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# Sparse Matrix Mapping Draft 11 2/10/2010

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## [Number of Sparse Labels]

Rules for Version 1.0-2.0 files:

[Number of Sparse Labels] is not permitted in Version 1.0-2.0 files.

Rules for Version 2.1 Files:

[Number of Sparse Labels] is an optional keyword whose argument specifies how many data pairs will appear for each frequency argument of [Network Data]. This same number of sparse-label arguments shall exist for [Sparse Matrix Mapping].

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Deleted: Note that, if [Number of Sparse Labels] is present, the number of entries under [Network Data] does NOT need to match the size of a matrix given by [Number of Ports] x [Number of Ports]. Instead, the number of data pairs under the [Network Data] keyword must match the number of sparse-labels under the [Sparse Matrix Mapping] keyword.¶

Deleted: [Number of Sparse Labels] is required if [Sparse Matrix Mapping] is present. Otherwise, it is prohibited.¶

[Number of Sparse Labels] requires a positive integer argument. The keyword and argument must be separated by whitespace.

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If [Matrix Format] is not present or its argument is "Full" the argument value for [Number of Sparse Labels] shall not exceed  $n^2$ , where n is the argument of [Number of Ports]. For [Matrix Format] arguments of "Upper" or "Lower" the argument of [Number of Sparse Labels] shall not exceed  $(n^2 + n)/2$ .

Deleted: The value must match the number of sparse-labels used under [Sparse Matrix Mapping]. The [Number of Sparse Labels] keyword is followed by a single positive integer argument, separated from the keyword by whitespace.

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[Number of Sparse Labels] is required if [Sparse Matrix Mapping] is present. Otherwise, it is prohibited.

When present, [Number of Sparse Labels] shall appear after [Number of Ports] and before both [Network Data] and [Sparse Matrix Mapping].

## [Sparse Matrix Mapping]

Rules for Version 1.0-2.0 files:

[Sparse Matrix Mapping] is not permitted in Version 1.0-2.0 files.

Rules for Version 2.1 files:

[Sparse Matrix Mapping] is an optional keyword whose arguments describe how the data pairs of [Network Data] map into the n-port matrix, where n is the argument of [Number of Ports].

[Sparse Matrix Mapping] is required if [Number of Sparse Labels] is present. Otherwise, it is prohibited.

[Sparse Matrix Mapping] requires two types of arguments: sparse-labels and index-pairs. [Sparse Matrix Mapping] and its arguments may span multiple lines.

A sparse-label is a string of one or more ASCII characters. The last character of this string shall be the colon character ':'. The colon character may not appear in the string other than as the last character. A sparse-label shall not begin with an open parenthesis '(', though this character may be present for any character other than the first or last in the string. A sparse-label may consist of only the colon character - a one character string ":".

One or more sparse-labels are required if [Sparse Matrix Mapping] is present. Each sparse-label must be followed by a group of one or more index-pairs before the next sparse-label or end of [Sparse Matrix Mapping].

An index-pair is a pair of positive integers each between 1 and n, separated without whitespace by a comma and enclosed without whitespace by parentheses - of the form (i,j). An index-pair references an element in the n-port matrix. The first integer is the element's row index and the second integer is the element's column index.

Index-pairs occur in groups of one or more. Each group of index-pairs shall be preceded by a sparse-label. Whitespace must separate the sparse-label from the first index-pair of the group. Whitespace must also exist between index-pairs in the group. Whitespace must separate the last index-pair in a group from the next sparse-label, if any.

A group of index-pairs specifies the row and column indices for a group of elements in the n-port matrix into which the corresponding data pair of [Network Data] is mapped. Therefore, all matrix elements represented by the group of index-pairs have identical numerical values.

Each unique index-pair may not occur more than once in [Sparse Matrix Mapping].

Matrix elements whose corresponding index-pairs do not occur in [Sparse Matrix Mapping] are assumed to be zero-valued, corresponding to a value with zero real and zero imaginary part. This zero-value is independent of the data pair format specified in the options line.

The mapping defined by [Sparse Matrix Mapping] is identical for every frequency argument of [Network Data]. The number of data pairs for each frequency is defined by the argument of [Number of Sparse Labels].

Multiple sparse-labels may appear on the same line. A sparse-label may be separated from its associated group of index-pairs by a line termination sequence. A group of index-pairs may span multiple lines because index-pairs may be separated by a line-termination sequence.

For [Matrix Format] argument of "Upper" the first integer of all index-pairs must be less than or equal to the second integer of that pair. For [Matrix Format] argument of "Lower" the first integer of all index-pairs must be greater than or equal to the second integer of that pair.

