

Module Interface Specification for Glass-BR

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Contents

1	Introduction	5
2	Notation	5
3	Module Hierarchy	5
4	MIS of Control Module	6
4.1	Module	6
4.2	Uses	6
4.3	Syntax	6
4.3.1	Exported Constants	6
4.3.2	Exported Access Programs	6
4.4	Semantics	6
4.4.1	State Variables	6
4.4.2	Access Routine Semantics	6
5	MIS of Input Module	8
5.1	Module	8
5.2	Uses	8
5.3	Syntax	8
5.4	Semantics	9
5.4.1	Environment Variables	9
5.4.2	State Variables	9
5.4.3	Assumptions	9
5.4.4	Access Routine Semantics	10
5.5	Considerations	11
6	MIS of LoadASTM Module	12
6.1	Module	12
6.2	Uses	12
6.3	Syntax	12
6.3.1	Exported Constants	12
6.3.2	Exported Access Programs	12
6.4	Semantics	12
6.4.1	Environment Variables	12
6.4.2	State Variables	12
6.4.3	State Invariant	12
6.4.4	Assumptions	12
6.4.5	Access Routine Semantics	12

7	MIS of Calc Module	14
7.1	Module	14
7.2	Uses	14
7.3	Syntax	14
7.3.1	Exported Constants	14
7.3.2	Exported Access Programs	14
7.4	Semantics	14
7.4.1	State Variables	14
7.4.2	State Invariant	14
7.4.3	Assumptions	14
7.4.4	Access Routine Semantics	15
8	MIS of GlassType ADT Module	16
8.1	Template Module	16
8.2	Uses	16
8.3	Syntax	16
8.3.1	Exported Constants	16
8.3.2	Exported Types	16
8.3.3	Exported Access Programs	16
8.4	Semantics	16
8.4.1	State Variables	16
8.4.2	State Invariant	16
8.4.3	Assumptions	16
8.4.4	Access Routine Semantics	17
9	MIS of Thickness ADT Module	18
9.1	Template Module	18
9.2	Uses	18
9.3	Syntax	18
9.3.1	Exported Constants	18
9.3.2	Exported Types	18
9.3.3	Exported Access Programs	18
9.4	Semantics	18
9.4.1	State Variables	18
9.4.2	State Invariant	18
9.4.3	Assumptions	18
9.4.4	Access Routine Semantics	19
10	MIS of FunctADT Module	20
10.1	Template Module	20
10.2	Uses	20
10.3	Syntax	20
10.3.1	Exported Constants	20

10.3.2	Exported Types	20
10.3.3	Exported Access Programs	20
10.4	Semantics	20
10.4.1	State Variables	20
10.4.2	State Invariant	21
10.4.3	Assumptions	21
10.4.4	Access Routine Semantics	21
10.5	Considerations	21
11	MIS of ContoursADT Module	22
11.1	Template Module	22
11.2	Uses	22
11.3	Syntax	22
11.3.1	Exported Constants	22
11.3.2	Exported Types	22
11.3.3	Exported Access Programs	22
11.4	Semantics	22
11.4.1	State Variables	22
11.4.2	State Invariant	22
11.4.3	Assumptions	23
11.4.4	Access Routine Semantics	23
12	MIS of SeqServices Module	25
12.1	Module	25
12.2	Uses	25
12.3	Syntax	25
12.3.1	Exported Constants	25
12.3.2	Exported Access Programs	25
12.4	Semantics	25
12.4.1	State Variables	25
12.4.2	State Invariant	25
12.4.3	Assumptions	25
12.4.4	Access Routine Semantics	25
13	MIS of Output Module	27
13.1	Module	27
13.2	Uses	27
13.3	Syntax	27
13.3.1	Exported Constants	27
13.3.2	Exported Access Programs	27
13.4	Semantics	27
13.4.1	Environment Variables	27
13.4.2	State Variables	27

