Karlsruhe Institute of Technology

Aperturantennen

by Thomas Zwick

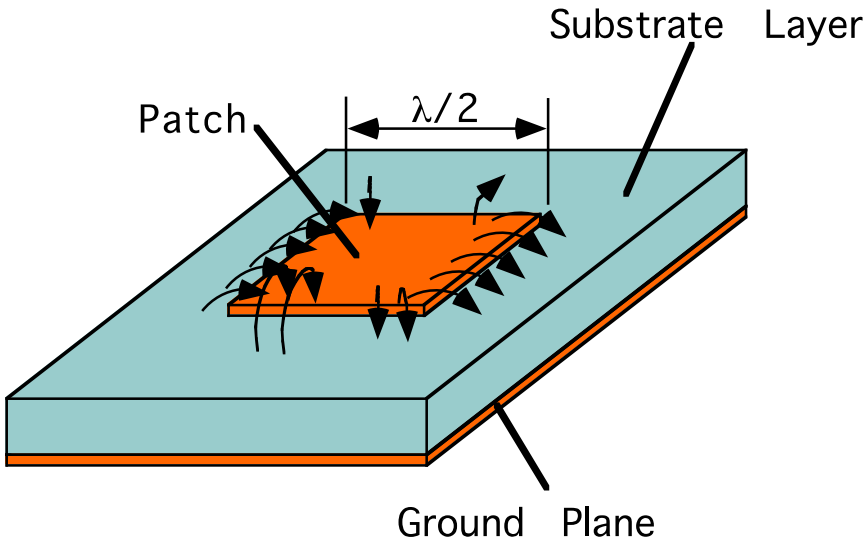
INSTITUT FÜR HOCHFREQUENZTECHNIK UND ELEKTRONIK

Inhalt

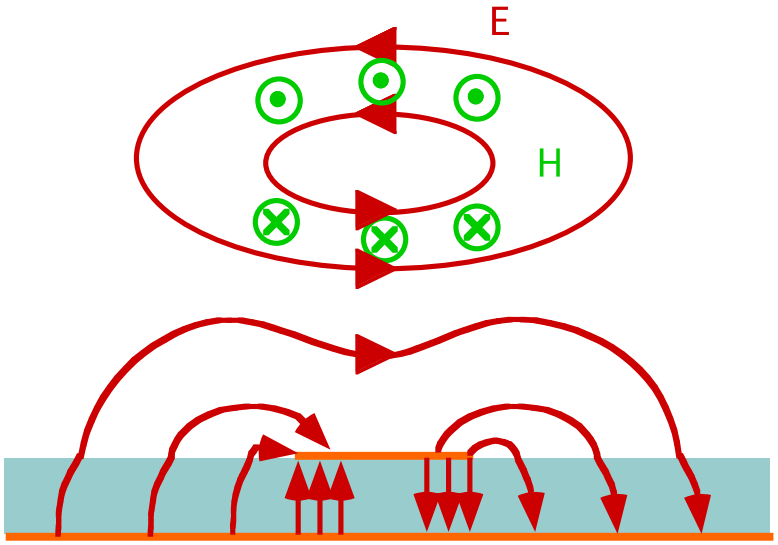
- Patch-Antennen
- Hornantennen
- Reflektorantennen
- Linsenantennen
- Dielektrische Antennen

Microstrip Patch Antenne

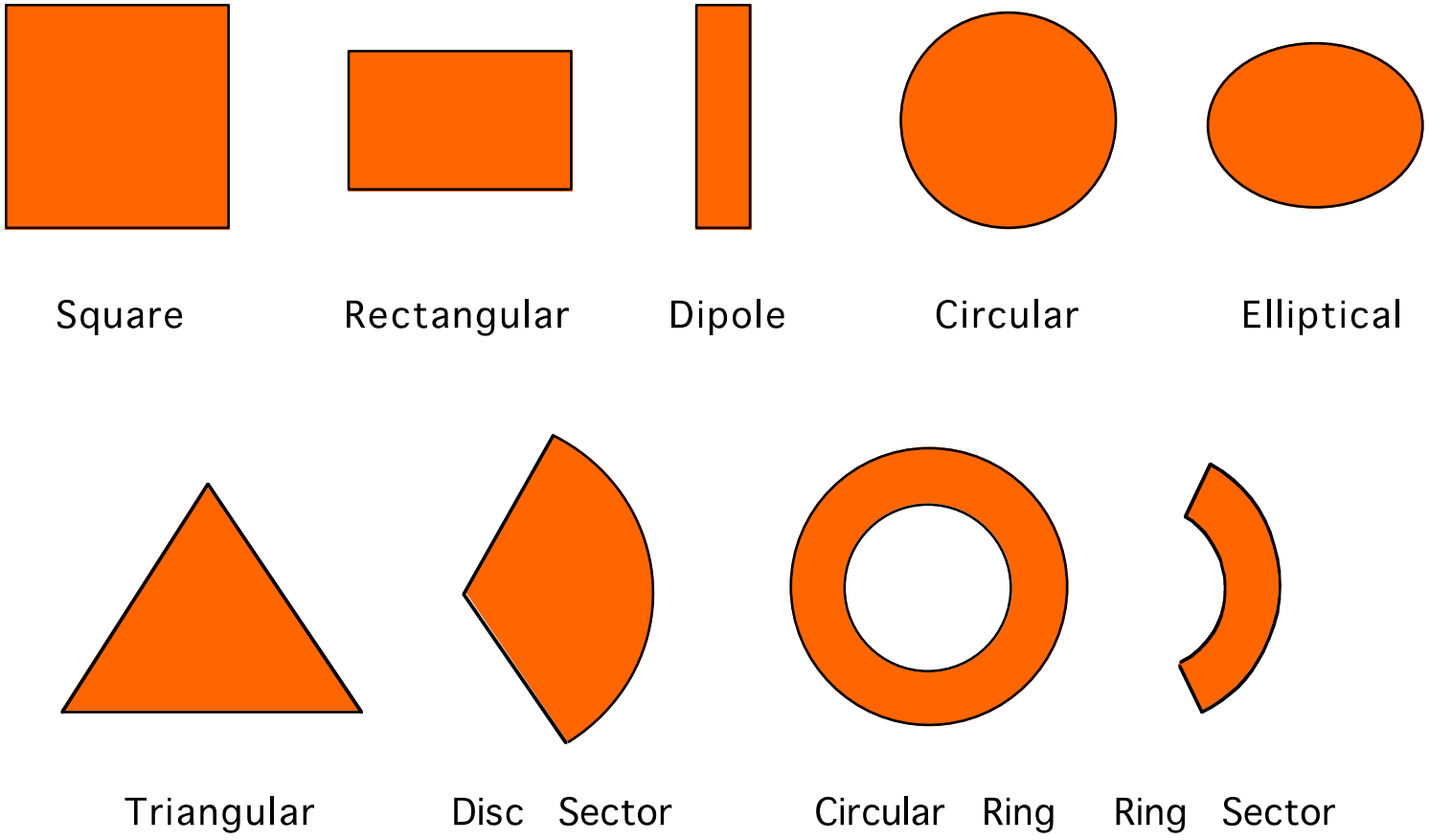
3D-View



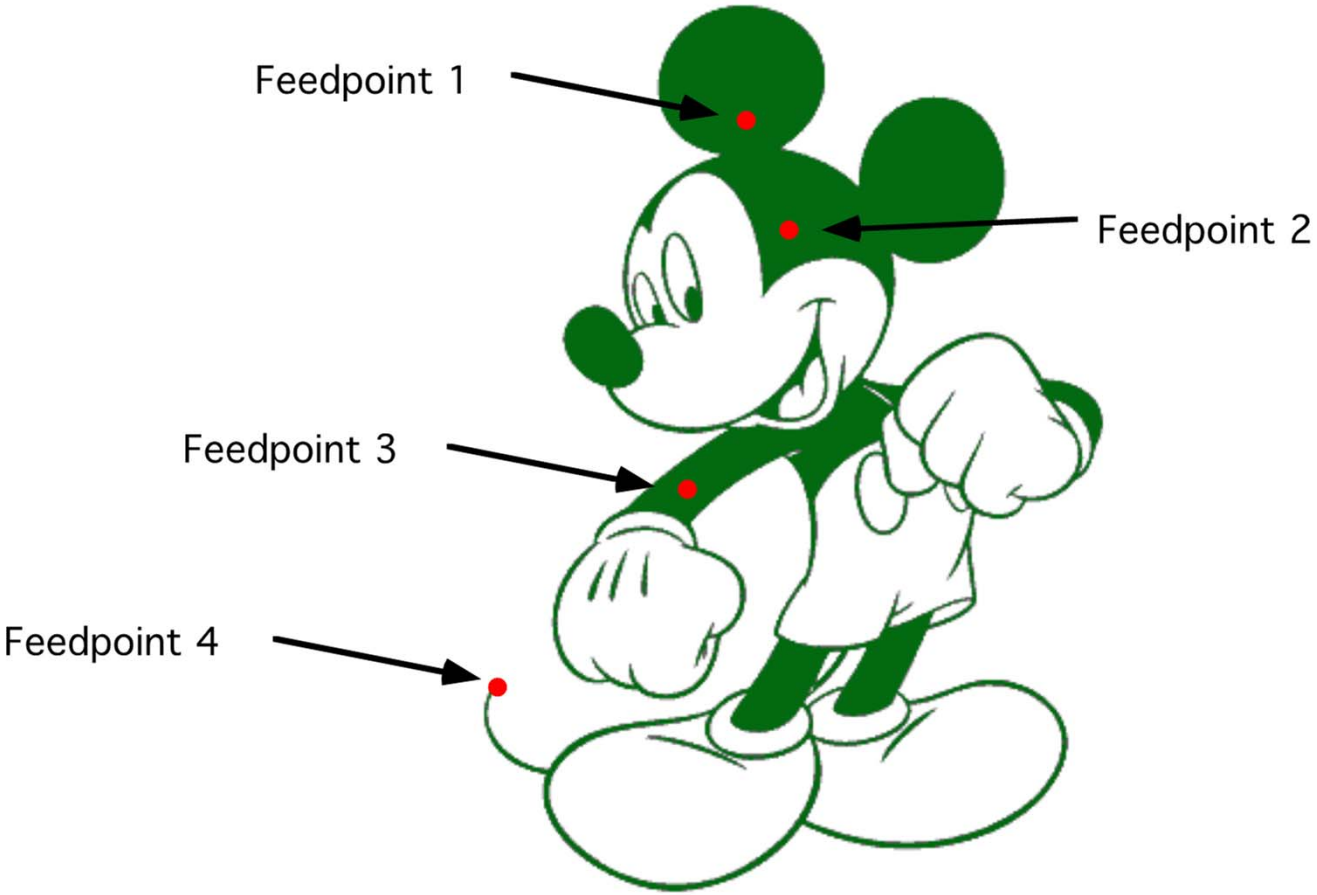
Side View (Cross Section)