**Deleted:** [Sparse Matrix Mapping] shall appear after the [Number of Ports] keyword and before any network data. The [Network Data] keyword data given later in the file changes in meaning from expressing data for an n x n matrix to expressing the data points remapped into the n x n matrix by the contents of the [Sparse Matrix Mapping] keyword.¶

¶ contains ...kinds ... ¶  
... [1]

**Deleted:** s...string is...terminated by , which restricts the presence of that character earlier in the string...S...s character of ...S...s... be null, except for the termination character - in which case the sparse-label is simply the...:'.  
... [2]

**Deleted:** Some may find it useful to implement sparse-labels as consecutive integers. In this case the first sparse label would be "1:" and the last sparse label would be "m:", where m is the integer argument of [Number of Sparse Labels]

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¶ [Sparse Matrix Mapping] and its arguments may span multiple lines.¶

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**Deleted:** any ...the ...character  
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**Deleted:** n...index ...in ... by [Sparse Matrix Mapping]...All index-pairs after a sparse-label and before the next sparse-label or the end of [Sparse Matrix Mapping] refer to the data pair under [Network Data] corresponding to  
... [4]

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Sparse-labels are required if [Sparse Matrix Mapping] is present.¶

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... [8]

**Deleted:** The maximum number of index-pairs under [Sparse Matrix Mapping] is given by the square of  
... [9]

The application of [Mixed-Mode Order], [Matrix Format], [Reference Impedance] and [Number of Ports] rules do not change in the presence of [Number of Sparse Labels] and [Sparse Matrix Mapping]. Each of these four keywords describes the n-port matrix populated by the contents of [Network Data] using the mapping defined by [Sparse Matrix Mapping]. [Number of Ports] describes the n-port matrix into which [Sparse Matrix Mapping] arguments map the data under [Network Data].

When present, [Sparse Matrix Mapping] shall appear after [Number of Ports], [Matrix Format] and [Number of Sparse Labels]. [Sparse Matrix Mapping] must appear before [Network Data].

**Example XX (Version 2.0):**

```
[Version] 2.0
# GHz S MA R 50
[Number of Ports] 4
[Number of Frequencies] 1
[Reference] 50 75 0.01 0.01
[Matrix Format] Full
[Number of Sparse Labels] 3
[Sparse Matrix Mapping]
1: (1,1) (2,2) (1,3) (3,3) (4,4) 2: (3,1) 3: (4,1) (2,1) (1,4) (4,3)
[Network Data]
5.000 0.60 161.24 0.40 -42.20 0.42 -66.58
[End]
```

This describes the following 4x4 matrix:

0.60	161.24	0.00	0.00	0.60	161.24	0.42	-66.58
0.42	-66.58	0.60	161.24	0.00	0.00	0.00	0.00
0.42	-66.58	0.00	0.00	0.60	161.24	0.00	0.00
0.42	-66.58	0.00	0.00	0.42	-66.58	0.60	161.24

The representation below is the same as the above:

```
[Sparse Matrix Mapping]
1: (1,1) (2,2) (1,3) (3,3) (4,4)
2: (3,1)
3: (4,1) (2,1) (4,3) (1,4)
```

The representation below is also the same as those above:

```
[Sparse Matrix Mapping]
: (1,1) (2,2) (1,3) (3,3) (4,4) : (3,1) : (4,1) (2,1) (4,3) (1,4)
```

**Example YY (Version 2.0):**

```
[Version] 2.0
# GHz S MA R 50
[Number of Ports] 4
[Number of Frequencies] 1
[Reference] 50 75 0.01 0.01
[Matrix Format] Lower
[Number of Sparse Labels] 4
[Sparse Matrix Mapping]
a: (1,1) (2,2) (3,3) (4,4) b: (3,1) (4,2) c: (2,1) (3,2) (4,3) d: (4,1)
```

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```
[Network Data]
5.000 0.60 161.24 0.40 -42.20 0.42 -66.58 0.38 -20.03
[End]
```

This describes the following 4x4 lower-half matrix:

```
0.60 161.24
0.42 -66.58 0.60 161.24
0.40 -42.20 0.42 -66.58 0.60 161.24
0.38 -20.03 0.40 -42.20 0.42 -66.58 0.60 161.24
```

The representation below is the same as the above:

```
[Sparse Matrix Mapping]
label_1 : (1,1) (2,2) (3,3) (4,4)
label_2 : (3,1) (4,2)
label_3 : (2,1) (3,2) (4,3)
label_4 : (4,1)
```

### Example ZZ (Version 2.0):

! Two diff pair thru lines, no mode conversion.  
! Ignore diff mode crosstalk, consider common mode crosstalk.

