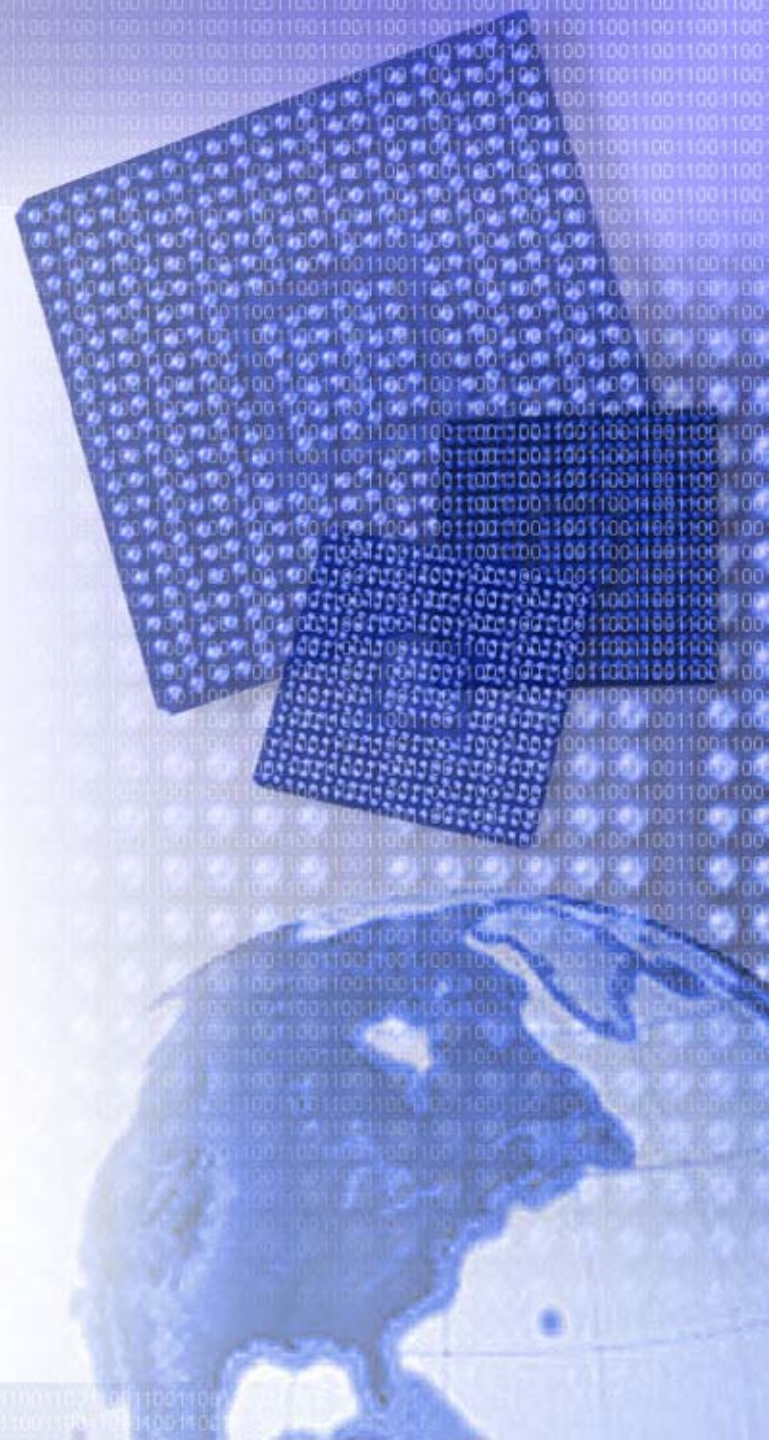




# Phase Delay Distortion

Brian Brunn  
Aug 5, 2004



# Phase Delay

- It appears the quantity of interest should be “Phase Delay” rather than “Group Delay”.

