

How to Design for EMC and Isolation with Fly-Buck™ Converters



Timothy Hegarty

Testament to its ease-of-use, small solution size, galvanic isolation, wide input voltage range, and low overall bill-of-materials cost, a properly-designed Fly-Buck™ circuit is as indispensable as it is convenient.

For example, programmable logic controllers (PLC), field transmitters, sensors and process instrumentation, industrial communication, human machine interface (HMI), and IGBT-based motor drives all have unique power solution requirements well suited to the Fly-Buck circuit. And as demanding isolated applications come to fruition, conformance to regulatory specifications is an increasingly-relevant power solution benchmark. For instance, various tests within IEC 61000-4 system-level EMC specification are related to low and high frequency disturbances (ESD, EFT/burst, lightning surge, and conducted and radiated RF immunity).

Fly-Buck Power Stage with Bridge Rectifier and Input Filter

Based on the 65V, 1.5A LM5160A synchronous buck converter, *Figure 1* shows an EMC-compliant Fly-Buck power supply that delivers ±12V isolated rails from a center-tapped secondary winding. Output voltages are scaled based on the turns ratio N_p/N_s of transformer T_1 . A 9V primary-side regulated aux rail sends bias power to VCC to reduce quiescent loss at high V_{IN} .

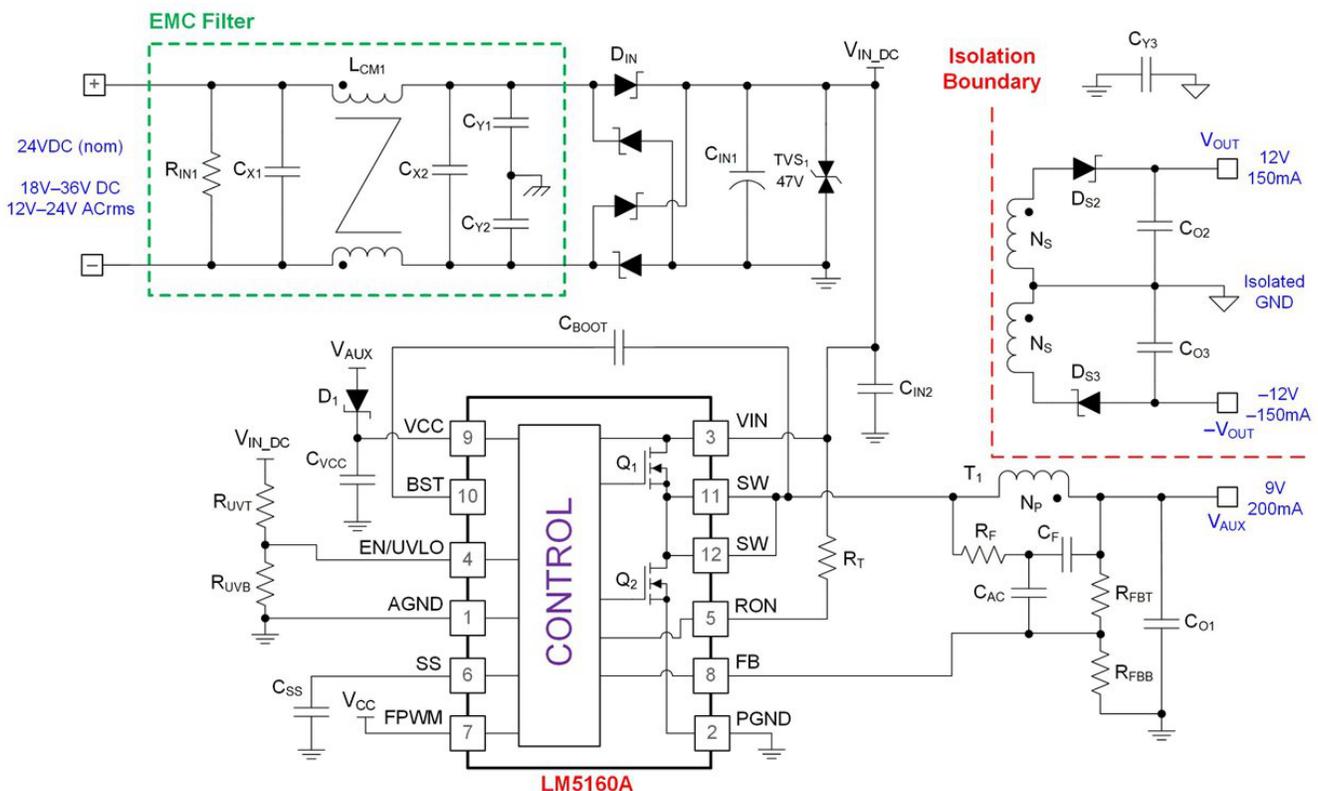


Figure 1. AC or DC-powered, EMC-compliant Fly-Buck Converter Supplying Isolated ±12V Rails

Transformer Isolation

Demarcated in red in [Figure 1](#) is the isolation boundary, apropos the need to provide user safety or break a ground loop. Interleaving the primary and secondary windings improves cross regulation and minimizes leakage inductance. To customize the converter design for additional outputs, simply add a transformer secondary winding (with the appropriate turns ratio), a rectifier diode, and an output capacitor. Triple, quad, and even octal outputs are easily obtained, with a small-size magnetic component for space-constrained designs.

For basic, supplementary, or reinforced insulation, when powering digital isolators or sensing systems for example, select the magnetic component that meets the isolation grade requirement and design the [PCB layout](#) to meet the relevant creepage and clearance specification of the referencing isolation standard.

EMC Performance

