DEMO CIRCUIT 1325A
QUICK START GUIDE

LT3653EDCB
High Voltage Buck Regulator with Output Current Limit

DESCRIPTION

Demonstration Circuit 1325 is a HV buck regulator battery tracking controller and interfaces with the DC1303 (LTC® 4098EUDC), a high efficiency USB Power/Li-Ion battery Manager with battery tracking controller, to produce a high voltage input to the USB Power/Li-Ion battery management system .

The LT3653EDCB is available in an 8- lead (3mm × 3mm) DFN surface mount package with an exposed pad.

Design files for this circuit board are available. Call the LTC factory.

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PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{USB}	Bus Input Voltage Range	Input disabled from 6V–30V	4.35		30	V
V_{HV}	High Voltage Input Voltage Range		7.5		30	V
V_{OUT}	Output Voltage Range	Range is mode and load dependant	3.7		4.9	V
V_{BAT}	Output Float Voltage	Constant voltage mode		4.2		V
ILIM	HV Buck Current Limit	R_{ILIM} equals 66.5kΩ		0.6		A
I_{BAT}	Output Charge Current	Constant current mode (R_{PROG} equals 2kΩ)		0.5		A

OPERATING PRINCIPLES

The LT3653 is specifically tailored to be used in conjunction with a battery charger power path controller. The role of the LT3653 is to regulate the high voltage input to a lower voltage to provide power to the system load and to the single cell Li-Ion battery charger. High efficiency in the battery charger is achieved by keeping the voltage across it as low as possible. To accomplish this, the battery charger takes control of the LT3653 regulator control node, VC, and overrides the error amp. The output voltage is regulated by the battery charger to a voltage slightly above the battery, typically 300mV.

The HVOK is a status pin which indicates to the charger that a high voltage input is present and that the LT3653 is ready to start providing power to the System Load. When the HVOK pin is low the LT3653 is not switching and the system output cannot be supported by the LT3653 regulator.

The LT3653 is a constant frequency, current mode step down regulator. A switch cycle is initiated when the 1.5MHz oscillator enables the RS flip flop, turning on an internal power switch, Q1. A sense amplifier monitors the switch current via the voltage dropped across an internal input current sense resistor. A comparator compares the current with the output of the error amplifier, VC. The switch is turned off when this current exceeds the VC value. The VC control of the LTC4098 overdrives the local VC control of the LT3653. Therefore, once the VC control of the LTC4098 is enabled, the output voltage is set independent of the LT3653's feedback network. An

active clamp on the VC node provides current limit. The LT3653 is internally compensated with a pole zero combination on the output of the gm amplifier.

An external capacitor and internal diode are used to generate a voltage at the BOOST pin that is higher than the input supply. This allows the driver to fully saturate the internal bipolar NPN power switch for efficient operation. The switch driver operates from either VIN or BOOST to ensure startup.

An internal regulator provides power to the control circuitry. This regulator includes an input under-voltage and overvoltage protection which disable switching action when VIN is less than 7.5V and greater than 33V, typical. When switching is disabled, the LT3653 can safely sustain input voltages up to 60V. Note that while switching is disabled the output will start to discharge.

Output current limiting is provided via the servo action of a second amplifier. It compares the voltage across an inductor current sense resistor, and compares it to a voltage programmed by external resistor on the ILIM pin. An internal capacitor, on the output of the second gm amplifier, averages the inductor ripple current. If the averaged inductor current exceeds the programmed value then the VC voltage is pulled low, reducing the current in the regulator. The average current limit circuit protects the regulator from over-current and short circuit conditions.

QUICK START PROCEDURE

Demo Board 1325A is easy to set up to evaluate the performance of the LT3653EDCB. A companion USB Compatible Switching Power Manager/Li-Ion Charger with Overvoltage Protection Demo Board (DC1303) is required for this evaluation procedure and will be used with the following procedure. Please refer to the DC1303 Quick Start Guide for further information.

Connect the DC1303 and the DC1325 together via the HV Buck Interface connector as indicated in Figure 1.

NOTE. Use short twisted pair leads for any power connections, with all loads and power supplies off.

