

Overview

NatureDSP Math library is a fixed point digital signal processing library. NatureDSP Math efficiently implements accurate fixed point representation of commonly used mathematic routines. NatureDSP Math saves product development time. It utilizes 100% of fixed point DSPs capabilities requiring minimum CPU cycles. The NatureDSP Math library is useful for signal processing algorithms developers and digital communication system designers.

Features

- **accurate** approximation of ANSI C mathematical functions
- **true** fixed point implementation with saturation, no floating point
- the **best real-time performance**
- fully **portable ANSI C code**
- supports most **C55, C64** and **C64+** intrinsic operators
- library for MS Visual Studio **for free** – enables development under PC environment

Applications

The NatureDSP Math library is used in mathematically extensive software running on DSP/RISC processors in the hard real time:

- software defined radio
- telephony
- audio/voice
- codecs
- digital modems

Specifications

Function	Input precision		Output precision		saturation
	16-bit	32-bit	16-bit	32-bit	
Basic operations – inline functions or macros:					
Add, subtract	x	x	x	x	x
Integer/fractional multiply/MAC	x	x	x	x	x
Integer/fractional division	x	x	x	x	x
Exponent	x	x	x		
Arithmetic shift	x	x	x	x	x
Rounding	x	x	x	x	x
Absolute value	x	x	x	x	x
Negation	x	x	x	x	x
Mathematics:					
square root	x	x	x	x	x
logarithms (natural, base 10, base 2)	x	x	x		x
sine/cosine	x	x	x		x
tangent	x	x	x		x
ceil/floor	x	x	x	x	x
exponential function, raising to a power	x			x	x
full arctangent	x	x	x		x
sinc		x	x		x
conversion to decibels	x	x	x		x

Availability

This library is available in binaries and in source code written on fully portable C-language for:

- Texas Instruments TMS320C54xx, TMS320C55xx, TMS320C64xx, OMAP, DaVinci
- ARM7, ARM9, ARM9E
- MS Windows (Object library)

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Performance

MIPS performance depends on multiple factors, i.e. DSP family, memory layout, and so on. Here is the performance comparison table for typical cases for C55xx and C64/C64+/DaVinci DSPs.

Function	Name	Cycles on platform		Accuracy
		C55xx	C64xx, DaVinci	
sine	S_sin_l	24	4	max.error $6.2 \cdot 10^{-5}$
cosine	S_cos_l	24	4	max.error $6.2 \cdot 10^{-5}$
tangent	L_tan_s	171	27	max.error $9.2 \cdot 10^{-5}$ @ $ x \leq \pi/4$, max.relative error $< 1.4 \cdot 10^{-4}$
full arctangent	S_atan2_ss	159	19	max.error $3.1 \cdot 10^{-5}$
square root	S_sqrt_s	82	9	max.error $3.1 \cdot 10^{-5}$
Base 2 logarithm	S_log2_l	91	13	max.error $2 \cdot 10^{-3}$
Natural logarithm	S_ln_l	92	16	max.error $2 \cdot 10^{-3}$
Base 10 logarithm	S_log10_l	114	16	max.error $2 \cdot 10^{-3}$
<i>sinc()</i>	S_sinc_l	160	19	average error $1.5 \cdot 10^{-5}$, maximum error $5.3 \cdot 10^{-5}$
2^x	L_pow2_s	71	9	max.error < 1 LSB @ $x < 1$, max. relative accuracy $3 \cdot 10^{-5}$
e^x	L_pow_s	79	10	max.error < 1 LSB @ $x < 0$, max. relative accuracy $4.6 \cdot 10^{-5}$
10^x	L_pow10_s	78	10	max.error < 1 LSB @ $x < 0$, max. relative accuracy $3.9 \cdot 10^{-5}$
x^y	L_pow_ss	192	30	max.error < 2 LSB @ $x < 0$, max. relative accuracy $1.2 \cdot 10^{-3}$, see NOTE
convert to dB	S_dB_l	106	13	0.02 dB
convert from dB	L_dB_s	105	10	1 LSB + 0.0015 dB

NOTE: depends on x, numbers are given for x=10