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M68040FPSP

Preliminary Technical Summary

M68040 Floating-Point Software Package

The M68040 floating-point software package (M68040FPSP) provides MC68040 users full compatibility with the MC68881/MC68882. An optimized subset of the MC6888x instruction set is executed by the MC68040 on-chip floating-point unit (FPU). The remaining floating-point instructions are emulated in software by the FPSP. There are two versions of the FPSP: one for applications compiled for the MC68881/MC68882 (FPSP kernel version) and the other for applications compiled for the MC68040 (FPSP library version).

Using the FPSP kernel version, system integrators can install the package as part of an MC68040-based operating system. The FPSP kernel version is used to execute preexisting user object code written for the MC68882 as part of the operating system. User applications need not be recompiled or modified in any way once the FPSP kernel version is installed.

The MC68040 compiler writer and system integrator use the FPSP library version, which provides less overhead than the FPSP kernel version. Overhead is reduced because the appropriate floating-point routine is called directly, rather than taking an unimplemented instruction TRAP. The library is M68000 application binary interface (ABI) as well as IEEE exception-reporting compliant; it is not UNIX® exception-reporting compliant.

The FPSP provides the following:

- Arithmetic and Transcendental Instructions
- IEEE-Compliant Exception Handlers
- MC68040 Unimplemented Data Type and Data Format Handlers
- Can Reside in a 64K-byte ROM
- Code is Reentrant

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INTRODUCTION

System designers integrate the FPSP into the system so that the user code runs unchanged and remains totally transparent to the end user. The FPSP can be installed into any operating system. It provides kernel routines to support unimplemented instructions and unsupported data types of the MC68040. Unimplemented instructions for end-user applications compiled for the MC68881/MC68882 are contained in a library for improved performance.

The FPSP satisfies the ANSI/IEEE standard 754 for binary floating-point arithmetic. The average performance of the transcendental function subroutines is equivalent to that of the 33-MHz MC68881/MC68882. The error bound is equivalent to that of the MC68881/MC68882.

INSTRUCTIONS

The FPSP can be installed into any operating system. The MC68040 FPU must be implemented as described in Reference 2. Table 1 lists the floating-point functions implemented as instructions by the MC68040.

Table 1. Instructions Provided by MC68040

Name	Description	Name	Description
FMOVE	Move to FPU	FMOVEM	Move Multiple Registers
FSMOVE	Single-Precision Move	FDMOVE	Double-Precision Move
FCMP	Compare	FABS	Absolute Value
FSABS	Single-Precision Absolute Value	FDABS	Double-Precision Absolute Value
FTST	Test	FNEG	Negate
FSNEG	Single-Precision Negate	FDNEG	Double-Precision Negate
FADD	Add	FSUB	Subtract
FDIV	Divide	FMUL	Multiply
FBcc	Branch Conditionally	FScc	Set According to Condition
FDBcc	Test Cond, Dec and Branch	FTRAPcc	Trap Conditionally
FSADD	Single-Precision Add	FSSUB	Single-Precision Subtract
FSMUL	Single-Precision Multiply	FSDIV	Single-Precision Divide
FDADD	Double-Precision Add	FDSUB	Double-Precision Subtract
FDMUL	Double-Precision Multiply	FDDIV	Double-Precision Divide
FSQRT	Square Root	FSSQRT	Single-Precision Square Root
FDSQRT	Double-Precision Square Root	FNOP	No Operation
FSGLDIV	Single-Precision Divide	FSGLMUL	Single-Precision Multiply
FSAVE	Save Internal State	FRESTORE	Restore Internal State

Tables 2 and 3 list the arithmetic and transcendental instructions that are implemented in the FPSP for the MC68040. New instructions have been added to the MC68881/MC68882 base instructions.

