5. When the transformer output voltage reaches the preset striking voltage level, the VSEN_DIM pin voltage should be ~3.0V and an internal timer starts.

6. After ~2 seconds, IC should shut down.

OZ9RR MULTIPLE-CCFL INVERTER TRANSFORMER SELECTION/ DESIGN GUIDE

1. Choose a transformer from a catalog based on the following parameters of the application:

   a) Output power
   b) Output voltage, including open voltage
   c) Size
   d) Operating temperature range

2. For a multiple-CCFL design, there are 3 options for implementation. Recommended ranges for secondary main inductance and leakage inductance of each transformer are indicated for each option suitable for most applications with operating frequency range of 40-60kHz and CCFL power rating of 3-5W. Secondary leakage inductance can be adjusted through gapping of the core. Theoretical relationships between the transformer parameters and the inverter output stage components are discussed in the supplemental information at the end of this document.

   a) Option 1 - 1 transformer driving 1 lamp

      Secondary main inductance = 300-500mH
      Secondary leakage inductance = 100-200mH

   b) Option 2 - 1 transformer driving 2 lamps using floating transformer topology (2 lamps in series)

      Secondary main inductance = 600-800mH
      Secondary leakage inductance = 150-250mH

   c) Option 3 - 1 transformer driving 2 or 3 lamps in parallel with differential chokes for lamp current balancing

      Secondary main inductance = 400-1800mH
      Secondary leakage inductance = 80-150mH

3. Determine the minimum number of primary turns required so as not to saturate the core. This number of turns is the same for the two primary windings of the transformer. It is recommended to have an operating flux density of <60% of the core's saturation flux density. Typical saturation density for most cores is 300-400mT. For OZ9RR design, we normally set operating flux density at ~200mT maximum. The minimum number of primary turns can then be determined from the following equation based on Faraday's Law:

$$N_P = V_{IN} \text{ X } t_{ON}/(\Delta B \text{ X } A_e)$$

   where
   N_P = Minimum number of primary turns
   V_{IN} = Input voltage (volts)
   t_{ON} = ON-time of the N-MOS switches (μs)
   ΔB = Core flux density swing (tesla)
   A_e = Smallest cross section area of the core where flux flows (mm^2)

   The transformer used in the OZ9RR push-pull topology operates in two quadrants of the B-H curve so that the maximum flux density $B_{max} = ½ \Delta B$.

4. For an OZ9RR inverter, the duty cycle of the mosfet gate drives are normally set at 25-30% at the nominal input voltage. As an example for calculating the minimum number of primary turns required for the transformer, we use the following sample parameters for an application:

   Nominal input voltage V_{IN} = 15 volts
   Operating frequency f_{op} = 48 kHz

ON-time	t_{ON} (30% of period)	= 6.2 µs
Core flux density swing ΔB		= 400 mT (twice B_{max} = 200mT)
Core cross section area A_e		= 8 mm^2 (Option 1)
		= 10mm^2 (Option 2)
		= 18mm^2 (Option 3)

The minimum number of primary turns is then calculated as,

a) Option 1

N_P = (15 X 6.2) / (0.4 X 8)
= 29.06 ⇒ 30 turns

b) Option 2

N_P = (15 X 6.2) / (0.4 X 10)
= 23.25 ⇒ 24 turns

c) Option 3

N_P = (15 X 6.2) / (0.4 X 18)
= 12.92 ⇒ 13 turns

5. Determine the number of secondary turns required to satisfy lamp voltage specifications. For example, if the lamp voltage rating is 650Vrms, Option 1 and Option 3 will require

the same secondary voltage. For Option 2, the required secondary voltage is twice this or 1300Vrms.

For number of primary turns N_p = 30 (Option 1) , N_p = 24 (Option 2), N_p = 13 (Option 3) and minimum input voltage of 13.5V, the minimum number of secondary turns N_s is calculated as,

a) Option 1

Ns = 30 X (650/13.5) = 1445 turns

b) Option 2

Ns = 24 X (1300/13.5) = 2312 turns

c) Option 3

Ns = 13 X (650/13.5) = 626 turns

6. Select the proper wire gauges for the primary and secondary transformer windings such that they can handle the rated currents of the application without generating excessive heat. It is desirable to have a transformer temperature rise of less than 30°C. The approximate primary winding RMS current I_p and approximate secondary winding RMS current I_s are determined from the following equations:

$$I_p = \frac{1.25\ P_{lamp}}{V_{in}}$$

$$I_s = \sqrt{I_{lamp}^2 + \left[2\pi(10^{-6})\ f_{op}\ C_{out}\ V_s\right]^2}$$

where
P_{lamp} = lamp output power rating (watts)
V_{in} = input voltage (volts)
f_{op} = operating frequency (kHz)
I_{lamp} = lamp current (mA rms)
C_{out} = output capacitor (pF)
V_s = transformer secondary voltage (V rms)