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### 3.0 GENERAL SYNTAX RULES AND GUIDELINES

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...

6) To facilitate portability between operating systems, file names used in the IBIS Connector file must only have lower case characters. File names should have a basename followed by a period ('.'), followed by a file name extension of no more than three characters. There is no length restriction on the basename. The basename and extension must use characters from the following set (space, ' ', 0x20 is not included):

```
a b c d e f g h i j k l m n o p q r s t u v w x y z
0 1 2 3 4 5 6 7 8 9 _ -
```

**SiQual Comment:** We would request that path names and/or hyperlinks be additionally allowed in addition to file names. Path names will facilitate better hierarchical organization of additional files used, such as jpg connector pictures.

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### 4.0 KEYWORD TREE DIAGRAM

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```
/-- Start of File
|
|  -----
|  /-- [Begin Header]
|  |   |-- [Comment Char]
|  |   |-- [IBIS Cn Model Ver]
|  |   |-- [File Name]
|  |   |-- [File Rev]
|  |   |-- [Date]
|  |   |-- [Source]
|  |   |-- [Notes]
|  |   |-- [Disclaimer]
|  |   |-- [Copyright]
|  |   |-- [Support]
|  |   |-- [Redistribution]
|  |   |-- [Redistribution Text]
|  \-- [End Header]
|
|  /-- [Begin Cn Model Family] (Section 7)
```

**SiQual Comment:** All items of the header can be relocated to the [Begin Cn Model Family] section. This allows multiple model

families to coexist in the same file. For portability, multiple models can be placed in one file, with each containing appropriate documentation.

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5.0 HEADER KEYWORDS

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Keyword: [File Rev]  
Required: Yes  
Argument: Text String  
Description: Tracks the revision level of a particular .icm file.  
Usage Rules: Revision level is set at the discretion of the engineer defining the file. The following guidelines are suggested:

- 0.x connector and/or file in development
- 1.x pre-manufacturing connector and/or model
- 2.x mature connector and or model, no more changes likely

-----

[File Rev]      1.0                                      Used for .icm file versions

**SiQual Comment:**      **Require a specific fixed format for the file revision. For example X.XX. A specific format will help in automating the file creation and revision control process, by making it uniform across vendors.**

=====

Keyword: [Date]  
Required: No  
Argument: Text String (Date)  
Description: Date this file was last modified.  
Usage Rules: This keyword is provided to insure the last changed date for this file is not lost if the file is transmitted between computer systems.

-----

[Date]                      July 1, 2000                                      The latest file revision date

**SiQual Comment:**      **Require a set of specific allowable fixed formats for the date. This will facilitate automated date tracking. Currently, since this field is defined as a text string, any format is allowable, including no actual date.**

=====  
Keyword: [Source]  
Required: No  
Argument: Text Block  
Description: Records the originating source of model data.  
Usage Rules: Use this keyword to record how the model information was  
obtained (physical measurement of device, simulations, data  
book, etc.). This field contain the name of the company who  
created the model.

NOTE: It is recommended that the argument to the [Source]  
keyword be limited to a maximum of 24 lines of text.

-----  
[Source] Put originator and the source of information here. For example:  
Results from field simulation

**SiQual Comment:** All sections with text blocks should be  
terminated with an end of block terminator, to resolve parsing  
problems. This can be done with a format such as [End Keyword],  
where Keyword is the Keyword that began the text block. In this  
case, [Source] would be terminated with [End Source].

=====  
Keyword: [Notes]  
Required: No  
Argument: Text Block  
Description: Optional notes regarding the file.  
Usage Rules: The keyword provides a place for the model maker to record  
important notes about the file or model data that are not  
included elsewhere. Such information may include notes on  
validation level, model limits, usage assumptions, etc.

NOTE: It is recommended that the argument to the [Notes]  
keyword be limited to a maximum of 24 lines of text.

The [Notes] keyword can only be used once.

-----  
[Notes] Use this section for any special notes related to the file.

**SiQual Comment:** See comment for [Source].

=====  
Keyword: [Disclaimer]  
Required: No  
Argument: Text Block  
Description: Legal disclaimer and copyright information  
Usage Rules: This keyword provides a place for the user to add a legal  
disclaimer.

NOTE: It is recommended that the argument to the [Disclaimer] keyword be limited to a maximum of 96 lines of text.

---

[Disclaimer] This information is for modeling purposes only, and is not guaranteed.

**SiQual Comment: See comment for [Source].**

---

Keyword: [Copyright]  
Required: No  
Argument: Text Block  
Description: Legal copyright information  
Usage Rules: Because model writers may consider the information in these keywords essential to users, and sometimes legally required, design automation tools should make this information available. Any text following the [Copyright] keyword must be included in any derivative models verbatim.

NOTE: It is recommended that the arguments to the [Copyright] keywords be limited to a maximum of 96 lines of text.

---

[Copyright] Copyright 2000, XYZ Corp., All Rights Reserved

**SiQual Comment: See comment for [Source].**

---

Keyword: [Support]  
Required: No  
Argument: Text Block (URL path name)  
Description: Specifies a web site that can be visited to get the latest version of the file.  
Usage Rules: Following the [Support] keyword is the URL of a web site the user may visit for more information on the model or model(s). The entire link, including any file extension, is required. The [Support] keyword may appear only once between the [Begin Header]/[End Header] keyword pair.

NOTE: It is recommended that a separate IBIS model web site (not page) be maintained to prevent accidental changes of page name from breaking this link.

---

[Support] <http://www.VendorNameIbisModels.com> |example ibis web site root

**SiQual Comment: See comment for [Source].**

=====  
Keyword: [Redistribution Text]  
Required: Yes, ONLY if [Redistribution] value is "Specific", otherwise it is optional  
Argument: Text block  
Description: Allows model creator to supply specific redistribution information.  
Usage Rules: If the argument to the [Redistribution] keyword is 'Specific', then the user must include additional information on licensing details, or where to find them.  
  
Note: It is recommended that the argument to the [Redistribution Text] keyword be limited to a maximum of 24 lines of text.

-----  
[Redistribution Text] Your text goes here.

**SiQual Comment: See comment for [Source].**

=====  
Keyword: [End Header]  
Required: Yes  
Argument: None  
Description: Marks the end of an IBIS Connector header section.  
Usage Rules: [End Header] must be the last keyword in any IBIS Connector header section.

-----  
[End Header]

**SiQual comment: Header and End Header are not necessary if this information is placed with a model family block.**

=====  
6.0 GLOBAL KEYWORDS  
=====

Keyword: [Comment Char]  
Required: No  
Argument: Text String  
Description: Defines a new comment character to replace the default "|" (pipe) character, if desired.  
Usage Rules: The new comment character to be defined must be followed by the underscore character and the letters "char". For example:

"|\_char" redundantly redefines the comment character to be the pipe character. The new comment character is in effect only following the [Comment Char] keyword. The following characters MAY be used:

! " # \$ % & ' ( ) \* , : ; < > ? @ \ ^ ` { | } ~

If used, the [Comment Char] keyword can only appear after the [Begin Header] and [IBIS-X Ver] keywords. A file may contain multiple [Comment Char] keywords

---

[Comment Char] |\_char

**SiQual Comment: Should IBIS-X be referenced in this specification?**

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## 7.0 CONNECTOR MODEL FAMILY KEYWORDS

---

Keywords: [Begin Cn Model Family]  
Required: Yes, NA is the null string  
Argument: Test String  
Description: The name of the connector family in this file.  
Usage Rules: This command starts the wrapping of connector family information.  
Only a single occurrence of each [Cn Model Family]

---

[Begin Cn Model Family] NA

**SiQual Comment: It is silly to require an NA here, just because. It provides absolutely no useful information not carried by the [Begin Cn Model Family] keyword. Remove from specification.**

---

Keywords: [Cn Family Description]  
Required: Yes  
Argument: Text Block  
Description: Provides a concise yet easily human-readable description of this connector family.  
Usage Rules: It is recommended that a maximum of 4 lines be used.

Only a single occurrence of [Cn Family Description] is allowed in the file. This key word must be wrapped between Begin [Cn Model Family] and [End Cn Model Family]

---

[Cn Family Description]

High Density 0.1 center square pin connector designed for use on IEEE 99999 buses.

**SiQual Comment:** See comment for [Source].

=====

