IEEE P802.3ba
New ICR fitted line methodology required

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Comments

- Current ICR fitted line equation does not do a good job at fitting ICR data for certain channels
- In some cases, raw ICR data meets the ICR requirements but fitted line does not
- Fitting results using a typical connectors shown
  - Link1 is a typical of mezzanine connector system

    20 inch trace → Vias → TwinMezz™ Connector → Vias → 20 inch trace
  - Link2 is a backplane connector system with 4 connectors

    3" trace → Vias → AirMax® connector → Vias → 7" trace → Vias → AirMax® connector → Vias → 7" trace → Vias → AirMax® connector → Vias → 7" trace → Vias → AirMax® connector →Vias → 3" trace
- Alternate ICR fitting equations explored and presented

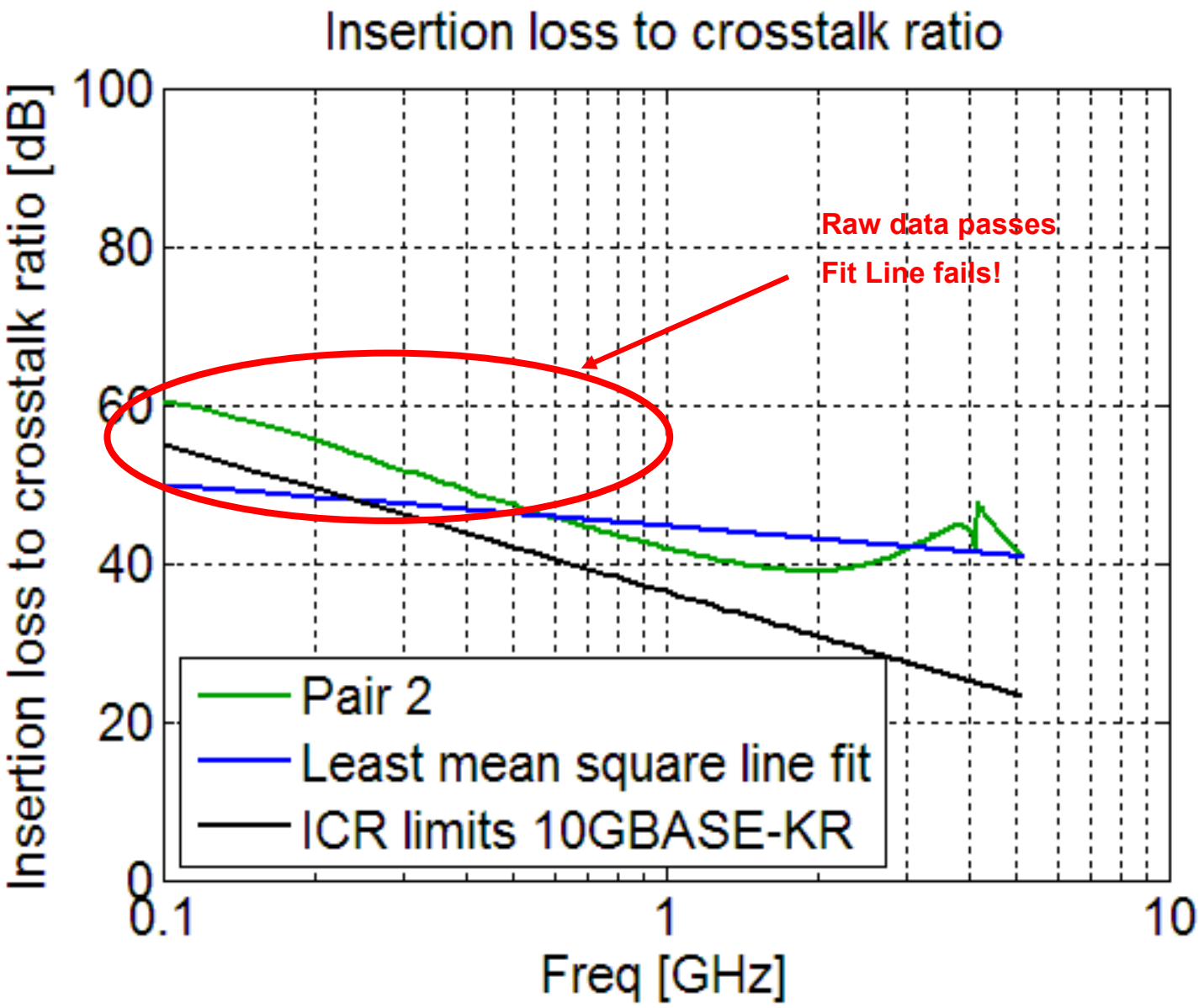
Current ICR Calculation Methodology

- Typical LMS linear fit
  - y = a + b log x, where
    - y = ICR(fit)
    - x = frequency
    - a = b_{ICR}
    - b = m_{ICR}
  - a & b are determined by solving the following matrix equation:

