In Regards to Package Representation Comment Resolution

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Background

- The Package insertion loss and return loss are represented in 802.3bj Rev 2.0 by a polynomial logarithmic approximation.

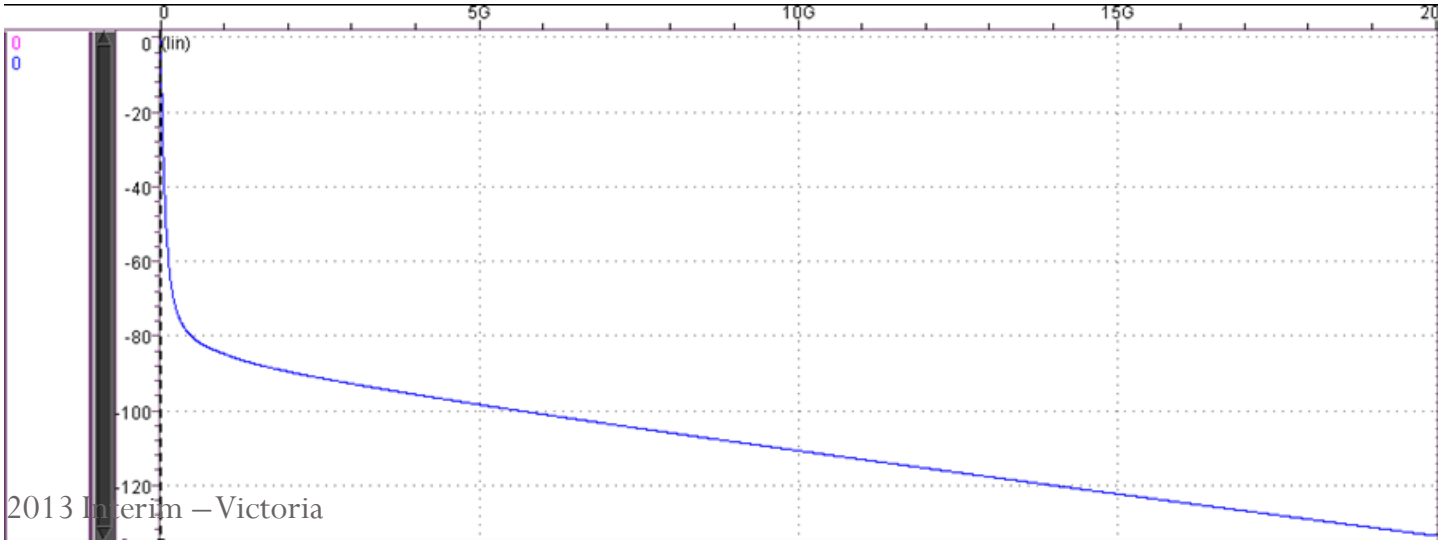
$$S_{11} = S_{22} = \exp(\rho_0 + \rho_1 * \sqrt{f} + \rho_2 * f + \rho_3 * f^2)$$

$$S_{21} = S_{12} = \exp(\gamma_0 + \gamma_1 * \sqrt{f} + \gamma_2 * f + \gamma_3 * f^2)$$

- Rho0 and Gamma0, each has an imaginary part which is not physical. The imaginary part was a result of the approximation process.
- Simply removing the imaginary part of the DC coefficient can work only in the case of a very small imaginary part (that can be neglected).

Why Does the Approximation Model Fail?

