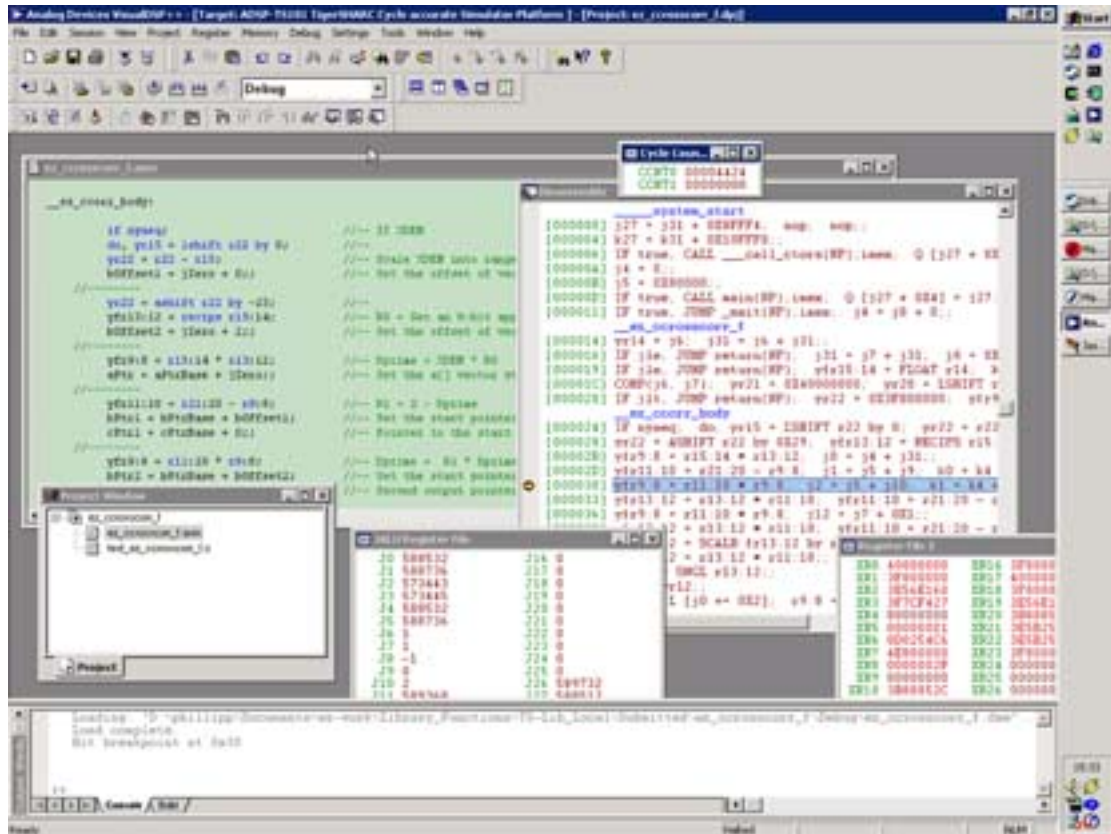


TS-LIB

Imaging and Signal Processing C-Library for the ADSP-TS101 DSP



Features

Over 400 critical DSP functions

Up to 400% Speed Improvement over existing libraries

1024 pt complex FFT	41 μ S
50 tap FIR filter on 1024 pt array	116 μ S
3x3 convolution on 256x256 array	1.2 mS
5x5 convolution on 256x256 array	20 mS

Individually hand crafted for the TigerSHARC DSP
Uses a logical and intuitive naming convention

Maintains a consistent calling interface

Execution flag indicators

Uses latest algorithm theory

TS-lib is an extensive, hand-optimized assembly language library for the TigerSHARC DSP. Designed to complement Analog Devices' run-time library (included within the VisualDSP++ tool-chain) it contains over 400 functions for signal and image processing applications. TS-LIB is operating system independent and can be used 'as is' in any C-applications - single-threaded or under operating systems such as VSPworks or OSE.