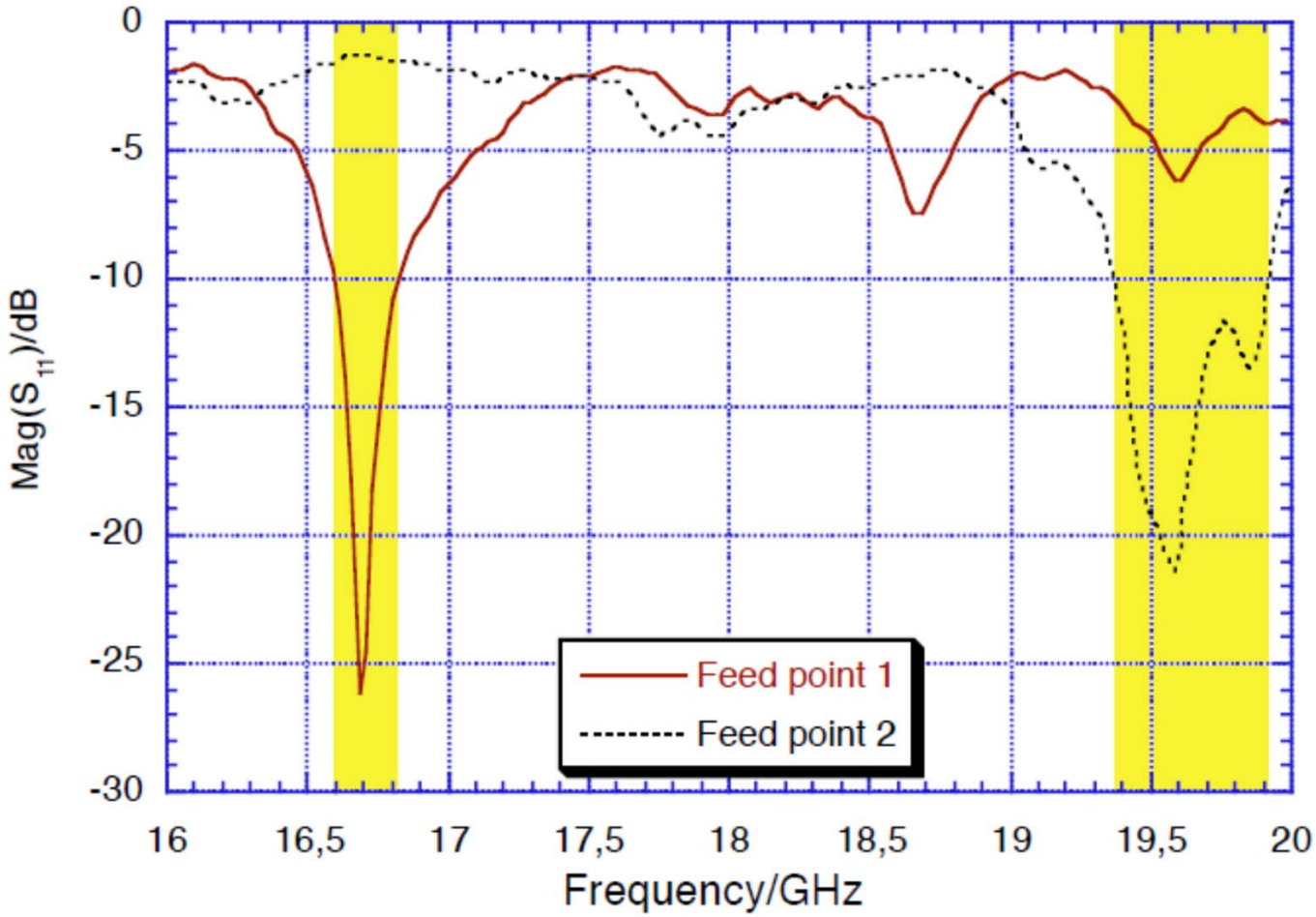
Geometrien für Patchantennen



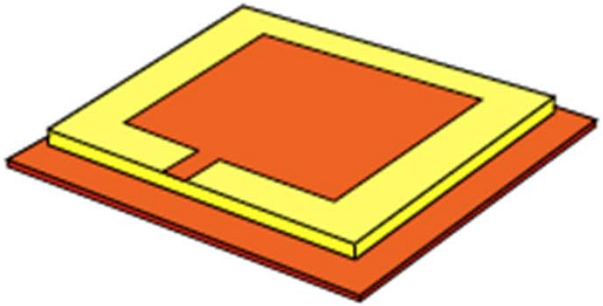
Daul-Band Antenne: Layout



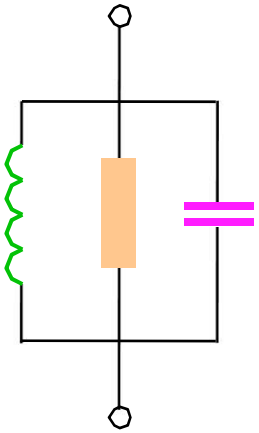
Dual-Band Antenne

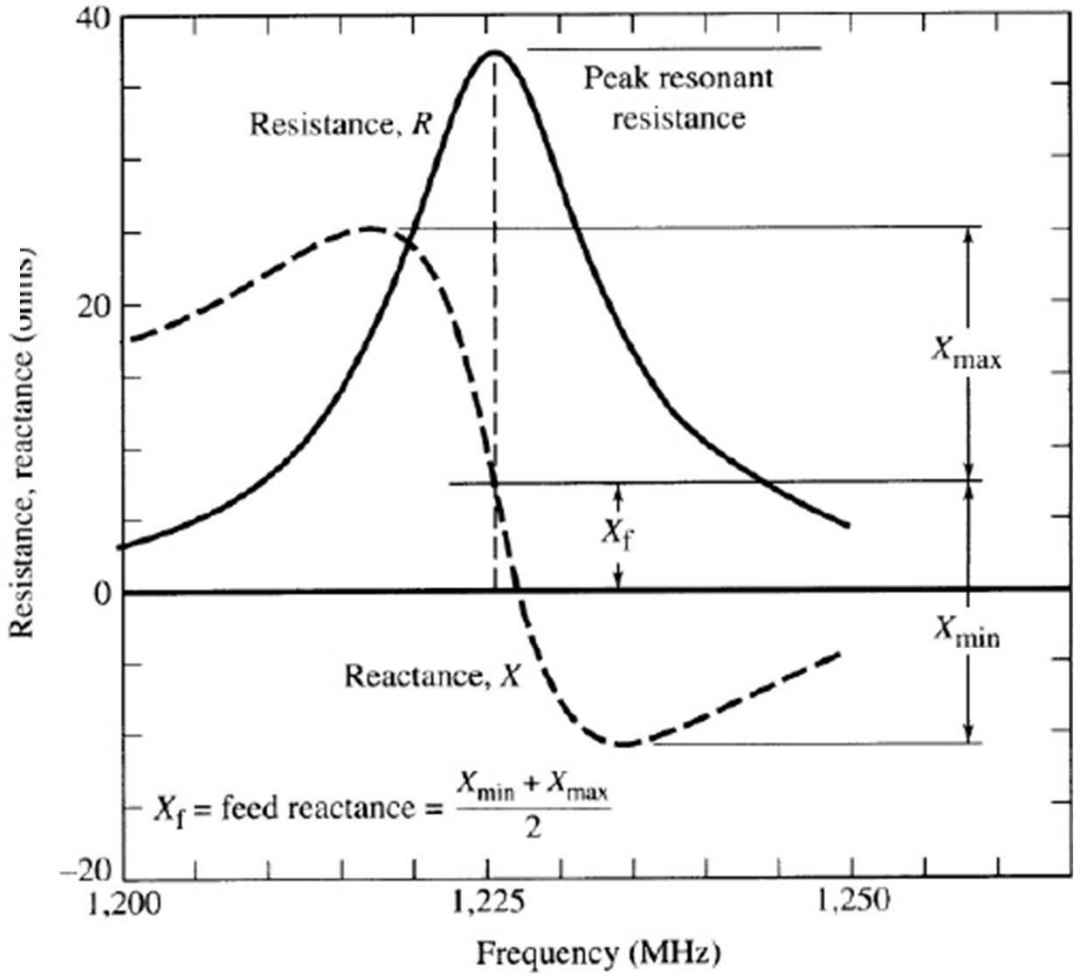


Eingangswiderstand einer Patchantenne

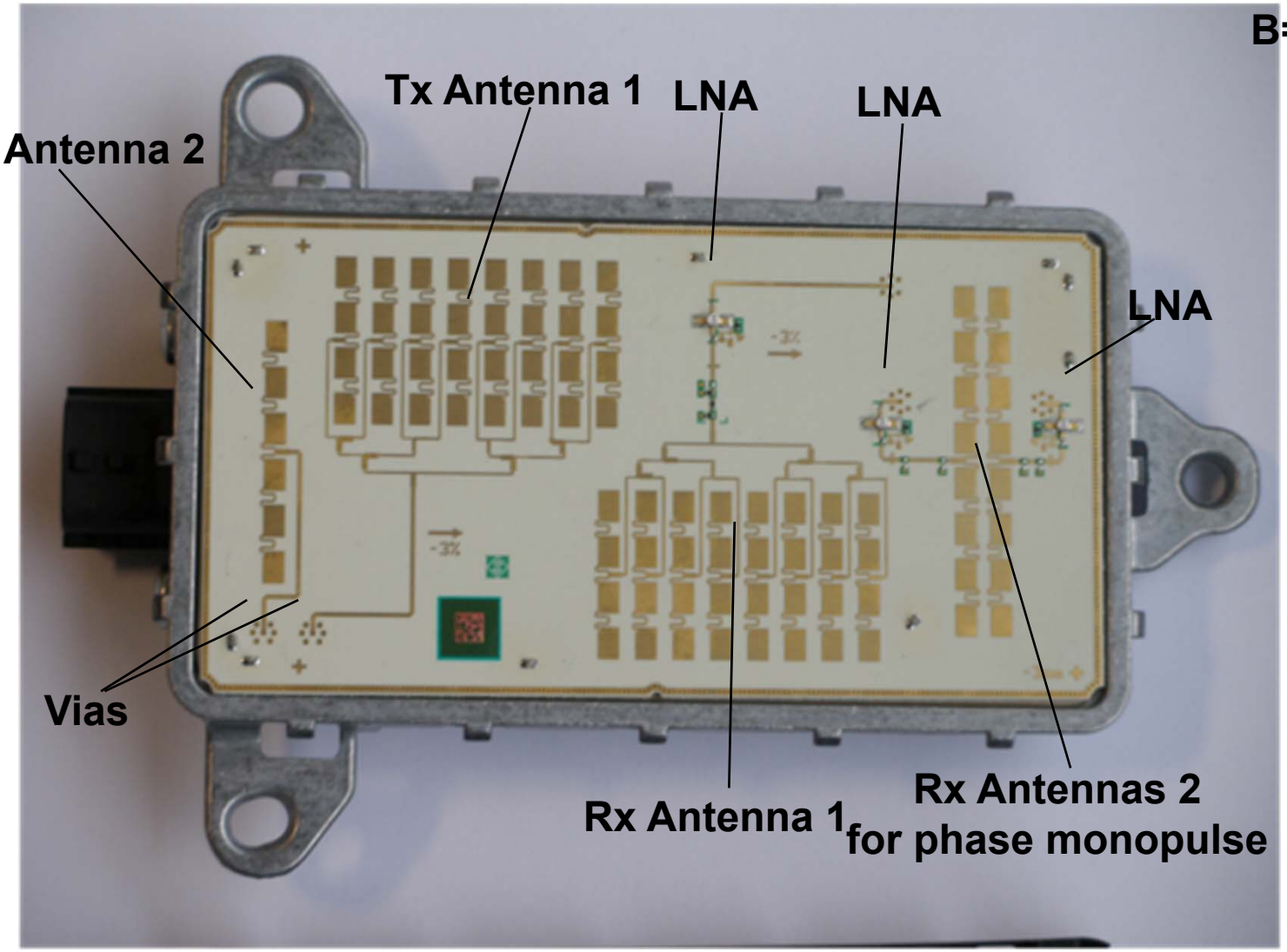


- Geometrie
- Substrat



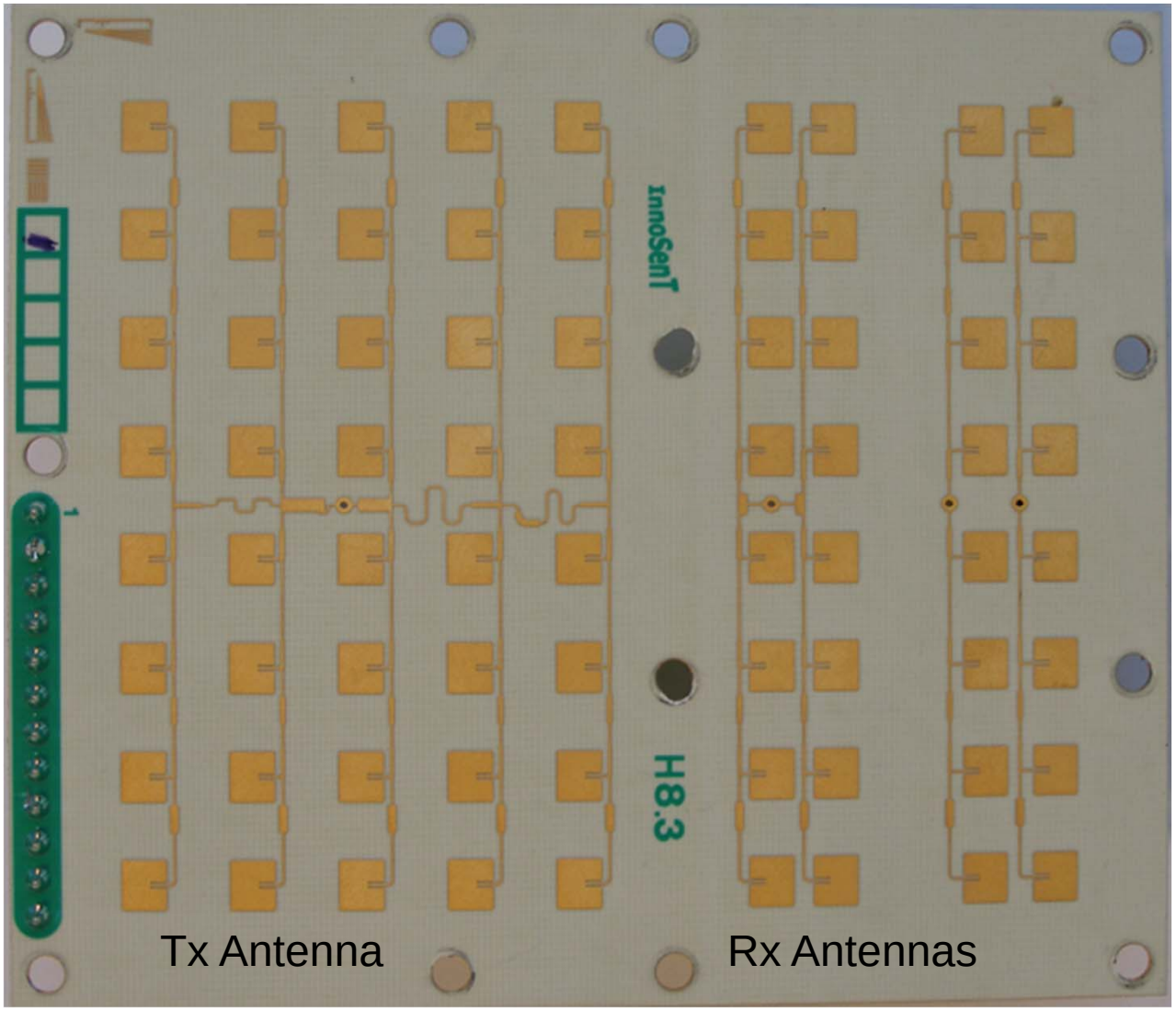


Blind Spot Detection Radar 24,5 GHz (Siemens VDO)



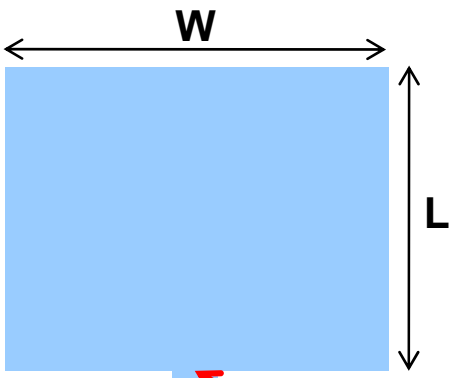
Courtesy
Siemens VDO

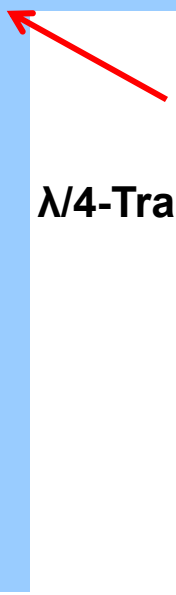
24GHz Spurwechselassistent (Hella/SMS/InnoSenT)



Courtesy
Hella/SMS

Inset Feed (1)

