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RF expertise
Antenna Integration
& Design Guidelines

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RF Expertise

Antenna 3F optimization (form-fit-function)

Close cooperation & collaboration with the customer for:

- SAR and shielding related issues
- PCB editing and ground plane related issues
- Impedance matching requirements
- Integration – microphone, speaker, camera, FPCB, etc.
- Diversity issues

Simulation

Rapid prototyping

Benchmarking

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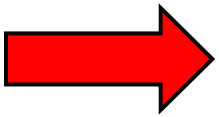
RF Expertise

Choice of material

$$\eta t = \eta r\ \eta c\ \eta d$$



Use Low loss Plastics and high conductivity radiators

$\eta t = total\ efficiency$

$\eta r = reflection\ efficiency = \left(1 - |\Gamma|^2\right)$

$\eta c = conduction\ efficiency$

$\eta d = dielectric\ efficiency$

Also effected by Hand and Head

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RF Expertise

Hand held positions

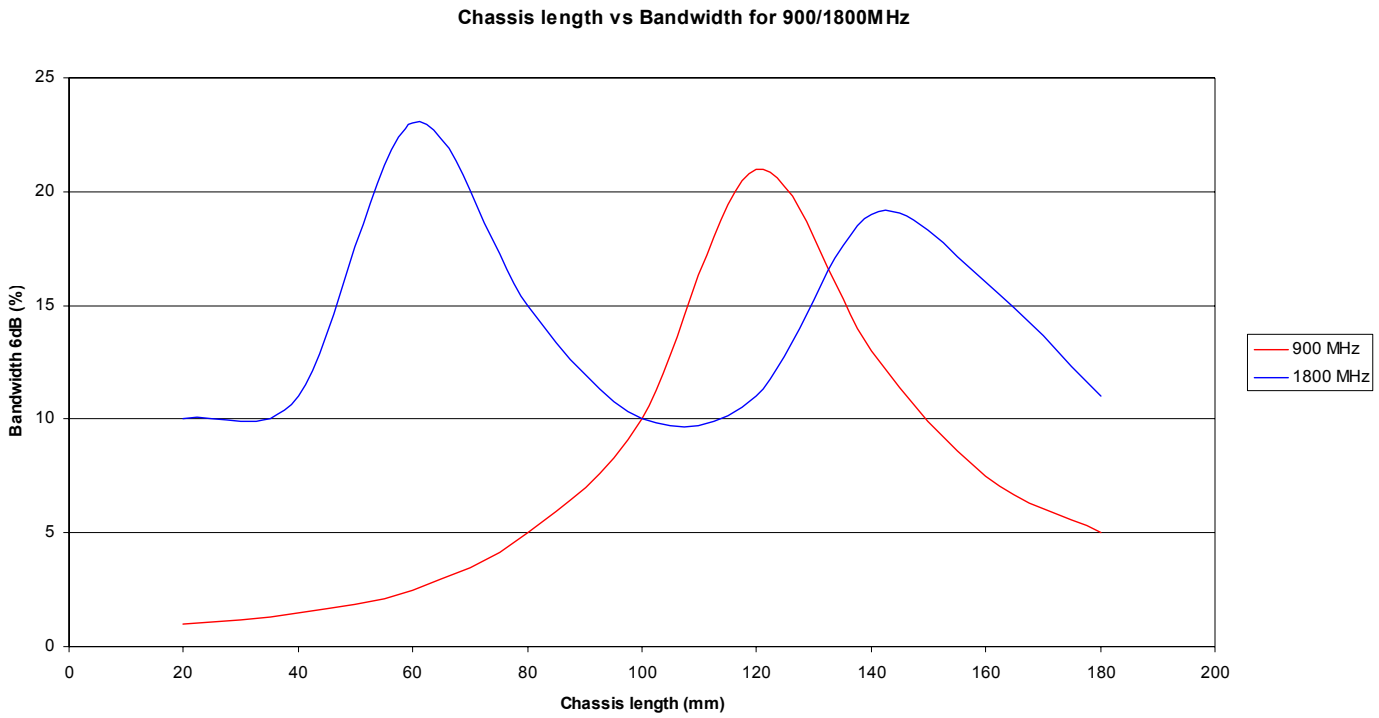
The hand and head can reduce the signal form 6 – 12 dB's depending on the phone structure and how the phone is held.

Careful consideration to antenna location can help reduce the performance loss.

RF Expertise

The Ground Plane

The length of the phone Chassis has a considerable effect on the performance of the antenna.



