LTC6990/LTC4124 25mA Wireless Li-Ion Charger Demonstration Kit

DESCRIPTION

DC2769A-B-KIT is a kit of the DC2771A-B transmitter board, featuring LTC®6990 and the DC2775A-B, featuring LTC4124. The DC2775A-B receiver can charge a single Li-Ion battery at up to 25mA with an air gap of 2mm to 5mm between the transmit and receive coils.

Design files for this circuit board kit are available.

KIT CONTENTS

1 × DC2771A-B (LTC6990) Transmitter Demo Board
1 × DC2775A-B (LTC4124) Receiver Demo Board

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	DC2771A-B Voltage Input	I_{VIN} ≤ 100mA	4.5		5.5	V
I_{IN}	DC2771A-B V_{IN} Current	V_{IN} = 5V			200	mA
V_{BAT}	DC2775A-B Battery Charge Voltage	V_{SEL1} = HI, V_{SEL2} = HI		4.35		V
		V_{SEL1} = HI, V_{SEL2} = LO		4.20		V
		V_{SEL1} = LO, V_{SEL2} = HI		4.1		V
		V_{SEL1} = LO, V_{SEL2} = LO		4.00		V
I_{BAT}	DC2775A-B Charge Current	V_{BAT} = 4.0V, I_{SEL1} = GND, I_{SEL2} = V_{CC}		25		mA
Air-Gap	Separation Between L_{TX} and L_{RX}		2.0	3.0	5.0	mm
f_{DRIVE}	DC2771A-B Drive Frequency			200		kHz
f_{TX_TANK}	DC2771A-B Resonant Tank Frequency			250		kHz
f_{RX_TANK}	DC2775A-B Resonant Tank Frequency			200		kHz

BOARD PHOTO

Figure 1. DC2771A-B Picture

Figure 2. DC2775A-B Picture

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QUICK START PROCEDURE

Refer to Figure 4 to Figure 7 for the proper measurement equipment setup, DC2775A-B mounting on DC2771A-B, 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 signal and GND terminals. See Figure 8 for proper scope probe technique.

1. Plug a Micro-USB cable into DC2771A-B.J1 connector, with the other end of the cable connected to a computer USB port or a 5V USB power adapter. The demo may also be powered by a 5V supply PS2 connecting between V_{IN} and GND turrets (Figure 5).
2. The default battery charge voltage is 4.2V and the charging current is 25mA. Battery charge voltage, charge current, pre-charge feature and low battery disconnect voltage can be programmed by jumpers on the DC2775A-B board.
3. Connect a voltage source PS1 and a 100Ω resistor RBAT1 between the BAT and GND turrets of DC2775A-B, respectively (Figure 4). PS1 and RBAT1 make up the battery emulator. Typical power supplies cannot sink current. By adding a resistor across the power supply inputs that draws more current than the maximum battery charging current, the power supply only sources current even when the battery charge current is at its maximum value.
4. Connect an ammeter AM1 between PS1 and the DC2775A-B BAT turret. Connect a voltmeter VM1 between DC2775A-B BAT and GND turrets.
5. Set PS1 = 3.7V. If PS2 is used instead of Micro-USB, set PS2 = 5V and turn on both power supplies simultaneously.
6. DC2771A-B.D1 LED should be turned on. DC2775A-B. D1 LED should start blinking intermittently. AM1 should be reading 25mA. If the AM1 meter reads much less than 25mA, read VM1 and check whether LTC4124 is in constant current mode (Figure 4).
7. Turn off PS1 and PS2 simultaneously.

