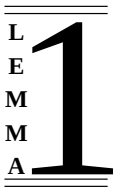

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ClawZ

Z Library Specification

Version: 10.7
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Reference: DAZ/ZED505
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Prepared by: R.B.Jones
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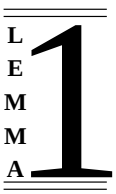

0 DOCUMENT CONTROL

0.1 Contents

0.2 Document Cross References

[1] LEMMA1/DAZ/PLN029. *Toolset Automation Enhancements — Proposal.* R.D. Arthan, Lemma 1 Ltd., `rda@lemma-one.com`.

[2] LEMMA1/DAZ/USR505. *ClawZ User Guide.* Lemma 1 Ltd., `http://www.lemma-one.com`.

[3] LEMMA1/DAZ/ZED504. *ClawZ - Model Translator Specification.* R.B. Jones, Lemma 1 Ltd., `rbjones@rbjones.com`.

[4] LEMMA1/DAZ/ZED506. *ClawZ - Z Library Implementation.* R.B. Jones, Lemma 1 Ltd., `rbjones@rbjones.com`.

[5] LEMMA1/DAZ/ZED507. *ClawZ - Extending the Z Library.* R.B. Jones, Lemma 1 Ltd., `rbjones@rbjones.com`.

0.3 Changes History

Issue 2.1 First issue to DERA.

Issue 3.1 Revised issue for Phase 2.

A convention is introduced for representation of initial states (see section 1.3).

Inclusion of missing *initial_state, state and state'* variables in *UnitDelay_S1*. Inclusion of missing *initial_state, state and state'* variables in *Clock*. Inclusion of missing *initial_state, state'* variables in *DiscreteIntegrator_FE*. Inclusion of missing *initial_state, state and state'* variables in *Derivative*. Inclusion of missing *initial_state, state and state'* variables in *Integrator*. *Gain* renamed to *Gain_I* since then name is already in use in the ProofPower *z_library* context.

Two new versions of the *UnitDelay* block have been specified in anticipation of problems in using the first version while system testing the first version of the translator.

A minor variant of sum is introduced, which appears in the F14 model.

The "Fcn" block is introduced since it is used in Alf's own Simulink version of his model. The 6 instances of this block which are supported match those used by Alf.

Min and max are introduced.

A Mux function with 2 scalar inputs is introduced.

Issue 5.1 Revised issue for Phase 3.

1. Expanded the section on conventions to include mention of the convention used for modelling continuous blocks (see:1.3.3).
2. Added missing Z signature for *Fcn_f*.
3. Corrected errors in signatures of *MinMax_min* and *MinMax_max*.
4. Theories shuffled to match the Simulink 3.0 library structure.
5. In order to allow submission of the DERA Bedford model for typechecking this specification has been enhanced to cover all the blocktypes used in that model (it is not intended that the library implementation will cover all the blocks required for this purpose since the signatures in this document will suffice for submitting the model to the typechecker).
6. Included some specifications to test new parameter types.
7. Included a section () on the use of metadata and library extensions to overcome translator limitations.
8. Included a section (1.4) on the rationale for the library coverage.

Issue 6.1 (Real ClawZ, first issue)

- Material describing the metafile format and providing guidance on the development of metadata and libraries for ClawZ has been moved from this document to the user guide [2].
- The metadata has been completely replaced with the current DERA metadata file. Some of the previous data has been moved to [5] so that the existing system tests will still work.
- The Z signature information previously provided in this document has been removed.
- More instances of the MinMax blocks have been included.

Issue 7.1 (Real ClawZ, final issue)

- The parameter type for the "catch-all" UnitDelay block has been changed from "Unquoted" to "Quoted".
- An *Fcn* block using the new *Fcn* parameter type has been included.
- Minor amendments to annotation.

Issue 7.4 (Toolset Automation Project)

- Remove "Inputs" parameter from "Logical Operator" block selection parameters (section 5.5).

- addition of *RoundingFunction*
- addition of $Product\_DM$, $Product\_MMDD$, $Product\_MMMD$, $Product\_MMMDD$, Sum_P6, $Logic\_AND\_4$, $Logic\_AND\_5$, $Logic\_AND\_6$, $Logic\_OR\_4$, $Logic\_OR\_5$, $Logic\_OR\_6$.

Issue 7.5 (ClawZ extension Project, first issue)

- Shortening of "Ports" parameters omitting trailing zeros to correspond with behaviour of version 6 of Simulink.
- Correction to "Ports" parameter for *Trigonometry_atan2*.
- Amendment to metadata for what was called *RoundingFunction*, covering all four cases and normalising Z specification names.

Issue 7.7 (ClawZ extension Project, second issue)

- Addition of scalar MinMax blocks.
- Addition of PortTypes parameters where appropriate.
- Removal of catch-all Mux and Demux to allow synthesis.
- Removed all Mux and Demux metadata.
- Scalar MinMax metadata moved after the vector cases to give priority to the scalar.