RF Expertise

Antenna Volume

The greater the Antenna volume the better the Bandwidth and Efficiency.

A good volume for Dual band is approx 4 - 6cc.

Quad-band volume approx 5 – 7cc.

The minimum height of the antenna above the ground plane should be about 5mm.

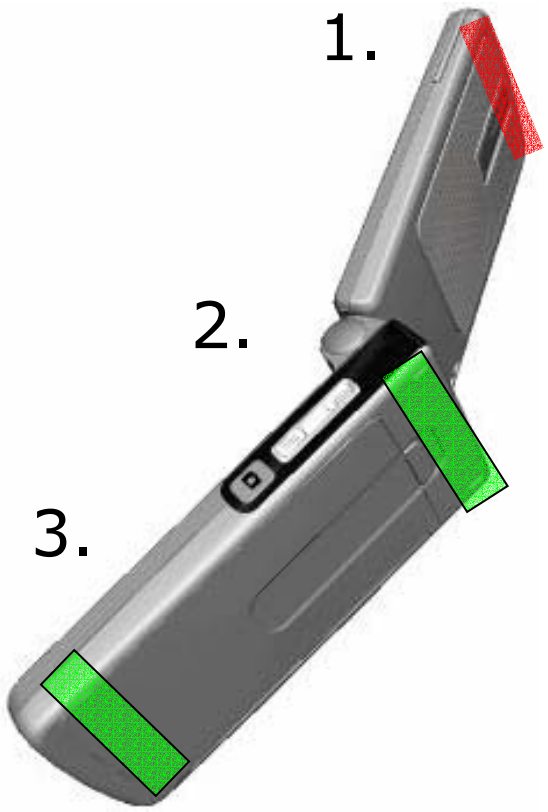
Bar Phone - Antenna Integration

This is the simplest phone type for antenna integration and has been done so for many years.

1. Best location for the antenna, antenna performance is very much dictated by the length of the Ground plane (phone)

2. Location can be used but the hand can cover antenna depending on the holding position of the phone. Antenna is close to bottom connector for the phone causing interference with data lines.

Clamshell Phone - Antenna Integration



1. Location poor due to a number of reasons:

Small antenna volume because top flip is normally thin.

Minimal ground plane support for antenna to work against especially if double sided LCD present.

Interaction with display, speaker and FPCB.

Miniature coax cable has to be run from main board to top flip adding extra loss and potential cable radiation problems.

Close Proximity to the head can give SAR issues.

2. and 3. are acceptable locations for antenna.