Designed by



in association with



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Functions Summary

Power Routines	Scalar, Vector, Complex Scalar Power, Complex Vector
Trigonometric Routines	Scalar & Vector Trigonometric, Scalar & Vector Hyperbolic
Vector Mathematic Routines	2-input term Vector & complex Vector, 3-input term Vector & Complex Vector, 4-input term Vector
Matrix Mathematic Routines	Matrix Vector & Scalar, Complex Matrix-Vector & Scalar
Simple Operations	Scalar, Vector, Complex Scalar, Complex Vector
Logic-Test-Sort Operations	Vector Test, Threshold, Logic, Shift, Sorting, Matrix Check
Statistic Operations	Vector Sum/Average, Vector Max/Min, Matrix Max/Min, Probability, Vector Gather/Scatter, Histogram, Integration, Interpolation
Filter Routines	Convolution, Correlation, Filtering, Windowing
Transform Routines	Conversion, Complex FFTs, Real FFTs, FFT Operator, DCT Routines, Compander, Coordinate Transform, Accumulating Spectrum
Matrix/Vector Creation & Moving Routines	Create Matrix / Vector, Complex Vector Creation, Distribution and Pseudo-Random Number Generation, Memory Move, Matrix/Vector
Other Routines	Doppler, Cholesky, Signal-Noise , Sub-matrix

Example Performance Increase (ADSP-TS101 Cycles)

Routine	Input Length	Visual DSP Run-time	TS-Lib	% Faster
Real Vector and Scalar Addition.	1000	900	527	70.8
Real Vector and Scalar Multiplication	1000	900	524	71.8
Real Vector and Vector Addition	1000	1273	776	64.0
Real Vector and Vector Multiplication	1000	1273	776	64.0
Complex Vector Addition	1000	2766	1526	81.3
Complex Vector Multiplication	1000	3012	2526	19.2
Complex Vector Dot Product	1000	3022	2039	48.2
Real Matrix Addition	{100,100}	12533	10043	24.8
Real Matrix Scalar Addition	{100,100}	8785	7542	16.5
Complex Matrix Addition	{100,100}	25030	12713	96.9
Real Vector Mean	1000	1431	1045	36.9
Real Vector Root Mean of Squares	1000	1134	1065	6.5
FIR	20 & 10000	202534	104420	94.0
Real Cross Correlation	1000 & 1000	1145056	260821	339.0
Real Convolution	1000 & 1000	2513531	874567	187.4

Power Routines

Scalar Power Routines

Scalar Exponential
Scalar Base 10 Exponential
Scalar Base 2 Exponential
Scalar Natural Logarithm
Scalar Base 10 Logarithm
Scalar Base 2 Logarithm
Scalar Power
Scalar Reciprocal Square Root
Scalar Square Root
Scalar Cube Root
Scalar Cube

Vector Power Routines

Vector Cube Root
Vector Cube
Vector Distance
Vector Exponential
Vector Base 10 Exponential
Vector Base 2 Exponential
Vector Logarithm
Vector Base 10 Logarithm
Vector Base 2 Logarithm
Vector Power
Vector Pythagoras
Vector Reciprocal Square Root
Vector Reciprocal
Vector Square
Vector Square Root
Vector Signed Square

Complex Scalar Power Routines

Complex Scalar Exponential
Complex Scalar Square Root
Complex Scalar Reciprocal

Complex Vector Power Routines

Complex Vector Exponential
Complex Vector Exponential & Multiply
Complex Vector Square Root
Complex Vector Reciprocal

Trigonometric Routines

Scalar Trig Routines

Scalar Cosine
Scalar Sine
Scalar Tangent
Scalar $\sin(x) / x$
Scalar Inverse Cosine
Scalar Inverse Sine
Scalar Inverse Tangent
Scalar Inverse Tangent 2

Vector Trig Routines

Vector Cosine
Vector Cotangent
Vector Cosecant
Vector Secant
Vector Sine
Vector Tangent
Vector $\sin(x) / x$
Vector Inverse Cosine
Vector Inverse Sine

Vector Inverse Tangent
Vector Inverse Tangent 2
Vector Inverse Cotangent
Vector Inverse Cosecant

Scalar Hyperbolic Routines

Hyperbolic Cosine
Hyperbolic Sine
Hyperbolic Tangent
Inverse Hyperbolic Cosine
Inverse Hyperbolic Sine
Inverse Hyperbolic Tangent