Issue 7.9 JANUARY 2002 (ClawZ extensions, final issue)

- Reinstatement of Mux/Demux metadata.

Issue 7.10 FEBRUARY 2002 (ClawZ extensions, final issue)

- Correction to "ceil" metadata.

Issue 7.11 JUNE 2002 (ClawZ extensions II, first release)

Removal of Mux/Demux metadata.

Issue 10.1 JUNE 2002 (ClawZ extensions II, first release)

Removal of Constant and Selector metadata.

Issue 10.5 JANUARY 2003 (Action Subsystems in ClawZ, first release)

Add section on subsystems, and metadata for *If*, *SwitchCase* and *Merge* blocks. Add names of hold and reset schemas where appriopriate.

Issue 10.7 MAY 2003 (Action Subsystems in ClawZ, second release)

Removed metadata for *Merge*. Add additional metadata for *If* blocks with *ShowElse* off and *SwitchCase* sample without default.

0.4 Changes Forecast

None.

1 GENERAL

1.1 Introduction

This document is one of the deliverables, originally from the Control Law project, placed by DERA Malvern with Lemma 1 Ltd., but most recently from the subsequent Toolset Automation project. For the relevant proposal see [1].

1.2 Overview

This specification is produced to make the library meet the needs of the revised ClawZ specification in [3], though this has no impact on the metadata since it is essentially backward compatible and there is no requirement at this stage to make use of the new parameter types.

The document is now exclusively concerned with metadata, and does not include library signatures.

At this issue it contains additions to the metadata as indicated in the changes history.

1.3 Notation and Conventions

The specification is presented in *library metadata* format (see [2]) with annotations in English where appropriate.

The integration testing for ClawZ will make direct use of the library metadata extracted from this document, supplemented by additional metadata in [5].

1.4 Rationale for Library Coverage

In the first case priority was given to providing libraries suitable for testing the translator functionality. This included a number of definitions to enable translation of large test models.

Some limited examples of continous blocks were specified and implemented to illustrate how such blocks might be modelled.

Prior to the placement or the Real ClawZ contract DERA refined and extended the library to make it suitable for the applications they were then working on. They also removed various definitions which were unnecessary for their applications.

In the Real ClawZ project the DERA version of the library has been adopted by the project and definitions not there present but required for the system test suite were moved to [5]. The library has been updated to work with the new ProofPower-Z real numbers, but since the signatures have been dropped from this document this is not apparent.

The following metadata is grouped according to the relevant Simulink library. For each case the library metadata for the case is provided here and the corresponding Z specifications are in [4].

2 CONTINUOUS

2.1 Memory

Text dumped to file zed505.lmf

```
BlockSpecification {
  Zname                        Memory
  HeldZname                    Memory_h
  ResetZname                   Memory_r
  SelectionParameters {
    BlockType                  Memory
  }
  TransmittedParameters {
    X0                         Quoted
  }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                        Memory
  HeldZname                    Memory_h
  ResetZname                   Memory_r
  SelectionParameters {
    BlockType                  Memory
  }
  TransmittedParameters {
    X0                         Vector
  }
  OutputPortTypes     "V"
}
BlockSpecification {
  Zname                        Memory
  HeldZname                    Memory_h
  ResetZname                   Memory_r
  SelectionParameters {
    BlockType                  Memory
  }
  TransmittedParameters {
    X0                         Scalar
  }
```

```
  OutputPortTypes     "S"
}
```

3 DISCRETE

3.1 Discrete State Space

Text appended to file zed505.lmf

```
BlockSpecification {
        Zname           DiscreteStateSpace
        HeldZname               DiscreteStateSpace_h
        ResetZname              DiscreteStateSpace_r
  SelectionParameters {
        BlockType       DiscreteStateSpace
  }
  TransmittedParameters {
        A               Matrix
        B               Matrix
        C               Matrix
        D               Matrix
        X0              Vector
  }
  OutputPortTypes     "V"
}
```

3.2 Discrete-Time Integrator

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                     DiscreteIntegrator_FE
  HeldZname                 DiscreteIntegrator_FE_h
  ResetZname                DiscreteIntegrator_FE_r
  SelectionParameters {
    BlockType               DiscreteIntegrator
    Ports                   [1, 1]
    IntegratorMethod        "ForwardEuler"
    ExternalReset           "none"
    InitialConditionSource  "internal"
    LimitOutput             off
    ShowSaturationPort      off
    ShowStatePort           off
  }
```

