Iowa State University
Electrical and Computer Engineering
E E 452. Electric Machines and Power Electronic Drives

Laboratory #7
Three-Phase Inverter & Space Vector Modulation – Simulation

Summary

In this lab you will run a simulation of a three-phase inverter that uses space vector modulation.

Learning objectives

- Simulation of space vector modulation-based inverters.
- Using blocks with discrete sampling in Simulink.
- Using embedded MATLAB functions in Simulink.

Background material (should be read before coming to the lab)

- Trzynadlowski chapters 4 and 7
- Lecture notes on three-phase inverters and space vector modulation
- *MATLAB User's Guide*

Exercises and Questions

*Instructions**:** every student should deliver his/her own report at the end of the lab session, even though the experiments are conducted in groups. You may want to answer the questions as you go along the exercises. Time yourselves according to the recommendations below.*

1. **Pre-lab assignment**

   Study section 7.1.2 and 7.1.3 in Trzynadlowski, which covers the *Three-phase Voltage Source Inverter* and *Space Vector PWM Techniques*. You will have to refer to parts of chapter 4 as well.

   DELIVERABLE 1:
   Write a short paragraph summarizing your reading. Identify one of the advantages to implementing a space vector modulation technique. Why is it necessary to know which sector the reference vector is in at any given time?

2. **Space-vector modulation switching signal generation** [90 minutes]

   You will be given a Simulink subsystem that implements space vector modulation for a three-phase inverter.

   In *Simulation/Configuration Parameters*, verify that the solver is a "Fixed-step" type. Set the *Tasking mode for periodic sample times* as *SingleTasking*. Also check the box to *Automatically handle rate transition for data transfer*.

   Note: You must define the switching period, "Tsw", and the simulation's fundamental time step, "Tstep", as a variable in the MATLAB workspace for the model to compile and run properly.

   Reverse-engineer the Simulink model and embedded MATLAB functions.

   DELIVERABLE 2:
   - Explain what every component of the simulation does in as much detail as possible.
   - Open the embedded MATLAB functions and explain the various pieces of the code. You can add comments to the script.
   - Identify differences in notation between the code and what we have done in the class.

   DELIVERABLE 3:
   Make a sketch of the switching signal output (S1, S2, S3) that would be obtained from the block for `vqss_star/vdc = 0.5` and `vdss_star/vdc = -0.5`.

   Hint: Sectors are numbered the same in Trzynadlowski as they are in the notes, but switching states are not.

3. **Simulation** [75 minutes]

Use ASMG to create the circuit of a three-phase bridge inverter. Connect the inverter to a symmetric 3-phase Y-connected *RL* load, with R = 10 Ω and L = 10 mH per phase. Connect the upper and lower rails to a constant voltage source V_{dc} = 500 V. Connect the semiconductor gates to the output of the SVM block.

DELIVERABLE 4:
Run a simulation where the inverter outputs a voltage of 60 Hz fundamental frequency and line-to-neutral rms value of 250 V. Select an appropriate switching period so that the output current has THD less than 5%. Sketch the waveforms of the load's line-to-neutral voltages, line-to-line voltages, and line currents.

Hint: Do not use the THD block available in the Simulink library; the result is not correct. Modify your MATLAB code from Lab 3 to calculate the THD. Make sure to run the simulation with a "Fixed Time Step", such that you can easily integrate the data.

4. **Conclusion** [15 minutes]

Write about one or two things you learned in this lab that you think are important or interesting, and why.