LTC3643
Bidirectional Charger/Regulator for System Power Backup

DESCRIPTION

Demonstration circuit 2220A is a 2A, bidirectional charger/regulator featuring the LTC®3643, a bidirectional synchronous step-up charger and step-down converter. DC2220A implements backup by charging a storage capacitor up to 40V in boost mode, when the input voltage is present. It discharges the storage capacitor in buck mode, providing a regulated load voltage of 3V to 17V (set to 5V), when the input is interrupted. Its wide voltage range, both in capacitor charger mode and in system backup mode, makes it well suited to a wide variety of applications. The ability of the LTC3643 to boost an input rail to a relatively high voltage of 40V, combined with the DC2220 option of adding external capacitor banks, makes this regulator an excellent choice for energy storage applications.

The DC2220A features automatic switching from charge to backup mode, 2A input current limit during charging, the ability to set maximum current in the backup mode of operation, Burst Mode® operation, fast 1MHz switching frequency, and open-collector outputs to indicate charge status and input power fail.

The 1MHz constant-frequency operation results in a small and efficient circuit. In backup mode, the LTC3643 provides high output voltage accuracy over a wide load range with no minimum load requirement.

Demo circuit 2220A is set up for automatic mode operation. In this mode, the DC2220 automatically charges the energy storage capacitor when a system voltage is present. It automatically switches to work as a step-down DC/DC converter providing system backup power to the load when system power is removed. An on board MOSFET isolates the backup circuit from the input line if the system voltage is not present, implementing PowerPath™ functionality.

The DC2220A supports three levels of load current limits: 2A, 3A and 4A when working as step-down converter discharging the energy storage capacitor.

The DC2220A has a small circuit footprint. It is a high performance and cost effective solution for high voltage capacitor backup converters, servers, solid-state drives, RAID and RF systems.

The LTC3643's input disconnect circuitry protects the DC2220A from short circuit and overcurrent conditions in the boost mode of operation, in case a short circuit occurs on a high voltage rail. A similar circuit protects the DC2220A against a short circuit in step-down mode, when the load is supplied from an energy storage capacitor.

Design files for this circuit board are available at http://www.linear.com/demo/DC2220A

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PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

PARAMETER	CONDITIONS		UNITS
Minimum Input Supply Voltage		3.0	V
Maximum Input Supply Voltage		17.0	V
System Voltage Range	Backup (Step-Down) Mode	3.0 to 17.0	V
Energy Storage Capacitor Voltage Range		3.0V to 40V	V
Typical Switching Frequency		1.0	MHz
Efficiency Typical, Backup Mode	V_{CAP} = 12V, V_{LOAD} = 5.0V, I_{LOAD} = 0.5A	93	%

QUICK START PROCEDURE

Demonstration circuit 2220A is easy to set up to evaluate the performance of the LTC3643 bidirectional regulator. Refer to Figure 1 for the proper measurement equipment setup and follow the procedure below.

NOTE: When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the V_{IN} or V_{OUT} and GND terminals. See Figure 2 for proper scope probe technique.

To verify the capability of the DC2220A for charging energy storage capacitors, proceed with the following steps:

1. Place jumper RUN (JP1) to OFF position.
2. Place jumper ILIM_BUCK (JP2) to 2.0A position.
3. With power off, connect the input power supply to terminals V_{IN} (E1) and GND, voltmeter to V_{CAP} (E8) and GND, load to LOAD (E3) and GND as shown on Figure 1.