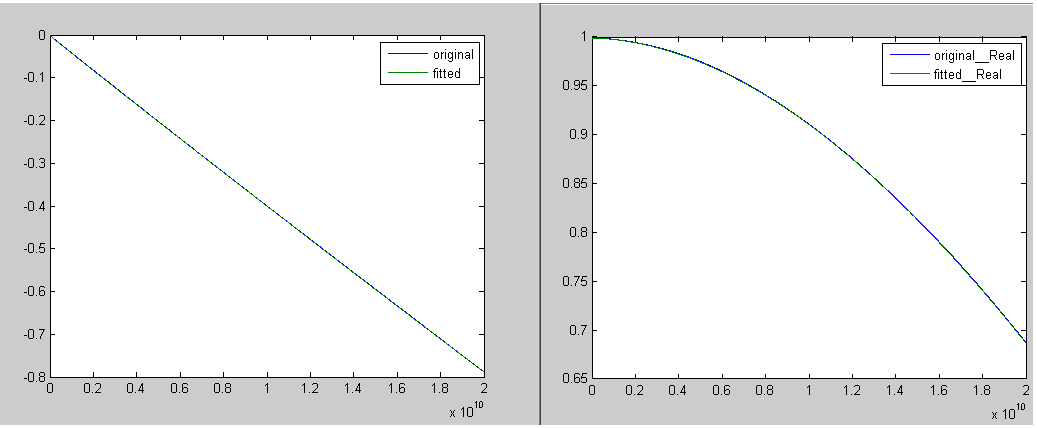
- Looking at an extracted return loss phase at low frequency there is high value transition from zero @ DC to ~90 degrees @1GHz.
- Fitting this behavior requires additional terms to account for this frequency range, or else the current DC value will shift from its right value.



One Possible Correction

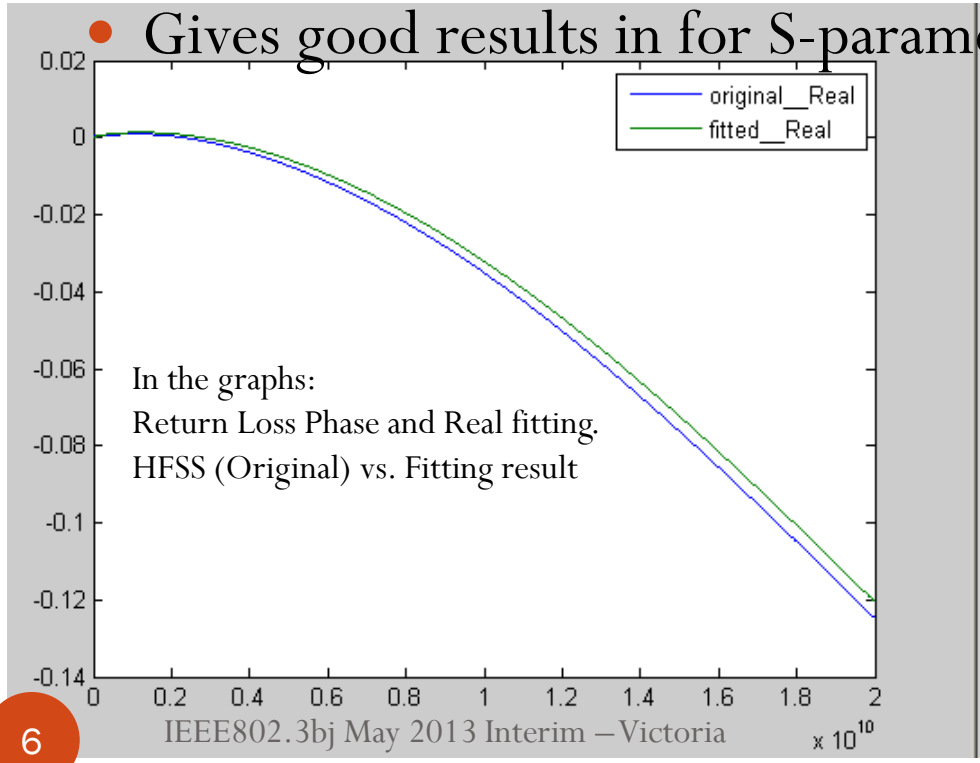
- The following suggested approximation equation represents the low frequency with adequate accuracy and results with a negligible imaginary value of the DC term.
- $S_{11} = S_{22} = \exp(\rho_0 + \rho_1 * \sqrt[32]{f} + \rho_2 * \sqrt[16]{f} + \rho_3 * \sqrt[8]{f} + \rho_4 * \sqrt[4]{f} + \rho_5 * \sqrt{f} + \rho_6 * f + \rho_7 * f^2)$
  - This requires updating the equation and providing 8 updated coefficients.
- The insertion loss representation has a negligible imaginary part at DC with 4 coefficients (current condition) and therefore needs no equation update.

