CABLE MODELS & PROCEDURES

SCSI SSM Meeting

12-13 December 2001

Bruce Manildi

T10/02-052r0

Participants

- Supporting Companies

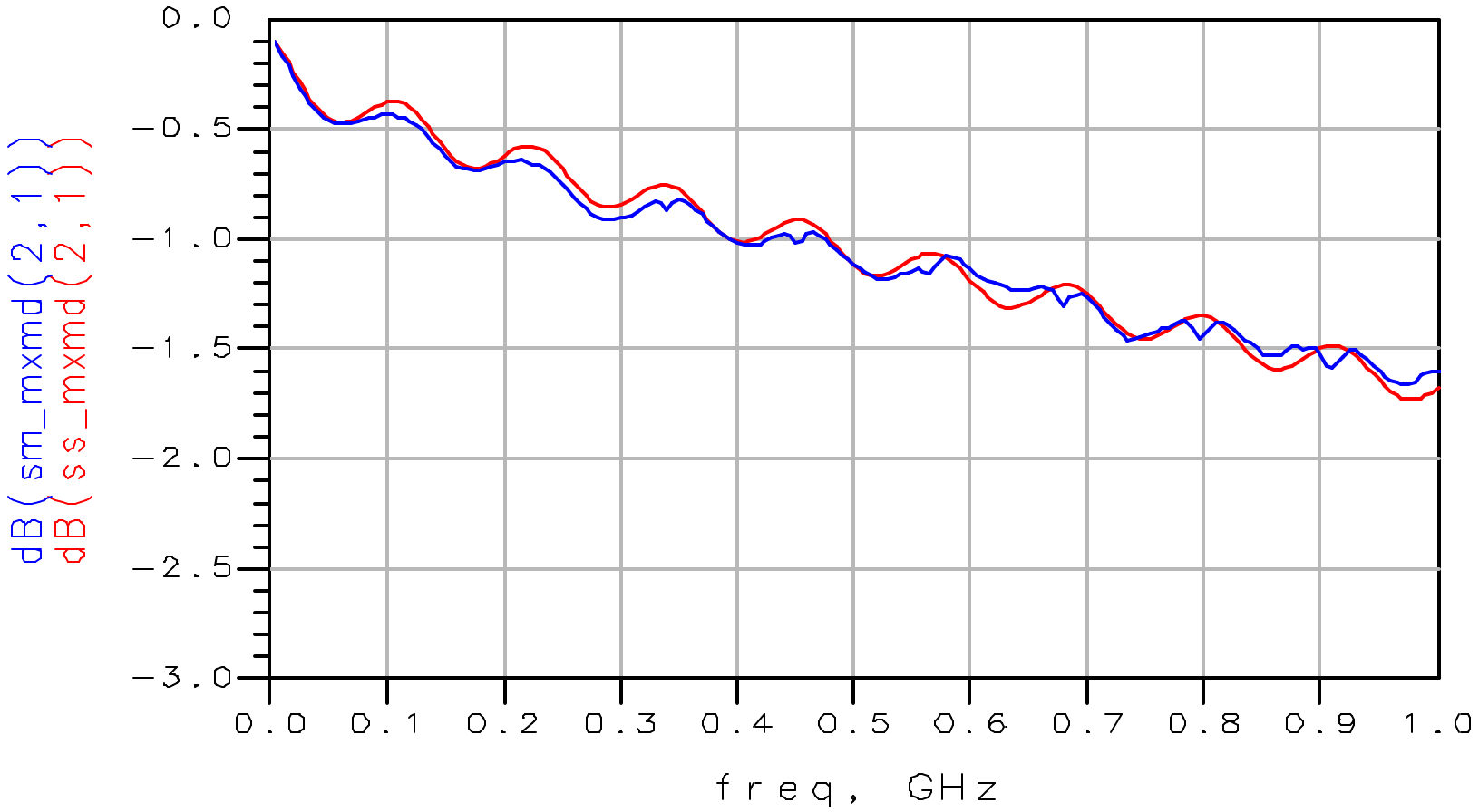
Methodology

- Measure cables on 4-port VNA (S-param) and TDR
- Load S-param into ADS and model
- Compare simulation using model to actual – tweak
- Run simulation of attenuation and crosstalk
- Convert to RLGC matrix (for H-Spice)
- Simulate in H-Spice (loss and xtalk) and compare to ADS simulation – tweak
- Publish RLGC model

Status

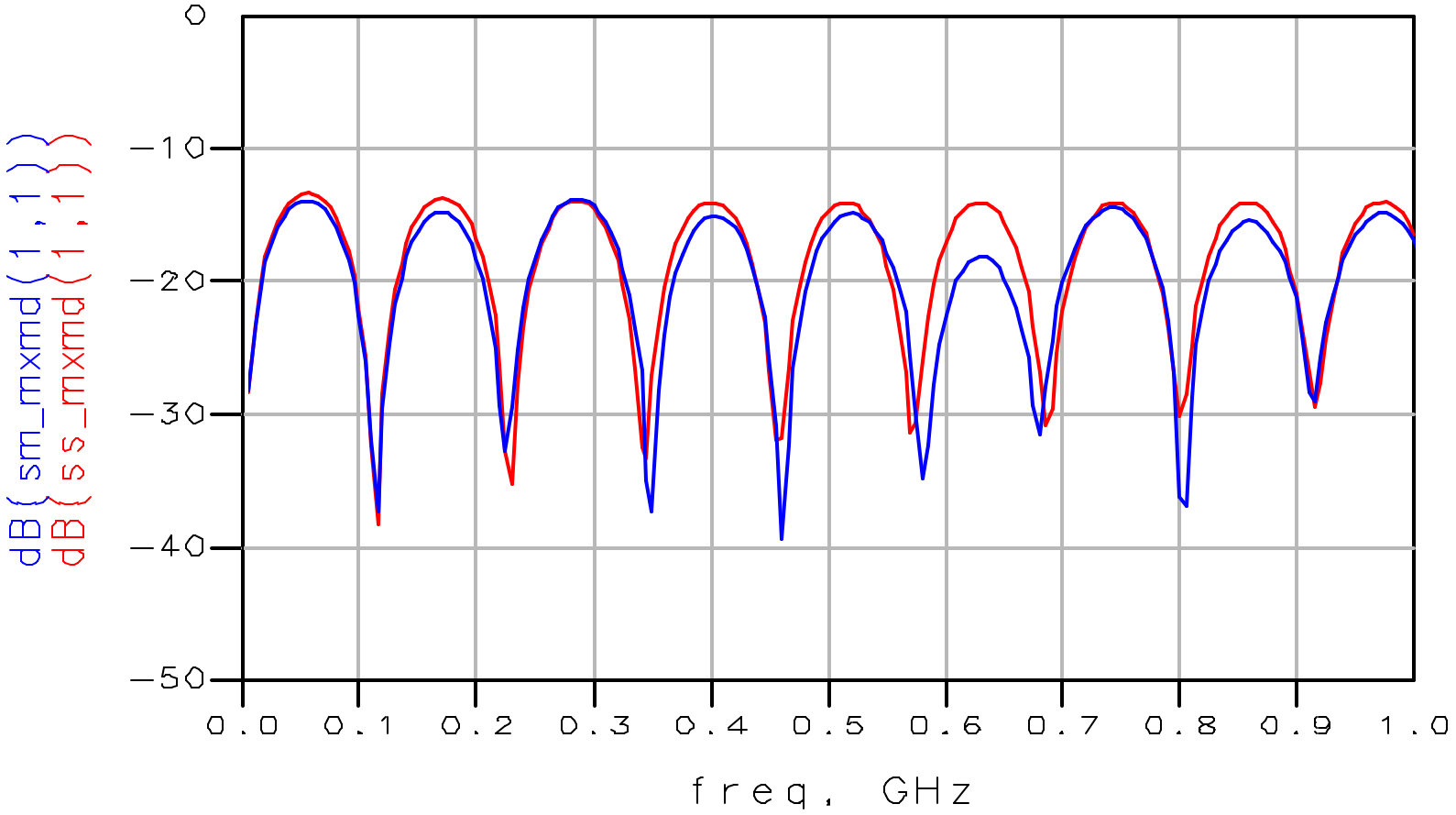
- Four (4) cables measured and modeled
  - Two round – TempFlex and Hitachi
  - Two T'n'F generating model for flat and twisted sections
- All models are RLGC and per meter
- About half way thru the project ($)
- Methodology completed for cables – can make models easily

Round (TempFlex) – Diff. Insertion Loss



TempFlex round cable, differential insertion loss, measured (blue) vs. simulated (red)

Round (TempFlex) – Differ. Return Loss



TempFlex round cable, differential return loss, measured (blue) vs. simulated (red)

RLGC Model – TempFlex

L0			
6.3578E-07			
3.3679E-07	6.3565E-07		
4.9635E-08	7.0042E-08	6.3565E-07	
3.5255E-08	4.9635E-08	3.3679E-07	6.3578E-07

G0			
0			
0	0		
0	0	0	
0	0	0	0

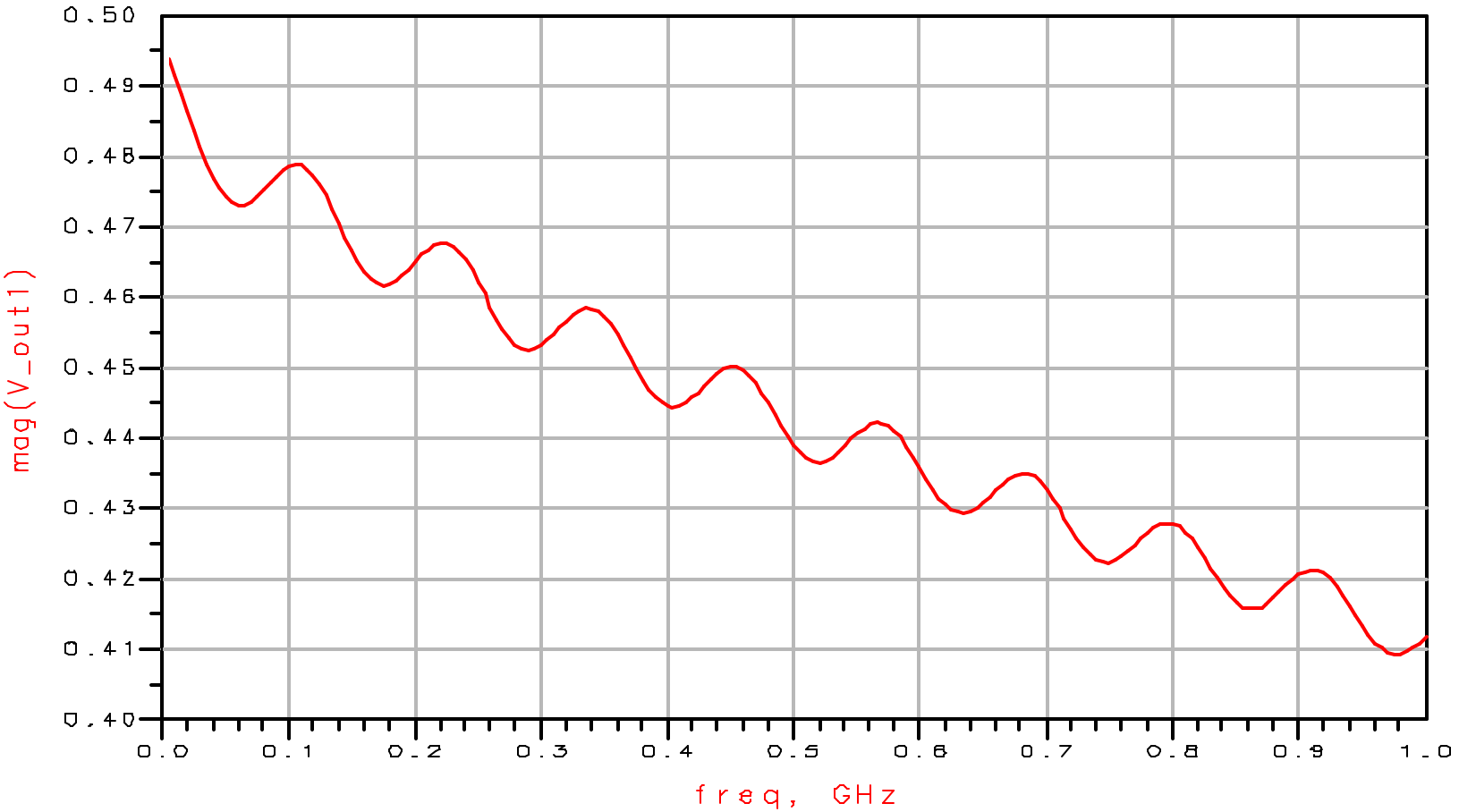
C0			
5.1096E-11			
-2.6955E-11	5.1433E-11		
-8.806E-13	-3.0961E-12	5.1433E-11	
-2.625E-13	-8.806E-13	-2.6955E-11	5.1096E-11

