System SNR Budget Analysis for 10GBASE-T

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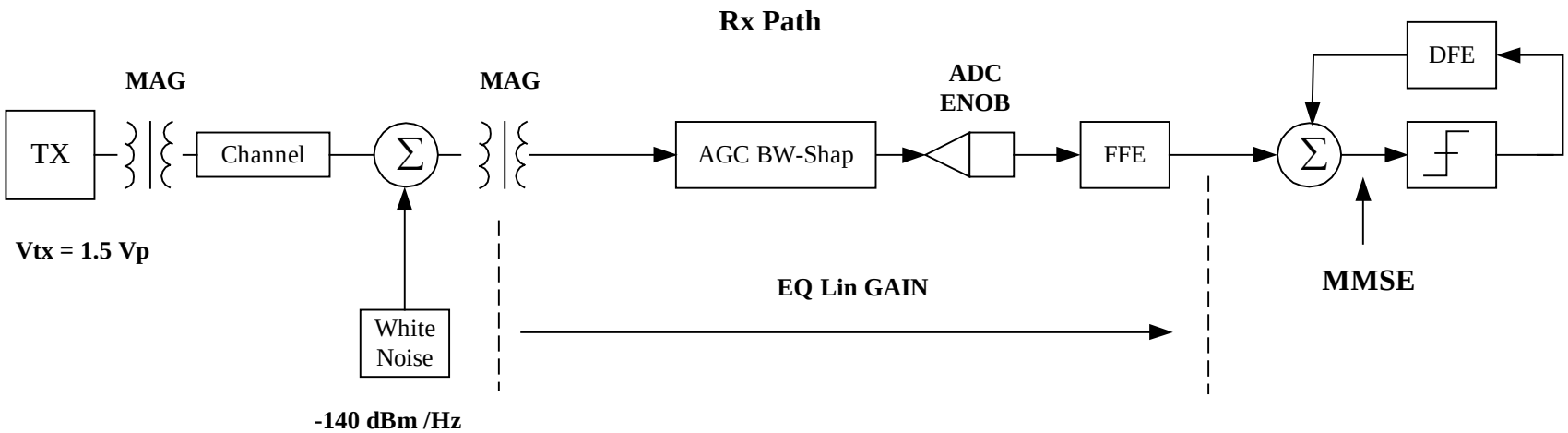
Outline

- Linear EQ Gain and SNR Margin vs Baud Rate
- What is Different from 1000BASE-T System Design
- SNR Budget 625 vs 833
- Conclusion