Keywords: [Cn Model List]

Required: Yes

Argument: Text Block

Description: For each connector described in this file an entry is provided which names the connector specifies it's mating, minimum slew time (for which the model is valid), and provides a link to a picture of the connector.

Usage Rules: Defines which models are present in the file. This key word must be wrapped between Begin Cn Model Family] and [End Cn Model Family]

**SiQual Comment:** See comment for [Source].

|-----

[Cn Model List]

Name	Mating	Min_Slew_Time	Image
HDI_TEST_202	Mated	100ps	HDI_TEST_202_Mated.jpg
HDI_TEST_202_UnMatedA	UnMated_Side_A	100ps	HDI_TEST_202_UnMatedA.jpg
HDI_TEST_202_UnMatedB	UnMated_Side_B	100ps	
HDI_TEST_202_ThruHole_to_Cable	Mated	25ps	HDI_TEST_202_Mated.jpg
HDI_TEST_202_SMT_to_Cable	Mated	25ps	HDI_TEST_202_Mated.jpg
HDI_TEST_202_SMT_to_ThruHole	Mated	25ps	HDI_TEST_202_Mated.jpg

**SiQual Comment:** We recommend that path names and urls be allowed, along with file names. Providing only a file name implies that all files are located in the same directory with a connector model. For systems with large numbers of models, it is generally common practice to place all models in one directory. Placing a large number of connector models and their associated jpg files in one directory could create quite a large number of files in a directory. It might be more appropriate to place the main model and it's associated files in a hierarchy of subdirectories, for better model management.

=====

Keywords: [Begin Cn Model] model\_name

Required: Yes

Argument: Text String

Description: Used to define the model name, model parameters and the

assignment of single or multiple sections of connector models as defined in the [Begin Cn Model List].

These sections define the R,L,C information making up the actual simulation data for the connector.

Usage Rules: The keyword [Begin Cn Model] must be followed by five required parameters in the following order:

Model Parameters:

Cn\_Model\_type = xxx

Required: Yes

Argument: Text String

Description: Used to define the type of connector model.

Usage Rules: Must be located between [Begin Cn Model] and [End Cn Model]. Must be either SLM or MLM

Option: SLM

SLM indicates this model is a "single-line model"

ALL sections MUST be specified using a matrix that is described by only the diagonal terms.

**SiQual Comment:** There are significant issues with single=line models and this diagonal matrix descriptor. We recommend that the limits of the model be further defined by the following options and option modifiers:

**Well\_Referenced** - SLM model matrix assumes that all other neighboring pins are grounds.

**Defined\_Reference\_Pattern** - SLM model matrix contains 0 for all reference conductors along the diagonal. (This type of model would be valid for standard connector pin configurations for standard busses, where signal and ground patterns are well defined.) (Can be combined with Min and Max.)

**Quiescent** - SLM model matrix assumes that all other neighboring signals are not switching. (Can be combined with Min and Max.)

**EvenMode** - SLM model matrix assumes that all other neighboring signals are switching in the even mode. (i.e. - all neighbors transition at the same time and in the same edge direction as the modeled pin.)

**OddMode** - SLM model matrix assumes that all other neighboring signals are switching in the odd mode. (i.e. - all neighbors transition at the same time and in the opposite edge direction as the modeled pin.)

**Min** - For GSR ratios less than 1:1, the position of a pin within the reference pin field will cause a variance in the extracted parasitic values. If Min option modifier is used, this SLM matrix represents the minimum possible value.

**Max** - For GSR ratios less than 1:1, the position of a pin within the reference pin field will cause a variance in the extracted parasitic values. If Max option modifier is used, this SLM matrix represents the maximum possible value.

**Nominal** - For GSR ratios less than 1:1, the position of a pin within the reference pin field will cause a variance in the extracted parasitic values. If Nominal option modifier is used, this SLM matrix represents the nominal value.

Model\_PinMap\_A = xxxxxxxx  
Required: Yes  
Argument: Text String  
Description: Used to define the name of the pin map for "side a" of the connector.  
Usage Rules: Must be located between [Begin Cn Model] and [End Cn Model]. The field ModelPinMap\_A be less than 20 characters. ModelPinMap\_A must appear before ModelPinMap\_B. This field is used to name one of the two ports of each connector terminal.

Under most conditions, these will be the same Name ModelPinMapA, however two variables are required to address crossover pin mapping.

Example: ModelPinMapA = abc

Model\_PinMap\_B = xxxxxxxxxxxx  
Required: Yes  
Argument: Text String  
Description: Used to define the name of the pin map for "side b" of the connector.  
Usage Rules: Must be located between [Begin Cn Model] and [End Cn Model]. The field ModelPinMap\_B be less than 20 characters. ModelPinMap\_B must appear after ModelPinMap\_A. This field is used to name one of the two ports of each connector terminal. Under most conditions, these will be the same name as ModelPinMapA, however two variables are required to address crossover pin mapping.

Example: ModelPinMapB = xyz

**SiQual Comment:** Remove Model\_PinMap\_B and Model\_PinMapA. Add Model\_PinMap to facilitate naming more than two ports on a connector. A minimum of three ports are necessary to model some conenctors which have multiple mating surfaces.

Model\_PinMap = xxxxxxxx  
Required: Yes  
Argument: Text String  
Description: Used to define the name of the pin map for a port  
On a connector.  
Usage Rules: Must be located between [Begin Cn Model] and  
[End Cn Model]. The field ModelPinMap be less  
than 20 characters. This field is used to name  
one port of each connector terminal.

Example: ModelPinMap = PortA\_Map  
ModelPinMap = PortB\_Map  
ModelPinMap = PortC\_Map

Each name created by a ModelPinMap statement may be instantiated by placement at one place with a [Begin Cn Model] and [End Cn Model] block. This placement defines the location of externally available ports for this model, and generally correspond to the mating surfaces of the connector.

Cn\_Section = xxxxxxxx  
Required: Yes  
Argument: Text Block  
Description: Used to define a straight through section  
of a connector model. Matrix sections are  
interconnected, scaled and may be re-used to  
form a connector model.  
Usage Rules: Sub-parameters "multiplier" and "section name"  
must follow the Cn\_Section parameter.

The multiplier is a scale factor.

The "section name" is the name of the section as specified under the [Begin Cn Section] keyword.

The multiplier may be used to scale any named section. The multiplier may be any positive value greater than zero. The multiplier allows a matrix section to be re-used as a scaled value. The scale factor is applied to each parameter of all matrices resulting in scaled R,L, and C matrices.

Any number of Cn\_Section may be used, however only one keyword is allowed per line.

Each scale factor and section name MUST be separated by at least one space. Each sub-parameter pair MUST be separated by at least one space.

Cn\_Section must appear after the keyword [Begin Cn Model] and before the keyword [End Cn Model].

Cn\_Stub = xxxxxxxxxxxx

Required: Yes

Argument: Text Block

Description: Used to define a "tee" section of a connector model. Matrix sections are interconnected, scaled and may be re-used to form a connector model.

Usage Rules: Sub-parameters "multiplier" and "section name" must follow Cn\_Stub.

The multiplier is a scale factor.

The "section name" is the name of the section as specified under the [Begin Cn Section] keyword.

The multiplier may be used to scale any named section. The multiplier may be any positive value greater than zero. The multiplier allows a matrix section to be re-used as a scaled value. The scale factor is applied to each parameter of all matrices resulting in scaled R,L, and C matrices.

Any number of Cn\_Stub may be used, however only one keyword is allowed per line.

Each scale factor and section name MUST be separated by at least one space. Each sub-parameter pair MUST be separated by at least one space.

Cn\_Stub must appear after the keyword [Begin Cn Model] and before the keyword [End Cn Model].

**SiQual Comment:** Cn\_stub can be removed and replaced by the Fork, Endfork and Section constructs. At a fork, a "tee" section is created. Matrix sections are connected to the previous section and interconnected to Zero or more sections between Fork and Endfork. If no pin map name is placed between a Fork and Endfork block, then the fork constitutes a stub. However, if a pin map

name is placed within the Fork and Endfork block, an externally available port is created on the connector.

#### General Cn\_Section and Cn\_Stub Notes

Each Cn\_Section is connected in series with the previous Cn\_Section.

The first Cn\_Section or Cn\_Stub sub-parameter after [Begin Cn Model] is connected to the side A connector pin.

The last Cn\_Section or Cn\_Stub sub-parameter after [Begin Cn Model] is connected to the side B connector pin. The last multiplier-name pair used with the Cn\_Stub sub-parameter is open circuit at the far end.

NOTE: Named sections are NOT specified in per-unit-length. They are specified as unit-less total R,L,C values for the given section.

=====  
"Cn Model" Examples  
=====

Old Example 1: (a simple single line model with one section)

