

# 35 Watt Isolated DC/DC Converter Replaces Modules at Half the Cost

by Robert Sheehan

## Introduction

The choice between building or buying an isolated DC/DC converter can be a complex decision. If you use an off-the-shelf, module you are constrained by what the module makers offer in their catalogs. In many cases, this may not precisely meet the requirements for a particular project. Also, while simple to use, the cost of these modules can be significantly higher than the cost of "rolling your own." The complexity of the DC/DC

design can be daunting and leads many to the decision to buy. Demonstration circuit DC227 provides a DC/DC solution that can serve the needs of many "standard" module applications and offers the designer the option of customizing the design to suit any slightly unusual system requirements. The power supply now becomes merely another collection of parts in the system.

## Features

Demonstration circuit DC227 is a board level replacement for "half-brick" DC/DC converters. It can provide 5V or 3.3V at up to 7A from an isolated 48V (36V to 72V) input. The isolation voltage is 500VDC with an option for 1500VDC. The circuit has low input capacitance, fast turn-on time, low shutdown power consumption and overtemperature protection. Continuous short-circuit protection eliminates any restriction on maximum capacitive load. The output overvoltage circuit provides protection for open or short circuits on the output power or sense lines. The standard footprint allows the circuit to fit

directly into the module's socket. Figure 1 shows a typical layout for a 2.28" by 2.40" circuit board.

DC227A-A is designed for 500VDC isolation and lowest cost; it uses a standard Coiltronics VERSA-PAC™ transformer and a Pulse Engineering inductor for the output filter. DC227A-B has 1500V isolation and uses a semicustom transformer, also from Coiltronics. DC227A-C has 500VDC isolation and achieves the highest efficiency using a Panasonic type PCC-S1 inductor for the output filter. The efficiency curves in Figures 2–5 are quite competitive, reaching 85% for the DC227A-C with a 5V output. The efficiency at 3.3V out is somewhat lower, due to the fixed losses of the output rectifier.

## Circuit Description

This single-ended forward converter operates at a nominal switching frequency of 200kHz. Referring to the schematic in Figure 6, pulse width modulation is controlled by U1, an LT1247 current mode PWM controller. Transformer T2 and optocoupler Q7 provide galvanic isolation. C2 is a

VERSA-PAC is a trademark of Coiltronics, Inc.

### DESIGN IDEAS

#### 35 Watt Isolated DC/DC Converter Replaces Modules at Half the Cost

Robert Sheehan

#### Comparator Circuit Provides Automatic Shutdown of the LT1795 High Speed ADSL Power Amplifier

Tim Regan

#### SMBus Controlled CCFL Power Supply

Jim Williams

#### Triple Output TFT-LCD Bias Supply Uses All Ceramic Capacitors

Gary Shockey

#### Low Noise Boost VCO Power Supply for Portable Applications

Ted Henderson

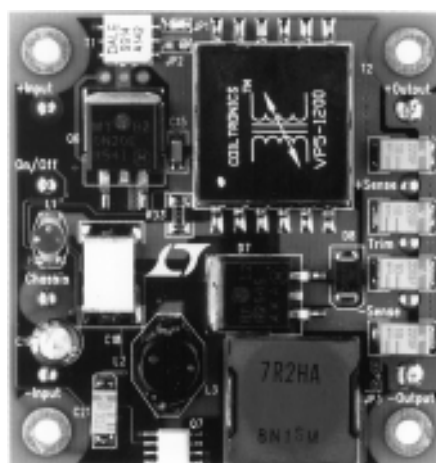
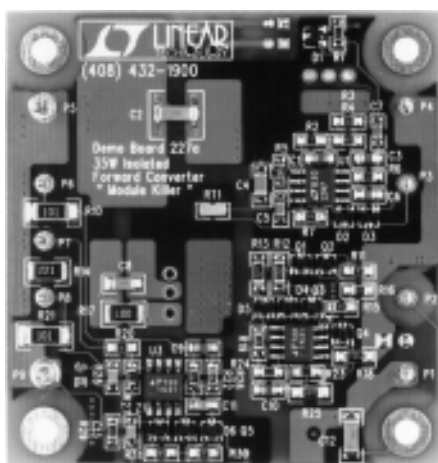
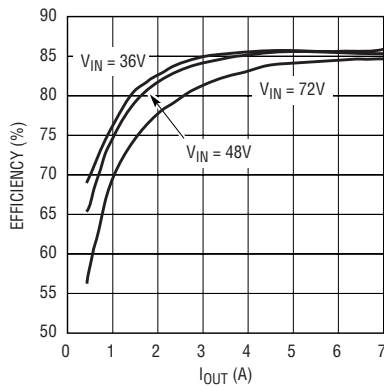


