

LTC4123EDC  
Low Power Wireless Charger  
Demonstration Kit

## DESCRIPTION

Demonstration Circuit DC2302A is a kit of the DC2300A demonstration board, featuring the [LTC® 4123EDC](#), and the DC2301A Single Switch Transmitter demonstration board. The DC2300A can charge a single NiMH battery at up to 25mA, with an air gap of 0.8mm to 4.0mm. The DC2300A detects Zinc-Air primary cells and will not charge them.

Design files for this circuit board are available at <http://www.linear.com/demo/DC2302A>

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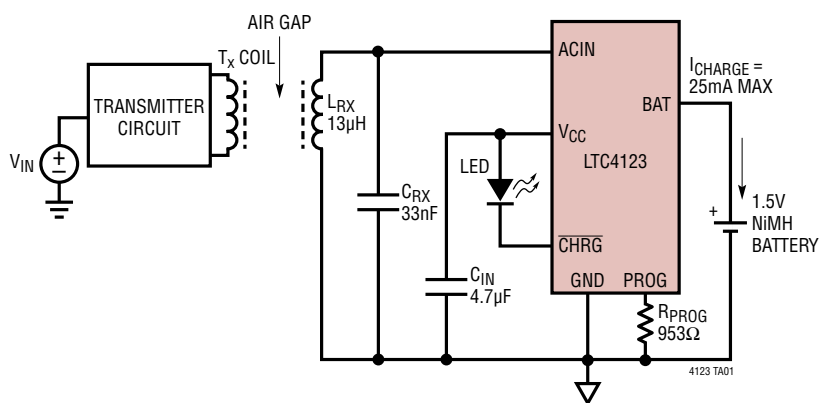
## PERFORMANCE SUMMARY

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

| SYMBOL           | PARAMETER                       | CONDITIONS                                   | MIN | TYP | MAX | UNITS |
|------------------|---------------------------------|----------------------------------------------|-----|-----|-----|-------|
| V <sub>IN</sub>  | DC2301A Voltage Input           | I <sub>VIN</sub> ≤ 0.5A                      | 4.5 |     | 5.5 | V     |
| I <sub>BAT</sub> | DC2300A Battery Charger Current | V <sub>CC</sub> = 3V ~ 5V, DC2300A.R1 = 953Ω | 24  |     | 26  | mA    |



**Figure 1. Demonstration Kit with Battery**



### Figure 2. Typical Application Circuit

## DEMO BOARD PROCEDURE

Refer to Figure 5 for the proper measurement equipment setup 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. Set PS1 to 1.3V and turn on.
2. Plug a Micro-USB cable into DC2301.J1, the other end of the cable should go to a computer USB port or a 5V wall charger.
3. Verify that DC2301A.D1 is lit. DC2301A.D1 is between the boards, near the front face.
4. The LTC4123EDC spends the first 90s after power up testing for either a reverse battery or a Zinc-Air primary battery. DC2300A.D1 should be blinking slowly. AM1 should read 25mA. VM1 should read between 3V and 5V.  
  
The LTC4123EDC tests for a Zinc-Air battery by applying the programmed charge current, and checking to see if V(BAT) rises above  $\approx 1.65V$ .  
  
If the battery is absent, reversed or Zinc-Air, DC2300A.D1 will start blinking rapidly.
5. Turn off and disconnect PS1, AM1 and VM1. Install the P675 NiMH battery in the DC2300A.BH1 battery holder. See Figure 4 for proper insertion. Warning: improper insertion may short battery.