The green box in [Figure 1](#) is the EMI filter shown with common-mode inductor, X- and Y-capacitors, parallel damping resistor, and bidirectional TVS voltage clamp. Generally, the goal of EMC-protected circuits is to shunt the external transients to ground with low impedance, thus protecting the circuit from damage. A Fly-Buck converter with wide V_{IN} capability permits a higher voltage TVS diode with lower power rating and smaller footprint to satisfy input transient immunity specifications for the power stage. Y-capacitors, denoted as C_{Y1} and C_{Y2} in [Figure 1](#), shunt transient energy from the input lines to the system's chassis ground. This approach is complemented by small [ferrite beads](#) that provide high impedance at particularly sensitive nodes in the signal chain where high attenuation is required.

Fly-Buck Value Proposition

A good understanding of EMI and isolation is obligatory for all power system designers. With that in mind, I recently penned an article for TI's Analog Applications Journal, "[Fly-Buck Converter Provides EMC and Isolation in PLC Applications](#)," that delves into EMC and isolation requirements in more detail. In summary, the value proposition of Fly-Buck topology is its cohesive feature set that addresses a variety of power solution needs:

- Multiple [converter](#)- or [controller](#)-based IC solutions depending on input voltage and output current specifications
- Reliable synchronous buck or buck-boost based converter design
- Extra margin from wide V_{IN} range to survive input rail transient voltages disturbances
- Small-size magnetic component ideal for space-constrained designs
- Easily modified configuration for additional outputs
- Absence of primary-side voltage spike from transformer leakage inductance reduces EMI
- Simple BOM: no loop compensation, error amplifier, or feedback opto-coupler components

So, please check out our Wide Vin portal to find out more about the Fly-Buck topology and the applicable devices within our portfolio of wide V_{IN} controllers, converters and power modules.

Additional Resources:

- Read "[Fly-Buck converter provides EMC and isolation in PLC applications](#)" in the 1Q 2015 edition of TI's Analog Applications Journal.
- Peruse the ever-expanding portfolio of Fly-Buck isolated designs from the [PowerLab](#) reference design library:
 - [EMI optimized layout design for Fly-Buck](#) TI Design reference design
 - [Isolated RS-485 to Wi-Fi bridge](#) with 24VAC power TI Design reference design
 - [Leakage current measurement](#) TI Design reference design for determining insulation resistance
- Review several [transient protection tips](#) for EMI-sensitive loads.
- Order the isolated and non-isolated EVMs for the [LM5160A](#) synchronous buck converter.
- Watch a Fly-Buck power solution [video](#).
- Start a design now with [WEBENCH® Power Designer](#).

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