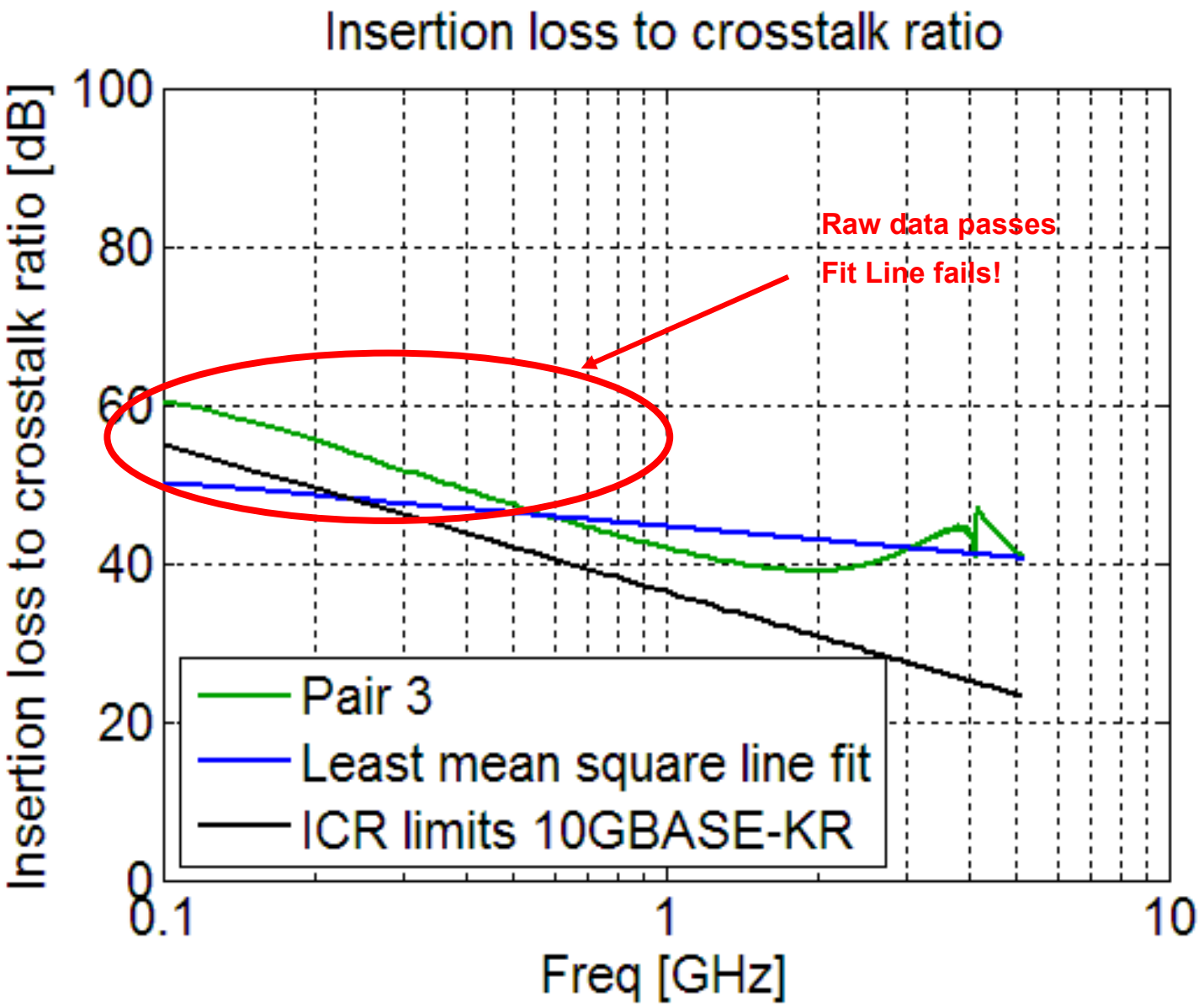
$$\begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} N & \sum \log(f) \\ \sum \log(f) & \sum (\log(f))^2 \end{bmatrix}^{-1} \begin{bmatrix} \sum ICR(f) \\ \sum ICR(f) \log(f) \end{bmatrix}$$

