

# 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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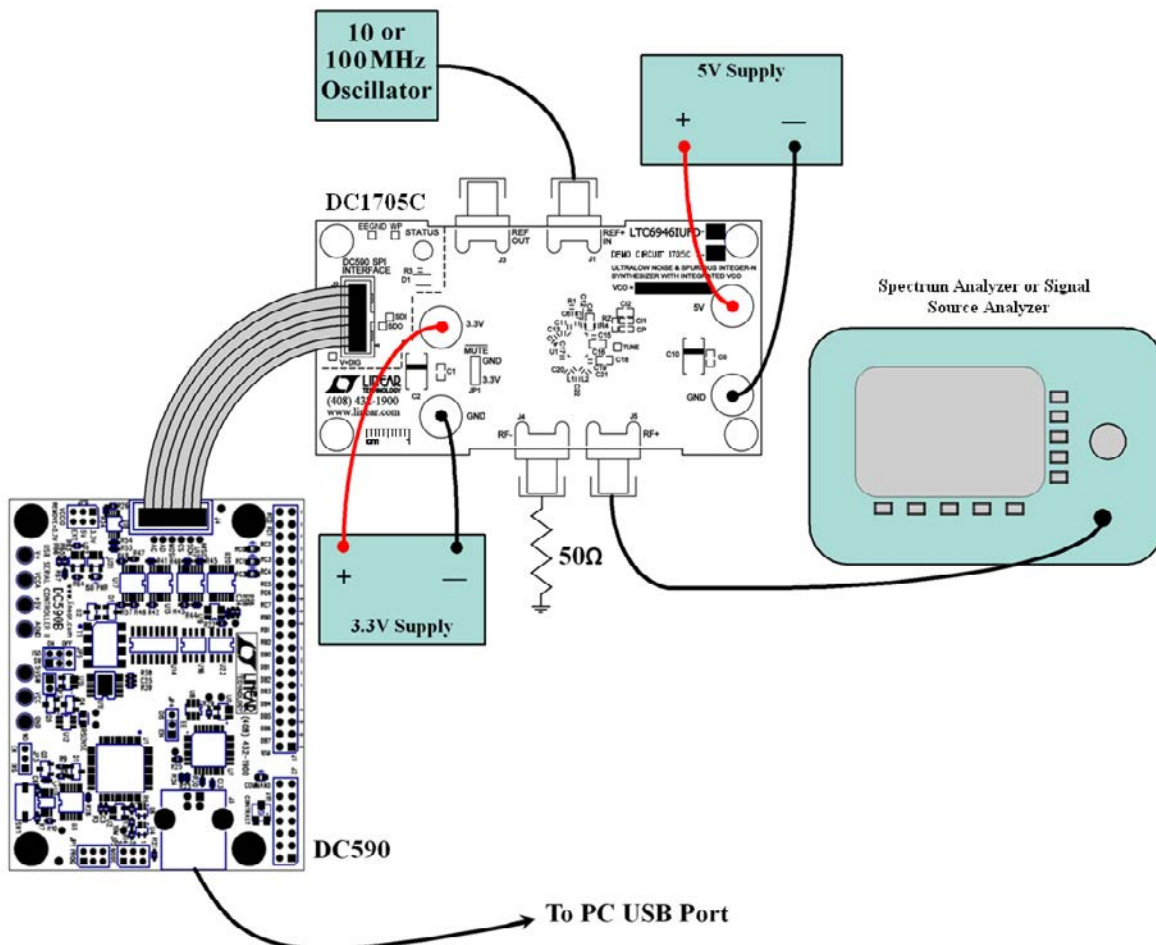


Figure 1. Proper Measurement Equipment Setup

## 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 <sub>REF</sub> , 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<sub>REF</sub> and R\_DIV boxes under the System tab in PLLWizard so that f<sub>PDF</sub> is still 1MHz. For example, if a 20MHz clock is used, f<sub>REF</sub> 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