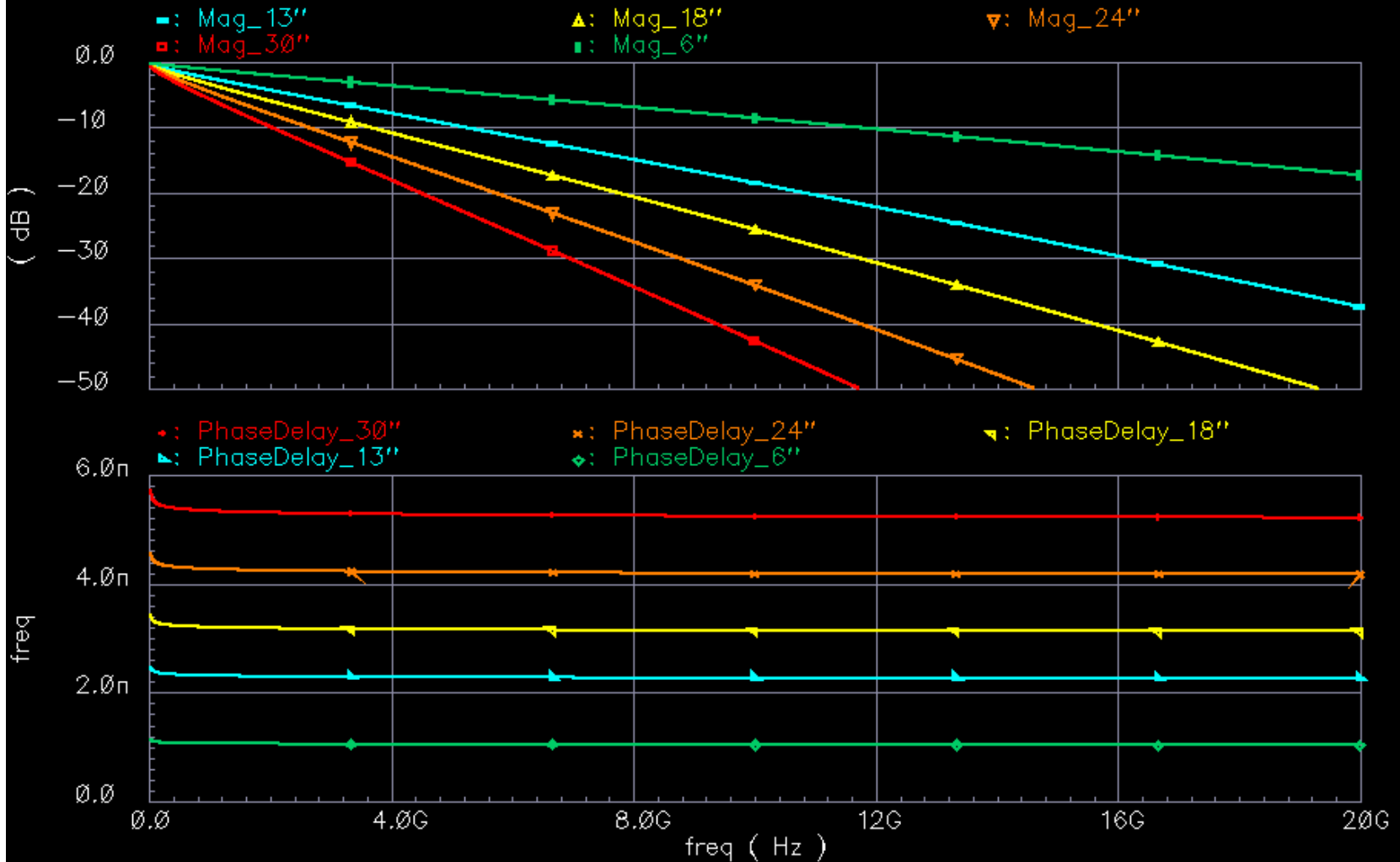
$$\text{PhaseDelay} := \frac{-\theta}{\omega} \qquad \text{GroupDelay} := -\left(\frac{d}{d\omega}\theta\right)$$

- Phase Delay is the delay of each frequency component [units sec].
- Group Delay is the delay of an envelope formed by narrow-band modulation [units sec].
- Phase Delay requires unwrapped phase, which we can get. Phase Delay may require less measurement averaging.
- Group Delay is very sensitive to frequency variation in materials and has numerical issues with derivative. Group Delay has more noise the finer the measurement resolution. Can measure Group Delay needing only wrapped phase.

