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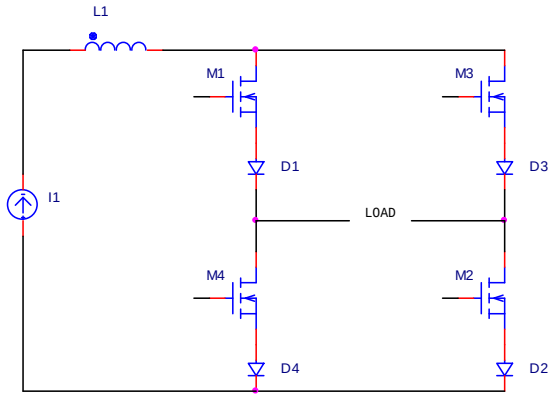
Lab 5: Current Source Inverters

Pre Lab

Current source inverters: As the name implies, current source inverters (CSI) allow the designer to set the current output of the inverter, while the voltage is allowed to vary. Here's a basic current source inverter topology:



Circuit 1 Current source inverter

One possible way to run this circuit is with the following gating sequence: M1 M2 → M2 M3 → M3 M4 → M4 M1 → M1 M2 …. where M1 and M2 are gated once every 1/60 s and two transistors are conducting at any given instant.

1. Draw the load current waveform if I1 were a 1A constant current source and the MOSFETs were gated as just described.

2. Why do you think the diodes are where they are in this CSI topology?

3. Recall from Lab 4 that one must be sure that neither “vertically aligned” switches nor “horizontally aligned” switches are on at the same time for a VSI. Is there anything like that to avoid for a CSI?

1. Do you think a VSI or a CSI would be a better choice to connect PV to the grid? Why?

Lab Exercises

Current source inverters:

The gating signals for a CSI are a little more complicated to generate than those for the simple VSI. Figure 1 is a plot of the gating signals you need. You can see that each gating signal is on and off for the same amount of time. Take the signal for M1 for example: let it turn on at some angle 0 (Now we’re talking in terms of phase shift). M1 then turns off at an angle of π, i.e it was on for the first half of the cycle, then off for the second half. M2 is the same signal, only delayed by a quarter of a cycle, or shifted by -π/2 radians. Similarly, M3 is the same signal as M1, only delayed by half of a cycle, or shifted by +-π rad.

1. What is the phase shift of M4 with respect to M1?

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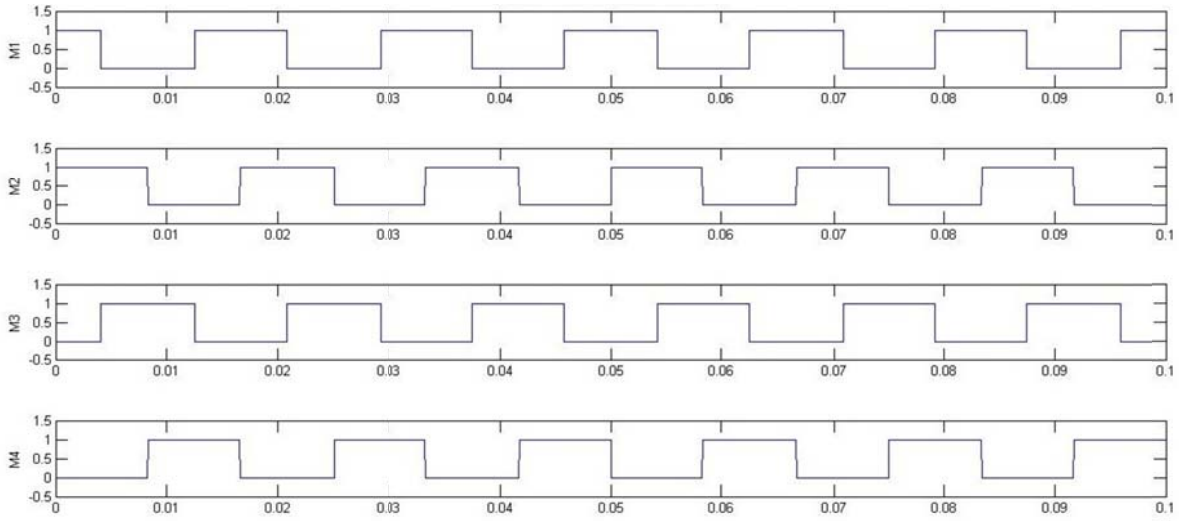
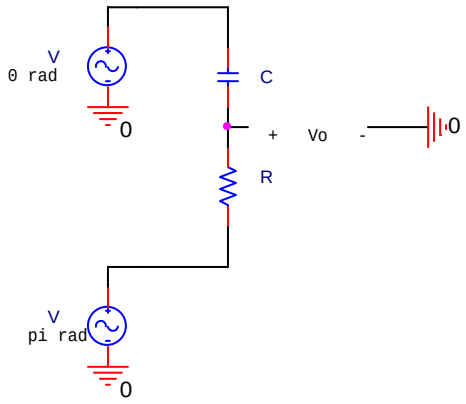


Figure 1 CSI gating signals

2. Your first quest is to design and build a circuit that produces these signals. You most likely won't want their voltage levels to be 0 and 1V, but since you'll be designing the CSI after you're done with this, that's really up to you. You're free to make this happen however you like. Take a screenshot of your gating signals when you're done. Here's a circuit you may find useful:



Circuit 2 Phase shifter (Horowitz and Hill)

By manipulating the values of R and C, circuit 2 can be used to produce an output, Vo, of the same magnitude, V, and a phase shift of 0 to –π. Hint: use the node voltage technique if you want to find an equation for phase shift in terms of R and C.

3. Include a screenshot of your gating signals.

4. Using the circuit you just designed to provide the gating signals, design and build a current source inverter using the same topology as Circuit 1. Use a 10W PV panel as the input and a 300Ω resistor as a load. Include a schematic of your gating circuit(s) in your report.
5. Take a screenshot of the output current on the Labvolt scope once your circuit is working.

6. Does the output current waveform look like you thought it would? If not, why?

7. Take a screenshot of the harmonic profile of the output current. How does it compare with that of the VSI in 180^0 conduction mode from Lab 4?

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8. Take a screenshot of the load voltage waveform. Does it look like you expected it to?

9. Vary the load resistance. Does the inverter respond how you expect it to? Why or why not?

10. Take a screenshot of the PV voltage, load voltage, and load current waveforms on the same screen. Explain why the PV voltage has the shape it does.

11. From the PV voltage screenshot screenshot, predict whether or not this CSI would work with the MPPT you designed during Lab 2.