  - This is the current method used to generate the LMS fit line

Mezzanine Link – Current Fitting Methodology



Mezzanine Link – Current Fitting Methodology



Options to fix ICR

- Use a second order LMS fit
  - $y = a + b \log x + c (\log x)^2$
    - where y = ICR(fit) and x = frequency
  - The coefficients a, b, & c can be determined by solving the following matrix equation:

$$\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} N & \sum \log(f) & \sum (\log(f))^2 \\ \sum \log(f) & \sum (\log(f))^2 & \sum (\log(f))^3 \\ \sum (\log(f))^2 & \sum (\log(f))^3 & \sum (\log(f))^4 \end{bmatrix}^{-1} \begin{bmatrix} \sum ICR(f) \\ \sum ICR(f) \log(f) \\ \sum ICR(f) (\log(f))^2 \end{bmatrix}$$

Options to fix ICR

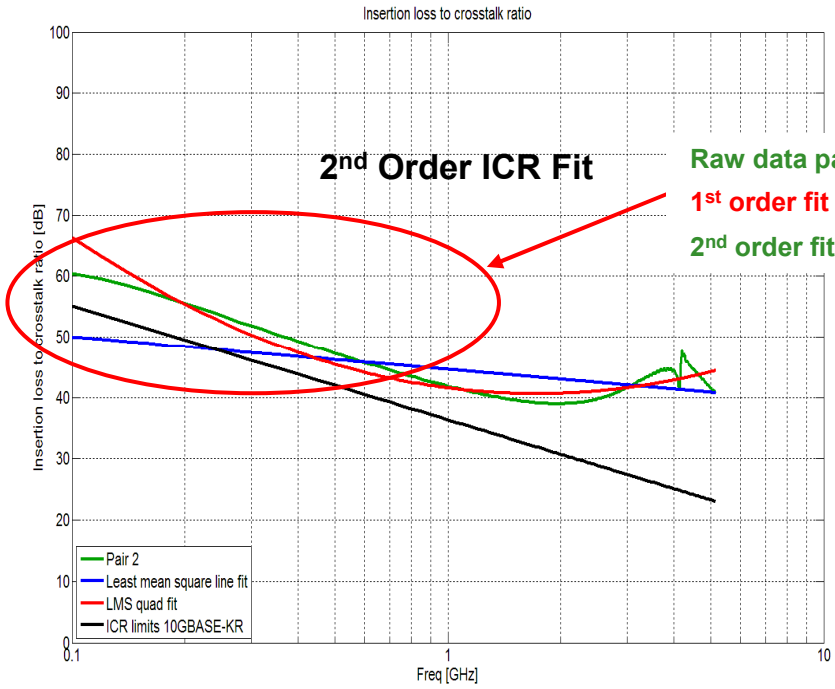
- Use a third order LMS fit
  - $y = a + b \log x + c (\log x)^2 + d (\log x)^3$
    - where y = ICR(fit) and x = frequency
  - The coefficients a, b, & c can be determined by solving the following matrix equation:

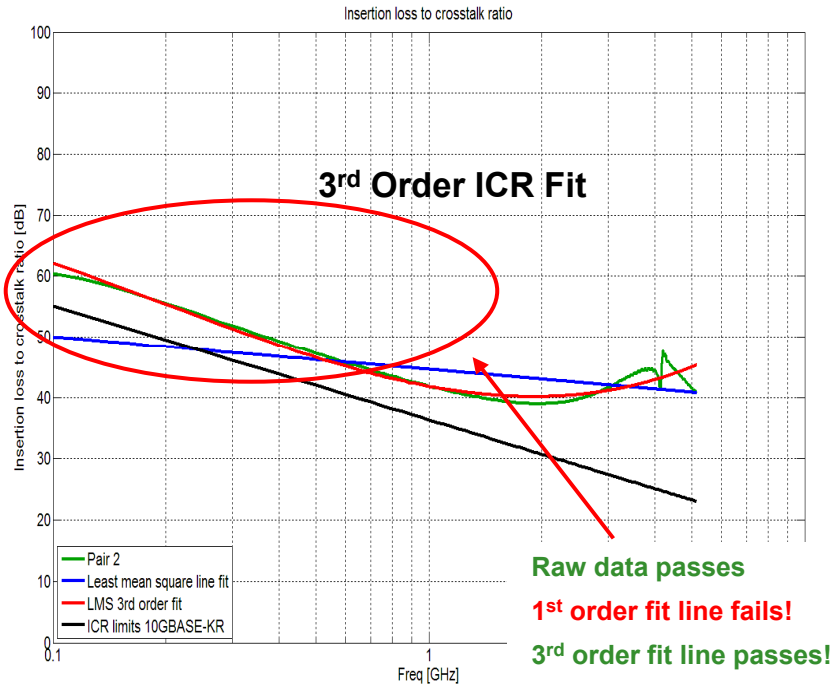
$$\begin{bmatrix} a \\ b \\ c \\ d \end{bmatrix} = \begin{bmatrix} N & \sum log(f) & \sum (log(f))^2 & \sum (log(f))^3 \\ \sum log(f) & \sum (log(f))^2 & \sum (log(f))^3 & \sum (log(f))^4 \\ \sum (log(f))^2 & \sum (log(f))^3 & \sum (log(f))^4 & \sum (log(f))^5 \\ \sum (log(f))^3 & \sum (log(f))^4 & \sum (log(f))^5 & \sum (log(f))^6 \end{bmatrix}^{-1} \begin{bmatrix} \sum ICR(f) \\ \sum ICR(f)\, log(f) \\ \sum ICR(f)\, (log(f))^2 \\ \sum ICR(f)\, (log(f))^3 \end{bmatrix}$$

