[Number of Sparse Labels]

Rules for Version ~~1.0 Files~~1.0-2.0 Files:
[Number of Sparse Labels] is not permitted in Version ~~1.0 files~~1.0-2.0 Files.

Rules for Version 2.1 Files:
[Number of Sparse Labels] describes how many columns of data, and therefore how many ~~integer label~~Integer Labels, will appear under the [Sparse Matrix Mapping] keyword.

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

[Number of Sparse Labels] accepts a single integer argument with value greater than zero. The value must match the number of ~~integer label~~Integer Labels used under [Sparse Matrix Mapping]. The argument may appear immediately after the keyword, or may they may be separated by a line termination sequence.

[Number of Sparse Labels] shall appear after the [Number of Ports] keyword and before any network data.

[Sparse Matrix Mapping]

Rules for Version ~~1.0 Files~~1.0-2.0 Files:
[Sparse Matrix Mapping] is not permitted in Version ~~1.0 files~~1.0-2.0 Files.

Rules for Version ~~2.0 Files~~2.1 Files:
[Sparse Matrix Mapping] is an optional keyword describing how the data under [Network Data] maps into a larger matrix (n by n, where n is given by [Number of Ports]). The [Network Data] keyword data given later in the file changes in meaning from expressing data in a full matrix to expressing the unique data points remapped into the full matrix by the contents of the [Sparse Matrix Mapping] keyword.

[Sparse Matrix Mapping] contains two kinds of arguments:

1. Integer Labels: integer numbers followed by the colon character. All index pairs between a pair of Integer Labels refer to the column in [Network Data] corresponding to the first ~~integer label~~Integer Labels and therefore force the corresponding entries in the full matrix to be identical.
   (a) Integer ~~labels~~ Labels are required, must be numerically increasing and the sequence must begin with 1.
   (b) Labels may not be re-used.

(c) Index pairs may not be duplicated either within a label group or between two or more label groups.

(d) The last ~~integer label~~<u>Integer Label</u> shall be the same as the [Number of Sparse Labels].

(e) ~~-~~White space is not permitted between the ~~integer label~~<u>Integer Label</u> and the colon character.

(f) White space is required before and after an ~~integer label~~<u>Integer Label</u>.

2. <u>Index Pairs: pairs of integers specifying a row and column in the full matrix to which the data in the corresponding Integer Label in the [Network Data] keyword is mapped.</u>

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

(b) <u>The row and column in an Index Pair are separated by a comma, are preceded by an open parenthesis and followed by a close parenthesis.</u>

(c) <u>White space is not permitted after the open parenthesis and before the closed parenthesis of an index pair.</u>

(d) <u>White space is required between index pairs.</u>

~~Index Pairs: pairs of integers specifying a row and column in the full matrix to which the data in the corresponding Integer Label in the [Network Data] keyword is mapped.~~

- ~~The row and column in an Index Pair are separated by a comma, are preceded by an open parenthesis and followed by a close parenthesis. For example, if the very first index pair under [Sparse Matrix Mapping] is (1,5) and the first row and column of the [Network Data] contains the real/imaginary pair 7 -0.8, then the values 7 -0.8 are assumed to occupy row 1, column 5 of the full, final matrix described by [Number of Ports]. 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.~~

Data in the full matrix that is not indicated by a matrix pair under [Sparse Matrix Mapping] is assumed to be zero-valued.

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

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Multiple labels may appear on the same line. Labels and associated index pairs may be separated by a line-termination sequence. An empty label is an ~~integer label~~Integer Label ~~may be~~ followed by another ~~integer label~~Integer Label without an intervening index pair. Empty labels ~~(i.e., labels with no associated index pairs)~~ are permitted.

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

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

Note that, if [Sparse Matrix Mapping] 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 Integer Labels under the [Network Data] keyword must match the number of colon-separated groups under the [Sparse Matrix Mapping] keyword.

The maximum number of index pairs under [Sparse Matrix Mapping] is given by the value given by [Number of Ports] x [Number of Ports].

Note that [Mixed-Mode Order], [Matrix Format], [Reference Impedance] and [Number of Ports] rules do not change. [Mixed-Mode Order], [Matrix Format], [Reference Impedance] and [Number of Ports] describe the full matrix which is populated by the contents of ~~to which~~ [Sparse Matrix Data] and~~maps, not the~~ [Network Data] ~~reduced data set~~. When [Matrix Format] is "Upper" then row must be less than or equal to column, and when [Matrix Format] is "Lower" then row must be greater than or equal to column,

~~*Interaction with [Matrix Format]*~~
~~No special adjustments to [Sparse Matrix Mapping] contents are required to support [Matrix Format]. [Sparse Matrix Mapping] information and mapping applies to the data as presented under the [Network Data] keyword, regardless of whether [Matrix Format] is "Full", "Upper" or "Lower". The [Sparse Matrix Mapping] keyword is organized by columns, and the upper- and lower-half matrices under [Network Data] will always have a consistent ordering of columns per row. In the case of lower-half, the first row will have a single column, the second row will have two columns, and so on. For upper-half~~

[Sparse Matrix Mapping] shall appear after the [Number of Ports] keyword and before any 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]
4
[Sparse Matrix Mapping]
1: (1,1) (2,2) (3,3) (4,4) 2: (3,1) (4,2) 3: 4: (4,1) (2,1) (3,2) (4,3)
[Network Data]
5.00000   0.60 161.24   0.40 -42.20   .999 .999   0.42 -66.58
Sparse Labels

[End]

This describes the 4x4 matrix shown below:

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

Other equivalent representations

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

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

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

[Mixed-Mode Order]

...

Every single-ended port (the number described under [Number of Ports]) shall be mentioned in a descriptor under [Mixed-Mode Order], except when [Sparse Matrix Mapping] is present. In the latter case, the number of rows and columns under [Network Data] shall simply be consistent with the format and content of [Mixed-Mode Order]. For example, if [Network Data] contains a full matrix with six rows and six columns, and [Sparse Matrix Mapping] is present elsewhere in the file, [Mixed-Mode Order] shall contain six descriptor groups, even if the argument for [Number of Ports] is larger value.