SPW 4–Communications Library

Overview

The SPW Basic Communications Library is a pre-built collection of commonly used communication functions, including basic capabilities like modulators, demodulators, adaptive equalizers, wireless channel models and other blocks created to take advantage of the latest wireless technologies. Demonstration systems (e.g. DVB-T and IS54 for TDMA) and a rich selection of channel models (e.g. the Saleh and Rappaport indoor radio channels, the Rayleigh flat and selective fading channels, and the Rummler Multipath channel) are included in this library. Also included are functions for radar, RF, and smart antenna systems.

A Comprehensive Modeling Library for Designing and Analyzing Communications Systems

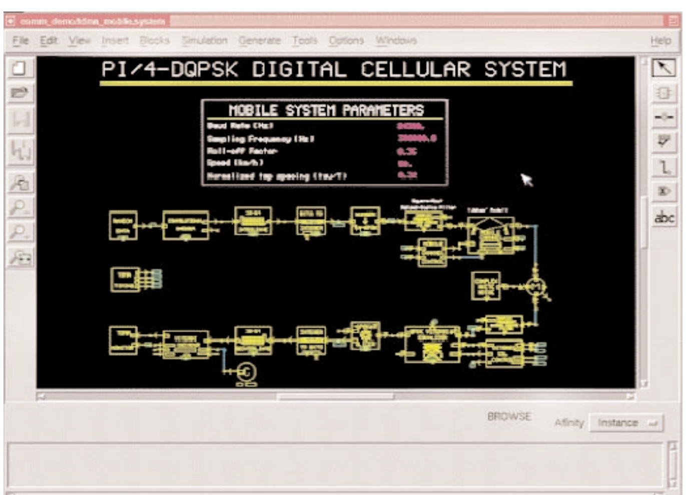
The SPW Communications Library lets you perform end-to-end design, modeling, and verification of communications systems within an operational context. It lets you quickly assemble “virtual prototypes” of systems that you can test and refine to develop innovative solutions optimizing cost and performance.

Helps You Utilize Emerging Technologies

The Communications Library contains modulators and demodulators, adaptive equalizers, wireless channel models and other blocks created to take advantage of the latest wireless technologies. These blocks are ideal for designing personal communications systems and networks, mobile communications systems, satellite systems, radar system, and other indoor and outdoor wireless systems. Two digital cellular demonstration systems (TDMA and CDMA) are provided, which you can use as tutorials or as starting places for your own designs. The TDMA system is based on the IS-54 digital cellular standard for the United States. The CDMA system implements full PN sequence acquisition and tracking using orthogonal Walsh codes. DVB-T demo system based on OFDM is also provided with a practical channel estimation model included.

Offers a Wide Selection of Channel Models

Renowned for their accuracy, the sixteen channel blocks of the SPW Communications Library reveal how transmitter and receiver proximity and environment can influence signal quality. Particularly useful are the Saleh and Rappaport indoor radio channels, the Rayleigh flat and selective fading channels, and the Multipath (Rummler) channel. Custom channels can be modeled with the Sparse FIR filter block. This block allows you to implement time varying and time-invariant models based on calculated data, measured data or statistics. Constant or dynamic tap coefficients and tap spacing can be specified from a file or generated statistically. The channel models also include special timing drift (clock skew) blocks for more true-to-life simulations. These blocks accurately model synchronization discrepancies between transmitter and receiver clocks by producing an output which slowly drifts from the input signal. Faster timing disparities can be simulated via the jitter input of a timing drift block.



Block diagram of digital cellular system built with components from the SPW Floating-Point Communications Library.

HIGHLIGHTS

- **Extensive professional libraries of communication functions**
- **Radar library blocks greatly ease the task of developing signal flow diagrams for radar signal processing systems. This unique collection of function blocks and signal calculator enhancements enables users to create specialized waveforms, scattering models, investigate hardware limitations in designs and apply radar filter and detection techniques to their designs**
- **RF library blocks, as well as the low pass equivalent modeling technique, can be used to characterize the nonlinear effects of the RF front-end design and interference on the overall system performance**
- **Smart Antenna blocks support 2G, 3G, and 4G communication-based designs, including:**
  - **Training sequence method with spatial array processing blocks**
  - **Constant modulus algorithm (CMA) with support for LMS, LS-DD, LMS-DD**
  - **CDMA post-correlation processing (PCP) with spatial array processing blocks**

Includes Importance Sampling Blocks for Faster Simulations

The SPW Floating-Point Communications Library exploits importance sampling techniques to significantly shorten simulation times when calculating bit and symbol error probabilities. This modification of the Monte Carlo method allows you to “bias” blocks so that more errors occur within a given sampling period. This cuts down on the number of symbols it takes to make an error rate estimation, allowing much shorter simulation runs.

