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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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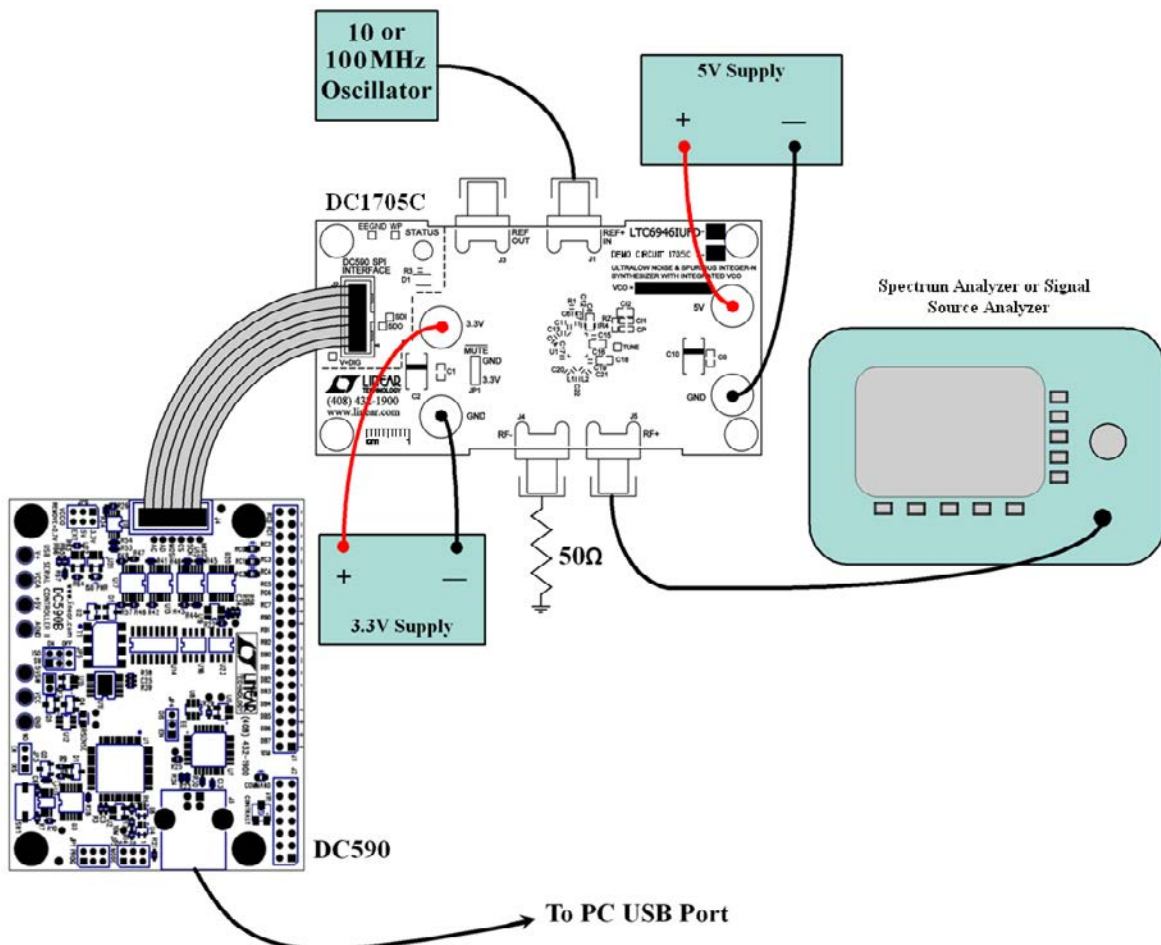

