

Libraries_Manual

COLLABORATORS

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Chapter 1

Libraries_Manual

1.1 Amiga® RKM Libraries: 35 Math Libraries

This chapter describes the structure and calling sequences required to access the Motorola Fast Floating Point (FFP), the IEEE single-precision math libraries and the IEEE double-precision math libraries via the Amiga-supplied interfaces.

In its present state, the FFP library consists of three separate entities: the basic math library, the transcendental math library, and C and assembly-language interfaces to the basic math library plus FFP conversion functions. The IEEE single-precision, introduced in Release 2, and the double-precision libraries each presently consists of two entities: the basic math library and the transcendental math library.

Open Each Library Separately.

Each Task using an IEEE math library must open the library itself. Library base pointers to these libraries may not be shared. Libraries can be context sensitive and may use the Task structure to keep track of the current context. Sharing of library bases by Tasks may seem to work in some systems. This is true for any of the IEEE math libraries.

Depending on the compiler used, it is not always necessary to explicitly call the library functions for basic floating point operations as adding, subtracting, dividing, etc. Consult the manual supplied with the compiler for information regarding the compiler options for floating point functions.

Math Libraries and Functions
FFP Floating Point Data Format
FFP Basic Mathematics Library
FFP Transcendental Mathematics Library
FFP Mathematics Conversion Library
IEEE Single-Precision Data Format
IEEE Single-Precision Basic Math Library
IEEE Single-Precision Transcendental Math Library
IEEE Double-Precision Data Format
IEEE Double-Precision Basic Math Library
IEEE Double-Precision Transcendental Math Library

Function Reference

Compile and Link Commands for SAS C 5.10

1.2 35 Math Libraries / Math Libraries and Functions

There are six math libraries providing functions ranging from adding two floating point numbers to calculating a hyperbolic cosine. They are:

```
mathffp.library
    the basic function library

mathtrans.library
    the FFP transcendental math library

mathieeesingbas.library
    the IEEE single-precision library

mathieeesingtrans.library
    the IEEE single-precision transcendental library

mathieeedoubbas.library
    the IEEE double-precision library

mathieeesingtrans.library
    the IEEE double-precision transcendental library
```

1.3 35 Math Libraries / FFP Floating Point Data Format

FFP floating-point variables are defined within C by the float or FLOAT directive. In assembly language they are simply defined by a DC.L/DS.L statement. All FFP floating-point variables are defined as 32-bit entities (longwords) with the following format:

	MMMMMMMM	MMMMMMMM	MMMMMMMM	EEEEEEEE	
	31	23	15	7	

The mantissa is considered to be a binary fixed-point fraction; except for 0, it is always normalized (the mantissa is shifted over and the exponent adjusted, so that the mantissa has a 1 bit in its highest position). Thus, it represents a value of less than 1 but greater than or equal to 1/2.

The sign bit is reset (0) for a positive value and set (1) for a negative value.

The exponent is the power of two needed to correctly position the mantissa to reflect the number's true arithmetic value. It is held in excess-64 notation, which means that the two's-complement values are adjusted upward

by 64, thus changing \$40 (-64) through \$3F (+63) to \$00 through \$7F. This facilitates comparisons among floating-point values.

The value of 0 is defined as all 32 bits being 0s. The sign, exponent, and mantissa are entirely cleared. Thus, 0s are always treated as positive.

The range allowed by this format is as follows:

DECIMAL:

$$9.22337177 * 10^{18} > +\text{VALUE} > 5.42101070 * 10^{-20}$$

$$-9.22337177 * 10^{18} < -\text{VALUE} < -2.71050535 * 10^{-20}$$

BINARY (HEXADECIMAL) :

$$.FFFFFF * 2^{63} > +\text{VALUE} > .800000 * 2^{-63}$$

$$-.FFFFFF * 2^{63} < -\text{VALUE} < -.800000 * 2^{-64}$$

Remember that you cannot perform any arithmetic on these variables without using the fast floating-point libraries. The formats of the variables are incompatible with the arithmetic format of C-generated code; hence, all floating-point operations are performed through function calls.

1.4 35 Math Libraries / FFP Basic Mathematics Library

The FFP basic math library contains entries for the basic mathematics functions such as add, subtract and divide. It resides in ROM and is opened by calling `OpenLibrary()` with "mathffp.library" as the argument.

```
#include <exec/types.h>
#include <libraries/mathffp.h>

#include <clib/mathffp_protos.h>

struct Library *MathBase;

VOID main()
{
    if (MathBase = OpenLibrary("mathffp.library", 0))
    {
        . . .

        CloseLibrary(MathBase);
    }
    else
        printf("Can't open mathffp.library\n");
}
```

The global variable `MathBase` is used internally for all future library references.

FFP Basic Functions

1.5 35 / FFP Basic Mathematics Library / FFP Basic Functions

SPAbs() FLOAT SPAbs(FLOAT parm);
Take absolute value of FFP variable.

SPAdd() FLOAT SPAdd(FLOAT leftParm, FLOAT rightParm);
Add two FFP variables.

SPCeil() FLOAT SPCeil(FLOAT parm);~
Computer largest integer less than or equal to variable.

SPCmp() LONG SPCmp(FLOAT leftParm, FLOAT rightParm);
Compare two FFP variables.

SPDiv() FLOAT SPDiv(FLOAT leftParm, FLOAT rightParm);
Divide two FFP variables.

SPFix() LONG SPFix(FLOAT parm);
Convert FFP variable to integer.

SPFloor() FLOAT SPFloor(FLOAT parm);
Compute least integer greater than or equal to variable.

SPFlt() FLOAT SPFlt(long integer);
Convert integer variable to FFP.

SPMul() FLOAT SPMul(FLOAT leftParm, FLOAT rightParm);
Multiply two FFP variables.

SPNeg() FLOAT SPNeg(FLOAT parm);
Take two's complement of FFP variable.

SPSub() FLOAT SPSub(FLOAT leftParm, FLOAT rightParm);
Subtract two FFP variables.

SPTst() LONG SPTst(FLOAT parm);
Test an FFP variable against zero.

