Asian IBIS Summit, Tokyo Japan
November 6. 2009
Guidance of Passive EDA models

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S-parameters Issue in Passive Devices

S-parameters circulate widely as simulation model
of Signal Integrity.

S-parameters are different by the vendor which are provided.
  e.g.
    Bandwidth
    Upper or lower limit frequency
    Frequency steps

Some simulators output a wrong calculation result by
these different S-parameters.

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Verification of S-parameters with limit

1. Measurement of S-parameters
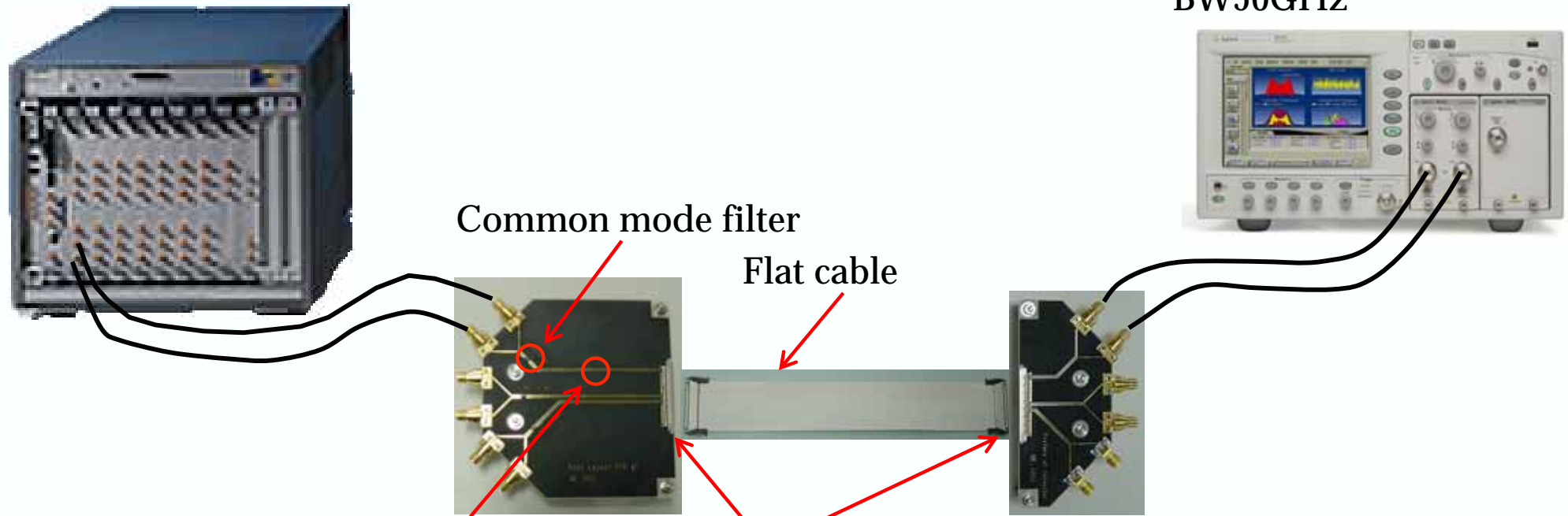They were measured between SMA-SMA connectors using Vector Network Analyzer(VNA).
BW 10M-20GHz, 10MHz steps

2. Measurement of transient waveforms
They were measured with sampling Oscilloscope and Signal Generator.

Signal Gnenrator13.5Gbps

Sampling Oscilloscope
BW50GHz

Common mode filter

Flat cable

Differential Pair Lane

Connectors

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Verification of S-parameters with limit

3.Transent simulation using measured S-parameters

    S-parameters bandwidth limitation

       10MHz-3.16GHz (Sdd21 -10dB)

       10MHz-7.82GHz (Sdd21 -20dB)

       10MHz-11.1GHz (Sdd21 -40dB)

       10MHz-20GHz   (full parameters)