Figure 1. Control (left) and power component (right) views of demonstration circuit DC227, a complete 35W DC/DC converter in a 2.28" by 2.40" footprint

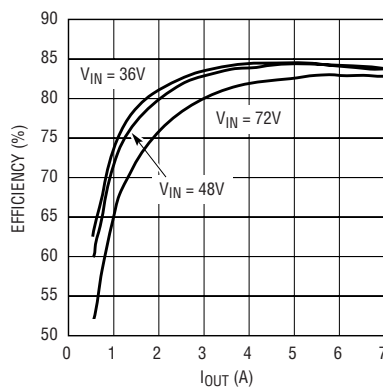


**Figure 2. DC227A-C 5V output efficiency (typical)**

local bypass cap to reduce common mode-induced current.

To achieve fast start-up time, a hysteretic buck regulator is used for the bias supply power. U2, an LT1431 shunt voltage regulator, provides control for this function, with Q1 acting as the switch element; L2 and C21 provide output filtering. Q2 and Q4 protect the circuit during a hot plug, making this a very robust design; it is also impervious to output short circuits. The input surge voltage is limited to 80V by the rating of Q1-Q4.

The main switching power path through T2 comprises L1 and C18 as the input filter, Q6 as the primary switch, D7 as the secondary rectifier and L3 and C14, C16, C17 and C20 as the secondary filter. Transient volt-



**Figure 3. DC227A-A/B 5V output efficiency (typical)**

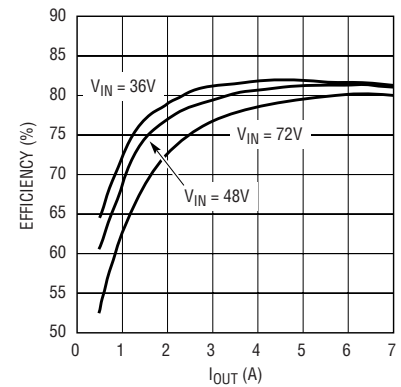
age suppressor D8 is used to protect Schottky diode D7 during large-signal transient conditions. Power is transferred during the on cycle of Q6 and integrated by the output filter, just as in a buck regulator. The input filter component values for L1 and C18 are optimal and should not be changed without careful evaluation. C19 damps the input filter and will provide adequate stability for large values of input inductance. See LTC Application Note 19 for a discussion of input filter stability analysis.

Output voltage feedback is controlled using U3, another LT1431 shunt voltage regulator, as an error amplifier. In the event of a fault on the output power or sense lines, Z1/Q5 will override U3 and provide overvoltage protection. R10 and R21 are sized to handle any overvoltage condition.

During an output short-circuit condition, the LT1247 is able to decrease the on time of Q6 to less than 200ns. This results in good control of the output short-circuit current, keeping power dissipation to a manageable level.


The demonstration circuit uses surface mount devices for Q6 and D7. For elevated temperature operation at the full rated load, TO-220 devices can be mounted on a standard half-brick heat sink.

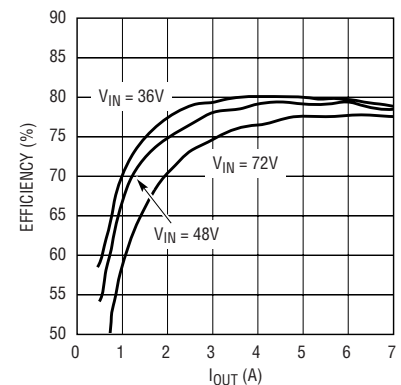
For -48V inputs that require hot swap capability, the LT1640H negative voltage HotSwap™ controller provides a seamless interface. Demonstration circuit DC223A-B using the LT1640HCS8 is the recommended solution for use with the DC227A.



