

LTC4126-ADJ 10mA Wireless Charger Demonstration Kit

DESCRIPTION

Demonstration Kit DC3080-KIT features **LTC®4126-ADJ**, wireless Li-Ion Charger with 1.2V Step-Down DC/DC Converter. This kit comprises a wireless transmitter DC3081A, a wireless receiver DC3078A and two 6mm application-sized receivers DC3079A.

DC3078A wireless charger receiver incorporates an external trickle charge circuit that reduces the charge current to

1mA when a deeply discharged battery with voltage lower than 2.8V is plugged in. The combination of DC3081A transmitter and DC3078A receiver can charge a single Li-Ion battery at up to 10mA with an airgap of 4.0mm to 8.0mm.

Design files for this circuit board are available.

All registered trademarks and trademarks are the property of their respective owners.

BOARD PHOTO

- 1 x DC3078A (LTC4126-ADJ) Receiver Demo Board
- 2 x DC3079A (LTC4126-ADJ) 6mm Application-Sized Receiver Demo Board
- 1 x DC3081A (LTC6990) Transmitter Demo Board

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

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	DC3081A Voltage Input		4.5		5.5	V
I_{BAT}	DC3078A Charge Current in CC Mode			10		mA
V_{BAT}	DC3078A Float Voltage			4.2		V
f_{DRIVE}	DC3081A Drive Frequency			205		kHz
f_{TX_TANK}	DC3081A Resonant Tank Frequency			255		kHz
f_{RX_TANK}	DC3078A Resonant Tank Frequency			203		kHz
AIR-GAP	Airgap Between DC3078A and DC3081A	$I_{BAT} = 10\text{mA}$	4		8	mm

