# TNY263-268

# *TinySwitch®-II* Family

## Enhanced, Energy Efficient, Low Power Off-line Switcher

POWER® INTEGRATIONS

## Product Highlights

### *TinySwitch-II* Features Reduce System Cost

- Fully integrated auto-restart for short circuit and open loop fault protection – saves external component costs
- Built-in circuitry practically eliminates audible noise with ordinary dip-varnished transformer
- Programmable line under-voltage detect feature prevents power on/off glitches – saves external components
- Frequency jittering dramatically reduces EMI (~10 dB) – minimizes EMI filter component costs
- 132 kHz operation reduces transformer size – allows use of EF12.6 or EE13 cores for low cost and small size
- Very tight tolerances and negligible temperature variation on key parameters eases design and lowers cost
- Lowest component count switcher solution
- Expanded scalable device family for low system cost

### Better Cost/Performance over RCC & Linears

- Lower system cost than RCC, discrete PWM and other integrated/hybrid solutions
- Cost effective replacement for bulky regulated linears
- Simple ON/OFF control – no loop compensation needed
- No bias winding – simpler, lower cost transformer
- Simple design practically eliminates rework in manufacturing

### *EcoSmart®* – Extremely Energy Efficient

- No load consumption <50 mW with bias winding and <250 mW without bias winding at 265 VAC input
- Meets California Energy Commission (CEC), Energy Star, and EU requirements
- Ideal for cell-phone charger and PC standby applications

### High Performance at Low Cost

- High voltage powered – ideal for charger applications
- High bandwidth provides fast turn on with no overshoot
- Current limit operation rejects line frequency ripple
- Built-in current limit and thermal protection improves safety

## Description

*TinySwitch-II* integrates a 700 V power MOSFET, oscillator, high voltage switched current source, current limit and thermal shutdown circuitry onto a monolithic device. The start-up and operating power are derived directly from the voltage on the DRAIN pin, eliminating the need for a bias winding and associated circuitry. In addition, the

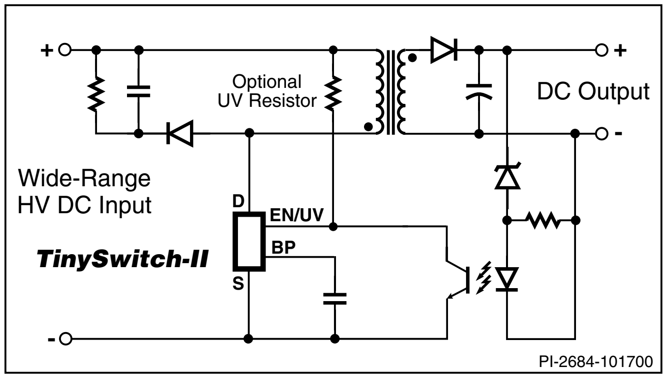


*Figure 1. Typical Standby Application.*

| OUTPUT POWER TABLE | | | | |
|---|---|---|---|---|
| PRODUCT[3] | 230 VAC ±15% | | 85-265 VAC | |
| | Adapter[1] | Open Frame[2] | Adapter[1] | Open Frame[2] |
| TNY263 P or G | 5 W | 7.5 W | 3.7 W | 4.7 W |
| TNY264 P or G | 5.5 W | 9 W | 4 W | 6 W |
| TNY265 P or G | 8.5 W | 11 W | 5.5 W | 7.5 W |
| TNY266 P or G | 10 W | 15 W | 6 W | 9.5 W |
| TNY267 P or G | 13 W | 19 W | 8 W | 12 W |
| TNY268 P or G | 16 W | 23 W | 10 W | 15 W |

*Table 1*. Notes: **1.** Minimum continuous power in a typical non-ventilated enclosed adapter measured at 50 °C ambient. **2.** Minimum practical continuous power in an open frame design with adequate heat sinking, measured at 50 °C ambient (See Key Applications Considerations). **3.** Packages: P: DIP-8B, G: SMD-8B. For lead-free package options, see Part Ordering Information.

*TinySwitch-II* devices incorporate auto-restart, line under-voltage sense, and frequency jittering. An innovative design minimizes audio frequency components in the simple ON/OFF control scheme to practically eliminate audible noise with standard 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 under-voltage threshold, which eliminates power down glitches caused by the slow discharge of input storage capacitors present in applications such as standby supplies. The operating frequency of 132 kHz is jittered to significantly reduce both the quasi-peak and average EMI, minimizing filtering cost.

