LMX2571EVM User's Guide

User's Guide

TEXAS INSTRUMENTS

Literature Number: SNAU176
January 2015

LMX2571EVM User's Guide

The Texas Instruments LMX2571EVM evaluation module (EVM) helps designers evaluate the operation and performance of the LMX2571 Wideband Frequency Synthesizer. The EVM contains one Frequency Synthesizer.

Device: U1

IC: LMX2571

Package: QFN36

Topic **Page**

1 Setup

1.1 Input and Output Connector Description

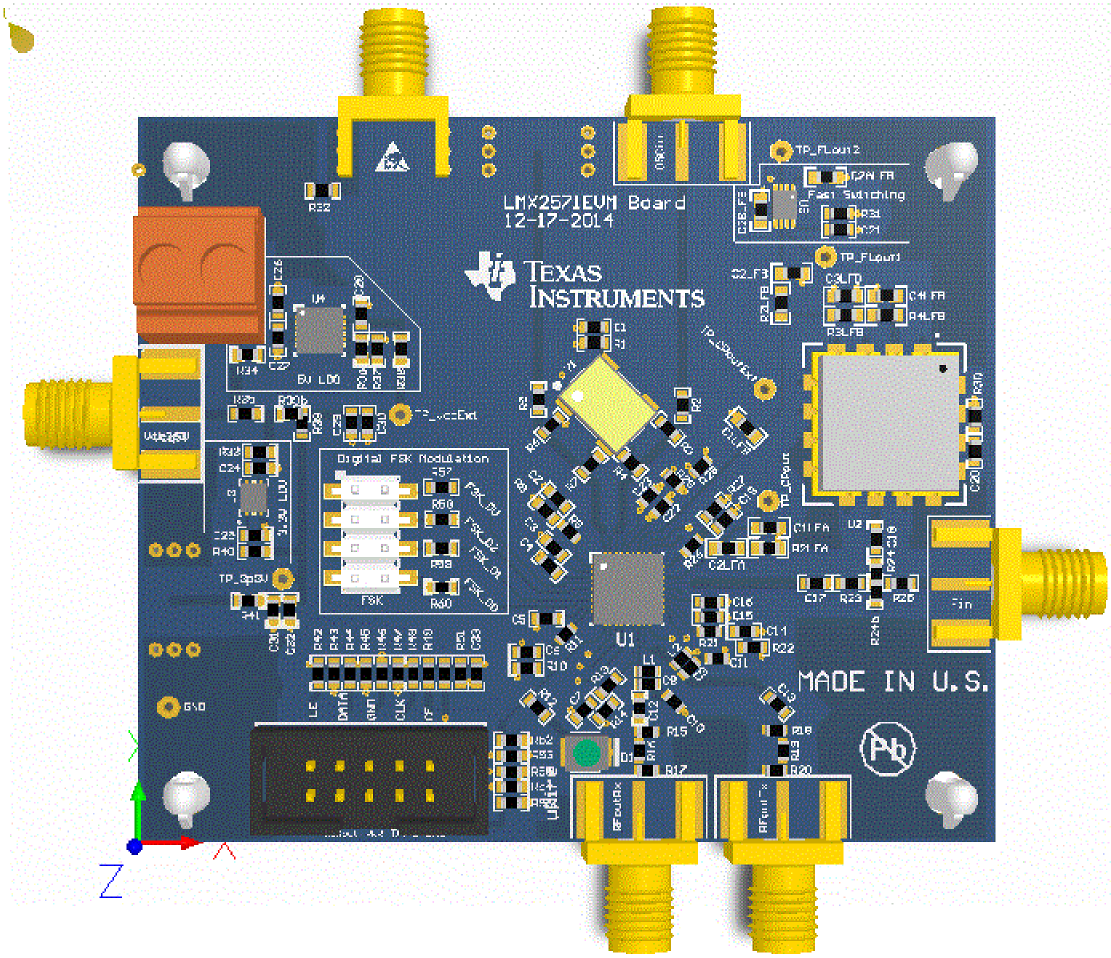

Figure 1. Evaluation Board Setup

Table 1. Inputs and Outputs

Output Name(s)	Input/Output	Required?	Function
RFoutRx RFoutRx	Output	Required	One of these outputs needs to be attached to phase noise measurement equiptment, like the Agilent E5052. The unused output need not be connected.
Vcc3p3	Input	Required	Connect to a 3.3 V Power Supply. Ensure the current limit is set above 100 mA.
Vcc5V Vcc5VTV_TB	Input	Optional	Instead of using the Vcc3p3 connector, one can connect 5V to one of these outputs and it is regulated down to 3.3V on the board.
Programming Interface	Input	Required	Connect the board to a PC using the USB2ANY (HPA665-001) interface provided in kit.
OSCin	Input	Optional	The on-board 20 MHz XO has been enabled. To use this input, the XO power supply resistor (R1) should be removed and resistor R3 moved to position R2.

1.2 Installing the EVM Software

Go to http://www.ti.com/tool/codeloader and download and run the most current software.

1.3 Loop Filter Values and Configuration Information

Table 2. Loop Filter values and Configuration

Category	Parameter	Value
Configuration	OSCin Frequency (MHz)	20 MHz
	Phase Detector Frequency (MHz)	80 MHz
	VCO Frequency	4300 to 5400 MHz
	Charge Pump Gain	1x 1240 µA
VCO Gain	VCO_L	46 to 61 MHz/V
	VCO_M	50 to 65 MHz/V
	VCO_H	55 to 73 MHz/V
Loop Filter Components	C1_LF	390 pF
	C2_LF	4.7 nF
	C3_LF (Internal)	50 pF
	C4_LF (Internal)	50 pF
	R2_LF	680 Ω
	R3_LF (Internal)	800 Ω
	R4_LF (Internal)	800 Ω
Loop Filter Characteristics (Assuming Fvco=4.8 GHz, Kvco=56 MHz/V)	Loop Bandwidth	234 kHz
	Phase Margin	43.7°

1.4 Readback Notification

Although the LMX2571 does support readback, there are some issues with the CodeLoader software and board to do this. In order to readback, this needs to be done with external software. As a means of debugging, consider using the power down feature and monitoring the changes in the current consumption.

1.5 Lock Detect Notification

The lock detect on the LMX2571 works perfectly well. However, the LED decides to light when it feels like it. Pressing on the LED with one's fingernail can sometimes get it to work better. The key takeaway from this is the green LED is not reliable for lock detect. If it is on, it indicates lock, but if it is off, it indicates unlock or an issue with the LED diode.

1.6 Pin 8 Component Notification

Note that Pin 8 has a capacitor to ground, but it was found that this component provided no benefit, although it does no harm either.

1.7 Crystal Oscillator Noise Notification

The following plot shows the XO noise compared to a much cleaner reference. The XO is included for quick startup and evaluation, but can be bypassed or changed. The criteria for choosing the XO was availability and standard footprint, which took priority over phase noise and stability. Sometimes if the XO is burn in by letting the board run for a few hours, the phase noise and stability will improve. Optimal phase noise is obtained with a clean input signal.