Rs			
0.00041011			
1.5295E-05	0.00041053		
8.1843E-06	9.7782E-06	0.00041053	
6.7196E-06	8.1843E-06	1.5295E-05	0.00041011

R0			
0.3357			
0	0.3357		
0	0	0.3357	
0	0	0	0.3357

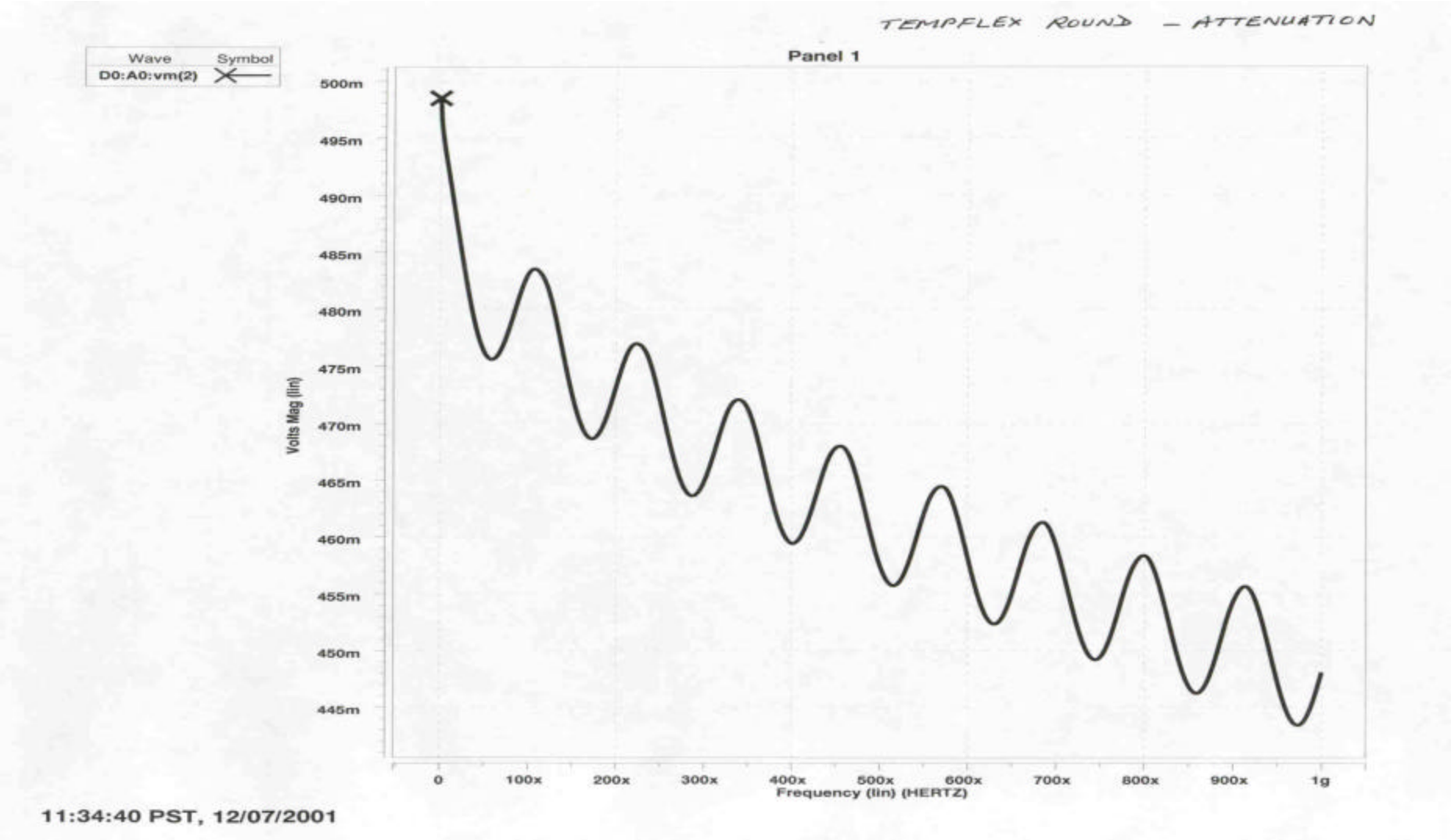
Gd			
1.9398E-15			
-1.0233E-15	1.9526E-15		
-3.3432E-17	-1.1754E-16	1.9526E-15	
-9.9675E-18	-3.3432E-17	-1.0233E-15	1.9398E-15

Round (TempFlex) – Diff. Atten.-HSpice



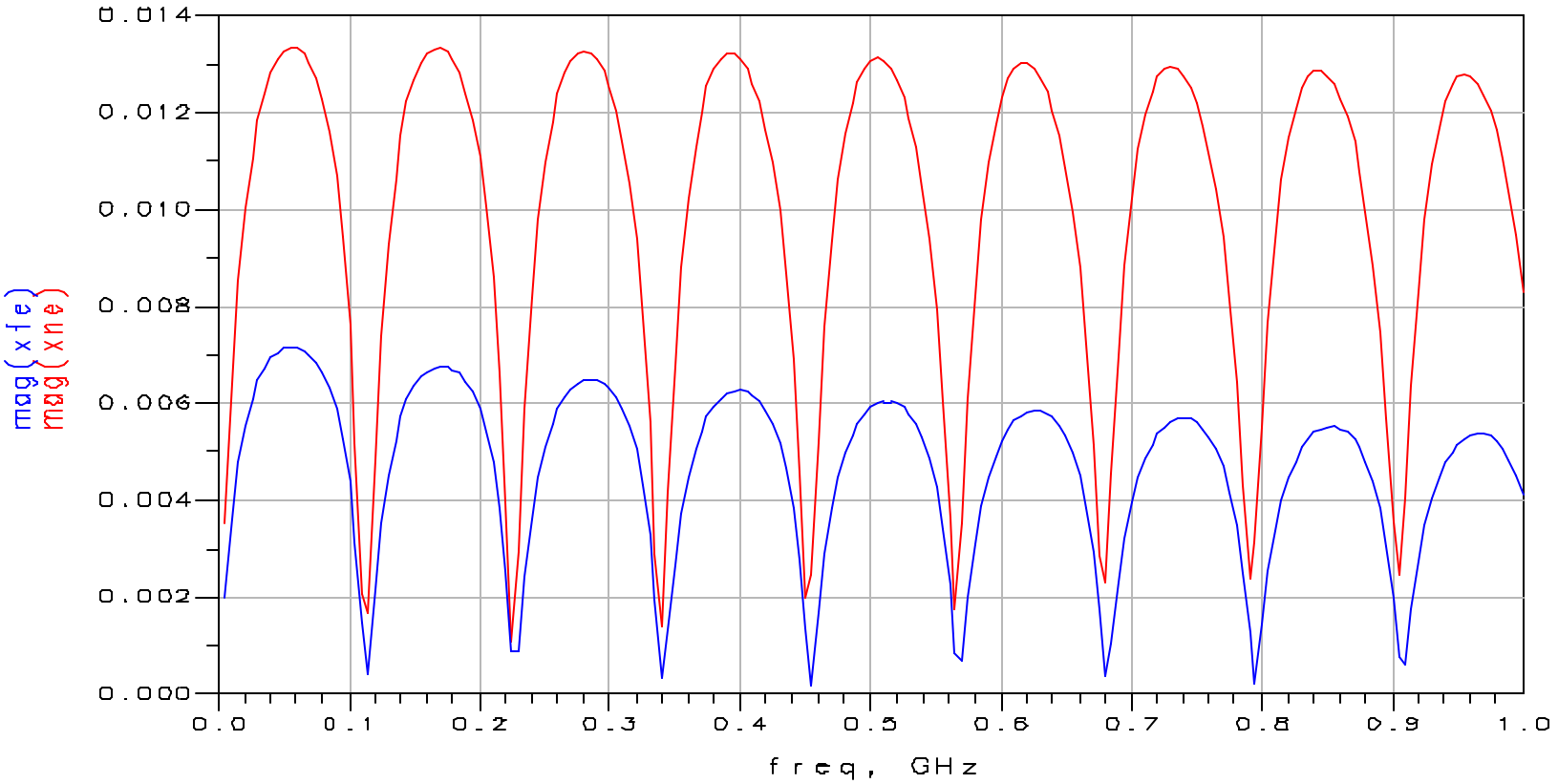
TempFlex round cable, differential attenuation simulation for correlation with HSPICE results

Tempflex Round - Attenuation



Seagate
Information the way you want it

Round (TempFlex) – Xtalk – HSpice



TempFlex round cable, crosstalk simulation for correlation with HSPICE results (near-end in red, far-end in blue)

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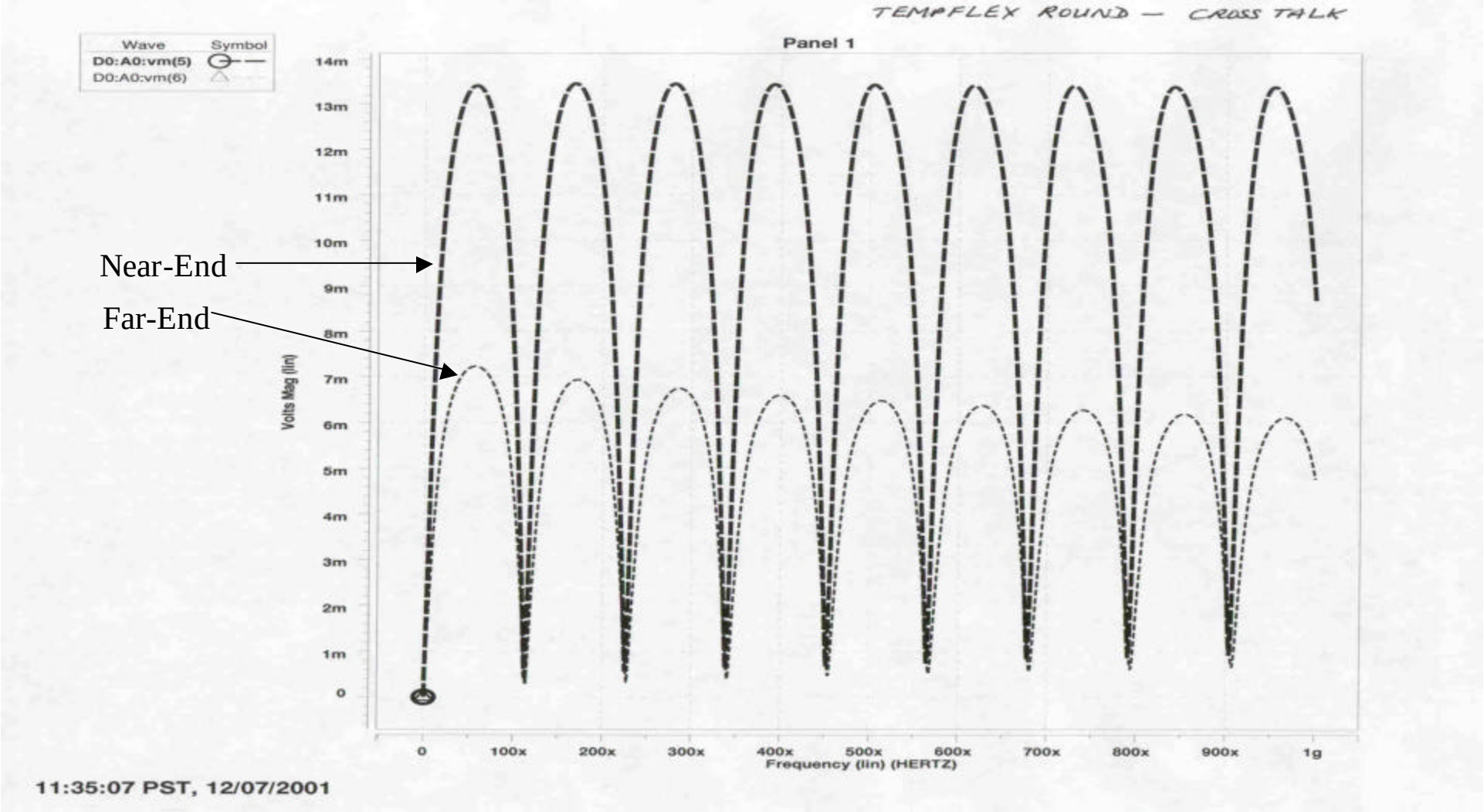
Tempflex Round - Crosstalk



