

# LTC6946

## Ultralow Noise and Spurious Integer-N Frequency Synthesizer with Integrated VCO

### DESCRIPTION

DC1705C features the [LTC®6946](#), an ultralow noise and spurious integer-N frequency synthesizer with integrated VCO. The VCO uses no external components and is internally calibrated without external system support.

There are four options of the DC1705C, one for each version of the LTC6946. Table 1 summarizes the available DC1705C options.

Each DC1705C provides 50Ω SMA connectors for the reference frequency input,  $f_{REF}$  (REF+ IN), the reference

output buffer (REF OUT), and the differential RF output (RF+ and RF-). A DC590 USB serial controller board is used for SPI communication with the LTC6946, controlled by the supplied PLLWizard™ software.

**Design files for this circuit board are available at <http://www.linear.com/demo/DC1705C>**

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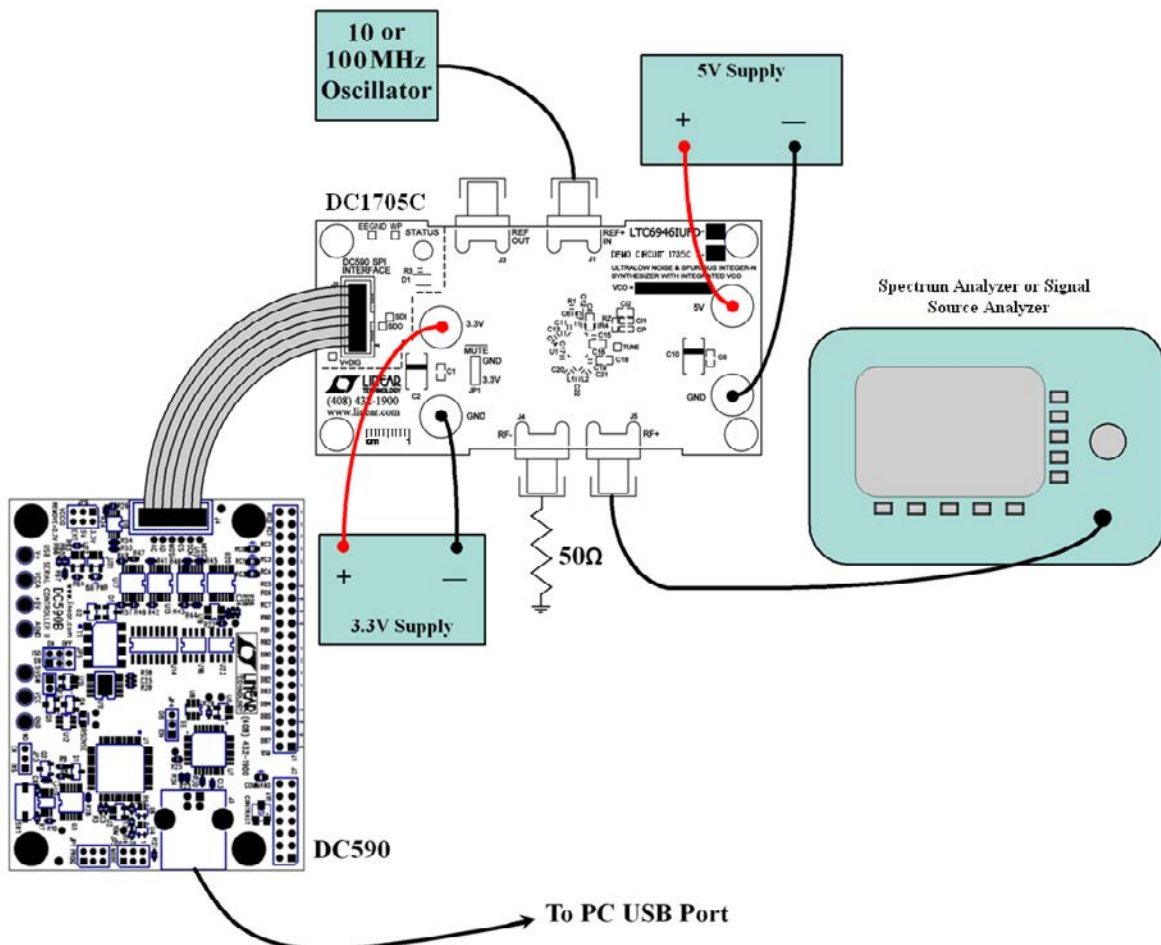


Figure 1. Proper Measurement Equipment Setup

## TYPICAL DC1705C REQUIREMENTS AND CHARACTERISTICS

| PARAMETER                                | INPUT OR OUTPUT | PHYSICAL LOCATION                   | DETAILS                                                                                                                               |
|------------------------------------------|-----------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| 3.3V Power Supply                        | Input           | 3.3V and GND Banana Jacks           | Low Noise and Spur-Free 3.3V, 115mA                                                                                                   |
| 5V Power Supply                          | Input           | 5V and GND Banana Jacks             | Low Noise and Spur-Free 5V, 45mA                                                                                                      |
| REF <sup>+</sup> IN, Reference Frequency | Input           | J1 SMA Connector                    | Low Noise 10MHz or 100MHz*, 6dBm into 50Ω (Note 1)                                                                                    |
| REF OUT, Buffered Reference              | Output          | J3 SMA Connector                    | Frequency = $f_{REF}$ , 0dBm                                                                                                          |
| RF <sup>+</sup> and RF <sup>-</sup>      | Two Outputs     | J4 and J5 SMA Connectors            | Frequency: 900MHz*, Power: 0dBm, Frequency Range: Depends on the version of the LTC6946 device – refer to Table 1, Step Size: 200kHz* |
| Loop Bandwidth                           | –               | Set by Loop Filter Component Values | 47kHz*                                                                                                                                |

\* These frequencies are for the DC1705C pllset files included with PLLWizard.

