action is removed. Due to inductance in the primary, the voltage reverses as the current tends to fall. This also reverses the voltage in feedback winding and another transistor which was in the state of non-induction is now pushed into operation. The frequency of operation is decided by the inductance of the winding, the saturation flux density and volts-turn on transformer.

Example 6.1. *Design a series inverter circuit for operation in the frequency range of 1 KHz to 3 KHz. The load resistance may vary from 20 ohms to 50 ohms while the peak load current is 3 Amps, the supply voltage being 110 Volts. Assume attenation factor to be 0.5.*

Solution. *Design of inductance L :*

With $f_r = 3 \times 10^3$ Hz, from the text, for series inverter,

$$L = \frac{-R}{8fo \ln\left(\varepsilon^{\frac{-R\pi}{4\omega_0 L}}\right)} \qquad \text{[where } \varepsilon^{\frac{-R\pi}{4\omega_0 L}} \text{ is the attenuation factor.]}$$

$$= \frac{-50}{8 \times 3 \times 10^3 \ln(0.5)} = \mathbf{3\ mH.}$$

Design of capacitor C :

From the text, for series inverter,

$$C = \frac{1}{L}\left[\frac{1}{\omega_0^2 + \left(\frac{R}{4L}\right)^2}\right]$$

$$= \frac{1}{3 \times 10^{-3}}\left[\frac{1}{(2\pi \times 5 \times 10^3)^2 + \left(\frac{50}{4 \times 3.0 \times 10^{-3}}\right)^2}\right]$$

$$= \mathbf{0.338\ \mu F}$$

Values of V_C and I_{peak} :

$$V_C = V_{dc}\frac{\varepsilon^{-\frac{R}{RL}\cdot\frac{\pi}{\omega}}}{1-\varepsilon^{-\frac{R}{2L}\frac{\pi}{\omega}}} = 110\frac{\varepsilon^{-\frac{20\pi}{2\times 3\times 10^{-3}\times 2\pi\times 3\times 10^3}}}{1-\varepsilon^{-\frac{20\pi}{2\times 3\times 10^{-3}\times 2\pi\times 3\times 10^3}}}$$

$$= 110\frac{0.5737}{0.4262} = \mathbf{148\ Volts.}$$

The peak load current is given by

$$I_{peak} = \frac{V_C + V_{dc}}{\omega_0 L}\varepsilon^{-\frac{R}{L}\times\frac{\pi}{4\omega_0}}$$

$$= \frac{110 + 148}{2\pi \times 3 \times 10^3 \times 3 \times 10^{-3}} \times 0.5 \qquad [\because \text{ Attenuation factor is 0.5}]$$

$$= \mathbf{2.282\ Amps.}$$

Thyristor rating :

Forward blocking voltage $\geq V_c + V_{dc}$ (*i.e.*, ≥ 258) = 400 V (say)

Current $\geq I_{load}$ (*i.e.*, ≥ 2.252 A = 4 A (say)

$$T_{off} = \pi\left[\frac{1}{\omega_{min}} - \frac{1}{\omega_{max}}\right] = \pi\left[\frac{1}{2\pi \times 1 \times 10^3} - \frac{1}{2\pi \times 3 \times 10^3}\right]$$

$= 0.33$ m sec.

Since $t_c \leq T_{off}$ $\therefore$ $t_c = 0.33$ m sec

Example 6.2. *A single phase half bridge inverter (Fig. E6.1) has a resistive load of resistance 5 ohms and the dc input voltage V_{dc} of 100 Volts. Obtain*

(*i*) *the rms output voltage at fundamental frequency,*

(*ii*) *the output power,*

(*iii*) *the average and peak current of each thyristor,*

(*iv*) *PIV of each thyristor.*

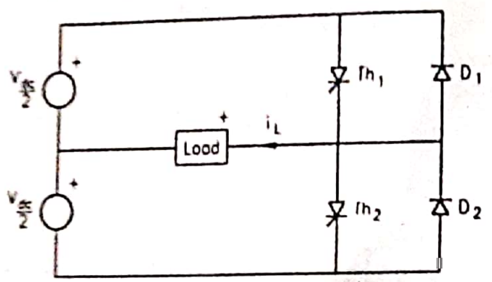

Fig. E6.1.

