Document Identification	
Identifier	E1356-GTD-SRS-01
Issue	1.4
Date	2018-04-30

Software Requirements Specification- Basic Mathematical Library for Flight Software

E1356 - MLFS

Written:	Fabian Schriever	c=DE, l=Markdorf, o=GTD GmbH, cn=Fabian Schriever, email=fabian.schriever@gtd-gmbh.de 2018.07.02 14:28:48 +02'00'
Reviewed:	Andoni Arregui	c=DE, l=Markdorf, o=GTD GmbH, cn=Andoni Arregui, email=andoni.arregui@gtd-gmbh.de 2018.07.02 16:26:06 +02'00'
Approved:	Andoni Arregui	c=DE, l=Markdorf, o=GTD GmbH, cn=Andoni Arregui, email=andoni.arregui@gtd-gmbh.de 2018.07.02 16:26:21 +02'00'
Authorized:		

GTD GmbH
Ravensburger Straße 30a
88677 Markdorf

☎ +49 (0) 7544 96440-0
+49 (0) 7544 96440-29

gtd@gtd-gmbh.de
http://www.gtd-gmbh.de

This work has been executed under ESA Contract No. 4000117691/16/NL/FE.

Contents

List of Figures

List of Tables

Revisions

Revision	Description	Date
1.0	First issue	2016-09-21
1.1	Implement changes from RR RIDs' AIs: • AJ-42_01 : Add ESA copyright to footers and ESA copyright notice above list of content. • AJ-43_01 : Add content to the Software Overview section's subsections. • AJ-44_01 : Insert 'floating-point remainder' in REQ-BL-0050. • AJ-45_01 : Add reference to RD03 to REQ-BL-0050. • AJ-46_01 : No more doubly assigned requirement numbers exist (see other AIs). • AJ-47_01, AJ-48_01 : Requirement REQ-BL-0202 removed, see AJ-55_01. • AJ-49_01 : Add referral to IEEE 754 to section 3.1 (Definitions). • AJ-50_01 : Delete requirement REQ-BL-0231. • AJ-51_01, AJ-53_01, AJ-77_01, AJ-82_01, AJ-103_01, AJ-136_01 : Remove remarks and requirements regarding errors: – Delete remark in REQ-BL-0240, -0280, -0330, -0460, -0490, -0550, -0710, -0740, -0860, -0864, -0910, -0920, -0960, -0970, -1121, -1122. – Delete requirement REQ-BL-0664, -0687. – Add new requirement REQ-BL-0022. • AJ-52_01 : Delete remark in REQ-BL-0251. • AJ-54_01 : Delete requirement REQ-BL-0290, REQ-BL-0291. • AJ-55_01 : Delete requirement REQ-BL-0201, -0202, -0301, -0302, -0501, -0502, -0601 as they were solely design related. • AJ-57_01 : Delete remark in REQ-BL-0203. • AJ-58_01 : Delete requirement REQ-BL-0320. • AJ-59_01 : Delete requirement REQ-BL-0481. • AJ-60_01 : Requirement in question removed, see AJ-55_01. • AJ-62_01 : Delete remark in REQ-BL-0503. • AJ-63_01 : Describe return value in REQ-BL-1300. • AJ-64_01 : Describe return value in REQ-BL-1320. • AJ-65_01 : Describe return value in REQ-BL-1340. • AJ-66_01 : Describe return value in REQ-BL-1360. • AJ-67_01 : Add requirement REQ-BL-1381. • AJ-68_01 : Add requirements REQ-BL-0061 and -0062, and modify requirement REQ-BL-0060 regarding execution time of procedures. • AJ-69_01 : Add Ada83, Ada95 to REQ-BL-0120.	2016-10-31

- AJ-71_01 : Add requirement REQ-BL-0021. Add reference to the requirement from 5.4.
- AJ-72_01 : Delete requirement REQ-BL-0190.
- AJ-73_01 : Remove Annex A.
- AJ-75_01 : Remove remark in REQ-BL-0602.
- AJ-76_01 : Delete remark in REQ-BL-0652.
- AJ-78_01 : Change 'the' to 'any' in REQ-BL-0670.
- AJ-79_01 : See AJ-89_01.
- AJ-80_01 : Change '> 0' to 'not 0' REQ-BL-0682 and REQ-BL-0683. Change -Inf to +Inf in REQ-BL-0683.
- AJ-81_01 : Change -Inf to +Inf in REQ-BL-0686.
- AJ-83_01, ODM-10_01 : Change -Inf to +Inf in REQ-BL-0730.
- AJ-84_01, AJ-85_01 : Remove remarks on implementation/design (except range reduction procedure where it is needed).
- AJ-86_01 : Delete requirement REQ-BL-0801.
- AJ-87_01 : Delete requirement REQ-BL-0836.
- AJ-88_01 : Add bulletpoints to REQ-BL-0864 for better readability.
- AJ-89_01 : Add tables to show special cases to all procedure sections.
- AJ-90_01 : Add bulletpoints to REQ-BL-0870 for better readability.
- AJ-92_01 : Delete REQ-BL-0901, REQ-BL-0902.
- AJ-93_01 : Change -Inf to +Inf in REQ-BL-0931.
- AJ-94_01 : Remove remark in REQ-BL-0950.
- AJ-95_01 : Change -Inf to +Inf in REQ-0981.
- AJ-97_01 : Fix formula for round procedure.
- AJ-98_01 : Add ', rounding halfway cases away from zero' to REQ-BL-1020.
- AJ-100_01 : Update text of REQ-BL-1120 to explicitly state the case that both arguments are NaN.
- AJ-101_01 : Change Infinite to ±Inf REQ-BL-1122.
- AJ-102_01 : Change Infinite to ±Inf REQ-BL-1131.
- AJ-104_01 : REQ-BL-1133 was deleted (see below), no consistency check necessary.
- AJ-105_01 : Add REQ-BL-1201.
- AJ-108_01 : Add requirement REQ-BL-1232 to handle one argument being -0 and the other +0.
- AJ-109_01 : Add requirement REQ-BL-1252 to handle one argument being -0 and the other +0.
- AJ-110_01 : Delete remark in REQ-BL-1260.
- AJ-114_01 : Add requirements REQ-BL-1900, -1901, -1902.
- AJ-115_01, AJ-130_01, ODM-04_01 : Add traceability to E1356-GTD-TR-01 to all but one requirement (REQ-BL-1902).

- AJ-116_01 :
  - Change verification method to ‘T’, REQ-BL-0300, -0450, -0500, -0600, -0650, -0700, -0800, -0850, -0900, -0950, -1000, -1020, -1040, -1060, -1080, -1100, -1200, -1220, -1240, -1260, -1300, -1320, -1340, -1360, -1380, -0060, -0020.
  - Change verification method to ‘R’, REQ-BL-0090, -0100, -0303, -0451, -0503, -0602, -0652, -0802, -0851.
  - Change verification method to ‘A’, REQ-BL-0110.
- DE-06_02 : Add requirements REQ-BL-1500, -1501.
- MP-04_01 : Add remarks to requirements REQ-BL-1100 and REQ-BL-1200.
- MP-10_01 : Specify in REQ-BL-0080 that BL shall be compatible to code generated with Simulink Coder.
- ODM-01_01 : Add content to section on environmental considerations.
- ODM-03_01 : All requirements are now traced to the technical report E1356-GTD-TR-01 (see AJ-115_01).
- ODM-13_01 : Correct typo in REQ-BL-1250.
- OK-01_01 :
  - Remove polynomial order from requirements REQ-BL-0203, -0303, -0503, -0602, -0802.
  - Remove specific calculation from requirements REQ-BL-0451, -0600.

Delete the following requirements regarding subnormal numbers: REQ-BL-0230, -0540, -0622, -1272. Instead add the more general requirements REQ-BL-0023 and -0024.
Delete the following requirements regarding under- and overflow: REQ-BL-0510, -0570, -0580, -0671, -0810, -0820, -0830, -0835, -0861, -0862, -0863, -0884, -1033, -1034, -1053, -1054, -1093, -1094, -1110, -1132, -1133.
Add requirements REQ-BL-0885 and -0886 to cover missing special cases of the pow/powf procedure.
Add TBDs to fill until RR/DDR where needed.
Replace HUGE_VAL with Inf where possible and remove now duplicate requirements: REQ-BL-0865, -0911, -0961.
Add new requirements to previously empty requirement sections: REQ-BL-1502, -1503, -1504, -1600, -1800, -2000.
Add ’Not applicable.’ to empty sections without requirements.
Add reference to validation methods and 5.1 to 6, add table containing a list of all requirements’ validation methods.
Add reference to traces and 5.1 to 7.
Add requirements REQ-BL-1400 regarding the unit of angles.
Add requirements REQ-BL-1420 to -1422 for new procedure deg2rad/deg2radf.
Modify requirements REQ-BL-0150 to -0152 and add -0153 to be for a wrapper procedure instead of the internal functionality. Additionally add a special cases table.

	Add requirement REQ-BL-0052 to refer to additional procedures. Modify requirement REQ-BL-0051 to list the constants provided to the outside. Replace PI with π throughout the document. Add content to the Logical Model Description section. Add requirement REQ-BL-0181 regarding memory consumption. Add requirement REQ-BL-0025 regarding compilation with GCC and Binutils, -0026 for compatibility to RTEMS OS, -0027 to not use FPU built-ins, and -0028 to not rely on FMA algorithm optimization. Add requirements REQ-BL-0111, -0112 regarding design.	
1.2	Implement peer review items from revision 1.1: • Modify requirements REQ-BL-0250, -0450, -0600, -0650 to more specifically refer to output ranges. • Change -Inf to +Inf in REQ-BL-0876 and -0877. • Remove double 'shall' in REQ-BL-0181. • Change verification method to 'D', REQ-BL-0080, -0120, -0130, -0131. Fix the special cases table for pow which still had a TBD for RR for REQ-BL-0864. Add requirement REQ-BL-0070 to define numerical accuracy. Add section and subsection to trace to SoW from REQ-BL-1902. Add missing traces to RID AIs to revision 1.1: AJ-42_01, ODM-01_01, ODM-03_01. Implement missing AI MP-09_01 by adding remarks with an example to REQ-BL-1100 and -1200. Implement missing AI MP-10_02 by adding a remark to REQ-BL-0080.	2016-11-15
1.3	Implement changes from RR RIDs' AIs that were missed or not complete in 1.2: • AJ-49_01 : Add referral to IEEE 754 to section 3.1 (Definitions). • AJ-54_01 : Add end markers to all requirements in the form of: □ • AJ-66_01 : Remove remark from requirement REQ-BL-1360. • AJ-67_01 : Add remark to requirement REQ-BL-1380. • AJ-108_01 : Add remark to requirement REQ-BL-1220. • AJ-109_01 : Add remark to requirement REQ-BL-1240. Correct behaviour for fmax/fmaxf and fmin/fminf with double zero input in requirements REQ-BL-1232 and -1252. Extend the description of requirements in §5.1 to include remarks, end markers, and special case tables. Remove all deleted requirements. Rephrase requirement REQ-BL-0150. Correct requirements REQ-BL-0879 and -0881 which had only regarded even integers, and correct the special cases table for pow/powf with regards to requirements REQ-BL-0864, -0886, -0879 and -0881. Correct requirement REQ-BL-0070, it listed a maximum of 2 ULPs.	2017-09-27

	Remove requirements REQ-BL-0023 and -0024 which stated the library would behave in a DAZ and FTZ way at all times. Add requirements REQ-BL-0029 instead. Correct requirement number of REQ-BL-1280 to REQ-BL-0980. Correct requirement REQ-BL-0874, REQ-BL-0877 and REQ-BL-0881 to return `+Inf`, clarify REQ-BL-0864 to "`x` is ± 0"	
1.4	Implement changes from DDR RIDs' AIs: • AJ-09_01 : Add description of validation methods in §5.1. Adjust validation methods of requirements REQ-BL-0010, -0020, -0027, -0028, -0051, -0060, -0062, -0090, -0100, -0110, -0181, and -1501. Remove mention of Ada and Mathlab from requirement REQ-BL-1900, as well as update sections §4.3 and §8.	2018-04-30

1 Introduction

This document is the Software Requirements Specification (SRS) for the development of a basic mathematical library for Flight Software.

The software requirements specification is a major constituent of the Technical Specification (TS). It describes the functional and non functional requirements applicable to the software item.

2 Applicable and Reference Documents

2.1 Applicable Documents

The documents listed below form part of this document. In case no issue number is specified for a document, the latest issue shall be applicable.

Ref.	Identification	Issue	Title
AD01	TEC-SWE/15-831	1.0	SoW Pre-qualification of a Mathematical Library for Flight Software

2.2 Reference Documents

The documents listed below were used to prepare this document and contain background information on topics discussed in this document.

