


Power supply accepts wide input-voltage range

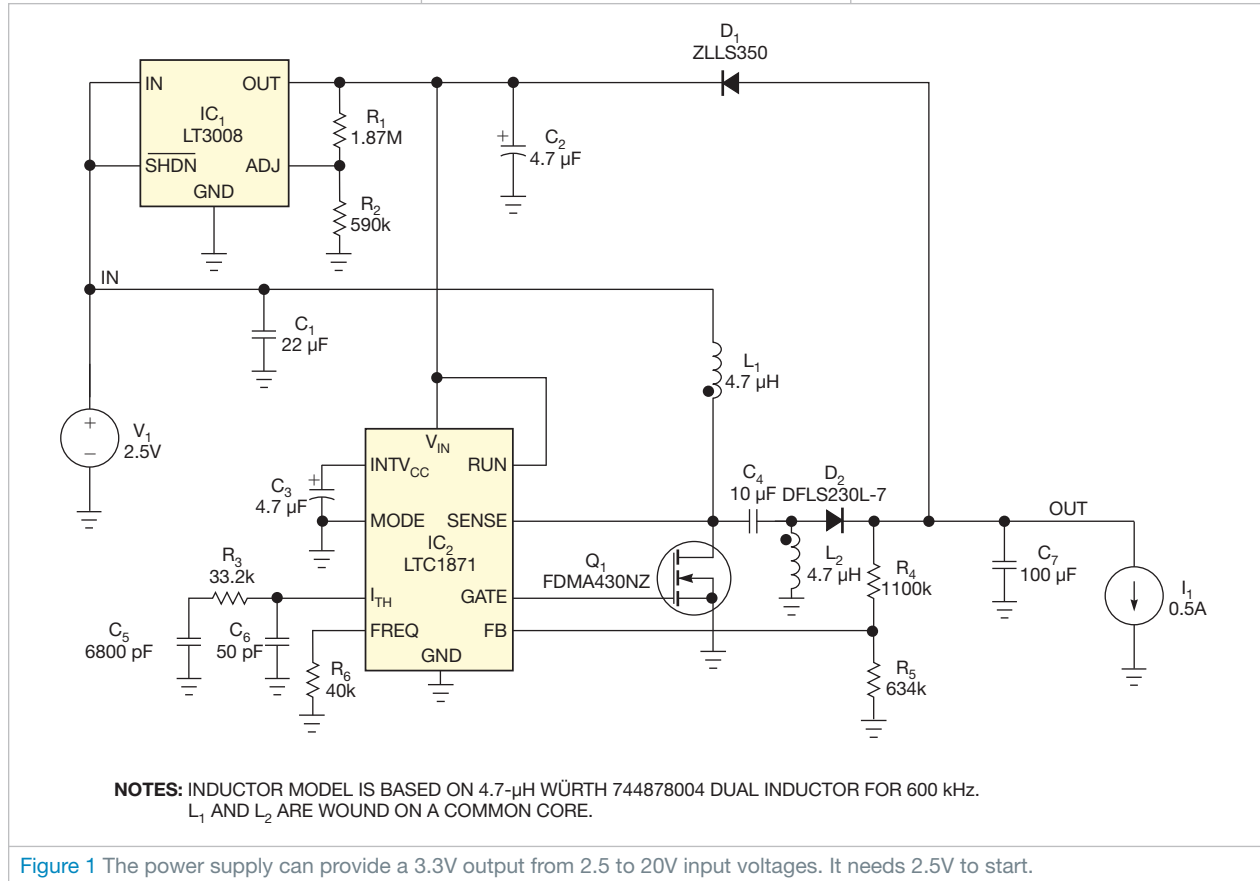
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 The switching power supply in **Figure 1** produces 3.3V dc from an input voltage of 2.5 to 20V dc with high efficiency. The circuit operates at

an input voltage as low as 1.5V once it starts from a minimum of 2.5V dc, allowing the switcher to fully discharge a pair of alkaline cell batteries nearing end

of life. The power supply can also run efficiently off higher input voltages, such as 12V automotive power. The heart of the circuit is a SEPIC (single-ended-primary-inductance-converter)-based switching power supply, which provides an output voltage greater than or less than the input voltage (**Reference 1**).

