

Checking and Converting Touchstone Files With TSCHK2

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TSCHK History

- 1984:
 - Touchstone format introduced by EEsof
- 2009
 - IBIS develops Touchstone 1.1 specification and Touchstone 2.0 with enhancements
 - IBIS releases TSCHK2 version 2.0.0
- 2021:
 - IBIS releases TSCHK2 version 2.0.1
 - 2 bug fixes and 2 enhancements

TSCHK2 Capabilities

Can:

- Check Touchstone syntax (78 checks)
- Show contents overview
- Convert Touchstone 1 to Touchstone 2
- Convert Touchstone 2 to Touchstone 1
- Change output formatting 
- Be integrated into other software
(with source code purchase)

Cannot:

- Check passivity
- Check causality
- Show charts
- Extract selected ports

Checking Touchstone Files

- `$ tschk2 test.s2p`
`test.s2p: valid Touchstone v2.0 file`
 - Printed to stdout
- `$ tschk2 tsird002.s2p`
`tsird002.s2p: error E2322: mixed-mode descriptor port number exceeds the number of ports`

- Finds the error shown in red:
- Printed to stderr

```
[Version] 2.0  
[Number of Ports] 2  
[Two-Port Data Order] 21_12  
[Number of Frequencies] 5  
[Mixed-Mode Order] D1,3 D2,4
```

Inspecting Touchstone Files

```
$ tschk2.exe -describe v1.s2p
----- TOUCHSTONE FILE -----
filename: v1.s2p
version: 1

OPTIONS
  frequency unit: GHz
  contents: S-parameters
  complex number representation: real-imaginary

PORTS
  number: 2
  reference impedance:
    (all ports use the same value)
    Z0[1] = 50 ohms
    Z0[2] = 50 ohms
```

Inspecting Touchstone Files

MIXED MODE

(default setup)

matrix row/column 1: single-ended data for port 1

matrix row/column 2: single-ended data for port 2

NETWORK PARAMETERS

frequency points: 2

frequency point #1: 5e+09 Hz

S[1,1] = 1 + 3 j

S[1,2] = 4.9 + 2.6 j

S[2,1] = 0.6 + 2 j

S[2,2] = 0.4 + 8.2 j

...

NOISE PARAMETERS

<none>

What's New in Touchstone 2?

- [Version] 2.0
- # *(# option line, the only one from Touchstone 1)*
- [Number of Ports]
- [Two-Port Order]
- [Number of Frequencies]
- [Number of Noise Frequencies]
- [Reference]
- [Matrix Format]
- [Mixed-Mode Order]
- [Begin Information]/[End Information]
- [Network Data]
- [Noise Data]
- [End]

Converting Touchstone 1 to 2

- ```
$ cat v1.s2p
RI
5 1 3 0.6 2 4.9 2.6 0.4 8.2
10 2.2 2.7 1.4 3.2 4.5 3.2 0.9 8.9
```
- ```
$ tschk2 -canonical-v2 v1.s2p
! Touchstone v2 data file
! Generated by tschk2 version 2.0.1
! Precision of data values is set to 2 digits, calculated from input data.
[Version] 2.0
# GHz S RI R 50
Number of Ports] 2
[Two-Port Data Order] 12_21
[Number of Frequencies] 2

[Network Data]
! freq S11re S11im S12re S12im S21re S21im s22re S22im
5 +1 +3 +4.9 +2.6 +0.6 +2 0.4 +8.2
10 +2.2 +2.7 +4.5 +3.2 +1.4 +3.2 +0.9 +8.9
[End]
```


Converting Touchstone 2 to 1

- `$ tschk2 -canonical-v1 v2.s2p`
! Touchstone v1 data file
! Generated by tschk2 version 2.0.1
! Precision of data values is set to 2 digits, calculated from input data.
GHZ S RI R 50
! freq S11re S11im S12re S12im S21re S21im s22re S22im
5 +1 +3 +4.9 +2.6 +0.6 +2 0.4 +8.2
10 +2.2 +2.7 +4.5 +3.2 +1.4 +3.2 +0.9 +8.9
- Output must be redirected to create a file
- Will be lost in the conversion:
 - Comments from original file
 - Any content new to Touchstone 2.0