1. On the DC1303 set D0(JP1) to 1,D1(JP2) and D2(JP3) to 0. Turn on PS2 (VUSB) and set to 5.0V. Turn on PS3. Set PS3, on BAT, to 3.8 V (Note PS3 has a 3.6 Ohm, 5 Watt resistor across its terminals). Verify that Vout is greater than 3.98V and that Ibat is approximately 500mA. This insures that the DC1303 is operating properly.
2. Set JP2 to 0 and JP3 to 0 on the DC1325

Table 2: LTC3653 Current Limit Control

ILIM	0.6A	0.8A	1.0A	1.2A
JP2	0	0	1	1
JP3	0	1	0	1

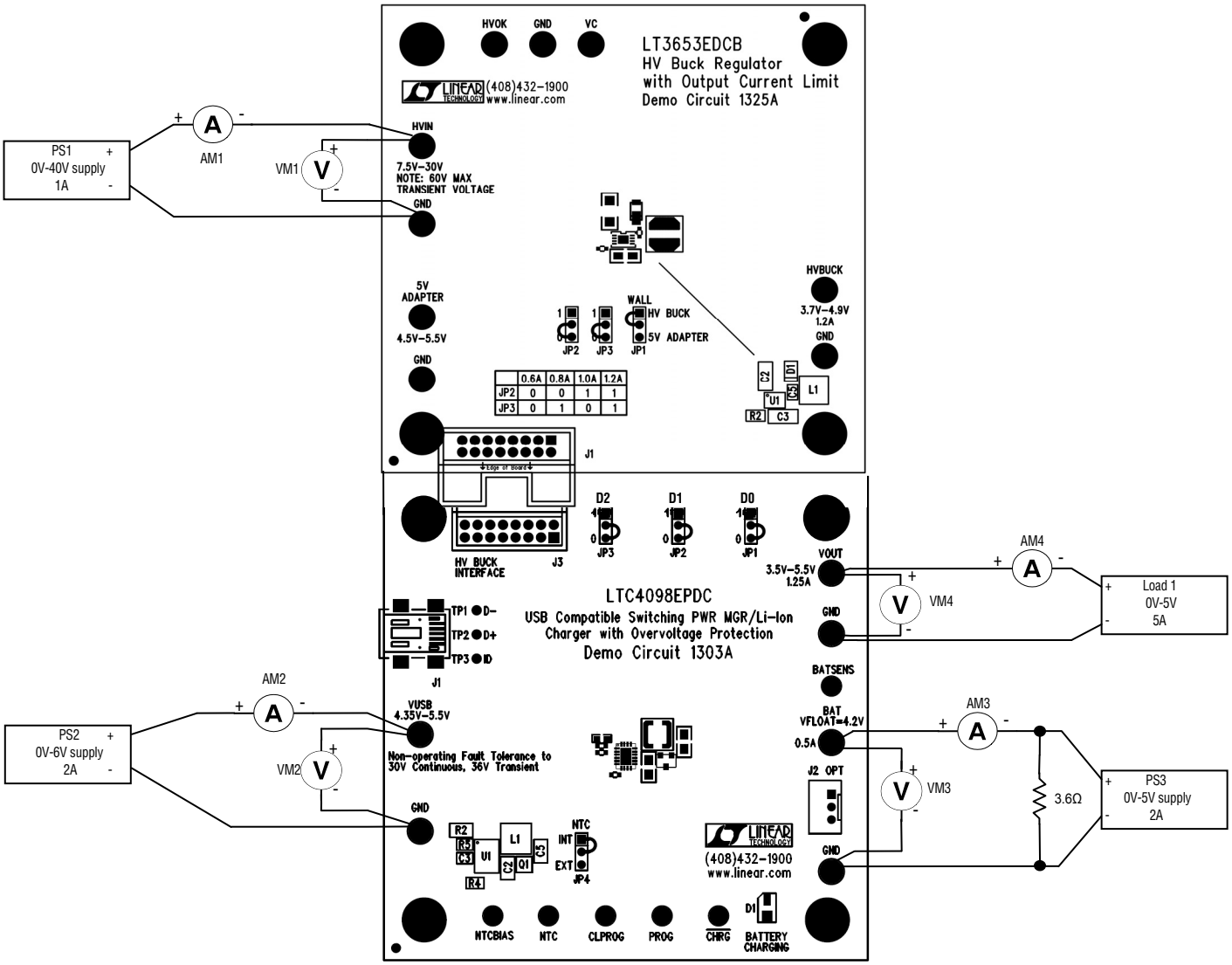
3. Turn on Ld1 and set to 50 mA. Observe Vout and Vbat. Verify that Ibat is approximately 500mA.
4. Turn off PS2. Turn on PS1 and set PS1 to 5V and verify that PS3 is supplying 50mA to Ld1.
5. Increase PS1 until Ibat current is into PS3. Observe Ibat, Vout, Vbat, HVOK and PS1 is at UVLO rising voltage.
6. Decrease PS1 until current is out of PS3. Observe Ibat, Vout, Vbat, HVOK and PS1 is at UVLO falling voltage.
7. Increase PS1 to 8V and increase the Ld1 until Ibat is zero. Observe Vbat, Vout and that ILd1 current at ILIM setting of Table 2.
8. On DC1325A, set JP2 to 0 and JP3 to 1. Repeat step 7
9. On DC1325A, set JP2 to 1 and JP3 to 0. Repeat step 7
10. On DC1325A, set JP2 to 1 and JP3 to 1. Repeat step 7
11. Set PS1 to 12V and Repeat step 10
12. Set PS1 to 30V and Repeat Step 10
13. Set PS1 to 12V. Set Ld1 to 1.5 A. Observe Vout, Vbat and that the load current minus the current