Be sure to include the proper data type definitions shown below.

```
#include <exec/types.h>
#include <libraries/mathffp.h>

#include <clib/mathffp_protos.h>

struct Library *MathBase;

VOID main()
{
    FLOAT f1, f2, f3;
    LONG   i1;

    if (MathBase = OpenLibrary("mathffp.library", 0))
```

```

{
i1 = SPFix(f1);          /* Call SPFix entry */
f1 = SPFlt(i1);          /* Call SPFlt entry */

if (SPCmp(f1,f2)) {};    /* Call SPCmp entry */
if (!(SPTst(f1))) {};    /* Call SPTst entry */

f1 = SPAbs(f2);          /* Call SPAbs entry */
f1 = SPNeg(f2);          /* Call SPNeg entry */
f1 = SPAdd(f2, f3);      /* Call SPAdd entry */
f1 = SPSub(f2, f3);      /* Call SPSub entry */
f1 = SPMul(f2, f3);      /* Call SPMul entry */
f1 = SPDiv(f2, f3);      /* Call SPDiv entry */
f1 = SPCEil(f2);         /* Call SPCEil entry */
f1 = SPFloor(f2);        /* Call SPFloor entry */

CloseLibrary(MathBase);
}
else
printf("Can't open mathffp.library\n");
}

```

The assembly language interface to the FFP basic math routines is shown below, including some details about how the system flags are affected by each operation. The access mechanism is:

```

MOVEA.L _MathBase,A6
JSR _LVOSPFix(A6)

```

FFP Basic Assembly Functions			
Function	Input	Output	Condition Codes
_LVOSPABs	D0=FFP arg	D0=FFP absolute value	N=0 Z=1 if result is zero V=0 C=undefined X=undefined
_LVOSPAdd	D1=FFP arg1 D0=FFP arg2	D0=FFP addition of arg1 + arg2	N=1 if result is negative Z=1 if result is zero V=1 if result overflowed C=undefined Z=undefined
_LVOSPCeil	D0=FFP arg	D0=least integer >=arg	N=1 if result is negative Z=1 if result is zero V=undefined

			C=undefined
			Z=undefined
<hr/>			
_LVOSPCmp	D1=FFP arg1	D0=+1 if arg1>arg2	N=0
	D0=FFP arg2	D0=-1 if arg1<arg2	Z=1 if result
		D0=0 if arg1=arg2	is zero
			V=0
			C=undefined
			X=undefined
			GT=arg2>arg1
			GE=arg2>=arg1
			EQ=arg2=arg1
			NE=arg2<>arg1
			LT=arg2<arg1
			LE=arg2<=arg1
<hr/>			
_LVOSPDiv	D1=FFP arg1	D0=FFP division	N=1 if result
	D0=FFP arg2	of arg2/arg1	is negative
			Z=1 if result
			is zero
			V=1 if result
			overflowed
			C=undefined
			Z=undefined
<hr/>			
_LVOSPFix	D0=FFP arg	D0=Integer	N=1 if result
		(two's complement)	is negative
			Z=1 if result
			is zero
			V=1 if overflow
			occurred
			C=undefined
			X=undefined
<hr/>			
_LVOSPFloor	D0=FFP arg	D0=largest integer	N=1 if result
		<= arg	is negative
			Z=1 if result
			is zero
			V=undefined
			C=undefined
			Z=undefined
<hr/>			
_LVOSPFlt	D0=Integer	D0=FFP result	N=1 if result
	(two's		is negative
	complement)		Z=1 if result
			is zero
			V=0
			C=undefined
			X=undefined
<hr/>			
_LVOSPMul	D0=FFP arg1	D0=FFP	N=1 if result
	D1=FFP arg2	multiplication	is negative
		of arg1*arg2	Z=1 if result
			is zero
			V=1 if result
			overflowed
			C=undefined

1.6 35 Math Libraries / FFP Transcendental Mathematics Library

```
#include <exec/types.h>
#include <libraries/mathffp.h>

#include <clib/mathffp_protos.h>
#include <clib/mathtrans_protos.h>

struct Library *MathTransBase;

VOID main()
{
    if (MathTransBase = OpenLibrary("mathtrans.library",0))
    {
        .
        .
        .
    }
}
```

```

        CloseLibrary(MathTransBase);
    }
    else
        printf("Can't open mathtrans.library\n");
}

```

The global variable MathTransBase is used internally for all future library references. Note that the transcendental math library is dependent upon the basic math library, which it will open if it is not open already. If you want to use the basic math functions in conjunction with the transcendental math functions however, you have to specifically open the basic math library yourself.

FFP Transcendental Functions

1.7 35 / Transcendental Mathematics Library / FFP Transcendental Functions

SPAsin() FLOAT SPAsin(FLOAT parm);
Return arccosine of FFP variable.

SPAcos() FLOAT SPAcos(FLOAT parm);
Return arctangent of FFP variable.

SPAtan() FLOAT SPAtan(FLOAT parm);
Return arcsine of FFP variable.

SPSin() FLOAT SPSin(FLOAT parm);
Return sine of FFP variable. This function accepts an FFP radian argument and returns the trigonometric sine value. For extremely large arguments where little or no precision would result, the computation is aborted and the "V" condition code is set. A direct return to the caller is made.

SPCos() FLOAT SPCos(FLOAT parm);
Return cosine of FFP variable. This function accepts an FFP radian argument and returns the trigonometric cosine value. For extremely large arguments where little or no precision would result, the computation is aborted and the "V" condition code is set. A direct return to the caller is made.

SPTan() FLOAT SPTan(FLOAT parm);
Return tangent of FFP variable. This function accepts an FFP radian argument and returns the trigonometric tangent value. For extremely large arguments where little or no precision would result, the computation is aborted and the "V" condition code is set. A direct return to the caller is made.

SPSincos() FLOAT SPSincos(FLOAT *cosResult, FLOAT parm);
Return sine and cosine of FFP variable. This function accepts an FFP radian argument and returns the trigonometric sine as its result and the trigonometric cosine in the first parameter. If both the sine and cosine are required for a single radian value, this function will result in almost twice the execution speed of calling the SPSin() and SPCos() functions independently. For extremely large arguments where little or no precision would result, the computation is aborted and

the "V" condition code is set. A direct return to the caller is made.

```
SPSinh()    FLOAT SPSinh( FLOAT parm );
            Return hyperbolic sine of FFP variable.

SPCosh()    FLOAT SPCosh( FLOAT parm );
            Return hyperbolic cosine of FFP variable.

SPTanh()    FLOAT SPTanh( FLOAT parm );
            Return hyperbolic tangent of FFP variable.

SPExp()     FLOAT SPExp( FLOAT parm );
            Return e to the FFP variable power. This function accepts an FFP
            argument and returns the result representing the value of e
            (2.71828...) raised to that power.

SPLog()     FLOAT SPLog( FLOAT parm );
            Return natural log (base e) of FFP variable.

SPLog10()   FLOAT SPLog10( FLOAT parm );
            Return log (base 10) of FFP variable.

SPPow()     FLOAT SPPow( FLOAT power, FLOAT arg );
            Return FFP arg2 to FFP arg1.

SPSqrt()    FLOAT SPSqrt( FLOAT parm );
            Return square root of FFP variable.

SPTieee()   FLOAT SPTieee( FLOAT parm );
            Convert FFP variable to IEEE format

SPFieee()   FLOAT SPFieee( FLOAT parm );
            Convert IEEE variable to FFP format.
```

Be sure to include proper data type definitions, as shown in the example below.

mathtrans.c

The Amiga assembly language interface to the FFP transcendental math routines is shown below, including some details about how the system flags are affected by the operation. This interface resides in the library file amiga.lib and must be linked with the user code. Note that the access mechanism from assembly language is:

```
MOVEA.L _MathTransBase,A6
JSR     _LVOSPAsin(A6)
```