**Note 1:** A low noise 10MHz or 100MHz reference frequency, such as the Wenzel 501-04608A or 501-04516D OCXO, is recommended. If using a different frequency, make sure to update the  $f_{REF}$  and R\_DIV boxes under the System tab in PLLWizard so that  $f_{PDF}$  is still 1MHz. For example, if a 20MHz clock is used,  $f_{REF}$  should be changed to 20MHz and R\_DIV to 20. REF BST and FILT under the System tab in PLLWizard might need to be changed if the reference frequency and/or power is different than what is recommended in the table above. More information can be found in the LTC6946 data sheet.

**Table 1. DC1705C Options and Frequency Ranges**

| ASSEMBLY VERSION | PART NUMBER   | VCO FREQUENCY RANGE (GHz) | OUTPUT DIVIDER SETTINGS |
|------------------|---------------|---------------------------|-------------------------|
| DC1705C-A        | LTC6946IUFD-1 | 2.240 to 3.740            | Integers 1 through 6    |
| DC1705C-B        | LTC6946IUFD-2 | 3.080 to 4.910            | Integers 1 through 6    |
| DC1705C-C        | LTC6946IUFD-3 | 3.840 to 5.790            | Integers 1 through 6    |
| DC1705C-D        | LTC6946IUFD-4 | 4.200 to 6.390            | Integers 1 through 6    |

## QUICK START PROCEDURE

The DC590 and PLLWizard application are required to control the DC1705C through a personal computer (PC).

### DC590 Configuration

The DC590's QuikEval™ drivers must be installed before the DC590 will be able to communicate with the LTC6946. To configure the DC590, follow the procedure below, starting with step 1. If you have already installed the DC590 software previously, skip to step 5.

**Note:** Once the QuikEval software is installed, the application does not need to be executed to run PLLWizard or to control the DC1705C.

1. Do Not plug in the DC590 before running the installation program.
2. Download the QuikEval installation program from <http://www.linear.com/software>.
3. Run the QuikEval installation program and follow the on-screen instructions. More detailed installation information may be found in the DC590's Quick Start guide.
4. Exit the QuikEval program once the installation is complete, as it is not needed to run the PLLWizard software.
5. Place the DC590 jumpers in the following positions:
  - JP4** EE Must be in the "EN" position.
  - JP5** ISO "ON" must be selected.
  - JP5** SW "ON" must be selected.
  - JP6** VCCIO "3.3V" must be selected. This sets the SPI port to 3.3V operation.
6. Connect the DC590 to one of your computer's USB ports with the included USB cable.

## QUICK START PROCEDURE

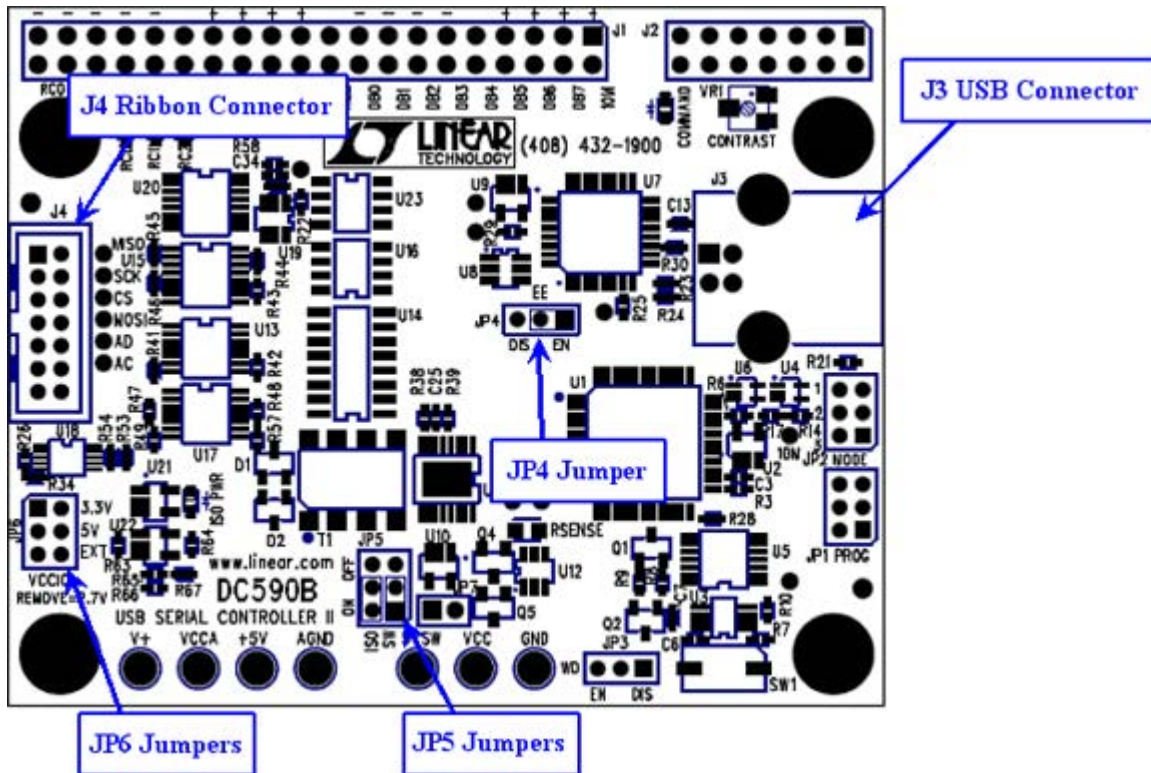


Figure 2. DC590 Jumper Locations

### PLLWizard Installation

The PLLWizard software is used to communicate with the LTC6946 synthesizer. It uses the DC590 to translate between USB and SPI-compatible serial communications formats. It also includes advanced PLL design and simulation capabilities. The following are the PLLWizard system requirements:

- Windows Operating System: Windows XP, Windows 2003 Server, Windows Vista, Windows 7
- Microsoft .NET 2.0 or later
- Windows Installer 3.1 or later
- Linear Technology's QuikEval and DC590 hardware

### Microsoft .NET

You must have Microsoft .NET 2.0 or later installed on your computer. PLLWizard will not run without it. Note that with Windows Vista and Windows 7, you should have at least version 3.5 pre-installed.

To manually determine your version of .NET using Windows XP, click *Start Menu* → *Settings* → *Control Panel* → *Add or Remove Programs*.

Depending upon your .NET version, choose one of two PLLWizard setup programs, downloaded from <http://www.linear.com/software>.

## QUICK START PROCEDURE

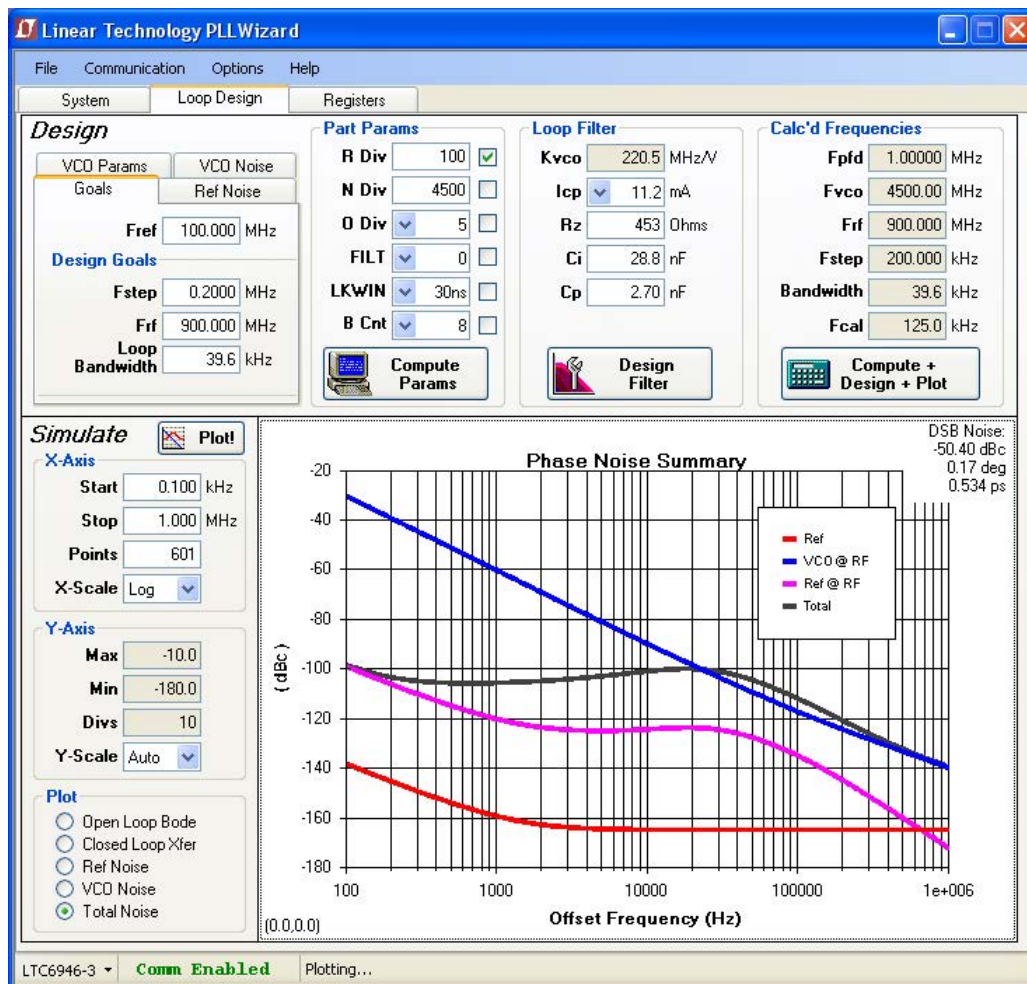
Either setup program will automatically install Microsoft .NET if a compatible .NET version is not found. But, the installation source depends upon which file you downloaded from Linear Technology's website. You should pick one of the following two choices, depending upon your version of .NET.

**Table 2. PLLWizard Installation File**

| FILE                     | .NET 2.0 SOURCE                          |
|--------------------------|------------------------------------------|
| PLLWizardSetup.exe       | Latest Version Downloaded from Microsoft |
| PLLWizardSetup_net20.exe | 2.0 SP2 Included (Much Larger File Size) |

- Choose *PLLWizardSetup* if you have .NET 2.0 or later, have Windows Vista or Windows 7, or if you have less than .NET 2.0 but want the latest .NET installed.
- Choose *PLLWizardSetup\_net20* if you have less than .NET 2.0, and want faster installation (no additional Microsoft downloads are needed, but the file size is much larger).

