LTC4124/LTC4125, 50mA Wireless Li-Ion Charger Demonstration Kit

DESCRIPTION

DC2770A-A-KIT is a kit of the DC2773A-A transmitter board (featuring LTC®4125) and the DC2775A-C (featuring LTC®4124). The DC2775A-C receiver board can charge a single Li-Ion battery at up to 50 mA with an air gap of 3.0 mm to 5.0 mm between the transmit and receive coils. The DC2773A-A transmitter board supports Foreign Object Detection via the LTC4125.

Design files for this circuit board are available.

CONTENTS

1 × DC2773A-A (LTC4125) Transmitter Demo Board

1 × DC2775A-C (LTC4124) Receiver Demo Board

PERFORMANCE SUMMARY

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	DC2773A-A Voltage Input	$I_{VIN} \leq 500mA$	4.5		5.5	V
I_{IN}	DC2773A-A V_{IN} Current	V_{IN} = 5V			500	mA
V_{BAT}	DC2775A-C 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-C Charge Current	V_{BAT} = 4.0V, I_{SEL1} = V_{CC}, I_{SEL2} = GND		50		mA
AIR-GAP	Separation Between L_{TX} and L_{RX} Coils		3	3.5	5	mm
f_{TX_TANK}	DC2773A-A Resonant Tank Frequency			200		kHz
f_{RX_TANK}	DC2775A-C Resonant Tank Frequency			200		kHz

BOARD PHOTO

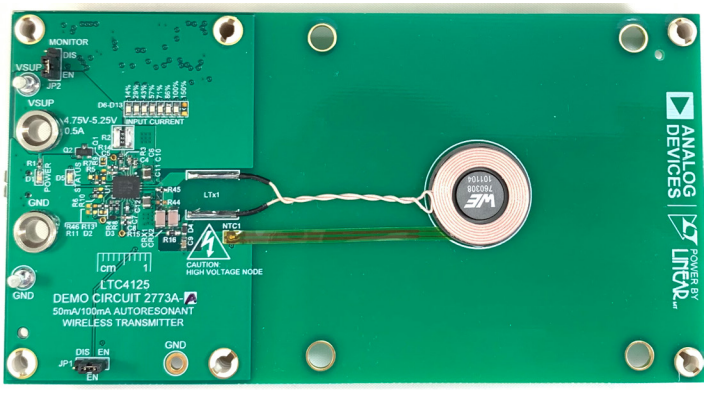


Figure 1. DC2773A-A Picture

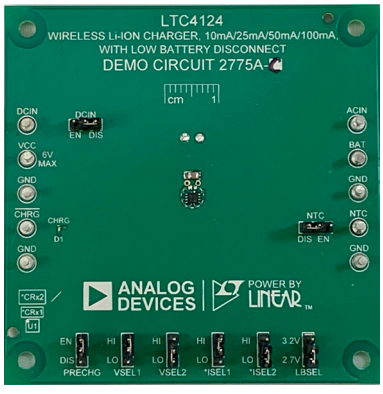


Figure 2. DC2775A-C Picture

QUICK START PROCEDURE

Refer to Figures 3, 4, and 5 for the proper measurement equipment setup, DC2775A-C mounting on DC2773A-A, 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 6 for proper scope probe technique.

1. Place the DC2775A-C board atop the DC2773A-A board by aligning the mounting holes and screws on both boards. Make sure the air-gap between two coils is at about 3.5mm.
2. The default battery charge voltage is 4.2V and the charging current is 50mA. Battery charge voltage, charge current, pre-charge feature and low battery disconnect voltage can be programmed by jumpers on the DC2775A-C board.
3. Connect a voltage source PS1 and a 20 Ohm resistor RBAT1 between the BAT and GND turrets of DC2775A-C, 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-C BAT turret. Connect a voltage meter VM1between DC2775A-C BAT and GND turrets.
5. Connect a power supply (PS2) between DC2773A-A V_{IN} turret and GND turret. DC2773A-A can also be powered through Micro-USB cable to a 5V power source.
6. Set PS1 = 3.7V, PS2 = 5V and enable both power supplies simultaneously. The DC2773A-A.D5 green LED should be turned on, indicating the transmitter is working properly. Note that current indicators on DC2773A-A.D6-D13 does not reflect the real input current in this version. It simply indicates a valid receiver is found.
7. The DC2775A-C. D1 should be turned on, indicating power is delivered to the load. Observe AM1. AM1 should be reading 50mA of charge current into the battery emulator when the battery charger is in constant current mode. Compare VM1 voltage with battery charge voltage setting to make sure the battery charger is in constant current mode.
8. When test is done, turn off PS1 and PS2 simultaneously.

