Flyback Transformer Design for the UCC28600

Lisa Dinwoodie

ABSTRACT

The flyback transformer plays a crucial role in the performance of the green-mode controller. Considerations must be given to adequate coupling for the bias windings, minimizing leakage inductance, and minimizing audible noise. All of these criteria can easily be met with proper transformer design from the start. Once the Design Calculator spreadsheet, (TI Literature Number SLVC104) , determines the required turns ratio, the following guidelines will enable the user to design a transformer that meets the performance requirements of the converter.

Once the Design Calculator spreadsheet has determined the recommended primary inductance, the acceptable leakage inductance, and the turns ratios for the secondary and bias windings, the transformer can be designed. Be sure to insert the actual turns used in the final design into the appropriate cells on the QR Simulator spreadsheet page. It is absolutely crucial that the bias windings be well coupled to the primary. These windings not only supply the operating bias to the UCC28600 and, possibly, the PFC controller, but also determine quasi-resonant status and play a key roll in accurate fault detection. Working in conjunction with the OVP resistors and the power limit and current sense resistors, the information provided by the bias windings sets up the internal reference current for limiting the power on a cycle-by-cycle basis. As a result, the bias windings must provide an accurate proportional portrayal of the primary current.

To minimize leakage inductance and still meet isolation requirements, design the windings using triple insulated wires and minimal tape layers. Filling the winding layers with bifilar windings and placing the bias windings as close as possible to the primary windings is necessary for a successful transformer design. Spreading the bias windings over the entire width of the bobbin and adding a small capacitor (under 100 pF) to primary ground at the diode end of the winding diverts noise out of the transformer. Also, cores with a round center post will help reduce leakage. Figure 1 shows a recommended winding pattern for the transformer.

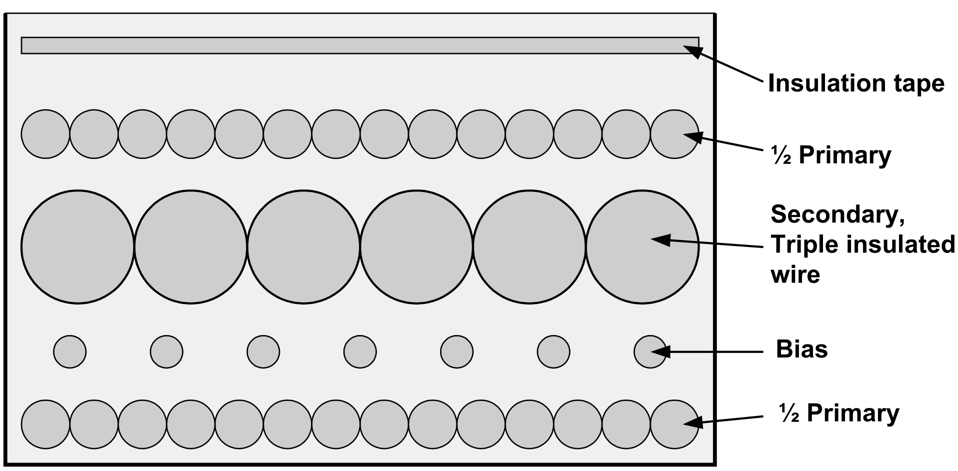

Figure 1. Example of a Recommended Transformer Design

NOTE: Use multiple strand wire to distribute each of the coils across the layer.

For a non-PFC design using universal ac line input or a boost-follower PFC design, the core and number of turns is selected based upon the minimum input voltage. For designs using a traditional boost PFC front end, the core must be selected based upon the steady state high line conditions but must also take into consideration the low line ac voltage. Because the UCC28600 always starts up with the PFC stage disabled via the STATUS pin, the flyback transformer must be designed to avoid saturating when turning on into any acceptable load at low line conditions.

Because the transformer is a major contributor to the audible noise that may be present on the converter, the entire transformer assembly should be varnished and glued. Also adding filler in the discrete gaps reduces the mechanical chatter between the bobbin, core, and coil. Be sure to match the temperature coefficients of any material used as closely as possible otherwise when the transformer warms up during normal operation, the audible noise will intensify.

Using a copper shield, or “belly band”, around the entire transformer will provide a circumferential radiation shield for the eddy currents in the transformer. This shield is simply a grounded loop of copper foil around the entire assembly; use of this technique requires careful consideration to isolation requirements and creepage and clearance issues. By winding the secondary so that the ground end is the outermost layer, this “belly band” may not be needed.

When gapping the flyback transformer, only gap the center leg because gapped outer legs will radiate excessive EMI from the fringing fields. Placing the drain end of the primary winding as close to the core as possible will help to shield the dv/dt noise emanating from it.