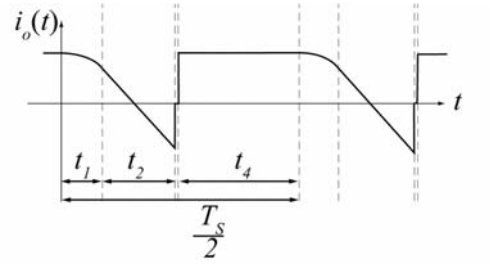
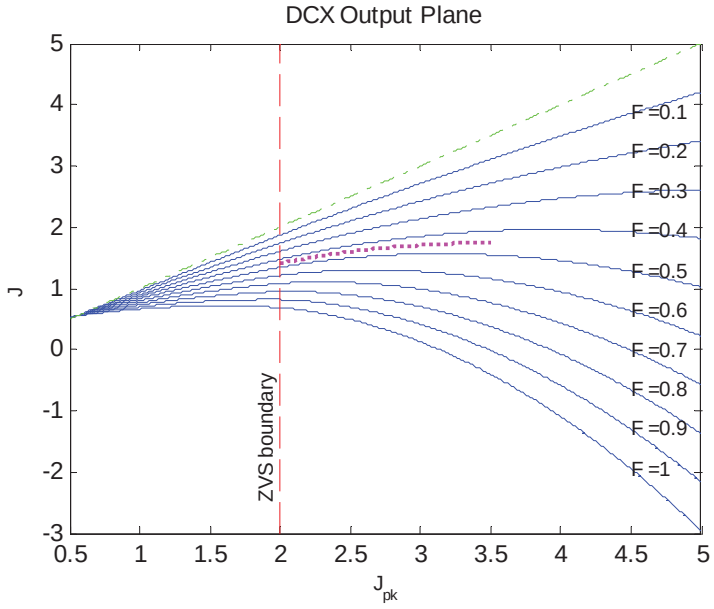
Averaging Step

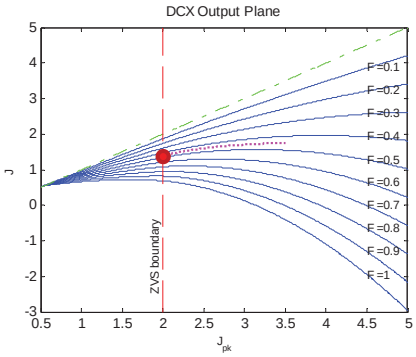


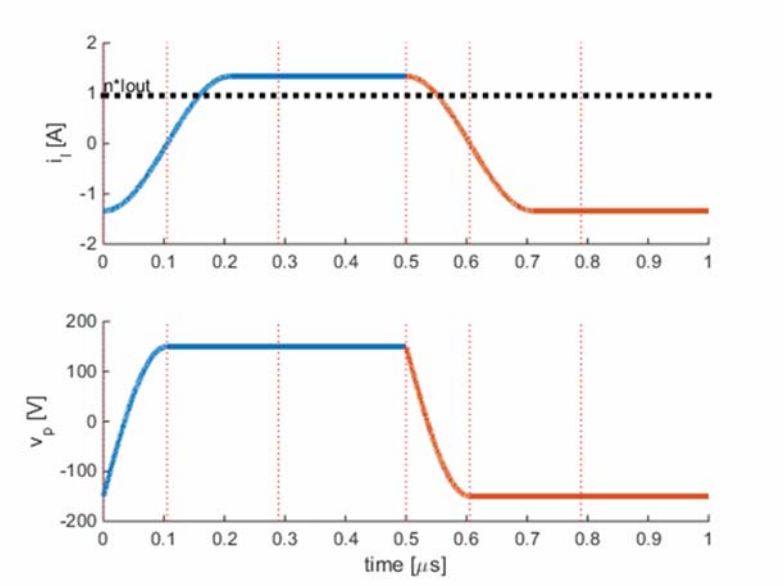
Output Plane

$$J = \frac{n\langle i_{out} \rangle}{I_{base}} = \frac{F}{\pi}\left[2 + \frac{1}{4}\left(J_1^{\,2} - J_2^{\,2}\right) + J_p\left(\frac{\pi}{F} - \alpha - \beta - \delta\right)\right]$$