Figure 3. DC2770A-A-KIT in Operation

TEST SETUP

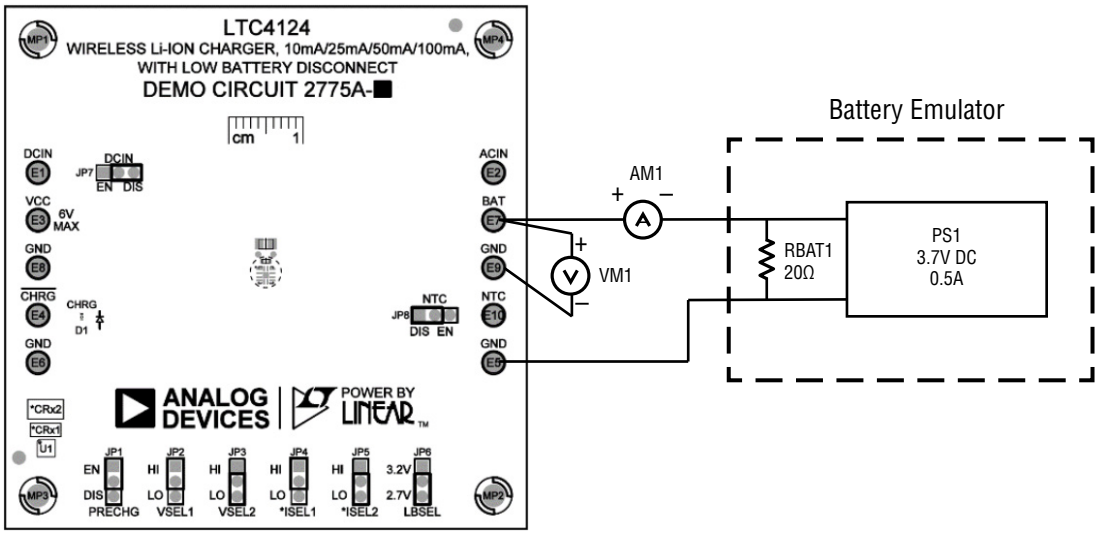


Figure 4. DC2775A-C Top

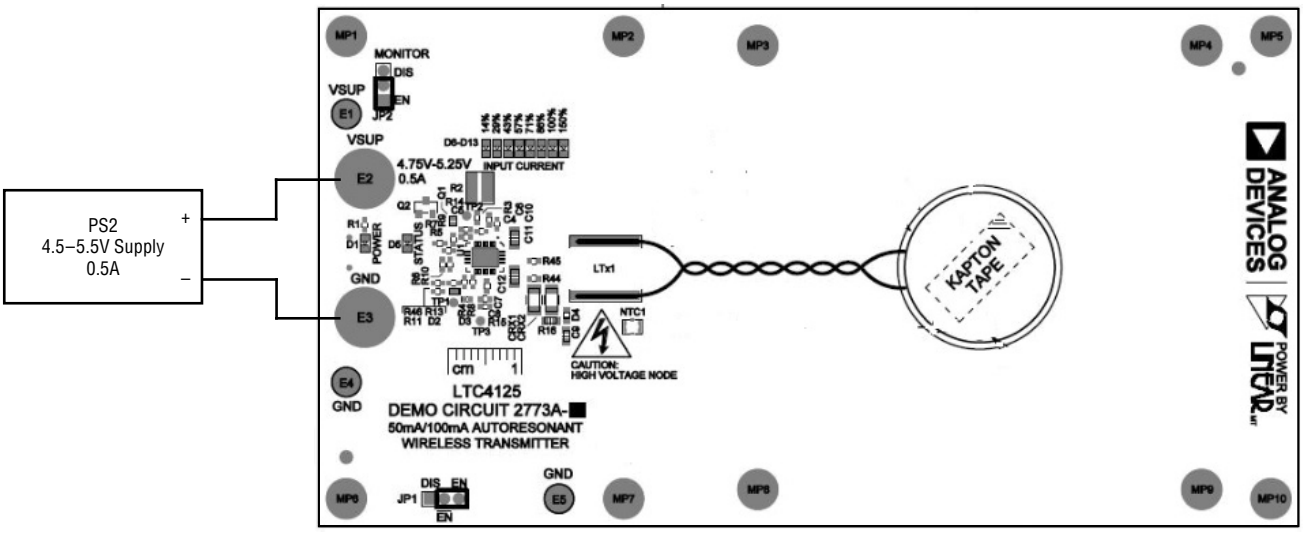


Figure 5. DC2773A-A Top

TEST SETUP

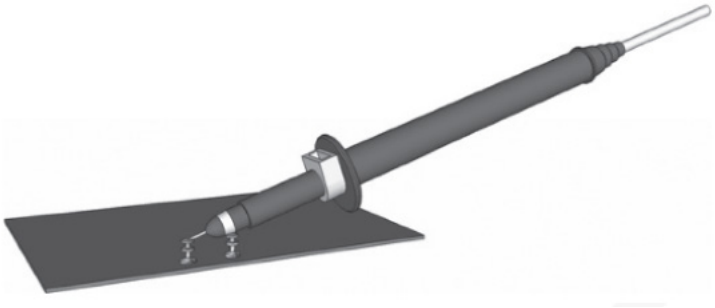


Figure 6. Measuring Input or Output Ripple

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.

THEORY OF OPERATION

The DC2770A-A-KIT demonstrates operation of a magnetically coupled resonant Wireless Power Transfer (WPT) system. The LTC4125 transmitter provides efficient wireless power for the LTC4124 receiver to charge the Li-Ion battery.

DC2773A-A – Wireless Power Transmitter Board featuring the LTC4125

The LTC4125 implements an AutoResonant drive of the series resonant transmit tank composed of the transmit coil LT_X, and the transmit capacitor CT_X. The AutoResonant driver uses a zero-crossing detector to determine the resonant frequency of the tank. All sub-sequent duty cycles discussed here use the resonant period determined by the AutoResonant circuitry.

The SW1 and SW2 pins each have a half bridge driver. At zero current crossing, whichever SW_X pin has positive going current, is set to V_{IN} for a duty cycle determined by the corresponding PTH_X pin. When the SW_X pin is set to V_{IN}, it increases the current flowing in the transmitter resonant tank. The absolute value of the tank current is determined by the resonant tank components and also by the reflected load impedance.