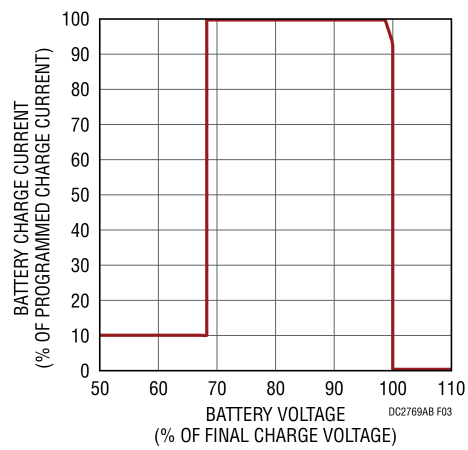

Figure 3. Battery Charge Current vs BAT Pin Voltage

QUICK START PROCEDURE

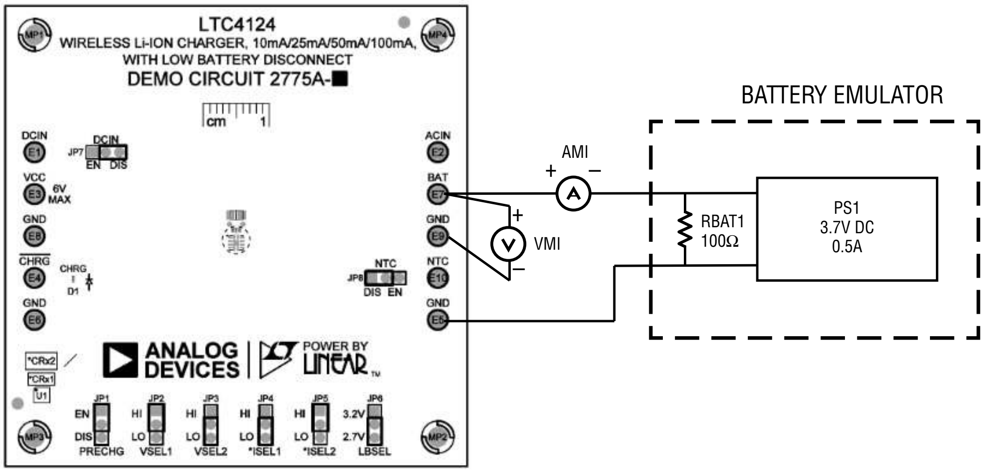

Figure 4. DC2775A-B Top

QUICK START PROCEDURE

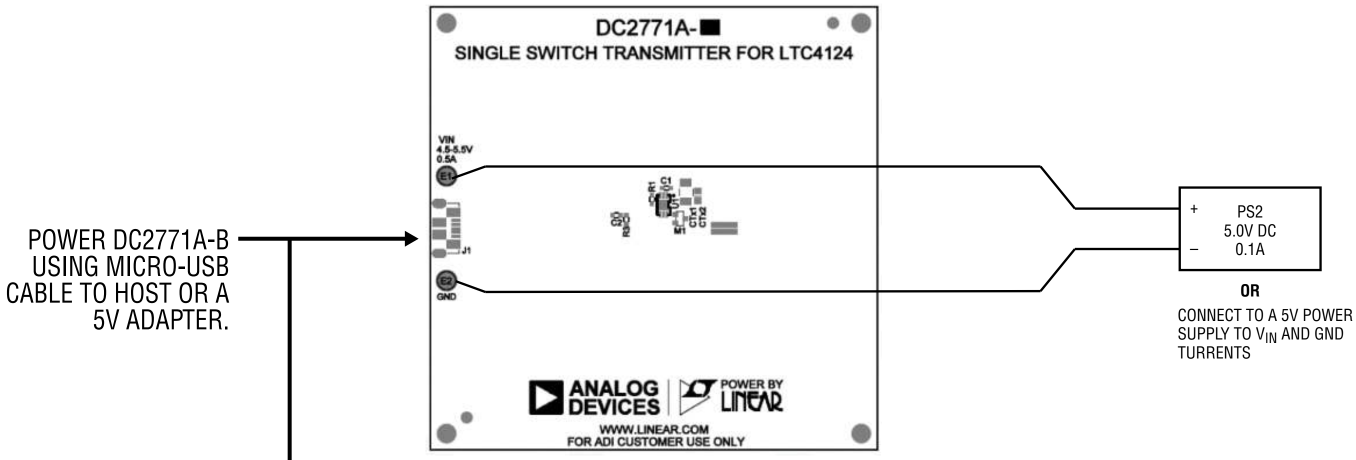

Figure 5. DC2771A-B Top

Figure 6. DC2775A-B on top of DC2771A-B

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HARDWARE SETUP

Figure 7. Measuring Input or Output Ripple

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

OPERATION

The DC2769A-B-KIT demonstrates operation of a magnetically coupled resonant Wireless Power Transfer (WPT) system. The LTC6990 based transmitter provides efficient wireless power for the LTC4124 receiver to charge the Li-Ion battery.