```
  TransmittedParameters {
    InitialCondition        Scalar
    SampleTime              Scalar
  }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                     DiscreteIntegrator_FE_Limit
  HeldZname                 DiscreteIntegrator_FE_Limit_h
  ResetZname                DiscreteIntegrator_FE_Limit_r
  SelectionParameters {
    BlockType               DiscreteIntegrator
    Ports                   [1, 1]
    IntegratorMethod        "ForwardEuler"
    ExternalReset           "none"
    InitialConditionSource  "internal"
    LimitOutput             on
    ShowSaturationPort      off
    ShowStatePort           off
  }
  TransmittedParameters {
    InitialCondition        Scalar
    UpperSaturationLimit    Scalar
    LowerSaturationLimit    Scalar
    SampleTime              Scalar
  }
  OutputPortTypes     "S"
}
```

3.3 Discrete Transfer Fcn

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                     DiscreteTransferFcn
  HeldZname                 DiscreteTransferFcn_h
  ResetZname                DiscreteTransferFcn_r
  SelectionParameters {
    BlockType               DiscreteTransferFcn
  }
  TransmittedParameters {
    Numerator               Quoted
    Denominator             Quoted
  }
```

```
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       DiscreteTransferFcn
  HeldZname                   DiscreteTransferFcn_h
  ResetZname                  DiscreteTransferFcn_r
  SelectionParameters {
    BlockType                 DiscreteTransferFcn
  }
  TransmittedParameters {
    Numerator                 Vector
    Denominator               Vector
  }
  OutputPortTypes     "S"
}
```

3.4 Unit Delay

Three ways of invoking the same generic *UnitDelay* are provided. The last one which matches will be used.

The first is a catch-all which transmits its parameter in quotes without any translation. This is bound to cause a type-error since the expected type on the wires will be "string", and serves only as a "template".

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                       UnitDelay_g
  HeldZname                   UnitDelay_g_h
  ResetZname                  UnitDelay_g_r
  SelectionParameters {
    BlockType                 UnitDelay
  }
  TransmittedParameters {
    X0                        Quoted
  }
  OutputPortTypes     "S"
}
```

The second covers numeric vectors.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                       UnitDelay_g
```

```
  HeldZname                 UnitDelay_g_h
  ResetZname                UnitDelay_g_r
  SelectionParameters {
    BlockType               UnitDelay
  }
  TransmittedParameters {
    X0                      Vector
  }
  OutputPortTypes     "V"
}
```

The third covers numeric scalars.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                     UnitDelay_g
  HeldZname                 UnitDelay_g_h
  ResetZname                UnitDelay_g_r
  SelectionParameters {
    BlockType               UnitDelay
  }
  TransmittedParameters {
    X0                      Scalar
  }
  OutputPortTypes     "S"
}
```

The metadata is presented in the given order because a scalar can be read as either a scalar, a vector or a matrix, and unless the Scalar metadata comes last it will never be reached and scalar uses of *UnitDelay* will be mistranslated and cause type checking errors in the specification.

3.5 Zero-Order Hold

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                     ZeroOrderHold
  SelectionParameters {
    BlockType               ZeroOrderHold
  }
  InputPortTypes      "G"
  OutputPortTypes     "G"
}
```

4 FUNCTIONS AND TABLES

4.1 Fcn

This block computes a function defined by a parameter as an expression over the components of its input vector. Since the translator cannot translate these expressions into Z the only way to use this block is to select on the parameter and provide a separate definition in the library for each different function use.

This is probably best done in applications specific library extensions.

For backwards compatability with the DERA version of the metadata a generic case is included.

It is not intended to implement this specification. The effect should be to default to translating *Fcn* blocks in a way which yields an unspecified function in the Z which is passed the untranslated matlab expression, which serves to document the unimplemented expression in the generated specification.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Fcn
  SelectionParameters {
    BlockType              Fcn
  }
  TransmittedParameters {
    Expr                   Quoted
  }
}

BlockSpecification {
  Zname                    Fcn
  SelectionParameters {
    BlockType              Fcn
  }
  TransmittedParameters {
    Expr                   Fcn
  }
  OutputPortTypes     "S"
}
```

4.2 Look-Up Table

Text appended to file zed505.lmf

```
BlockSpecification {
```

```
  Zname                         Lookup
  SelectionParameters {
    BlockType                   Lookup
  }
  TransmittedParameters {
    InputValues                 Quoted
    OutputValues                Quoted
  }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                         Lookup
  SelectionParameters {
    BlockType                   Lookup
  }
  TransmittedParameters {
    InputValues                 Vector
    OutputValues                Vector
  }
  OutputPortTypes     "S"
}
```

4.3 Look-Up Table (2-D)

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                         Lookup2D
  SelectionParameters {
    BlockType                   Reference
    Ports                       [2, 1]
    SourceBlock                 "simulink3/Functions\n&  Tables/Look-Up\nTable (2-D)"
    SourceType                  "Lookup  Table (2-D)"
  }
  TransmittedParameters {
    x                           Quoted
    y                           Quoted
    t                           Quoted
  }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                         Lookup2D
  SelectionParameters {
```

```
    BlockType                   Reference
    Ports                       [2, 1]
    SourceBlock                 "simulink3/Functions\n& Tables/Look-Up\nTable (2-D)"
    SourceType                  "Lookup Table (2-D)"
  }
  TransmittedParameters {
    x                           Vector
    y                           Vector
    t                           Matrix
  }
  OutputPortTypes     "S"
}
```

