

## Cascode Facilitates Simple Startup

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Offline converters present a challenge in starting up, due to the mismatch between the high voltage input, and the low voltage power supply requirements of the controller IC. A typical application uses a string of resistors, Zener diodes and a high voltage BJT combination to generate  $\sim 12\text{ V}$  to power the controller until the feedback winding can generate enough energy to power the IC at an operational voltage (Figure 1). This application note will describe a self-generated startup voltage that can be used by taking advantage of a cascode configuration.

### Traditional Startup Circuit

Figure 1 shows an often used startup technique. There are a lot of positives with this approach, but the one downside is the need for the high voltage bipolar device. In applications running off of 800 V rails, every 1 mA will dissipate  $\sim 0.8\text{ W}$ , which will need to be thermally accounted for, if the system will be in standby for an indefinite period of time.

### Cascode Startup

The cascode technique uses the high voltage device already in the system. In Figure 2, a cascode configuration utilizes a low voltage MOSFET ( $\sim 30\text{V}$ ) to convert a “normally on” high voltage device to enhancement mode, so that it can be controlled with standard gate drive (0 to 12 V). In this example a 1 ohm, 1.7kV silicon carbide JFET (UJN171K0K) is used as the high voltage device.

The key element of this approach is to take advantage of the cascode “off state” where the MOSFET drain will settle above the absolute value of the JFET threshold. This is typically in the 10 V range.

A diode (D2) is attached to the MOSFET drain, and with a resistor to limit the peak current, the diode conducts during the “off state” of the cascode, which charges C1 until the PWM controller can begin to operate, and the auxiliary winding can supply power to the IC. In Figure 3, scope shots of  $V_{DD}$  and  $V_{GATE}$  are shown during startup.

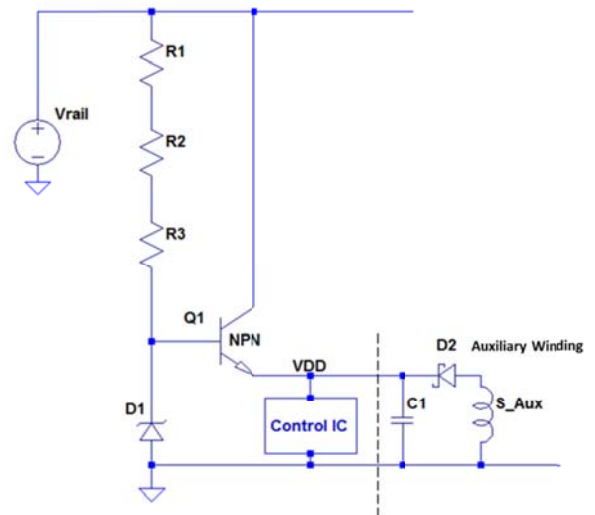


Figure 1: Traditional Startup Circuit

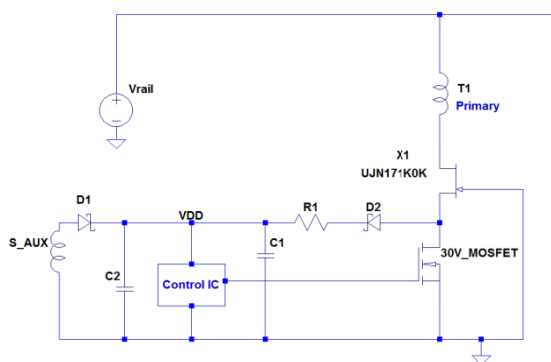


Figure 2: Cascode Startup Circuit

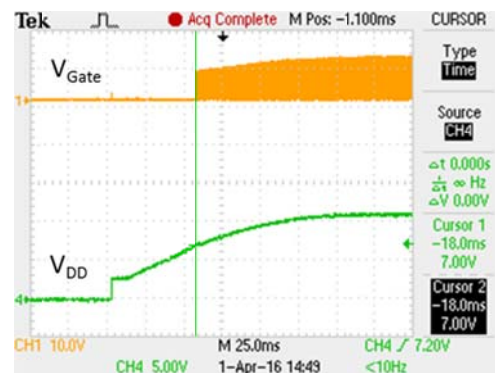


Figure 3: Cascode Startup (UJN171K0K / FDT457N)

The controller engages as  $V_{DD}$  crosses 7 Volts, the under voltage lockout of the controller. This illustrates that with some care in sizing the components (capacitor and currently limiting resistor) one can eliminate the need for an additional high voltage device, and reliably use a cascode to generate startup voltages in power converters.

**References**

*Depletion-mode SiC VJFET Simplifies High Voltage SMPS*, PCIM 2012, Nigel Springett and Jeff Casady