# FR-4 Mag and PhaseDelay (linear freq)

S90\_WHITNEY\_IB\_BTBO1\_channel\_Mag\_delay\_sim\_schematic : Aug 3 16:20:43 2004

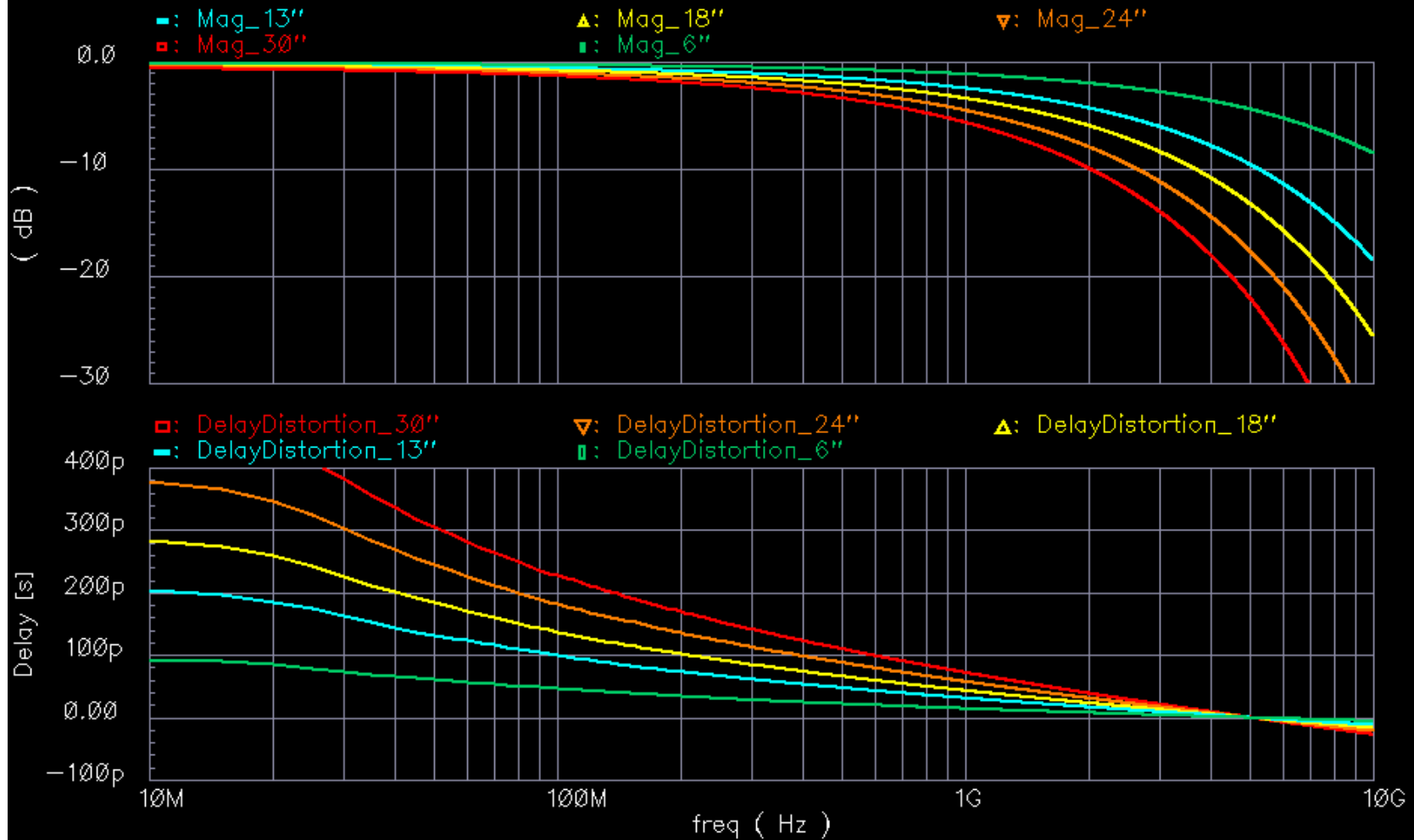
FR4 6, 13, 18, 24, 30"