Ref.	Identification	Issue	Title
RD01	ISO 60559 – IEEE 754-2008	2011	Information technology – Microprocessor Systems – Floating-Point arithmetic
RD02	IEEE Std 1003.1	2008	Standard for Information Technology - Portable Operating System Interface (POSIX®)
RD03	ISO/IEC 9899	2011	Programming languages – C
RD04	SPARC	Version 8	The SPARC Architecture Manual
RD05	ECSS-Q-HB-80-04	A	Space Product Assurance – Software metrication programme definition and implementation
RD06	MISRA C:2012	March 2013	Guidelines for the use of C language in critical systems
RD07	E1356-GTD-TR-01	2.1	Numerical Computing for Spacecraft Systems – Deriving Requirements, Guidelines and Best Practices
RD08	ECSS-E-ST-40	C	Space Engineering - Software

3 Terms, Definitions, and Abbreviated Terms

Agency	refers to European Space Agency
AOCS	Attitude and Orbit Control System
BL	Basic mathematical Library
DAZ	Denormals are Zero
ECSS	European Cooperation for Space Standardization
ESA	European Space Agency
FES	Functional Engineering Simulator
FMA	Fused Multiply-Add
FPU	Floating Point Unit
FSW	Flight Software
FTZ	Flush to Zero
GCC	GNU C Compiler
GNC	Guidance Navigation and Control
MLFS	Mathematical Library for Flight Software
NaN	Not a Number
OBSW	On-Board Software
OS	Operating System
RTEMS	Real-Time Executive for Multiprocessor Systems
S/C	Spacecraft
SDD	Software Design Document
SoW	Statement of Work
SRS	Software Requirements Specification
subnormal	See IEEE-754 standard for the definition.
SUM	Software User Manual
SVF	Software Validation Facility

SVS	Software Validation Specification
TS	Technical Specification
ULP	Unit in the Last Place
WCET	Worst Case Execution Time

4 Software Overview

4.1 Function and Purpose

Mathematical libraries are necessary for the development of Spacecraft (S/C) systems; they are incorporated into the S/C Guidance Navigation and Control (GNC) systems and are used during the whole Flight Software (FSW) production cycle for simulation purposes (e.g. Attitude and Orbit Control System (AOCS) algorithm simulations and S/C equipment simulators). They are also necessary for scientific payload data processing.

Mathematical libraries like the `libm` present in the `Newlib` library are widely used for FSW production but none has been pre-qualified in conformance with European Cooperation for Space Standardization (ECSS) standards.

The re-engineering of such a library in conformance with the ECSS standards and the generation of pre-qualification evidence and a corresponding test-suite will provide an additional *building block* for future FSW production. We will call it Mathematical Library for Flight Software (MLFS).

4.2 Environmental Considerations

The Basic mathematical Library (BL) shall run on x86-64 and SPARC V8 processor architectures and compiled by GNU C Compiler (GCC). For example it shall be usable with the Real-Time Executive for Multiprocessor Systems (RTEMS) Operating System (OS) as well as current Linux and Windows distributions.

4.3 Relation to Other Systems

S/C On-Board Software (OBSW) is often implemented using the C and Ada programming languages, therefore it needs to be possible to link the BL to either. This creates the need to provide an Ada wrapper as the intention is to implement the BL itself in C.

The BL should also be usable by GNC and AOCS development environments which often feature usage of Matlab and Simulink. To provide the BL to Matlab a set of best practices will be defined to create the corresponding C-MEX and S-functions to use the BL from within Matlab and Simulink.

In Software Validation Facility (SVF) and Functional Engineering Simulator (FES) systems where the BL will also be used, the same considerations as for S/C OBSW apply.

4.4 Constraints

The proposed BL development is bound to Newlib's `libm`, meaning the BL shall try to stay as close as possible to the original `libm` while still implementing the changes necessary to comply to

this document's requirements. This close attachment to Newlib's `libm` is justified by the `libm`'s heritage for being widely used in the European space industry.

5 Requirements

5.1 General

The requirements defined in this SRS have the following associated meta-data:

- Requirement identifier: Unique identifier in the form of **REQ-BL-NNNN** where:
  - REQ stands for "Requirement",
  - BL stands for "Basic mathematical Library", and
  - NNNN represents a four digit unique number.
- Requirement justification or rationale: Trace to the reason for the existence of the requirement. This is usually one or multiple requirements from the E1356-GTD-TR-01 [RD07] , or the Statement of Work (SoW).
- Requirement validation method: T (Test), A (Analysis), I (Inspection), D (Demonstration), R (Review of design).
- A requirement may contain one or multiple remarks that are non normative. Remarks begin with *Remark:*
- All requirements end with the following marker: □
- The special cases table never belong to a single requirement but to the procedure as a whole, they are meant to better visualize all special cases of the procedure and are non normative.

In addition to the definitions and abbreviations defined in §3, this SRS follows these conventions:

- Not a Number (NaN) floating-point datums are represented with: `NaN`
- Infinite floating-point numbers are represented with: `Inf`
- Numeric values are represented in normal font: e.g. +1.0
- Mathematical expressions and constants are represented in cursive[1]: e.g. $x < 0$, π, e, &c.
- Programming language related elements are represented in typewriter font: e.g. `double sin(double x)`

[1]This statement is not exactly true. Mathematical expressions are represented in a combination of cursive and normal font; for example the arccosine function is represented as "$\arccos x$", where the $\arccos$ function name is represented in normal font and the x function argument in cursive.

- Constants defined in a programming language are represented in typewriter font: e.g. `M_PI`, `M_E`, `FLT_MAX`, &c.
- Literal numeric values in a programming language are represented in typewriter font: e.g. `1.0f`

Thus, this SRS will define requirements for *procedures* like `sin(x)` that evaluates the mathematical *function* $\sin x$, and the mathematical transcendental constant π, which cannot be represented accurately in this text, is approximated in programming languages like C with constants such as `M_PI` (which have a finite precision value assigned like `3.14159265358979323846`).

Regarding the validation methods of the requirements we define them as follows:

- **T**est - Validated via Software Validation Specification (SVS) testing,
- **A**nalysis - Validated via manual analysis effort.
- **I**nspection - Validated via source code inspection.
- **D**emonstration - Validated via one-time display of an example execution.
- **R**eview of design - Validated via review of the Software Design Document (SDD).

5.2 Functional Requirements

This SRS describes the capabilities to be provided by the basic mathematical library.

REQ-BL-0050//GTD-TR-01-BL-0015/R

The Basic Library shall implement the following procedures of the ISO C99 standard [RD03] :

function	description
`sin`	Procedure returning the trigonometric sine
`asin`	Procedure returning the trigonometric arcsine
`cos`	Procedure returning the trigonometric cosine
`acos`	Procedure returning the trigonometric arccosine
`tan`	Procedure returning the trigonometric tangent
`atan`	Procedure returning the trigonometric arctangent
`sqrt`	Procedure returning the square root
`atan2`	Procedure returning the trigonometric arctangent of y/x
`exp`	Procedure returning the base `E` exponential of `x`
`pow`	Procedure returning `x` raised to the power of `y`
`log`	Procedure returning the natural logarithm
`log10`	Procedure returning the base 10 logarithm
`fabs`	Procedure returning the absolute value

function	description
`round`	Procedure for rounding to the nearest integer (Halfway values rounded away from 0)
`floor`	Procedure for rounding downwards to the nearest integer
`trunc`	Procedure for rounding towards 0 to the nearest integer
`ceil`	Procedure for rounding upwards to the nearest integer
`fmod`	Procedure returning the floating-point remainder of x/y
`modf`	Procedure breaking x in its integral and fractional part
`fmin`	Procedure returning the smaller of two values
`fmax`	Procedure returning the larger of two values
`hypot`	Procedure returning the square root of $x^2 + y^2$
`isfinite`	Procedure returning whether the value of the argument is finite or not (not ±`Inf` and not NaN)
`isinf`	Procedure returning whether the value of the argument is positive or negative Infinity or not
`isnan`	Procedure returning whether the argument is a not-a-number (NaN) floating-point value or not
`signbit`	Procedure returning whether the argument is negative or not
`copysign`	Procedure returning a floating-point number with the magnitude of x and the sign of y

Remark: The description of these procedures are not to be understood as the requirements and specification of the procedures but as a description for identification purposes. For the exact specification of the procedure refer to the ISO C99 standard. □

REQ-BL-0052//GTD-TR-01-BL-0019, GTD-TR-01-BL-0020/R

The Basic Library shall implement the following additional procedures:

function	description
`deg2rad`	Procedure returning the radians value of a provided degree value
`rem2pi`	Procedure returning the provided value reduced to the range $[+0, 2\pi]$

Remark: The description of these procedures are not to be understood as the requirements and specification of the procedures but as a description for identification purposes. □

REQ-BL-0040//GTD-TR-01-BL-0017/T

The Basic Library shall provide procedures for 32 bit (binary32) and 64 bit (binary64) precision floating-point datums.

Remark: This refers to the ISO C99 procedures with 32 bit floating-point arguments and return values and the procedures with 64 bit floating-point arguments and return values (e.g. `float sinf(float x)` and `double sin(double x)`). □

REQ-BL-0051//GTD-TR-01-BL-0018/I

The Basic Library shall provide the following constants:

Name	description
`M_E`	Value of e
`M_LOG2E`	Value of $log_{10}e$
`M_LOG10E`	Value of log_2e
`M_LN2`	Value of log_e2
`M_LN10`	Value of log_e10
`M_PI`	Value of π
`M_PI_2`	Value of $\frac{\pi}{2}$
`M_PI_4`	Value of $\frac{\pi}{4}$
`M_1_PI`	Value of $\frac{1}{\pi}$
`M_2_PI`	Value of $\frac{2}{\pi}$
`M_2_SQRTPI`	Value of $\frac{2}{\sqrt{\pi}}$
`M_SQRT2`	Value of $\sqrt{2}$
`M_SQRT1_2`	Value of $\sqrt{\frac{1}{2}}$

Name	description
`HUGE_VAL`	Value of `+Inf` (double)
`HUGE_VALF`	Value of `+Inf` (float)
`INFINITY`	Value of `+Inf`
`NAN`	Value of `NaN`
`MAXFLOAT`	Synonym of `FLT_MAX`

Remark: Both `INFINITY` and `NAN` expand to floats or doubles depending on the context. □

REQ-BL-1400//GTD-TR-01-BL-0016/R

The Basic Library shall consider all arguments and return values that represent an angle to be in radians unless otherwise specified. □

5.2.1 Angle Degree to Radians Conversion

REQ-BL-1420//GTD-TR-01-BL-0019/T

The `deg2rad` and `deg2radf` procedures shall return the radians value equal to the argument `x` given in degrees. □

REQ-BL-1421//GTD-TR-01-BL-0019/T

The `deg2rad` and `deg2radf` procedures shall return `NaN` if the argument is `NaN`. □

REQ-BL-1422//GTD-TR-01-BL-0019/T

The `deg2rad` and `deg2radf` procedures shall return the value of the argument if the argument is `±0` or `±Inf`. □

X	Result	Requirement
±0	X	REQ-BL-1422
±Inf	X	REQ-BL-1422
NaN	NaN	REQ-BL-1421

Table 5.5: Special cases for deg2rad(X)

5.2.2 Angle Range Reduction

REQ-BL-0150//GTD-TR-01-BL-0020/T

The `rem2pi` and `rem2pif` procedures shall return the positive remainder of the argument `x` n-times divided by the value 2π such that:

$$+0 \leq x - n * 2\pi \leq 2\pi$$

Remark: The target range is $[+0, +2\pi]$. n can be a positive or negative integer. □

REQ-BL-0151//GTD-TR-01-BL-0020/T

The `rem2pi` and `rem2pif` procedures shall return `NaN` if the argument is `NaN`. □

REQ-BL-0152//GTD-TR-01-BL-0020/T

The `rem2pi` and `rem2pif` procedures shall return the value of the argument if the argument is `±0`. □

REQ-BL-0153//GTD-TR-01-BL-0020/T

The `rem2pi` and `rem2pif` procedures shall return `NaN` if the argument is `±Inf`. □

X	Result	Requirement
±0	X	REQ-BL-0152
±Inf	NaN	REQ-BL-0153
NaN	NaN	REQ-BL-0151

Table 5.6: Special cases for rem2pi(X)

5.2.3 SIN ($\sin x$)

REQ-BL-0200//GTD-TR-01-BL-0015/T

The `sin` and `sinf` procedures shall evaluate the `sine` of their argument `x` in radians. □

REQ-BL-0203//GTD-TR-01-BL-0015/R

The `sin` and `sinf` procedures shall use a minimax polynomial for the calculation. □

REQ-BL-0210//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `sin` and `sinf` procedures shall return NaN if the argument is NaN. □

REQ-BL-0220//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `sin` and `sinf` procedures shall return the value of the argument if the argument is ±0. □

REQ-BL-0240//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `sin` and `sinf` procedures shall return NaN if `x` is ±`Inf`. □