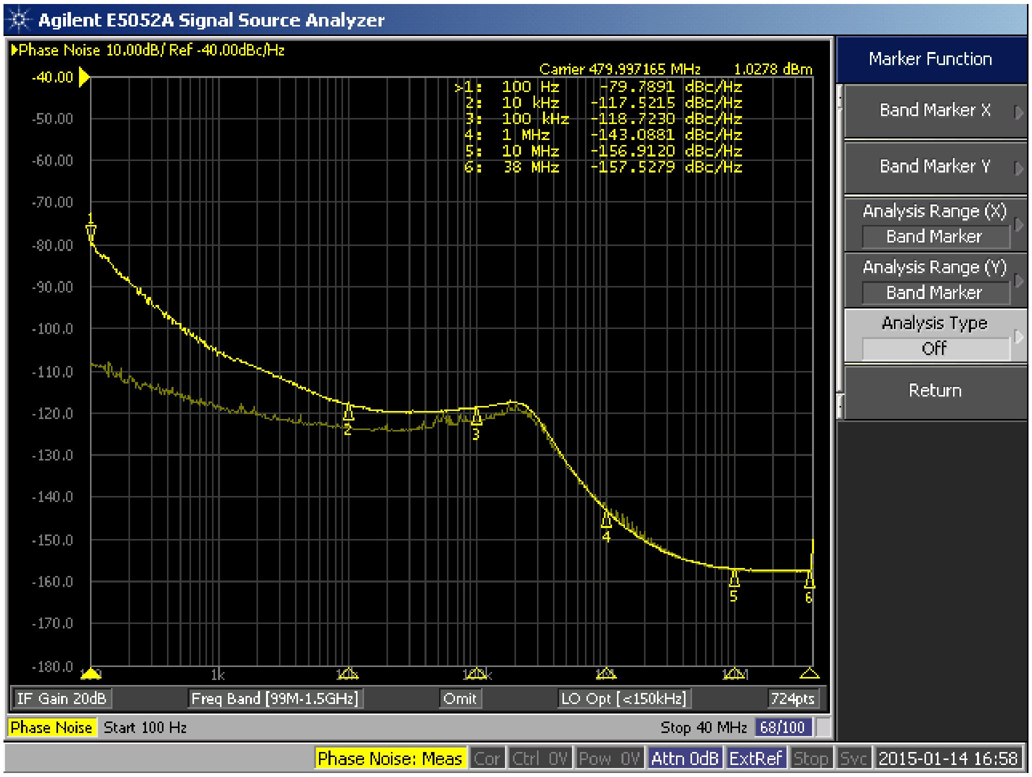

Figure 2. Impact of XO Noise

2 Using the EVM Software

2.1 Main Setup and Default Mode

Choose the default startup mode on the main tab as shown. After the default mode is loaded, don't forget to load the device with Ctrl+L or with Keyboard Controls -> Load Device.

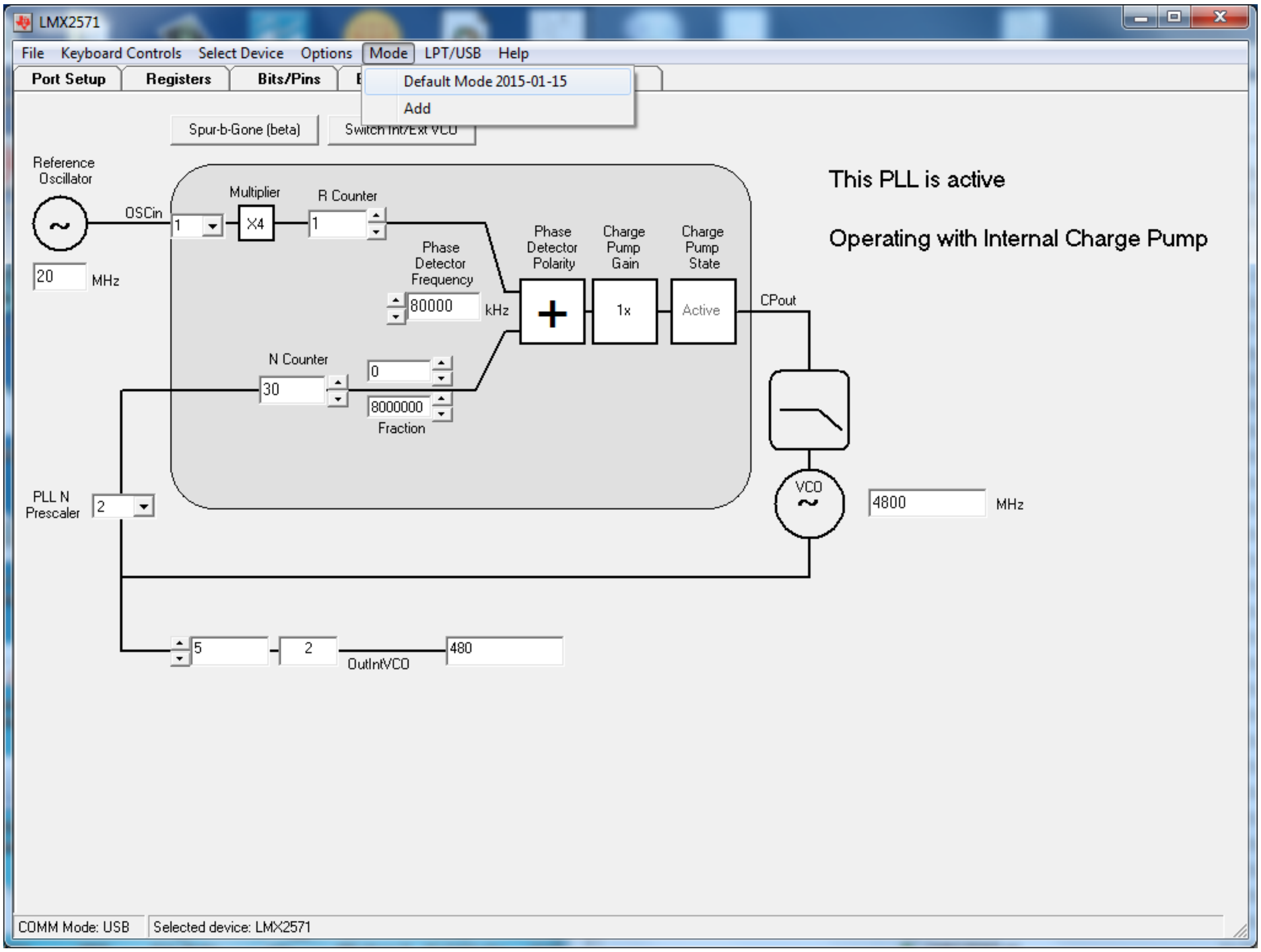

Figure 3. Loading Default Mode for the Main Configuration Screen

2.2 Port Setup

On the Port Setup tab, the user may select the type of communication port (USB or Parallel) that will be used to program the device on the evaluation board. If parallel port is selected, the user should ensure that the correct port address is entered. CodeLoader does NOT auto detect the correct settings for this. The identify function verifies that the computer is communicating wit the USB2ANY board, but does NOT verify that the USB2ANY board is communicating with the device.

