

# 14-Bit Direct Conversion Receiver Subsystem

## DESCRIPTION

Demonstration circuit 1513 is an evaluation board featuring Linear Technology Corporation's LTM<sup>®</sup>9004 14-bit direct conversion receiver subsystem. DC1513 demonstrates good circuit layout techniques and recommended external circuitry for optimal system performance.

DC1513 comes with Linear Technology's 14-bit LTM9004 receiver subsystem installed. The board includes output CMOS buffers. DC1513 plugs into the DC890 data

acquisition demo board and the output can be easily analyzed with Linear Technology's PScope<sup>™</sup> data processing software, which is available for no charge on our website at <http://www.linear.com/software>.

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

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**Table 1. DC1513B Variants**

| DC1513B VARIANTS | RESOLUTION | MAXIMUM SAMPLE RATE | BASEBAND BANDWIDTH |
|------------------|------------|---------------------|--------------------|
| 1513B-AA         | 14-Bit     | 125Msps             | DC - 1.92MHz       |
| 1513B-AB         | 14-Bit     | 125Msps             | DC - 4.42MHz       |
| 1513B-AC         | 14-Bit     | 125Msps             | DC - 9.42MHz       |
| 1513B-AD         | 14-Bit     | 125Msps             | DC - 20MHz         |

## QUICK START PROCEDURE

Validating the performance of the LTM9004 is simple with DC1513, and requires only two input sources, a clock source, a computer, and a lab power supply. Refer to Figure 1 for proper board evaluation equipment setup and follow the procedure below:

1. Connect the power supply as shown in Figure 1. There are onboard low noise voltage regulators that provide the two supply voltages for the DC1513. The entire board and all components share a common ground. The power supply should still be a low noise lab power supply capable of supplying at least 0.5A at 5VDC, and 1A at 3VDC.
2. Provide an encode clock to the ADC via SMA connector J7. Use a low-phase-noise clock source such as a filtered RF signal generator or a high quality clock oscillator.

**NOTE:** Similar to having a noisy input, a high jitter (phase noise) encode clock will degrade the signal-to-noise ratio (SNR) of the system.

**Table 2. DC1513 Connectors and Jumpers**

| REFERENCE         | FUNCTION                                                                                                                        |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------|
| J3 (SHDN)         | Enables/Disables the ADC. Default Is ON.                                                                                        |
| J4 (MODE)         | Output Format and Clock Duty Stabilizer Pin. Default Is VDD.                                                                    |
| J5 (SHDN_AMP)     | Enables/Disables the Amplifiers. Default Is ON.                                                                                 |
| J6 (LO)           | Board LO Signal Input. Impedance Matched to 50Ω for Use with Lab Signal Generators.                                             |
| J7 (CLK)          | Board Clock Input. Impedance Matched to 50Ω. Drive with a Low-Phase-Noise Clock Oscillator or Filtered Sine Wave Signal Source. |
| J8 (MIXER ENABLE) | Enables/Disables the RF Mixer. Default Is ON.                                                                                   |
| J11 (RF)          | Board RF Signal Input. Impedance Matched to 50Ω for Use with Lab Signal Generators.                                             |
| TP1 (SENSE_I)     | Reference Input to Adjust the Full-Scale Range of the DC1513, I-Channel. Default Is VDD.                                        |
| TP2 (GND)         | DC Ground.                                                                                                                      |
| TP4 (GND)         | DC Ground.                                                                                                                      |
| TP5 (3V)          | DC Supply Input (3VDC).                                                                                                         |
| TP7 (5V)          | DC Supply Input (5VDC).                                                                                                         |
| TP8 (GND)         | DC Ground.                                                                                                                      |
| TP12 (SENSE_Q)    | Reference Input to Adjust the Full-Scale Range of the DC1513, Q-Channel. Default Is VDD.                                        |

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## QUICK START PROCEDURE

3. Apply an RF input signal to the board. For best results, use a low distortion, low noise signal generator with sufficient filtering to avoid degrading the performance of the receiver.
4. Apply an LO input signal to the board. Note that the difference in frequency between this signal and the RF signal will be the IF frequency resulting at the IF filter and ADC input.
5. Observe the ADC output with demo circuit DC890B, a USB cable, a Windows computer, and Linear Technology's PScope data processing software.