DC2771A-B – Wireless Power Transmitter Board Featuring the LTC6990

The DC2771A-B is a wireless power transmitter board using LTC6990 oscillator. The NMOS, M1(see DC2771A-B schematic on Page 8), is driven by a 50% duty cycle square wave generated by the oscillator. During the first half of the cycle, M1 is switched on and the current through the LC resonant tank rises linearly. During the second half of the cycle, M1 is switched off and the current circulates through the LC resonant tank. If the transmit LC tank frequency is set to 1.29 times the driving frequency, which is 1MHz in this application, switching losses in M1 are significantly reduced due to the zero-voltage switching (ZVS). Figure 8 illustrates the ZVS operation in DC2771A-B. The peak voltage of the transmit resonant tank that appears at the drain of M1 is:

$$V_{IN} = 1.038 \bullet \pi \bullet V_{IN}$$

This equation is derived by performing voltage second balance equation on the resonant tank inductor.

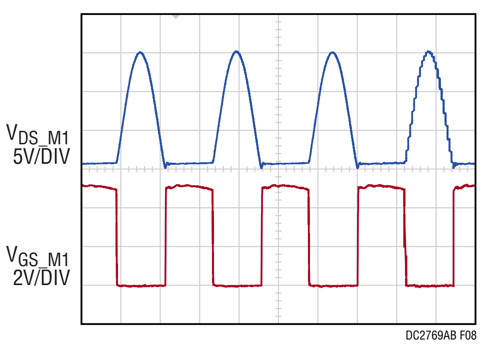


Figure 8. ZVS Operation on M1 when f_{TX_TANK} = 1.29 • $f_{DRIVEZVS\ OO}$

DC2775A-B – Wireless Power Receiver Board Featuring the LTC4124

The DC2775A-B demo board implements a parallel resonant LC circuit that connects the LTC4124 between ACIN and GND pins. The AC waveform on the resonant circuit is rectified by the internal wireless power managing circuitry to DC voltage on V_{CC} pin. This DC source is then fed into the internal linear battery charger to charge a Li-Ion battery.

As shown in Figure 9, when the LTC4124 receives more energy than it needs to charge the battery, the wireless power manager in the IC keeps the input voltage to the IC, V_{CC}, low by shunting the receiver resonant tank to ground. In this way, the linear charger is highly efficient as its input is always kept just above the battery voltage, V_{BAT}. The resonant tank also receives less power when the shunting circuit is engaged, as the resonant frequency is detuned from the transmitter frequency.

The LTC4124 includes a full featured CC/CV (Constant Current/Constant Voltage) linear battery charger with trickle current pre-charge, safety timer termination, bad battery detection, temperature qualified safe charging and automatic recharge. The maximum charge current supported by DC2775A-B is 25mA and the charge voltage is programmable by $VSEL_X$ jumpers.

