Contents

	rigures, tables, and Listings Xi			
Preface	About This Book xvii			
	What's in This Book xviii Conventions Used in This Book xviii Special Fonts xix Types of Notes xix For More Information xix			
Part 1	The PowerPC Numerics Environment			
Chapter 1	IEEE Standard Arithmetic 1-1			
	About the IEEE Standard 1-3 Starting to Use IEEE Arithmetic 1-5 Careful Rounding 1-5 Exception Handling 1-6 Example: Finding Zero Return Values 1-7 Example: Searching Without Stopping 1-8 Example: Parallel Resistances 1-8 Using IEEE Arithmetic 1-9 Evaluating Continued Fractions 1-9 Computing the Area of a Triangle 1-11 About the FPCE Technical Report 1-12 PowerPC Numerics Versus SANE 1-13			
Chapter 2	Floating-Point Data Formats 2-1			
	About Floating-Point Data Formats 2-3 Interpreting Floating-Point Values 2-4 Normalized Numbers 2-5 Denormalized Numbers 2-6 Infinities 2-7 NaNs 2-8 Zeros 2-10			

Formats 2-11
Single Format 2-11
Double Format 2-13
Double-Double Format 2-14
Range and Precision of Data Formats 2-16

Chapter 3 Expression Evaluation 3-1

About Expression Evaluation 3-3
Evaluating Expressions Without Widest Need 3-3
Evaluating Expressions With Widest Need 3-5
Comparisons of Expression Evaluation Methods 3-8

Chapter 4 Environmental Controls 4-1

Rounding Direction Modes
Rounding Precision 4-4
Exception Flags 4-4
Invalid Operation 4-5
Underflow 4-5
Overflow 4-5
Divide-by-Zero 4-6
Inexact 4-6

Chapter 5 Conversions 5-1

About Conversions 5-3 Converting Floating-Point to Integer Formats 5-3 5-4 Rounding Floating-Point Numbers to Integers 5-5 Converting Integers to Floating-Point Formats 5-5 Converting Between Floating-Point Formats Converting Between Single and Double Formats 5-5 Converting Between Single and Double-Double Formats 5-5 Converting Between Double and Double-Double Formats 5-7 Converting Between Binary and Decimal Numbers 5-7 Accuracy of Decimal-to-Binary Conversions 5-7 **Automatic Conversions** 5-8 **Manual Conversions** 5-10 Converting Between Floating-Point and Decimal Structures 5-10 Converting Between Floating-Point and Decimal Strings 5-12

Chapter 6	Numeric Operations and Functions 6-1
	Comparisons 6-3 Comparisons With NaNs and Infinities 6-3 Comparison Operators 6-3 Arithmetic Operations 6-5 Auxiliary Functions 6-14 Transcendental Functions 6-15
Part 2	The PowerPC Numerics C Implementation
Chapter 7	Numeric Data Types in C 7-1
	C Data Types 7-3 Efficient Type Declarations 7-3 Inquiries: Class and Sign 7-4 Creating Infinities and NaNs 7-5 Numeric Data Types Summary 7-6 C Summary 7-6 Constants 7-6 Data Types 7-7 Special Value Routines 7-7
Chapter 8	Environmental Control Functions 8-1
	Controlling the Rounding Direction 8-3 Controlling the Exception Flags 8-5 Accessing the Floating-Point Environment 8-9 Environmental Controls Summary 8-14 C Summary 8-14 Constants 8-14 Data Types 8-14 Environment Access Routines 8-15
Chapter 9	Conversion Functions 9-1
	Converting Floating-Point to Integer Formats 9-3 Rounding Floating-Point Numbers to Integers 9-6 Converting Integers to Floating-Point Formats 9-12 Converting Between Floating-Point Formats 9-13 Converting Between Binary and Decimal Numbers 9-13

Chapter 10	Transcendental Functions 10-1					
	Comparison Functions 10-3 Sign Manipulation Functions 10-9 Exponential Functions 10-12 Logarithmic Functions 10-21 Logarithmic Functions 10-25 Trigonometric Functions 10-31 Hyperbolic Functions 10-42 Financial Functions 10-50 Error and Gamma Functions 10-55					
	Miscellaneous Functions 10-60 Transcendental Functions Summary 10-65 C Summary 10-65 Constants 10-65 Data Types 10-65 Transcendental Functions 10-65					
Part 3	Numerics in PowerPC Assembly Language					
Chapter 11	Introduction to Assembly-Language Numerics 11-1					
	PowerPC Floating-Point Architecture 11-3 Floating-Point Data Formats 11-3 Floating-Point Registers 11-3 Floating-Point Special-Purpose Registers 11-4 The Machine State Register 11-4 Floating-Point Instructions 11-4 Load and Store Instructions 11-5 Numerics Example Using PowerPC Assembly Language 11-7					

