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Effect of Package Trace and Termination Resistance on Tx Specification

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Background

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- I have reported that we may need to revise package trace impedance (Zc, 90Ω) and termination resistance (Rd, 55Ω) in the COM parameters, because they do not necessarily cover corner cases (hidaka_100516_3cd_adhoc.pdf)

- There was a concern that Tx-related COM parameters such as signal amplitude and SNR_{TX} may have to be changed consistently with package parameters, because Tx output amplitude and Tx SNDR will be also affected by the package trace impedance and termination resistance

- Hence, I have studied the effect of package trace impedance and termination resistance on Tx output amplitude and Tx SNDR

Simulated Package Parameters

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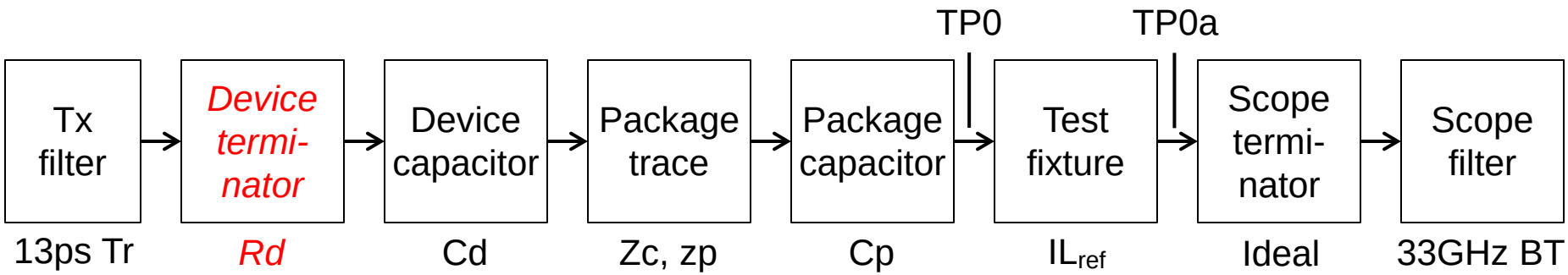
- The following 10 combinations of parameters were simulated

Case	zp Package trace length	Rd Termination resistance	Zc Package trace impedance
#1	12 mm	45 Ω	90 Ω
#2			110 Ω
#3		55 Ω	90 Ω
#4			110 Ω
#5	30 mm	45 Ω	90 Ω
#6			110 Ω
#7		55 Ω	90 Ω
#8			110 Ω
#9	12 mm	50 Ω	100 Ω
#10	30 mm		

- The original conditions were #3 and #7
- The proposed conditions were #2/#3/#4 and #6/#7/#8
  - See hidaka_100516_3cd_adhoc.pdf