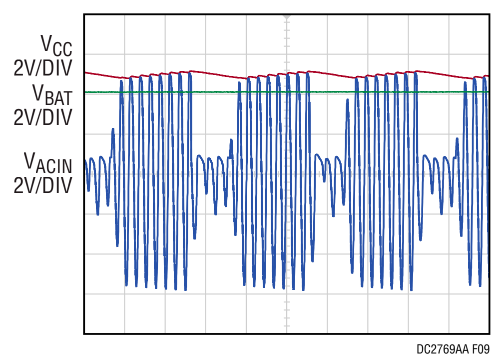
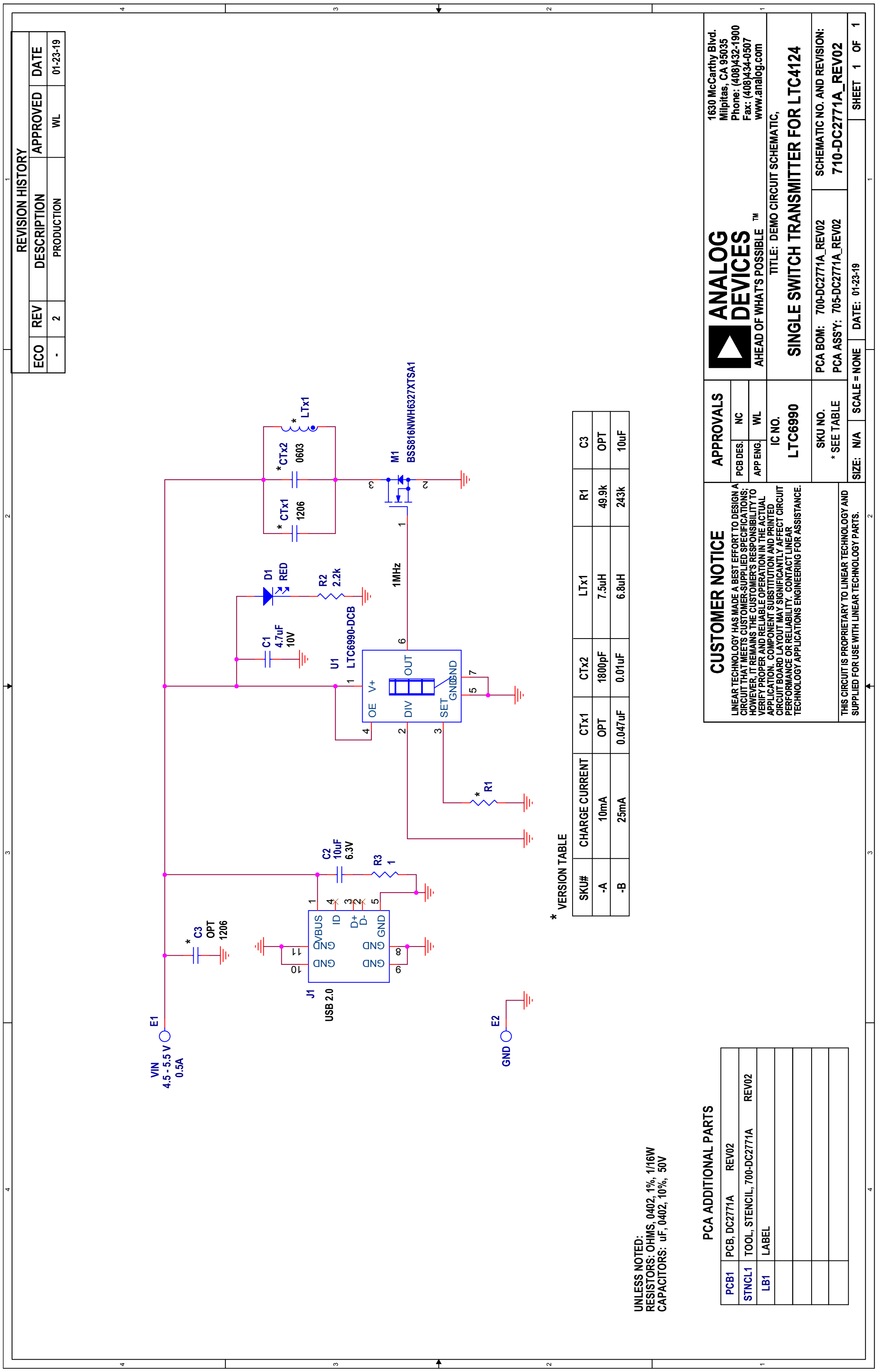