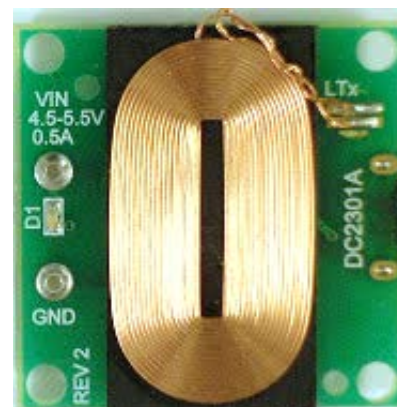
(a) DC2300A Top



(b) DC2301A Top



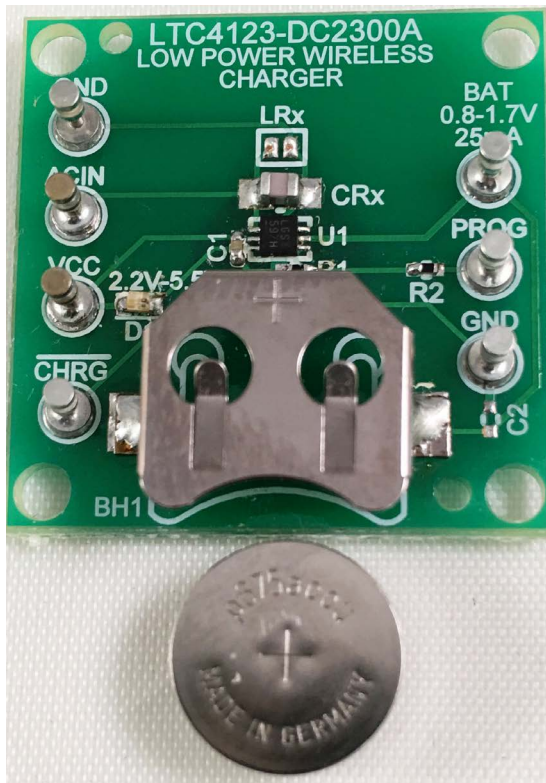
(c) DC2300A Bottom



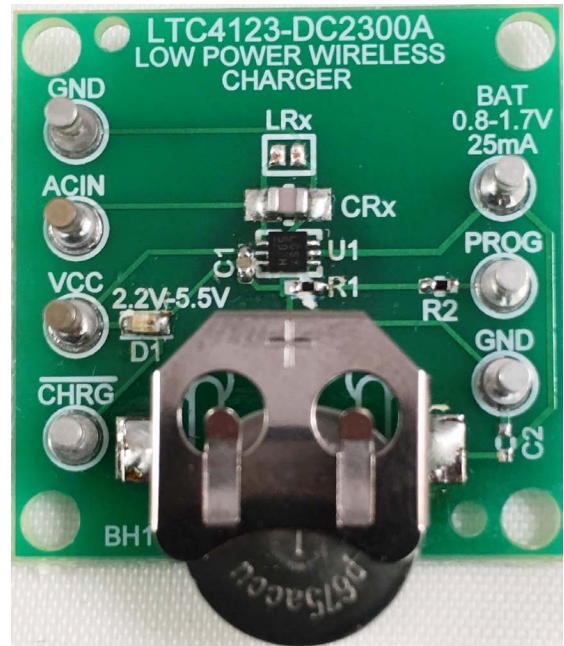
(d) DC2301A Bottom

Figure 3. DC2300A and DC2301A Demo Boards

## DEMO BOARD PROCEDURE



(a)