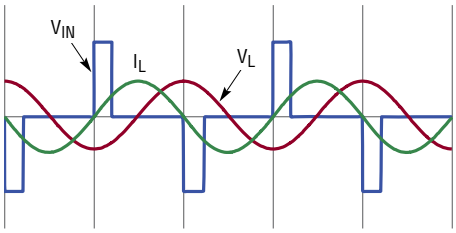


Figure 7. AutoResonant LC Tank Voltage and Current Waveforms with Square Wave Input at less than 50% Duty Cycle

The LTC4125 also features optimum power search algorithm. However, it is not implemented in this demo kit. To check the operation details of optimum power search, please refer to DC2770A-B-KIT demo manual.

In this demo kit, a 1V voltage reference ADR510 is placed between IMON pin and GND. In this way, the exit condition of the search algorithm is always triggered. As a result, the duty cycle remains almost constant in the operation, regardless of the change in load current or air gap distance. The duty cycle of the two half bridge drivers is pre-defined by PTHM resistors R4 and R8.

The FB pin is driven by the node forming the junction of the transmit coil LT_X, and the transmit capacitor CT_X. The voltage at this node is proportional to the circulating current in the transmitter resonant tank.

If the receiver is removed from the transmitter, resonant tank current will rise significantly. The FB pin captures the rise of resonant current and terminates both half bridge drivers. As a result, the transmit power is reduced to standby mode.

If metal foreign objects are inserted between the transmit coil and the receive coil, the resonant frequency will increase significantly. The LTC4125 captures the rise of resonant frequency and reduces the transmit power to standby mode.

