
PROPOSAL FOR A STANDARD VHDL MATHEMATICAL PACKAGE

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Abstract

As part of the VHDL standardization activities, an IEEE working group has been created to gather information and put together a proposal for a set of standard VHDL Mathematical Packages that include most oftenly used real and complex elementary functions with floating point real and complex arguments.

This type of functionality can be supported by IEEE 1076, but there is not a set of standard definitions provided in IEEE 1076 for this purpose.

The idea behind this effort is to provide a set of standard definitions that can help increase the portability and interoperability of models that make use of this type of functionality.

This paper will present the status of the working group, the intended schedule, as well as the current proposal for the contents of these packages.

Handouts

Proposal for a Standard VHDL Mathematical Package

October 20, 1992

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Agenda

- Objectives
- Motivation
- Working Group
- Design Process
- Plans
- Status and Schedule
- Deliverables
- Strawman Proposal
- Concluding Remarks

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Objectives

A set of standard VHDL Mathematical Packages that include:

- **most oftenly used real and complex elementary functions, and**
- **required data types and type conversion functions**

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Motivation

- **Lack of a set of standard definitions in IEEE 1076 for this purpose**
- **Need for portability and interoperability of models that use this functionality**
- **Need for efficient implementation for simulation**

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Working Group

- An IEEE working subgroup has been created
- Current active group members are
 - Jose A. Torres (chair), Synopsys, Inc.
 - Donald F. Hanson, University of Mississippi
 - Charles Swart, Mentor Graphics Corp.
 - Alex Zamfirescu, Vantage
 - Others are welcome !
- First meeting took place on June 13, 1992

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Design Process

- 1) Set General Scope and Objectives
- 2) Gather Requirements
- 3) Design the Package's Definition and Body
- 4) Document
- 5) Validate
- 6) Ballot
- 7) Negative Ballot Review
- 8) Publish Finalized/Approved Standard

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Plans

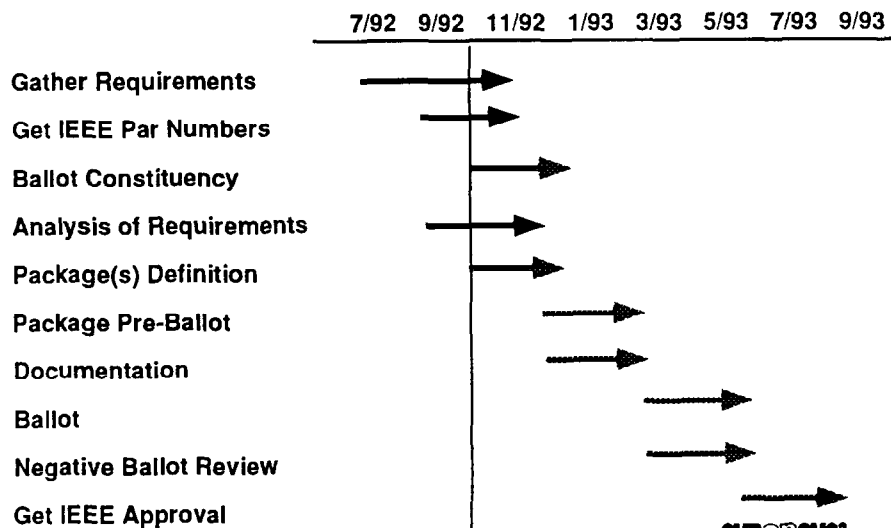
- Broadcast information and look for participants
- Review work done for other languages (e.g., ADA, C) for same functionality
- Get par number(s) for the package(s)
- Collect information from VHDL community
- Study 1992 changes impact (e.g., global var. & priv. types)
- Put together proposal
- Distribute proposal for feedback

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Status and Schedule



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Deliverables

- **Two or more VHDL packages with basic functionality from which other functions can be built:**
 - All in standard VHDL
 - An implementation may modify the package body, as long as the functionality is preserved as documented.
- **Documentation for the packages**
- **Set of test benches to validate simulation results:**
 - Not part of the standard

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Package Names

- **Library: IEEE**
- **MATH_REAL** for real elementary functions.
XXXX_STD when par number gets assigned.
- **MATH_COMPLEX** for complex elementary functions.
YYYY_STD when par number gets assigned.