13.4.3	State Invariant	27
13.4.4	Assumptions	27
13.4.5	Access Routine Semantics	28
14	MIS of Constants Module	29
14.1	Module	29
14.2	Uses	29
14.3	Syntax	29
14.3.1	Exported Constants	29
14.3.2	Exported Types	29
14.3.3	Exported Access Programs	29
14.4	Semantics	29
14.4.1	State Variables	29
14.4.2	State Invariant	30
15	MIS of Hardware Module	31
15.1	Module	31
15.2	Uses	31

1 Introduction

The following document details the Module Interface Specifications for the implemented modules in the program Glass-BR. It is intended to ease navigation through the program for design and maintenance purposes. Complementary documents include the [System Requirement Specifications](#) (SRS) and [Module Guide](#) (MG). The full documentation and implementation can be found at <https://github.com/smiths/caseStudies/tree/master/CaseStudies/glass>.

2 Notation

The structure of the MIS for modules comes from ?, with the addition that template modules have been adapted from ?. The mathematical notation comes from Chapter 3 of ?. For instance, the symbol $:=$ is used for a multiple assignment statement and conditional rules follow the form $(c_1 \Rightarrow r_1 | c_2 \Rightarrow r_2 | \dots | c_n \Rightarrow r_n)$.

The following table summarizes the primitive data types used by Glass-BR

Data Type	Notation	Description
character	char	a single symbol or digit
integer	\mathbb{Z}	a number without a fractional component in $(-\infty, \infty)$
natural number	\mathbb{N}	a number without a fractional component in $[1, \infty)$
real	\mathbb{R}	any number in $(-\infty, \infty)$
string	\mathbb{S}	all finite sequences of symbols from the ASCII character set

The specification of Glass-BR uses some derived data types: sequences, strings, and tuples. Sequences are lists that represent a countable number of ordered values of the same data type, where the same value may occur more than once. Strings are sequences of characters. Tuples contain a list of values, potentially of different types. In addition, Glass-BR uses functions, which are defined by the data types of their inputs and outputs. Local functions are described by giving their type signature followed by their specification.

3 Module Hierarchy

To view the Module Hierarchy, see section 3 of the [MG](#).

4 MIS of Control Module

4.1 Module

Control

4.2 Uses

Input (Section 5), LoadASTM (Section 6), Calc (Section 7), Output (Section 13)

4.3 Syntax

4.3.1 Exported Constants

sTSD = # *String for path and filename for TSD file*
sSDF = # *String for path and filename for SDF file*
sIn = # *String for path and filename for Input file*
sOut = # *String for path and filename for Output file*

4.3.2 Exported Access Programs

Name	In	Out	Exceptions
main	-	-	-

4.4 Semantics

4.4.1 State Variables

cTSD: ContoursT
cSDF: ContoursT
 $q : \mathbb{R}$
 $\hat{q} : \mathbb{R}$
 $J_{\text{tol}} : \mathbb{R}$
 $J : \mathbb{R}$
 $\hat{q}_{\text{tol}} : \mathbb{R}$
 $B : \mathbb{R}$
 $P_b : \mathbb{R}$
NFL : \mathbb{R}
LR : \mathbb{R}
is_safePb : \mathbb{B}
is_safeLR : \mathbb{B}

4.4.2 Access Routine Semantics

main():

- transition: Using the steps below, modify the state variables of this module, the state of the Input module, and the environment variable for the Output module.
 - $cTSD = LoadASTM.LoadTSD(sTSD)$
 - $cSDF = LoadASTM.LoadSDF(sSDF)$
 - $Input.load_params(sIn)$
 - $q = cTSD.eval(Input.SD, Input.w * Input.TNT) \# \textit{From SRS IM3}$
 - $\hat{q} = Calc.calc_q_hat(q)$
 - $J_{tol} = Calc.calc_J_tol()$
 - $J = cSDF.evaly(Input.AR, \hat{q}) \# \textit{From SRS DD4}$
 - $\hat{q}_{tol} = cSDF.eval(Input.AR, J_{tol}) \# \textit{From SRS DD8}$
 - $B = Calc.calc_B(J)$
 - $P_b = Calc.calc_Pb(B)$
 - $NFL = Calc.calc_NFL(\hat{q}_{tol})$
 - $LR = Calc.calc_LR(NFL)$
 - $is_safePb = Calc.calc_is_safePb(P_b)$
 - $is_safeLR = Calc.calc_is_safeLR(LR, q)$
 - $Output.output(sOut, is_safePb, is_safeLR, P_b, B, LR, q, J, NFL, \hat{q}, \hat{q}_{tol}, J_{tol})$
 - $print(\text{“Main has been executed and the results have been written to ”} + sOut)$

5 MIS of Input Module

The secrets of this module are the data structure for input parameters, how the values are input and how the values are verified. The load and verify secrets are isolated to their own access programs. This module follows the singleton pattern; that is, there is only one instance of this module.