In standby mode, the LTC4125 will look for a valid receiver every 5s. If a valid receiver is found, the power transfer is resumed.

The LTC4125 uses an NTC resistor to monitor the temperature of the LT_X and shut off the transmit power if the NTC reports a temperature higher than approximately 42°C. Please see the applications section of the data sheet for more detailed information.

DC2775A-C – Wireless Power Receiver Board featuring the LTC4124

The DC2775A-C 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 manager circuit 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 8, 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 (at V_{CC} Pin) low by shunting the receiver resonant

THEORY OF OPERATION

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 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-C is 50mA and the charge voltage is programmable by $VSEL_X$ jumpers.

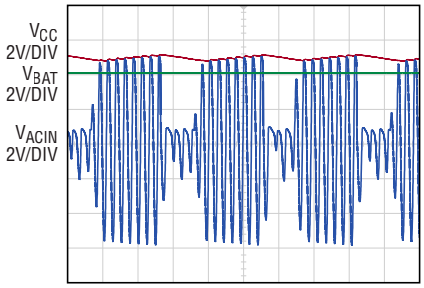


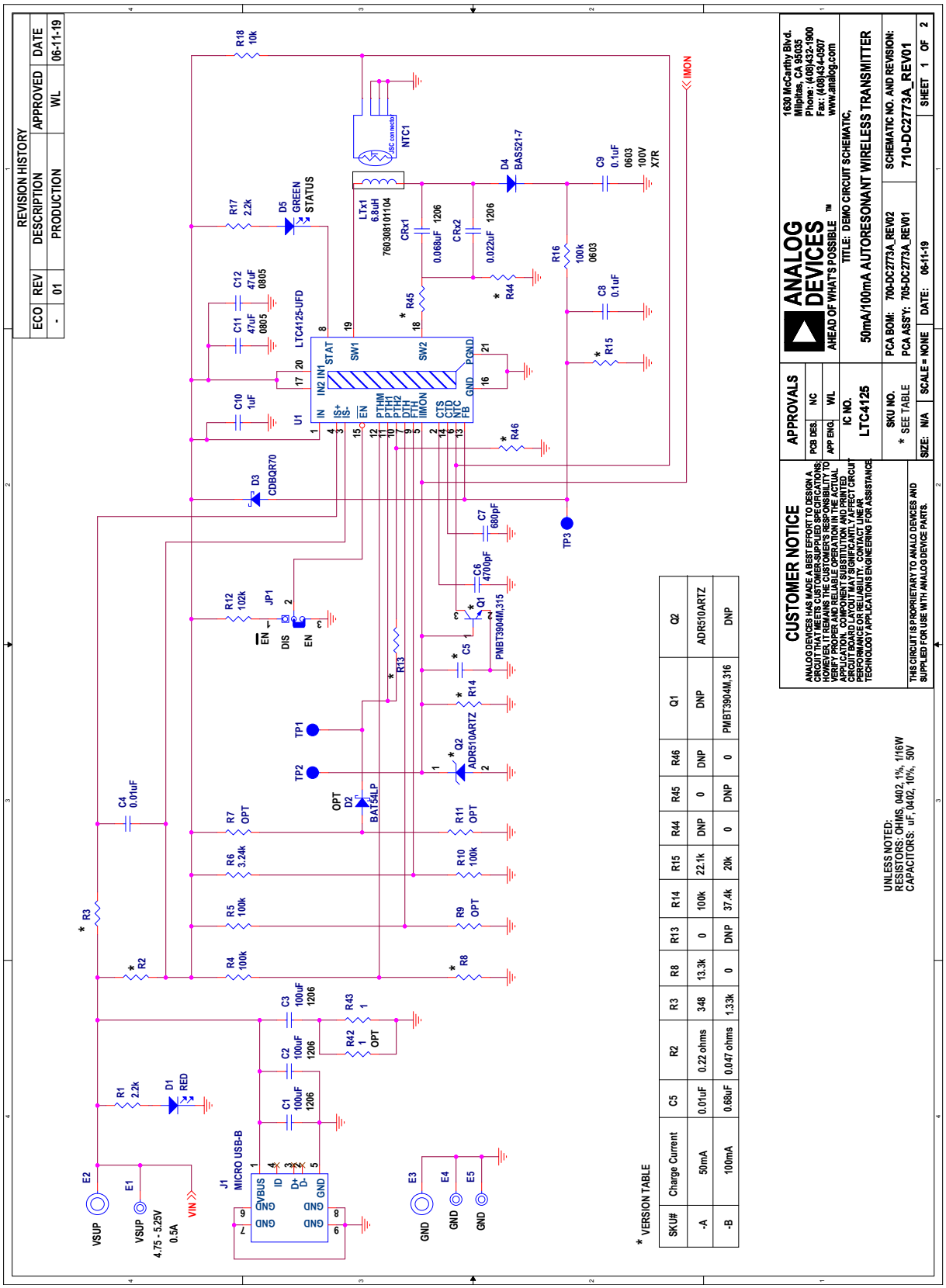
Figure 8. Rectification of AC Input and Regulation of V_{CC}