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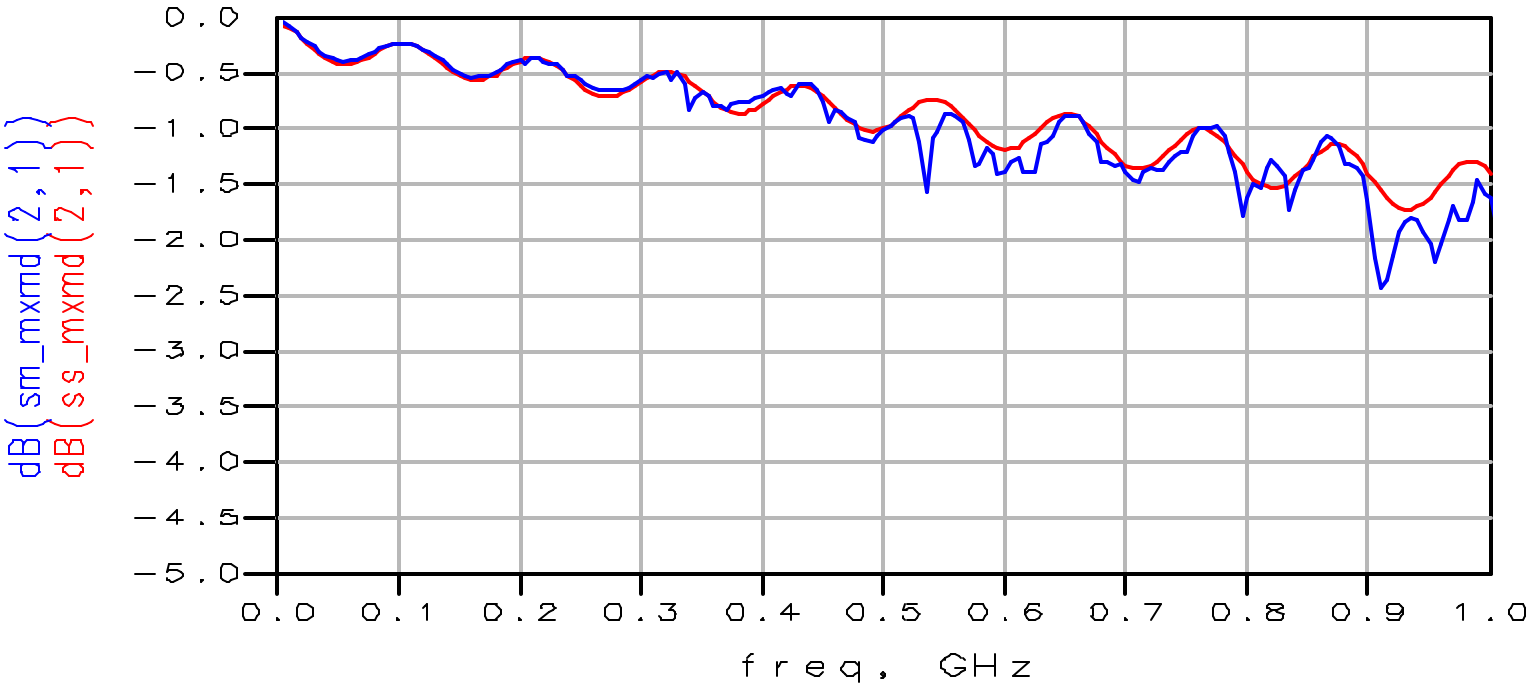
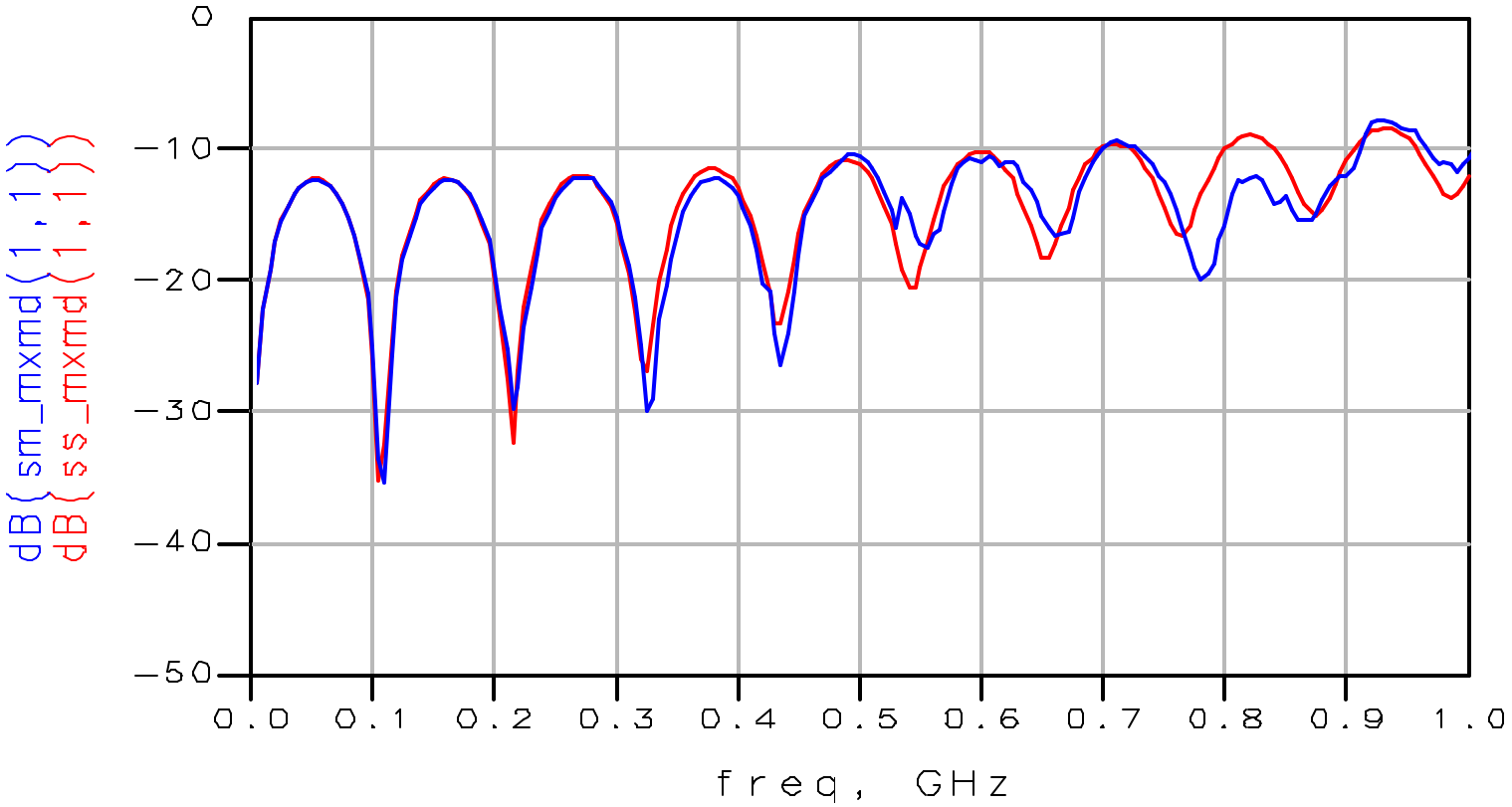
Round (Hitachi) 28 AWG-Diff. Insertion Loss



Hitachi 28 AWG, differential insertion loss, measured (blue) vs. simulated (red)

Round (Hitachi) 28 AWG-Diff. Return Loss



Hitachi 28 AWG, differential return loss, measured (blue) vs. simulated (red)

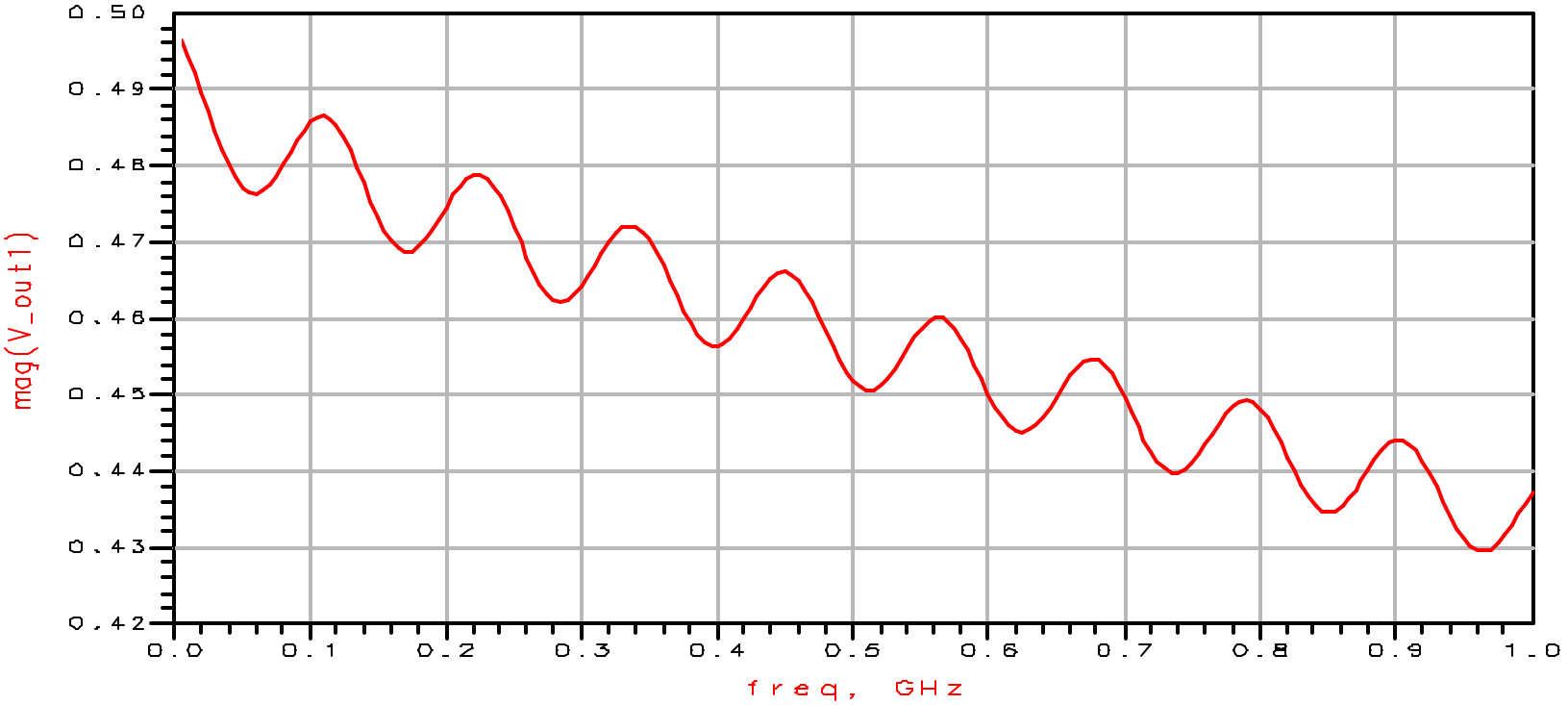
RLCG Model – Hitachi 28 AWG

L0					C0			
5.4124E-07	2.2961E-07	1.6839E-08	9.2424E-09		5.3879E-11	-2.2838E-11	-3.5591E-13	-5.8521E-14
2.2961E-07	5.4116E-07	3.0703E-08	1.6839E-08		-2.2838E-11	5.401E-11	-2.2027E-12	-3.5591E-13
1.6839E-08	3.0703E-08	5.4116E-07	2.2961E-07		-3.5591E-13	-2.2027E-12	5.401E-11	-2.2838E-11
9.2424E-09	1.6839E-08	2.2961E-07	5.4124E-07		-5.8521E-14	-3.5591E-13	-2.2838E-11	5.3879E-11
R0					G0			
0.120858	0	0	0		0	0	0	0
0	0.120858	0	0		0	0	0	0
0	0	0.120858	0		0	0	0	0
0	0	0	0.120858		0	0	0	0
Rs					Gd			
0.00024789	1.419E-05	4.033E-06	2.6259E-06		1.7046E-15	-7.2255E-16	-1.126E-17	-1.8515E-18
1.419E-05	0.00024803	5.9919E-06	4.033E-06		-7.2255E-16	1.7087E-15	-6.9686E-17	-1.126E-17
4.033E-06	5.9919E-06	0.00024803	1.419E-05		-1.126E-17	-6.9686E-17	1.7087E-15	-7.2255E-16
2.6259E-06	4.033E-06	1.419E-05	0.00024789		-1.8515E-18	-1.126E-17	-7.2255E-16	1.7046E-15