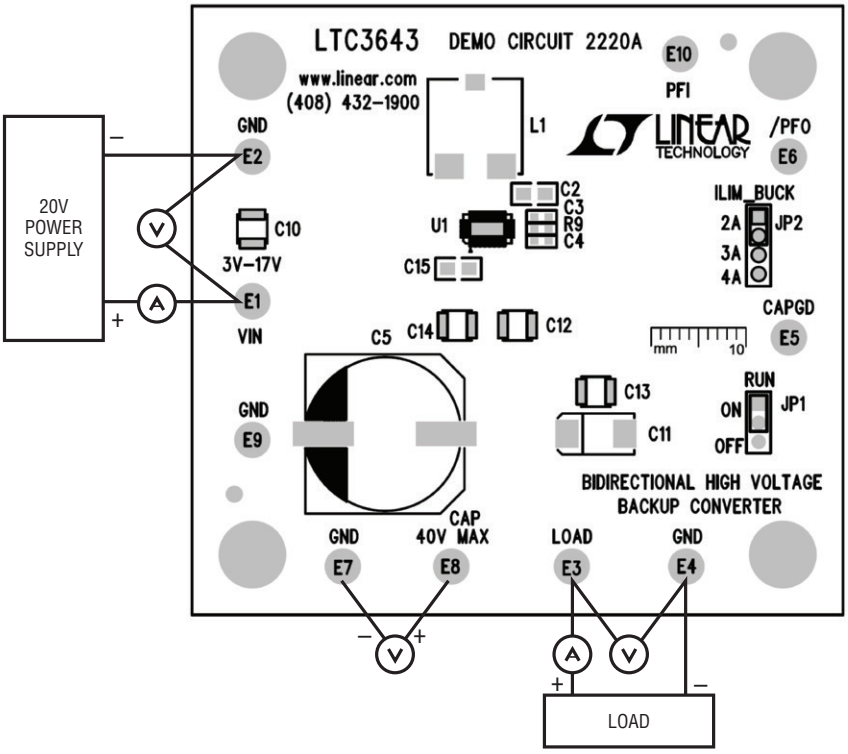


Figure 1. Proper Measurement Equipment Setup

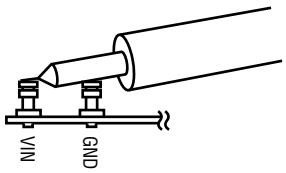


Figure 2. Measuring Input or Output Ripple

QUICK START PROCEDURE

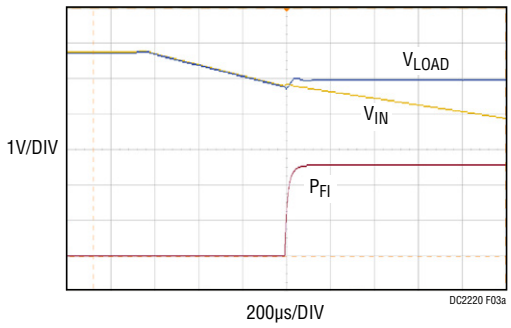
4. Turn the input power source on and slowly increase the input voltage to 5.5V. Set the load to 0.1A. You have to see voltage around 4.8V on terminal LOAD, a diode forward voltage drop lower compared to V_{IN}. If there is no output, temporarily disconnect the load to make sure that the load is not set too high.
5. Place jumper RUN (JP1) in the ON position. Voltage on V_{CAP} terminal should rise to 39V level. Voltage on terminal LOAD should be equal to input voltage.

To verify the ability of DC2220 to work in backup mode, proceed with the following:

6. Disconnect input power from V_{IN} terminal; energy storage capacitor C5 starts discharging from 39V level, however LTC3643 will maintain a voltage of 5.0V on terminal LOAD.
7. To increase holdup time, install optional capacitor C6 on the bottom side of DC2220A or connect additional capacitor bank to terminals V_{CAP} (E8) and GND (E7).
8. Repeat steps 1 to 7 for different load currents and V_{IN} voltages.
9. You can measure voltage regulation and ripple in backup mode on V_{LOAD} terminals.
10. Make sure that input voltage on V_{IN} terminals does not exceed 17V and V_{CAP} voltage is not set above 40V.

Figure 3 illustrates power interruption. In the beginning of the process V_{IN} (yellow) is 5.5V and supplies LOAD rail, PFI signal is low and step-down converter is OFF. Once V_{IN} value is reduced to 4.75V, PFI signal changes state to high, the step-down converter turns ON and starts to supply the LOAD rail by 5.0V taking energy from the storage capacitor C5. The efficiency curve is presented in Figure 4.

The efficiency measurement was conducted in step-down mode. A constant DC voltage of 12V was applied to the V_{CAP} and GND terminals with the input voltage disconnected from the V_{IN} and GND terminals.