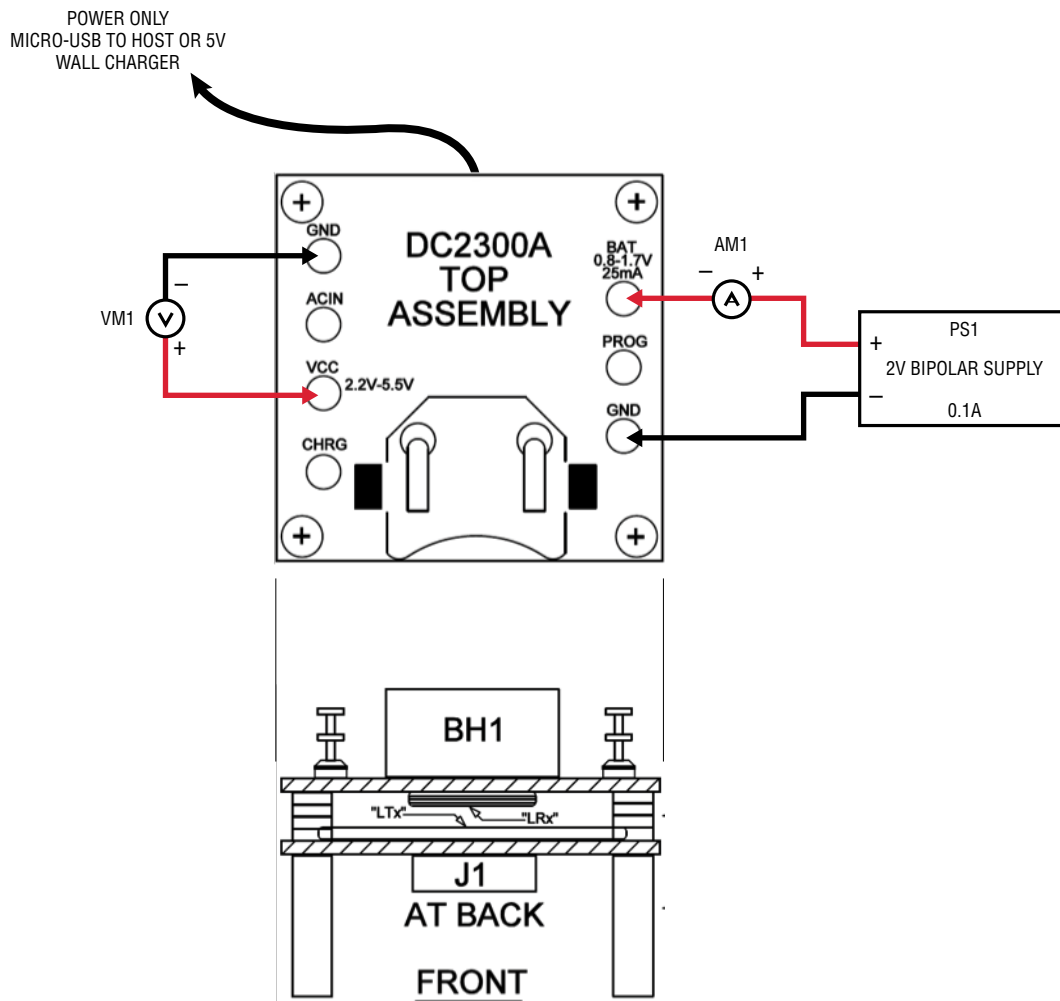
(b)



(c)

Figure 4. Proper Insertion of Battery in Demo Kit

## DEMO BOARD PROCEDURE



DC2302A F03

Figure 5. DC2300A Mounted on Top of DC2301A

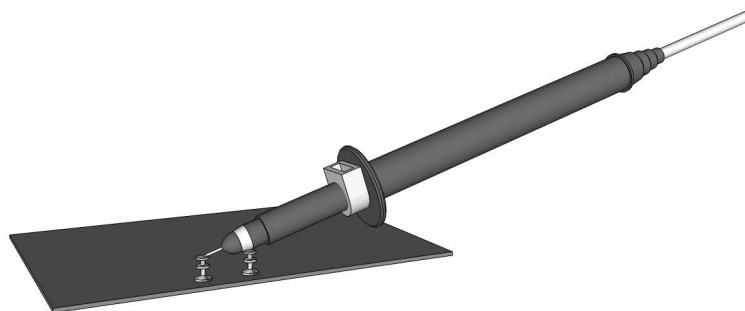


Figure 6. Measuring Input or Output Ripple

**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 DC2302A kit demonstrates operation of the LTC4123EDC Low Power Wireless Charger. The kit is composed of the DC2300A Wireless Power Transfer (WPT) receiver and the DC2301A WPT transmitter.

### DC2300A – Low Power Battery Charger Board Featuring the LTC4123EDC

The LTC4123EDC integrates a low power CC-CV linear charger optimized for NiMH cells. The LTC4123EDC also contains a low leakage diode for rectifying the output of the WPT resonant tank. The DC2300A WPT resonant tank is set to 244kHz. Tested receive coils are listed in [Table 1](#).