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
DC2773A-A: Required Circuit Components				
1	3	C1, C2, C3	CAP., 100uF, X5R, 6.3V, 10%, 1206	MURATA, GRM31CR60J107KE39L
2	1	C4	CAP., 0.01uF, X7R, 50V, 10%, 0402	KEMET, C0402C103K5RAC7867
3	1	C5	CAP., 0.01uF, X7R, 25V, 10%, 0402, AEC-Q200	MURATA, GCM155R71E103KA37D
4	1	C6	CAP., 4700pF, X7R, 50V, 10%, 0402	AVX, 04025C472KAT2A
5	1	C7	CAP., 680pF, C0G, 25V, 5%, 0402	KEMET, C0402C681J3GACTU
6	1	C8	CAP., 0.1uF, X7R, 50V, 10%, 0402	AVX, 04025C104KAT2A
7	1	C9	CAP., 0.1uF, X7R, 100V, 10%, 0603	AVX, 06031C104KAT2A
8	1	C10	CAP., 1uF, X5R, 16V, 10%, 0402	AVX, 0402YD105KAT2A
9	2	C11, C12	CAP., 47uF, X5R, 6.3V, 20%, 0805	SAMSUNG, CL21A476MQYNNNE
10	1	CRx1	CAP., 0.068uF, C0G, 50V, 5%, 1206, AEC-Q200	MURATA, GCM31C5C1H683JA16L
11	1	CRx2	CAP., 0.022uF, C0G, 50V, 5%, 1206, AEC-Q200	KEMET, C1206C223J5GACAUTO
12	1	D3	DIODE, SCHOTTKY, 70V, 70mA, 0402/SOD-923F	COMCHIP, CDBQR70
13	1	D4	DIODE, SWITCHING, 300V, 250mA, SOD-523	DIODES INC., BAS521-7
14	1	D5	LED, GREEN, WATER CLEAR, 0603	LITE-ON, LTST-C190KGKT
15	1	LTx1	IND., 6.8uH, WIRELESS CHRG. COIL, TX., 10%, 2.5A, 125mOHMS, 20.5mm Dia x 2.6mm H, 1 COIL, 1 LAYER	WURTH ELEKTRONIK, 760308101104
16	1	NTC1	RES., 10k OHMS, 1%, NTC THERMISTOR	MURATA, FTN55XH103FD4B
17	1	Q2	IC VREF SHUNT 1V SOT23-3	ANALOG DEVICES, INC., ADR510ARTZ#PBF
18	2	R1, R17	RES., 2.2k OHMS, 5%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW04022K20JNED
19	1	R2	RES., 0.22 OHMS, 1W, 1206, AEC-Q200 WIDE TERMINAL	PANASONIC, ERJB2BFR22V
20	1	R3	RES., 348 OHMS, 1%, 1/16W, 0402	VISHAY, CRCW0402348RFKED
21	2	R4, R5	RES., 100k OHMS, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402100KFKED
22	1	R6	RES., 3.24k OHMS, 1%, 1/10W, 0402	PANASONIC, ERJ2RKF3241X
23	1	R8	RES., 13.3k OHMS, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW040213K3FKED
24	2	R10, R14	RES., 100k OHMS, 1%, 1/10W, 0402, AEC-Q200	PANASONIC, ERJ2RKF1003X
25	1	R12	RES., 102k OHMS, 1%, 1/16W, 0402, AEC-Q200	STACKPOLE ELECTRONICS, INC., RMCF0402FT102K
26	1	R15	RES., 22.1K OHMS, 1%, 1/16W, 0402, THICK FILM, AEC-Q200	VISHAY, CRCW040222K1FKEDC
27	1	R16	RES., 100k OHMS, 1%, 1/10W, 0603, 350V, AEC-Q200	ROHM, KTR03EZPF1003
28	1	R18	RES., 10k OHMS, 5%, 1/16W, 0402	YAGEO, RC0402JR-0710KL
29	1	R43	RES., 1 OHM, 5%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3GEYJ1R0V
30	1	U1	IC, 5W Wireless Power Transmitter, QFN-20 (4x5), AutoResonant	ANALOG DEVICES, LTC4125EUFD#PBF
Additional Circuit Components				
1	3	C13, C15, C16	CAP., 0.01uF, X7R, 50V, 10%, 0402	KEMET, C0402C103K5RAC7867
2	2	C14, C17	CAP., 1uF, X5R, 16V, 10%, 0402	AVX, 0402YD105KAT2A
3	1	D1	LED, RED, WATER-CLEAR, 0603	LITE-ON, LTST-C193KRKT-5A
4	7	D6-D12	LED, BLUE, WATER CLEAR, 0603	LUMEX, SML-LXFP0603USBCTR
5	1	R41	RES., 2.2k OHMS, 5%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW04022K20JNED

