

LTC4125EUF and LTC4120EUD Wireless Power Transfer Battery Charger Demonstration Kit

DESCRIPTION

Demonstration kit DC2386A is a kit of the DC2330A LTC®4125EUF demonstration board, the DC2445A-A/DC2445A-B LTC4120EUD demonstration board, and an assortment of different length standoffs. The DC2330A can deliver up to 1.68W to the receive board with up to 12mm spacing between the transmit and receive coils. The

DC2330A transmitter supports Foreign Object Detection via the [LTC4125](#).

Design files for this circuit board are available at <http://www.linear.com/demo/DC2386A>

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CONTENTS

- 1 × DC2330A (LTC4125EUF) Demo Board
- 1 × DC2445A-A/DC2445A-B (LTC4120EUD) Demo board (with 12.5mm (0.5") Nylon Standoffs, 8.25mm Gap), see Figure 3
- 4 × 6.25mm (0.25") Nylon Standoffs (2.0mm Gap)
- 4 × 9.5mm (0.375") Nylon Standoffs (5.25mm Gap)
- 4 × 15.9mm (0.625") Nylon Standoffs (11.65mm Gap)

Kit Build Options

KIT NUMBER	T _X BOARD	LTC T _X PART NUMBER	R _X BOARD	LTC R _X PART NUMBER	R _X OPTION
DC2386A-A	DC2330A	LTC4125EUF	DC2445A-A	LTC4120EUD-4.2	Fixed 4.2V Float Voltage
DC2386A-B	DC2330A	LTC4125EUF	DC2445A-B	LTC4120EUD	Adjustable Float Voltage

PERFORMANCE SUMMARY Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V _{IN}	DC2330A Voltage Input	I _{VIN} ≤ 2.5A	3		5.5	V
I _{VIN}	DC2330A V _{IN} Current	V _{IN} = 5V			2.0	A
V _{BAT}	DC2445A-A BAT Pin Voltage		4.15	4.2	4.25	V
V _{BAT}	DC2445A-B BAT Pin Voltage	R9 = 1.40MΩ, R10 = 1.05MΩ		4.2		V
I _{BAT}	DC2445A BAT Pin Current	V _{BAT} = 3.7V, DC2445A-A/DC2445A-B(R5) = 3.01kΩ	370mA	385mA	400mA	A
AIR GAP	Separation Between LT _X and LR _X	I _{BAT} = 400mA (Figure 3)		8.25		mm

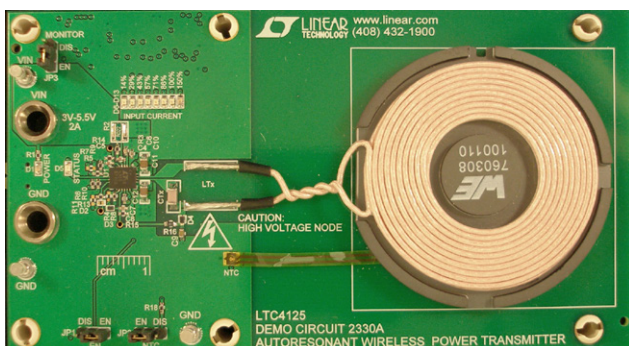


Figure 1. DC2330A Picture

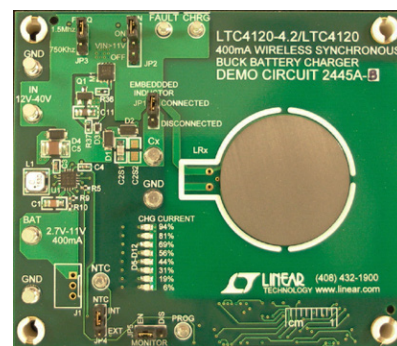


Figure 2. DC2445A-A/DC2445A-B Picture

dc2386aabfa

QUICK START PROCEDURE

Refer to Figure 4 for the proper measurement equipment setup and jumper settings, DC2445A mounting on DC2330A, 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_{CC} or V_{IN} and GND terminals. See Figure 5 for proper scope probe technique.

1. Place the DC2445A-A/DC2445A-B board atop the DC2330A board, by aligning: (See Figure 4)

DC2330A Mounting Hole		DC2445A-A/B MH
MH3	=>	MH1
MH2	=>	MH2
MH4	=>	MH3
MH6	=>	MH4

This should result in the transmit antenna being directly above the receive antenna, with the centers aligned. The standoffs on the DC2445A-A/DC2445A-B are 0.5" (12.5mm) when shipped. This results in an air gap of 8.25mm (See Figure 3). The DC2386A kit ships with three additional standoff sizes. This allows the air gap to be varied from 0.083" (~2.0mm) to 0.46" (~11.6mm).

2. Set PS1 = 3.7V, PS2 = 5V, and enable the power supplies. The DC2330A should start sweeping the LT_x current looking for a load. This is evinced by the blue LEDs

lighting up sequentially. When a valid load is found the LED sweeping will freeze until the next search period, ~ 3.7s later. Note that the last LED, the red LED, should not normally be lit.

Observe AM1 and AM2. AM2 should have increased from ~10mA RMS, 250mA peak to about 600mA. AM1 should be reading 380mA ~ 400mA of charge current into the battery emulator. All the charge LEDs on the DC2445A-X should now be lit.

If the DC2445A-X board is receiving power, it will attempt to charge the battery. Again this is evinced by the green LEDs lighting. If all the green LEDs are lit, the LTC4120EUD, on the DC2445A, is charging at the full programmed battery charge current.

3. The LTC4125EUDF on the DC2330A, keeps the transmit power at slightly more than the load requires for ~ 3.7s, then searches again. This is why the blue LEDs on the DC2330A go out and start ramping up again.
4. When the system is operating correctly, slide a piece of blank PCB*, or coin between the transmit and receive coils. The transmit current should immediately drop to 0A. This is the Foreign Object Detection in operation, preventing a foreign object from getting hot.
5. Please change the standoffs on the DC2445A-A/DC2445A-B board to yield the air gap most appropriate for your project.

*Testing with a blank PCB of at least 10cm² (1.5 IN²) of copper.

