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Practical Design of Wireless Digital Communications Systems

Course Code: RF4-ON **Duration:** 3 Days **Course Level:** Intermediate

Course Overview

This 3-day intermediate-level course focuses on the practical design and development of modern RF and wireless communications circuits and systems using common digital modulation standards. In today's ultra-competitive global wireless industry, the design-to-production cycle is of crucial importance. However, developing modern wireless products, such as 3G cellular telephones, Wi-Fi and WiMAX systems, presents many challenges. Advanced skills and knowledge are required not only to architect these systems and devise suitable circuit topologies, but also to solve the challenging integration and manufacturability issues associated with high-volume products. This course teaches the practical aspects of developing robust RF and wireless designs suitable for high-volume production.

Who Will Benefit?

The course is aimed at engineers, technicians and engineering managers working in the wireless communications industry. The audience typically includes RF engineers and technicians working in research and development, manufacturing test and production environments and systems engineers responsible for the architecture of RF communications systems. The course will also be of interest to managers who oversee these groups.

Learning Outcomes

Upon completion of this course, participants will be able to:

- Describe common digital modulation standards and modulation formats
- Explain the component-level measurements required to characterise digital modulation systems
- Explain the system-level measurements required to characterise digital modulation systems
- List the key features, strengths and weaknesses of common transceiver architectures
- Specify the key measurements for digital receivers and transmitters
- Identify the effects of PCB layout on system performance and use best practices to minimise layout-related problems
- Understand integration risks and use verification methods to validate digital modulation systems

Business Benefits

The course will deliver the following business benefits:

- Reduced design and development times and costs
- Improved design and development efficiency
- Improved design quality and system performance
- Reduced development and project risks

Course Programme

The course content covers:

- Digital modulation fundamentals
- Common modulation standards and implications for RF implementation
- Transceiver system considerations
- RF component-level measurements
- Transmitter and receiver measurements
- High-speed PCB design, layout and fabrication
- RF system integration
- EM shielding and EMC engineering
- Integration of RF and baseband systems
- Design verification process
- Case studies

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Instructor
Detailed information about the course instructor is available on request.

Prerequisites
Participants would normally be qualified to degree level or equivalent in an electronic engineering, physics or mathematics-related subject. They should also have a good understanding of RF and microwave technology.

Course Level
Intermediate: Assumes the participant has general knowledge of the subject and professional experience of the specific areas covered.

Course Venue
Delivered on-site either at customer premises or at any suitable venue throughout the UK, Europe and Rest of the World.

Dates
Flexible according to your requirements.

Course Fees
Please call us on +44 (0)1962 855 730 to request a quote.

What's Included?
Course participants will each receive a set of high-quality bound course notes printed in full colour and a Certificate of Attendance.

Customisation
For on-site courses, we do not force your organisation to adopt a standard, 'one-size-fits-all' training programme. The standard course programme can be adapted both in content and duration according to your exact requirements and specifications. Our technical experts will assist you in identifying these, even if they are uncertain or unclear. The course programme is then fitted to your exact requirements. Please call us on +44(0)1962 855 730 to discuss your requirements in more detail.

Related Courses
Related courses include Antennas and Propagation for Wireless Communications Systems (RF2), Practical RF and Microwave Measurements (RF3), PCB Design for RF and High-Speed Applications (RF5) and RF and Microwave Power Amplifier Design (RF6).

Terms and Conditions
We encourage you to read our Terms and Conditions, which cover important issues like payment and cancellation policies. Our Terms and Conditions can be found on our website.

Further Information
For further information about this course, please call us on +44 (0)1962 855 730.

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Detailed Course Content

Digital Modulation Fundamentals

- System link block diagram: Modulation, transmission, channel, reception, demodulation
- Why digital? Resistance to fading, voice versus packet data, capacity
- IQ modulation representation: Constellation, eye diagram display formats
- BPSK, QPSK, MSK, properties of Gaussian and RRC filtering, concept of ISI
- Channel characteristics, diversity, fading types, mitigation techniques, spread spectrum, OFDM, equalisation
- Definitions of TDMA, FDMA and CDMA
- TDD and FDD

Common Modulation Standards and Implications for RF Implementation

- Constant envelope modulation examples: Bluetooth and GSM
- Non-constant envelope modulation: EDGE, W-CDMA, LTE, IS-95, CDMA2000 etc., WiMAX 802.16 family, 802.11a/b/g Wireless LAN, Bluetooth, GPS

Transceiver System Considerations

- Common RF system components: Amplifiers, mixers, filters, etc.
- Imperfections: Distortion and noise
- Transceiver architectures and trade-offs: Frequency planning, analysis of cascaded blocks, TDD and FDD considerations
- Transceiver architectural examples: GSM example, Bluetooth example, 3GPP example, transmitter linearisation

RF Component-level Measurements

- Linear measurements: Power, S-parameters (including balanced devices), group delay, noise figure, phase noise
- Nonlinear measurements: Intermodulation, load-pull, EVM, ACP, AM-AM and AM-PM calculated from IQ measurements
- Two-tone intermodulation
- ACP: GSM and W-CDMA measurement examples
- Modulation accuracy: EVM, RMS, peak, 95th percentile
- Measurement uncertainty properties of small EVMs
- Load-pull: Source and load plane contours of gain, efficiency, ACP and EVM

Receiver Measurements

- Analysis of cascaded blocks
- BER: Bit errors, block errors, frame erasure, sync errors, typical measurement system, loopback mode
- Sensitivity definitions, eg. 1E-3 BER point
- Receiver blocking mechanisms
- Selectivity measurements
- Spurious response measurements
- Measurement techniques: Analogue IF/IQ/RSSI level sweep with interferer

Transmitter Measurements

- Spurious emissions: Tx noise in Rx baseband, harmonics and mixing products
- Transient behaviour: Power-time response, frequency spectrum due to power burst, frequency kick due to power ramping
- ACP: Modulation and power switching transients
- Modulation accuracy: EVM
- Code domain power and PCDE

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Continued...

Fabrication Technologies

- PCB types
- Etching tolerances, board layer construction, vias/drill sizes, thermal reliefs, implications for RF performance
- TDR characterisation

RF System Integration

- Choosing PCB layer structures
- Grounding strategies
- Coupling between components
- Floorplanning: Placing components to maximse isolation
- Shielding/screening, gaskets, effectiveness
- Mismatches when cascading filters and amplifiers, pulling and buffering
- Tolerancing/yield
- Thermal and electrical derating for reliability

Integration of RF and Baseband

- Processor clock signals in receivers
- System planning to avoid harmonics at specific frequencies
- Reference spurs on VCOs
- Hot supply lines and control lines: Effect on the system

The Design Verification Process

- What to test and look for at each prototype iteration
- Integration do's and don'ts
- Minimising the number of prototype iterations required
- Automated design verification testing

Case Studies

- GSM (GMSK and EDGE)
- W-CDMA
- DECT
- FSK
- PWT products

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