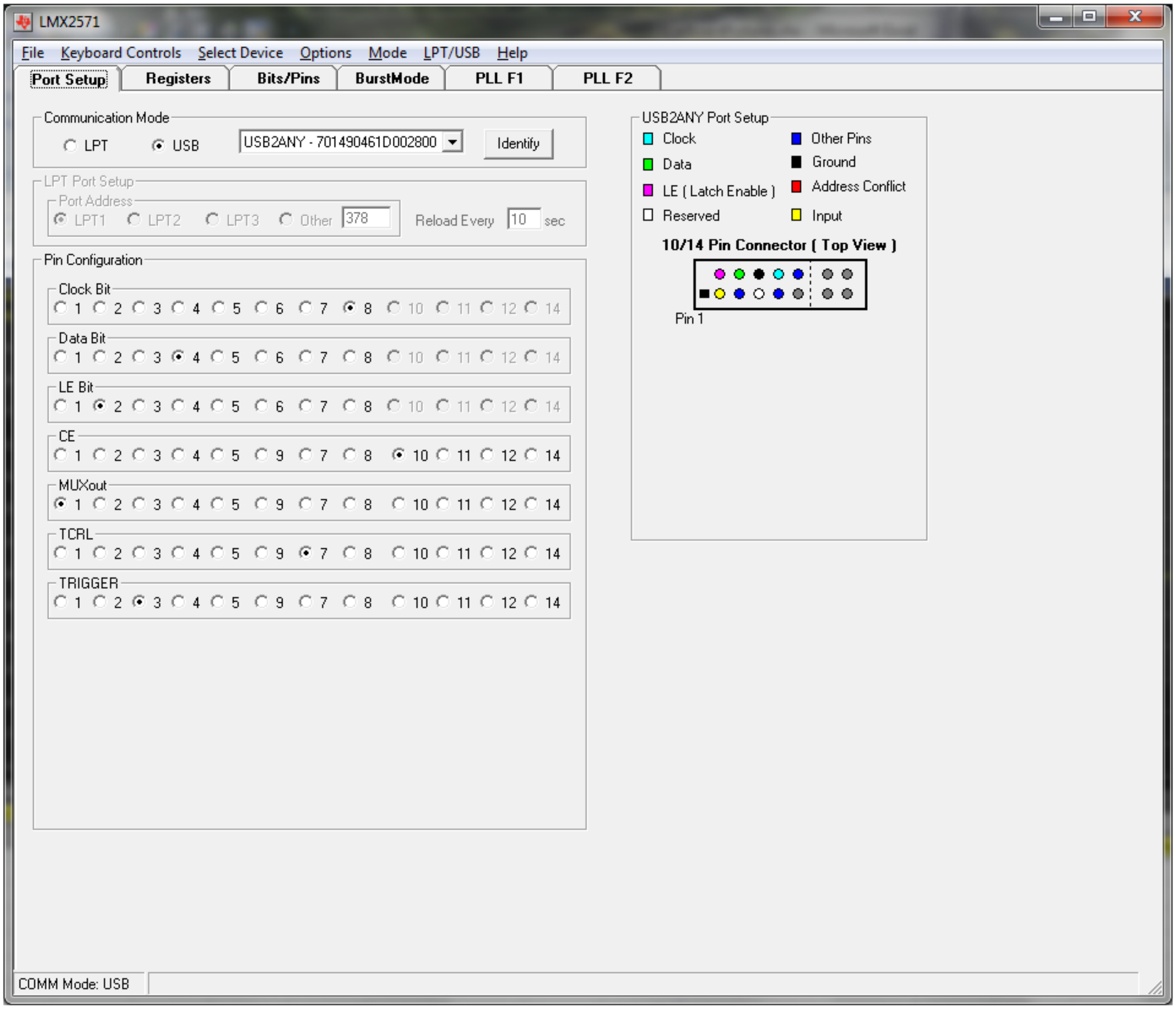

Figure 4. Port Setup Tab

2.3 Bits/Pins Settings

To view the function of any bit on the CodeLoader configuration tabs, place the cursor over the desired bit register label and click the right mouse button on it for a description.

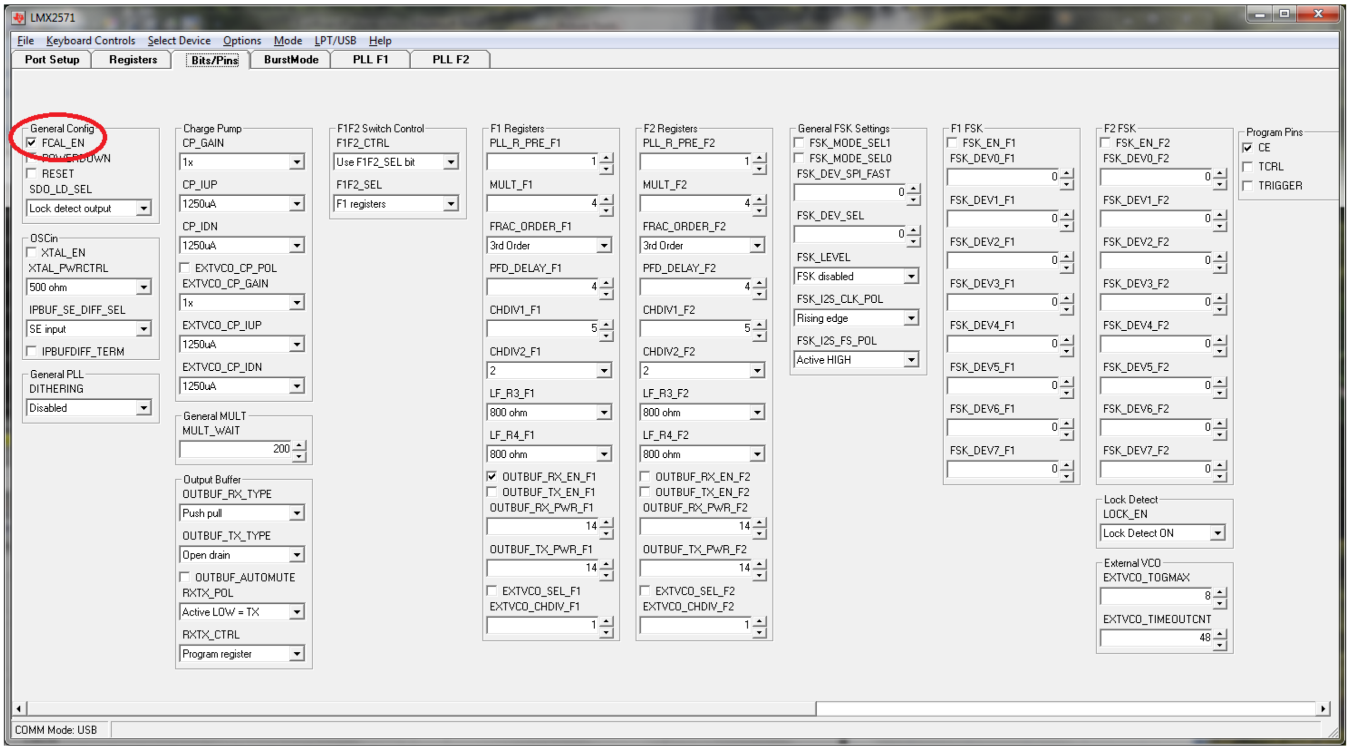

Figure 5. Bits/Pins Tab

3 Board Construction

3.1 Board Layer Stack Up

The board is made on FR4 for the Prepreg and Core Layers. The top layer is 1 oz copper.

