New Smyrna Beach, FL
Phone: 386.478.1979
Fax: 386.478.1760
E-mail: admin@soft-test.com

RF (Wireless) Fundamentals
1- Day Seminar

In addition to testing Digital, Mixed Signal, and Memory circuitry many Test and Product Engineers are now faced with additional challenges: RF, Microwave and Wireless technology. This course is designed to explain RF components, specifications, and test methodologies to engineers involved with testing of RF circuits using Automated Test Equipment (ATE).

Like all Soft Test courses this RF course presents practical information, relating to test problems, test programs, and test equipment. The information presented will enable you to better understand how the various tests are implemented, the type of test hardware needed, and how to verify and trouble-shoot RF test results.

The Course
This course is designed for engineers new to the field of microwave. It enables engineers to quickly increase their understanding of microwave terminology, components and test. The course material includes pictures and diagrams to help explain microwave technology in a clear and simplified manner without the need of complex mathematics. Lecture subjects include RF Terminology, RF Components, RF Device Models, Transmission Line Theory, S-Parameters, Smith Charts, and of course RF Test Concepts and Test Hardware.

Who Should Attend
Test and Product Engineers, Engineering Managers, Sales Engineers, Service Engineers, and Technicians have all benefited from this course.

When, Where & Cost
Soft Test offers training services at our Sunnyvale CA facility on a regular basis and we also offer on-site training at your facility. Tuition is $595 per attendee and includes all course material. Give us a call for additional information and class schedules or visit our web site at **www.soft-test.com**

Class Registration
Registration is available on-line at our web site or contact the East Coast sales office at 386 478-1979. Email inquires to **admin@soft-test.com**

Summary
Many engineering skills can be learned on-the-job, but in the case of RF the more subtle issues are best addressed directly with lecture and examples. Get a head start now by attending our RF Fundamentals 1-day course.

There's More
Please visit our web site at for additional information and schedules for this course or download the "Quiz" and see if this course is right for you. Soft Test also offers technical training and publications for Digital Test, Mixed Signal Test, Memory Test and a variety of books and videos related to the semiconductor industry.

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Course Length: 1-day

Purpose

The purpose of this course is to introduce the terminology, concepts, and techniques associated with testing RF semiconductor circuits. The course begins by discussing RF components, moves to transmission line theory, and then concentrates on RF test concepts.

Many digital, and mixed signal engineers are now faced with the task of testing integrated RF, Microwave, and Wireless circuits. This course is designed to jump-start your understanding of RF terminology, components, test hardware, and test methodologies.

Our Goal

Our goal is to provide useful information that will quickly improve the skill set required to be a productive RF Test or Product Engineer. We present an environment where questions and interactions are welcomed and everyone is treated with respect regardless of their experience level.

Content

The course information presented includes the following:

- Microwaves and their special characteristics
- Popular acronyms used in microwave theory, testing and application
- Conversion of dB and dBm values
- Microwave devices and their functions
- Microwave devices within communication systems
- Transmission line theory and how it relates to microwave circuit design
- Relationships between propagation co-efficient, characteristic impedance, phase velocity, reflection coefficient, voltage standing wave ratios (VSWR) and transmission line theory
- Types of transmission lines
- The function and operation of various component of a microwave system
- Test methodologies for verifying scattering parameters
- Components and essence of Smith Charts
- Smith Chart calculations used to design microwave circuits
- Ways to compensate for impedance and admittance
- Common devices tested in the microwave frequencies
- Common tests performed on microwave devices
- Microwave instruments in the ATE environment

Distribution Materials

Handout of course slides and all classroom materials are provided with the course

Prerequisites

Students should have completed the Soft Test *Digital Test Technology* class or have equivalent experience.

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Course Outline: RF Fundamentals 1- Day

Introduction – RF Terminolgy
Freespace wavelength
The Electromagnetic Spectrum
Mirocwave Spectrum
Bandwidth / Channel
DB / dBc / dBm
Decibels / Linear / Logarithmic
Digital Modulation & Distortion
Down-converter / Conversion Loss / Dynamic Range
Noise Floor / Pad / EMI
Frequency Modulation and Accuracy
Types of Signal Modulation
Harmonic Signals
IF / Impedance / Intercept Point / IP3
Isolation / Isolators / Network Analyzer
Noise Figure / P1dB / Small Signal Gain
Spurious-Free Dynamic Range / S/N / SNR
THD / VSWR
FFT / DSP / LNA / BPF / LPF / HPF
Wireless Standards
Class Exercise

RF Components
Connectors / N / BNC / SMA / SMB / SMC / SSMA / OSSM / BMA / OSP / OSSP
3.5 and 1mm Connectors
Spectrum Analyzer
Terminators and Attenuators
Directional Couplers / Coupling Factor
Power Divider

Generic RF Device Models
RF Circuitry
Receive Path – low noise amplifier / mixer
Transmit Path – modulator and VGA

Transmission Line Theory and S-Parameter
Wave Analogy
Impedance
Transmission Line Termination
High Frequency Device Characterization
Scalar Transmission Measurements
Scalar Reflection Measurements
Reflection Coefficient / Return Loss

