

Current Source Inverter - 2 (PE_CSI_2.sqproj)

Question: For the current source inverter shown in Fig. 1,

- (a) Find the maximum instantaneous value of the output voltage.
- (b) Find the value of current through capacitor at this instant.

(Given switching frequency $f = 50\text{Hz}$)

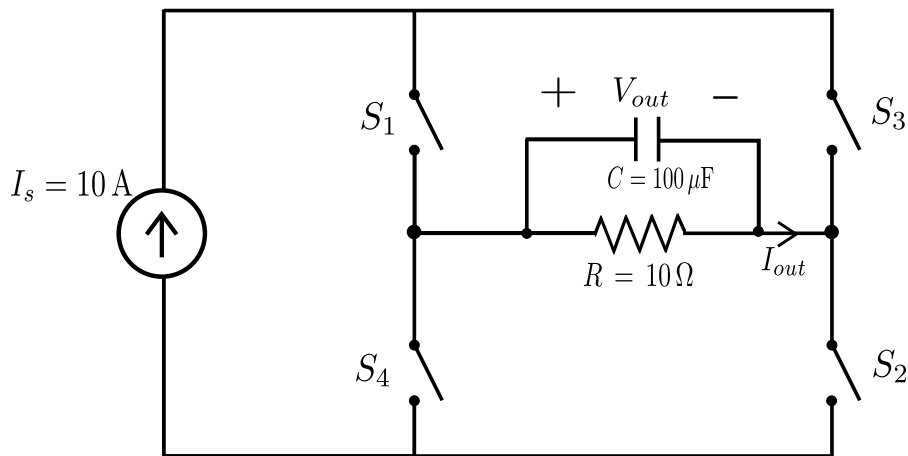


Figure 1: Current source inverter with RC load

Solution:

- (a) For the circuit in Fig. 1, switches S_1 and S_2 are on during $\omega t = 0$ to π and switches S_3 and S_4 are on during during $\omega t = \pi$ to 2π in one complete cycle. The output current waveform is obtained as shown in Fig. 2. Let us consider the positive half cycle with S_1 and S_2 conducting. Current source (I_s) parallel with resistor (R) can be converted in voltage source ($V_s = I_s R$) in series with resistor (R) as shown in Fig. 3.