Spice Deck

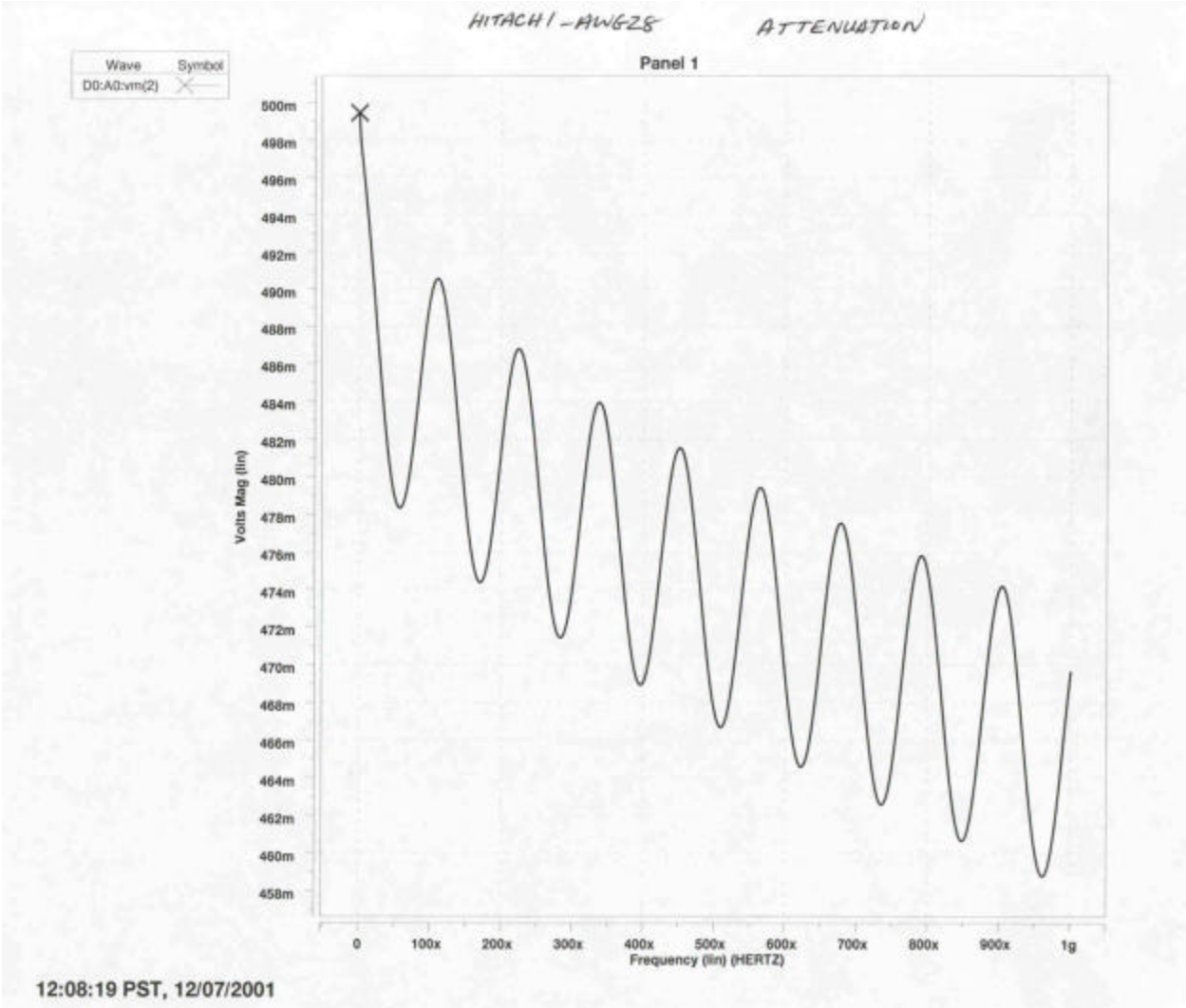
- Add the H-Spice Deck HERE

Round (Hitachi) -Diff. Insertion Loss-HSpice

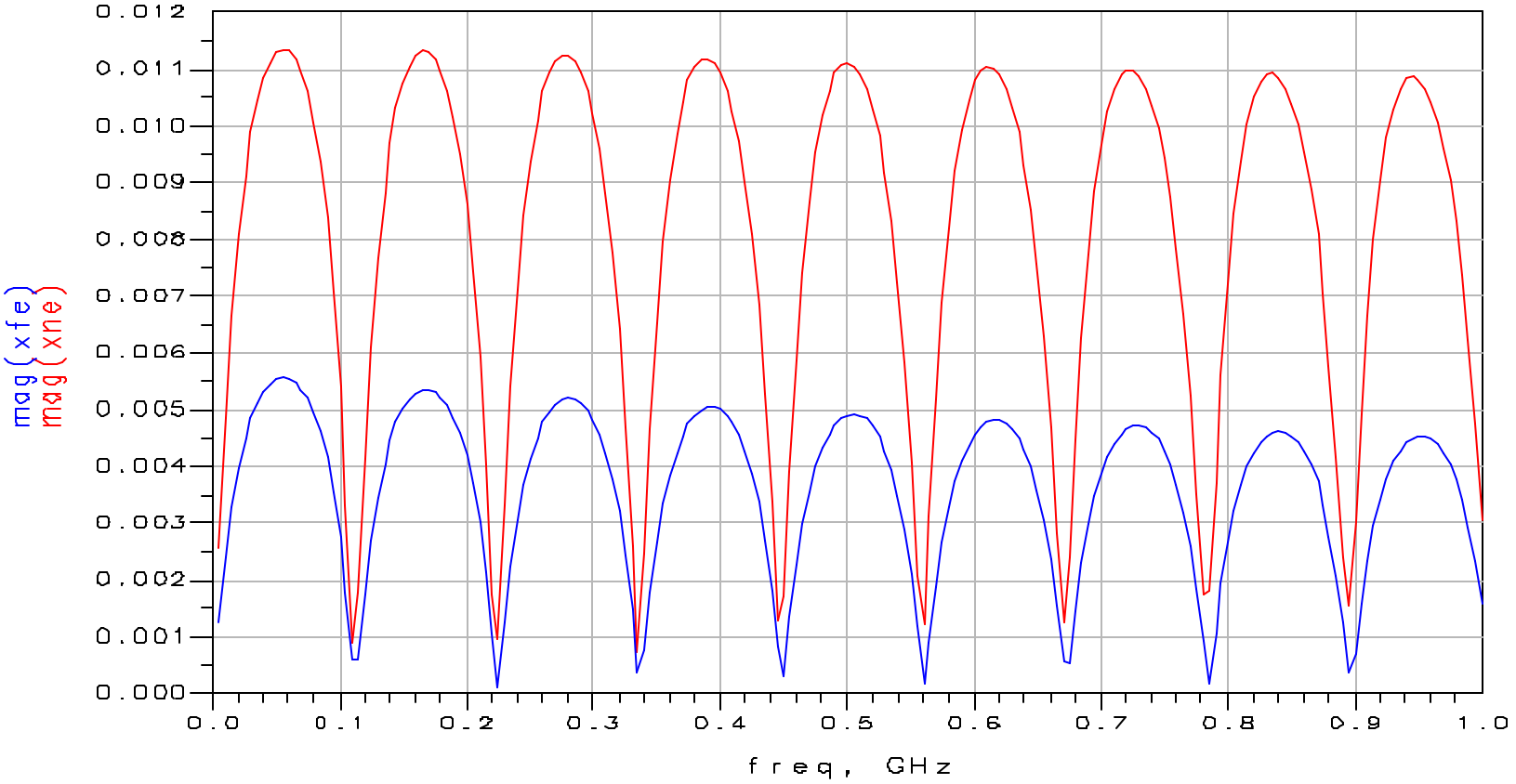


Hitachi 28 AWG, differential attenuation simulation for correlation with HSPICE results

Round (Hitachi) 28AWG - Attenuation

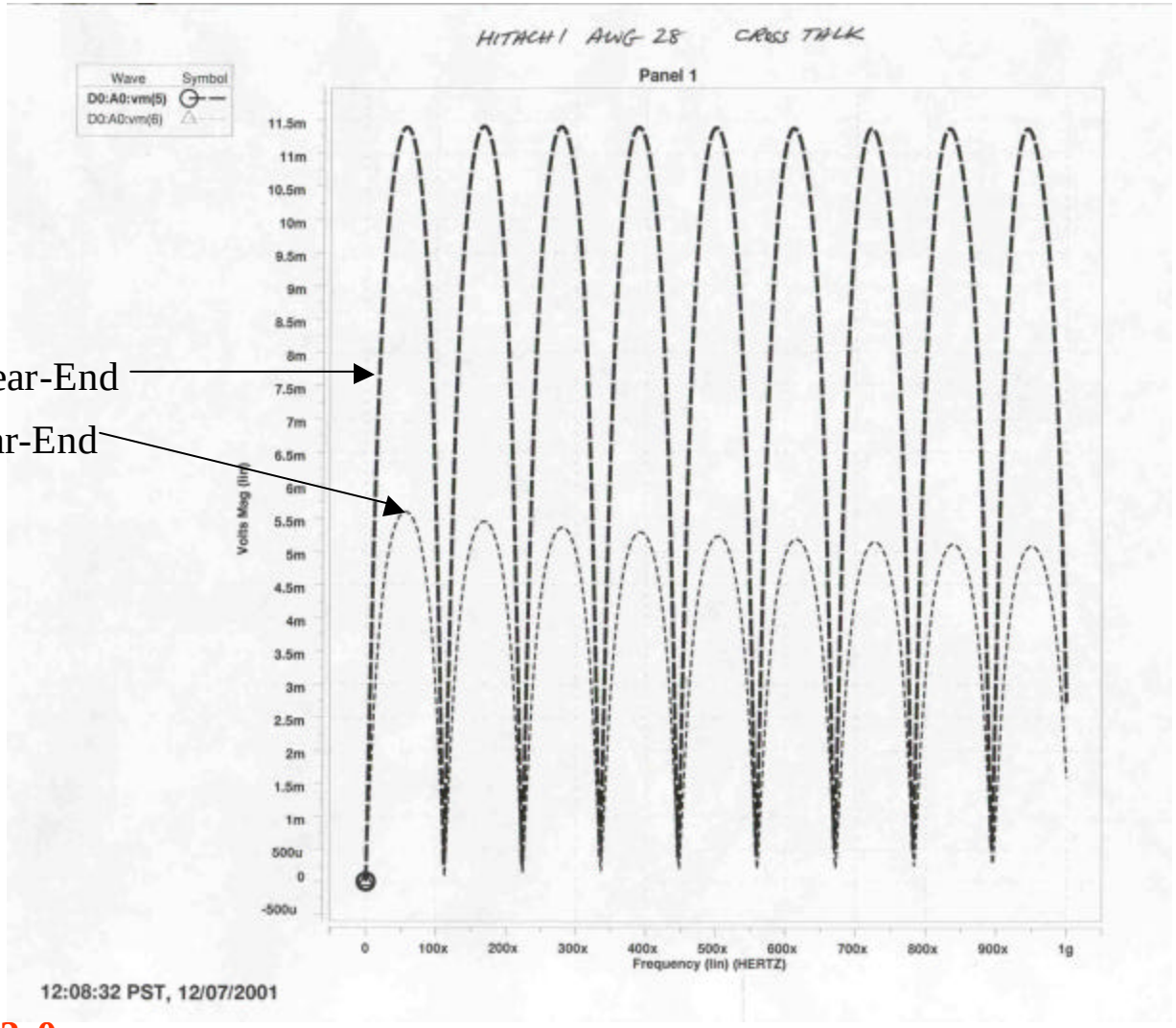


Round (Hitachi) – Xtalk – HSpice



Hitachi 28 AWG, crosstalk simulation for correlation with HSPICE results (near-end in red, far-end in blue)