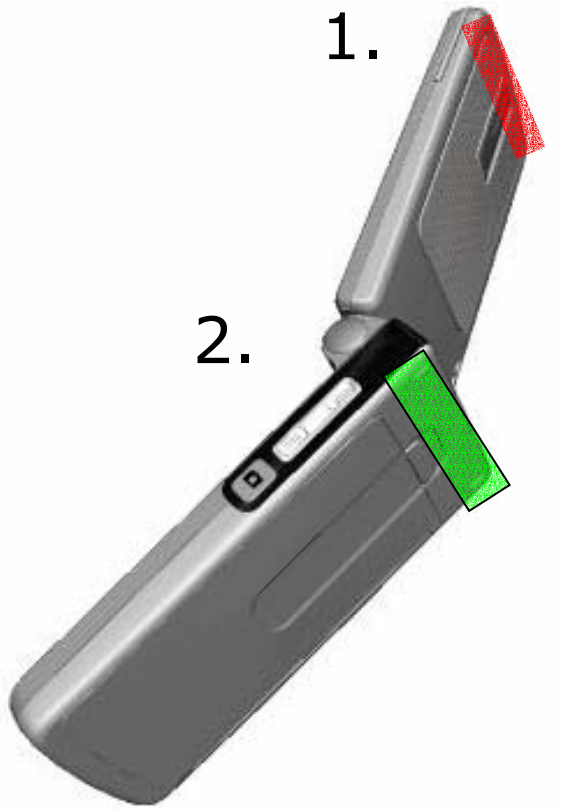
Slider Phone - Antenna Integration

1. Location poor due to antenna being shielded in closed position.

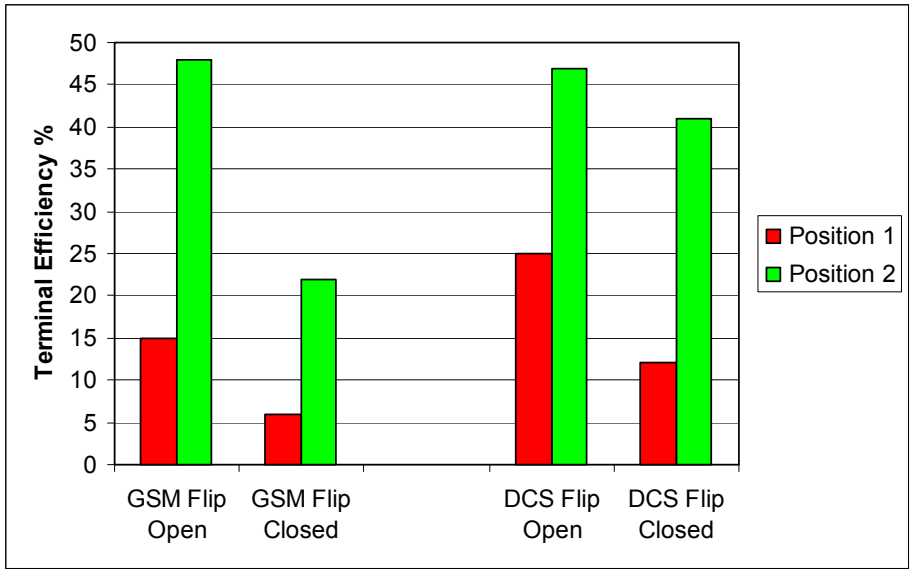
2. Position is workable but hand coverage can be an issue, care has to be taken with the FPCB that connects the two parts of the phone.

3. Position is probably the best for Slider phones minimal hand coverage.

Clamshell Phone - Real Example



Antenna relocated from position 1 to 2 for improvement in performance.



Bar Phone – Battery position

One the key effects impacting on the antenna performance is the position of the battery. If the battery is placed too close to the antenna, radiation efficiency might be reduced significantly.

A distance of 10mm in recommended. As this is not achievable in some phones especially clam shell types a minimum of 5mm is advised.

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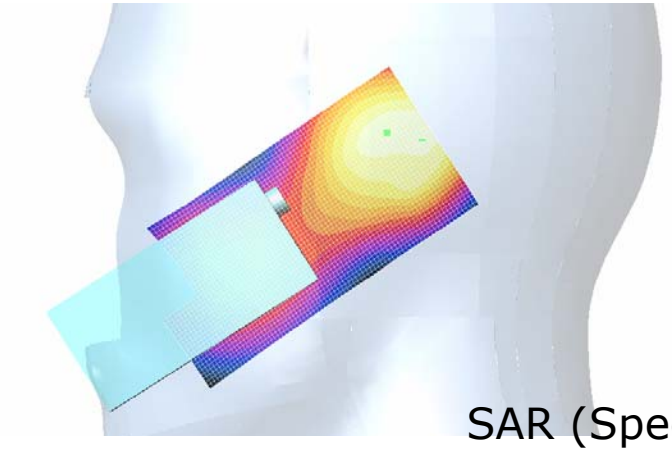
Expertise beyond the antenna

- SAR reduction techniques

-Simulation of RF fields around the antenna

-Noise and Sensitivity issues created by other parts in the phone



SAR Considerations

SAR (Specific absorption rate) – Portion of power absorbed in the biological tissue.

Any location where the antenna is close to the head in talk position will increase the SAR

PIFA designs where there is a ground shield in between the Antenna and the users head will have lower SAR than an internal Monopole design with no shield.

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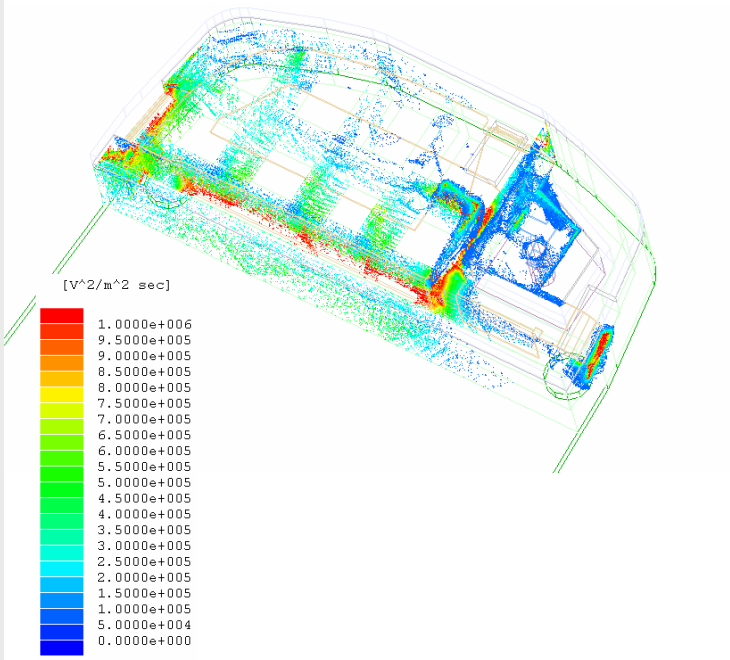
Simulation of RF Fields



