

High Efficiency 2-Cell Supercapacitor Charger and Balancer Converter

DESCRIPTION

Demonstration circuit 1887 is a DC/DC supercapacitor buck-boost charger and balancer converter featuring the LTC[®]3128. The DC1887A operates over 1.72V to 5.5V input and charges the output up to 5.5V. Also, the LTC3128 has 2% precision input current limit, which allows the circuit to operate effectively with current limited input power sources like the USB. The 1.2MHz switching frequency operation results in a small and efficient circuit. The converter provides high output voltage accuracy (typically $\pm 2\%$) over a 1.72V to 5.5V input. The demonstration circuit can be easily modified to generate different output voltages.

The DC1887 has a small circuit footprint. It is a high performance and cost effective solution for charging and balancing supercapacitors. Please read the LTC3128 data sheet along with this manual.

Design files for this circuit board are available at <http://www.linear.com/demo>

LT, LT, LTC, LTM, Linear Technology and the Linear logo are registered trademarks of Linear Technology Corporation. All other trademarks are the property of their respective owners.

PERFORMANCE SUMMARY

Specifications are at $T_A = 25^\circ\text{C}$

PARAMETER	CONDITIONS	VALUE
Minimum Input Voltage	$I_{OUT} = 0\text{A to }1\text{A}$	1.72V
Maximum Input Voltage	$I_{OUT} = 0\text{A to }1\text{A}$	5.5V
V_{OUT}	$V_{IN} = 1.72\text{V to }5.5\text{V}, I_{OUT} = 0\text{A}$	4.2V $\pm 2\%$
Input Current Limit (Programmable to 3A)	$V_{IN} = 1.72\text{V to }5.5\text{V}$	0.9A
Nominal Switching Frequency		1.2MHz

QUICK START PROCEDURE

Demonstration circuit 1887 is easy to set up to evaluate the performance of the LTC3128. For proper measurement equipment setup refer to Figure 1 and follow the procedure below:

NOTE: When measuring the input or output voltage ripple, care must be taken to minimize the length of oscilloscope probe ground lead. Measure the input or output voltage ripple by connecting the probe tip directly across the VIN or VOUT and GND terminals as shown in Figure 2.

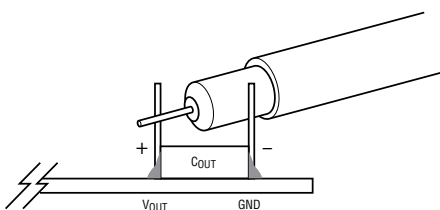


Figure 2. Measuring Input or Output Ripple

1. With power off, connect the input power supply to V_{IN} and GND.
2. Keep the load set to 0A or disconnected.
3. Turn the input power source on and slowly increase the input voltage. Be careful not to exceed 5.5V.

NOTE: Make sure that the input voltage V_{IN} does not exceed 5.5V.

4. Set the input voltage to 3.3V and check for the proper output voltage of 4.2V. If there is no output, temporarily disconnect the load to make sure that the load is not set too high.
5. Once the proper output voltage is established, adjust the load and observe the output voltage regulation, ripple voltage, efficiency and other parameters.
6. Note that the output voltage V_{OUT} will vary with load. This is due to the current source nature of the LTC3128 power converter. As the output voltage increases the output current will decrease in order to maintain the input current below the preset limit.

The LTC3128 circuit maximizes the output current while keeping the input current within the preset current limit. This keeps the supercapacitor charging time to a minimum.

CHANGING THE OUTPUT VOLTAGE

To change the output voltage from the programmed 4.2V, change the voltage divider resistors connected to the LTC3128 FB pin (see the schematic on page 5).