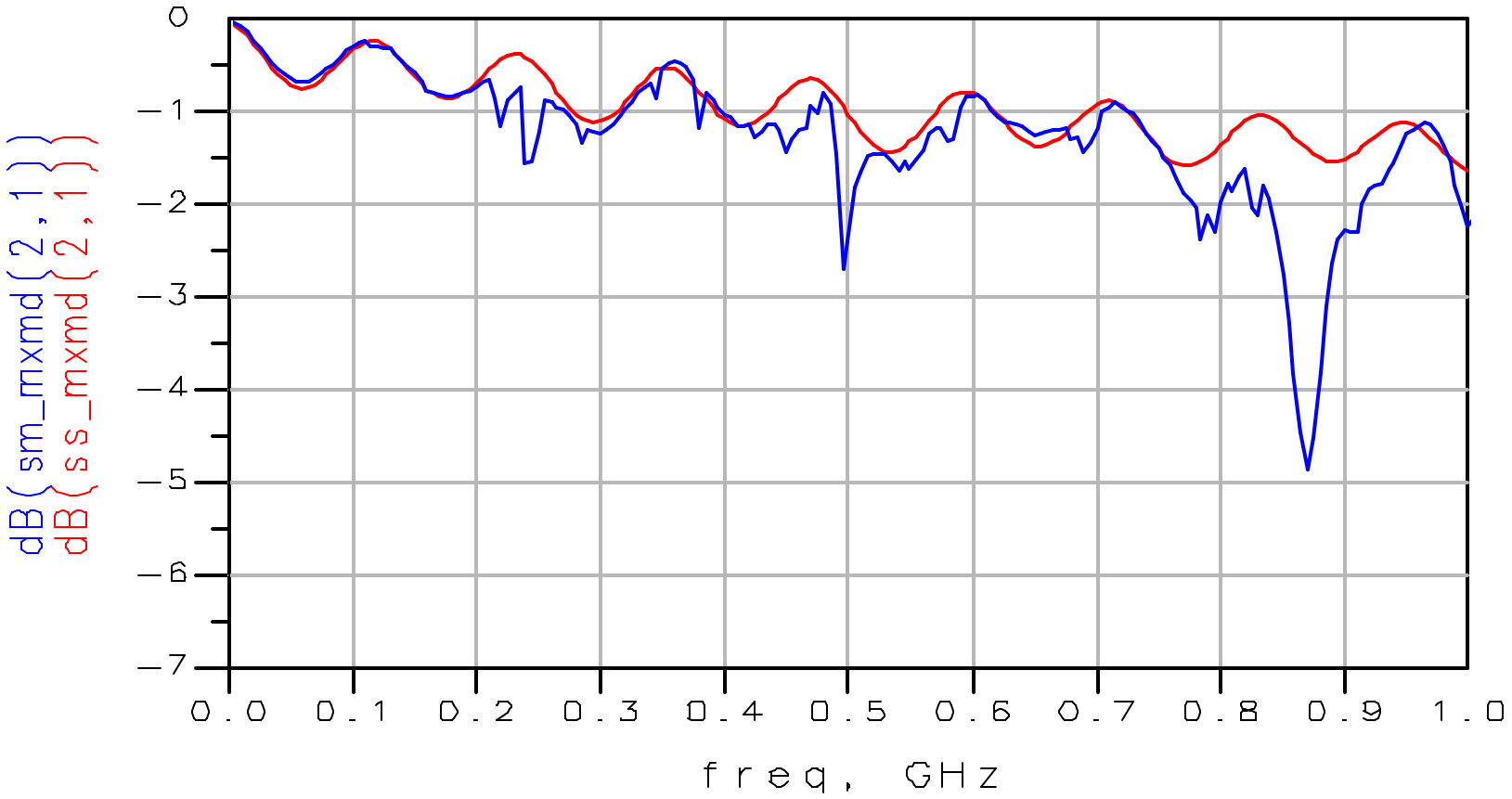
Round (Hitachi) 28AWG - Crosstalk



Near-End

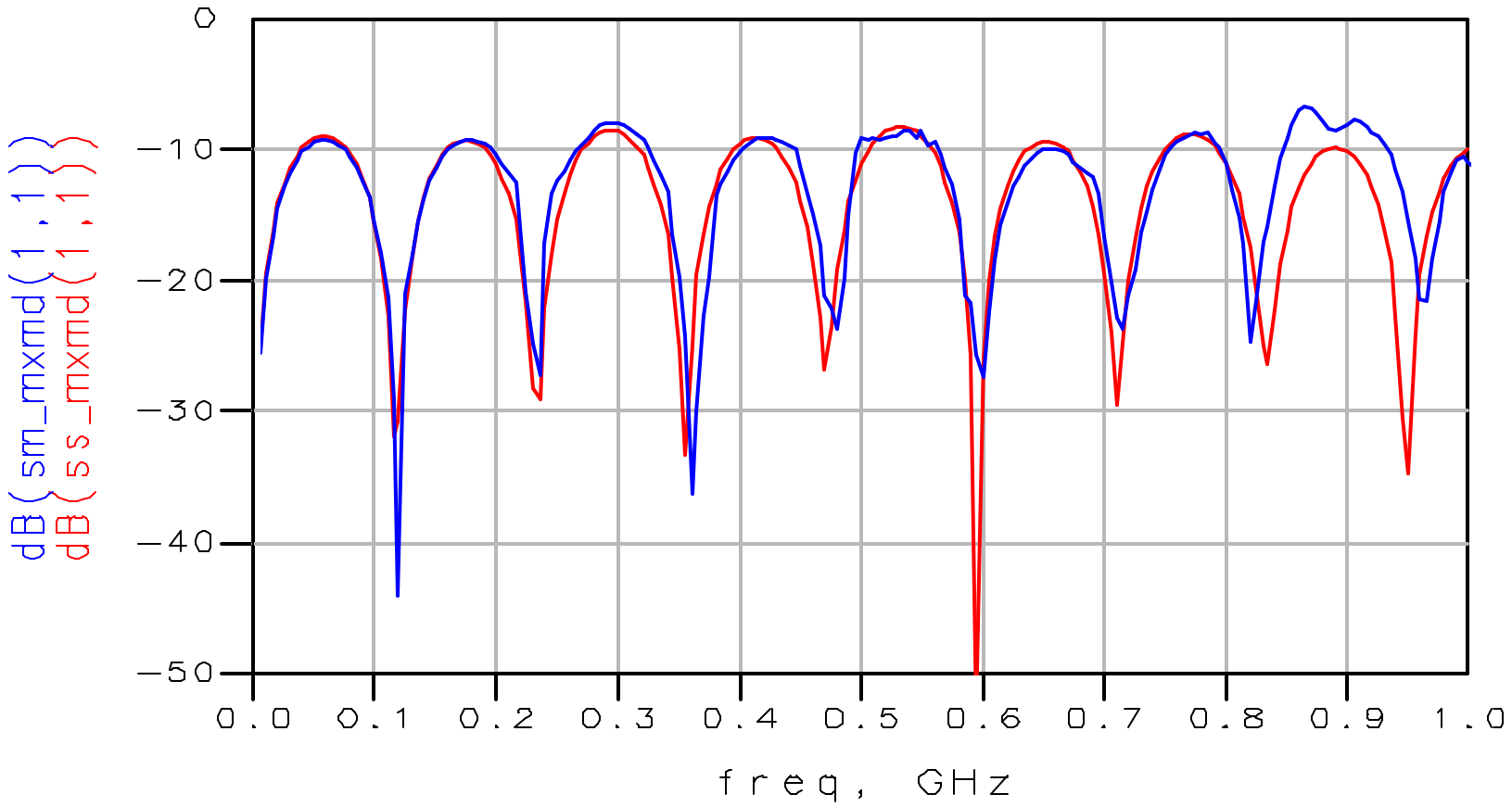
Far-End

T'n'F (16") Spectra – Diff. Insert. Loss



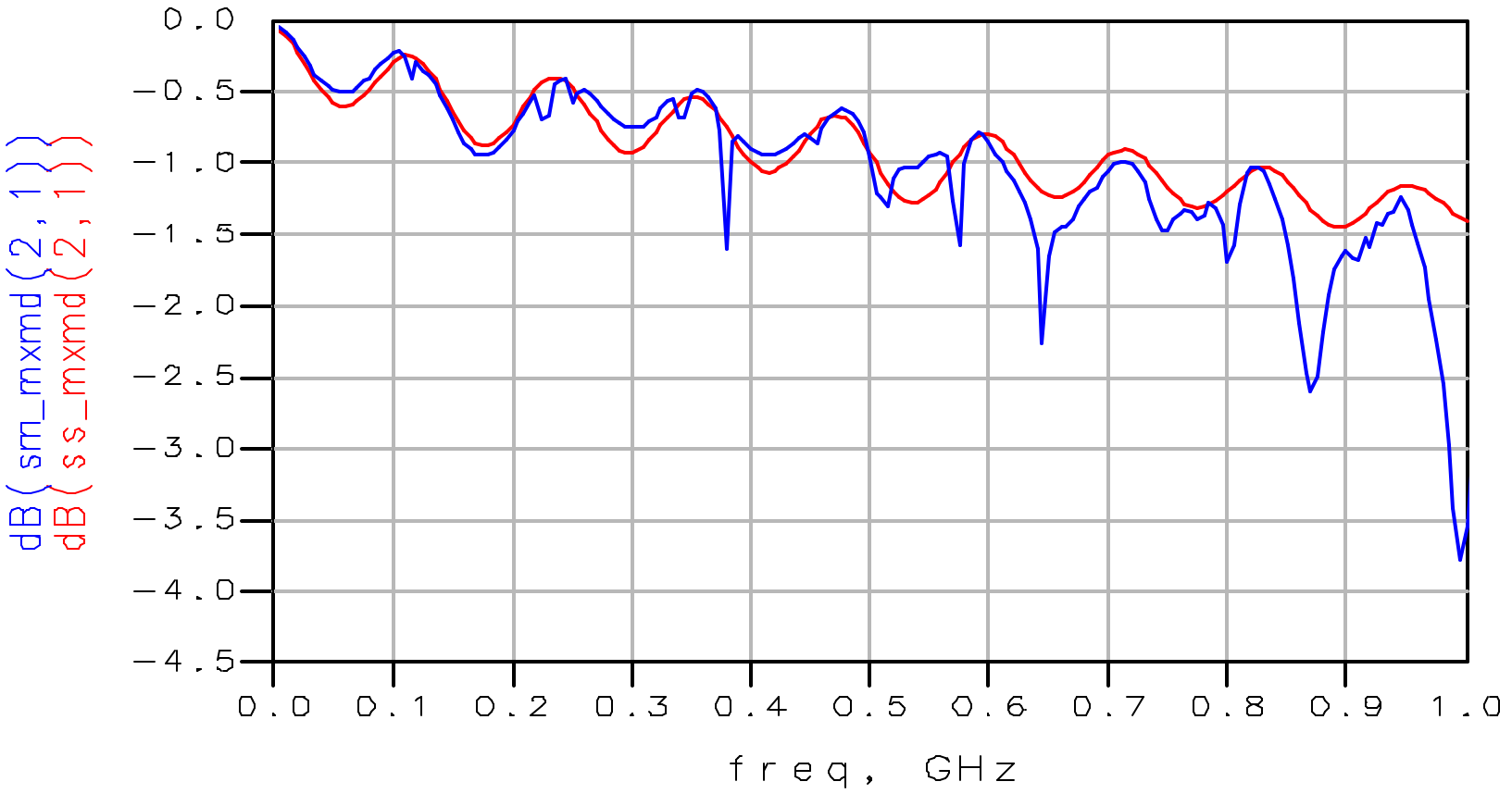
Amphenol ribbon cable (16" pitch), differential return loss, measured (blue) vs. simulated (red)