Solution. $V_{dc} = 100$ V ; $R = 5\,\Omega$

(*i*) V_1 (fundamental component of rms voltage) $= \frac{2V_s}{\sqrt{2}\,\pi} = 0.45\,V_s$

$= 0.45\,V_{dc} = 0.45 \times 100 = 45$ **Volts.**

$$\left[\text{RMS output voltage} = \frac{V_s}{2} = \frac{V_{dc}}{2} = \frac{100}{2} = 50 \text{ Volts}\right]$$

(*ii*) Output power $P_0 = \frac{(\text{RMS output voltage})^2}{5} = \frac{50^2}{3} = $ **833.3 W.**

(*iii*) Peak thyristor current $(I_{peak}) = \frac{V_{dc}/2}{R} = \frac{100/2}{5} = $ **10 A.**

Since each thristor conducts for a 50% duty cycle, the average current of each thyristor is

$I_{av} = I_{peak} \times 0.5 = 0.5 \times 10 = $ **5 A.**

(*iv*) $PIV = 2 \times \frac{V_{dc}}{2} = $ **100 Volts.**

Example 6.3. *A single phase full bridge inverter has a resistive load of R = 10 ohms and the dc input voltage V_{dc} of 100 Volts. Find*

(*i*) *rms output voltage at fundamental frequency*

(*ii*) *the output power P_{out}*

(*iii*) *peak and average current of each thyristor.*

(*iv*) *PIV of each thyristor.*

Solution. $V_{dc} = 100$ Volts ; $R = 10\,\Omega$

(*i*) RMS value of fundamental component is given by

$$V_1 = \frac{4}{\sqrt{2}\,\pi} V_{source} = 0.9\,V_{source}$$

$= 0.9\,V_{dc} = 0.9 \times 100 = $ **90 Volts.**

(*ii*) RMS output voltage is given by

$$V_{rms} = \left(\frac{2}{T}\int_0^{T/2} V_{dc}^2\,dt\right)^{1/2} = V_{dc} = 100 \text{ Volts}$$

$$P_0 = \frac{V_{dc}^2}{R} = \frac{100^2}{10} = \textbf{1000 W}$$

(*iii*) Peak thyristor current $I_{peak} = \frac{V_{dc}}{R} = \frac{100}{10} = 10$ A

$\therefore$ average current for each thyristor $(I_{av}) = 10 \times 0.5 = $ **5 A.**

(*iv*) $PIV = V_{dc} = $ **100 Volts.**

Example 6.4. *In a single phase Mc Murry inverter circuit, obtain the values of the commutating components when supply voltage (min) is 200 Volts, turn off time of thyristor 60 μ sec., maximum load current 100 Amps.*

Solution. $t_{off} = 60\,\mu$ sec.

For Mc Murry inverter,

$$C = 0.893\frac{I_0\,t_{off}}{V_C} = \frac{0.893 \times 100 \times 60 \times 10^{-6}}{200}$$

$= 26.8\,\mu$ **F.**

$$L = 0.397\frac{V_C\,t_{off}}{I_0} = \frac{0.397 \times 200 \times 60 \times 10^{-6}}{100}$$

$= 47.64\,\mu$ **H.**

EXERCISES

1. Explain what is "inversion". Write expressions for average dc voltages for three phase half bridge and full bridge inverter. What is the voltage drop in half bridge and full bridge inverter due to overlap ?

2. (a) Classify forced commutation techniques used in inverters.
   (b) What are the different categories of inverters depending on different types of connections.
3. (a) Describe the operation of series inverter. What are the disadvantages ?
   (b) How does a three phase series inverter function ?
4. Explain briefly the operation of a self-commutated inverter and state the expressions for frequency of resonance. What is the value of commutating capacitor ?
5. (a) How does a single phase centre tapped parallel inverter operate ? What is its circuit modification when the load is of inductive type ?
   (b) Derive an expression for source current in a centre tapped parallel inverter.
6. Briefly state the aspects of thyristor selection for parallel and series inverter.
7. Describe the operation of a single phase half-bridge voltage source inverter. What are the expressions of RMS output voltage, instantaneous output voltage and output power ? How does the performance of such an inverter change with application of inductive load at output ?
8. Define : Harmonic Factor, Total Harmonic Distortion and Distortion factor.
9. Discuss the operation of a single phase transistorised full bridge inverter. State the operational aspects of such an inverter feeding resistive load as well as inductive load.
10. Briefly describe the operation of a thyristorised full bridge inverter and derive the magnitude of output voltage and its fundamental.
11. Explain the mechanism of operation of a thyristorised three phase half bridge inverter.
12. Show how three single phase inverters (transistorised) constitute a three phase inverter.
13. How is it possible to construct a transistorised three phase bridge inverter using six transistors ? Describe the operation for both 180° mode of conduction. Why this inverter is called quasi-square wave inverter ?
14. Describe the operation of a three phase thyristorised bridge inverter for 120° conduction mode. Compare between these two (180° and 120°) conduction states.
15. (a) State different methods of voltage control in inverters.
    (b) Describe about PWM control in inverters.
16. Explain the concept of current source inverters. What are the differences between voltage source and current source inverters ?
17. Briefly describe the operation of single phase current source inverter.
18. Draw the schematic of a three phase current source inverter and describe its operation.
19. Explain the principle and operation of a complimentary commutated thyristorised inverter circuit. Show the voltage and current waveform for lagging load on such an inverter. How could you achieve such a full bridge inverter ?
20. Describe the Mc Murry inverter. What type of commutation does it apply ? What are the expressions for commutating elements ?
21. Write short notes on
    (i) Reversible converters
    (ii) UPS
    (iii) A domestic inverter.