

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.

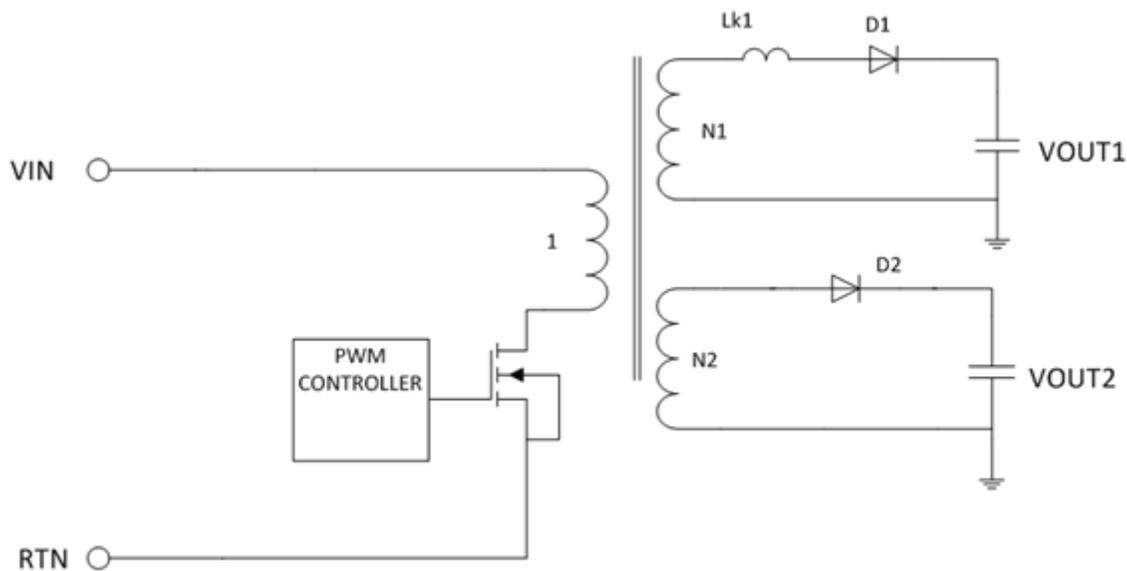


Figure 1. Dual Output Flyback with Independently Wound Dual Secondaries.

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.

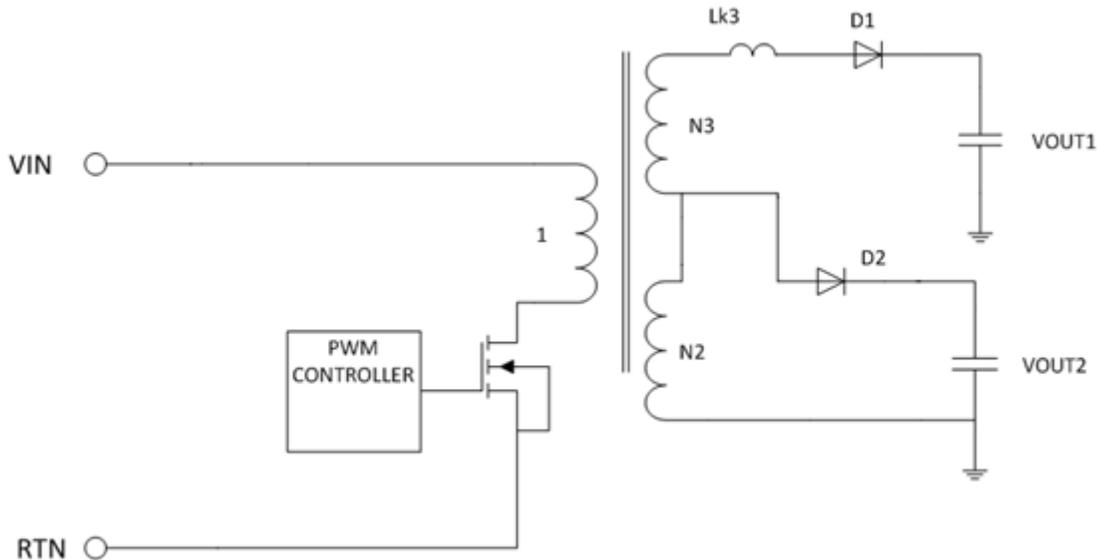


Figure 2. Dual Output Flyback with AC Stacking of the Secondaries

Stacking the outputs, as shown in Figure 2, results in a significantly lower value of leakage- L_{k3} .