The CC-CV charger will operate with a  $V_{CC}$  as low as 2.2V, and charge a NiMH battery to 1.61V ( $T_A = -10^\circ\text{C}$ ). The Charge Voltage is temperature dependent, a temperature coefficient of  $-2.5\text{mV}/^\circ\text{C}$ , and a typical charge voltage of 1.5075, at room (see Figure 7).

The LTC4123EDC has a fault state machine that checks for battery reversal and presence of a Zinc-Air primary cell in the first 90s after  $V_{CC}$  is applied.

The LTC4123EDC has an on-die temperature sensing that will shut down the charger if the sensed temperature is too high or low.

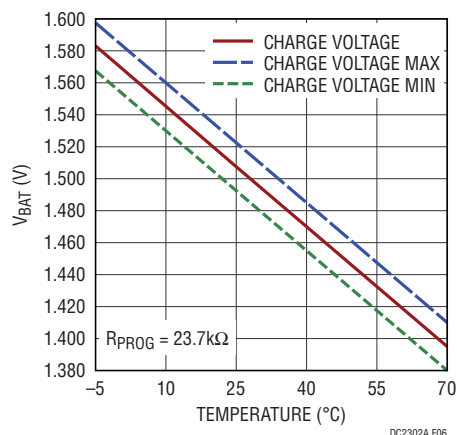


Figure 7. Charge Voltage vs Temperature (Placeholder)

The WPT for the LTC4123EDC is implemented as resonant power transfer, with the LTC4123EDC rectifying the resonant tank voltage to generate  $V_{CC}$  (see Figure 9).

### DC2301A – Wireless Power Transmitter Board Featuring the LTC6990IDCB

The DC2301A is a wireless power transmitter board using an LTC6990IDCB TimerBlox®, followed by a zero voltage switching Class C amplifier.

The LTC6990IDCB is programmed to generate a 244kHz square wave, but the Class C amplifier tank is resonant at 315kHz, resulting in zero voltage switching (see Figure 8). Tested transmit coils are listed in [Table 2](#).

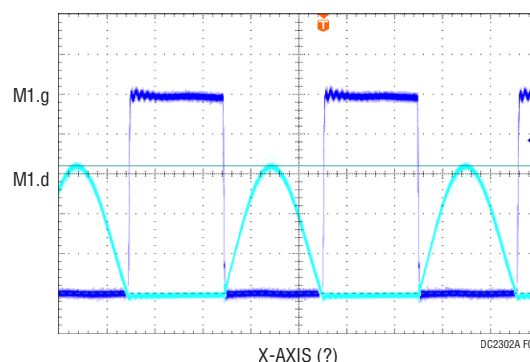


Figure 8. DC2301A  $V_{IN} = 5\text{V}$ , Air Gap = 4mm

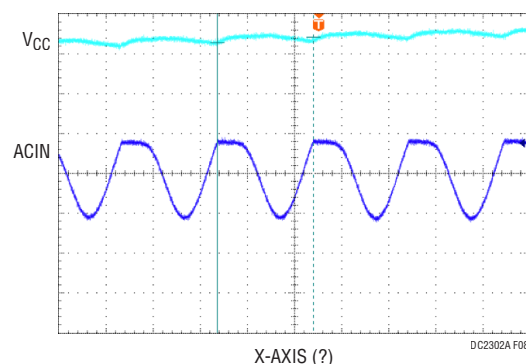


Figure 9. DC2300A  $V_{IN} = 5\text{V}$ , Air Gap = 4mm

## THEORY OF OPERATION

### Operating the DC2302A WPT Kit from a USB Port

The DC2302A WPT Demo Kit can comply with the requirements for a USB peripheral. One requirement is the 50 $\mu$ C inrush charge specification, which drives the maximum input capacitance. Another requirement is that a USB peripheral must draw less than 100mA, until negotiating for more. The DC2302A WPT kit does not contain a microcontroller to negotiate for more than 100mA, so, it must operate at less than 100mA.