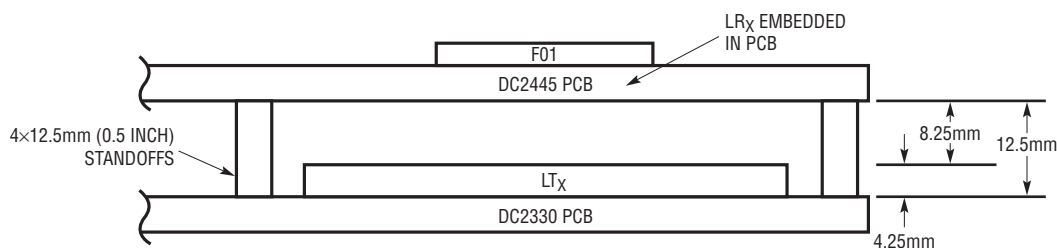


Figure 3. As Shipped Demo Kit Air Gap

QUICK START PROCEDURE

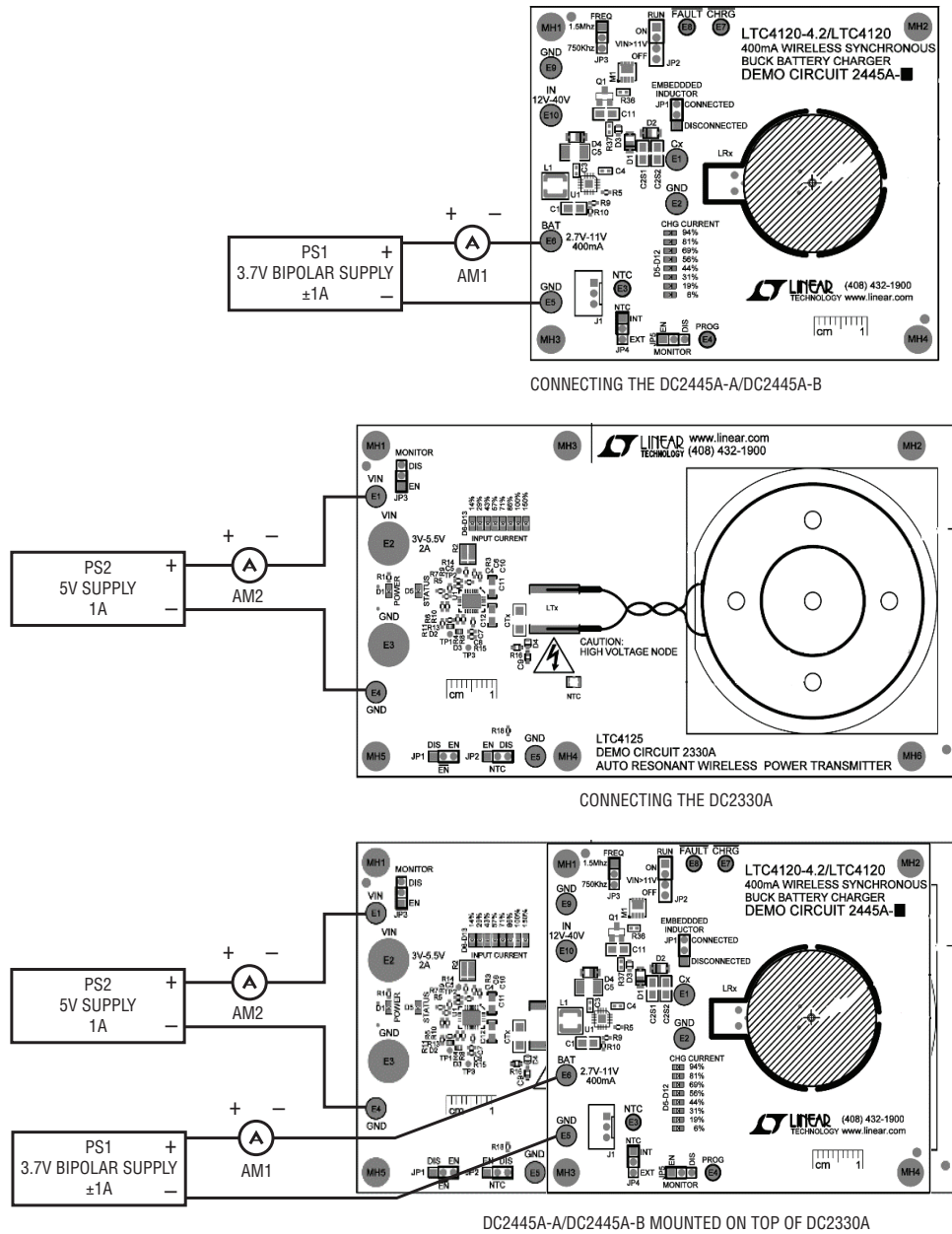


Figure 4. Equipment Setup for DC2386A-A/DC2386A-B Kit

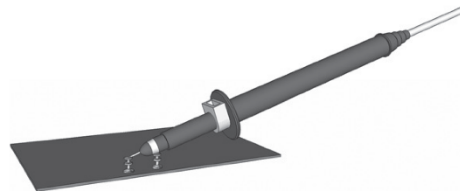


Figure 5. Measuring Input or Output Ripple

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 DC2386A kit demonstrates operation of a magnetically coupled resonant Wireless Power Transfer (WPT) system. The LTC4125EUFD transmitter searches for a suitable load, and powers it until the next search period. The LTC4120EUD battery charger uses DHC to control its input power ensuring full power charging under a variety of operating conditions.

DC2330A – Wireless Power Transmitter Board featuring the LTC4125EUFD

The DC2330A Wireless Power Transmitter is used to power a load wirelessly. In this kit, it is used in conjunction with the DC2445A-X Wireless Power Receiver Board to charge a Li-Ion battery.

The LTC4125EUFD implements an AutoResonant drive of the series resonant tank composed of LT_X (See LT_X Table 1 for a list of tested LT_X coils) and CT_X (See DC2330A Schematic on page 12). The AutoResonant drive uses a zero crossing detector to determine the resonant frequency of the series LC circuit. All subsequent duty cycles discussed here use the resonant period determined by the AutoResonant circuitry.

The SW1 and SW2 pins each have a half bridge drive. At zero current crossing, whichever SW_X pin has current flowing out of the pin, is set to V_{IN} for a duty cycle determined by the corresponding PTH_X pin (see Figure 10). When the

SW_X pin is set to V_{IN} , it increases the current flowing in the transmitter series resonant LC circuit. The absolute value of the tank current is determined by the resonant tank components **and also by the reflected load impedance**.

The LTC4125EUFD sweeps the duty cycle by way of a 5 bit DAC that sets the PTH_X voltage, and hence duty cycle.

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 (see Figure 8).

The LTC4125EUFD monitors the FB pin and when a valid exit condition is found, stops incrementing the PTH VDAC. The PTH VDAC is held at the detection level for the rest of the sweep cycle. Some exit conditions are adjustable by the user, and some are proprietary and not adjustable.

As load power requirements may change or foreign objects may enter the WPT transfer field, the LTC4125EUFD periodically repeats the sweep as described above. Several of the components of the sweep period are adjustable, but the DC2330A sets the overall sweep period to about 3.7s (see Figure 9).

The AutoResonant detect circuitry will shift the transmitter frequency for some fault conditions, particularly Foreign Object Detection (FOD).

Table 1. Tested LTX Coils

Vendor	Part Number	URL
Würth	760308100110	http://www.we-online.com
Inter-Technical	L4000T02	http://www.inter-technical.com/index.php?page=products#
Sunlord	SWA50N50H35C05B	http://www.sunlordinc.com/