Figure 1. Proper Measurement Equipment Setup

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+ 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+ and RF−	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_{PFD} 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
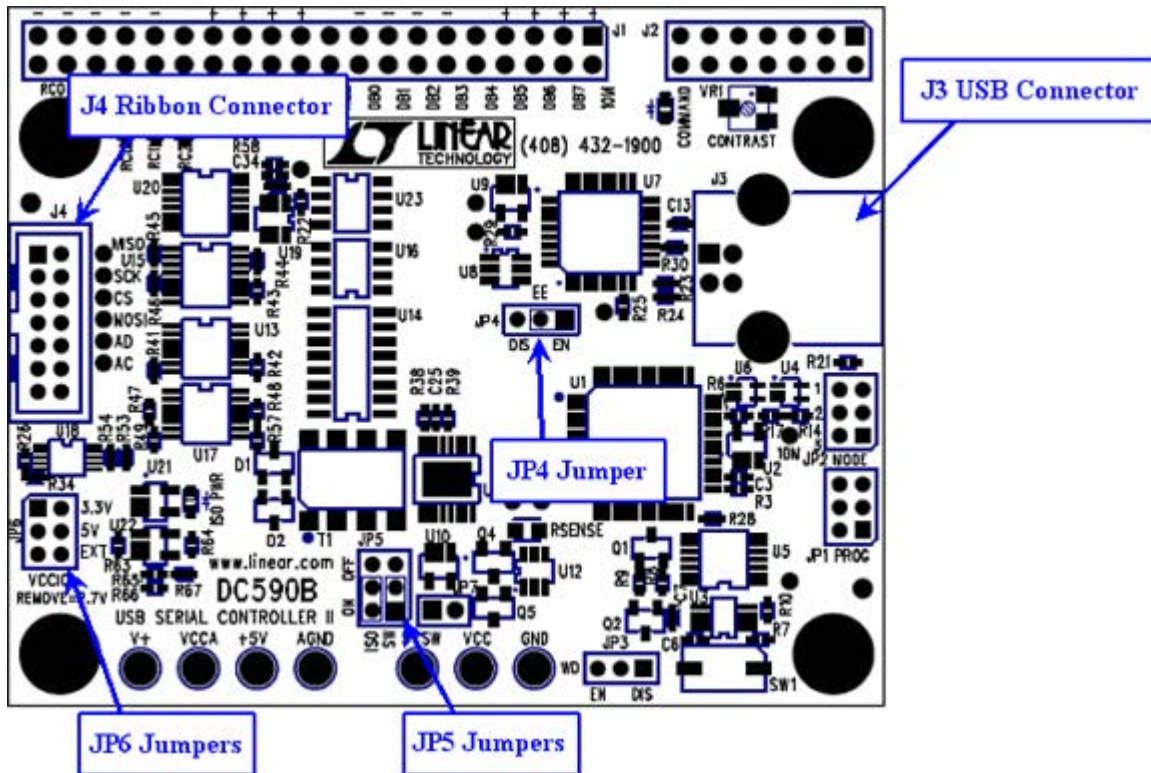
Figure 2. DC590 Jumper Locations

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 down-loaded 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.
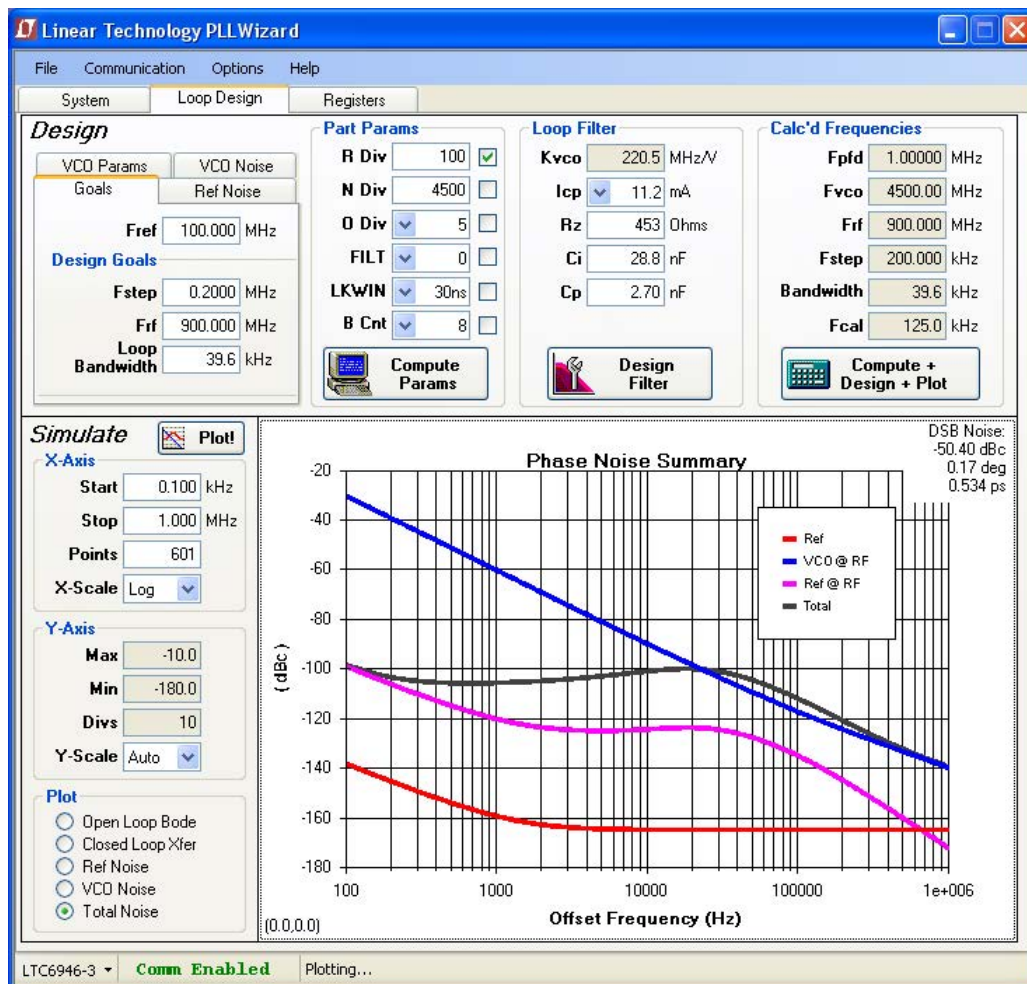