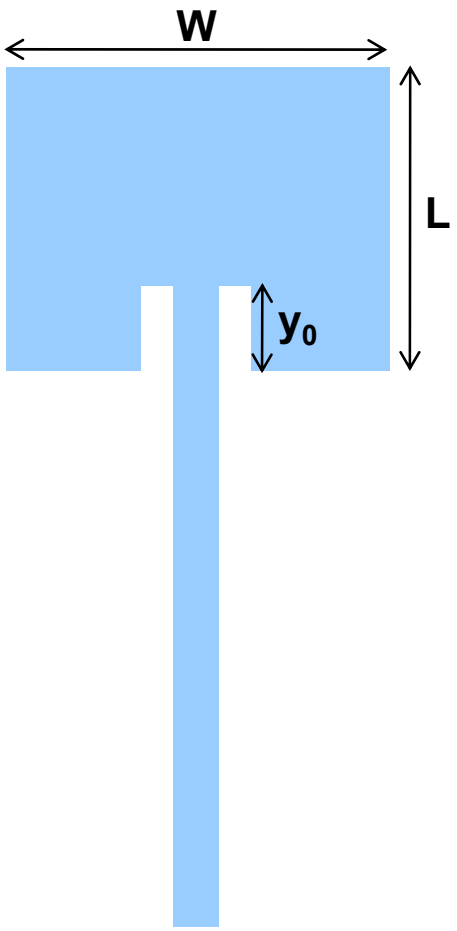




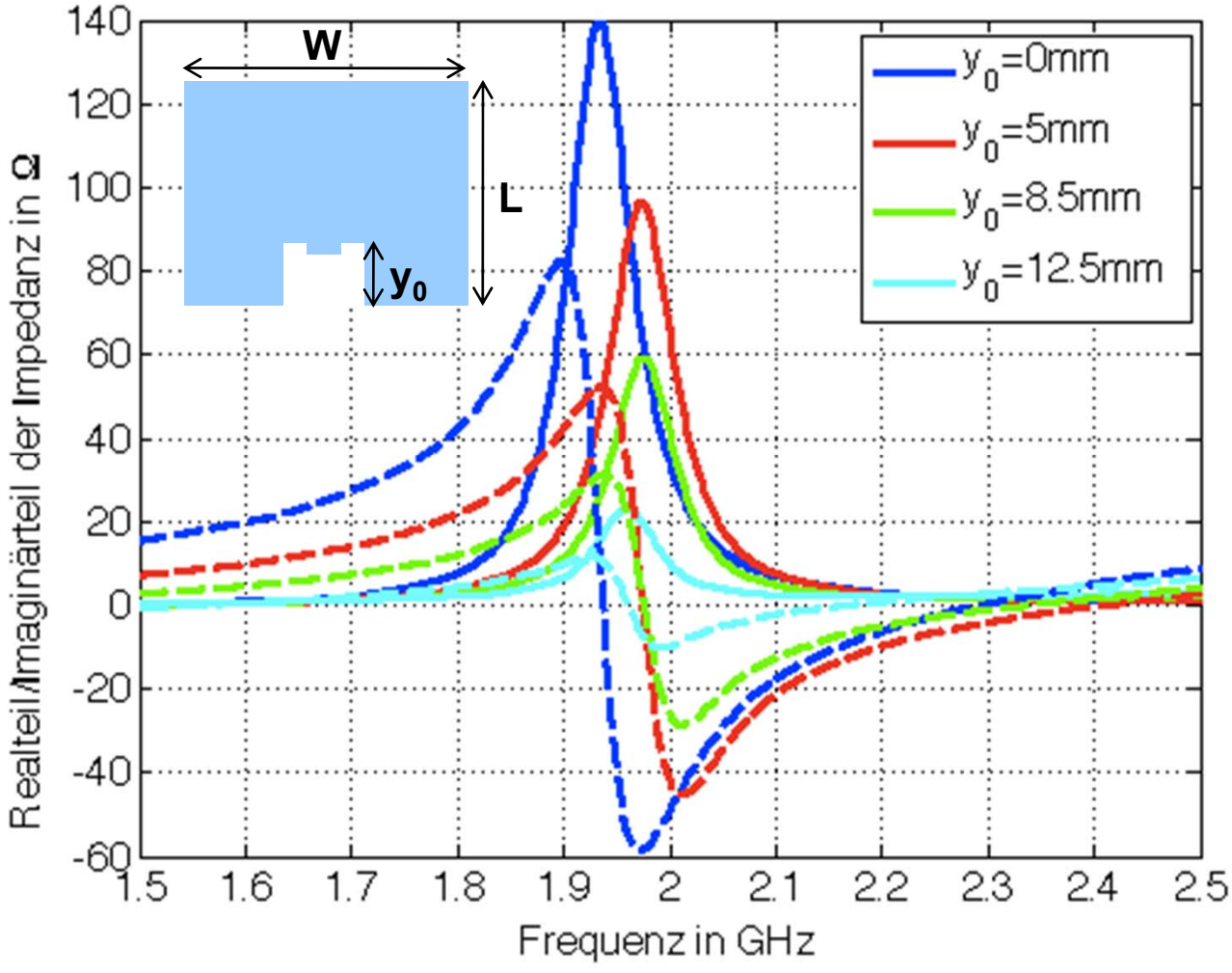
Problem: hoher Eingangswiderstand

λ/4-Transformator

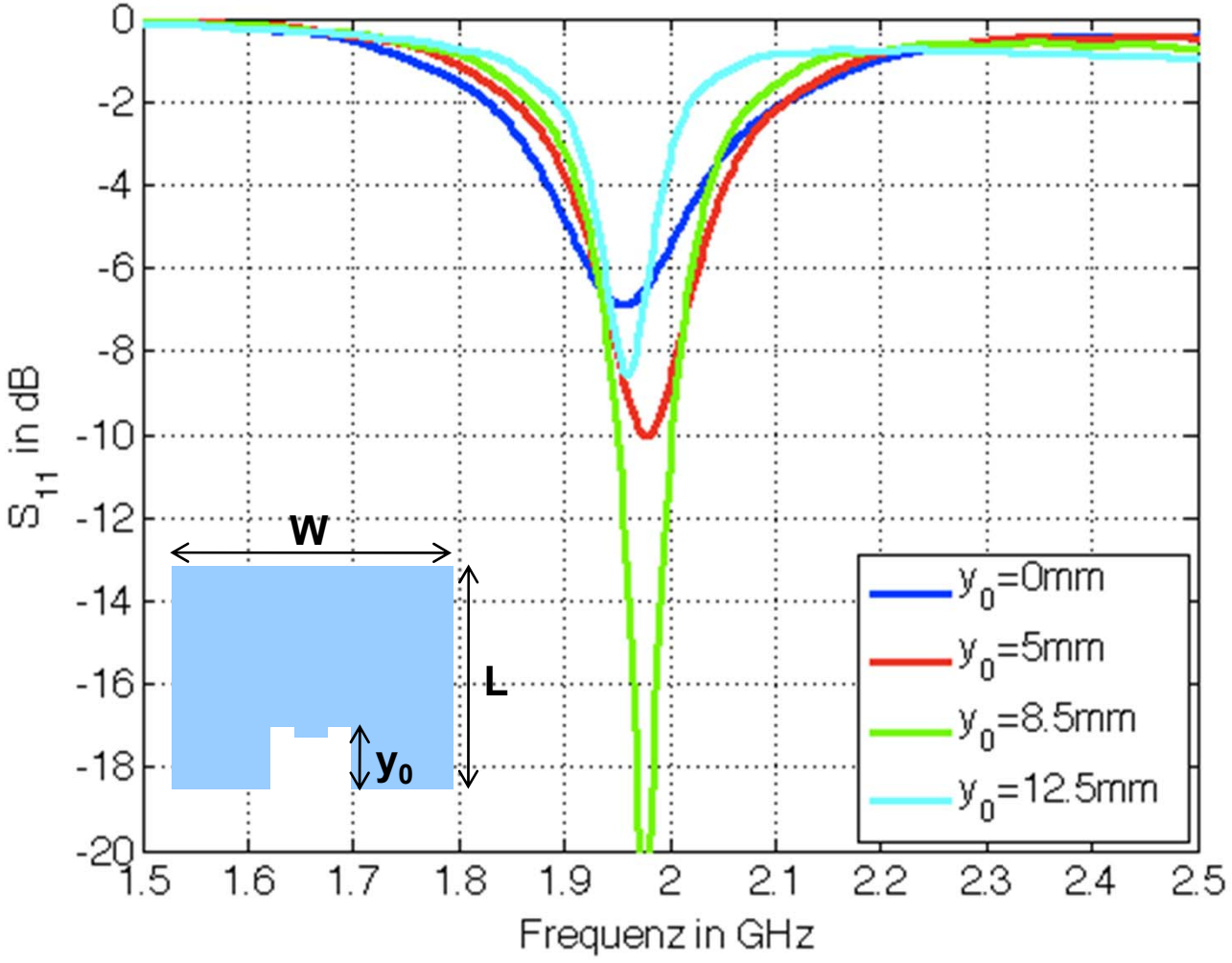
Lösung: Inset Feed



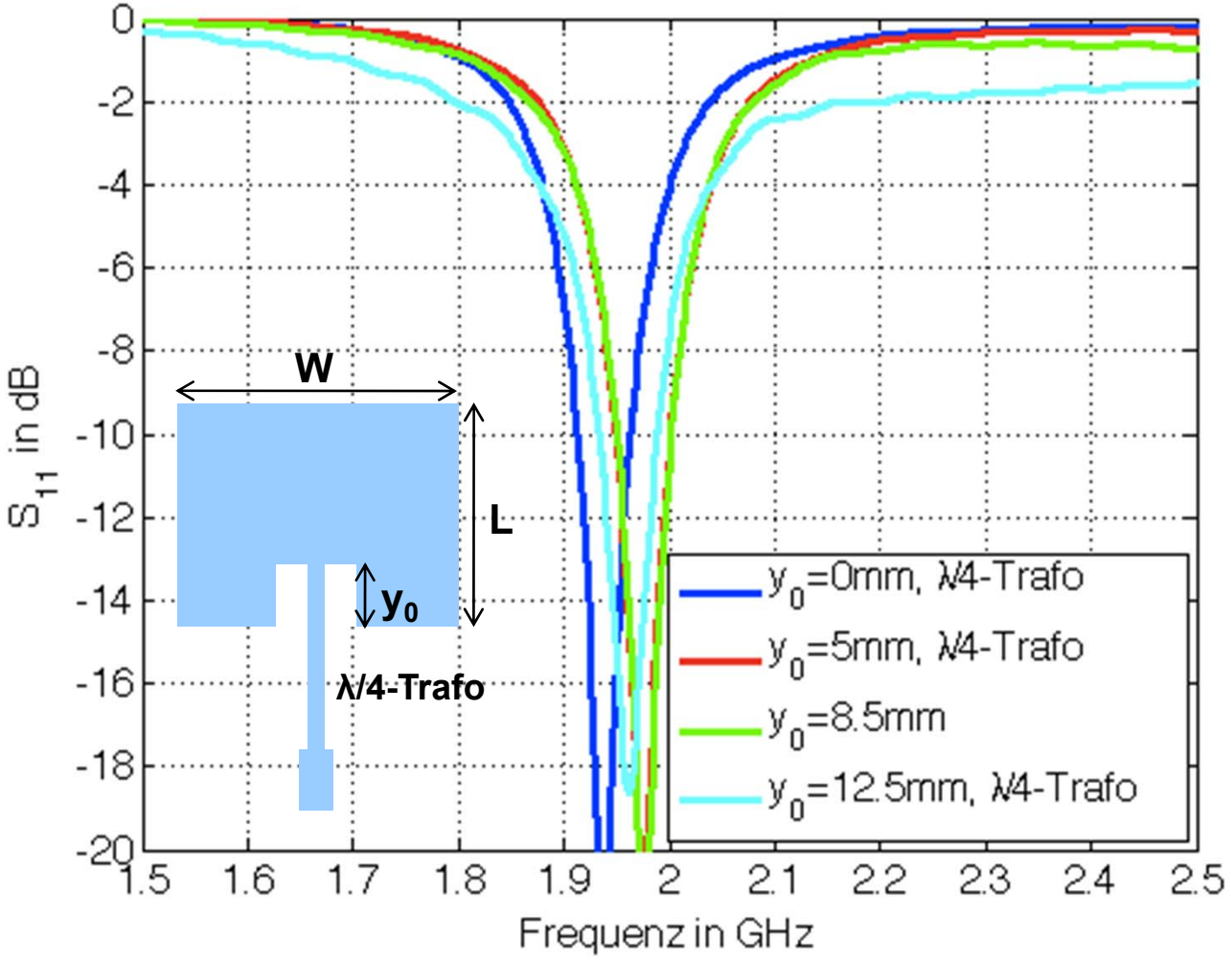
Inset Feed (2)


W
L
y_0
y_0=0mm
y_0=5mm
y_0=8.5mm
y_0=12.5mm
Realteil/Imaginärteil der Impedanz in Ω
Frequenz in GHz
140
120
100
80
60
40
20
0
-20
-40
-60
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
2.4
2.5

Inset Feed (3)

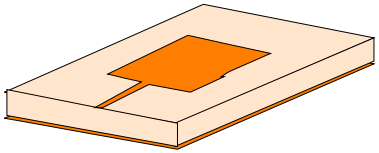

0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
S_{11} in dB
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
2.4
2.5
Frequenz in GHz
W
L
y_0
y_0=0mm
y_0=5mm
y_0=8.5mm
y_0=12.5mm

Inset Feed (4)


0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
S11 in dB
1.5
1.6
1.7
1.8
1.9
2
2.1
2.2
2.3
2.4
2.5
Frequenz in GHz
W
L
y0
λ/4-Trafo
y0=0mm, λ/4-Trafo
y0=5mm, λ/4-Trafo
y0=8.5mm
y0=12.5mm, λ/4-Trafo

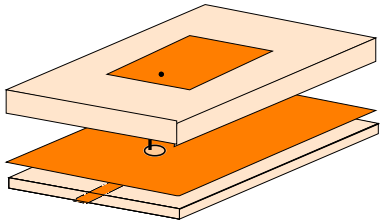
Feed Concepts for Single Polarized Patch Antennas

Conventional Microstrip Antennas



- narrow bandwidth
- low efficiency
- surface waves
- parasitic radiation

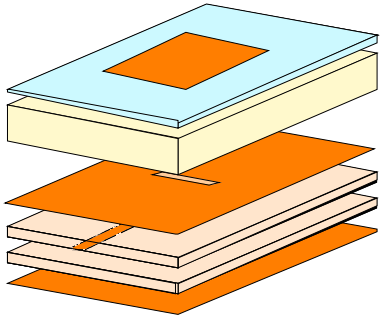
Microstrip fed



- solder connections
- high production costs
- thermal and mechanical stress

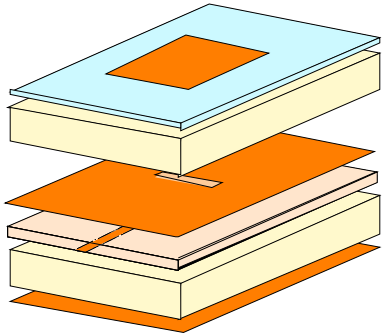
Probe fed

Aperture-Coupled Microstrip Antennas



- wide bandwidth
- high radiation efficiency
- low cross-polarisation level

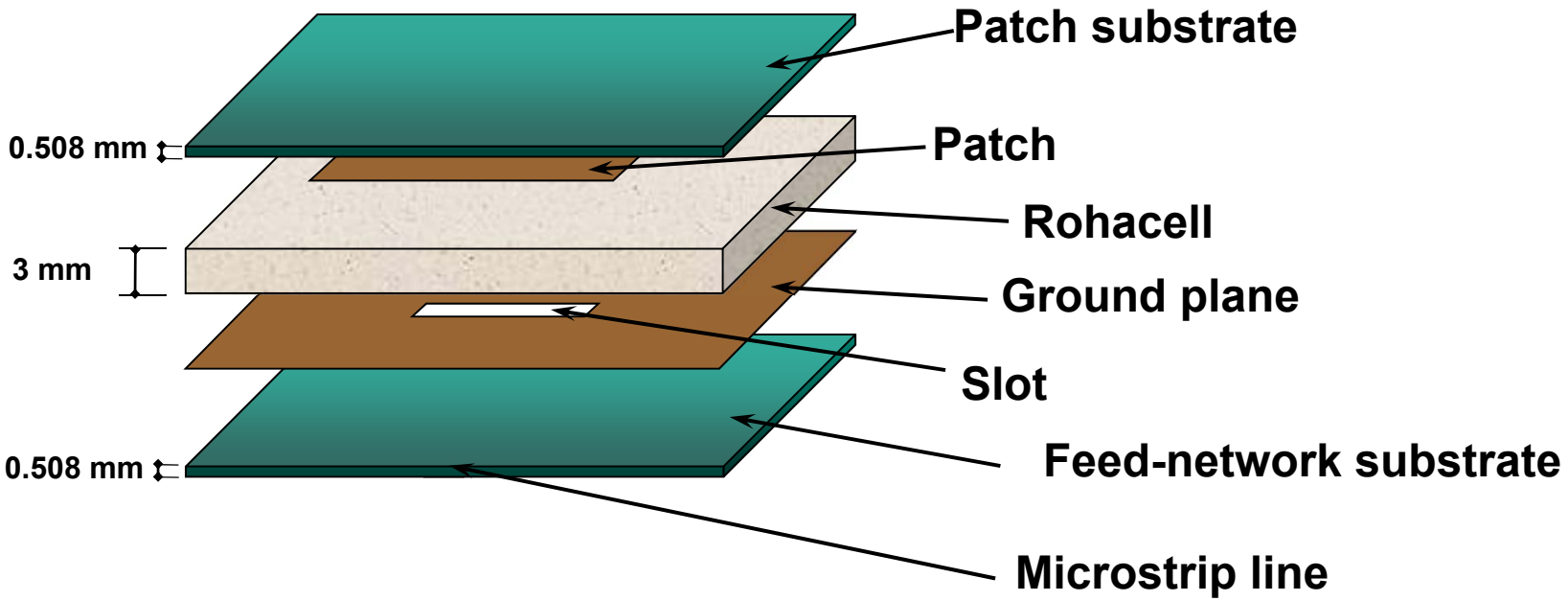
Stripline fed



- most suitable substrates for patch and feed network

Shielded Microstrip fed

Patch Antenna: Single Element

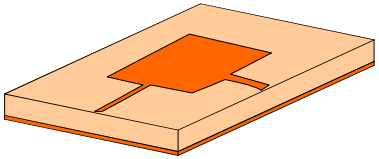


Dielectric substrate Duroid : $\varepsilon_r = 2.2$

Rohacell : $\varepsilon_r = 1.05$

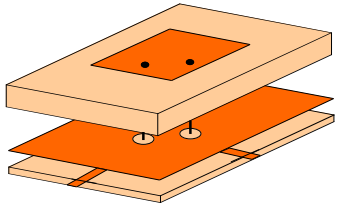
Feed Concepts for Dual Polarized Patch Antennas

Conventional Microstrip Antennas



Microstrip fed

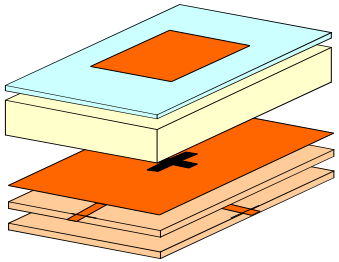
- narrow bandwidth
- low efficiency
- surface waves
- parasitic radiation