THEORY OF OPERATION

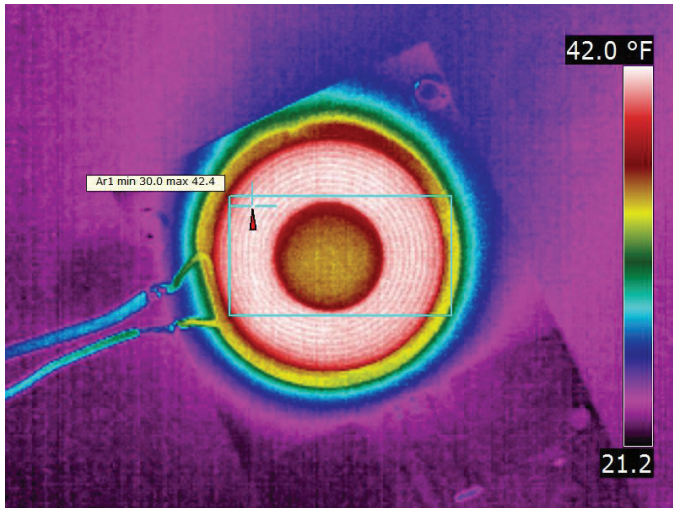


Figure 6. Coil Side of Transmit Coil, LT_X

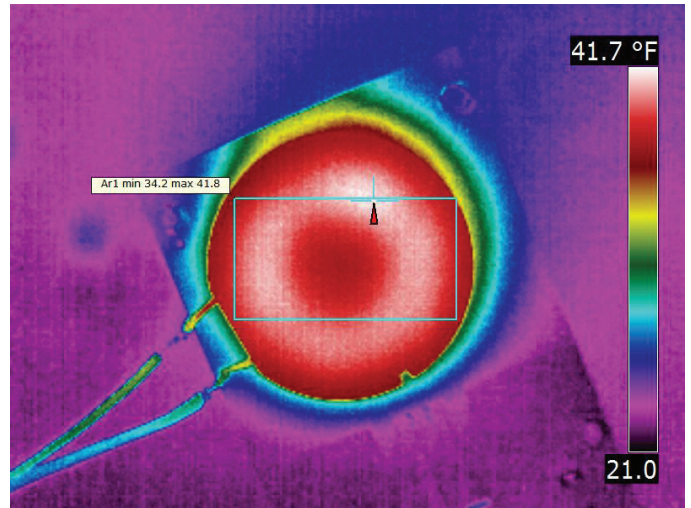


Figure 7. Backside of Transmit Coil, LT_X

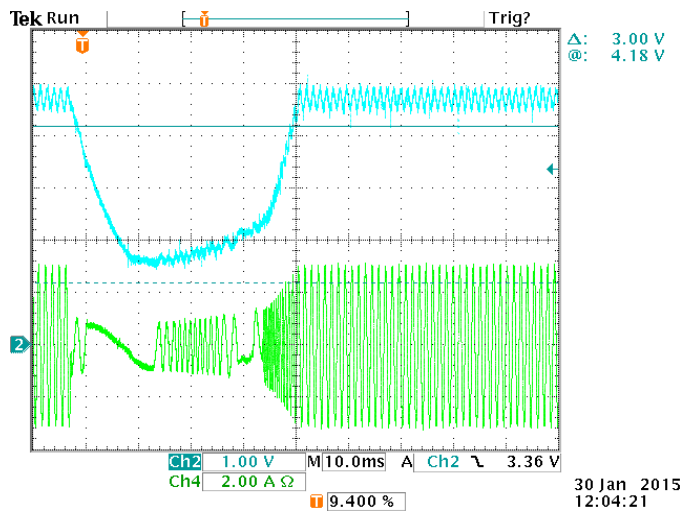


Figure 8. $FB \propto I(LT_X)$, Lt. Blue = LTC4125.FB, Grn. = $I(LT_X)$

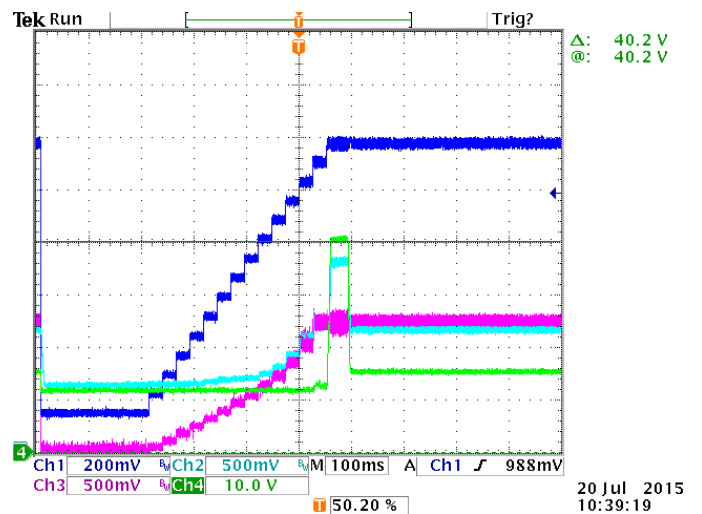


Figure 9. Dk. Blue = V(PTH), Lt. Blue = LTC4125.FB, Pk. = V(PROG), Grn. = LTC4120.IN

THEORY OF OPERATION

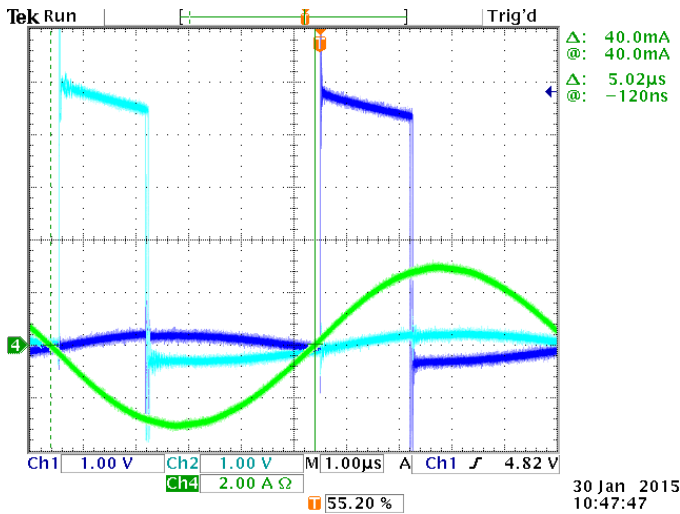


Figure 10. Dk. Blue = LTC4125.SW1, Lt. Blue = LTC4125.SW2, Grn. = I(LT_X)

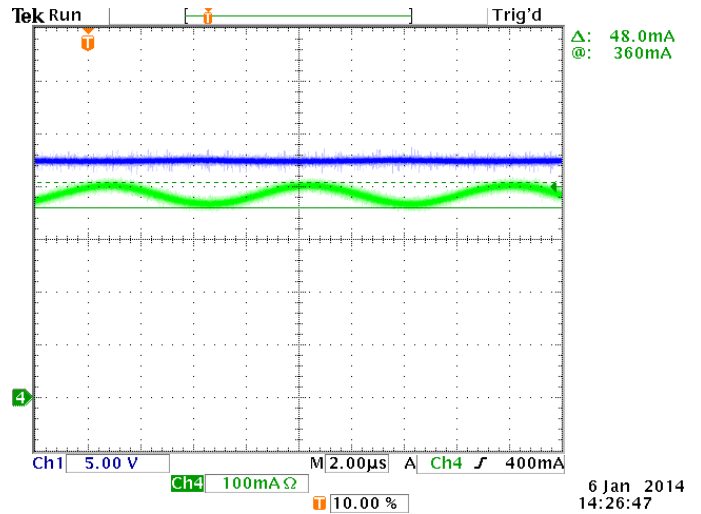


Figure 11. Dk. Blue = LTC4120.IN, Grn. = I(BAT)

The LTC4125EUF also monitors the FB for fault conditions and terminates the sweep if one is detected.

Thermal Shutdown

The LTC4125 needs to produce a large magnetic field in LT_X, in order to transfer as much power as possible. The magnetic field is proportional to the current flowing in LT_X, and the RMS value of the current flowing in LT_X will dissipate any power not transferred to the load.

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

Transmit coils are often quite large and bulky, composed of the windings and a very usually a ferrite shield. It is undesirable to place the temperature monitoring NTC resistor on the windings. This is because the winding are radiating power, and the NTC resistor and wires form a loop. If this loop is immediately adjacent to the transmit coil windings, it will pick up significant voltage and apply it to the LTC4125 NTC pin.

The ideal place for the NTC would be on the side of the transmit coil distal to the windings. Therefore it is necessary to study the relationship between winding temperature and

ferrite shield temperature, especially on the distal surface of the ferrite shield.