3a

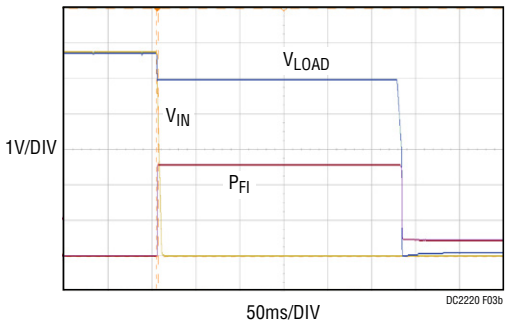


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Figure 3. Power interruption, V_{LOAD} 5.0V, I_{LOAD} 0.5A

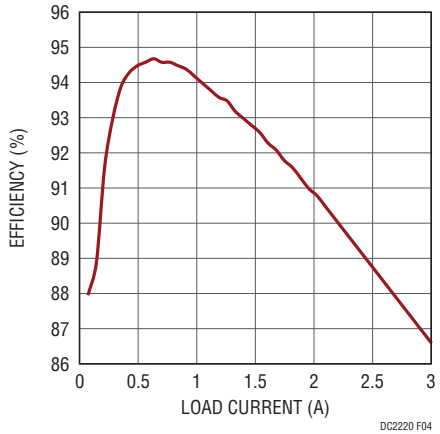

Figure 4. Efficiency vs Load, V_{CAP} 12V, LOAD 5.0V, Step-Down Mode

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP., X7R, 0.1µF, 25V, 10%, 0603	AVX, 06033C104KAT2A
2	1	C2	CAP., X5R, 4.7µF,16V, 10%, 0805	TDK C2012X5R1C475K
3	1	C3	CAP., C0G, 470pF 50V, 5%, 0603	AVX, 06035A471JAT2A
4	1	C4	CAP., C0G, 22pF, 25V, 5%, 0603	AVX, 06033A220JAT2A
5	1	C5	CAP., ALUM., ELECT., 1000µF, 50V, 16x16.5	PANASONIC, EEEFK1H102AM
6	2	C9, C11	CAP., POS 47µF, 20V, 20%,TQC-D2	PANASONIC, 20TQC47MYF
7	1	C10	CAP., X7R, 4.7µF, 50V, 10%,1210	AVX, 12105C475KAT2A
8	3	C12, C13, C14	CAP., X7R, 10µF, 50V, 10%, 210	AVX, 12105C106KAT2A
9	1	C15	CAP., X7S, 1µF, 100V, 10%, 0805	TDK C2012X7S2A105K
10	1	L1	IND, 7.2µH POWER	SUMIDA, CDEP105NP-7R2MC-88
11	1	Q1	MOSFET, P-CHN, 30V, LFPAK	VISHAY, Si4491EDY-T1-GE3
12	1	R1	RES., CHIP, 511k, 1/10W, 1%, 0603	VISHAY, CRCW0603511KFKEA
13	1	R2	RES., CHIP, 0.01, 1/4W, 1%, 1206	VISHAY, WSL1206R0100FEA
14	1	R3	RES., CHIP, 133k, 1/16W, 1%, 0603	VISHAY, CRCW0603133KFKEA
15	1	R4	Res., CHIP, 1MEG, 1/10W, 1%, 0603	VISHAY, CRCW06031M00FKEA
16	1	R5	RES., CHIP, 37.4k, 1/10W, 1%, 0603	VISHAY, CRCW060337K4FKEA
17	2	R6, R11	RES., CHIP, 5.11k, 1/10W, 1%, 0603	VISHAY, CRCW06035K11FKEA
18	2	R7, R8	RES., CHIP, 510k, 1/10W, 1%, 0603	VISHAY, CRCW0603510KFKEA
19	1	R9	RES., CHIP, 402k, 1/10W, 1%, 0603	VISHAY, CRCW0603402K0FKEA
20	1	R10	RES., CHIP, 332k, 1/10W, 1%, 0603	VISHAY, CRCW0603332KFKEA
21	1	U1	I.C., LTC3643EUDD, QFN24UDD-3X5	LINEAR TECH., LTC3643EUDD#PBF
Additional Demo Board Circuit Components				
1		C6	CAP., ALUM. OPTION,16X16.5	OPT
2		C7, C8	CAP., OPTION, 0603	OPT
3		R12	RES., OPTION, 0603	OPT
Hardware: For Demo Board Only				
1	10	E1 – E10	TP, TURRET, 0.094"	MILL-MAX, 2501-2-00-80-00-00-07-0
2	1	JP1	HEADER, 1X3, 0.079 SINGLE ROW	WURTH, 620-003-111-21
3	1	JP2	HEADER, 1X4, 0.079 SINGLE ROW	WURTH, 620-004-111-21
4	2	XJP1, XJP2	SHUNT, 0.079" CENTER	WURTH, 608-002-134-21