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Straw Proposal -- Data Types for MATH_Real

- Floating point type name: REAL
- Package where is defined: STD.STANDARD
- Valid REAL ranges: minimum -1.0E38 to +1.0E38
- Representation precision: minimum 6 fractional digits
- Arithmetic operations predefined (+, -, *, /)
- Comparison operations predefined (=, <, >, <=, >=, /=)
- Detection of invalid parameters for out of range or overflow conditions is required

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Straw Proposal -- Constants for MATH_Real

```
constant CNST_E : real := 2.718281_828469; -- value of e
constant CNST_PI : real := 3.141592_653589; -- value of pi
constant LOG_OF_2: real := 0.693147_180559; -- natural log of 2
constant LOG_OF_10: real := 2.302585_092994; -- natural log of 10
constant SQRT_OF_2: real := 1.414213_562373; -- sqrt of 2
```

NOTE: Requirement is to support at least 6 fractional digits

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Straw Proposal -- Functions for MATH_Real I

function **SIGN** (X: real; Y: real) return real;

SIGN -- returns value of X with sign of Y

MAX **MIN**

function **ABS** (X: real) return real;

ABS

function **ROUND** (X: real) return integer;

ROUND **CEILING** **FLOOR**

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Straw Proposal -- Functions for MATH_Real II

function **INIT_SEED** (seed: natural) return natural;

-- set value of seed for sequence of pseudo-random numbers.
-- The seed value (a global variable -- as per LCS46 in VHDL 1992)
-- is used and modified by the function **RANDOM()**.
-- Returns previous seed value.

function **RANDOM** () return real;

-- Returns pseudo-random number uniformly distributed between 0 & 1
-- Uses global for seed set by the **init_seed()** function, as per LCS44 in
-- VHDL 1992

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Straw Proposal -- Functions for MATH_Real III

```
function ■ (X: real) return real;  
  SQRT  
  LOG  LOG10  EXP  
  SIN  COS  TAN  X in radians  
  ASIN  ACOS  ATAN  
  SINH  COSH  TANH  ASINH  ACOSH  ATANH  
  
function ■ (X: real; Y: real) return real;  
  ATAN2  "****"  
  
function "****" (X: real; Y: integer) return real;  
function "****" (X: integer; Y: real) return real;
```

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Straw Proposal -- Data Types for MATH_Complex

```
subtype RADIANS is real range -CNST_PI to CNST_PI;  
  
type COMPLEX is record  
  CREAL, CIMAG: real;  
end record;  
  
type COMPLEX_VECTOR is array (integer range <>) of COMPLEX;  
  
type COMPLEX_POLAR is record  
  CMAG: real; CANG: radians;  
end record;
```

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Straw Proposal -- Functions for MATH_Complex I

function **■** (CV: complex) return complex;

"-" **CONJ** **CEXP**

function **■** (CV: complex) return real;

CREAL **CIMAG** **CABS**

function **CANG** (CV:complex) return radians;

function **CMPLX** (X, Y : real) return complex;

function **CSQRT** (CV : complex) return complex_vector;

function **■** (L: complex; R: complex) return boolean;

= **<** **>** **<=** **>=** **/=**

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Straw Proposal -- Functions for MATH_Complex II

function **■** (L: complex; R: complex) return complex;

+ **-** ***** **/**

function **■** (L: complex; R: real) return complex;

+ **-** ***** **/**

function **■** (L: real; R: complex) return complex;

+ **-** ***** **/**

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Current Discussion Topics

- Accuracy and Digits of Precision
- Portability and Platform Independence
- Overlaps with IEEE 1076-1992
- Error Detection
- Floating Point Comparisons for Equality
- Use of foreign functions (non-VHDL) or customized VHDL bodies by an implementation
- Quality of random number generator
- Additional Requirements

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Concluding Remarks

- An overview of the VHDL Mathematical Package work has been presented
- The design work has just started and is in the process of gathering requirements
- Work on the VHDL Mathematical Package will continue through March 1993
- Active participants and submission of requirements is highly desired and needed!

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