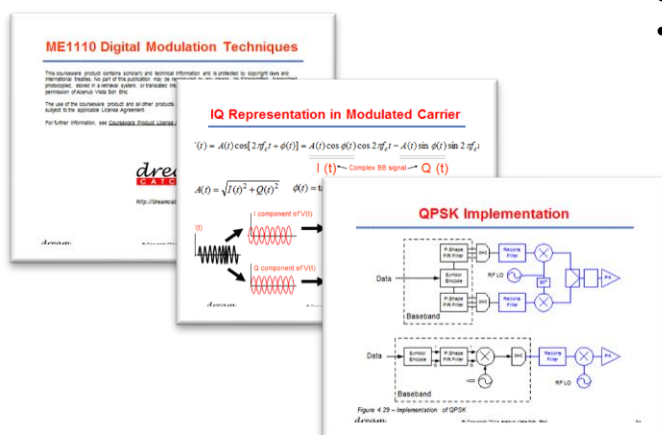


ME1110

Digital Modulation (OFDM) Techniques Courseware

Teaching slides

- Editable Microsoft® PowerPoint® slides
- Covers 45 hours of teaching



Training kit

- Digital modulation kit
- Lab sheets and model answers
- Problem-based assignments
- Covers 18 hours of labs



Target university subject	Target year of study	Prerequisite(s)
Analog and Digital Communications	Second or third year undergraduates	Basic Electronics

The ME1110 serves as a ready-to-teach package in the area of analog and digital modulations. The various modulated communication signals (including OFDM) for hands-on lab exercises are implemented using Digital Signal Processing technique. This is a resource for lecturers consisting of teaching slides, training kits, lab sheets, and problem-based assignments.

Learning Outcomes

Students would be able to:

- Describe the main features of analog and digital communication systems
- Analyze signals in time and frequency domains
- Analyze IQ modulation technique from digital bits to baseband signal and modulated sinusoidal signal
- Analyze various types of basic analog and digital modulation schemes
- Evaluate modulation signals using industrial grade test and measurement instruments

Benefits of the ME1110 courseware

- The digital IQ modulator is not a “black box”, students are able to get an insight on the modulation process as the In-phase (I) and Quadri-phase (Q) signals go through each stage of the modulation process from raw serial bit-stream to baseband signal envelopes and finally to modulated sinusoidal signal.
- This hardware kit is capable of producing various types of standard analog and digital modulation waveforms such as AM, FM, BASK, FSK, BPSK, QPSK, 8-PSK, QAM16, QAM64 and OFDM.
- The raw data bits come from the built-in pseudo-random bit generator at 1 Mbps. Students can feed in user-specific data from the external bit pattern generator or use the on-board manual on-off push-button for simple serial bit generation.
- Students get to experience the usage of industry-grade tool, such as mixed-signal oscilloscope to capture digital and analog signals for verification, and the Keysight Vector Signal Analyzer software for spectrum and baseband signal analysis.





Teaching Slides

More than 400 editable Microsoft PowerPoint teaching slides, covering 45 hours of teaching for one full semester are provided. The slides cover the following topics:

- Principle of Communications
- Analog Modulation Techniques
- Baseband Pulse Transmission
- Digital Modulation Techniques
- OFDM Techniques
- Transmitter and Receiver Architectures