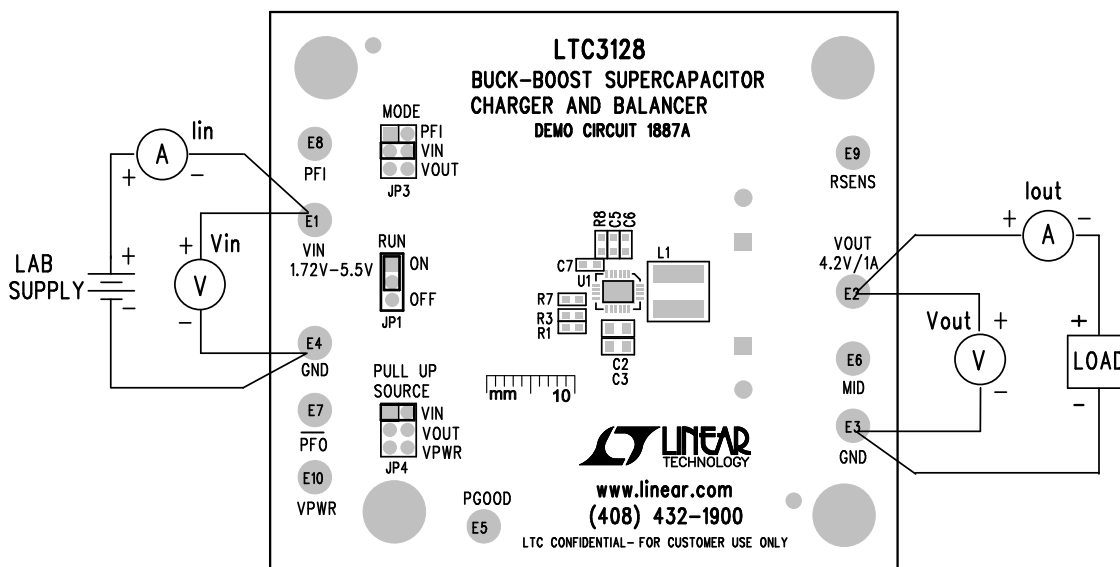


Figure 1. Proper Measurement Equipment Setup

QUICK START PROCEDURE

CONVERTER OUTPUT CURRENT

The DC1887 output current capability depends on the input voltage and programmed input current limit. Typical performance of the DC1887A is shown in Figure 3. As can be seen from Figure 3, the output current decreases as the output voltage is approaching the programmed output voltage of 4.2V.

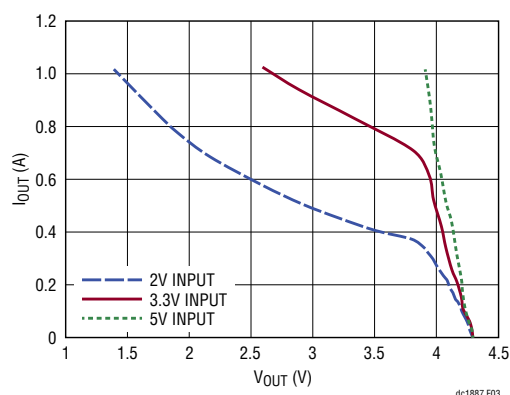


Figure 3. The Output Current Decreases as the Supercap Voltage Increases Due to Precise Input Current Limit.

OUTPUT LOAD STEP RESPONSE

The load step response of DC1887A is dependent on the supercap used. If higher load steps need to be handled more output capacitance can be added in order to keep the voltage transients at the desired level. The load step transients are shown in Figure 4.

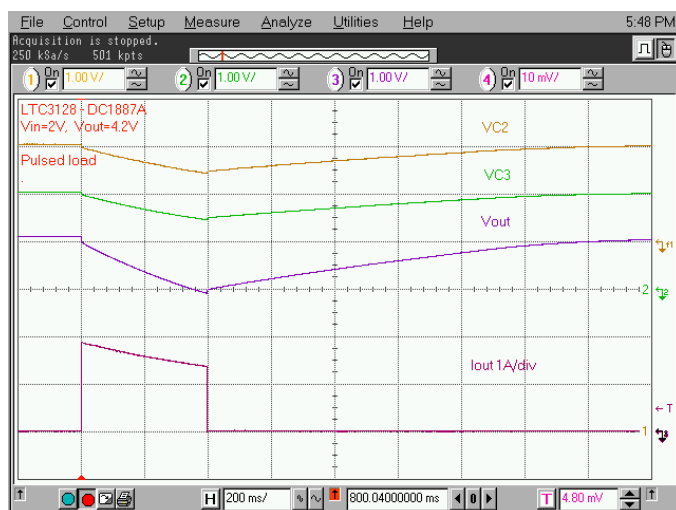


Figure 4. The Supercap Supplies Most of the Pulsed Load Current. The LTC3128 Makes a Small Contribution to Load Current as Shown in Figure 3.

START-UP AND CURRENT LIMIT FUNCTION

The DC1887 features an input current limit circuit that controls the inrush current and output voltage ramp at start-up and during recharge cycles. The input current limit of DC1887 is set to 900mA and it should be suitable for operation from a USB port. The input current limit can be seen in Figure 5. While charging the supercap, the current is constant. Once the output voltage is close to the set point the current limit is reduced in order to prevent output voltage overshoot.

The input current limit can be programmed up to 3A by changing the resistor R8 in the Schematic Diagram.

OUTPUT VOLTAGE BALANCING

The LTC3128 can charge two output capacitors in series that are not identical. The internal capacitor voltage balancing circuit can compensate for the difference in capacitance by moving the charge from the capacitor at a higher voltage (smaller cap) to a capacitor with a lower voltage (bigger cap).