**NOTE:** EVEN A HIGH QUALITY SIGNAL SYNTHESIZER WILL STILL HAVE NOISE AND HARMONICS THAT SHOULD BE ATTENUATED WITH A LOWPASS OR BANDPASS FILTER. FOR GOOD QUALITY HIGH ORDER FILTERS, SEE TTE, LARK ENGINEERING, OR EQUIVALENT.

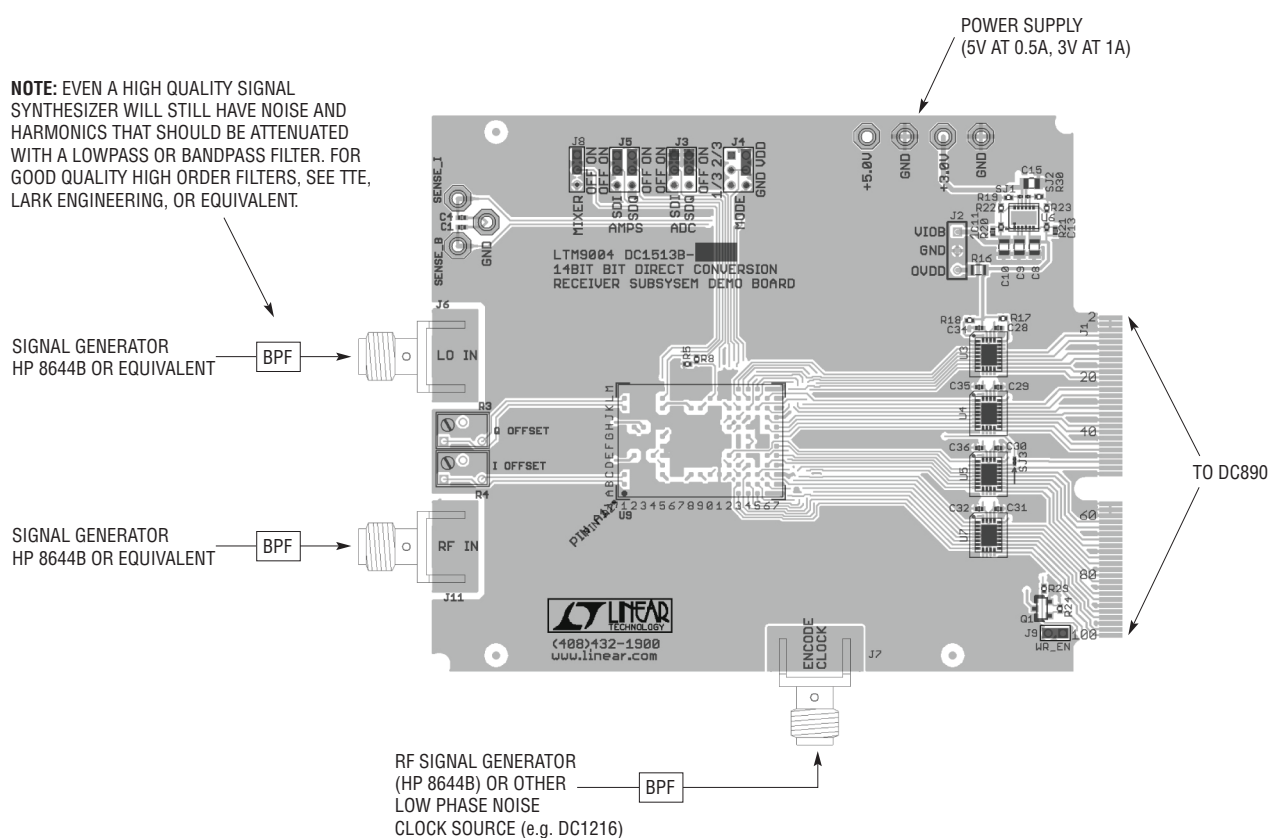


Figure 1. Proper Measurement Equipment Setup

## QUICK START PROCEDURE

### OTHER BOARD CIRCUITRY

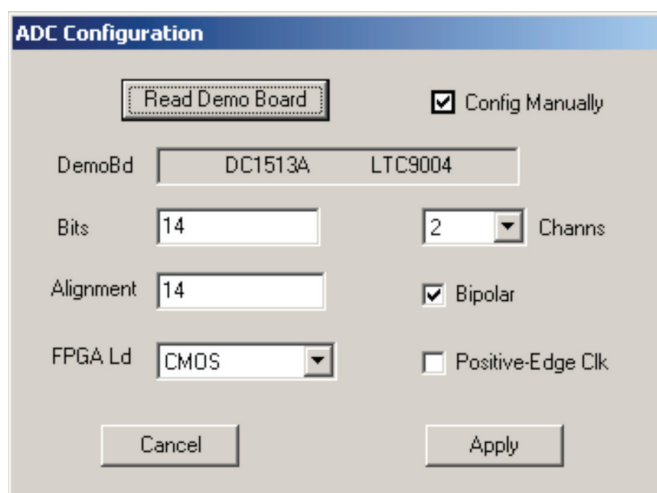
Device U1 is an EEPROM device that is used by the PScope software to identify the board and apply the correct settings for the data collection.

### USING PScope SOFTWARE

PScope, downloadable from Linear Technology's website <http://www.linear.com/>, processes data from the DC890 data acquisition board and displays FFT and signal analysis information on the computer screen.

The onboard EEPROM U1 should enable automatic board detection and auto configuration of the software, but if the user wishes to change the settings, they can easily do so.

From the configure menu in the toolbar, uncheck autode-tect device. The default settings for DC1513 are shown in Figure 2.



The image shows the 'ADC Configuration' dialog box. At the top left is a button labeled 'Read Demo Board'. To its right is a checked checkbox labeled 'Config Manually'. Below these are two text boxes: 'DemoBd' containing 'DC1513A' and 'LTC9004'. Under 'DemoBd' are two more text boxes: 'Bits' with '14' and 'Channs' with '2'. Below 'Bits' is an 'Alignment' text box with '14'. To the right of 'Alignment' is a checked checkbox labeled 'Bipolar'. Below 'Alignment' is an 'FPGA Ld' dropdown menu set to 'CMOS'. To its right is an unchecked checkbox labeled 'Positive-Edge Clk'. At the bottom are two buttons: 'Cancel' and 'Apply'.

**Figure 2. Entering the Correct Device Information for Your ADC. Select the Correct Parameters for the DC1513. Under Normal Conditions, PScope Should Automatically Recognize the Board and Adjust the Software Settings Accordingly.**