Converting Between Decimal Formats

9-24

9-24

9-24

9-24

9-25

Conversions Summary

C Summary

Constants

Data Types

Conversion Routines

9-19

Chapter 12	Assembly-Language Environmental Controls 12-1
	The Floating-Point Environment 12-3 The Floating-Point Status and Control Register 12-3 The Condition Register 12-5 Inquiries: Class and Sign 12-7 Floating-Point Result Flags and Condition Codes 12-7 Example: Determining Class 12-8 Setting the Rounding Direction 12-9 Floating-Point Exceptions 12-10 Exception Bits in the FPSCR 12-10 Signaling and Clearing Floating-Point Exceptions 12-11 Enabling and Disabling Floating-Point Exceptions 12-12 Testing for Floating-Point Exceptions 12-12 Saving and Restoring the Floating-Point Environment 12-14
Chapter 13	Assembly-Language Numeric Conversions 13-1
	Conversions From Integer to Floating-Point Formats Conversions From Floating-Point to Integer Formats Conversions From Single to Double Format 13-3 Conversions From Double to Single Format 13-5
Chapter 14	Assembly-Language Numeric Operations 14-1
	Comparison Operations 14-3 Arithmetic Operations 14-4 Arithmetic Instructions 14-4 Multiply-Add Instructions 14-6 Move Instructions 14-7 Transcendental and Auxiliary Functions 14-8
Appendix A	SANE Versus PowerPC Numerics A-1
	Comparison of SANE and PowerPC Numerics A-1 Floating-Point Data Formats A-1 Conversions A-1 Expression Evaluation A-2 Infinities, NaNs, and Denormalized Numbers A-2 Arithmetic and Comparison Operations A-2 Environmental Controls A-3 Transcendental (Elementary) Functions A-3 Porting SANE to PowerPC Numerics A-3 Replacing Variables of Type comp A-4

Using MathLib Instead of the SANE Library A-4 Replacing Extended Format Variables A-5 Using MathLib Functions Differences in Transcendental Functions A-5 Differences in Class and Sign Inquiries A-6 Differences in Environmental Controls A-7 Compatibility Tools in MathLib Portable Declarations A-9 Macros A-10

Appendix B Porting Programs to PowerPC Numerics B-1

Semantics of Arithmetic Evaluation B-1
Mixed Formats B-2
Floating-Point Precision B-2
The Rules of Evaluation B-2
The Invalid Exception B-3

Appendix C MathLib Header Files C-1

C-1 Floating-Point Header File (fp.h) Constants C-1 **Inquiry Macros** C-2 Data Types C-3 **Functions** C-4 C-4 **Trigonometric Functions** C-5 Hyperbolic Functions C-5 **Exponential Functions** C-7 Power and Absolute Value Functions C-7 Gamma and Error Functions C-8 **Nearest Integer Functions** C-9 Remainder Functions **Auxiliary Functions** C-9 Maximum, Minimum, and Positive Difference Functions C-9 Internal Prototypes C-10 Non-NCEG Extensions C-10 Floating-Point Environment Header File (fenv.h) C-12 Constants C-12 Floating-Point Exception Flags C-12 **Rounding Direction Modes** Data Types C-13 **Functions** C-13 Controlling the Floating-Point Exceptions C-13 Controlling the Rounding Direction Controlling the Floating-Point Environment C-13

Appendix D	FPCE Recommendations for Compilers D-1			
	Environmental Access Switch D-1 Contraction Operator Switch D-2 Hexadecimal Floating-Point Constants D-3 Implementing an Expression Evaluation Method D-3 Expression Evaluation Without Widest Need D-4 Expression Evaluation With Widest Need D-5 Floating-Point Constant Evaluation D-5 Initializing Floating-Point Objects D-7 Compiler Extensions for Expression Evaluation D-8 Determining the Expression Evaluation Method D-8 Widening for Efficiency D-8			
Appendix E	MathLib Reference E-1			
	Floating-Point Data Formats E-1 Environmental Controls E-3 Operations and Functions E-3			
Appendix F	PowerPC Assembly-Language Numerics Reference F-1			
	Floating-Point Data Formats F-1 Floating-Point Status and Control Register F-2 Instructions F-4			
	Glossary GL-1			
	Bibliography BI-1			
	Index IN-1			