```
[Begin Cn Model] MyExample1
  Cn_Model_Type = SLM
  Model_Name = MyModel1
  Model_PinMap_A = MyModelPinMapA
  Model_PinMap_B = MyModelPinMapB
  GSR = 3:1
  Cn_Section 1.0 Diagonal_matrix1
[End Cn Model] MyExample1
```

**New Example 1: (a simple single line model with one section)**

```
[Begin Cn Model] MyExample1
  Cn_Model_Type = SLM
  Model_Name = MyModel1
  Model_PinMap = MyModelPinMapA
  Model_PinMap = MyModelPinMapB
  GSR = 3:1
  MyModelPinMapA
  Cn_Section 1.0 Diagonal_matrix1
  MyModelPinMapB
[End Cn Model] MyExample1
```

Old Example 2: (5 sections straight through)

```
          SectionA      SectionB      SectionC      SectionD      SectionE
Pin >-----< >-----< >-----< >-----< >-----< Pin
```

```
[Begin Cn Model] MyExample2
  Cn_Model_Type = SLM
  Model_Name = MyModel2
  Model_PinMap_A = MyModelPinMapA
  Model_PinMap_B = MyModelPinMapB
  GSR = 3:1
  Cn_Section 1.0 SectionA
  Cn_Section 1.0 SectionB
  Cn_Section 1.0 SectionC
  Cn_Section 1.0 SectionD
  Cn_Section 1.0 SectionE
[End Cn Model] MyExample2
```

New Example 2: (5 sections straight through)

```
          SectionA      SectionB      SectionC      SectionD      SectionE
Pin >-----< >-----< >-----< >-----< >-----<
---< Pin
```

```
[Begin Cn Model] MyExample2
  Cn_Model_Type = SLM
  Model_Name = MyModel2
  Model_PinMap = MyModelPinMapA
  Model_PinMap = MyModelPinMapB
  GSR = 3:1
  MyModelPinMapA
  Cn_Section 1.0 SectionA
  Cn_Section 1.0 SectionB
  Cn_Section 1.0 SectionC
  Cn_Section 1.0 SectionD
  Cn_Section 1.0 SectionE
  MyModelPinMapB
[End Cn Model] MyExample2
```

Old Example 3: (2 series sections with one stub)

```
          SectionA      SectionB
Pin >-----< >-----< Pin
      |
      StubSection1
```

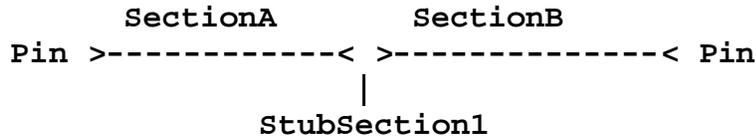
```
[Begin Cn Model] MyExample3
  Cn_Model_Type = MLM
  Model_Name = MyModel3
  Model_PinMap_A = MyModelPinMapA
  Model_PinMap_B = MyModelPinMapB
```

```

Cn_Section 1.0 SectionA
Cn_Stub 1.0 StubSection1
Cn_Section 1.0 SectionB
[End_Cn_Model] MyExample3

```

**New Example 3: (2 series sections with one stub)**

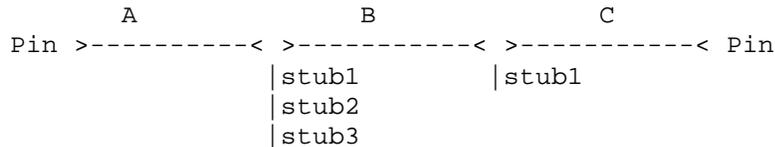


```

[Begin Cn Model] MyExample3
  Cn_Model_Type = MLM
  Model_Name = MyModel3
  Model_PinMap = MyModelPinMapA
  Model_PinMap = MyModelPinMapB
  MyModelPinMapA
  Cn_Section 1.0 SectionA
  Fork
    Cn_Section 1.0 StubSection1
  Endfork
  Cn_Section 1.0 SectionB
  MyModelPinMapB
[End_Cn_Model] MyExample3

```

Old Example 4: (2 stub sections, one stub matrix is re-used)

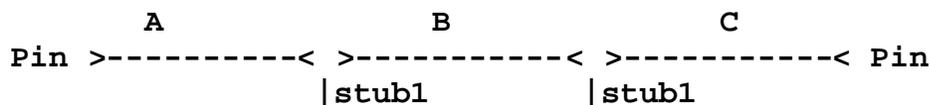


```

[Begin Cn Model] MyExample4
  Cn_Model_Type = MLM
  Model_Name = MyModel4
  Model_PinMap_A = MyModelPinMapA
  Model_PinMap_B = MyModelPinMapB
  Cn_Section 1.0 A
  Cn_Stub 1.0 stub1
  Cn_Stub 1.0 stub2
  Cn_Stub 1.0 stub3
  Cn_Section 1.0 B
  Cn_Stub 1.0 stub1
  Cn_Section 1.0 C
[End_Cn_Model] MyExample4

```

**New Example 4: (2 stub sections, one stub matrix is re-used)**



```

|stub2
|stub3

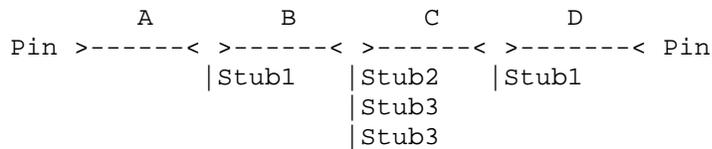
```

```

[Begin Cn Model] MyExample4
  Cn_Model_Type = MLM
  Model_Name = MyModel4
  Model_PinMap = MyModelPinMapA
  Model_PinMap = MyModelPinMapB
  MyModelPinMapA
  Cn_Section 1.0 A
  Fork
    Cn_Section 1.0 stub1
    Cn_Section 1.0 stub2
    Cn_Section 1.0 stub3
  Endfork
  Cn_Section 1.0 B
  Fork
    Cn_Section 1.0 stub1
  Endfork
  Cn_Section 1.0 C
  MyModelPinMapB
[End_Cn_Model] MyExample4

```

Old Example 5: (3 stubs)



```

[Begin Cn Model] MyModel MyModelPinMap_A MyModelPinMap_B MLM
  Cn_Model_Type = MLM
  Model_Name = MyModel4
  Model_PinMap_A = MyModelPinMapA
  Model_PinMap_B = MyModelPinMapB
  Cn_Section 1.0 A
  Cn_Stub 1.0 Stub1
  Cn_Section 1.0 B
  Cn_Stub 1.0 Stub2
  Cn_Stub 1.0 Stub3
  Cn_Stub 1.0 Stub4
  Cn_Section 1.0 C
  Cn_Stub 1.0 Stub1
  Cn_Section 1.0 D
[End Cn Model] MyModel

```

New Example 5: (3 stubs)



```

|Stub1   |Stub2   |Stub1
          |Stub3
          |Stub3

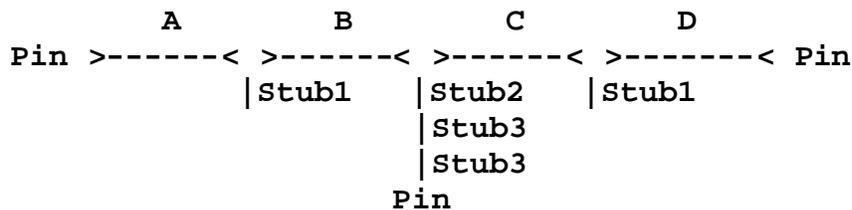
```

```

[Begin Cn Model] MyModel MyModelPinMap_A MyModelPinMap_B MLM
  Cn_Model_Type = MLM
  Model_Name = MyModel4
  Model_PinMap = MyModelPinMapA
  Model_PinMap = MyModelPinMapB
  MyModelPinMapA
  Cn_Section 1.0 A
  Fork
    Cn_Section 1.0 Stub1
  Endfork
  Cn_Section 1.0 B
  Fork
    Cn_Section 1.0 Stub2
    Cn_Section 1.0 Stub3
    Cn_Section 1.0 Stub4
  Endfork
  Cn_Section 1.0 C
  Fork
    Cn_Section 1.0 Stub1
  Fork
    Cn_Section 1.0 D
  MyModelPinMapB
[End Cn Model] MyModel

```

New Example 6: (3 stubs, 3 ports)



```

[Begin Cn Model] MyModel MyModelPinMap_A MyModelPinMap_B MLM
  Cn_Model_Type = MLM
  Model_Name = MyModel4
  Model_PinMap = MyModelPinMapA
  Model_PinMap = MyModelPinMapB
  Model_PinMap = MyModelPinMapC
  MyModelPinMapA
  Cn_Section 1.0 A
  Fork
    Cn_Section 1.0 Stub1

```

```

Endfork
Cn_Section 1.0 B
Fork
Cn_Section 1.0 Stub2
Cn_Section 1.0 Stub3
Cn_Section 1.0 Stub4
MyModelPinMapC
Endfork
Cn_Section 1.0 C
Fork
Cn_Section 1.0 Stub1
Fork
Cn_Section 1.0 D
MyModelPinMapB
[End Cn Model] MyModel

```

```

=====
Keyword:  [Cn Number of Conductors]
Required: Yes, when [Begin Cn Auto Map] is NOT used
Argument: Numeric Value or VARIABLE
Description: Number of current carrying conductors used in the model.
             It is assumed that all matrices in for the associated connector
             model will have the SAME number of indices.
             This also defines the size of the expected Matrix(s) unless the
             optional [Begin Cn Swath] keyword is used.

