Planar Antennas for WLAN Applications

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Outlines

- **WLAN Mobile-Unit Antennas**
  - Surface mountable antennas
  - Printed monopole antennas
  - Printed dipole antennas
  - Slot antennas, PIFAs

- **WLAN Access-Point Antennas**
  - Patch antennas for broadside radiation
  - Printed monopole antennas
  - Printed dipole array antennas
Surface Mountable Antennas

- Ceramic chip antennas
- Plastic chip or Folded strip monopole antennas
- Dielectric resonator antennas
SMA- Ceramic Chip Antennas

- Regular patch antenna (ceramic chip as a substrate)
- PIFAs
- Monopoles (ceramic chip as a support for the monopole)
SMA- Ceramic Chip Antenna (1)

CP Design

ceramic chip

radiating patch

protruded ground for easy connection to the system ground

ground plane

feed

US Patent 6140968
SMA- Ceramic Chip Antenna (2)

CP Design, dual side-feed, feed at A for RHCP, feed at B for LHCP

ceramic chip ($\varepsilon_r = 45$)
SMA- Ceramic Chip Antenna (2.2)

CP Design, dual side-feed ceramic chip antenna; Gain level about 3.0 dBiC (test board 50 mm x 50 mm) for 1575 GHz GPS operation

Patent pending
3D Model in Ansoft HFSS
Current Plot on Antenna

Ansoft HFSS
SMA- Ceramic Chip Antenna (3)

Helix monopole embedded within the ceramic chip

Meandered monopole embedded within the ceramic chip

US Patent 5977927, 5892490
SMA- Plastic Chip or Folded Strip Monopole (1)

Dual-band operation in 2.4/5.2 GHz WLAN bands;
Antenna size: 12 x 8 x 3 mm³

Planar structure

Bending line

Patent pending
SMA- Plastic Chip or Folded Strip Monopole (1.1)

10 dB RL BW: 130 MHz for 2.4 GHz band, 418 MHz for 5.2 GHz band;
Gain level about 2 dBi in the 2.4 and 5.2 GHz bands
SMA-DR Antennas

- Dielectric constant = 20 ~ 100
- Compact size
- Very low dielectric loss
- No metallic loss, Suitable for higher-frequency operation
- Wider bandwidth than microstrip antennas
SMA- DR Antenna with a CPW feed or a microstrip-line feed

DR antenna can be easily excited by a CPW line or a microstrip line

Low-profile square-disk DR
SMA- Broadband DR Antenna with a Microstrip Feed (1)

DRA with size $1.6 \times 10 \times 10$ mm$^3$ and $\varepsilon_r = 90.5$ has a 250-MHz BW for WLAN operation in the 5.2 GHz band.
SMA- DR Antenna for CP Radiation (1) using a loading patch

DRA with size 28 x 28 x 4.9 mm$^3$ and $\varepsilon_r = 79$ has a 1.1% CP BW@2 GHz

Patent pending
SMA- DR Antenna for CP Radiation (2) using a cross-slot-coupled feed

DRA with radius 14.7 mm, height 5.1 mm, and $\varepsilon_r = 79$ has a 3.9% CP BW@2 GHz
WLAN Printed Monopole Antennas

- Integrated design with the system circuit board
  - Dual-band monopole antenna
  - Diversity monopole antenna
  - Diversity dual-band monopole antenna

- Printed monopole with a coaxial feed line
WLAN Printed Monopole-Dual-band monopole (1)

Dual-band F-shaped monopole for 2.4/5.2 GHz WLAN bands; antenna size: 10 x 15 mm²

F-shaped monopole
feed point
microstrip feed line
ground
circuit board (45 x 80 mm²)

Patent pending
3D Model in Ansoft HFSS & Vector Current Plot
WLAN Printed Monopole-Dual-band monopole (2)

Dual-band spiral monopole for 2.4/5.2 GHz WLAN bands

Patent pending
3D Model in Ansoft HFSS

Without substrate

Ground plane

substrate
Magnitude Current Plot on Antenna

Ansoft HFSS
WLAN Printed Monopole-Dual-band design (3)