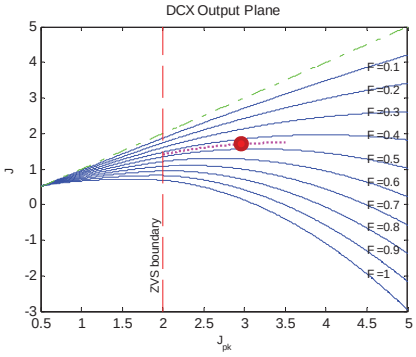


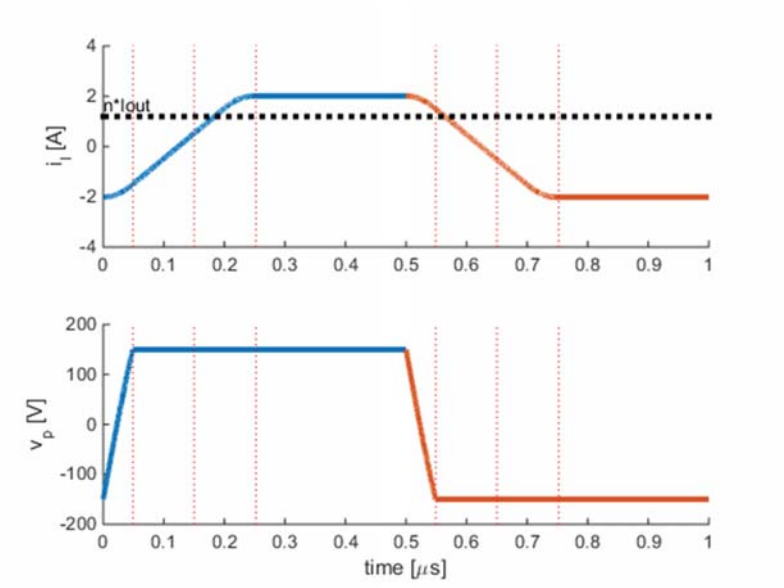
Example Waveforms



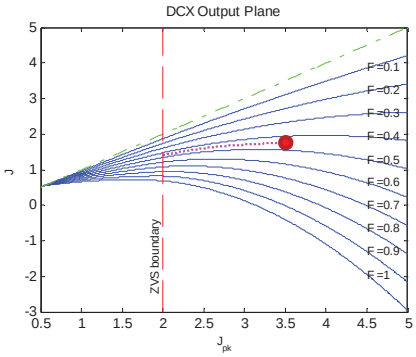


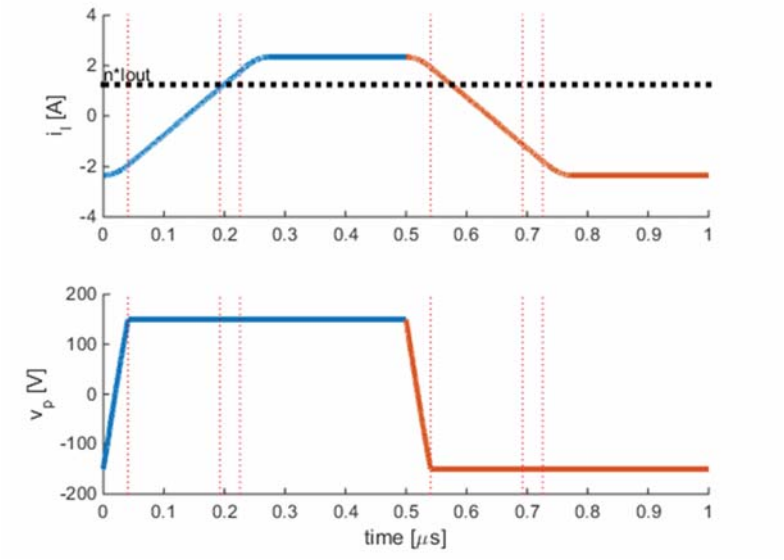
Example Waveforms



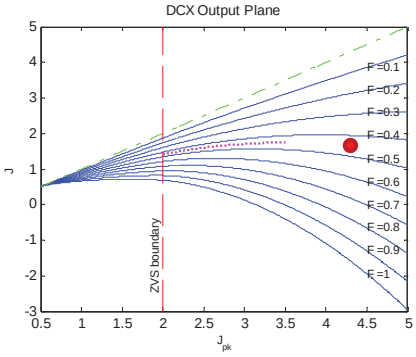


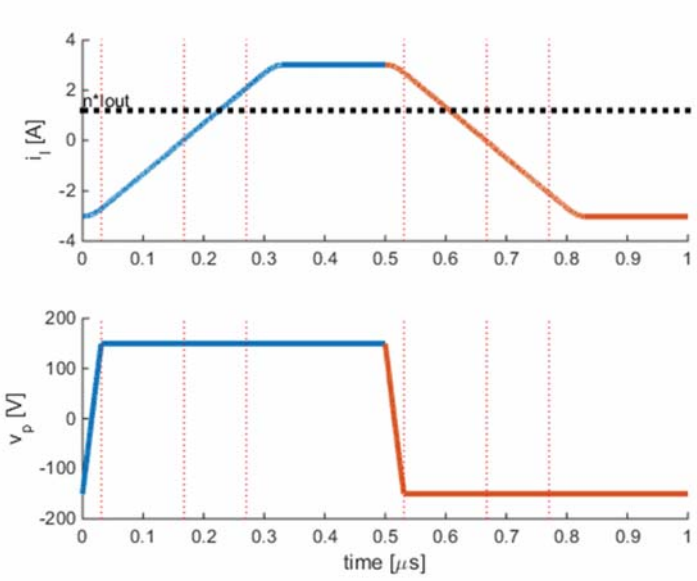