SNR Margin Evaluation Diagram



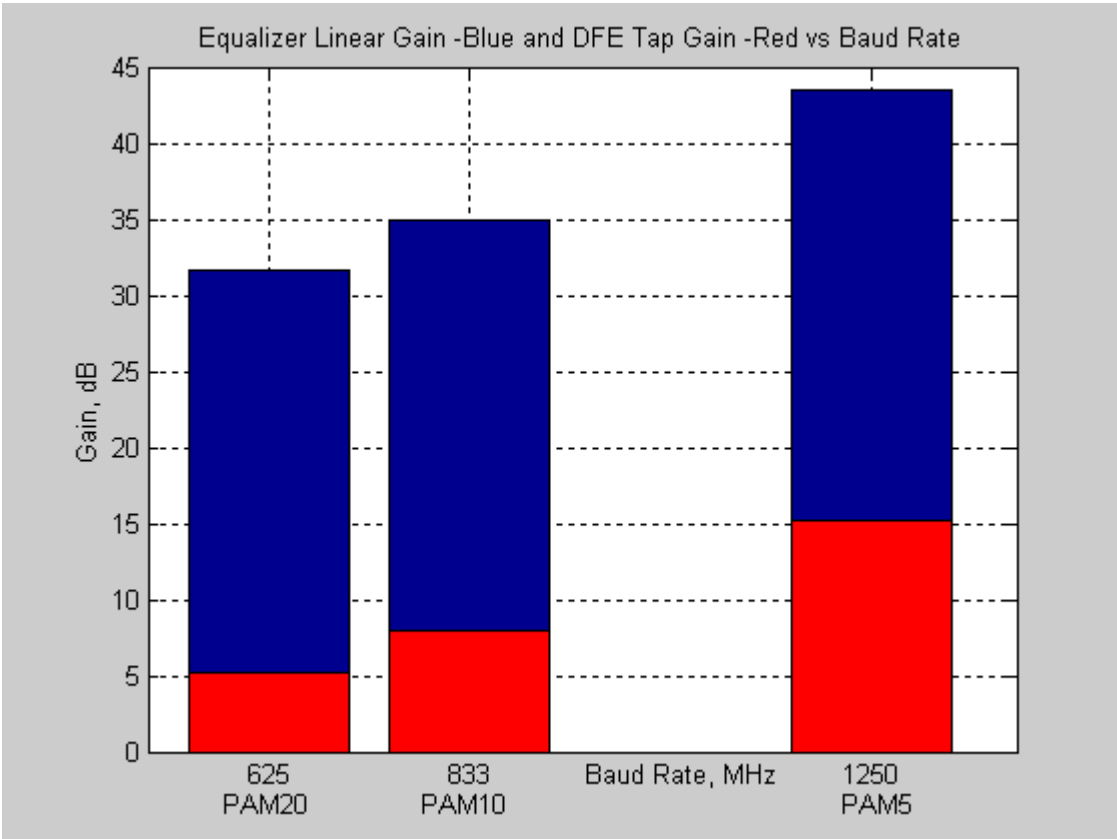
Channel - Avaya CAT6 Approximation TF

SNR_Margin = Achievable_SNR – Req_SNR + Coding_Gain

6.47*Sigma For 1e-10 SER

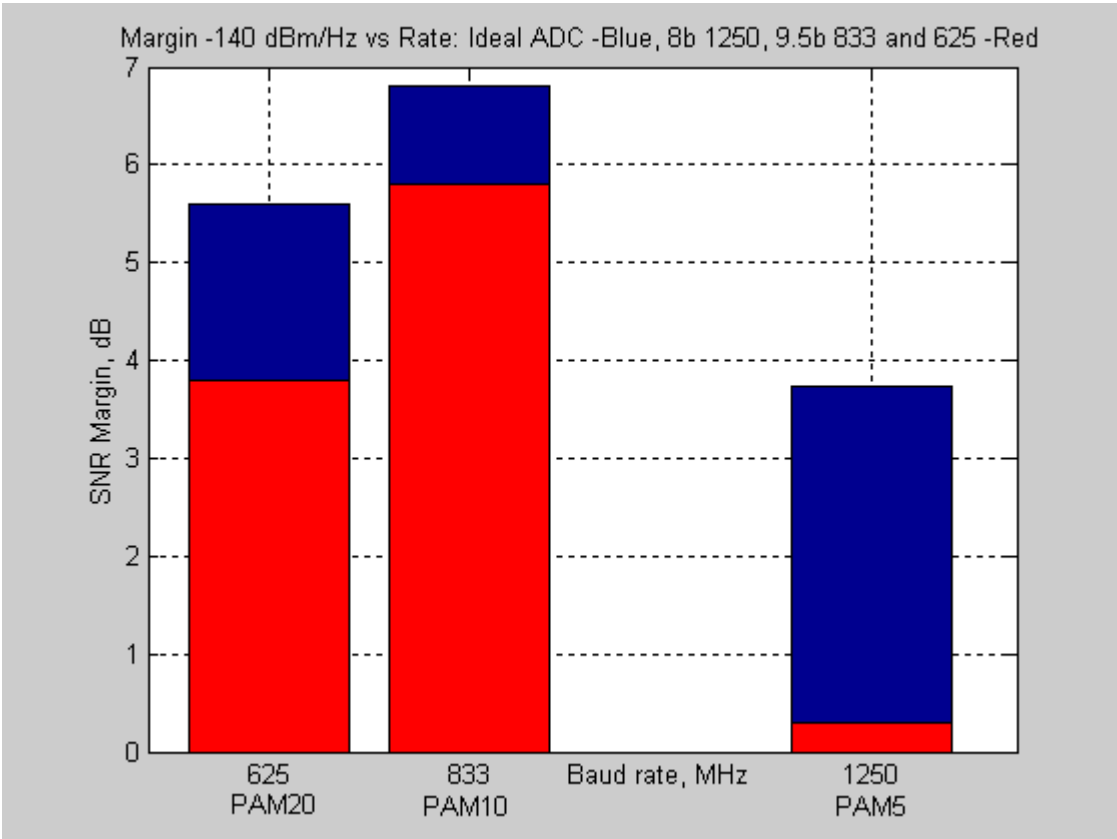
- EQ Linear Gain Increases with Baud Rate due to Channel Loss