TYPICAL APPLICATION SCHEMATIC

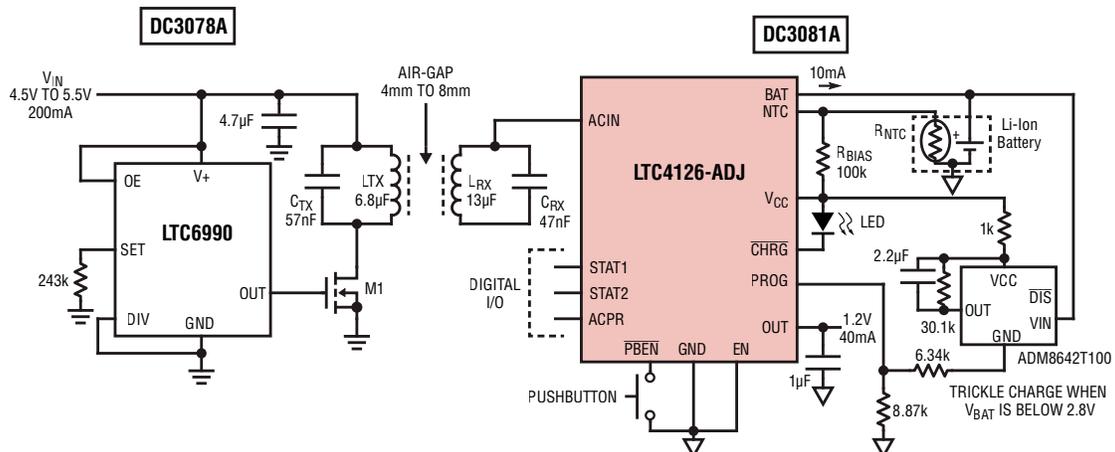


Figure 1. 10mA Wireless Charging System Using DC3078A and DC3081A

DEMO MANUAL DC3080A-KIT

BOARD PHOTO

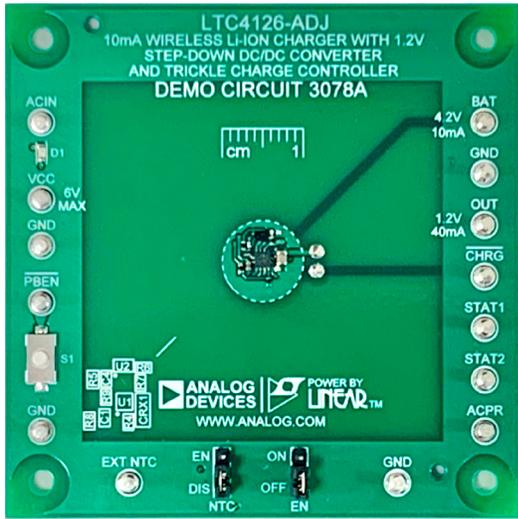


Figure 2. DC3078A Front

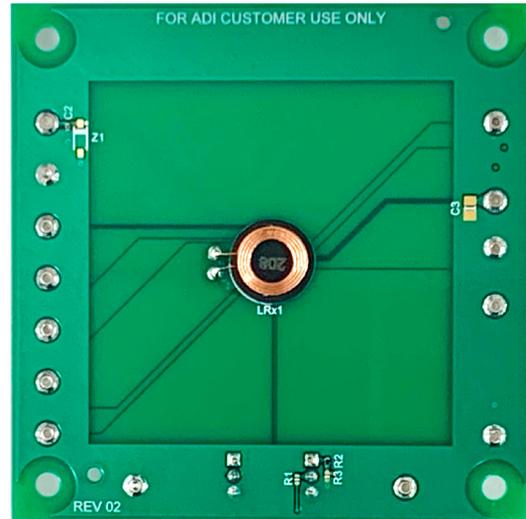


Figure 3. DC3078A Back

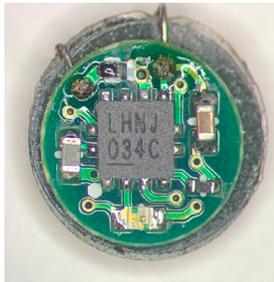


Figure 4. DC3079A Front



Figure 5. DC3079A Back

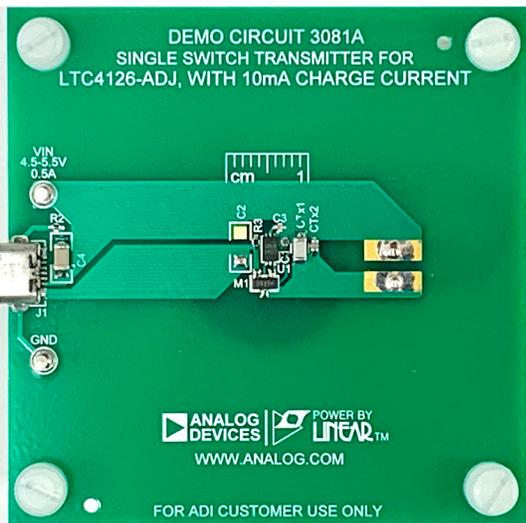


Figure 6. DC3081A Front

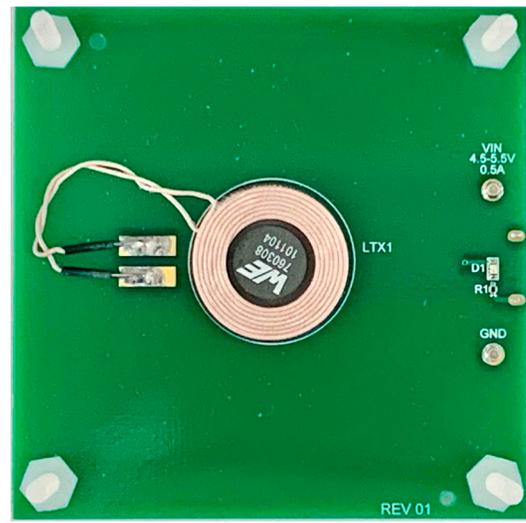


Figure 7. DC3081A Back

QUICK START PROCEDURE

Refer to Figure 9 and Figure 11 for the proper measurement equipment setup and follow the procedure below:

1. Connect a voltage source PS1 and a 50Ω resistor RBAT1 between the BAT and GND turrets of the DC3078A as shown in Figure 9. PS1 and RBAT1 make up the battery emulator. Typical power supply cannot sink current. By adding a resistor across the power supply inputs that draws more current than the maximum battery charge current, the power supply only sources current at all time. Connect a voltmeter VM1 to measure the BAT pin to GND voltage. Connect an ammeter AM1 to measure the charge current to the battery emulator.
2. Connect a voltage source PS2 between the VIN and GND turrets of the DC3081A, as shown in Figure 10.
3. Set PS1 to 2.5V, and power up PS1. Set PS2 to 5V, and power up PS2. The LED indicator on DC3078A receiver board should start blinking slowly, indicating power is delivered to the receiver. AM1 should read around 1mA trickle charge current.
4. Slowly increase PS1 until VM1 reads 3.6V. The charge current should jump up to 10mA. Further increase PS1 voltage slowly, until VM1 reads 4.2V. The charge current should drop to zero.
5. Connect an electronic load LD1 and a voltmeter between OUT and GND pin. If EN jumper is at ON position, VM2 should read 1.2V. If not, OUT can be turned on/off by the pushbutton.