4.4 S-Function

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                         S_Function
  SelectionParameters {
    BlockType                   "S-Function"
    Ports                       [1, 1]
  }
  TransmittedParameters {
    FunctionName                Quoted
  }
  OutputPortTypes     "S"
}
```

5 MATH

5.1 Abs

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                         Abs
  SelectionParameters {
    BlockType                   Abs
  }
  OutputPortTypes     "S"
}
```

5.2 Combinatorial Logic

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    CombinatorialLogic
  SelectionParameters {
    BlockType              CombinatorialLogic
  }
  TransmittedParameters {
    TruthTable             Quoted
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    CombinatorialLogic
  SelectionParameters {
    BlockType              CombinatorialLogic
  }
  TransmittedParameters {
    TruthTable             Matrix
  }
  OutputPortTypes    "V"
}
```

5.3 Dot Product

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    DotProduct
  SelectionParameters {
    BlockType              Reference
    Ports                  [2, 1]
    SourceBlock            "simulink3/Math/Dot Product"
    SourceType             "Dot Product"
  }
  OutputPortTypes    "S"
}
```

5.4 Gain

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Gain_I
```

```
  SelectionParameters {
    BlockType                 Gain
  }
  TransmittedParameters {
    Gain                      Scalar
  }
  OutputPortTypes     "S"
}
```

5.5 Logical Operator

AND gates.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                       Logic_AND_2
  SelectionParameters {
    BlockType                 Logic
    Ports                     [2, 1]
    Operator                  "AND"
  }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       Logic_AND_3
  SelectionParameters {
    BlockType                 Logic
    Ports                     [3, 1]
    Operator                  "AND"
  }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       Logic_AND_4
  SelectionParameters {
    BlockType                 Logic
    Ports                     [4, 1]
    Operator                  "AND"
  }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       Logic_AND_5
```

```
  SelectionParameters {
    BlockType                 Logic
    Ports                     [5, 1]
    Operator                  "AND"
  }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       Logic_AND_6
  SelectionParameters {
    BlockType                 Logic
    Ports                     [6, 1]
    Operator                  "AND"
  }
  OutputPortTypes     "S"
}
```

OR gates.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                       Logic_OR_2
  SelectionParameters {
    BlockType                 Logic
    Ports                     [2, 1]
    Operator                  "OR"
  }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       Logic_OR_3
  SelectionParameters {
    BlockType                 Logic
    Ports                     [3, 1]
    Operator                  "OR"
  }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       Logic_OR_4
  SelectionParameters {
    BlockType                 Logic
    Ports                     [4, 1]
```

```
    Operator                "OR"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                   Logic_OR_5
  SelectionParameters {
    BlockType             Logic
    Ports                 [5, 1]
    Operator              "OR"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                   Logic_OR_6
  SelectionParameters {
    BlockType             Logic
    Ports                 [6, 1]
    Operator              "OR"
  }
  OutputPortTypes    "S"
}
```

NAND gates.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                   Logic_NAND_2
  SelectionParameters {
    BlockType             Logic
    Ports                 [2, 1]
    Operator              "NAND"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                   Logic_NAND_3
  SelectionParameters {
    BlockType             Logic
    Ports                 [3, 1]
    Operator              "NAND"
  }
  OutputPortTypes    "S"
```

```
}
```

NOR gates.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Logic_NOR_2
  SelectionParameters {
    BlockType              Logic
    Ports                  [2, 1]
    Operator               "NOR"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Logic_NOR_3
  SelectionParameters {
    BlockType              Logic
    Ports                  [3, 1]
    Operator               "NOR"
  }
  OutputPortTypes    "S"
}
```

XOR gates.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Logic_XOR_2
  SelectionParameters {
    BlockType              Logic
    Ports                  [2, 1]
    Operator               "XOR"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Logic_XOR_3
  SelectionParameters {
    BlockType              Logic
    Ports                  [3, 1]
    Operator               "XOR"
  }
  OutputPortTypes    "S"
```

```
}
```

The NOT gate.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Logic_NOT
  SelectionParameters {
    BlockType              Logic
    Ports                  [1, 1]
    Operator               "NOT"
  }
  OutputPortTypes    "S"
}
```

5.6 Math Function

This block provides a variety of math functions.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Math_exp
  SelectionParameters {
    BlockType              Math
    Ports                  [1, 1]
    Operator               "exp"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Math_10u
  SelectionParameters {
    BlockType              Math
    Ports                  [1, 1]
    Operator               "10^u"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Math_square
  SelectionParameters {
    BlockType              Math
```

```
    Ports                   [1, 1]
    Operator                "square"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     Math_reciprocal
  SelectionParameters {
    BlockType               Math
    Ports                   [1, 1]
    Operator                "reciprocal"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     Math_hypot
  SelectionParameters {
    BlockType               Math
    Ports                   [2, 1]
    Operator                "hypot"
  }
  OutputPortTypes    "S"
}
```

5.7 MinMax

This block provides either a min function or a max function, selected by parameter.