X	Result	Requirement
±0	X	REQ-BL-0220
±Inf	NaN	REQ-BL-0240
NaN	NaN	REQ-BL-0210

Table 5.7: Special cases for sin(X)

5.2.4 ASIN ($\arcsin x$)

REQ-BL-0250//GTD-TR-01-BL-0015/T

The `asin` and `asinf` procedures shall evaluate the arcsine of their argument `x` in the output range $[-\frac{\pi}{2}, \frac{\pi}{2}]$ radians. □

REQ-BL-0251//GTD-TR-01-BL-0015/R

The `asin` and `asinf` procedures shall use a rational approximation for the calculation. □

REQ-BL-0260//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `asin` and `asinf` procedures shall return `NaN` if the argument is `NaN`. ☐

REQ-BL-0270//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `asin` and `asinf` procedures shall return the value of the argument if the argument is ±0. ☐

REQ-BL-0280//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `asin` and `asinf` procedures shall return `NaN` if the argument is ±`Inf`. ☐

REQ-BL-0281//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `asin` and `asinf` procedures shall return `NaN` if the argument is not in the range [-1, 1]. ☐

X	Result	Requirement
±0	X	REQ-BL-0270
∉[-1, 1]	NaN	REQ-BL-0281
±Inf	NaN	REQ-BL-0250
NaN	NaN	REQ-BL-0260

Table 5.8: Special cases for asin(X)

5.2.5 COS ($\cos x$)

REQ-BL-0300//GTD-TR-01-BL-0015/T

The `cos` and `cosf` procedures shall evaluate the `cosine` of their argument `x` in radians. ☐

REQ-BL-0303//GTD-TR-01-BL-0015/R

The `cos` and `cosf` procedures shall use a minimax polynomial for the calculation. ☐

REQ-BL-0310//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `cos` and `cosf` procedures shall return `NaN` if the argument is `NaN`. ☐

REQ-BL-0320//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `cos` and `cosf` procedures shall return `1.0` if the argument is ±0. ☐

REQ-BL-0330//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `cos` and `cosf` procedures shall return `NaN`, if the argument is ±`Inf`. ☐

X	Result	Requirement
±0	1.0	REQ-BL-0320
±Inf	NaN	REQ-BL-0330
NaN	NaN	REQ-BL-0310

Table 5.9: Special cases for cos(X)

5.2.6 ACOS ($\arccos x$)

REQ-BL-0450//GTD-TR-01-BL-0015/T

The `acos` and `acosf` procedures shall evaluate the principal value of the arccosine of their argument `x` in the output range [0,π] radians. □

REQ-BL-0451//GTD-TR-01-BL-0015/R

The `acos` and `acosf` procedures shall use a rational approximation for the calculation. □

REQ-BL-0460//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `acos` and `acosf` procedures shall return `NaN`, if the argument `x` is not in the range [-1,1]. □

REQ-BL-0470//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `acos` and `acosf` procedures shall return `NaN` if the argument is `NaN`. □

REQ-BL-0480//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `acos` and `acosf` procedures shall return `+0` if the argument is `+1`. □

REQ-BL-0490//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `acos` and `acosf` procedures shall return `NaN` if the argument `x` is `±Inf`. □

X	Result	Requirement
+1	+0	REQ-BL-0480
$\notin$[-1, 1]	NaN	REQ-BL-0460
±Inf	NaN	REQ-BL-0490
NaN	NaN	REQ-BL-0470

Table 5.10: Special cases for acos(X)

5.2.7 TAN ($\tan x$)

REQ-BL-0500//GTD-TR-01-BL-0015/T

The `tan` and `tanf` procedures shall evaluate the tangent of their argument x in radians. ☐

REQ-BL-0503//GTD-TR-01-BL-0015/R

The `tan` and `tanf` procedures shall use a minimax polynomial for the calculation. ☐

REQ-BL-0520//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `tan` and `tanf` procedures shall return NaN if the argument is NaN. ☐

REQ-BL-0530//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `tan` and `tanf` procedures shall return the value of the argument if the argument is ±0. ☐

REQ-BL-0550//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `tan` and `tanf` procedures shall return NaN, if the argument is ±`Inf`. ☐

X	Result	Requirement
±0	X	REQ-BL-0530
±Inf	NaN	REQ-BL-0550
NaN	NaN	REQ-BL-0520

Table 5.11: Special cases for tan(X)

5.2.8 ATAN ($\arctan x$)

REQ-BL-0600//GTD-TR-01-BL-0015/T

The `atan` and `atanf` procedures shall calculate the arctangent of their argument x in the output range $[-\frac{\pi}{2},\frac{\pi}{2}]$ radians. ☐

REQ-BL-0602//GTD-TR-01-BL-0015/R

The `atan` and `atanf` procedures shall use a minimax polynomial for the calculation. ☐

REQ-BL-0610//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan` and `atanf` procedures shall return NaN if the argument is NaN. ☐

REQ-BL-0620//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan` and `atanf` procedures shall return the argument if the argument is ±0. ☐

REQ-BL-0621//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan` and `atanf` procedures shall return $\pm\frac{\pi}{2}$ if the argument is `±Inf`. □

X	Result	Requirement
±0	X	REQ-BL-0620
-Inf	$-\frac{\pi}{2}$	REQ-BL-0621
+Inf	$+\frac{\pi}{2}$	REQ-BL-0621
NaN	NaN	REQ-BL-0610

Table 5.12: Special cases for atan(X)

5.2.9 ATAN2 ($\arctan y/x$)

REQ-BL-0650//GTD-TR-01-BL-0015/T

The `atan2` and `atan2f` procedures shall calculate the arctangent of the division y/x of their arguments x and y in the output range [-π,π] radians. □

REQ-BL-0652//GTD-TR-01-BL-0015/R

The `atan2` and `atan2f` procedures shall use `atan` and `atanf` procedures. □

REQ-BL-0660//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan2` and `atan2f` procedures shall return ±π, if the argument y is ±0 and the argument $x < 0$. □

REQ-BL-0661//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan2` and `atan2f` procedures shall return ±0, if the argument y is ±0 and the argument $x > 0$. □

REQ-BL-0662//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan2` and `atan2f` procedures shall return -$\frac{\pi}{2}$, if the argument y is < 0 and the argument x is ±0. □

REQ-BL-0663//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan2` and `atan2f` procedures shall return $\frac{\pi}{2}$, if the argument y is > 0 and the argument x is ± 0. □

REQ-BL-0670//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan2` and `atan2f` procedures shall return NaN if any argument is NaN. □

REQ-BL-0680//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan2` and `atan2f` procedures shall return $\pm\pi$, if the argument y is ± 0 and the argument x is -0. □

REQ-BL-0681//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan2` and `atan2f` procedures shall return ± 0, if the argument y is ± 0 and the argument x is +0. □

REQ-BL-0682//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan2` and `atan2f` procedures shall return $\pm\pi$, if the argument $\pm$y is finite and not 0, and the argument x is `-Inf`. □

REQ-BL-0683//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan2` and `atan2f` procedures shall return ± 0, if the argument $\pm$y is finite and not 0, and the argument x is `+Inf`. □

REQ-BL-0684//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan2` and `atan2f` procedures shall return $\pm\frac{\pi}{2}$, if the argument y is $\pm$`Inf` and the argument x has a finite value. □

REQ-BL-0685//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan2` and `atan2f` procedures shall return $\pm\frac{3\pi}{4}$, if the argument y is $\pm$`Inf` and the argument x is `-Inf`. □

REQ-BL-0686//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `atan2` and `atan2f` procedures shall return $\pm\frac{\pi}{4}$, if the argument y is $\pm$`Inf` and the argument x is `+Inf`. □

X	Y	Result	Requirement
<0	-0	$-\pi$	REQ-BL-0660
<0	+0	$+\pi$	REQ-BL-0660
-0	-0	$-\pi$	REQ-BL-0680
-0	+0	$+\pi$	REQ-BL-0680
±0	<0	$-\frac{\pi}{2}$	REQ-BL-0662
±0	>0	$+\frac{\pi}{2}$	REQ-BL-0663
+0	-0	-0	REQ-BL-0681
+0	+0	+0	REQ-BL-0681
>0	-0	-0	REQ-BL-0661

X	Y	Result	Requirement
>0	+0	+0	REQ-BL-0661
-Inf	<0 $\wedge \neq$ -Inf	-π	REQ-BL-0682
-Inf	>0 $\wedge \neq$ +Inf	+π	REQ-BL-0682
+Inf	<0 $\wedge \neq$ -Inf	-0	REQ-BL-0683
+Inf	>0 $\wedge \neq$ +Inf	+0	REQ-BL-0683
$\neq$ ±Inf	-Inf	-$\frac{\pi}{2}$	REQ-BL-0684
$\neq$ ±Inf	+Inf	+$\frac{\pi}{2}$	REQ-BL-0684
-Inf	-Inf	-$\frac{3\pi}{4}$	REQ-BL-0685
-Inf	+Inf	+$\frac{3\pi}{4}$	REQ-BL-0685
+Inf	-Inf	-$\frac{\pi}{4}$	REQ-BL-0686
+Inf	+Inf	+$\frac{\pi}{4}$	REQ-BL-0686
NaN	Any	NaN	REQ-BL-0670
Any	NaN	NaN	REQ-BL-0670

Table 5.13: Special cases for atan2(Y, X)

5.2.10 SQRT ($\sqrt{x}$)

REQ-BL-0700//GTD-TR-01-BL-0015/T

The `sqrt` and `sqrtf` procedures shall calculate the square root of their argument x. □

REQ-BL-0710//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `sqrt` and `sqrtf` procedures shall return NaN, if the argument x < -0. □

REQ-BL-0720//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `sqrt` and `sqrtf` procedures shall return NaN if the argument x is NaN. □

REQ-BL-0730//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `sqrt` and `sqrtf` procedures shall return the argument if the argument x is ±0 or `+Inf`. □

REQ-BL-0740//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `sqrt` and `sqrtf` procedures shall return NaN, if the argument x is `-Inf`. □

X	Result	Requirement
<-0	NaN	REQ-BL-0710
±0	X	REQ-BL-0730
-Inf	NaN	REQ-BL-0740

X	Result	Requirement
+Inf	+Inf	REQ-BL-0730
NaN	NaN	REQ-BL-0720

Table 5.14: Special cases for sqrt(X)

5.2.11 EXP (e^x)

REQ-BL-0800//GTD-TR-01-BL-0015/T

The `exp` and `expf` procedures shall calculate the base e exponential value of their argument `x`. □

REQ-BL-0802//GTD-TR-01-BL-0015/R

The `exp` and `expf` procedures shall use a minimax polynomial for the calculation. □

REQ-BL-0831//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `exp` and `expf` procedures shall return `NaN` if the argument `x` is `NaN`. □

REQ-BL-0832//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `exp` and `expf` procedures shall return 1 if the argument `x` is ±0. □

REQ-BL-0833//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `exp` and `expf` procedures shall return +0 if the argument `x` is `-Inf`. □

REQ-BL-0834//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `exp` and `expf` procedures shall return the argument if the argument `x` is `+Inf`. □

X	Result	Requirement
±0	+1	REQ-BL-0832
-Inf	+0	REQ-BL-0833
+Inf	+Inf	REQ-BL-0834
NaN	NaN	REQ-BL-0831

Table 5.15: Special cases for exp(X)

5.2.12 POW (x^y)

REQ-BL-0850//GTD-TR-01-BL-0015/T

The pow and powf procedures shall calculate the value of their argument x raised to the power of y. □

REQ-BL-0851//GTD-TR-01-BL-0015/R

The pow and powf procedures shall use a binary logarithm for the calculation. □

REQ-BL-0860//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The pow and powf procedures shall return NaN if the argument x is < 0 and finite, and the argument y is a finite, non-integer value. □

REQ-BL-0864//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The pow and powf procedures shall return
- ±Inf respectively if y is an odd integer, or
- +Inf if y is not an odd integer

if the argument y is < 0 and x is ±0. □

REQ-BL-0870//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The pow and powf procedures shall return NaN if
- the argument y is NaN and x is not 1, or
- the argument x is NaN and y is not ±0. □

REQ-BL-0885//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The pow and powf procedures shall return ±0 respectively, if the argument x is ±0 and the argument y is an odd integer > 0. □

REQ-BL-0886//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The pow and powf procedures shall return +0, if the argument x is ±0 and the argument y is > 0 and not an odd integer. □

REQ-BL-0871//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The pow and powf procedures shall return 1.0 if the argument x is +1. □

REQ-BL-0872//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The pow and powf procedures shall return 1.0 if the argument y is ±0. □

REQ-BL-0873//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `pow` and `powf` procedures shall return `1.0` if the argument `x` is `-1`, and the argument `y` is `±Inf`. □

REQ-BL-0874//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `pow` and `powf` procedures shall return `+Inf` if $|x| < 1$ and the argument `y` is `-Inf`. □