Usage Rules: If the [Begin Cn Pin Map] keyword is in use in this model
             then a single numeric value from 1 to 100000 is recommended.
             Larger values shall create warnings by the parser.  Smaller
             values shall create errors by the parser.

             If the [Begin Cn Auto Map] keyword is in use in this model
             then a range MUST be specified from 1 to 100000 is
             recommended. Larger values shall create warnings by the
             parser.  Smaller values shall create errors by the parser.

             If the [Begin Cn Auto Map] keyword is also used for this
             connector model than a range MUST be specified as a
             minimum values to a maximum value (see example below).  If
             the [Begin Cn Auto Map] is not used than a single fixed
             number of conductors must be specified.

             This keyword MUST BE USED BETWEEN KEYWORDS
             [Begin Cn Model] and [End Cn Model].

```

Fixed sized connector example:

```

-----
[Cn Number of Conductors] 8

```

=====  
Keyword: [Cn Col of Pins]  
Required: Yes, when [Begin Cn Auto Map] is NOT used  
Argument: Numeric Value  
Description: The number of columns of pins for a non-rectangular connectors  
the maximum number of pins "across" the connector should be  
specified.  
Usage Rules: If the keyword [Begin Cn Auto Map] is present in this  
connector model than the keyword VARIABLE MUST be used to  
indicate a variable width connector.  
  
Else a numeric value from 1 to 100000 is recommended. Larger  
values shall create warnings by the parser. Smaller values  
shall create errors by the parser.  
  
If the keyword VARIABLE is used it must be all upper case.  
  
This keyword pair MUST BE USED BETWEEN KEYWORDS  
[Begin Cn Model] and [End Cn Model].  
  
That is it MUST BE specified after the keyword  
[Cn Number of Conductors] for this model.

-----  
| For fixed sized connector models use a single numeric value as shown below  
[Cn Columns of Pins] 4

| For variable size connector models using the [Begin Cn Auto Map] keyword  
| the special keyword VARIABLE may be used to indicate this axis is variable  
| width.  
[Cn Col of Pins] VARIABLE

=====  
Keyword: [Cn Rows of Pins]  
Required: Yes, when [Begin Cn Auto Map] is NOT used  
Argument: Numeric Value  
Description: The number of rows of pins.  
For a non-rectangular connectors the maximum number of pins  
"down" the connector should be specified.  
Usage Rules: A numeric value is required following the keyword to specify  
the number of rows this connector model requires.  
A numeric value from 1 to 100000 is recommended. Larger  
values shall create warnings by the parser. Smaller values  
shall create errors by the parser.  
  
This keyword pair MUST BE USED BETWEEN KEYWORDS  
[Begin Cn Model] and [End Cn Model].  
  
That is it MUST BE specified after the keyword  
[Cn Number of Conductors] for this model.

-----  
[Cn Rows of Pins] 2

=====  
Keywords: [Cn Col Swath]; [Cn Row Swath]

Required: No, except if [Define Cn Auto Map] is used or if the number of matrix entries does not match the number defined by [Cn Number of Conductors] for [Define Cn Pin Map].

Argument: Numeric Values

Description: Describes a "swath" which is a smaller matrix used to represent connectors of equal or larger size and the matrix order convention. To visualize this, consider the swath matrix being a smaller version of the connector. The edges of the matrix represent the same edge effects that exists in the full size connector. The center area of the matrix represents the same effects as the center of the full size connector.

It is the responsibility of the EDA tool to use the matrix and the required keyword information as a "mini" connector that is centered about the electrical paths of interest and/or to expand this information into a larger sized swath up to the full sized connector itself.

For example a 2x8 matrix might be expanded to represent a connector that is 2x100. The "swath" can also be combined with the [Begin Cn Auto Map] keyword to create multiple connector models from a single description. For example a 2x10 matrix might be used to represent connectors ranging from 2x10 to 2x200 with a single descriptive model.

**SiQual Comment: This is a horrible section to understand without the Usage Context 5 pages down in the file. The Usage Rules section shows examples which are predicated upon information which is not defined until later in the Usage context. We recommend that the Usage Context section be moved up to the Description section for better readability and understandability. It is absolutely impossible to understand the next 5 pages without previously understanding what is written in the usage context. This reader spent 2 hours trying to understand the Usage of the mysterious Numeric Values of the [Cn Col Swath] and [Cn Row Swath] keywords, until finally stumbling upon the Usage Context 5 pages later.**

Usage Rules: Full sized swath: If the [Cn Number of Conductors] value is the same as the number of matrix pin entries for [Begin Cn Section] then neither [Cn Column Swath] nor [Cn Row Swath] are used. The matrices must be ordered exactly as the pins listed under [Begin Cn Pin Map].

Smaller sized swath: The swath matrix must contain a set of pins documenting a complete rectangular section organized by rows and columns. [Cn Row Swath] describe the pins ordered by rows (starting with the top row), and [Cn Column Swath] describe the same information ordered by columns (starting with the left column from a "side A" perspective).

For example, consider a swath that documents rows A and B and columns 1, 2, and 3 of a six pin rectangular [Cn Column Swath] describe pins ordered by columns (for

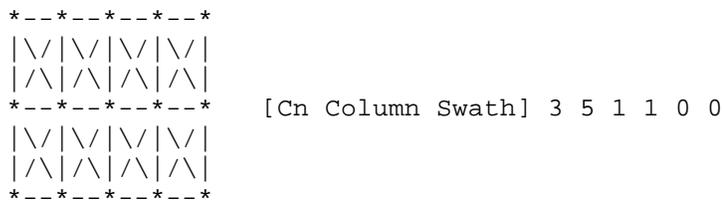
example, A1, B1, A2, B2, A3, B3), and [Cn Row Swath] defines pins ordered by rows (for example, A1, A2, A3, B1, B2, and B3).

When a smaller sized swath is defined for a fixed pin map as defined by [Begin Cn Pin Map], the pin order must be grouped in the same order (by rows or by columns) as the given by EITHER [Cn Row Swath] or [Cn Column Swath]

The edge effects describe the edge rows or columns that do not contain all of the coupling effects (from both sides) that the centermost rows or columns. This information is useful for "swath expansion" when determining what larger size to use.

When the swath represents a SLM or else documents all of the pins in a physical connector, the off diagonal entries are 0 by convention. If the swath describes a section with few columns, but the same number of rows as the physical connector, then the row edge effects are 0 by convention. Similarly, if the swath describes a section with fewer rows, but the same number of columns as the physical connector, then the column edge effects are 0 by convention.

In a fully coupled swath where all pins couple to all others, all of the rows or columns except for the one designated as the centermost row or column can have edge effect simplification. So the number of rows or columns can extend to all but the center row or column. On the other hand, a coupling pattern that extends over a few columns may result in a smaller number of edges designated. Below is an example of a 3 row by 5 column swath, where the lines in a rectangular connector represent the electrical coupling:



Notice that columns 2, 3, and 4 have the maximum amount of coupling from each side. In this case the edge effect columns 1 and 5 do not have coupling from both sides.

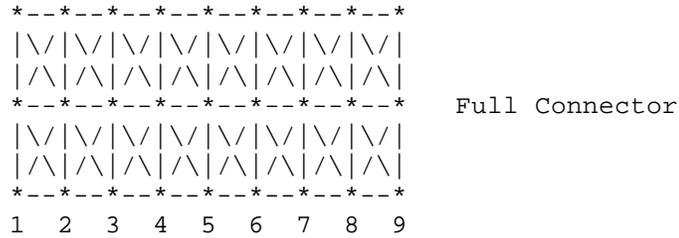
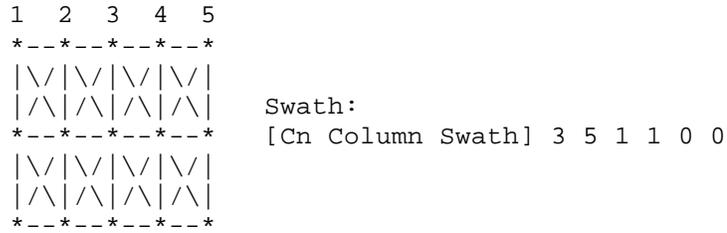
Application of Swath Matrices:

For the purposes of this discussion a 3 row by 5 column swath is used and the full sized connector is 3 rows by 9 columns. The swath matrix data can be organized by [Cn Column Swath] or [Cn Row Swath] pin ordering convention. However, the column expansion algorithms discussed later can be implemented using the [Cn Column Swath] format.

Three methods can be used to apply the Swath matrix

information:

(1) Centering the Swath around the pins of interest



The Swath above is centered about column 4. The paths of interest including those of columns 3 and 5 are also described by swath matrix data that has coupling from both sides. However, because of edge effects, columns 2 and 6 are less accurately approximated.

The centering algorithm is a way to map the swath matrix pins directly into the corresponding pins of the actual connector.

When the signals of interest are at the left or right edges, the swath would normally be positioned just to the edges. For example, column 1 of the swath matrix would line up with column 1 of the connector.

(2) Expansion and Centering: Expanding the Swath matrix into a larger sized Swath matrix and centering it about the paths of interest.

This approach is the same as centering. However, the signal pins of interest might have more columns than the non-edge section of the swath. One solution is to expand the swath to a larger swath and then use the larger swath for centering. This is a subset of expanding the swath into the full sized connector.

Some EDA tools work with the a larger swath, and other tools work with full sized connectors. A larger swath might be constructed to span the number of columns of interest plus the edge effect columns to assure that the most accurate coupling information from both sides is used for the columns of interest.

(3) Expansion to Full Sized Connector: Expanding the swath matrix to the full sized connector matrix. the Full-sized matrix

There are three steps to this procedure (a, b, and c below). This is illustrated using the 3 row, 5 column swath and showing how it is expanded into a 3 row, 9 column full sized connector

(a) Copy the left column pattern

