

# RFC ls017 Transcendental instructions for 3D and </>

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- <https://libre-soc.org/openpower/sv/rfc/ls017.transcendentals/>
- [https://bugs.libre-soc.org/show\\_bug.cgi?id=1196](https://bugs.libre-soc.org/show_bug.cgi?id=1196)

**Severity:** Major

**Status:** New

**Date:** 29 Apr 2023

**Target:** v3.2B

**Source:** v3.1B

## **Books and Section affected:**

Book I Floating-Point Instructions  
Appendix E Power ISA sorted by opcode  
Appendix F Power ISA sorted by version  
Appendix G Power ISA sorted by Compliancy Subset  
Appendix H Power ISA sorted by mnemonic

## **Summary**

Instructions added: 43 transcendental mathematical to SFFS

**Submitter:** Luke Leighton (Libre-SOC)

**Requester:** Libre-SOC

## **Impact on processor:**

Addition of new Transcendental instructions

## **Impact on software:**

Requires support for new instructions in assembler, debuggers, and related tools. Greatly decreases instruction count in 3D and HPC.

## **Keywords:**

Scientific Computing, HPC, 3D, OpenCL,

## **Motivation**

Allows 3D GPU Products to be commercially viable.

## **Changes**

Add the following entries to:

- the Appendices of Book I
  - Book I 4.6.6.4 Transcendental Instructions
  - Book I 1.6.1 and 1.6.2
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## Opcode Tables for PO=59/63 XO=1–011- </>

Power ISA v3.1B opcodes extracted from:

- Power ISA v3.1B Appendix D Table 23 sheet 2/3 of 4 page 1391/1392
- Power ISA v3.1B Appendix D Table 25 sheet 2/3 of 4 page 1399/1400

Parenthesized entries are not part of fptrans.

- Entries whose mnemonic ends in *s* are only in PO=59.
- Entries whose mnemonic does not end in *s* are only in PO=63.
- Entries whose mnemonic ends in (*s*) are in both PO=59 and PO=63.

XO LSB half → XO MSB half ↓	01100	01101	01110	01111
10000	10000 01100 fcbprt(s) (draft)	10000 01101 fsinpi(s) (draft)	10000 01110 fatan2pi(s) (draft)	10000 01111 fasinpi(s) (draft)
10001	10001 01100 fcosp(s) (draft)	10001 01101 ftanpi(s) (draft)	10001 01110 facosp(s) (draft)	10001 01111 fatanpi(s) (draft)
10010	10010 01100 frsqrt(s) (draft)	10010 01101 fsin(s) (draft)	10010 01110 fatan2(s) (draft)	10010 01111 fasin(s) (draft)
10011	10011 01100 fcos(s) (draft)	10011 01101 ftan(s) (draft)	10011 01110 facos(s) (draft)	10011 01111 fatan(s) (draft)
10100	10100 01100 frecip(s) (draft)	10100 01101 fsinh(s) (draft)	10100 01110 fhypot(s) (draft)	10100 01111 fasinh(s) (draft)
10101	10101 01100 fcosh(s) (draft)	10101 01101 ftanh(s) (draft)	10101 01110 facosh(s) (draft)	10101 01111 fatanh(s) (draft)
10110	10110 01100	10110 01101	10110 01110	10110 01111
10111	10111 01100	10111 01101	10111 01110	10111 01111

XO LSB half → XO MSB half ↓	01100	01101	01110	01111
11000	11000 01100 fexp2m1(s) (draft)	11000 01101 flog2p1(s) (draft)	11000 01110 (cffpro) (draft)	11000 01111 (ctfpr(s)) (draft)
11001	11001 01100 fexpm1(s) (draft)	11001 01101 flogp1(s) (draft)	11001 01110 (fctid)	11001 01111 (fctidz)
11010	11010 01100 fexp10m1(s) (draft)	11010 01101 flog10p1(s) (draft)	11010 01110 (fcfid(s))	11010 01111 fmod(s) (draft)
11011	11011 01100 fpown(s) (draft)	11011 01101 frootn(s) (draft)	11011 01110	11011 01111
11100	11100 01100 fexp2(s) (draft)	11100 01101 flog2(s) (draft)	11100 01110 (mffpr(s)) (draft)	11100 01111 (mtfpr(s)) (draft)
11101	11101 01100 fexp(s) (draft)	11101 01101 flog(s) (draft)	11101 01110 (fctidu)	11101 01111 (fctiduz)
11110	11110 01100 fexp10(s) (draft)	11110 01101 flog10(s) (draft)	11110 01110 (fcfidu(s))	11110 01111 fremainder(s) (draft)
11111	11111 01100 fpowr(s) (draft)	11111 01101 fpow(s) (draft)	11111 01110	11111 01111

XO LSB half → XO MSB half ↓	10000	10001	10010	10011
///0	...0 10000 fminmax (draft)	///0 10001	///0 10010 (fdiv(s))	///0 10011
///1	///1 10000	///1 10001	///1 10010 (fdiv(s))	///1 10011

## DRAFT List of 2-arg opcodes </>

These are X-Form, recommended Major Opcode 63 for full-width and 59 for half-width (ending in s).

