

Modeling Methods for Complex S-Parameters in Touchstone V2.0

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 Requirement of Multi-port S-Parameters for Crosstalk Analysis

- Advantage of Touchstone V2.0
- Modeling Methods for Complex S-Parameters
- Lab Correlation for S28P Parameters
- Conclusions

Requirement of Multi-port S-Parameters for Crosstalk Analysis



Touchstone V2.0 file can include more crosstalk information of > 4 port case
 In this case, we need 28-port S-parameters for crosstalk analysis



Advantages of Touchstone V2.0

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 No restriction exists on the number of data pairs on a line in Version 2.0 files.(Data format restrictions relaxed)



Version 2.0

Advantages of Touchstone V2.0

The [Matrix Format] keyword: "Full", "Lower", or "Upper".

s11	s12	s13	s14	s15	s16	s11	s12	s13	s14	s15	s16	s11	s12	s13	s14	s15	s16
s21	s22	s23	s24	s25	s26	s21	s22	s23	s24	s25	s26	s21	s22	s23	s24	s25	s26
s31	s32	s33	s34	s35	s36	s31	s32	s33	s34	s35	s36	s31	s32	s33	s34	s35	s36
s41	s42	s43	s44	s45	s46	s41	s42	s43	s44	s45	s46	s41	s42	s43	s44	s45	s46
s51	s52	s53	s54	s55	s56	s51	s52	s53	s54	s55	s56	s51	s52	s53	s54	s55	s56
s61	s62	s63	s64	s65	s66	s61	s62	s63	s64	s65	s66	s61	s62	s63	s64	s65	s66

SE, MM & GMM data



What can an N-port (n≥4) VNA do ?

- VNAs with less than 4 ports are very common.
- Even 16 ports VNA can't get whole information directly in this sort of case.
- Some methods can be used for n-port (n≥4) S-parameters conversion based on 4-port S-parameters.

• How do we get s4p file if we have a 2 ports VNA only?



• Need 6 times measurement to get all data

 $C_{4}^{2} = 6$



• This is a actual case



• Needs 91 times measurement with a 4 port VNA

Step1





- Using Matlab to abstract proper data
- According to Touchstone V2.0 format









• Error check

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• Passivity & Causality



Based on victim differential signal measurements



- Saving every channel waveform and recalling them as a PWL source in Hspice netlist
- Using S28P file to model whole channel

• Far end crosstalk in time-Domain



• Far end crosstalk in frequency-Domain





• Near end crosstalk in time-Domain



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• Near end crosstalk in frequency-Domain



- Contrast with measure data and result of FFT, this method is effective for modeling of multi-port S parameters.
- FFT analysis shows the S28P file can include detail information of frequency response very clearly.
- Matlab programming is useful to process individual cases. But the way we coding is not a general way.



- A proposition for complex S-parameters modeling
 - Adding keywords to give information of S-parameters need to be combined
- Such as [Combine information] Ninp Noutp Tsn Sorder
 - Ninp means (number of input S file port) for example : 4 means (number of output S file port) Noutp means (total S parameter Number) Tsn
 - means (input S file combination order) Sorder
- for example : 28 for example : 91
- for example : 2 of 91

Conclusions

- Multi-port S-parameter is widely used for crosstalk analysis in high-speed system design, Touchstone V2.0 provide favourable conditions to model multi-port interconnect networks.
- Based on certain times 4-port S-parameter measurement we can get SnP (n>4) file through programming process
- We expect a general S-parameter conversion method supported by EDA software.
- We may give keywords to combine S4P files , and software can abstract proper data from each S4P file in a general rules and orders.

References

- Touchstone Syntax for Versions 1.0 and 2.0
 Bob Ross TERASPEED CONSULTING GROUP
- Touchstone Version 2.0 Mixed-Mode Syntax Updated Bob Ross TERASPEED CONSULTING GROUP
- S-Parameter Conversions

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