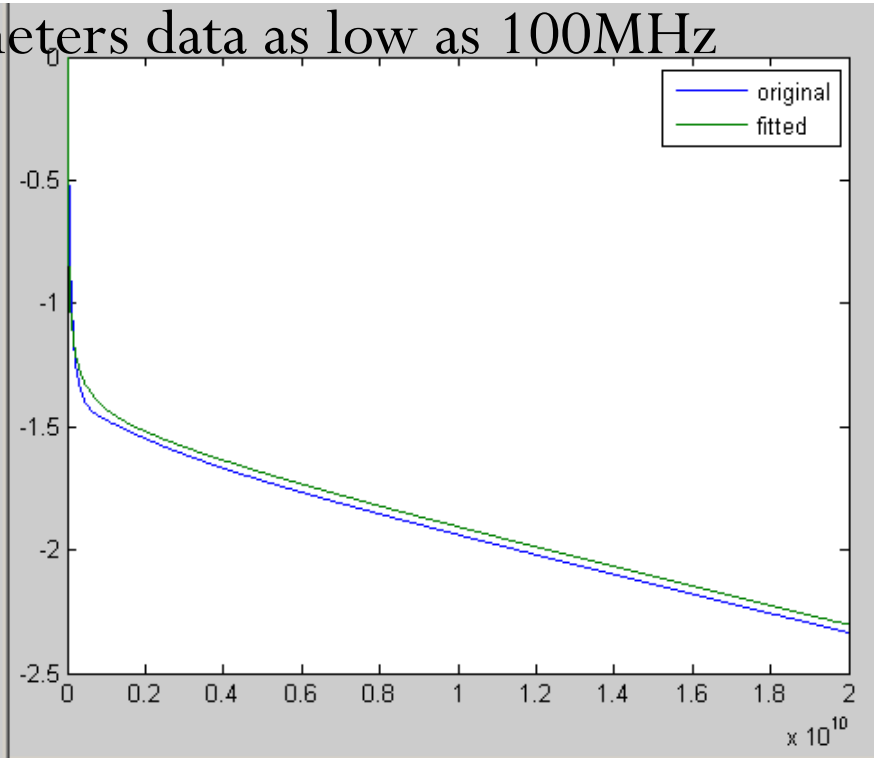
In the graphs:
Insertion Loss Phase and Real fitting.
HFSS (Original) vs. Fitting result



Having 7 Coefficients… What happens by zeroing ρ_0(Imag)