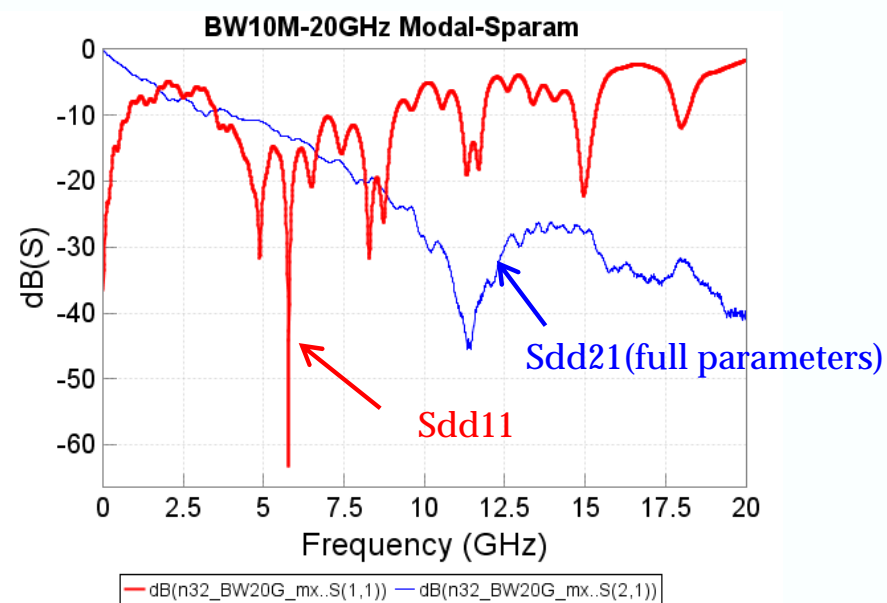4.Compariosn between measured transient waveforms and simulated transient waveforms
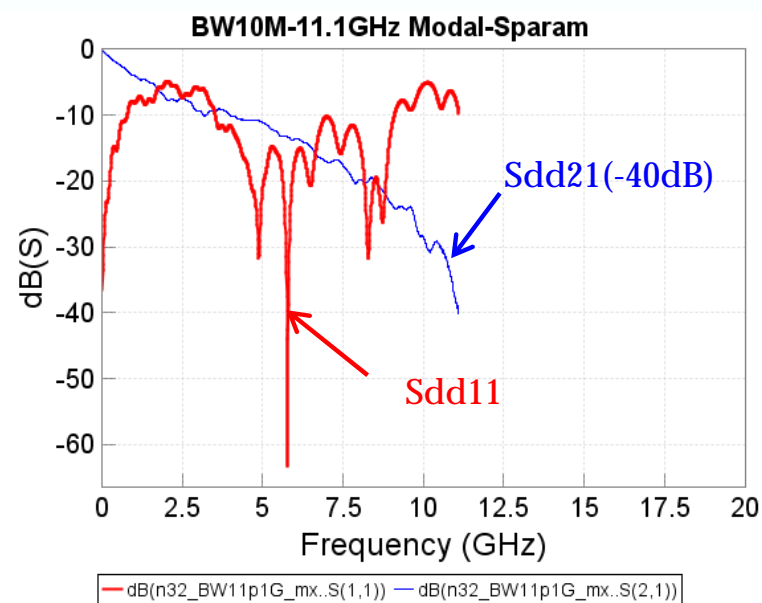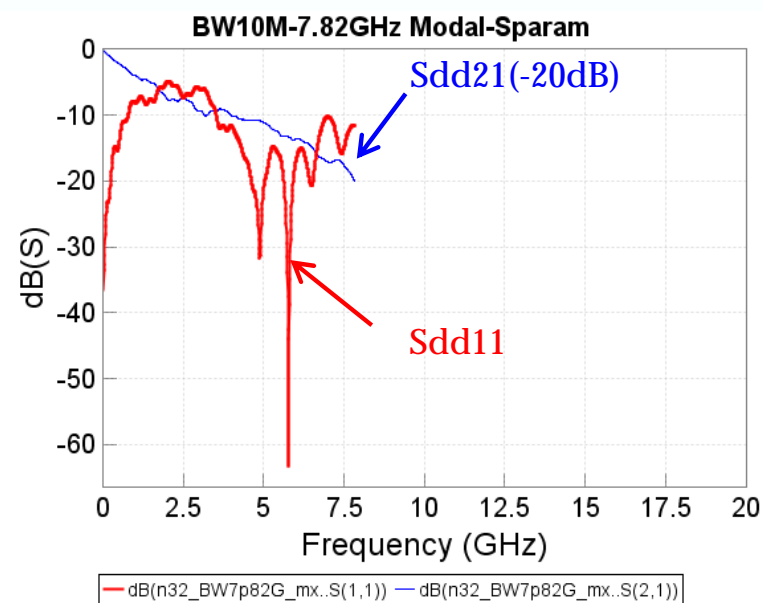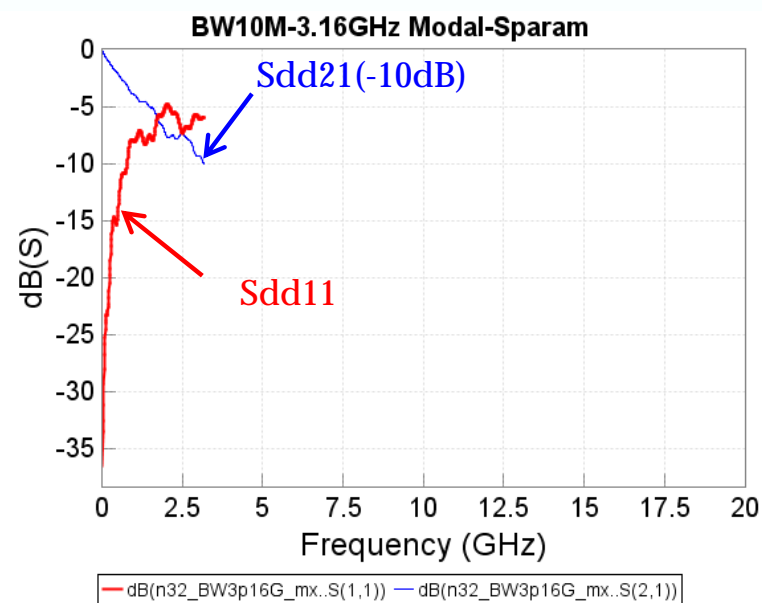
    The measured transient waveforms