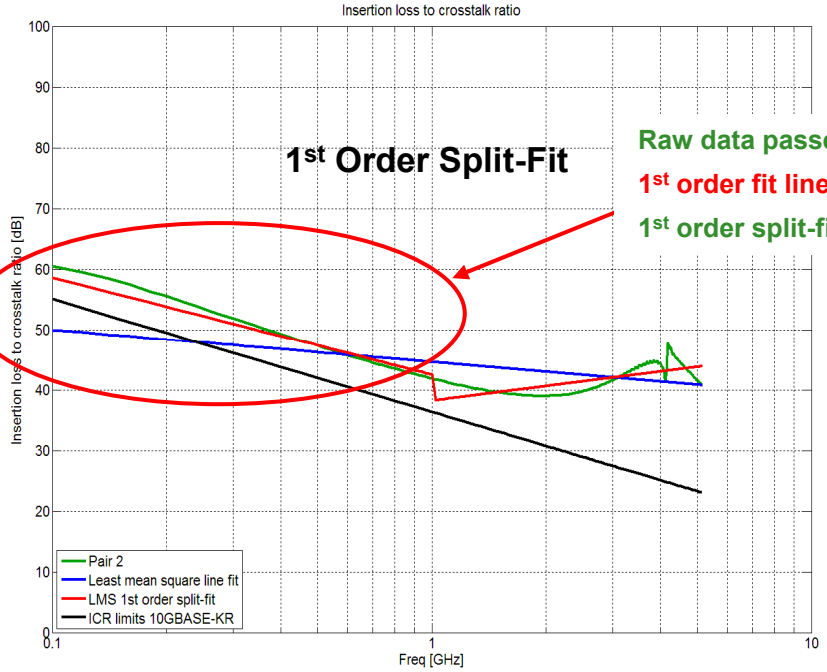
Options to fix ICR

- Use current ICR equations – with two distinct linear segments for different frequency ranges
  - y = a + b log x
    - where y = ICR(fit) and x = frequency
  - Frequency ranges
    - 100 MHz ≤ f ≤ 1 GHz
    - 1 GHz < f ≤ 5.15625 GHz
- This requires the following changes
  - Eqn. 69B-15 changes to:
    - $PSNEXT_1(f) = -10\log\left(\sum 10^{-NEXT_n(f)/10}\right)$ for 100 MHz ≤ f ≤ 1 GHz
    - $PSNEXT_2(f) = -10\log\left(\sum 10^{-NEXT_n(f)/10}\right)$ for 1 GHz < f ≤ 5.15625 GHz
  - Eqns. 69B-16 through 69B-24 are changed similarly to accommodate for two linear segments