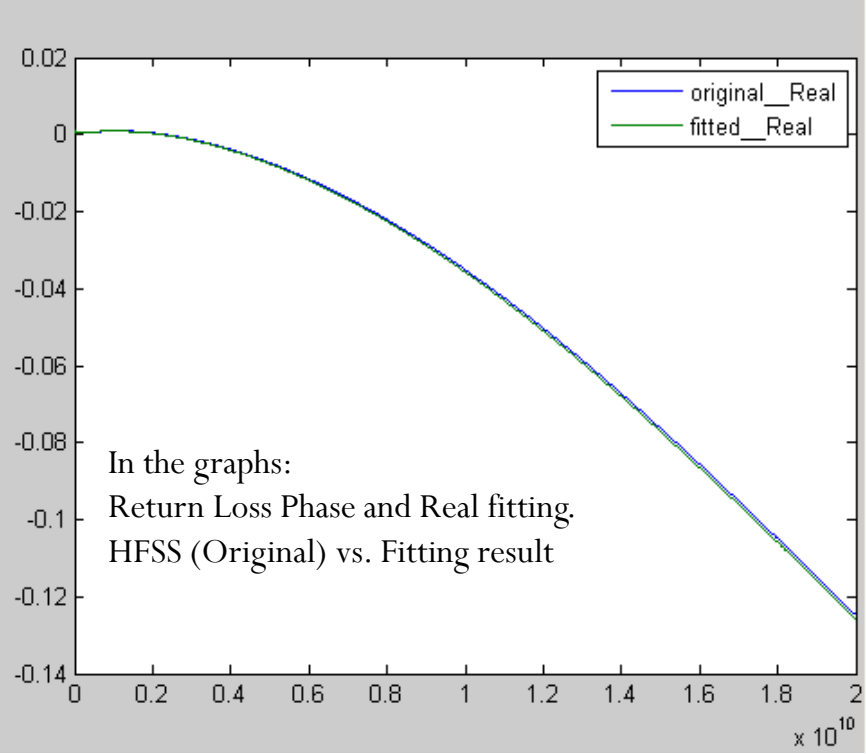
- Real and phase "almost" match the HFSS model , but not quite enough if we want to include very low frequency details…
- $S_{22} = S_{11} = \exp(\rho_0 + \rho_1 * \sqrt[16]{f} + \rho_2 * \sqrt[8]{f} + \rho_3 * \sqrt[4]{f} + \rho_4 * \sqrt{f} + \rho_5 * f + \rho_6 * f^2)$
- Gives good results in for S-parameters data as low as 100MHz

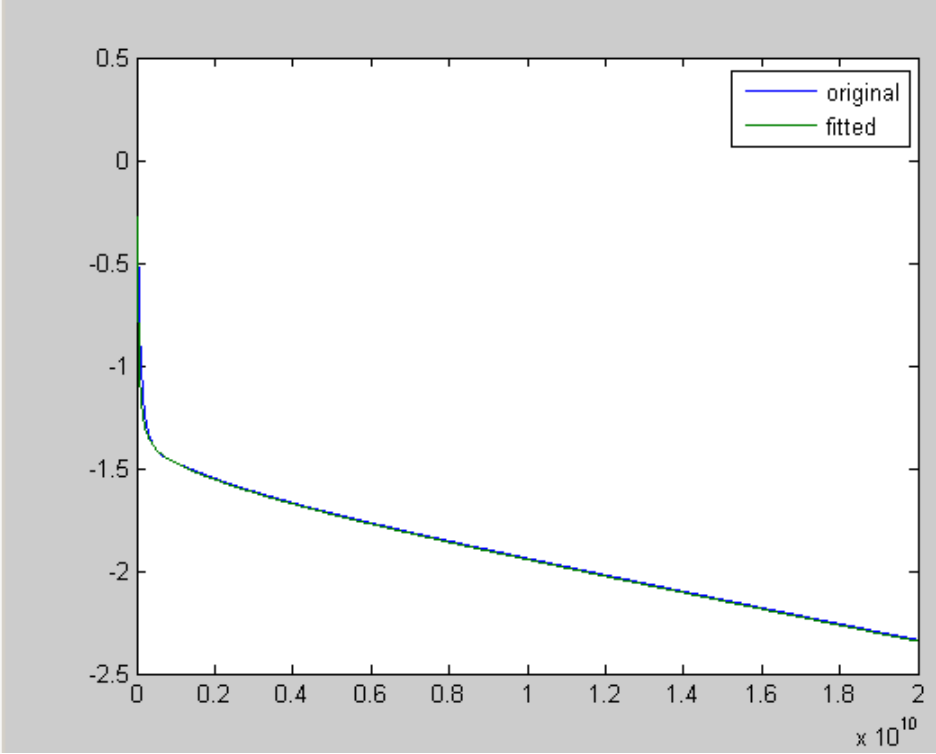




Having 8 Coefficients

- A very good correlation down to very close to DC or real and phase… but requires 8 coefficients… Let's try a different approach…