6. When OUT is on, set LD1 to CC mode. Slowly tune up the load current to 40mA. VM2 should be regulated at around 1.2V
7. Turn off LD1, PS2 and PS1.
8. To test DC3079A, 6mm application-sized demo, please remove the DC3078A away from DC3081A. Place DC3079A on top of the DC3081A transmitter coil LTx1.
9. Turn on PS1. The LED on DC3079A should start blinking slowly, indicating power is delivered to the receiver.

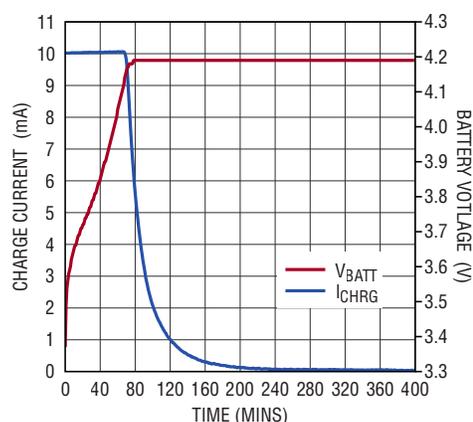


Figure 8. DC3078A and DC3081A Wireless Charging Profile with 19mAh Li-Ion Battery

TEST SETUP

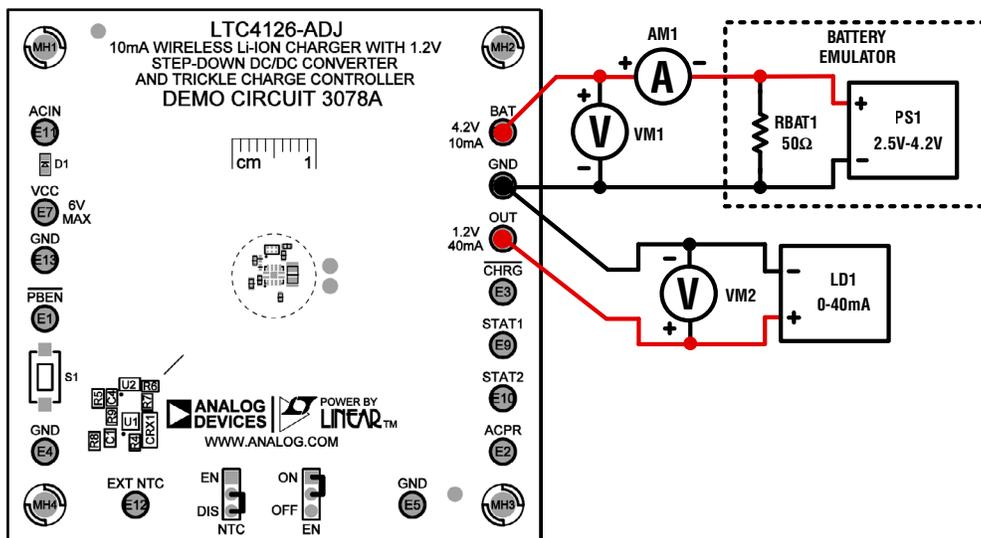


Figure 9. Test Setup for DC3078A Receiver

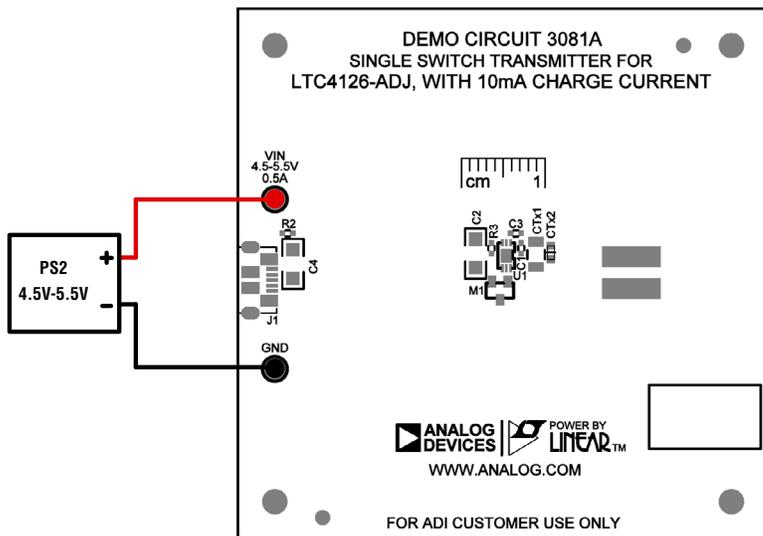


Figure 10. Test Setup for DC3081 Transmitter

TEST SETUP

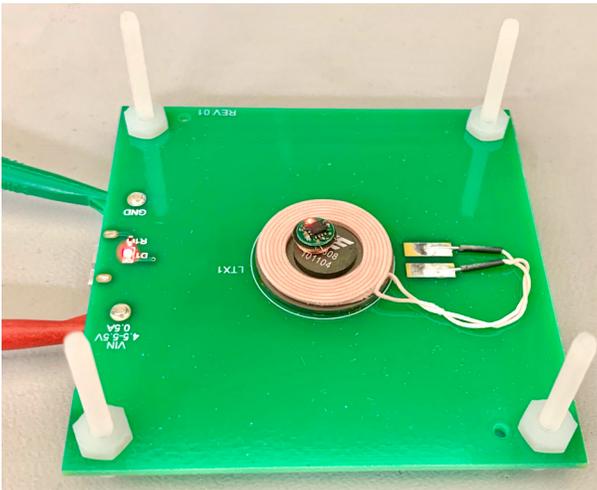


Figure 11. Test Setup for DC3079A 6mm Application-Sized Receiver



Figure 12. DC3078A and DC3081A Combination

THEORY OF OPERATION

The DC3080A-KIT demonstrates the operation of LTC4126-ADJ, wireless battery charger. This kit is composed of a DC3081A transmitter board, a DC3078A receiver board and two DC3079A 6mm application-sized receiver boards.

DC3078A Wireless Charger Receiver Board

DC3078A features the LTC4126-ADJ, a wireless Li-Ion charger with 1.2V step-down DC/DC converter. The charge current in CC mode is 10mA. This charge current is programmed by the resistor on PROG pin of LTC4126-ADJ.