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Standing Wave Ration
S-Parameters
Forward Measurement
Reverse Measurement
Class Exercise

Smith Chart Concepts
Overview of Smith Charts
Groups
Normalized
Impedance
Class Exercise

RF Test Concepts
Time Domain / Combining Sine Waves
Measurement Setups
Power Gain / Gain Measurements
Amplifier Compression / P1dB Measurement
Common Types of Noise / Noise Figures
Phase Noise / Phase Relationships
Power Spectral Density / VCO Measurements
Signal Matching
Distortion and Mixer Measurements
Intermodulation Distortion
Third Order Intercept
Converters and Tuners
Down-converting Mixer Measurements
Adjacent Channel Power Ratio (ACPR)
Measuring ACPR
Low-Noise Amplifier / Frequency Synthesizers

Bluetooth Concepts
SOC – Increasing Levels of Integration
Block Diagram
Bluetooth Transmitter / Receiver Tests
Bluetooth ATE Tester Requirements
Typical Test List
Bit Error Rate / Time Domain / Synthesizer Lock / Bandwidth

WLAN Concepts
What is WLAN
WLAN Standard
WLAN and Cellular
WLAN ATE test requirements
Test Parameters
Key Features
Measurements – 802.11a and 802.111b

Modulation
Wireless Communications
Transmitting / Modulation
Fundamentals
Demodulation Error Quantities
Frequency Errors / Amplitude Droop

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Magnitude and Phase Errors – Making the Measurements

DUT Board Design, Fixturing and De-embedding

Fixturing Considerations
Test Head Fixtures
DUT Interface Fixtures
DUT Board Design Criteria
Materials and Board Fabrication
Contactors / Calibration / De-embedding
Standard Calibration vs. De-embedding

Test Head Configuration

Guidelines for Configuring the Test Head

Summary

Q & A

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RF Fundamentals - Training Evaluation

Name: _____ Date: _____

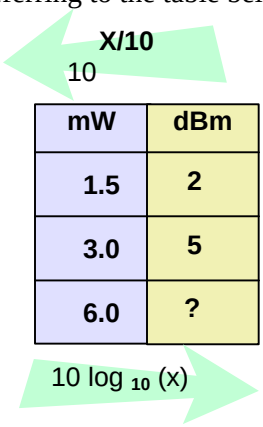
1. Microwave signals usually transfer an electromagnet spectrum with a high wave length.
   a. True
   b. False

2. If $P_{dBm} = 10\log(V_{rms}{}^2 \times 20)$, what is the power when V_{pk} = 0.3V?

   a. ~ -0.7 dBm
   b. ~ -0.5 dBm
   c. ~ 0.7 dBm
   d. ~ 0.5 dBm

3. S-Parameter test is equivalent to continuity (contact) test in Digital world.
   a. True
   b. False

4. Referring to the table below, what is the power in dBm for 6mW?



mW	dBm
1.5	2
3.0	5
6.0	?

   a. 7 dBm
   b. 8 dBm
   c. 8 dBm
   d. 10 dBm

5. A 20dB pad also refers to
   a. 20dB gain
   b. 20dB attenuator
   c. 20 dB loss
   d. 20dB reflection

6. During characterization, suppose we get two readings from the same test of a device that varies by 3dBm. Is this acceptable?
   a. Yes
   b. No

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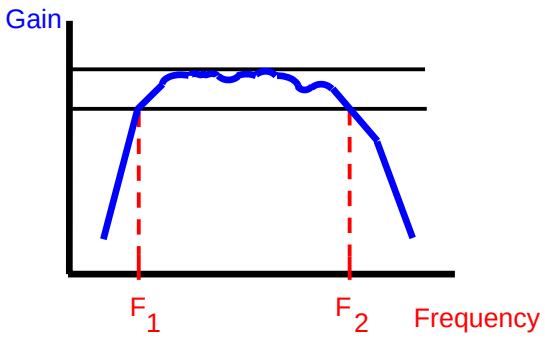
7. A S21 parameter for a two-port network is also known as:
   a. forward voltage-gain
   b. reserve transfer coefficient
   c. input reflection coefficient
   d. All the above

8. Smith Chart was traditionally used to
   a. solve lengthy complex equation graphically on the chart
   b. reduce the possible errors encountered during manual calculations
   c. translate the reflection coefficient into impedance
   d. All the above

9. The gain measurement plot on the chart below can be used to determine
   a. 3dB bandwidth
   b. Minimum passband gain
   c. Gain flatness
   d. All the above



10. Usually the P1dB test is done after the regular gain test.
    a. True
    b. False

11. Mixer are used to:
    a. convert one frequency to power at another frequency
    b. provide harmonic signals
    c. create multitone signals

12. Third Order Intercept Point (IP3) cannot be measured. Why?

13. Why is the ACPR test important for RF devices used in communication systems?

14. What is function of the frequency synthesizer in an ATE machine?

15. How might the test results be changed if there is an impedance mismatch on a RF circuit?

Answers at: http://www.soft-test.com/RF/answers.htm