Technical Article

Designing Multiple Output Converters with Primary Side Sensing

In the unforgiving world of low cost electronics, multiple output flyback power supplies have several market advantages. These advantages include: inherent reliability (lower number of components implies less chance of failure), good form factor (smaller size for a given output power) and low cost.

Unfortunately, there are also a few drawbacks to the multiple output flyback power supply, including increased switching power loss and poor cross regulation. An additional drawback associated with primary side type controller (PSR) flybacks is that the controller has difficulty deciding which of the outputs to control- potentially leading to large output ripple or system instability.

In end products such as home automation, standby power supplies for set top boxes, and even washing machines, PSRs, such as TI's UCC28722 and UCC28911, can be used in multiple output designs and this blog will describe a simple circuit for doing so.

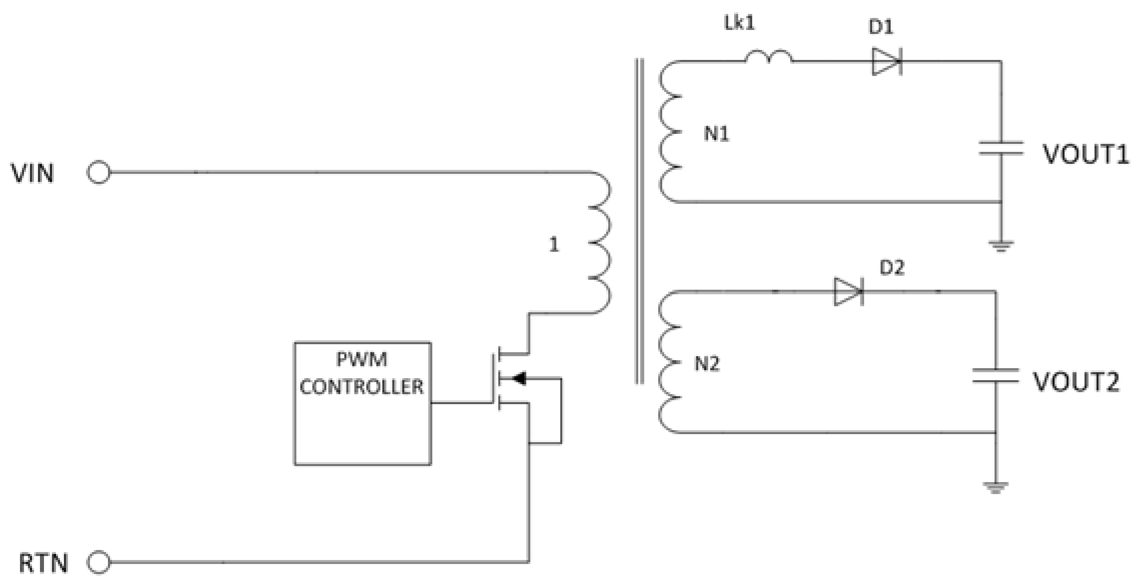

Figure 1. Dual Output Flyback with Independently Wound Dual Secondaries.

Figure 1 shows the simplest method of implementing a dual output flyback converter. The leakage inductance, Lk1, causes an AC voltage drop that varies with load and gives rise to cross regulation errors. Lk1 can be reduced as shown in Figure 2.

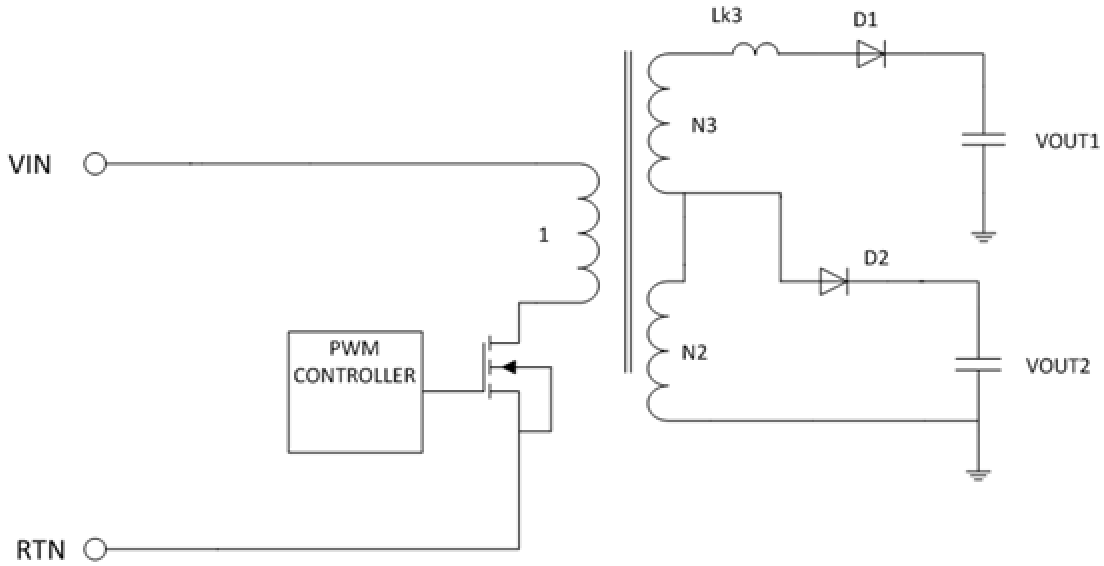

Figure 2. Dual Output Flyback with AC Stacking of the Secondaries

Stacking the outputs, as shown in Figure 2, results in a significantly lower value of leakage- Lk3.