REQ-BL-0875//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `pow` and `powf` procedures shall return `+0`, if $|x| > 1$ and the argument `y` is `-Inf`. □

REQ-BL-0876//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `pow` and `powf` procedures shall return `+0`, if $|x| < 1$ and the argument `y` is `+Inf`. □

REQ-BL-0877//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `pow` and `powf` procedures shall return `+Inf`, if $|x| > 1$ and the argument `y` is `+Inf`. □

REQ-BL-0878//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `pow` and `powf` procedures shall return `-0`, if the argument `x` is `-Inf` and the argument `y` is an odd integer < 0. □

REQ-BL-0879//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `pow` and `powf` procedures shall return +0, if the argument `x` is `-Inf` and the argument `y` is < 0 and not an odd integer. □

REQ-BL-0880//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `pow` and `powf` procedures shall return `-Inf`, if the argument `x` is `-Inf` and the argument `y` is an odd integer > 0. □

REQ-BL-0881//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `pow` and `powf` procedures shall return `+Inf`, if the argument `x` is `-Inf` and the argument `y` is > 0 and not an odd integer. □

REQ-BL-0882//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `pow` and `powf` procedures shall return +0, if the argument `x` is `+Inf` and the argument `y` < 0. □

REQ-BL-0883//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The pow and powf procedures shall return +Inf, if the argument x is +Inf and the argument y > 0. □

X	Y	Result	Requirement
<0	$\notin \mathbb{Z}$	NaN	REQ-BL-0860
-0	$\{2k+1 : k \in \mathbb{Z}_{<0}\}$	-Inf	REQ-BL-0864
-0	$\in \mathbb{R}_{<0} \setminus \{2k+1 : k \in \mathbb{Z}\}$	+Inf	REQ-BL-0864
+0	<0	+Inf	REQ-BL-0864
±0	$\{2k-1 : k \in \mathbb{Z}_{>0}\}$	X	REQ-BL-0885
±0	$\in \mathbb{R}_{>0} \setminus \{2k-1 : k \in \mathbb{Z}\}$	+0	REQ-BL-0886
+1	Any	1.0	REQ-BL-0871
Any	±0	1.0	REQ-BL-0872
-1	±Inf	1.0	REQ-BL-0873
∈]-1, 1[	-Inf	+Inf	REQ-BL-0874
∉[-1, 1]	-Inf	+0	REQ-BL-0875
∈]-1, 1[	+Inf	+0	REQ-BL-0876
∉[-1, 1]	+Inf	+Inf	REQ-BL-0877
-Inf	$\{2k+1 : k \in \mathbb{Z}_{<0}\}$	-0	REQ-BL-0878
-Inf	$\in \mathbb{R}_{<0} \setminus \{2k+1 : k \in \mathbb{Z}\}$	+0	REQ-BL-0879
-Inf	$\{2k-1 : k \in \mathbb{Z}_{>0}\}$	-Inf	REQ-BL-0880
-Inf	$\in \mathbb{R}_{>0} \setminus \{2k-1 : k \in \mathbb{Z}\}$	+Inf	REQ-BL-0881
+Inf	<0	+0	REQ-BL-0882
+Inf	>0	+Inf	REQ-BL-0883
NaN	$\neq$±0	NaN	REQ-BL-0870
$\neq$1	NaN	NaN	REQ-BL-0870

Table 5.16: Special cases for pow(X, Y)

5.2.13 LOG ($\ln x$)

REQ-BL-0900//GTD-TR-01-BL-0015/T

The log and logf procedures shall calculate the natural logarithm of their argument x. □

REQ-BL-0910//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The log and logf procedures shall return -Inf if the argument x is ±0. □

REQ-BL-0920//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `log` and `logf` procedures shall return `NaN` if the argument `x` is finite and less than 0 or `x` is `-Inf`. □

REQ-BL-0921//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `log` and `logf` procedures shall return `NaN`, if the argument `x` is `NaN`. □

REQ-BL-0930//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `log` and `logf` procedures shall return +0, if the argument `x` is 1. □

REQ-BL-0931//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `log` and `logf` procedures shall return `+Inf`, if the argument `x` is `+Inf`. □

X	Result	Requirement
<0	NaN	REQ-BL-0920
±0	-Inf	REQ-BL-0910
1	+0	REQ-BL-0930
+Inf	+Inf	REQ-BL-0931
NaN	NaN	REQ-BL-0921

Table 5.17: Special cases for log(X)

5.2.14 LOG10 ($\log_{10} x$)

REQ-BL-0950//GTD-TR-01-BL-0015/T

The `log10` and `log10f` procedures shall calculate the base 10 logarithm of their argument `x`. □

REQ-BL-0960//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `log10` and `log10f` procedures shall return `-Inf` if the argument `x` is ±0. □

REQ-BL-0970//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `log10` and `log10f` procedures shall return `NaN` if the argument `x` is finite and less than 0 or `x` is `-Inf`. □

REQ-BL-0971//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `log10` and `log10f` procedures shall return `NaN`, if the argument `x` is `NaN`. □

REQ-BL-0980//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `log10` and `log10f` procedures shall return +0, if the argument x is 1. □

REQ-BL-0981//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `log10` and `log10f` procedures shall return `+Inf`, if the argument x is `+Inf`. □

X	Result	Requirement
<0	NaN	REQ-BL-0970
±0	-Inf	REQ-BL-0960
1	+0	REQ-BL-1280
+Inf	+Inf	REQ-BL-0981
NaN	NaN	REQ-BL-0971

Table 5.18: Special cases for log10(X)

5.2.15 FABS ($|x|$)

REQ-BL-1000//GTD-TR-01-BL-0015/T

The `fabs` and `fabsf` procedures shall calculate the absolute values of their argument x. □

REQ-BL-1010//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fabs` and `fabsf` procedures shall return NaN, if the argument x is NaN. □

REQ-BL-1011//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fabs` and `fabsf` procedures shall return +0, if the argument x is ±0. □

REQ-BL-1012//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fabs` and `fabsf` procedures shall return `+Inf`, if the argument x is `±Inf`. □

X	Result	Requirement
±0	+0	REQ-BL-1011
±Inf	+Inf	REQ-BL-1012
NaN	NaN	REQ-BL-1010

Table 5.19: Special cases for fabs(X)

5.2.16 ROUND ($\lfloor x + 0.5 \rfloor, x \geqslant 0; \lceil x - 0.5 \rceil, x < 0$)

REQ-BL-1020//GTD-TR-01-BL-0015/T

The `round` and `roundf` procedures shall round their argument `x` to the nearest integer value, rounding halfway cases away from zero. □

REQ-BL-1031//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `round` and `roundf` procedures shall return `NaN`, if the argument `x` is `NaN`. □

REQ-BL-1032//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `round` and `roundf` procedures shall return the argument, if the argument `x` is `±0` or `±Inf`. □

X	Result	Requirement
±0	X	REQ-BL-1032
±Inf	X	REQ-BL-1032
NaN	NaN	REQ-BL-1031

Table 5.20: Special cases for round(X)

5.2.17 FLOOR ($\lfloor x \rfloor$)

REQ-BL-1040//GTD-TR-01-BL-0015/T

The `floor` and `floorf` procedures shall calculate the largest integral value not greater than their argument `x`. □

REQ-BL-1051//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `floor` and `floorf` procedures shall return `NaN`, if the argument `x` is `NaN`. □

REQ-BL-1052//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `floor` and `floorf` procedures shall return the argument, if the argument `x` is `±0` or `±Inf`. □

X	Result	Requirement
±0	X	REQ-BL-1052
±Inf	X	REQ-BL-1052
NaN	NaN	REQ-BL-1051

Table 5.21: Special cases for floor(X)

5.2.18 TRUNC ($\lfloor x \rfloor, x \geqslant 0; \lceil x \rceil, x < 0$)

REQ-BL-1060//GTD-TR-01-BL-0015/T

The `trunc` and `truncf` procedures shall round their argument `x` to the integer value nearest to but no larger in magnitude than the argument. □

REQ-BL-1070//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `trunc` and `truncf` procedures shall return `NaN`, if the argument `x` is `NaN`. □

REQ-BL-1071//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `trunc` and `truncf` procedures shall return the argument, if the argument `x` is `±0` or `±Inf`. □

X	Result	Requirement
±0	X	REQ-BL-1072
±Inf	X	REQ-BL-1072
NaN	NaN	REQ-BL-1071

Table 5.22: Special cases for trunc(X)

5.2.19 CEIL ($\lceil x \rceil$)

REQ-BL-1080//GTD-TR-01-BL-0015/T

The `ceil` and `ceilf` procedures shall compute the smallest integral value not less than argument `x`. □

REQ-BL-1091//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `ceil` and `ceilf` procedures shall return `NaN`, if the argument `x` is `NaN`. □

REQ-BL-1092//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `ceil` and `ceilf` procedures shall return the argument, if the argument `x` is `±0` or `±Inf`. □

X	Result	Requirement
±0	X	REQ-BL-1092
±Inf	X	REQ-BL-1092
NaN	NaN	REQ-BL-1091

Table 5.23: Special cases for ceil(X)

5.2.20 FMOD ($x \mod y$)

REQ-BL-1100//GTD-TR-01-BL-0015/T

The `fmod` and `fmodf` procedures shall calculate the floating-point remainder of the division of the argument `x` by the argument `y`.

Remark: The sign of the remainder is defined by the ISO C99 standard as the sign of the dividend (argument `x`). Therefore an argument `y` < 0 produces the same result as it's absolute value.

Example: Input of x = 3.456 and y = -2 results in a return value of 1.456. □

REQ-BL-1120//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fmod` and `fmodf` procedures shall return `NaN`, if any argument is `NaN`. □

REQ-BL-1121//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fmod` and `fmodf` procedures shall return `NaN`, if the argument `y` is 0. □

REQ-BL-1122//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fmod` and `fmodf` procedures shall return `NaN`, if the argument `x` is ±Inf. □

REQ-BL-1130//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fmod` and `fmodf` procedures shall return ±0, if the argument `x` is ±0 and the argument `y` is not zero. □

REQ-BL-1131//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fmod` and `fmodf` procedures shall return the argument `x`, if the argument `x` is not ±Inf and the argument `y` is `±Inf`. □

X	Y	Result	Requirement
Any	±0	NaN	REQ-BL-1121
±Inf	Any	NaN	REQ-BL-1122
±0	$\neq$ ±0	X	REQ-BL-1130
$\neq$ ±Inf	±Inf	X	REQ-BL-1131
NaN	Any	NaN	REQ-BL-1120
Any	NaN	NaN	REQ-BL-1120

Table 5.24: Special cases for fmod(X, Y)

5.2.21 MODF

REQ-BL-1200//GTD-TR-01-BL-0015/T

The `modf` and `modff` procedures shall compute the integral and fractional part of the argument `x`.

Remark: The sign of both the integral and fractional part is defined by the ISO C99 standard as the sign of the argument `x`.

Example: Input of x = -3.456 results in a return value of -0.456 and sets the value pointed to by the argument $*iptr$ to -3.0. □

REQ-BL-1201//GTD-TR-01-BL-0015/T

The `modf` and `modff` procedures shall return the fractional part of the argument `x` and write the integral part of the argument `x` to the pointer provided by the argument $*iptr$. □

REQ-BL-1210//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `modf` and `modff` procedures shall return `NaN` and set the argument $*iptr$ to `NaN`, if the argument `x` is `NaN`. □

REQ-BL-1211//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `modf` and `modff` procedures shall return `±0` and set the argument $*iptr$ to `±Inf`, if the argument `x` is `±Inf`. □

X	$*iptr$	Result	Requirement
-Inf	-Inf	-0	REQ-BL-1211
+Inf	+Inf	+0	REQ-BL-1211
NaN	NaN	NaN	REQ-BL-1210

Table 5.25: Special cases for modf(X, $*iptr$)

5.2.22 FMIN ($min(x, y)$)

REQ-BL-1220//GTD-TR-01-BL-0015/T

The `fmin` and `fminf` procedures shall determine the minimum numeric value of the argument `x` and `y`.

Remark: This includes `±Inf`, with `-Inf` being lesser than any other numeric value and `+Inf` being greater than any other numeric value. □

REQ-BL-1230//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fmin` and `fminf` procedures shall return `NaN`, if the arguments `x` and `y` are `NaN`. □

REQ-BL-1231//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fmin` and `fminf` procedures shall return the one argument if only the other argument is NaN. □

REQ-BL-1232//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fmin` and `fminf` procedures shall return the y argument if both arguments are zero. □

X	Y	Result	Requirement
-0	-0	-0	REQ-BL-1232
-0	+0	+0	REQ-BL-1232
+0	-0	-0	REQ-BL-1232
+0	+0	+0	REQ-BL-1232
NaN	$\neq$ NaN	Y	REQ-BL-1231
$\neq$ NaN	NaN	X	REQ-BL-1231
NaN	NaN	NaN	REQ-BL-1230

Table 5.26: Special cases for fmin(X, Y)

5.2.23 FMAX ($max(x, y)$)

REQ-BL-1240//GTD-TR-01-BL-0015/T

The `fmax` and `fmaxf` procedures shall determine the maximum numeric value of the argument `x` and `y`.