Figure 9. Rectification of AC Input and Regulation of V_{CC}

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
DC2771A-B: Required Circuit Components				
1	1	C1	CAP., 4.7µF, X5R, 10V, 10%, 0402	TDK, C1005X5R1A475K050BC
2	1	C2	CAP., 10µF, X5R, 6.3V, 20%, 0402	MURATA, GRJ155R60J106ME11D
3	1	C3	CAP., 10µF, X5R, 16V, 20%, 1206	TDK, C3216X5R1C106M160AA
4	1	CTx1	CAP., 0.047µF, C0G, 50V, 5%, 1206	MURATA, GCM31M5C1H473JA16L
5	1	CTx2	CAP., 0.01µF, C0G, 25V, 5%, 0603	KEMET, C0603C103J3GACTU
6	1	LTx1	IND., 6.8µH, WIRELESS CHRG. COIL TX., 10%, 2.5A, 125mΩ, 20.5mm DIA × 2.6mm H, 1 COIL, 1 LAYER	WURTH ELEKTRONIK, 760308101104
7	1	M1	XSTR., MOSFET, N-CH, 20V, 1.4A, SOT-323, AEC-Q200	INFINEON, BSS816NWH6327XTSA1
8	1	R1	RES., 243k, 1%, 1/16W, 0402, AEC-Q200	NIC, NRC04F2433TRF
9	1	R2	RES., 2.2k, 5%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW04022K20JNED
10	1	R3	RES., 1Ω, 1%, 1/16W, 0402, ±100ppm, AEC-Q200	VISHAY, CRCW04021R00FKED
11	1	U1	OSCILLATOR, TIMERBLOX: VCO, 5pF, 90ppm, DFN-5	ANALOG DEVICES, INC., LTC6990CDCB#PBF
Additional Demo Board Circuit Components				
1	1	D1	LED, RED, WATER-CLEAR, 0603	LITE-ON, LTST-C193KRKT-5A
Hardware: For Demo Board Only				
1	2	E1, E2	TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THICK	MILL-MAX, 2308-2-00-80-00-00-07-0
2	1	J1	CONN., µUSB 2.0, RCPT., 5 PINS, 1 PORT, REVERSE MOUNT, R/A HORZ., TYPE B, FLANGELESS	TE CONNECTIVITY, 1932788-1
DC2775A-B: Required Circuit Components				
1	1	C3	CAP., 2.2µF, X5R, 25V, 10%, 0603	MURATA, GRM188R61E225KA12D
2	1	CRx2	CAP., 0.047µF, C0G, 25V, 5%, 0805	KEMET, C0805C473J3GACAUTO
3	1	LRx1	IND., 13µH, WIRELESS CHRG. COIL RX. Qi, 10%, 0.8A, 500mΩ, 10mm DIA x 1.68mm H, 1 COIL, 1 LAYER	WURTH ELEKTRONIK, 760308101208
4	1	RT1	RES., 100k, 1%, 0201, NTC THERMISTOR	TDK, NTCG064EF104FTBX
5	1	U1	IC, 100mA WIRELESS LI-ION CHARGER WITH LOW BATTERY DISCONNECT, LQFN-12	ANALOG DEVICES, INC., LTC4124EV#PBF
Additional Circuit Components				
1	1	D1	LED, RED, WATER-CLEAR, 0603	LITE-ON, LTST-C193KRKT-5A
2	1	R2	RES., 0Ω, 5%, 1/16W, 0402	ROHM, MCR01MZPJ000
Hardware: For Demo Board Only				
1	10	E1-E10	TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THICK	MILL-MAX, 2308-2-00-80-00-00-07-0
2	8	JP1-JP8	CONN., HDR, MALE, 1×3, 2mm, VERT, STR, THT	WURTH ELEKTRONIK, 62000311121
3	8	XJP1-XJP8	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421