EQ Linear Gain and DFE Tap-Gain vs Baud Rate 10GBASE-T



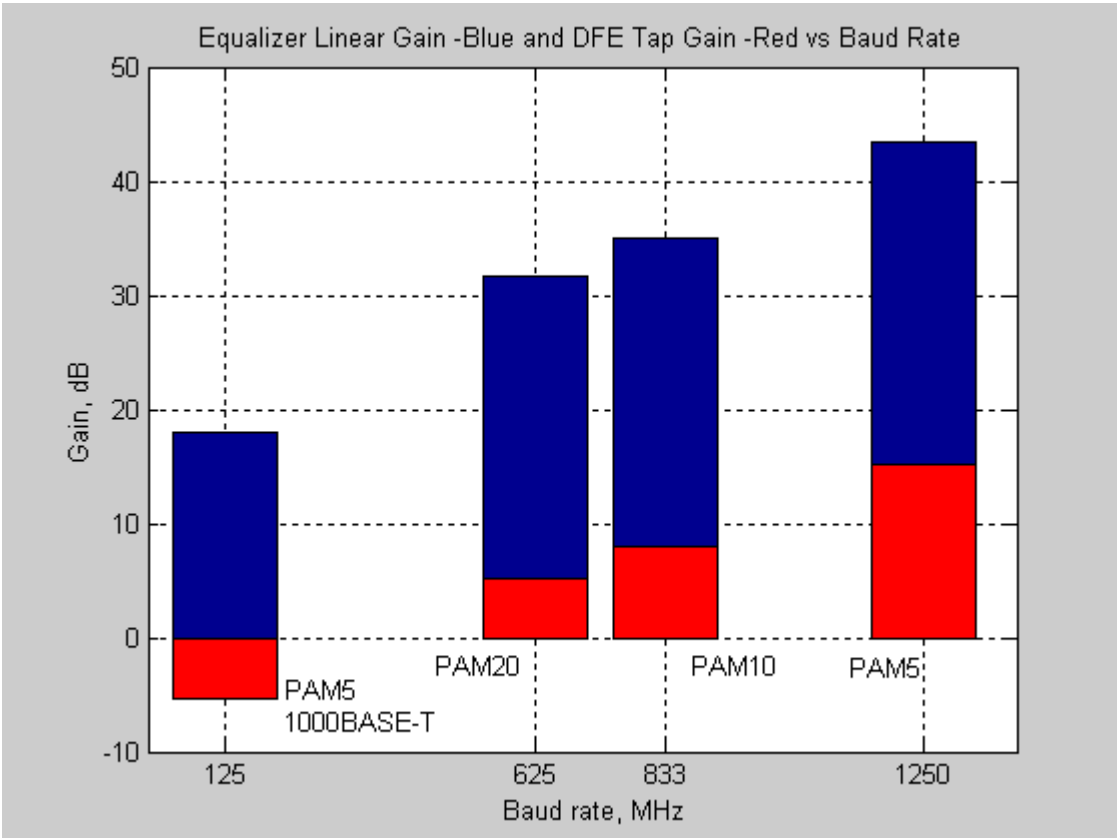
- Analog TF Shaping Alleviates Excessive DFE Tap-Gain & Size: Small ISI, 24-Tap FFE & DFE

