Essential RF Microwave Concepts - A Practical Approach

Training Programme
by
Dream Catcher Technologies Pte Ltd

25 - 27 Jun 19
Keysight Technologies, Singapore

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Synopsis

The rising cost and scarcity of frequency spectrum, the increasing demand for higher data speed and mobility have driven the explosive growth in RF Microwave (RF/MW) industry. Therefore there is increasing many whose work in one way or another is related to this seemingly complex and confusing technical area.

A firm grasp of fundamental concepts in RF Microwave (RF/MW) is important for a fulfilling career in this area, even for those who is not working directly in this industry. For example a basic grasp of the subject area will enable a project manager to appreciate the technical challenge faced in the project or help a mechanical engineer understand why the circuit designer insists on specific technical decision.

With this objective in mind, this course is designed to equip participants with both foundation knowledge and broad appreciation of each underlying application, and therefore increased interest and confidence for their future undertaking. The subject is delivered with minimal complex equations, stressing on practical applications instead.

Course Highlight

This course starts with essential fundamentals of RF/MW. The participants are then taught the measurement theories of commonly-used RF/MW test equipment. Once equipped with the essential concepts and measurement knowledge, the participants are then introduced to the operating principles of typical building blocks of a RF Transceiver (transmitter/receiver).

To conclude the course, an end-to-end walkthrough of each stage of the RF Transceiver is demonstrated with various RF/MW equipments. This serves to show the practical applications of the various subject areas learned in this course.

What previous participants say about this course

Answers to the question 'what did you like most about the course'  

- "The course uses actual example we normally see/encounter at work, make me to be able to appreciate more easily"
- "Instructors gave a lot of example on application of RF, this is what I like the most"
- "performing measurement using NA/SA and basic RF consideration when dealing with transmission line"
- "Practical day of learning about the machines that going to be used in the future"
- "RF block diagram, smith chart, RF equipment"
- "Practical example and explanation with less formula or derivation involved."
- "Skin effect of RF signal and how to use the smith chart accordingly impact by inductor and capacitor"
- "Gain a new knowledge in RF in technical approach by using the equipment that have been provided"

Figures below showing RF Transceiver and RF instruments used in the training
What You Will Learn

- essential fundamental concepts for those working with RF/MW components, circuits and systems
- commonly-used RF/MW test equipment measurement theories such as Network Analysis and Spectrum Analysis
- operating principles and appreciation for typical building blocks of RF/MW system such as antenna, amplifier, mixer, oscillator/synthesizer, filter
- application of RF/MW concepts, measurements and RF/MW building blocks in a typical RF Transceiver, in end-to-end manner

Who Should Attend

The primary target audience for this course is technicians and engineers involved in product marketing, test and development, characterization, design and development, field installation and maintenance and QA of RF/MW components, circuits and systems.

This course is also applicable to a broad audience from various industries who need to have strong basic understanding of the various concepts, terms and technologies of the RF/MW industries, for example:

- Project Managers
- Software Engineers
- Program Managers
- Mechanical Engineers
- QA Engineers
- Technical Marketing and Sales Engineers

Prerequisite

Interest in RF/MW knowledge and desire to acquire better conceptual understanding in this area. Technical background in electrical/electronic engineering or physics at Diploma or Degree level would be desirable.

Course Methodology

The students are first taught the theories in classroom setting with the aid of video and software tools. The concepts are then re-enforced through exercises and examples of how the theories are applied in real-life. Demonstration using various RF/MW instruments and building blocks of an RF Transceiver will be carried out to illustrate various principles and techniques.