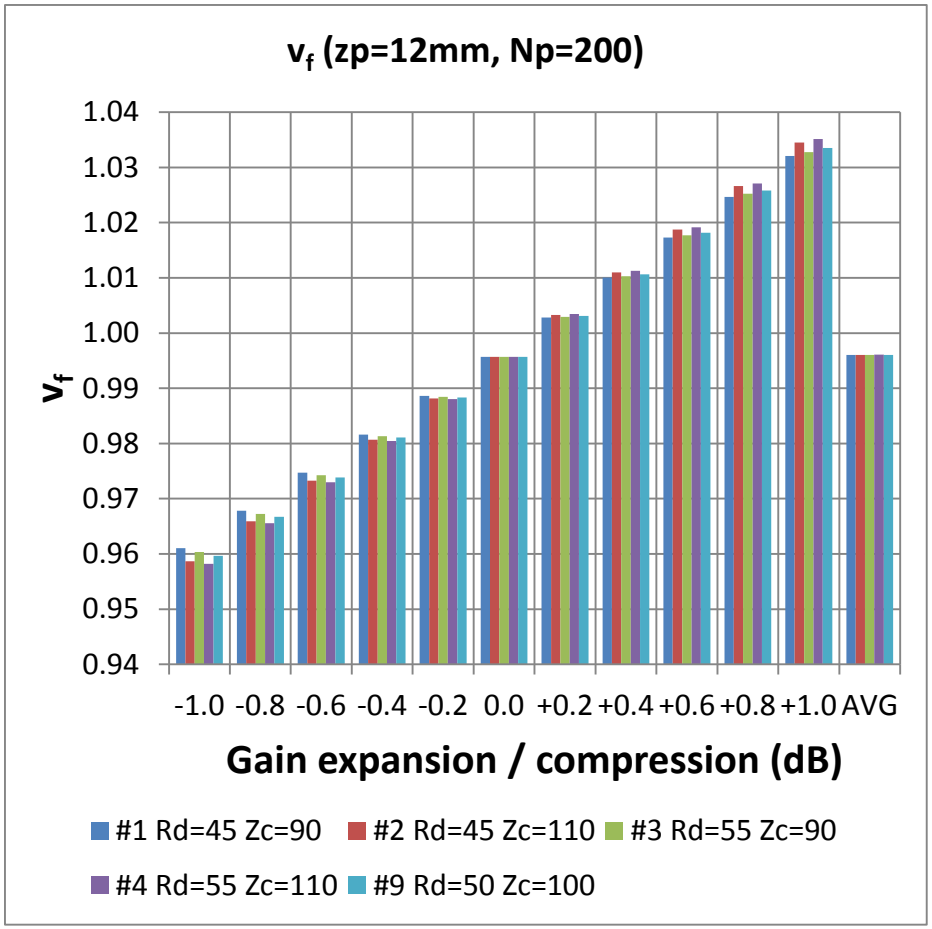
Simulated Model

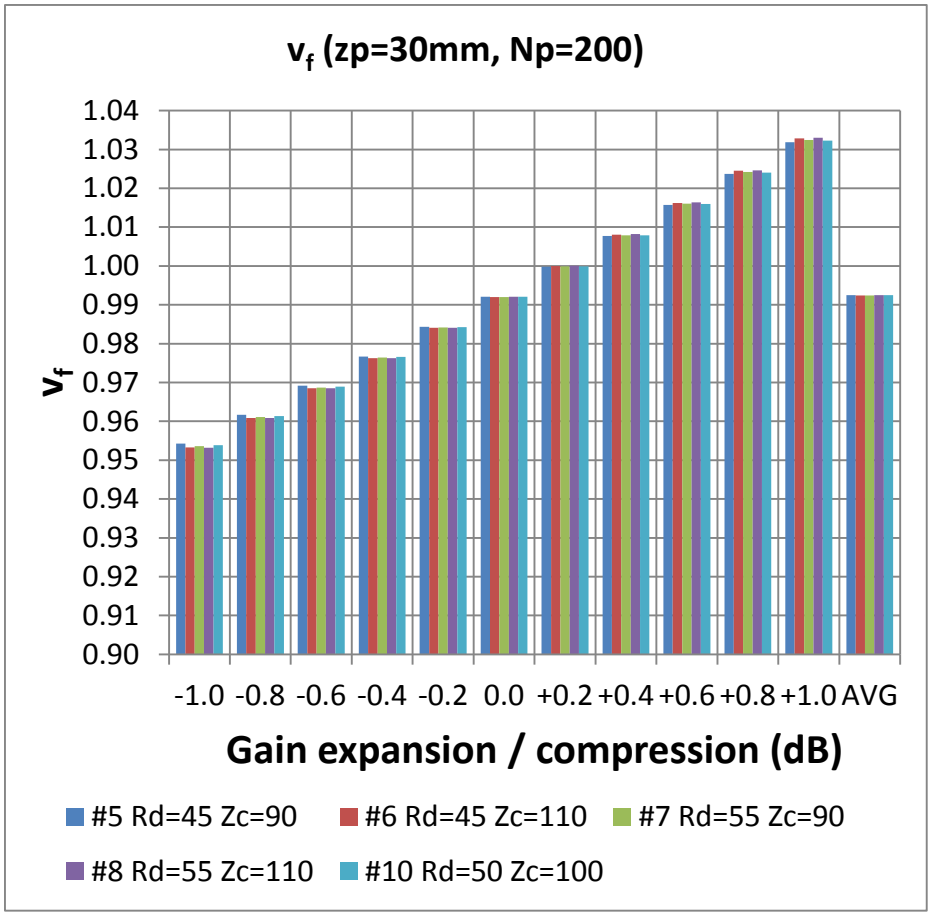


- Tx filter: $S_{21} = (\mathrm{EQ93A{-}46} | T_r = 13\mathrm{ps}, \beta = 2)$ (i.e. 13ps 20-80% Tr)
- Device terminator: $S_{21} = 1, S_{22} = \frac{Rd - 50\Omega}{Rd + 50\Omega}$ (i.e. same as Tx in COM)
  - *No effect of impedance matching on amplitude* (i.e. only effect on reflection)
- Device capacitor: $S = (\mathrm{EQ93A{-}8} | C = C_d)$
- Package trace: $S = \left(\mathrm{EQ93A{-}13,14} \middle| \mathrm{Table93A{-}3\ except}\ Z_c, z_p\right)$