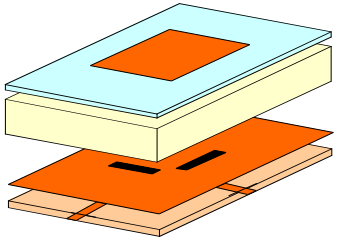
Probe fed

- solder connections
- high production costs
- thermal and mechnical stress

Aperture-Coupled Microstrip Antennas



- wide bandwidth
- high radiation efficiency
- low cross-polarisation level



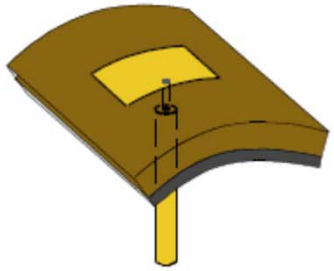
- most suitable substrates for patch and feed network

Conformal Microstrip Patch Antennas

Conventional Microstrip Antennas

Microstrip fed

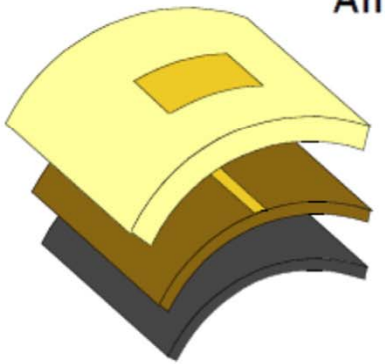
- narrow bandwidth
- low efficiency
- surface waves
- parasitic radiation



Probe fed

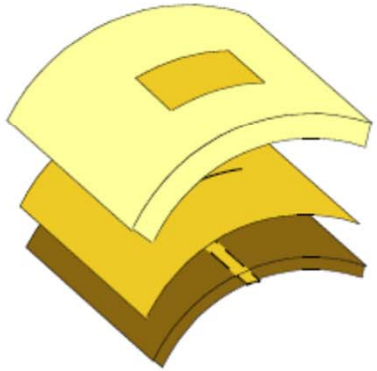
- solder connections
- high production costs
- thermal and mechnical stress

Electromagnetically Coupled Microstrip Antennas



Proximity Coupled

+ wide bandwidth
+ high radiation efficiency
- cross-polarisation level
- surface waves
- parasitic radiation

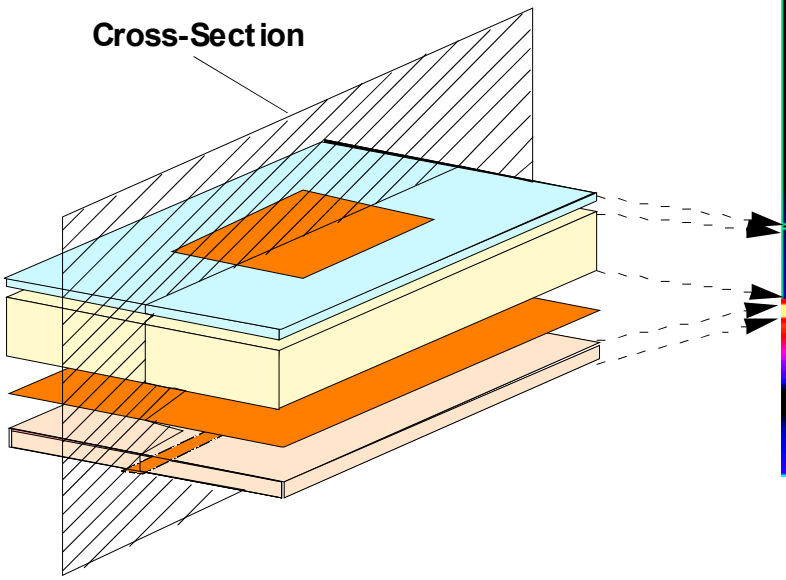


Aperture Coupled

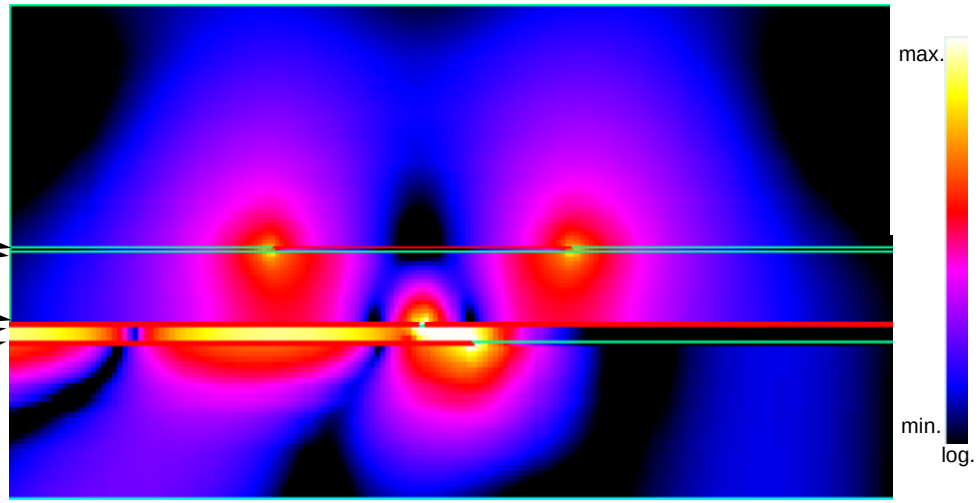
+ wide bandwidth
+ high radiation efficiency
+ low cross-polarisation level

E-Feld bei Aperturkopplung

Layout (Exploded View)