Figure 3. PLLWizard Screenshot

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 PLL-Wizard'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.
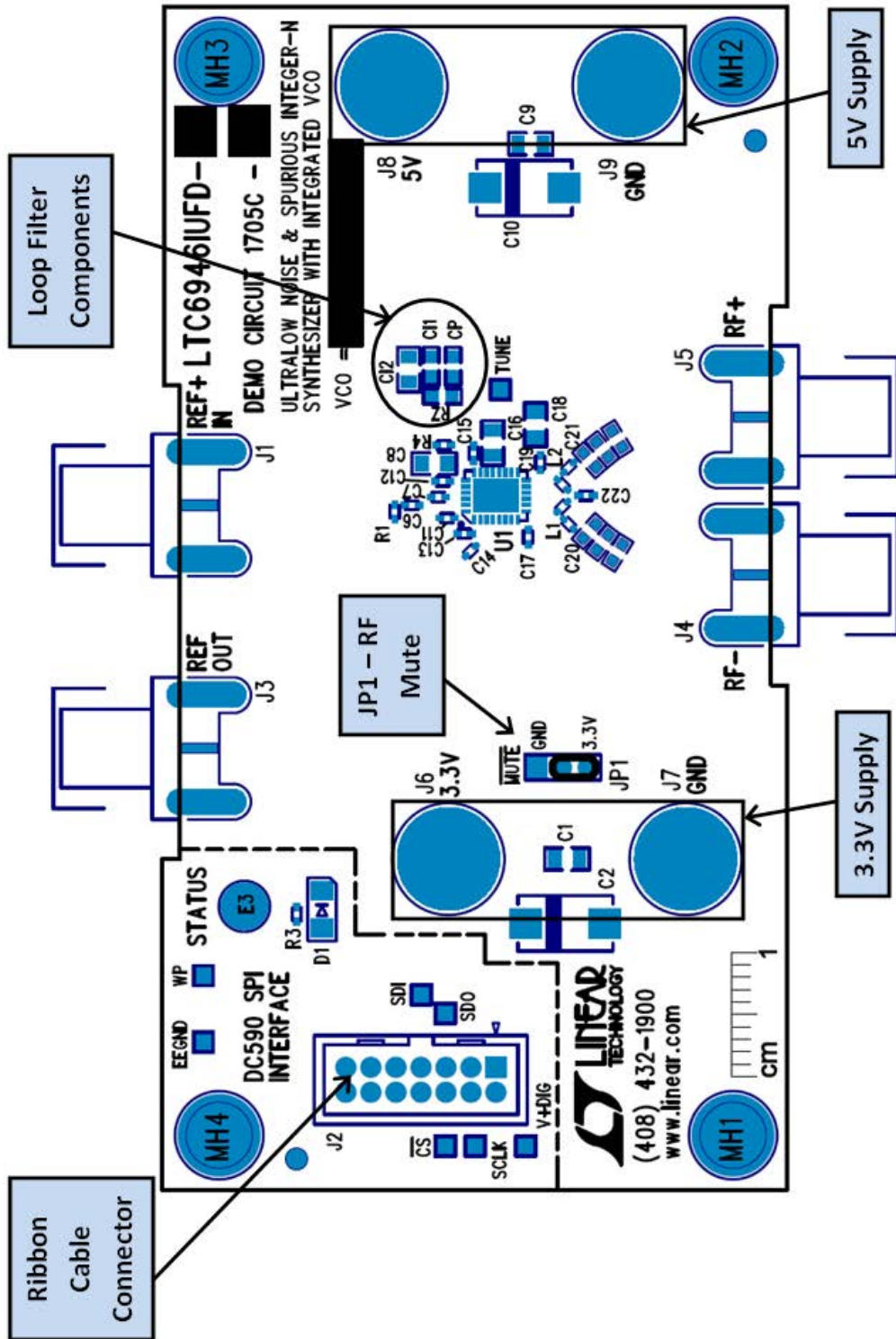
QUICK START PROCEDURE
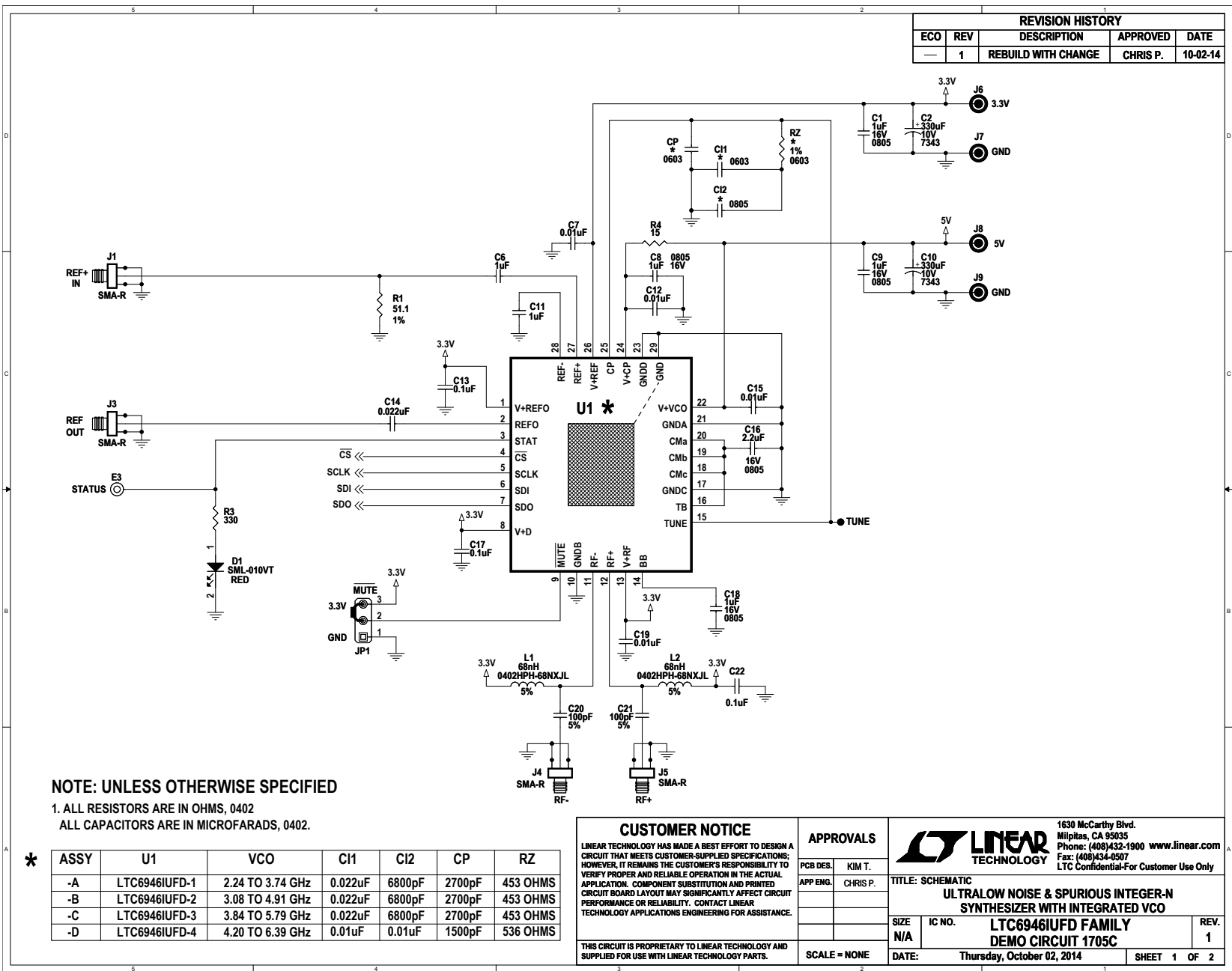