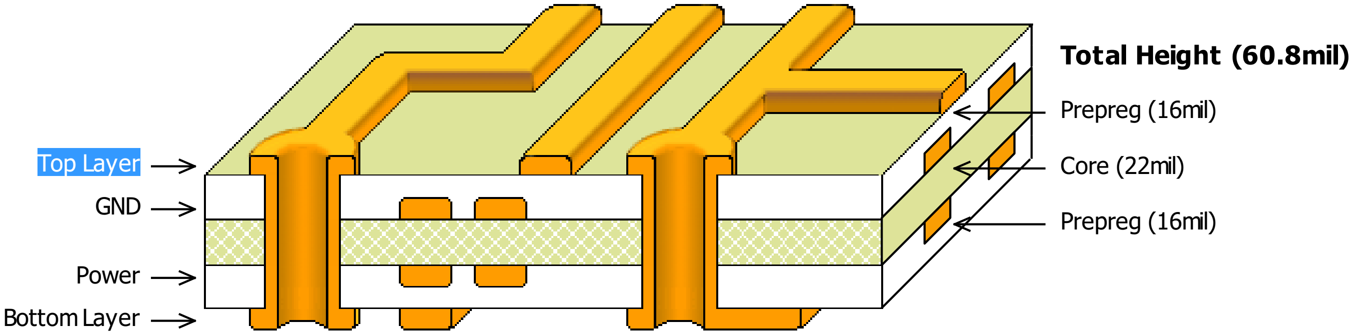

Figure 6. Board Layer Stack Up

FR4 material was chosen because of convenience, availability, and cost.

3.2 Schematic

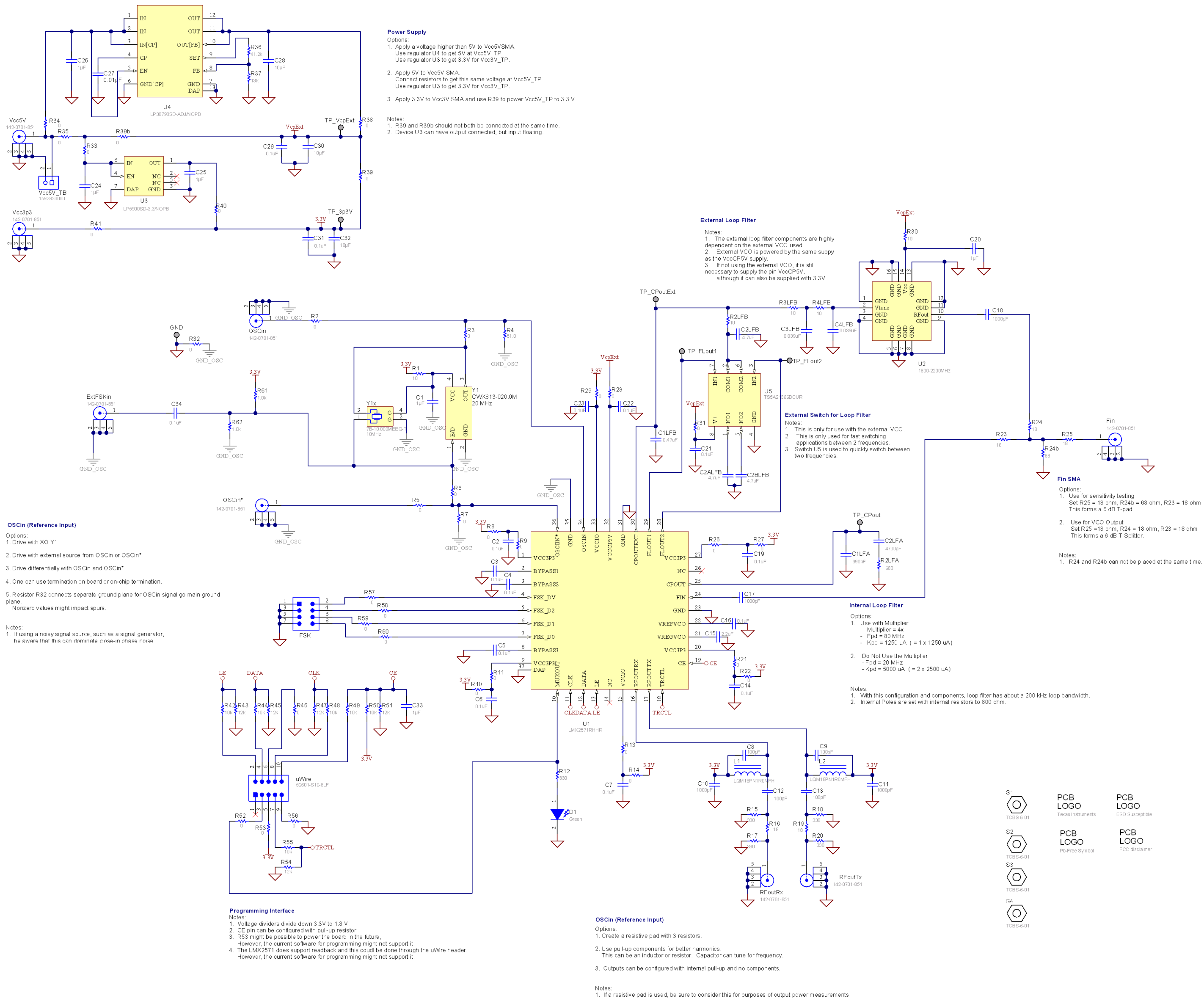

Figure 7. LMX2571 Schematic

4 PCB Layers

Figure 8 shows the assembly diagram that indicates where the components are placed.