The setup file will verify and/or install Microsoft .NET and install PLLWizard. Refer to the Help menu for software operation.



**Figure 3. PLLWizard Screenshot**

## QUICK START PROCEDURE

### DC1705C Configuration

1. Connect an appropriate reference frequency source (at J1) and signal analyzers (at J4 and/or J5) using the SMA connectors (see Figure 1 and the Typical DC1705C Requirements and Characteristics table).
2. Choose the  $\overline{\text{MUTE}}$  jumper setting: **JP1 - GND/3.3V**  $\overline{\text{MUTE}}$  position. Select GND to mute the RF output, 3.3V to un-mute.
3. Connect the GND, 3.3V and 5V banana jacks to a power supply and apply power (see Figure 1 and the Typical DC1705C Requirements and Characteristics table).
4. Connect the DC590 to the DC1705C with the provided ribbon cable.
5. Run the PLLWizard application.
6. In PLLWizard, click File → Load Settings and point to the appropriate pllset file. For example, if you are using a 10MHz reference with a DC1705C-B to evaluate the LTC6946-2, load the “DC1705-B (LTC6946-2) 10MHz.pllset” file found in the PLLWizard installation directory (typically Program Files → LTC → PLLWizard → Set Files).

The red LED on DC1705C should turn on indicating that the loop is locked at 900MHz.

You can then change the values of N\_DIV and/or O\_DIV in PLLWizard to change the output frequency.

### Troubleshooting

If the red LED does not illuminate, follow the instructions below:

1. Verify that you are able to communicate with the DC1705C. The bottom status line in PLLWizard should read “LTC6946” and “Comm Enabled.” Refer to PLLWizard’s Troubleshoot and Help if not.
2. Verify that the 3.3V and 5V have the correct voltages on them and that the reference frequency is applied to the REF+ IN SMA input.

If the red LED is on but you cannot detect an RF output, make sure jumper JP1 is at the 3.3V position. Run Help → Troubleshoot in PLLWizard if the problem is not resolved.

### DC1705C Reconfiguration

You can redesign the frequency plan of the DC1705C using PLLWizard. You can change the loop filter as found using PLLWizard by reinstalling the loop filter components shown in Figure 4.