5.1 Module

Input

5.2 Uses

GlassTypeADT (Section 8), ThicknessADT (Section 9), Constants (Section 14), Hardware (Section 15)

5.3 Syntax

Name	In	Out	Exceptions
load_params	string	-	FileError
verify_params	-	-	ValueError
a	-	\mathbb{R}	
b	-	\mathbb{R}	
w	-	\mathbb{R}	
$P_{b_{tol}}$	-	\mathbb{R}	
TNT	-	\mathbb{R}	
SD_x	-	\mathbb{R}	
SD_y	-	\mathbb{R}	
SD_z	-	\mathbb{R}	
g	-	GlassTypeT	
t	-	ThicknessT	
m	-	\mathbb{R}	
k	-	\mathbb{R}	
E	-	\mathbb{R}	
t_d	-	\mathbb{R}	
LDF	-	\mathbb{R}	
LSF	-	\mathbb{R}	
h	-	\mathbb{R}	
GTF	-	\mathbb{R}	
SD	-	\mathbb{R}	
AR	-	\mathbb{R}	

5.4 Semantics

5.4.1 Environment Variables

inputFile: sequence of string $\#f[i]$ is the i th string in the text file f

5.4.2 State Variables

$\#$ From SRS R1

$a: \mathbb{R}$

$b: \mathbb{R}$

$w: \mathbb{R}$

$P_{b_{tol}}: \mathbb{R}$

TNT: \mathbb{R}

$SD_x: \mathbb{R}$

$SD_y: \mathbb{R}$

$SD_z: \mathbb{R}$

g : GlassTypeT

t : ThicknessT

$\#$ From SRS R2

$m: \mathbb{R}$

$k: \mathbb{R}$

$E: \mathbb{R}$

$t_d: \mathbb{R}$

LDF: \mathbb{R}

LSF: \mathbb{R}

$h: \mathbb{R}$

GTF: \mathbb{R}

SD: \mathbb{R}

AR: \mathbb{R}

5.4.3 Assumptions

- load_params will be called before the values of any state variables will be accessed.
- The file contains the string equivalents of the numeric values for each input parameter in order, each on a new line. The order is the same as in the table in R1 of the SRS. Any comments in the input file should be denoted with a '#' symbol.

5.4.4 Access Routine Semantics

a:

- output: $out := a$
- exception: none

b:

- output: $out := b$
- exception: none

...

GTF:

- output: $out := \text{GTF}$
- exception: none

load_params(*s*):

- transition: The filename *s* is first associated with the file f. inputFile is used to modify the state variables using the following procedural specification:
 1. Read data sequentially from inputFile to populate the state variables from SRS R1 (*a* to *w*).
 2. Calculate the derived quantities (all other state variables, from SRS R2) as follows:
 - m, k, E, t_d, LSF as defined in Constants (Section 14)
 - $\text{LDF} = (\frac{t_d}{60})^{m/16} \# \text{From SRS DD3}$
 - $h = t.\text{toMinThick}()$ (Section 9)
 - $\text{GTF} = g.\text{GTF}()$ (Section 8)
 - $\text{SD} = \sqrt{\text{SD}_x^2 + \text{SD}_y^2 + \text{SD}_z^2} \# \text{From SRS DD10}$
 - $\text{AR} = a/b \# \text{From SRS DD11}$
 3. verify_params()
- exception: $\text{exc} := \text{a file name } s \text{ cannot be found OR the format of inputFile is incorrect} \Rightarrow \text{FileError}$

verify_params():

- out: $out := \text{none}$
- exception: $\text{exc} := \# \text{From the SRS Table 2, R3}$

