T10/07-252r0

Minimizing Delay in Electrically Long Touchstone Files
(including 6G SAS TxTestLoad)

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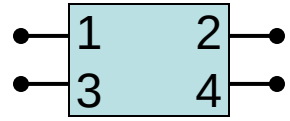
Motivation to Reduce Delay

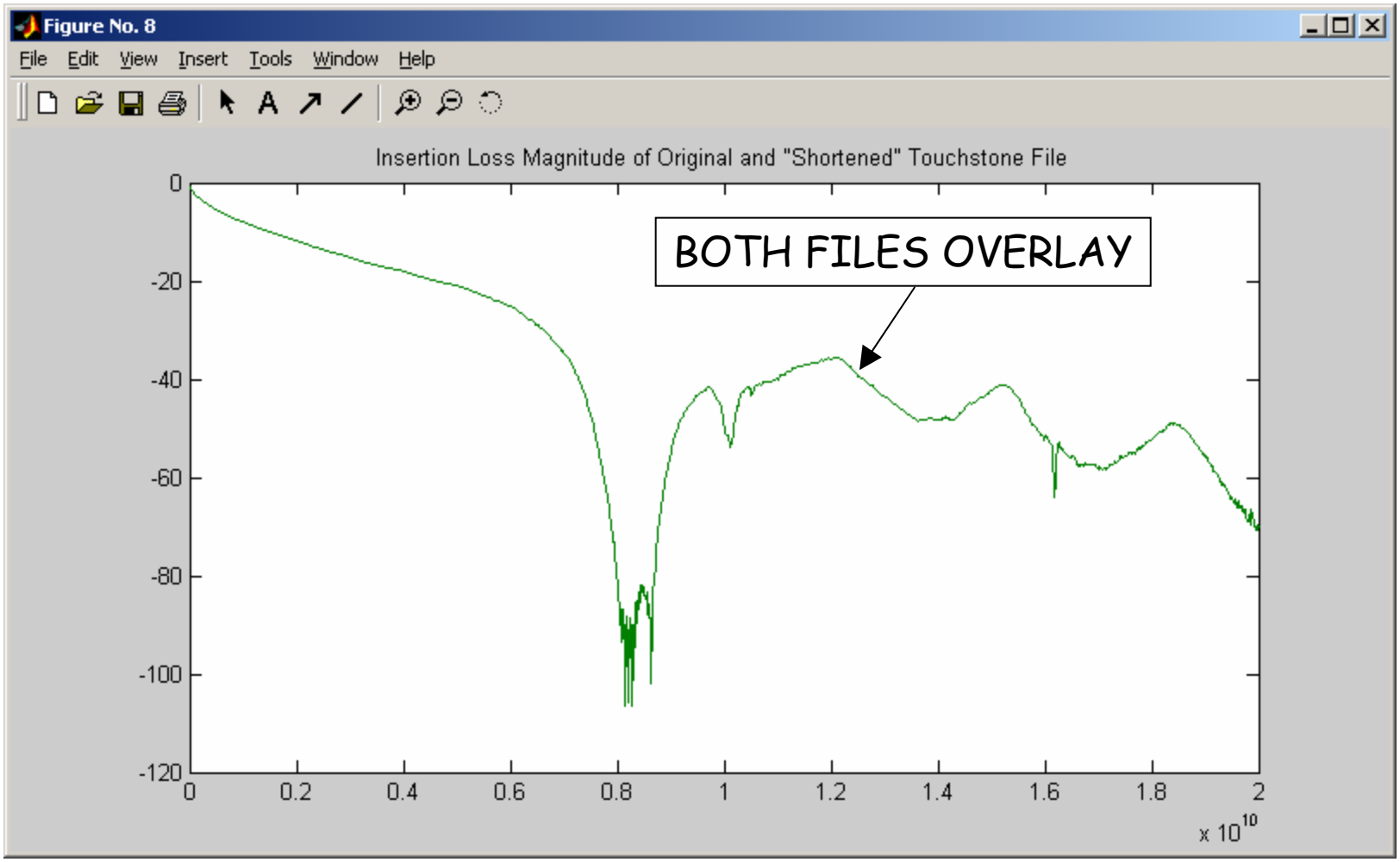
- Rapidly rotating phase of insertion loss requires frequency points less than 180° apart
  - Violating this confuses simulator algorithms that interpolate/extrapolate s-parameters
- Large number of frequency points slows simulation time

