Design Idea DI-91
TinySwitch®*-III*
12 W Universal Input CV Adapter

Application	Device	Power Output	Input Voltage	Output Voltage	Topology
General Purpose	TNY278P	12 W	85-265 VAC	12 V	Flyback

Design Highlights

- No-load consumption <50 mW at 265 VAC (R8 fitted)
- Active mode efficiency >75% (CEC standard: ≥71%)
- BP/M pin capacitor value selects MOSFET current limit (I_{LIMIT}–1, I_{LIMIT}, or I_{LIMIT}+1): for design flexibility
- Output OVP function senses overvoltage on the output through the primary bias winding
- Accurate (±5%), auto-recovering, hysteretic thermal shutdown function maintains safe PCB temperatures
- Auto-restart function protects against output short circuits and open feedback loops
- > 3.2 mm package pin creepage: reliable operation in high humidity and high pollution environments

Operation

This universal input, 12 V, 1 A, flyback converter was designed around a member of the *TinySwitch-III* IC family, the TNY278P. Because of the many features integrated into the device family, the supply only requires 31 through-hole components (no SMT), which enables a simple, single-sided PCB layout to be used.

The use of an *E-shield*™ in the transformer, a low-noise drain-node clamp (R2, C4 and D5), a single Y capacitor (C5) and the device's switching frequency jitter function enable a low-cost pi (π) filter (C1, L1 and C2) to attenuate conducted EMI enough to provide more than 10 dB of margin to EN550022 requirements (see Figure 4). The clamp circuit Zener (VR1) only conducts briefly during startup and at worst-case overload, just before the auto-restart function is activated.

Although *TinySwitch-III* family members do not need a bias winding to operate, one was used in this design to take advantage of the IC's output OVP detection function. If an open loop fault causes an overvoltage on the output, VR2 will conduct. When the current into the BP/M pin exceeds 5.5 mA, an internal latch triggers and disables MOSFET switching (see Figure 3), until AC power is removed and reapplied (to reset the latch). Resistor R3 limits the current through VR2, while R3 and R7 attenuate the portion of the leakage inductance spike that appears in the bias winding.
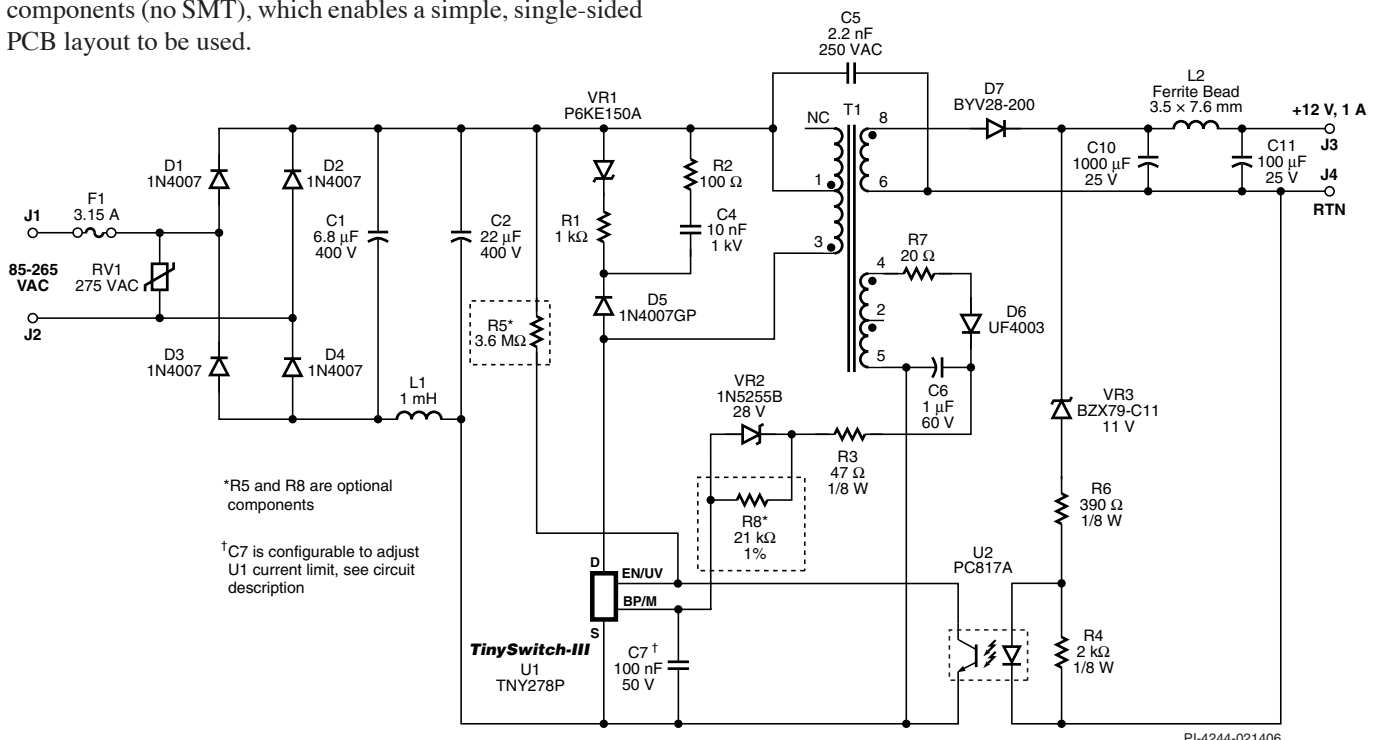

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Figure 1. TinySwitch-III 12 W, Universal Input, CV Adapter.

