DC−AC Converter (`PE_1ph_VSI_3.sqproj`)

Question: A single-phase full-bridge voltage source inverter is fed from a DC source such that the fundamental RMS output voltage is 230 V. The desired fundamental frequency is 50 Hz. Find the RMS values of the switch and diode currents for a resistive load of 2 Ω.

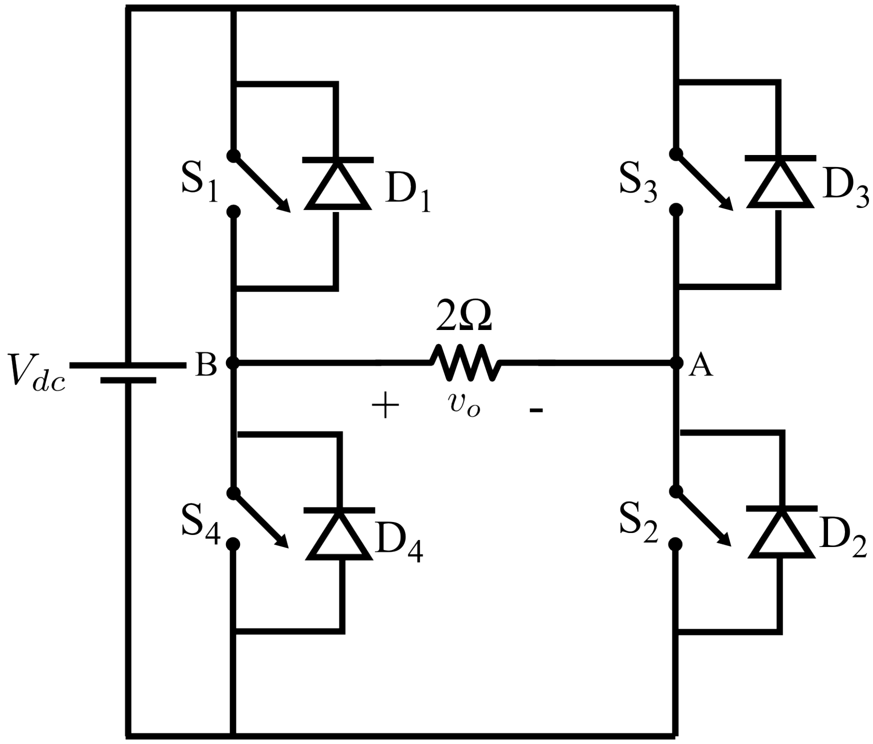

Figure 1: Full−bridge inverter

Solution :

Figs. 2 (a) and 2 (b) shows states of switches such that the output voltage is a square waveform.

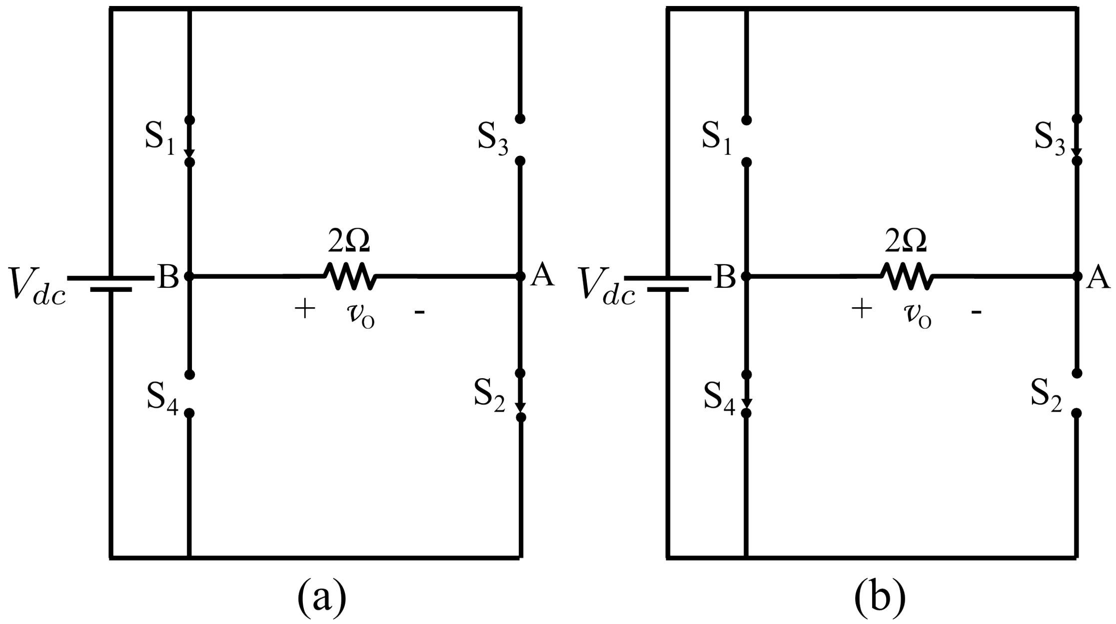

Figure 2: Full− bridge VSI circuit. (a) $S_1.S_2$ are ON, (b) S_3, S_4 are ON

For an unmodulated voltage source inverter, the v_o waveform is half wave symmetrical square, irrespective of the type of load. Therefore, the pattern of conduction of switches and diodes should be as follows.