T'n'F (16") Spectra – Diff. Return Loss



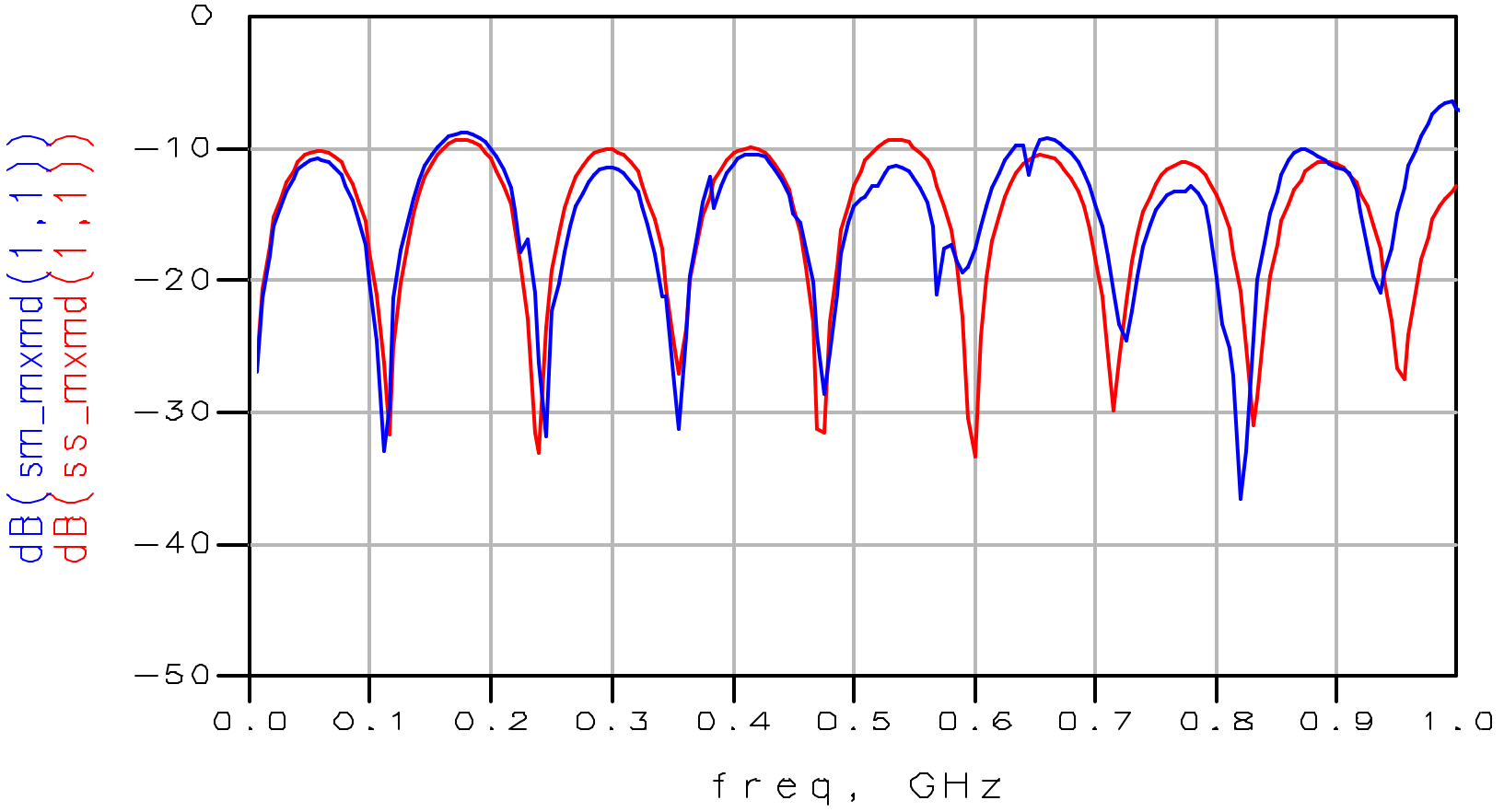
Amphenol ribbon cable (16" pitch), differential return loss, measured (blue) vs. simulated (red)

T'n'F (45") Spectra – Diff. Insert. Loss



Amphenol ribbon cable (45" pitch), differential insertion loss, measured (blue) vs. simulated (red)

T'n'F (45") Spectra – Diff. Return Loss



Amphenol ribbon cable (45" pitch), differential return loss, measured (blue) vs. simulated (red)

T'n'F Straight Section – RLGC Model

C0			
4.4764E-11	-1.5391E-11	-1.7147E-12	-3.5965E-13
-1.5391E-11	5.1786E-11	-1.6923E-11	-1.7147E-12
-1.7147E-12	-1.6923E-11	5.1786E-11	-1.5391E-11
-3.5965E-13	-1.7147E-12	-1.5391E-11	4.4764E-11

L0			
5.4257E-07	1.9356E-07	9.4363E-08	4.42E-08
1.9356E-07	5.3734E-07	2.1005E-07	9.44E-08
9.4363E-08	2.1005E-07	5.3734E-07	1.94E-07
4.4219E-08	9.4363E-08	1.9356E-07	5.43E-07

R0			
0.120858	0	0	0
0	0.120858	0	0
0	0	0.120858	0
0	0	0	0.120858

G0			
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

Rs			
0.00024523	1.3597E-05	1.0766E-05	7.3712E-06
1.3597E-05	0.00025628	1.3791E-05	1.0766E-05
1.0766E-05	1.3791E-05	0.00025628	1.3597E-05
7.3712E-06	1.0766E-05	1.3597E-05	0.00024523

Gd			
1.6994E-15	-5.8434E-16	-6.5098E-17	-1.4E-17
-5.8434E-16	1.966E-15	-6.425E-16	-6.5E-17
-6.5098E-17	-6.425E-16	1.966E-15	-5.8E-16
-1.3654E-17	-6.5098E-17	-5.8434E-16	1.7E-15

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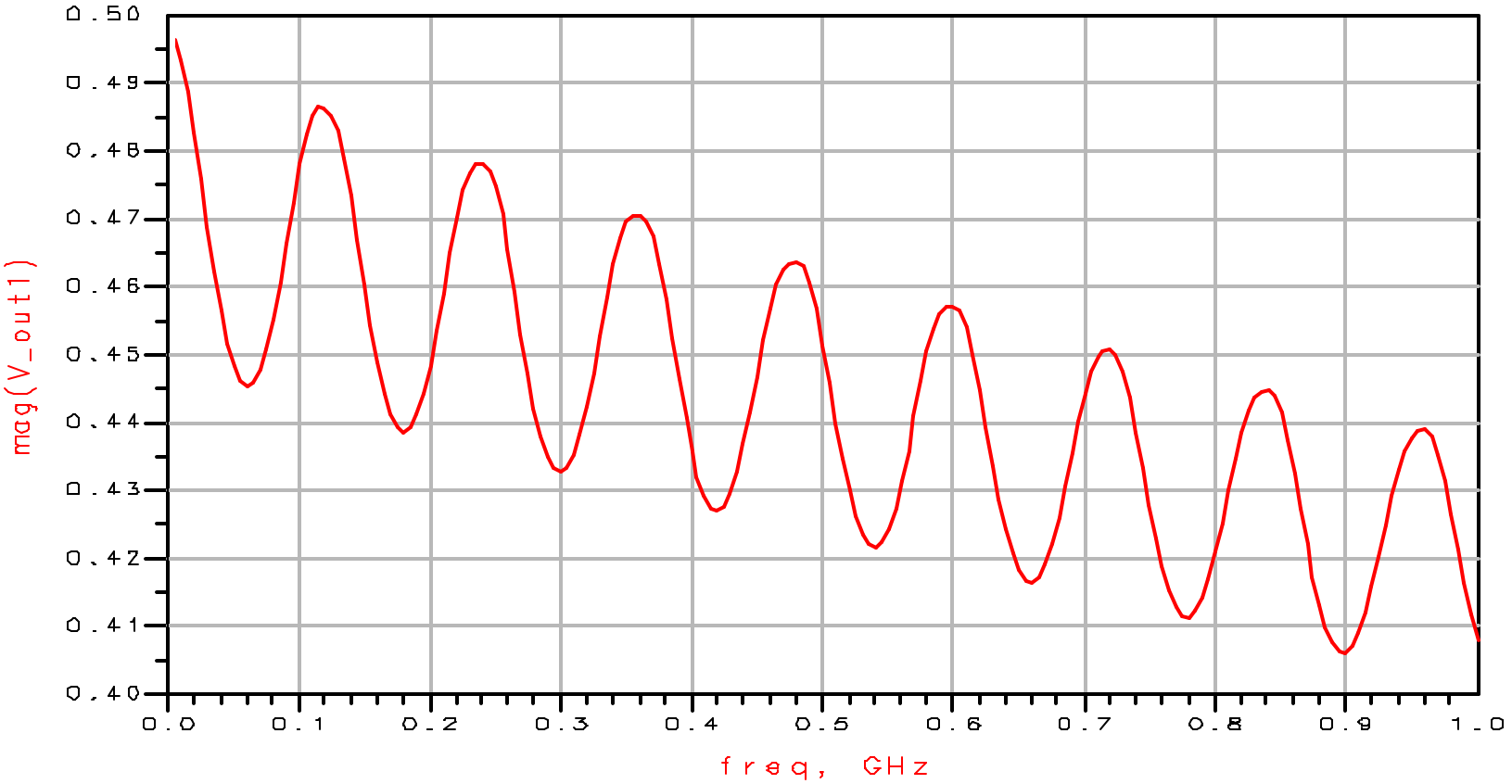
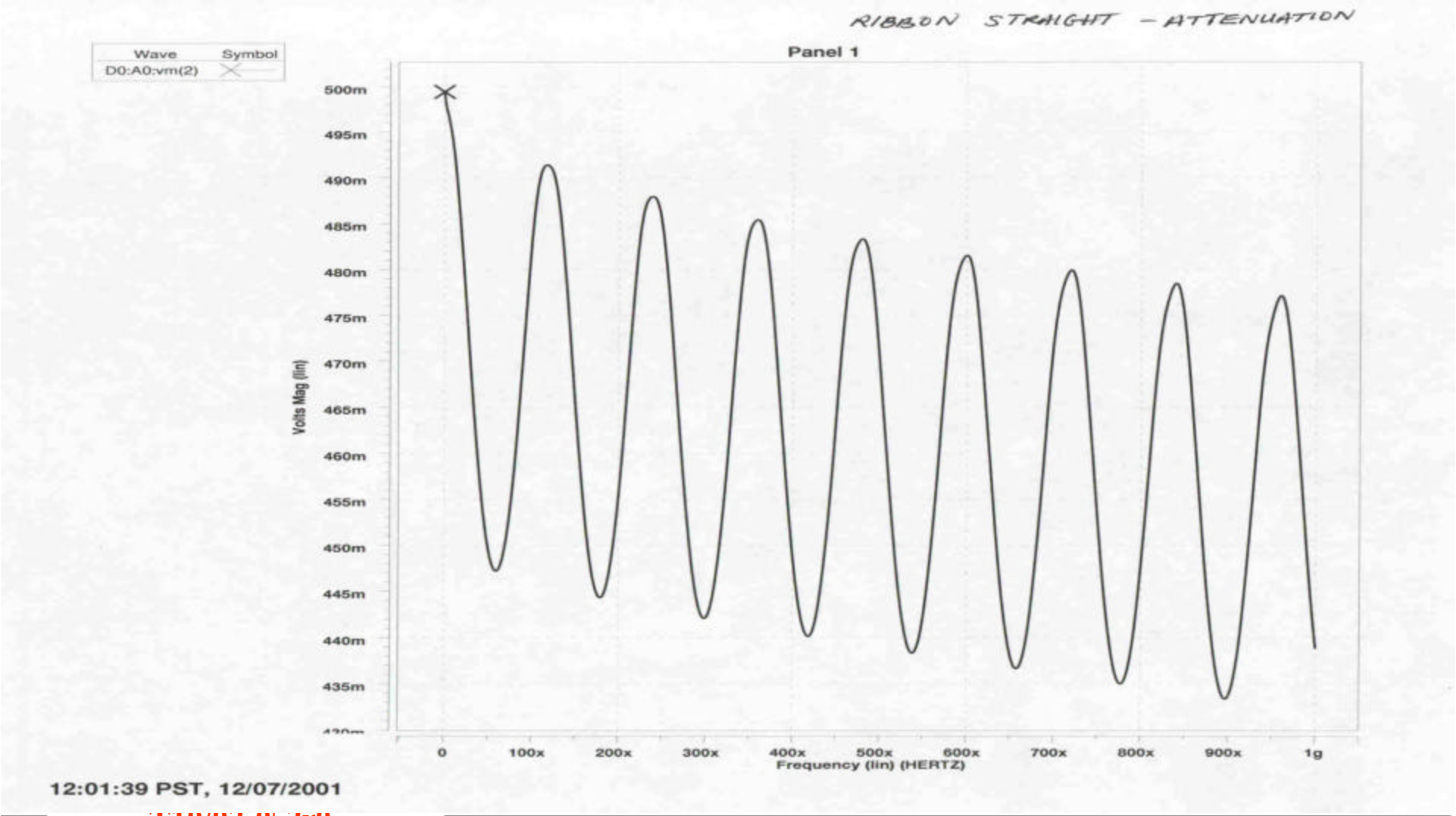
T'n'F Flat (Straight) Section – Loss



Amphenol straight-section of ribbon cable, differential attenuation simulation for correlation with HSPICE results