The library include minmax blocks with up to four inputs, both for all scalar and for all vector signals. However, there is at present no effective way of selecting these blocks. InputPortTypes and OutputPortTypes parameters are now added, but these are not used in current version of ClawZ for selection. Consequently, with this metadata on current versions of ClawZ, the vectorised versions will always be selected. Application specific metadata may have to be appended to force selection of the scalar versions.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                     MinMax_min
  SelectionParameters {
    BlockType               MinMax
    Function                "min"
    Ports                   [1, 1]
    Inputs                  "1"
```

```
  }
  InputPortTypes      "V"
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       MinMax_min2
  SelectionParameters {
    BlockType                 MinMax
    Function                  "min"
    Ports                     [2, 1]
    Inputs                    "2"
  }
  InputPortTypes      "VV"
  OutputPortTypes     "V"
}
BlockSpecification {
  Zname                       MinMax_min3
  SelectionParameters {
    BlockType                 MinMax
    Function                  "min"
    Ports                     [3, 1]
    Inputs                    "3"
  }
  InputPortTypes      "VVV"
  OutputPortTypes     "V"
}
BlockSpecification {
  Zname                       MinMax_min4
  SelectionParameters {
    BlockType                 MinMax
    Function                  "min"
    Ports                     [4, 1]
    Inputs                    "4"
  }
  InputPortTypes      "VVVV"
  OutputPortTypes     "V"
}
BlockSpecification {
  Zname                       MinMax_max
  SelectionParameters {
    BlockType                 MinMax
    Function                  "max"
```

```
    Ports                   [1, 1]
    Inputs                  "1"
  }
  InputPortTypes    "V"
  OutputPortTypes   "S"
}
BlockSpecification {
  Zname                     MinMax_max2
  SelectionParameters {
    BlockType               MinMax
    Function                "max"
    Ports                   [2, 1]
    Inputs                  "2"
  }
  InputPortTypes    "VV"
  OutputPortTypes   "V"
}
BlockSpecification {
  Zname                     MinMax_max3
  SelectionParameters {
    BlockType               MinMax
    Function                "max"
    Ports                   [3, 1]
    Inputs                  "3"
  }
  InputPortTypes    "VVV"
  OutputPortTypes   "V"
}
BlockSpecification {
  Zname                     MinMax_max4
  SelectionParameters {
    BlockType               MinMax
    Function                "max"
    Ports                   [4, 1]
    Inputs                  "4"
  }
  InputPortTypes    "VVVV"
  OutputPortTypes   "V"
}
BlockSpecification {
  Zname                     MinMax_smin2
  SelectionParameters {
```

```
    BlockType                MinMax
    Function                 "min"
    Ports                    [2, 1]
    Inputs                   "2"
  }
  InputPortTypes     "SS"
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                      MinMax_smin3
  SelectionParameters {
    BlockType                MinMax
    Function                 "min"
    Ports                    [3, 1]
    Inputs                   "3"
  }
  InputPortTypes     "SSS"
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                      MinMax_smin4
  SelectionParameters {
    BlockType                MinMax
    Function                 "min"
    Ports                    [4, 1]
    Inputs                   "4"
  }
  InputPortTypes     "SSSS"
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                      MinMax_smax2
  SelectionParameters {
    BlockType                MinMax
    Function                 "max"
    Ports                    [2, 1]
    Inputs                   "2"
  }
  InputPortTypes     "SS"
  OutputPortTypes    "S"
}
BlockSpecification {
```