Figure 6 is a thermal image of the coil side of the Würth 760308100110 transmit coil at 42.0°C, and Figure 7 is a thermal image of the backside of the same coil at 41.7°C. Figure 7 was taken in free air, after heating the coil while in contact with the DC2330A PCB. The NTC is located in hole N, which is aligned with the ring of max temperature, on the backside of the transmit coil, LT_X.

These thermal images are very specific to the Würth 760308100110 transmit coil and PCB mount. This study should be repeated for any application circuit, using a different transmit coil to ensure proper NTC placement.

DC2445A-A/DC2445A-B – Wireless Power Receiver Board featuring the LTC4120EUD

The DC2445A-A/DC2445A-B demo board implements a series resonant LC circuit. The AC waveform on the resonant circuit is rectified and applied to the IN pin of the LTC4120EUD Wireless power receiver IC. The Undervoltage Current limit (UVCL) of the LTC4120EUD is at ≈ 12V. So, when V_{IN} exceeds the UVCL threshold, the LTC4120EUD tries to charge a battery on its BAT pin. The LTC4120EUD also has Dynamic Harmonization Control (DHC), which can be used to tune or detune the

THEORY OF OPERATION

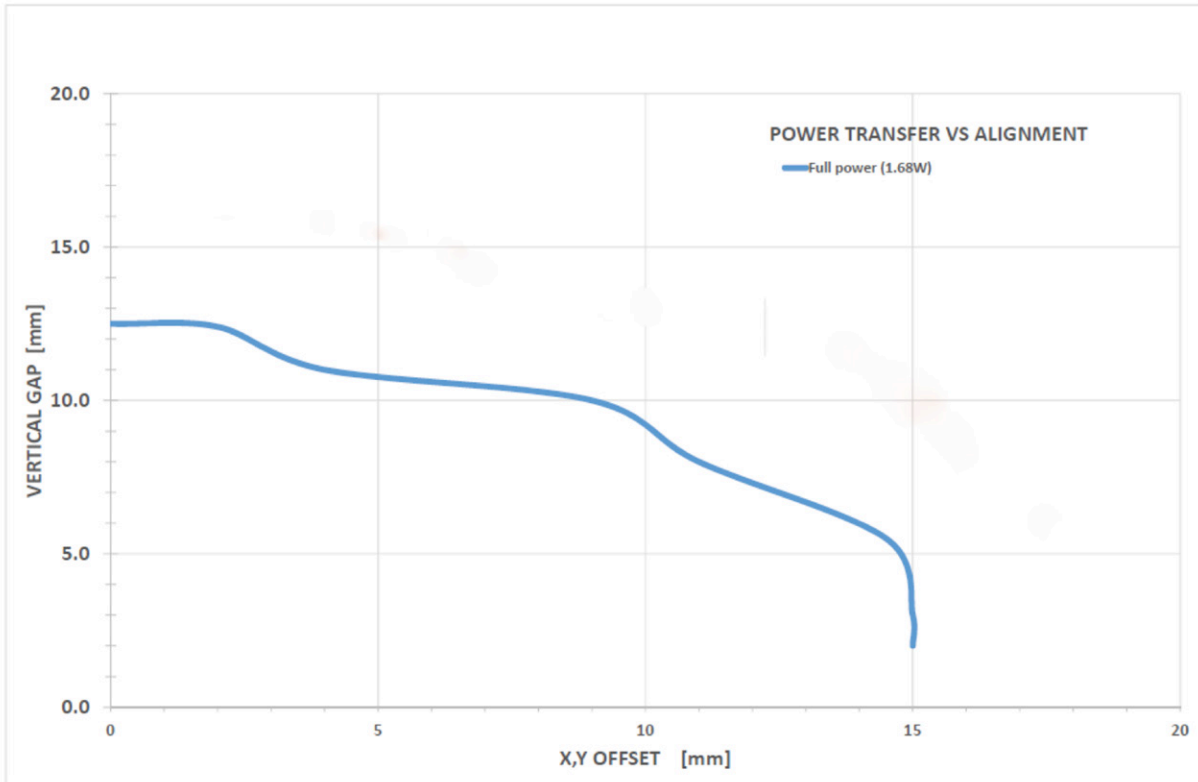


Figure 12. Power Transfer vs Axial Distance and Misalignment

THEORY OF OPERATION

receive circuit to receive more or less power as needed. The DC2445A-X is designed to work with the DC2330A wireless power transmitter board. The LTC4125EUF on the DC2330A is already searching for an appropriate load so the DHC loop has been repurposed on the DC2445A demo board to provide presence detect.

DHC

Because the LTC4125EUF on the DC2330A wireless power transmitter already searches for an appropriate load, the DHC loop on the DC2445A has been repurposed. When V_{IN} is above 14V, the DHC pin is high impedance, and when it is below 14V it is grounded through a MOSFET.

The receive tank is tuned to a fixed 127kHz, and on the DC2445A-X the DHC does not change this frequency. On the DC2445A-X the DHC pin is used to activate a 15V clamp. The assertion of this clamp signals the LTC4125, on the DC2330A board, that it is transmitting sufficient power.

The Battery Charger

The battery charger is a current mode buck regulator from IN to BAT. The current in the switching inductor (L1) is monitored by an on die current sense resistor between the CHGSNS and BAT pins.

This current is used for cycle by cycle PWM duty cycle determination, and averaged to indicate battery charge current.

The charger is a full featured CC-CV charger, with low battery trickle charge (See Figure 11). The Charge Voltage is fixed at 4.2V for the LTC4120EUD-4.2, and programmable on the LTC4120EUD. The charge current is programmed by the resistor on the PROG pin, R5 on the DC2445A-X.

Summary

The DC2386A Wireless Power Transfer Battery Charger Demonstration Kit allows full exploration of the LTC4125EUF Wireless Power Transmitter and LTC4120EUD Wireless Power battery charger.

The DC2386A makes it possible to determine how the LTC4125EUF identifies a valid load or foreign object.