```

1  2  3  4  5
*--*--*--*--*
|\|/\|/\|/\|
|/\|/\|/\|/\| Swath:
*--*--*--*--* [Cn Column Swath] 3 5 1 1 0 0
|\|/\|/\|/\|
|/\|/\|/\|/\|
*--*--*--*--*

*--*--*--*--*--*--*--*--*
|\|/\|/\|/\|/\|/\|/\|/\|/\|
|/\|/\|/\|/\|/\|/\|/\|/\|/\|
*--*--*--*--*--*--*--*--* Full Connector
|\|/\|/\|/\|/\|/\|/\|/\|/\|
|/\|/\|/\|/\|/\|/\|/\|/\|/\|
*--*--*--*--*--*--*--*--*
1  2  3  4  5  6  7  8  9

```

The matrix data for swath columns 1 and 2 (including forward references) copied into the new full connector matrix.

(b) repeat the center pattern,

```

1  2  3  4  5
*--*--*--*--*
|\|/\|/\|/\|
|/\|/\|/\|/\| Swath:
*--*--*--*--* [Cn Column Swath] 3 5 1 1 0 0
|\|/\|/\|/\|
|/\|/\|/\|/\|
*--*--*--*--*

*--*--*--*--*--*--*--*--*
|\|/\|/\|/\|/\|/\|/\|/\|/\|
|/\|/\|/\|/\|/\|/\|/\|/\|/\|
*--*--*--*--*--*--*--*--* Full Connector
|\|/\|/\|/\|/\|/\|/\|/\|/\|
|/\|/\|/\|/\|/\|/\|/\|/\|/\|
*--*--*--*--*--*--*--*--*
1  2  3  4  5  6  7  8  9

```

Starting at the center of the swath, the coupling pattern of



connector model.

MUST be followed by 6 numbers in order as follows:

Rows in the swath matrix

Columns in the swath matrix

LEFT EDGE: Columns in the swath matrix

used to represent left edge

RIGHT EDGE: Columns in the swath matrix

used to represent right edge

TOP EDGE: Rows in the swath matrix used

to represent top edge

BOTTOM EDGE: Rows in the swath matrix

used to represent bottom

edge

Please see the example below to see how these are used with the keyword

Note, the orientation is with respect to 'side A' of the connector.

```
-----  
                SwathRows SwathCols LeftEdge RightEdge TopEdge BottomEdge  
[Cn Column Swath]      2           8           1           1           0           0
```

SiQual Comment: Move this whole section up to the top of the keyword description section.

```
=====  
Keywords: [Cn Pin Map]
```

Required: If the [Begin Cn Auto Map] keyword is NOT present than this keyword is required else it shall not be used.

Argument: Text String

Description: Describes the index into the matrix for which a given pin applies.

SiQual Comment: This section does not seem to actually define a mapping into the matrix, but rather, the mapping of the physical connector pin number to a logical name. Two new fields are added to facilitate mapping of pins to matrix rows and columns:

Matrix\_Row\_Number and Matrix\_Column\_Number.

Note: Row and Column numbers for matrix need to be added to the auto mapping section, also.

Usage Rules: The keyword [Begin Cn Pin Map] must be followed one or more required parameters which are ModelPinMapName\_A and ModelPinMapName\_B.  
e.g. [Begin Cn Pin Map] ModelPinMapName\_A ModelPinMapName\_B

Change to:

**Usage Rules:** The keyword [Begin Cn Pin Map] must be followed by two required parameters which are Model\_PinMap names.

e.g. [Begin Cn Pin Map] MyModelPinMapA

or [Begin Cn Pin Map] MyModelPinMapA MyModelPinMapB

or [Begin Cn Pin Map] MyModelPinMapA MyModelPinMapB MyModelPinMapC

A ModelPinMapName fields is required and must be less than 20 characters. The ModelPinMapName fields MUST appear after the [Begin Cn Pin Map] and may optionally appear as parameters following the [End Cn Pin Map] keyword. This name is used by the [Begin Cn Model] keyword to reference a pin map.

More than one [Begin Cn Model] record may reference the same pin map.

The keyword NA indicates that there is not a pin in the location (e.g. PGA socket with corner pin missing)

An end of line character indicates the end of the information for the row

The lines between [Begin Cn Pin Map] and [Begin Cn Pin Map] shall contain one line for each pin in this connector model. The pin map line shall contain the following parameters.

Pin

Required. This allows EDA tools to align pin names in the model with pin names in the net list.

**Matrix\_Row\_Number**

**Required. This maps a particular pin to a matrix row.**

**Matrix\_Column\_Number**

**Required. This maps a particular pin to a matrix row.**

Signal

Optional, based on application but recommended if applicable. NA should be used to indicate this field is not available.

This can be used by EDA tools or by users interactively to easily identify the pins of the connector.

This is an alternate method for EDA tools to align signal names in the model with net names from the design's net list if the pin names cannot be aligned.

Maximum of 20 characters allowed for Pin Name

Maximum of 20 characters allowed for Signal Name

Pin or Signal names longer than 20 should be truncated to 20 to fit this specification.

It is acceptable to have more than one pin map in a file. Therefore the keywords [Begin Cn Pin Map] and [End Cn Pin Map] may appear as a pair more than once in a file.

Usage Context:

This keyword pair MUST be placed outside the keyword pair [Begin Cn Model] / [End Cn Model] keywords to allow it to be reused.

Special Reserved Pin Names

POWER, RET, GND, and PWRGND

Used to indicate that this pin should be connected to either a decoupled power source (POWER), a ground node (RET or GND), or either a power or ground pin (PWRGND). The keyword RET is available to indicate it is a return pin and could be either power or ground.

---

**Old syntax:**

```
[Begin Cn Pin Map] 20PinHdiPin
Pin      Signal
A1       GND
A2       D0
A3       CLK
A4       D1
B1       STROBE1
B2       A0
B3       POWER
B4       PWRGND
[End Cn Pin Map]
```

**New Syntax:**