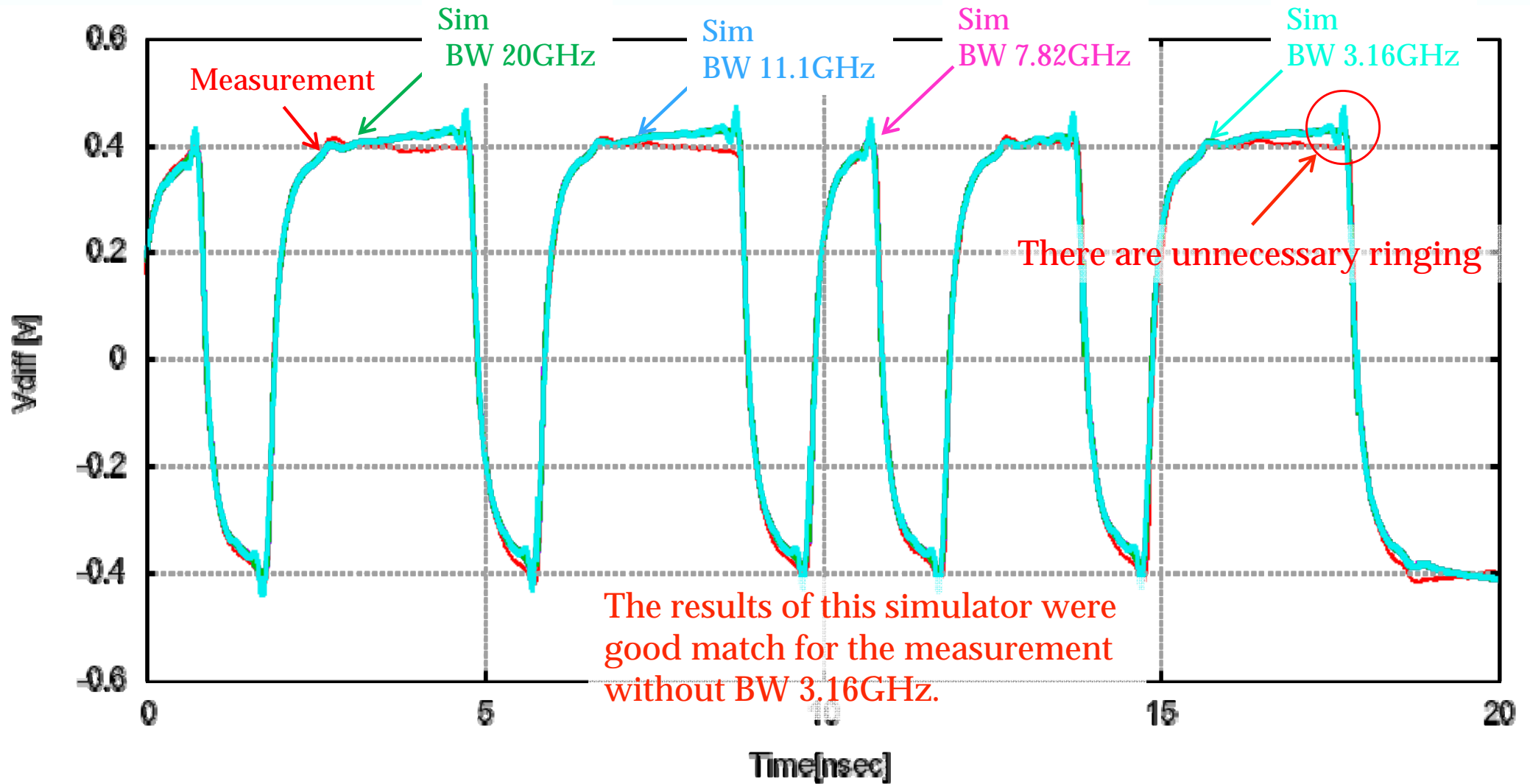   They were measured by using SG and OSC.