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
DC2330A Required Circuit Components				
1	1	CT _x	CAP, CHIP, COG, 0.1μF, ±5%, 100V, 1206	TDK, C3216C0G2A104J160AC
2	2	C4, C5	CAP, CHIP, X7R, 0.01μF, ±10%, 50V, 0402	TDK, C1005X7R1H103K050BB
3	1	C6	CAP, CHIP, X7R, 4700pF, ±10%, 50V, 0402	MURATA, GRM155R71H472KA01
4	1	C7	CAP, CHIP, COG, 470pF, ±10%, 50V, 0402	KEMET, C0402C471K5GACTU
5	1	C8	CAP, CHIP, X5R, 0.1μF, ±10%, 25V, 0402	TDK, C1005X5R1E104K050BC
6	1	C9	CAP, CHIP, X7R, 0.1μF, ±10%, 100V, 0603	MURATA, GRM188R72A104KA35D
7	1	C10	CAP, CHIP, X5R, 1μF, ±10%, 16V, 0402	TDK, C1005X5R1C105K050BC
8	2	C11, C12	CAP, CHIP, X5R, 47μF, ±20%, 6.3V, 0805	TDK, C2012X5R0J476M125AC
9	1	D3	DIODE, SMT, SCHOTTKY, 30V, 200mA, 0.6mm × 1.0mm DFN2	DIODES INC., BAT54LP
10	1	D4	DIODE, SMT, 100V, 250mA, 50ns, SOD523	DIODES INC., BAS521-7
11	1	LT _x	Transmit Antenna, 24μH, ±10%, 6A, 0.1Ω, Round, 50mm Diameter	WURTH, 760308100110
12	1	NTC Assembly	NTC Resistor Assembly, 10k AT 25°C, ±1%	MURATA, FTN55XH103FD4B
13	1	R2	RES, CHIP, 4 Terminal, 22mΩ, ±1%, 1W, 3216T4	SUSUMU, KRL3216T4-M-R022-F
14	1	R3	RES, CHIP, 12.4kΩ, ±1%, 1/16W, 040+D20:D262	VISHAY, CRCW040212K4FKED
15	0	R4-OPT, R7-OPT, R11-OPT	RES, CHIP, TBD , ±1%, 1/16W, 0402	TBD
16	2	R5, R6	RES, CHIP, 100kΩ, ±1%, 1/16W, 0402	VISHAY, CRCW0402100KFKED
17	1	R8	RES, CHIP, 0Ω Jumper, 1/16W, 0402	VISHAY, CRCW04020000Z0ED
18	1	R9	RES, CHIP, 3.83kΩ, ±1%, 1/16W, 0402	VISHAY, CRCW04023K83FKED
19	1	R10	RES, CHIP, 59.0kΩ, ±1%, 1/16W, 0402	VISHAY, CRCW040259K0FKED
20	1	R14	RES, CHIP, 348kΩ, ±1%, 1/16W, 0402	VISHAY, CRCW0402348KFKED
21	1	R15	RES, CHIP, 5.23kΩ, ±1%, 1/16W, 0402	VISHAY, CRCW04025K23FKED
22	1	R16	RES, CHIP, 100kΩ, ±1%, 1/8W, 350V, 0603	ROHM, KTR03EZPF1003
23	1	R18	RES, CHIP, 10kΩ, ±1%, 1/16W, 0402	VISHAY, CRCW040210K0FKED
24	1	U1	IC, AutoResonant Wireless Power Transmitter, 4mm × 5mm QFN20	LINEAR TECH., LTC4125EUFDP#PBF
Additional Demo Board Circuit Components				
1	3	C1, C2, C3	CAP, CHIP, X5R, 100μF, ±20%, 6.3V, 1206	MURATA, GRM31CR60J107ME39L
2	3	C13, C15, C16	CAP, CHIP, X7R, 0.01μF, ±10%, 50V, 0402	TDK, C1005X7R1H103K050BB
3	2	C14, C17	CAP, CHIP, X5R, 1μF, ±10%, 16V, 0402	TDK, C1005X5R1C105K050BC
4	2	D1, D13	LED, RED, SMT, 0603	LUMEX, SML-LX0603SIW-TR
5	0	D2-OPT	DIODE, SMT, SCHOTTKY, 30V, 200mA, 0.6mm × 1.0mm DFN2	DIODES INC., BAT54LP
6	1	D5	LED, GREEN, SMT, 0603	LUMEX, SML-LX0603SUGW-TR
7	7	D6 ~ D12	LED, BLUE, SMT, 0603	LITE-ON, LTST-C193TBKT-5A
8	3	R1, R17, R41	RES, CHIP, 2.2kΩ, ±5%, 1/16W, 0402	VISHAY, CRCW04022K20JNED
9	8	R12, R24 ~ R30	RES, CHIP, 102kΩ, ±1%, 1/16W, 0402	VISHAY, CRCW0402102KFKED
10	1	R13	RES, CHIP, 0Ω jumper, 1/16W, 0402	VISHAY, CRCW04020000Z0ED
11	1	R19	RES, CHIP, 10kΩ, ±5%, 1/16W, 0402	VISHAY, CRCW040210K0JNED
12	2	R20, R33	RES, CHIP, 432Ω, ±1%, 1/16W, 0402	VISHAY, CRCW0402432RFKED
13	1	R21	RES, CHIP, 15.4kΩ, ±1%, 1/16W, 0402	VISHAY, CRCW040215K4FKED
14	1	R22	RES, CHIP, 27.4kΩ, ±1%, 1/16W, 0402	VISHAY, CRCW040227K4FKED
15	1	R23	RES, CHIP, 340kΩ, ±1%, 1/16W, 0402	VISHAY, CRCW0402340KFKED

DEMO MANUAL

DC2386A-A/DC2386A-B

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
16	1	R31	RES, CHIP, 11.3k Ω , \pm 1%, 1/16W, 0402	VISHAY, CRCW040211K3FKED
17	1	R32	RES, CHIP, 787k Ω , \pm 1%, 1/16W, 0402	VISHAY, CRCW0402787KFKED
18	7	R34 ~ R40	RES, CHIP, 6.20k Ω , \pm 5%, 1/16W, 0402	VISHAY, CRCW04026K20JNED
19	1	R42-OPT, R43	RES, CHIP, 1 Ω , \pm 5%, 1/10W, 0603	VISHAY, CRCW06031R00JNED
20	2	U2, U3	IC, Ultralow Power Quad Comparators with Reference, 3mm \times 3mm DFN8	LINEAR TECH., LTC1445CDHD#PBF

Hardware: For Demo Board Only

1	3	E1, E4, E5	TURRET, 0.09" DIA	MILL-MAX, 2501-2-00-80-00-00-07-0
2	2	E2, E3	Vertical Nana Jack, 575-4	KEYSTONE, 575-4
3	1	J1	Micro-USB Receptacle	WURTH, 629105136821
4	1	J2	JSC Connector for NTC Assembly	MURATA, MM5829-2700RJ4
5	3	JP1, JP2, JP3	3 PIN JUMPER, 2mm	Wurth, 62000311121
6	3	JP1, JP2, JP3	SHUNT, 2mm	SAMTEC, 2SN-KB-G
7	4		STAND - OFF, NYLON, 0.375" Tall (Snap on)	KEYSTONE, 8832 (SNAP ON)
8	0.01		SCOTCH, REMOVABLE POSTER TAPE W/DISPENSER, 0.75in.x 150in.	3M, MMM109
9	0.0004		Heat Cure Thermal Epoxy, 30CC tube	ELLSWORTH ADH. 3-6752 TC Adhesive 75G