To efficiently receive energy from the transmitter, the resonant frequency of this receiver board is set up to be 203kHz, matching the drive frequency of the transmitter board. The LTC4126-ADJ rectifies the resonant AC voltage to generate V_{CC} . When enough energy is received by the LTC4126-ADJ, V_{CC} is kept between 5-5.5V by a wireless power manager. As V_{CC} voltage reaches 5.5V, the resonant tank will be shunted to GND. In this way, receiver stops receiving energy and V_{CC} starts to drop until it reaches 5V. The resonant tank also receives less power when the shunting circuit is engaged, as the resonant frequency is detuned from the transmitter frequency.

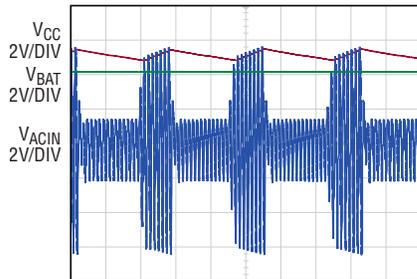


Figure 13. Rectification of AC Input and Regulation of DC Rail Voltage

The transmitter board also includes an external circuit to achieve the trickle charge function. When a low voltage (<2.8V) battery is connected, the charge current is reduced to 1mA until BAT pin voltage rises over 2.8V.

When BAT pin is lower than 2.8V before charging, the comparator on board will inject current to the PROG pin resistor once V_{CC} is available. The effective current coming out from PROG pin is reduced. As PROG pin output current is proportional to charge current, the charge current is reduced. When the battery voltage is charged up to above 2.8V, the comparator stops injecting current and the charge current increases to the original programmed level.