$\neg(a > 0)$	$\Rightarrow \text{ValueError}(\text{"dimension } a \text{ must be positive"})$
$\neg(\text{AR} \geq 0)$	$\Rightarrow \text{ValueError}(\text{"}a \text{ must be equal to, or greater than, } b\text{"})$
$\neg(d_{\min} \leq a \leq d_{\max})$	$\Rightarrow \text{ValueError}(\text{"}a \text{ too large or small"})$
$\neg(\text{AR} < \text{AR}_{\max})$	$\Rightarrow \text{ValueError}(\text{"Allowable aspect ratio exceeded"})$
$\neg(b > 0)$	$\Rightarrow \text{ValueError}(\text{"dimension } b \text{ must be positive"})$
$\neg(d_{\min} \leq b \leq d_{\max})$	$\Rightarrow \text{ValueError}(\text{"}b \text{ too large or small"})$
$\neg(0 < P_{\text{tol}} < 1)$	$\Rightarrow \text{ValueError}(\text{"}P_{\text{tol}} \text{ must lie between 0 and 1"})$
$\neg(w \geq 0)$	$\Rightarrow \text{ValueError}(\text{"charge weight } w \text{ must be greater or equal to zero"})$
$\neg(w_{\min} < w < w_{\max})$	$\Rightarrow \text{ValueError}(\text{"charge weight } w \text{ is too small or too large"})$
$\neg(\text{TNT} > 0)$	$\Rightarrow \text{ValueError}(\text{"TNT must be positive"})$
$\neg(\text{SD} > 0)$	$\Rightarrow \text{ValueError}(\text{"stand off distance (SD) must be positive"})$
$\neg(\text{SD}_{\min} < \text{SD} < \text{SD}_{\max})$	$\Rightarrow \text{ValueError}(\text{"stand off distance (SD) is too small or too large"})$

5.5 Considerations

The value of each state variable can be accessed through its name (getter). An access program is available for each state variable. There are no setters for the state variables, since the values will be set and checked by load params and not changed for the life of the program.

6 MIS of LoadASTM Module

6.1 Module

LoadASTM

6.2 Uses

FunctADT (Section 10), ContoursADT (Section 11)

6.3 Syntax

6.3.1 Exported Constants

None

6.3.2 Exported Access Programs

Routine name	In	Out	Exceptions
LoadTSD	$s : \text{string}$	ContoursT	FileError
LoadSDF	$s : \text{string}$	ContoursT	FileError

6.4 Semantics

6.4.1 Environment Variables

infile: two dimensional sequence of text characters

6.4.2 State Variables

None

6.4.3 State Invariant

None

6.4.4 Assumptions

The input file will match the given specification.

6.4.5 Access Routine Semantics

LoadTSD(s)

- output: Create *out* following the following steps. Read data from the file infile associated with the string *s*. Use this data to create a ContoursT object. For each value of *w* create an object of FunctT and add it to the ContoursT object. Each of the FunctT objects will consist of *q* versus SD data. The first row of the TSD file contains the values of *w*. The subsequent columns are grouped in pairs. Each pair corresponds to a column of SD data and a column of *q* data. There is a pair of columns in this pattern for each value of *w*.
- exception: exc := a file name *s* cannot be found OR the format of inputFile is incorrect
⇒ FileError

LoadSDF(*s*)

- output: Create *out* following the following steps. Read data from the file infile associated with the string *s*. Use this data to create a ContoursT object. For each value of *J* create an object of Funct T and add it to the ContoursT object. Each of the FunctT objects will consist of q^* versus AR data. The first row of the SDF file contains the values of *J*. The subsequent columns are grouped in pairs. Each pair corresponds to a column of AR data and a column of q^* data. There is a pair of columns in this pattern for each value of *J*.
- exception: exc := a file name *s* cannot be found OR the format of inputFile is incorrect
⇒ FileError

7 MIS of Calc Module

7.1 Module

Calc

7.2 Uses

Input (Section 5), ContoursADT (Section 11), Constants (Section 14)

