

## DESCRIPTION

Demonstration board DC088 is a complete DC/DC converter that can generate 5V at 200mA from a 2-cell input. Just two capacitors, an inductor, a diode and the LT1304CS8-5 IC are required to realize the DC/DC function. High efficiency is maintained over a broad range of load current due to the LT1304-5's 120 $\mu$ A quiescent

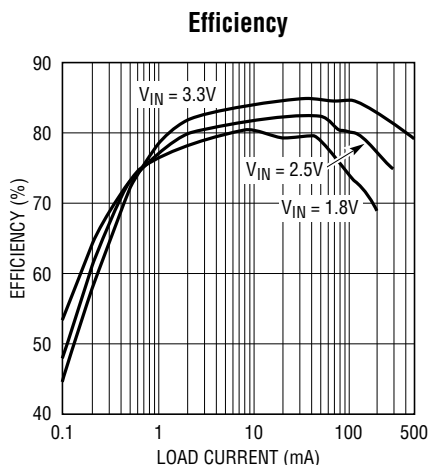
current and Burst Mode™ operation. A  $\overline{\text{SHDN}}$  pin disables the converter when pulled low, reducing supply current to 10 $\mu$ A. An independent low-battery detector with open-collector output remains active in shutdown.

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## PERFORMANCE SUMMARY $0^{\circ}\text{C} \leq T_A \leq 70^{\circ}\text{C}$ , $V_{\text{IN}} = 2.5\text{V}$ , $V_{\text{SHDN}} = 2\text{V}$ unless otherwise specified.

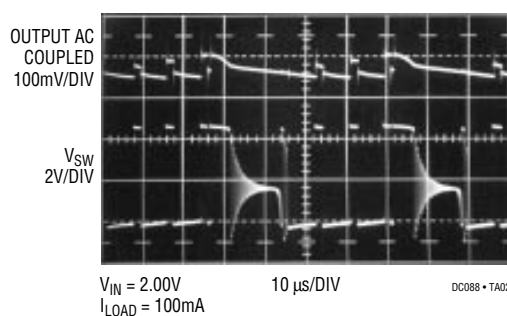
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Input Voltage		1.65	2.50		V
Output Voltage		4.80	5.05	5.25	V
Load Current	$V_{\text{IN}} = 3.30\text{V}$		500		mA
Quiescent Current	Not Switching		120	200	$\mu\text{A}$
Shutdown Current	$\overline{\text{SHDN}} = 0\text{V}$		10		$\mu\text{A}$

## TYPICAL PERFORMANCE CHARACTERISTICS AND BOARD PHOTO



DC088 F02

**Output and Switch Waveforms**

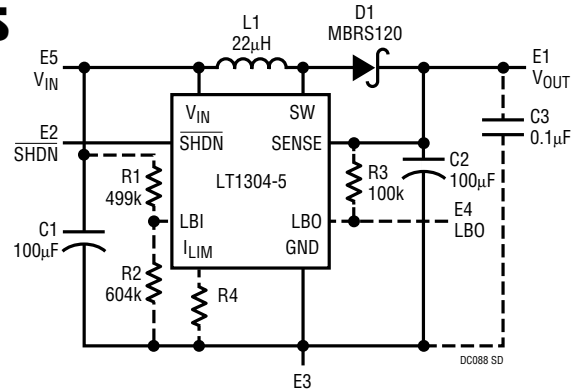
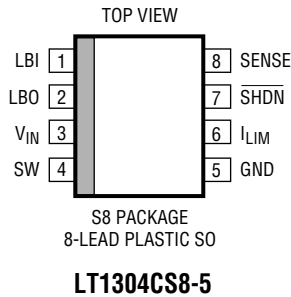


**Component Side**



DC088 • TA03

## PACKAGE AND SCHEMATIC DIAGRAMS



**Figure 1. 2- to 3-Cell to 5V Converter. Dashed Lines Indicate Optional Components and Are Not Necessary to Converter Function**

## PARTS LIST

REFERENCE DESIGNATOR	QUANTITY	PART NUMBER	DESCRIPTION	VENDOR	TELEPHONE
C1, C2	2	TPSD107M010	100µF, 10V Tantalum Capacitor	AVX	(803) 448-9411
D1	1	MBRS120	Schottky Diode	Motorola	(800) 521-6274
L1	1	CD54-220	22µH Inductor	Sumida	(708) 956-0666
U1	1	LT1304-5	DC/DC Converter IC	LTC	(408) 432-1900
<b>Optional Components</b>					
C3	1	12065C103	0.01µF, 50V Ceramic Capacitor	AVX	
R1	1	CR324993	499k, 1/8W, 1% Resistor	AVX	
R2	1	CR326043	604k, 1/8W, 1% Resistor	AVX	
R3	1	CR321003	100k, 1/8W, 1% Resistor	AVX	

## OPERATION

The LT1304-5 DC/DC converter uses Burst Mode operation to provide a fixed output of 5V DC. The circuit can deliver 200mA from fully discharged (2.00V) cells. Operation typically extends to  $V_{IN} = 1.5V$  and is guaranteed with  $V_{IN} = 1.65V$ . Component values, PC board layout and vendors are recommended by Linear Technology. For best performance do not modify the PC board layout.