SNR Margin vs Baud Rate 10GBASE-T

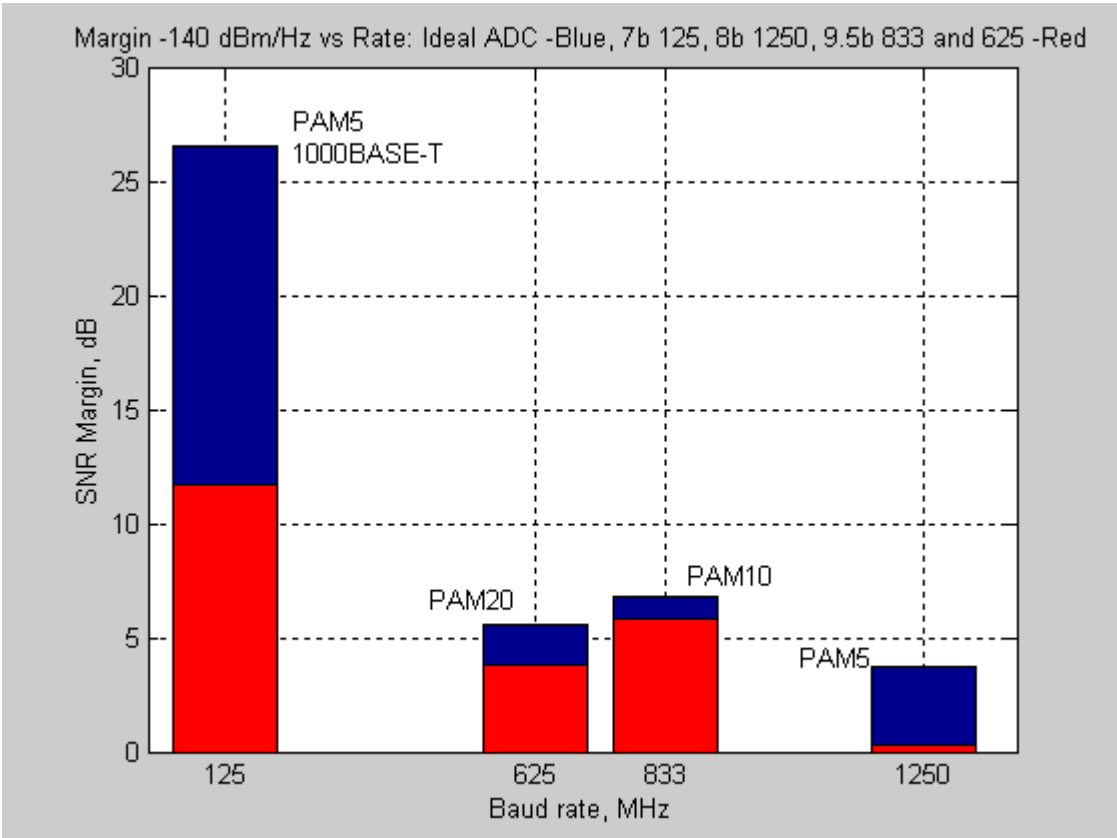


- 1250 MHz Case is Out of Reach

EQ Linear Gain and DFE Tap-Gain vs 1000BASE-T

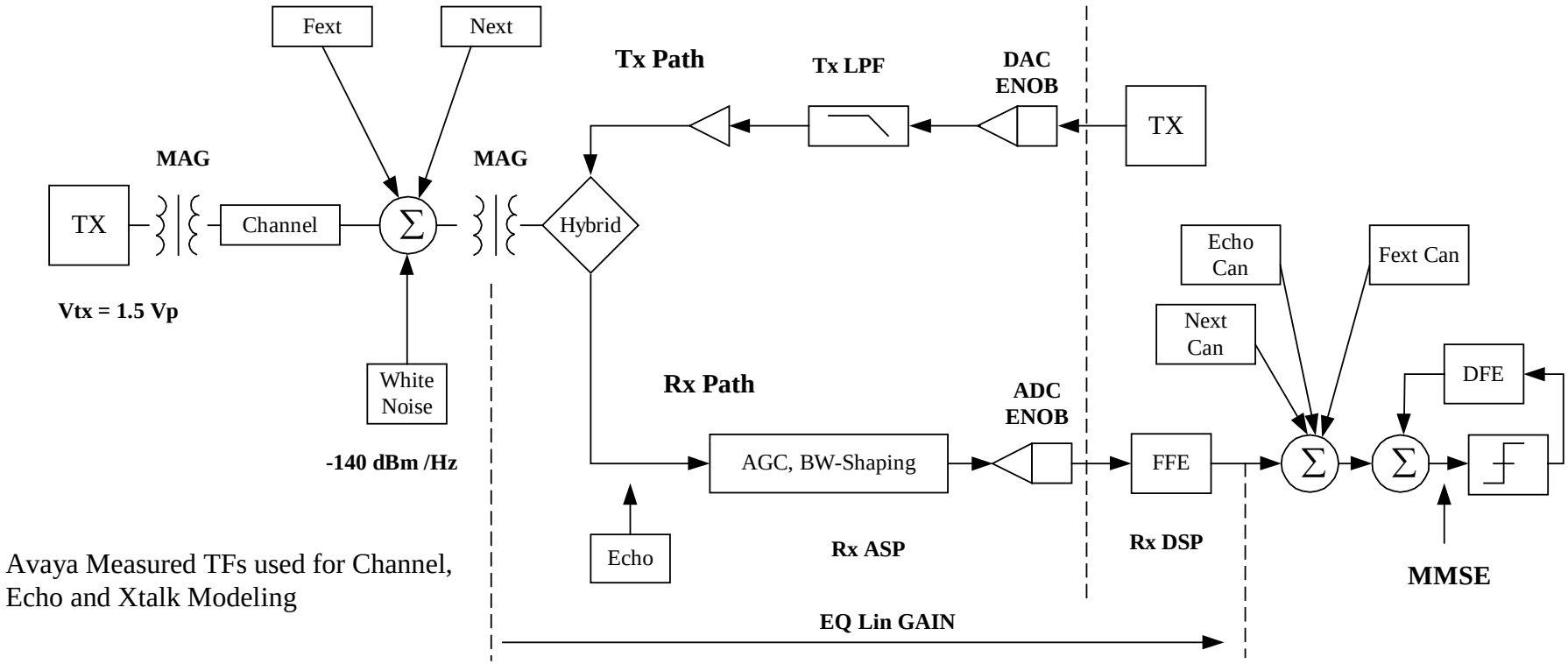


SNR Margin vs Baud Rate: 1000BASE-T vs 10GBASE-T



- Margin Trade-Off for ADC resolution was possible in 1000BASE-T

Time Domain SNR Bench



Avaya Measured TFs used for Channel, Echo and Xtalk Modeling

- White Noise Accounts for the Floor and Active/Passive Noisy Transceiver Elements

SNR Margin Utilization (5 dB Coding Gain): 625 vs 833 Simulation Results

- **625 System – Max. Margin 3.9 dB**
  - A/D ENOB: 9.5b, 625 MHz
  - D/A ENOB: 20-Lev, 9.5b, 625 MHz
  - Tx LPF: 1st Order 300 MHz
  - Rx LPF: 2nd Order 225 MHz
  - FFE: 24 Tap
  - DFE: 24 Tap
  - Echo FIR: 560 Tap
  - NEXT FIR: 200 Tap
  - FEXT FIR: 120 Tap
  - Canc. Echo: ~43 dB
  - Canc. NEXT: 16-25 dB
  - Canc. FEXT: 16-28 dB
- **Achieved SNR Margin: 3 dB**