Use High frequency structure simulator HFSS

-Analyze power dissipation in and around the antenna

- Determine hotspots and area of energy losses

- Recommend choice of material

- Ensure best design

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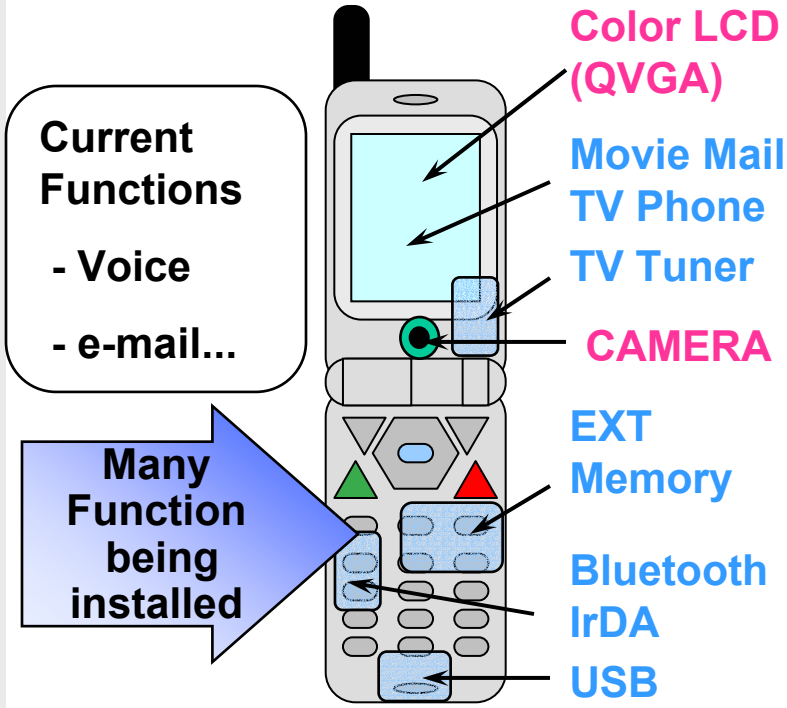
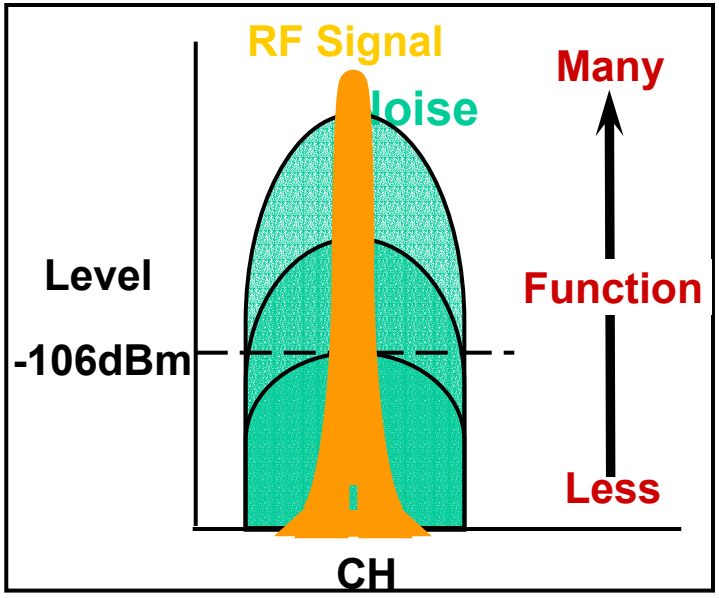
Noise issues Considerations