# DEMO MANUAL DC1513B

## PARTS LIST

| ITEM              | QTY | REFERENCE                                   | PART DESCRIPTION                                 | MANUFACTURER/PART NUMBER           |
|-------------------|-----|---------------------------------------------|--------------------------------------------------|------------------------------------|
| <b>DC1513B</b>    |     |                                             |                                                  |                                    |
| 1                 | 2   | C11, C13                                    | CAP, X7R, 1000pF, 16V, 10%, 0402                 | AVX 0402YC102KAT                   |
| 2                 | 13  | C2, C6, C24, C25, C27 TO C32, C34, C35, C36 | CAP, 0402 0.1µF 10% 10V X5R                      | AVX 0402ZD104KAT2A                 |
| 3                 | 2   | C20, C23                                    | CAP, X7R, 0.1µF, 16V, 10%, 0603                  | AVX 0603YC104KAT                   |
| 4                 | 2   | C21, C22                                    | CAP, NPO, 100pF, 50V, 5%, 0402                   | AVX 04025A101JAT2A                 |
| 5                 | 7   | C3, C8 TO C10, C14, C15, C19                | CAP, 0805 4.7µF 20% 25V X7R                      | TAIYO YUDEN TMK212BJ475MG-T        |
| 6                 | 0   | C1, C4, C5, C12, C16, C18                   | CAP, 0402, DNI                                   |                                    |
| 7                 | 2   | C7, C17                                     | CAP, NPO, 10pF, 50V, 5%, 0402                    | AVX 04025A100JAT2A                 |
| 8                 | 3   | J3, J4, J5                                  | HEADER, 3 × 2 PIN, 2mm                           | SAMTEC TMM-103-02-L-D              |
| 9                 | 3   | J6, J7, J11                                 | CONN, SMA 50Ω EDGE-LANCH                         | E.F. JOHNSON, 142-0701-851         |
| 10                | 1   | J8                                          | HEADER, 3 × 1 PIN, 2mm                           | SAMTEC TMM-103-02-L-S              |
| 11                | 1   | J9                                          | HEADER, 2 × 1 PIN, 2mm                           | SAMTEC TMM-102-02-L-S              |
| 12                | 7   | JP1 TO JP7                                  | SHUNT                                            | SAMTEC, 2SN-BK-G                   |
| 13                | 1   | L1                                          | FERRITE BEAD, 60Ω, 0603                          | MURATA BLM18PG600SN1D              |
| 14                | 1   | Q1                                          | XSTR, MOSFET, SOT23                              | DIODES/ZETEX 2N7002-7-F            |
| 15                | 9   | R1, R2, R12, R14, R33, R34                  | RES, 0402 1k 1% 1/16W                            | NIC NRC04F1001TRF                  |
| 16                | 2   | R36, R37, R42, R10, R15                     | RES, 0402 33.2Ω 1% 1/16W                         | NIC NRC04F33R2TRF                  |
| 17                | 1   | R13                                         | RES, 0402 49.9Ω 1% 1/16W                         | NIC NRC04F49R9TRF                  |
| 18                | 1   | R16                                         | RES, 0805 0Ω JUMPER                              | VISHAY CRCW08050000Z0EA            |
| 19                | 5   | R19, R21, R22, R24, R30                     | RES, 0402 100k 1% 1/16W                          | VISHAY CRCW0402100KFKED            |
| 20                | 1   | R20                                         | RES, 0402 75k 1% 1/16W                           | VISHAY CRCW040275K0FKED            |
| 21                | 0   | R23, R27, R28                               | RES, 0402, DNI                                   |                                    |
| 22                | 2   | R3, R4                                      | POT, 10k, TOP ADJUSTMENT, THROUGH HOLE           | BOURNS 3262W-1-103LF               |
| 23                | 1   | R39                                         | RES, 0402 10k 1% 1/16W                           | VISHAY CRCW040210K0FKED            |
| 24                | 2   | R6, R7                                      | RES, 0402 4.75k 1% 1/16W                         | VISHAY CRCW04024K75FKED            |
| 25                | 8   | R8, R11, R17, R18, R25, R26, R29, R43       | RES, 0402 4.99k 1% 1/16W                         | VISHAY CRCW04024K99FKED            |
| 26                | 7   | TP1, TP2, TP4, TP5, TP7, TP8, TP12          | TURRET                                           | MILL-MAX, 2308-2-00-80-00-00-07-0  |
| 27                | 1   | U1                                          | IC, SERIAL EEPROM, TSSOP                         | MICROCHIP 24LC025-I/ST             |
| 28                | 2   | U2, U8                                      | IC, LOGIC, INV, UNBUFFERED SC70                  | FAIRCHILD NC7SVU04P5X              |
| 29                | 4   | U3, U4, U5, U7                              | IC, BUS BUF LVL XLATE CMOS, OCTAL, DFN 8mm × 4mm | FAIRCHILD FXLH42245MPX             |
| 30                | 1   | U6                                          | IC, DFN12, VREG, DUAL, 500MA, 100MA              | LINEAR TECHNOLOGY LT3024IDE#PBF    |
| 31                | 4   |                                             | HW, SPACER, NYLON, 0.25"                         | KEYSTONE 8831                      |
| <b>DC1513B-AA</b> |     |                                             |                                                  |                                    |
| 1                 | 1   | DC1513B                                     | GENERAL BOM                                      |                                    |
| 2                 | 1   | R31                                         | RES, 0603 0Ω JUMPER                              | VISHAY CRCW06030000Z0EA            |
| 3                 | 0   | R32                                         | RES, 0603 DNI                                    |                                    |
| 4                 | 0   | R5, R9                                      | RES, 0402 DNI                                    |                                    |
| 5                 | 1   | U9                                          | LTM9004CV-AA                                     | LINEAR TECHNOLOGY LTM9004CV-AA#PBF |
| 6                 | 1   |                                             | FAB, PRINTED CIRCUIT BOARD                       | DEMO CIRCUIT 1513B                 |