Vector Hyperbolic Routines

Vector Hyperbolic Cosine
Vector Hyperbolic Cotangent
Vector Hyperbolic Cosecant
Vector Hyperbolic Secant
Vector Hyperbolic Sine
Vector Hyperbolic Tangent
Vector Inverse Hyperbolic Cosine
Vector Inverse Hyperbolic Cotangent
Vector Inverse Hyperbolic Cosecant
Vector Inverse Hyperbolic Secant
Vector Inverse Hyperbolic Sine
Vector Inverse Hyperbolic Tangent

Vector Mathematic Routines

2-input term vector Math Routines

Vector Dot Product
Vector Scalar Add
Vector Scalar Divide
Vector Scalar Multiply
Vector Scalar Subtract
Vector Vector Add
Vector Vector Divide
Vector Vector Multiply
Vector Vector Subtract

2-input term Complex Vector Math Routines

Complex Vector Dot Product By Conjugate
Complex Vector Dot Product
Complex Vector Multiply & Add
Complex Vector Add
Complex Divide
Complex Vector Multiply
Complex Vector Subtract
Complex Vector Add With Real Vector
Complex Vector Divided By Real Vector
Complex Vector Multiplied By Real Vector
Complex Vector Subtracted By Real Vector
Complex Vector Scalar Add
Complex Vector Scalar Divide
Complex Vector Scalar Multiply
Complex Vector Scalar Subtract

3-input term Complex Vector Math Routines

Complex Vector Conjugate, Multiply & Add
Complex Vector Conjugate & Multiply
Complex Vector Scalar Multiply & Add Complex Vector

3-input term vector Math Routines

Vector Scalar Add & Scalar Multiply
Vector Scalar Add & Scalar Subtract
Vector Scalar Multiply & Scalar Add
Vector Scalar Multiply & Scalar Subtract

Vector Scalar Subtract & Scalar Add
Vector Scalar Subtract & Scalar Multiply
Vector Add & Scalar Multiply
Vector Add & Scalar Subtract
Vector Multiply & Scalar Add
Vector Multiply & Scalar Subtract
Vector Scalar Multiply & Vector Add
Vector Subtract & Scalar Add
Vector Scalar Multiply & Vector Subtract
Vector Subtract & Scalar Multiply
Vector Add & Multiply
Vector Multiply & Add
Vector Multiply & Subtract
Vector Subtract & Multiply

4-input term vector Math Routines

Vector Add, Add & Multiply
Vector Add, Subtract & Multiply
Vector Multiply, Multiply & Add
Vector Multiply, Multiply & Subtract
Vector Multiply By Scalar Added to Vector Multiplied By Scalar
Vector Subtract, Subtract & Multiply

Matrix Mathematic Routines

Matrix Math Routines

Matrix Add
Matrix Determinant
Matrix Multiply
Matrix Subtract
Matrix Transpose
Determinant of 2x2 Matrix
Determinant of 3x3 Matrix
Kronecker Product
Matrix LU Decomposition

Matrix-Vector Math Routines

Vector-Matrix Multiply
Matrix Vector Multiply
Matrix Vector Multiply 2 by 2
Matrix Vector Multiply 3 by 3
Matrix Vector Multiply 4 by 4
Vector Matrix Multiply 2 by 2
Vector Matrix Multiply 3 by 3
Vector Matrix Multiply 4 by 4

Matrix-Scalar Math Routines

Matrix Scalar Multiply
Matrix Scalar Subtract
Matrix Scalar Addition
Matrix Scalar Division
Matrix Multiply 2 by 2
Matrix Multiply 3 by 3
Matrix Multiply 4 by 4

Complex Matrix Math Routines

Multiply Complex Matrix By Complex Conjugate Matrix
Complex Matrix Addition
Complex Matrix Subtraction
Complex Matrix Multiplication
Complex Matrix Transpose

Complex Matrix-Vector Math Routines

Multiply Complex Matrix By Complex Vector
Multiply Complex Vector By Complex Scalar

Complex Matrix-Scalar Math Routines

Multiply Complex Scalar By Complex Conjugate Matrix
Multiply Complex Scalar By Complex Matrix