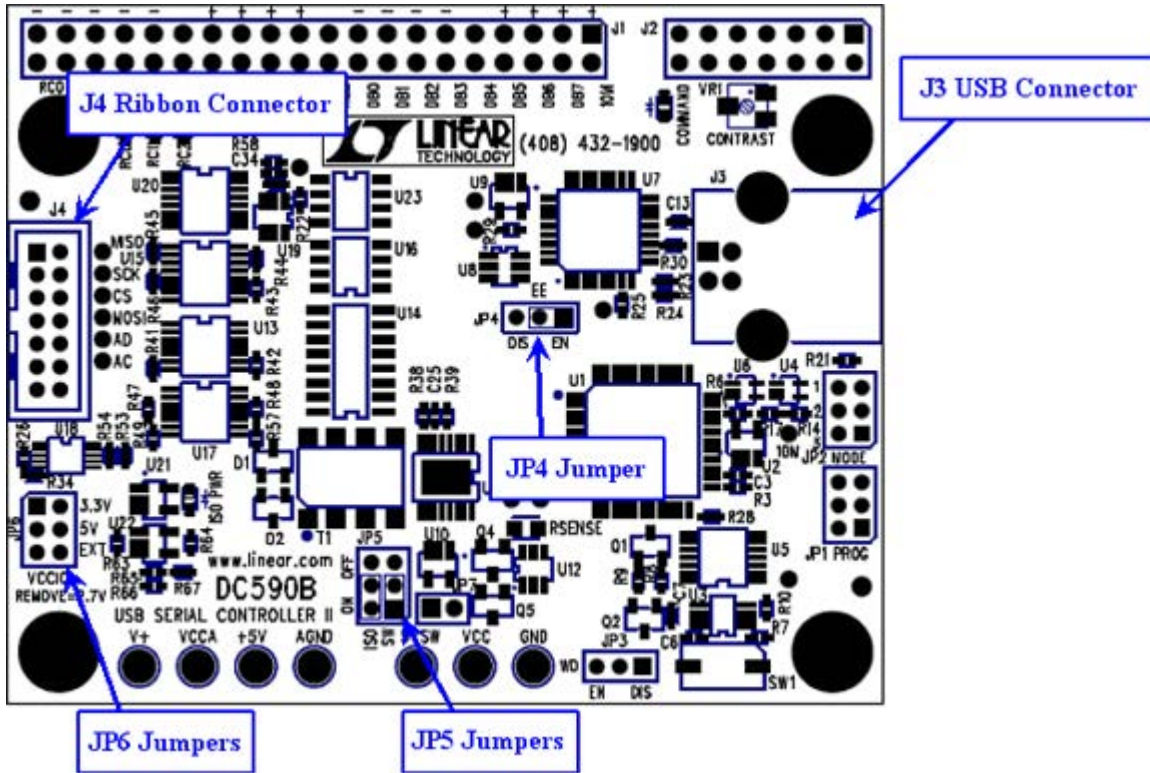


Figure 2. DC590 Jumper Locations

### 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

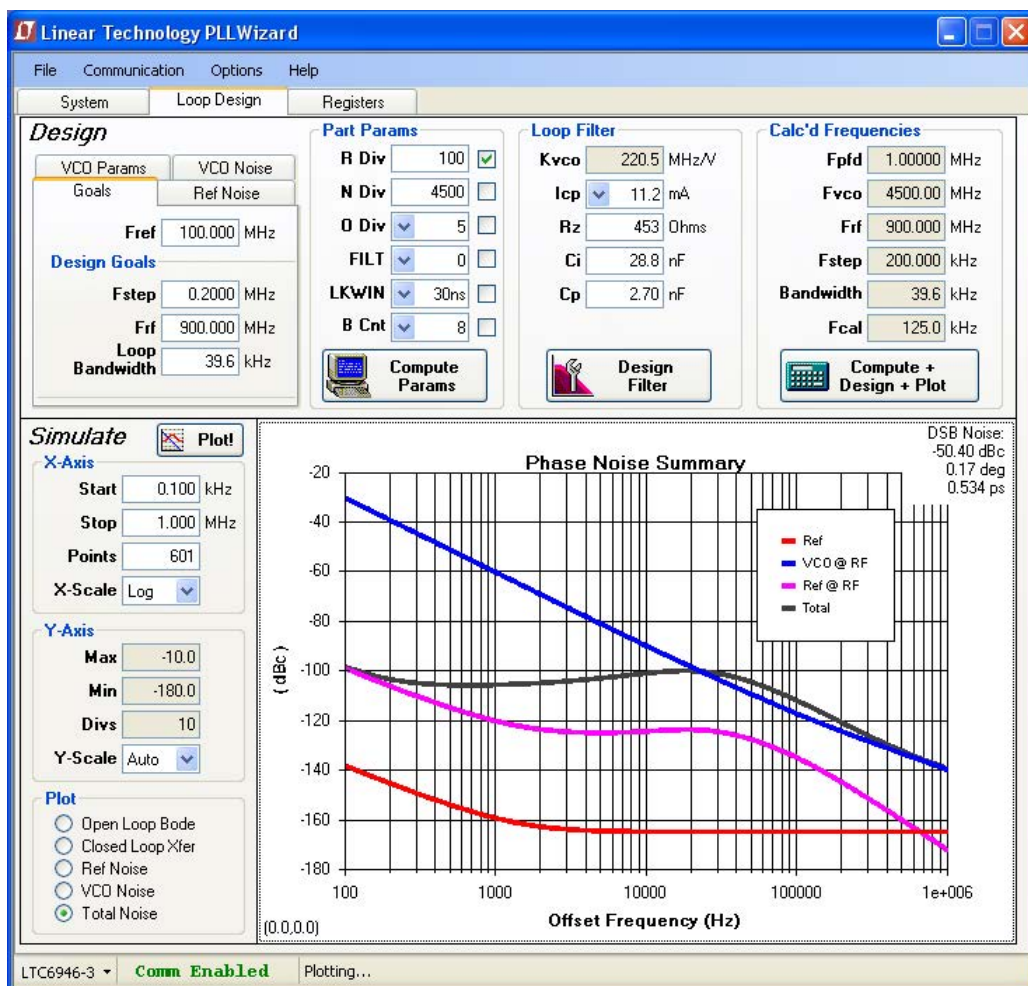
Either setup program will automatically install Microsoft .NET if a compatible .NET version is not found. But, the installation source depends upon which file you downloaded from Linear Technology's website. You should pick one of the following two choices, depending upon your version of .NET.

