# Design Idea DI-130

# TinySwitch®-III
## Passive PFC LED Lighting Supply

| Application | Device | Power Output | Input Voltage | Output Voltage | Topology |
|---|---|---|---|---|---|
| LED Lighting | TNY279P | 18 W | 185-265 VAC | 10 V | Flyback |

## Design Highlights

- Very high efficiency: ≥82%
- Low component count: only 40 parts
- No common-mode choke required to meet EN55022B conducted EMI requirements
- Valley Fill circuit allows supply to meet IEC61000-3-2 THD limits
- ON/OFF control rejects the high line ripple voltage caused by the Valley Fill (THD correction) circuit

## Operation

The flyback converter shown in Figure 1 uses a member of the *TinySwitch-III* family (U2, a TNY279P) to provide up to 1.8 A of load current to six, high-intensity, Luxeon LEDs (the LXHL series).

The output voltage is slightly below the forward voltage drop of the LEDs. Therefore, when the LEDs are connected to the supply, it operates in constant current (CC) mode. If the LEDs are disconnected from the supply, Zener diode VR1 provides voltage feedback, which regulates the output voltage at about 13.5 VDC. A 100 mΩ resistor (R11) senses the output current and an Opamp (U1) drives the optocoupler (U3), which provides feedback to U2. The *TinySwitch-III* family of devices regulate by disabling or skipping MOSFET

switching cycles. As the load current reaches the current limit set-point threshold, U1 drives U3 on. The photo-transistor in U3 pulls current out of the EN/UV pin of U2, causing it to skip switching cycles. Once the output current drops below the current limit set-point threshold, U1 stops driving U3, which stops pulling current out of the EN/UV pin of U2, and switching cycles are enabled again. The TL431 (U4) provides a reference for U1 to compare against the voltage drop across R11.

The output diode (D9) is located in the lower leg of the transformer (T1) secondary winding to reduce EMI noise generation. An RCD clamp (R16, C4 and D13) protects the drain node of the MOSFET from the flyback voltage spike.

The Valley Fill circuit (D5, D6, D7, C15, C16 and R15) limits the values of the third and fifth harmonics of the line frequency current, which enables this supply to meet the requirements for Total Harmonic Distortion (THD) specified in IEC61000-3-2.

The frequency jittering function in U2, a shield winding in T1 and a Y class capacitor (C8) across T1 reduce the generation of conducted EMI so that a simple pi filter (C13, L1, L2 and C14) allows the supply to meet EN55022B limits.
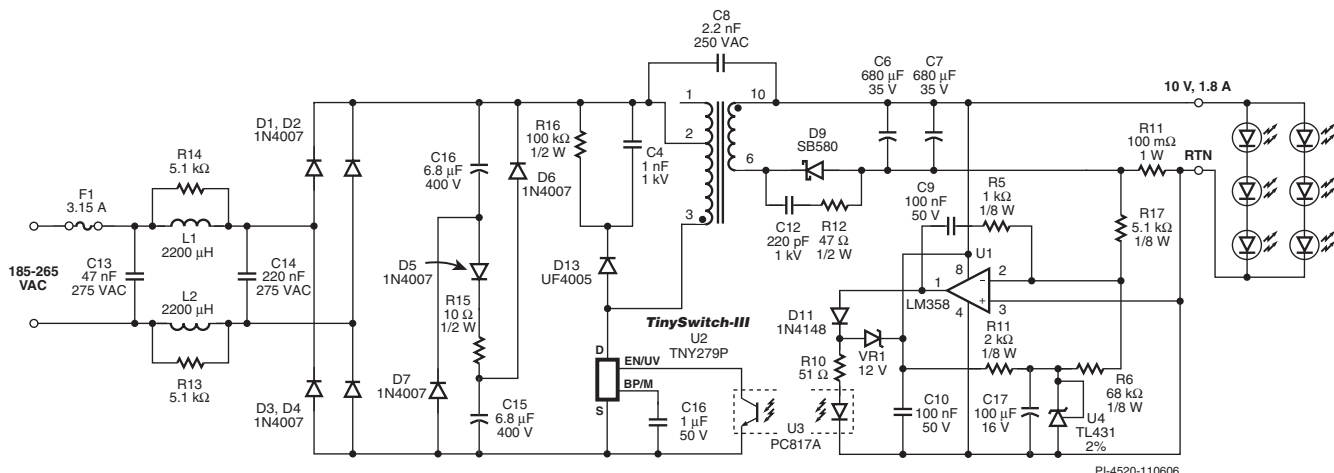