```
  Zname                    MinMax_smax3
  SelectionParameters {
    BlockType              MinMax
    Function               "max"
    Ports                  [3, 1]
    Inputs                 "3"
  }
  InputPortTypes     "SSS"
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    MinMax_smax4
  SelectionParameters {
    BlockType              MinMax
    Function               "max"
    Ports                  [4, 1]
    Inputs                 "4"
  }
  InputPortTypes     "SSSS"
  OutputPortTypes    "S"
}
```

5.8 Product

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Product
  SelectionParameters {
    BlockType              Product
  }
  TransmittedParameters {
    Ports                  Quoted
    Inputs                 Quoted
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Product_M1
  SelectionParameters {
    BlockType              Product
    Ports                  [1, 1]
    Inputs                 "*"
```

```
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                      Product_M1
  SelectionParameters {
    BlockType                Product
    Ports                    [1, 1]
    Inputs                   "1"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                      Product_M2
  SelectionParameters {
    BlockType                Product
    Ports                    [2, 1]
    Inputs                   "**"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                      Product_M2
  SelectionParameters {
    BlockType                Product
    Ports                    [2, 1]
    Inputs                   "2"
  }
  OutputPortTypes    "S"
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                      Product_MD
  SelectionParameters {
    BlockType                Product
    Ports                    [2, 1]
    Inputs                   "*/"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
   Zname                     Product_DM
```

```
  SelectionParameters {
    BlockType              Product
    Ports                  [2, 1]
    Inputs                 "/*"
  }
 OutputPortTypes    "S"
}
BlockSpecification {
 Zname                     Product_M3
 SelectionParameters {
   BlockType               Product
   Ports                   [3, 1]
   Inputs                  "***"
 }
 OutputPortTypes    "S"
}
BlockSpecification {
 Zname                     Product_M3
 SelectionParameters {
   BlockType               Product
   Ports                   [3, 1]
   Inputs                  "3"
 }
 OutputPortTypes    "S"
}
BlockSpecification {
 Zname                     Product_MMD
 SelectionParameters {
   BlockType               Product
   Ports                   [3, 1]
   Inputs                  "**/"
 }
 OutputPortTypes    "S"
}
BlockSpecification {
 Zname                     Product_MMDD
 SelectionParameters {
   BlockType               Product
   Ports                   [4, 1]
   Inputs                  "**//"
 }
 OutputPortTypes    "S"
```

```
}
BlockSpecification {
  Zname                    Product_MMMD
  SelectionParameters {
    BlockType              Product
    Ports                  [4, 1]
    Inputs                 "***/"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Product_MMMDD
  SelectionParameters {
    BlockType              Product
    Ports                  [5, 1]
    Inputs                 "***//"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Product_M4
  SelectionParameters {
    BlockType              Product
    Ports                  [4, 1]
    Inputs                 "****"
  }
  OutputPortTypes    "S"
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Product_M4
  SelectionParameters {
    BlockType              Product
    Ports                  [4, 1]
    Inputs                 "4"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Product_M5
  SelectionParameters {
    BlockType              Product
```

```
    Ports                   [5, 1]
    Inputs                  "*****"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     Product_M5
  SelectionParameters {
    BlockType               Product
    Ports                   [5, 1]
    Inputs                  "5"
  }
  OutputPortTypes    "S"
}
```

5.9 Relational Operator

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                     RelationalOperator_EQ
  SelectionParameters {
    BlockType               RelationalOperator
    Operator                "=="
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     RelationalOperator_NEQ
  SelectionParameters {
    BlockType               RelationalOperator
    Operator                "~="
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     RelationalOperator_LT
  SelectionParameters {
    BlockType               RelationalOperator
    Operator                "<"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
```

```
  Zname                    RelationalOperator_LE
  SelectionParameters {
    BlockType              RelationalOperator
    Operator               "<="
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    RelationalOperator_GE
  SelectionParameters {
    BlockType              RelationalOperator
    Operator               ">="
  }
  OutputPortTypes    "S"
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    RelationalOperator_GT
  SelectionParameters {
    BlockType              RelationalOperator
    Operator               ">"
  }
  OutputPortTypes    "S"
}
```

5.10 Sign

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Sign
  SelectionParameters {
    BlockType              Signum
  }
  OutputPortTypes    "S"
}
```

5.11 Rounding Function

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Rounding_floor
  SelectionParameters {
```

