

CHAPTER 6

Wideband ADSP-21K Optimized DSP Library Timing Benchmarks, Code Size & Minimum Vector Length Tables

The following series of benchmarks were derived by testing the Wideband 21K Optimized DSP Library with the Test Programs included in the distribution of the library.

The “Overhead In Cycles” category of the benchmarks represents the minimum number of instructions necessary to enter and exit a given routine. Note that this is a one-time cost incurred each time the routine is called and becomes less significant the more data points that are processed by the routine.

The “Inner-Loop Cycles/Element” category represents the number of processor cycles necessary to compute the final answer for each element that is to be processed.

The “Sizes In Words” category represent the size of the actual memory space occupied by a given routine. All size parameters are measured in words.

The “Min Vec Size” category represent the minimum number of data points that the user must supply to the routine in order for the algorithm to work properly. Routines supplied with a number less than the minimum vector size will not work properly.

TABLE 10
Power Functions

Function Name	Function Description	Cycles/Routine	Size In Words
exp_wci	Exponential	44 Cycles Normal	0x2a
exp10_wci	Base 10 Exponential	46 Cycles Normal	0x2c
log_wci	Natural Logarithm	43 Cycles Normal	0x2b
log10_wci	Base 10 Logarithm	42 Cycles Normal	0x2a
pow_wci	Power	83 Cycles Normal	0x53

TABLE 11
Simple Trigonometric Functions

Function Name	Function Description	Cycles/Routine	Size In Words
cos_wci	Cosine	31 Cycles Normal	0x1c
sin_wci	Sine	28 Cycles Normal	0x1b
tan_wci	Tangent	49 Cycles Normal	0x31

TABLE 12
Simple Scalar Functions

Function Name	Function Description	Cycles/Routine	Size In Words
fabs_wci	Absolute Value	4 Cycles Normal	0x04
fmod_wci	Floating-Point Remainder	44 Cycles Normal	0x2c
frexp_wci	Get Mantissa & Exponent	14 Cycles Normal	0x0e
ldexp_wci	Multiply By A Power of 2	4 Cycles Normal	0x04
modf_wci	Get Fraction & Integer	13 Cycles Normal	0x0d
rsqrt_wci	Reciprocal Square Root	19 Cycles Normal	0x13
sqrt_wci	Square Root	20 Cycles Normal	0x14

TABLE 13 Inverse Trigonometric Functions

Function Name	Function Description	Cycles/Routine	Size In Words
acos_wci	Inverse Cosine	If a <= 0.5 then 55 Cycles Normal	0x68
acos_wci	Inverse Cosine	If a > 0.5 then 75 Cycles Normal	0x68
asin_wci	Inverse Sine	If a <= 0.5 then 55 Cycles Normal	0x68
asin_wci	Inverse Sine	If a > 0.5 then 73 Cycles Normal	0x68
atan_wci	Inverse Tangent	59 Cycles Normal	0x39
atan2_wci	Inverse Tangent 2	76 Cycles Normal	0x4a

TABLE 14 Hyperbolic Functions

Function Name	Function Description	Cycles/Routine	Size In Words
cosh_wci	Hyperbolic Cosine	58 Cycles Normal	0x38
sinh_wci	Hyperbolic Sine	56 Cycles Normal	0x38
tanh_wci	Hyperbolic Tangent	66 Cycles Normal	0x42

TABLE 15 Inverse Hyperbolic Functions

Function Name	Function Description	Cycles/Routine	Size In Words
acosh_wci	Inverse Hyperbolic Cosine	72 Cycles Normal	0x48
asinh_wci	Inverse Hyperbolic Sine	57 Cycles Normal	0x39
atanh_wci	Inverse Hyperbolic Tangent	59 Cycles Normal	0x3d

TABLE 16 Truncation Functions

Function Name	Function Description	Cycles/Routine	Size In Words
ceil_wci	Truncate To Next Higher Whole Number	20 Cycles Normal	0x13
floor_wci	Round Down To Next Lower Whole Number	21 Cycles Normal	0x15

TABLE 17 Simple Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vabs	Vector Absolute Value	22	2*(N-1)	0x24	2
vclr	Vector Clear	8	1*N	0x9	1
vfill	Vector Fill	8	1*N	0x9	1
vmov	Vector Move	18	2*N	0x14	2
vmov_dp	Vector Move Data Memory to Program Memory	5	N	0x0c	2
vmov_pd	Vector Move Program Memory to Data Memory	5	N	0x0c	2
vmov_pp	Vector Move Program Memory to Program Memory	18	2*N	0x14	2
vnabs	Vector Negate Absolute Value	23	2*(N-1)	0x19	2
vneg	Vector Negate	20	2*(N-1)	0x16	2
vrecip	Vector Reciprocal	20	10*N	0x1e	1
vrecipz	Vector Reciprocal With Zero Domain Check	25	13*N	0x1e	1
vrvrs	Vector Reverse Order	23	4*N	0x15	2
vswap	Vector Swap	23	4*N	0x15	1

TABLE 18 Power Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vcbrt	Vector Cube Root	50	75*N	0x7d	1
vcube	Vector Cube	23	3*(N-1)	0x1a	2