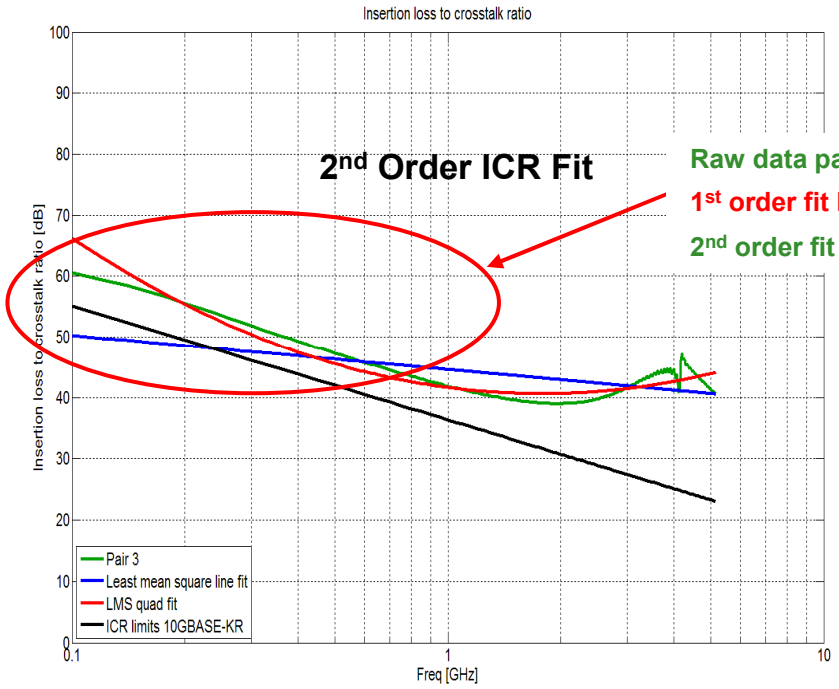
TwinMezz – Long Link – Pair 2

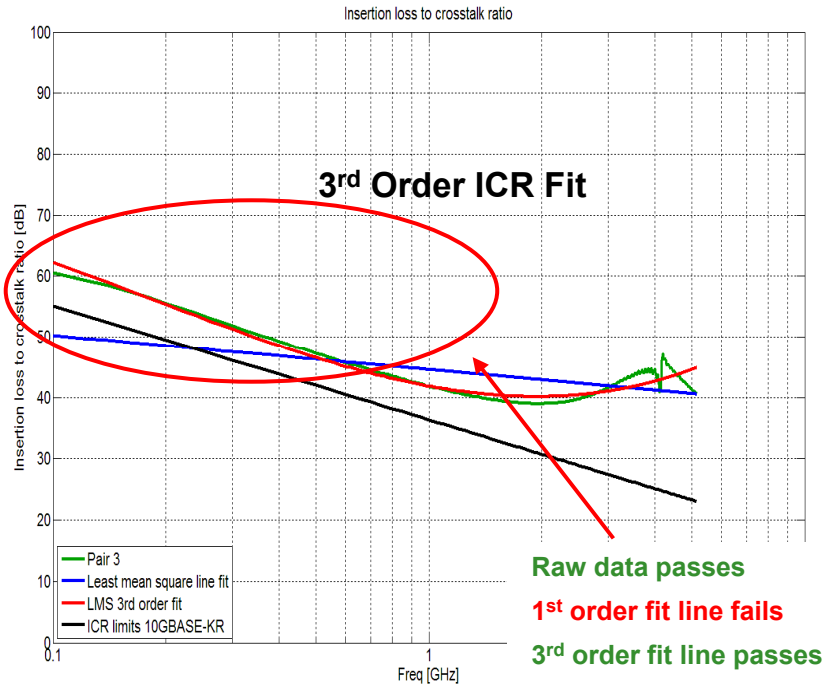


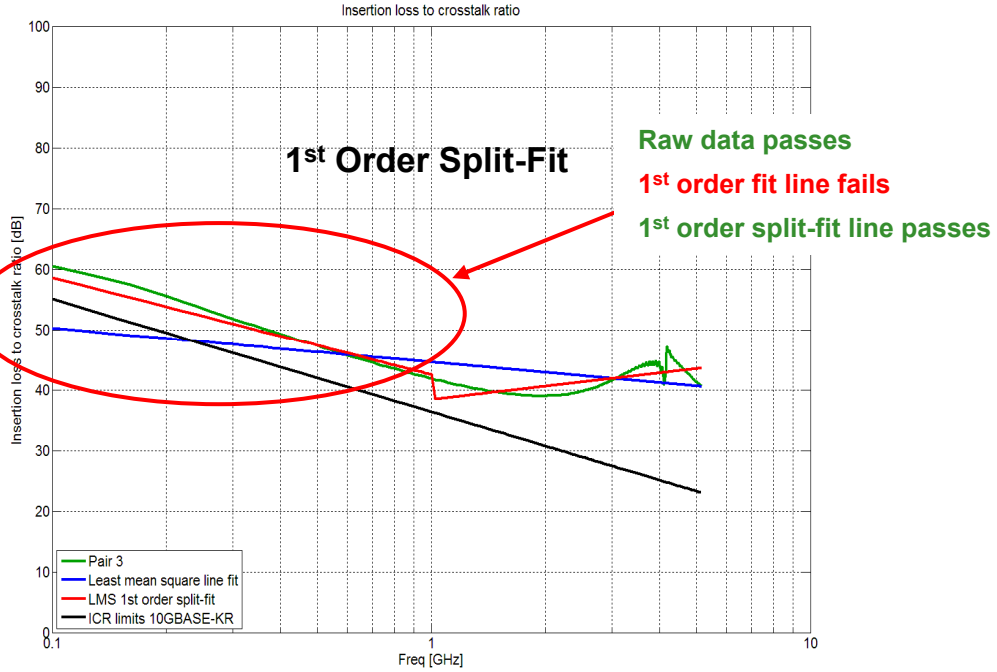




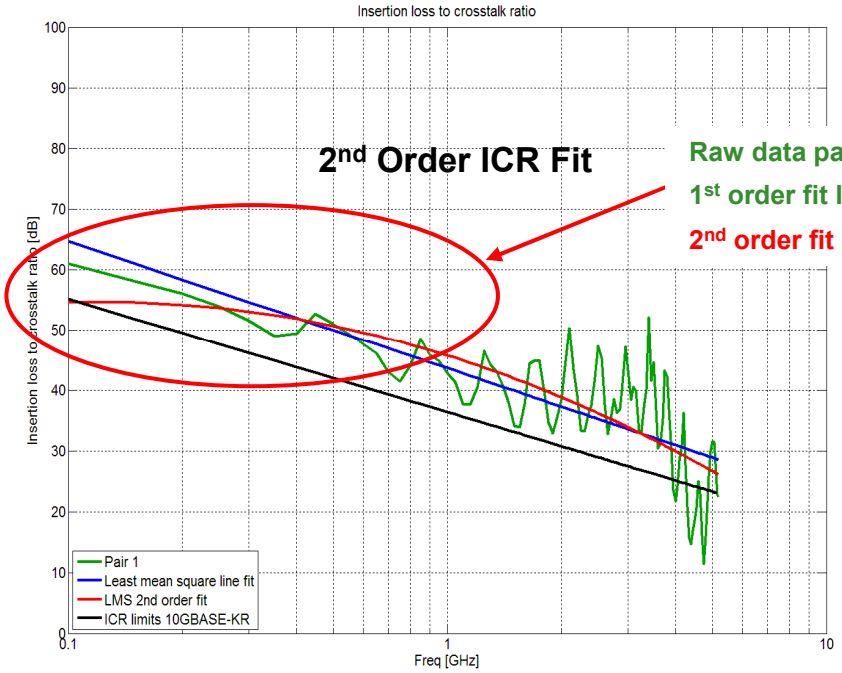
TwinMezz – Long Link – Pair 3

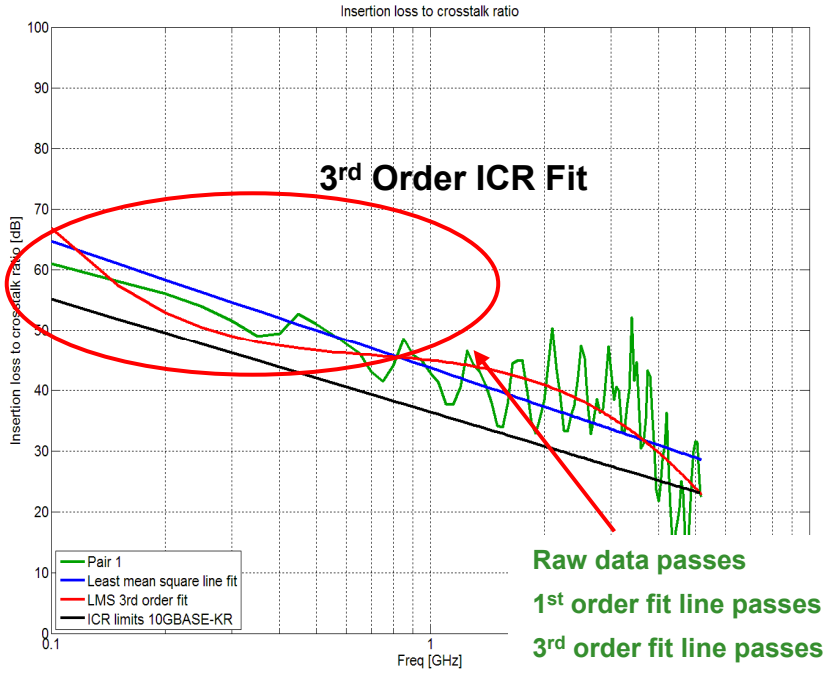