- Effects on antenna sensitivity



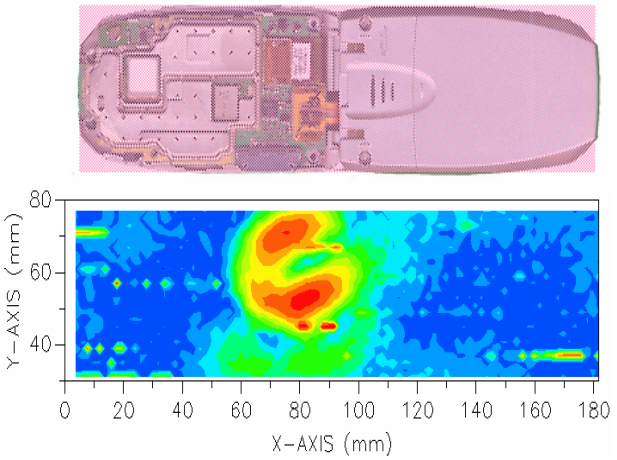
- In todays mobile phone the communication through RF signals is paralleled with many other functions.
- Many new functions are installed in the baseband
- Many additional features are installed which carry large amount of data signals
- Examples are camera, color LCD, external memory, USB and bluetooth ports and others

Noise issues Considerations



- The ability of the phone to receive the RF signals from the communicating Basestation depends largely on the strength of the RF signal above the noise floor level.
- Most of the new functions installed increase the noise floor level of the phone
- Depending on the quality of the shielding the noise will disturb the RF signal received by the antenna
- Concurrently the Receiver sensitivity decreases as the Bit Error Rate (BER) and Frame Error Rate (FER) are increased

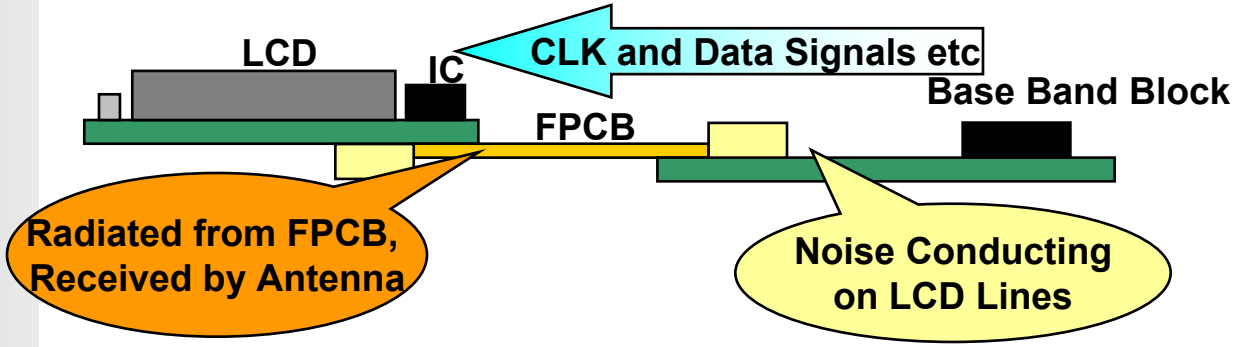
Noise related to the LCD



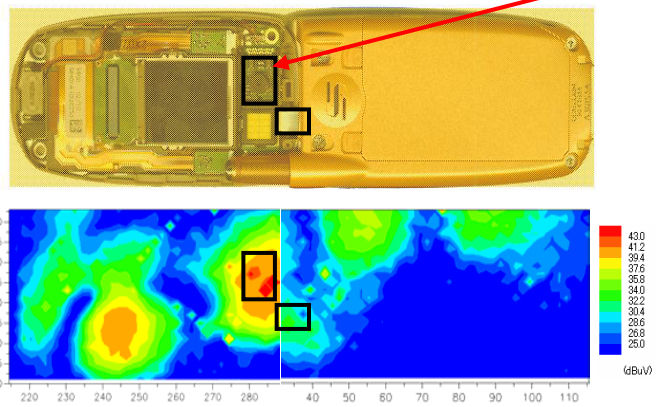
➢**The Sensitivity depends on the RF signal to Noise ratio**

➢ Noise Related to the LCD is coming from Base Band Block :

- Clock and Data Signals
- Noise on Power Line to Data processing IC
- Noise Generated by IC operating at High Frequency



Noise related to the camera



➢**The Sensitivity depends on the RF signal to Noise ratio**

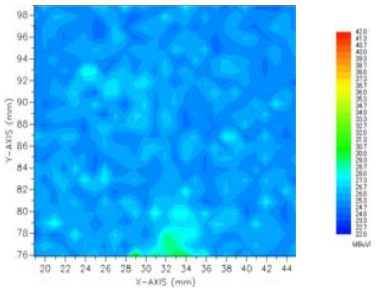
Noise from the camera will couple to the antenna through its flex film circuit