TABLE 18

Power Functions

vdist	Vector Distance	54	20*N	0x3f	2
vexp	Vector Exponential	47	29*N	0x4c	2
vexp10	Vector Base 10 Exponential	47	29*N	0x4c	2
vexp2	Vector Base 2 Exponential	47	29*N	0x4c	2
vlog	Vector Logarithm	58	30*N	0x58	1
vlog10	Vector Base 10 Logarithm	58	30*N	0x58	1
vlog2	Vector Base 2 Logarithm	58	30*N	0x58	1
vpow	Vector Power	52	69*N	0x79	1
vpythag	Vector Pythagoras	81	23*(N-1)	0x68	2
vrsqrt	Vector Reciprocal Square Root	33	15*N	0x30	1
vrsqrtz	Vector Reciprocal Square Root With Domain Check	31	(17 to 5)*N	0x2a	1
vsq	Vector Square	22	2*(N-1)	0x16	2
vsqrt	Vector Square Root	19	14*N	0x21	1
vssq	Vector Signed Square	19	17*N	0x24	1

TABLE 19

Simple Trigonometric Functions

Function Name	Function Description	Over-head In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vcos	Vector Cosine	39	23*N	0x36	1
vcos_pd	Vector Cosine Program Memory to Data Memory	27	22*N	0x2d	1
vcot	Vector Cotangent	39	32*N	0x47	1
vcsc	Vector Cosecant	51	34*N	0x4d	1
vsec	Vector Secant	51	34*N	0x4d	1
vsin	Vector Sine	38	23*N	0x35	1
vtan	Vector Tangent	47	32*N	0x4f	1

TABLE 20

Sorting Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vbsort	Vector Bubble Sort	45	$N*(6 + 7*N)$	0x45	2
vqsort	Vector Quick Sort	66	$N*\log N$ (average) N^2 (worst case)	0xa0	1
vssort	Vector Selection Sort	18	$7C + 3 \sum_{i=N-C}^N i$	0x20	1

TABLE 21

Arc Trigonometric Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vacos	Vector Arc Cosine	71	$(36 \text{ to } 56)*N$	0x7f	1
vacot	Vector Arc Cotangent	48	$(60 \text{ to } 70 \text{ to } 63 \text{ to } 53)*N$	0x6d	1
vacsc	Vector Arc Cosecant	54	$(43 \text{ to } 62)*N$	0x87	1
vasec	Vector Arc Cosecant	63	$(46 \text{ to } 65)*N$	0x77	1
vasin	Vector Arc Sine	71	$(38 \text{ to } 58)*N$	0x7f	1
vatan	Vector Arc Tangent	34	$57*N$	0x52	1
vatan2	Vector Arc Tangent 2	50	$70*N$	0x6b	1

TABLE 22 Hyperbolic Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vcosh	Vector Hyperbolic Cosine	38	44*N	0x50	1
vcoth	Vector Hyperbolic Cotangent	38	52*N	0x5a	1
vcsch	Vector Hyperbolic Cosecant	36	52*N	0x58	1
vsech	Vector Hyperbolic Secant	36	52*N	0x58	1
vsinh	Vector Hyperbolic Sine	36	44*N	0x50	1
vtanh	Vector Hyperbolic Tangent	38	52*N	0x52	1

TABLE 23 Inverse Hyperbolic Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vacosh	Vector Inverse Hyperbolic Cosine	66	(35 to 56)*N	0x71	1
vacoth	Vector Inverse Hyperbolic Cotangent	39	59*N	0x5a	1
vacsch	Vector Inverse Hyperbolic Cosecant	44	55*N	0x5b	1
vasech	Vector Inverse Hyperbolic Secant	37	(7 to 9 to 60)*N	0x5a	1
vasinh	Vector Inverse Hyperbolic Sine	38	53*N	0x5b	1
vatanh	Vector Inverse Hyperbolic Tangent	38	51*N	0x59	1

TABLE 24 Average & Summing Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
movavg	Moving Average	50	$3*N-2W$	0x30	2
mve	Mean Value of Vector Elements	29	$1*(N-1)$	0x1d	2
mvemg	Mean Value of Vector Element Magnitudes	24	$2*(N-1)$	0x1f	2
mvessq	Mean Value of Vector Element Squares	30	$2*(N-1)$	0x1f	2
mvessq	Mean Value of Vector Element Signed Squares	32	$3*(N-1)$	0x21	2
rmvesq	Root Mean Square of Vector Elements	46	$2*(N-1)$	0x30	2
slidwin	Sliding Window Summation	38	$(W-1)+3*(N-W)$	0x23	2
sve	Vector Summation	14	$1*(N-1)$	0x14	2
svemg	Sum of Vector Element Magnitudes	19	$2*(N-1)$	0x15	2
svessq	Sum of Vector Element Squares	19	$2*(N-1)$	0x15	2
svessq	Sum of Vector Element Signed Squares	21	$3*(N-1)$	0x19	2

TABLE 25 Comparison Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vcmprs	Vector Compress	28	$4*N$	0x20	1
vcmerg	Vector Compressed Merge	45	$6*N$	0x33	1

TABLE 25 Comparison Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
venvp	Vector Envelope	35	8*N	0x2b	1
veq	Logical Vector Equal	41	5*N	0x2d	1
vge	Logical Vector Greater Than or Equal	41	5*N	0x2d	1
vgt	Logical Vector Greater Than	41	5*N	0x2d	1
vle	Logical Vector Less Than or Equal	41	5*N	0x2d	1
vlt	Logical Vector Less Than	41	5*N	0x2d	1
vne	Vector Not Equal	41	5*N	0x2d	1
vlmerg	Vector Logical Merge	45	6*N	0x33	1
vnmerg	Vector Negative Merge	45	6*N	0x33	1
vpmerg	Vector Positive Merge	45	6*N	0x33	1
vtmerg	Vector Tapered Merge	51	7*N	0x3a	1

