POWER ELECTRONICS TECHNOLOGY

High Voltage ICs Simplify Off-Line Supplies

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Following up its earlier success with single chip, off-line supplies, Power Integrations has come up with the TinySwitch II®, an upgraded version of their previous TinySwitch family. Like the original TinySwitch, the IC integrates a 700V power MOSFET, oscillator, high-voltage switched current source, current limit, and thermal shutdown into a monolithic IC. *Fig. 1* shows a typical TinySwitch II supply.

You derive start-up and operating power directly from the voltage on the drain pin, this eliminates the need for a bias winding and associated circuitry. In addition, the TinySwitch-II incorporates auto-restart, line undervoltage sense, and frequency jittering. Its design minimizes audio frequency noise with a simple On/Off control scheme using ordinary taped/varnished transformer construction. The fully integrated auto-restart circuit safely limits output power during fault conditions, such as output short circuit or open loop, reducing component count and secondary feedback circuitry cost.

An optional line sense resistor externally programs a line undervoltage threshold, which eliminates power down glitches caused by the slow discharge of input storage capacitors present in applications such as standby supplies. Jittering its 132 kHz operating frequency reduces quasi-peak and average EMI, minimizing filtering cost.

Overtemp Protection

Internal thermal shutdown circuitry senses the die temperature. The threshold is typically set at 135°C with 70° C hysteresis. If the die temperature rises above this threshold the chip disables the power MOSFET, and it remains disabled until the die temperature falls by 70°C, at which point it is re-enabled.

A current limit circuit senses the power MOSFET's current. If it exceeds the internal threshold, the chip turns the power MOSFET off for the remainder of that cycle. The current limit state machine reduces the current limit threshold by discrete amounts under medium and light loads.

Leading edge blanking inhibits the current limit comparator for a short time after the power MOSFET turns on. This blanking time prevents current spikes caused by capacitance and secondary-side rectifier reverse recovery time from causing premature termination of the switching pulse.

In the event of an output overload, output short circuit, or an open loop condition, TinySwitch-II enters into auto-restart operation. An internal counter clocked by the oscillator gets reset every time the EN/UV pin goes low. If the EN/UV pin isn't pulled low for 50 ms, the power MOSFET switching will disable for 850 ms (except in the case of line undervoltage condition in which case it's disabled until the condition is removed). Auto-restart alternately enables and disables the power MOSFET's switching until removal of the fault condition.

You can monitor the dc line voltage by connecting an external resistor from the dc line to the EN/UV pin.

During power-up or disabled switching of the power MOSFET in auto-restart, the current into the EN/UV pin must exceed 50µA to initiate power MOSFET switching. During power-up, the chip holds the BYPASS pin to 4.8V, while line undervoltage condition exists. The BYPASS pin rises from 4.8V to 5.8V when the line undervoltage condition goes away. The auto-restart counter stops when you disable the MOSFET switching and a line undervoltage exists. This stretches the disable time beyond its normal 850 ms until the line undervoltage condition ends.

These devices operate in the current limit mode. When enabled, the oscillator turns the power MOSFET on at the beginning of each cycle. The MOSFET turns off when the current ramps up to the current limit, or when it reaches the dc max limit. The highest current limit level and frequency are constant, so the power delivered to the load is proportional to the primary inductance of the transformer and peak primary current squared. Therefore, designing the supply involves calculating the primary inductance of the transformer for the maximum output power required. By choosing the appropriate TinySwitch-II for the power level, the current in the calculated inductance will ramp up to current limit before reaching the dc max limit.

Pricing for the TinySwitch II family in 1,000 piece quantities ranges from $0.74 each for the TNY264P, a 5W part in a plastic 8-pin DIP, to $1.09 each for the 23W rated TNY268G, housed in an 8-pin SMD package.