- Package capacitor: $S = \left(\mathrm{EQ93A{-}8} \middle| C = C_p\right)$
- Test fixture: $|S_{21}| = 10^{-(\mathrm{EQ93-1})/20}, \angle S_{21} = \mathrm{minimum\ phase}(|S_{21}|)$
- Scope terminator: $S_{21} = 1, S_{11} = 0$ (i.e. ideal)
- Scope filter: 4-th order Bessel-Thomson LPF with 33GHz 3dB BW
  - $\omega_0 = 98.28967142447435\ \mathrm{G\ rad/s}$

Effect on v_f (Np=200)

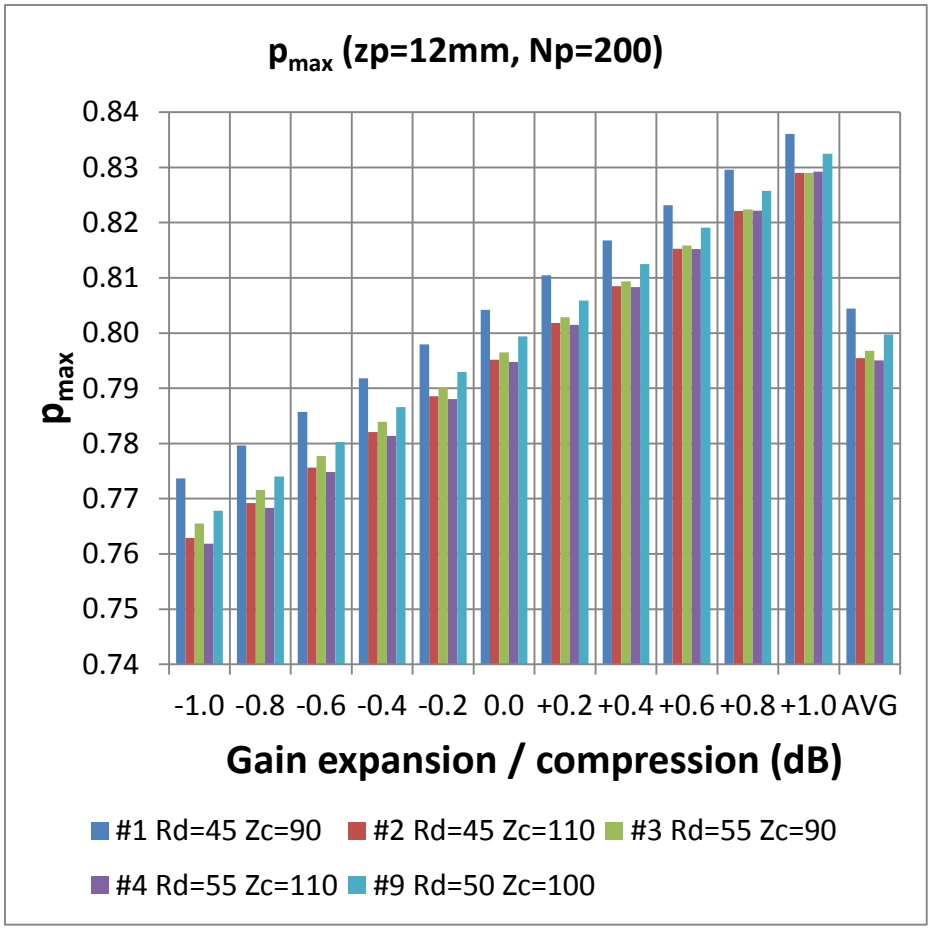
- The effect of Rd and Zc on v_f is very small