DC3081A Wireless Charger Transmitter Board

The DC3081A is a wireless power transmitter board, using LTC6990 TimerBlox. The NMOS M1 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 resonant tank rises linearly. During the second half of the cycle, M1 is switched off and the current circulates through the resonant tank. When the transmit resonant tank frequency is set to about 1.29 times the driving frequency, M1 is turned on at zero voltage, and the switching loss is significantly reduced. The peak voltage of the transmit resonant tank that appears at the drain of M1 is :

$$V_{IN} = 1.038 \times \pi \times V_{IN} \quad (1)$$

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

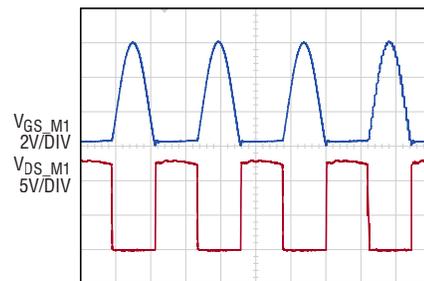


Figure 14. ZVS Operation on M1

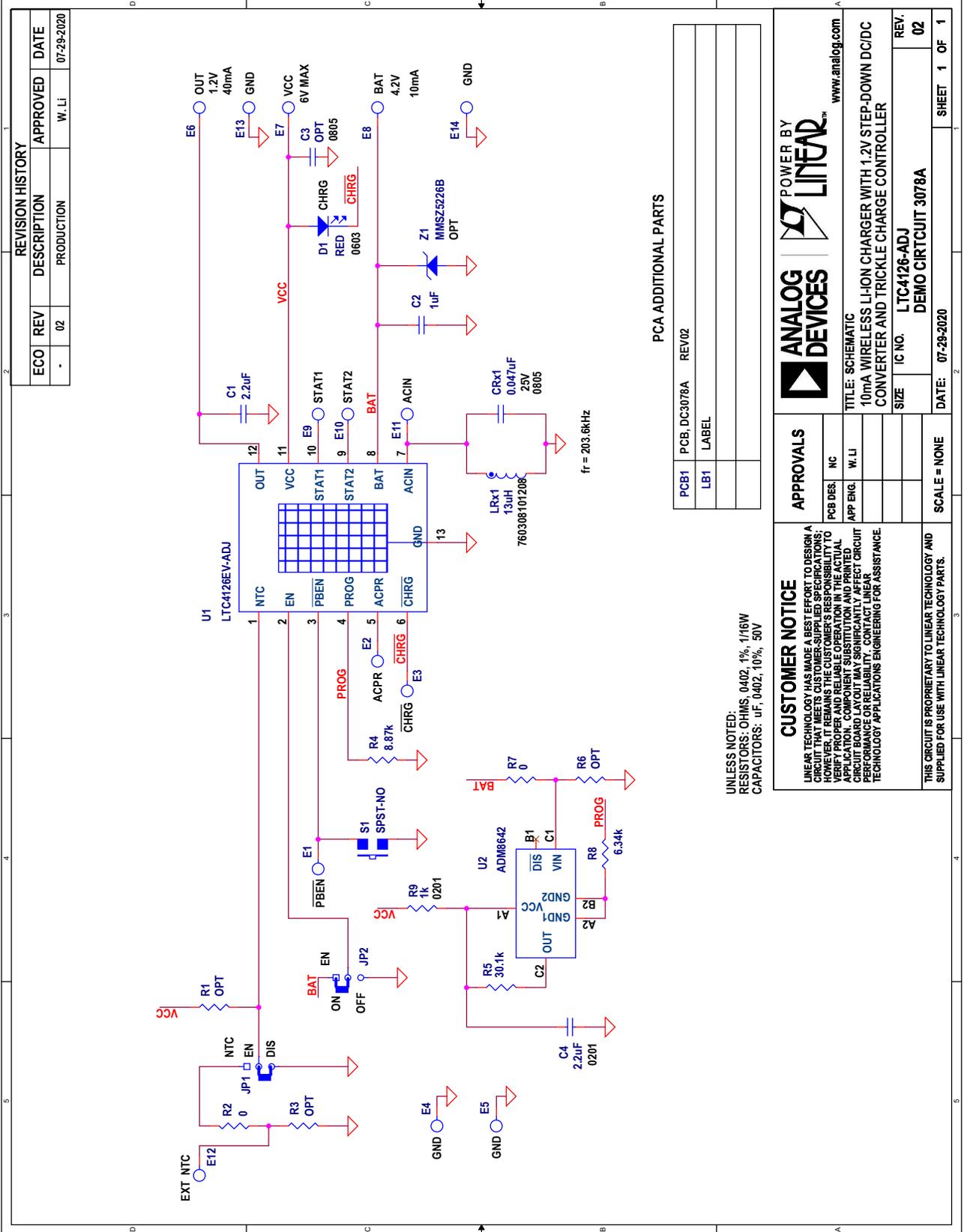
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
DC3078A Evaluation Receiver: Required Circuit Components				
1	1	C1	CAP, 2.2uF, X5R, 16V, 20%, 0402	TDK, C1005X5R1C225M050BC
2	1	C2	CAP, 1uF, X5R, 16V, 10%, 0402	AVX, 0402YD105KAT2A
3	1	C4	CAP CER 2.2UF 6.3V X5R 0201	MURATA, GRM033R60J225ME47D
4	1	CRx1	CAP, 0.047uF, C0G, 25V, 5%, 0805, AEC-Q200	KEMET, C0805C473J3GACAUTO
5	1	LRx1	IND., 13uH, WIRELESS CHRG. COIL RX. Qi, 10%, 0.8A, 500mOHMS, 10mm Dia x 1.68mm H,	WURTH ELEKTRONIK, 760308101208
6	1	R4	RES., 8.87k OHMS, 1%, 1/16W, 0402, AEC-Q200	ROHM, MCR01MZPF8871