RF Signal from Base Station

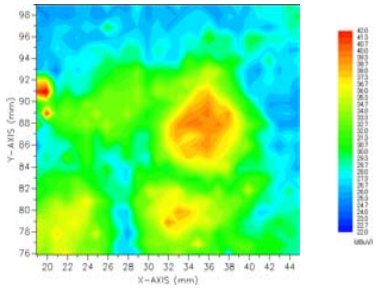
Will be Interfered by Noise from the camera module

Sensitivity at 915MHz

Waiting mode
-106 dBm



Operating mode
-101.5 dBm



General Design Guidelines

1. Keep antenna away from moveable Camera and Flexible PCB.

2. Keep battery and battery metal cage a minimum of 5 mm away from antenna space or antenna element.

3. Use inductors on speaker wires if speaker is inside antenna space.

4. Keep counter balance vibrators away from antenna.

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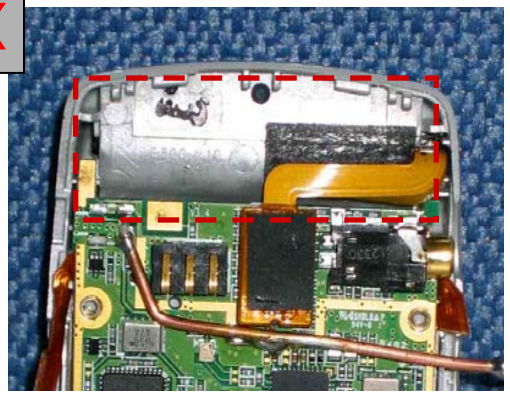

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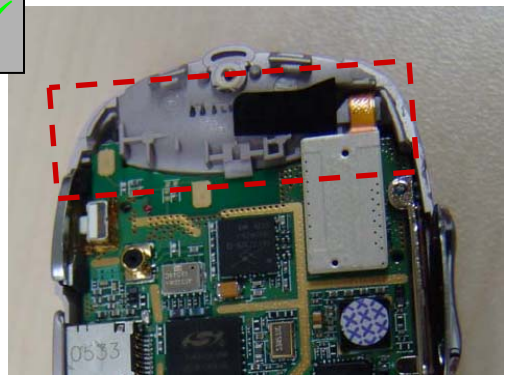

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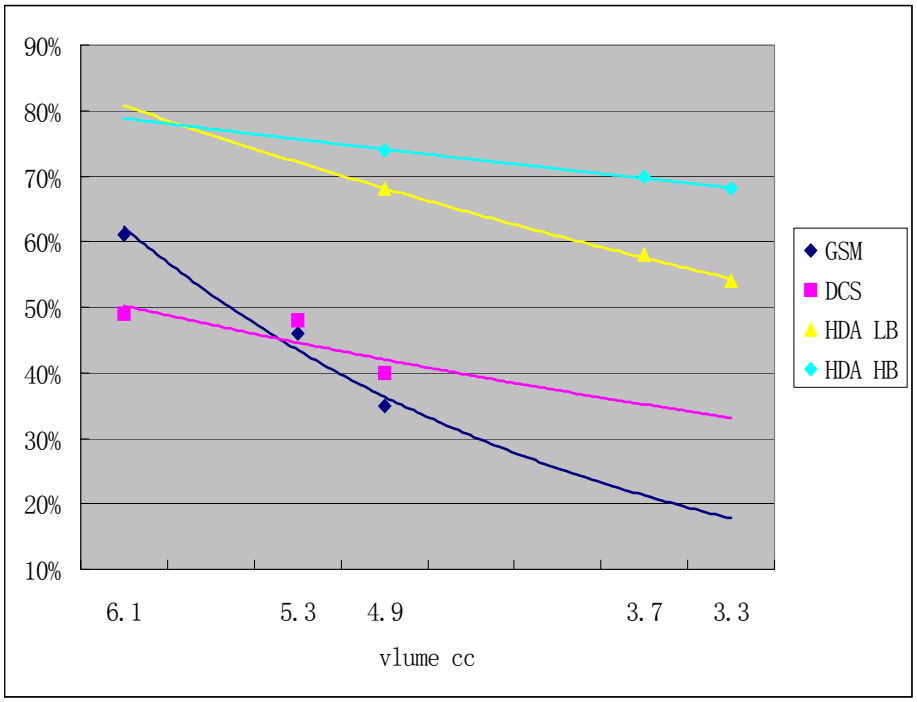
5. Keep antenna volume sensible.