7.3 Syntax

7.3.1 Exported Constants

None

7.3.2 Exported Access Programs

Routine name	In	Out	Exceptions
calc_q_hat	$q : \mathbb{R}$	\mathbb{R}	-
calc_J_tol		\mathbb{R}	-
calc_Pb	$B : \mathbb{R}$	\mathbb{R}	InvalidOutput
calc_B	$J : \mathbb{R}$	\mathbb{R}	-
calc_NFL	$\hat{q}_{\text{tol}} : \mathbb{R}$	\mathbb{R}	-
calc_LR	$\text{NFL} : \mathbb{R}$	\mathbb{R}	-
calc_is_safePb	$P_b : \mathbb{R}$	\mathbb{B}	-
calc_is_safeLR	$\text{LR} : \mathbb{R}, q : \mathbb{R}$	\mathbb{B}	-

7.4 Semantics

7.4.1 State Variables

None

7.4.2 State Invariant

None

7.4.3 Assumptions

None

7.4.4 Access Routine Semantics

$\text{calc_q_hat}(q) \# \text{From SRS DD7 Dimensionless Load } (\hat{q})$

- output: $out := \frac{q(ab)^2}{Eh^4\text{GTF}}$
- exception: None

$\text{calc_J_tol}() \# \text{From SRS DD9 Tolerable Stress Distribution Factor } (J_{tol})$

- output: $out := \ln[\ln(\frac{1}{1-P_{b_{tol}}}) \frac{(a \times b)^{m-1}}{k(Eh^2)^m \text{LDF}}]$
- exception: None

$\text{calc_Pb}(B) \# \text{From SRS IM1 Probability of Glass Breakage}$

- output: $out := 1 - e^{-B}$
- exception: $\neg(0 < (1 - e^{-B}) < 1) \Rightarrow \text{InvalidOutput} \# \text{From SRS Table 3, Output Variables}$

$\text{calc_B}(J) \# \text{From SRS DD1 Risk of Failure } (B)$

- output: $out := \frac{k}{(a \times b)^{m-1}} (Eh^2)^m \times \text{LDF} \times e^J$
- exception: None

$\text{calc_NFL}(\hat{q}_{tol}) \# \text{From SRS DD5 Non-Factored Load}$

- output: $out := \frac{\hat{q}_{tol} Eh^4}{(ab)^2}$
- exception: None

$\text{calc_LR}(\text{NFL}) \# \text{From SRS IM2 Calculation of Capacity } (LR)$

- output: $out := \text{NFL} \times \text{GTF} \times \text{LSF}$
- exception: None

$\text{calc_is_safePb}(P_b) \# \text{From SRS T1 Safety Req-Pb}$

- output: $out := P_b < P_{b_{tol}}$
- exception: None

$\text{calc_is_safeLR}(\text{LR}, q) \# \text{From SRS T2 Safety Req-LR}$

- output: $out := \text{LR} > q$
- exception: None

8 MIS of GlassType ADT Module

From DD6 (Glass Type Factor (GTF))

8.1 Template Module

GlassTypeADT

8.2 Uses

None

8.3 Syntax

8.3.1 Exported Constants

None

8.3.2 Exported Types

GlassTypeT = ?

8.3.3 Exported Access Programs

Routine name	In	Out	Exceptions
new GlassTypeT	\$	GlassTypeT	ValueError
GTF		\mathbb{R}	
toString		\$	

8.4 Semantics

8.4.1 State Variables

g : {AN, FT, HS}

8.4.2 State Invariant

None

8.4.3 Assumptions

None

8.4.4 Access Routine Semantics

new GlassTypeT(s):

- transition: $g := (s = \text{“AN”} \Rightarrow \text{AN} | s = \text{“FT”} \Rightarrow \text{FT} | s = \text{“HS”} \Rightarrow \text{HS})$
- output: $out := \text{self}$
- exception: $(\neg(s \in \{\text{“AN”}, \text{“FT”}, \text{“HS”}\}) \Rightarrow \text{ValueError})$

GTF():

- output: $out := (g = \text{AN} \Rightarrow 1.0 | g = \text{FT} \Rightarrow 4.0 | g = \text{HS} \Rightarrow 2.0)$
- exception: None

toString():

- output: $out := (g = \text{AN} \Rightarrow \text{“AN”} | g = \text{FT} \Rightarrow \text{“FT”} | g = \text{HS} \Rightarrow \text{“HS”})$
- exception: None

9 MIS of Thickness ADT Module

From DD2 (Minimum Thickness from Nominal Thickness)

9.1 Template Module

ThicknessADT

9.2 Uses

None

9.3 Syntax

9.3.1 Exported Constants

None

9.3.2 Exported Types

ThicknessT = ?