Ribbon Attenuation – Straight Section



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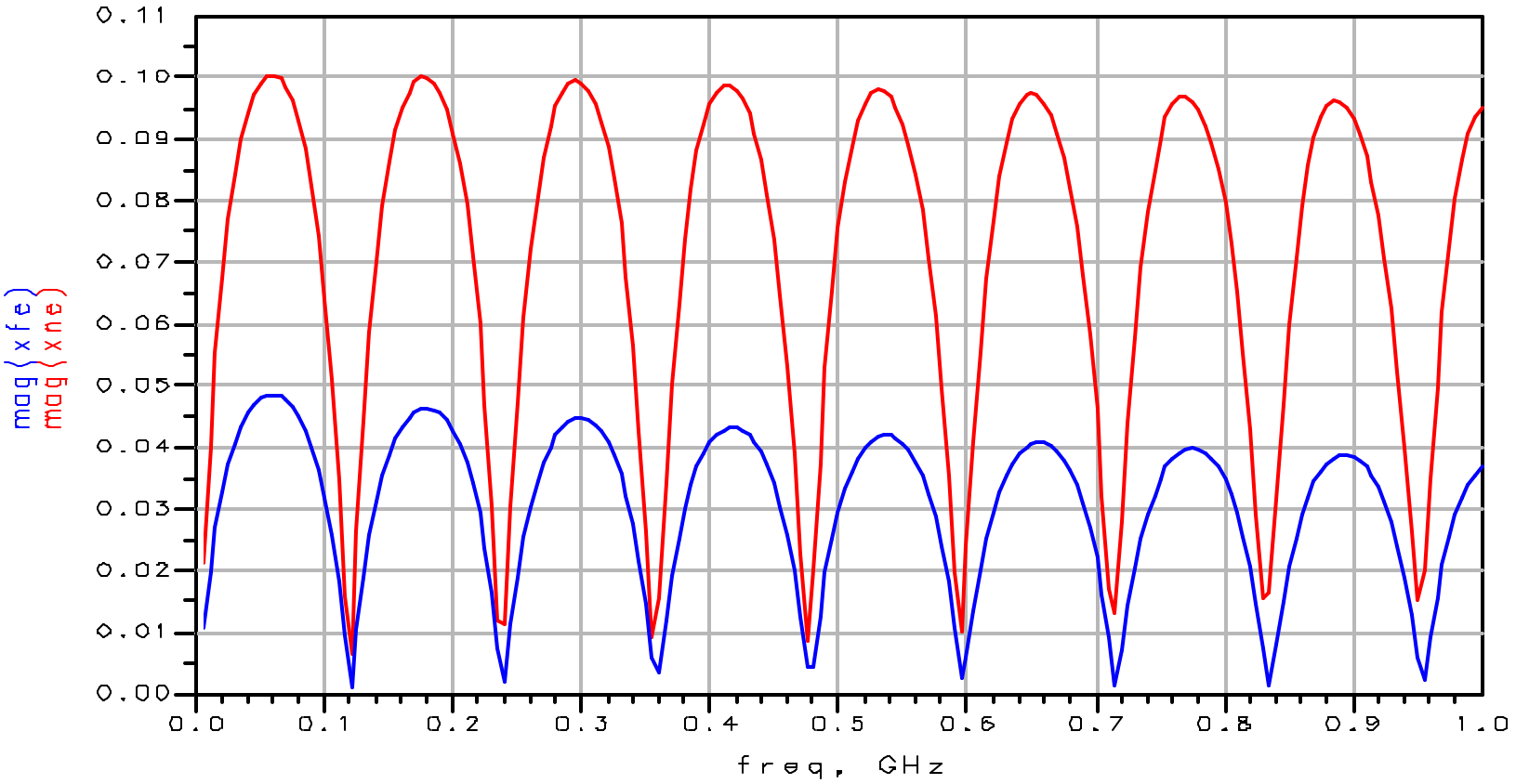
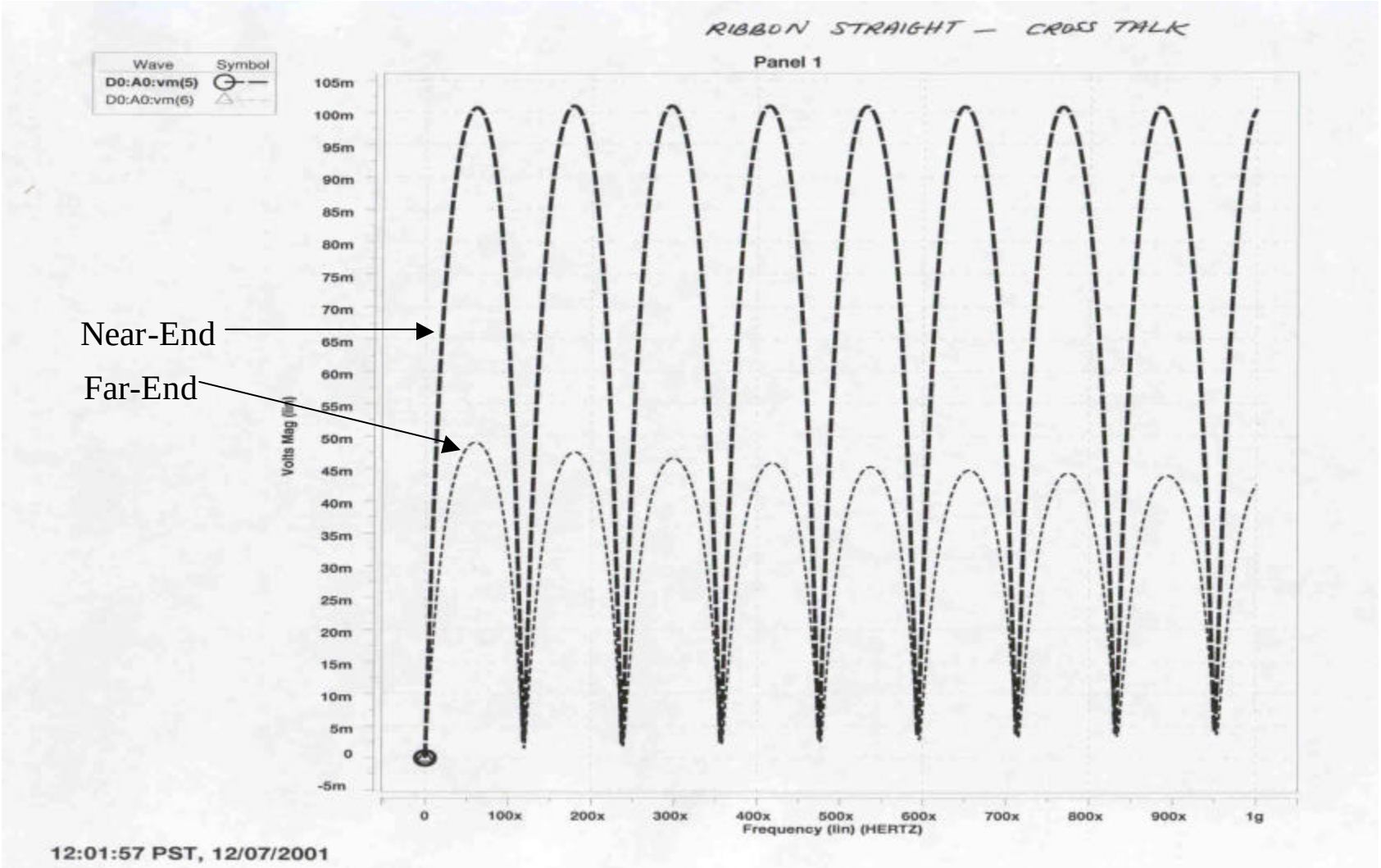
T'n'F Flat (Straight) Section – XTalk



Amphenol straight-section of ribbon cable, crosstalk simulation for correlation with HSPICE results (near-end in red, far-end in blue)

Ribbon Crosstalk – Straight Section



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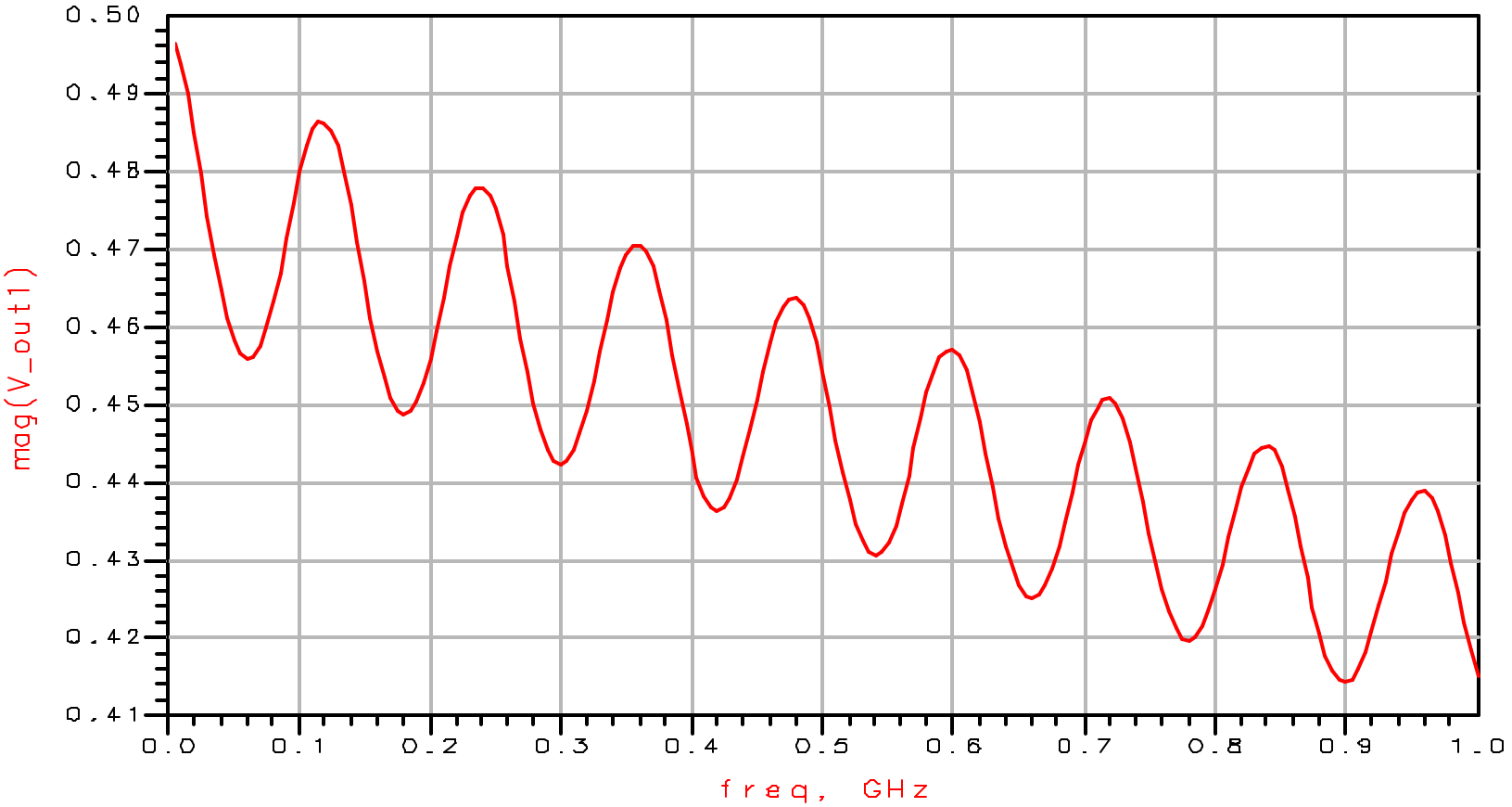
Seagate
Information the way you want it

RLGC Model – T'n'F Twisted Section

C0			
4.5854E-11	-1.7322E-11	-1.3599E-12	-2.555E-13
-1.7322E-11	4.8991E-11	-1.0698E-11	-1.3599E-12
-1.3599E-12	-1.0698E-11	4.8991E-11	-1.7322E-11
-2.555E-13	-1.3599E-12	-1.7322E-11	4.5854E-11
R0			
0.120858	0	0	0
0	0.120858	0	0
0	0	0.120858	0
0	0	0	0.120858
Rs			
0.0002461	1.3844E-05	9.6557E-06	6.6616E-06
1.3844E-05	0.00025069	1.2705E-05	9.6557E-06
9.6557E-06	1.2705E-05	0.00025069	1.3844E-05
6.6616E-06	9.6557E-06	1.3844E-05	0.0002461

