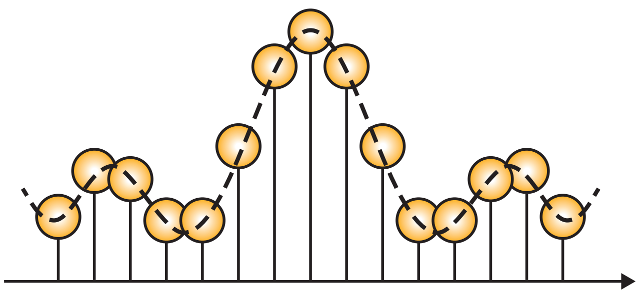
INTERLLIGENT
RF & Microwave Solutions

Training course programme

Fundamentals of digital wireless communication

Advanced level training course

44 Hours: 36 theory + 8 hands-on practice



Hands-on baseband experience | VSA & VSG practical experiments | Modem design and simulation | Matlab introduction given | Signal processing preface given

RF Training | Test Equipment | RF Components & Systems | Engineering Services | RF Ventures Incubator

RF is our Business... Signal us!

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Introduction

“Fundamentals of digital wireless communications” is an advanced level, 44 hours training course that deals with the physical layer of digital wireless communications systems.
This in-depth, hands-on training focuses on the theory, design and practical implementation aspects of single-carrier digital wireless communication systems. The Course presents in a simple and intuitive approach - the fundamentals of modern wireless digital communication systems, and incorporates unique HANDS-ON lab, SW simulation and exercises, utilizing the latest Keysight test equipment, signal creation and signal analysis software.

Target audience

The target audience for this seminar consists of RF & microwave system engineers, wireless hardware experts and electronics engineers who plan to make a transition into digital wireless communications technology, and wish to understand its basic concepts and unique challenges.

Specific measurable training goals

As an outcome of participation in this training, the student shall become able to:

1. Simulate, calculate and compare BER vs. SNR curves for single-carrier constellations.
2. Understand and calculate coding gain of simple block and convolutional codes.
3. Simulate and measure (using a VSA software) EVM effects of I/Q impairments due to phase noise, non-linearity, gain / phase imbalances, ISI and additive noise.
4. Represent Baseband (complex) signals and their corresponding RF modulated (real) signals.
5. Design and build in the lab different RF front end architectures for digital communications, such as Zero-IF, Near zero IF and image reject (Weaver / Hartley).
6. Characterize RF ADCs and DACs, calculate their ENOB, maximum SNR and EVM effects and simulate clock jitter / quantization effects.
7. Model the RF multipath channel and its resulting ISI on the received signal.
8. Understand the concepts carrier synchronization, preamble and pilot signals.
9. Operate standard test equipment for digital wireless communications, such as a VSA, and VSG, generate complex modulations and download signal recordings from the analyser.
10. Perform end-to-end transmitter-channel-receiver design for a single-carrier wireless communications system, calculate and simulate the resulting EVM and BER.

Presenter

The main presenter will be Mr. **Oren Hagai,** the founder of INTERLLIGENT RF and Microwave Solutions.
Bio available online at: https://www.linkedin.com/in/4x1vi

Short form syllabus with chronologic order

Lesson 1 (Theory) | **Introduction and basic terms in digital wireless communications**
Historical overview of digital wireless communications, End to end performance metrics and physical resources of a digital wireless communication system. General block diagram of a digital wireless modem, Basic terms from Information theory, Shannon’s capacity theorem.

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Lesson 2 (Theory) | **Coding intro**

The mathematical memoryless binary symmetric channel, the concept of coding gain, simple block codes, simple convolutional codes, the Viterbi algorithm, coding gain calculation.

Lessons 3 + 4 (Theory) | **Fundamentals of I/Q Modulation**

Why I/Q Modulation? Occupied BW and orthogonal carriers' considerations. Complex (Base band) and real (RF) signals presentation. The quadrature modulator / demodulator, Definition and attributes of the Signal Space, Selection of carrier waveforms, Presentation of signals in the Signal-Space, Baseband Normalized Power analysis, PAPR calculations, Deterministic vs. Measured parameters. Primary Constellations: M-QAM, M-PSK, M-Orthogonal. Demodulation in the presence of noise and distortion: The ML and MAP criteria, Constellation Slicing, SER and BER calculations, Noise CDF and CCDF, Eb/No vs. BER Comparison between different constellations. Signal quality and system performance metrics: EVM, MER SER, BER, PER. Effects of multipath (ISI) on demodulation.

Lesson 5 (Simulation lab #1) | **Simulation of I/Q modulation and coding using Octave (MATLAB compatible in basic commands) software**

Lesson 6 (Theory) | **Test equipment and standard test set-ups for measuring digital wireless communications systems**

VSA premier: block diagram, presentation modes, using Keysight's 89601B VSA platform. VSG premier: block diagram, uploading and generating binary files, Markers, using Keysight's signal studio SW. Baseband generation using broadband AWGs. Channel emulators: RF to RF and Baseband-to-Baseband.

Lesson 7 (Lab experiment) | **Measuring digitally modulated signals using standard test equipment**

VSA measurements of distinct signal deformation mechanisms in the VSA: Additive noise, Non-Linearity, Phase Noise, I/Q Gain Imbalance, I/Q Phase imbalance, Carrier leakage (DC offset), Adjacent channel interference, Multipath constellation replicas.

Lesson 8 (Theory) | **IF / RF sampling**

Analog to Digital conversion: "Transparent" and "Non-Transparent" ADC's, ADC's block diagram, frequency transfer function (Nyquist zones), dynamic performance metrics: SQNR, SJNR, ENOB, SNRMax, Over-sampling processing gain. The Flash, Pipeline and SAR architectures.

Lesson 9 (Theory) | **From Baseband to Microwave: RF front end architectures for digital wireless systems**

Real-IF, Zero IF, Near Zero IF architectures, Weaver and Hartley architectures. Image rejection and DC-offset cancellation (Mixer Calibration).
Carrier sync PLL mechanisms, pilot and preamble signals.

Lesson 10 (Theory) | **Radio channel modeling and measurements**

Stationary vs. time varying channels, impulse and frequency response parameters, delay spread, coherence bandwidth, the Doppler effect, Doppler spread. Channel models for indoor / outdoor propagation. Practical set-ups for channel sounding.

Lesson 11 (Simulation lab #2) | **End-to-end simulation of transmitter-channel-receiver single-carrier communications system**

Total **44 training hours:** 32 theory hours, 8 simulation hours, 4 lab experiment hours

More details including opening dates are available online at **www.int-rf.com/rf-training**

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