0.5	6.10	11.15	16.20	21..30	31	name	Form
NN	FRT	FRA	FRB	1xxxx011xx	Rc	transcendental	X-Form
NN	FRT	FRA	RB	1xxxx011xx	Rc	transcendental	X-Form
NN	FRT	FRA	FRB	xxxxx10000	Rc	transcendental	X-Form

Recommended 10-bit XO assignments:

opcode	Description	Major 59 and 63	bits 16..20
fatan2(s)	atan2 arc tangent	10010 01110	FRB
fatan2pi(s)	atan2 arc tangent / $\pi$	10000 01110	FRB
fpow(s)	$x^y$	11111 01101	FRB
fpown(s)	$x^n$ ( $n \in \mathbb{Z}$ )	11011 01100	RB
fpowr(s)	$x^y$ ( $x \geq 0$ )	11111 01100	FRB
frootn(s)	$\sqrt[n]{x}$ ( $n \in \mathbb{Z}$ )	11011 01101	RB
fhypot(s)	$\sqrt{x^2 + y^2}$	10100 01110	FRB
fminmax	min/max	...0 10000	FRB
fmod(s)	modulus	11010 01111	FRB
fremainder(s)	IEEE 754 remainder	11110 01111	FRB

## DRAFT List of 1-arg transcendental opcodes </>

These are X-Form, and are mostly identical in Special Registers Altered to fsqrt (the exact fp exceptions they can produce differ). Recommended Major Opcode 63 for full-width and 59 for half-width (ending in s).

Special Registers Altered (FIXME: come up with correct list):

FPRF FR FI FX OX UX XX

VXSNAN VXIMZ VXZDZ

CR1 (if Rc=1)

0.5	6.10	11.15	16.20	21..30	31	name	Form
NN	FRT	///	FRB	1xxxx011xx	Rc	transcendental	X-Form

Recommended 10-bit XO assignments:

opcode	Description	Major 59 and 63
frsqrt(s)	$1 / \sqrt{x}$	10010 01100
fcbrt(s)	$\sqrt[3]{x}$	10000 01100
frecip(s)	$1 / x$	10100 01100
fexp2m1(s)	$2^x - 1$	11000 01100
flog2p1(s)	$\log_2(x + 1)$	11000 01101
fexp2(s)	$2^x$	11100 01100
flog2(s)	$\log_2 x$	11100 01101
fexpm1(s)	$e^x - 1$	11001 01100
flogp1(s)	$\log_e(x + 1)$	11001 01101
fexp(s)	$e^x$	11101 01100
flog(s)	$\log_e x$	11101 01101
fexp10m1(s)	$10^x - 1$	11010 01100
flog10p1(s)	$\log_{10}(x + 1)$	11010 01101
fexp10(s)	$10^x$	11110 01100
flog10(s)	$\log_{10} x$	11110 01101

## DRAFT List of 1-arg trigonometric opcodes </>

These are X-Form, and are mostly identical in Special Registers Altered to fsqrt (the exact fp exceptions they can produce differ). Recommended Major Opcode 63 for full-width and 59 for half-width (ending in s)

Special Registers Altered:

FPRF FR FI FX OX UX XX

VXSNAN VXIMZ VXZDZ

CR1 (if Rc=1)

0.5	6.10	11.15	16.20	21..30	31	name	Form
NN	FRT	///	FRB	1xxxx011xx	Rc	trigonometric	X-Form

Recommended 10-bit XO assignments:

opcode	Description	Major 59 and 63
fsin(s)	sin (radians)	10010 01101
fcos(s)	cos (radians)	10011 01100

opcode	Description	Major 59 and 63
ftan(s)	tan (radians)	10011 01101
fasin(s)	arcsin (radians)	10010 01111
facos(s)	arccos (radians)	10011 01110
fatan(s)	arctan (radians)	10011 01111
fsinpi(s)	$\sin(\pi * x)$	10000 01101
fcospi(s)	$\cos(\pi * x)$	10001 01100
ftanpi(s)	$\tan(\pi * x)$	10001 01101
fasinpi(s)	$\arcsin(x) / \pi$	10000 01111
facospi(s)	$\arccos(x) / \pi$	10001 01110
fatanpi(s)	$\arctan(x) / \pi$	10001 01111
fsinh(s)	hyperbolic sin	10100 01101
fcosh(s)	hyperbolic cos	10101 01100
ftanh(s)	hyperbolic tan	10101 01101
fasinh(s)	inverse hyperbolic sin	10100 01111
facosh(s)	inverse hyperbolic cos	10101 01110
fatanh(s)	inverse hyperbolic tan	10101 01111

## Appendices </>

Appendix E Power ISA sorted by opcode  
Appendix F Power ISA sorted by version  
Appendix G Power ISA sorted by Compliancy Subset  
Appendix H Power ISA sorted by mnemonic

Form	Book	Page	Version	Mnemonic	Description
A	I	#	3.2B	maddsubrs	Integer DCT/FFT Twin-Butterfly
X	I	#	3.2B	fdmadds	FP DCT Twin-Butterfly Single
X	I	#	3.2B	ffmadds	FP FFT Twin-Butterfly Single
X	I	#	3.2B	fdmadds	FP DCT Twin-Butterfly Double
X	I	#	3.2B	ffmadds	FP FFT Twin-Butterfly Double
X	I	#	3.2B	ffadds	FP FFT Twin-Butterfly Single
X	I	#	3.2B	ffadd	FP FFT Twin-Butterfly Double
X	I	#	3.2B	ffsubs	FP FFT Twin-Butterfly Single
X	I	#	3.2B	ffsub	FP FFT Twin-Butterfly Double

[[!tag opf\_rfc]]