TABLE 26 Vector Fix, Float & Truncation

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vceil	Vector Truncate To Next Higher Whole Number	24	7*N	0x1f	1
vfix	Vector Floating-Point To Integer Conversion	37	5*(N-1)	0x23	2
vfloat	Vector Integer To Floating-Point Conversion	34	2*(N-1)	0x24	2
vfloor	Vector Truncate To Next Lower Whole Number	31	2*(N-1)	0x1b	1
virnd	Vector Floating-Point to Integer Round	34	2*(N-1)	0x1d	2
vpfix	Vector Floating-Point To Integer Conversion for Positive Numbers	32	2*(N-1)	0x1c	2
vfrac	Vector Truncate To Fraction	32	5*(N-1)	0x20	1
vfexp	Vector Get Mantissa and Exponent	49	9*N	0x3a	1
vldexp	Vector Scale By Raising to Power of 2	36	4*N	0x28	1
vmodf	Vector Split Into Floating-Point & Integer Portions	50	9*N	0x36	1

TABLE 26 Vector Fix, Float & Truncation

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vnfix	Vector Floating-Point To Integer Conversion for Negative Numbers	38	5*(N-1)	0x25	2
vround	Vector Floating-Point To Nearest Integer Conversion	28	2*(N-1)	0x1e	2
vsfloat	Vector Integer To Floating-Point Conversion of Short Word	30	6*(N-1)	0x2a	2

TABLE 27 Limiting Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vclip	Vector Clip	22	6*N	0x1c	2
viclip	Vector Inverse Clip	25	10*N	0x23	1
vlim	Vector Limit	22	4*N	0x1a	2
vlthr	Vector Lower Threshold	27	2(N-1)	0x*6	2
vtthr	Vector Threshold Normalized	29	4*N	0x21	1
vtthres	Vector Threshold, Zero Fill	29	4*N	0x21	1
vtthresc	Vector Threshold, Signed Constant	22	4*N	0x1a	1
vuthr	Vector Upper Threshold	13	4*N	0x0d	2

TABLE 28

Logical Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop In Cycles	Size In Words	Min Vec Size
vand	Vector Logical And	33	3*(N-1)	0x24	2
vashift	Vector Arithmetic Shift	33	3*(N-1)	0x24	2
vlshift	Vector Logical Shift	33	3*(N-1)	0x24	2
vnand	Vector Logical And Followed By And	33	3*(N-1)	0x24	2
vnor	Vector Logical Or Followed By Complement	33	3*(N-1)	0x24	2
vnot	Vector Logical Complement	27	2*(N-1)	0x16	2
vnxor	Vector Not Exclusive Bitwise Or	33	3*(N-1)	0x24	2
vor	Vector Logical Or	33	3*(N-1)	0x24	2
vrol	Vector Rotate Left	23	2*(N-1)	0x24	2
vrer	Vector Rotate Right	23	2*(N-1)	0x24	2
vrot	Vector Rotate	23	2*(N-1)	0x24	2
vxor	Vector Logical Exclusive Or	33	3*(N-1)	0x24	2

TABLE 29

2-Vector & 1-Scalar Math Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vscadd	Vector Scalar Add	34	2*(N-1)	0x24	2
vscdiv	Vector Scalar Divide	31	2*(N-1)	0x21	2
vscmul	Vector Scalar Multiply	34	2*(N-1)	0x24	2
vscsub	Vector Scalar Subtract	34	2*(N-1)	0x24	2

TABLE 30 2-Vector & 2-Scalar Math Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vsasm	Vector Scalar Add & Scalar Multiply	31	2*(N-1)	0x1a	2
vsassb	Vector Scalar Add & Scalar Subtract	29	2*(N-1)	0x18	2
vsmsad	Vector Scalar Multiply & Scalar Add	31	2*(N-1)	0x1f	2
vsmsb	Vector Scalar Multiply & Scalar Subtract	29	2*(N-1)	0x19	2
vssbsa	Vector Scalar Subtract & Scalar Add	29	2*(N-1)	0x18	2
vssbsm	Vector Scalar Subtract & Scalar Multiply	29	2*(N-1)	0x18	2

TABLE 31 3-Vector Math Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vadd	Vector Add	29	3*(N-1)	0x20	2
vdiv	Vector Divide	29	11*(N-1)	0x28	2
vdivz	Vector Divide with Domain Check	29	14*N	0x2b	1
vmul	Vector Multiply	29	3*(N-1)	0x20	2
vsub	Vector Subtract	29	3*(N-1)	0x20	2

TABLE 32 3-Vector and 1-Scalar Math Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vascm	Vector Add & Scalar Multiply	38	3*(N-1)	0x29	2
vascs	Vector Add & Scalar Subtract	38	3*(N-1)	0x29	2
vmzca	Vector Multiply & Scalar Add	38	3*(N-1)	0x29	2
vmzcs	Vector Multiply & Scalar Subtract	38	3*(N-1)	0x29	2
vscma	Vector Scalar Multiply & Vector Add	38	3*(N-1)	0x29	2

TABLE 32 3-Vector and 1-Scalar Math Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vssca	Vector Subtract & Scalar Add	38	3*(N-1)	0x29	2
vscmsb	Vector Scalar Multiply & Vector Subtract	38	3*(N-1)	0x29	2
vsscm	Vector Subtract & Scalar Multiply	38	3*(N-1)	0x29	2

