During the interval Δ when both the switches are off, the inductor current splits equally between the two secondary half-windings and $v_{oi} = 0$. Therefore, for $t_{on} < t < t_{on} + \Delta$,

$$v_L = -V_o$$

and

$$i_{D1} = i_{D2} = \tfrac{1}{2} i_L$$

The next half-cycle consists of t_{on} (during which T_2 is on) and the interval Δ. The waveforms repeat with a period $\tfrac{1}{2}T_s$ and

$$t_{on} + \Delta = \tfrac{1}{2}T_s$$

Equating the time interval of the inductor voltage during one repetition period to zero and using Eqs. 10-22, 10-23, and 10-25 yields

$$\frac{V_o}{V_d} = 2\frac{N_2}{N_1}D \qquad 0 < D < 0.5$$

where $D = t_{on}/T_s$ is the duty ratio of switches 1 and 2 and the maximum value it can attain is 0.5 (in practice, to maintain a small blanking time to avoid turning both the switches on simultaneously, D should be kept smaller than 0.5). The average value of the waveform in Fig. 10-13b equals V_o.

It should be noted that in the push–pull inverter of Chapter 8, the feedback diodes connected in antiparallel to the switches were required to carry the reactive current and their conduction interval depended inversely on the power factor of the output load. In the push–pull dc–dc converter, these antiparallel diodes shown dotted in Fig. 10-13a are needed to provide a path for the current required due to leakage flux of the transformer.

In push–pull circuits, due to a slight and unavoidable difference in the switching times of two switches T_1 and T_2, there is always an imbalance between the peak currents of the two switch currents. This imbalance can be eliminated by means of current-mode control of the converter, which is discussed later in this chapter.

10-4-5 HALF-BRIDGE CONVERTER (DERIVED FROM STEP-DOWN CONVERTER)

Figure 10-14a shows a half-bridge dc–dc converter. As discussed in Chapter 8 in connection with the half-bridge inverters, the capacitors C_1 and C_2 establish a voltage midpoint between zero and the input dc voltage. The switches T_1 and T_2 are turned on alternatively, each for an interval t_{on}. With T_1 on, $v_{oi} = (N_2/N_1)(V_d/2)$ as shown in Fig. 10-14b and, therefore,

$$v_L = \frac{N_2}{N_1}\frac{V_d}{2} - V_o \qquad 0 < t < t_{on}$$

During the interval Δ, when both switches are off, the inductor current splits equally between the two secondary halves. Assuming ideal diodes, $v_{oi} = 0$, and therefore

$$v_L = -V_o \qquad t_{on} < t < t_{on} + \Delta$$

In steady state, the waveforms repeat with a period $\tfrac{1}{2}T_s$ and

$$t_{on} + \Delta = \tfrac{1}{2}T_s$$