Theoretical Justification

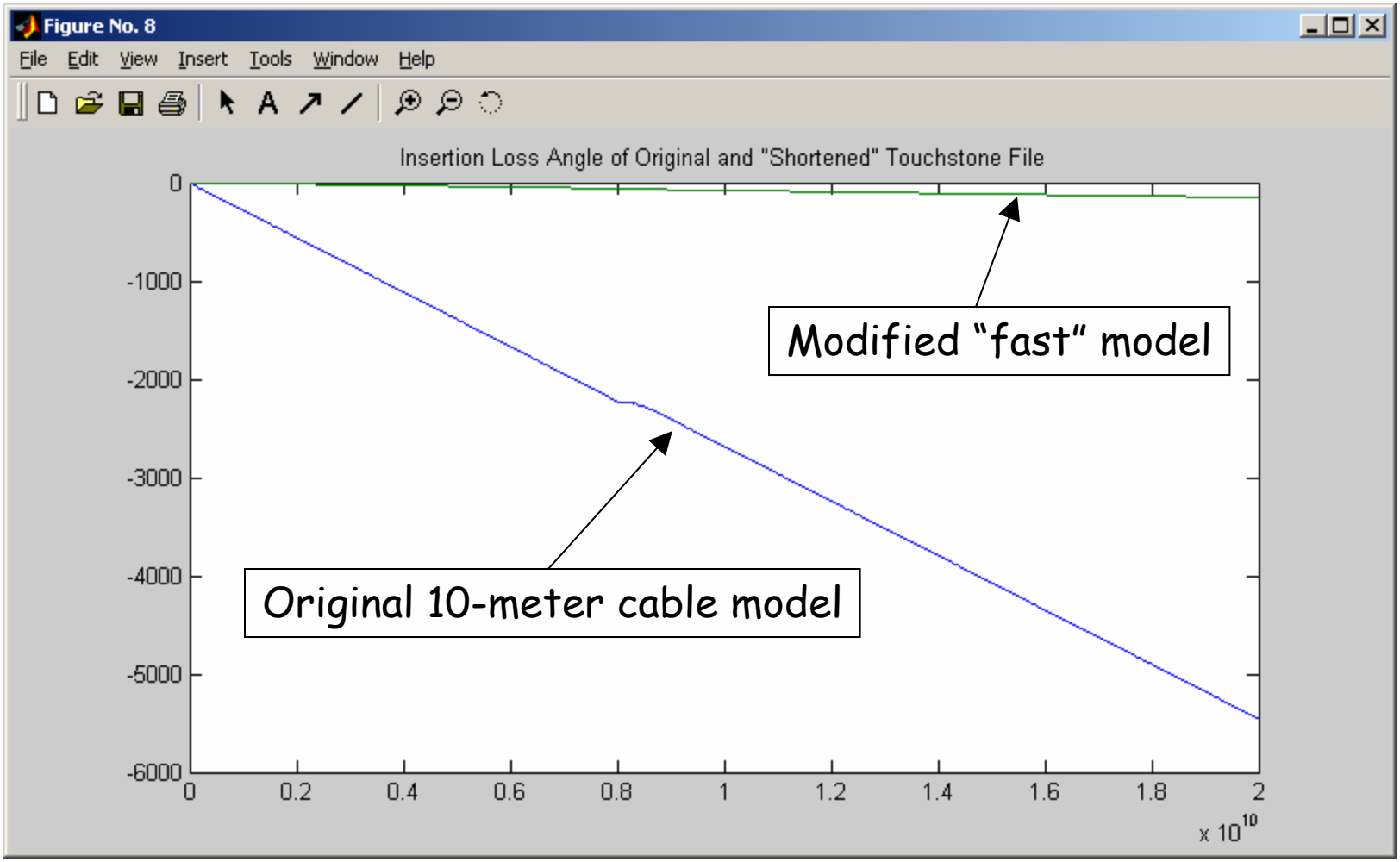


- Divide s-parameters into the half that "go the distance" & half that "stay home"
  - Go the distance: S12, S14, S32, S34, S21, S23, S41 & S43
  - Stay home: S11, S13, S33, S31, S22, S24, S44 & S42
- Insertion losses (i.e., "go the distance" params) for single-ended and all mixed mode parameters are linear combinations exclusively of this "go the distance" group
  - Therefore, multiplying 1st group parameters by e^{jwT} changes only the phase of all insertion losses ('T' is the delay decrease)
  - Insertion loss magnitudes are unaffected
- Return losses (i.e., "stay home" params) for single-ended and all mixed mode parameters are linear combinations exclusively of this "stay home" group
  - These parameters are unchanged by this procedure

