Libraries

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Contents

Chapter 1

Libraries

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.

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

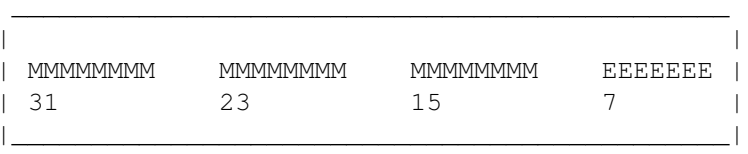
mathieesingtrans.library
    the IEEE single-precision transcendental library

mathieeedoubbas.library
    the IEEE double-precision library

mathieesingtrans.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:



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 > +VALUE > 5.42101070 * 10^-20
    -9.22337177 * 10^18 < -VALUE < -2.71050535 * 10^-20


BINARY (HEXADECIMAL):

     .FFFFFF * 2^63 > +VALUE > .800000 * 2^-63
    -.FFFFFF * 2^63 < -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
_LVOSPCmp	D1=FFP arg1 D0=FFP arg2	D0=+1 if arg1>arg2 D0=-1 if arg1<arg2 D0=0 if arg1=arg2	N=0 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
_LVOSPDiv	D1=FFP arg1 D0=FFP arg2	D0=FFP division of arg2/arg1	N=1 if result is negative Z=1 if result is zero V=1 if result overflowed C=undefined Z=undefined
_LVOSPFix	D0=FFP arg	D0=Integer (two's complement)	N=1 if result is negative Z=1 if result is zero V=1 if overflow occurred C=undefined X=undefined
_LVOSPFloor	D0=FFP arg	D0=largest integer <= arg	N=1 if result is negative Z=1 if result is zero V=undefined C=undefined Z=undefined
_LVOSPFlt	D0=Integer (two's complement)	D0=FFP result	N=1 if result is negative Z=1 if result is zero V=0 C=undefined X=undefined
_LVOSPMul	D0=FFP arg1 D1=FFP arg2	D0=FFP multiplication of arg1*arg2	N=1 if result is negative Z=1 if result is zero V=1 if result overflowed C=undefined

			Z=undefined
_LVOSPNeg	D0=FFP arg	D0=FFP negated	N=1 if result is negative Z=1 if result is zero V=0 C=undefined X=undefined
_LVOSPSub	D1=FFP arg1 D0=FFP arg2	D0=FFP subtraction of arg2-arg1	N=1 if result is negative Z=1 if result is zero V=1 if result overflowed C=undefined Z=undefined
_LVOSPTst	D1=FFP arg Note: This routine trashes the arg in D1.	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

1.6 35 Math Libraries / FFP Transcendental Mathematics Library

The FFP transcendental math library contains entries for the transcendental math functions sine, cosine, and square root. It resides on disk and is opened by calling OpenLibrary() with "mathtrans.library" as the argument.

```
    #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
_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
_LVOSPAtan	D0=FFP arg	D0=FFP arctangent radian	N=0 Z=1 if result is zero V=0 C=undefined X=undefined
_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
_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
_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
_LVOSPSincos	D0=FFP arg in radians D1=Address to store	D0=FFP sine (D1)=FFP cosine	N=1 if result is negative Z=1 if result 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
_LVOSPTanh	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
_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
_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
_LVOSPTieee	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
_LVOSPFieee	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

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

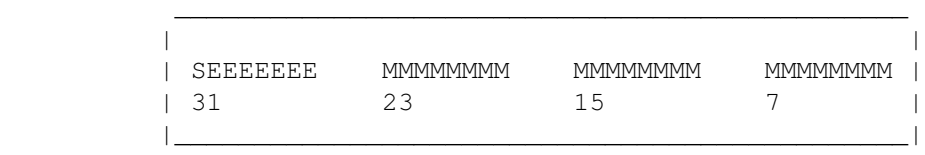
```
afp()    FLOAT afp( BYTE *string );
    Convert ASCII string into FFP equivalent.

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:



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

_LVOIEEESPFix	D0=IEEE arg double-precision	D0=Integer (two's complement)	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPFlt	D0=Integer arg (two's complement)	D0=IEEE single-precision	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPCmp	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
_LVOIEEESPTst	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
_LVOIEEESPAbs	D0=IEEE arg single-precision	D0=IEEE single-precision absolute value	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPNeg	D0=IEEE arg single-precision	D0=IEEE single-precision negated	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPAdd	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

_LVOIEEESPSub	D0=IEEE arg1 single-precision D1=IEEE arg2 single-precision	D0=IEEE single-precision subtraction of arg1-arg2	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPMul	D0=IEEE arg1 single-precision D1=IEEE arg2 single-precision	D0=IEEE single-precision multiplication of arg1*arg2	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPDiv	D0=IEEE arg1 single-precision D1=IEEE arg2 single-precision	D0=IEEE single-precision division of arg1/arg2	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPCeil	D0=IEEE variable single-precision	D0=least integer >= variable	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPFloor	D0=IEEE variable single-precision	D0=largest integer <= arg	N=undefined 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.

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

IEEESPExp()    FLOAT IEEESPExp( 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.

IEEESPFieee()  FLOAT IEEESPFieee( 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.

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

IEEESPLog10()  FLOAT IEEESPLog10( FLOAT parm );
    Return log (base 10) of IEEE single-precision variable.