# QUICK START PROCEDURE

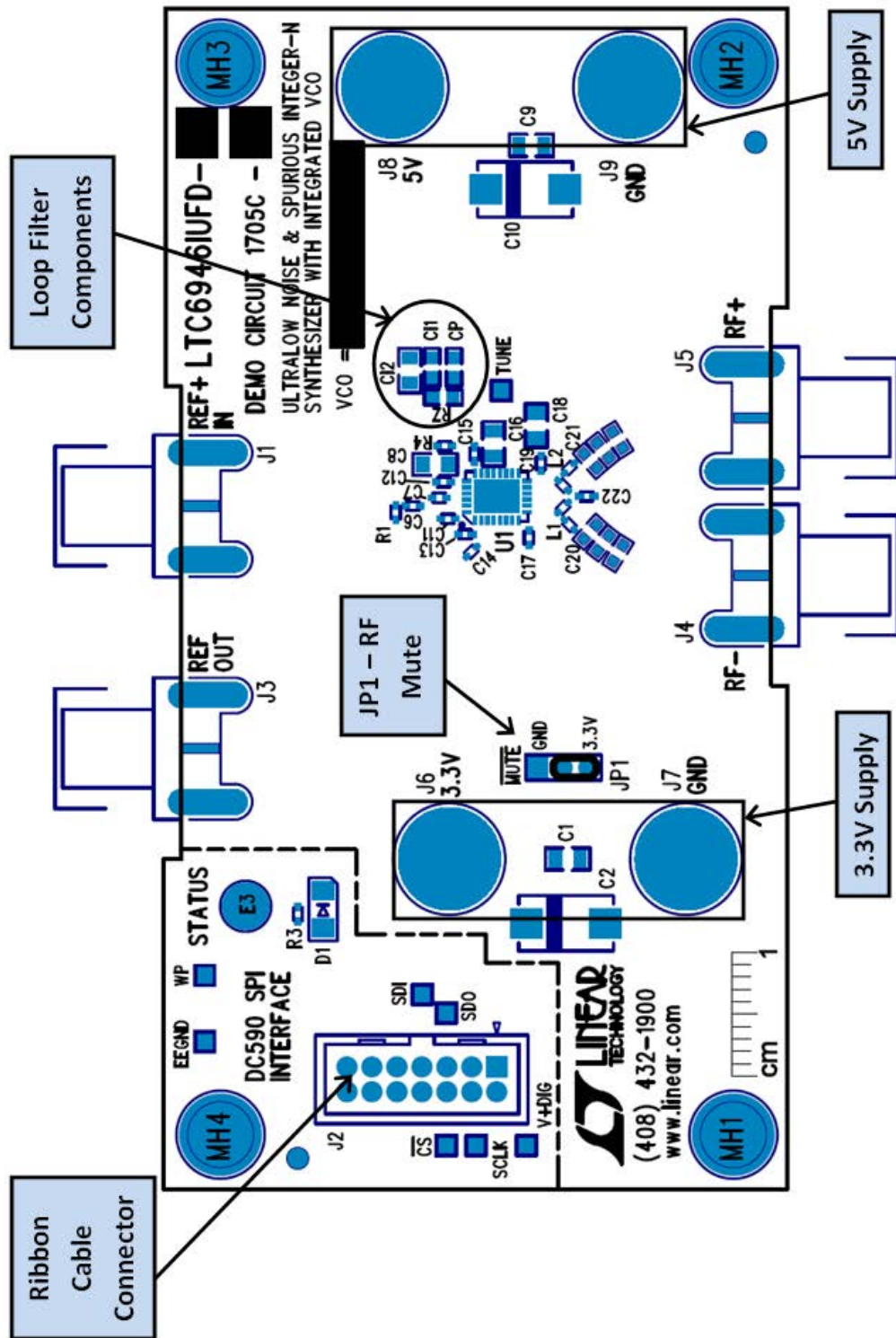


Figure 4. DC1705C Components and Connections

# DEMO MANUAL DC1705C

## PARTS LIST

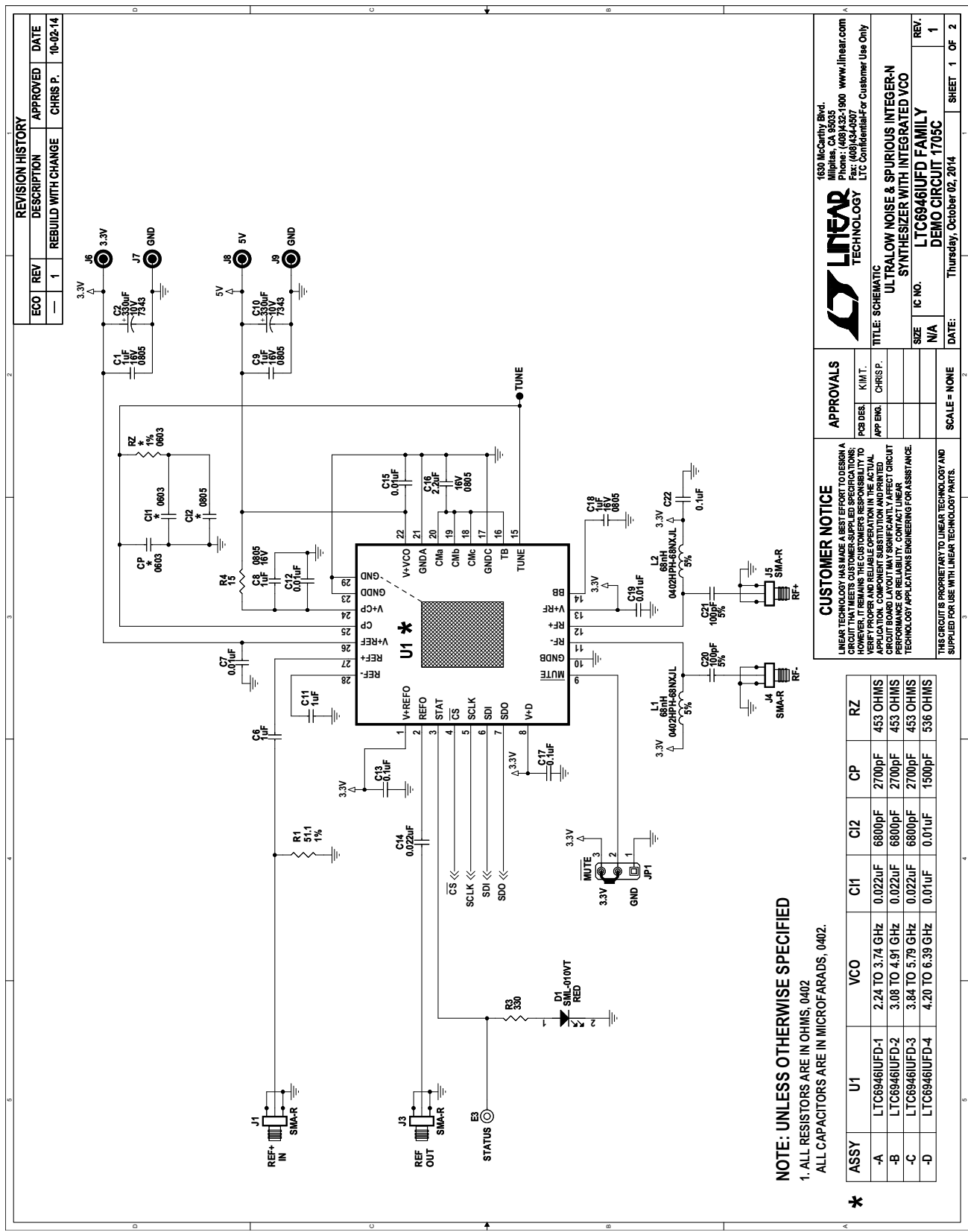
| ITEM                       | QTY | REFERENCE                             | PART DESCRIPTION                     | MANUFACTURER/PART NUMBER          |
|----------------------------|-----|---------------------------------------|--------------------------------------|-----------------------------------|
| <b>DC1705C GENERAL BOM</b> |     |                                       |                                      |                                   |
| 1                          | 4   | C1, C8, C9, C18                       | CAP, X7R, 1.0µF 16V, 10%, 0805       | TDK, C2012X7R1C105K               |
| 2                          | 2   | C2, C10                               | CAP, TANTALUM, 330µF, 10V, 10%, 7343 | AVX, TPME337K010R0035             |
| 3                          | 8   | C3, C13, C17, C22, C23, C24, C25, C26 | CAP, X5R, 0.1µF, 10V, 10%, 0402      | TDK, C1005X5R1A104K               |
| 4                          | 2   | C6, C11                               | CAP, X5R, 1.0µF, 16V, 10%, 0402      | TDK, C1005X5R1C105K               |
| 5                          | 4   | C7, C12, C15, C19                     | CAP, X7R, 0.01µF, 16V, 10%, 0402     | AVX, 0402YC103KAT2A               |
| 6                          | 1   | C14                                   | CAP, X7R 0.022µF 16V 10%, 0402       | AVX 0402YC223KAT2A                |
| 7                          | 1   | C16                                   | CAP, X7R, 2.2µF, 16V, 10%, 0805      | TDK, C2012X7R1C225K               |
| 8                          | 2   | C20, C21                              | CAP, NPO, 100pF, 50V, 5%, 0402       | TDK, C1005C0G1H101J               |
| 9                          | 1   | D1                                    | LED, RED                             | ROHM, SML-010VTT86L               |
| 10                         | 1   | E3                                    | TURRET, TESTPOINT, 2501              | MILL-MAX, 2501-2-00-80-00-00-07-0 |
| 11                         | 1   | JP1                                   | HEADERS, 3 PINS 2mm CTRS.            | SAMTEC TMM-103-02-L-S             |
| 12                         | 4   | J1, J3, J4, J5                        | CON., SMA 50Ω EDGE-LANCH             | E.F. JOHNSON, 142-0701-851        |
| 13                         | 1   | J2                                    | CON., HEADER, 14 PIN, 2mm            | MOLEX, 87831-1420                 |
| 14                         | 4   | J6, J7, J8, J9                        | JACK, BANANA                         | KEYSTONE, 575-4                   |
| 15                         | 2   | L1, L2                                | IND, 68nH 5%, 0402                   | COILCRAFT, 0402HPH-68NXJLW        |