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When R8 (optional) is installed, it supplies current to the BP/M pin, which reduces the no-load consumption of the supply. When R5 (also optional) is installed, the current it feeds into the EN/UV pin of the IC enables the input under-voltage lockout function (UVLO), and sets the start-up threshold at 65 VAC.

The output voltage is determined by the series sum of the voltages across VR3, R6, and the LED in U2. The values of R4 and R6 can be adjusted to fine tune the output voltage of the supply, and a TL431 can be used in place of VR3, for tighter output voltage regulation.

Key Design Points

- In the *TinySwitch-III* family of devices, the MOSFET current limit can be selected from 3 levels by the value of capacitance on the BP/M pin. This gives the designer a number of options, which are shown in Figure 2. First, a TNY279 could be used, with the current limit of a TNY278, to obtain higher efficiency. Second, a TNY277 could be used, with the current limit of a TNY278, to deliver the same power at a lower efficiency. Lastly, a TNY278 could be used, with the current limit of a TNY279, to extend the power capability of the supply*.

- The UVLO function integrated into U1 only enables MOSFET switching to occur once the current flowing into the EN/UV pin exceeds 25 µA. Changing the UVLO threshold voltage requires changing the value of R5 so that 25 µA flows through it at the desired threshold voltage.

- If output OVP is not required and no-load power consumption of 150 mW (max, at 265 VAC input) is acceptable, then R7, D6, C6, R3 and VR2 can be eliminated and the bias winding removed from T1, for an even lower parts count.

*Note: This supply was not thermally designed to continuously deliver the extended power range that could be obtained by operating a TNY278 with its MOSFET current limit set at that of a TNY279.
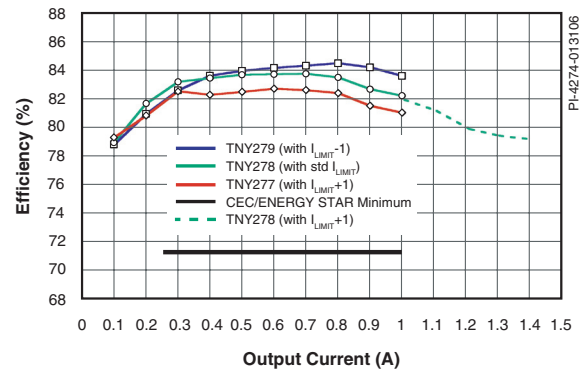

Figure 2. *Operating Efficiency vs.* $I_{LIMIT}+$, $I_{LIMIT}-$ *and Device Size.*
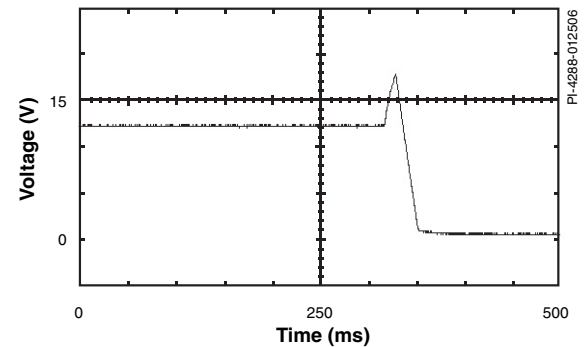
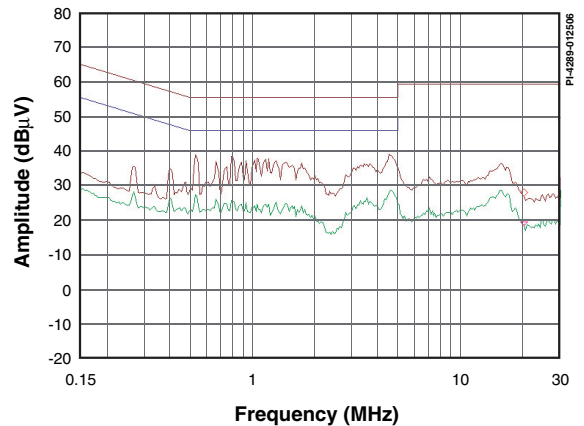

Figure 3. *BP/M Pin OVP Function Shuts Down Power Supply.*

Figure 4. *Conducted EMI Scan (Line): 115 VAC, Full Load.*

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