

ISO/IEC 10967-2:2001-08 (E)

Information technology - Language independent arithmetic - Part 2: Elementary numerical functions

Contents	Page
Foreword	viii
Introduction	ix
1 Scope 1 1.1 Inclusions	1
1.2 Exclusions	2
2 Conformity 2 3 Normative references 3 4 Symbols and definitions 4 4.1 Symbols	4
4.1.1 Sets and intervals	4
4.1.2 Operators and relations	4
4.1.3 Mathematical functions	5
4.1.4 Exceptional values	5
4.1.5 Datatypes	6
4.2 Definitions of terms	7
5 Specifications for integer and floating point operations 10 5.1 Basic integer operations ...	10
5.1.1 The integer result and wrap helper functions	10
5.1.2 Integer maximum and minimum	11
5.1.3 Integer diminish	11
5.1.4 Integer power and arithmetic shift	12
5.1.5 Integer square root	12
5.1.6 Divisibility tests	12
5.1.7 Integer division (with floor, round, or ceiling) and remainder	13
5.1.8 Greatest common divisor and least common positive multiple	13
5.1.9 Support operations for extended integer range	14
5.2 Basic floating point operations	15
5.2.1 The rounding and floating point result helper functions	15
5.2.2 Floating point maximum and minimum	17
5.2.3 Floating point diminish	18
5.2.4 Floor, round, and ceiling	19
5.2.5 Remainder after division with round to integer	20
5.2.6 Square root and reciprocal square root	20
5.2.7 Multiplication to higher precision floating point datatype	20
5.2.8 Support operations for extended floating point precision	21
5.3 Elementary transcendental floating point operations	22
5.3.1 Maximum error requirements	22
5.3.2 Sign requirements	23
5.3.3 Monotonicity requirements	23
5.3.4 The result helper function	23
5.3.5 Hypotenuse	24
5.3.6 Operations for exponentiations and logarithms	24
5.3.6.1 Integer power of argument base	24
5.3.6.2 Natural exponentiation	25
5.3.6.3 Natural exponentiation, minus one	26
5.3.6.4 Exponentiation of 2	27
5.3.6.5 Exponentiation of 10	27
5.3.6.6 Exponentiation of argument base	28
5.3.6.7 Exponentiation of one plus the argument base, minus one	29
5.3.6.8 Natural logarithm	29
5.3.6.9 Natural logarithm of one plus the argument	30

5.3.6.10	2-logarithm	30
5.3.6.11	10-logarithm	31
5.3.6.12	Argument base logarithm	31
5.3.6.13	Argument base logarithm of one plus each argument	32
5.3.7	Introduction to operations for trigonometric elementary functions	32
5.3.8	Operations for radian trigonometric elementary functions	33
5.3.8.1	Radian angle normalisation	34
5.3.8.2	Radian sine	35
5.3.8.3	Radian cosine	35
5.3.8.4	Radian tangent	36
5.3.8.5	Radian cotangent	36
5.3.8.6	Radian secant	37
5.3.8.7	Radian cosecant	37
5.3.8.8	Radian cosine with sine	38
5.3.8.9	Radian arc sine	38
5.3.8.10	Radian arc cosine	38
5.3.8.11	Radian arc tangent	39
5.3.8.12	Radian arc cotangent	40
5.3.8.13	Radian arc secant	41
5.3.8.14	Radian arc cosecant	41
5.3.8.15	Radian angle from Cartesian co-ordinates	42
5.3.9	Operations for trigonometrics with given angular unit	43
5.3.9.1	Argument angular-unit angle normalisation	43
5.3.9.2	Argument angular-unit sine	44
5.3.9.3	Argument angular-unit cosine	45
5.3.9.4	Argument angular-unit tangent	45
5.3.9.5	Argument angular-unit cotangent	46
5.3.9.6	Argument angular-unit secant	47
5.3.9.7	Argument angular-unit cosecant	47
5.3.9.8	Argument angular-unit cosine with sine	48
5.3.9.9	Argument angular-unit arc sine	48
5.3.9.10	Argument angular-unit arc cosine	48
5.3.9.11	Argument angular-unit arc tangent	49
5.3.9.12	Argument angular-unit arc cotangent	50
5.3.9.13	Argument angular-unit arc secant	51
5.3.9.14	Argument angular-unit arc cosecant	51
5.3.9.15	Argument angular-unit angle from Cartesian co-ordinates	52
5.3.10	Operations for angular-unit conversions	53
5.3.10.1	Converting radian angle to argument angular-unit angle	53
5.3.10.2	Converting argument angular-unit angle to radian angle	54
5.3.10.3	Converting argument angular-unit angle to (another) argument angular-unit angle	55
5.3.11	Operations for hyperbolic elementary functions	56
5.3.11.1	Hyperbolic sine	56
5.3.11.2	Hyperbolic cosine	56
5.3.11.3	Hyperbolic tangent	57
5.3.11.4	Hyperbolic cotangent	58
5.3.11.5	Hyperbolic secant	58
5.3.11.6	Hyperbolic cosecant	59
5.3.11.7	Inverse hyperbolic sine	59
5.3.11.8	Inverse hyperbolic cosine	60
5.3.11.9	Inverse hyperbolic tangent	60
5.3.11.10	Inverse hyperbolic cotangent	60
5.3.11.11	Inverse hyperbolic secant	61
5.3.11.12	Inverse hyperbolic cosecant	61
5.4	Operations for conversion between numeric datatypes	62
5.4.1	Integer to integer conversions	63
5.4.2	Floating point to integer conversions	63
5.4.3	Integer to floating point conversions	64
5.4.4	Floating point to floating point conversions	64
5.4.5	Floating point to fixed point conversions	65
5.4.6	Fixed point to floating point conversions	66
5.5	Numerals as operations in a programming language	67