SCHEMATIC DIAGRAM



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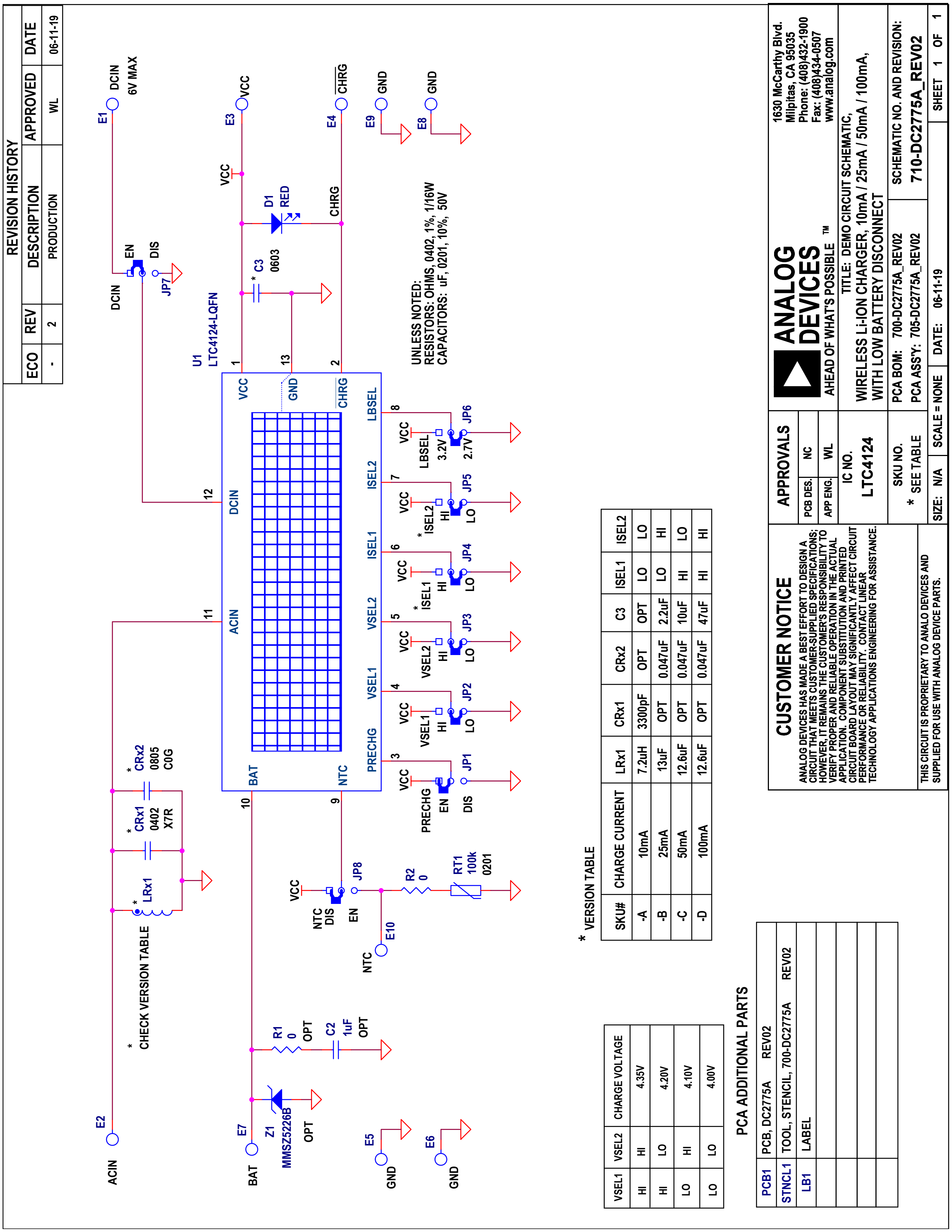
SCHEMATIC DIAGRAM



REVISION HISTORY

ECO	REV	DESCRIPTION	APPROVED	DATE
-	2	PRODUCTION	WL	06-11-19

* VERSION TABLE

SKU#	CHARGE CURRENT	LRx1	CRx1	CRx2	C3	ISEL1	ISEL2
-A	10mA	7.2uH	3300pF	OPT	OPT	LO	LO
-B	25mA	13uF	OPT	0.047uF	2.2uF	LO	HI
-C	50mA	12.6uF	OPT	0.047uF	10uF	HI	LO
-D	100mA	12.6uF	OPT	0.047uF	47uF	HI	HI

VSEL1	VSEL2	CHARGE VOLTAGE
HI	HI	4.35V
HI	LO	4.20V
LO	HI	4.10V
LO	LO	4.00V

PCA ADDITIONAL PARTS

PCB1	PCB, DC2775A	REV02
STNCL1	TOOL, STENCIL, 700-DC2775A	REV02
LB1	LABEL	

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ESD Caution

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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