7	1	R5	RES., 30.1k OHMS, 1%, 1/16W, 0402, AEC-Q200	NIC, NRC04F3012TRF
8	1	R7	RES., 0 OHM, 1/16W, 0402	NIC, NRC04ZOTRF
9	1	R9	RES 1 KOHM, ERJ1G Series, 25V, 0201, 50 mW	PANASONIC, ERJ-1GEJ102C
10	1	U1	IC, Li-ion Charger with Step-Down Reg. for Hearing Aids with Adj. Current, LQFN-12	ANALOG DEVICES, INC., LTC4126EV-ADJ#PBF
DC3078A: Additional Circuit Components				
1	1	D1	LED, RED, WATER-CLEAR, 0603	LITE-ON, LTST-C193KRKT-5A
2	1	R2	RES., 0 OHM, 5%, 1/16W, 0402	ROHM, MCR01MZPJ000
DC3078A: Hardware, For Demo Board Only				
1	2	E1-E14	TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2308-2-00-80-00-00-07-0
2	1	JP1, JP2	CONN., HDR, MALE, 1x3, 2mm, VERT, ST, THT	WURTH ELEKTRONIK, 62000311121
2	1	XJP1, XJP3	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421
DC3079A 6mm Receiver: Required Circuit Components				
1	1	COUT1	CAP, 2.2uF, X5R, 16V, 20%, 0402	TDK, C1005X5R1C225M050BC
2	1	CRx1	CAP, 0.068uF, X7R, 25V, 10%, 0402, AEC-Q200	TDK, CGA2B3X7R1E683K050BB
3	1	LRx1	IND., 7.2uH, WIRELESS CHRG. COIL RX., +/-10%, 500mA, 440mOHMS, 6mmX2mm, 1 COIL, 1 LAYER	WURTH ELEKTRONIK, 760308101216
4	1	R1	RES., 8.87k OHMS, 1%, 1/20W, 0201, AEC-Q200	PANASONIC, ERJ1GNF8871C
4	1	RT1	RES., 100k OHMS, 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
DC3079A: Additional Circuit Components				
1	1	D1	LED, RED, CLEAR, 0402, SMD	ROHM, SML-P11UTT86
2	1	Z1	DIODE, ZENER, 3.3V, 100mW, 0201	COMCHIP, CZRZ3V3B-HF