L_{k3} is less than L_{k1} because the number of turns N_3 is less than N_1 .

A further improvement in cross regulation can be achieved by forcing V_{OUT1} to share current through D_2 with V_{OUT2} , as in Figure 3.

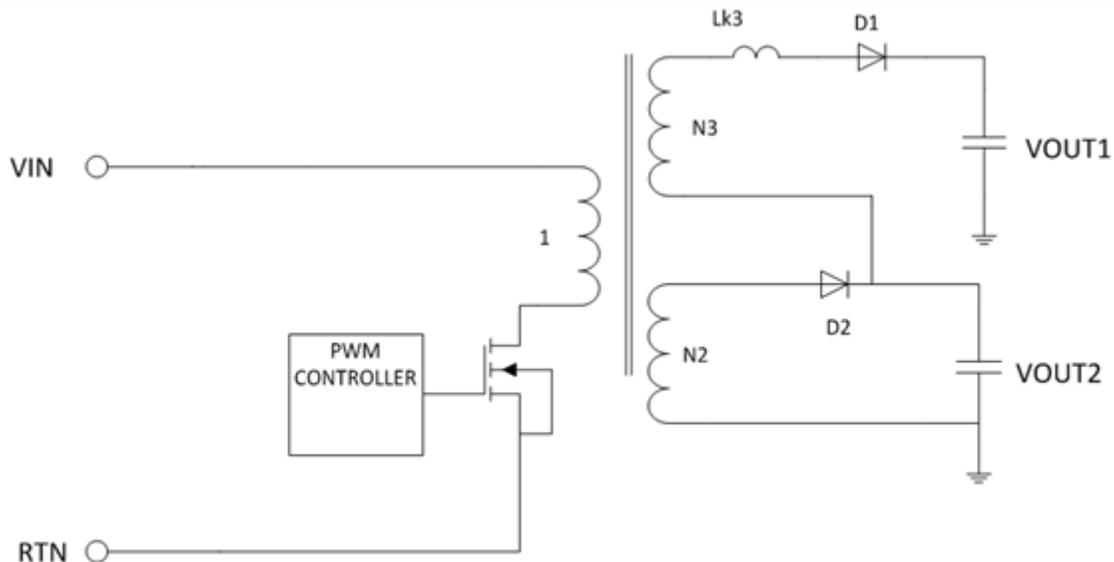


Figure 3. Dual Output Flyback with DC Stacking of the Secondaries

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.

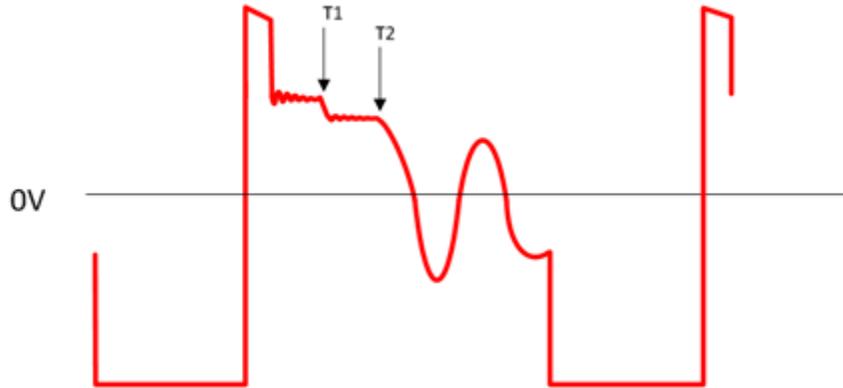


Figure 4. Sensed Voltage for Circuit of [Figure 1](#) or [Figure 2](#)

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](#).