Remark: This includes ±`Inf`, with `-Inf` being lesser than any other numeric value and `+Inf` being greater than any other numeric value. □

REQ-BL-1250//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fmax` and `fmaxf` procedures shall return NaN, if the arguments `x` and `y` are NaN. □

REQ-BL-1251//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fmax` and `fmaxf` procedures shall return the one argument if only the other argument is NaN. □

REQ-BL-1252//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `fmax` and `fmaxf` procedures shall return the y argument if both arguments are zero. □

X	Y	Result	Requirement
-0	-0	-0	REQ-BL-1252
-0	+0	+0	REQ-BL-1252

X	Y	Result	Requirement
+0	-0	-0	REQ-BL-1252
+0	+0	+0	REQ-BL-1252
NaN	$\neq$ NaN	Y	REQ-BL-1251
$\neq$ NaN	NaN	X	REQ-BL-1251
NaN	NaN	NaN	REQ-BL-1250

Table 5.27: Special cases for fmax(X, Y)

5.2.24 HYPOT ($\sqrt{x^2 + y^2}$)

REQ-BL-1260//GTD-TR-01-BL-0015/T

The `hypot` and `hypotf` procedures shall compute the length of the hypotenuse of a rightangled triangle with sides of length `x` and `y`. □

REQ-BL-1270//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `hypot` and `hypotf` procedures shall return `+Inf`, if one of the arguments `x` or `y` is `±Inf`. □

REQ-BL-1271//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `hypot` and `hypotf` procedures shall return `NaN`, if one of the arguments `x` or `y` is `NaN` and the other is not `±Inf`. □

X	Y	Result	Requirement
Any	±Inf	+Inf	REQ-BL-1270
±Inf	Any	+Inf	REQ-BL-1270
NaN	$\neq$ ±Inf	NaN	REQ-BL-1271
$\neq$ ±Inf	NaN	NaN	REQ-BL-1271

Table 5.28: Special cases for hypot(X, Y)

5.2.25 ISFINITE

REQ-BL-1300//GTD-TR-01-BL-0015/T

The `isfinite` procedure shall return a non-zero value if the argument `x` has a finite value and is neither `NaN` nor `±Inf`. □

5.2.26 ISINF

REQ-BL-1320//GTD-TR-01-BL-0015/T

The `isinf` procedure shall return a non-zero value if and only if the argument `x` is `±Inf`. □

5.2.27 ISNAN

REQ-BL-1340//GTD-TR-01-BL-0015/T

The `isnan` procedure shall return a non-zero value if and only if the argument `x` is NaN. □

5.2.28 SIGNBIT

REQ-BL-1360//GTD-TR-01-BL-0015/T

The `signbit` procedure shall return a non-zero value if and only if the argument `x` is negative. □

5.2.29 COPYSIGN ($|x| \cdot sgn\ y$)

REQ-BL-1380//GTD-TR-01-BL-0015/T

The `copysign` and `copysignf` procedures shall compute a new number with the magnitude of the argument `x` and the the sign of `y`.

Remark: This includes NaN values for argument y, as NaN values have a sign just as any other value. □

REQ-BL-1381//GTD-TR-01-BL-0015, GTD-TR-01-BL-0026/T

The `copysign` and `copysignf` procedures shall return NaN if the argument `x` is NaN. □

X	Y	Result	Requirement
NaN	Any	NaN	REQ-BL-1381

Table 5.29: Special cases for copysign(X, Y)

5.3 Performance Requirements

REQ-BL-0061//GTD-TR-01-BL-0029/T

The execution time of all procedures shall be bounded. □

REQ-BL-0062//GTD-TR-01-BL-0030/A

The execution time of all procedures shall be characterizable within subdomains which cover the complete domain of the procedure.

Remark: For example the sin procedure can be split into the subdomains (`-Inf`, -2^{-27}], (-2^{-27}, $+2^{-27}$) and [$+2^{-27}$, `+Inf`), figure 5.1 shows a plot of the execution time of sine for positive arguments. □

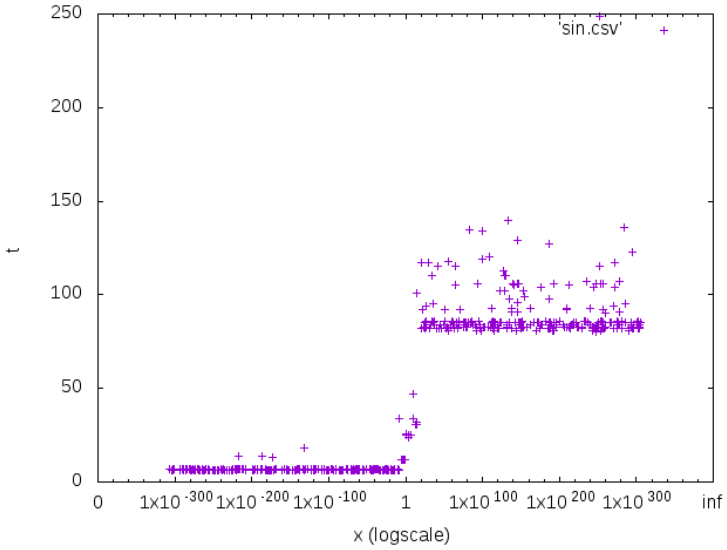

Figure 5.1: Execution time of sine for positive arguments

REQ-BL-0060//GTD-TR-01-BL-0030/A

The Worst Case Execution Time (WCET) of the procedures shall not deviate by more than 30% from the median execution times of the characterized ranges.

Remark: The median shall be defined with random arguments within the range. □

REQ-BL-0070//GTD-TR-01-BL-0033/T

The BL procedure results shall differ from theoretical results by less than 0.5 Units in the Last Place (ULPs). □

5.4 Interface Requirements

The requirement REQ-BL-0021 regarding compliance to the definitions in math.h of the ISO C99 standard [RD03] can be found in §5.9. □

REQ-BL-0010//GTD-TR-01-BL-0004/T

The Basic Library shall be compliant to IEEE 754-2008. □

REQ-BL-0080//GTD-TR-01-BL-0012/D

The Basic Library shall be compatible with code auto-generated with Matlab R2016a Simulink Coder.

Remark: The auto-generated code will require an include of `mlfs.h`.

Remark: All C definition and function signatures not present in `mlfs.h` need to be provided by the user. He will then have to link his own libm after linking with the MLFS. □

REQ-BL-0120//GTD-TR-01-BL-0013/D

The Basic Library shall provide best practices within the Software User Manual (SUM) to produce Ada wrappers to enable the use of the library from Ada83 and Ada95. ☐

REQ-BL-0130//GTD-TR-01-BL-0008, GTD-TR-01-BL-0010/D

The Basic Library shall provide best practices within the SUM to produce C-MEX function wrappers, to enable the use of the Basic Library in Matlab and Simulink Matlab function blocks. ☐

REQ-BL-0131//GTD-TR-01-BL-0009, GTD-TR-01-BL-0011/D

The Basic Library shall provide best practices within the SUM to produce S-function wrappers, to enable the use of the Basic Library in Simulink. ☐

5.5 Operational Requirements

Not applicable.

5.6 Resources Requirements

REQ-BL-0180//GTD-TR-01-BL-0001/T

The Basic Library shall run on x86-64 and SPARC V8 processor architectures. ☐

REQ-BL-0181//GTD-TR-01-BL-0031/D

The Basic Library shall contribute less than 100kB to the size of the final OBSW executable. ☐

5.7 Design Requirements and Implementation Constraints

REQ-BL-0090//GTD-TR-01-BL-0001/I

For the Basic Library it shall be selectable for which processor architecture it will be compiled. ☐

REQ-BL-0100//GTD-TR-01-BL-0007/D

For the Basic Library it shall be configurable which procedures of the library will be included in the linking step. ☐

REQ-BL-0110//GTD-TR-01-BL-0028/R

The Basic Library procedures shall be reentrant and thread-safe. ☐

REQ-BL-0111//GTD-TR-01-BL-0027/R

The Basic Library design shall define the behavior of the procedures in a tabular format, presenting the parameter domain decomposition and the corresponding output. □

REQ-BL-0112//GTD-TR-01-BL-0032/R

The Basic Library design shall justify every modification to be carried out on the reused library. □

5.8 Security and Privacy Requirements

Not applicable.

5.9 Portability Requirements

REQ-BL-0020//GTD-TR-01-BL-0002/I

The Basic Library shall be implemented in ISO C99. □

REQ-BL-0021//GTD-TR-01-BL-0016/R

The Basic Library shall be compliant to the math.h definitions as per ISO C99 standard [RD03] . □

REQ-BL-0022//GTD-TR-01-BL-0025/I

The Basic Library shall not provide error handling with the `errno` global variable.
Remark: All procedures that would have produced an error will instead return a defined value (see requirements for special cases), often NaN. □

REQ-BL-0025//GTD-TR-01-BL-0007/T

The Basic Library shall be compileable with GCC version 4.2.1 with Binutils version 2.18. □

REQ-BL-0026//GTD-TR-01-BL-0003/T

The Basic Library shall be compatible to RTEMS OS version 4.8 distributed by Edisoft. □

REQ-BL-0027//GTD-TR-01-BL-0021/I

The Basic Library shall not use Floating Point Unit (FPU) built in functions for elementary math function evaluation. □

REQ-BL-0028//GTD-TR-01-BL-0022/R

The Basic Library shall not rely on the presence of the Fused Multiply-Add (FMA) operation for algorithm optimization. □

REQ-BL-0029//GTD-TR-01-BL-0023/T

The Basic Library shall be able to convert to a modus that mirrors the FPU's behaviour regarding subnormal numbers in case the FPU does not handle subnormal numbers the same as normal numbers.

Remark: For example the FPU may simply throw a trap, or have the possibility to be set to Denormals are Zero (DAZ) and Flush to Zero (FTZ) behaviour. In both cases the library shall behave the same way as the FPU does. □

5.10 Software Quality Requirements

REQ-BL-1500//GTD-TR-01-BL-0006/A

The Basic Library source shall be compliant to the mandatory and required rules depicted in MISRA C:2012 [RD06] . □

REQ-BL-1501//GTD-TR-01-BL-0006/A

The Basic Library shall provide a justification for not respected required rules in MISRA C:2012 [RD06] . □

REQ-BL-1502//GTD-TR-01-BL-0005/A

The Basic Library shall comply to the mandatory metrics provided by ECSS-HB-Q-80 [RD05] with their proposed targets. □

REQ-BL-1503//GTD-TR-01-BL-0005/A

The Basic Library shall comply to the following project depending mandatory metrics proposed by ECSS-HB-Q-80 [RD05] :

Metric name	Target
Statement Coverage (Source Code)	1
Modified Condition and Decision Coverage (Source Code)	1
Reuse modification rate	0.3
Code size stability	1.3
Requirement stability	0.3

□

REQ-BL-1504//GTD-TR-01-BL-0005/A

The Basic Library shall comply to required metric 'User documentation completeness' proposed by ECSS-HB-Q-80 [RD05] with their proposed targets. ☐

5.11 Software Reliability Requirements

REQ-BL-1600//GTD-TR-01-BL-0014/T

The Basic Library shall return the exact same value whenever a procedure is called multiple times with the same argument(s). ☐

5.12 Software Maintainability Requirements

Upholding the requirements listed in 5.10 should produce a maintainable software. No additional maintainability requirements specified.

5.13 Software Safety Requirements

REQ-BL-1800//GTD-TR-01-BL-0001/R

The Basic Library shall never cause either CPU or FPU to stop. ☐

5.14 Software Configuration and Delivery Requirements

REQ-BL-1900//GTD-TR-01-BL-0002/I

The Basic Library source shall be delivered as a collection of C source files.
Remark: There will be neither a binary nor an executable delivered. ☐

REQ-BL-1901//GTD-TR-01-BL-0007/I

The Basic Library shall be delivered with a GNU Make makefile and associated scripts to configure, build and install the Basic Library. ☐

REQ-BL-1902//SoW §3.5/I

Each modified or newly created file, be it source or documentation, of the Basic Library shall contain a header including the ESA copyright notice:
Copyright European Space Agency, 20xx
Remark: xx corresponds to the applicable year. ☐

5.15 Data Definition and Database requirements

REQ-BL-2000//GTD-TR-01-BL-0017/R

The Basic Library shall use 32bit and 64bit IEEE 754 [RD01] floating-point datums as well as 32bit integers to exchange data. □

5.16 Human Factors Related Requirements

Not applicable.

5.17 Adaptation and Installation Requirements

The Basic Library can be installed using a GNU Make makefile, see REQ-BL-1901 in 5.14.