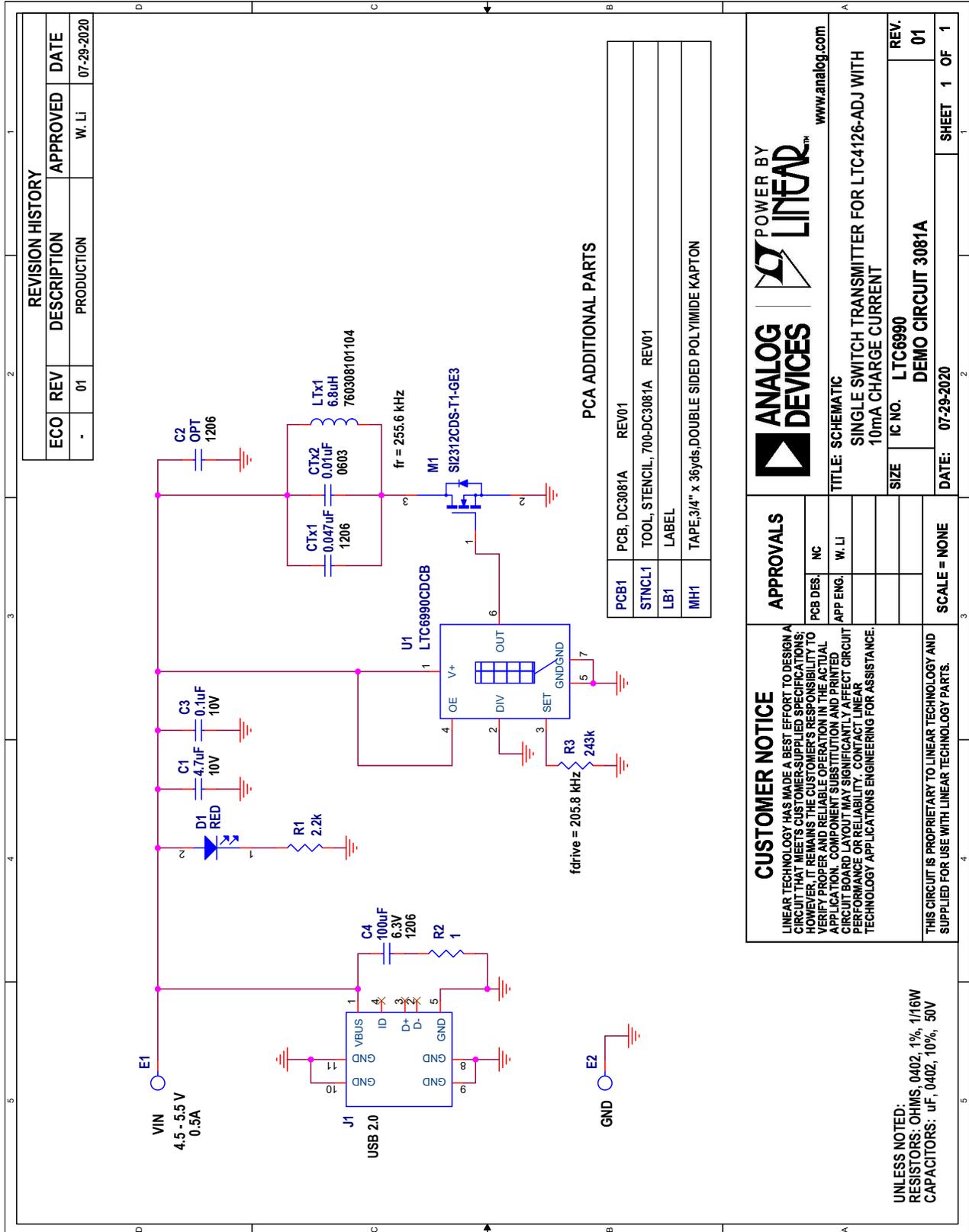
DEMO MANUAL DC3080A-KIT

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
DC3081A Transmitter: Required Circuit Components				
1	1	C1	CAP, 4.7uF, X5R, 10V, 10%, 0402	TDK, C1005X5R1A475K050BC
2	1	C3	CAP, 0.1uF, X5R, 10V, 10%, 0402	AVX, 0402ZD104KAT2A
3	1	CTx1	CAP, 0.047uF, COG, 50V, 5%, 1206	MURATA, GCM31M5C1H473JA16L
4	1	CTx2	CAP, 0.01uF, COG, 25V, 5%, 0603	KEMET, C0603C103J3GACTU
5	1	LTx1	IND., 6.8uH, WIRELESS CHRG. COIL, 10%, 2.5A, 125mOHMS, 20.5mm Dia x 2.6mm H	WURTH ELEKTRONIK, 760308101104
6	1	R3	RES., 243k OHMS, 1%, 1/16W, 0402, AEC-Q200	NIC, NRC04F2433TRF
7	1	M1	XSTR., MOSFET, N-CH, 20V, 6A, SOT23-3	VISHAY, Si2312CDS-T1-GE3
8	1	U1	OSCILLATOR, TimerBlox: VCO, 5pF, 90ppm, DFN-5	ANALOG DEVICES, LTC6990CDCB#PBF
DC3081A: Additional Circuit Components				
1	1	D1	LED, RED, WATER-CLEAR, 0603	LITE-ON, LTST-C193KRKT-5A
2	1	C4	CAP, 100uF, X5R, 6.3V, 20%, 1206	MURATA, GRM31CR60J107ME39L
3	1	R1	RES., 2.2k OHMS, 5%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW04022K20JNED
4	1	R2	RES., 1 OHM, 1%, 1/16W, 0402, AEC-Q200	VISHAY, CRCW04021R00FKED
DC3081A: Hardware, For Demo Board Only				
1	2	E1, E2	TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062"	MILL-MAX, LTST-C193KRKT-5A
1	1	J1	CONN., uUSB 2.0, RCPT., 5-PIN, 1PORT, REVERSE MOUNT, R/A HORZ., TYPE B, FLANGELESS	TE CONNECTIVITY, 1932788-1

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM





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.