9.3.3 Exported Access Programs

Routine name	In	Out	Exceptions
new ThicknessT	\mathbb{R}	ThicknessT	ValueError
toMinThick		\mathbb{R}	
toFloat		\mathbb{R}	

9.4 Semantics

9.4.1 State Variables

$t : T$ where $T = \{2.5, 2.7, 3.0, 4.0, 5.0, 6.0, 8.0, 10.0, 12.0, 16.0, 19.0, 22.0\}$

9.4.2 State Invariant

None

9.4.3 Assumptions

None

9.4.4 Access Routine Semantics

new ThicknessT(x):

- transition: $t := x$
- output: $out := self$
- exception: $(\neg(x \in T) \Rightarrow \text{ValueError})$

toMinThick():

- output:

$t = 2.5 \Rightarrow 2.16$	$t = 2.7 \Rightarrow 2.59$	
$t = 3.0 \Rightarrow 2.92$	$t = 4.0 \Rightarrow 3.78$	
$t = 5.0 \Rightarrow 4.57$	$t = 6.0 \Rightarrow 5.56$	
$t = 8.0 \Rightarrow 7.42$	$t = 10.0 \Rightarrow 9.02$	
$t = 12.0 \Rightarrow 11.91$	$t = 16.0 \Rightarrow 15.09$	
$t = 19.0 \Rightarrow 18.26$	$t = 22.0 \Rightarrow 21.44$)
- exception: None

toFloat():

- output: $out := t$
- exception: None

10 MIS of FunctADT Module

10.1 Template Module

FunctADT

10.2 Uses

SeqServices (Section 12)

10.3 Syntax

10.3.1 Exported Constants

MAX_ORDER = 2

10.3.2 Exported Types

FunctT = ?

10.3.3 Exported Access Programs

Routine name	In	Out	Exceptions
new FunctT	$X_{\text{in}} : \mathbb{R}^n, Y_{\text{in}} : \mathbb{R}^n, i : \mathbb{N}$	FunctT	IndepVarNotAscending, SeqSizeMismatch, InvalidInterpOrder, TooFewDataPts
minD		\mathbb{R}	
maxD		\mathbb{R}	
order		\mathbb{N}	
eval	$x : \mathbb{R}$	\mathbb{R}	OutOfDomain

10.4 Semantics

10.4.1 State Variables

X: \mathbb{R}^n

Y: \mathbb{R}^n

minx: \mathbb{R}

maxx: \mathbb{R}

o: \mathbb{N}

10.4.2 State Invariant

None

10.4.3 Assumptions

None

10.4.4 Access Routine Semantics

new FunctT($X_{\text{in}}, Y_{\text{in}}, i$):

- transition: $X, Y, \text{minx}, \text{maxx}, o := X_{\text{in}}, Y_{\text{in}}, X_{\text{in}}[0], X_{\text{in}}[|X| - 1], i$
- output: $out := \text{self}$
- exception: $(\neg \text{isAscending}(X_{\text{in}}) \Rightarrow \text{IndepVarNotAscending} || |X_{\text{in}}| \neq |Y_{\text{in}}| \Rightarrow \text{SeqSizeMismatch} | i \notin [1..MAX_ORDER] \Rightarrow \text{InvalidInterpOrder} || |X_{\text{in}}| < 3 \Rightarrow \text{TooFewDataPts})$

minD():

- output: $out := \text{minx}$
- exception: None

maxD():

- output: $out := \text{maxx}$
- exception: None

order():

- output: $out := o$
- exception: None

eval(x):