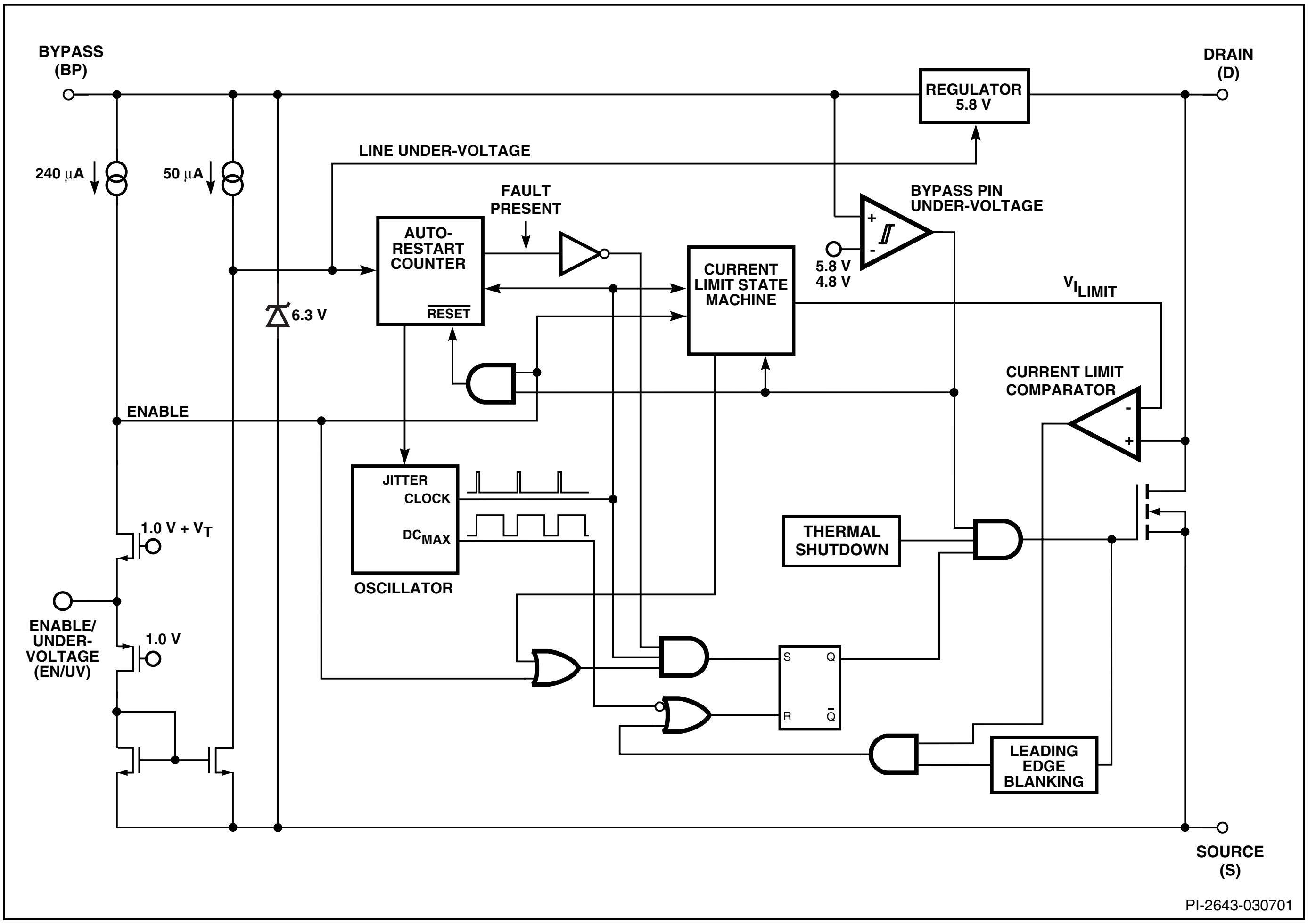


*Figure 2. Functional Block Diagram.*

## Pin Functional Description

**DRAIN (D) Pin:**
Power MOSFET drain connection. Provides internal operating current for both start-up and steady-state operation.

**BYPASS (BP) Pin:**
Connection point for a 0.1 µF external bypass capacitor for the internally generated 5.8 V supply.

**ENABLE/UNDER-VOLTAGE (EN/UV) Pin:**
This pin has dual functions: enable input and line under-voltage sense. During normal operation, switching of the power MOSFET is controlled by this pin. MOSFET switching is terminated when a current greater than 240 µA is drawn from this pin. This pin also senses line under-voltage conditions through an external resistor connected to the DC line voltage. If there is no external resistor connected to this pin, *TinySwitch-II* detects its absence and disables the line under-voltage function.

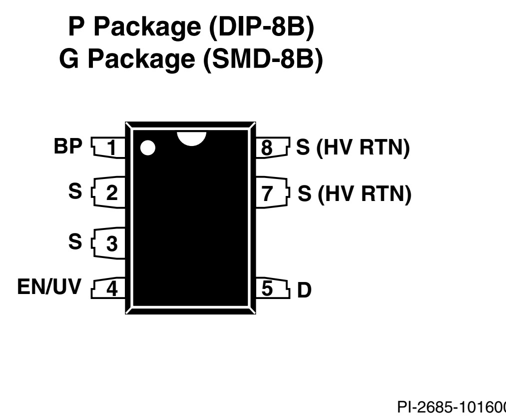


*Figure 3. Pin Configuration.*

**SOURCE (S) Pin:**
Control circuit common, internally connected to output MOSFET source.

**SOURCE (HV RTN) Pin:**
Output MOSFET source connection for high voltage return.

## *TinySwitch-II* Functional Description

*TinySwitch-II* combines a high voltage power MOSFET switch with a power supply controller in one device. Unlike conventional PWM (pulse width modulator) controllers, *TinySwitch-II* uses a simple ON/OFF control to regulate the output voltage.