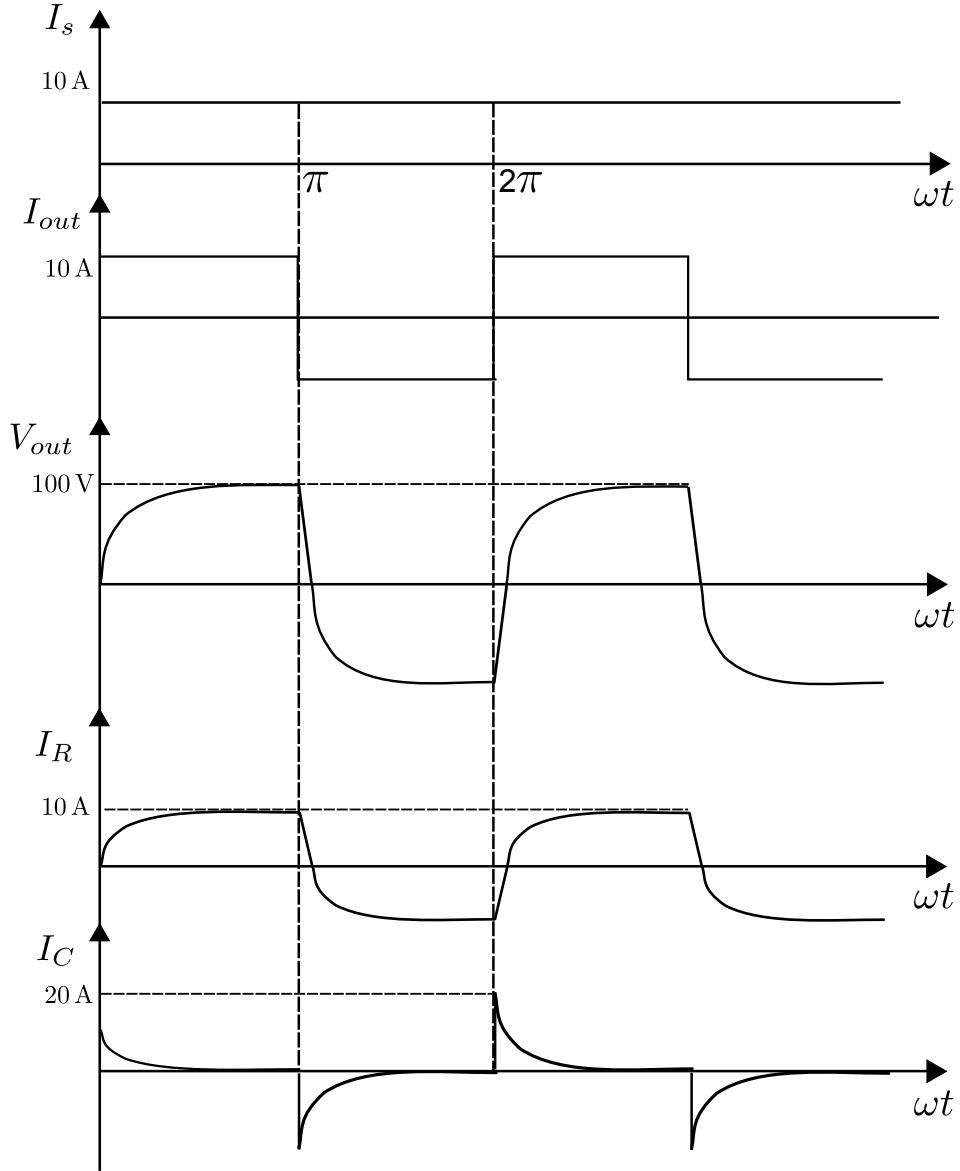


Figure 2: waveforms of current source inverter with RC load

For an RC circuit as shown in Fig. 3, the capacitor voltage at any instant is given by

$$V_c(t) = V_c(\infty) + (V_c(0) - V_c(\infty))e^{-t/\tau} \quad (1)$$

Considering steady state operation,

$$V_c(0) = -V_m$$

$$V_c(\infty) = V_s = 100 \text{ V}$$

$$V_c(t) = V(1 - e^{-t/\tau}) - V_m e^{-t/\tau} \quad (2)$$

$$I_c(t) = \frac{dV_c}{dt} = C\left(\frac{V}{\tau}e^{-t/\tau} + \frac{V_m}{\tau}e^{-t/\tau}\right) \quad (3)$$

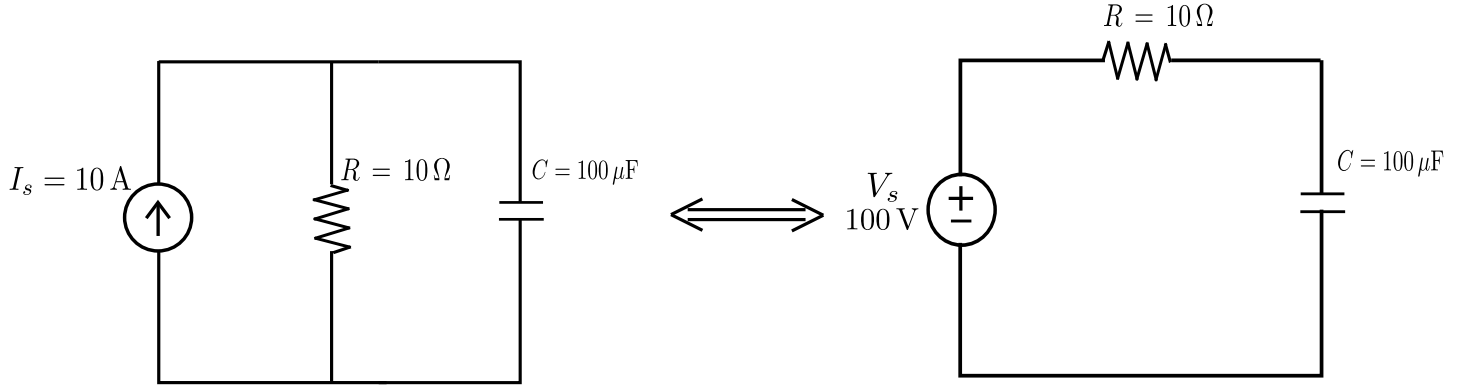


Figure 3: Source transformation from current source to voltage source

Let us consider the total time period as T . The capacitor charges to maximum voltage v_m at $t = T/2$ and then from $t = T/2$ to T capacitor charges with opposite polarity as the direction of current flow changes. The maximum instantaneous value of output voltage,

$$V_m = V(1 - e^{-T/2\tau}) - V_m e^{-T/2\tau} \quad (4)$$

$$V_m = V \frac{1 - e^{-T/2\tau}}{1 + e^{-T/2\tau}} \quad (5)$$

Substituting $T = \pi/\omega$ and $\tau = RC$

$$V_m = 99.99 \text{ V} \quad (6)$$

- (b) Substituting values of C , V , V_m , τ in eqn. 3, the value of current through capacitor at this instant,

$$I_c = 0.001 \text{ A} \quad (7)$$

SequelApp Exercises:

For the circuit in Fig. 1, find the following if the values of capacitance and resistance are changed to $C = 50 \mu\text{F}$ and $R = 20 \Omega$.

- (a) The maximum instantaneous value of the output voltage.
- (b) The value of current through resistor at $t = 5 \text{ ms}$.

Verify your answers using SequelApp.