```
    BlockType                 Rounding
    Operator                  "floor"
   }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       Rounding_ceil
  SelectionParameters {
    BlockType                 Rounding
    Operator                  "ceil"
   }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       Rounding_round
  SelectionParameters {
    BlockType                 Rounding
    Operator                  "round"
   }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       Rounding_fix
  SelectionParameters {
    BlockType                 Rounding
    Operator                  "fix"
   }
  OutputPortTypes     "S"
}
```

5.12 Sum

The Simulink Sum library block takes an arbitrary number of input ports and adds or subtracts each according to a parametrically supplied string of "+" and "-" characters. With the prototype translator these can only be handled by overloaded definitions selected on the parameter string.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                       Sum
  SelectionParameters {
    BlockType                 Sum
  }
  TransmittedParameters {
```

```
    Ports                   Quoted
    Inputs                  Quoted
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     Sum_P1
  SelectionParameters {
    BlockType               Sum
    Ports                   [1, 1]
    Inputs                  "+"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     Sum_P1
  SelectionParameters {
    BlockType               Sum
    Ports                   [1, 1]
    Inputs                  "1"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     Sum_P2
  SelectionParameters {
    BlockType               Sum
    Ports                   [2, 1]
    Inputs                  "++"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     Sum_P2
  SelectionParameters {
    BlockType               Sum
    Ports                   [2, 1]
    Inputs                  "2"
  }
  OutputPortTypes    "S"
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Sum_PM
  SelectionParameters {
    BlockType              Sum
    Ports                  [2, 1]
    Inputs                 "+-"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Sum_MP
  SelectionParameters {
    BlockType              Sum
    Ports                  [2, 1]
    Inputs                 "-+"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Sum_MM
  SelectionParameters {
    BlockType              Sum
    Ports                  [2, 1]
    Inputs                 "--"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Sum_P3
  SelectionParameters {
    BlockType              Sum
    Ports                  [3, 1]
    Inputs                 "+++"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Sum_P3
  SelectionParameters {
    BlockType              Sum
    Ports                  [3, 1]
```

```
    Inputs                  "3"
  }
  OutputPortTypes    "S"
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                   Sum_PPM
  SelectionParameters {
    BlockType             Sum
    Ports                 [3, 1]
    Inputs                "++-"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                   Sum_PMP
  SelectionParameters {
    BlockType             Sum
    Ports                 [3, 1]
    Inputs                "+-+"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                   Sum_PMM
  SelectionParameters {
    BlockType             Sum
    Ports                 [3, 1]
    Inputs                "+--"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                   Sum_MPP
  SelectionParameters {
    BlockType             Sum
    Ports                 [3, 1]
    Inputs                "-++"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
```

```
  Zname                    Sum_MPM
  SelectionParameters {
    BlockType              Sum
    Ports                  [3, 1]
    Inputs                 "-+-"
  }
  OutputPortTypes    "S"
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Sum_MMP
  SelectionParameters {
    BlockType              Sum
    Ports                  [3, 1]
    Inputs                 "--+"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Sum_MMM
  SelectionParameters {
    BlockType              Sum
    Ports                  [3, 1]
    Inputs                 "---"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Sum_P4
  SelectionParameters {
    BlockType              Sum
    Ports                  [4, 1]
    Inputs                 "++++"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                    Sum_P4
  SelectionParameters {
    BlockType              Sum
    Ports                  [4, 1]
    Inputs                 "4"
```

```
  }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       Sum_P5
  SelectionParameters {
    BlockType                 Sum
    Ports                     [5, 1]
    Inputs                    "+++++"
  }
  OutputPortTypes     "S"
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                       Sum_P5
  SelectionParameters {
    BlockType                 Sum
    Ports                     [5, 1]
    Inputs                    "5"
  }
  OutputPortTypes     "S"
}
BlockSpecification {
  Zname                       Sum_P6
  SelectionParameters {
    BlockType                 Sum
    Ports                     [6, 1]
    Inputs                    "++++++"
  }
  OutputPortTypes     "S"
}
```

5.13 Trigonometric Function

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                       Trigonometry_sin
  SelectionParameters {
    BlockType                 Trigonometry
    Ports                     [1, 1]
    Operator                  "sin"
```

```
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     Trigonometry_cos
  SelectionParameters {
    BlockType               Trigonometry
    Ports                   [1, 1]
    Operator                "cos"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     Trigonometry_tan
  SelectionParameters {
    BlockType               Trigonometry
    Ports                   [1, 1]
    Operator                "tan"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     Trigonometry_asin
  SelectionParameters {
    BlockType               Trigonometry
    Ports                   [1, 1]
    Operator                "asin"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     Trigonometry_acos
  SelectionParameters {
    BlockType               Trigonometry
    Ports                   [1, 1]
    Operator                "acos"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                     Trigonometry_atan
  SelectionParameters {
```

```
    BlockType                Trigonometry
    Ports                    [1, 1]
    Operator                 "atan"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                      Trigonometry_atan2
  SelectionParameters {
    BlockType                Trigonometry
    Ports                    [2, 1]
    Operator                 "atan2"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                      Trigonometry_sinh
  SelectionParameters {
    BlockType                Trigonometry
    Ports                    [1, 1]
    Operator                 "sinh"
  }
  OutputPortTypes    "S"
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                      Trigonometry_cosh
  SelectionParameters {
    BlockType                Trigonometry
    Ports                    [1, 1]
    Operator                 "cosh"
  }
  OutputPortTypes    "S"
}
BlockSpecification {
  Zname                      Trigonometry_tanh
  SelectionParameters {
    BlockType                Trigonometry
    Ports                    [1, 1]
    Operator                 "tanh"
  }
  OutputPortTypes    "S"
```

```
}
```

6 NONLINEAR

6.1 DeadZone

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    DeadZone
  SelectionParameters {
    BlockType              DeadZone
  }
  TransmittedParameters {
    LowerValue             Scalar
    UpperValue             Scalar
  }
  OutputPortTypes    "S"
}
```

6.2 Saturation

Note that the name of this block in the Simulink 3.0 library is *Saturation* which differs from its blocktype (which is *Saturate*).