- **833 System – Max. Margin 5.9 dB**
  - A/D ENOB: 9.5b, 833 MHz
  - D/A ENOB: 10-Lev, 9.5b, 833 MHz
  - Tx LPF: 1st Order 400 MHz
  - Rx LPF: 2nd Order 300 MHz
  - FFE: 24 Tap
  - DFE: 24 Tap
  - Echo FIR: 640 Tap
  - NEXT FIR: 250 Tap
  - FEXT FIR: 120 Tap
  - Canc. Echo: ~40 dB
  - Canc. NEXT: 18-23 dB
  - Canc. FEXT: 17-25 dB
- **Achieved SNR Margin: 3.6 dB**

- Existing Definition for **ANEXT** TF Totally Consumes SNR Margin in Both Cases
- In Practice SNR Margin Utilization could prove more challenging due Factors not considered

Conclusion

- 1250–MHz System is Out of Reach with Close to Zero SNR Margin
- Both 625– and 833–MHz Systems Exhibit Positive SNR Margin (no ANEXT)
- More Detailed 625 vs 833 MHz Sys Choice Considerations Required
- Very Tight SNR Margin for Both 625– and 833–MHz Systems
- Study needed to see if –143 dBm/Hz is Feasible – will Increase SNR Margin
- Efficient Treatment of ANEXT is Crucial for 10GBASE-T Feasibility