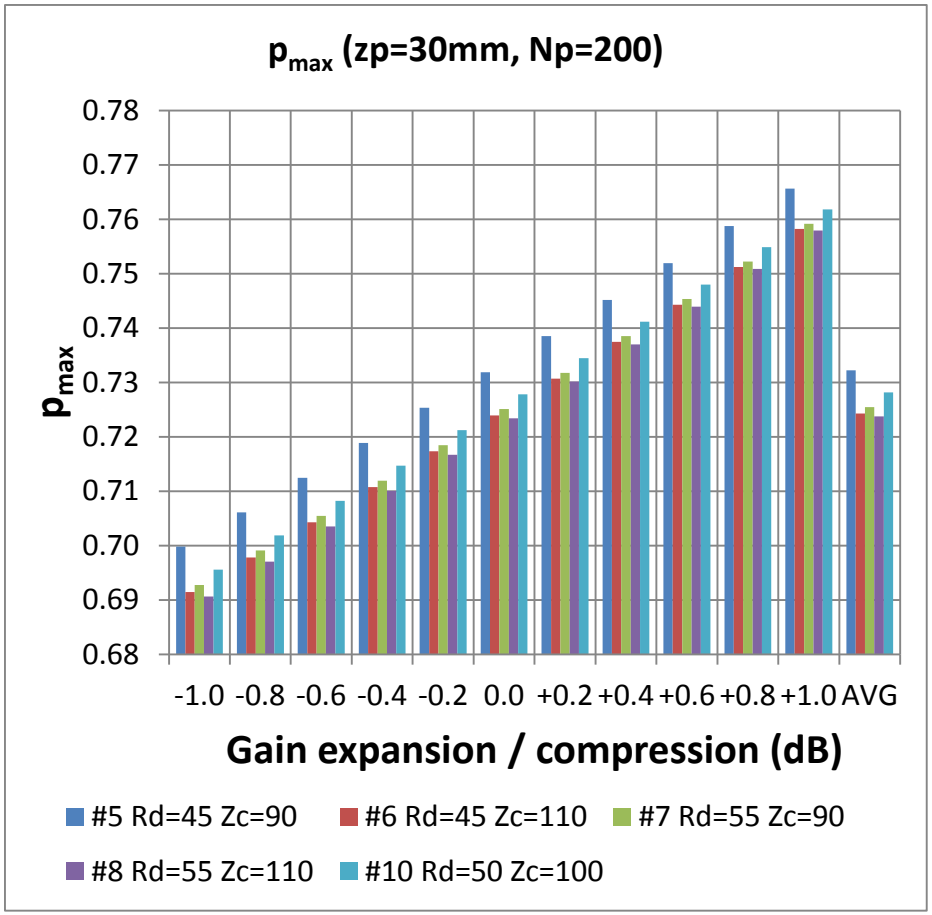




Effect on p_{max} (Np=200)

- The effect of Rd and Zc on p_{max} is very small





Effect on the Ratio of p_{max} to v_f (Np=200)