supplied by Ibat is approximately equal to the ILIM current of step 11.

14. Set PS3 to 4.2V.

15. Decrease Ld1 to 1.0A, Observe Vout, Vbat and that Ibat is approximately zero amps.

16. Turn off all supplies.



Note: All connections from equipment should be Kelvin connected directly to the Board PINS which they are connected to on this diagram and any input, or output, leads should be twisted pair

Figure 1. Proper Measurement Equipment Setup

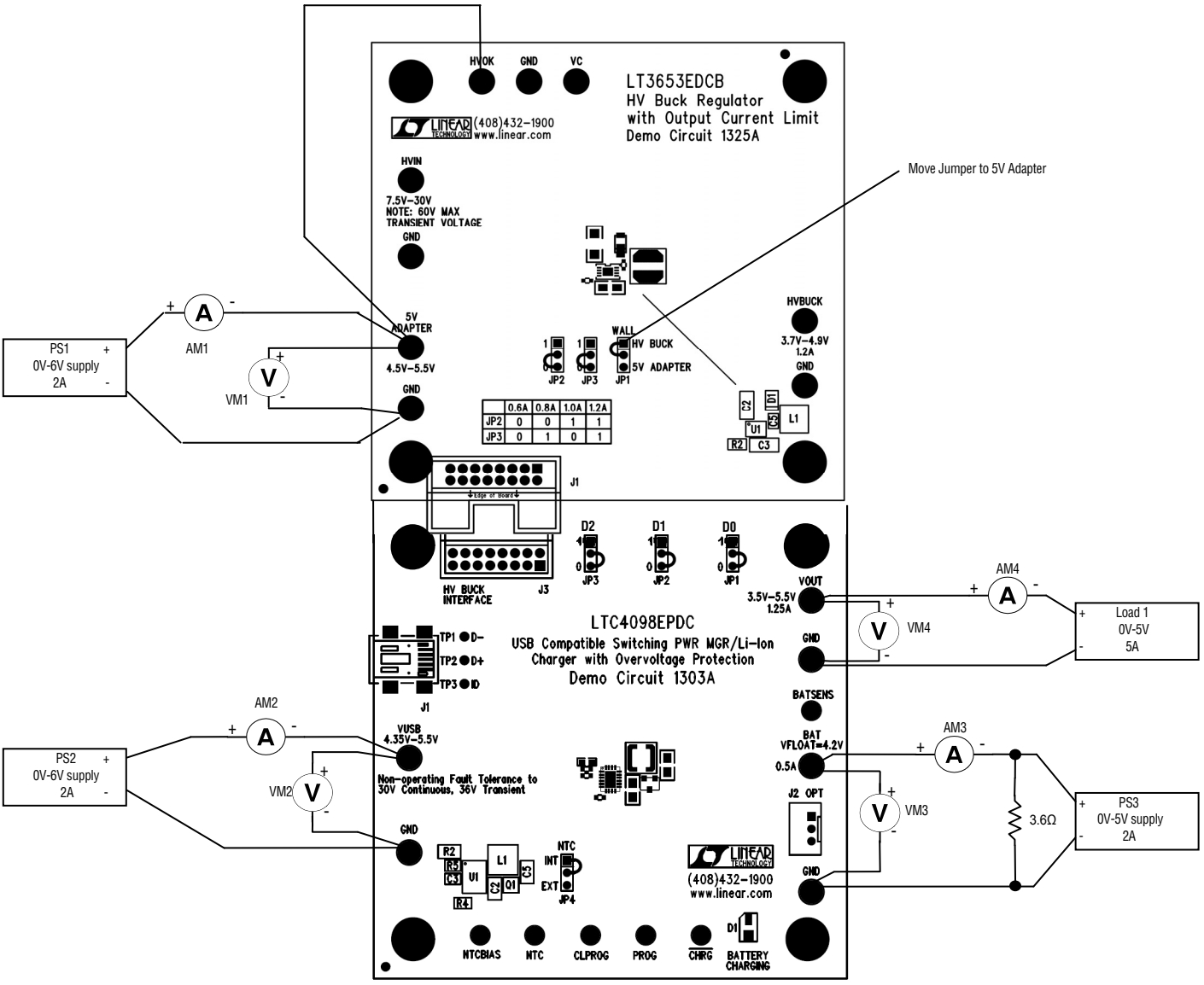
Wall Adapter Feature:

Connect the DC1303 and the DC1325 together via the HV Buck Interface connector as indicated in Figure 2.

17. Verify that the HVIN turret of the DC1325A is disconnected from any power sources and is open circuited.

18. Set JP1 on the DC1325 to 5V Adapter and connect a jumper between the 5V Adapter turret and the HVOK turret.

19. Adjust PS1 to 5.0V and proceed with the DC1303A Quick Start Guide.



Note: All connections from equipment should be Kelvin connected directly to the Board PINS which they are connected to on this diagram and any input, or output, leads should be twisted pair

Figure 2. Proper Measurement Equipment Setup

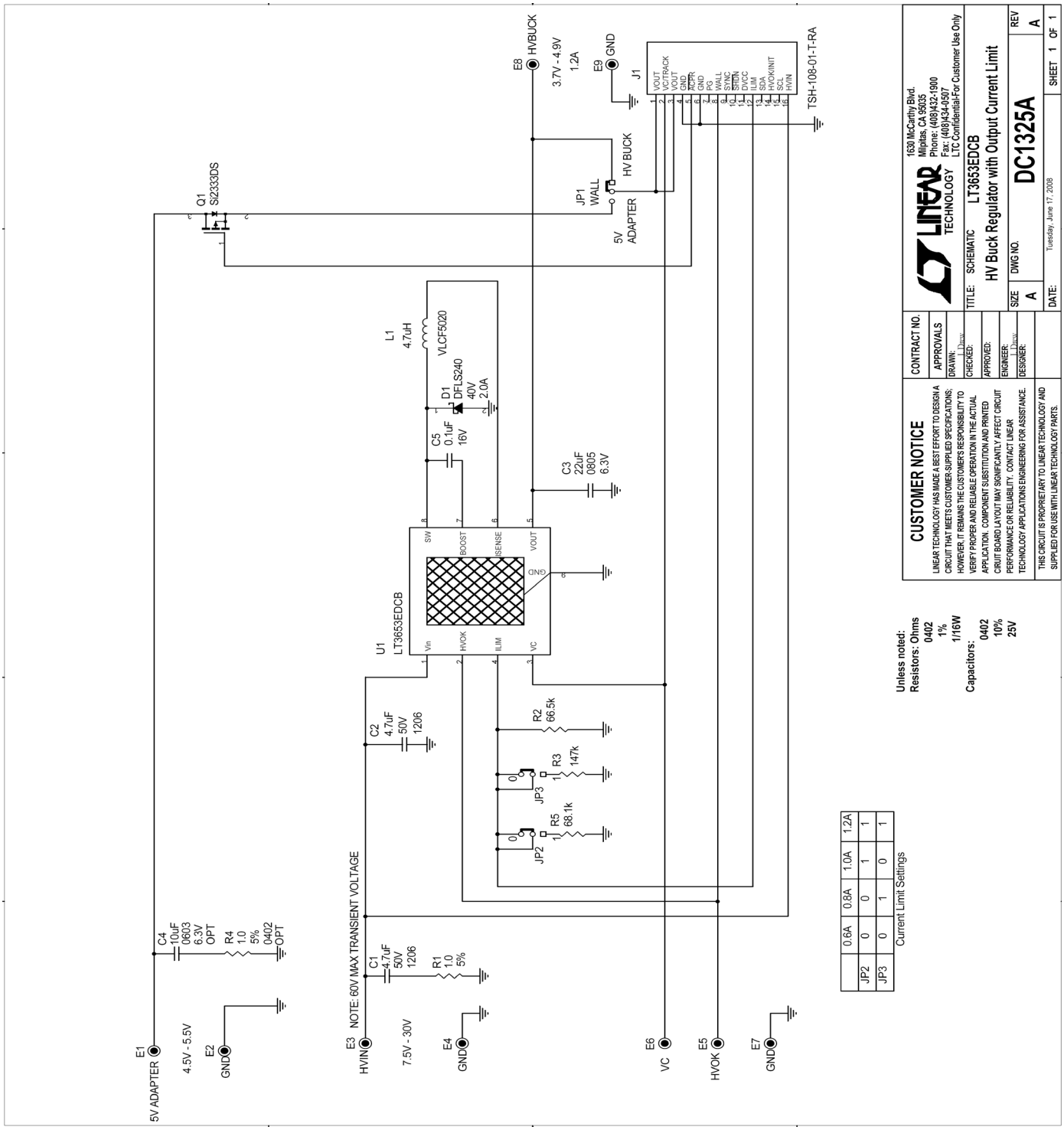


Figure 3: Schematic diagram

	Qty	Reference	Part Description	Manufacture / Part #
			NUMBER OF BOARDS =	
REQUIRED CIRCUIT COMPONENTS:				
1	2	C1,C2	CAP, CHIP, X5R, 4.7µF, ±10%, 50V, 1206	MURATA, GRM31CR71H475KA12L
2	1	C3	CAP, CHIP, X5R, 22µF, ±20%, 6.3V, 0805	TAIYO YUDEN JMK212BJ226MG
3	1	C5	CAP, CHIP, X5R, 0.1µF, ±10%, 16V, 0402	MURATA, GRM155R71C104KA88
4	1	D1	DIODE, SCHOTTKY, 2A, 40V, SMB	DIODES INC, DFLS240L