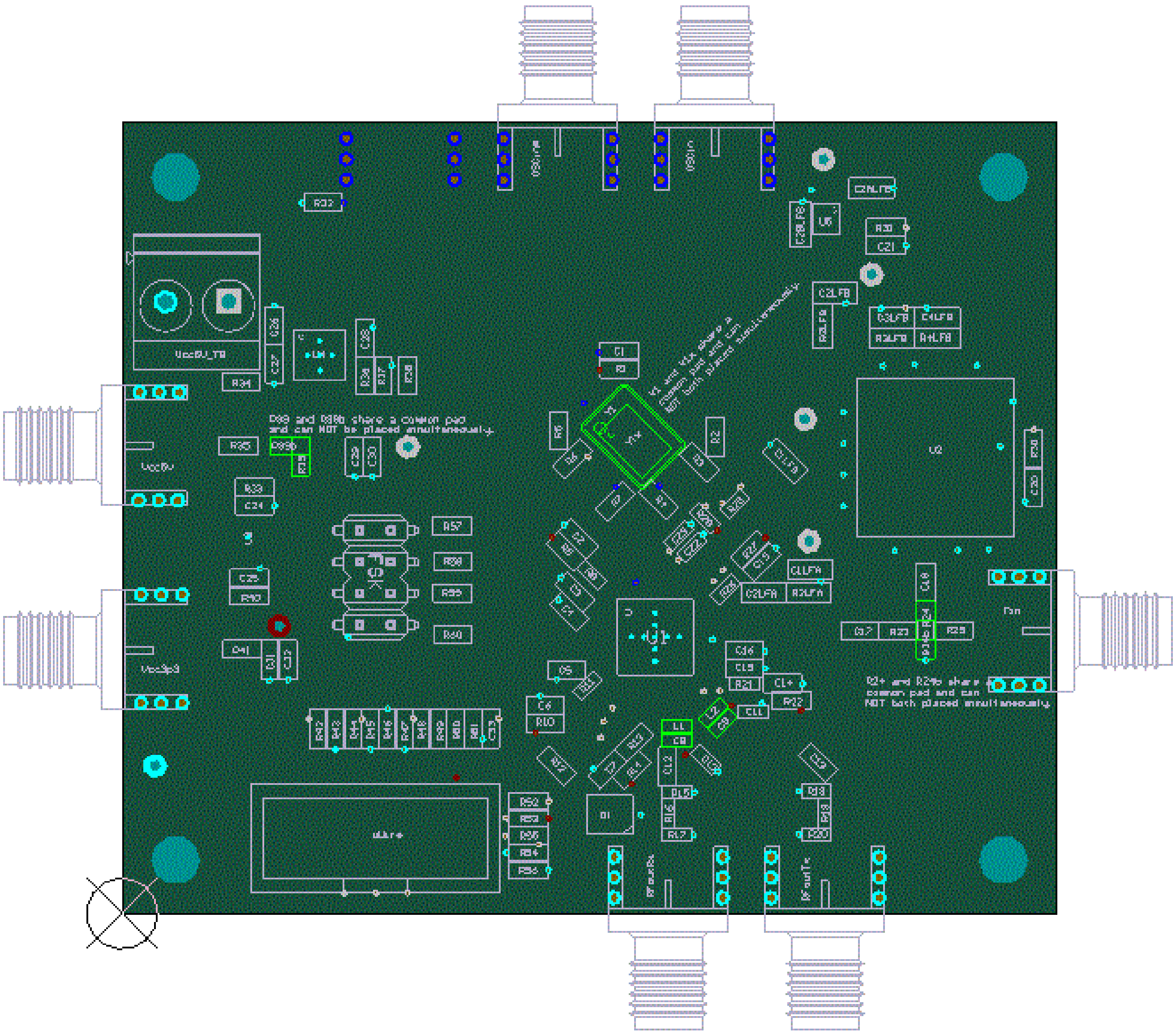

Figure 8. Top Assembly Layer

In the Top Layer, Figure 9, the ground plane is pulled far away from the signal traces to minimize the potential of spur energy coupling onto them. This board can be assembled with all components on the top layer.

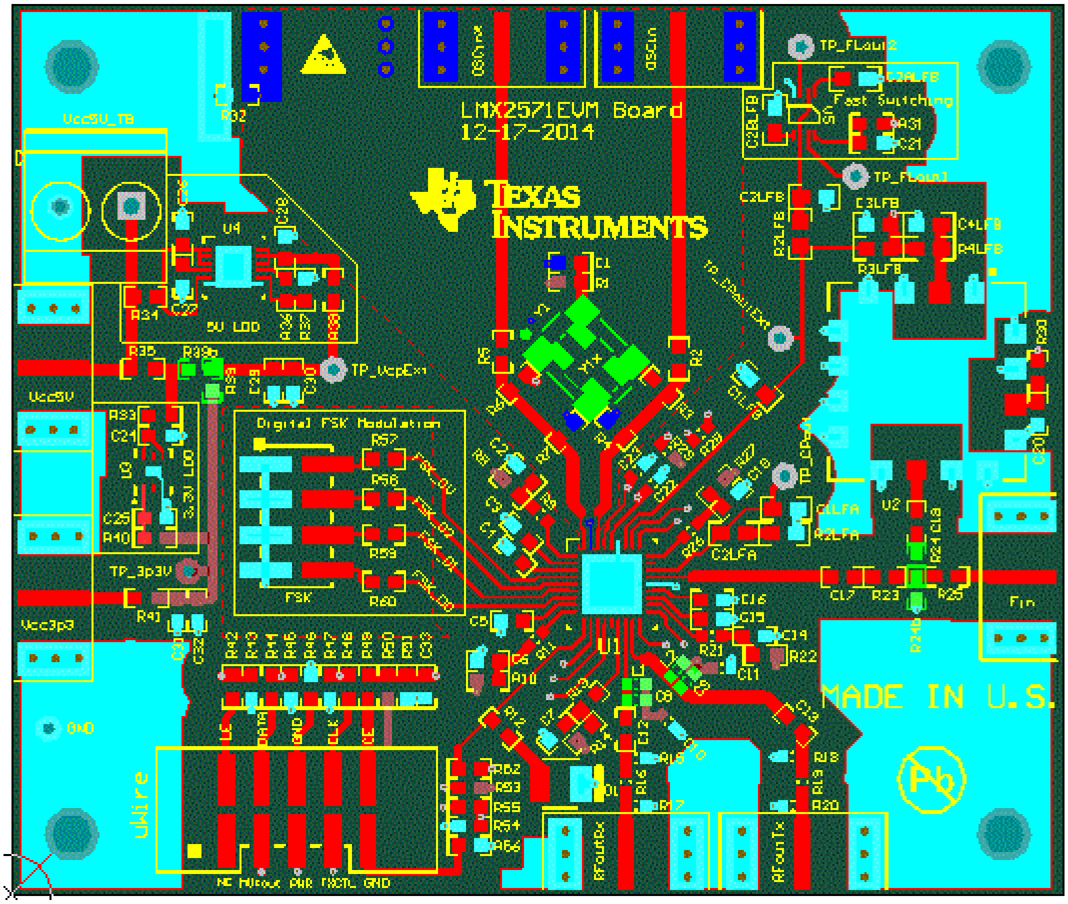

Figure 9. Top Layer

On the Ground Layer, Figure 10, notice that there is a separate ground plane below the OSCin signal. This is to prevent the OSCin signal coupling to the other ground plane. They are connected by a resistor on the top layer.