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
6	2	R13, R45	RES., 0 OHM, 1/16W, 0402	NIC, NRC04ZOTRF
7	1	R19	RES., 10k OHMS, 5%, 1/16W, 0402	YAGEO, RC0402JR-0710KL
8	2	R20, R33	RES., 430 OHMS, 5%, 1/16W, 0402	YAGEO, RC0402JR-07430RL
9	1	R21	RES., 15.4k OHMS, 1%, 1/16W, 0402, AEC-Q200	KOA SPEER, RK73H1ETTP1542F
10	1	R22	RES., 27.4k OHMS, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW040227K4FKED
11	1	R23	RES., 511k OHMS, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW0402511KFKED
12	7	R24-R30	RES., 75k OHMS, 1%, 1/16W, 0402	VISHAY, CRCW040275K0FKED
13	1	R31	RES., 11.3k OHMS, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW040211K3FKED
14	1	R32	RES., 787k OHMS, 1%, 1/16W, 0402	NIC, NRC04F7873TRF
15	7	R34-R40	RES., 6.2k OHMS, 1%, 1/16W, 0402	YAGEO, RC0402FR-076K2L
16	1	R45	RES., 0 OHM, 1/16W, 0402	ROHM, MCR01MZPJ000
17	2	U2, U3	IC, QUAD COMPARATOR LP 1.221VREF, DFN-16 (5x4)	ANALOG DEVICES, LTC1445CDHD#PBF
Hardware: For Demo Board Only				
1	3	E1, E4, E5	TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062" THICK	MILL-MAX, 2501-2-00-80-00-00-07-0
2	2	E2, E3	CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE, 0.218"	KEYSTONE, 575-4