    The simulated waveforms

    They were simulated by using S-parameters which were measured using VNA.

Measured S-parameters

Measured transient waveform vs. Simulated waveform using Simulator A

Vertical axis is not adjustment.
Lower limit of S-parameters are 10MHz without 0Hz

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Measured transient waveform vs. Simulated waveform using Simulator A

Vertical axis is not adjustment.
Lower limit of S-parameters are 0Hz.
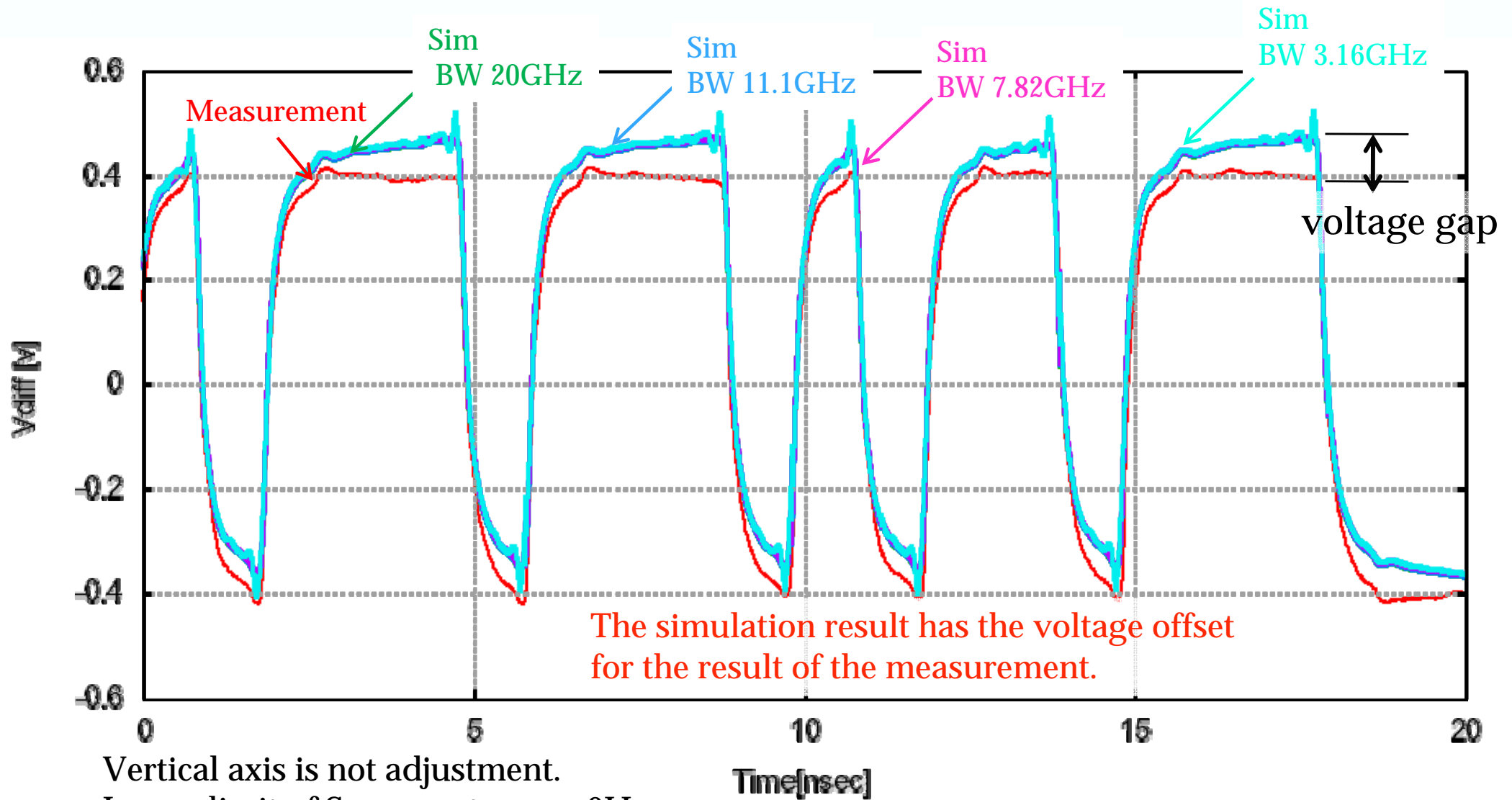(extrapolated using 10MHz of S-parameters.)