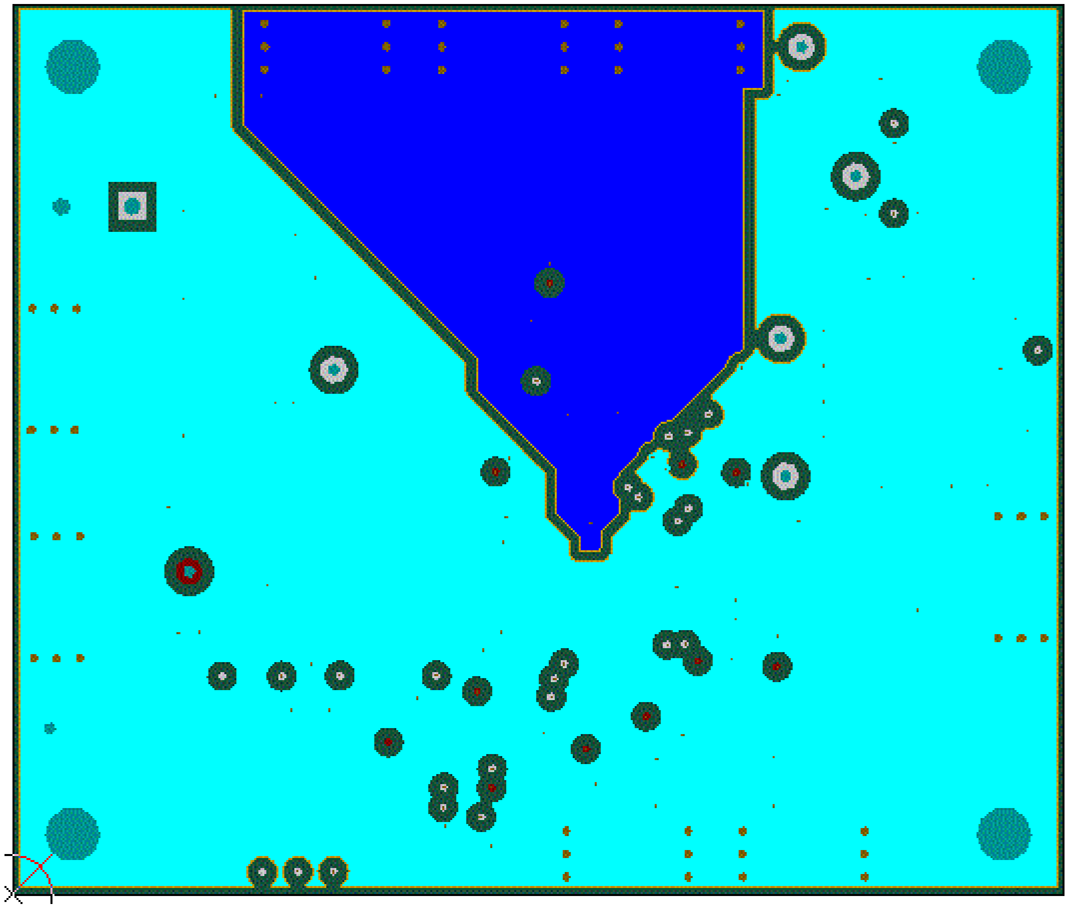

Figure 10. Ground Layer

The power layer, Figure 11, effort is made to avoid putting any plane below the OSCin signal ground, to minimize the potential of spur coupling. The upper right plaine is the 5V plane and the lower left is the 3.3V pPlane.

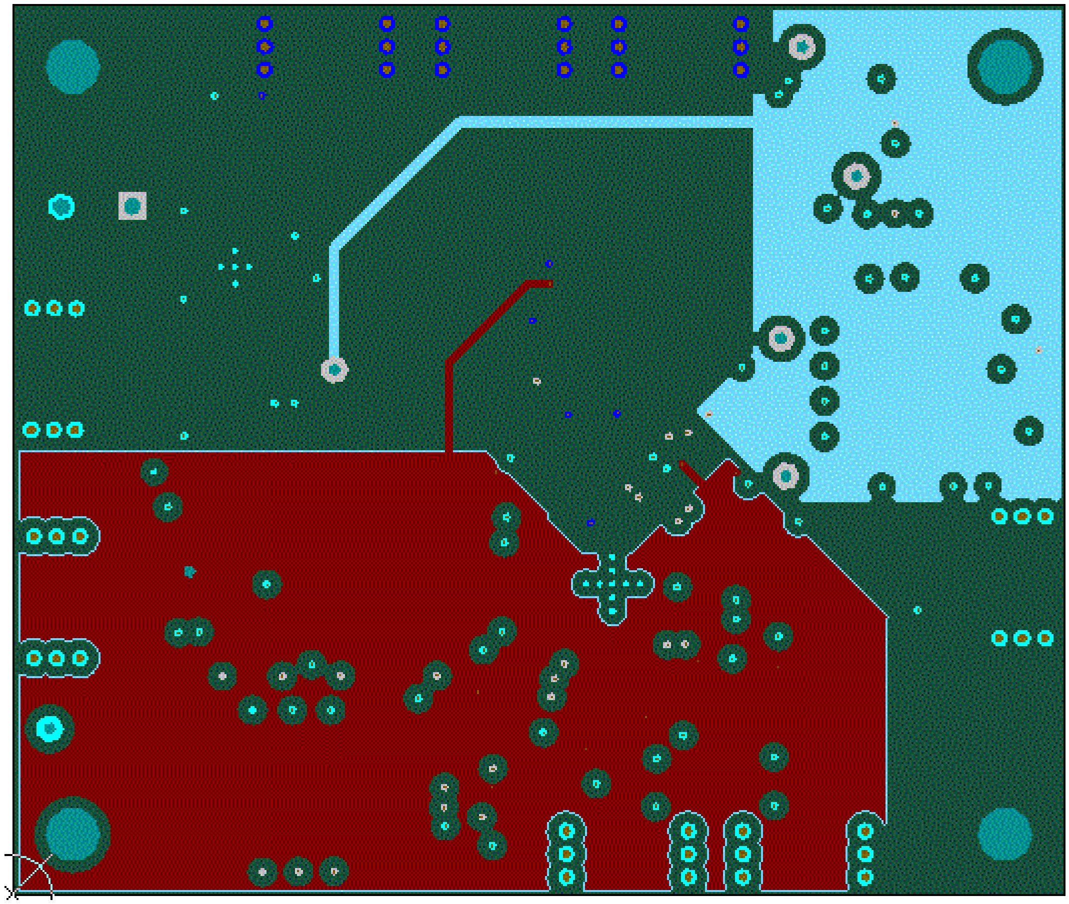

Figure 11. Power Layer

The Bottom Layer, Figure 12, is used to route less critical functions.