FFP Transcendental Assembly Functions			
Function	Input	Output	Condition Codes
_LVOSPAsin	D0=FFP arg	D0=FFP arcsine radian	N=0 Z=1 if result

			is zero
			V=0
			C=undefined
			X=undefined
<hr/>			
_LVOSPACos	D0=FFP arg	D0=FFP arccosine radian	N=0
			Z=1 if result
			is zero
			V=1 if overflow
			occurred
			C=undefined
			X=undefined
<hr/>			
_LVOSPAtan	D0=FFP arg	D0=FFP arctangent radian	N=0
			Z=1 if result
			is zero
			V=0
			C=undefined
			X=undefined
<hr/>			
_LVOSPSin	D0=FFP arg in radians	D0=FFP sine	N=1 if result
			is negative
			Z=1 if result
			is zero
			V=1 if result
			is meaningless
			(input magnitude
			too large)
			C=undefined
			X=undefined
<hr/>			
_LVOSPCos	D0=FFP arg in radians	D0=FFP cosine	N=1 if result
			is negative
			Z=1 if result
			is zero
			V=1 if result
			is meaningless
			(input magnitude
			too large)
			C=undefined
			X=undefined
<hr/>			
_LVOSPTan	D0=FFP arg in radians	D0=FFP tangent	N=1 if result
			is negative
			Z=1 if result
			is zero
			V=1 if result
			is meaningless
			(input magnitude
			too large)
			C=undefined
			X=undefined
<hr/>			
_LVOSPSincos	D0=FFP arg in radians	D0=FFP sine	N=1 if result
		(D1)=FFP cosine	is negative
	D1=Address		Z=1 if result
	to store		is zero

	cosine result		V=1 if result is meaningless (input magnitude too large) C=undefined X=undefined
-----	-----	-----	-----
_LVOSPSinh	D0=FFP arg in radians	D0=FFP hyperbolic sine	N=1 if result is negative Z=1 if result is zero V=1 if overflow occurred C=undefined X=undefined
-----	-----	-----	-----
_LVOSPCosh	D0=FFP arg in radians	D0=FFP hyperbolic cosine	N=1 if result is negative Z=1 if result is zero V=1 if overflow occurred C=undefined X=undefined
-----	-----	-----	-----
_LVOSP Tanh	D0=FFP arg in radians	D0=FFP hyperbolic tangent	N=1 if result is negative Z=1 if result is zero V=1 if overflow occurred C=undefined X=undefined
-----	-----	-----	-----
_LVOSPExp	D0=FFP arg	D0=FFP exponential	N=0 Z=1 if result is zero V=1 if overflow occurred C=undefined Z=undefined
-----	-----	-----	-----
_LVOSPLog	D0=FFP arg	D0=FFP natural logarithm	N=1 if result is negative Z=1 if result is zero V=1 if arg is negative or zero C=undefined Z=undefined
-----	-----	-----	-----
_LVOSPLog10	D0=FFP arg	D0=FFP logarithm (base 10)	N=1 if result is negative Z=1 if result is zero V=1 if arg is negative or zero

			C=undefined
			Z=undefined
<hr/>			
_LVOSPPow	D0=FFP exponent value D1=FFP arg value	D0=FFP result of arg taken to exp power	N=0 Z=1 if result is zero V=1 if result overflowed or arg < 0 C=undefined Z=undefined
<hr/>			
_LVOSPSqrt	D0=FFP arg	D0=FFP square root	N=0 Z=1 if result is zero V=1 if arg was negative C=undefined Z=undefined
<hr/>			
_LVOSP ieee	D0=FFP format arg	D0=IEEE floating-point format	N=1 if result is negative Z=1 if result is zero V=undefined C=undefined Z=undefined
<hr/>			
_LVOSPF ieee	D0=IEEE floating-point format arg	D0=FFP format	N=undefined Z=1 if result is zero V=1 if result overflowed C=undefined Z=undefined
<hr/>			

1.8 35 Math Libraries / FFP Mathematics Conversion Library

The FFP mathematics conversion library provides functions to convert ASCII strings to their FFP equivalents and vice versa.

It is accessed by linking code into the executable file being created. The name of the file to include in the library description of the link command line is `amiga.lib`. When this is included, direct calls are made to the conversion functions. Only a C interface exists for the conversion functions; there is no assembly language interface. The basic math library is required in order to access these functions.

```
#include <exec/types.h>
#include <libraries/mathffp.h>

#include <clib/mathffp_protos.h>

struct Library *MathBase;
```

```

VOID main()
{
if (MathBase = OpenLibrary("mathffp.library", 33))
{
    . . .

    CloseLibrary(MathBase);
}
else
    printf("Can't open mathffp.library\n");
}

```

Math Support Functions

1.9 35 / FFP Mathematics Conversion Library / Math Support Functions

```

afp()    FLOAT afp( BYTE *string );
          Convert ASCII string into FFP equivalent.

arnd()   VOID arnd( LONG place, LONG exp, BYTE *string);
          Round ASCII representation of FFP number.

dbf()    FLOAT dbf( ULONG exp, ULONG mant);
          Convert FFP dual-binary number to FFP equivalent.

fpa()    LONG fpa( FLOAT fnum, BYTE *string);
          Convert FFP variable into ASCII equivalent.

```

Be sure to include proper data type definitions, as shown in the example below. Print statements have been included to help clarify the format of the math conversion function calls.

mathffp.c

1.10 35 Math Libraries / IEEE Single-Precision Data Format

The IEEE single-precision variables are defined as 32-bit entities with the following format:

	SEEEEEEE	MMMMMMMM	MMMMMMMM	MMMMMMMM	
	31	23	15	7	

Hidden Bit In The Mantissa.

 There is a "hidden" bit in the mantissa part of the IEEE numbers. Since all numbers are normalized, the integer (high) bit of the mantissa is dropped off. The IEEE single-precision range is 1.3E-38

(1.4E-45 de-normalized) to 3.4E+38.

The exponent is the power of two needed to correctly position the mantissa to reflect the number's true arithmetic value. If both the exponent and the mantissa have zero in every position, the value is zero. If only the exponent has zero in every position, the value is an unnormal (extremely small). If all bits of the exponent are set to 1 the value is either a positive or negative infinity or a Not a Number (NaN). NaN is sometimes used to indicate an uninitialized variable.

1.11 35 Math Libraries / IEEE Single-Precision Basic Math Library

The ROM-based IEEE single-precision basic math library was introduced in V36. This library contains entries for the basic IEEE single-precision mathematics functions, such as add, subtract, and divide. (Note, registered developers can license a disk-based version of this library from CATS, for usage with V33).

