

## [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 of network data. This same number of sparse-labels shall exist for [Sparse Matrix Mapping].

[Number of Sparse Labels] requires a positive integer argument.

If [Matrix Format] is not present or its argument is “Full” the 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 number of sparse-labels shall not exceed  $(n^2 + n)/2$ .

[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.

[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, as defined in the *General Syntax Rules and Guidelines* section. 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. Whitespace (space 20h or tab 09h) or a line termination (LF 0Ah or CR 0Dh) shall not occur in the string. The comment character '!' shall not occur in the string. 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 ":".

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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 keyword. Multiple sparse-labels may appear on the same line.

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. 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 group of index-pairs shall be preceded by a sparse-label. Whitespace or a line termination must separate a sparse-label from the first index-pair of the group. Whitespace or a line termination must also exist between index-pairs in the group and must separate the last index-pair in a group from the next sparse-label, if any.

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 of network data. The number of data pairs for each frequency is defined by the argument of [Number of Sparse Labels].

For [Matrix Format] "Upper" the first integer of each index-pair must be less than or equal to the second integer of that pair. For [Matrix Format] "Lower" the first integer of each index-pair must be greater than or equal to the second integer of that pair. For either of these cases, only the (i,j) matrix elements are specified but the (j,i) element are implied for the full symmetric matrix.

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 2.1):**

```
[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
0.40 -42.20 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 2.1):**

```
[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)
[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 matrix:

```
0.60 161.24 0.42 -66.58 0.40 -42.20 0.38 -20.03
0.42 -66.58 0.60 161.24 0.42 -66.58 0.40 -42.20
0.40 -42.20 0.42 -66.58 0.60 161.24 0.42 -66.58
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 2.1):

```
! 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 matrix:

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