Training Kit

Digital Modulation Kit

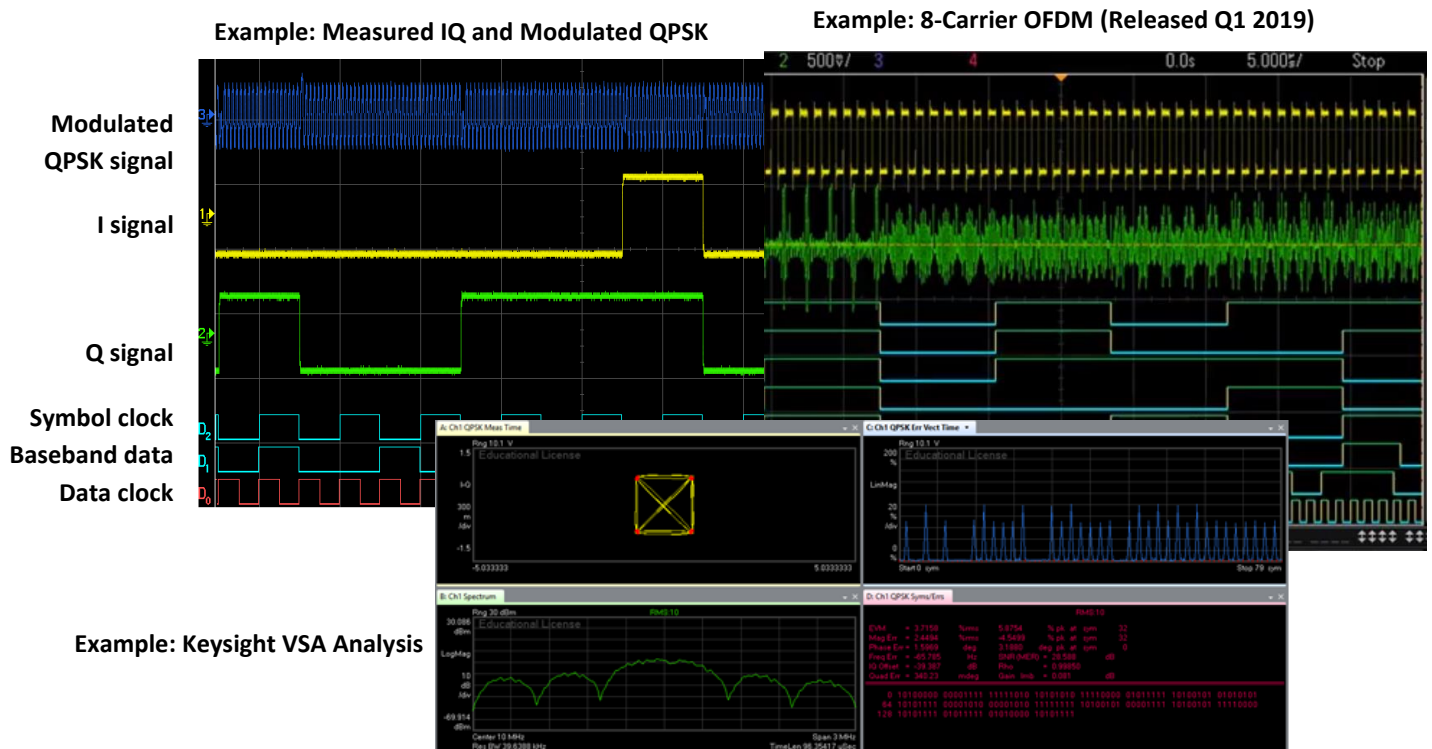
The ME1110 hardware uses a full-digital approach to implement a standard I-Q band-pass modulator system with a 10 MHz carrier. It incorporates a FPGA (Field Programmable Gate Array) chip, a high-speed DAC (Digital-to-Analog Converter) chip, and high-frequency analog circuitry such as amplifiers and filters. Various probing points are also available for students to study and analyze the effect of the modulated signal at various stages.



The ME1110 Analog/Digital Modulation Board is a versatile system that can produce a variety of digitally modulated band-pass signals. It is also programmed to produce standard analog modulated signals such as AM and FM signals. The default RF (radio-frequency) carrier used by the system is 10 MHz. One of its special features is the board contains two RF outputs. This allows the outputs to be connected to a Vector Signal Analyzer (for demodulation and observing the IQ constellation) and to a low-cost Spectrum Analyzer for observing the real-time spectrum. In addition to the RF outputs, the ME1110 board has a number of Analog and Digital outputs. For instance, the user can observe the Baseband IQ channels voltage, Baseband digital data, data-clock, symbol-clock, etc. to understand how a digital transmitter operates.