```
[Begin Cn Pin Map] 20PinHdiPin
Pin      Row      Column      Signal
A1       1         1         GND
A2       1         2         D0
A3       1         3         CLK
A4       1         4         D1
B1       2         1         STROBE1
B2       2         2         A0
B3       2         3         POWER
B4       2         4         PWRGND
[End Cn Pin Map]
```

---

Keywords: [End Cn Model Family]

Required: Yes

Argument: None

Description: Defines the end of the connector connector model family

Usage Rules: These commands wrap the entire model in this file.

---

[End Cn Model Family]

=====  
Keyword: [Begin Cn Section]  
Required: No  
Argument: Text String  
Description: Indicates the beginning and the name of a set of R,L,C matrix data.  
Usage Rules: Each matrix used for given connector model MUST have exactly the same number conductors.

If the swath method is used the matrix may have fewer conductors than the connector model.

If the swath method is not used the matrix MUST have exactly the same number of conductors as the connector has pins.

The matrices used for the R,L,C description can be defined using any of the matrix description methods allowed in the specification. The matrix description methods can also be mixed within a given section. For example the resistance matrix might use the Diagonal\_matrix and the inductance matrix might use a Full matrix.

MUST be placed outside the context of keywords [Begin Cn Model] and [End Cn Model] as sections may be reused by more than one connector model.

MUST be placed inside the context of the family

The following keywords are optional:  
[Resistance Matrix], [Bandwidth], [Row]

Must include [Derivation Method]

For an example of [Begin Cn Section] see matrix examples that follow.

=====  
Derivation Method = xxxxx  
Required: Yes  
Argument: Lumped or Distributed  
Description: Describes the type of model that should be generated from the Matrices.  
Usage Rules: Must be between [Begin Cn Section] and [End Cn Section]

The [Derivation Method] keyword is required for each section.

"Lumped" or "Distributed"  
For LUMPED models any single, any pair, or all of the following keywords could be used:  
[Inductance Matrix], [Capacitance Matrix] ,  
[Resistance Matrix]

For DISTRIBUTED models BOTH the [Inductance Matrix] and [Capacitance Matrix] keywords are

required. The [Resistance Matrix] keyword is optional.

All three matrices within the same section share the same derivation method

If ModelType is SLM then simulators should use this data to create a non-coupled fully distributed transmission line model. It may be also be used to create a multi-section ladder RLC-LCR model as is often used with SPICE simulators.

If a ladder network is substituted for a fully distributed transmission line model the simulator vendor should insure enough sections are provided to insure the bandwidth specified by the Min\_Slew\_Time of this model is achieved. The symmetric RLC-LCR method should be used as opposed to the non-symmetric RLC-RLC method if a ladder network is used.

-----  
[Derivation Method] LUMPED

=====  
Keywords: [Resistance Matrix], [Inductance Matrix], [Capacitance Matrix]

Required: Yes, If a simple single line model is defined then the following matrices are required:

case 1: [Resistance Matrix] only

OR

case 2: [Inductance Matrix] and [Capacitance Matrix] only for which the [Resistance Matrix] is assumed to be zero ohms

OR

case 3: [Resistance Matrix] and [Inductance Matrix] and [Capacitance Matrix]

NOTE: In case 1,2,3 the matrices must be Diagonal\_matrix.

If a coupled model is defined then the following matrices are required:

case 4: [Inductance Matrix] and [Capacitance Matrix] only for which the [Resistance Matrix] is assumed to be zero ohms

OR

case 5: [Resistance Matrix] and [Inductance Matrix] and [Capacitance Matrix]

NOTE: In case 4,5 the matrices shall be any combination of matrix types (Diagonal, Banded, Sparse, Full).

Argument: Matrix Type

Description: The sub-parameters mark the beginning of a matrix, and specify how the matrix data is formatted.

Usage Rules: For each matrix keyword, use only one of the sub-parameters.

After each of these sub-parameters, insert the matrix data in the appropriate format. (These formats are described in detail below.)

MUST BE USED between keywords [Begin Cn Section] and [End Cn Section].

Matrix Type Options:

Diagonal\_matrix, Banded\_matrix, Sparse\_matrix, or Full\_matrix

Diagonal\_matrix

Required: No

Argument: None

Description: The Diagonal\_matrix is used to specify uncoupled models.

This sub-parameter is exactly the same as using the Banded\_matrix described below with a Bandwidth=0. It has the added benefit of requiring half as many lines.

A Diagonal\_matrix is one whose entries are guaranteed to be zero if they are not on the main diagonal.

Specify the Diagonal\_matrix one row at a time, starting with row 1 and working up to higher rows. Diagonal elements are entered one per line. MUST be used between keywords [Begin Cn Section] and [End Cn Section].

Banded\_matrix

Required: No

Argument: None

Description: The Banded\_matrix is used to specify the coupling effects up to "X" pins on either side for a given pin.

A Banded\_matrix is one whose entries are guaranteed to be zero if they are farther away from the main diagonal than a certain distance, known as the "bandwidth."

The bandwidth for a Banded\_matrix must be specified using the [Bandwidth] keyword.

Specify the banded matrix one row at a time, starting with row 1 and working up to higher rows. Mark each row with the [Row] keyword.

Symmetry is exploited. Entries other than the main diagonal are not required.

### Sparse\_matrix

Required: No  
Argument: None  
Description: A Sparse\_matrix is expected to consist mostly of zero-valued entries, except for a few nonzero. Unlike the Banded\_matrix, there is no restriction on where the nonzero entries can occur.

Symmetry can be exploited to reduce the amount of data by eliminating from the matrix any entries below the main diagonal.

An N x N Sparse\_matrix is specified one row at a time, starting with row 1 and continuing down to row N. Each new row is marked with [Row] keyword, as in the other matrix formats.

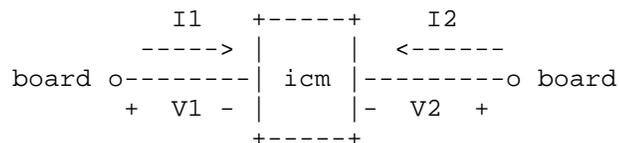
### Full\_matrix

Required: No  
Argument: None  
Description: When the Full\_matrix format is used, the couplings between every Pair of elements is specified explicitly. Assume that the Matrix has N rows and N columns.

The Full\_matrix is specified one row at a time, starting with Row 1 and continuing down to Row N. Each new row is identified with the [Row] keyword.

### Matrix Descriptions

The resistance, inductance, and capacitance matrices may also be referred to as "RLC matrices" within this specification. When measuring the entries of the RLC matrices, either with laboratory equipment or field-solver software, currents are defined as ENTERING the pins of the package from the board. The corresponding voltage drops are to be measured with the current pointing "in" to the "+" sign and "out" of the "-" sign.



It is important to observe this convention in order to get the correct signs for the mutual inductance and resistances.

For each [Resistance Matrix], [Inductance Matrix], or [Capacitance Matrix] a different matrix type can be used for the data.

Resistance Matrix Description

=====

UNITS: OHMS
DESCRIPTION: The resistance matrix represents the total DC resistance between the two ends of this section of the connector.

NOTES:
The resistance matrix is optional. Simulation tools shall use 0.0 ohms for all diagonal entries and "infinite" for all off diagonal entries if this matrix is not present.

DO NOT USE ohms/meter as this is the total value and includes the length of this section.

Values should all appear in the diagonal terms of the matrix. For example: value 1,1 is the resistance for pin 1 and value 2,2 is the resistance for pin 2.

A "Diagonal\_matrix" matrix type is the best choice for describing the resistance matrix. Diagonal elements may be dominant. Comparably, the off diagonal elements may be negligible thus leading to off diagonal element values of zero leading to the [Diagonal\_matrix] format

Inductance Matrix Description

=====

UNITS: HENRIES
DESCRIPTION: Two inductance matrix methods are supported:
Loop-Inductance Matrix for SLMs ONLY (non-coupled)
Partial-Inductance Matrix for MLMs ONLY (coupled)

If ModelType is SLM then all sections must use loop-inductance and capacitance matrices.

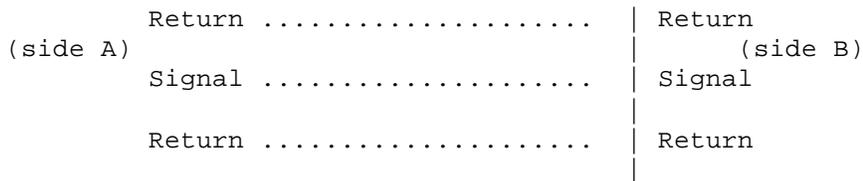
If ModelType is MLM then all sections must use partial-inductance and capacitance matrices.

Loop-Inductance Matrix Description (SLMs ONLY):

=====

DESCRIPTION: To define inductance requires a loop. The loop consists of a closed path including a signal and all possible return paths. The inductance is a coefficient between the emf induced in the loop and the change of magnetic flux through the loop.

connector or section



The return path must include all pins that are power or ground. In a loop inductance matrix, the diagonal terms represent the loop inductance of a specific pin with return currents assumed returned through all pins defined to be power or ground.

NOTES (Single-Line Loop-Inductance Matrix):

This method must be used if the ModelType is SLM.

Loop inductance can be experimentally measured.

Loop inductance matrices can be created using field solvers.

An SGR value is normally specified for an SLM model that indicates the ratio of signal pins to return path pins (i.e. power or ground) pins.

SLM models make have zero values for power or ground R,L,C values which prevents there use in analyzing connector ground bounce effects.

Typical uses for SLM model might include for example a 2x17 header connector where the bottom row is all grounded. The SGR would be specified in this case as 1:1. A model would be developed with these assumptions made. Then all pins would be filled with average values. To further expand this example see the figure below:

Pin out:

```
1 ..... 17
18 ..... 34
```

Measurement or Field solver connection:

```
Sig Sig Sig ... Sig Sig
Gnd Gnd Gnd ... Gnd Gnd
```

Measured or Computed values:

```
3nH 4nH 4nH ....4nH 3nH
```

Matrix data:

```
3nH 4nH 4nH ....4nH 3nH
3nH 4nH 4nH ....4nH 3nH
```

This allows the user to specify any of the following power/ground connections and still use this model:

Simulator Connection A:

```
Sig Sig Sig ... Sig Sig
Gnd Gnd Gnd ... Gnd Gnd
```

Simulator Connection B:

```
Gnd Gnd Gnd ... Gnd Gnd
Sig Sig Sig ... Sig Sig
```

Simulator Connection C:

```
Sig +5V Sig ... Gnd Sig
```

Gnd Sig Gnd ... Sig +5V

Given the following connection a simulation should generate a warning to the user indicate the ground-signal-ratio has been violated.

Simulator Connection D:

Sig Sig Sig ... Sig Sig  
Gnd Sig Sig ... Sig Sig

All connector pins must be specified with non-zero L and C values in at least one of the sections. The simulator will zero out portions of all sections corresponding to the ground or power pins.

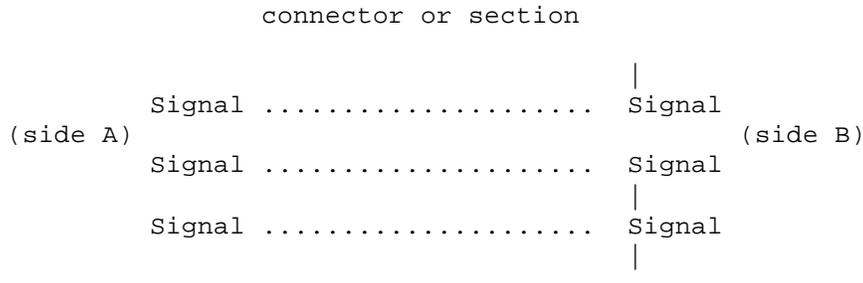
SLM models are most useful where coupling analysis is not critical and where the rise time of the signal is long compared to the electrical delay through the connector.

Partial Self Inductance Matrix Description (MLMs ONLY):

=====

DESCRIPTION: A partial self inductance is an approximation of the loop inductance in situations where the current return path cannot be explicitly stated in the field extraction stages. Partial self inductance can be numerically calculated by introducing a current in a circuit element that originates on one end and terminates on the other end. There is no physical loop per se, instead charges will build up on each side of the circuit element. In practice, this situation cannot exist more than instantaneously. For the purposes of simulation the condition does not affect the resultant loop inductance values. Then from the currents found the magnetic fields and inductance's can be calculated. In this way, the self and mutual inductances of any section of a closed circuit can be calculated.

This representation of inductance in terms of partial self and mutual inductance allows the analysis of any combination of current paths. The signal and return current paths can be defined in circuit after the model is established. Assuming that the self inductance is included in the return path, the circuit under simulation can account for the impact on signal-integrity, cross-talk and ground-bounce from currents passing through any combination of pins.



There are many ways to create this information using either 2D or 3D field solvers. It may also be possible to create this information using other methods which are left to the model developer.

For an MLM model it is required that at least one section include partial inductance and capacitance matrices.

#### Capacitance Matrix Description

=====

UNITS: FARAD  
DESCRIPTION: A capacitance is an approximation of the capacitance in situations where the return path cannot be explicitly stated in the field extraction stages.

See "Multi-Line Capacitance Matrix" section above for more information on Multi-Line Matrices.

USAGE RULES: Two Maxwell capacitance matrix methods are supported:

SLM, Single-Line, Loop-capacitance Matrix (non-coupled)  
MLM, Multi-Line, Capacitance Matrix (coupled)

If ModelType is SLM then all sections must only contain a single capacitance value per line.

If ModelType is MLM then all sections must use a Maxwell Capacitance as stated below.

#### Single-Line Capacitance Matrix Description:

-----

To define capacitance requires conductors separated by a dielectric. The conductors are those found in a loop consisting of a closed path including a signal and all possible return paths. The Maxwell Capacitance matrix relates the total charges on the conductors to the voltages applied to them.  $[Q]=[Cm][V]$  Where  $[Cm]$  is the Maxwell matrix,  $[Q]$  is the vector of total conductor charges, and  $[V]$  is a vector of applied voltages. The negative values of the off-diagonal entries can be explained on physical grounds: if you put +1 Volt on a single conductor and 0 Volts on the others, then you induce negative charges on those other conductors to terminate the field lines emanating from the conductor at 1 Volt.

In the Maxwell Capacitance matrix, the diagonal term is the maximum capacitance that the conductor encounters, meaning the capacitance to ground plus the capacitances to all the other conductors.

In the Maxwell Capacitance matrix, the OFF-diagonal term is the capacitance that the conductor encounters relative to a second conductor. This capacitance value is effected by other nearby conductors during the field extraction phase. As such it should

not normally be used by itself to determine the capacitance of a random pair of conductors in a given structure.

#### Loss Matrix Description

=====  
This release does not support frequency dependent loss matrices.  
A future release is expected to add support for frequency dependent loss matrices.

#### Un-Coupled Models:

=====  
Single-Line-Models or SLM models are used for un-coupled models. These models are useful for most simulations where coupled effects can be ignored safely. These models are most accurate if closely spaced ground pins or a ground plane is present.

A "Diagonal\_matrix" matrix type is the best choice for describing all matrices R,L and C for SLM models.  
(see matrix descriptions below).

Several methods can be used:

Field solvers with return path pins defined. Only the diagonal matrix data is used. The coupling information is ignored. The R,L,C matrices should represent the electrical parameters for a specific section.

2D field solver with a specific return path or ground. Only the diagonal matrix data is needed. No coupling data is present in the final matrix

Closed form round wire inductance equation.

Experimental lab data may be obtained from TDR, VNA or other means

#### Coupled Models:

=====  
Multi-Line-Models or MLM models are used for coupled models.

A "Full\_matrix" matrix type is the best choice for describing all matrices R,L and C for MLMs. (see matrix descriptions below)

Several methods can be used:

3D field solver can be used to create partial inductance and capacitance matrices that allow accurate simulations without the need to pre-define the ground pins.

Field solvers without specific return path pins. A return plane  
May be specified as a reference only and is placed far field.

Experimental lab data may be obtained from multichannel measurements that incorporate TDR, VNAs or other means as long as the resulting inductance matrix contains partial inductance values.

## Common to Coupled and Un-Coupled Models

---

One common aspect of all the different formats is that they exploit the symmetry of the matrices they describe. This means that the entries below the main diagonal of the matrix are identical to the corresponding entries above the main diagonal. Therefore, only roughly one-half of the matrix needs to be described. By convention, the main diagonal and the UPPER half of the matrix are provided.

In the following text, we use the notation [I, J] to refer to the entry in row I and column J of the matrix. Note that I and J are allowed to be alphanumeric strings as well as integers.

The ordering of these strings is determined by the row/column ordering convention given by the [Cn Row Swath] or [Cn Column Swath] convention, or else matches exactly the [Cn Pin Map] order when the pin map contains the same number of pins as the Swath.

In the following text, "Row 1", means the row corresponding to the first pin.

Also note that the numeric entries of the RLC matrices are standard IBIS floating point numbers. As such, it is permissible to use metric "suffix" notation. Thus, an entry of the C matrix could be given as 1.23e-12 or as 1.23p or 1.23pF.

Each new row is identified with the Row keyword.

---

Keyword: [Bandwidth]  
Required: Yes, if a Banded\_matrix matrix is being defined.  
Argument: Numeric Value  
Description: Indicates the size of the width of the coupling matrix....  
of the matrix. This has nothing to do with electrical bandwidth. The bandwidth field must be a nonnegative integer. This is the number of off-diagonal matrix rows for which data is provided.  
Usage Rules: MUST be used between keywords [Begin Cn Section] and [End Cn Section].  
MUST follow any usage of one of the following keyword:  
Banded\_matrix

---

See example "Matrix Example" lower in this document.

---

Keyword: [Row]  
Required: Yes if a matrix is being defined.  
Argument: None  
Description: Indicates the beginning of a new row of the matrix.  
Usage Rules: The argument must be a sequential number beginning at 1 and continuing to the last row for the matrix

Following a [Row] keyword is a block of numbers that represent the entries for that row. Suppose that the current row is number M. Then the first number listed is the diagonal entry, [M,M]. Following this number are the entries of the upper half of the matrix that belong to row M: [M, M+1], [M, M+2], ... up to [M,N].

For even a modest-sized matrix, this data will not all fit on one line. You can break the data up with new-line characters so that this limit is observed.

Example: Suppose the matrix has 40 conductors and that we are currently working on Row 19. There is 1 diagonal entry, plus  $40 - 19 = 21$  entries in the upper half of the matrix to be specified, for 22 entries total.

Row 1 always has the most entries, and that each successive row has one fewer entry than the last; the last row always has just a single entry.

Usage Context:

MUST be used between keywords [Begin Cn Section] and [End Cn Section].

MUST follow any usage of one of the following keywords:  
Banded\_matrix, Sparse\_matrix, Full\_matrix

-----  
See example "Matrix Example" lower in this document.

=====  
Keyword: [End Cn Section]  
Required: Yes  
Argument: Text String  
Description: Indicates the end of [Begin Cn Section]

#### Matrix Examples

-----

The resistance matrix for this package has no coupling

