RF Measurement Fundamentals - A New Series for go/semi

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1. Introduction

Wireless SOC test is a very fast paced industry. The approaches used a few years ago for common measurements must constantly be changed and updated in order to meet today's test requirements. As devices become more complex, the ability to make complex measurements is paramount to successfully bringing new products to market.

Equally important is test time. For bench setups, a 100ms measurement settling time, or a 50ms source seek time are perfectly acceptable. In test engineering, time is a very valuable commodity and delays such as these cannot be tolerated. Entirely new measurement approaches need to be exploited in order to get the same information about DUT performance in a fraction of the time for traditional methods.

This article is the first in a series of articles that will appear in the coming issues of go/semi. The goal of these articles will be to review some RF measurement fundamentals and to explore some of the latest findings and techniques used to achieve fast and reliable results with modern ATE systems.

2. Test Challenges

The topics that can be addressed under RF measurement fundamentals are too many to list in this forum. However, it is possible to focus the discussion on relevant issues common to today's RF SOC application engineering challenges. Verigy's wireless center of expertise will write a different article each month describing some of the latest RF techniques that are being used to solve today's test problems. The following is a list that describes the different paper topics that will be published as part of this series.

2.1 P1 dB Compression Point

This is an essential measurement which checks the limits of transmit and receive linearity. Traditional approaches require multiple baseband stimuli, in which the input versus the output power is swept and plotted. At some point in the power sweep, the two values begin to deviate from linearity and compression is encountered. Unfortunately, this can be an iterative and time intensive measurement. This article will show some modern techniques to reduce test time in a novel way while still giving very repeatable results.

2.2 Noise Figure

In order to predict how well a device's RF receiver will be able to pick an intended signal from a great distance, its noise figure needs to be measured. Traditionally, noise in vs. noise out is plotted and once gain is known it is removed from the equation. The problem in a production environment is that this measurement can be very sensitive and not very repeatable. To measure noise figure in production, methods must be employed to make the results be stable as well as extremely fast. Techniques to do this will be discussed and different noise generation techniques will be presented and tradeoffs discussed.

2.3 High Density RF Load Board Design:

Modern wireless devices have a lot of functionality. A typical mobile phone transceiver part needs to support GSM, Edge, and CDMA modulation across multiple bands. Add to this the requirement to support other functionalities such as GPS, WLAN, Bluetooth, and FM and the RF port counts can easily exceed 20 ports per DUT. To drive test cost down, multi site test is commonly implemented as well. As a test engineer implementing a quad-site test on a 20 RF port device, it is easy to imagine how many wireless traces and connections need to be supported. This article will analyze different approaches to handling high density RF load boards and provide recommendation about how to reliably route and layout high density RF connections.

2.4 Fundamentals of Vector Network Analysis

In RF/Microwave device testing that involves higher load board density, more complex impedance matching approaches need to be understood. Understanding and debuging high frequency RF connections are both crucial skills as even small impedance mismatches can cause degradation in device performance. Vector Network Analysis is one of the most effective methods of characterizing impedance matching. The purpose of this article is to provide fundamental knowledge of vector network analysis to the test engineer. The article will start by describing the fundamentals of impedances and loads. It will go on to describe common terms for RF/Microwave device characterization such as return loss, SWR (standing wave ratio), group delay, and S-parameters. Other RF fundamentals such as calibration methods and the Smith chart will also be reviewed.

2.5 Concurrent Test with RF

Most complex wireless SOC devices have quite a bit of functionality beyond RF. They include functional blocks such as power management, DSPs, memories, PLLs and many others. Test engineers can save a significant test time by performing as many of these tests as possible at the same time, so that the test time impact of some blocks are effectively hidden or driven to zero. The latest techniques and approaches to do this will be covered in this article.

2.6 Modulated RF Stimulus and Analysis: Debugging Setups

One of the latest buzzwords in test engineering is Error Vector Magnitude (EVM.) The concept of EVM has been covered in other articles published in Go/Semi. However, the engineering approach and debug methodologies have not yet been explored. This article will attempt to give users a practical step-by-step approach to set up and debug most EVM tests for both transmitters and receivers.

3.0 Conclusions

Staying current with the latest test engineering techniques is more important than ever. This series of articles will attempt to demystify some of the approaches used to drive costs down, and enhance the repeatability and predictability of measured results. The authors are all highly experienced test and applications engineers currently working for Verigy. They will share their experience and results around technologies and projects currently underway in the RF SOC space. We hope that the content of the articles can answer some questions and help drive the industry's overall test methodology forward to the next level.

Coming Next Month:
P1dB Tests, reducing test time with a Swept Amplitude Approach.