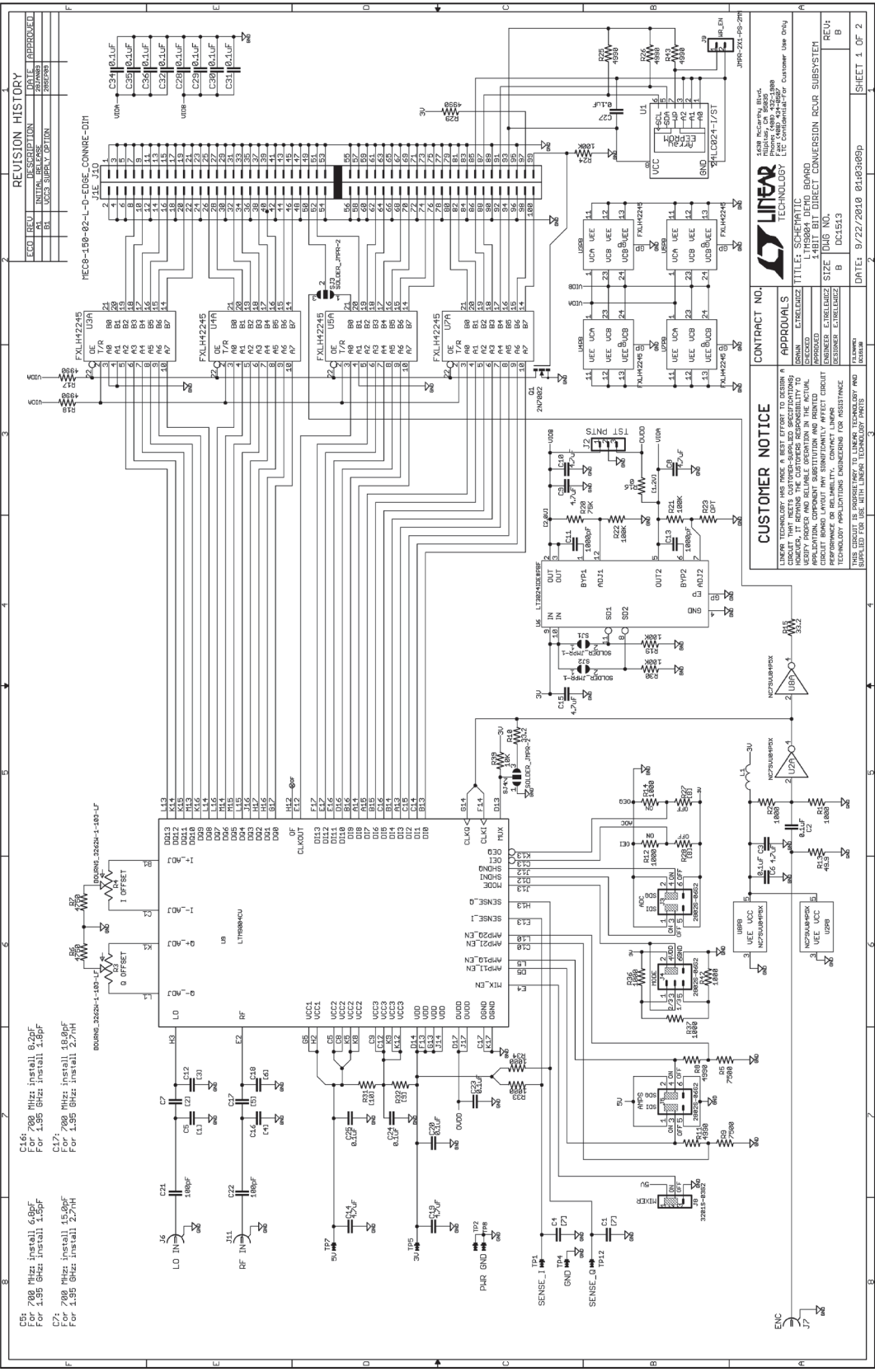
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## PARTS LIST