| 16                         | 1   | R1                                    | RES., CHIP, 51.1Ω, 1/16W, 1%, 0402   | NIC, NRC04F51R1TRF                |
| 17                         | 1   | R3                                    | RES., CHIP, 330Ω, 1/16W, 1%, 0402    | NIC, NRC04F3300TRF                |
| 18                         | 1   | R4                                    | RES., CHIP, 15Ω, 1/16W, 1%, 0402     | NIC, NRC04F15R0TRF                |
| 19                         | 4   | R5, R6, R7, R13                       | RES., CHIP, 200k, 1/16W, 1%, 0402    | NIC, NRC04F2003TRF                |
| 20                         | 3   | R8, R9, R14                           | RES., CHIP, 4.99k, 1/16W, 1%, 0402   | NIC, NRC04F4991TRF                |
| 21                         | 4   | R10, R11, R12, R16                    | RES., CHIP, 100Ω 1/16W, 5%, 0402     | NIC, NRC04J101TRF                 |
| 22                         | 1   | R15                                   | RES., CHIP, 0Ω, 0603                 | VISHAY, CRCW06030000Z0EA          |
| 23                         | 2   | U2, U3                                | I.C., DUAL BUFFER, SC70              | FAIRCHILD SEMI., NC7WZ17P6X       |
| 24                         | 1   | U4                                    | I.C., DUAL TRANSCEIVER, SOT363       | NXP, 74LVC1T45GW                  |
| 25                         | 1   | U5                                    | I.C., SERIAL EEPROM, TSSOP8          | MICROCHIP, 24LC025-I /ST          |
| 26                         | 1   | SHUNT ON JP1 (2&3)                    | SHUNT, 2mm CTRS.                     | SAMTEC 2SN-BK-G                   |
| 27                         | 4   | MH1-MH4                               | STANDOFF, NYLON, 0.5, 1/2"           | KEYSTONE, 8833 (SNAP ON)          |
| 28                         | 2   |                                       | STENCILS (TOP & BOTTOM)              | DC1705C-1                         |
| <b>DC1705C-A</b>           |     |                                       |                                      |                                   |
| 1                          | 1   |                                       | GENERAL BOM                          |                                   |
| 2                          | 1   | CI1                                   | CAP, X7R 0.022µF 50V 5% 0603         | AVX 06035C223JAT2A                |
| 3                          | 1   | CI2                                   | CAP, COG 6800pF 50V 5% 0805          | MURATA GRM2195C1H682JA01D         |
| 4                          | 1   | CP                                    | CAP, COG 2700pF 50V 5% 0603          | MURATA GRM1885C1H272JA01D         |
| 5                          | 1   | RZ                                    | RES., CHIP, 453Ω, 1/10W 1%, 0603     | NIC, NRC06F4530TRF                |
| 6                          | 1   | U1                                    | I.C. SYNTHESIZER, QFN28UFD-4X5       | LINEAR TECH., LTC6946IUFD-1       |