The library is opened by making calling `OpenLibrary()` with "mathieeesingbas.library" as the argument. Do not share the library base pointer between tasks -- see note at beginning of chapter for details.

```
#include <exec/types.h>
#include <libraries/mathieeesp.h>

#include <clib/mathsingbas_protos.h>

struct Library *MathIeeeSingBasBase;

VOID main()
{
    /* do not share base pointer between tasks. */
    if (MathIeeeSingBasBase = OpenLibrary("mathieeesingbas.library", 37))
    {
        .
        .
        .
        CloseLibrary(MathIeeeSingBasBase);
    }
    else
        printf("Can't open mathieeesingbas.library\n");
}
```

The global variable `MathIeeeSingBasBase` is used internally for all future library references.

If an 680X0/68881/68882 processor combination is available, it will be used by the IEEE single-precision basic library instead of the software emulation. Also, if an autoconfigured math resource is available, that will be used. Typically this is a 68881 designed as a 16 bit I/O port, but it could be another device as well.

SP IEEE Basic Functions (V36 or Greater)

1.12 35 / SP Basic Math Library / SP IEEE Basic Functions (V36 or Greater)

```

IEEESPAbs()    FLOAT ( FLOAT parm );
    Take absolute value of IEEE single-precision variable.

IEEESPAdd()    FLOAT IEEESPAdd( FLOAT leftParm, FLOAT rightParm);
    Add two IEEE single-precision variables.

IEEESPCeil()   FLOAT IEEESPCeil( FLOAT parm );
    Compute least integer greater than or equal to variable.

IEEESPCmp()    LONG  IEEESPCmp( FLOAT leftParm, FLOAT rightParm );
    Compare two IEEE single-precision variables.

IEEESPDiv()    FLOAT IEEESPDiv( FLOAT dividend, FLOAT divisor );
    Divide two IEEE single-precision variables.

IEEESPFix()    LONG  IEEESPFix( FLOAT parm );
    Convert IEEE single-precision variable to integer.

IEEESPFloor()  FLOAT IEEESPFloor( FLOAT parm );
    Compute largest integer less than or equal to variable.

IEEESPFlt()    FLOAT IEEESPFlt( long integer );
    Convert integer variable to IEEE single-precision.

IEEESPMul()    FLOAT IEEESPMul( FLOAT leftParm, FLOAT rightParm );
    Multiply two IEEE single-precision variables.

IEEESPNeg()    FLOAT IEEESPNeg( FLOAT parm );
    Take two's complement of IEEE single-precision variable.

IEEESPSub()    FLOAT IEEESPSub( FLOAT leftParm, FLOAT rightParm );
    Subtract two IEEE single-precision variables.

IEEESPTst()    LONG  IEEESPTst( FLOAT parm );
    Test an IEEE single-precision variable against zero.

```

Be sure to include proper data type definitions, as shown in the example below.

```
mathieeesingbas.c
```

The Amiga assembly language interface to the IEEE single-precision basic math routines is shown below, including some details about how the system flags are affected by each operation. Note that the access mechanism from assembly language is as shown below:

```

MOVEA.L _MathIeeeSingBasBase,A6
JSR     _LVOIEEESPFix(A6)

```

SP IEEE Basic Assembly Functions			
Function	Input	Output	Condition Codes

<code>_LVOIEEESPFix</code>	D0=IEEE arg double-precision	D0=Integer (two's complement)	N=undefined Z=undefined V=undefined C=undefined X=undefined
<code>_LVOIEEESPFlt</code>	D0=Integer arg (two's complement)	D0=IEEE single-precision	N=undefined Z=undefined V=undefined C=undefined X=undefined
<code>_LVOIEEESPCmp</code>	D0=IEEE arg1 single-precision D1=IEEE arg2 single-precision	D0=+1 if arg1>arg2 D0=-1 if arg1<arg2 D0=0 if arg1=arg2	N=1 if result is negative Z=1 if result is zero V=0 C=undefined X=undefined GT=arg2>arg1 GE=arg2>=arg1 EQ=arg2=arg1 NE=arg2<>arg1 LT=arg2<arg1 E= arg2<=arg1
<code>_LVOIEEEESPtst</code>	D0=IEEE arg single-precision	D0=+1 if arg>0.0 D0=-1 if arg<0.0 D0=0 if arg=0.0	N=1 if result is negative Z=1 if result is zero V=0 C=undefined X=undefined EQ=arg=0.0 NE=arg<>0.0 PL=arg>=0.0 MI=arg<0.0
<code>_LVOIEEESPAbs</code>	D0=IEEE arg single-precision	D0=IEEE single-precision absolute value	N=undefined Z=undefined V=undefined C=undefined X=undefined
<code>_LVOIEEESPNeg</code>	D0=IEEE arg single-precision	D0=IEEE single-precision negated	N=undefined Z=undefined V=undefined C=undefined X=undefined
<code>_LVOIEEESPAdd</code>	D0=IEEE arg1 single-precision D1=IEEE arg2 single-precision	D0=IEEE single-precision addition of arg1+arg2	N=undefined Z=undefined V=undefined C=undefined X=undefined

_LVOIEEEESPSub	D0=IEEE arg1	D0=IEEE	N=undefined
	single-precision	single-precision	Z=undefined
	D1=IEEE arg2	subtraction of	V=undefined
	single-precision	arg1-arg2	C=undefined
			X=undefined
_LVOIEEEESPMul	D0=IEEE arg1	D0=IEEE	N=undefined
	single-precision	single-precision	Z=undefined
	D1=IEEE arg2	multiplication of	V=undefined
	single-precision	arg1*arg2	C=undefined
			X=undefined
_LVOIEEEESPDiv	D0=IEEE arg1	D0=IEEE	N=undefined
	single-precision	single-precision	Z=undefined
	D1=IEEE arg2	division of	V=undefined
	single-precision	arg1/arg2	C=undefined
			X=undefined
_LVOIEEEESPCeil	D0=IEEE variable	D0=least integer	N=undefined
	single-precision	>= variable	Z=undefined
			V=undefined
			C=undefined
			X=undefined
_LVOIEEEESPFloor	D0=IEEE variable	D0=largest integer	N=undefined
	single-precision	<= arg	Z=undefined
			V=undefined
			C=undefined
			X=undefined

1.13 35 Math Libraries / IEEE Single-Precision Transcendental Math Library

The IEEE single-precision transcendental math library was introduced in V36. It contains entries for transcendental math functions such as sine, cosine, and square root.

This library resides on disk and is opened by calling `OpenLibrary()` with "mathieeesingtrans.library" as the argument. Do not share the library base pointer between tasks -- see note at beginning of chapter.

```
#include <exec/types.h>
#include <libraries/mathieeesp.h>

struct Library *MathIeeeSingTransBase;

#include <clib/mathsingtrans_protos.h>

VOID main()
{
  if (MathIeeeSingTransBase = OpenLibrary("mathieeesingtrans.library",37))
  {
    . . .
  }
}
```

```

        CloseLibrary(MathIeeeSingTransBase);
    }
    else printf("Can't open mathieeesingtrans.library\n");
}

```

The global variable MathIeeeSingTransBase is used internally for all future library references.