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                    Saturate
  SelectionParameters {
    BlockType              Saturate
  }
  TransmittedParameters {
    UpperLimit             Scalar
    LowerLimit             Scalar
  }
  OutputPortTypes    "S"
}
```

6.3 Switch

This is generic in the two inputs which are being switched and the resulting output.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                 Switch
  SelectionParameters {
    BlockType           Switch
  }
  TransmittedParameters {
    Threshold           Scalar
  }
  InputPortTypes        "GSG"
  OutputPortTypes       "G"
}
```

7 SIGNALS AND SYSTEMS

Mux and Demux are now handled by synthesis and all metadata for these blocks has therefore been removed.

7.1 From

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                 From
  SelectionParameters {
    BlockType           From
  }
  TransmittedParameters {
    GotoTag             Unquoted
  }
}
```

7.2 Goto

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                 Goto
  SelectionParameters {
    BlockType           Goto
  }
  TransmittedParameters {
```

```
    GotoTag                 Unquoted
    TagVisibility           Unquoted
  }
}
```

7.3 Ground

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                     Ground
  SelectionParameters {
    BlockType               Ground
  }
  OutputPortTypes     "S"
}
```

8 SOURCES

None

9 SINKS

9.1 Display

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                     Display
  SelectionParameters {
    BlockType               Display
    Ports                   [1]
    Floating                off
  }
}
```

9.2 Scope

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                     Scope
  SelectionParameters {
    BlockType               Scope
```

```
    Ports                [1]
    Floating             off
    NumInputPorts        "1"
  }
}
```

9.3 To Workspace

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                  ToWorkspace
  SelectionParameters {
    BlockType            ToWorkspace
  }
}
```

10 SUBSYSTEMS

10.1 Action Ports

No metadata is required for these schemas.

10.2 If

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                  If_Else_1_1
  SelectionParameters {
    BlockType            If
    Ports                [1, 1]
    NumInputs            "1"
    IfExpression         "u1"
    ShowElse             off
  }
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                  If_Else_1_2
  SelectionParameters {
    BlockType            If
```

```
    Ports                [1, 2]
    NumInputs            "1"
    IfExpression         "u1"
    ShowElse             on
  }
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                  If_Else_2_2
  SelectionParameters {
    BlockType            If
    Ports                [2, 2]
    NumInputs            "2"
    IfExpression         "u1"
    ElseIfExpressions    "u2"
    ShowElse             off
  }
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                  If_Else_2_3
  SelectionParameters {
    BlockType            If
    Ports                [2, 3]
    NumInputs            "2"
    IfExpression         "u1"
    ElseIfExpressions    "u2"
    ShowElse             on
  }
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                  If_Else_3_3
  SelectionParameters {
    BlockType            If
    Ports                [3, 3]
    NumInputs            "3"
    IfExpression         "u1"
    ElseIfExpressions    "u2, u3"
    ShowElse             off
```

```
  }
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                 If_Else_3_4
  SelectionParameters {
    BlockType           If
    Ports               [3, 4]
    NumInputs           "3"
    IfExpression        "u1"
    ElseIfExpressions   "u2, u3"
    ShowElse            on
  }
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                 If_Else_4_4
  SelectionParameters {
    BlockType           If
    Ports               [4, 4]
    NumInputs           "4"
    IfExpression        "u1"
    ElseIfExpressions   "u2, u3, u4"
    ShowElse            off
  }
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                 If_Else_4_5
  SelectionParameters {
    BlockType           If
    Ports               [4, 5]
    NumInputs           "4"
    IfExpression        "u1"
    ElseIfExpressions   "u2, u3, u4"
    ShowElse            on
  }
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
```

```
  Zname                  If_Else_5_5
  SelectionParameters {
    BlockType            If
    Ports                [5, 5]
    NumInputs            "5"
    IfExpression         "u1"
    ElseIfExpressions    "u2, u3, u4, u5"
    ShowElse             on
  }
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                  If_Else_5_6
  SelectionParameters {
    BlockType            If
    Ports                [5, 6]
    NumInputs            "5"
    IfExpression         "u1"
    ElseIfExpressions    "u2, u3, u4, u5"
    ShowElse             on
  }
}
```

10.3 SwitchCase

These are samples only.

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                  SwitchCase_sample
  SelectionParameters {
      BlockType          SwitchCase
      Ports              [1, 3]
      CaseConditions     "{1,[2,3]}"
      CaseShowDefault    on
  }
}
```

Text appended to file zed505.lmf

```
BlockSpecification {
  Zname                  SwitchCase_nodefault_sample
  SelectionParameters {
```

```
    BlockType           SwitchCase
    Ports               [1, 3]
    CaseConditions      "{1,[2,3],4}"
    CaseShowDefault     off
  }
}
```