SCHEMATIC DIAGRAM

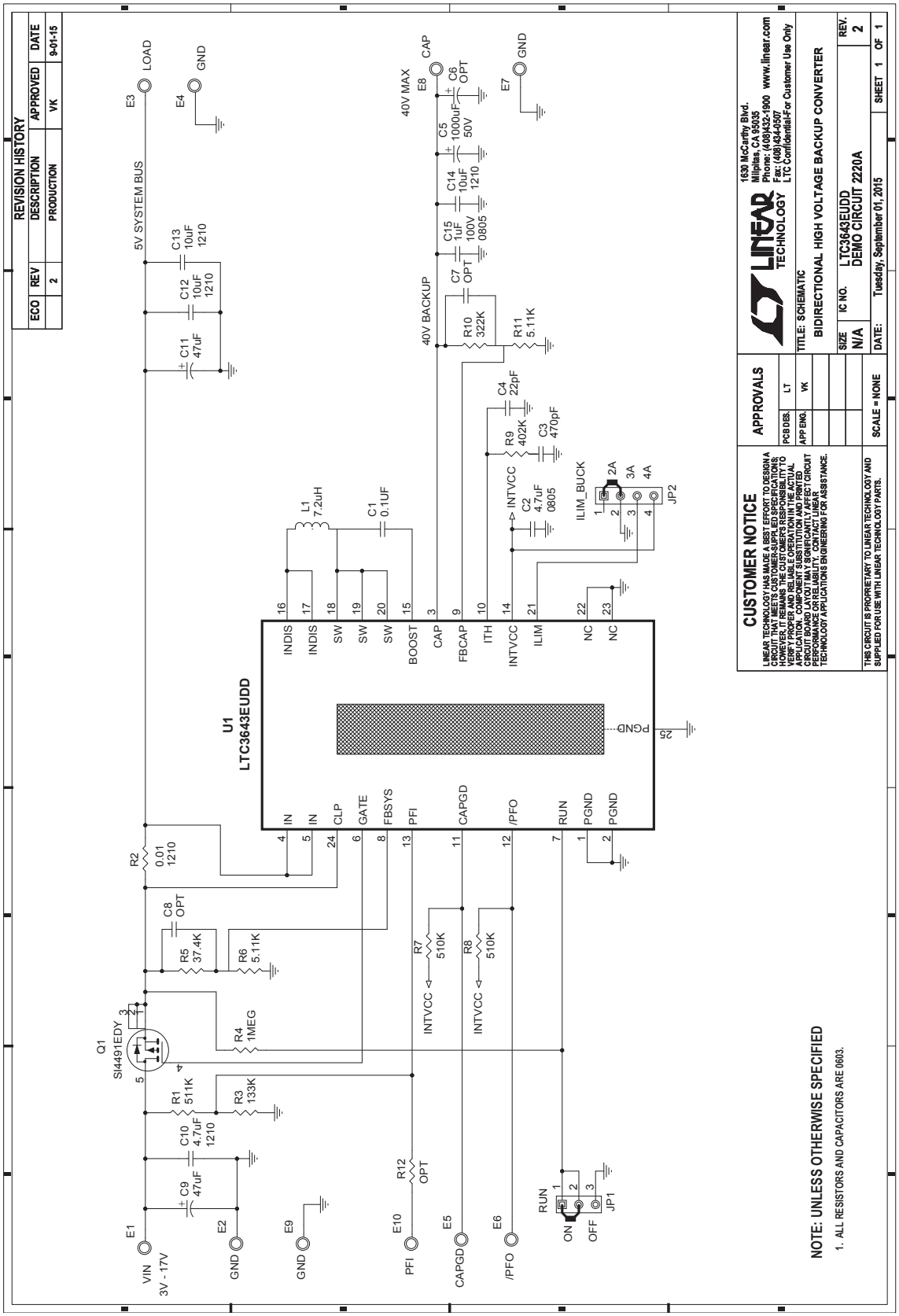

Figure 5. DC2220A Demo Circuit Schematic

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