The IEEE single-precision transcendental math library is dependent upon the IEEE single-precision basic math library, which it will open if it is not open already. If you want to use the IEEE single-precision basic math functions in conjunction with the transcendental math functions however, you have to specifically open the basic math library yourself.

Just as the IEEE single-precision basic math library, the IEEE single-precision transcendental math library will take advantage of a 680X0/68881 combination or another math resource, if present.

SP IEEE Transcendental Functions (V36 Or Greater)

1.14 35 // SP IEEE Transcendental Functions (V36 Or Greater)

```

IEEESPAsin()    FLOAT IEEESPAsin( FLOAT parm );
    Return arcsine of IEEE single-precision variable.

IEEESPAcos()    FLOAT IEEESPAcos( FLOAT parm );
    Return arccosine of IEEE single-precision variable.

IEEESPAtan()    FLOAT IEEESPAtan( FLOAT parm );
    Return arctangent of IEEE single-precision variable.

IEEESPSin()     FLOAT IEEESPSin( FLOAT parm );
    Return sine of IEEE single-precision variable. This function accepts
    an IEEE radian argument and returns the trigonometric sine value.

IEEESPCos()     FLOAT IEEESPCos( FLOAT parm );
    Return cosine of IEEE single-precision variable. This function
    accepts an IEEE radian argument and returns the trigonometric cosine
    value.

IEEESPTan()     FLOAT IEEESPTan( FLOAT parm );
    Return tangent of IEEE single-precision variable. This function
    accepts an IEEE radian argument and returns the trigonometric tangent
    value.

IEEESPSincos()  FLOAT IEEESPSincos( FLOAT *cosptr, FLOAT parm );
    Return sine and cosine of IEEE single-precision variable. This
    function accepts an IEEE radian argument and returns the
    trigonometric sine as its result and the ?cosine in the first
    parameter.

IEEESPSinh()    FLOAT IEEESPSinh( FLOAT parm );
    Return hyperbolic sine of IEEE single-precision variable.

IEEESPCosh()    FLOAT IEEESPCosh( FLOAT parm );

```

Return hyperbolic cosine of IEEE single-precision variable.

IEEEESPTanh() FLOAT IEEEESPTanh(FLOAT parm);
Return hyperbolic tangent of IEEE single-precision variable.

IEEEESPExp() FLOAT IEEEESPExp(FLOAT parm);
Return e to the IEEE variable power. This function accept an IEEE single-precision argument and returns the result representing the value of e (2.712828...) raised to that power.

IEEEESPFieee() FLOAT IEEEESPFieee(FLOAT parm);
Convert IEEE single-precision number to IEEE single-precision number. The only purpose of this function is to provide consistency with the double-precision math IEEE library.

IEEEESPLog() FLOAT IEEEESPLog(FLOAT parm);
Return natural log (base e of IEEE single-precision variable.

IEEEESPLog10() FLOAT IEEEESPLog10(FLOAT parm);
Return log (base 10) of IEEE single-precision variable.

IEEEESPpow() FLOAT IEEEESPpow(FLOAT exp, FLOAT arg);
Return IEEE single-precision arg2 to IEEE single-precision arg1.

IEEEESPSqrt() FLOAT IEEEESPSqrt(FLOAT parm);
Return square root of IEEE single-precision variable.

IEEEESPTieee() FLOAT IEEEESPTieee(FLOAT parm);
Convert IEEE single-precision number to IEEE single-precision number. The only purpose of this function is to provide consistency with the double-precision math IEEE library.

Be sure to include the proper data type definitions as shown below.

mathieeesingtrans.c

The section below describes the Amiga assembly interface to the IEEE single-precision transcendental math library. The access mechanism from assembly language is:

MOVEA.L _MathIeeeSingTransBase,A6
JSR _LVOIEEEESPAsin(A6)

SP IEEE Transcendental Assembly Functions			
Function	Input	Output	Condition Codes
_LVOIEEEESPAsin	D0=IEEE arg	D0=IEEE arcsine radian	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----

_LVOIEEEESPAcos	D0=IEEE arg single-precision	D0=IEEE arccosine radian	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEESPAtan	D0=IEEE arg single-precision	D0=IEEE arctangent radian	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEESPSin	D0=IEEE arg in radians single-precision	D0=IEEE sine	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEESPCos	D0=IEEE arg in radians single-precision	D0=IEEE cosine	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEESPTan	D0=IEEE arg in radians single-precision	D0=IEEE tangent	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEESPSincos	A0=Addr to store cosine result D0=IEEE arg in radians	D0=IEEE sine (A0)=IEEE cosine	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEESPSinh	D0=IEEE arg in radians single-precision	D0=IEEE hyperbolic sine	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEESPCosh	D0=IEEE arg in radians single-precision	D0=IEEE hyperbolic cosine	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEESPTanh	D0=IEEE arg in radians single-precision	D0=IEEE hyperbolic tangent	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEESPExp	D0=IEEE arg single-precision	D0=IEEE exponential	N=undefined Z=undefined V=undefined

			C=undefined
			X=undefined
-----	-----	-----	-----
_LVOIEEEESPLog	D0=IEEE arg single-precision	D0=IEEE natural logarithm	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEESPLog10	D0=IEEE arg single-precision	D0=IEEE logarithm (base 10)	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEESPow	D0=IEEE exponent value single-precision D1=IEEE arg value single-precision	D0=IEEE result of arg taken to exp power	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEESPSqrt	D0=IEEE arg single-precision	D0=IEEE square root	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----

1.15 35 Math Libraries / IEEE Double-Precision Data Format

The IEEE double-precision variables are defined as 64-bit entities with the following format:

SEEEEEEE	EEEEIMM	MMMMMMMM	MMMMMMMM
63	55	47	39
MMMMMMMM	MMMMMMMM	MMMMMMMM	MMMMMMMM
31	23	15	7

Hidden Bit In The Mantissa.

There is a "hidden" bit in the mantissa part of the IEEE numbers. Since all numbers are normalized, the integer (high) bit of the mantissa is dropped off. The IEEE double-precision range is 2.2E-308 (4.9E-324 de-normalized) to 1.8E+307.

The exponent is the power of two needed to correctly position the mantissa

to reflect the number's true arithmetic value. If both the exponent and the mantissa have zero in every position, the value is zero. If only the exponent has zero in every position, the value is an unnormal (extremely small). If all bits of the exponent are set to 1 the value is either a positive or negative infinity or a Not a Number (NaN). NaN is sometimes used to indicate an uninitialized variable.