6 Validation Requirements

All requirements have their validation method stated after their identifier and the trace, see 5.1 for a more thorough description.

Validation method matrix (contains only the requirement numbers and omits the REQ-BL):

Validation Method	Requirements
T (Test)	-0010, -0025, -0026, -0029, -0040, -0061, -0070, -0150, -0151, -0152, -0153, -0180, -0200, -0210, -0220, -0240, -0250, -0260, -0270, -0280, -0281, -0300, -0310, -0320, -0330, -0450, -0460, -0470, -0480, -0490, -0500, -0520, -0530, -0550, -0600, -0610, -0620, -0621, -0650, -0660, -0661, -0662, -0663, -0670, -0680, -0681, -0682, -0683, -0684, -0685, -0686, -0700, -0710, -0720, -0730, -0740, -0800, -0831, -0832, -0833, -0834, -0850, -0860, -0864, -0870, -0871, -0872, -0873, -0874, -0875, -0876, -0877, -0878, -0879, -0880, -0881, -0882, -0883, -0885, -0886, -0900, -0910, -0920, -0921, -0930, -0931, -0950, -0960, -0970, -0971, -0981, -1280, -1000, -1010, -1011, -1012, -1020, -1031, -1032, -1040, -1051, -1052, -1060, -1070, -1071, -1080, -1091, -1092, -1100, -1120, -1121, -1122, -1130, -1131, -1200, -1210, -1211, -1220, -1230, -1231, -1232, -1240, -1250, -1251, -1252, -1260, -1270, -1271, -1300, -1320, -1340, -1360, -1380, -1381, -1420, -1421, -1422, -1600
A (Analysis)	-0060, -0062, -1500, -1501, -1502, -1503, -1504
I (Inspection)	-0020, -0022, -0027, -0051, -0090, -1900, -1901, -1902
D (Demonstration)	-0080, -0100, -0120, -0130, -0131, -0181
R (Review of design)	-0021, -0028, -0050, -0052, -0110, -0111, -0112, -0203, -0251, -0303, -0451, -0503, -0602, -0652, -0802, -0851, -1400, -1800, -2000

Table 6.1: Requirements by validation method

7 Traceability

All requirements have their traces stated after their identifier, see 5.1 for a more thorough description. In general all requirements of this document shall trace to the E1356-GTD-TR-01 [RD07] . The only exception is REQ-BL-1902 (regarding the ESA copyright notice) which traces to the SoW [AD01] .

In the following tables (7.1, 7.2) column **Upstream** represents the E1356-GTD-TR-01 requirements or the SoW, and **Downstream** this document's requirements.

Upstream	Downstream
GTD-TR-01-BL-0001	REQ-BL-1800
GTD-TR-01-BL-0001	REQ-BL-0090
GTD-TR-01-BL-0001	REQ-BL-0180
GTD-TR-01-BL-0002	REQ-BL-1900
GTD-TR-01-BL-0002	REQ-BL-0020
GTD-TR-01-BL-0003	REQ-BL-0026
GTD-TR-01-BL-0004	REQ-BL-0010
GTD-TR-01-BL-0005	REQ-BL-1504
GTD-TR-01-BL-0005	REQ-BL-1503
GTD-TR-01-BL-0005	REQ-BL-1502
GTD-TR-01-BL-0006	REQ-BL-1501
GTD-TR-01-BL-0006	REQ-BL-1500
GTD-TR-01-BL-0007	REQ-BL-1901
GTD-TR-01-BL-0007	REQ-BL-0025
GTD-TR-01-BL-0007	REQ-BL-0100
GTD-TR-01-BL-0008	REQ-BL-0130
GTD-TR-01-BL-0009	REQ-BL-0131
GTD-TR-01-BL-0010	REQ-BL-0130
GTD-TR-01-BL-0011	REQ-BL-0131
GTD-TR-01-BL-0012	REQ-BL-0080
GTD-TR-01-BL-0013	REQ-BL-0120
GTD-TR-01-BL-0014	REQ-BL-1600
GTD-TR-01-BL-0015	REQ-BL-1381
GTD-TR-01-BL-0015	REQ-BL-1380
GTD-TR-01-BL-0015	REQ-BL-1360
GTD-TR-01-BL-0015	REQ-BL-1340

Upstream	Downstream
GTD-TR-01-BL-0015	REQ-BL-1320
GTD-TR-01-BL-0015	REQ-BL-1300
GTD-TR-01-BL-0015	REQ-BL-1271
GTD-TR-01-BL-0015	REQ-BL-1270
GTD-TR-01-BL-0015	REQ-BL-1260
GTD-TR-01-BL-0015	REQ-BL-1252
GTD-TR-01-BL-0015	REQ-BL-1251
GTD-TR-01-BL-0015	REQ-BL-1250
GTD-TR-01-BL-0015	REQ-BL-1240
GTD-TR-01-BL-0015	REQ-BL-1232
GTD-TR-01-BL-0015	REQ-BL-1231
GTD-TR-01-BL-0015	REQ-BL-1230
GTD-TR-01-BL-0015	REQ-BL-1220
GTD-TR-01-BL-0015	REQ-BL-1211
GTD-TR-01-BL-0015	REQ-BL-1210
GTD-TR-01-BL-0015	REQ-BL-1201
GTD-TR-01-BL-0015	REQ-BL-1200
GTD-TR-01-BL-0015	REQ-BL-1131
GTD-TR-01-BL-0015	REQ-BL-1130
GTD-TR-01-BL-0015	REQ-BL-1122
GTD-TR-01-BL-0015	REQ-BL-1121
GTD-TR-01-BL-0015	REQ-BL-1120
GTD-TR-01-BL-0015	REQ-BL-1100
GTD-TR-01-BL-0015	REQ-BL-1092
GTD-TR-01-BL-0015	REQ-BL-1091
GTD-TR-01-BL-0015	REQ-BL-1080
GTD-TR-01-BL-0015	REQ-BL-1071
GTD-TR-01-BL-0015	REQ-BL-1070
GTD-TR-01-BL-0015	REQ-BL-1060
GTD-TR-01-BL-0015	REQ-BL-1052
GTD-TR-01-BL-0015	REQ-BL-1051
GTD-TR-01-BL-0015	REQ-BL-1040
GTD-TR-01-BL-0015	REQ-BL-1032
GTD-TR-01-BL-0015	REQ-BL-1031
GTD-TR-01-BL-0015	REQ-BL-1020

Upstream	Downstream
GTD-TR-01-BL-0015	REQ-BL-1012
GTD-TR-01-BL-0015	REQ-BL-1011
GTD-TR-01-BL-0015	REQ-BL-1010
GTD-TR-01-BL-0015	REQ-BL-1000
GTD-TR-01-BL-0015	REQ-BL-0981
GTD-TR-01-BL-0015	REQ-BL-0980
GTD-TR-01-BL-0015	REQ-BL-0971
GTD-TR-01-BL-0015	REQ-BL-0970
GTD-TR-01-BL-0015	REQ-BL-0960
GTD-TR-01-BL-0015	REQ-BL-0950
GTD-TR-01-BL-0015	REQ-BL-0931
GTD-TR-01-BL-0015	REQ-BL-0930
GTD-TR-01-BL-0015	REQ-BL-0921
GTD-TR-01-BL-0015	REQ-BL-0920
GTD-TR-01-BL-0015	REQ-BL-0910
GTD-TR-01-BL-0015	REQ-BL-0900
GTD-TR-01-BL-0015	REQ-BL-0883
GTD-TR-01-BL-0015	REQ-BL-0882
GTD-TR-01-BL-0015	REQ-BL-0881
GTD-TR-01-BL-0015	REQ-BL-0880
GTD-TR-01-BL-0015	REQ-BL-0879
GTD-TR-01-BL-0015	REQ-BL-0878
GTD-TR-01-BL-0015	REQ-BL-0877
GTD-TR-01-BL-0015	REQ-BL-0876
GTD-TR-01-BL-0015	REQ-BL-0875
GTD-TR-01-BL-0015	REQ-BL-0874
GTD-TR-01-BL-0015	REQ-BL-0873
GTD-TR-01-BL-0015	REQ-BL-0872
GTD-TR-01-BL-0015	REQ-BL-0871
GTD-TR-01-BL-0015	REQ-BL-0886
GTD-TR-01-BL-0015	REQ-BL-0885
GTD-TR-01-BL-0015	REQ-BL-0870
GTD-TR-01-BL-0015	REQ-BL-0864
GTD-TR-01-BL-0015	REQ-BL-0860
GTD-TR-01-BL-0015	REQ-BL-0851

Upstream	Downstream
GTD-TR-01-BL-0015	REQ-BL-0850
GTD-TR-01-BL-0015	REQ-BL-0834
GTD-TR-01-BL-0015	REQ-BL-0833
GTD-TR-01-BL-0015	REQ-BL-0832
GTD-TR-01-BL-0015	REQ-BL-0831
GTD-TR-01-BL-0015	REQ-BL-0802
GTD-TR-01-BL-0015	REQ-BL-0800
GTD-TR-01-BL-0015	REQ-BL-0740
GTD-TR-01-BL-0015	REQ-BL-0730
GTD-TR-01-BL-0015	REQ-BL-0720
GTD-TR-01-BL-0015	REQ-BL-0710
GTD-TR-01-BL-0015	REQ-BL-0700
GTD-TR-01-BL-0015	REQ-BL-0686
GTD-TR-01-BL-0015	REQ-BL-0685
GTD-TR-01-BL-0015	REQ-BL-0684
GTD-TR-01-BL-0015	REQ-BL-0683
GTD-TR-01-BL-0015	REQ-BL-0682
GTD-TR-01-BL-0015	REQ-BL-0681
GTD-TR-01-BL-0015	REQ-BL-0680
GTD-TR-01-BL-0015	REQ-BL-0670
GTD-TR-01-BL-0015	REQ-BL-0663
GTD-TR-01-BL-0015	REQ-BL-0662
GTD-TR-01-BL-0015	REQ-BL-0661
GTD-TR-01-BL-0015	REQ-BL-0660
GTD-TR-01-BL-0015	REQ-BL-0652
GTD-TR-01-BL-0015	REQ-BL-0650
GTD-TR-01-BL-0015	REQ-BL-0621
GTD-TR-01-BL-0015	REQ-BL-0620
GTD-TR-01-BL-0015	REQ-BL-0610
GTD-TR-01-BL-0015	REQ-BL-0602
GTD-TR-01-BL-0015	REQ-BL-0600
GTD-TR-01-BL-0015	REQ-BL-0550
GTD-TR-01-BL-0015	REQ-BL-0530
GTD-TR-01-BL-0015	REQ-BL-0520
GTD-TR-01-BL-0015	REQ-BL-0503

Upstream	Downstream
GTD-TR-01-BL-0015	REQ-BL-0500
GTD-TR-01-BL-0015	REQ-BL-0490
GTD-TR-01-BL-0015	REQ-BL-0480
GTD-TR-01-BL-0015	REQ-BL-0470
GTD-TR-01-BL-0015	REQ-BL-0460
GTD-TR-01-BL-0015	REQ-BL-0451
GTD-TR-01-BL-0015	REQ-BL-0450
GTD-TR-01-BL-0015	REQ-BL-0330
GTD-TR-01-BL-0015	REQ-BL-0320
GTD-TR-01-BL-0015	REQ-BL-0310
GTD-TR-01-BL-0015	REQ-BL-0303
GTD-TR-01-BL-0015	REQ-BL-0300
GTD-TR-01-BL-0015	REQ-BL-0281
GTD-TR-01-BL-0015	REQ-BL-0280
GTD-TR-01-BL-0015	REQ-BL-0270
GTD-TR-01-BL-0015	REQ-BL-0260
GTD-TR-01-BL-0015	REQ-BL-0251
GTD-TR-01-BL-0015	REQ-BL-0250
GTD-TR-01-BL-0015	REQ-BL-0240
GTD-TR-01-BL-0015	REQ-BL-0220
GTD-TR-01-BL-0015	REQ-BL-0210
GTD-TR-01-BL-0015	REQ-BL-0203
GTD-TR-01-BL-0015	REQ-BL-0200
GTD-TR-01-BL-0015	REQ-BL-0050
GTD-TR-01-BL-0016	REQ-BL-0021
GTD-TR-01-BL-0016	REQ-BL-1400
GTD-TR-01-BL-0017	REQ-BL-2000
GTD-TR-01-BL-0017	REQ-BL-0040
GTD-TR-01-BL-0018	REQ-BL-0051
GTD-TR-01-BL-0019	REQ-BL-1422
GTD-TR-01-BL-0019	REQ-BL-1421
GTD-TR-01-BL-0019	REQ-BL-1420
GTD-TR-01-BL-0019	REQ-BL-0052
GTD-TR-01-BL-0020	REQ-BL-0153
GTD-TR-01-BL-0020	REQ-BL-0152