```
[Version] 2.0
# GHz S MA R 50
[Number of Ports] 8
[Mixed Mode Order] D1,2 D3,4 D5,6 D7,8 C1,2 C3,4 C5,6 C7,8
[Number of Frequencies] 1
[Matrix Format] Lower
[Number of Sparse Labels] 6
[Sparse Matrix Mapping]
Rdd: (1,1) (2,2) (3,3) (4,4)
Tdd: (3,1) (4,2)
Rcc: (5,5) (6,6) (7,7) (8,8)
Tcc: (7,5) (8,6)
NEXTcc: (6,5) (8,7)
FEXTcc: (7,6) (8,5)
[Network Data]
5.000 0.1 -75 0.9 -46 0.2 116 0.8 -63 0.1 14 0.3 82
[End]
```

This describes the following 8x8 lower-half matrix:

```
0.1 -75
0.0 0 0.1 -75
0.9 -46 0.0 0 0.1 -75
0.0 0 0.9 -46 0.0 0 0.1 -75
0.0 0 0.0 0 0.0 0 0.0 0 0.2 116
0.0 0 0.0 0 0.0 0 0.0 0 0.1 14 0.2 116
0.0 0 0.0 0 0.0 0 0.0 0 0.8 -63 0.3 82 0.2 116
0.0 0 0.0 0 0.0 0 0.0 0 0.3 82 0.8 -63 0.1 14 0.2 116
```

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0.42 -66.58	0.60 161.24¶
0.40 -42.20	0.42 -66.58
0.60 161.24 ¶	
0.38 -20.03	0.40 -42.20
0.42 -66.58	0.60 161.24 ¶

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¶

[Network Data]¶

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[Sparse Matrix Mapping] shall appear after the [Number of Ports] keyword and before any network data. The [Network Data] keyword data given later in the file changes in meaning from expressing data for an n x n matrix to expressing the data points remapped into the n x n matrix by the contents of the [Sparse Matrix Mapping] keyword.		
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contains		
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string is		
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terminated by		
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, which restricts the presence of that character earlier in the string		
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S		
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S		
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character of		
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S		
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be null, except for the termination character – in which case the sparse-label is simply the		
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‘.’		
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any		
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the		
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index

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in

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by [Sparse Matrix Mapping]

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All index-pairs after a sparse-label and before the next sparse-label or the end of [Sparse Matrix Mapping] refer to the data pair under [Network Data] corresponding to the first sparse-label and therefore force the corresponding entries in the  $n \times n$  matrix to be identical

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either within a sparse-label group or between two or more sparse-label groups.

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In each index-pair, the row index is always the first integer and the column index is always the second. Zero values are not permitted within an index-pair. The value for any row or column index in an index-pair must be no larger than the [Number of Ports] argument.

For example, if the very first index-pair under [Sparse Matrix Mapping] is (1,5) and the first data pair under [Network Data] is the real/imaginary pair 7 -0.8, then the values 7 -0.8 are assumed to occupy row 1, column 5 of the  $n$ -port matrix described by [Number of Ports].

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The row and column indices in an index-pair are separated by a comma, are preceded by an open parenthesis and followed by a close parenthesis.

White space is not permitted after the open parenthesis and before the closed parenthesis of an index-pair. White space is required between index-pairs.

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Data in the n-port matrix that is not indicated by an index-pair under [Sparse Matrix Mapping] is assumed to be zero-valued, corresponding to a value with zero real and zero imaginary part, regardless of the data format applied in the [Network Data] section..

[Sparse Matrix Mapping] assumes that the matrix mapping between its entries and those of [Network Data] apply across all frequency points given under [Network Data]

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s and associated index-pairs may be separated by a line-termination sequence.

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Empty sparse-labels (sparse-labels followed by other sparse-labels without an intervening index-pair) are not permitted.

[Sparse Matrix Mapping] must contain at least one sparse-label. The number of sparse-labels must agree with the argument used for [Number of Sparse Labels].

## Lists

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The maximum number of index-pairs under [Sparse Matrix Mapping] is given by the square of the argument to [Number of Ports].

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Note that

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[Mixed-Mode Order], [Matrix Format] and [Reference Impedance]

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[Sparse Matrix Mapping] and

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When [Matrix Format] is “Upper” then the row index of any index-pair must be less than or equal to column index of that pair. Similarly, when [Matrix Format] is “Lower” then the row index of any index-pair must be greater than or equal to the column index of that pair. For either “Upper” or “Lower” [Matrix Format], the number of index-pairs shall not exceed  $(n^2 + n)/2$ , where n is the number of ports given by [Number of Ports].

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0.60	161.24	0	0	0.60	161.24	0.42	-66.58
0.42	-66.58	0.60	161.24	0	0	0	0
0.40	-42.20	0	0	0.60	161.24	0	0
0.42	-66.58	0	0	0.42	-66.58	0.60	161.24

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