Legal Terms and Conditions

By using the evaluation board discussed herein (together with any tools, components documentation or support materials, the "Evaluation Board"), you are agreeing to be bound by the terms and conditions set forth below ("Agreement") unless you have purchased the Evaluation Board, in which case the Analog Devices Standard Terms and Conditions of Sale shall govern. Do not use the Evaluation Board until you have read and agreed to the Agreement. Your use of the Evaluation Board shall signify your acceptance of the Agreement. This Agreement is made by and between you ("Customer") and Analog Devices, Inc. ("ADI"), with its principal place of business at One Technology Way, Norwood, MA 02062, USA. Subject to the terms and conditions of the Agreement, ADI hereby grants to Customer a free, limited, personal, temporary, non-exclusive, non-sublicensable, non-transferable license to use the Evaluation Board FOR EVALUATION PURPOSES ONLY. Customer understands and agrees that the Evaluation Board is provided for the sole and exclusive purpose referenced above, and agrees not to use the Evaluation Board for any other purpose. Furthermore, the license granted is expressly made subject to the following additional limitations: Customer shall not (i) rent, lease, display, sell, transfer, assign, sublicense, or distribute the Evaluation Board; and (ii) permit any Third Party to access the Evaluation Board. As used herein, the term "Third Party" includes any entity other than ADI, Customer, their employees, affiliates and in-house consultants. The Evaluation Board is NOT sold to Customer; all rights not expressly granted herein, including ownership of the Evaluation Board, are reserved by ADI. CONFIDENTIALITY. This Agreement and the Evaluation Board shall all be considered the confidential and proprietary information of ADI. Customer may not disclose or transfer any portion of the Evaluation Board to any other party for any reason. Upon discontinuation of use of the Evaluation Board or termination of this Agreement, Customer agrees to promptly return the Evaluation Board to ADI. ADDITIONAL RESTRICTIONS. Customer may not disassemble, decompile or reverse engineer chips on the Evaluation Board. Customer shall inform ADI of any occurred damages or any modifications or alterations it makes to the Evaluation Board, including but not limited to soldering or any other activity that affects the material content of the Evaluation Board. Modifications to the Evaluation Board must comply with applicable law, including but not limited to the RoHS Directive. TERMINATION. ADI may terminate this Agreement at any time upon giving written notice to Customer. Customer agrees to return to ADI the Evaluation Board at that time. LIMITATION OF LIABILITY. THE EVALUATION BOARD PROVIDED HEREUNDER IS PROVIDED "AS IS" AND ADI MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WITH RESPECT TO IT. ADI SPECIFICALLY DISCLAIMS ANY REPRESENTATIONS, ENDORSEMENTS, GUARANTEES, OR WARRANTIES, EXPRESS OR IMPLIED, RELATED TO THE EVALUATION BOARD INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTY OF MERCHANTABILITY, TITLE, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. IN NO EVENT WILL ADI AND ITS LICENSORS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, OR CONSEQUENTIAL DAMAGES RESULTING FROM CUSTOMER'S POSSESSION OR USE OF THE EVALUATION BOARD, INCLUDING BUT NOT LIMITED TO LOST PROFITS, DELAY COSTS, LABOR COSTS OR LOSS OF GOODWILL. ADI'S TOTAL LIABILITY FROM ANY AND ALL CAUSES SHALL BE LIMITED TO THE AMOUNT OF ONE HUNDRED US DOLLARS (\$100.00). EXPORT. Customer agrees that it will not directly or indirectly export the Evaluation Board to another country, and that it will comply with all applicable United States federal laws and regulations relating to exports. GOVERNING LAW. This Agreement shall be governed by and construed in accordance with the substantive laws of the Commonwealth of Massachusetts (excluding conflict of law rules). Any legal action regarding this Agreement will be heard in the state or federal courts having jurisdiction in Suffolk County, Massachusetts, and Customer hereby submits to the personal jurisdiction and venue of such courts. The United Nations Convention on Contracts for the International Sale of Goods shall not apply to this Agreement and is expressly disclaimed.