ECE 529: Homework #4

Due Session 40 (April 24)

1. Implement a modified averaged model of a three phase VSC from hws 2 and 3 with an AC source voltage of 2.3 kV (L-L), R = 0.0096 Ω , X_s = 0.144 ohm (X/R = 15) and a switching frequency of 3060Hz in a transient simulation program.

   The DC link has two 10,000 μF capacitors connected pole to ground. The output of the converter goes to a 2.3kV:24kV, 5 MVA, Y-Yg step up transformer with X = 0.08 pu on the transformer rating base and an X/R ratio of 15 and then connects to a power system with a Thevenin equivalent impedance Z = (0.05 + j 0.5) pu (on a base of 24 kV and 5 MVA) and an equivalent source voltage of 24 kV.

   The point of interconnect is on the high side of the transformer. Take your voltage and current measurements on the high side of the transformer and scale them to the low voltage side for your control loops.

   A. Implement a phase locked loop for a point of interconnect at the high voltage side of the transformer and test with ideal voltage sources on the dc link and a couple of P and Q ranging between 0 and 5 MVA total to the Thevenin source. The converter can supply up to 5 MVAR, but can only absorb about 1.5 - 2 MVAR depending on your controls.

   B. Replace the dc voltage sources with a capacitor banks in parallel with a current source behind a small resistance. Implement a dc bus voltage regulator to determine the direct axis current reference for the controls. Set up the DC current source to be able to ramp from an equivalent of 0 MW to 4 MW in 0.5 seconds while the converter is at unity power factor and the stays at 4 MW for the rest of the simulation.

   C. Repeat part B with a power factor of 0.8 for supplying reactive power and a power factor of 0.966 for absorbing reactive power. Compare the magnitude of the voltage at the point of interconnect the two different power factor cases.

   D. Repeat part B with the quadrature axis current reference determined by a closed loop voltage regulator set to maintain the voltage at the point of interconnect at 24 kV line to line.