DESIGN NOTES

Single IC, Power Factor Corrected, Off-Line Supply

Design Note 143

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An ever increasing number of off-line power supplies now include power factor correction (PFC) in order to reduce input current and meet future regulatory requirements. Switching power supplies that incorporate a bridge rectifier followed by bulk capacitance create harmonic currents. These harmonics only increase the supply's RMS input current, while contributing nothing to real power. The typical solution to this problem has been to add a PFC preregulator and a separate controller to an existing design.

The LT®1508 (voltage mode) and LT1509 (current mode) eliminate the need for separate controllers by combining the PFC and a pulse width modulator (PWM) function in a single 20-pin IC. PFC is achieved by programming the input current of a boost regulator to follow the input line voltage. This results in a near-unity power factor compared to 0.5 to 0.7 for a typical capacitive input switcher. Linear's unique architecture maintains 0.99 power factor over a 20:1 load range. Figure 1 shows input current with output powers of 30W, 150W and 300W.

A number of issues associated with a 2-IC approach are addressed within the LT1508 and LT1509, resulting in a lower part count and improved PC board layout. Start-up is controlled by separate PFC and PWM soft start pins. The PWM Soft Start pin is held low, disabling the PWM output until the PFC stage is in regulation. The PWM will remain enabled as long as the PFC output voltage stays above 73% of its preset value (typically 280V out of 383V for universal input). A separate overvoltage protection pin can be connected to the output through an independent resistor divider. This ensures overvoltage protection during safety agency abnormal testing conditions, such as opening the main feedback path. The two stages are synchronized and the PWM turn-on is delayed for 50% of the oscillator cycle. This minimizes noise and conducted emission problems. 2A peak current gate drivers and a 1.2V optoisolator offset on the V_C pin further simplify the design.

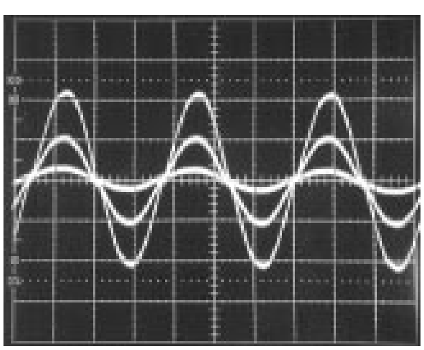

Figure 1. Input Current at 30W, 150W and 300W

A universal input, 24VDC, 300W converter using the LT1508 is shown in Figure 2. The circuit's user benefits include low cost, customizable footprint and off-the-shelf magnetics designed to meet UL and EC safety standards. Following the PFC boost preregulator is a 2-transistor forward converter that features low voltage (500VDC) switches, low peak currents and automatic nondissipative core reset. Under worst case conditions (low line, full power), the PFC and PWM stages have efficiencies of 90% and 92% respectively. See the graph in Figure 2 for typical overall efficiency versus input line and output power. The LT1508's low start-up current (250µA) minimizes start-up resistor power dissipation. An overwinding on T1 provides the bootstrapped chip supply. The intermediate bus voltage of 382V is well controlled, simplifying the post regulator and increasing capacitor holdup time compared to a typical off-line converter. This results in lower transformer primary current and simplified magnetics design. Different or additional outputs are easily accommodated with this topology by modifying T2 and L1.

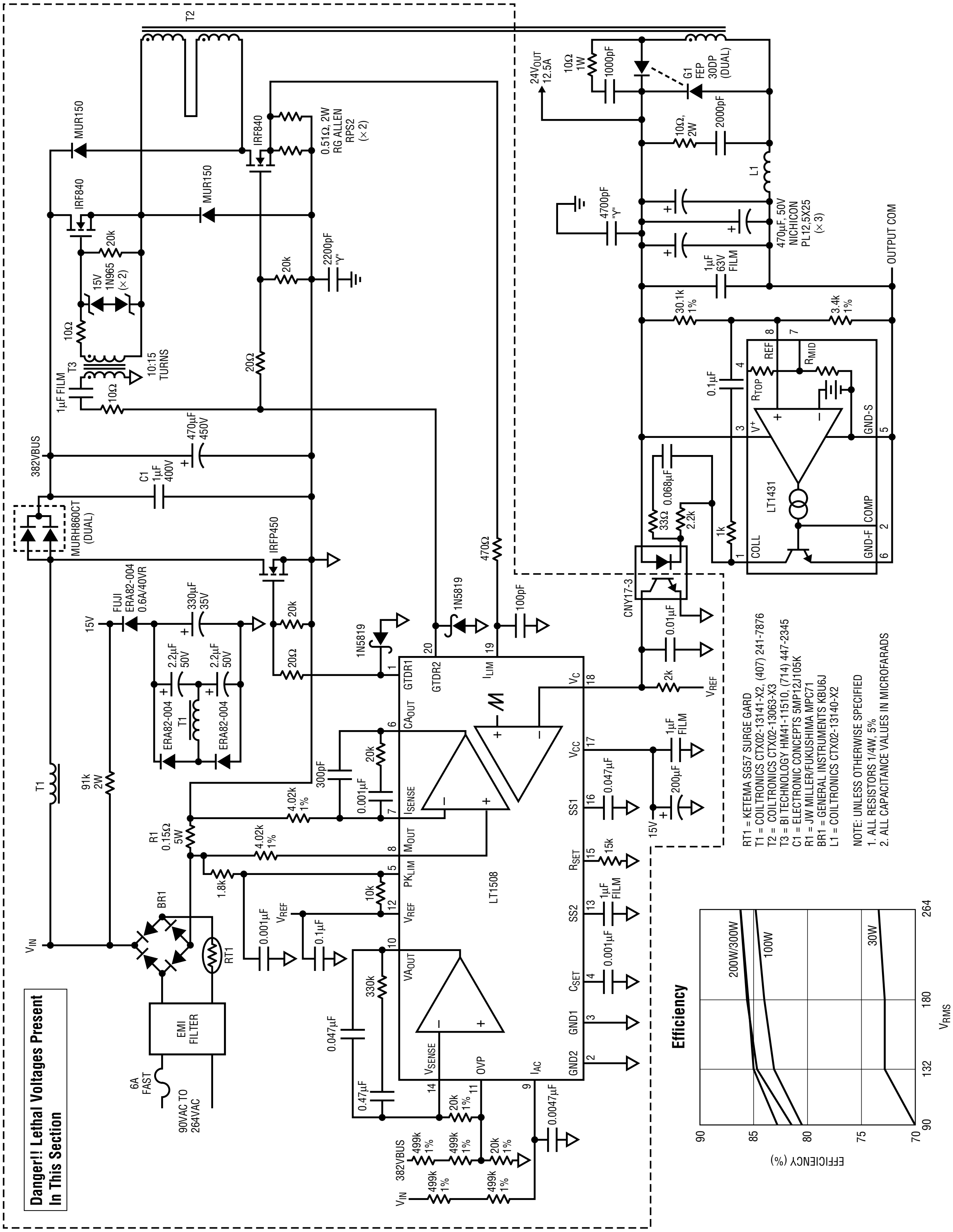

Figure 2. 24V, 300W Off-Line PFC Supply

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