DC2445A-A/DC2445A-B Required Circuit Components

1	1	C2S1	CAP, CHIP, COG, 0.033 μ F, \pm 5%, 50V, 1206/0805	TDK, C2012C0G1H333J125AA
2	1	C1	CAP, CHIP, X5R, 4.7 μ F, \pm 10%, 25V, 0805	TDK, C2012X5R1E475K
3	1	C2	CAP, CHIP, X5R, 47 μ F, \pm 10%, 16V, 1210	MURATA, GRM32ER61C476KE15L
4	1	C3	CAP, CHIP, X7R, 0.01 μ F, \pm 10%, 50V, 0402	TDK, C1005X7R1H103R050BB
5	1	C4	CAP, CHIP, X5R, 2.2 μ F, \pm 20%, 6.3V, 0402	MURATA, GRM155R60J225ME15D
6	1	C5	CAP, CHIP, X7S, 10 μ F, \pm 20%, 50V, 1210	TDK, C3225X7S1H106M
7	1	C11	CAP, CHIP, X5R, 47 μ F, \pm 20%, 6.3V, 0805	TDK, C2012X5R0J476M
8	2	D1, D2	DIODE, SCHOTTKY, 40V, 2A, PowerDI123	DIODES, DFLS240L
9	1	D3	DIODE, ZENER, 13V, \pm 5%, 150mW, SOD-523	DIODES, BZT52C13T-7
10	1	D4	DIODE, Zener, 39V, \pm 5%, 1W, PowerDI123	DIODES, DFLZ39
11	1	FD1	25mm Ferrite Disc	ELNA MAGNETICS, B67410-A0223-X195
12	0	LRx	IND, EMBEDDED, 47 μ H, 43 Turns	EMBEDDED
13	1	L1	IND, SMT, 15 μ H, 260m Ω , \pm 20%, 0.86A, 4mm \times 4mm	LPS4018-153ML
14	1	M1	MOSFET, SMT, 60V, 72m Ω , PowerPAK1212-8	VISHAY, Si7308DN-T1-GE3
15	1	M2	MOSFET, SMT, 30V, 75m Ω , SOT23	VISHAY, Si2343CDS-T1-GE3
16	1	Q1	NPN, SMT, 40V, SOT23	Diodes Inc, MMBT3904-7-F
17	1	R1	RES, CHIP, 1.40M, \pm 1%, 1/16W, 0402	VISHAY, CRCW04021M40FKED
18	1	R2	RES, CHIP, 412k Ω , \pm 1%, 1/16W, 0402	VISHAY, CRCW0402412KFKED
19	2	R3, R7	RES, CHIP, 10k Ω , \pm 1%, 1/16W, 0402	VISHAY, CRCW040210K0FKED
20	1	R5	RES, CHIP, 3.01k Ω , \pm 1, 1/16W, 0402	VISHAY, CRCW04023K01FKED
21	2	R6, R8	RES, CHIP, 0 Ω Jumper, 1/16W, 0402	VISHAY, CRCW04020000Z0ED
26	1	R12	RES, CHIP, 5.1k Ω , \pm 5%, 1/16W, 0402	VISHAY, CRCW04025K10JNED
22	1	R36	RES, CHIP, 1k Ω , \pm 5%, 1/16W, 0402	VISHAY, CRCW04021K00JNED
23	1	R37	RES, CHIP, 24.9k Ω , \pm 1%, 1/16W, 0402	VISHAY, CRCW040224K9FKED

dc2386aabfa

SCHEMATIC DIAGRAM

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
24	1	R38	RES, CHIP, 470k Ω , \pm 5%, 1/16W, 0402	VISHAY, CRCW0402470KJNED
25	1	R39	RES, CHIP, 51k Ω , \pm 5%, 1/16W, 0402	VISHAY, CRCW040251K0JNED

Additional Demo Board Circuit Components

1	1	C2S2-OPT	CAP, CHIP, COG, TBD , \pm 5%, 50V, 0603	TBD
2	2	C7, C10	CAP, CHIP, X5R, 1 μ F, \pm 10%, 16V, 0402	TDK, C1005X5R1C105K
3	3	C6, C8, C9	CAP, CHIP, X7R, 0.01 μ F, \pm 10%, 25V, 0402	TDK, C1005X7R1E103K
4	8	D5 ~ D12	DIODE, LED, GREEN, 0603	LITE-ON, LTST-C193KGKT-5A
5	1	R4	RES, CHIP, 2k Ω , \pm 5%, 1/16W, 0402	VISHAY, CRCW04022K00JNED
6	1	R11	RES, CHIP, 100k Ω , \pm 5%, 1/16W, 0402	VISHAY, CRCW0402100KJNED
7	1	R13	RES, CHIP, 10k Ω , \pm 5%, 1/16W, 0402	VISHAY, CRCW040210K0JNED
8	2	R14, R35	RES, CHIP, 432 Ω , \pm 1%, 1/16W, 0402	VISHAY, CRCW0402432RFKED
9	2	R15, R33	RES, CHIP, 22.6k Ω , \pm 1%, 1/16W, 0402	VISHAY, CRCW040222K6FKED
10	1	R16	RES, CHIP, 34.8k Ω , \pm 1%, 1/16W, 0402	VISHAY, CRCW040234K8FKED
11	7	R17 ~ R23	RES, CHIP, 100k Ω , \pm 1%, 1/16W, 0402	VISHAY, CRCW0402100KFKED
12	1	R24	RES, CHIP, 49.9k Ω , \pm 1%, 1/16W, 0402	VISHAY, CRCW040249K9FKED
13	8	R25 ~ R32	RES, CHIP, 1k Ω , \pm 5%, 1/16W, 0402	VISHAY, CRCW04021K00JNED
14	1	R34	RES, CHIP, 787k Ω , \pm 1%, 1/16W, 0402	VISHAY, CRCW0402787KFKED
15	2	U2, U3	Ultralow Power Quad Comparators with Reference, 5mm \times 4mm DFN16	LINEAR TECH., LTC1445CDHD

Hardware: For Demo Board Only

1	6	E1, E2, E5, E6, E9, E10	TURRET, 0.091"	MILL-MAX, 2501-2-00-80-00-00-07-0
2	4	E3, E4, E7, E8	TURRET, 0.061"	MILL-MAX, 2308-2-00-80-00-00-07-0
3	0	J1-OPT	CONN, 3 Pin Polarized	HIROSE, DF3-3P-2DSA
4	4	JP1, JP3-JP5	HEADER, 3 PIN JUMPER, 2mm	SAMTEC, TMM-103-02-L-S
5	1	JP2	HEADER, 4 PIN JUMPER, 2mm	SAMTEC, TMM-104-02-L-S
6	5	JP1-JP5	SHUNT, 2mm	SAMTEC, 2SN-BK-G
7	4		Clear 0.085" \times 0.335" bumper	KEYSTONE, 784-C
8	0.005		SCOTCH, REMOVABLE POSTER TAPE W/DISPENSER, 0.75in. \times 0.75in.	3M, MMM109
9	4		STAND-OFF, NYLON, 0.375"	KEYSTONE, 8832

DC2445A-A Required Circuit Components

1	0	R9	No Load. SMD 0402	
2	1	R10	RES, CHIP, 0 Ω Jumper, 1/16W, 0402	VISHAY, CRCW04020000Z0ED
3	1	U1	400mA Wireless Synchronous Buck Battery Charger, 3mm \times 3mm QFN16	LINEAR TECH., LTC4120EUD-4.2