- output: $out :=$
 $(o = 1 \Rightarrow \text{interpLin}(X_i, Y_i, X_{i+1}, Y_{i+1}, x) || o = 2 \Rightarrow \text{interpQuad}(X_{i-1}, Y_{i-1}, X_i, Y_i, X_{i+1}, Y_{i+1}, x))$
where $i = \text{index}(X, x)$
- exception: $(\neg(\text{minx} \leq x \leq \text{maxx}) \Rightarrow \text{OutOfDomain}) || \neg(1 \leq \text{index}(X, x) \leq |X| - 2) \Rightarrow \text{OutOfDomain}) \#$ *first check if within domain, then make sure not too close to edge, so quadratic interpolation is defined*

10.5 Considerations

For simplicity the function evaluation is not defined within one step of the boundaries. By considering the special cases it would be possible to get right to the edge.

11 MIS of ContoursADT Module

11.1 Template Module

ContoursADT

11.2 Uses

FunctADT (Section 10) for FunctT

11.3 Syntax

11.3.1 Exported Constants

MAX_ORDER = 2

11.3.2 Exported Types

ContoursT = ?

11.3.3 Exported Access Programs

Routine name	In	Out	Exceptions
new ContoursT	$i : \mathbb{R}$		InvalidInterpOrder
add	$s: \text{FunctT}, z : \mathbb{R}$		IndepVarNotAscending
getC	$i : \mathbb{N}$		InvalidIndex
eval	$x : \mathbb{R}, z : \mathbb{R}$		OutOfDomain
evaly	$x : \mathbb{R}, y : \mathbb{R}$		OutOfDomain
slice	$x : \mathbb{R}, \text{flip} : \mathbb{B}$	FunctT	

11.4 Semantics

11.4.1 State Variables

S : sequence of FunctT

Z : sequence of \mathbb{R}

o : \mathbb{N}

11.4.2 State Invariant

None

11.4.3 Assumptions

None

11.4.4 Access Routine Semantics

new ContoursT(i):

- transition: $S, Z, o := \langle \rangle, \langle \rangle, i$
- exception: $(i \notin [1..MAX_ORDER] \Rightarrow \text{InvalidInterpOrder})$

add(s, z):

- transition: $S, Z := S || \langle s \rangle, Z || \langle z \rangle$
- exception: $exc := (|Z| > 0 \wedge z \leq Z_{|Z|-1} \Rightarrow \text{IndepVarNotAscending})$

getC(i):

- output: $out := S[i]$
- exception: $exc := (\neg(0 \leq i < |S|) \Rightarrow \text{InvalidIndex})$

eval(x, z):

- output: $out := \text{self.slice}(x, \text{False}).\text{eval}(z)$
- exception: none *# appropriate exceptions are generated by slice and eval*

evaly(x, y):

- output: $out := \text{self.slice}(x, \text{True}).\text{eval}(y)$
- exception: none *# appropriate exceptions are generated by slice and eval*

slice(x, flip):

- output and exception:

```
Zdef = []
F = []
for i in [0 .. |S|-1]:
    try y = S[i].eval(x):
        Zdef.append(Z[i])
        F.append(y)
    except OutOfDomain:
        pass
if |Zdef| > 0:
```



```
    if flip:
        return FunctT(F, Zdef, o)
    else:
        return FunctT(Zdef, F, o)
else:
    raise OutOfDomain
```

12 MIS of SeqServices Module

12.1 Module

SeqServices

12.2 Uses

None

12.3 Syntax

12.3.1 Exported Constants

None

12.3.2 Exported Access Programs

Routine name	In	Out	Exceptions
isAscending	$X : \mathbb{R}^n$	\mathbb{B}	
interpLin	$x_1 : \mathbb{R}, y_1 : \mathbb{R}, x_2 : \mathbb{R}, y_2 : \mathbb{R}, x : \mathbb{R}$	\mathbb{R}	
interpQuad	$x_0 : \mathbb{R}, y_0 : \mathbb{R}, x_1 : \mathbb{R}, y_1 : \mathbb{R}, x_2 : \mathbb{R}, y_2 : \mathbb{R}, x : \mathbb{R}$	\mathbb{R}	
index	$X : \mathbb{R}^n, x : \mathbb{R}$	\mathbb{N}	