Upstream	Downstream
GTD-TR-01-BL-0020	REQ-BL-0151
GTD-TR-01-BL-0020	REQ-BL-0150
GTD-TR-01-BL-0020	REQ-BL-0052
GTD-TR-01-BL-0021	REQ-BL-0027
GTD-TR-01-BL-0022	REQ-BL-0028
GTD-TR-01-BL-0023	REQ-BL-0029
GTD-TR-01-BL-0025	REQ-BL-0022
GTD-TR-01-BL-0026	REQ-BL-1381
GTD-TR-01-BL-0026	REQ-BL-1271
GTD-TR-01-BL-0026	REQ-BL-1270
GTD-TR-01-BL-0026	REQ-BL-1252
GTD-TR-01-BL-0026	REQ-BL-1251
GTD-TR-01-BL-0026	REQ-BL-1250
GTD-TR-01-BL-0026	REQ-BL-1232
GTD-TR-01-BL-0026	REQ-BL-1231
GTD-TR-01-BL-0026	REQ-BL-1230
GTD-TR-01-BL-0026	REQ-BL-1211
GTD-TR-01-BL-0026	REQ-BL-1210
GTD-TR-01-BL-0026	REQ-BL-1131
GTD-TR-01-BL-0026	REQ-BL-1130
GTD-TR-01-BL-0026	REQ-BL-1122
GTD-TR-01-BL-0026	REQ-BL-1121
GTD-TR-01-BL-0026	REQ-BL-1120
GTD-TR-01-BL-0026	REQ-BL-1092
GTD-TR-01-BL-0026	REQ-BL-1091
GTD-TR-01-BL-0026	REQ-BL-1071
GTD-TR-01-BL-0026	REQ-BL-1070
GTD-TR-01-BL-0026	REQ-BL-1052
GTD-TR-01-BL-0026	REQ-BL-1051
GTD-TR-01-BL-0026	REQ-BL-1032
GTD-TR-01-BL-0026	REQ-BL-1031
GTD-TR-01-BL-0026	REQ-BL-1012
GTD-TR-01-BL-0026	REQ-BL-1011
GTD-TR-01-BL-0026	REQ-BL-1010
GTD-TR-01-BL-0026	REQ-BL-0981

Upstream	Downstream
GTD-TR-01-BL-0026	REQ-BL-0980
GTD-TR-01-BL-0026	REQ-BL-0971
GTD-TR-01-BL-0026	REQ-BL-0970
GTD-TR-01-BL-0026	REQ-BL-0960
GTD-TR-01-BL-0026	REQ-BL-0931
GTD-TR-01-BL-0026	REQ-BL-0930
GTD-TR-01-BL-0026	REQ-BL-0921
GTD-TR-01-BL-0026	REQ-BL-0920
GTD-TR-01-BL-0026	REQ-BL-0910
GTD-TR-01-BL-0026	REQ-BL-0883
GTD-TR-01-BL-0026	REQ-BL-0882
GTD-TR-01-BL-0026	REQ-BL-0881
GTD-TR-01-BL-0026	REQ-BL-0880
GTD-TR-01-BL-0026	REQ-BL-0879
GTD-TR-01-BL-0026	REQ-BL-0878
GTD-TR-01-BL-0026	REQ-BL-0877
GTD-TR-01-BL-0026	REQ-BL-0876
GTD-TR-01-BL-0026	REQ-BL-0875
GTD-TR-01-BL-0026	REQ-BL-0874
GTD-TR-01-BL-0026	REQ-BL-0873
GTD-TR-01-BL-0026	REQ-BL-0872
GTD-TR-01-BL-0026	REQ-BL-0871
GTD-TR-01-BL-0026	REQ-BL-0886
GTD-TR-01-BL-0026	REQ-BL-0885
GTD-TR-01-BL-0026	REQ-BL-0870
GTD-TR-01-BL-0026	REQ-BL-0864
GTD-TR-01-BL-0026	REQ-BL-0860
GTD-TR-01-BL-0026	REQ-BL-0834
GTD-TR-01-BL-0026	REQ-BL-0833
GTD-TR-01-BL-0026	REQ-BL-0832
GTD-TR-01-BL-0026	REQ-BL-0831
GTD-TR-01-BL-0026	REQ-BL-0740
GTD-TR-01-BL-0026	REQ-BL-0730
GTD-TR-01-BL-0026	REQ-BL-0720
GTD-TR-01-BL-0026	REQ-BL-0710

Upstream	Downstream
GTD-TR-01-BL-0026	REQ-BL-0686
GTD-TR-01-BL-0026	REQ-BL-0685
GTD-TR-01-BL-0026	REQ-BL-0684
GTD-TR-01-BL-0026	REQ-BL-0683
GTD-TR-01-BL-0026	REQ-BL-0682
GTD-TR-01-BL-0026	REQ-BL-0681
GTD-TR-01-BL-0026	REQ-BL-0680
GTD-TR-01-BL-0026	REQ-BL-0670
GTD-TR-01-BL-0026	REQ-BL-0663
GTD-TR-01-BL-0026	REQ-BL-0662
GTD-TR-01-BL-0026	REQ-BL-0661
GTD-TR-01-BL-0026	REQ-BL-0660
GTD-TR-01-BL-0026	REQ-BL-0621
GTD-TR-01-BL-0026	REQ-BL-0620
GTD-TR-01-BL-0026	REQ-BL-0610
GTD-TR-01-BL-0026	REQ-BL-0550
GTD-TR-01-BL-0026	REQ-BL-0530
GTD-TR-01-BL-0026	REQ-BL-0520
GTD-TR-01-BL-0026	REQ-BL-0490
GTD-TR-01-BL-0026	REQ-BL-0480
GTD-TR-01-BL-0026	REQ-BL-0470
GTD-TR-01-BL-0026	REQ-BL-0460
GTD-TR-01-BL-0026	REQ-BL-0330
GTD-TR-01-BL-0026	REQ-BL-0320
GTD-TR-01-BL-0026	REQ-BL-0310
GTD-TR-01-BL-0026	REQ-BL-0281
GTD-TR-01-BL-0026	REQ-BL-0280
GTD-TR-01-BL-0026	REQ-BL-0270
GTD-TR-01-BL-0026	REQ-BL-0260
GTD-TR-01-BL-0026	REQ-BL-0240
GTD-TR-01-BL-0026	REQ-BL-0220
GTD-TR-01-BL-0026	REQ-BL-0210
GTD-TR-01-BL-0027	REQ-BL-0111
GTD-TR-01-BL-0028	REQ-BL-0110
GTD-TR-01-BL-0029	REQ-BL-0061

Upstream	Downstream
GTD-TR-01-BL-0030	REQ-BL-0060
GTD-TR-01-BL-0030	REQ-BL-0062
GTD-TR-01-BL-0031	REQ-BL-0181
GTD-TR-01-BL-0032	REQ-BL-0112
GTD-TR-01-BL-0033	REQ-BL-0070
SoW Sec.3.5	REQ-BL-1902

Table 7.1: Traceability downstream

Downstream	Upstream
REQ-BL-0010	GTD-TR-01-BL-0004
REQ-BL-0020	GTD-TR-01-BL-0002
REQ-BL-0021	GTD-TR-01-BL-0016
REQ-BL-0022	GTD-TR-01-BL-0025
REQ-BL-0025	GTD-TR-01-BL-0007
REQ-BL-0026	GTD-TR-01-BL-0003
REQ-BL-0027	GTD-TR-01-BL-0021
REQ-BL-0028	GTD-TR-01-BL-0022
REQ-BL-0029	GTD-TR-01-BL-0023
REQ-BL-0040	GTD-TR-01-BL-0017
REQ-BL-0050	GTD-TR-01-BL-0015
REQ-BL-0051	GTD-TR-01-BL-0018
REQ-BL-0052	GTD-TR-01-BL-0019
REQ-BL-0052	GTD-TR-01-BL-0020
REQ-BL-0060	GTD-TR-01-BL-0030
REQ-BL-0061	GTD-TR-01-BL-0029
REQ-BL-0062	GTD-TR-01-BL-0030
REQ-BL-0070	GTD-TR-01-BL-0033
REQ-BL-0080	GTD-TR-01-BL-0012
REQ-BL-0090	GTD-TR-01-BL-0001
REQ-BL-0100	GTD-TR-01-BL-0007
REQ-BL-0110	GTD-TR-01-BL-0028
REQ-BL-0111	GTD-TR-01-BL-0027
REQ-BL-0112	GTD-TR-01-BL-0032
REQ-BL-0120	GTD-TR-01-BL-0013
REQ-BL-0130	GTD-TR-01-BL-0008

Downstream	Upstream
REQ-BL-0130	GTD-TR-01-BL-0010
REQ-BL-0131	GTD-TR-01-BL-0009
REQ-BL-0131	GTD-TR-01-BL-0011
REQ-BL-0150	GTD-TR-01-BL-0020
REQ-BL-0151	GTD-TR-01-BL-0020
REQ-BL-0152	GTD-TR-01-BL-0020
REQ-BL-0153	GTD-TR-01-BL-0020
REQ-BL-0180	GTD-TR-01-BL-0001
REQ-BL-0181	GTD-TR-01-BL-0031
REQ-BL-0200	GTD-TR-01-BL-0015
REQ-BL-0203	GTD-TR-01-BL-0015
REQ-BL-0210	GTD-TR-01-BL-0015
REQ-BL-0210	GTD-TR-01-BL-0026
REQ-BL-0220	GTD-TR-01-BL-0015
REQ-BL-0220	GTD-TR-01-BL-0026
REQ-BL-0240	GTD-TR-01-BL-0015
REQ-BL-0240	GTD-TR-01-BL-0026
REQ-BL-0250	GTD-TR-01-BL-0015
REQ-BL-0251	GTD-TR-01-BL-0015
REQ-BL-0260	GTD-TR-01-BL-0015
REQ-BL-0260	GTD-TR-01-BL-0026
REQ-BL-0270	GTD-TR-01-BL-0015
REQ-BL-0270	GTD-TR-01-BL-0026
REQ-BL-0280	GTD-TR-01-BL-0015
REQ-BL-0280	GTD-TR-01-BL-0026
REQ-BL-0281	GTD-TR-01-BL-0015
REQ-BL-0281	GTD-TR-01-BL-0026
REQ-BL-0300	GTD-TR-01-BL-0015
REQ-BL-0303	GTD-TR-01-BL-0015
REQ-BL-0310	GTD-TR-01-BL-0015
REQ-BL-0310	GTD-TR-01-BL-0026
REQ-BL-0320	GTD-TR-01-BL-0015
REQ-BL-0320	GTD-TR-01-BL-0026
REQ-BL-0330	GTD-TR-01-BL-0015
REQ-BL-0330	GTD-TR-01-BL-0026

Downstream	Upstream
REQ-BL-0450	GTD-TR-01-BL-0015
REQ-BL-0451	GTD-TR-01-BL-0015
REQ-BL-0460	GTD-TR-01-BL-0015
REQ-BL-0460	GTD-TR-01-BL-0026
REQ-BL-0470	GTD-TR-01-BL-0015
REQ-BL-0470	GTD-TR-01-BL-0026
REQ-BL-0480	GTD-TR-01-BL-0015
REQ-BL-0480	GTD-TR-01-BL-0026
REQ-BL-0490	GTD-TR-01-BL-0015
REQ-BL-0490	GTD-TR-01-BL-0026
REQ-BL-0500	GTD-TR-01-BL-0015
REQ-BL-0503	GTD-TR-01-BL-0015
REQ-BL-0520	GTD-TR-01-BL-0015
REQ-BL-0520	GTD-TR-01-BL-0026
REQ-BL-0530	GTD-TR-01-BL-0015
REQ-BL-0530	GTD-TR-01-BL-0026
REQ-BL-0550	GTD-TR-01-BL-0015
REQ-BL-0550	GTD-TR-01-BL-0026
REQ-BL-0600	GTD-TR-01-BL-0015
REQ-BL-0602	GTD-TR-01-BL-0015
REQ-BL-0610	GTD-TR-01-BL-0015
REQ-BL-0610	GTD-TR-01-BL-0026
REQ-BL-0620	GTD-TR-01-BL-0015
REQ-BL-0620	GTD-TR-01-BL-0026
REQ-BL-0621	GTD-TR-01-BL-0015
REQ-BL-0621	GTD-TR-01-BL-0026
REQ-BL-0650	GTD-TR-01-BL-0015
REQ-BL-0652	GTD-TR-01-BL-0015
REQ-BL-0660	GTD-TR-01-BL-0015
REQ-BL-0660	GTD-TR-01-BL-0026
REQ-BL-0661	GTD-TR-01-BL-0015
REQ-BL-0661	GTD-TR-01-BL-0026
REQ-BL-0662	GTD-TR-01-BL-0015
REQ-BL-0662	GTD-TR-01-BL-0026
REQ-BL-0663	GTD-TR-01-BL-0015