**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**

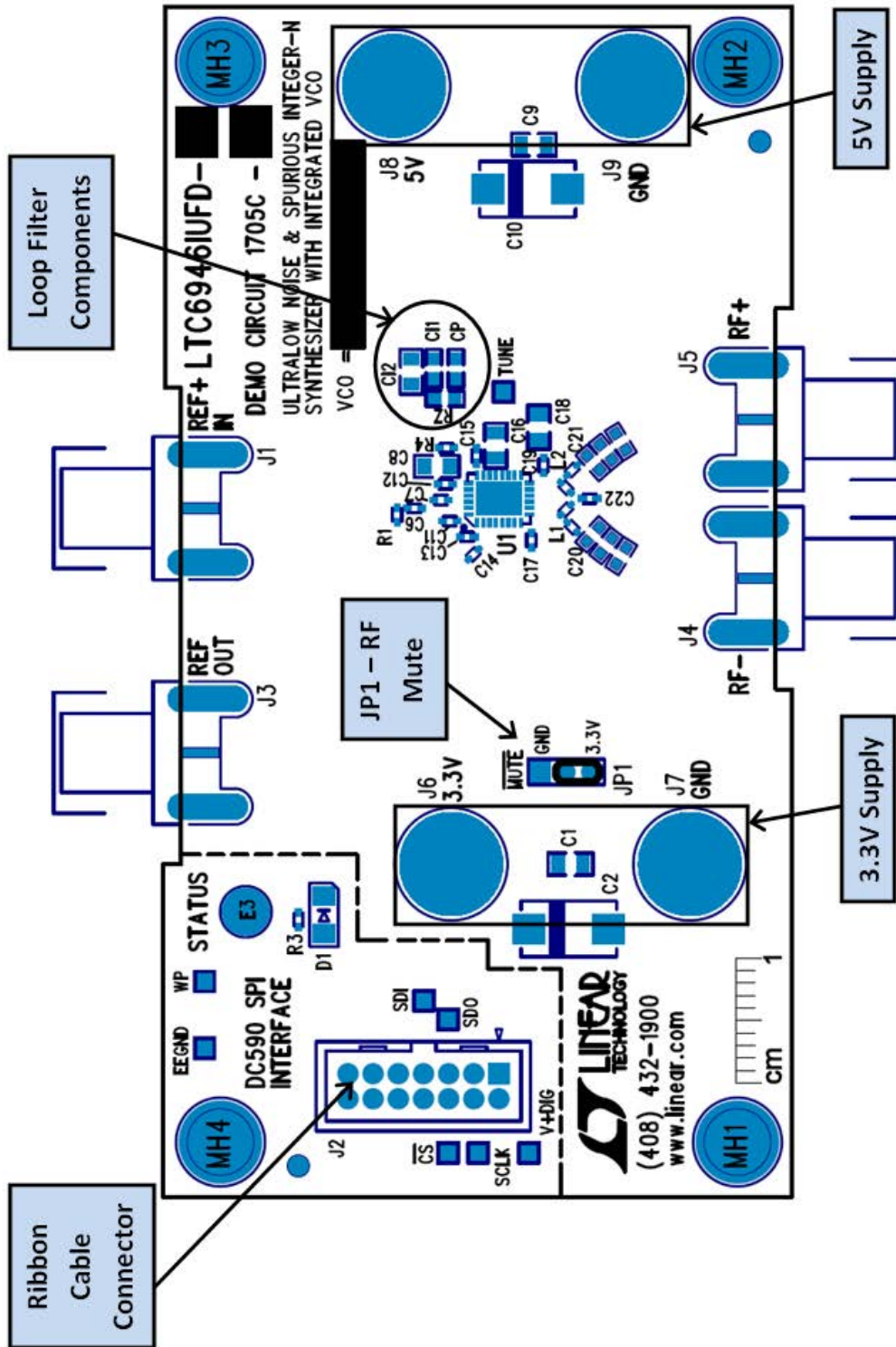


Figure 4. DC1705C Components and Connections

# DEMO MANUAL DC1705C

## PARTS LIST

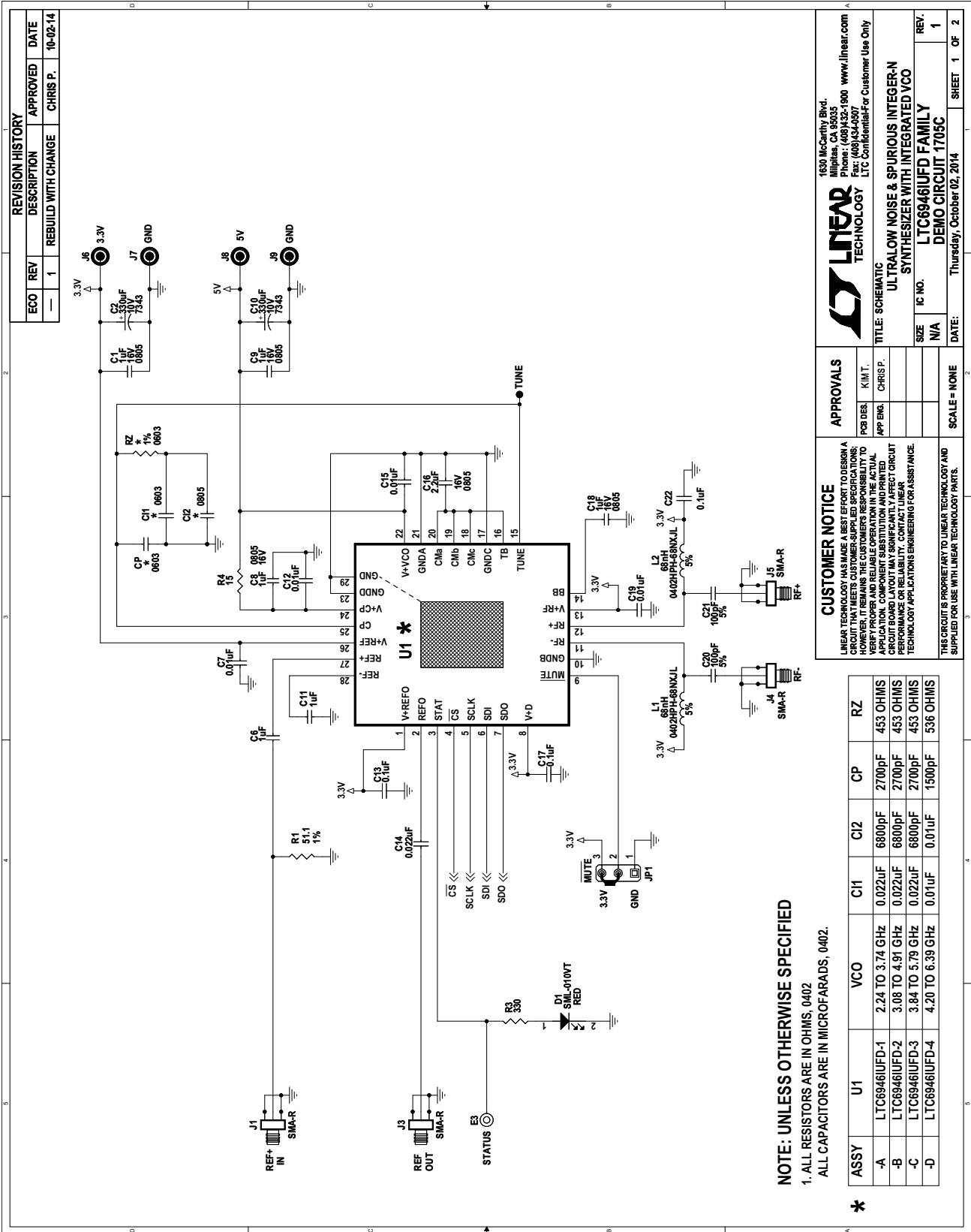
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>DC1705C GENERAL BOM</b>				
1	4	C1, C8, C9, C18	CAP, X7R, 1.0µF 16V, 10%, 0805	TDK, C2012X7R1C105K
2	2	C2, C10	CAP, TANTALUM, 330µF, 10V, 10%, 7343	AVX, TPME337K010R0035
3	8	C3, C13, C17, C22, C23, C24, C25, C26	CAP, X5R, 0.1µF, 10V, 10%, 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	C11	CAP, X7R 0.022µF 50V 5% 0603	AVX 06035C223JAT2A
3	1	C12	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 0.022 $\mu$ F 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, 453 $\Omega$ , 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 0.022 $\mu$ F 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, 453 $\Omega$ , 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 0.01 $\mu$ F 50V 5% 0603	AVX 06035C103JAT2A
3	1	CI2	CAP., COG 0.01 $\mu$ F 50V 5% 0805	MURATA GRM2195C1H103JA01
4	1	CP	CAP., COG 1500pF 50V 5% 0603	MURATA GRM1885C1H152JA01D
5	1	RZ	RES., CHIP, 536 $\Omega$ , 1/10W 1%, 0603	NIC, NRC06F5360TRF
6	1	U1	I.C. SYNTHESIZER, QFN28UFD-4X5	LINEAR TECH., LTC6946IUFD-4

## SCHEMATIC DIAGRAM



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**SCHEMATIC**  
ULTRALOW NOISE & SPURIOUS INTEGRATED VCO  
SYNTHESIZER WITH INTEGRATED VCO