Figure 4. DC1705C Components and Connections

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
DC1705C GENERAL BOM				
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
DC1705C-A				
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
DC1705C-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
DC1705C-C				
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
DC1705C-D				
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

REVISION HISTORY				
ECO	REV	DESCRIPTION	APPROVED	DATE
—	1	REBUILD WITH CHANGE	CHRIS P.	10-02-14

3.3V J6 3.3V
C1 1uF 16V 0805
C2 +330uF 10V 7343
J7 GND

CP * 0603
CI1 * 0603
RZ * 1% 0603
CI2 * 0805

5V J8 5V
C9 1uF 16V 0805
C10 +330uF 10V 7343
J9 GND

C7 0.01uF
R4 15
C8 0805 1uF 16V
C12 0.01uF

J1 REF+ IN SMA-R
C6 1uF
R1 51.1 1%
C11 1uF
C13 0.1uF
3.3V

U1 *
28 REF−
27 REF+
26 V+REF
25 CP
24 V+CP
23 GNDD
GND

1 V+REFO
2 REFO
3 STAT
4 CS
5 SCLK
6 SDI
7 SDO
8 V+D

22 V+VCO
21 GNDA
20 CMa
19 CMb
18 CMc
17 GNDC
16 TB
15 TUNE

C15 0.01uF
C16 2.2uF 16V 0805

J3 REF OUT SMA-R
C14 0.022uF

CS
SCLK
SDI
SDO

E3 STATUS
R3 330
D1 SML-010VT RED

C17 0.1uF
3.3V

TUNE

MUTE
9 MUTE
10 GNDB
11 RF−
12 RF+
13 V+RF
14 BB

3.3V
MUTE 3
2
GND 1
JP1

C19 0.01uF
C18 1uF 16V 0805
3.3V

3.3V
L1 68nH 0402HPH-68NXJL 5%
L2 68nH 0402HPH-68NXJL 5%
3.3V
C22 0.1uF

C20 100pF 5%
C21 100pF 5%

J4 SMA-R RF−
J5 SMA-R RF+

NOTE: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS, 0402
   ALL CAPACITORS ARE IN MICROFARADS, 0402.

*
ASSY	U1	VCO	CI1	CI2	CP	RZ
-A	LTC6946IUFD-1	2.24 TO 3.74 GHz	0.022uF	6800pF	2700pF	453 OHMS
-B	LTC6946IUFD-2	3.08 TO 4.91 GHz	0.022uF	6800pF	2700pF	453 OHMS
-C	LTC6946IUFD-3	3.84 TO 5.79 GHz	0.022uF	6800pF	2700pF	453 OHMS
-D	LTC6946IUFD-4	4.20 TO 6.39 GHz	0.01uF	0.01uF	1500pF	536 OHMS

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

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TITLE: SCHEMATIC
ULTRALOW NOISE & SPURIOUS INTEGER-N SYNTHESIZER WITH INTEGRATED VCO

SIZE N/A
IC NO.
LTC6946IUFD FAMILY DEMO CIRCUIT 1705C
REV. 1

SCALE = NONE
DATE: Thursday, October 02, 2014
SHEET 1 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.

