

Ultra-Wideband Wireless Communications (UWB)

Introduction

Module 01: Fundamentals

- Overview of UWB
- History
- Regulatory
- Applications
- Pulse- or Multicarrier-Based UWB

Module 02: Issues Unique to UWB 4

- Antennas
- Propagation and Channel Model
- Modulations
- A/D Sampling
- Timing Acquisition
- Receiver Structures
- Multiple Access

Module 03: Emerging Technologies

- Low-Complexity Noncoherent Receivers
- Location-Based Sensor Networks
- Time Reversal
- MAC
- Future Directions

Modulation and Signal Detection in UWB

Module 01: Overview

- Evolution and Definition
- Major Differences from Narrowband and CDMA Systems
- Types of UWB Modulation
- UWB Applications

Module 02: Single-Carrier–Based Modulation

- Time-Hopping PPM
- Other Types of Modulations
- Channel Estimation
- Signal Detection

Module 03: OFDM-Based Modulation

- Channel Estimation
- Interference Suppression
- Conclusion and Further Reading

UWB Pulse Propagation and Detection

Module 01: Introduction

- UWB Pulse Propagation
- Generalized Multipath Model
- IEEE 802.15.4a Channel Model
- UWB Pulse Signal Detection

Module 02: Optimum Receiver

- Generalized RAKE Receiver
- Optimum Receiver with Intersymbol Interference
- Receiver with Time-Reversal Channel Impulse Response
- Optimum Receiver with Multiuser Detection

Timing Synchronization for UWB Impulse Radios

Module 01: Introduction

Module 02: Signal Model

Module 03: Signal Detection and Symbol-Level Acquisition

- Analog Energy Detectors
- Discrete-Time Energy Detectors

Module 04: SAT and MAT: Templates with and without Timing

Module 05: Coarse Synchronization Using Symbol-Rate Samples

- Discrete-Time Correlator Output Model under Mistiming
- CML Timing Synchronization
- Analytic and Simulated Performance

Module 06: Synchronization with Flexible Timing Resolution

- Timing-Offset Search via Sample Mean Square
- Timing-Offset Search via Cross-Correlation Mean Square
- Comparative Study and Implementation Aspects

Module 07: Timing Acquisition for Ad Hoc Multiple Access

- Training-Based Multiuser TOE
- Blind Synchronization for Multiuser Ad Hoc Access
- TOE Performance Analysis
- Demodulation and BER Sensitivity to Mistiming

Error Performance of Pulsed Ultra-wideband Systems in Indoor Environments

Module 01: Introduction

Module 02: Signal Model

Module 03: Error Performance in Indoor Environments

- Pulse Amplitude Modulation and Pulse Position Modulation
- Receiver with Self-Derived Template Waveforms
- System with Multiple Antennas

Mixed-Signal Ultra-wideband Communications Receivers

Module 01: Introduction

Module 02: Analog-to-Digital Conversion via Signal Expansion

Module 03: Mixed-Signal Communication Receivers Based on A/D Conversion via Signal Expansion

- Transmitted Signal and Channel Model
- Digital Linear Receivers Based on ADC via Signal Expansion

Module 04: Analog-to-Digital Conversion in the Frequency Domain

Module 05: Frequency-Domain Mixed-Signal Receivers

- Multicarrier Communication Systems Based on A/D Conversion in the Frequency Domain
- Relationship to the Fourier Series Coefficients
- Mixed-Signal Transmitted-Reference Receiver

Trends in Ultra-wideband Transceiver Design

Module 01: Introduction

Module 02: Status of UWB Transceiver Design

Module 03: Digital UWB Receivers

- PPM-Based TH-UWB System Model
- Channel Estimation Techniques
- Design of Linear Receivers
- Some Thoughts about Complexity Reduction
- Finite Resolution Digital Receivers

Module 04: Analog/Digital UWB Transceivers

- Near Full-Rate TR Transceivers
- Full-Rate TR Transceivers

UWB MAC and Ad Hoc Networks

Module 01: Introduction

- Overview of IEEE 802.15.3 MAC
- Overview of MBOA MAC

Module 02: QoS Scheduling in PNC

- Problem Definition
- Deadline-Aware Scheduling Algorithm
- Calculation of the Reserved CTA

Module 03: Simulation Results

- Power Management in IEEE 802.15.3
- Problem Definition
- Proposed Approach
- Simulation Results

Module 04: Adaptive Dly-ACK

- Problem Definition
- Adaptive Dly-ACK
- Simulation Results

Module 05: Ad Hoc Networks

- Child Piconet
- Independent Piconets

Radio Resource Management for Ultra-wideband Communications

Module 01: Introduction

Module 02: Radio Resource Management

- Pulse-Based UWB Physical Layer Characteristics
- Challenges and Opportunities

Module 03: Multiple Access

- Exclusive versus Concurrent Transmissions
- Code Assignment
- Interference Mitigation in TH-UWB

Module 04: Overhead Reduction

- ACK Mechanisms
- Long Acquisition Time

Module 5: Power/Rate Allocation

- Power Allocation
- Rate Guarantee
- Rate Control
- Cross-Layer Design

Pulsed UWB Interference to Narrowband Receivers

Module 01: Introduction

Module 02: Pulsed UWB Signal Model

Module 03: Narrowband Receiver Model

Module 04: Equivalent Receiver Model and Response to a Pulse

Module 05: Response to a Pulse Sequence

Module 06: simulating the Response to a Pulse Sequence

- I/Q Component Formulation
- Simulation Parameters
- Normalization
- Example Filter Response: The n-Pole Filter

Module 07: General Properties of the IF Output

- Case 1: Pulse Rate Less than IF Bandwidth
- Case 2: Pulse Rate Greater than IF Bandwidth

Module 08: Power Spectral Density

Module 09: Discrete PDF PSD Example: Equally Spaced, Equally Likely Time Offsets

Module 10: Continuous PDF PSD Examples

- The Poisson Process
- Continuous PDF Uniform Random Pulse Position
- Comparison of PSD and Simulation Results
- Statistical Properties of the Output Envelope

Digital-Carrier Spreading Codes for Baseband UWB Multiaccess

Module 01: Introduction

Module 02: Digital-Carrier Multiband User Codes

- Baseband Single-Carrier UWB
- Baseband Multicarrier UWB

Module 03: Low Duty-Cycle Access in the Presence of NBI

- General Rake Reception Model
- SINR Analysis
- Simulations and Numerical Results

Module 04: Improved Rate Access in the Presence of Multipath

- Rake Reception Model with IFI
- Performance Comparisons
- Simulated Examples
- Multiuser Interference Mitigation

Localization

Module 01: Introduction

Module 02: Time-of-Arrival Estimation

- Estimation Accuracy
- Energy-Collection–Based TOA Estimation
- Two-Stage TOA Estimation
- Simulation Results

Module 03: Location and Tracking

- Position Estimation
- Tracking
- Simulation Results

Module 04: Location in Distributed Architectures

- Overview
- Proposed Algorithm
- Simulation Results

Module 05: Theoretical Positioning Accuracy

- Analysis Tool
- Hyperbolic Location Accuracy