DSP Design Blocks

Adaptive

LMS, LMS Linear Combiner, RLS, RLS Linear Combiner

Conversion

Bits To Integer, Complex Conjugate, Complex Magnitude, Complex Phase, Complex To Real/Imag, Complex To Mag/Phase, dB To Real, Degress To Radians, Hz To Radian, Integer Part, Integer To Bits, Logical To Real, Mag/Phase To Complex, Real To dB, Real To Integer, Real-Imag To Complex

Decision

Equal Real, Generic Compare, Max Real, Min Real, Inc If Not Eq Real, Inc If Not Eq Complex

Dynamic Multirate

Timing Drift, Case In, Case Out, If In, If Out, Downsample, Resample Input, Resample Output, Upsample

Estimators

Find Max and Min, Find Max Magnitude, Leaky Correlator, Mean, Power, Running Sum,Variance

Filters

Arbitrary Mag/Phase, Arbitrary Mag/Group Delay, General Filter, Bessel Bandpass, Bessel Highpass, Bessel Lowpass, Butterworth Bandpass, Butterworth Bandstop, Butterworth Highpass, Butterworth Lowpass, Chebyshev I Bandpass, Chebyshev I Bandstop, Chebyshev I Highpass, Chebyshev I Lowpass, Chebyshev II Bandpass, Chebyshev II Bandstop, Chebyshev II Highpass, Chebyshev II Lowpass, Elliptic Bandpass, Elliptic Bandstop, Elliptic Highpass, Elliptic Lowpass, Raised Cosine, Convolution, Hilbert, Lead Lag, Pole-Zero

Logical

Clock, Up-Down Counter, Simple Counter, Modulo Counter, Timing Signal, Threshold Counter, And, Inverter, Or, Xor, Xnor, Switch In, Switch Out, Latch

Math

Add, Divide, Constant, Gain, Multiply, Subtract, Reciprocal, Complex Conjugate, Magnitude, Exp, Ln, Log, X**Y, Absolute Value, Square Root, Modulo, Differentiator, Integrator, Modulo Integrator, Sliding Integrator, Arc Tangent, Cosine, Sine, Tangent, Matrix Condition, Extract Matrix Diagonal, Insert Matrix Diagonal, Overdetermined Solve, Pseudo-Inverse, QR Decomposition, Singular Value Decomposition, Symmetric Toeplitz Solve, Symmetric Toeplitz Inverse, Matrix Product, Matrix Multiply, Sum Elements, Determinant, Dot Product, Rank, Trace, Eigenvalues, Eigenvectors, Solve Ax=b, Outer Product, Offset, Transpose, Scale, Matrix Invert, Entropy, Mean, Variance, Power, Correlation, RMS Error, SNR, Sort, FFT, Window

Memory/Delay

Bulk Delay, Circular Buffer, Hold, Hold True, Tapped Delay Line, Unit Delay, Variable Delay, RAM, Vector Bulk Delay, Vector To Serial

Multirate

Upsample, Downsample, Interpolate, Decimate, Ratio, Repeat, Bits to Integer, Integer to Bits, Matrix to Scalar, Matrix To Vector, Scalar To Matrix, Scalar To Vector, Vector To Matrix, Vector To Scalar, Commutator, Distributor, Merge, Split

Non-Linear

Clip, Hard Limiter, Soft Limiter, Threshold, Phase Unwrap, Quantize, Rectifier Positive, Rectifier Negative

Probes

Generic, Image, Interactive, Statistics Over Time, Statistics Per Input, Histogram, Histogram Interactive, Compare To Previous, Bit Activity Clocked, Power Spectrum, Autocorrelation, Power

Sources/Sinks

Arbitrary CDF, Arbitrary PMF, Binary, Exponential Random, Gaussian Random, Poisson Impulsive, Poisson Random, Noise Given SNR & Bandwidth, White Noise, Write to File, Read from File, Complex Tone, File Constant, Impulse, Impulse Train, Function Generator, Unit Step

SPW Communications Library Design Blocks

Random Source Blocks

PSK (8,16), 16-QAM, 64-QAM, 256-QAM, Binary, Biphase-Level, Biphase-Mark, Bipolar-Half, Bipolar-Full, Miller, PI/4-QPSK, QPSK

Equalizer Blocks

FS PSK Linear Adaptive, FS QAM Linear Adaptive, FS General Linear Adaptive, Equalizer Core, FS PSK Decision Feedback, FS QAM Decision Feedback, Viterbi, FS General Decision Feedback