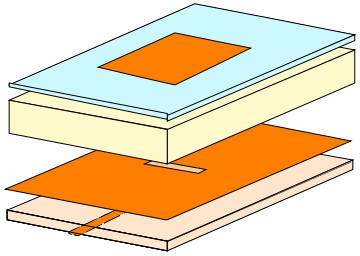


Calculated Electrical Field Strength in the Cross-Section

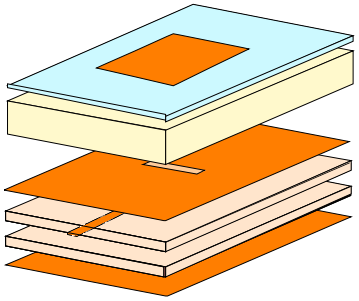


Comparison of Patch Antenna Feed Concepts

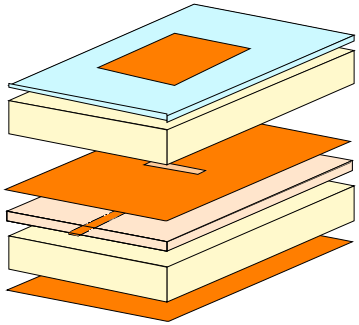
Various Feeding Techniques



Microstrip Fed

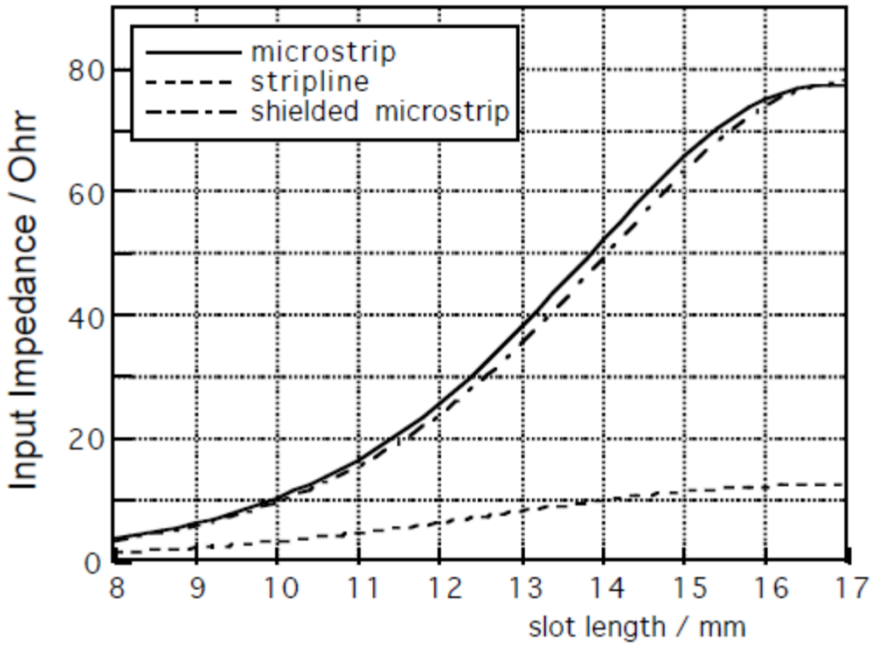


Stripline Fed



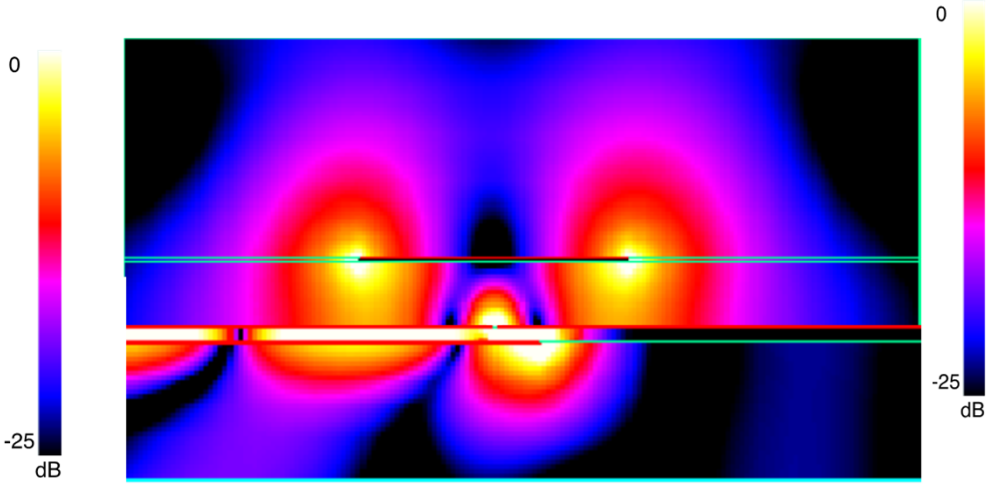
Shielded Microstrip Fed

Input Impedance vers. Slot Length

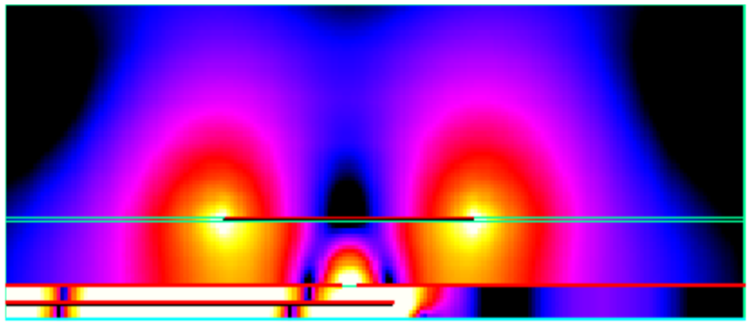


E-Feld bei verschiedenen Speisekonzepten

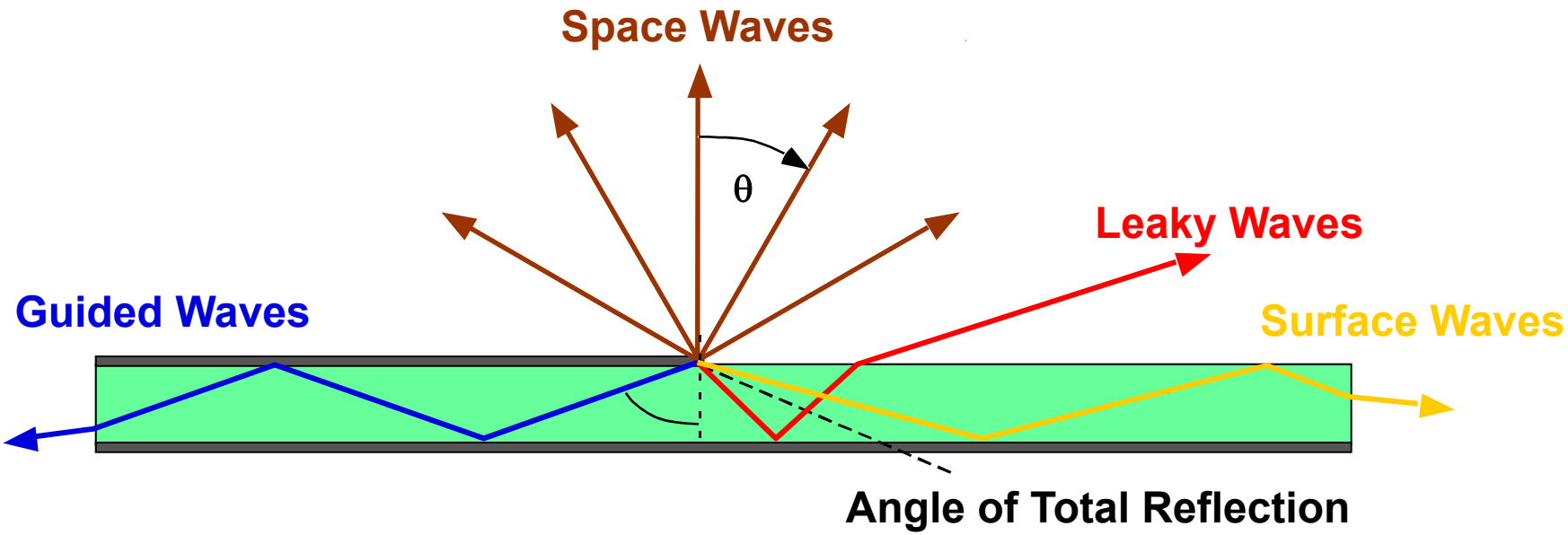
Microstrip-Speisung



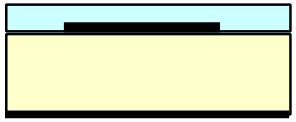
Triplate-Speisung



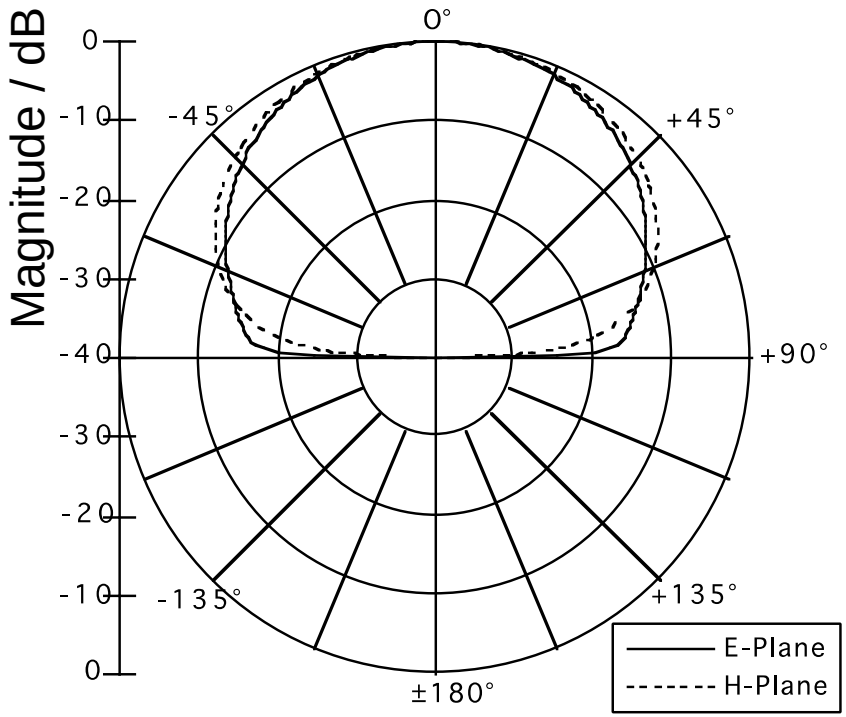
Waves in Microstrip Struktures

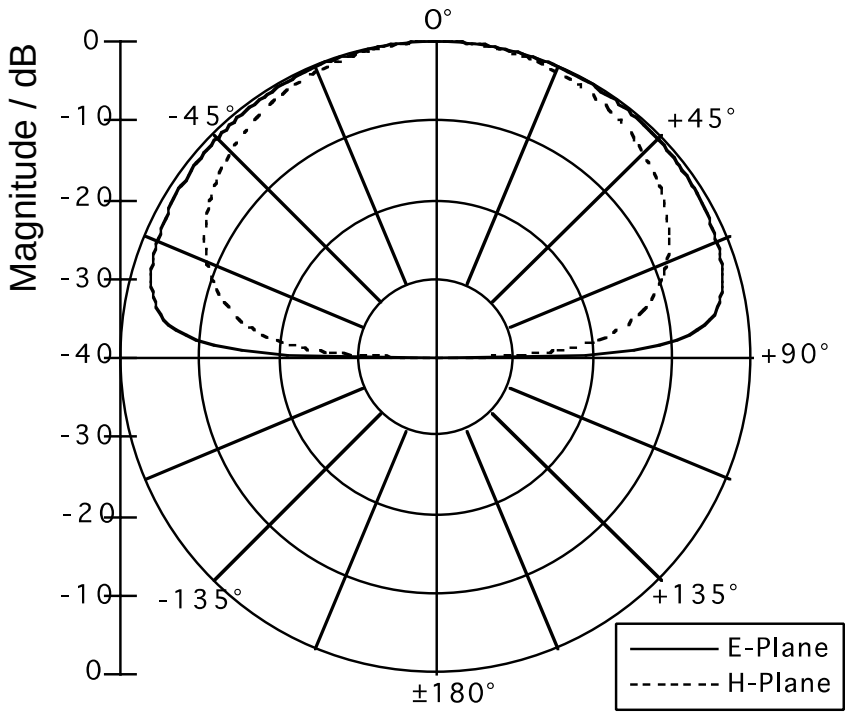


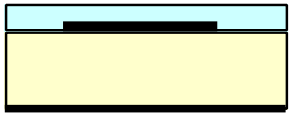
Efficiency of Patches on Commercial Substrates

Rohacell/Kapton	Duroid 5880	Duroid 6010
 Kapton Film 0.09 mm ε_r=3.8 Rohacell HF 51 2 mm ε_r=1.1	 RT/Duroid 5880 1.57 mm ε_r=2.2	 RT/Duroid 6010 1.57 mm ε_r=10.5
Efficiency	Efficiency	Efficiency
η = 97 %	η = 88.9 %	η = 68.7 %
Directivity	Directivity	Directivity
D = 8.9 dBi	D = 7.55 dBi	D = 6.05 dBi
Gain	Gain	Gain
G = 8.67 dBi	G = 6.7 dBi	G = 4.15 dBi