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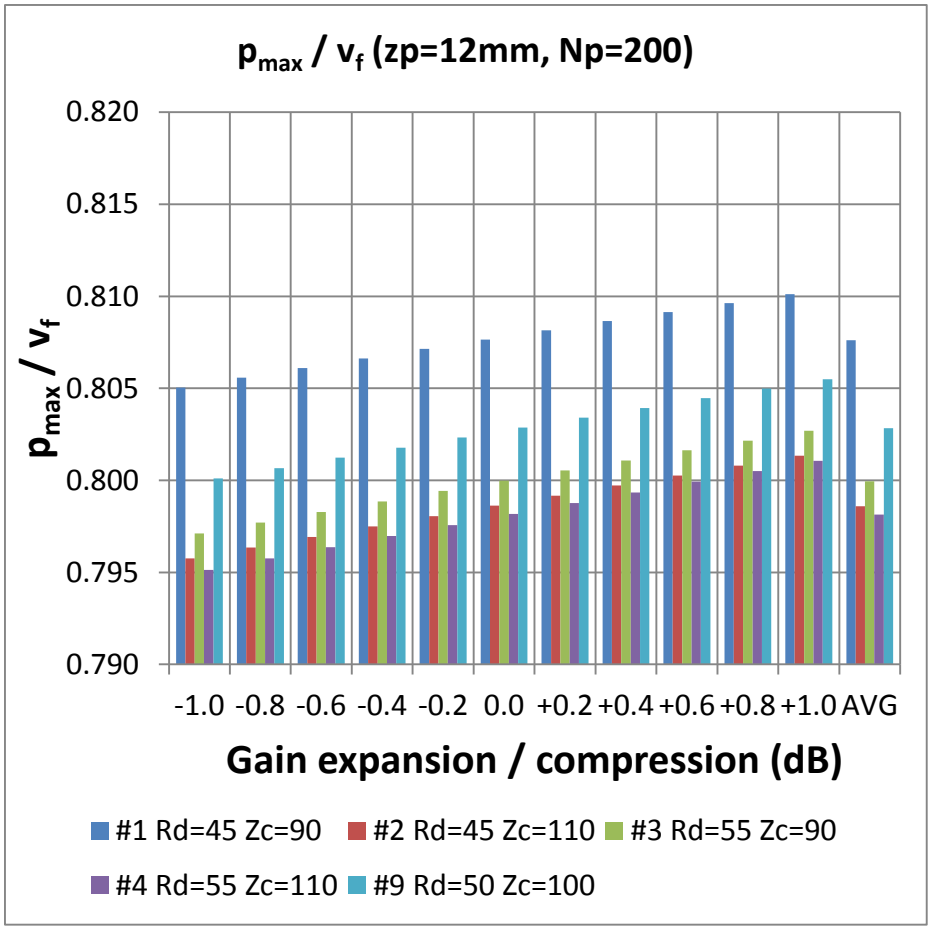
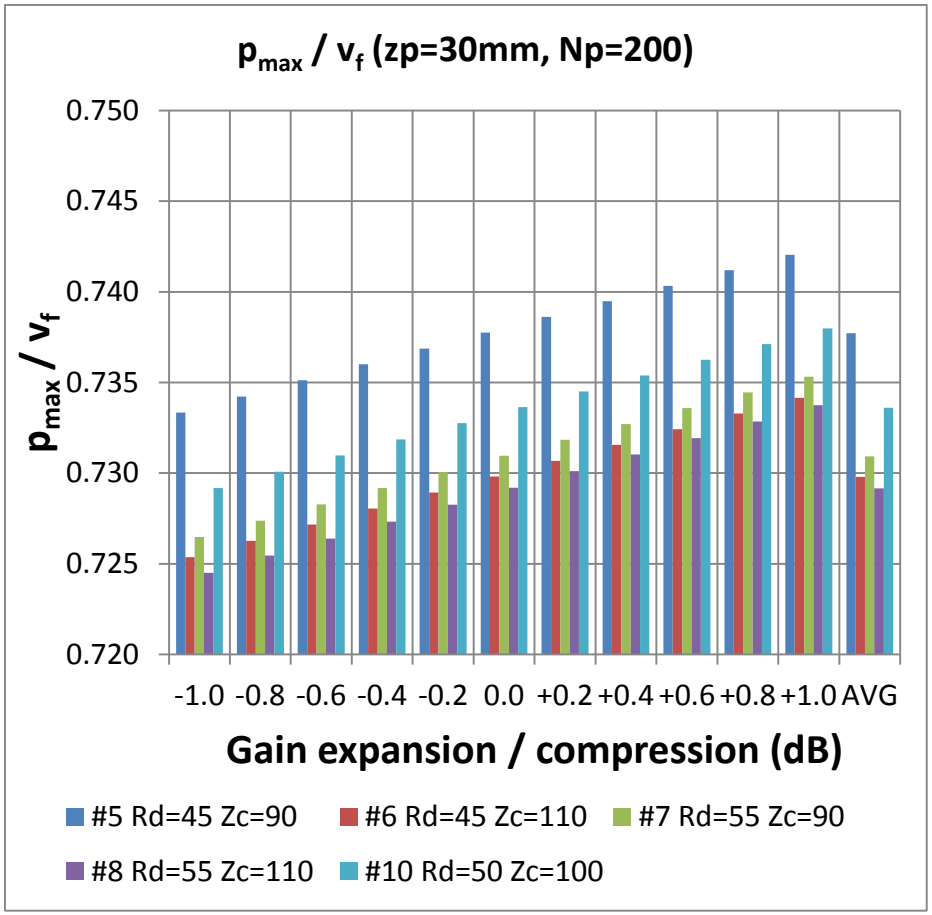