Efficiency Evaluation –PIFA versus HDA



- The performance of 3 existing PIFA antenna designs on Bar-type phones are compared with an HDA antenna
- For a regular PIFA design the recommended antenna volume is 4.5-6cc
- The extrapolated average efficiency for a volume as small as 3.5cc is estimated at 20% for the GSM band and 35% for the DCS band.

General Design Guidelines

6. Keep antenna contact pad size to a minimum

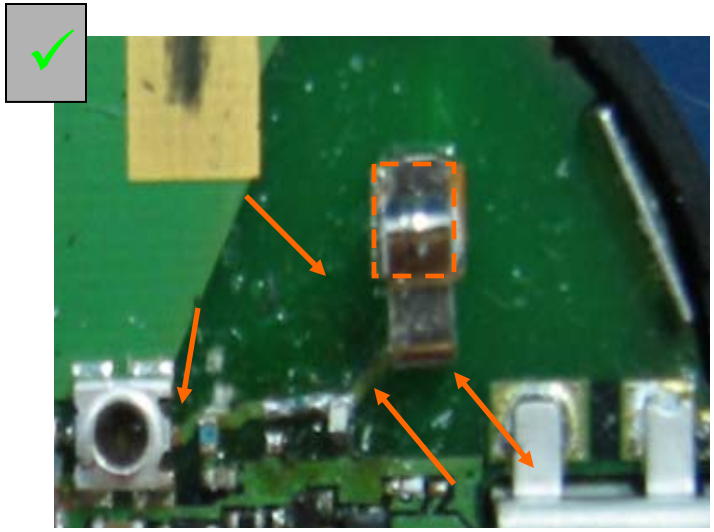
7. No ground on any layers below the contact pad neither inside nor on the opposite side of the PCB

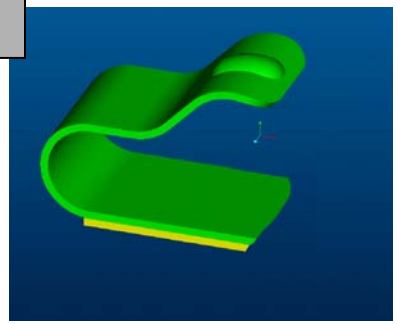
8. No ground on layers inside the PCB below matching circuit