# FR-4 Mag and PhaseDelayDistortion (log freq) delay @ 5GHz = 0 sec

S90\_WHITNEY\_IB\_BT001 channel\_Mag\_delay\_sim schematic : Aug 3 16:20:43 2004

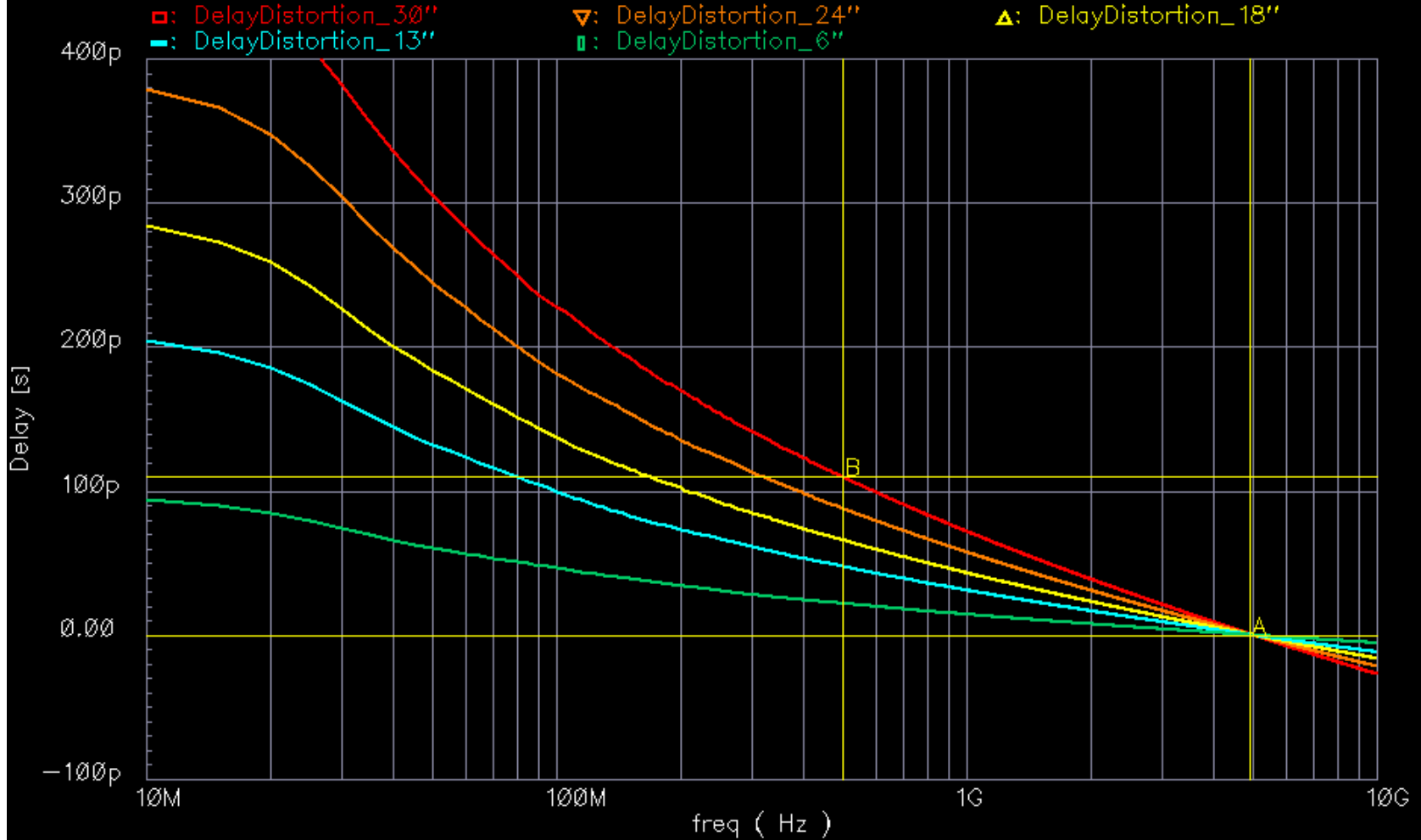
FR4 6, 13, 18, 24, 30''



# PhaseDelayDistortion 109ps 500MHz to 5GHz

S90\_WHITNEY\_IB\_BT001\_channel\_Mag\_delay\_sim\_schematic : Aug 3 16:20:43 2004

FR4 6, 13, 18, 24, 30"



A: (4.915G 143.257f) delta: (-4.415G 109.508p)  
B: (500M 109.651n) slope: -24.8036z

