DC−AC Converter (PE_1ph_VSI_1.sqproj)

Question: A single phase half−bridge voltage source inverter (VSI) has a resistive load of 2.4 Ω and input dc voltage $V_{dc} = 48$ V as shown in Fig. 1. The desired fundamental frequency of the load voltage is 50 Hz. Determine

(i) RMS output voltage at fundamental frequency.

(ii) voltage rating of switches.

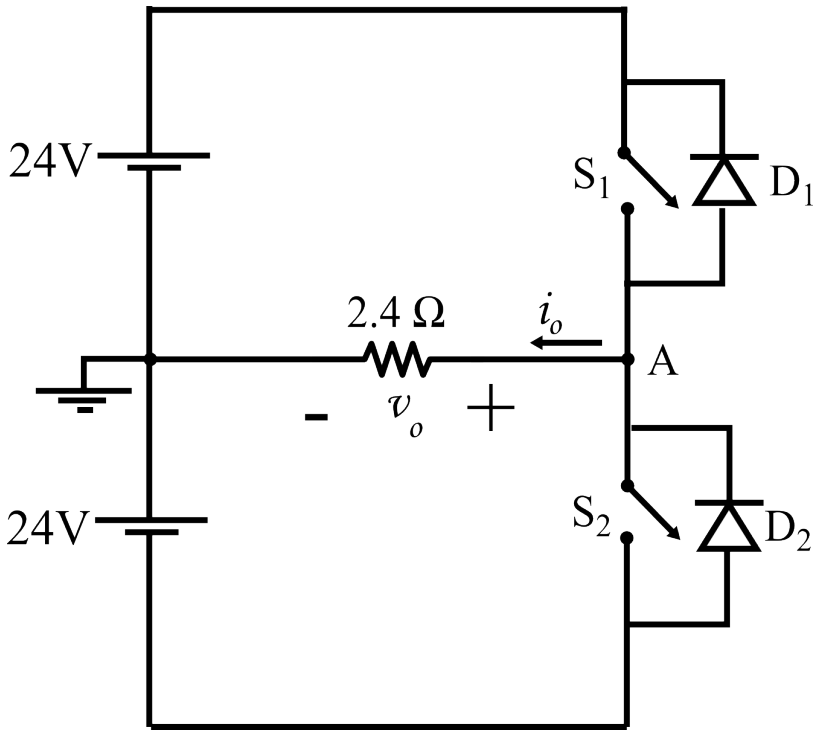

Figure 1: Half-bridge inverter

Solution :

Switches are operated in a complementary manner, i.e., the switches will not be be in the ON state together.

Figs. 2 (a) and 2 (b) shows ON states of switches S_1 ans S_2, respectively.

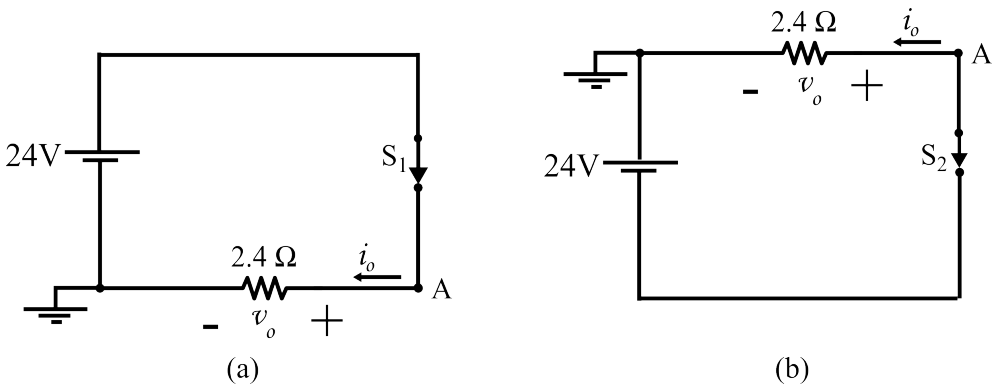

Figure 2: Half bridge VSI circuit. (a) S_1 is ON, (b) S_2 is ON

For an unmodulated VSI, the v_o waveform is half symmetrical square for all types of load. The pattern of conduction of switches and diodes are as follows.

	v_o	i_o
S_1	+	+
D_1	+	−
S_2	−	−
D_2	−	+

Operation : When the switch S_1 is ON ($0 < t < \frac{T}{2}$), the voltage across load is positive and hence the current is positive. When the switch S_2 is ON ($\frac{T}{2} < t < T$), the voltage across load is negative and hence the current is negative. Diodes will not conduct for a resistive load.

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

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 voltage waveform is given by the eqn. 1.

$$v_o(\omega t) = \sum_{n=1,3,5....}^{\infty} \frac{4}{n\,\pi} \frac{V_{dc}}{2} \sin(n\omega t) \tag{1}$$

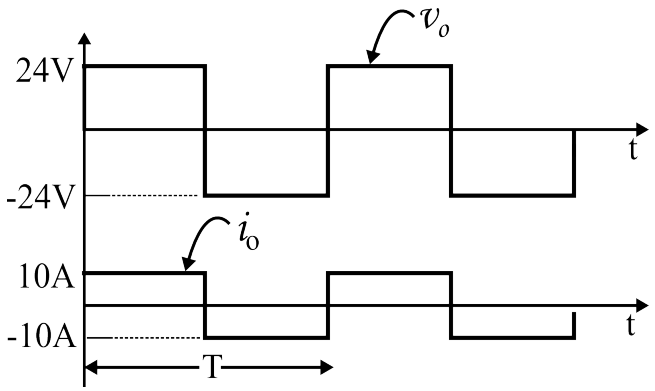

Figure 3: Output voltage and current waveforms

RMS output voltage at the fundamental frequency $= \frac{4}{\sqrt{2}\pi} \times \frac{48}{2} = 21.6\,\text{V}$

(ii) When the switch S_1 is ON ($0 < t < \frac{T}{2}$), the inverter circuit is as shown in the figure below.

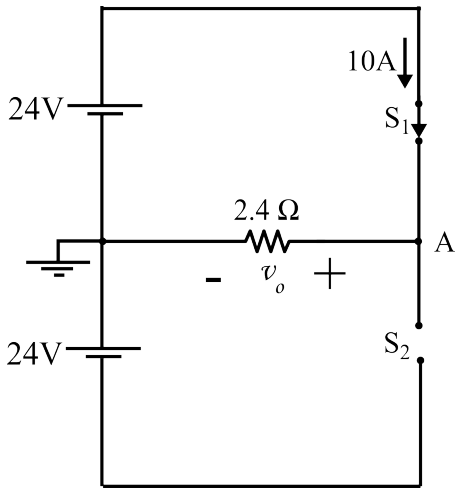

Figure 4: Half bridge VSI when S_1 is ON

$\therefore$ Voltage rating of switch $S_2 = \frac{V_{dc}}{2} + i_o R = 48\,\text{V}$

SequelApp Exercises:

(1) In a half-bridge VSI, if the load resistance R is $3\,\Omega$ and the RMS switch current is $10\,\text{A}$, find the input dc voltage. The desired fundamental frequency is $50\,\text{Hz}$.

Verify your answer using SequelApp.