```
[Begin Cn Section]      ExampleMatrix00
[Derivation Method]    Distributed
[Resistance Matrix]     Diagonal_matrix
10.0
15.0
15.0
10.0
10.0
15.0
15.0
```

10.0

[End Cn Section] ExampleMatrix00

[Begin Cn Section] ExampleMatrix01

The resistance matrix for this package does not have coupling and is exactly the same as the Diagonal\_matrix shown above it is described using a trivial version of the Banded\_matrix as an example only. The Diagonal\_matrix should be used for this example to conserve file size.

```
[Resistance Matrix]      Banded_matrix
[Bandwidth]              0
[Row] 1
10.0
[Row] 2
15.0
[Row] 3
15.0
[Row] 4
10.0
[Row] 5
10.0
[Row] 6
15.0
[Row] 7
15.0
[Row] 8
10.0
```

The inductance matrix has coupling between pins

```
[Inductance Matrix]      Full_matrix
[Row] 1
3.04859e-07      4.73185e-08      1.3428e-08      6.12191e-09
1.74022e-07      7.35469e-08      2.73201e-08      1.33807e-08
[Row] 2
3.04859e-07      4.73185e-08      1.3428e-08      7.35469e-08
1.74022e-07      7.35469e-08      2.73201e-08
[Row] 3
3.04859e-07      4.73185e-08      2.73201e-08      7.35469e-08
1.74022e-07      7.35469e-08
[Row] 4
3.04859e-07      1.33807e-08      2.73201e-08      7.35469e-08
1.74022e-07
[Row] 5
4.70049e-07      1.43791e-07      5.75805e-08      2.95088e-08
[Row] 6
4.70049e-07      1.43791e-07      5.75805e-08
[Row] 7
4.70049e-07      1.43791e-07
[Row] 8
4.70049e-07
```

The capacitance matrix has sparse coupling

```
[Capacitance Matrix]      Sparse_matrix
```

```
[Row] 1
1      2.48227e-10
2      -1.56651e-11
5      -9.54158e-11
6      -7.15684e-12
[Row] 2
2      2.51798e-10
3      -1.56552e-11
5      -6.85199e-12
6      -9.0486e-11
7      -6.82003e-12
[Row] 3
3      2.51798e-10
4      -1.56651e-11
6      -6.82003e-12
7      -9.0486e-11
8      -6.85199e-12
[Row] 4
4      2.48227e-10
7      -7.15684e-12
8      -9.54158e-11
[Row] 5
5      1.73542e-10
6      -3.38247e-11
[Row] 6
6      1.86833e-10
7      -3.27226e-11
[Row] 7
7      1.86833e-10
8      -3.38247e-11
[Row] 8
8      1.73542e-10
```

[End Cn Section] ExampleMatrix01

---

## 9.0 End Keyword

---

Keyword: [End]  
Required: Yes  
Argument: None  
Description: Specifies end of file

---

[End]

---

10.0 ICM EXAMPLES  
!!!!!! NEEDS MAJOR REVISION !!!!!

INCLUDE IN DIFFERENT DOCUMENT????

=====

```
[IBIS Cn Model Ver] 1.0
[File Rev]          1.0          1.0 -> design data, no verification
[Date]             July 1, 2000  The latest file revision date
```

```
[Begin Cn Model Family]
[Begin Cn Model List]
DB9          Mated          10ns          db9mated.jpg
Header2x5    Mated          500ps         Header100.jpg
Header2x5s   Mated          500ps         Header100.jpg
[End Cn Model List]
```

EXAMPLE: single SLM DB9 connector  
(NOTE: DATA IS "MAKE BELIEVE")

```
[Begin Cn Model] DB9 PinMapDB9a PinMapDB9b SLM 1:9
[Cn Number of Conductors] 9
[Cn Columns of Pins]      5
[Cn Rows of Pins]        2
Cn_Section                SectionDB9
[End Cn Model] DB9
```

EXAMPLE: single SLM DB9 connector with swath  
(NOTE: DATA IS "MAKE BELIEVE")

```
[Begin Cn Model] DB25swath PinMapDB25_in PinMapDB25_out SLM 1:25
[Cn Number of Conductors] 25
[Cn Columns of Pins]      13
[Cn Rows of Pins]        2
Cn_Section                SectionDBSwath
          SwathRows SwathCols RightEdge LeftEdge TopEdge BottomEdge
[Begin Cn Swath]  2      3      1      1      0      0
[End Cn Swath]
[End Cn Model] DB25swath
```

Pin maps for DB9

```
[Begin Cn Pin Map] PinMapDB9
|Index Pin  Signal
1          1    CD
2          2    RXD
3          3    TXD
4          4    DTR
5          5    GND
6          6    DSR
7          7    RTS
8          8    CTS
9          9    RI
[End Cn Pin Map]
```

```
[Begin Cn Pin Map] PinMapDB25
```

Index	Pin	Signal
1	1	CD
2	2	RXD
3	3	TXD
4	4	DTR
5	5	GND
6	6	DSR
7	7	RTS
8	8	CTS
9	9	RI
10	10	CD
11	11	CD
12	12	RXD
13	13	TXD
14	14	DTR
15	15	GND
16	16	DSR
17	17	RTS
18	18	CTS
19	19	RI
20	20	RI
21	21	CD
22	22	RXD
23	23	TXD
24	24	DTR
25	25	GND

[End Cn Pin Map]

SECTION EXAMPLES WITH MATRICES

```
[Begin Cn Section] SectionDB9
[Derivation Method] Distributed
[Resistance Matrix] Diagonal_matrix
.05
.05
.05
.05
.05
.05
.05
.05
.05
.05
.05
[Inductance Matrix] Diagonal_matrix
1.5nH
[Capacitance Matrix] Diagonal_matrix
0.3pF      |Edge pin has less capacitance
0.5pF
0.5pF
0.5pF
```

```
0.3pF          |Edge pin has less capacitance
0.3pF          |Edge pin has less capacitance
0.5pF
0.5pF
0.3pF          |Edge pin has less capacitance
[End Cn Section] SectionDB9

[Begin Cn Section] SectionDBswath
[Resistance Matrix] Diagonal_matrix
.05
.05
.05
.05
.05
.05
  [Inductance Matrix] Diagonal_matrix
1.5nH
1.5nH
1.5nH
1.5nH
1.5nH
1.5nH
  [Capacitance Matrix] Diagonal_matrix
0.3pF          |Edge pin has less capacitance
0.3pF          |Edge pin has less capacitance
0.5pF
0.5pF
0.3pF          |Edge pin has less capacitance
0.3pF          |Edge pin has less capacitance
  [End Cn Section] SectionDBswath

[End Cn Model Family]

[End]
```