Simple Operations

Scalar Simple Routines

Scalar Absolute Value
Scalar Floating-Point Remainder
Scalar Get Mantissa & Exponent
Scalar Multiply By A Power of 2
Scalar Get Fraction & Integer
Truncate To Next Higher Whole - Ceil
Round Down To Next Lower - Floor

Vector Simple Routines

Vector Absolute Value
Vector Clear
Vector Fill
Vector Move
Vector Move Program Memory to Data Memory
Vector Move Program Memory to Program Memory
Vector Negate Absolute Value
Vector Negate
Vector Reverse Order
Vector Swap
Vector Truncate To Next Higher Whole Number
Vector Floating-Point To Integer Conversion
Vector Integer To Floating-Point Conversion
Vector Truncate To Next Lower Whole Number
Vector Floating-Point to Integer Round
Vector Floating-Point To Integer Conversion for Positive Numbers
Vector Truncate To Fraction
Vector Get Mantissa and Exponent
Vector Scale By Raising to Power of 2
Vector Split Into Floating-Point & Integer Portions
Vector Floating-Point To Integer Conversion for Negative Numbers
Vector Floating-Point To Nearest Integer Conversion
Vector Integer To Floating-Point Conversion of Short Word

Complex Scalar Simple Routines

Complex Absolute Value
Complex Conjugate

Complex Vector Simple Routines

Complex Absolute Value
Complex Vector Fill
Complex Vector Move
Complex Vector Move From Data Memory To Program Memory
Complex Vector Move From Program Memory to Data Memory
Complex Vector Negate
Complex Vector Conjugate

Logic-Test-Sort Operations

Vector Test

Vector Compress
Vector Compressed Merge
Vector Envelope
Logical Vector Equal
Logical Vector Greater Than or Equal
Logical Vector Greater Than
Logical Vector Less Than or Equal
Logical Vector Less Than
Vector Not Equal

Vector Logical Merge
Vector Negative Merge
Vector Positive Merge
Vector Tapered Merge

Threshold Operations

Vector Clip
Vector Inverse Clip
Vector Limit
Vector Lower Threshold
Vector Threshold Normalized
Vector Threshold, Zero Fill
Vector Threshold, Signed Constant
Vector Upper Threshold

Logic Operations

Vector Logical And
Vector Logical Or
Vector Logical Exclusive Or
Vector Not Exclusive Bitwise Or
Vector Logical And Followed By And
Vector Logical Or Followed By Complement
Vector Logical Complement

Shift Operations

Vector Arithmetic Shift
Vector Logical Shift
Vector Rotate Left
Vector Rotate Right
Vector Rotate

Sorting Operations

Vector Bubble Sort

Matrix Check Operations

Check Matrix Orthogonal
Partial Matrix Pivoting
Check Matrix Skew
Check Matrix Symmetry
Matrix Trace

Statistic Operations

Vector Sum / Average

Moving Average
Vector Range
Mean Value of Vector Elements
Mean Value of Vector Element Magnitudes
Mean Value of Vector Element Squares
Mean Value of Vector Element Signed Squares
Root Mean Square of Vector Elements
Sliding Window Summation
Vector Summation
Sum of Vector Element Magnitudes
Sum of Vector Element Squares
Sum of Vector Element Signed Squares
Vector Exponential Average
Vector Linear Average
Vector Running Sum

Vector Max/Min

Maximum Magnitude
Maximum Magnitude with Index
Maximum Element of a Vector
Maximum Element of a Vector With Index
Minimum Magnitude
Minimum Magnitude with Index

Minimum Element of a Vector
Minimum Element of a Vector With Index
Vector Maximum of 3 Vectors
Vector Minimum of 3 Vectors

Matrix Max/Min

Maximum Value of a Matrix
Maximum Value of a Matrix w/ Coordinates
Minimum Value of a Matrix
Minimum Value of a Matrix w/ Coordinates
Maximum Value of 2 Matrices
Minimum Value of 2 Matrices

Probability Routines

Combination
Factorial
Least Square Regression Fit
Mean Deviation
Mean Squared Error
Permutation
Standard Error of Estimate
Standard Deviation Function
Variance
Weighted Mean