## PARTS LIST

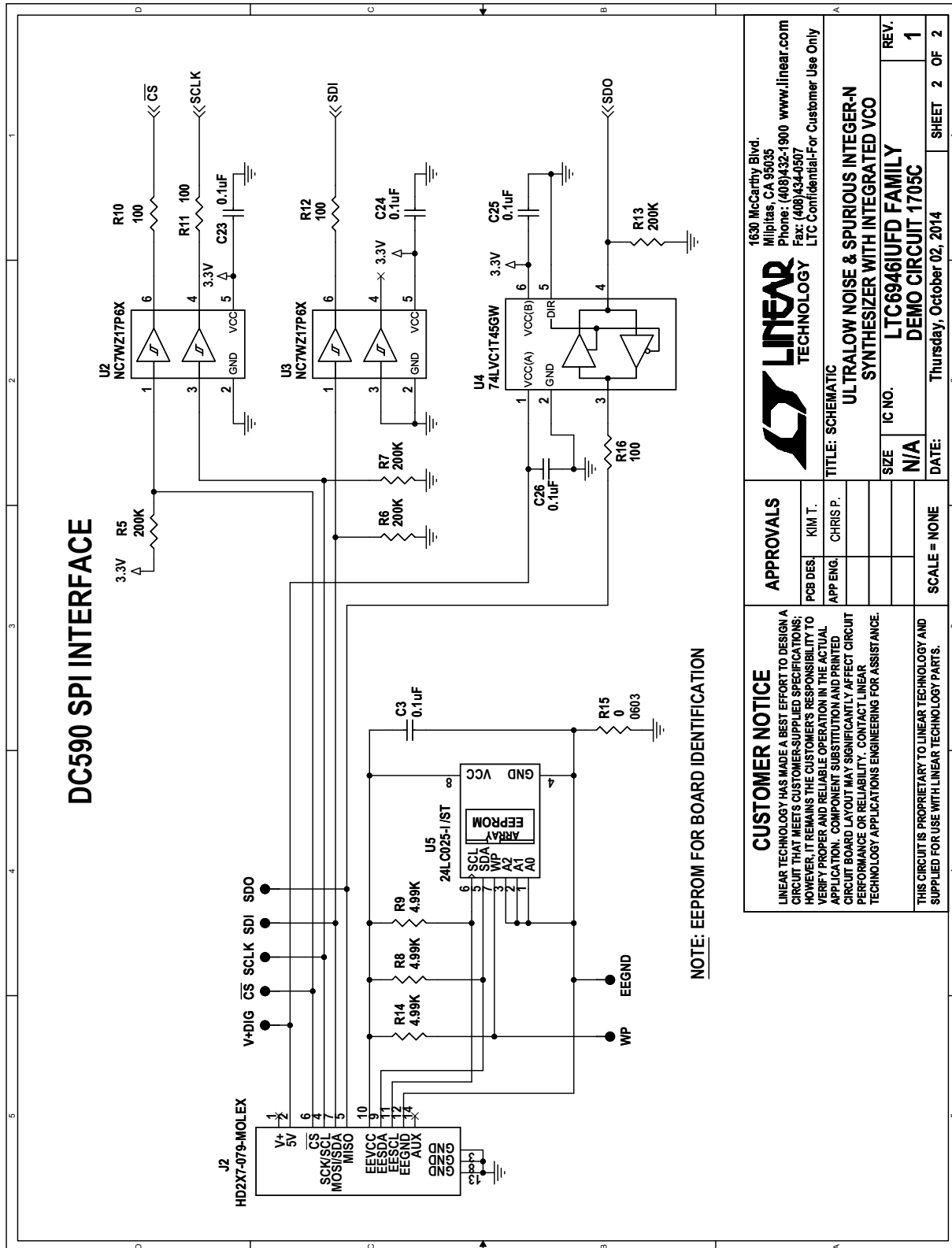
| ITEM             | QTY | REFERENCE | PART DESCRIPTION                 | MANUFACTURER/PART NUMBER    |
|------------------|-----|-----------|----------------------------------|-----------------------------|
| <b>DC1705C-B</b> |     |           |                                  |                             |
| 1                | 1   |           | GENERAL BOM                      |                             |
| 2                | 1   | CI1       | CAP., X7R 0.022µF 50V 5% 0603    | AVX 06035C223JAT2A          |
| 3                | 1   | CI2       | CAP., COG 6800pF 50V 5% 0805     | MURATA GRM2195C1H682JA01D   |
| 4                | 1   | CP        | CAP., COG 2700pF 50V 5% 0603     | MURATA GRM1885C1H272JA01D   |
| 5                | 1   | RZ        | RES., CHIP, 453Ω, 1/10W 1%, 0603 | NIC, NRC06F4530TRF          |
| 6                | 1   | U1        | I.C. SYNTHESIZER, QFN28UFD-4X5   | LINEAR TECH., LTC6946IUFD-2 |
| <b>DC1705C-C</b> |     |           |                                  |                             |
| 1                | 1   |           | GENERAL BOM                      |                             |
| 2                | 1   | CI1       | CAP., X7R 0.022µF 50V 5% 0603    | AVX 06035C223JAT2A          |
| 3                | 1   | CI2       | CAP., COG 6800pF 50V 5% 0805     | MURATA GRM2195C1H682JA01D   |
| 4                | 1   | CP        | CAP., COG 2700pF 50V 5% 0603     | MURATA GRM1885C1H272JA01D   |
| 5                | 1   | RZ        | RES., CHIP, 453Ω, 1/10W 1%, 0603 | NIC, NRC06F4530TRF          |
| 6                | 1   | U1        | I.C. SYNTHESIZER, QFN28UFD-4X5   | LINEAR TECH., LTC6946IUFD-3 |
| <b>DC1705C-D</b> |     |           |                                  |                             |
| 1                | 1   |           | GENERAL BOM                      |                             |
| 2                | 1   | CI1       | CAP., X7R 0.01µF 50V 5% 0603     | AVX 06035C103JAT2A          |
| 3                | 1   | CI2       | CAP., COG 0.01µF 50V 5% 0805     | MURATA GRM2195C1H103JA01    |
| 4                | 1   | CP        | CAP., COG 1500pF 50V 5% 0603     | MURATA GRM1885C1H152JA01D   |
| 5                | 1   | RZ        | RES., CHIP, 536Ω, 1/10W 1%, 0603 | NIC, NRC06F5360TRF          |
| 6                | 1   | U1        | I.C. SYNTHESIZER, QFN28UFD-4X5   | LINEAR TECH., LTC6946IUFD-4 |