Table 2. FPSP Arithmetic Instructions

Name	Description	Name	Description
FADD*	Add	FSUB*	Subtract
FSADD* †	Single-Precision Add	FSSUB* †	Single-Precision Subtract
FDADD* †	Double-Precision Add	FDSUB* †	Double-Precision Subtract
FMUL*	Multiply	FDIV*	Divide
FSMUL* †	Single-Precision Multiply	FSDIV* †	Single-Precision Divide
FDMUL* †	Double-Precision Multiply	FDDIV* †	Double-Precision Divide
FINT	Integer Part	FINTRZ	Integer Part (Truncated)
FABS*	Absolute Value	FNEG*	Negate
FGETEXP	Get Exponent	FGETMAN	Get Mantissa
FTST*	Test Operand	FCMP*	Compare
FREM	IEEE Remainder	FSCALE	Scale Exponent
FMOVE*	Move FP data register	FSMOVE*	Single-Precision Move
FDMOVE*	Double-Precision Move	FSQRT*	Square Root
FSSQRT*	Single-Precision Square Root	FTWOTOX	2 to the x Power
FMOD	Modulo Remainder	FDSQRT*	Double-Precision Square Root
FDMOD	Double-Precision Modulo Remainder	FSMOD	Single-Precision Modulo Remainder

* The MC68040 provides these functions for all data formats except single, double, and extended denormalized data types and extended unnormalized data types. The FPSP provides the functions for the special data types.
† Additional functions not provided by the MC68881/MC68882.

Table 3. FPSP Transcendental Instructions

Name	Description	Name	Description
FCOS	Cosine	FSIN	Sine
FACOS	Arc Cosine	FASIN	Arc Sine
FCOSH	Hyperbolic Cosine	FSINH	Hyperbolic Sine
FSINCOS	Simultaneous Sine & Cosine	FXTOY*	x to the y Power
FTAN	Tangent	FATAN	Arc Tangent
FTANH	Hyperbolic Tangent	FATANH	Hyperbolic Arc Tan
FLOG2	Log Base 2	FLOG10	Log Base 10
FLOGN	Log Base e	FLOGNP1	Log Base e of (x + 1)
FETOX	e to the x Power	FETOXM1	(e to the x Power) −1
FTENTOX	10 to the x Power	FTWOTOX	2 to the x Power

*Additional function not provided by the MC68881/MC68882.

DATA FORMATS AND DATA TYPES

All data types and data formats not supported by the MC68040 FPU are supported by the FPSP.

Table 4. Support for Data Types and Data Formats

Data Types	Data Formats						
	SGL	DBL	EXT	Decimal	Byte	Word	Long Word
Normalized	†	†	†	*	†	†	†
Zero	†	†	†	*	†	†	†
Infinity	†	†	†	*			
NaN	†	†	†	*			
Denormalized	‡	‡	*	*			
Unnormalized			*	*			

* = Supported by FPSP
† = Supported by the MC68040 FPU
‡ = Supported by FPSP after being converted to extended precision by the MC68040 FPU

EXCEPTIONS

The FPSP provides system designers with a simple path to port existing MC68882 exceptions handlers to the MC68040. It also provides an entry point for the following IEEE-defined trap conditions. Table 5 lists the exception types. For a detailed description of exceptions, see Reference 4.

Table 5. Exception Types

Mnemonic	Description
BSUN	Branch/Set on Unordered
SNAN	Signaling Not-a-Number
OPERR	Operand Error
OVFL	Overflow
UNFL	Underflow
DZ	Divide by Zero
INEX1 / INEX2	Inexact Result 1/2

ORDERING INFORMATION

The FPSP is written in M68000 assembly code and comes with an installation guide. Tape contains both Motorola syntax and UNIX "as" syntax. Media is tape cartridge (M68040FPSPT) or 9 track (M68040FPSPP) and is written in CPIO or TAR format.

A license is required to obtain rights to use and distribute the M68040FPSP. License terms include the right to use and modify source code and redistribute resulting object code.

REFERENCES

1. MC68881UM/AD, *MC68881/MC68882 Motorola Floating-Point Coprocessor User's Manual*. Motorola Inc., 1989
2. MC68040UM/AD, *MC68040 32-Bit Microprocessor User's Manual*, Motorola, Inc., 1989.
3. ANSI/IEEE Std. 754-1985, *Standard for Binary Floating-Point Arithmetic*, 1985.
4. MC68040DH/AD, *MC68040 Designers Handbook*, Motorola Inc., 1990.
5. M68000PM/AD, *Programmer's Reference Manual*, Motorola Inc., 1990.

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A30260 PRINTED IN USA (1993) MPS/POD MPU YGABAA

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