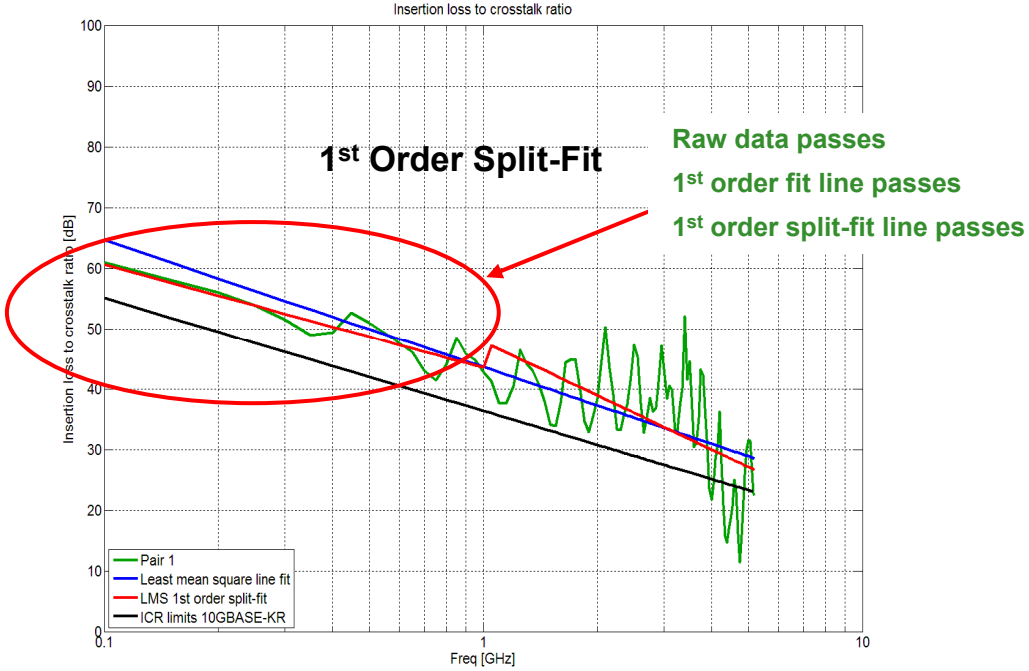




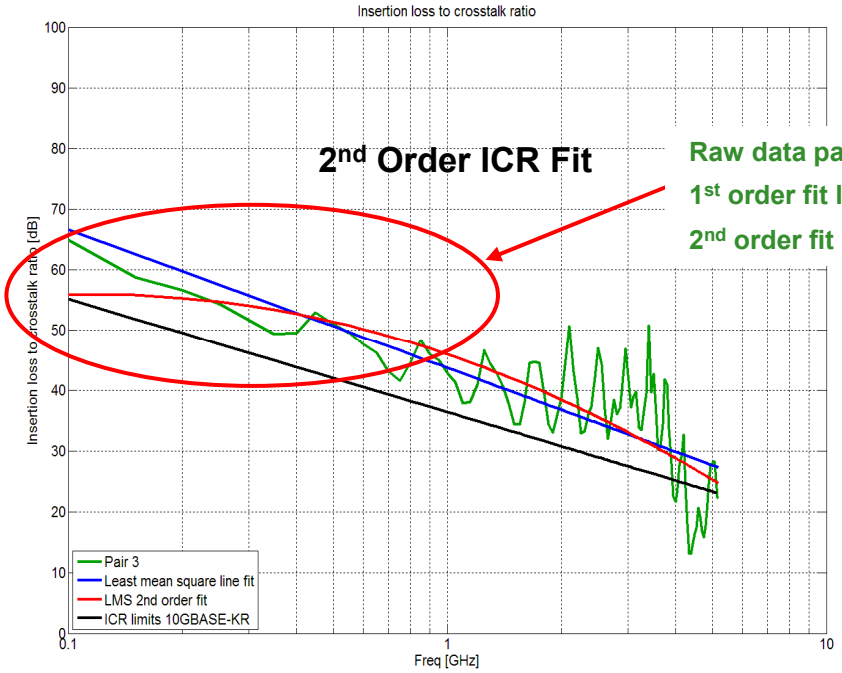
AirMax Link – Pair 1 ICR

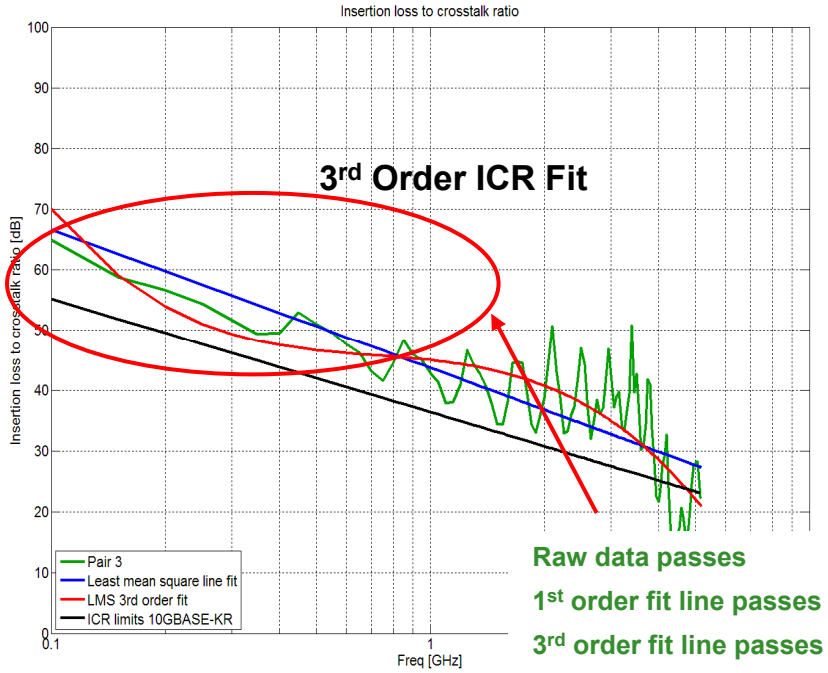


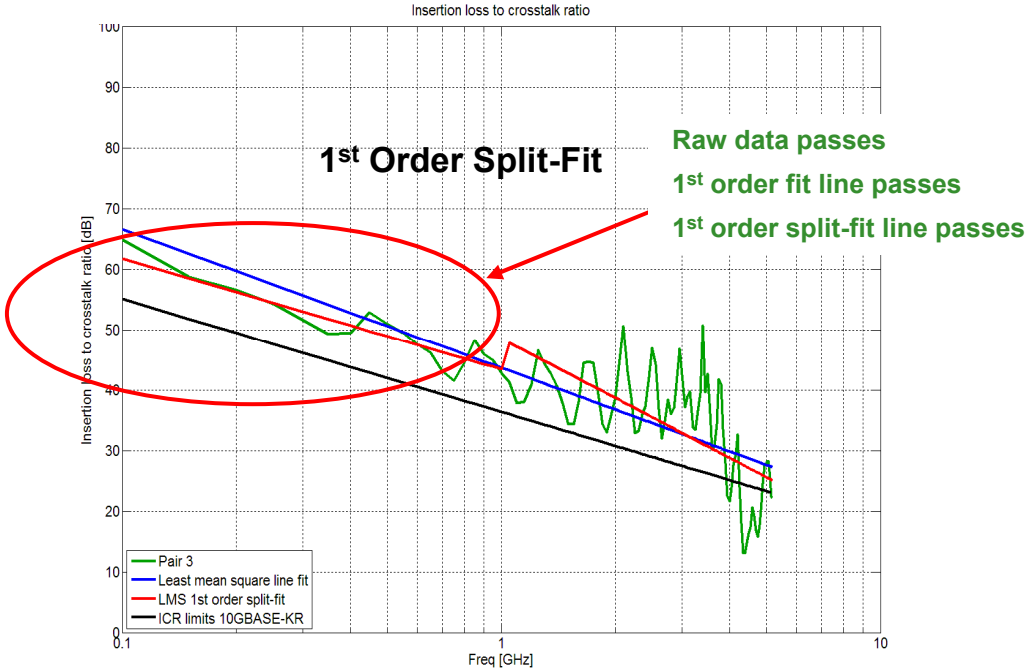




AirMax Link – Pair 3 ICR







Conclusion

- Current linear least-mean-squares fit curve does not correctly fit all cases
- Possible Options
  - 2nd order least-mean-squares fit curve improves some but has errors in other cases
    - Not desirable
  - 3rd order least-mean-squares fit curve is accurate, but mathematically very involving
    - Not desirable
  - Propose changing the ICR fit line to a two-segment linear least-mean-squares fit
    - Best solution
- Change needs to be made to both backplane and copper cable assembly ICR fit equations