Patch Antenna Pattern on Different Substrates



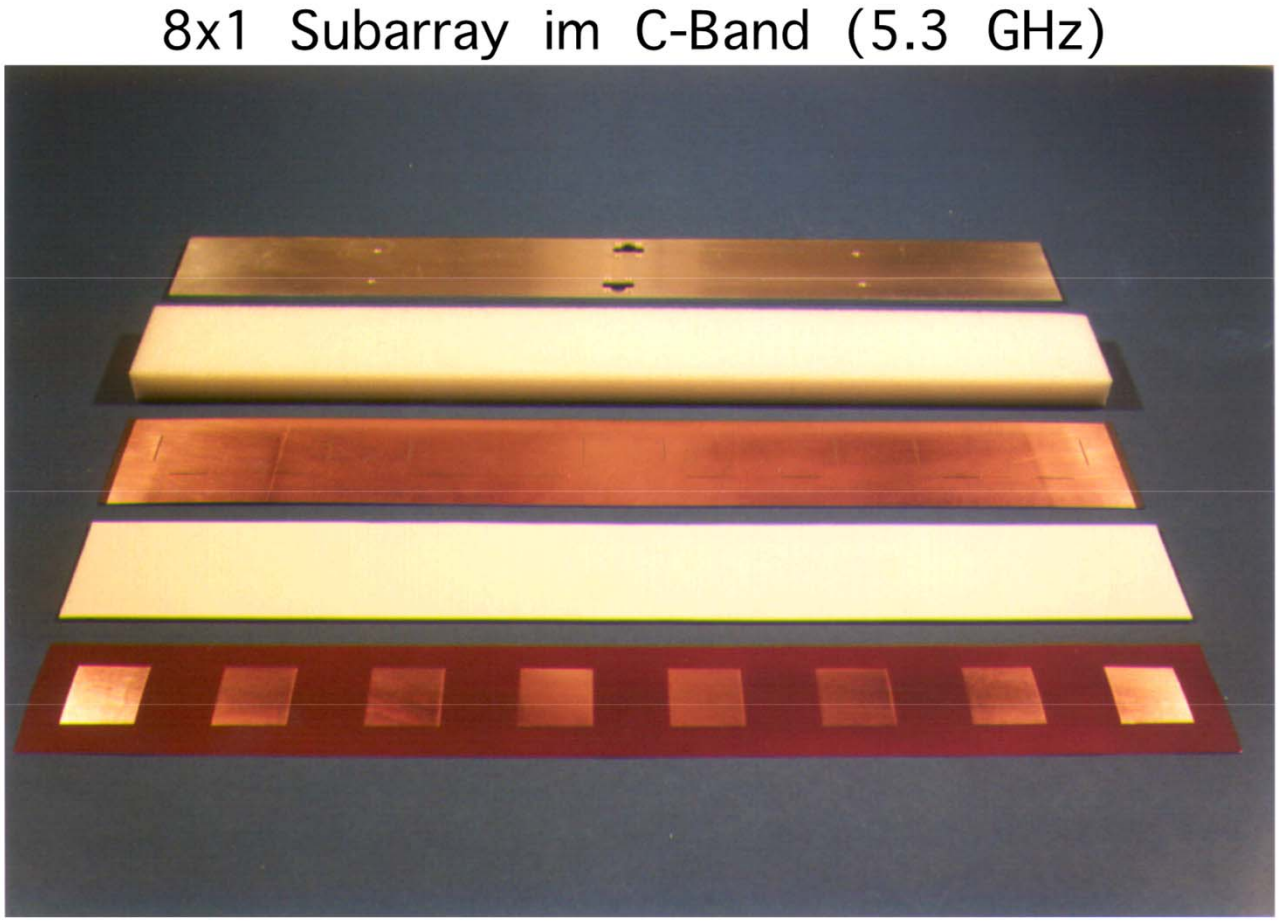




Kapton Film
0.09 mm ε_r=3.8
Rohacell HF 51
2 mm ε_r=1.1

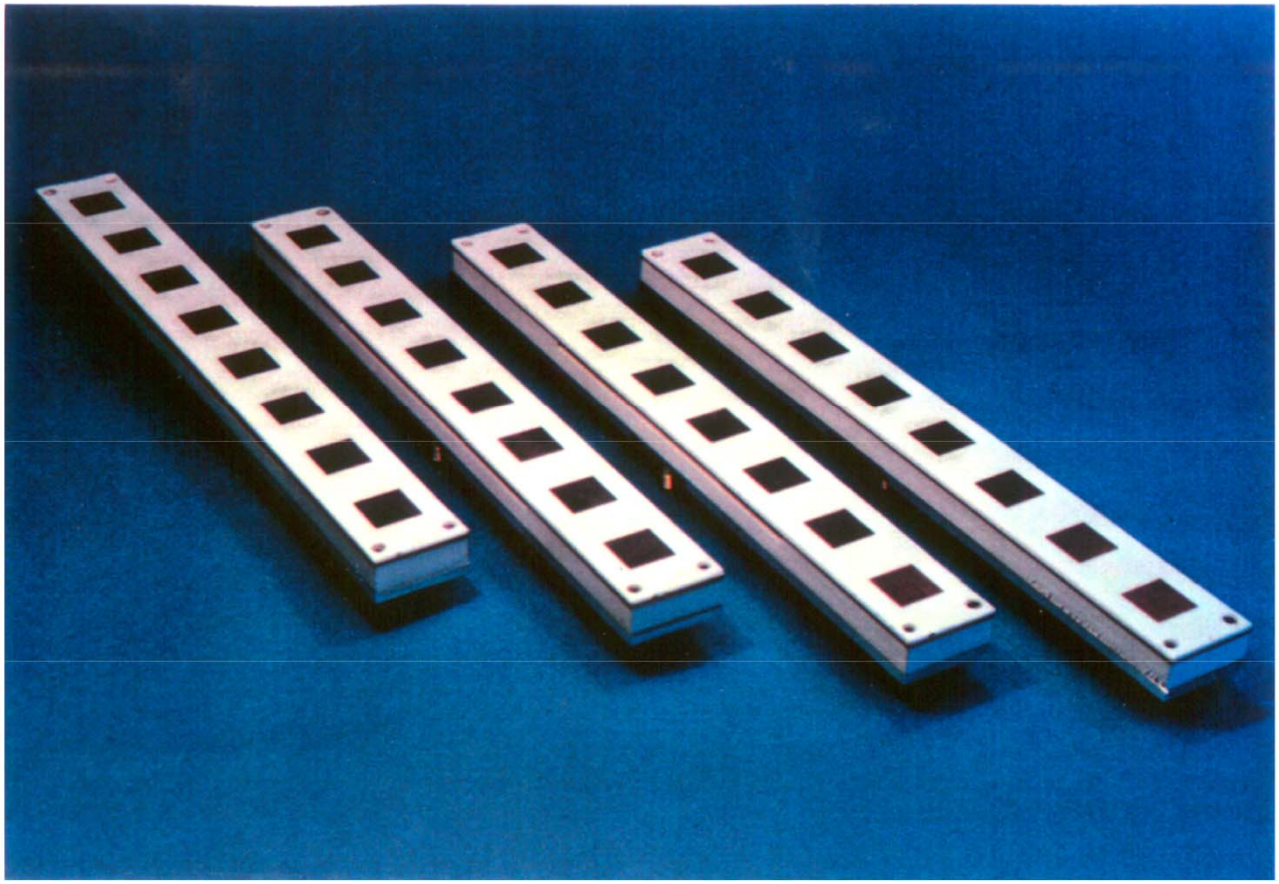
RT/Duroid 6010
1.57 mm
ε_r=10.5

8x1 Patch-Array



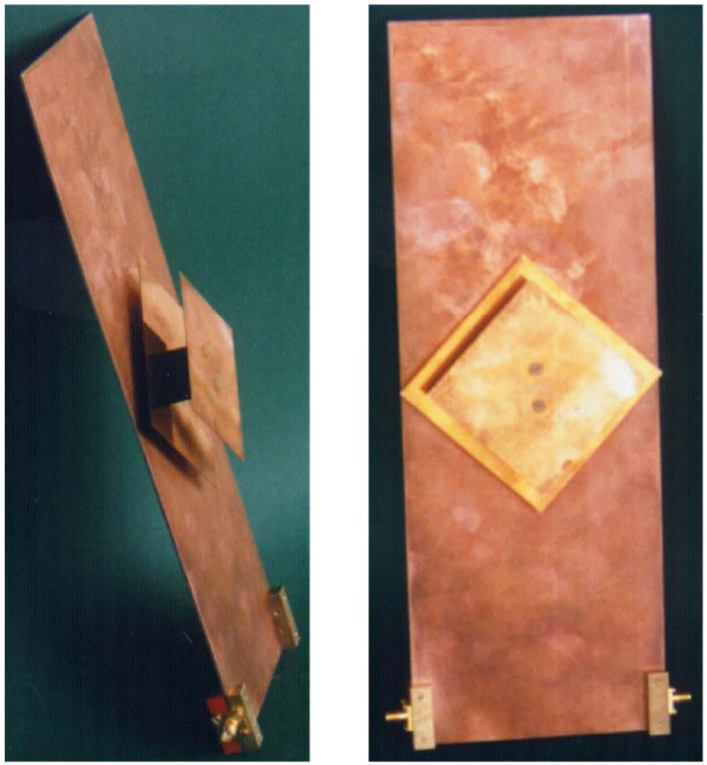
8x1 Patch-Array

8x1 Subarrays im X-Band (9.6 GHz)