IC NO. LTC6946IUFD FAMILY  
DEMO CIRCUIT-1705C

DATE: Thursday, October 02, 2014 SHEET 1 OF 2

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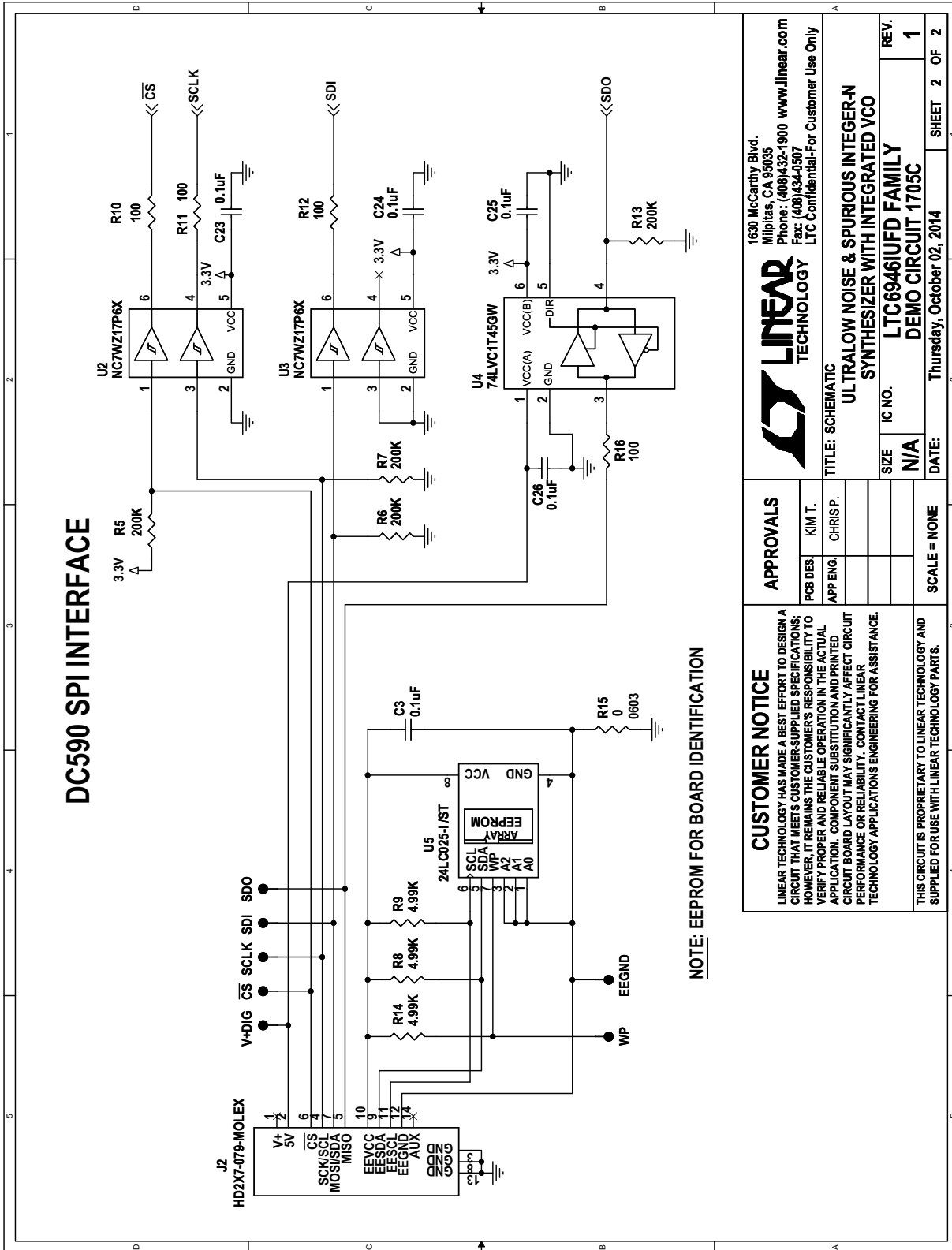
**APPROVALS**

PCB DES.	KIM T.
APP ENG.	CHRIS P.

SCALE = NONE

THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.