The following software tools are used in this training:

- AppCAD
- Agilent VEE
- Murata S-Parm Library
- Smith Chart Software

The RF Transceiver's building blocks used are:
- Antenna
- Low Noise Amplifier
- Power Amplifier
- Filter
- Mixer
- Synthesizer

The RF/MW instruments used are:
- Signal Generator
- Spectrum Analyzer
- Vector Network Analyzer

### Course Duration

3 day(s), 9am - 5pm

### Course Structure

**Signal and Spectrum**
- Sine Wave
- Wavelength, Speed, Frequency
- Time Domain and Frequency Domain
- Frequency Spectrum
- Frequency Response, Bandwidth
- Simplex, Duplex
- TDD, FDD
- dB, dBx

**Circuit Fundamentals**
- Electrical Elements
- Ideal vs Real-world Components
- Skin Effect
- SRF
- Parasitics Implications
- Model and Model Parameters

**Transmission Line**
- Lumped Element vs Transmission Line
- Telegraphic Equation
- Characteristic Impedance
- Standing Wave
- SWR, Rho, Gamma, Return Loss
- Impedance Transformation Concept
- Quarter Wavelength Transformer
- TDR
- Practical Transmission Line
S-parameter

- Network Model
- Definition of s-parameter
- Measurement of 2-port, n-port
- Applications of s-parameter

Smith Chart and Impedance Matching

- Concept
- Impedance Chart
- Impedance Transformation
- Max Power Transfer
- Matching using Smith Chart and Computer Tool

Linearity

- Linear, Non-linear Devices
- Harmonic and Intermodulation
- Criteria for Distortionless Transmission
- Group Delay, Harmonics, Gain Compression (P1dB), Intermodulation (OIP3)
- Linearity for High-Speed Digital

RF Test Equipment

- Spectrum Analyzer - Time vs Frequency Domain, Superhet vs Fourier Analyzer, Resolution, RBW, Sweep Time, Video Filter, Attenuation, Power Measurement, Tuned vs Broadband
- Network Analyzer - Reflection and Transmission Tests, Network Analyzer Config, Measurement Errors, Cal Concepts, Time Domain (Gating, Fault Detection), Scalar vs Vector Network Analyzer

RF Transceiver

- Block Diagram of Transceiver
- Passive Components - Transmission Line, Antenna, Filter, Duplexer, Diplexer
- Active Components - LNA, PA, Mixer, Oscillator / Synthesizer
- Filtering - Rejection of Image, Harmonics, Intermodulations
- Isolation - Leakage, Oscillation
- End-to-end Transceiver Signal Flow
- Need of Modulation
- Analog Modulation and Digital Modulation
- IQ Diagram
- IQ Modulator/Demodulator

Course Instructor(s)

Dr Teoh Chin Soon

Education and Research Work
In 1992 Teoh Chin Soon received the B.Eng. degree in Electronic Engineering from the
University of Manchester, United Kingdom, graduating with high honors, and continued on to do a Ph.D. in Microwave Engineering, graduating in 1996. In his research he designed and demonstrated a novel 3- and 4-port broadband circulator using a nonreciprocal distributed-coupling phenomenon. During his PhD, he received for two consecutive years the IEEE MTT-S Graduate Fellowship Award. He has authored or co-authored 7 technical papers in international journals and conferences, and 2 local conference papers.

Industry Experience
From 1996-97 Teoh Chin Soon was with SCM Integrated Systems in Kuala Lumpur, where he was involved in the installation, alignment and maintenance of digital microwave radio links and site-testing of marine-radar systems operating at 3GHz and 10GHz bands. Subsequently he joined the Test and Measurement Division of Hewlett-Packard in 1997 (renamed Agilent Technologies in 1999) as an application engineer for RF/MW and wireless instrumentation and later on developed and supported test solutions for mobile wireless handsets. In 2002 he moved into RFIC design work with Avago Technologies, and successfully released a 0.5-6GHz low-noise amplifier into the market. During this time, he designed 2.4GHz and 5GHz baluns and filters for WLAN bands, initiated ESD improvement efforts and introduced new methodologies in ESD design for GaAs PHEMTs. In early 2007, he ventured out with some partners to found DreamCore Technologies Sdn Bhd to provide RF Design Services to the electronics industry particularly in the area of RF devices and components. In the past 5 years, through DreamCore he has designed and developed many GaAs/InGaP RFICs such as low-noise amplifiers, power amplifiers and RF switches, as well as RF test boards and fixtures for customers in Malaysia, USA and China.