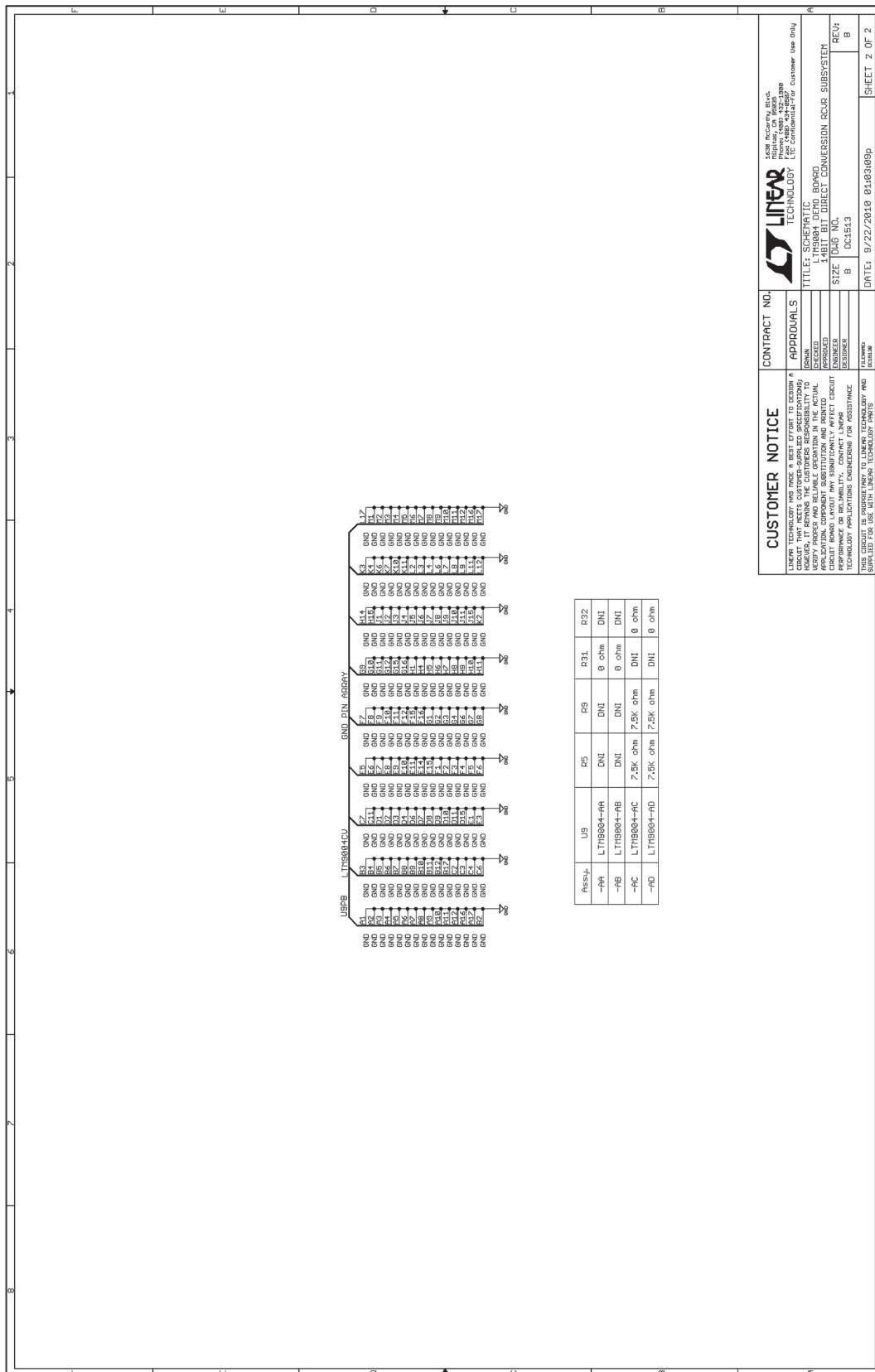
| ITEM              | QTY | REFERENCE | PART DESCRIPTION            | MANUFACTURER/PART NUMBER           |
|-------------------|-----|-----------|-----------------------------|------------------------------------|
| <b>DC1513B-AB</b> |     |           |                             |                                    |
| 1                 | 1   | DC1513B   | GENERAL BOM                 |                                    |
| 2                 | 1   | R31       | RES, 0603 0 $\Omega$ JUMPER | VISHAY CRCW06030000Z0EA            |
| 3                 | 0   | R32       | RES, 0603 DNI               |                                    |
| 4                 | 0   | R5, R9    | RES, 0402 DNI               |                                    |
| 5                 | 1   | U9        | LTM9004CV-AB                | LINEAR TECHNOLOGY LTM9004CV-AB#PBF |
| 6                 | 1   |           | FAB, PRINTED CIRCUIT BOARD  | DEMO CIRCUIT 1513B                 |
| <b>DC1513B-AC</b> |     |           |                             |                                    |
| 1                 | 1   | DC1513B   | GENERAL BOM                 |                                    |
| 2                 | 0   | R31       | RES, 0603 DNI               |                                    |