Encoder/Decoder Blocks

Diff Decoder (1-bit, 2-bit), BCH (Encoder, Decoder), Biphase-Level Encoder, Biphase-Mark Encoder, Bipolar-Full Encocder, Bipolar-Half Encoder, Convolutional Encoder, Gray, Interleave, MAP Decoder, Miller Encoder, Reed-Solomon (Encoder, Decoder), TCM (Encoder, Decoder), V.32 (Encoder, Decoder), Vector BCH (Encoder, Decoder), Vector RD-SL (Encoder, Decoder), Viterbi Decoder (Hard, Soft)

Filter Blocks

Frequency Domain: Gaussian, Gaussian Vector, Group Delay, Group Delay Vec, Parabolic Phase, Parabolic Phase Vec, Raised Cosine, Raised Cosine Vec

Time Domain: Fading Spectrum, Gaussian, Group Delay, Parabolic Phase, Raised Cosine Complex, Raised Cosine Real, Sparse FIR

Channel Blocks
Am-Am/Am-Pm, Am-Am/Am-Pm 0, Am-Am/Am-Pm Table, Indoor (Saleh, Rappaport), Rayleigh (Flat, Selective), Tabular Non-Linear, Timing Drift, Timing Drift Complex, Trav Wav Tub (Amp, Ana), Multipath (Rummler)

Importance Sampling Blocks
Weight Computation, De-biasing

Estimator Blocks
Delay/Phase Meter, Correlation, General Error Rate, Noise Given SNR & BW, Simple Error Rate, Time Align, Viterbi Sequence

Modulator Blocks
BPSK, Double-Sided Bw, GMSK, MSK, QPSK, SQPSK, SSB, TCM, 8-PSK, 16-PSK, 16-QAM, 64-QAM, 256-QAM, PI/4-QPSK, Table Lookup, V.32, Volt Contrl Osc VSB

Demo Systems

Communication Demo Systems
- DVB (Non-hierarchical) Terrestrial Television Demo System
- Pi/4 DQPSK Digital Cellular System
- ANSI T1.413 ADSL Downlink Demo System
- 802.14 Cable Modem Downlink Demo System
- 16QAM Signaling Through Nonlinear Satellite Link
- 64QAM Digital Radio Link
- Dual Dwell CDMA Sequence Acquisition Demo System
- CDMA Spread Spectrum over Indoor Wireless Links
- Importance Sampling Demo Systems
- Concatenated Coding for Deep Space Communications
- Continuous Phase Modulation Demo System
- BCH Coding, Reed Solomon Coding, Convolutional Coding, and Turbo Coding Demo Systems
- DS Spread Spectrum Anti-Narrow-Band Jamming Communication System
- End-to-end FM System Using Phase-locked Loop and FM-balanced Discriminator
- Four-State Trellis code for 8PSK modulation over additive White Gaussian Channel
- Transmission Quality Probes Example
- Lognormal Shadow Fading Test System
- ISDB-T Demo Systems
- BPSK Timing Recovery Demo System
- Narrow Band Passive Sonar Linear Array Direction Finder using FFT Beamformer
- Envelope Detector Demo System
- V.22bis Modem Demo Dystem (2400bps, 16QAM)
- Digital Reverberation System
- 9.6 kbps Digital Speech Signal Transmission over the Telephone Channel Model Simulation
- 16-Kbps Sub-band Coder for Speech Using QMF Bank and Adaptive Quantization with Backward Estimation (AQB)
- G.721/G.723 ADPCM Demo System
- Waterfall Spectral Analysis
- Spectrogram Demo System

RF and Radar Demo Systems
- Two Tone Test for an RF Front End System
- RF Amplifier Performance Measurement
- Mixer Performance Measurement
- PSB RF Demo System
- Radar Pulse Compression
- Pulse Doppler Processing System

Smart Antenna Demo Systems
- CDMA Post Correlation Processing Adaptive Beamformer
- Constant Modulus Adaptive Antenna Array
- Space-time Block Code for 2 Transmit Antenna (Rate: 1/1)
- Space-time Block Code for 3 Transmit Antenna (Rate: 1/2)
- Space-time Block Code for 3 Transmit Antenna (Rate: 3/4)
- Space-time Block Code for 4 Transmit Antenna (Rate: 1/2)
- Space-time Block Code for 4 Transmit Antenna (Rate: 3/4)
- Training Sequence Method Demo System

Customer Focus
CoWare provides a complete range of training, support, design methodology consulting, and integration services. Technical support requests are handled directly by experienced design engineers who are fully familiar with the application of CoWare tools and methodologies to real-world designs. Training courses are available at CoWare offices or at the customer site and can be tailored to meet the specific needs of the design team.

Sales Offices
CoWare has sales offices in the U.S., Europe, and Japan. For a complete listing with contact information visit www.coware.com.
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Differentiate By Design™

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