Example Waveforms



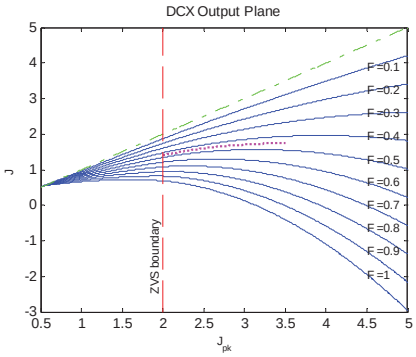


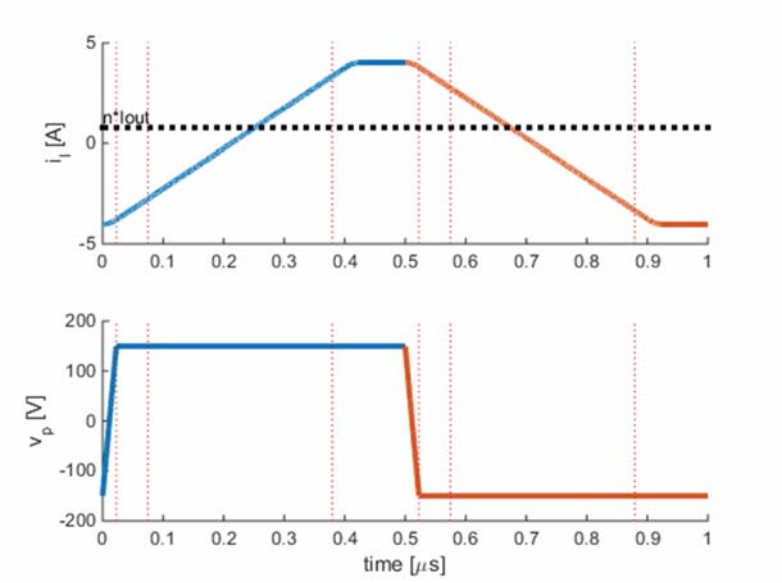
Example Waveforms



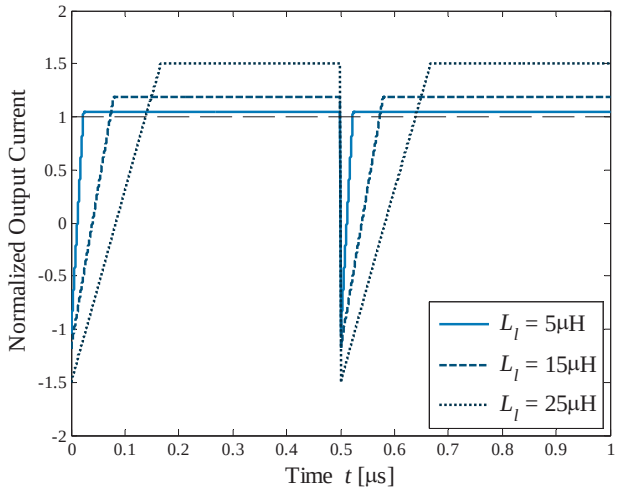


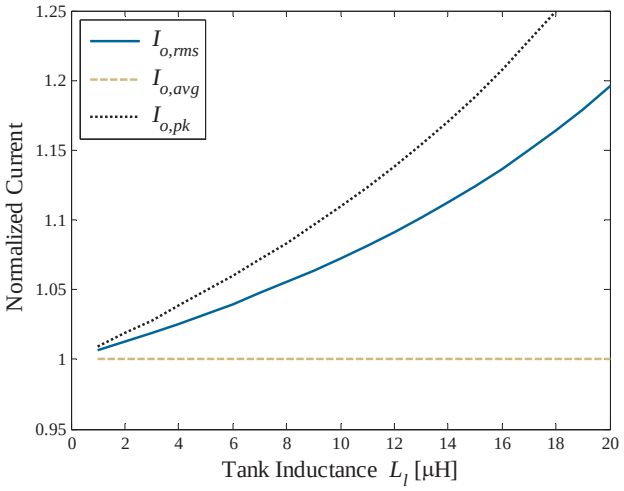
Example Waveforms



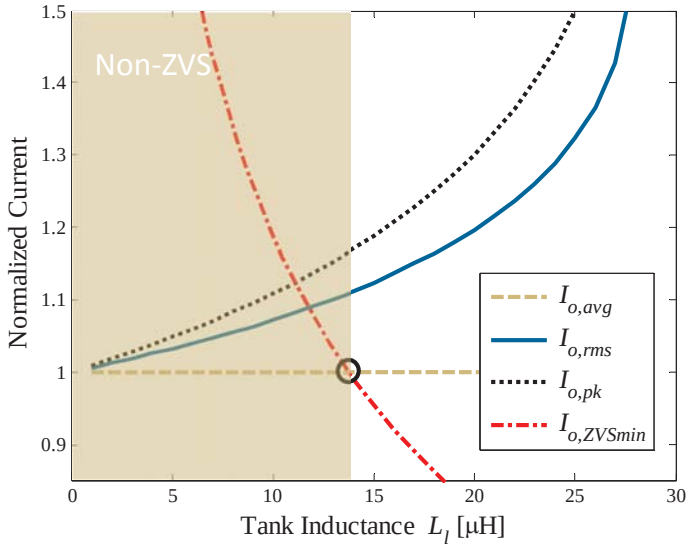