This hardware kit is capable of producing various types of standard analog and digital modulation waveforms such as sine wave, AM, FM, BASK, FSK, BPSK, QPSK, 8PSK, 16-QAM, 64-QAM and OFDM.





Accessories

The following accessories are provided with the training kit.

Item	Quantity
SMA(m)-BNC(m) cable assembly - 1 meter	1
USB cable	1
Power adapter, 5 Vdc, 2 A	1

Lab Sheets

The training kit includes six lab sheets in editable Microsoft® Word format. Each lab sheet requires three hours to complete. Model answers are provided with all lab sheets. The required instruments for the lab sheets are listed below.

Lab Sheet	Required Items
	Mixed-Signal Oscilloscope and VSA software
1. Overview of the Digital Modulation Kit	✓
2. BASK Generation and Analysis	✓
3. BPSK Generation and Analysis	✓
4. QPSK and 8-PSK Generation and Analysis	✓
5. AM & FM Generation and Analysis	✓
6. QAM Generation and Analysis	✓
7. OFDM(8 carriers) Generation and Analysis (released Q1 2019)	✓



Problem-Based Assignments

The problem-based assignments below allow students to enhance their problem-solving skills.

1. Design of analog AM and FM modulator
2. Baseband pulse shaping
3. Using external data



Instruments

The recommended instruments and software from Keysight Technologies, to be purchased separately, are listed below.

Instrument / Software ^[1]	Model
Oscilloscope and VSA Software	Minimum 100 MHz Mixed-Signal Oscilloscope, 2 analog and 8 digital channels Recommendation: MSOX2012A ^[2] 89601C Vector Signal Analysis Software - PathWave VSA 89600C Custom Modulation Package includes 89601200C/89601AYAC/89601BHFC/89601PSMC

[1] Refer to the Lab sheets section for the instrument selection.

[2] The 89601C VSA software can support MSOX 2000, 3000, 4000 series model of oscilloscopes. Refer to link:

<https://edadocs.software.keysight.com/kkbopen/what-hardware-platforms-are-supported-by-89600-vsa-589745148.html>



Training Kit Hardware Specifications

Digital Modulation Kit

Digital

Signal generation method	DDS
IQ modulation schemes	AM/FM/BPSK/QPSK/QAM16/QAM32
On-board crystal oscillator	8 MHz
Low-Pass Filter passband (3 dB)	DC to 12 MHz

General

Input voltage	4.8 to 5.5 V
Input current	180 mA (typical)
External data input	2.2 to 3.5 V
Carrier frequency at CW mode	9.995 to 10.005 MHz
Clock output (for external data input)	2.5 to 2.6 V
RF Out (Main) into 50 Ω load at CW mode	0.30 to 0.70 dBm
RF Out (Aux) into 50 Ω load at CW mode	3.00 to 4.2 dBm

EMC designed to	IEC61326-1:2005 / EN61326-1:2006 CISPR11:2003/EN55011:2007 Group 1, Class A
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Warranty	1 year
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Ordering Information

Description	Package	Product Number
Teaching Slides	1 user license	ME1110-100
Training Kit	1 set	ME1110-200
Teaching Slides + Training Kit	1 user license + 1 set	ME1110-300
Instruments	Where applicable	Purchase separately from Keysight or its distributor

Training courses related to the subject matter are available on request. Visit dreamcatcher.asia for details.

For more information or inquiries: Website: dreamcatcher.asia/cw E-mail: cw.sales@dreamcatcher.asia Acehub Vista Sdn Bhd (785702-P) 70-03-79, D'Piazza Mall, Jalan Mahsuri 11900 Bayan Lepas, Penang Malaysia	© 2010-2015 Acehub Vista Sdn Bhd We reserve the right to change or alter the information in this material without prior notice. The information provided in this material is accurate as of the print date. Microsoft, Windows, and Office Programs are trademarks of Microsoft Corporation in the United States and/or other countries. All other copyrights and trademarks belong to their respective owners. Updated on 1st Feb 2024 
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