9.4.2 Single Phase Full Bridge Inverter with RL Load

9.4.2 Operation with RL Load

Voltage and current waveforms for single-phase bridge inverter with RL load are shown in Fig. 9.8. The operation of the circuit is explained in four-modes.

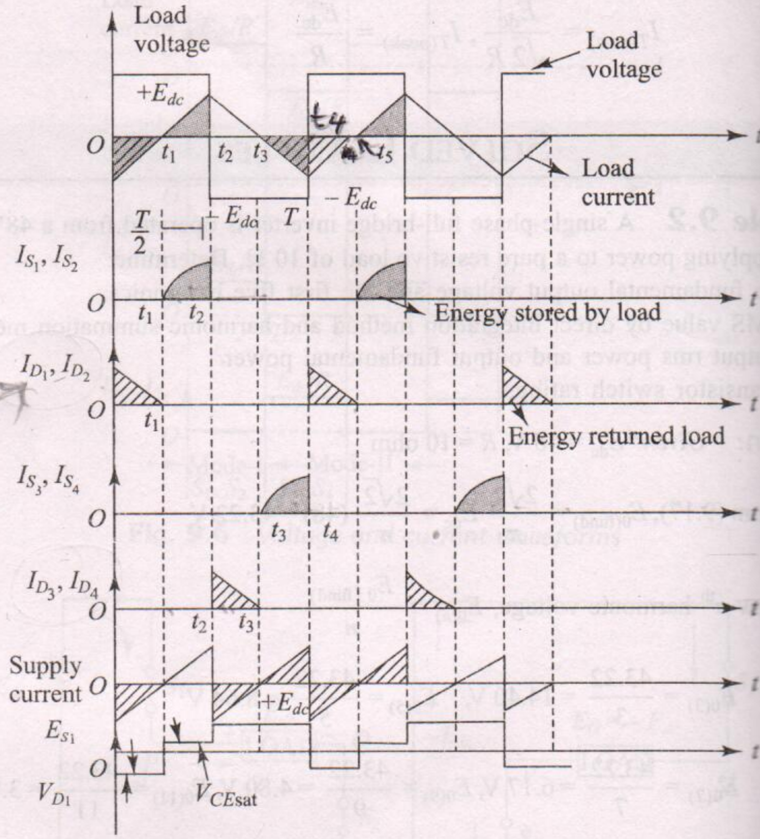

Fig. 9.8 *Voltage and current waveforms*

(i) Mode-I ($t_1 < t < t_2$): At instant t_1, the switch S_1 and S_2 are turned-on. Switches are assumed to be ideal switches. Point P gets connected to positive point of d.c. Source E_{dc} through S_1 and point Q gets connected to negative point of input supply. The output voltage, $e_0 = + E_{dc}$, Fig. 9.9(a). The load current starts increasing exponentially due to the inductive nature of the load. The instantaneous current through S_1 and S_2 is equal to the instantaneous load current. During this interval, energy is stored in inductive load.

(ii) Mode-II ($t_2 < t < t_3$): Both the switches Q_1 and Q_2 are turned-off at instant t_2. Due to the inductive nature of the load, the load current does not reduce to zero instantaneously. There is a self-induced voltage across the load which maintains the flow of current in the same-direction. The polarity of this voltage is exactly opposite to that in mode-1, The output voltage becomes $-E_{dc}$ but the load current continues to flow in the same direction, through D_3 and D_4 as shown in Fig. 9.9(b). Thus, in this mode, the stored energy in the load inductance returned back to the source. Load current decreases exponentially and goes to zero at instant t_3 when all the energy stored in the load is returned back to supply. D_3 and D_4 are turned-off at t_3.

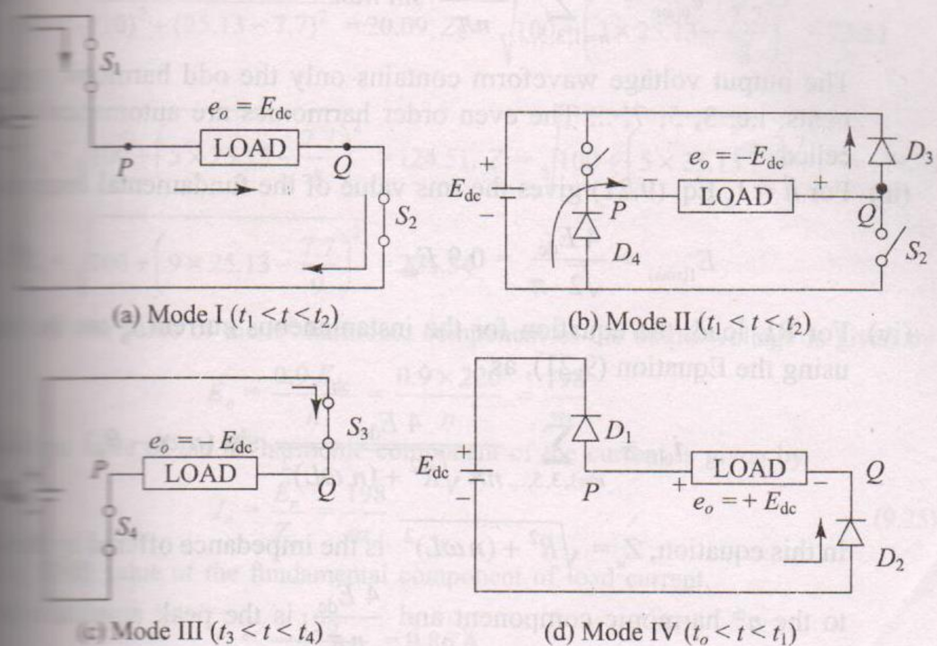

Fig. 9.9 *Equivalent circuits*

Mode III ($t_3 < t < t_4$): Switches S_3 and S_4 are turned-on simultaneously at instant t_3. Load voltage remains negative ($- E_{dc}$) but the direction of load current will reverse. The current increases exponentially in the other direction and the load again stores the energy.

Mode IV ($t_0 < t < t_1$): Switches S_3 and S_4 are turned-off at instant t_0 (or t_4). The load inductance tries to maintain the load current in the same direction by reversing the positive-load voltage. This will forward-bias the diodes D_1 and D_2. The stored energy is returned back to the input dc supply. The load voltage becomes $+E_{dc}$ but the load current remains negative and decreases exponentially towards 0. At t_1 (or t_5), the load current goes to zero and switches S_1 and S_2 can be turned-on again. The conduction period with a very highly inductive load, will be 90° for all the switches as well as the diodes. The conduction period of switches will increase towards $T/2$ or 180° with increase in the load power-factor.

Circuit Analysis

The RMS output voltage can be obtained from

$$E_{0\text{rms}} = \left[\frac{2}{T/2} \int_0^{T/2} E^2 \, dt \right]^{1/2} \quad \therefore \quad E_{0\text{rms}} = E_{dc} \tag{9.20}$$