

The Elegance of a Flyback Controller Without a Dedicated Isolated Feedback Path

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Figure 1 shows the architecture of a conventional isolated flyback converter. These converters can be found frequently in power classes of up to about 60 W. A supply voltage is converted to an output voltage with the help of a primary-side switch and a transformer with adjusted turns ratio. Information about the output voltage is transferred via a feedback path to the primary-side PWM generator so that this output voltage can be kept as stable as possible. If the output voltage is too high or too low, the duty cycle of the PWM generator is adapted.

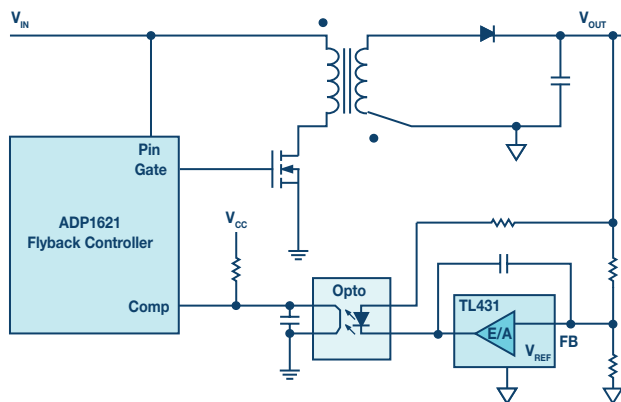


Figure 1. Conventional flyback controller with feedback path based on an optocoupler.

This type of feedback path costs money, takes up space on the board, and determines the maximum isolation voltage of the circuit together with the isolation voltage of the transformer. Optocouplers typically age, change their properties over time, and are usually not designed for temperatures above 85°C.

Besides an optocoupler, a third transformer winding can be used to provide information about the state of the output voltage. Regulation of the output voltage can be based on this. However, this additional transformer winding makes the transformer more expensive and the regulation of the output voltage is not particularly accurate.

A better alternative is a substitute device that replaces the optocoupler and the secondary-side control module of the optocoupler. The ADuM3190 is available for this, with integrated iCoupler® isolation technology which transfers the feedback signals by inductive coupling—that is, without an optocoupler—across the galvanic isolation.

However, there is another option besides these. An especially elegant solution is to do away with a discrete feedback path completely. Figure 2 shows a flyback converter without a discrete feedback path. A suitable converter IC, the LT8300 from the Power by Linear™ group of Analog Devices shown in Figure 2, recognizes whether and how the duty cycle generated by the PWM generator must be adjusted by means of the voltage reflected back from the secondary side to the primary side. The advantage of this solution is that no optocoupler or other feedback circuit is required. This can save money and space. Any possible limiting influence of the maximum isolation voltage of the feedback path is then no longer relevant. As long as the transformer being used is designed for a certain isolation voltage, the complete circuit can be operated up to this maximum isolation voltage.

This concept is based on boundary mode regulation. Here, the secondary-side current drops to zero amps in every cycle. Then the output voltage, reflected back to the primary winding of the transformer, can be measured and used for the primary-side regulation.

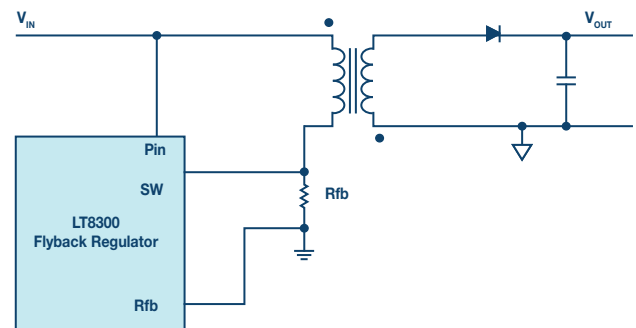


Figure 2. Flyback controllers without discrete feedback paths, but with regulation via the primary-side transformer winding.

Whether this type of circuit, without a discrete feedback path, is possible in a given application depends strongly on the required output voltage regulation accuracy. It can be better than $\pm 1\%$, but the deviation can also be greater, depending on the application.

The output voltage can be calculated using the following formula:

$$V_{OUT} = 100 \mu\text{A} \times (R_{fb}/N_{ps}) - V_f$$

R_{fb} is shown in Figure 2. With it, the output voltage can be adjusted. N_{ps} is the turns ratio of the transformer used, and V_f is the voltage drop across the secondary-side flyback diode. This is usually quite temperature dependent. For output voltages set to high values such as 12 V or 24 V, the absolute effect of V_f is low. For a voltage of 3.3 V or even lower set at the output, the effect of temperature on the output voltage is quite high. Some no-optocoupler family members offer integrated temperature correction to make up for the different rectification diode voltage drops at different temperatures.

A minimum load at the output is also usually necessary for regulation to function properly. In the LT8300, it is approximately 0.5% of the maximum possible load.

Conclusion

Flyback controllers without discrete feedback paths, but with control via the primary-side transformer windings, make a simpler design without error-prone optocouplers possible.

About the Author

Frederik Dostal studied microelectronics at the University of Erlangen in Nuremberg, Germany. Starting work in the power management business in 2001, he has been active in various applications positions including four years in Phoenix, Arizona, working on switch mode power supplies. He joined Analog Devices in 2009 and works as a field applications engineer for power management at Analog Devices in München. He can be reached at frederik.dostal@analog.com.

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