1.16 35 Math Libraries / IEEE Double-Precision Basic Math Library

The IEEE double-precision basic math library contains entries for the basic IEEE mathematics functions, such as add, subtract, and divide. This library resides on disk and is opened by calling `OpenLibrary()` with `"mathieeedoubbas.library"` as the argument. Do not share the library base pointer between tasks -- see note at beginning of chapter for details.

```
#include <exec/types.h>
#include <libraries/mathieeedp.h>

#include <clib/mathdoubbas_protos.h>

struct Library *MathIeeeDoubBasBase;

VOID main()
{
    /* do not share base pointer between tasks. */
    if (MathIeeeDoubBasBase = OpenLibrary("mathieeedoubbas.library", 34))
    {
        . . .

        CloseLibrary(MathIeeeDoubBasBase);
    }
    else printf("Can't open mathieeedoubbas.library\n");
}
```

The global variable `MathIeeeDoubBasBase` is used internally for all future library references.

If an 680X0/68881/68882 processor combination is available, it will be used by the IEEE basic library instead of the software emulation. Also, if an autoconfigured math resource is available, that will be used. Typically this is a 68881 designed as a 16 bit I/O port, but it could be another device as well.

DP IEEE Basic Functions

1.17 35 /IEEE Double-Precision Basic Math Library / DP IEEE Basic Functions

```
IEEEDPAbs()    DOUBLE IEEEDPAbs( DOUBLE parm );
               Take absolute value of IEEE double-precision variable.

IEEEDPAdd()    DOUBLE IEEEDPAdd( DOUBLE leftParm, DOUBLE rightParm );
               Add two IEEE double-precision variables.
```

```
IEEEEDPCeil()    DOUBLE IEEEEDPCeil( DOUBLE parm );
    Compute least integer greater than or equal to variable.

IEEEEDPCmp()     LONG IEEEEDPCmp( DOUBLE leftParm, DOUBLE rightParm );
    Compare two IEEE double-precision variables.

IEEEEDPDiv()     DOUBLE IEEEEDPDiv( DOUBLE dividend, DOUBLE divisor );
    Divide two IEEE double-precision variables.

IEEEEDPFix()     LONG IEEEEDPFix( DOUBLE parm );
    Convert IEEE double-precision variable to integer.

IEEEEDPFloor()   DOUBLE IEEEEDPFloor( DOUBLE parm );
    Compute largest integer less than or equal to variable.

IEEEEDPFlt()     DOUBLE IEEEEDPFlt( long integer );
    Convert integer variable to IEEE double-precision.

IEEEEDPMul()     DOUBLE IEEEEDPMul( DOUBLE factor1, DOUBLE factor2 );
    Multiply two IEEE double-precision variables.

IEEEEDPNeg()     DOUBLE IEEEEDPNeg( DOUBLE parm );
    Take two's complement of IEEE double-precision variable.

IEEEEDPSub()     DOUBLE IEEEEDPSub( DOUBLE leftParm, DOUBLE rightParm );
    Subtract two IEEE double-precision variables.

IEEEEDPTst()     LONG IEEEEDPTst( DOUBLE parm );
    Test an IEEE double-precision variable against zero.
```

Be sure to include proper data type definitions, as shown in the example below.

mathieeeedoubbas.c

The Amiga assembly language interface to the IEEE double-precision floating-point basic math routines is shown below, including some details about how the system flags are affected by each operation. The access mechanism from assembly language is:

```
MOVEA.L _MathIeeeDoubBasBase,A6
JSR     _LVOIEEEEDPFix(A6)
```

DP IEEE Basic Assembly Functions			
Function	Input	Output	Condition Codes
_LVOIEEEEDPFix	D0/D1=IEEE arg double-precision	D0=Integer (two's complement)	N=undefined
			Z=undefined
			V=undefined
			C=undefined
			X=undefined

<code>_LVOIEEEEDPF1</code>	D0=Integer arg (two's complement)	D0/D1=IEEE double-precision	N=undefined Z=undefined V=undefined C=undefined X=undefined
<code>_LVOIEEEEDPCmp</code>	D0/D1=IEEE arg1 double-precision D2/D3=IEEE arg2 double-precision	D0=+1 if arg1>arg2 D0=-1 if arg1<arg2 D0=0 if arg1=arg2	N=1 if result is negative Z=1 if result is zero V=0 C=undefined X=undefined GT=arg2>arg1 GE=arg2>=arg1 EQ=arg2=arg1 NE=arg2<>arg1 LT=arg2<arg1 LE=arg2<=arg1
<code>_LVOIEEEEDPTst</code>	D0/D1=IEEE arg double-precision	D0=+1 if arg>0.0 D0=-1 if arg<0.0 D0=0 if arg=0.0	N=1 if result is negative Z=1 if result is zero V=0 C=undefined X=undefined EQ=arg=0.0 NE=arg<>0.0 PL=arg>=0.0 MI=arg<0.0
<code>_LVOIEEEEDPAbs</code>	D0/D1=IEEE arg double-precision	D0/D1=IEEE double-precision absolute value	N=undefined Z=undefined V=undefined C=undefined X=undefined
<code>_LVOIEEEEDPNeg</code>	D0/D1=IEEE arg double-precision	D0/D1=IEEE double-precision negated	N=undefined Z=undefined V=undefined C=undefined X=undefined
<code>_LVOIEEEEDPAdd</code>	D0/D1=IEEE arg1 double-precision D2/D3=IEEE arg2 double-precision	D0/D1=IEEE double-precision addition of arg1+arg2	N=undefined Z=undefined V=undefined C=undefined X=undefined
<code>_LVOIEEEEDPSub</code>	D0/D1=IEEE arg1 double-precision D2/D3=IEEE arg2 double-precision	D0/D1=IEEE double-precision subtraction of arg1-arg2	N=undefined Z=undefined V=undefined C=undefined X=undefined

_LVOIEEEEDPMul	D0/D1=IEEE arg1	D0/D1=IEEE	N=undefined	
	double-precision	double-precision	Z=undefined	
		multiplication of	V=undefined	
	D2/D3=IEEE arg2	arg1*arg2	C=undefined	
	double-precision		X=undefined	
-----	-----	-----	-----	
_LVOIEEEEDPDiv	D0/D1=IEEE arg1	D0/D1=IEEE	N=undefined	
	double-precision	double-precision	Z=undefined	
		division of	V=undefined	
	D2/D3=IEEE arg2	arg1/arg2	C=undefined	
	double-precision		X=undefined	
-----	-----	-----	-----	
_LVOIEEEEDPCeil	D0/D1=IEEE arg	D0/D1=least	N=undefined	
	double-precision	integer	Z=undefined	
		>= arg	V=undefined	
			C=undefined	
			X=undefined	
-----	-----	-----	-----	
_LVOIEEEEDPFloor	D0/D1=IEEE arg	D0/D1=largest	N=undefined	
	double-precision	integer	Z=undefined	
		<= arg	V=undefined	
			C=undefined	
			X=undefined	

1.18 35 Math Libraries / IEEE Double-Precision Transcendental Math Library

The IEEE double-precision transcendental math library contains entries for the transcendental math functions such as sine, cosine, and square root. The library resides on disk and is opened by calling `OpenLibrary()` with "mathieeedoubtrans.library" as the argument. Do not share the library base pointer between tasks -- see note at beginning of chapter for details.

```
#include <exec/types.h>
#include <libraries/mathieeedp.h>

#include <clib/mathdoubtrans_protos.h>

struct Library *MathIeeeDoubTransBase;

VOID main()
{
  if (MathIeeeDoubTransBase = OpenLibrary("mathieeedoubtrans.library", 34))
  {
    . . .

    CloseLibrary(MathIeeeDoubTransBase);
  }
  else printf("Can't open mathieeedoubtrans.library\n");
}
```

The global variable `MathIeeeDoubTransBase` is used internally for all future library references.