12.4 Semantics

12.4.1 State Variables

None

12.4.2 State Invariant

None

12.4.3 Assumptions

None, unless noted with a particular access program

12.4.4 Access Routine Semantics

isAscending(X)

- output: $out := \neg \exists (i | i \in [0..|X| - 2] : X_{i+1} < X_i)$
- exception: none

$\text{interpLin}(x_1, y_1, x_2, y_2, x) \# \text{ assuming isAscending is True}$

- output: $out := \frac{(y_2 - y_1)}{(x_2 - x_1)}(x - x_1) + y_1$
- exception: none

$\text{interpQuad}(x_0, y_0, x_1, y_1, x_2, y_2, x) \# \text{ assuming isAscending is True}$

- output: $out := y_1 + \frac{y_2 - y_0}{x_2 - x_0}(x - x_1) + \frac{y_2 - 2y_1 + y_0}{2(x_2 - x_1)^2}(x - x_1)^2$
- exception: none

$\text{index}(X, x) \# \text{ assuming isAscending is True and that } x \text{ is within bounds}$

- output: $out := i$ such that $X_i \leq x < X_{i+1}$
- exception: none

13 MIS of Output Module

13.1 Module

Output

13.2 Uses

Input (Section 5), ThicknessADT (Section 9), GlassTypeADT (Section 8), Hardware (Section 15)

13.3 Syntax

13.3.1 Exported Constants

None

13.3.2 Exported Access Programs

Routine name	In	Out	Exceptions
output	$s : \mathbb{S}, \text{is_safePb} : \mathbb{B}, \text{is_safeLR} : \mathbb{B}, P_b : \mathbb{R}, B : \mathbb{R}, \text{LR} : \mathbb{R}, q : \mathbb{R}, J : \mathbb{R}, \text{NFL} : \mathbb{R}, \hat{q} : \mathbb{R}, \hat{q}_{\text{tol}} : \mathbb{R}, J_{\text{tol}} : \mathbb{R}$	-	-

13.4 Semantics

13.4.1 Environment Variables

outfile: two dimensional sequence of text characters

13.4.2 State Variables

None

13.4.3 State Invariant

None

13.4.4 Assumptions

None

13.4.5 Access Routine Semantics

output(s , is_safePb, is_safeLR, P_b , B , LR, q , J , NFL, \hat{q} , \hat{q}_{tol} , J_{tol})

- transition: write data to the file outfile associated with the string s . The data to output follows:
 - From SRS R4: values from SRS R1 (a , b , g , $P_{b_{\text{tol}}}$, SD_x , SD_y , SD_z , t , TNT, w), values from SRS R2 (m , k , E , t_d , LDF, LSF, h , GTF, SD, AR)
 - From SRS R5: (is_safePB \wedge is_safeLR \Rightarrow “For the given input parameters, the glass is considered safe” | True \Rightarrow “For the given input parameters, the glass is NOT considered safe”)
 - From SRS R6 (P_b , B , LR, q , J , NFL, \hat{q} , \hat{q}_{tol} , J_{tol})
- exception: None

14 MIS of Constants Module

14.1 Module

Constants

14.2 Uses

N/A

14.3 Syntax

14.3.1 Exported Constants

From Table 8 in SRS

$m := 7$

$k := (2.86) 10^{-53}$

$E := (7.17) 10^7$

$t_d := 3$

$\text{LSF} := 1$

$d_{\max} := 5.0$

$d_{\min} := 0.1$

$\text{AR}_{\max} := 5.0$

$w_{\max} := 910.0$

$w_{\min} := 4.5$

$\text{SD}_{\min} := 6.0$

$\text{SD}_{\max} := 130.0$

14.3.2 Exported Types

None

14.3.3 Exported Access Programs

None

14.4 Semantics

14.4.1 State Variables

None

14.4.2 State Invariant

None

15 MIS of Hardware Module

This module hides the underlying hardware for I/O (to the screen, or file, or other device). In general it will be provided by the selected programming language and operating system.

15.1 Module

Hardware

15.2 Uses

None