

[Number of Sparse Matrix Columns]

Rules for Version 1.0 Files:

[Number of Sparse Matrix Columns] is not permitted in Version 1.0 files.

Rules for Version 2.0 Files:

[Number of Sparse Matrix Columns] describes how many columns of data, and therefore how many integer labels, will appear under the [Sparse Matrix Mapping] keyword.

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

[Number of Sparse Matrix Columns] accepts a single integer argument with value greater than zero. The value must match the number of 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 Matrix Columns] shall appear after the [Number of Ports] keyword and before any network data.

[Sparse Matrix Mapping]

Rules for Version 1.0 Files:

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

Rules for Version 2.0 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.

The arguments of [Sparse Matrix Mapping] are "index pairs" of integers, plus separators and integer labels. Each pair corresponds to a row and column in the full matrix to which the data in the corresponding *position by column* in the [Network Data] keyword is mapped. 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].

Index pairs are grouped by colon characters and integer labels. All index pairs between a pair of colon characters refer to the *same* element in [Network Data] and therefore force the corresponding entries in the full matrix to be identical.

Integer labels refer to the corresponding column of data under the [Network Data] keyword. Integer labels are required, must be numerically increasing and the sequence must begin with 1. Labels may not be re-used. Index pairs may not be duplicated either within a label group or between two or more label groups.

[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].

Permitted characters in the arguments include alphanumeric characters for the index pairs and:

- the colon character (required to separate a group of pairs of indices and the integer label from other groups of indices and labels)
- the comma character (required to separate the row and column integers in an index pair)
- open and close parentheses (required to group index pairs)
- numeric characters (integers, required to label a group of identical pairs)

White space is required between pairs. White space is not permitted between the integer label and the colon character.

Lists of index pairs may span multiple lines. Multiple labels may appear on the same line. Labels and associated index pairs may be separated by a line-termination sequence.

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. Empty labels (i.e., labels with no associated index pairs) are permitted.

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 columns under the [Network Data] keyword must match the number of colon-separated groups under the [Sparse Matrix Mapping] keyword.

[Sparse Matrix Mapping] must contain at least one label.

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

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

Note that [Reference Impedance] and [Number of Ports] rules do not change. [Reference Impedance] and [Number of Ports] describe the full matrix to which [Sparse Matrix Data] maps, not the [Network Data] reduced data set.

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 matrices, the first row has as many columns as ports are defined in the sparse matrix, the second row has one fewer columns, and so on.

Because the upper- and lower-half matrix representations already use symmetry to reduce the size of [Network Data], [Sparse Matrix Mapping] should not contain any information about matrix pairs which are assumed but not present under [Network Data].

Interaction with [Mixed-Mode Order]

No special adjustments to [Sparse Matrix Mapping] contents are required to support [Mixed-Mode Order]. Where [Sparse Matrix Mapping] is present, [Mixed-Mode Order] applies only to the matrices under [Network Data]. This assumes that [Network Data] and [Mixed-Mode Order] describe a reduced matrix of mixed-mode data, which is mapped to a larger matrix by the [Sparse Matrix Mapping] keyword. The mixed-mode relationships described under [Mixed-Mode Order] and [Network Data] map into the larger matrix according to [Sparse Matrix Mapping].

When [Sparse Matrix Mapping] is present, agreement between [Number of Ports] and [Mixed-Mode Order] is not required. In this case, [Number of Ports] describes the full matrix into which [Sparse Matrix Mapping] maps data in [Network Data]. [Mixed-Mode Order] describes the arrangement and relationships of the data described under [Network Data], regardless of its mapping into a larger matrix.

[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
[Network Data]
```

5.00000 0.60 161.24 0.40 -42.20 0.42 -66.58

[Number of Sparse Matrix Columns]

3

[Sparse Matrix Mapping]

1: (1,1) (2,2) (3,3) (4,4) 2: (3,1) (4,2) 3: (4,1) (2,1) (3,2) (4,3)

[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

[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.