**SCHEMATIC DIAGRAM**

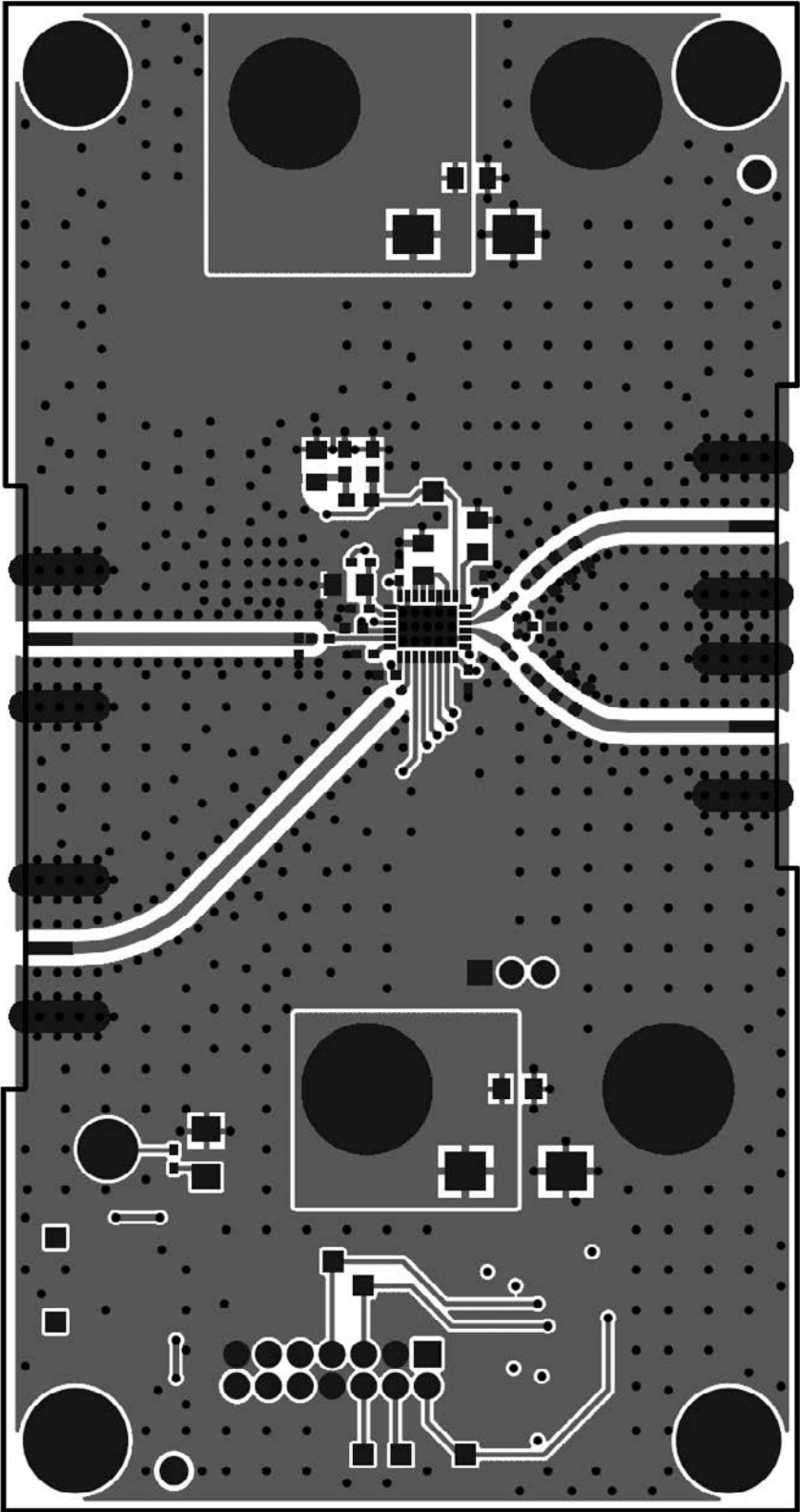


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<b>APPROVALS</b>		<b>TITLE: SCHEMATIC</b>	
PCB DES.	KIM T.	<b>ULTRALOW NOISE &amp; SPUROUS INTEGER-N SYNTHESIZER WITH INTEGRATED VCO</b>	
APP ENG.	CHRIS P.	SIZE	REV.
		N/A	LTC6946IUFD FAMILY
		DATE:	DEMO CIRCUIT 1705C
		SCALE = NONE	Thursday, October 02, 2014
			SHEET 2 OF 2

**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.

## 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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