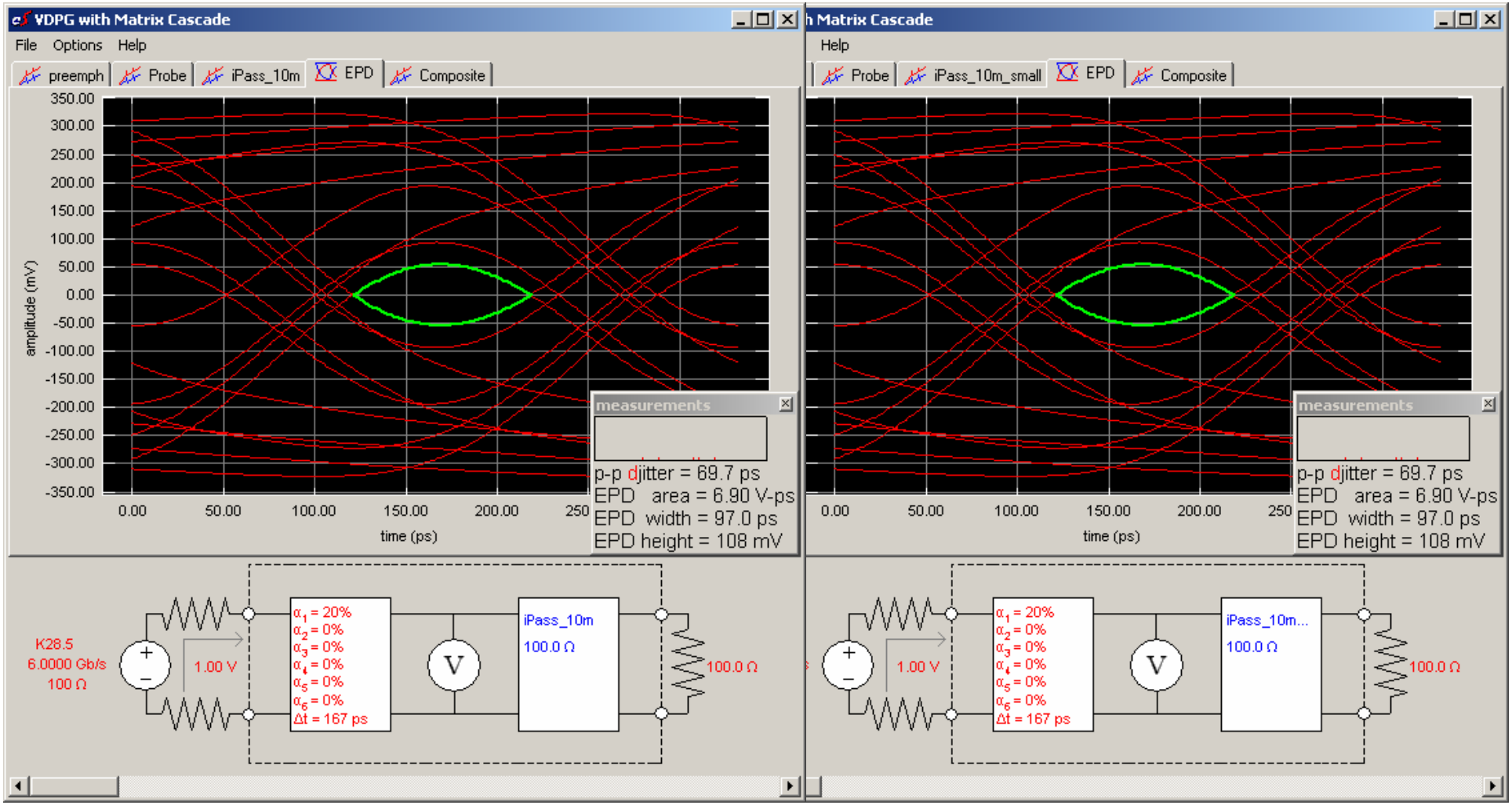
Dif'l Insertion Loss Magnitude



Dif'l Insertion Loss Angle



Simulation of Both Models



Caveat

- The hidden assumption is that multiple reflections are insignificant
  - How reflections and original signal combine is influenced by time of flight (which has been artificially changed)
- Therefore, this should be used only for
  - long, lossy models (i.e., reflections absorbed), or
  - long models that are very well terminated (i.e., no reflections)

Matlab Function

```
function [Snew] = SxPChangeDelay(S,freq,inputs,outputs,delay);
%   Mike Jenkins    LSI Corp.
%
% delay is change in propagation delay between any node in inputs and any
% node in outputs.  Negative values decrease propagation delay.

DelayVec=exp(-j*2*pi*permute(freq,[2 1])*delay);
N=size(S,1);
Snew=S;

for i=1:N
   for j=1:N
      if ((ismember(i,inputs)&&ismember(j,outputs))||(ismember(j,inputs)&&ismember(i,outputs)))
         Snew(i,j,:)=squeeze(S(i,j,:)).*DelayVec;
      end;
   end;
end;
```