The IEEE double-precision transcendental math library is dependent upon

the IEEE double-precision basic math library, which it will open if it is not open already. If you want to use the IEEE double-precision basic math functions in conjunction with the transcendental math functions however, you have to specifically open the basic math library yourself.

Just as the IEEE double-precision basic math library, the IEEE double-precision transcendental math library will take advantage of a 680X0/68881 combination or another math resource, if present.

DP IEEE Transcendental Functions

1.19 35 // DP IEEE Transcendental Functions

IEEEEDPAsin() DOUBLE IEEEEDPAsin(DOUBLE parm);
Return arcsine of IEEE variable.

IEEEEDPAcos() DOUBLE IEEEEDPAcos(DOUBLE parm);
Return arccosine of IEEE variable.

IEEEEDPATan() DOUBLE IEEEEDPATan(DOUBLE parm);
Return arctangent of IEEE variable.

IEEEEDPSin() DOUBLE IEEEEDPSin(DOUBLE parm);
Return sine of IEEE variable. This function accepts an IEEE radian argument and returns the trigonometric sine value.

IEEEEDPCos() DOUBLE IEEEEDPCos(DOUBLE parm);
Return cosine of IEEE variable. This function accepts an IEEE radian argument and returns the trigonometric cosine value.

IEEEEDPTan() DOUBLE IEEEEDPTan(DOUBLE parm);
Return tangent of IEEE variable. This function accepts an IEEE radian argument and returns the trigonometric tangent value.

IEEEEDPSincos() DOUBLE IEEEEDPSincos(DOUBLE *pf2, DOUBLE parm);
Return sine and cosine of IEEE variable. This function accepts an IEEE radian argument and returns the trigonometric sine as its result and the trigonometric cosine in the first parameter.

IEEEEDPSinh() DOUBLE IEEEEDPSinh(DOUBLE parm);
Return hyperbolic sine of IEEE variable.

IEEEEDPCosh() DOUBLE IEEEEDPCosh(DOUBLE parm);
Return hyperbolic cosine of IEEE variable.

IEEEEDPTanh() DOUBLE IEEEEDPTanh(DOUBLE parm);
Return hyperbolic tangent of IEEE variable.

IEEEEDPExp() DOUBLE IEEEEDPExp(DOUBLE parm);
Return e to the IEEE variable power. This function accept an IEEE argument and returns the result representing the value of e (2.712828...) raised to that power.

IEEEEDPFieee() DOUBLE IEEEEDPFieee(FLOAT single);
Convert IEEE single-precision number to IEEE double-precision number.

```

IEEEEDPLog()    DOUBLE IEEEEDPLog( DOUBLE parm );
    Return natural log (base e of IEEE variable.

IEEEEDPLog10()  DOUBLE IEEEEDPLog10( DOUBLE parm );
    Return log (base 10) of IEEE variable.

IEEEEDPPow()    DOUBLE IEEEEDPPow( DOUBLE exp, DOUBLE arg );
    Return IEEE arg2 to IEEE arg1.

IEEEEDPSqrt()   DOUBLE IEEEEDPSqrt( DOUBLE parm );
    Return square root of IEEE variable.

IEEEEDPTieee()  FLOAT IEEEEDPTieee( DOUBLE parm );
    Convert IEEE double-precision number to IEEE single-precision number.

```

Be sure to include proper data type definitions as shown below.

```
mathieeeedoubtrans.c
```

The section below describes the Amiga assembly interface to the IEEE double-precision transcendental math library. The access mechanism from assembly language is:

```

MOVEA.L _MathIeeeDoubTransBase,A6
JSR     _LVOIEEEEDPAsin(A6)

```

DP IEEE Transcendental Assembly Functions			
Function	Input	Output	Condition Codes
_LVOIEEEEDPAsin	D0/D1=IEEE arg	D0/D1=IEEE arcsine radian	N=undefined
			Z=undefined
			V=undefined
			C=undefined
			X=undefined
_LVOIEEEEDPAcos	D0/D1=IEEE arg	D0/D1=IEEE arccosine radian	N=undefined
			Z=undefined
			V=undefined
			C=undefined
			X=undefined
_LVOIEEEEDPATan	D0/D1=IEEE arg	D0/D1=IEEE arctangent radian	N=undefined
			Z=undefined
			V=undefined
			C=undefined
			X=undefined
_LVOIEEEEDPSin	D0/D1=IEEE arg in radians	D0/D1=IEEE sine	N=undefined
			Z=undefined
			V=undefined
			C=undefined
			X=undefined

-----	-----	-----	-----
_LVOIEEEEDPCos	D0/D1=IEEE arg in radians	D0/D1=IEEE cosine	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEEDPTan	D0/D1=IEEE arg in radians	D0/D1=IEEE tangent	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEEDPSincos	A0=Address to store cosine result D0/D1=IEEE arg in radians	D0/D1=IEEE sine (A0)=IEEE cosine	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEEDPSin	D0/D1=IEEE arg in radians	D0/D1=IEEE hyperbolic sine	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEEDPCosh	D0/D1=IEEE arg in radians	D0/D1=IEEE hyperbolic cosine	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEEDPTanh	D0/D1=IEEE arg in radians	D0/D1=IEEE hyperbolic tangent	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEEDPExp	D0/D1=IEEE arg	D0/D1=IEEE exponential	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEEDPLog	D0/D1=IEEE arg	D0/D1=IEEE natural logarithm	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEEDPLog10	D0/D1=IEEE arg	D0/D1=IEEE logarithm (base 10)	N=undefined Z=undefined V=undefined C=undefined X=undefined
-----	-----	-----	-----
_LVOIEEEEDPPow	D0/D1=IEEE exp D2/D3=IEEE arg	D0/D1=IEEE of arg taken to	N=undefined Z=undefined

		exp power	V=undefined
			C=undefined
			X=undefined

_LVOIEEEEDPSqrt	D0/D1=IEEE arg	D0/D1=IEEE square root	N=undefined
			Z=undefined
			V=undefined
			C=undefined
			X=undefined

_LVOIEEEEDPTieee	D0/D1=IEEE arg	D0=single-precision IEEE floating-point format	N=undefined
			Z=undefined
			V=undefined
			C=undefined
			X=undefined

1.20 35 Math Libraries / Function Reference

Here's a brief summary of the functions covered in this chapter. Refer to the Amiga ROM Kernel Reference Manual: Includes and Autodocs for additional information.