3	1	J1	CONN., MICRO USB-B, RCPT., FEMALE, 5-PIN, HORZ. R/A SMT	WURTH ELEKTRONIK, 629105136821
4	2	JP1, JP2	CONN., HDR., MALE, 1x3, 2mm, THT, STR, NO SUBS. ALLOWED	SAMTEC, TMM-103-02-L-S
5	6	MP1, MP2, MP5-MP7, MP10	STANDOFF, NYLON, SNAP-ON, 0.50"	WURTH ELEKTRONIK, 702935000
6	1	NTC ASSEMBLY_1	CONN., JSC COAXIAL SOCKET, RCPT., FEMALE, SMD, 1PORT, I/O TERM.	MURATA, MM5831-2700RB
7	2	XJP1, XJP3	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421
DC2775A-C: Required Circuit Components				
1	1	C3	CAP., 10uF, X5R, 6.3V, 20%, 0603	MURATA, GRM188R60J106ME47D
2	1	CRx2	CAP., 0.047uF, C0G, 25V, 5%, 0805, AEC-Q200	C0805C473J3GACAUTO
4	1	LRx1	IND., 12.6uH, WIRELESS CHRG. COIL RX Qi, 10%, 1.1A, 340mOHMS, 17mm Dia x 0.8mm H, 1 COIL, 1 LAYER	WURTH ELEKTRONIK, 760308101220
5	1	R2	RES., 0 OHM, 5%, 1/16W, 0402	ROHM, MCR01MZPJ000
6	1	RT1	RES., 100k OHMS, 1%, 0201, NTC THERMISTOR	TDK, NTCG064EF104FTBX
Additional Circuit Components				
1	1	D1	LED, RED, WATER CLEAR, 0201	KINGBRIGHT, APG0603SEC-E-TT
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, 1x3, 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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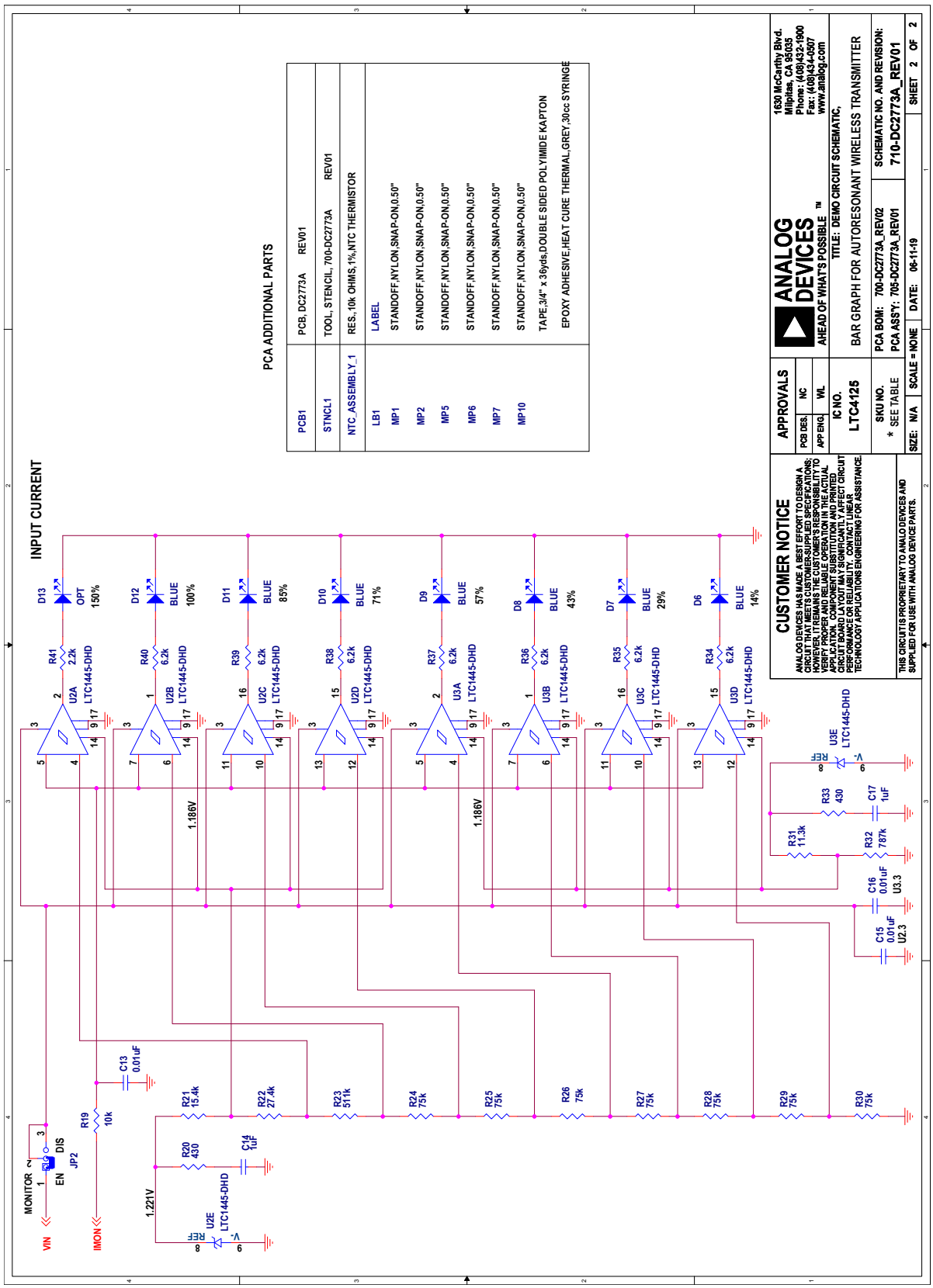

