SnP (Touchstone) File Format

PLTS can import and export SnP files (*.s1p, *.s2p, *.s3p. and so forth). The SnP data file format is also known as Touchstone format.

This file format is used by CAE programs such as:

- Keysight's Microwave Design System (MDS)
- Advanced Design System (ADS)
- TDA MeasureXtracter
- Cadence Allegro PCB SI.

Beginning with PLTS 2012, Touchstone 2.0 files can be imported and exported. Learn more.

Both Touchstone 1.0 and Touchstone 2.0 files contain S-parameters that describe frequency-dependent linear networks.

The difference between *.s1p, *.s2p, *.s3p, (and so forth) files is the number of ports involved in the measurement, and therefore, the number of S-parameters that are saved.

File Type	# of Ports	# of S-parameters saved
***.s1p**	1	1 S-parameter
***.s2p**	2	4 S-parameters
***.s3p**	3	9 S-parameters
***.s4p**	4	16 S-parameters
*.sNp	N	N^2 parameters

SnP (Touchstone1) Data

SnP files contain header information, stimulus data, a response data pair for EACH data point. There can be up to 16,000 data points (records) in each file.

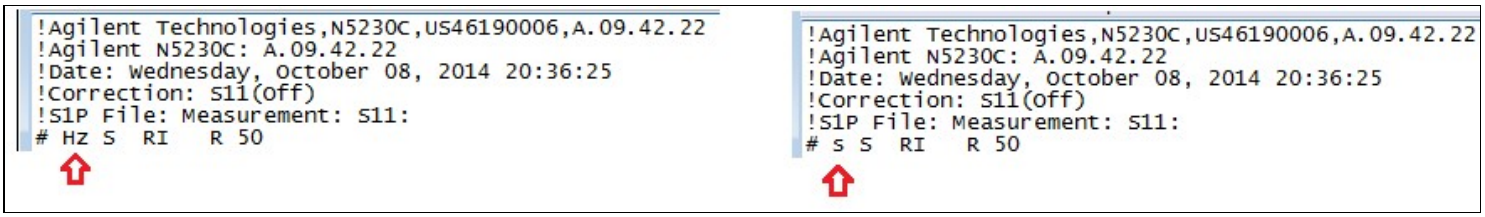
The following is a sample of **Header information:**

! is a commented line.

```
!Keysight Technologies,E8362B,US42340026,Q.03.54
!Keysight E8362B: Q.03.54
!Date: Friday, April 25, 2003 13:46:41
!Correction: S11(Full 2 Port SOLT,1,2) S21(Full 2 Port SOLT,1,2) S12(Full 2 Port SOLT,1,2) S22(Full 2 Port SOLT,1,2)
!S2P File: Measurements:S11,S21,S12,S22:
# Hz  S RI R 50
```

Note: Although the following shows **Real / Imag** pairs, the format could also be **LogMag / Phase** or **LinMag / Phase**

Time Domain touchstone file format is similar to frequency domain touchstone except the x-axis unit is time (s, ns) instead of frequency (Hz, MHz).



Each record is a data point. There can be up to 16,000 data points (records) in each file.

***.s1p Files**

Each record contains 1 stimulus value and 1 S-parameter (total of 3 values).

Stim Real (Sxx) Imag(Sxx)

***.s2p Files**

Each record contains 1 stimulus value and 4 S-parameters (total of 9 values)

Stim Real (S11) Imag(S11) Real(S21) Imag(S21) Real(S12) Imag(S12) Real(S22) Imag(S22)

***.s3p Files**

Each record contains 1 stimulus value and 9 S-parameters (total of 19 values)

Stim Real (S11) Imag(S11) Real(S12) Imag(S12) Real(S13) Imag(S13)
Real (S21) Imag(S21) Real(S22) Imag(S22) Real(S23) Imag(S23)
Real (S31) Imag(S31) Real(S32) Imag(S32) Real(S33) Imag(S33)

***.s4p Files**

Each record contains 1 stimulus value and 16 S-parameters (total of 33 values)

Stim Real (S11) Imag(S11) Real(S12) Imag(S12) Real(S13) Imag(S13) Real(S14) Imag(S14)
Real (S21) Imag(S21) Real(S22) Imag(S22) Real(S23) Imag(S23) Real(S24) Imag(S24)
Real (S31) Imag(S31) Real(S32) Imag(S32) Real(S33) Imag(S33) Real(S34) Imag(S34)
Real (S41) Imag(S41) Real(S42) Imag(S42) Real(S43) Imag(S43) Real(S44) Imag(S44)

This pattern continues for N ports involved in the measurement.

Touchstone 2.0 Data Files

Touchstone 2.0 has specifications for saving Mixed-mode (Balanced) S-parameters. When Touchstone 2.0 is selected in PLTS from the Import and Export dialogs, data are saved to *.ts files.