This power supply includes bootstrap circuitry comprising IC₁, an LT3008



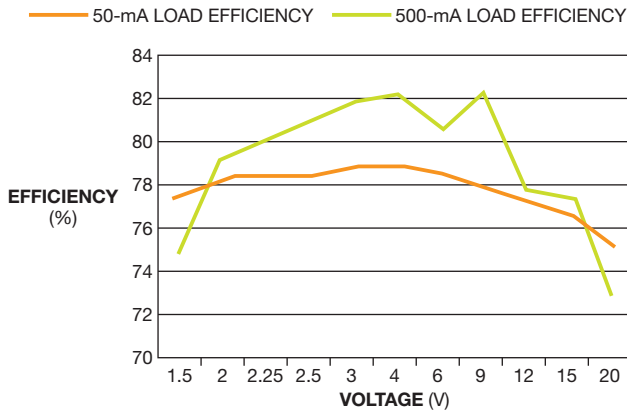


Figure 2 The power supply's efficiency is consistent over 50- and 500-mA loads.

voltage regulator; Schottky diode D_1 ; and capacitor C_2 . It needs a minimum of 2.5V to start. Voltage regulator IC_1 provides 2.5V to start SEPIC controller IC_2 . Once the output voltage of the SEPIC power supply reaches its normal output voltage of 3.3V, D_1 lets the output power of the switcher flow back to power IC_2 . Once this action occurs, IC_1 drops out of the circuit because the voltage at its output is above its setpoint voltage. The converter's own output now powers IC_2 , and the regulator's internal circuitry prevents backflow of power through IC_1 . MOSFET Q_1 has low threshold voltage, appropriate on-resistance to provide current feedback to IC_2 , and a maximum

drain-to-source voltage of 30V to allow for operation up to a 20V input.

The bootstrap circuit allows the converter to run from very low input voltages by maintaining the input voltage to IC_2 , and it increases efficiency at high input voltages by eliminating the use of IC_2 's internal linear voltage regulator. **Figure 2** shows the efficiency of the prototype power supply at both 50- and 500-mA loads. The power supply's efficiency is consistent over a range of operating voltages because of the bootstrapping circuit.

Because the circuit uses a low-threshold-voltage MOSFET, the switch, keeping the gate drive voltage low, reduces

the total charge that must go into and out of the MOSFET gate, further improving efficiency. SEPIC controller IC_2 normally uses its internal low-dropout capability to generate an operating voltage of 5V from the input. Running IC_2 from the bootstrapped output reduces IC_2 's operating voltage to approximately 3V, which also limits the drive voltage to Q_1 's gate.

Table 1 lists the key components for the power supply, including an appropriate commercially available coupled inductor. The PCB (printed-circuit-board) design and the choice of coupled inductors for this power supply are critical for good performance. For the power supply to achieve high efficiency at low input voltages and high output current, the coupled inductor must have low-resistance windings, and the high current tracks should use wide copper pours to minimize resistance

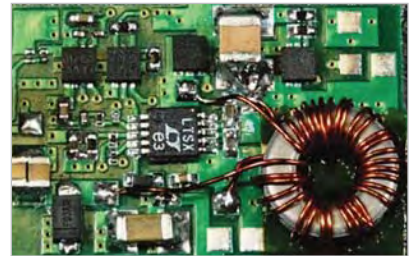


Figure 3 The complete power supply fits onto a 23x15x3.5-mm PCB.

TABLE 1 KEY PARTS FOR POWER SUPPLY

Component	Description	Manufacturer	Part
Input capacitor	22- μ F, 25V, 10%-tolerance, 1210-size X5R ceramic capacitor	AVX	12063D106KAT2A
Output capacitor	100- μ F, 6.3V, 1206-size X5R ceramic capacitor	Kemet	C1206C107M9PACTU
Coupled inductor	4.7- μ H coupled-inductor Cuk SEPIC	Würth	744878004
Bootstrap low-dropout regulator	Regulated-low-dropout-adjustment, 20-mA, 6-DFN-packaged IC	Linear Technology	LT3008EDC#TRMPBF
SEPIC controller	10-MSOP-packaged current-mode-IC controller	Linear Technology	LTC1871EMS#PBF
MOSFET	30V, 5A, N-channel microMOSFET	Fairchild Semiconductor	FDMA430NZ
Bootstrap diode	SOD-523-packaged, 40V Schottky diode	Diodes Inc	ZLLS350TA
SEPIC diode	2A, 30V Schottky power diode	Diodes Inc	DFLS230L-7

losses and unwanted inductance.

A prototype of the power supply measures 23×15×3.5 mm (**Figure 3**). It uses a custom coupled inductor, but you can choose from many off-the-shelf coupled inductors available from BH Electronics (www.bhelectronics.com), Coilcraft (www.coilcraft.com), and Würth Elektronik (www.we-online.com).

You can download the Linear Technology LTSpice code for this circuit from the online version of this Design Idea at www.edn.com/110217dia.**EDN**

REFERENCE

1 “Designing a SEPIC Converter,” Application Note 1484, National Semiconductor, April 30, 2008, <http://bit.ly/ich5pf>.