TABLE 33 4-Vector Math Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vam	Vector Add & Multiply	44	4*(N-1)	0x30	2
vma	Vector Multiply & Add	44	4*(N-1)	0x30	2
vms	Vector Multiply & Subtract	44	4*(N-1)	0x30	2
vsm	Vector Subtract & Multiply	44	4*(N-1)	0x30	2

TABLE 34 5-Vector Math Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vaam	Vector Add, Add & Multiply	59	5*(N-1)	0x40	2
vasm	Vector Add, Subtract & Multiply	59	5*(N-1)	0x40	2
vmma	Vector Multiply, Multiply & Add	59	5*(N-1)	0x40	2
vmms	Vector Multiply, Multiply & Subtract	59	5*(N-1)	0x40	2
vsmvsma	Vector Multiply By Scalar Added to Vector Multiplied By Scalar	46	3*(N-1)	0x27	2
vssm	Vector Subtract, Subtract & Multiply	59	5*(N-1)	0x40	2

TABLE 35 Maximum/Minimum Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
maxmgv	Maximum Magnitude	21	16*(N-1)	0x16	2
maxmgvi	Maximum Magnitude with Index	31	4*N	0x12	2
maxv	Maximum Element of a Vector	20	1*(N-1)	0x29	2
maxvi	Maximum Element of a Vector With Index	21	3*N	0x1c	2
minmgv	Minimum Magnitude	21	16*(N-1)	0x16	2
minmgvi	Minimum Magnitude with Index	31	4*N	0x12	2
minv	Minimum Element of a Vector	20	1*(N-1)	0x29	2
minvi	Minimum Element of a Vector With Index	21	3*N	0x34	2
vmax	Vector Maximum	29	3*(N-1)	0x20	2
vmax3	Vector Maximum of 3 Vectors	57	4*(N-1)	0x16	2
vmin	Vector Minimum	29	3*(N-1)	0x20	2
vmin3	Vector Minimum of 3 Vectors	57	4*(N-1)	0x2f	2
vmaxmg	Vector Maximum Magnitudes	31	3*(N-1)	0x20	2
vminmg	Vector Minimum Magnitudes	31	3*(N-1)	0x20	2

TABLE 36 Gather/Scatter Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
vgathr	Vector Gather	27	5*N	0x20	1
vindex	Vector Index	27	5*N	0x21	1
vscatr	Vector Scatter	27	5*N	0x20	1

TABLE 37 Conversion Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
polar	Rectangular to Polar Conversion	63	91*N	0x9a	1
rect	Polar to Rectangular Conversion	41	49*N	0x52	1
vdblina	Vector Convert Decibels to Linear Amplitude	40	36*N	0x4c	2
vdblincp	Vector Convert Decibels to Linear Power	44	30*N	0x42	2
vdeg	Vector Convert Radians to Degrees	21	2*(N-1)	0x17	2
vlindba	Vector Convert Linear Volt Units to Decibels Amplitude	65	33*N	0x59	2
vlindbp	Vector Convert Linear Power to Decibels	65	33*N	0x59	2
vrad	Vector Convert Degrees to Radians	21	2*(N-1)	0x17	2

TABLE 38 Complex Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
ccdopr	Complex Vector Dot Product By Conjugate	64	4*(N-1)	0x48	2
cdopr	Complex Vector Dot Product	64	4*(N-1)	0x48	2
cvexp	Complex Vector Exponential	39	47*N	0x4e	1
cvexpm	Complex Vector Exponential & Multiply	54	51*N	0x60	1
cvma	Complex Vector Multiply & Add	68	8*(N-1)	0x4c	2
cvphase	Complex Vector Phase	62	76*N	0x8a	1
cvsqrt	Complex Vector Square Root	67	171*N	0xdd	1

TABLE 39 Complex Vector Magnitude Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
cvmags	Complex Vector Magnitude Squared	25	3*(N-1)	0x1c	2
cvmagsa	Complex Vector Magnitude Squared & Add	34	4*(N-1)	0x26	2

TABLE 40 Complex Vector Creation Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
cvcmpx	Complex Vector Create From Real	31	4*N	0x23	2
cvcmpxi	Complex Vector Create From Integer	30	4*N	0x22	2
vimag	Create Vector From Imaginary Components	20	2*(N-1)	0x16	2
vreal	Create Vector From Real Components	19	2*(N-1)	0x15	2
vreim	Extract Real & Imaginary Components From Complex Vector	22	4*N	0x21	2

TABLE 41 Complex Vector Simple Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
cvabs	Complex Absolute Value	49	17*(N-1)	0x42	2
cvfill	Complex Vector Fill	21	2*N	0x17	2
cvmov	Complex Vector Move	23	4*N	0x1b	1
cvmov_dp	Complex Vector Move From Data Memory To Program Memory	25	2*(N-1)	0x1b	1
cvmov_pd	Complex Vector Move From Program Memory to Data Memory	27	2*(N-1)	0x1b	1
cvneg	Complex Vector Negate	23	4*N	0x1b	1
cvrecp	Complex Vector Reciprocal	70	21*(N-1)	0x51	2

TABLE 42 Complex Vector Fundamental Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
cvadd	Complex Vector Add	52	6*(N-1)	0x3a	2
cvadd_pd	Complex Vector Add	33	4*(N-1)	0x3a	2
cvadd_pp	Complex Vector Add	33	4*(N-1)	0x3a	2
cvdiv	Complex Divide	85	26*(N-1)	0x6f	2
cvmul	Complex Vector Multiply	58	6*(N-1)	0x40	1
cvsub	Complex Vector Subtract	52	6*(N-1)	0x3a	2