The *TinySwitch-II* controller consists of an oscillator, enable circuit (sense and logic), current limit state machine, 5.8 V regulator, BYPASS pin under-voltage circuit, over-temperature protection, current limit circuit, leading edge blanking and a 700 V power MOSFET. *TinySwitch-II* incorporates additional circuitry for line under-voltage sense, auto-restart and frequency jitter. Figure 2 shows the functional block diagram with the most important features.

**Oscillator**

The typical oscillator frequency is internally set to an average of 132 kHz. Two signals are generated from the oscillator: the maximum duty cycle signal ($DC_{MAX}$) and the clock signal that indicates the beginning of each cycle.

The *TinySwitch-II* oscillator incorporates circuitry that introduces a small amount of frequency jitter, typically 8 kHz peak-to-peak, to minimize EMI emission. The modulation rate of the frequency jitter is set to 1 kHz to optimize EMI reduction for both average and quasi-peak emissions. The frequency jitter should be measured with the oscilloscope triggered at the falling edge of the DRAIN waveform. The waveform in Figure 4 illustrates the frequency jitter of the *TinySwitch-II*.

**Enable Input and Current Limit State Machine**

The enable input circuit at the EN/UV pin consists of a low impedance source follower output set at 1.0 V. The current through the source follower is limited to 240 µA. When the current out of this pin exceeds 240 µA, a low logic level (disable) is generated at the output of the enable circuit. This enable circuit output is sampled at the beginning of each cycle on the rising edge of the clock signal. If high, the power MOSFET is turned on for that cycle (enabled). If low, the power MOSFET remains off (disabled). Since the sampling is done only at the beginning of each cycle, subsequent changes in the EN/UV pin voltage or current during the remainder of the cycle are ignored.

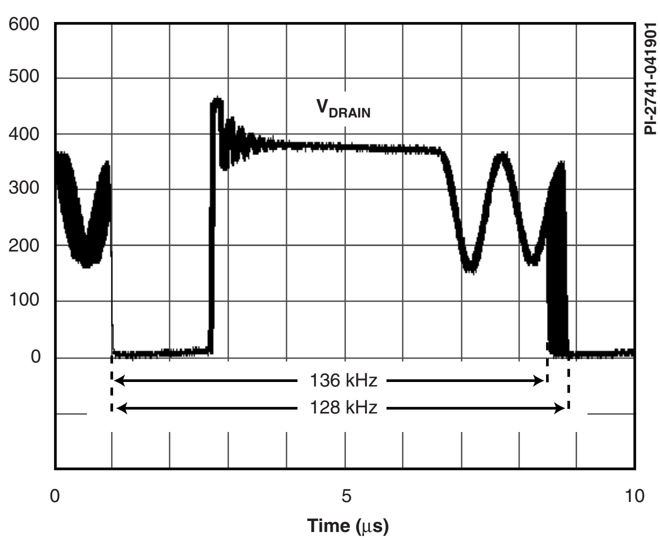


*Figure 4. Frequency Jitter.*

The current limit state machine reduces the current limit by discrete amounts at light loads when *TinySwitch-II* is likely to switch in the audible frequency range. The lower current limit raises the effective switching frequency above the audio range and reduces the transformer flux density, including the associated audible noise. The state machine monitors the sequence of EN/UV pin voltage levels to determine the load condition and adjusts the current limit level accordingly in discrete amounts.

Under most operating conditions (except when close to no-load), the low impedance of the source follower keeps the voltage on the EN/UV pin from going much below 1.0 V in the disabled state. This improves the response time of the optocoupler that is usually connected to this pin.

**5.8 V Regulator and 6.3 V Shunt Voltage Clamp**

The 5.8 V regulator charges the bypass capacitor connected to the BYPASS pin to 5.8 V by drawing a current from the voltage on the DRAIN pin whenever the MOSFET is off. The BYPASS pin is the internal supply voltage node for the *TinySwitch-II*. When the MOSFET is on, the *TinySwitch-II* operates from the energy stored in the bypass capacitor. Extremely low power consumption of the internal circuitry allows *TinySwitch-II* to operate continuously from current it takes from the DRAIN pin. A bypass capacitor value of 0.1 µF is sufficient for both high frequency decoupling and energy storage.

In addition, there is a 6.3 V shunt regulator clamping the BYPASS pin at 6.3 V when current is provided to the BYPASS pin through an external resistor. This facilitates powering of *TinySwitch-II* externally through a bias winding to decrease the no-load consumption to about 50 mW.

**BYPASS Pin Under-Voltage**

The BYPASS pin under-voltage circuitry disables the power MOSFET when the BYPASS pin voltage drops below 4.8 V. Once the BYPASS pin voltage drops below 4.8 V, it must rise back to 5.8 V to enable (turn-on) the power MOSFET.

**Over Temperature Protection**

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