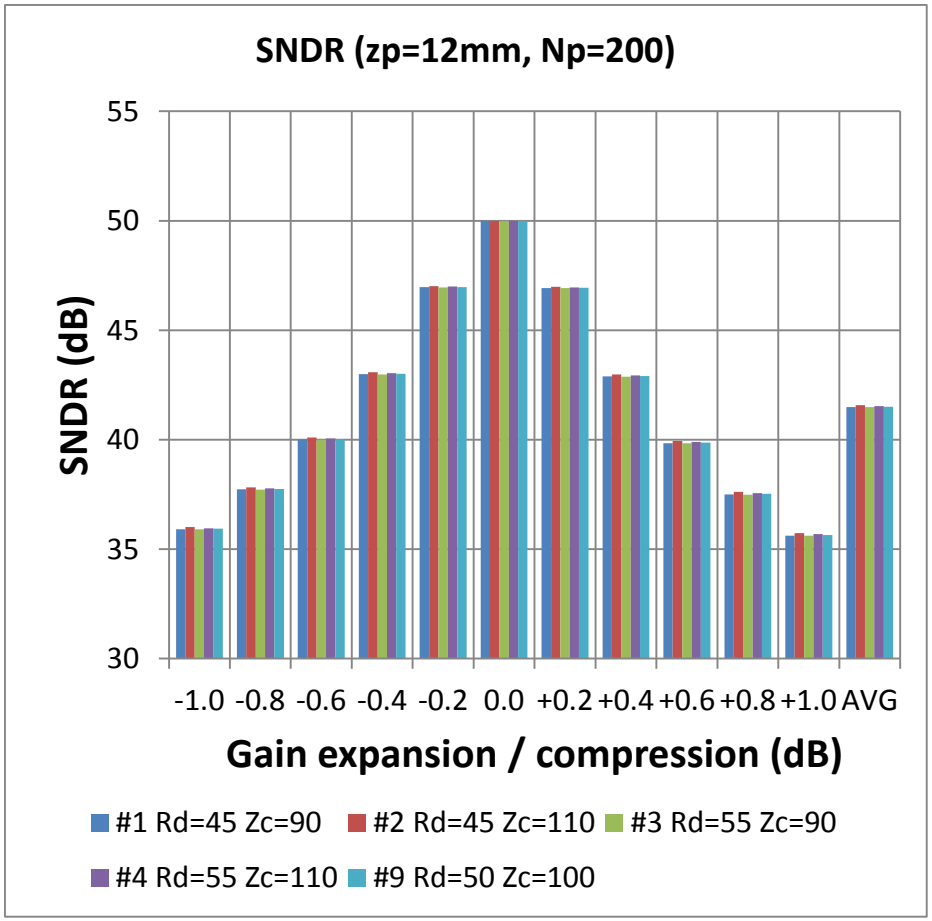
- The effect of Rd and Zc on the ratio of p_{max} to v_f is rather small between proposed conditions (#2/3/4, #6/7/8)