Controlling Output

- Example input file with:
 - One space between values
 - Excessive frequency digits

```
$ cat compact.s4p
# GHZ S MA R 50
0 1 180 4.05226e-06 -45 0.00214819 -135 0.0326957 0
0.0749999955 0.999678 178.746 0.0001547 44.2365 4.40317e-05 -137.093 0.0312474 -13.366
0.149999991 0.998953 177.518 0.000154895 156.805 6.23325e-05 -137.592 0.0280867 -24.2334
0.224999994 0.998173 176.312 0.000191275 -138.125 7.47758e-05 -137.862 0.0245106 -31.5581
0.299999982 0.997505 175.117 0.000132603 -89.9357 8.48586e-05 -139.217 0.0214594 -36.0664
0.375 0.996964 173.926 6.99054e-06 -136.62 9.55566e-05 -140.334 0.018411 -40.3768
```

Controlling Numerical Precision

- OPTION: -freq-precision freqDigits
 - Set to 0 to calculate precision based on precision of inputs.
 - Default: 15 digits
- OPTION: -data-precision dataDigits
 - Set to 0 to calculate precision based on precision of inputs.
 - Default: calculate precision from inputs

```
$ tschk2.exe -canonical-v1 -freq-precision 4 compact.s4p
```

```
! Touchstone V1 data file
```

```
! Generated by tschk2 version 2.0.1
```

```
! Precision of data values is set to 6 digits, calculated from input data.
```

```
# GHZ S MA R 50
```

! freq	S11mag	S11ang	S21mag	S21ang	S12mag	...
0	+1	+180	+4.05226e-06	-45	+0.0021	...
0.075	+0.999678	+178.746	+0.0001547	+44.2365	+4.4031	...
0.15	+0.998953	+177.518	+0.000154895	+156.805	+6.2332	...
0.225	+0.998173	+176.312	+0.000191275	-138.125	+7.4775	...
0.3	+0.997505	+175.117	+0.000132603	-89.9357	+8.4858	...
0.375	+0.996964	+173.926	+6.99054e-06	-136.62	+9.5556	...

Controlling Whitespace

- OPTION: `-spacing` aligned *or* compact
 - Default is aligned (see previous slide)
 - Compact places only one space between values

```
$ tschk2.exe -canonical-v1 -spacing compact aligned.s4p
! Touchstone v1 data file
! Generated by tschk2 version 2.0.1
! Precision of data values is set to 6 digits, calculated from input data.
# GHz S MA R 50
! freq      S11mag      S11ang      S21mag      S21ang      S12mag      ...
0 1 180 4.05226e-06 -45 0.00214819 -135 0.0326957 0 ...
0.0749999955 0.999678 178.746 0.0001547 44.2365 4.40317e-05 -137.093 ...
0.149999991 0.998953 177.518 0.000154895 156.805 6.23325e-05 -137.592 ...
0.224999994 0.998173 176.312 0.000191275 -138.125 7.47758e-05 -137.862 ...
0.299999982 0.997505 175.117 0.000132603 -89.9357 8.48586e-05 -139.217 ...
0.375 0.996964 173.926 6.99054e-06 -136.62 9.55566e-05 -140.334 0.0184 ...
```

Summary of Command Options

- Usage modes:
 - tschk2 FILE
 - tschk2 -canonical <options> FILE (produces V2)
 - tschk2 -canonical-v2 <options> FILE
 - tschk2 -canonical-v1 <options> FILE
 - tschk2 -describe FILE
 - tschk2 -version
 - tschk2 -help
- Canonical output options:
 - -freq-precision freqDigits
 - -data-precision dataDigits
 - -spacing aligned|compact

Getting TSCHK2

- Executables freely available:
 - <https://ibis.org/tschk2/>
 - Supported: Windows, Linux, Mac
- Source code available:
 - Same URL
 - C++, Cmake, Doxygen
 - Automated regression suite with 568 testcase files
 - License: \$1000