antenna Theory, Analysis and Design, Balanis, pg 833



(a) Trimmed square ($L = W$) (b) Elliptical with tabs

Figure 14.37 Circular polarization by trimming opposite corners of a square patch and by making circular patch slightly elliptical and adding tabs.

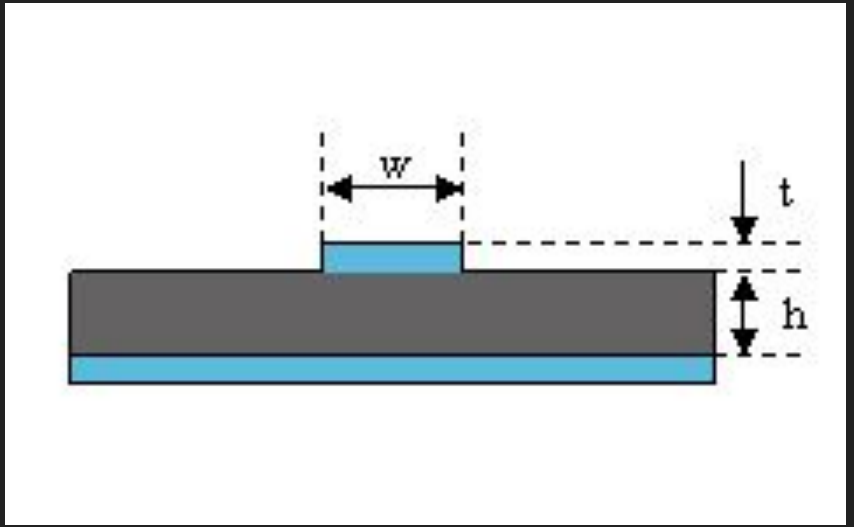
Antenna Theory, Analysis and Design, Balanis, pg 834

Microstrip Lines

Transmission line separated from ground plane by dielectric

Impedance determined primarily by width

The wider the strip, the lower the characteristic impedance (Z0)



Microstrip Impedance Calculator

Vivaldis

Microwave frequencies

Linearly polarized

Directional pattern

High gain

Wider bandwidth

Might need a balun

Tips and tricks

The higher the frequency, the more surface roughness will affect your design

Board dielectric should be suitable for application/environment

Integrated board - use high-quality FR4 circuit boards

- Don’t place other components in near-field of antenna

Don’t forget your connector footprints!

Resources

Microstrip (Patch) Antennas

Microstrip Patch Antenna Calculator

Inset Fed Microstrip Patch Antenna w/ tools

Microstrip Impedance Calculator

Slot Antenna

Design An X-Band Vivaldi Antenna

Michael Ossmann: Simple RF Circuit Design

Coming up next class

Introduction to microwave antenna design. Topics covered will be, but are not limited to: horns, reflectors, waveguides and microwave frequencies.

Questions?