FFP Basic Functions	
=====	
SPAbs()	Take absolute value of FFP variable
SPAdd()	Add two FFP variables
SPCeil()	Compute least integer greater than or equal to variable.
SPCmp()	Compare two FFP variables
SPDiv()	Divide two FFP variables
SPFix()	Convert FFP variable to integer
SPFloor()	Computer largest integer less than or equal to variable.
SPFlt()	Convert integer variable to FFP
SPMul()	Multiply two FFP variables
SPNeg()	Take two's complement of FFP variable
SPSub()	Subtract two FFP variables
SPTst()	Test an FFP variable against zero

FFP Transcendental Functions	
=====	
SPAcos()	Return arccosine of FFP variable.
SPAsin()	Return arcsine of FFP variable.
SPAtan()	Return arctangent of FFP variable.
SPCos()	Return cosine of FFP variable.
SPCosh()	Return hyperbolic cosine of FFP variable.
SPExp()	Return e to the FFP variable power.
SPFieee()	Convert IEEE variable to FFP format.
SPLog()	Return natural log (base e) of FFP variable.
SPLog10()	Return log (base 10) of FFP variable.
SPPow()	Return FFP arg2 to FFP arg1.

SPSin()	Return sine of FFP variable.
SPSincos()	Return sine and cosine of FFP variable.
SPSinh()	Return hyperbolic sine of FFP variable.
SPSqrt()	Return square root of FFP variable.
SPTan()	Return tangent of FFP variable.
SPTanh()	Return hyperbolic tangent of FFP variable.
SPTieee()	Convert FFP variable to IEEE format

Math Support Functions	
afp()	Convert ASCII string into FFP equivalent.
fpa()	Convert FFP variable into ASCII equivalent.
arnd()	Round ASCII representation of FFP number.
dbf()	Convert FFP dual-binary number to FFP equivalent.

SP IEEE Basic Functions (V36)	
IEEESPAbs()	Take absolute value of IEEE single-precision variable.
IEEESPAdd()	Add two IEEE single-precision variables.
IEEESPCeil()	Compute least integer greater than or equal to variable.
IEEESPCmp()	Compare two IEEE single-precision variables.
IEEESPDiv()	Divide two IEEE single-precision variables.
IEEESPFix()	Convert IEEE single-precision variable to integer.
IEEESPFloor()	Compute largest integer less than or equal to variable.
IEEESPFlt()	Convert integer variable to IEEE single-precision.
IEEESPMul()	Multiply two IEEE single-precision variables.
IEEESPNeg()	Take two's complement of IEEE single-precision variable.
IEEESPSub()	Subtract two IEEE single-precision variables.
IEEESPtst()	Test an IEEE single-precision variable against zero.

SP IEEE Transcendental Functions (V36)	
IEEESPACos()	Return arccosine of IEEE single-precision variable.
IEEESPASin()	Return arcsine of IEEE single-precision variable.
IEEESPAtan()	Return arctangent of IEEE single-precision variable.
IEEESPCos()	Return cosine of IEEE single-precision variable.
IEEESPCosh()	Return hyperbolic cosine of IEEE single-precision variable.
IEEESPExp()	Return e to the IEEE variable power.
IEEESPLog()	Return natural log (base e of IEEE single-precision variable.
IEEESPLog10()	Return log (base 10) of IEEE single-precision variable.
IEEESPPow()	Return power of IEEE single-precision variable.
IEEESPSin()	Return sine of IEEE single-precision variable.

IEEESPSincos()	Return sine and cosine of IEEE single-precision variable.
IEEESPSinh()	Return hyperbolic sine of IEEE single-precision variable.
IEEESPSqrt()	Return square root of IEEE single-precision variable.
IEEESPTan()	Return tangent of IEEE single-precision variable.
IEEESPTanh()	Return hyperbolic tangent of IEEE single-precision variable.

DP IEEE Basic Functions	
IEEEDPAbs()	Take absolute value of IEEE double-precision variable.
IEEEDPAdd()	Add two IEEE double-precision variables.
IEEEDPCeil()	Compute least integer greater than or equal to variable.
IEEEDPComp()	Compare two IEEE double-precision variables.
IEEEDPDiv()	Divide two IEEE double-precision variables.
IEEEDPFix()	Convert IEEE double-precision variable to integer.
IEEEDPFloor()	Compute largest integer less than or equal to variable.
IEEEDPFlt()	Convert integer variable to IEEE double-precision.
IEEEDPMul()	Multiply two IEEE double-precision variables.
IEEEDPNeg()	Take two's complement of IEEE double-precision variable.
IEEEDPSub()	Subtract two IEEE single-precision variables.
IEEEDPtst()	Test an IEEE double-precision variable against zero.

DP IEEE Transcendental Functions	
IEEEDPACos()	Return arccosine of IEEE double-precision variable.
IEEEDPASin()	Return arcsine of IEEE double-precision variable.
IEEEDPAtan()	Return arctangent of IEEE double-precision variable.
IEEEDPCos()	Return cosine of IEEE double-precision variable.
IEEEDPCosh()	Return hyperbolic cosine of IEEE double-precision variable.
IEEEDPExp()	Return e to the IEEE variable power.
IEEEDPFieee()	Convert IEEE single-precision number to IEEE double-precision number.
IEEEDPLog()	Return natural log (base e of IEEE double-precision variable.
IEEEDPLog10()	Return log (base 10) of IEEE double-precision variable.
IEEEDPPow()	Return power of IEEE double-precision variable.
IEEEDPSin()	Return sine of IEEE double-precision variable.
IEEEDPSincos()	Return sine and cosine of IEEE double-precision variable.
IEEEDPSinh()	Return hyperbolic sine of IEEE double-precision variable.
IEEEDPSqrt()	Return square root of IEEE double-precision variable.
IEEEDPTan()	Return tangent of IEEE double-precision variable.
IEEEDPTanh()	Return hyperbolic tangent of IEEE double-precision

	variable.	
	IEEEDPTieee() Convert IEEE double-precision number to IEEE	
	single-precision number.	

1.21 35 Math Libraries / Compile and Link Commands for SAS C 5.10

FFP Basic, Transcendental and Math Support functions

```
-----  
lc -bl -cfistq -ff -v -y <filename>.c  
blink lib:c.o + <filename>.o TO  
    <filename> LIB lib:lcmffp.lib + lib:lc.lib + lib:amiga.lib
```

IEEE Single-Precision and Double-Precision Basic and Transcendental Functions

```
-----  
lc -bl -cfistq -fi -v -y <filename>.c  
blink lib:c.o + <filename>.o TO  
    <filename> LIB lib:lcmieee.lib + lib:lc.lib + lib:amiga.lib
```