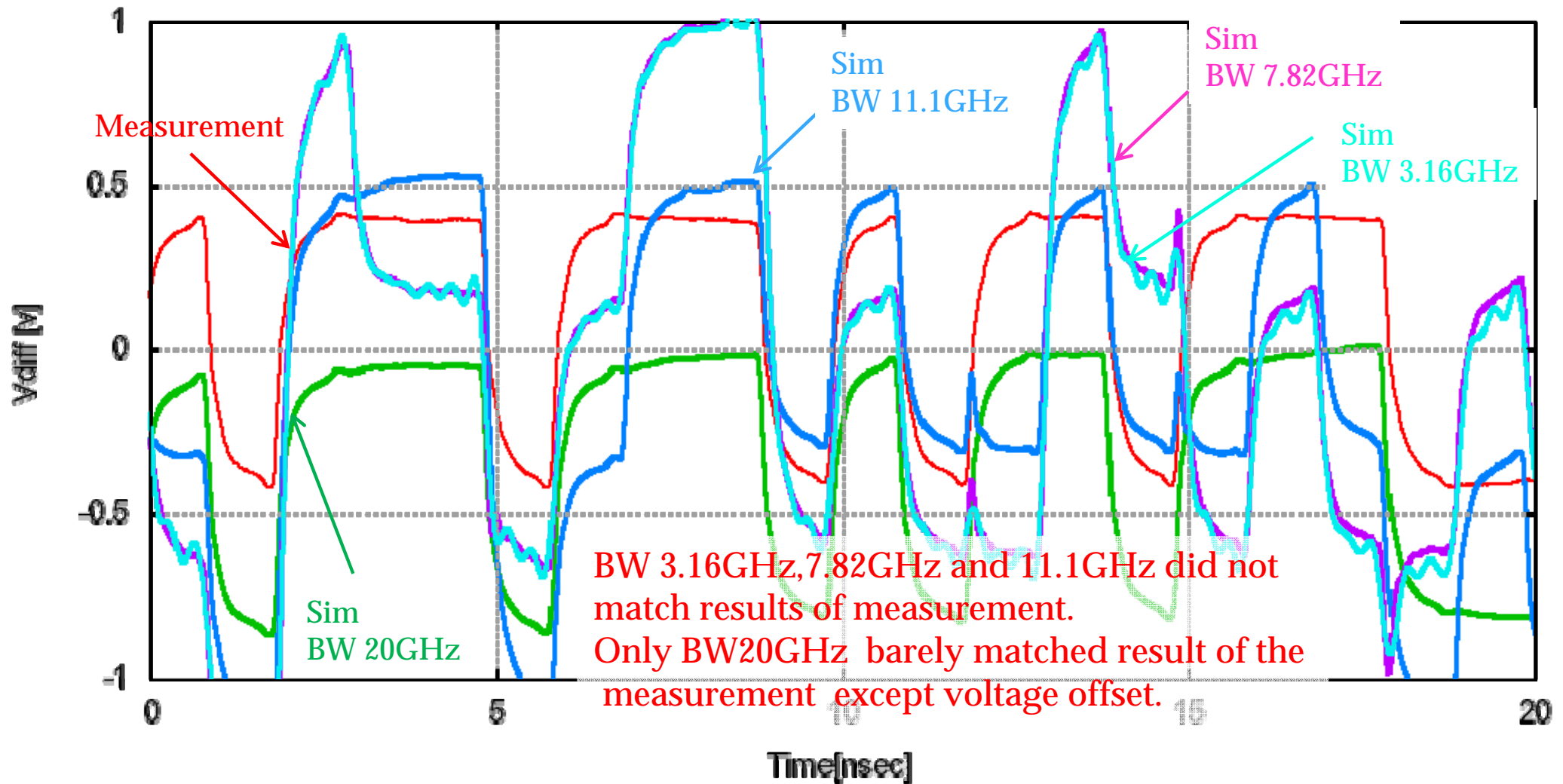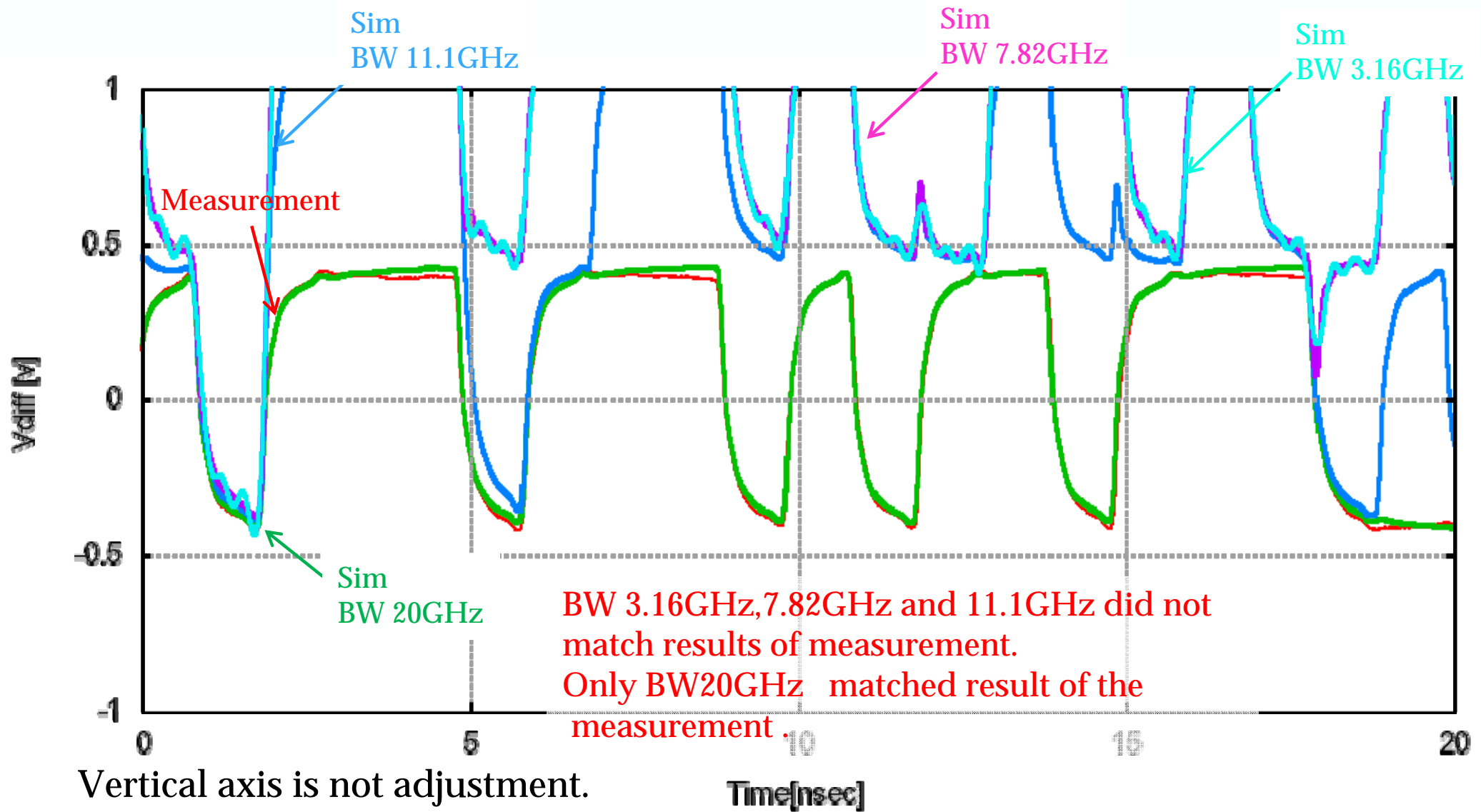# Measured transient waveform vs. Simulated waveform Using Simulator B