### HOOK-UP

The demonstration board comes with turrett terminals for connecting the battery. These terminals will accommodate up to 18AWG stranded wire. For the best efficiency, it is important to make a good, *solid* connection to the battery using short wires. Some inexpensive battery holders use a resistive metal for the springs, resulting in as much as 0.2Ω in series with the battery. This much resistance can reduce operating time significantly, especially at high output levels.

## FUNCTIONAL DESCRIPTION

### Regulator

The LT1304-5 uses Burst Mode operation to achieve micropower operation, yet delivers over 1W of output power. In this mode the output voltage is monitored by Sense pin 8. This potential is divided by an internal resistor string and applied to one side of a comparator. The other side is referred to 1.24V. When the output voltage drops sufficiently to reduce the divided voltage to less than 1.24V, the comparator enables the internal oscillator. The oscillator OFF time is fixed at 1.5µs. The ON time can, however, be determined in either of two ways. Without intervention of the current limit circuit, the oscillator will have an ON time of 6µs. The current limit circuit will intervene if the switch current exceeds either the internally trimmed maximum of 1A or a lower value forced by the addition of an external current-limiting resistor (R4). In

## OPERATION

either event, the switch will be forced off and the ON time will be reduced from 6μs to some value greater than the propagation delay of the current-limit circuitry (about 200ns).

### Low-Battery Detector

The low-battery comparator is a hysteretic comparator with one side referred to 1.17V. The divider consisting of R1 and R2 has been selected to provide a low-battery output signal when the input voltage falls below 2.14V. R1 can be changed to obtain other low-battery threshold voltages according to the formula:

$$R1 = R2 \left( \frac{V_{IN}}{1.17} - 1 \right)$$

The output, LBO, is an open collector capable of sinking 500μA in the low-battery detected state. The creative designer may find this comparator useful in other applications similar to those found in the LT1304-5 data sheet. The regulator can be placed in a 10μA shutdown state by pulling the SHDN pin 7 to ground (<0.4V). In this state the low-battery detector remains active, yet the input current is a mere 10μA.

## COMPONENTS

### Capacitors

The capacitors on this board are low ESR tantalum units specifically designed for switch mode power supply applications. The LT1304-5 requires a good input bypass capacitor located less than 0.25 inches from the device for

proper operation. The 100μF, 10V input capacitor may be replaced by a lower cost (>0.1ESR) 100μF unit at a slight loss of efficiency.

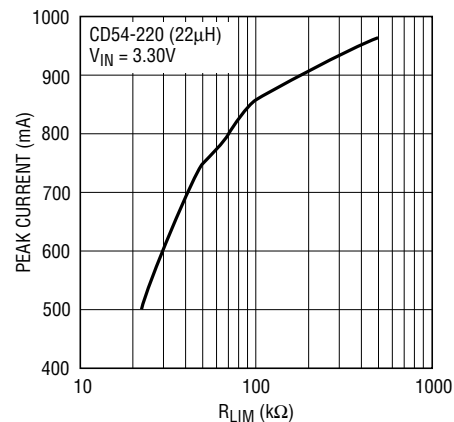
### Inductors

The Sumida CD54-220 inductor is a low cost, ferrite, unshielded unit. Wire resistance (DCR) is specified at 0.1Ω. For improved efficiency, the Sumida DC75-220 can be used. A toroidal core unit may be preferred in some cases due to superior flux containment, resulting in improved RFI/EMI suppression.

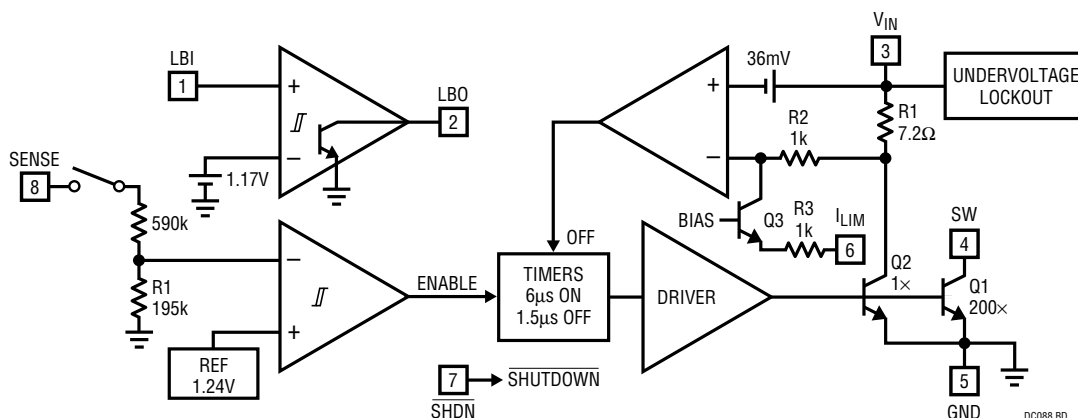
### Diodes

The MBRS120 Schottky diode has an excellent forward drop and 20V breakdown. Using an MBRS130 may result in improved efficiency at low load currents at the expense of greater forward drop. A 1N5818 diode is also suitable.

