UCC3817 Current Sense Transformer Evaluation

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ABSTRACT

To theoretically show how to set up a PFC boost regulator using current sense transformers using the UCC3817 control IC.

1 Schematic

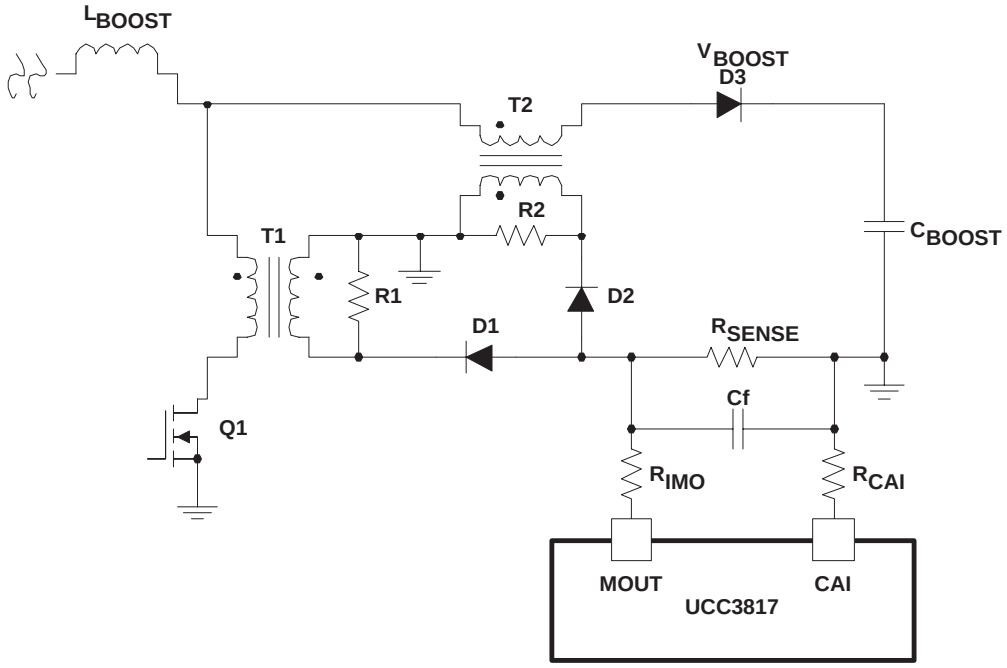

Figure 1.

2 Theory of Operation

1. Current sense transformers T1 and T2 are used to sense the input current to the PFC stage.
2. The sum of these two currents will represent boost inductor current.
3. Resistors R1 and R2 are used to reset the current sense transformers.
4. R_{SENSE} is the current sense resistor used to shape the input current waveform.
5. Capacitor Cf is used to filter out high frequency noise.

3 Setting Up the Circuit

1. Current sense transformer secondary turns ratio
   a. $N_S = \left[\frac{I_{L(boost)}}{\left(\frac{1\,V}{R_{SENSE}} \right)} \right]$ if $N_P = 1$
   b. $N = \frac{1}{N_S}$
   c. The turns N can be set to reduce losses.
   d. The current sense transformers' turn ratios need to be the same.
2. The following calculations can be used to select transformer reset resistors R1 and R2.
   a. DCR is the dc resistance of T1's primary.
   b. L_M is T1's primary magnetizing inductance.
   c. $R1 = R2 = 100 \times \left(L_M \times \left(\frac{f_S}{0.9} + DCR \right) \right) \times \left(N_S \right)^2$
   d. These calculations should work as long as the duty cycle D is below 90%
3. The maximum reverse voltage stress of diode D1 and D2 can be calculated as follows. Where Im is T1 and T2 magnetizing current.
   a. $V_{D1} = V_{D2} = I_M \times N \times R1$

4 Conclusion

1. A current sense transformer can be used in PFC pre-regulator application using the UCC3817 PFC control device.
2. Special care must be given to current sense transformer reset by properly selecting reset resistors R1 and R2.
3. Current sense transformer T1 will add negligible voltage stress to transistor Q1.
4. You can use current sense transformers in a PFC pre-regulator.
5. R_{SENSE} should be much smaller than R_{IMO} and R_{CAI}.
6. Treat the rest of the design as if R_{SENSE} were the resistor used in a direct measurement application.

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