# DEMO MANUAL DC1705C

## SCHEMATIC DIAGRAM



## SCHEMATIC DIAGRAM

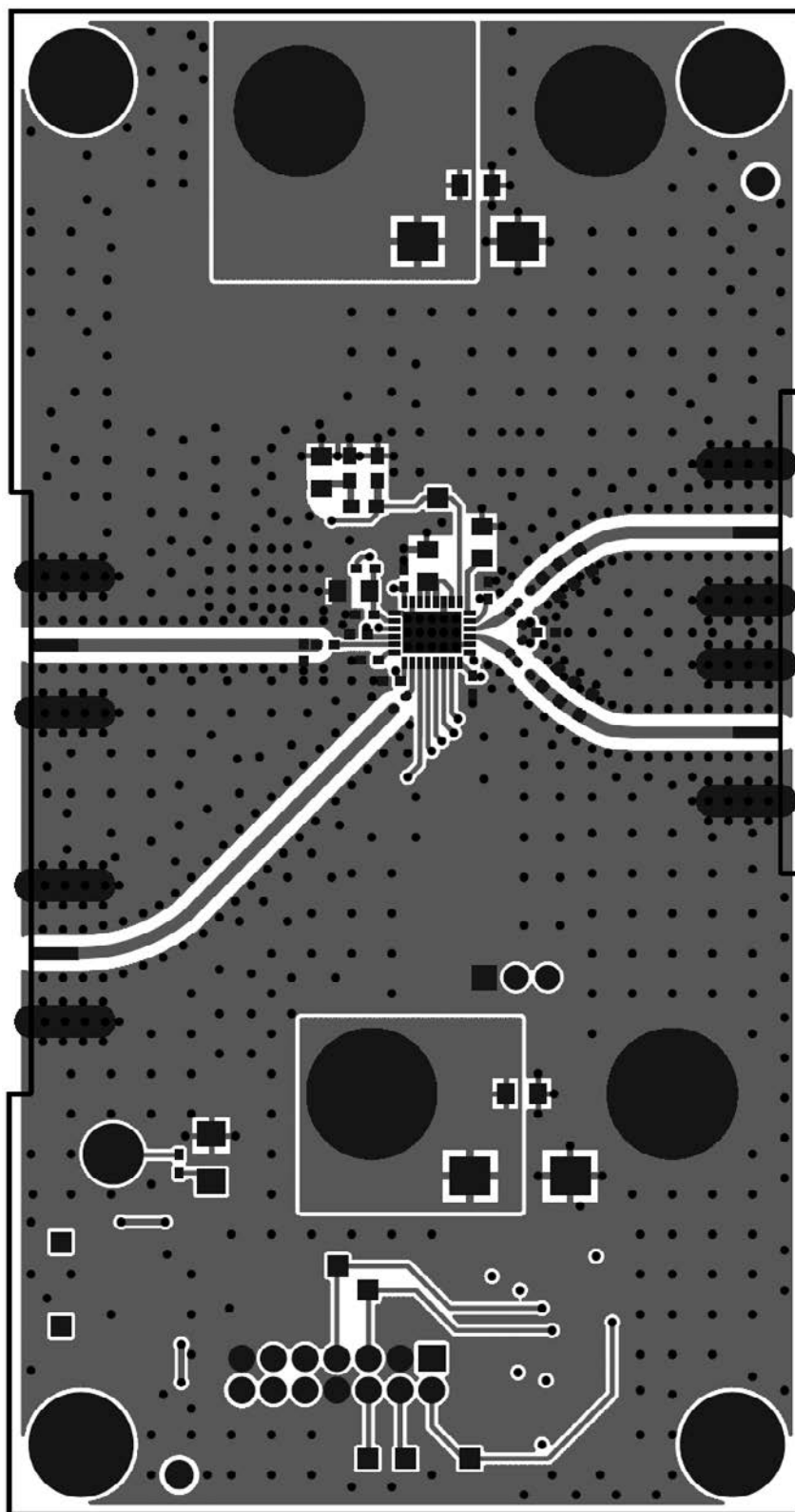


**Note:** The buffers shown on sheet 2 of 2 of the schematic are used to protect the LTC6946 when communicating to it starts before powering it up. There is no need for such circuitry if the SPI bus is not active before powering up the LTC6946. The EEPROM is for identification and is not needed to program the LTC6946.

dc1705cfc

## LAYOUT

The top metal layer of the DC1705C is shown here as an example of good PCB layout for the LTC6946.



## REVISION HISTORY

| BOARD REV | DATE  | DESCRIPTION                                               |
|-----------|-------|-----------------------------------------------------------|
|           |       | Original Design                                           |
| B         | 03/12 | Added EEPROM for identification purposes.                 |
| C         | 05/13 | Added support for 5V SPI in addition to the default 3.3V. |
|           | 11/14 | Added DC1705C-D version                                   |

# DEMO MANUAL DC1705C

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Mailing Address:

Linear Technology  
1630 McCarthy Blvd.  
Milpitas, CA 95035

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