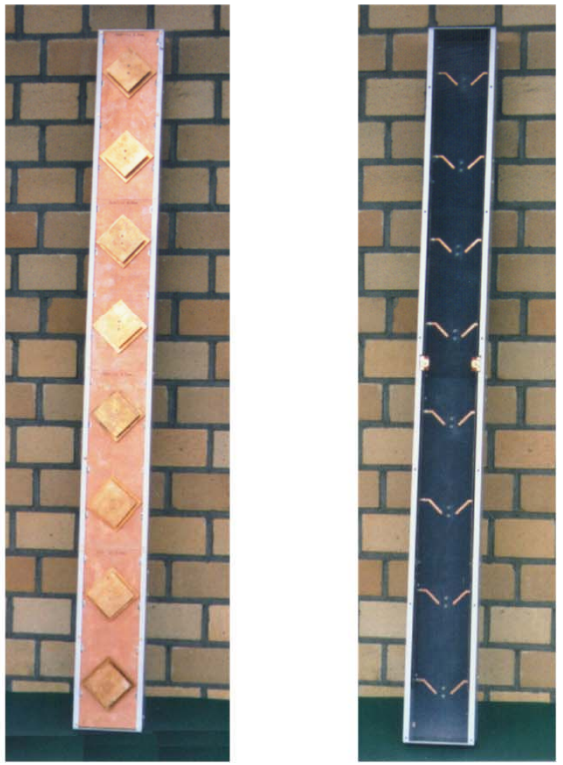


1,8 GHz, Basisstationsantenne

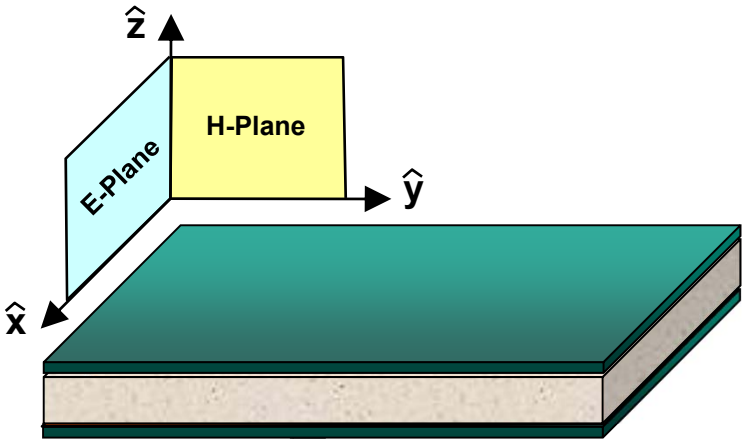
Einzelelement

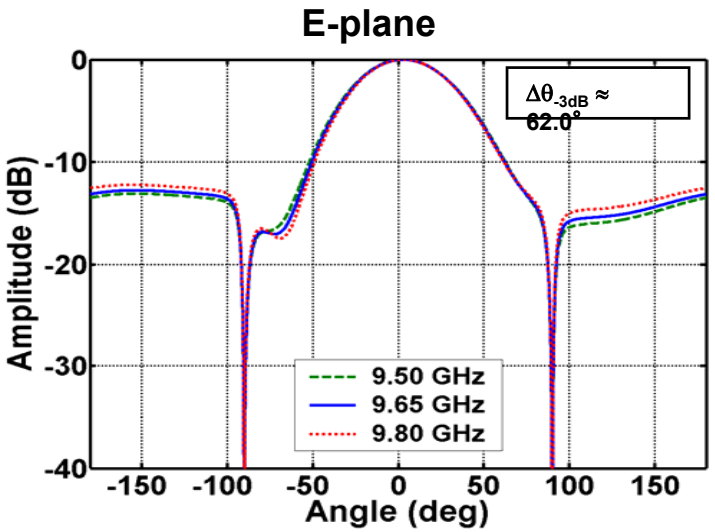


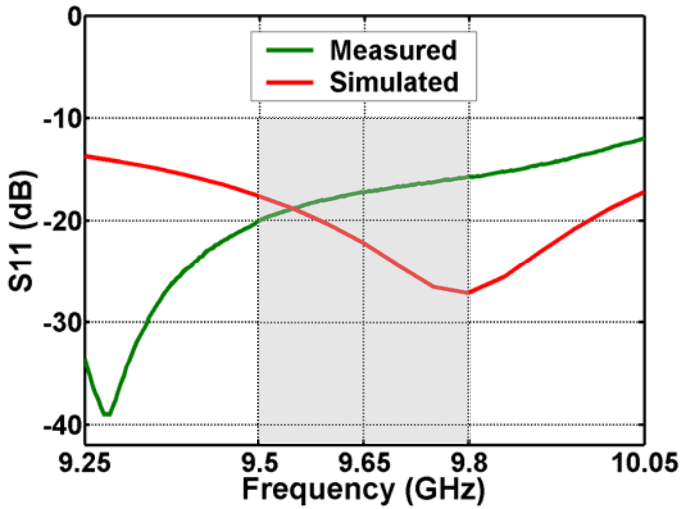
8x1 Subarray

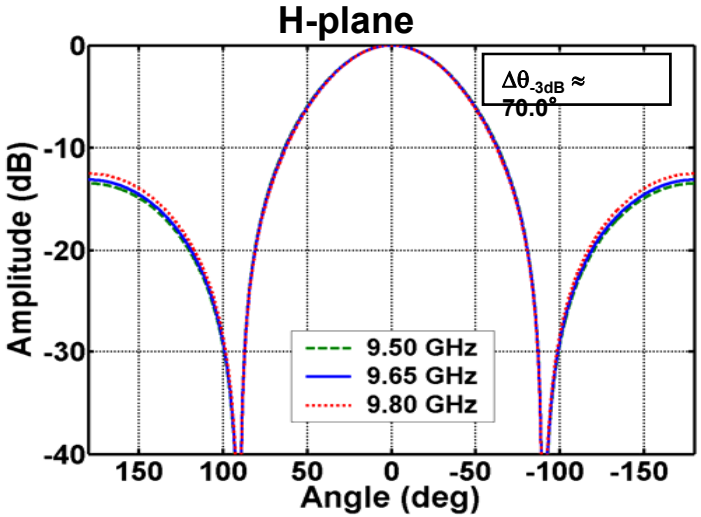


X-Band Patch Antenna: Single Element

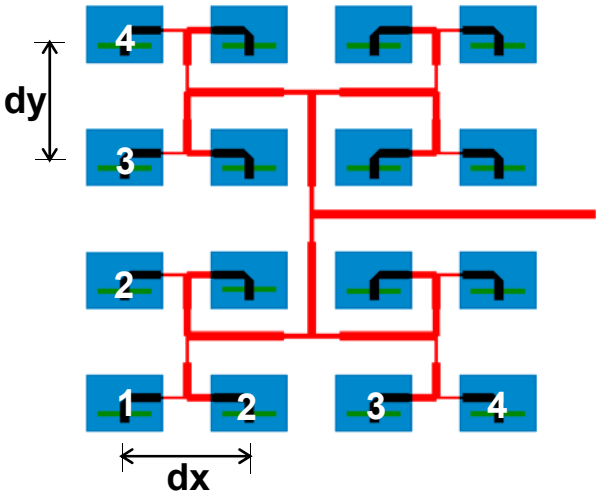








X-Band Patch Array: Pattern Synthesis

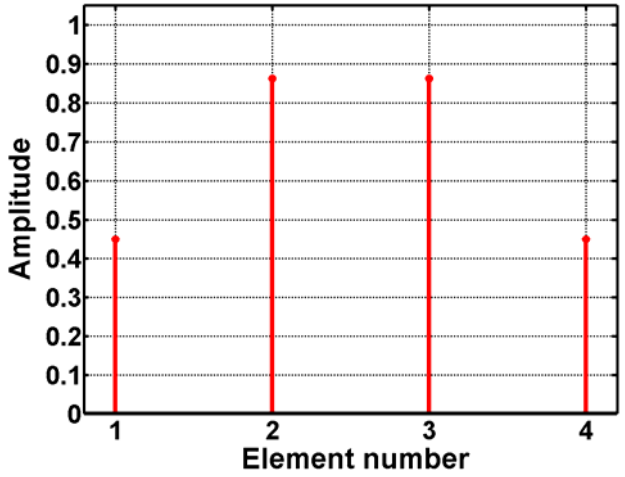


$\lambda_0 = 31.1$ mm

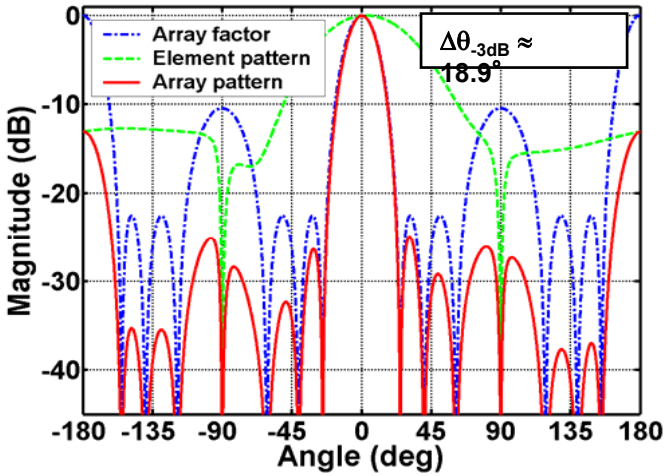
$dx = 0.78\lambda_0 = 24.26$ mm

$dy = 0.77\lambda_0 = 23.95$ mm