Lk3 is less than Lk1 because the number of turns N3 is less than N1.

A further improvement in cross regulation can be achieved by forcing VOUT1 to share current through D2 with VOUT1, as in Figure 3.

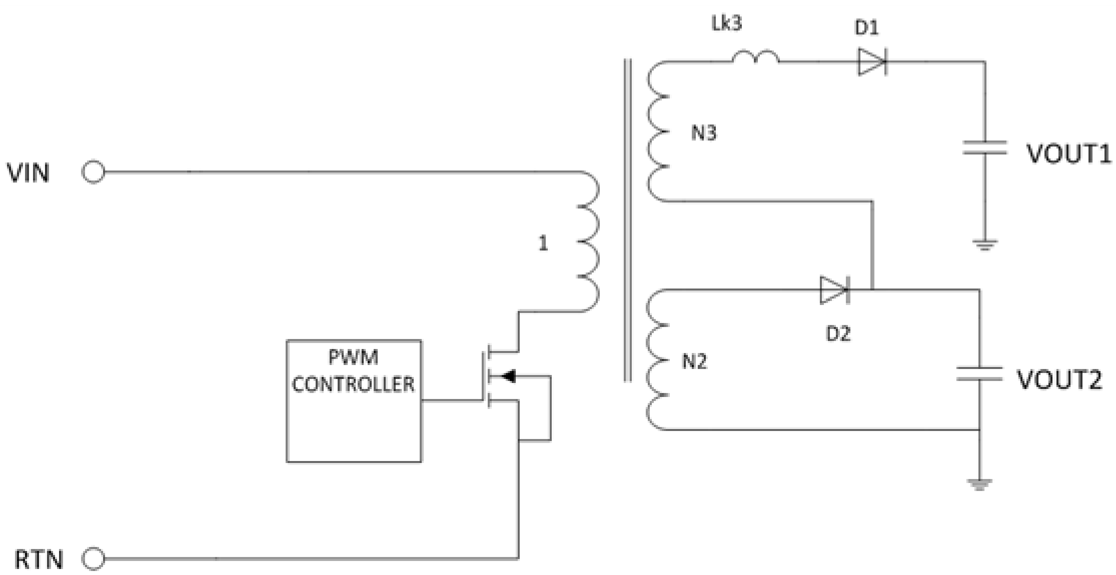

Figure 3. Dual Output Flyback with DC Stacking of the Secondaries

The circuit in Figure 3 can be used with optocoupler type feedback controllers or with PSR type controllers. The next section describes how to design PSR controllers with multiple outputs.

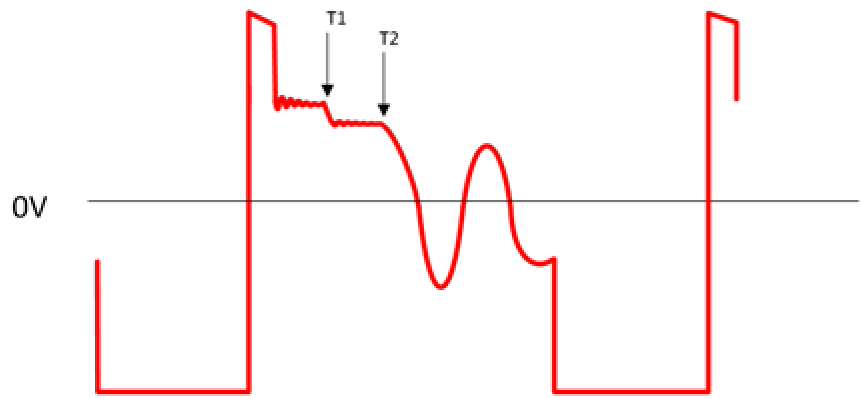

Figure 4. Sensed Voltage for Circuit of Figure 1 or Figure 2

PSR type controllers sample the output voltage at the same instant the output diode stops conducting.

The transformer configurations of Figure 1 or Figure 2 would result in a sensed voltage waveform shape, as in Figure 4.

- The slight voltage step in the waveform at time T1 occurs when the most lightly loaded output stops conducting.
- The dip at time T2 occurs when the more heavily loaded output ceases to conduct.
- The position of T1 relative to T2 changes with load.

The difficulty for the PSR controller is that it needs to determine when the most heavily loaded diode has ceased conducting. The sampler within the controller needs to ignore the voltage at time T1 and measure the voltage at time T2. If the voltage is sampled at the wrong time there will be output an voltage error that changes with load.

With the circuit of Figure 3, there is no significant dip in sensed voltage when the lightly loaded output rail ceases conducting. The auxiliary wave shape is as in Figure 5.