DC590 SPI INTERFACE

3.3V R5 200K

U2 NC7WZ17P6X R10 100 $\overline{CS}$

R11 100 SCLK
3.3V C23 0.1uF
GND VCC

J2 HD2X7-079-MOLEX

V+DIG $\overline{CS}$ SCLK SDI SDO

V+ 1 2
5V
$\overline{CS}$ 6
SCK/SCL 4
MOSI/SDA 7
MISO 5

U3 NC7WZ17P6X R12 100 SDI
3.3V C24 0.1uF
GND VCC

R6 200K R7 200K

EEVCC 10
EESDA 9
EESCL 11
EEGND 12
AUX 14

GND GND GND
13 8 3

R14 4.99K R8 4.99K R9 4.99K

C3 0.1uF

U5 24LC025-I /ST

6 SCL
5 SDA
7 WP
3 A2
2 A1
1 A0

ARRAY EEPROM

VCC 8
GND 4

U4 74LVC1T45GW 3.3V C25 0.1uF

1 VCC(A) VCC(B) 6
C26 0.1uF 2 GND DIR 5
3 4 SDO

R16 100

R13 200K

WP EEGND

R15 0 0603

NOTE: EEPROM FOR BOARD IDENTIFICATION

APPROVALS

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

LINEAR TECHNOLOGY

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SIZE N/A

IC NO. **LTC6946IUFD FAMILY DEMO CIRCUIT 1705C**

REV. 1

DATE: Thursday, October 02, 2014

SHEET 2 OF 2

LAYOUT

The top metal layer of the DC1705C is shown here as an example of good PCB layout for the LTC6946.
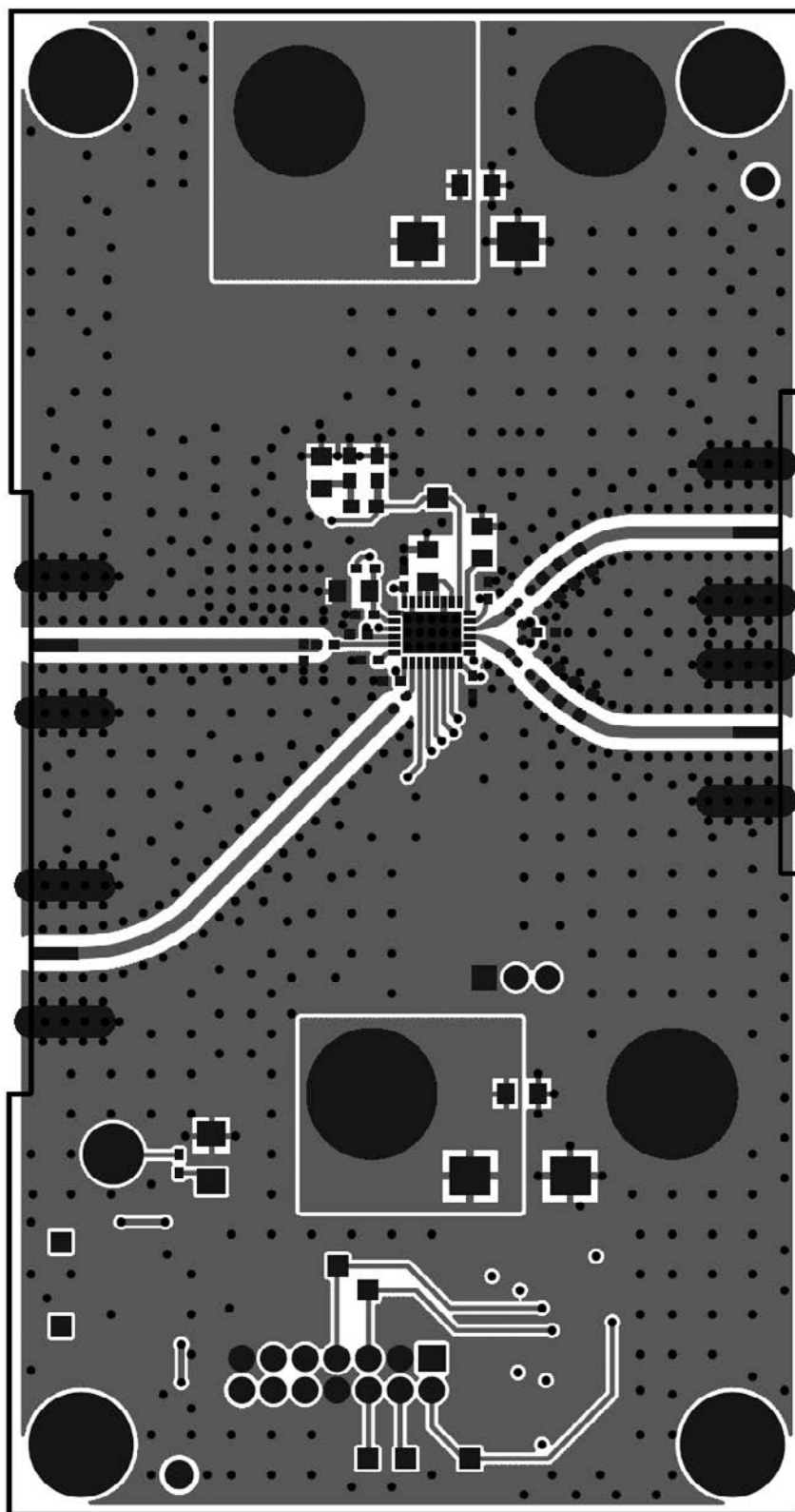
dc1705cfb

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

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If this evaluation kit does not meet the specifications recited in the DEMO BOARD manual the kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY THE SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THIS INDEMNITY, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

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This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

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dc1705cfb

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