	v_o	i_o
S_1, S_2	+	+
D_1, D_2	+	−
S_3, S_4	−	−
D_3, D_4	−	+

Operation : When the switches S_1, S_2 are ON $(0 < t < \frac{T}{2})$, the voltage across load (v_o) is positive. When the switches S_3, S_4 are ON $(\frac{T}{2} < t < T)$, the voltage across load (v_o) is negative. The shape of current waveform is identical to that of voltage waveform in a resistive load, hence diodes does not conduct in this case.

v_o waveform is shown in Fig. 3 (a).

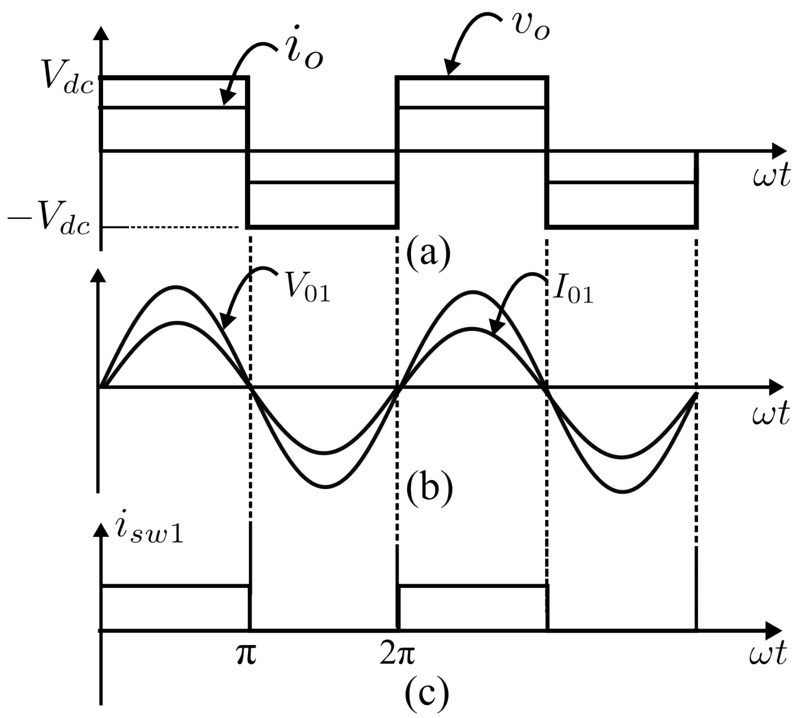

Figure 3: Waveforms (a) Output voltage and current (b) Fundamental output voltage and current (c) Switch current

The waveform has half-wave symmetry. Hence the Fourier series consists of odd harmonic terms alone. Also, the waveform is an odd periodic signal, i.e., only the sine terms of the Fourier series exist.

Therefore, the trigonometric Fourier series representation of the waveform is given by the eqn. 1.

$$v_o\,(\omega t) = \sum_{n=1,3,5,....}^{\infty} \frac{4V_{dc}}{n\,\pi}\,\sin(n\omega t) \tag{1}$$

$\therefore$ RMS output voltage at the fundamental frequency $(V_{01}^{\text{rms}}) = \dfrac{4}{\sqrt{2}\pi} \times V_{dc} = 230\,\text{V}$

$$\Longrightarrow V_{dc} = \frac{230 \times \sqrt{2}\pi}{4} = 255.47\,\text{V}$$

For a square waveform, the RMS value and the magnitude of waveform are equal.

$$\therefore V_o^{\text{rms}} = V_{dc} = 255.47\,\text{V}$$

and the RMS output current (I_o^{rms}) is given by

$$(I_o^{\text{rms}}) = \frac{V_o^{\text{rms}}}{R} = \frac{255.47}{2} = 127.79\,\text{A}$$

When the switch S_1 is ON $(0 < t < \frac{T}{2})$, the switch current (i_{sw1}) is as shown in Fig. 3 (c). RMS value of switch current is given by

$$i_{sw1}^{\text{rms}} = \frac{I_o^{\text{rms}}}{\sqrt{2}} = \frac{127.79}{\sqrt{2}} = 89.96\,\text{A}$$

For resistive load, diodes will not conduct, i.e., RMS value of diode current is zero.

SequelApp Exercises:

In a full-bridge VSI, the load resistance R is $5\,\Omega$, and the fundamental RMS output current is 20 A. The desired fundamental frequency is 50 Hz.

(1) Find the input dc voltage required for the above conditions, assuming the switches to be ideal.

(2) What is the source current in this case?

Verify your answer using SequelApp.