Downstream	Upstream
REQ-BL-0663	GTD-TR-01-BL-0026
REQ-BL-0670	GTD-TR-01-BL-0015
REQ-BL-0670	GTD-TR-01-BL-0026
REQ-BL-0680	GTD-TR-01-BL-0015
REQ-BL-0680	GTD-TR-01-BL-0026
REQ-BL-0681	GTD-TR-01-BL-0015
REQ-BL-0681	GTD-TR-01-BL-0026
REQ-BL-0682	GTD-TR-01-BL-0015
REQ-BL-0682	GTD-TR-01-BL-0026
REQ-BL-0683	GTD-TR-01-BL-0015
REQ-BL-0683	GTD-TR-01-BL-0026
REQ-BL-0684	GTD-TR-01-BL-0015
REQ-BL-0684	GTD-TR-01-BL-0026
REQ-BL-0685	GTD-TR-01-BL-0015
REQ-BL-0685	GTD-TR-01-BL-0026
REQ-BL-0686	GTD-TR-01-BL-0015
REQ-BL-0686	GTD-TR-01-BL-0026
REQ-BL-0700	GTD-TR-01-BL-0015
REQ-BL-0710	GTD-TR-01-BL-0015
REQ-BL-0710	GTD-TR-01-BL-0026
REQ-BL-0720	GTD-TR-01-BL-0015
REQ-BL-0720	GTD-TR-01-BL-0026
REQ-BL-0730	GTD-TR-01-BL-0015
REQ-BL-0730	GTD-TR-01-BL-0026
REQ-BL-0740	GTD-TR-01-BL-0015
REQ-BL-0740	GTD-TR-01-BL-0026
REQ-BL-0800	GTD-TR-01-BL-0015
REQ-BL-0802	GTD-TR-01-BL-0015
REQ-BL-0831	GTD-TR-01-BL-0015
REQ-BL-0831	GTD-TR-01-BL-0026
REQ-BL-0832	GTD-TR-01-BL-0015
REQ-BL-0832	GTD-TR-01-BL-0026
REQ-BL-0833	GTD-TR-01-BL-0015
REQ-BL-0833	GTD-TR-01-BL-0026
REQ-BL-0834	GTD-TR-01-BL-0015

Downstream	Upstream
REQ-BL-0834	GTD-TR-01-BL-0026
REQ-BL-0850	GTD-TR-01-BL-0015
REQ-BL-0851	GTD-TR-01-BL-0015
REQ-BL-0860	GTD-TR-01-BL-0015
REQ-BL-0860	GTD-TR-01-BL-0026
REQ-BL-0864	GTD-TR-01-BL-0015
REQ-BL-0864	GTD-TR-01-BL-0026
REQ-BL-0870	GTD-TR-01-BL-0015
REQ-BL-0870	GTD-TR-01-BL-0026
REQ-BL-0871	GTD-TR-01-BL-0015
REQ-BL-0871	GTD-TR-01-BL-0026
REQ-BL-0872	GTD-TR-01-BL-0015
REQ-BL-0872	GTD-TR-01-BL-0026
REQ-BL-0873	GTD-TR-01-BL-0015
REQ-BL-0873	GTD-TR-01-BL-0026
REQ-BL-0874	GTD-TR-01-BL-0015
REQ-BL-0874	GTD-TR-01-BL-0026
REQ-BL-0875	GTD-TR-01-BL-0015
REQ-BL-0875	GTD-TR-01-BL-0026
REQ-BL-0876	GTD-TR-01-BL-0015
REQ-BL-0876	GTD-TR-01-BL-0026
REQ-BL-0877	GTD-TR-01-BL-0015
REQ-BL-0877	GTD-TR-01-BL-0026
REQ-BL-0878	GTD-TR-01-BL-0015
REQ-BL-0878	GTD-TR-01-BL-0026
REQ-BL-0879	GTD-TR-01-BL-0015
REQ-BL-0879	GTD-TR-01-BL-0026
REQ-BL-0880	GTD-TR-01-BL-0015
REQ-BL-0880	GTD-TR-01-BL-0026
REQ-BL-0881	GTD-TR-01-BL-0015
REQ-BL-0881	GTD-TR-01-BL-0026
REQ-BL-0882	GTD-TR-01-BL-0015
REQ-BL-0882	GTD-TR-01-BL-0026
REQ-BL-0883	GTD-TR-01-BL-0015
REQ-BL-0883	GTD-TR-01-BL-0026

Downstream	Upstream
REQ-BL-0885	GTD-TR-01-BL-0015
REQ-BL-0885	GTD-TR-01-BL-0026
REQ-BL-0886	GTD-TR-01-BL-0015
REQ-BL-0886	GTD-TR-01-BL-0026
REQ-BL-0900	GTD-TR-01-BL-0015
REQ-BL-0910	GTD-TR-01-BL-0015
REQ-BL-0910	GTD-TR-01-BL-0026
REQ-BL-0920	GTD-TR-01-BL-0015
REQ-BL-0920	GTD-TR-01-BL-0026
REQ-BL-0921	GTD-TR-01-BL-0015
REQ-BL-0921	GTD-TR-01-BL-0026
REQ-BL-0930	GTD-TR-01-BL-0015
REQ-BL-0930	GTD-TR-01-BL-0026
REQ-BL-0931	GTD-TR-01-BL-0015
REQ-BL-0931	GTD-TR-01-BL-0026
REQ-BL-0950	GTD-TR-01-BL-0015
REQ-BL-0960	GTD-TR-01-BL-0015
REQ-BL-0960	GTD-TR-01-BL-0026
REQ-BL-0970	GTD-TR-01-BL-0015
REQ-BL-0970	GTD-TR-01-BL-0026
REQ-BL-0971	GTD-TR-01-BL-0015
REQ-BL-0971	GTD-TR-01-BL-0026
REQ-BL-0980	GTD-TR-01-BL-0015
REQ-BL-0980	GTD-TR-01-BL-0026
REQ-BL-0981	GTD-TR-01-BL-0015
REQ-BL-0981	GTD-TR-01-BL-0026
REQ-BL-1000	GTD-TR-01-BL-0015
REQ-BL-1010	GTD-TR-01-BL-0015
REQ-BL-1010	GTD-TR-01-BL-0026
REQ-BL-1011	GTD-TR-01-BL-0015
REQ-BL-1011	GTD-TR-01-BL-0026
REQ-BL-1012	GTD-TR-01-BL-0015
REQ-BL-1012	GTD-TR-01-BL-0026
REQ-BL-1020	GTD-TR-01-BL-0015
REQ-BL-1031	GTD-TR-01-BL-0015

Downstream	Upstream
REQ-BL-1031	GTD-TR-01-BL-0026
REQ-BL-1032	GTD-TR-01-BL-0015
REQ-BL-1032	GTD-TR-01-BL-0026
REQ-BL-1040	GTD-TR-01-BL-0015
REQ-BL-1051	GTD-TR-01-BL-0015
REQ-BL-1051	GTD-TR-01-BL-0026
REQ-BL-1052	GTD-TR-01-BL-0015
REQ-BL-1052	GTD-TR-01-BL-0026
REQ-BL-1060	GTD-TR-01-BL-0015
REQ-BL-1070	GTD-TR-01-BL-0015
REQ-BL-1070	GTD-TR-01-BL-0026
REQ-BL-1071	GTD-TR-01-BL-0015
REQ-BL-1071	GTD-TR-01-BL-0026
REQ-BL-1080	GTD-TR-01-BL-0015
REQ-BL-1091	GTD-TR-01-BL-0015
REQ-BL-1091	GTD-TR-01-BL-0026
REQ-BL-1092	GTD-TR-01-BL-0015
REQ-BL-1092	GTD-TR-01-BL-0026
REQ-BL-1100	GTD-TR-01-BL-0015
REQ-BL-1120	GTD-TR-01-BL-0015
REQ-BL-1120	GTD-TR-01-BL-0026
REQ-BL-1121	GTD-TR-01-BL-0015
REQ-BL-1121	GTD-TR-01-BL-0026
REQ-BL-1122	GTD-TR-01-BL-0015
REQ-BL-1122	GTD-TR-01-BL-0026
REQ-BL-1130	GTD-TR-01-BL-0015
REQ-BL-1130	GTD-TR-01-BL-0026
REQ-BL-1131	GTD-TR-01-BL-0015
REQ-BL-1131	GTD-TR-01-BL-0026
REQ-BL-1200	GTD-TR-01-BL-0015
REQ-BL-1201	GTD-TR-01-BL-0015
REQ-BL-1210	GTD-TR-01-BL-0015
REQ-BL-1210	GTD-TR-01-BL-0026
REQ-BL-1211	GTD-TR-01-BL-0015
REQ-BL-1211	GTD-TR-01-BL-0026

Downstream	Upstream
REQ-BL-1220	GTD-TR-01-BL-0015
REQ-BL-1230	GTD-TR-01-BL-0015
REQ-BL-1230	GTD-TR-01-BL-0026
REQ-BL-1231	GTD-TR-01-BL-0015
REQ-BL-1231	GTD-TR-01-BL-0026
REQ-BL-1232	GTD-TR-01-BL-0015
REQ-BL-1232	GTD-TR-01-BL-0026
REQ-BL-1240	GTD-TR-01-BL-0015
REQ-BL-1250	GTD-TR-01-BL-0015
REQ-BL-1250	GTD-TR-01-BL-0026
REQ-BL-1251	GTD-TR-01-BL-0015
REQ-BL-1251	GTD-TR-01-BL-0026
REQ-BL-1252	GTD-TR-01-BL-0015
REQ-BL-1252	GTD-TR-01-BL-0026
REQ-BL-1260	GTD-TR-01-BL-0015
REQ-BL-1270	GTD-TR-01-BL-0015
REQ-BL-1270	GTD-TR-01-BL-0026
REQ-BL-1271	GTD-TR-01-BL-0015
REQ-BL-1271	GTD-TR-01-BL-0026
REQ-BL-1300	GTD-TR-01-BL-0015
REQ-BL-1320	GTD-TR-01-BL-0015
REQ-BL-1340	GTD-TR-01-BL-0015
REQ-BL-1360	GTD-TR-01-BL-0015
REQ-BL-1380	GTD-TR-01-BL-0015
REQ-BL-1381	GTD-TR-01-BL-0015
REQ-BL-1381	GTD-TR-01-BL-0026
REQ-BL-1400	GTD-TR-01-BL-0016
REQ-BL-1420	GTD-TR-01-BL-0019
REQ-BL-1421	GTD-TR-01-BL-0019
REQ-BL-1422	GTD-TR-01-BL-0019
REQ-BL-1500	GTD-TR-01-BL-0006
REQ-BL-1501	GTD-TR-01-BL-0006
REQ-BL-1502	GTD-TR-01-BL-0005
REQ-BL-1503	GTD-TR-01-BL-0005
REQ-BL-1504	GTD-TR-01-BL-0005

Downstream	Upstream
REQ-BL-1600	GTD-TR-01-BL-0014
REQ-BL-1800	GTD-TR-01-BL-0001
REQ-BL-1900	GTD-TR-01-BL-0002
REQ-BL-1901	GTD-TR-01-BL-0007
REQ-BL-1902	SoW Sec.3.5
REQ-BL-2000	GTD-TR-01-BL-0017

Table 7.2: Traceability upstream

8 Logical Model Description

The BL is a passive software module. It is never an actor but instead is used by other software components to evaluate the results of elementary mathematical functions.

RESOURCES	ACTIVITIES	OUTPUTS
Newlib's libm will be used as a base to work on	Evaluate elementary mathematical functions based on input provided by other software components calling this library	Return the results to the caller software component for further use

Table 8.1: Program logic model

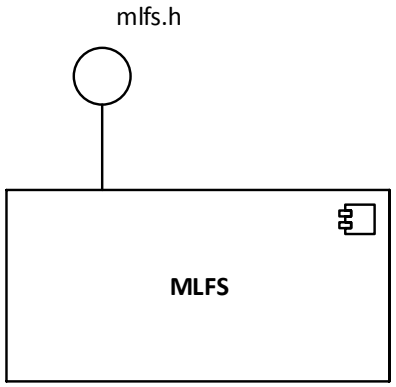

Figure 8.1: Logical component model of the Basic Library

The figure 8.1 describes the logical component model of the Basic Library as an UML component diagram. It includes the component for access from C programs.

The Basic Library itself consists of a single component providing a function interface compatible to the following functions of ISO C99 `math.h`:

- `sin`
- `asin`
- `cos`
- `acos`
- `tan`
- `atan`
- `atan2`
- `sqrt`

- `exp`
- `pow`
- `log`
- `log10`
- `fabs`
- `round`
- `floor`
- `trunc`
- `ceil`
- `fmod`
- `modf`
- `fim`
- `fmax`
- `hypot`
- `isfinite`
- `isinf`
- `isnan`
- `signbit`
- `copysign`

And additional functions not present in `math.h`:

- `deg2rad`
- `rem2pi`