| 3                 | 1   | R32       | RES, 0603 0 $\Omega$ JUMPER | VISHAY CRCW06030000Z0EA            |
| 4                 | 2   | R5, R9    | RES, 0402 7.5k 1% 1/16W     | VISHAY CRCW04027K50FKED            |
| 5                 | 1   | U9        | LTM9004CV-AC                | LINEAR TECHNOLOGY LTM9004CV-AC#PBF |
| 6                 | 1   |           | FAB, PRINTED CIRCUIT BOARD  | DEMO CIRCUIT 1513B                 |
| <b>DC1513B-AD</b> |     |           |                             |                                    |
| 1                 | 1   | DC1513B   | GENERAL BOM                 |                                    |
| 2                 | 0   | R31       | RES, 0603 DNI               |                                    |
| 3                 | 1   | R32       | RES, 0603 0 $\Omega$ JUMPER | VISHAY CRCW06030000Z0EA            |
| 4                 | 2   | R5, R9    | RES, 0402 7.5k 1% 1/16W     | VISHAY CRCW04027K50FKED            |
| 5                 | 1   | U9        | LTM9004CV-AD                | LINEAR TECHNOLOGY LTM9004CV-AD#PBF |
| 6                 | 1   |           | FAB, PRINTED CIRCUIT BOARD  | DEMO CIRCUIT 1513B                 |

# DEMO MANUAL DC1513B

## SCHEMATIC DIAGRAM



## SCHEMATIC DIAGRAM



# DEMO MANUAL DC1513B

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