*Figure 1. Circuit Diagram of a Passive PFC Power Supply for Driving Lighting LEDs.*

## Key Design Points

- Take the value of input capacitance calculated by *PI Expert* or the *PI Xls* spreadsheet, divide it by two, and round up to the next standard value to select the values of C15 and C16.
- Using *PI Expert* or the *PI Xls* spreadsheet, design the supply for the maximum output power at the maximum $V_F$ of the LEDs.
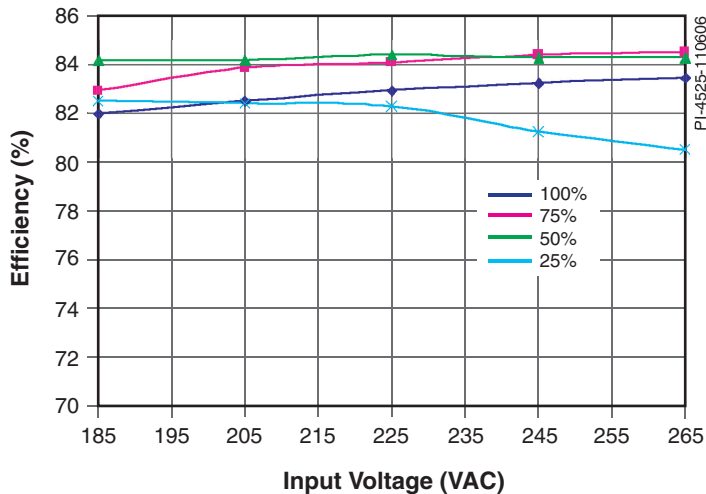- The LM358 (U1) contains two operational amplifiers. Ensure that the inputs to the second amplifier (pins 5 and 6) are connected to secondary ground.



*Figure 2. Efficiency vs. Input Voltage at Different Load Levels, Room Temperature, 50 Hz Line.*
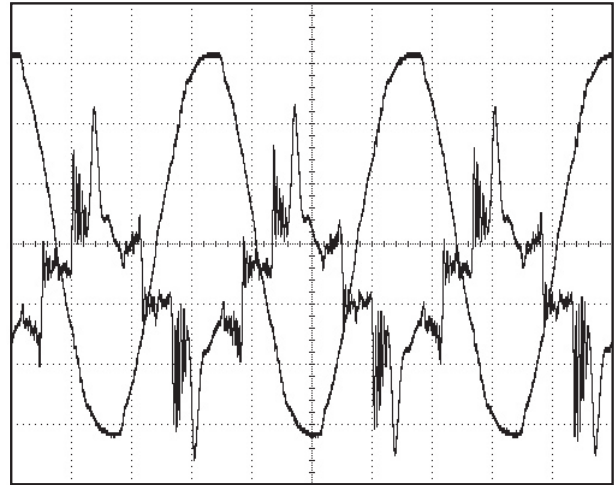


*Figure 3. Input Voltage (100 V /div) and Current (100 mA/div), Showing the Effect of the Valley Fill Circuit.*

| TRANSFORMER PARAMETERS | |
|---|---|
| Core Material | PC40EF25-Z |
| Bobbin | EF25 Horizontal bobbin |
| Winding Details | Primary: 92T, 0.3 mm heavy nyleze magnet wire Secondary: 14T 2 × 0.4 mm Triple Insulated Wire (TIW) |
| Winding Order (pin numbers) | Primary (2-4), Secondary (6-10) |
| Inductance | 1.6 mH |

*Table 1. Transformer Design Parameters.*

TIW = Triple Insulated Wire, NC = No Connect, FL = Flying Lead

Power Integrations
5245 Hellyer Avenue
San Jose, CA 95138
Phone: 1-408-414-9200
Apps: 1-408-414-9660
Apps Fax: 1-408-414-9760

For a complete listing of worldwide sales offices, please visit
www.powerint.com

**POWER INTEGRATIONS**