The format is slightly different from Touchstone 1.0 files as shown in the following partial image of an *.ts file.

```
[Version] 2.0
# MHz S MA R 50
[Number of Ports] 4
[Number of Frequencies] 200
[Reference] 50 50 50 50
[Network Data]
! FREQ                                    S11
!                                        S21
!                                        S31
!                                        S41
!                          MAG                      ANGLE
   10.00000000000000       0.01994073849849      81.19021783554790
                           0.99723228501060      -5.54959751821198
                           0.02097549698360      83.45989116775950
                           0.00772266131977     -96.48764257706840
   20.00000000000000       0.03860201357502      75.87639051989720
```

Touchstone 2.0 has the ability to save data with different reference impedance for each port, indicated by [Reference] in the above image. However, currently PLTS does NOT have the ability to measure data into different impedances for each port.

TDA Systems MeasureXtractor

PLTS exports 4-port S-parameters in Touchstone format for import into TDA Systems' MeasureXtractor. This is a powerful capability that allows you to describe the exact frequency dependent behavior of your passive device using an S-parameter block inside of MeasureXtractor. MeasureXtractor also allows you to create a SPICE compatible model for further circuit simulation.

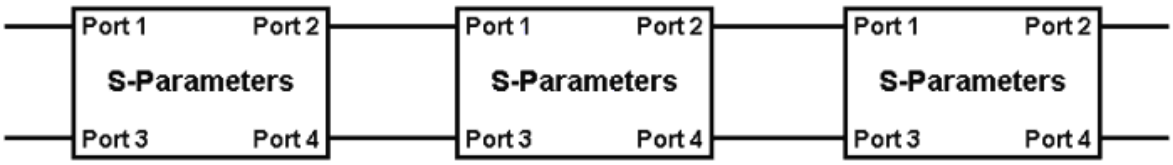
Access the PLTS Æ TDA MeasureXtractor export feature by selecting **Export** then **TDA MeasureXtractor** from the **File** menu.

File Format and Port Conventions

The format of the 4-port S-parameter Touchstone file is magnitude (in dB) and phase (in degrees) information at each frequency point. Port designations in the resultant Touchstone file are as they appear in the DUT file.

- If you are only using a single S-parameter defined data block in your MeasureXtractor schematic, your results are specific to what you attach to each of the ports.
- If you are using cascaded S-parameter data blocks in your schematic they must have ports 1 and 3 as the input ports and ports 2 and 4 as the output ports. Since TDR measurements typically have ports 1 and 2 as the input ports and 3 and 4 as outputs, a port swap between port 2 and port 3 will need to be performed. You can also read TDR waveforms directly into TDA MeasureXtractor for data driven models.

Requirement when S-Parameter Blocks are Cascaded



Recommendations for a Good MeasureXtractor-compatible File

- For TDR-based measurements set the number of points to 2000 or above and make all 16 single-ended measurements (differential measurements are not required). A complete 4-port measurement set is required to export directly to MeasureXtractor. Alternately, you can export selected S-parameters directly from PLTS into a Touchstone file from the **File** menu by selecting **Export**, **Touchstone**, and **Magnitude, angle**.
- When using a VNA, perform your measurements with a 20 MHz start frequency and a 20 GHz stop frequency. Since Start and Step frequency settings are coupled, this will ensure several things including getting about 1000 points of data (so as to avoid undersampling) and an adequate extrapolation down to dc. Not following these precautions can lead to difficulty with successfully extracting a circuit in MeasureXtractor.
- Maintain good fixturing, calibration practices, and a low IF bandwidth when using a VNA to ensure good reciprocity and prevent your passive device from turning active at any frequency point. The MeasureXtractor software requires good reciprocity (e.g. S12 = S21, S34 = S43 to better than about 2%) for its algorithms to function and utilizes an input checker that will reject files with poor reciprocity. You can visually check for reciprocity or perform math functions within PLTS before exporting to MeasureXtractor as an early indicator.
- Use only short-to-medium length devices. Using devices that are less than 20 wavelengths, or no more than 100 rise times long, will keep extraction time and simulation time of the resultant S-parameter block in MeasureXtractor reasonable.
- Obtain dc response information on your device if possible. This will enhance the accuracy of the model created inside of MeasureXtractor.

Recommendations for Using the Exported File in MeasureXtractor

In TDA Systems' software:

- Change the **Max Frequency** field under **Tools > Options > Waveform Viewer** to match the maximum frequency of your Touchstone file.
- Follow the guidelines listed in the TDA Systems' documentation for rise time, truncating, and dc values.
- To avoid difficulties in performing the extraction, make sure your device takes up a significant portion of the total time domain window (> 33%). If your device only takes up 10% or less of the time domain window, you can eliminate the lowest frequency data points to shorten the time span by directly editing the Touchstone file.

See other File and Print Operations topics