Peak Switch Current Can Be Reduced by Connecting a Resistor Between I<sub>LIM</sub> and Ground

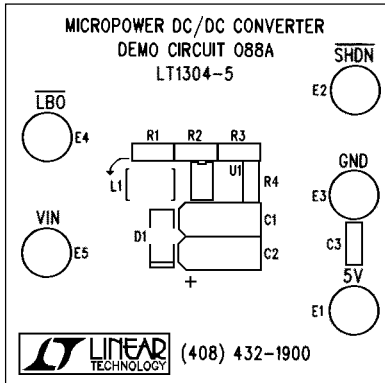


LT1304-5 Block Diagram

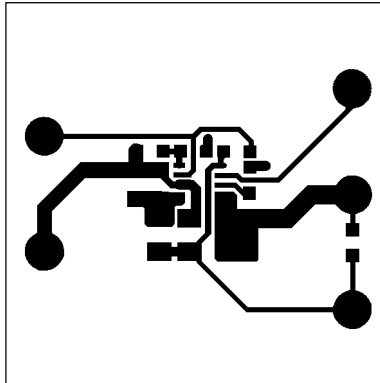


# DEMO MANUAL DC088

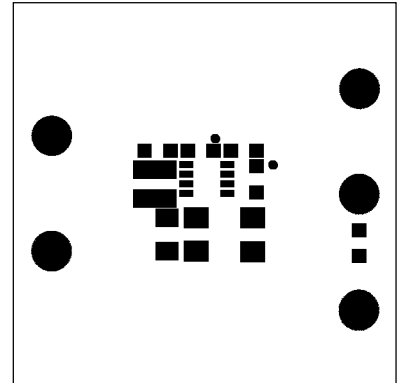
## PCB LAYOUT AND FILM



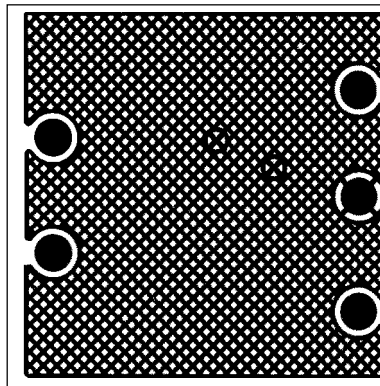
Component Side Silkscreen



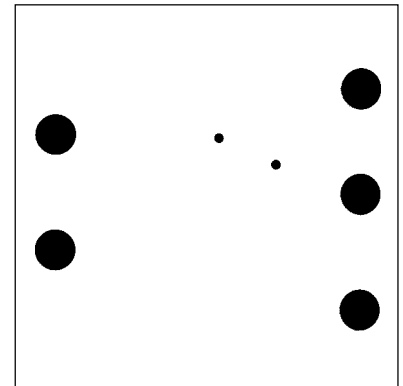
Component Side



Component Side Solder Mask

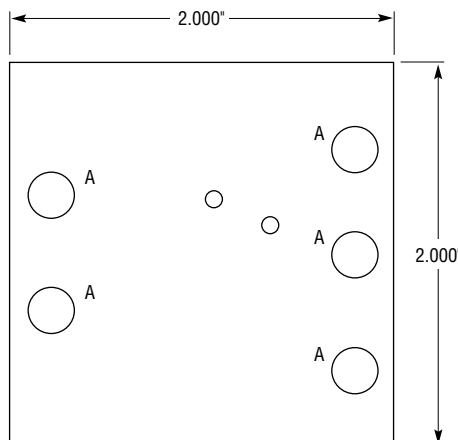


Solder Side



Solder Side Solder Mask

## PC FAB DRAWING



**NOTES:**

1. FINISHED MATERIAL IS FR4, 0.062 THICK, 2-OZ COPPER
2. PCB WILL BE DOUBLE-SIDED WITH PLATED THROUGH-HOLES
3. PTH SIZES AFTER PLATING, 0.001 MIN WALL THICKNESS
4. SOLDER MASK BOTH SIDES USING PC401 OR EQUIVALENT
5. SILKSCREEN COMPONENT SIDE USING WHITE NONCONDUCTIVE INK
6. ALL DIMENSIONS IN INCHES,  $\pm 0.005$
7. ALL HOLE SIZES AFTER PLATING,  $-0$  TO 0.003 MAX

HOLE CHART		
SYMBOL	DIAMETER	QTY PLT
NONE	0.025	2 YES
A	0.094	5 YES
TOTAL HOLES 11		

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