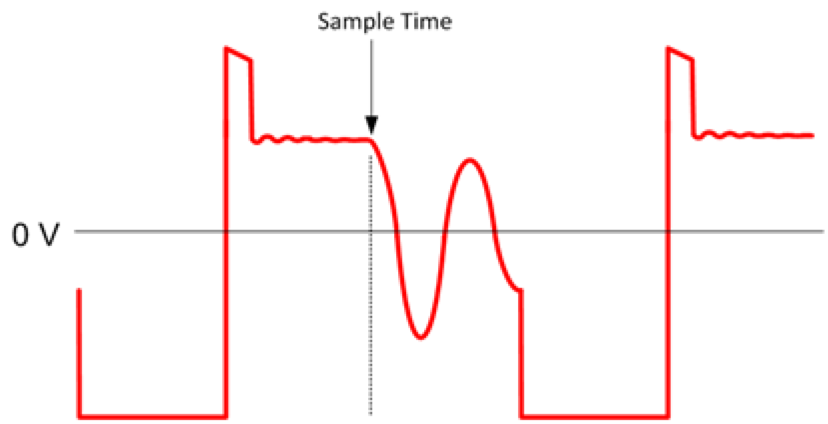

Figure 5. Sensed Voltage for Circuit of Figure 3

This will result in reliable and consistent sampling of the voltage and both outputs will be well regulated.

Figure 6 and Figure 7 below shows the load regulation obtained with the TIDA-00618 reference design

This is a dual output +12V,+5V 500mA flyback converter based on the UCC28911.

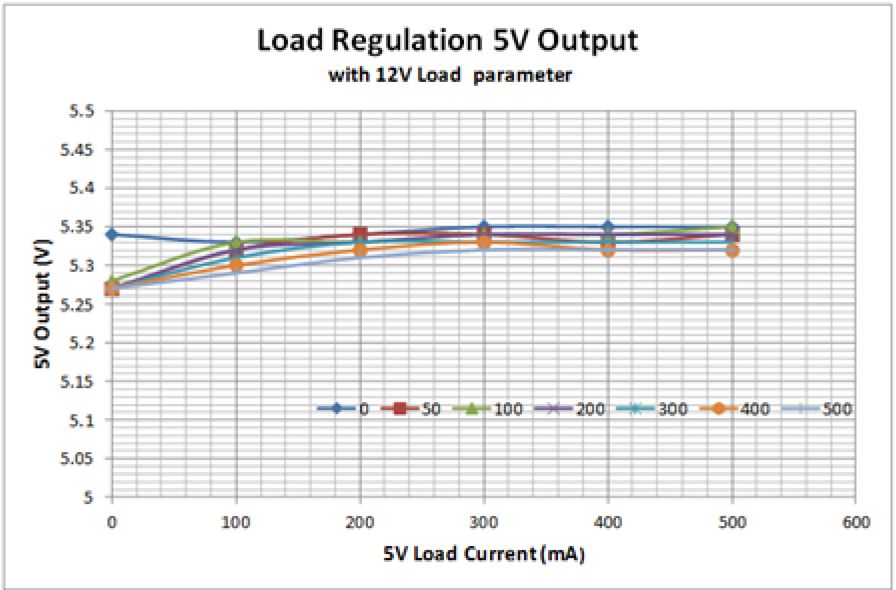

Figure 6. 5V Load Regulation

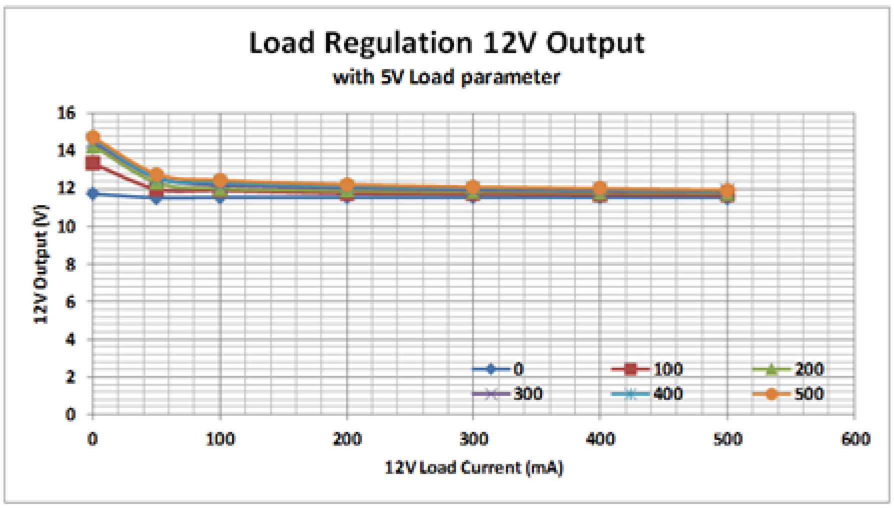

Figure 7. 12V Load Regulation

The TIDA-00618 reference design provides very good cross regulation performance and indeed is similar to that from opto-coupler based designs.

Reference:

Products that are capable of being designed into multiple output reference designs, include: UCC28700, UCC28710, UCC28720, UCC28910