

# (Re-) Re-Introducing Touchstone® 2.0

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February 20, 2009

# Introducing Touchstone 2.0

What is it?

- A revision to Touchstone, the specification that describes frequency-dependent network data (S-, Z-, etc. parameters)
- A fully backward-compatible update to Touchstone

Why is it needed?

- The original Touchstone is ambiguous in several areas
  - Maximum number of ports
  - Definition of “line” and organization of network data
- The original specification did not support some applications
  - Mixed-mode or balanced network parameters (i.e., “differential”)
  - Network data describing both power planes and signal lines

The changes make the format easier to use  
and to integrate with ICM and modern industry flows

# Touchstone 2.0 Key Concepts

## Major Changes from Touchstone

- Added mixed-mode support **NEW!**
- Added optional per-port reference impedances
- Added explicit keyword for numbers of ports, frequencies in the file
- Added explicit version control
- Removed any limit on the maximum number of ports described
- Removed normalization for non-S-parameter data sets
- Added support for upper- and lower-half matrices

Original Touchstone files are supported  
as-written under Touchstone 2.0

# Touchstone 2.0 Key Concepts

## What Has Changed Since 2007 Review

- Mixed-mode support added, with explanatory appendix
- Information block added, as placeholder
  - *May eventually support node-to-port mapping*
- Explicit handling of unusual S12/S21 ordering in 2-port networks
- Explicit [Network Data], [Noise Data] and [End] keywords

## What Was NOT Included

- No support for data compression formats (binary, ZIP, etc.)
- No support for complex reference impedances
- No support for frequency-dependent reference impedances
  - Most systems can still be mathematically treated to use frequency-independent, real-only references
  - Most simulators use real-only references consistently, but may differ on interpretation of complex impedances

# Touchstone Major Feature Summary

Feature	Touchstone	Touchstone 2.0
Network data format	Single-ended only	Single-ended or mixed-mode (numbering is still single-ended)
Reference impedances	One impedance for all ports	Either one impedance or per-port impedances may be used
Normalization	G-, H-, Y-, Z- parameters are normalized to reference	Data is NOT normalized to the reference
Number of ports	Implied from size of data matrices	Explicitly stated through [Number of Ports]
Number of frequencies	Only known after complete reading of file	Explicitly stated through [Number of Frequencies], [Number of Noise Frequencies]
Version	No version control stated	Specification version is stated under [Version]
Data arrangement	Maximum of 4 data pairs per line; matrices must be complete (e.g., a 2 port network must include 4 data pairs plus a frequency point)	Data may be split across multiple lines; matrix data may be reduced into upper- or lower-half formats, assuming symmetry

# Other Notes & Next Steps

## Technical and Editorial Changes

- To be handled during IBIS Open Forum reviews

## Parser

- Is a standard parser required, as with IBIS and ICM?
- Should this instead be left to the adopting EDA tool vendors?

## Next Steps

- Review and comment period through end of April (at minimum)
- Call for vote once all major issues are closed
- GEIA balloting after IBIS vote (PINS has been filed)

**Thanks to Agilent for permission to use the name and to the Interconnect Task Group for their hard work in development!**