TABLE 43 Complex Vector Real Vector Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
cvradd	Complex Vector Add With Real Vector	38	5*(N-1)	0x2a	2
cvrdiv	Complex Vector Divided By Real Vector	40	12*N	0x2b	1
cvrmul	Complex Vector Multiplied By Real Vector	38	5*(N-1)	0x2a	2
cvrmul_dpd	Complex Vector Multiplied By Real Vector	32	4*(N-1)	0x2a	2
cvrmul_dpp	Complex Vector Multiplied By Real Vector	32	4*(N-1)	0x2a	2
cvrmul_pdd	Complex Vector Multiplied By Real Vector	36	3*(N-1)	0x2a	2
cvrmul_pdp	Complex Vector Multiplied By Real Vector	33	4*(N-1)	0x2a	2
cvrsub	Complex Vector Subtracted From Real Vector	38	5*(N-1)	0x2a	2

TABLE 44 Complex Vector Conjugation Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size In Words	Min Vec Size
cvcma	Complex Vector Conjugate, Multiply & Add	68	8*(N-1)	0x4c	2
cvcmul	Complex Vector Conjugate & Multiply	58	6*(N-1)	0x40	2
cvconj	Complex Vector Conjugate	23	4*N	0x1b	2

TABLE 6-1

TABLE 45

Complex Vector Complex Scalar Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop In Cycles	Size In Words	Min Vec Size
cv sadd	Complex Vector Scalar Add	37	$4*(N-1)$	0x25	2
cv sdiv	Complex Vector Scalar Divide	55	$6*(N-1)$	0x37	2
cv sma	Complex Vector Scalar Multiply & Add Complex Vector	65	$6*(N-1)$	0x47	2
cv smul	Complex Vector Scalar Multiply	41	$4*(N-1)$	0x25	2
cv ssub	Complex Vector Scalar Subtract	36	$4*(N-1)$	0x26	2

TABLE 46

Convolution Kernel Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycle/Element	Size	Min Vec Size
conv	Convolution	42	$(7+NC)*N$	0x24h	m=2
conv2d	2-Dimensional Convolution, KxK Kernel	43	$(3+(6+(6+2K)K)(NC-K+1))(NR-K+1)$	0x35	1
conv3x3	2-Dimensional Convolution, 3x3 Kernel	52	$23*(Y-2)(X-2)$	0x41	9
conv3x3p	2-Dimensional Convolution, 3x3 Kernel - PM Memory	54	$(30+27(Y-2))(X-2)/2$	0x59	9
conv5x5	2-Dimensional Convolution, 5x5 Kernel	58	$76*(X-4)(Y-4)$	0x7e	25
cnv5x5p	2-Dimensional Convolution, 5x5 Kernel - PM Memory	95	$(74+75(Y-4))(X-4)/2$	0xba	25
conv7x7	2-Dimensional Convolution, 7x7 Kernel	33	$(3+235(Y-6))(X-6)$	0x2B	49

TABLE 47

Correlation Functions

Function Name	Function Description	Over-head In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
acort	Auto-Correlation Time Domain	31	$9*M+(M+1)(2*N-M)$	0x23	1
cacort	Complex Auto-Correlation Time Domain	39	$9+5*N$	0x31	2
cccort	Complex Correlation Time Domain	41	$(9+5*N)*M$	0x33	2
ccort	Cross-Correlation Time Domain	32	$9*M+(M+1)(2*N-M)$	0x24	1
corr	Correlation	52	$N*(11+(NB-1)*2)$	0x34	m=2
corr2d	2-Dimensional Correlation, KxK Kernel	35	$(4+(5+(5+4K)K)(NC-K+1))*(NR-K+1)$	0x30	1

Filtering Functions

TABLE 48

Function Name	Function Description	Over-head In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
biquad	Bi-Quad IIR Filter	65	$13*N$	0x43	1
cdesamp	ComplexDecimating FIR Filter	36	$(7+5*P)$	0x30	2
cfir	Complex FIR Filter	59	$(9+5*P)*N$	0x45	2
desamp	Direct Form Decimating FIR Filter	25	$(7+P-1)*NC$	0x1c	1
desampd	Compute FIR of 2 Vectors w/ Decimation & Delay Memory	86	$FILL + (6+NC+D)*W$ $W=(INT)((N-FILL)/D)+1$	0x53	2
fir5	5-Tap Finite Impulse Response Filter	55	$(N-1)*7$	0x2e	2
fir_wci	Direct Form FIR Filter	50	$P+(N-1)*(4+P)$	0x28	2
firlms	Direct Form LMS FIR Filter	TBS	TBS	TBS	1

TABLE 49 Windowing Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
alpha	Kaiser-Bessel Window Shape Function	NA	$a \geq 50 = 143$ $21 < a < 50 = 221$ $a \leq 21 = 124$	0xd8	NA
bartlett	Bartlett Window Multiply	44	$17*(N-1)$	0x37	1
blkman	Blackman Window Multiply	41	$4*(N-1)$	0x25	1
blkmnh	Blackman-Harris Window Multiply	54	$6*(N-1)$	0x2f	1
hamm	Hamming Window Multiply	35	$3*N$	0x1e	1
hann	Hanning Window Multiply	36	$2*N$	0x1e	1
kaiser	Kaiser-Bessel Window Multiply	68	$B^* + (41 + 18*B)*(N-1)$	0x95	1
welch	Welch Window Multiply	67	$15*(N-1)$	0x4a	2
*B=	The number of iterations to complete the 0th order Bessel function which can be indeterminate	NA	NA	NA	NA