5.5.1	Numerals for integer datatypes	67
5.5.2	Numerals for floating point datatypes	68
6	Notification 68 6.1 Continuation values	69
7	Relationship with language standards 69 8 Documentation requirements 70 Annex A (normative) Partial conformity 73 A.1 Maximum error relaxation	73
A.2	Extra accuracy requirements relaxation	74
A.3	Relationships to other operations relaxation	74
A.4	Very-close-to-axis angular normalisation relaxation	74
A.5	Part 1 requirements relaxation	75
	Annex B (informative) Rationale 77 B.1 Scope	77
B.1.1	Inclusions	77
B.1.2	Exclusions	78
B.2	Conformity	78
B.2.1	Validation	79
B.3	Normative references	79
B.4	Symbols and definitions	79
B.4.1	Symbols	79
B.4.1.1	Sets and intervals	79
B.4.1.2	Operators and relations	80
B.4.1.3	Mathematical functions	80
B.4.1.4	Exceptional values	80
B.4.1.5	Datatypes	81
B.4.2	Definitions of terms	81
B.5	Specifications for the numerical functions	81
B.5.1	Basic integer operations	82
B.5.1.1	The integer result and wrap helper functions	82
B.5.1.2	Integer maximum and minimum	82
B.5.1.3	Integer diminish	82
B.5.1.4	Integer power and arithmetic shift	83
B.5.1.5	Integer square root	83
B.5.1.6	Divisibility tests	83
B.5.1.7	Integer division (with floor, round, or ceiling) and remainder	83
B.5.1.8	Greatest common divisor and least common positive multiple	84
B.5.1.9	Support operations for extended integer range	84
B.5.2	Basic floating point operations	84
B.5.2.1	The rounding and floating point result helper functions	86
B.5.2.2	Floating point maximum and minimum	86
B.5.2.3	Floating point diminish	86
B.5.2.4	Floor, round, and ceiling	86
B.5.2.5	Remainder after division and round to integer	87
B.5.2.6	Square root and reciprocal square root	87
B.5.2.7	Multiplication to higher precision floating point datatype	88
B.5.2.8	Support operations for extended floating point precision	88
B.5.3	Elementary transcendental floating point operations	89
B.5.3.1	Maximum error requirements	89
B.5.3.2	Sign requirements	90
B.5.3.3	Monotonicity requirements	90
B.5.3.4	The result helper function	90
B.5.3.5	Hypotenuse	91
B.5.3.6	Operations for exponentiations and logarithms	91
B.5.3.7	Introduction to operations for trigonometric elementary functions 93 B.5.3.8 Operations for radian trigonometric elementary functions	94
B.5.3.9	Operations for trigonometrics with given angular unit	96
B.5.3.10	Operations for angular-unit conversions	97
B.5.3.11	Operations for hyperbolic elementary functions	98
B.5.4	Operations for conversion between numeric datatypes	98
B.5.5	Numerals as operations in a programming language	99

B.5.5.1	Numerals for integer datatypes	99
B.5.5.2	Numerals for floating point datatypes	99
B.6	Notification	100
B.6.1	Continuation values	100
B.7	Relationship with language standards	101
B.8	Documentation requirements	101
Annex C (informative) Example bindings for specific languages 103		104
C.1	Ada	104
C.2	BASIC	110
C.3	C	114
C.4	C++	120
C.5	Fortran	126
C.6	Haskell	132
C.7	Java	137
C.8	Common Lisp	142
C.9	ISLisp	147
C.10	Modula-2	152
C.11	Pascal and Extended Pascal	157
C.12	PL/I	162
C.13	SML	167