Vertical axis is not adjustment.
Lower limit of S-parameters are 10MHz without 0Hz

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Measured transient waveform vs. Simulated waveform Using Simulator B

Vertical axis is not adjustment.
Lower limit of S-parameters are 0Hz.
(extrapolated using 10MHz of S-parameters.)

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Summary of results

There is a simulator that can execute the accurate transition analysis without 0Hz or S-parameter to 20GHz. (Simulator A)

So that all simulators may simulate transient waveform using S-parameters accurately, they are necessary to use the band of S-parameters from 0Hz to 20GHz.(Simulator B)

Four ports S-parameters with the band from 0Hz to 20GHz are large size of the file.(928kB)
  Therefore, a lot of time is needed, when calculating with the simulator using the full band S-parameters (0Hz-20GHz).

BW	Simulator A	Simulator B
0Hz - 3.16GHz (-10dB)	(offset,ringing)	×
0Hz - 7.82GHz (-20dB)	(need offset)	×
0Hz - 11.1GHz (-40dB)	(need offset)	×
0Hz - 20GHz (Full)	(need offset)	
10MHz - 3.16GHz (-10dB)	(ringing)	×
10MHz - 7.82GHz (-20dB)		×
10MHz - 11.1GHz (-40dB)		×
10MHz - 20GHz (Full)		(offset)

Guide line for using S-parameters

It is the following items are discussed in JEITA EDA-WG.

1. Lower frequency limitation of S-parameters
   Are S-parameters of 0Hz necessary?
   How should extrapolate when there are no S-parameters of 0Hz?
   How should be measured S-parameter of 0Hz?

2. Upper frequency limitation of S-parameters
   How many harmonics at input signal wave are necessary?

3. Frequency steps
   At least, how many are the number of frequency steps necessaries?

In these items, it is the purposes to rouse notes when using S-parameters.