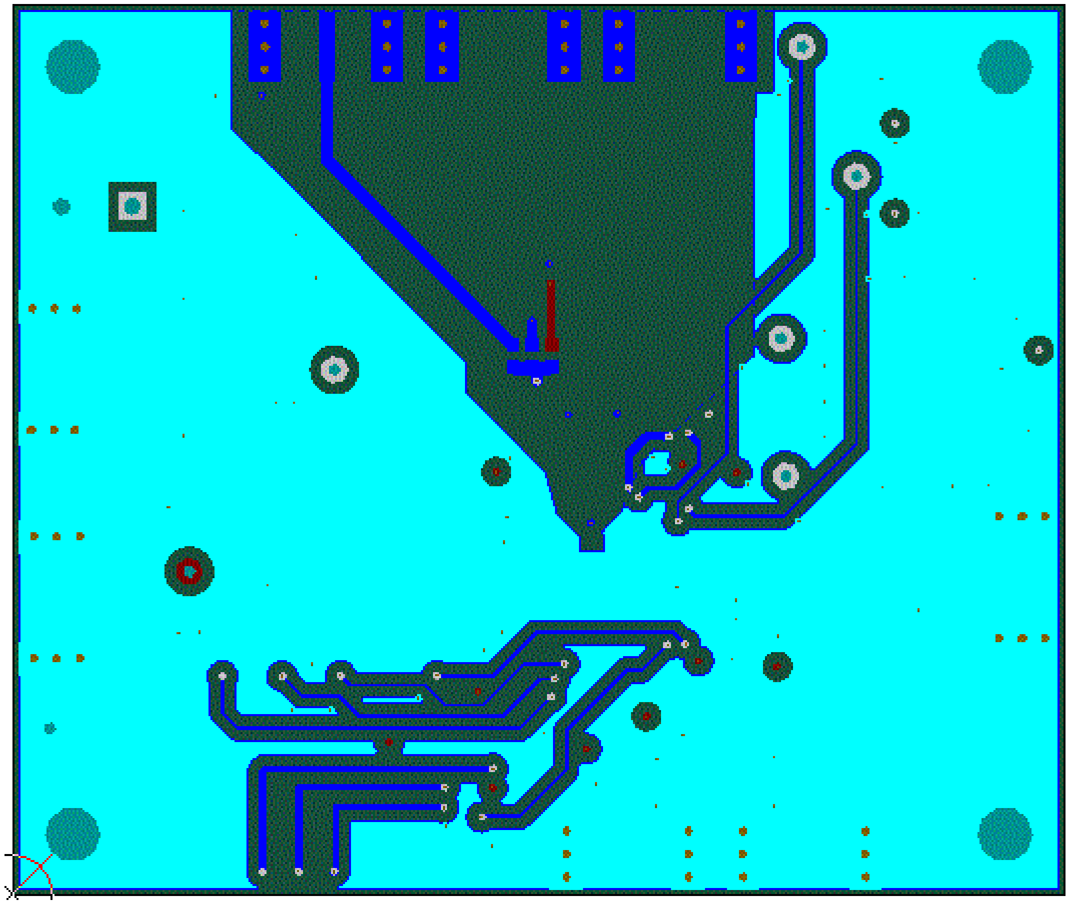

Figure 12. Bottom Layer

5 Measured Performance Data

5.1 Phase Noise in Default Mode

Figure 13 shows the phase noise in default mode.

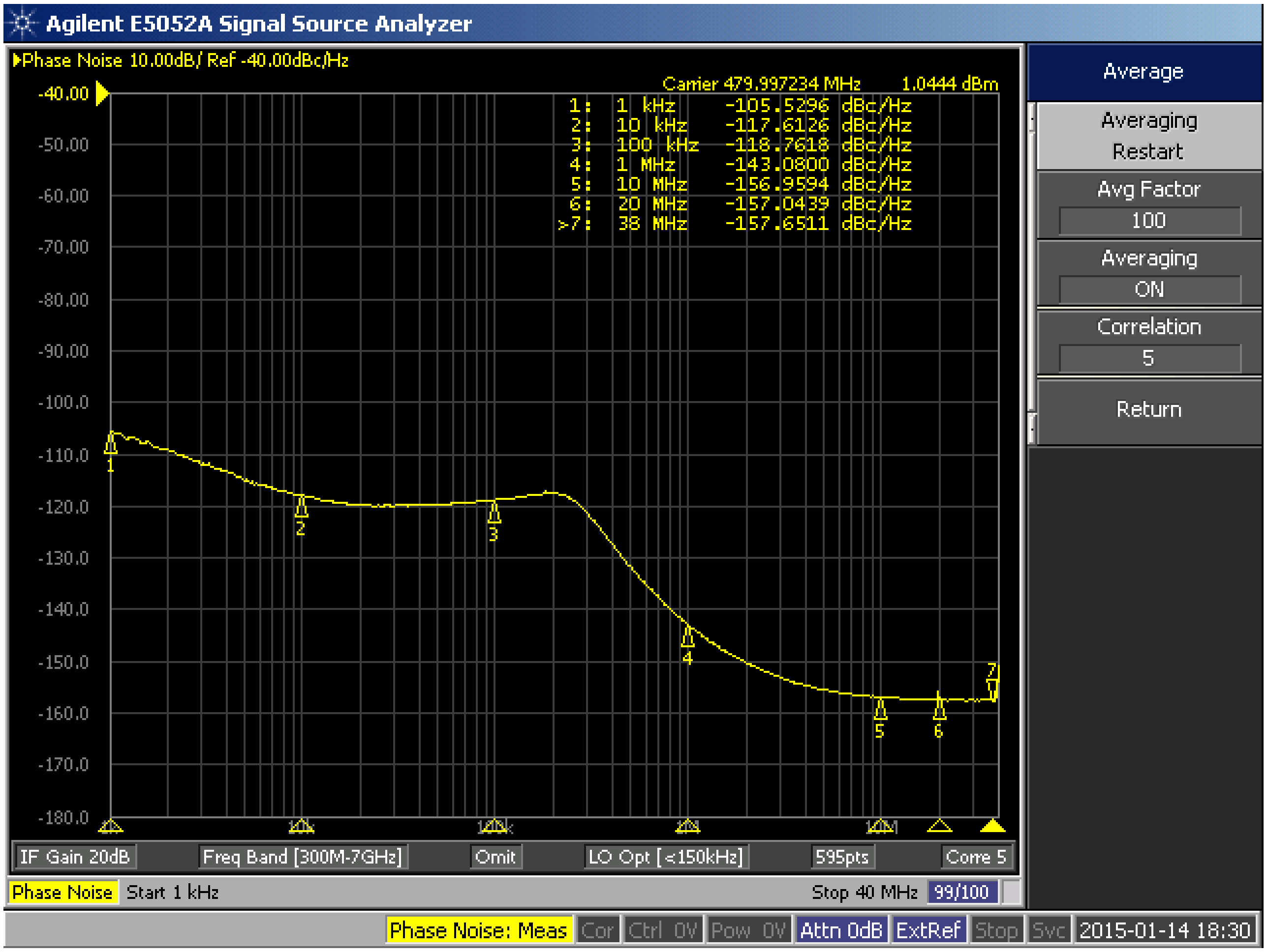

Figure 13. Phase Noise (Default Mode)

Figure 14 shows the phase noise in default mode as well. The dim trace is the default mode (Fpd=80MHz) and the bright trace has Fpd=20 MHz and 4 times the charge pump current (to keep the same bandwidth). We see that the results are similar.