TABLE 50 Complex FFTs

Function Name	Function Description	Cycles	Points	Size	Min Vec Size
cfft	Complex FFT	771 1,274 2,368 4,724 10,060 21,618 46,744 101,054 217,828 467,722 1,000,240 2,130,774	32 Pts. 64 Pts. 128 Pts. 256 Pts. 512 Pts. 1,024 Pts. 2,048 Pts. 4,096 Pts. 8,192 Pts. 16,384 Pts. 32,768 Pts. 65,536 Pts.	0x196	32
cfft2d	Complex 2-Dimensional FFT	66,950 3,393,654	32x32 Pts. 256x256 Pts.	0xe7	32
cfft8	8-Point Complex FFT	184	8 Points	0x80	8

TABLE 50

Complex FFTs

Function Name	Function Description	Cycles	Points	Size	Min Vec Size
cfft	Complex FFT	771	32 Pts.	0x196	32
		1,274	64 Pts.		
		2,368	128 Pts.		
		4,724	256 Pts.		
		10,060	512 Pts.		
		21,618	1,024 Pts.		
		46,744	2,048 Pts.		
		101,054	4,096 Pts.		
		217,828	8,192 Pts.		
		467,722	16,384 Pts.		
		1,000,240	32,768 Pts.		
2,130,774	65,536 Pts.				
cfft16	16-Point Complex FFt	388	16 Points	0xf2	16
cfft1	Inverse Complex FFT	868	@32 Pts.	0x196	32
		1,435	@64 Pts.		
		2,657	@128 Pts.		
		5,319	@256 Pts.		
		11,117	@512 Pts.		
		23,699	@1,024 Pts.		
		50,873	@2,048 Pts.		
		109,281	@4,096 Pts.		
		234,244	@8,192 Pts.		
		500,525	@16,384 Pts.		
		1,072,560	@32,768 Pts.		
2,288,128	@65,536 Pts.				

TABLE 51

Real FFTs

Function Name	Function Description	Cycles	Points	Size	Min Vec Size
rfft	Real FFT * Extrapolated from Previous Timings	805 1,430 2,774 5,686 11,990 25,590 54,806 117,302 268,576* 575,520* 1,227,776*	64 Pts. 128 Pts. 256 Pts. 512 Pts. 1,024 Pts. 2,048 Pts. 4,096 Pts. 8,192 Pts. 16,384 Pts. 32,768 Pts. 65,536 Pts.	0x133	64
rfftip	Real FFT In Place * Extrapolated from Previous Timings (Formally rfft() in previous versions of library)	1,426 2,329 4,221 8,229 16,715 34,673 72,599 152,509 374,416* 802,320* 1,711,616*	64 Pts. 128 Pts. 256 Pts. 512 Pts. 1,024 Pts. 2,048 Pts. 4,096 Pts. 8,192 Pts. 16,384 Pts. 32,768 Pts. 65,536 Pts.	0xf4	64
rffts	Real FFT (Sorenson Algorithm) * Extrapolated from Previous Timings	1,426 2,329 4,221 8,229 16,715 34,673 72,599 152,509 286,249* 613,392* 1,308,569*	64 Pts. 128 Pts. 256 Pts. 512 Pts. 1,024 Pts. 2,048 Pts. 4,096 Pts. 8,192 Pts. 16,384 Pts. 32,768 Pts. 65,536 Pts.	0x212	64
rfft8	8-Point Real FFT	136	8 Points	0x67	8
rfft16	16-Point Real FFT	337	16 Points	0xe4	16
rfft32	32-Point Real FFT	689	32 Points	0x1a1	32
vrfftip	Sort rfftip() Data for rfft() Function	26	3*N	0x17	2
vrffts	Sort rffts() Data for rfft() Function	35	3*N	0x1d	2

TABLE 52 FFT Weighting Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
fftwts	FFT Weights Array	37	45*(N-1)	0x4e	1
winwts	Window Cosine/Sine Weights Array	30	23*(N-1)	0x38	1

TABLE 53 Other Transforms

Function Name	Function Description	Cycles	Points	Size	Min Vec Size
dct8x8	8x8 Discrete Cosine Transform	2,464 Forward 2,578 Inverse	64 Points 64 Points	0x2d0	64

TABLE 54 Integration Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
vhist	Vector Histogram	47	15*N	0x39	1
vhisti	Vector Integer Histogram	49	16*N	0x3c	1
vpoly	Vector Polynomial Evaluation	46	(5+2*(P-1))*N	0x27	1
vramp	Vector Build Ramp	10	N	0x17	1
vrsum	Vector Running Sum	26	2*N	0x14	1
vsimps	Simpson's Integration	46	7*N	0x34	1
vtrapz	Trapezoidal Integration	30	3*(N-1)	0x1b	1

TABLE 55 Distribution and Pseudo-Random Number Generation Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
vprn	Vector Pseudo-Random Number (PRN) Generator	17	11*N	0x1c	1
vrandn	Vector Build Normal Distribution	26	87*N	0x1e	1
vrandu	Vector Build Uniform Distribution	23	7*N	0x19	1