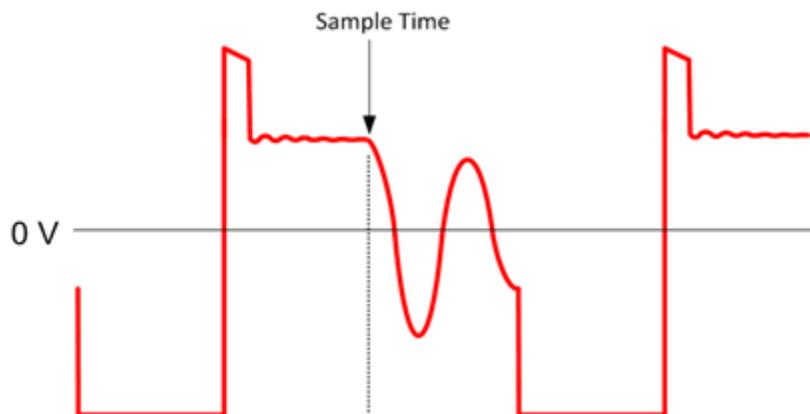


Figure 5. Sensed Voltage for Circuit of [Figure 3](#)

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](#).

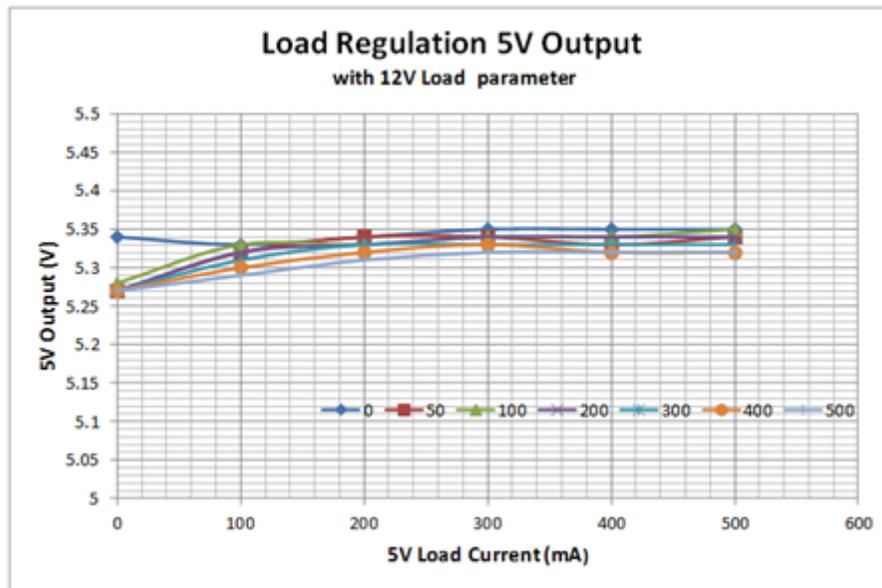


Figure 6. 5V Load Regulation

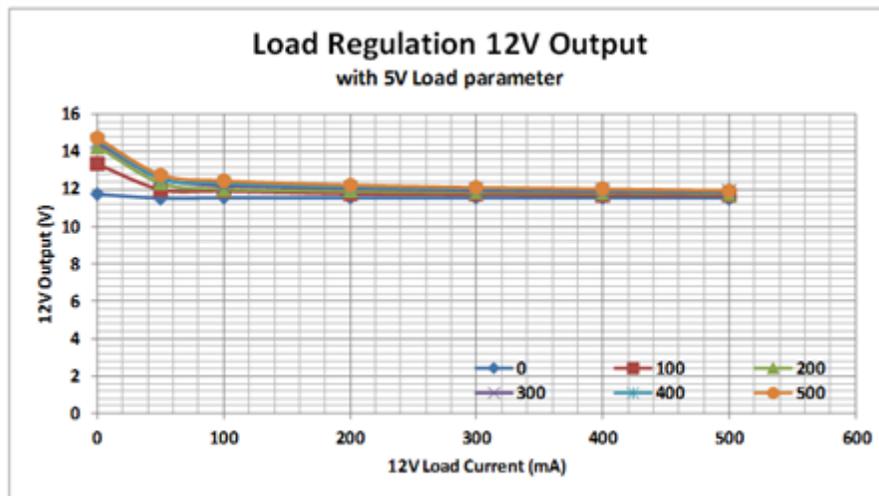


Figure 7. 12V Load Regulation

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](#)

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to [TI's Terms of Sale](#) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2023, Texas Instruments Incorporated