**IBIS-ISS ISSUE RESOLUTION DOCUMENT (ISSIRD)**

**ISSIRD NUMBER:** 1.0 {draft 1}

**ISSUE TITLE:** Enable Cascading of S-parameters Through W-element Wrapping

**REQUESTOR:**  Michael Mirmak, Intel Corp.

**DATE SUBMITTED:** {July 27, 2022}

**DATE REVISED:**

**DATE ACCEPTED:**

**DEFINITION OF THE ISSUE:**

IBIS-ISS omits a critical option available in several EDA tools today: the capability to use S-parameter data within the W-element. In these commercial implementations, the W-element defines the nodal connections for an interconnect model but uses an S-parameter file or model definition as the behavioral data, instead of using an RLGC file or model definition.

S-parameters are often used to represent unitary circuit elements (e.g., a solder pad), but can be used in these commercial implementations to represent scalable structures (e.g., a portion of PCB trace modeled as a transmission line). Without support in IBIS-ISS for S-parameter data within the W-element, S-parameters cannot be scaled for use in PCB traces, cables, or similar structures. The proposed text adds this support.

**SOLUTION REQUIREMENTS:**

The IBIS-ISS specification must meet these requirements:

Table 1: Solution Requirements

|  |  |
| --- | --- |
| Requirement | Notes |
| 1. Modify the W-element to point to the S Model
 | The W-element definitions will be expanded to support S-parameter data through existing model data structures |
| 1. Use consistent terminology throughout the document
 | Instances of “S-Model” and “S-Element Model” will be modified to ensure clarity |

**SUMMARY OF PROPOSED CHANGES:**

For review purposes, the proposed changes are summarized as follows:

Table 2: IBIS-ISS Structures Affected

|  |  |  |
| --- | --- | --- |
| Specification Item | New/Modified/Other | Notes |
| Rename “S-Element Model” and “S-Model” to “S Model” for consistency with usage elsewhere in the document | Modified |  |
| Add parameters to the W-element definition to support the S Model | New |  |

**PROPOSED CHANGES:**

Page 37 of the IBIS-ISS Specification is modified as is shown in the highlighted text below:

The W-element is a versatile transmission line model that may be used to describe a variety of transmission line structures, from a simple lossless line to complex frequency-dependent lossy-coupled lines.

Syntax

**W**xxx i1 i2 ... in ir o1 o2 ... on or **N=**val **L=**val

+ **RLGCMODEL=**name | **TABLEMODEL=**name | **SMODEL=**name [**FGD=***val*]

Page 38 of the IBIS-ISS Specificaiton is modeified as is shown in the highlighted text below:

|  |  |
| --- | --- |
| **RLGCMODEL=***name* | Defines string *name* as the name of the RLGC model |
| **TABLEMODEL=***name* | Defines string *name* as the name of the frequency-dependent tabular model |
| **SMODEL=***name* | Defines string *name* as the name of the scattering parameter S model |
| **FGD=***val* | Specifies the cut-off frequency of dielectric loss, in hertz, as positive real number *val*. Zero is permitted (if set to zero, dielectric loss is assumed to maintain a linear dependence on frequency). |

Specify the number of signal conductors, N, after the list of nodes. The W-element does not limit the number of coupled conductors.

The W-element supports three formats to specify transmission line properties:

* Format 1: RLGC specification, specified in a .MODEL statement
* Format 2: Frequency-dependent tabular specification, specified in a .MODEL statement
* Format 3: Scattering parameter specification using Touchstone data, specified in .MODEL statement

The **RLGCMODEL**. **TABLEMODEL**, and **SMODEL** arguments associate a W-element definition with a .MODEL using either Format 1, Format 2 or Format 3, respectively. A W-element shall use either **RLGCMODEL, TABLEMODEL** or **SMODEL**, but no more than one in the same W-element.

In Formats 1 and 2, the characteristics of the W-element are expressed in per-unit-length matrices: Ro (DC resistance), L, G, C, Rs (skin effect), and Gd (dielectric loss). In Format 3, the characteristics of the W-element are expressed in scattering parameters, using Touchstone formatted data in a separate file.

Page 39 of the IBIS-ISS Specificaiton is modeified as is shown in the highlighted text below:

**Format 3: Scattering Parameter S Model**

The S model may be used as a method to scale a set of frequency-dependent scattering parameters according to length.

The W-element syntax in this approach supports data provided in a Touchstone file (using a .MODEL statement of type S). The .MODEL statement uses the "type" S and names the Touchstone file containing the appropriate scattering parameters.

The following requirements apply when using an S model with a W-element:
• If the W-element input model is SMODEL, an S model definition must accompany that
input model.
• The associated S-parameters must have even number of terminals.
• The associated S-parameters must be symmetric.
• The associated S-parameters must be passive.
• Transmission-line based S-parameters can be used with different lengths of a system
when the varying length parameter (L) in a W-element instance statement is present.
• The XLINELENGTH keyword shall be set when the associated S model will be used in a W-element.

Page 47 of the IBIS-ISS Specificaiton is modeified as is shown in the highlighted text below:

**S Model Syntax**

Use the following syntax to describe specific S models:

**.MODEL** Smodel\_name **S** **N=**val **TSTONEFILE=**filename [**XLINELENGTH**=val]

Table 22: S Model Definition Arguments

|  |  |
| --- | --- |
| Argument | Description |
| *Smodel\_name* | Name of the S model. |

Page 48 of the IBIS-ISS Specificaiton is modeified as is shown in the highlighted text below:

|  |  |
| --- | --- |
| **N=***val* | Sets positive, non-zero integer *val* as the number of ports for the S model. This value must match the number of ports defined in the associated Touchstone file. |
| **TSTONEFILE=***filename* | Sets the string *filename* as the name of a Touchstone file.Note that string parameters are supported for TSTONEFILEExample:.subckt sparam n1 n2 tsfile=str('ss\_ts.s2p')S1 n1 n2 0 mname=s\_model.model s\_model S TSTONEFILE=str(tsfile).endsx1 A B sparam tsfile=str('ss\_ts.s2p')…For details, see Touchstone® File Format Specification by the IBIS Open Forum (http://www.ibis.org). |
| **XLINELENGTH** | Sets the length of the transmission line from which the referenced S-parameters in the Touchstone file were extracted. |

**BACKGROUND INFORMATION/HISTORY:**