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

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

IEEESPTieee()  FLOAT IEEESPTieee( 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     _LVOIEEESPAsin(A6)
```

SP IEEE Transcendental Assembly Functions

Function	Input	Output	Condition Codes
_LVOIEEESPAsin	D0=IEEE arg	D0=IEEE arcsine radian	N=undefined Z=undefined V=undefined C=undefined X=undefined

_LVOIEEESPAcos	D0=IEEE arg single-precision	D0=IEEE arccosine radian	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPAtan	D0=IEEE arg single-precision	D0=IEEE arctangent radian	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPSin	D0=IEEE arg in radians single-precision	D0=IEEE sine	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPCos	D0=IEEE arg in radians single-precision	D0=IEEE cosine	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPTan	D0=IEEE arg in radians single-precision	D0=IEEE tangent	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPSincos	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
_LVOIEEESPSinh	D0=IEEE arg in radians single-precision	D0=IEEE hyperbolic sine	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPCosh	D0=IEEE arg in radians single-precision	D0=IEEE hyperbolic cosine	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPTanh	D0=IEEE arg in radians single-precision	D0=IEEE hyperbolic tangent	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPExp	D0=IEEE arg single-precision	D0=IEEE exponential	N=undefined Z=undefined V=undefined

			C=undefined
			X=undefined
_LVOIEEESPLog	D0=IEEE arg single-precision	D0=IEEE natural logarithm	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPLog10	D0=IEEE arg single-precision	D0=IEEE logarithm (base 10)	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEESPPow	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
_LVOIEEESPSqrt	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	EEEEEIMM	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.
```

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

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

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

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

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

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

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

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

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

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

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

mathieeedoubbas.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     _LVOIEEEDPFix(A6)
```

DP IEEE Basic Assembly Functions

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

_LVOIEEEDPFl	D0=Integer arg (two's complement)	D0/D1=IEEE double-precision	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPCmp	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
_LVOIEEEDPTst	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
_LVOIEEEDPAbs	D0/D1=IEEE arg double-precision	D0/D1=IEEE double-precision absolute value	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPNeg	D0/D1=IEEE arg double-precision	D0/D1=IEEE double-precision negated	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPAdd	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
_LVOIEEEDPSub	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

_LVOIEEEDPMul	D0/D1=IEEE arg1 double-precision D2/D3=IEEE arg2 double-precision	D0/D1=IEEE double-precision multiplication of arg1*arg2	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPDiv	D0/D1=IEEE arg1 double-precision D2/D3=IEEE arg2 double-precision	D0/D1=IEEE double-precision division of arg1/arg2	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPCeil	D0/D1=IEEE arg double-precision	D0/D1=least integer >= arg	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPFloor	D0/D1=IEEE arg double-precision	D0/D1=largest integer <= arg	N=undefined Z=undefined 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

```
IEEEDPAsin()   DOUBLE IEEEDPAsin( DOUBLE parm );
    Return arcsine of IEEE variable.

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

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

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

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

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

IEEEDPSincos() DOUBLE IEEEDPSincos( 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.

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

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

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

IEEEDPExp()    DOUBLE IEEEDPExp( 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.

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

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

IEEEDPLog10()  DOUBLE IEEEDPLog10( DOUBLE parm );
    Return log (base 10) of IEEE variable.

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

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

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

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

mathieeedoubtrans.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     _LVOIEEEDPAsin(A6)
```

DP IEEE Transcendental Assembly Functions

Function	Input	Output	Condition Codes
_LVOIEEEDPAsin	D0/D1=IEEE arg	D0/D1=IEEE arcsine radian	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPAcos	D0/D1=IEEE arg	D0/D1=IEEE arccosine radian	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPAtan	D0/D1=IEEE arg	D0/D1=IEEE arctangent radian	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPSin	D0/D1=IEEE arg in radians	D0/D1=IEEE sine	N=undefined Z=undefined V=undefined C=undefined X=undefined

_LVOIEEEDPCos	D0/D1=IEEE arg in radians	D0/D1=IEEE cosine	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPTan	D0/D1=IEEE arg in radians	D0/D1=IEEE tangent	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPSincos	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
_LVOIEEEDPSin	D0/D1=IEEE arg in radians	D0/D1=IEEE hyperbolic sine	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPCosh	D0/D1=IEEE arg in radians	D0/D1=IEEE hyperbolic cosine	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPTanh	D0/D1=IEEE arg in radians	D0/D1=IEEE hyperbolic tangent	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPExp	D0/D1=IEEE arg	D0/D1=IEEE exponential	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPLog	D0/D1=IEEE arg	D0/D1=IEEE natural logarithm	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPLog10	D0/D1=IEEE arg	D0/D1=IEEE logarithm (base 10)	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPPow	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
_LVOIEEEDPSqrt	D0/D1=IEEE arg	D0/D1=IEEE square root	N=undefined Z=undefined V=undefined C=undefined X=undefined
_LVOIEEEDPTieee	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.
IEEEDPCmp()	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 -b1 -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 -b1 -cfistq -fi -v -y <filename>.c
    blink lib:c.o + <filename>.o TO
         <filename> LIB lib:lcmieee.lib + lib:lc.lib + lib:amiga.lib
```