Depletion-mode MOSFET kick-starts power supply

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Many switch-mode power supplies use "kick-start" circuits to initialize their offline operation. These circuits may be simple resistors, such as International Rectifier's (www.irf.com) IRIS4015, or more complicated arrangements built with bipolar transistors or MOSFETs (**Reference 1**). These transistors provide the initial current for the flyback or PFC (power-factor-correction) IC. When such a power supply starts operating in normal mode, a supply voltage from a dedicated winding keeps supplying the PFC IC, thus reducing power consumption of the kick-start circuitry.

Such schemes reduce—but do not eliminate—the power consumption of the kick-start circuitry, because the active component is usually a high-voltage bipolar transistor or high-voltage enhancement-mode MOSFET. These transistors' base or gate requires forward-biasing with respect to the emitter or the source for normal operation. Therefore, a power loss always occurs in the circuits that keep the transistors in the off state. Unfortunately, engineers pay too little attention to depletion-mode MOSFETs, which require no forward-biasing for normal operation and, moreover, require gate potentials below the source. These valuable properties of depletion-mode MOSFETs suit them for a role in no-loss kick-start circuits for power supplies.

Figure 1 shows a conventional PFC circuit whose IC initially receives power from the output through a depletion-mode MOSFET, Q_2, a DN2470 from Supertex (www.supertex.com, **Reference 2**). Q_2's source feeds PFC IC_1 with an initial supply current of approximately 10 to 15 mA or less depending on the IC model. A brief power dissipation of approximately 4 to 6W can do no harm to the MOSFET soldered to a copper pour. If you have concerns about the MOSFET's health, you can use an IXTY02N50D from Ixys (www.ixys.com, **Reference 3**). Resistors R_3 and R_4 set up Q_2's working point to obtain the minimum required current. Zener diode D_5 limits its voltage across IC_1 to approximately 15V for an input voltage of 18V, which is usually necessary for most PFC ICs and is less than the maximum for MOSFET Q_2.

When IC_1 starts working normally, the secondary winding of the PFC inductor, L, generates the IC's supply voltage, which diodes D_1 and D_3 and capacitors C_1 and C_2 condition. Transistor Q_3 keeps feeding zener diode D_5 and IC_1 for a short interval. Eventually, bipolar transistor Q_3 gets its base supply through resistor R_5 from diode D_2, turning on and clamping Q_2's gate to ground. Q_3's power source is the IC's positive-supply potential of approximately 15V, which is more than enough to shut off Q_2. The residual thermal current of 10 to 20 µA produces no substantial power loss. EDN

REFERENCES

1. "IRIS4015(K) Integrated Switcher," Data Sheet No. PD60190-C, International Rectifier, www.irf.com/product-info/datasheets/data/iris4015.pdf.
2. "DN2470 N-Channel Depletion-Mode Vertical DMOS FET," Supertex Inc, www.supertex.com/pdf/datasheets/DN2470.pdf.
3. "High Voltage MOSFET: IXTP 02N50D, IXTU 02N50D, IXTY 02N50D," Ixys, http://ixdev.ixys.com/DataSheet/98861.pdf.

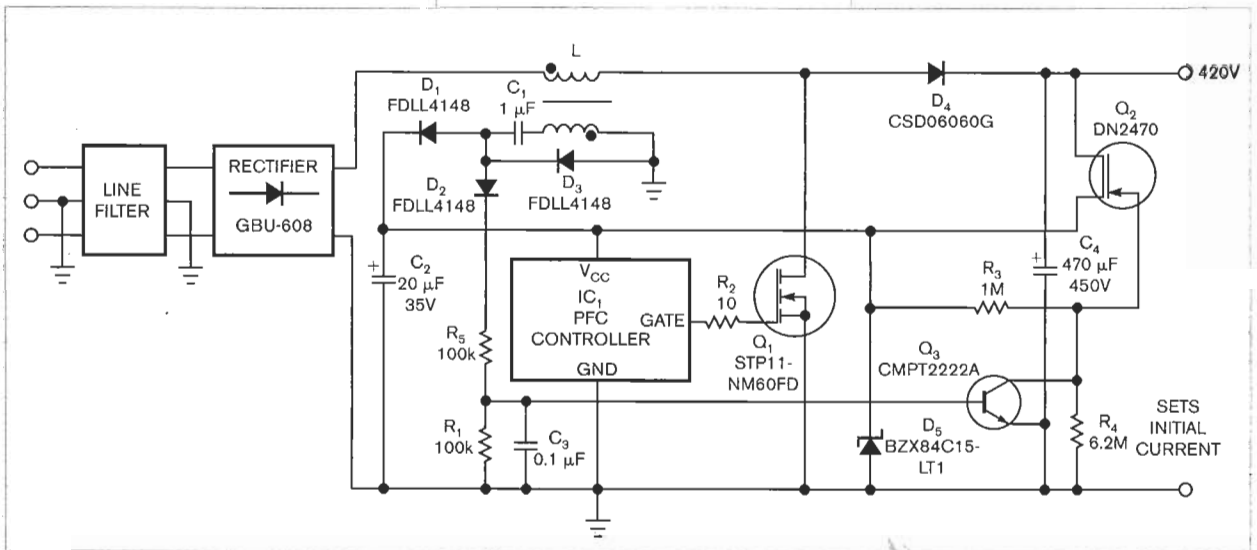

Figure 1 A depletion-mode, high-voltage MOSFET provides a kick-start for a PFC IC. During normal operation, the MOSFET switches off and dissipates negligible power.