9. Antenna contact clip length to be at minimum

10. Distance between antenna contact and shielding cans etc. to be minimum 2 to 4mm (parasitic effect)

11. RF switch and amplifier or duplexer to be as close as possible to the matching circuit area



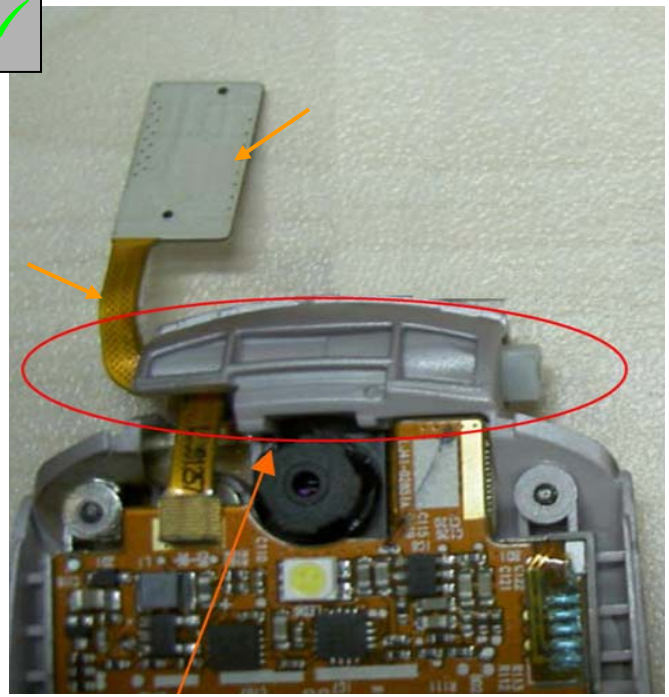


General Design Guidelines

12. No conductive paint (EMI shield) around antenna area or close to its contact

13. Minimize length of Flex circuit that connects the upper folder on clam shell phones

14. Flex circuit connection to flip should be covered with ground layer on both sides which connects well to main ground



射 频 和 天 线 设 计 培 训 课 程 推 荐

易迪拓培训(www.edatop.com)由数名来自于研发第一线的资深工程师发起成立，致力并专注于微波、射频、天线设计研发人才的培养；我们于 2006 年整合合并微波 EDA 网(www.mweda.com)，现已发展成为国内最大的微波射频和天线设计人才培养基地，成功推出多套微波射频以及天线设计经典培训课程和 ADS、HFSS 等专业软件使用培训课程，广受客户好评；并先后与人民邮电出版社、电子工业出版社合作出版了多本专业图书，帮助数万名工程师提升了专业技术能力。客户遍布中兴通讯、研通高频、埃威航电、国人通信等多家国内知名公司，以及台湾工业技术研究院、永业科技、全一电子等多家台湾地区企业。

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射频工程师养成培训课程套装

该套装精选了射频专业基础培训课程、射频仿真设计培训课程和射频电路测量培训课程三个类别共 30 门视频培训课程和 3 本图书教材；旨在引领学员全面学习一个射频工程师需要熟悉、理解和掌握的专业知识和研发设计能力。通过套装的学习，能够让学员完全达到和胜任一个合格的射频工程师的要求…

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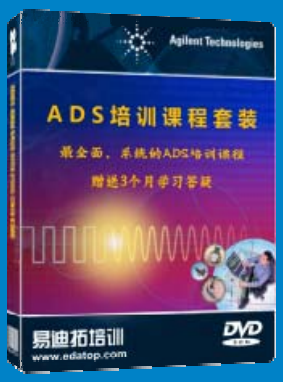
ADS 学习培训课程套装



该套装是迄今国内最全面、最权威的 ADS 培训教程，共包含 10 门 ADS 学习培训课程。课程是由具有多年 ADS 使用经验的微波射频与通信系统设计领域资深专家讲解，并多结合设计实例，由浅入深、详细而又全面地讲解了 ADS 在微波射频电路设计、通信系统设计和电磁仿真设计方面的内容。能让您在最短的时间内学会使用 ADS，迅速提升个人技术能力，把 ADS 真正应用到实际研发工作中去，成为 ADS 设计专家...

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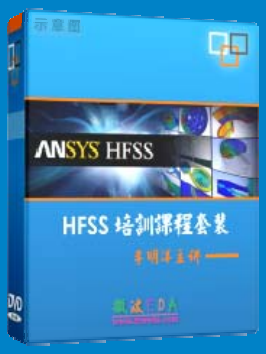

HFSS 学习培训课程套装

该套课程套装包含了本站全部 HFSS 培训课程，是迄今国内最全面、最专业的 HFSS 培训教程套装，可以帮助您从零开始，全面深入学习 HFSS 的各项功能和在多个方面的工程应用。购买套装，更可超值赠送 3 个月免费学习答疑，随时解答您学习过程中遇到的棘手问题，让您的 HFSS 学习更加轻松顺畅…

课程网址：http://www.edatop.com/peixun/hfss/11.html

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课程网址：http://www.edatop.com/peixun/cst/24.html

HFSS 天线设计培训课程套装

套装包含 6 门视频课程和 1 本图书，课程从基础讲起，内容由浅入深，理论介绍和实际操作讲解相结合，全面系统的讲解了 HFSS 天线设计的全过程。是国内最全面、最专业的 HFSS 天线设计课程，可以帮助您快速学习掌握如何使用 HFSS 设计天线，让天线设计不再难…

课程网址：http://www.edatop.com/peixun/hfss/122.html

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套装包含 4 门视频培训课程，培训将 13.56MHz 线圈天线设计原理和仿真设计实践相结合，全面系统地讲解了 13.56MHz 线圈天线的工作原理、设计方法、设计考量以及使用 HFSS 和 CST 仿真分析线圈天线的具体操作，同时还介绍了 13.56MHz 线圈天线匹配电路的设计和调试。通过该套课程的学习，可以帮助您快速学习掌握 13.56MHz 线圈天线及其匹配电路的原理、设计和调试…

详情浏览：http://www.edatop.com/peixun/antenna/116.html

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※ 成立于 2004 年，10 多年丰富的行业经验，

※ 一直致力并专注于微波射频和天线设计工程师的培养，更了解该行业对人才的要求

※ 经验丰富的一线资深工程师讲授，结合实际工程案例，直观、实用、易学

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