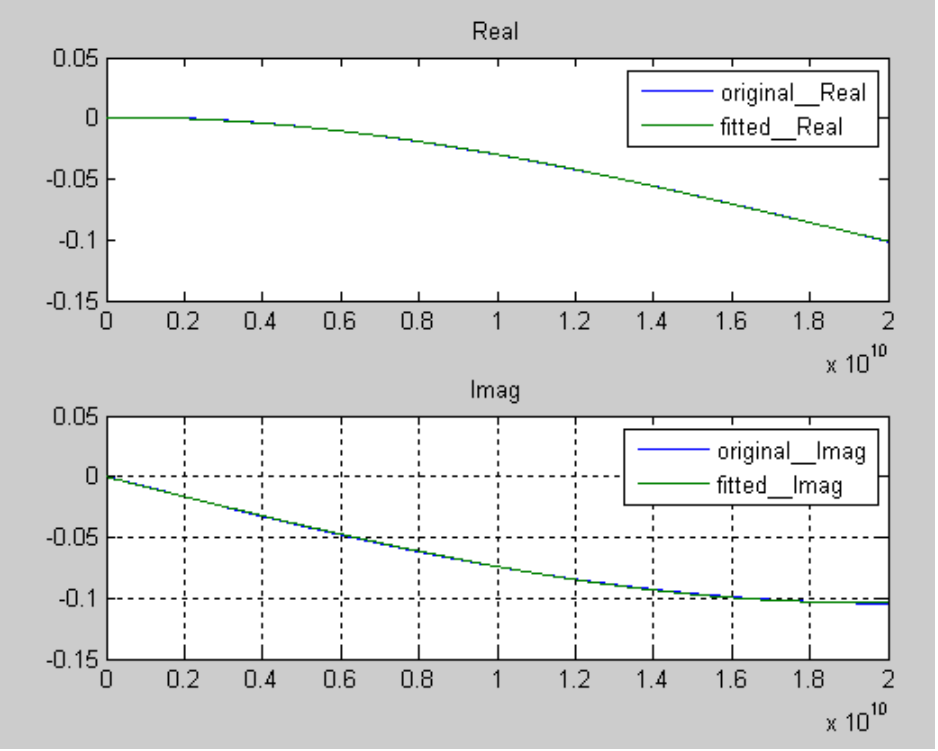
Correction Remedy Proposition

- The following polynomial approximation (fit) equation is suggested while maintaining a zero imaginary part at DC.

$$S_{11} = S_{22} = \rho_0 + \rho_1 * f + \rho_2 * f^2 + \rho_3 * f^3 + \rho_4 * f^4$$