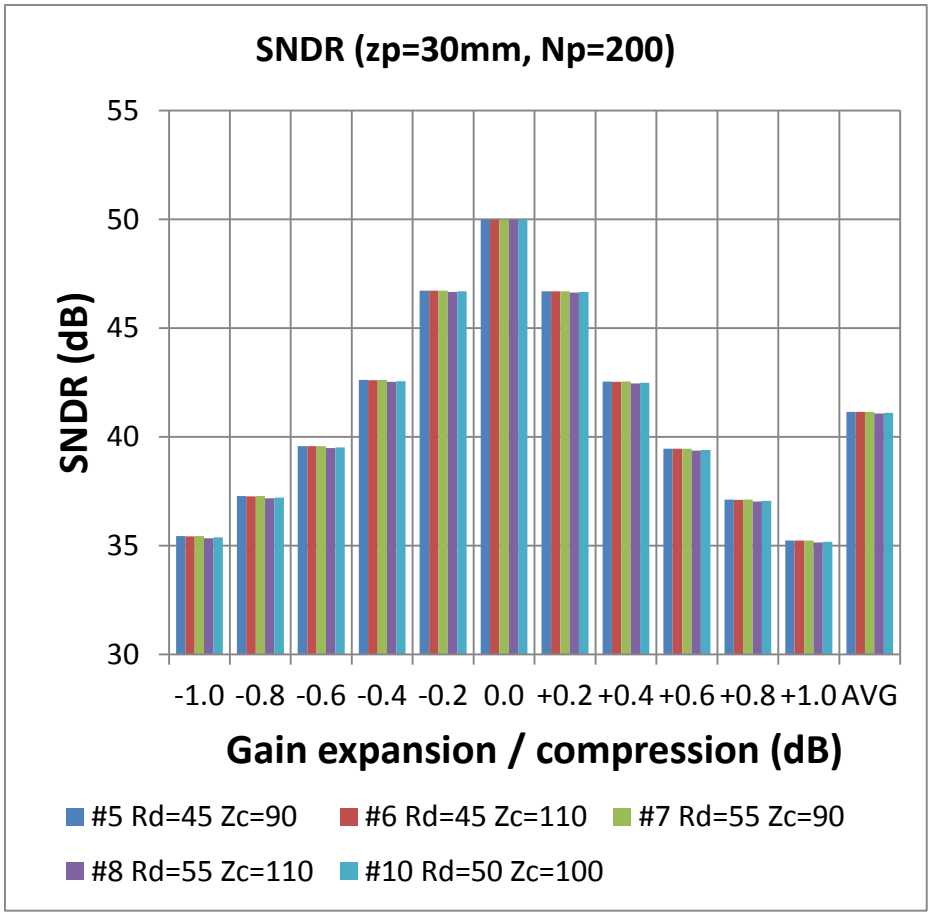




Effect on SNDR (Np=200)

- The effect of Rd and Zc on SNDR is very small





Conclusion

- The effects on the p_{max}-to-v_f ratio and the SNDR are rather small

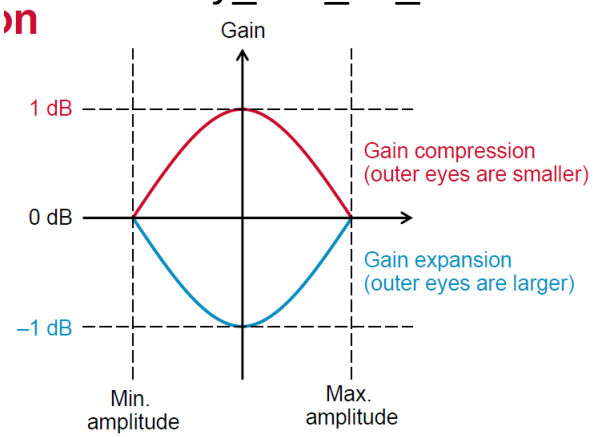
Back up Slides

- Simulation Methodology

Simulation Methodology

1. Get S_{21} of the entire model from 1MHz to f_{max} with 1MHz step
   - $f_{max} = 26.5625\text{GHz} \times M \div 2$, where $M = 32$
2. Get a single-bit pulse response
3. Get a linear cycle response of PRBS13Q with ideal levels
4. Cancel the DC offset of the linear cycle response of PRBS13Q
5. Get a non-linear cycle response of PRBS13Q by gain expansion / compression (similar to a methodology in healey_3bs_02_0916)
   - Simulated from -1.0dB to +1.0dB with 0.2dB step
6. Get V0, V1, V2, and V3 per 120D.3.1.2.1
7. Get Vmid, ES1, and ES2 per 120D.3.1.2
8. Get ES=(ES1+ES2)/2 per 120D.3.1.3
9. Get linear fit pulse p(k) and error e(k) per 120D.3.1.3, 94.3.12.5.2, 85.8.3.3.5
   - Dp=2 and Np=200
10. Get steady-state voltage v_f and linear fit pulse peak p_{max} per 120D.3.1.4
11. Get σ_e from e(k), then get SNDR per 120D.3.1.6
    - σ_n is always set to $p_{max} \times 10^{(-50/20)}$ (i.e. -50dB) to have noise floor

From healey_3bs_02_0916



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Thank you