5	1	L1	IND, SMT, 4.7µH, 1.7A, ±30%,	TDK, VLCF5020T-4R7N1R7-1
6	1	Q1	MOSFET, -12V, 35mΩ, -5.3A, SOT-23	VISHAY, Si2333DS
7	1	R2	RES, CHIP, 66.5kΩ, 100ppm, 1/16W, 1%, 0402	VISHAY, CRCW040265K5FKED
8	1	R1	RES, CHIP, 1.0Ω, 200ppm, 1/16W, 5%, 0402	VISHAY, CRCW04021R00JNED
9	1	R3	RES, CHIP, 147kΩ, 100ppm, 1/16W, 1%, 0402	VISHAY, CRCW0402147KFKED
10	1	R5	RES, CHIP, 68.1kΩ, 100ppm, 1/16W, 1%, 0402	VISHAY, CRCW040268K1FKED
11	1	U1	IC, SMT, HV Input Preregulator with Average Output Current Limit for Battery Charger Applications	LTC, LT3653EDCB
ADDITIONAL DEMO BOARD CIRCUIT COMPONENTS:				
1	1	C4	CAP, CHIP, X5R, 10µF, ±20%, 6.3V, 0603	TDK, C1608X5R0J106M
2	1	R4	RES, CHIP, 1.0Ω, 200ppm, 1/16W, 5%, 0402	VISHAY, CRCW04021R00JNED
HARDWARE FOR DEMO BOARD ONLY:				
1	9	E1,E2,E3,E4,E5,E6,E7, E8,E9	Turret, 0.09"	MIL-MAX, 2501-2
2	1	J1	2x8 Pin Right Angle Connector	SAMTEC, TSH-108-01-T-RA
3	3	JP1,JP2,JP3	3 Pin Jumper, 2mm	SAMTEC, TMM-103-02-L-S
4	3	JP1,JP2,JP3	SHUNT 2mm	SAMTEC, 2SN-BK-G
5	4		STAND-OFF, NYLON 0.375" tall (SNAP ON)	KEYSTONE, 8832 (SNAP ON)

Bill of Materials