To see this effect, monitor V_{MID} (VC3) and V_{OUT} with a scope as shown in Figure 5. The trace 1 in Figure 5 is showing the top cap voltage ($VC3 = V_{OUT} - V_{MID}$).

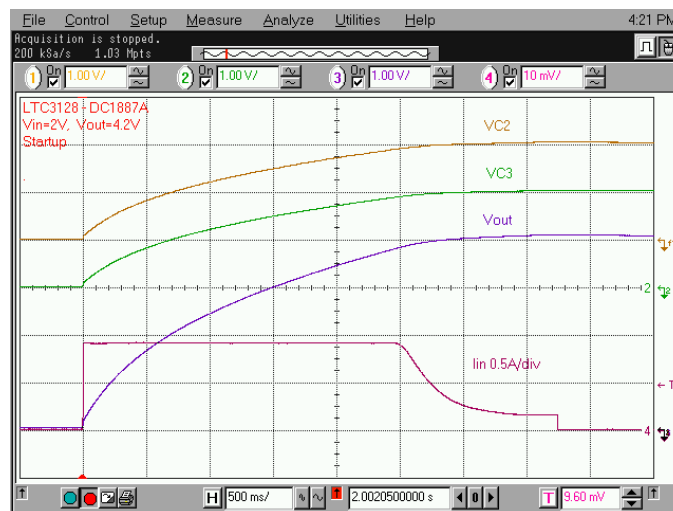


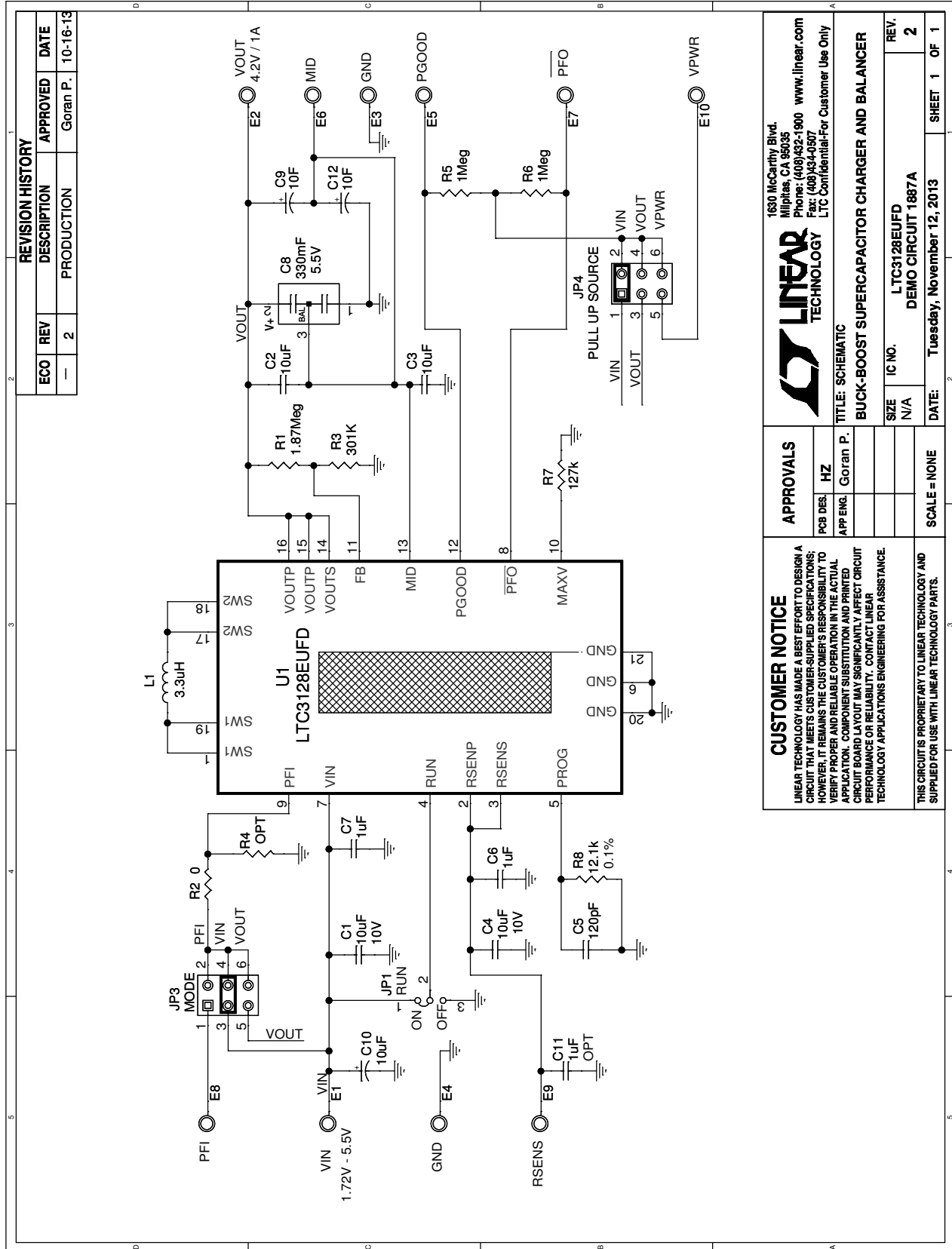
Figure 5. The DC1887 Ramps the Output Slowly at Start-Up without Generating an Input Current Surge.