Publications

Mr Tan Cheng Yian

Tan Cheng Yian was the R&D Technology Manager from Agilent Technologies, responsible for technology roadmap, platform development and R&D competence development of Agilent Measurement Systems Division. Cheng Yian joined Hewlett-Packard Singapore in 1982 after graduating from the National University of Singapore with a first-class honors degree in Electrical & Electronics Engineering. He took on various technical positions from Customer Support Engineer, Application Engineer, Project Manager to Region Solution Consultant in the Test and Measurement business unit of Hewlett-Packard.

Cheng Yian started his management career in Hewlett-Packard (Later became Agilent Technologies) in 1990 as Services and Support Manager in Singapore. He later expanded his role to cover south Asia through his leadership in building support organizations in countries

Before he left Agilent, Cheng Yian established a software R&D team in China, Beijing for his service division and a R&D team in Singapore to take over the charter of In-Circuit System development from US. He led his R&D teams successfully launched many new services and products including the award winning in-circuit test innovations in 2007. Besides being an internal mentor for junior managers attending corporate Leadership program, Cheng Yian was also a qualified internal trainer for Rummler Brache Process Management class. His expertise includes quality processes, electronic and RF testing and cold chain solutions.
Administrative Details

Programme Logistics

**Duration:** 3 day(s), 9am - 5pm  
**Date:** 25 - 27 Jun 19  
**Venue:** Keysight Technologies, Singapore

Morning break, lunch and tea break will be provided throughout the course duration. Course Manual and Certificate of Attendance will be provided.

Your Investment

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<th>Condition</th>
<th>Price per Pax</th>
<th>GST (7%)</th>
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<td>Regular fee</td>
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3 Easy Steps to Register

- **Phone** +65-62981892  
- **Fax registration form** to +65-62968392  
- **Email registration form** to register@dreamcatcher.asia
Method of Payment

**Cheque Payment:**
Crossed cheque / bank draft made in favour of Dream Catcher Technologies Pte Ltd should be mailed to:
Block 11 Kallang Place #07-01
Singapore 339155

**Telegraphic Transfer:**
Oversea-Chinese Banking Corporation Ltd, Singapore, Jalan Besar Branch
Bank Code : 7339; Branch Code : 521; A/C No.: 521-851048-001; Swift Code : OCBCSGSG

Payment must be received no later than 10 working days before the course commences. An undertaking may be accepted in cases where payment is delayed. However all payments must be made before the course commences.

Refund and Cancellation

Fees will only be refunded in full for cancellation received in writing more than 10 working days prior to the commencement date. Substitute attendee(s) will be accepted at no extra charge.

Disclaimer

Dream Catcher Technologies Pte Ltd reserves the right to change the instructors, date and to vary/cancel the programme should unavoidable circumstances arise. All effort will be taken to inform participants of the changes. Upon sending the registration form, you are deemed to have read and accepted the terms.

Enquiries

Email us at enquiry@dreamcatcher.asia
# Registration Form

<table>
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<th>No.</th>
<th>Name</th>
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**Total Amount**

*(Emails are required to ensure notification of any changes reach the participant)*

**Submitted by:**

- **Company Name:**
- **Company Address:**
- **Contact Person:**
- **Designation:**
- **Dept:**
- **Phone:**
- **Email:**

*Please complete this form with an authorised signature below and fax to fax registration form to +65-62968392 or email to email registration form to register@dreamcatcher.asia. Call us at phone +65-62981892 for any enquiry.*

**Authorised Signature:**

*Please print full name (authorised signature) if you submit via email*

- **Name:**
- **Designation:**
- **Dept:**
- **Date:**

*This registration is invalid without a signature. Payment must be made no later than 10 working days before the course commences. An undertaking may be accepted in cases where payment is delayed, however all payment must be made before the course commences. Participants who registered but did not attend will be invoiced accordingly. Fees will only be refunded in full for cancellation received in writing more than 10 working days prior to the commencement date. Substitute attendee(s) will be accepted at no extra charge.*

Please send payment with this form to
Dream Catcher Technologies Pte Ltd
Dream Catcher Technologies Pte Ltd,
Block 11 Kallang Place #07-01,
Singapore 339155

Enclosed cheque/bank draft no __________________ made in favour of DREAM CATCHER TECHNOLOGIES PTE LTD