Vector Gather/Scatter

Vector Gather
Vector Index
Vector Scatter

Histogram Routines

Vector Histogram
Vector Integer Histogram

Integration Routines

Vector Polynomial Evaluation
Vector Build Ramp
Simpson's Integration
Trapezoidal Integration

Interpolation Routines

Linear Interpolation Using Reference Grid of Points
Vector Linear Interpolate
Vector Generation By Linear Interpolation and Extrapolation
Vector Quadratic Interpolation

Filter Routines

Convolution Routines

Convolution
2-Dimensional Convolution

Correlation Routines

Auto-Correlation Time
Complex Auto-Correlation Time Domain
Complex Correlation Time Domain
Cross-Correlation Time Domain
Correlation
2-Dimensional Correlation

Filtering Routines

Bi-Quad IIR Filter
Complex Decimating FIR Filter
Complex FIR Filter
Direct Form Decimating FIR Filter
Compute FIR of 2 Vectors w/ Decimation & Delay Memory
5-Tap Finite Impulse Response Filter
Direct Form FIR Filter
Direct Form LMS FIR Filter

Windowing Routines

Hamming Window Multiply
Blackman Window Multiply
Kaiser-Bessel Window Shape Function
Bartlett Window Multiply
Blackman-Harris Window Multiply
Hanning Window Multiply
Kaiser-Bessel Window Multiply
Welch Window Multiply

Transform Routines

Conversion Routines

Rectangular to Polar Conversion
Polar to Rectangular Conversion
Vector Convert Decibels to Linear Amplitude
Vector Convert Decibels to Linear Power
Vector Convert Radians to Degrees
Vector Convert Linear Volt Units to Decibels Amplitude
Vector Convert Linear Power to Decibels
Vector Convert Degrees to Radians

Complex FFTs

Complex FFT
Complex 2-Dimensional
8-Point Complex FFT
16-Point Complex FFT
Inverse Complex FFT

Real FFTs

Real FFT
Real FFT In Place
Real FFT (Sorenson Algorithm)
8-Point Real FFT
16-Point Real FFT
32-Point Real FFT

FFT Operator Routines

FFT Weights Array
Window Cosine/Sine Weights Array
Sort rfft() Data for rfft()
Sort rffts() Data for rffts()

DCT Routines

8x8 Discrete Cosine Transform

Compander Routines

a-Law Compression
a-Law Expansion
 μ -Law Compression
 μ -Law Expansion

Coordinate Transform Routines

2-Dimensional Coordinate Transformation
3-Dimensional Coordinate Transformation

Accumulating Spectrum Routines

Accumulating Autospectrum
Accumulating Cross-Spectrum

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Matrix / Vector Creation and Moving Routines

Create Matrix / Vector

Null Matrix
Unity Matrix
Complex Vector Create From Real
Complex Vector Create From Integer
Create Vector From Imaginary Components
Create Vector From Real Components
Extract Real & Imaginary Components From Complex Vector

Complex Vector Creation Routines

Vector Magnitude Squared
Power Spectra
Vector Transfer Function
Vector Multiply By Cosine and Sine Function

Distribution and Pseudo-Random Number Generation Routines

Vector Build Normal Distribution
Vector Build Uniform Distribution
Vector Pseudo-Random Number (PRN) Generator

Memory Move Matrix / Vector

Matrix Move
Matrix Move From Data Memory to Program Memory
Matrix Move From Program Memory to Data Memory
Move a Source Complex Matrix to a Destination Complex Matrix
Unpack Integer Matrix to IQ Matrices
Pack Floating-Point Vector
Pack Integer Vector
Unpack into Floating-Point Vector
Unpack into Integer Vector

Other Routines

Generate Doppler Signal
Endian Order
Integral Non-Linearity
Linear Magnitude
Log Based Magnitude
Monopulse Function
Monopulse Function (Program Memory)
Compute NCO Values
Compute NCO Table Values
Signal to Noise Density
Compute NCO Table Values
Zero Crossing Detector
Complex Vector Phase
Complex Vector Magnitude Squared
Complex Vector Magnitude Squared & Add
Choleski Matrix Decomposition
Constant Matrix
Complete Matrix Pivot
Extract a Sub Matrix
Matrix Identity
Insert a Sub Matrix
Matrix Forward-Back Substitution



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