DC2301A.C2 can be changed to 4.7 $\mu$ F, which in parallel with DC2301A.C1 = 4.7 $\mu$ F, will be less than the 10 $\mu$ F. The DC2302A will then meet the 50 $\mu$ C inrush charge specification.

All air gaps mentioned below are the coil face to coil face distances:

|            |                                                                                                                                                      |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0.8mm gap: | USB.V <sub>CC</sub> current = 102mA @ USB.V <sub>CC</sub> = 4.5 ~ 5.5V<br>300mV of 255kHz ripple on USB.V <sub>CC</sub><br>DC2300A.V(BAT) = 1 ~ 1.4V |
| 2.4mm gap: | USB.V <sub>CC</sub> current = 84mA @ USB.V <sub>CC</sub> = 4.5 ~ 5.5V<br>280mV of 255kHz ripple on USB.V <sub>CC</sub><br>DC2300A.V(BAT) = 1 ~ 1.4V  |
| 4.0mm gap: | USB.V <sub>CC</sub> current = 73mA @ USB.V <sub>CC</sub> = 4.5 ~ 5.5V<br>240mV of 255kHz ripple on USB.V <sub>CC</sub><br>DC2300A.V(BAT) = 1 ~ 1.4V  |

So, if the gap is kept greater than  $\approx 1.5$ mm and DC2301A.C2  $\leq 4.7\mu$ F, the DC2302A should meet the compliance requirements for a USB peripheral. The DC2302A will not support suspend mode operation.

## PARTS LIST

Table 1. Tested LRx Coils

| Vendor          | Part number     | URL                                                                                                                           |
|-----------------|-----------------|-------------------------------------------------------------------------------------------------------------------------------|
| Würth           | 760308101208    | <a href="http://www.wurth-online.com">http://www.wurth-online.com</a>                                                         |
| Inter-Technical | L4120R19        | <a href="http://www.inter-technical.com/index.php?page=products#">http://www.inter-technical.com/index.php?page=products#</a> |
| Sunlord         | SWA12R10H17C01B | <a href="http://www.sunlordinc.com/">http://www.sunlordinc.com/</a>                                                           |

Table 2. Tested LTx Coils

| Vendor          | Part number     | URL                                                                                                                           |
|-----------------|-----------------|-------------------------------------------------------------------------------------------------------------------------------|
| Würth           | 760308103206    | <a href="http://www.wurth-online.com">http://www.wurth-online.com</a>                                                         |
| Inter-Technical | L41200T23       | <a href="http://www.inter-technical.com/index.php?page=products#">http://www.inter-technical.com/index.php?page=products#</a> |
| Sunlord         | SWA28R15H08C01B | <a href="http://www.sunlordinc.com/">http://www.sunlordinc.com/</a>                                                           |

## PARTS LIST

| ITEM | QTY | REFERENCE | PART DESCRIPTION | MANUFACTURER/PART NUMBER |
|------|-----|-----------|------------------|--------------------------|
|------|-----|-----------|------------------|--------------------------|

### DC2300A

#### Required Circuit Components

|   |   |     |                                                   |                          |
|---|---|-----|---------------------------------------------------|--------------------------|
| 1 | 1 | C1  | CAP, CHIP, X5R, 4.7 $\mu$ F, $\pm$ 10%, 10V, 0402 | SAMSUNG, CL05A475KP5NRNC |
| 2 | 1 | CRx | CAP, CHIP, C0G, 33nF, $\pm$ 5%, 50V, 1206/0805    | TDK, C2012C0G1H333J125AA |
| 4 | 1 | LRx | RECEIVE ANTENNA, 13 $\mu$ H, $\pm$ 10%, 10mm      | WURTH, 760308101208      |
| 5 | 1 | R1  | RES, CHIP, 953 $\Omega$ , $\pm$ 1%, 1/16W, 0402   | VISHAY, CRCW0402953RKFED |
| 6 | 1 | U1  | LOW POWER WIRELESS CHARGER, 2mm $\times$ 2mm DFN6 | LINEAR TECH., LTC4123EDC |