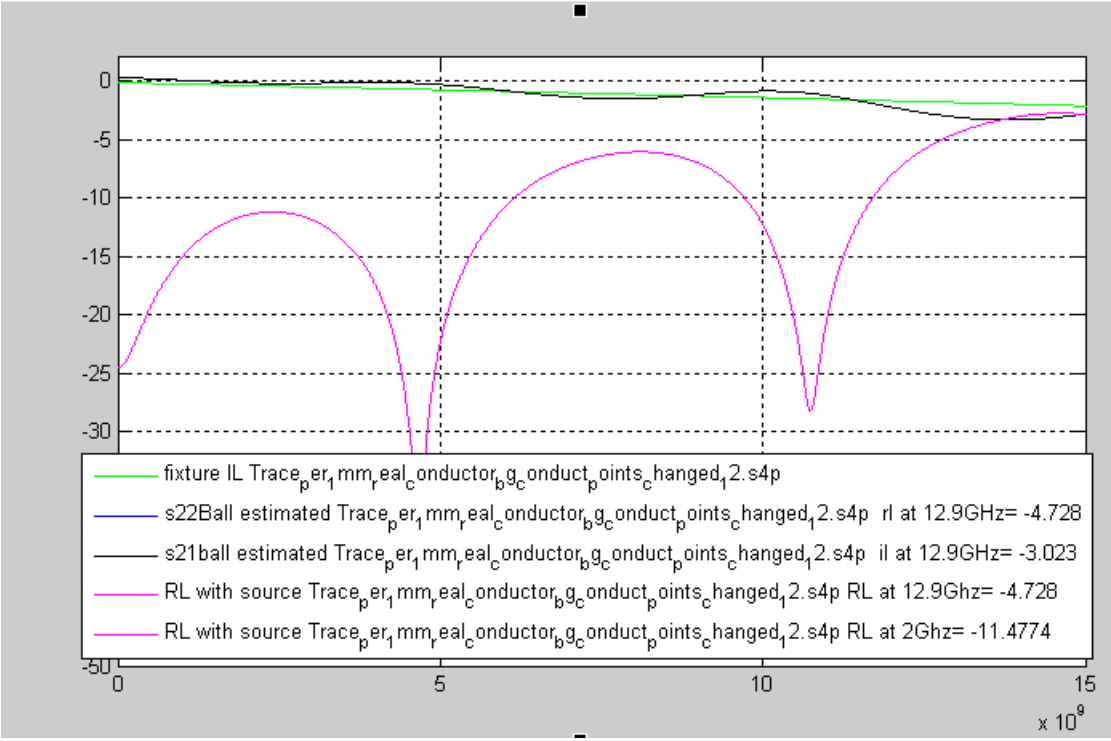
- The above fit provides adequate accuracy to both imaginary and real parts of the return loss while maintaining low coefficient amount:

In the graphs:
Return Loss Imag and Real fitting.
HFSS (Original) vs. Fitting result



Suggested Remedy - Results

- The suggested coefficients follow the package return loss requirements as were agreed by the package return loss ad-hoc and presented in Benartsi_3bj_01_0113



Correction Remedy Proposition

- Use the current insertion loss equation with updated coefficients.
- The following polynomial approximation (fit) equation is suggested while maintaining a zero imaginary part at DC.

EQ1:

$$S_{22} = S_{11} = \rho_0 + \rho_1 * f + \rho_2 * f^2 + \rho_3 * f^3 + \rho_4 * f^4$$

- This requires updating equation (93A–9) to EQ1
- Correct table 93A–2 - Transmission line model parameters values and add required coefficients according to the Table1 on slide 11

Table1 – Updated Coefficients

Gamma0	-10.037e-4	-------
Gamma1	-3.538e-4 -3.355e-3i	$1/GHz^{(1/2)}$
Gamma2	-1.027e-3 -3.818e-2i	1/GHz
Gamma3	-1.178e-5 +3.363e-5i	$1/GHz^{\wedge 2}$
Rho0	11.007e-4	--------
Rho1	3.679E-18 -8.124ie-3	1/GHz
Rho2	-3.235e-4 -3.544E-20i	$1/GHz^2$
Rho3	-1.021E-20 +7.434ie-6	$1/GHz^3$
Rho4	1.722E-07 -1.78E-21i	$1/GHz^4$

Thank You!

Backup slides

Suggested Remedy – Backup 8 Coefficients Case

- Change equation (93A–9) to:

$$S_{11} = S_{22} = \exp(\rho_0 + \rho_1 * \sqrt[32]{f} + \rho_2 * \sqrt[16]{f} + \rho_3 * \sqrt[8]{f} + \rho_4 * \sqrt[4]{f} + \rho_5 * \sqrt{f} + \rho_6 * f + \rho_7 * f^2)$$

- Correct table 93A–2 - Transmission line model parameters values and add required coefficients according to the Table2 on slide 9