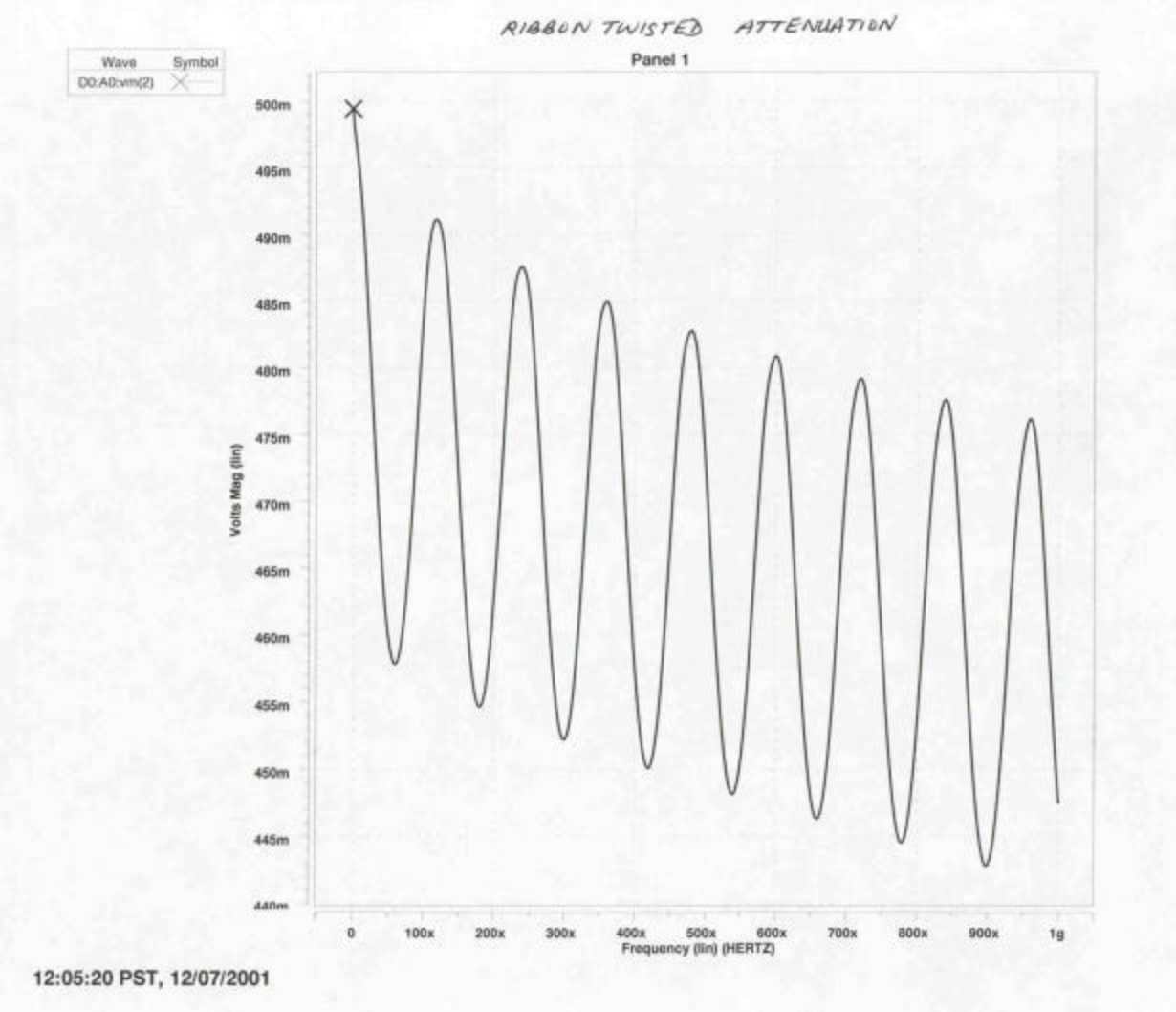
L0			
5.421E-07	2.0881E-07	7.3755E-08	3.7077E-08
2.0881E-07	5.399E-07	1.4977E-07	7.3755E-08
7.3755E-08	1.4977E-07	5.399E-07	2.0881E-07
3.7077E-08	7.3755E-08	2.0881E-07	5.421E-07
G0			
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
Gd			
1.7408E-15	-6.5764E-16	-5.163E-17	-9.6999E-18
-6.5764E-16	1.8599E-15	-4.0615E-16	-5.163E-17
-5.163E-17	-4.0615E-16	1.8599E-15	-6.5764E-16
-9.6999E-18	-5.163E-17	-6.5764E-16	1.7408E-15

T'n'F Twisted Section – Loss

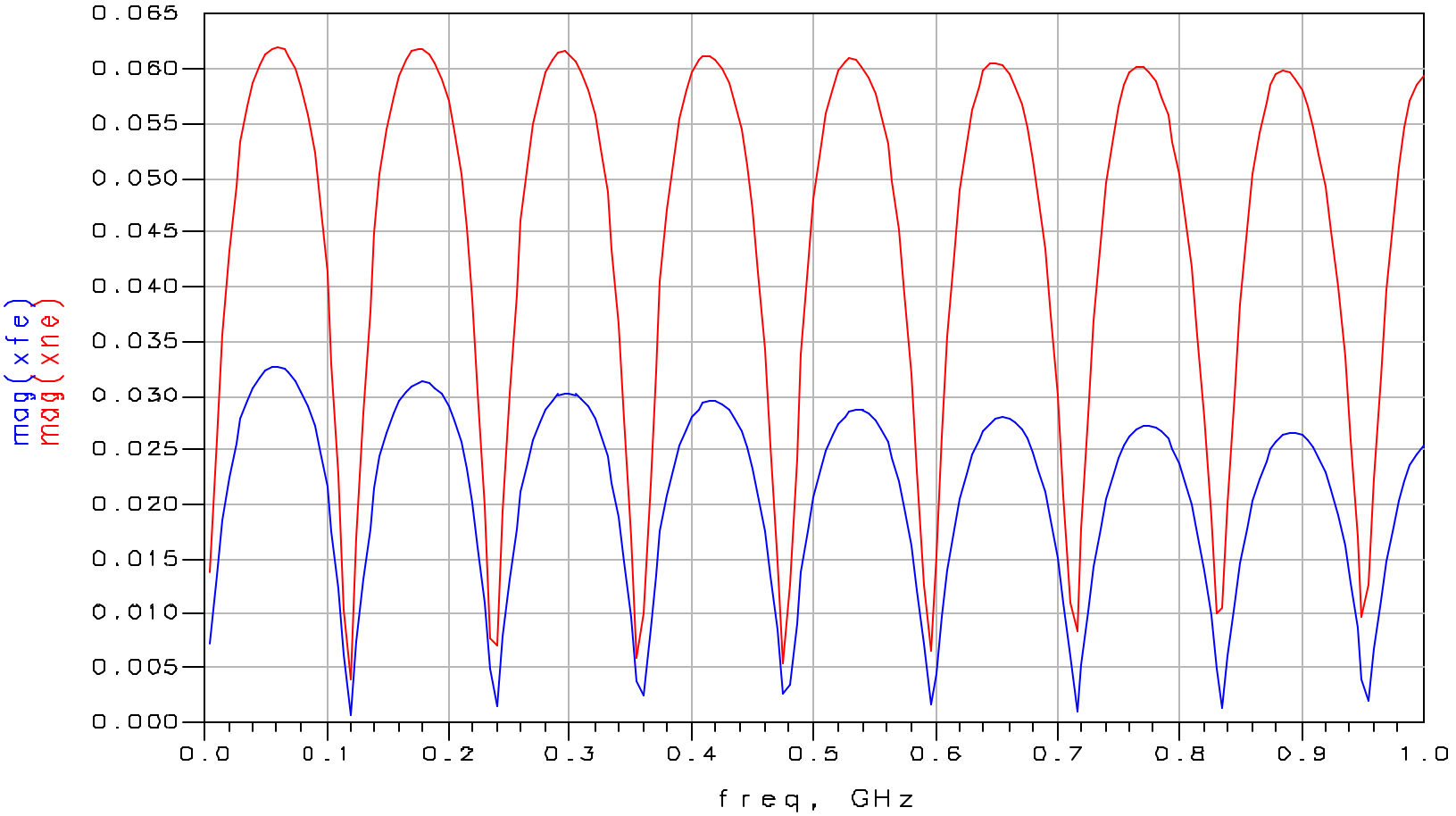


Amphenol twisted-section of ribbon cable, differential attenuation simulation for correlation with HSPICE results

Ribbon Attenuation – Twisted Section

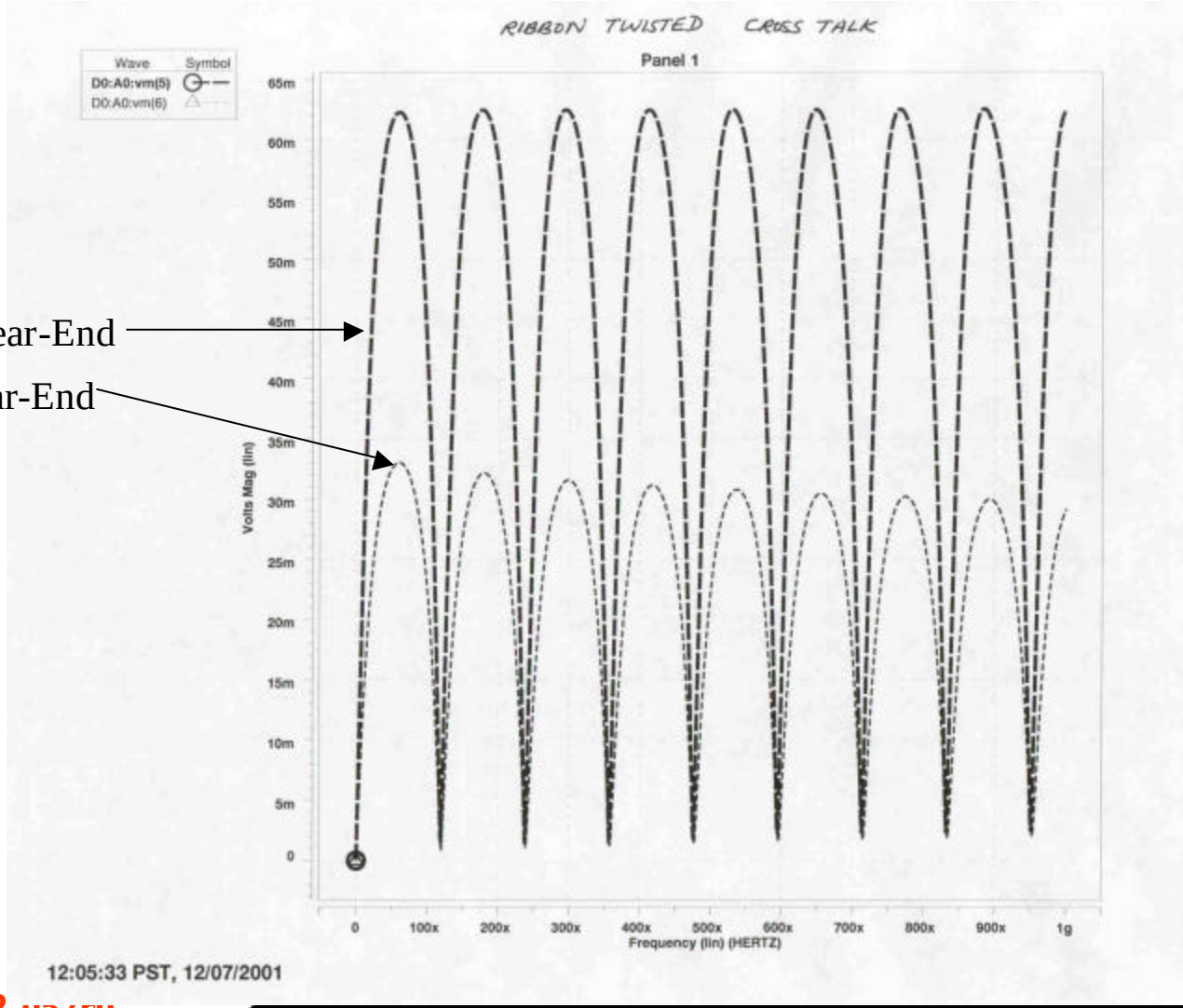


T'n'F Twisted Section – XTalk



Amphenol twisted-section of ribbon cable, crosstalk simulation for correlation with HSPICE results (near-end in red, far-end in blue)

Ribbon Crosstalk – Twisted Section



Summary of what was heard

- Model is simplified version of actual DUT (sample)
  - Dramatically reduces the amount of data required
  - Reduces the amount of time for simulation(s)
  - Can be used for lengths different than the test sample
- The model generated creates a baseline against which a difference function can be calculated
  - The difference function can be evaluated to determine if it is caused by noise or by features of the sample not included in the model
- Ability to project in other configurations (needs to be proven)

What's next

- Measure and model 3-4 more cables
- Predict using model and verify using measurement
- Model Assy. – JPM cable with connector pair
  - Measure bulk cable piece, install connector pair in the middle, re-measure
  - Generate connector pair and fan-out model as difference
- Make preliminary model of 2 backplanes and verify predictability