ECE581

Design of a DAB Converter

The dual active bridge (DAB) converter is shown in Fig. 1. The converter operates with phase-shift modulated control, as shown in Fig. 1. Consider the following design of the converter:

- $V_g = 100$ V
- $V = 100$ V
- $n_t = 1$
- $f_s = 1$ MHz
- All devices Q_1-Q_8 have an effective output capacitance of $C_{ds} = 200$ pF
- C_{out} is very large

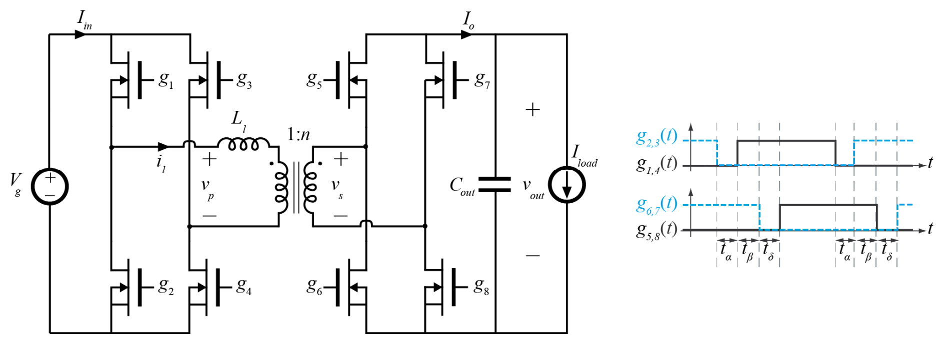

Figure 1: DAB converter

1. Sketch the j_l-m_p and j_l-m_s state planes for operation at P_{out} large enough such that all devices obtain ZVS and the phase shift $t_\beta > 0$. Solve the state planes for a set of equations describing circuit operation; complete the averaging step to solve for the normalized average output current, J.
2. Solve an expression for the normalized *RMS* output current J_{rms} (*Note: see Appendix A.2 of Fundamentals of Power Electronics*).
3. Manipulate the equations from (1) so that you obtain a single equation of the form:

$$J = f(F, J_{pk})$$

   Plot the resulting equation on J_{pk}-J axes, for $F = 0.1$ 0.5 and 1. Plot only the values of J_{pk} over which this solution is valid.
4. Design the tank (i.e. select L_l) so that minimum conduction losses occur while maintaining ZVS down to an output power of $P_{min} = 50$ W. What is F?
5. What is the maximum power that can be delivered to the load with the design from (4)?

(*continued on next page*)

The following devices are available for implementing Q_1-Q_8

	$R_{ds,on}$ [mΩ]	C_{ds} [pF]	V_{bv} [V]
MOSFET A	100	200	200
MOSFET B	15	4000	200
MOSFET C	50	400	200
MOSFET D	500	40	200

For each MOSFET, L_l is designed so that P_{min} = 50 W. You may assume that conduction losses can be modeled by the ideal rms currents solved for in (2).

6. Which MOSFET results in the smallest losses in-circuit, when operated at P_{out} = 50 W?