DC−AC Converter (PE_1ph_VSI_5.sqproj)

Question: A single phase full−bridge voltage source inverter (VSI) controls the power in a resistive load. The nominal value of source voltage is 220V and a uniform pulse−width modulation with 2 pulses per half cycle is used. The desired fundamental frequency is 50 Hz. For the required control, the width of each pulse is 50°.

(i) Determine the RMS load voltage.

(ii) If the DC supply increases by 10 %, determine the pulse−width required to maintain the same load power.

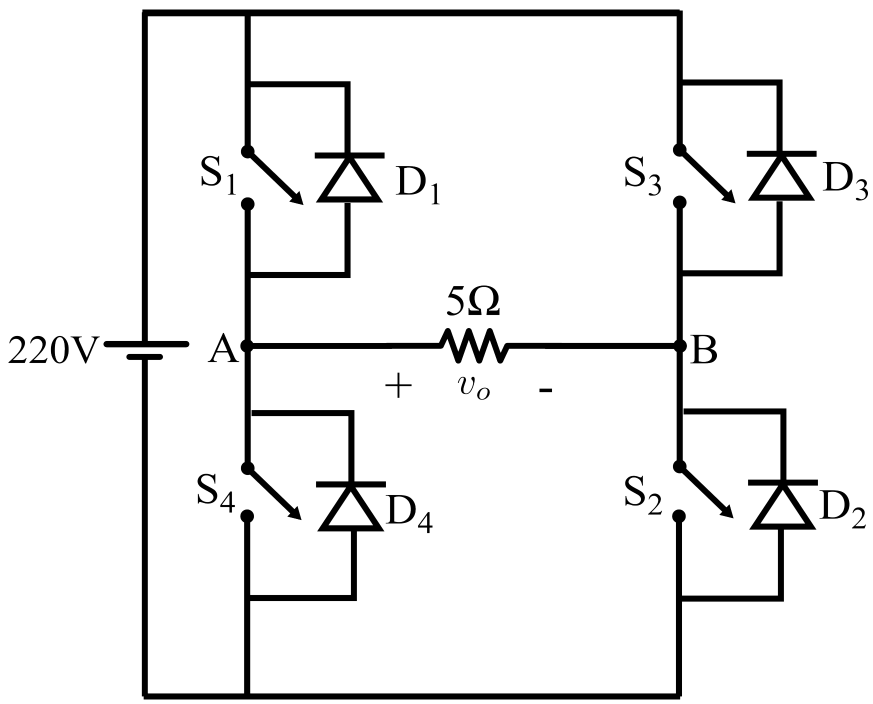

Figure 1: Full−bridge inverter

Solution :

Pulse−width modulation (PWM) techniques are employed for the control of output voltage. In PWM method, width of the output voltage gets modulated while maintaining amplitude as constant.

Operation : Multiple pulse−width modulation technique uses a low−frequency square-wave as the reference signal and a high−frequency triangular wave as the carrier signal. From the intersections between the reference and the carrier signals, number of pulses with the same width are generated in every half cycle of the output voltage giving a fundamental component which is higher than the respective single pulse−width modulation. These pulses functions as the trigger pulses for the respective switches.

For a resistive load, when the switches S_1, S_2 are ON, the voltage across load (v_o) is positive, the current (i_o) is also positive. Similarly, when the switches S_3, S_4 are ON, the voltage across load (v_o) is negative, the current (i_o) is also negative. The diodes will not conduct in this case.

The modulated output voltage waveform with two pulses per half - cycle is shown in the Fig 2 (b).

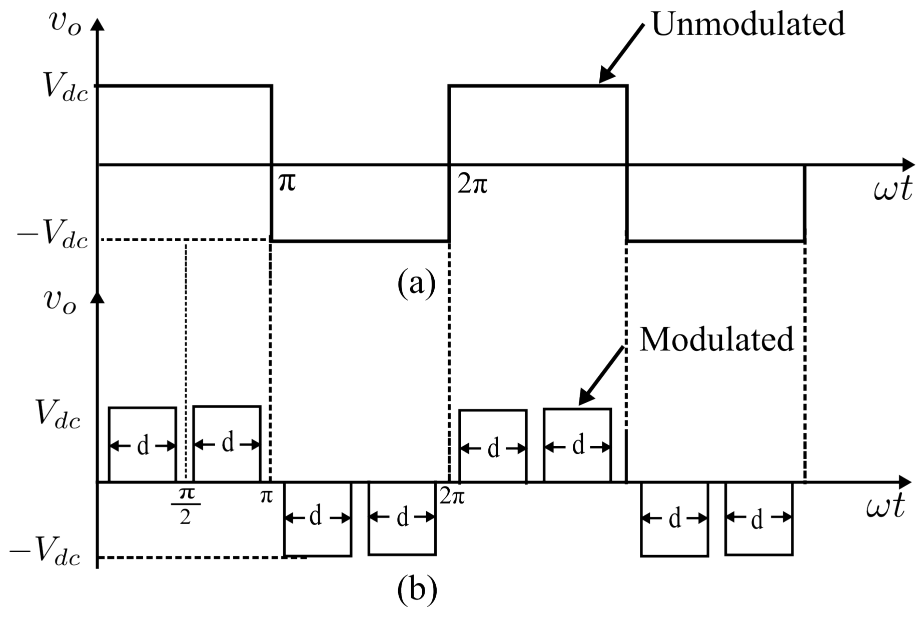

Figure 2: Output voltage waveforms (a) Unmodulated (b) Modulated

If the inverter circuit is operated with more number of pulses, the lower order harmonic content can be reduced. But higher order harmonics will be increased which can be eliminated with small sized filters. The limiting factor in selecting more number of pulses is switching speed capability of power semiconductor devices.

(i) The RMS value of output voltage is given by

$$V_o^{\text{rms}} = V_{dc}\sqrt{\frac{2d}{\pi}}$$

$$\therefore V_o^{\text{rms}} = \sqrt{\frac{220^2 \times (100^\circ \times \frac{\pi}{180^\circ})}{\pi}} = 163.97\,\text{V}$$

(ii) V_{dc} is increased by 10%. Thus the dc value changes to 242 V.

The load power remains the same. Therefore the RMS value of the output voltage remains unchanged.

$$\text{i.e., } 163.97\,\text{V} = \sqrt{\frac{242^{\,2} \times (2d \times \frac{\pi}{180^\circ})}{\pi}} \Longrightarrow d = 41.37^\circ$$

$\therefore$ The pulse−width is 41.37°

SequelApp Exercises:

(1) A single phase full−bridge VSI controls the power in a resistive load of 5 Ω. A uniform pulse−width modulation with 2 pulses per half cycle is used. If the pulse−width is 35°, determine the input dc source voltage to maintain the same power as in the previous question. The desired fundamental frequency is 50 Hz.

Verify your answer using SequelApp.