Dual-band double-T monopole for 2.4/5.2 GHz WLAN bands

Patent pending
WLAN Printed Monopole-Diversity monopole design (1)

Spatial/ polarization diversity in the 2.4 GHz band

Protruded ground plane improves port decoupling between ports 1 and 2

Patent pending
WLAN Printed Monopole-Diversity monopole design (1.1)

Gain level $\sim$ 1.8 dBi for ports 1 and 2
WLAN Printed Monopole-Diversity monopole design (1.3)

Other promising diversity monopole antennas with highly decoupled feeding ports

Patent pending
WLAN Printed Monopole-Diversity dual-band monopole (1)

Diversity monopole antenna for 2.4 and 5.2 GHz dual-band operations

Protruded ground plane improves port decoupling between ports 1 and 2

Patent pending
WLAN Printed Monopole- Diversity dual-band monopole (1.1)

Within the 2.4 and 5.2 GHz bands, $S_{11} < -10 \, \text{dB}$ and $S_{21} < -28 \, \text{dB}$
WLAN Printed Monopole—using a coaxial feed line

Dual-band spiral monopole for 2.4/5.2 GHz WLAN bands

FR4 substrate (size 8.5 x 19 mm²)

FR4 substrate (size 8.5 x 8 mm²)

50-Ω microstrip line

50-Ω coaxial line

Patent pending
Dual-Band Printed Dipole Antennas

- With trident arms
- With open-loop arms
- With L-slit-loaded arms
- With U-slotted arms
- With folded arms
Dual-Band Printed Dipole-Fed by a Coaxial Line (1)

- dipole arm for lower operating frequency
- dipole arm for upper operating frequency
- open-loop dipole arm for dual-frequency operation
- FR4 substrate

NSYSU, Taiwan

Patent pending
Printed Dipoles/Monopoles/Slot Antennas/PIFAs Applied to Notebook Computer
Radiation patterns across the 2.4 and 5.2 GHz bands are stable and close to those of a simple dipole antenna.

Patent pending
WLAN Slot Antenna/PIFA Applied to Notebook Computer

slot antenna
0.5 wavelength in length

PIFA
0.25 wavelength in length
WLAN 2.4/5.2 GHz Dual-Band Slot Antenna

Antenna gain level in both the 2.4 and 5.2 GHz about 6.0~7.0 dBi
PIFAs for WLAN Operation - PIFA with a parasitic shorted patch

Antenna operates at the first resonant frequency of the driven and parasitic patches (2.4/5.8 GHz dual band)

Patch 5 mm above ground

Patent pending
WLAN AP Antennas

- Broadband CP design
- Dual-polarized design
- Dual-band design
- Printed dipole array for omnidirectional radiation
WLAN AP Antenna-Broadband CP design (1)

- Single-feed design with low cost in construction

3dB AR CP bandwidth > 10% @2.45 GHz, gain level ~ 8.5 dBi

Patent pending
WLAN AP Antenna-Broadband CP design (1.1)
WLAN AP Antenna-Broadband CP design (1.2)
WLAN AP Antenna - Dual-Band design - Printed monopole

2.4 GHz band: 3.5-4.0 dBi
5.2 GHz band: 4.0-5.5 dBi
Omnidirectional radiation

Patent pending
WLAN AP Antenna-
Omnidirectional printed dipole array (1)

5 GHz AP dipole array:
1.5:1 VSWR: 5.15-5.35 GHz
Peak gain: > 5.5 dBi
Omnidirectional ripple: < 2 dBi
Size: 12 mm x 90 mm
Omnidirectional pattern

Ports 1, 2: 0°, 1/4 power
Ports 3, 4: 180°, 1/4 power
WLAN AP Antenna-Diversity printed dipole

**top view**

**bottom view**

- balun
- feed line
- port 1
- port 2
Conclusions

- Planar antennas are good candidates for WLAN applications
- More promising planar antenna designs and applications are in progress