Output Current Vs. Inductance

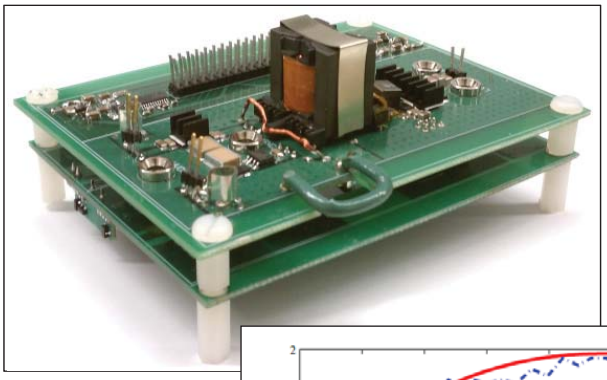


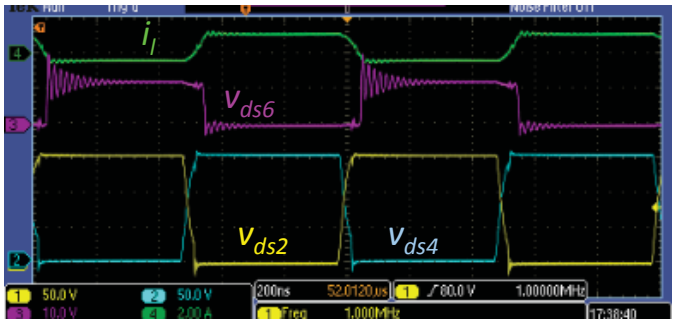


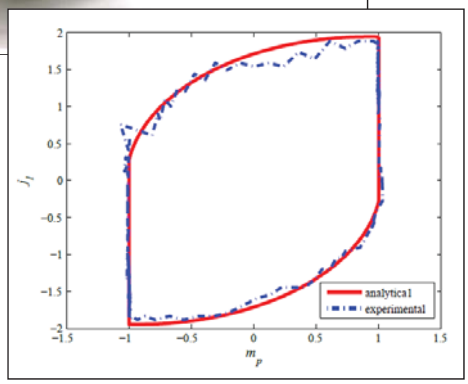
Constraints on Inductance

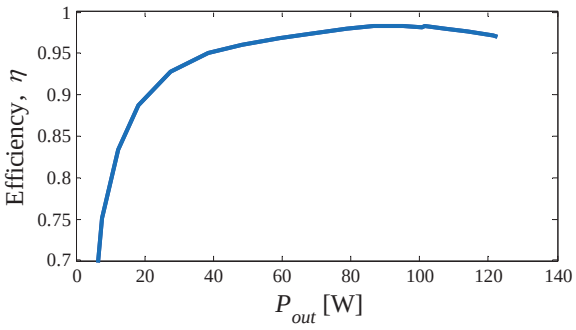


DAB: Experimental Results



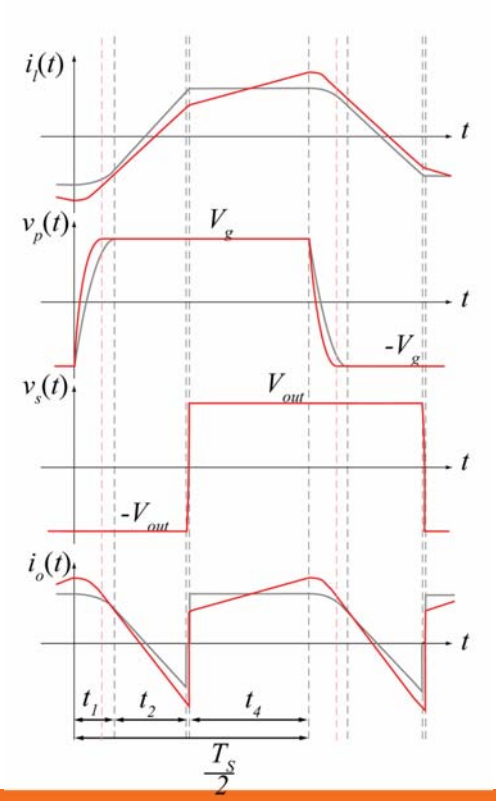


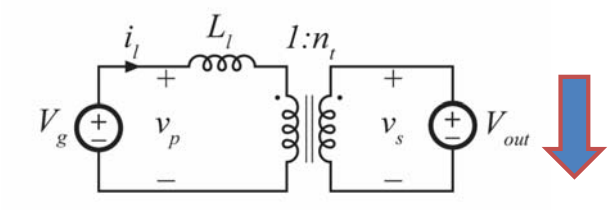




D. Costinett, D. Maksimovic, and R. Zane, "Design and control for high efficiency in high step-down dual active bridge converters operating at high switching frequency," IEEE Trans. Power Electron., vol. PP, no. 99, p. 1, 2012.