The Resulting Return Loss

- The suggested coefficients follow the package return loss requirements as were agreed by the package return loss ad-hoc and presented in Benartsi_3bj_01_0113

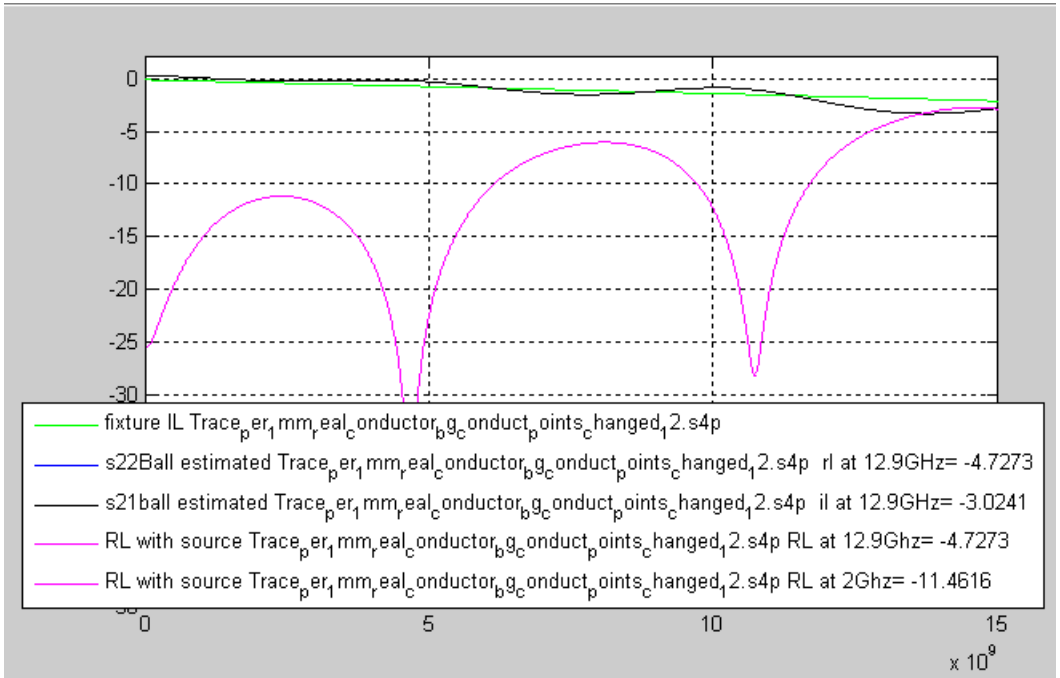


Table2 – Updated Coefficients for the equation in slide 14

Gamma0	-10.037e-4	-------
Gamma1	-3.538e-4 -3.355e-3i	1/GHz^(1/2)
Gamma2	-1.027e-3 -3.818e-2i	1/GHz
Gamma3	-1.178e-5 3.363e-5i	1/GHz^2
Rho0	-7.335	--------
Rho1	1012.883 173.944i	1/GHz^(1/32)
Rho2	-1937.471 -318.625i	1/GHz^(1/16)
Rho3	1168.218 175.931i	1/GHz^(1/8)
Rho4	-260.873 -34.854i	1/GHz^(1/4)
Rho5	20.15 2.362i	1/GHz^(1/2)
Rho6	-0.399 -7.648e-2i	1/GHz
Rho7	6.792e-4 +8.31e-5i	1/GHz^2

Gamma and Rho values as in slide 11 before mathematical depth reduction (Fit Output)

Rhos
0.001100711
3.6792472619508E-18 -0.00812419785387629i
-0.000323491523609175 -3.54485015169846E-20i
-1.02099611925522E-20 +0.0000074399895902425i
1.72248636548057E-07 -1.79969601835744E-21i

Gammas
-0.0010037
-0.000353858870172842 -0.00335517659743865i
-0.001027 -0.03818i
-0.00001178 +0.00003363i