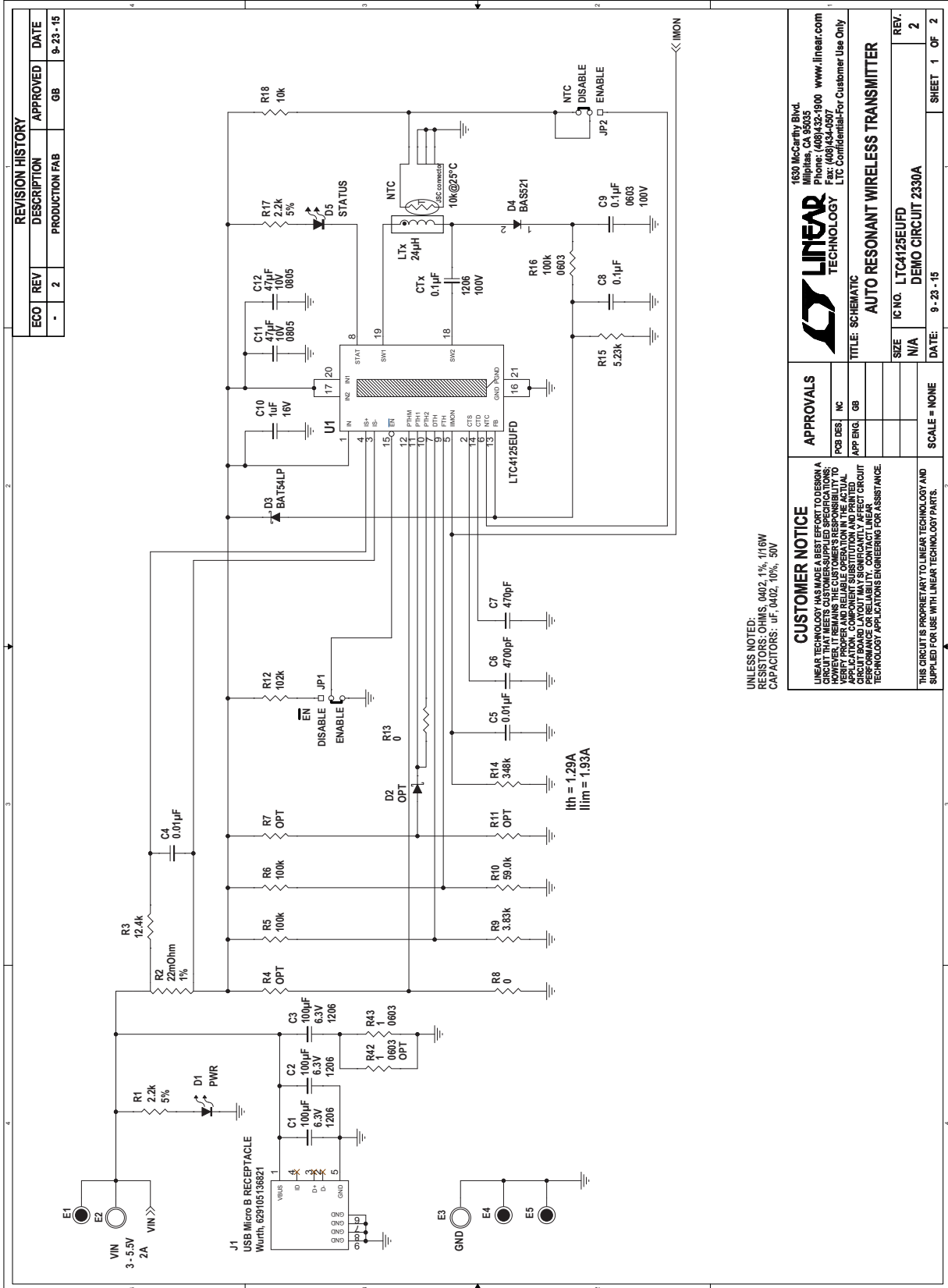
DC2445A-B Required Circuit Components

1	1	R9	RES, CHIP, 1.40M, \pm 1%, 1/16W, 0402	VISHAY, CRCW04021M40FKED
2	1	R10	RES, CHIP, 1.05M, \pm 1%, 1/16W, 0402	VISHAY, CRCW04021M05FKED
3	1	U1	400mA Wireless Synchronous Buck Battery Charger, 3mm \times 3mm QFN16	LINEAR TECH., LTC4120EUD