TABLE 56

Averaging and Interpolation Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
linint	Linear Interpolation Using Reference Grid of Points	57	where sflag = 1, $14*(N-1)+(14+W)*m$ where sflag = 0, $14*(14+W)*m$	0x4c	2
vavexp	Vector Exponential Average	39	$3*N$	0x2a	1
vavlin	Vector Linear Average	39	$3*N$	0x2a	1
vintb	Vector Linear Interpolate	42	$3*(N-1)$	0x2d	2
vgenp	Vector Generation By Linear Interpolation and Extrapolation	42	$3*(N-1)$	0x2d	1
vsqint	Vector Quadratic Interpolation	53	$20*N$	0x49	1

TABLE 57

Probability & Statistical Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
comb	Combination	33	$(A-B)*4$	0x24	1
fact	Factorial	N/A	13	0x10	1
lsqreg	Least Square Regression Fit	99	$5*(N-1)$	0x60	2
meandev	Mean Deviation	50	$3*(N-1)$	0x2e	2
movavg	Moving Average	52	$(W+3) * (N-W+1)$	0x31	2
msqe	Mean Squared Error	53	$3*(N-1)$	0x2f	2
perm	Permutation	20	$B*2$	0x15	1
range	Vector Range	24	$2*(N-1)$	0x16	2
see	Standard Error of Estimate	82	$5*(N-1)$	0x4e	2
std	Standard Deviation Function	57	$4*(N-1)$	0x38	2
var	Variance	40	$3*(N-1)$	0x27	2
wtmean	Weighted Mean	53	$3*(N-1)$	0x30	2

TABLE 58

Matrix Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
madd	Matrix Add	26	$3*(N-1)$	0x17	4
maxm	Maximum Value of a Matrix	20	$3*(X*Y-1)$	0x14	4
maxmc	Maximum Value of a Matrix w/ Corrdinates	27	$8*X*Y$	0x20	4
mchol	Choleski Matrix Decomposition	116	$(3(N-1)+(3+2N)N+(42+3(N-1)+9+4(N-1))(N-2))(N-2)$	0xae	4
mconst	Constant Matrix	15	$X*Y$	0x0c	4
mcpivot	Complete Matrix Pivot	82	$(2X+(43+8X+(2+11X)X)X)$	0x86	4
mdeterm	Matrix Determinant	51	$(12+(16+4*X)*(X-1))*(X-1)+(X-1)$	0x4b	4
mdetrm2	Determinant of 2x2 Matrix	NA	12	0x0a	4
mdetrm3	Determinat of 3x3 Matrix	NA	25	0x17	9
mextr	Extract a Sub Matrix	48	$(3+2*Y)*X$	0x31	9
mident	Matrix Identity	14	$(2+X)*X$	0x10	4
minsrt	Insert a Sub Matrix	48	$(3+2*Y)*X$	0x31	9
mfbsub	Matrix Forward-Back Substitution	72	$(8+4*X-1)(X-1)+(28+4*X-1)(X-1)$	0x67	4
minm	Minimum Value of a Matrix	20	$3*(X*Y-1)$	0x14	4
minmc	Minimum Value of a Matrix w/ Corrdinates	27	$8*X*Y$	0x20	4

TABLE 59

Matrix Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
minvrt	Matrix Invert	N/A	See Manual Table	See Manual	N/A
mkron	Kronecker Product	44	$(4+(4+(4+3*N)*Y)*M)*X$	0x34	2
mlu	Matrix LU Decompoistion	NA	3*N*N Matrix Decomposition Loop $(11+12*X+(9+4*X)*X*X$ Decomposition Loop $(7+5*X)*X$ Scalar Swap Loop	0x70	4
mmax	Maximum Value of 2 Matrices	20	$3*(X*Y-1)$	0x14	4
mmin	Minimum Value of 2 Matrices	10	$X*Y$	0x0a	4
mmov	Matrix Move	12	$2*X*Y$	0x0b	4
mmov_dp	Matrix Move From Data Memory to Program Memory	10	$X*Y$	0x8b	2
mmov_pd	Matrix Move From Program Memory to Data Memory	10	$X*Y$	0x8b	2
mmul	Matrix Multiply	48	$(5+(9+2*Y)*Z)*X$	0x22	4
mmul_dpd	Matrix Multiply	34	$((4+(6+Y)*Z)*X)$	0x22	4
mmul_dpp	Matrix Multiply	34	$((4+(6+Y)*Z)*X)$	0x22	4
mmul_pdd	Matrix Multiply	34	$((4+(6+Y)*Z)*X)$	0x22	4
mmul_pdp	Matrix Multiply	34	$((4+(6+Y)*Z)*X)$	0x22	4
mnull	Null Matrix	13	$X*Y$	0x0c	4
morth	Check Matrix Orthogonal	30	$(8+(12+2*X)*X)*X$	0x31	4
mppivot	Partial Matrix Pivoting	46	$(17+11*X)*X$	0x44	4
mskew	Check Matrix Skew	10	$(3+5*X)*X$	0x11	4
msmul	Matrix Scalar Multiply	23	$2*X*Y$	0x22	4
msub	Matrix Subtract	23	$3*X*Y$	0x19	4
msym	Check Matrix Symetry	18	$(3+4X)*X$	0x16	4
mtrace	Matrix Trace	30	$8+X$	0x8	4
mtrans	Matrix Transpose	32	$(3+2*Y)*X$	0x1e	4
munity	Unity Matrix	13	$X*Y$	0x0c	4
mvmul	Matrix Vector Multiply	33	$(7+2*Y)*X$	0x24	4/2
vmmul	Vector-Matrix Multiply	29	$(6+2*(X-1))*Y$	0x1c	2/4