Operation with $V \neq nV_g$



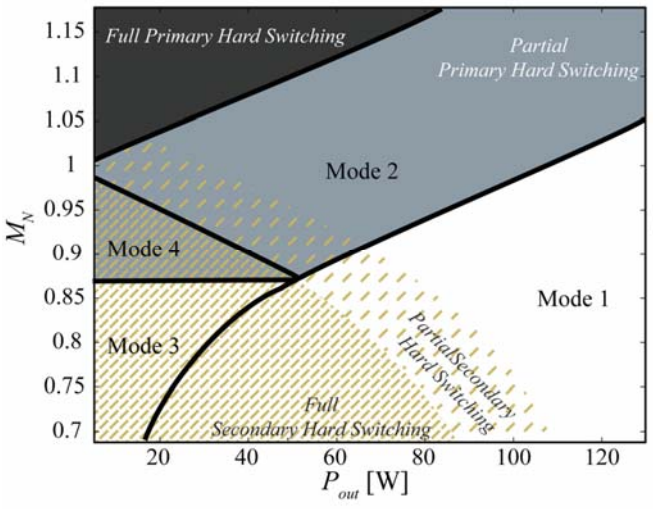


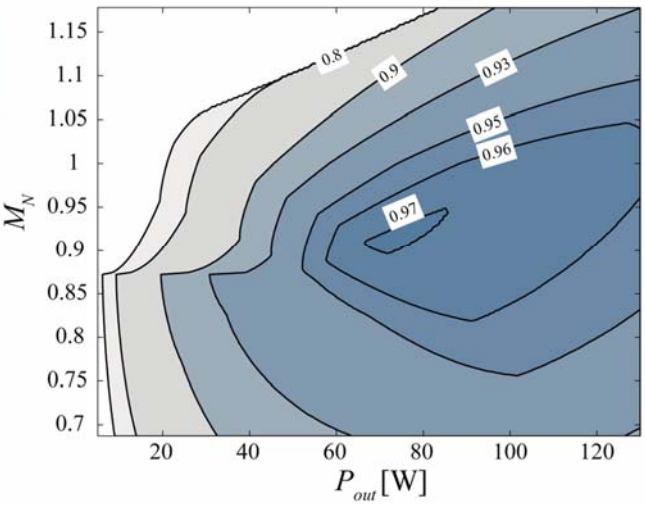
- E.g. Decrease to

  $M_N < 1$

  by decreasing output voltage
- Current now ramping, causing more energy available for primary ZVS, but higher RMS currents
- Can use behavior to extend ZVS range of one bridge

Soft Switching Range with Varying V_{out}





Application Example: Automotive

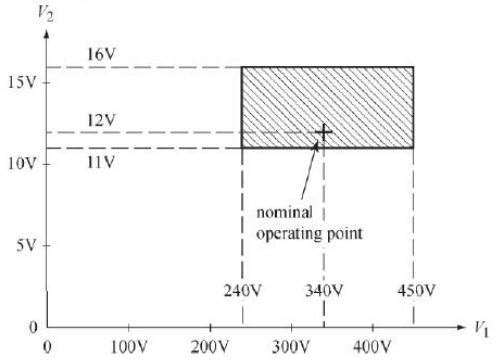


Fig. 1. Converter operating voltage ranges required for automotive application.

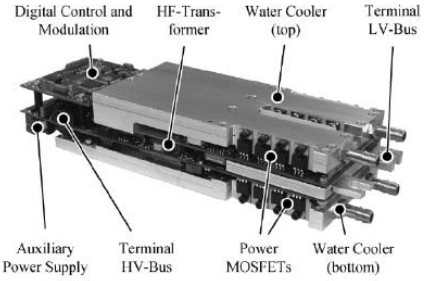
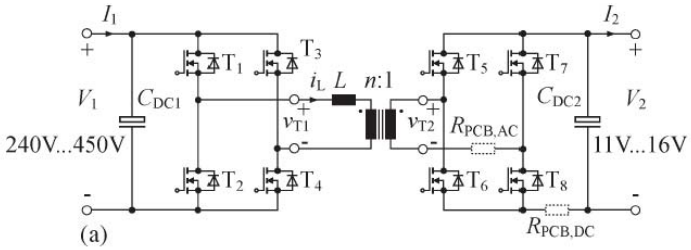


Fig. 3. Automotive DAB converter (273 × 90 × 53 mm).



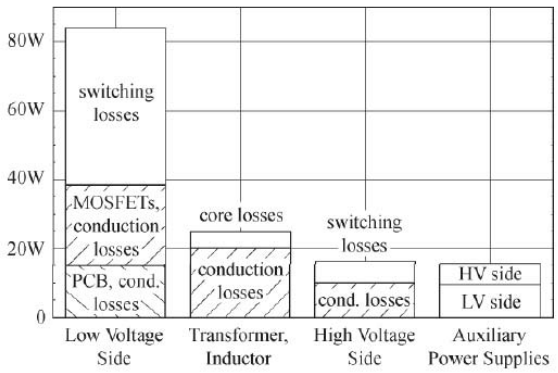


Fig. 13. Calculated distribution of the power losses for operation at $V_1 = 340$ V, $V_2 = 12$ V, and $P_2 = 2$ kW.

*F. Krismer, J.W.Kolar, "Accurate Power Loss Model Derivation of a High-Current Dual Active Bridge Converter for an Automotive Application, IEEE Trans. On Industrial Electronics, March 2010

Alternate Modulation Schemes