DEMO MANUAL

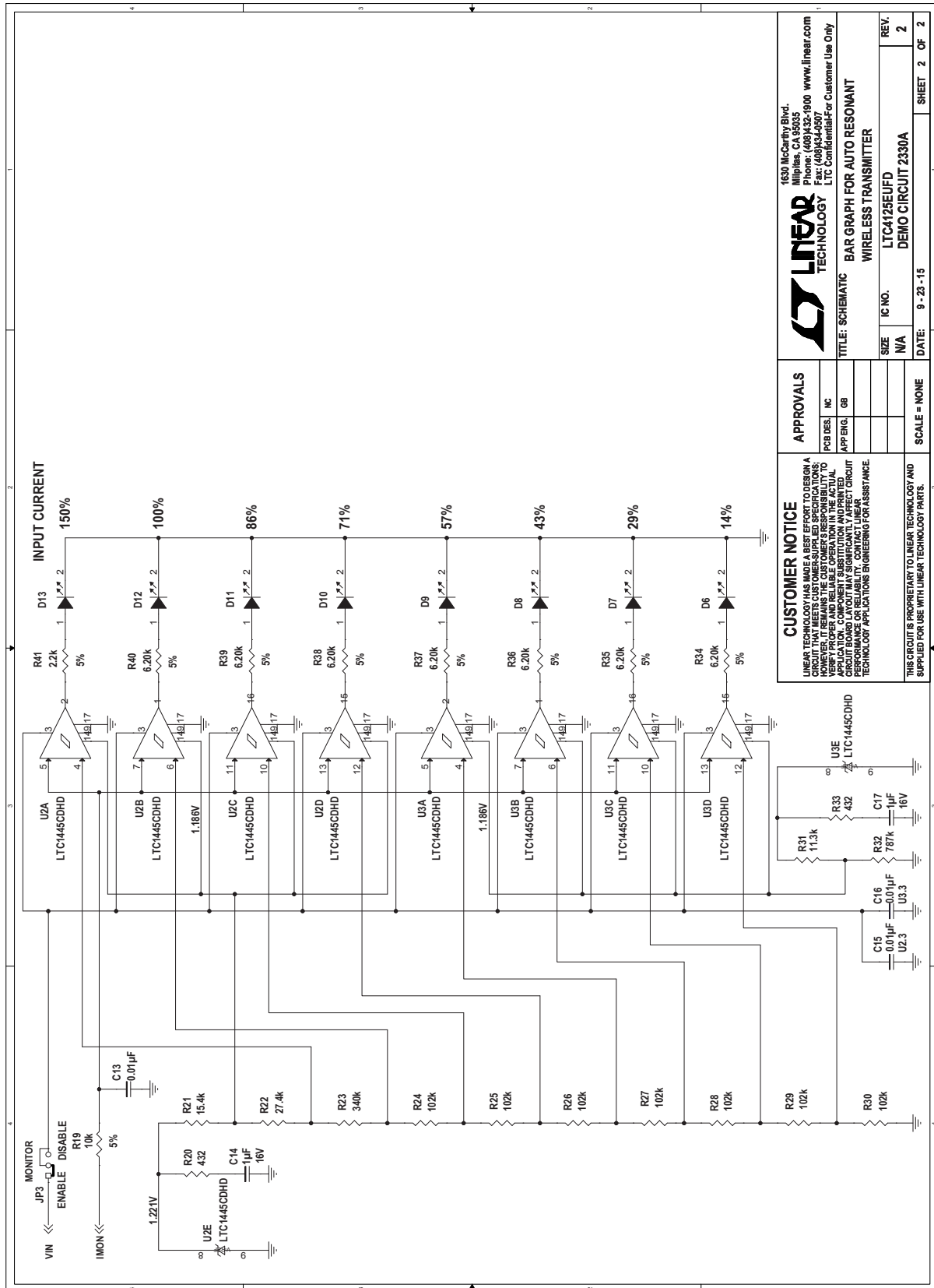
DC2386A-A/DC2386A-B

SCHEMATIC DIAGRAM



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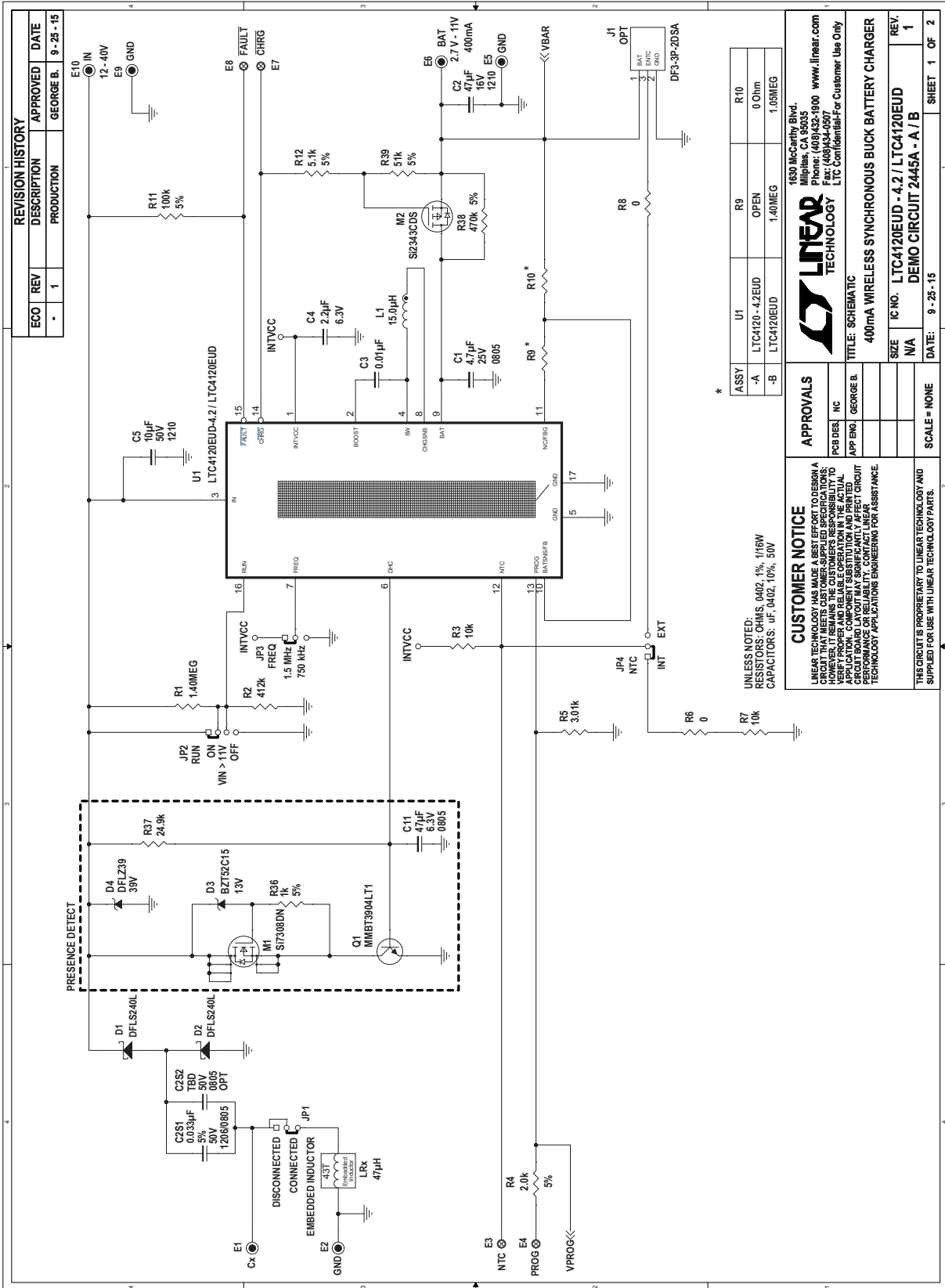
SCHEMATIC DIAGRAM



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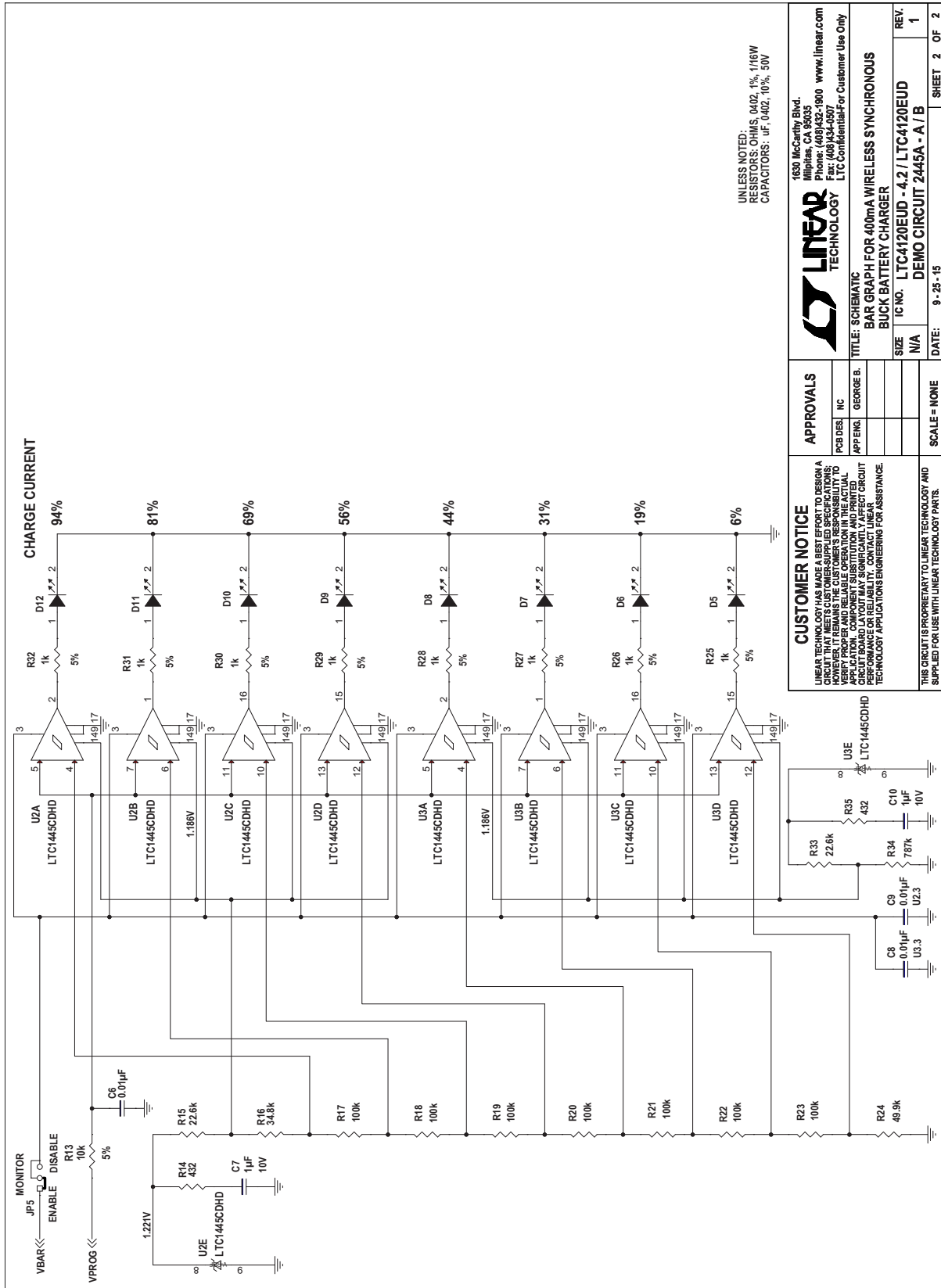
DEMO MANUAL DC2386A-A/DC2386A-B

SCHEMATIC DIAGRAM



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SCHEMATIC DIAGRAM



dc2386aabfa

DEMO MANUAL

DC2386A-A/DC2386A-B

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