DEMO MANUAL DC1887A

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	2	C2, C3	CAP, X5R, 10 μ F, 25V, 10%, 0805	AVX, 08053D106KAT2A
2	2	C1, C4	CAP, X5R, 10 μ F, 25V, 10%, 1206	MURATA, GRM31CR61E106KA12L
3	1	C5	CAP, NPO, 120pF, 25V, 10%, 0603	AVX, 06033A121JAT2A
4	3	C6, C7, C10	CAP, X5R, 1 μ F, 25V, 10%, 0603	AVX, 06033D105KAT2A
5	1	C8	SUPERCAP, 5.5V, 330mF	MURATA, DMF3Z5R5H334M3DTA0
6	2	C9, C12	SUPERCAP, 10.0F, 2.7V, 10mm \times 30mm	ILLINOIS CAP, 106DCN2R7Q
7	1	L1	IND, POWER INDUCTOR, 3.3 μ H	COILCRAFT: XAL6030-332MEB
8	1	R1	RES, CHIP, 1.87M, 1%, 0603	VISHAY, CRCW06031M87FKEA
9	1	R2	RES, CHIP, 0, 0603	VISHAY, CRCW06030000Z0EA
10	1	R3	RES, CHIP, 301k, 1%, 0603	VISHAY, CRCW0603301KFKEA
11	2	R5, R6	RES, CHIP, 1M, 1%, 0603	VISHAY, CRCW06031M00FKEA
12	1	R7	RES, CHIP, 127k, 1%, 0603	VISHAY, CRCW0603127KFKEA
13	1	R8	RES, CHIP, 12.1k, 0.1%, 0603	VISHAY, TNPW060312K1BEEA
14	1	U1	LTC3128EUFD, QFN 4mm \times 5mm	LINEAR TECHNOLOGY, LTC3128EUFD
Additional Demo Board Circuit Components				
1	0	C11 (OPT)	CAP, 0603	
2	0	R4 OPT	RES, CHIP OPTIONAL	
Hardware: For Demo Board Only				
1	10	E1 TO E10	TESTPOINT, TURRET, 0.095"	MILL-MAX, 2501-2-00-80-00-00-07-0
2	1	JP1	0.079 SINGLE ROW HEADER, 3 PIN	SAMTEC, TMM-103-02-L-S
3	2	JP3, JP4	0.079 DOUBLE ROW HEADER, 2X3 PIN	SAMTEC, TMM-103-02-L-D
4	3	JP1, JP3, JP4	SHUNT	SAMTEC, 2SN-BK-G
5	4	STAND OFF	STAND OFF	KEYSTONE, 8833
6	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT 1887A
7	1		STENCIL	STENCIL DC1887A

SCHEMATIC DIAGRAM



dc1887af

DEMO MANUAL DC1887A

DEMONSTRATION BOARD IMPORTANT NOTICE

Linear Technology Corporation (LTC) provides the enclosed product(s) under the following **AS IS** conditions:

This demonstration board (DEMO BOARD) kit being sold or provided by Linear Technology is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not provided by LTC for commercial use. As such, the DEMO BOARD herein may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including but not limited to product safety measures typically found in finished commercial goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may or may not meet the technical requirements of the directive, or other regulations.

If this evaluation kit does not meet the specifications recited in the DEMO BOARD manual the kit may be returned within 30 days from the date of delivery for a full refund. **THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY THE SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THIS INDEMNITY, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.**

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user releases LTC from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge. Also be aware that the products herein may not be regulatory compliant or agency certified (FCC, UL, CE, etc.).

No License is granted under any patent right or other intellectual property whatsoever. **LTC assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or any other intellectual property rights of any kind.**

LTC currently services a variety of customers for products around the world, and therefore this transaction **is not exclusive**.

Please read the DEMO BOARD manual prior to handling the product. Persons handling this product must have electronics training and observe good laboratory practice standards. **Common sense is encouraged.**

This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

Mailing Address:

Linear Technology
1630 McCarthy Blvd.
Milpitas, CA 95035

Copyright © 2004, Linear Technology Corporation