**Figure 4. DC227A-C 3.3V output efficiency (typical)**

## Conclusion

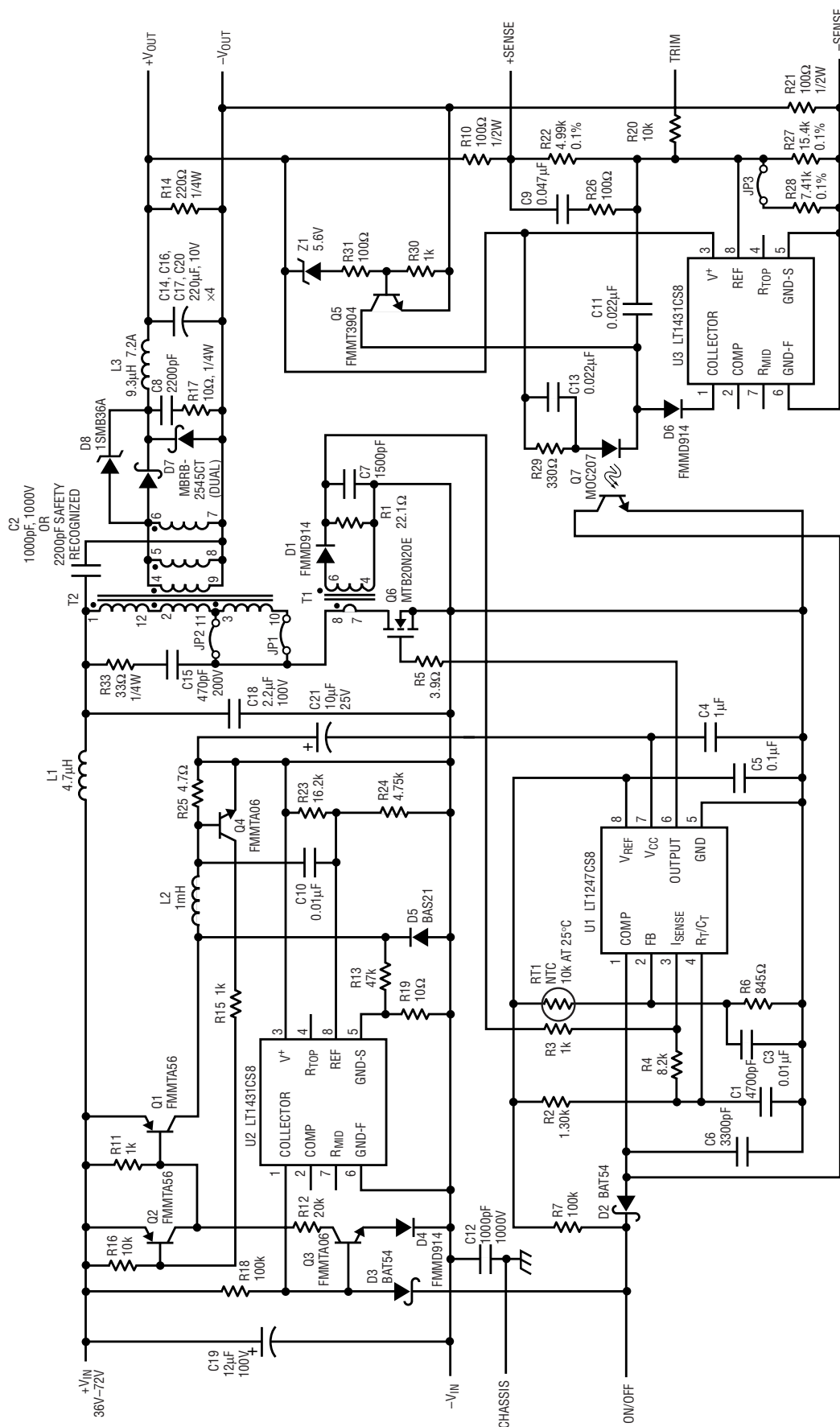
At 35 watts, the topology presented here is one of the most common used by the module manufacturers. This is only one solution for isolated power, and opens up many possibilities for other input and output voltage combinations. For lower power, demonstration circuit DC211 using the LT1425 isolated flyback switching regulator is designed for 10 watts. Demonstration circuit DC259 using the LT1339 adds synchronous rectification, providing a high efficiency solution for 50 watts. See the DC/DC Converter Module section of LTC's Volume 1 1999 New Products Catalog for additional information. 



**Figure 5. DC227A-A/B 3.3V output efficiency (typical)**

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NOTES:  
1. CHANGE Z1 TO A 3.3V ZENER FOR 3.3V OUT  
2. JP3: OPEN = 3.3V; SHORTED = 5V

	T2 AND JUMPER	L3	C2
DC227A-A	500VDC ISOLATION	COILTRONICS VP5-1200; JP1	PULSE ENGINEERING PE-53663
DC227A-B	1500VDC ISOLATION	COILTRONICS CTX02-14281-X2; JP2	PULSE ENGINEERING PE-53663
DC227A-C	500VDC ISOLATION HIGH EFFICIENCY	COILTRONICS VP5-1200; JP1	PANASONIC ETQPAF7R2HA

L1: COILCRAFT D01608C-472  
L2: COILCRAFT D03316P-105  
T1: DALE LPE-3325-A142  
C14, C16, C17, C20: AVXTPSE227M010R0100  
C18: ITW PAKTRON 225100ST3827T  
C19: SANYO 100MV12GX

Figure 6. 35W isolated DC/DC converter schematic diagram