#### Additional Demo Board Circuit Components

|   |   |        |                                                  |                          |
|---|---|--------|--------------------------------------------------|--------------------------|
| 1 | 0 | C2-OPT | CAP, CHIP, X5R, 1 $\mu$ F, $\pm$ 10%, 16V, 0402  | TDK, C1005X5R1C105K      |
| 2 | 1 | D1     | LED, RED, SMT, 0603                              | ROHM, SML-311UTT86       |
| 3 | 1 | R2     | RES, CHIP, 4.7k $\Omega$ , $\pm$ 5%, 1/16W, 0402 | VISHAY, CRCW04024K70JNED |

#### Hardware: For Demo Board Only

|   |   |                            |                                    |                                   |
|---|---|----------------------------|------------------------------------|-----------------------------------|
| 1 | 1 | BH1                        | COIN CELL BATTERY RETAINER, 11.6mm | KEYSTONE, 2996                    |
| 2 | 7 | E1, E2, E3, E4, E5, E6, E7 | TURRET, 0.061"                     | MILL-MAX, 2308-2-00-80-00-00-07-0 |

### DC2301A

#### Required Circuit Components

|   |   |      |                                                                         |                            |
|---|---|------|-------------------------------------------------------------------------|----------------------------|
| 1 | 1 | C2   | CAP, CHIP, X5R, 100 $\mu$ F, $\pm$ 20%, 6.3V, 1206                      | MURATA, GRM31CR60J107ME39L |
| 2 | 1 | CTx1 | CAP, CHIP, C0G, 33nF, $\pm$ 1%, 25V, 1206/0805                          | KEMET, C0805C333F3GACTU    |
| 3 | 1 | CTx2 | CAP, CHIP, C0G, 1nF, $\pm$ 5%, 50V, 0603                                | TDK, C1608C0G1H102J080AA   |
| 4 | 1 | LTx  | TRANSMIT ANTENNA, 7.5 $\mu$ H, $\pm$ 10%, 28mm $\times$ 15mm            | WURTH, 760308103206        |
| 5 | 1 | M1   | MOSFET, N-CH 20V, 6A, SOT23-3                                           | VISHAY, SI2312CDS-T1-GE3   |
| 6 | 1 | R1   | RES, CHIP, 205k $\Omega$ , $\pm$ 1%, 1/16W, 0402                        | VISHAY, CRCW0402357KFKED   |
| 7 | 1 | U1   | TimerBlox: VOLTAGE CONTROLLED SILICON OSCILLATOR, 2mm $\times$ 3mm DFN6 | LINEAR TECH., LTC6990IDCB  |

#### Additional Demo Board Circuit Components

|   |   |    |                                                    |                          |
|---|---|----|----------------------------------------------------|--------------------------|
| 1 | 1 | C1 | CAP, CHIP, X5R, 4.7 $\mu$ F, $\pm$ 20%, 6.3V, 0402 | TDK, C1005X5R0J475M      |
| 2 | 1 | D1 | LED, RED, SMT, 0603                                | LITEON, LTST-C193KRKT-5A |
| 3 | 1 | J1 | USB2.0 MICRO-B RECEPTACLE, RT, REVERSED, 1932788-1 | TE, 1932788-1            |
| 4 | 1 | R2 | RES, CHIP, 2.2k $\Omega$ , $\pm$ 5%, 1/16W, 0402   | VISHAY, CRCW04022K20JNED |

#### Hardware: For Demo Board Only

|   |   |        |                |                                   |
|---|---|--------|----------------|-----------------------------------|
| 1 | 2 | E1, E2 | TURRET, 0.061" | MILL-MAX, 2308-2-00-80-00-00-07-0 |
|---|---|--------|----------------|-----------------------------------|





# DEMO MANUAL DC2302A

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Mailing Address:

Linear Technology  
1630 McCarthy Blvd.  
Milpitas, CA 95035

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dc2302afa

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### Офис по работе с юридическими лицами:

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: [info@moschip.ru](mailto:info@moschip.ru)

Skype отдела продаж:

moschip.ru

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