TABLE 60 Complex Matrix Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
cmmul	Multiply Complex Matrix By Complex Conjugate Matrix	62	$(6+(12+7*Y)*Z)*X$	0x4f	2
ccmsmul	Multiply Complex Scalar By Complex Conjugate Matrix	46	$2*X*Y$	0x2b	4
cmadd	Complex Matrix Addition	32	$3*X*Y$	0x1d	2
cmmov	Move a Source Complex Matrix to a Destination Complex Matrix	13	$2*X*Y$	0x0c	2
cmmul	Complex Matrix Multiplication	45	$(4+(10+5*Y)*Z)*X$	0x3a	2
cmmul_pdp	Complex Matrix Multiplication	49	$(4+(6+4*Y)*Z)*X$	0x3b	2
cmmul_dpp	Complex Matrix Multiplication	49	$(4+(6+4*Y)*Z)*X$	0x3b	2
cmmul_pdd	Complex Matrix Multiplication	49	$(4+(6+4*Y)*Z)*X$	0x3b	2
cmmul_pdp	Complex Matrix Multiplication	49	$(4+(6+4*Y)*Z)*X$	0x3b	2
cmsmul	Multiply Complex Scalar By Complex Matrix	46	$2*X*Y$	0x2b	4
cmsub	Complex Matrix Subtraction	32	$3*X*Y$	0x1d	2
cmtrans	Complex Matrix Transpose	34	$(3+4*Y)*X$	0x22	4
cmvmul	Multiply Complex Matrix By Complex Vector	41	$(14+(7*Y))*X$	0x3d	2
cvmmul	Multiply Complex Vector By Complex Scalar	44	$12+7(X-1)Y$	0x37	2

TABLE 61 Compander Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
alawc	a-Law Compression	49	$12*(N-1)$	0x3a	1
alawe	a-Law Expansion	46	$17*(N-1)$	0x37	1
mulawc	μ -Law Compression	49	$16*(N-1)$	0x39	1
mulawe	μ -Law Expansion	48	$14*(N-1)$	0x3b	1

TABLE 62 Coordinate Transform Functions

Function Name	Function Description	Over-head In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
coord2d	2-Dimensional Coordinate Transformation	56	9*(N-1)	0x3a	4
coord3d	3-Dimensional Coordinate Transformation	79	16(N-1)	0x58	9

TABLE 63 Memory Test and Checksum Functions

Function Name	Function Description	Over-head In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
chksum	Perform Checksum	17	2*N	0x15	1
memtest	Memory Test	16	4*N	0x16	1

TABLE 64

Other Functions

Function Name	Function Description	Over-head In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
doppler	Generate Doppler Signal	56	50*N	0x62	1
dotpr	Vector Dot Product	32	2*(N-1)	0x22	2
dotpr_dp	Vector Dot Product	23	N	0x22	2
endian	Endian Order	21	6*(N-1)	0x1f	2
inl	Integral Non-Linearity	48	5 * (Int) (N + 0.5)	0x2e	2
linmag	Linear Magnitude	49	19*(N-1)	0x3c	2
logmag	Log Based Magnitude	63	35*N	0x59	2
mpulse	Monopulse Function	70	19*N	0x4d	1
mpulsep	Monpulse Function (Program Memory)	75	19*N	0x51	1
vnco	Compute NCO Values	49	29*2^n	0x4a	2^n
vncoarb	Compute NCO Table Values	22	6*N	0x15	1
vmags	Vector Magnitude Squared	32	3*N	0x1b	2
sinc	Sin x / x Function	49	35*N	0x4c	2
snd	Signal to Noise Density	130	2*(N-1)	0x7e	2
vipimul	Multiply by 1/π	30	2*(N-1)	0x1b	2
vncoarb	Compute NCO Table Values	22	6*N	0x15	1
vpimul	Multiply by π	30	2*(N-1)	0x1b	2
vpspec	Power Spectra	21	4*(N-1)	0x15	2
vtrans	Vector Transfer Function	52	10*(N-1)	0x0x36	1
vxcs	Vector Multiply By Cosine and Sine Function	66	48* N	0x69	1
zeroxng	Zero Crossing Detector	45	N*(7+H-1)	0x2b	1

TABLE 65 Packing and Unpacking Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
iqunpk	Unpack Integer Matrix to IQ Matrices	49	$3+(3+6*N)*M$	0x33	4
vpack	Pack Floating-Point Vector	43	$65*(Integer) (N/32)+ 2*(N Mod 32)$	0x68	1
vpacki	Pack Integer Vector	40	$65*(Integer) (N/32)+ 2*(N Mod 32)$	0x65	1
vunpack	Unpack into Floating-Point Vector	44	$97*(Integer) (N/32)+ 3*(N Mod 32)$	0x8a	1
vunpcki	Unpack into Integer Vector	41	$97*(Integer) (N/32)+ 2*(N Mod 32)$	0x66	1

TABLE 66 Accumulating Spectrum Functions

Function Name	Function Description	Overhead In Cycles	Inner-Loop Cycles/Element	Size	Min Vec Size
aspec	Accumulating Autospectrum	28	$6*N$	0x32	0x23
cspec	Accumulating Cross-Spectrum	37	$8*N$	0x2d	0x2d