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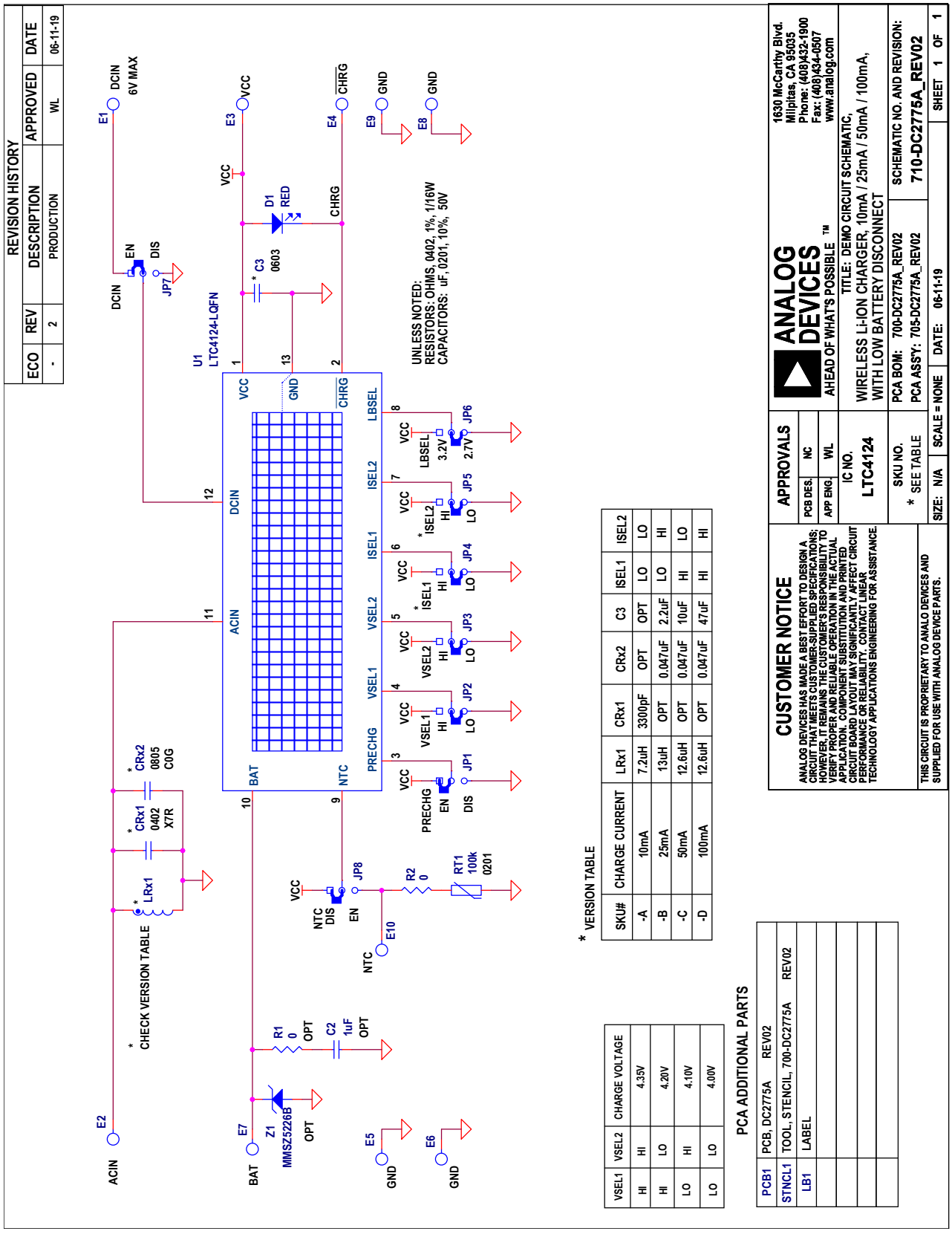

ESD Caution

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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