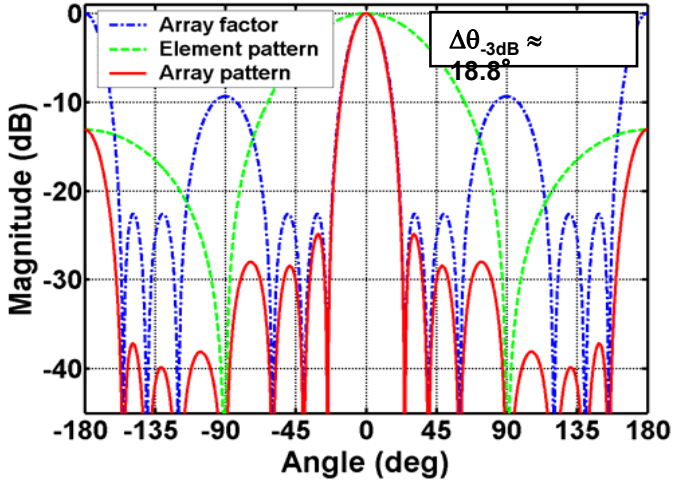
Current distribution (both E and H plane)



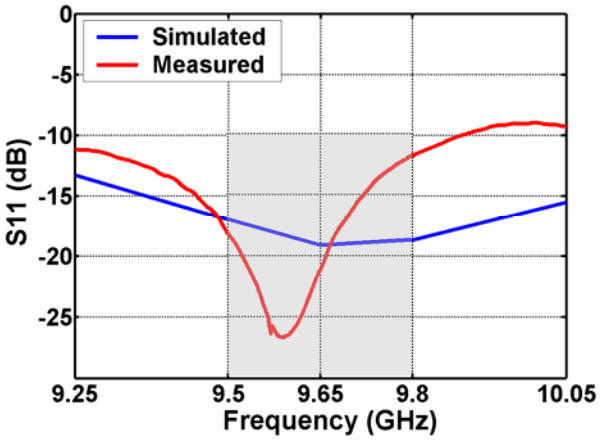
E-plane

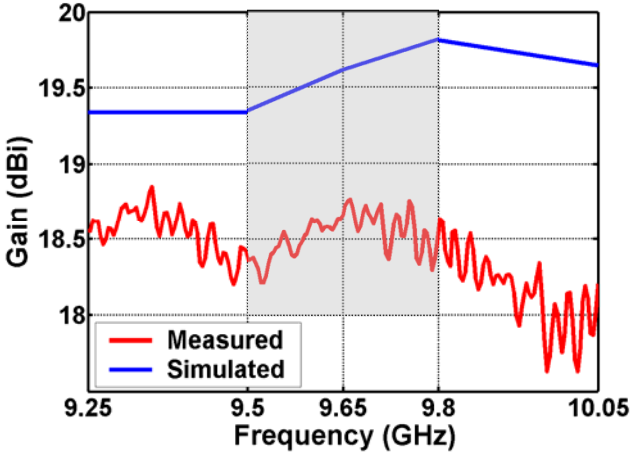


H-plane

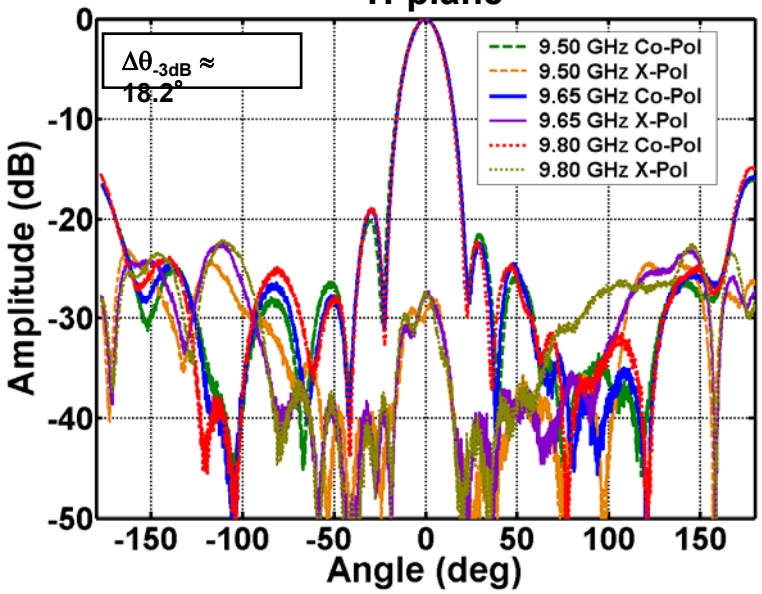


X-Band Patch Array: Measurements

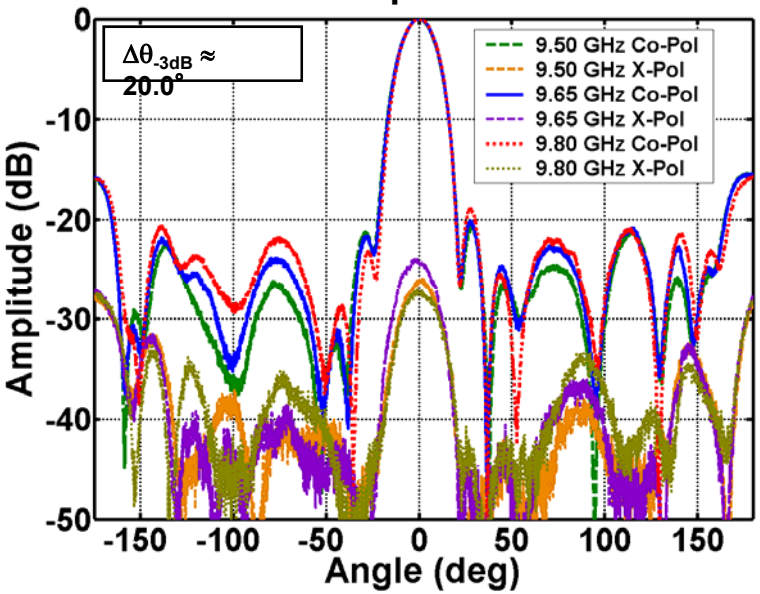




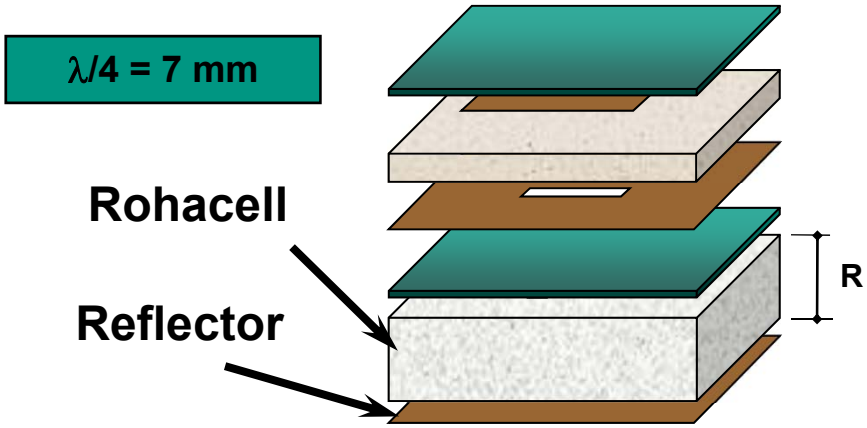
H-plane

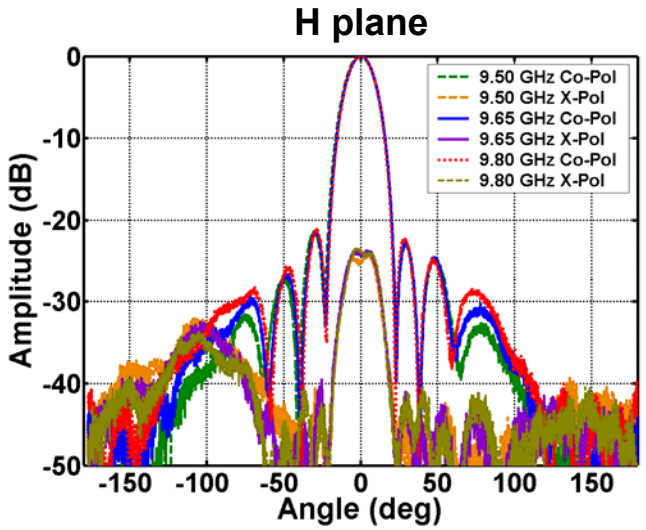


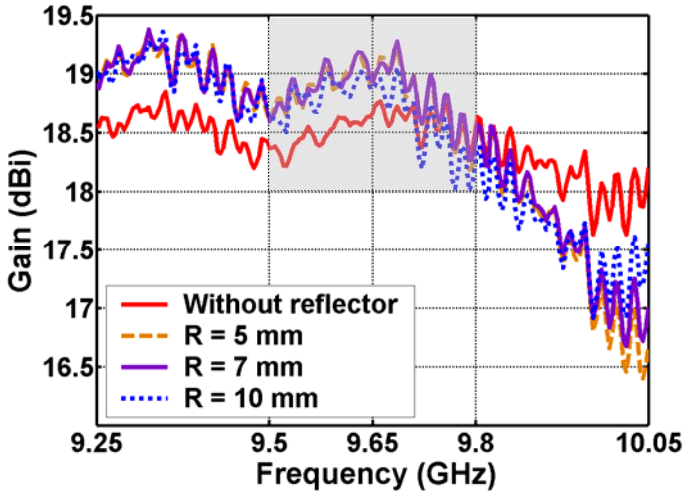
E-plane

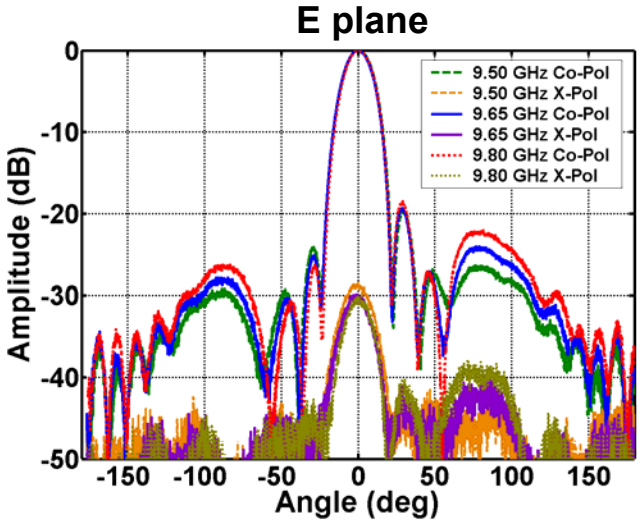


X-Band Patch Antenna









Patch Antenna