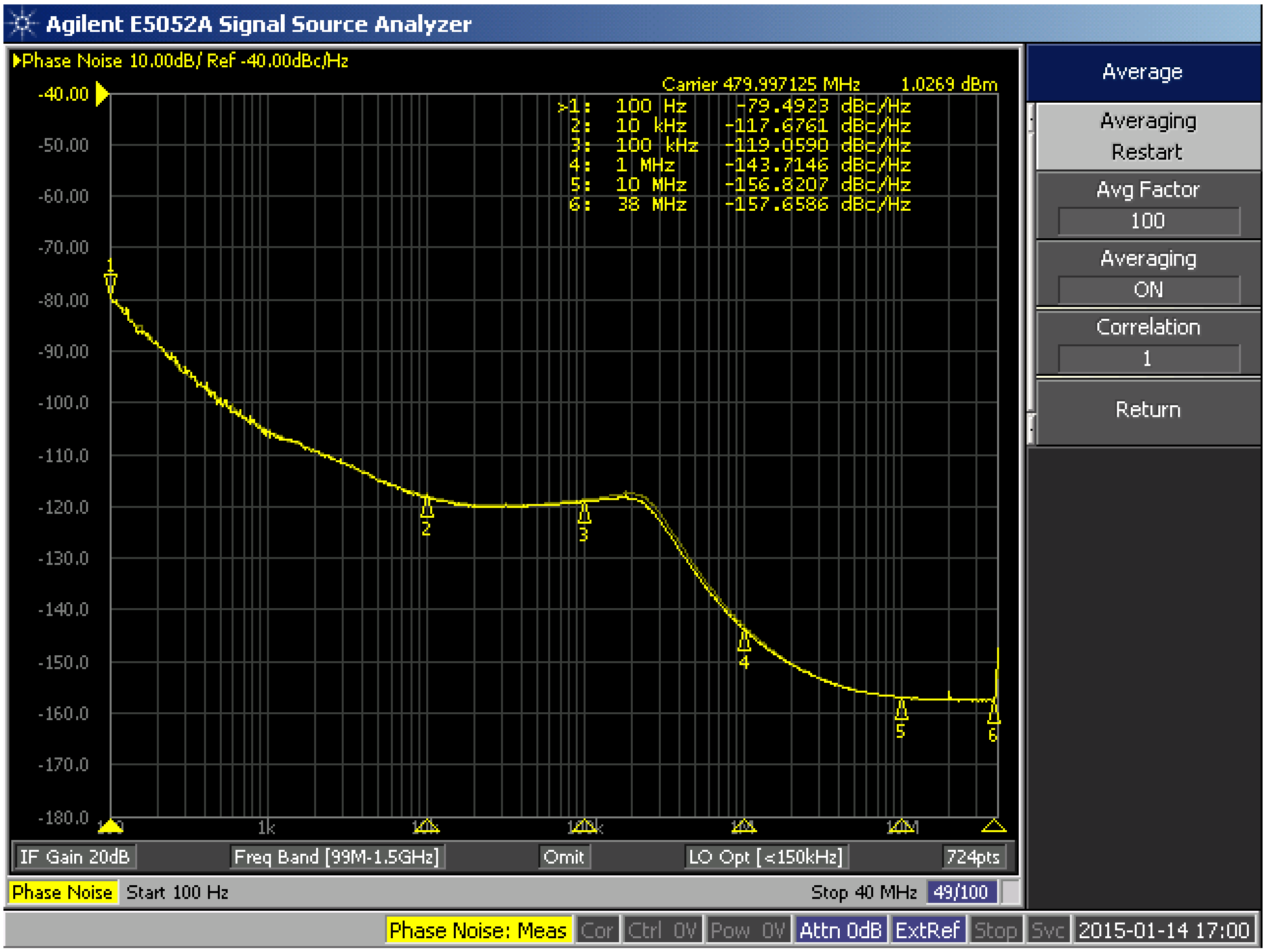

Figure 14. Default Mode vs. Fpd = 20 MHz and 4x Higher Charge Pump Gain

Figure 15 Shows the impact of taking a 4800 MHz VCO signal and dividing with the pre divider values of 4,5,6, and 7. We see a textbook 20*log relationship for phase noise. about -155 dBc/Hz. The second plot shows when the secondary channel divider is used. Close in, we see the 20*log relationship, but eventually, this hits a noise floor.

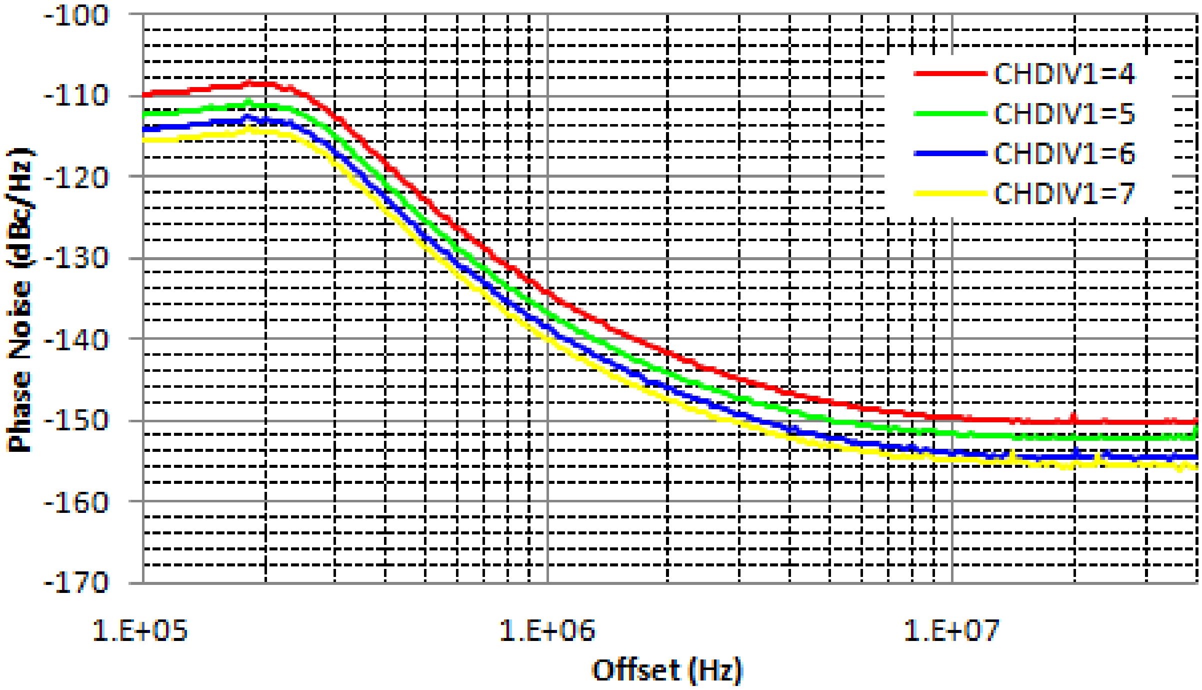

Figure 15. Phase Noise (Default Mode)

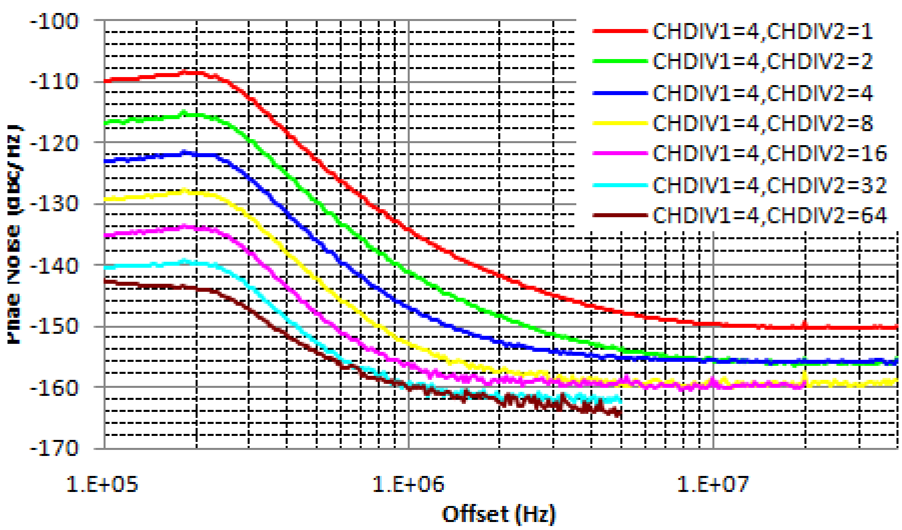

Figure 16. Noise Floor with CHDIV2

5.2 VCO Phase Noise

5.2.1 Fvco = 4400 MHz / 4

Figure 17 shows the phase noise of just the VCO at 4400 MHz and divided by 4. To take this measurement, the charge pump was set to tri-state and this is why the frequency is off.

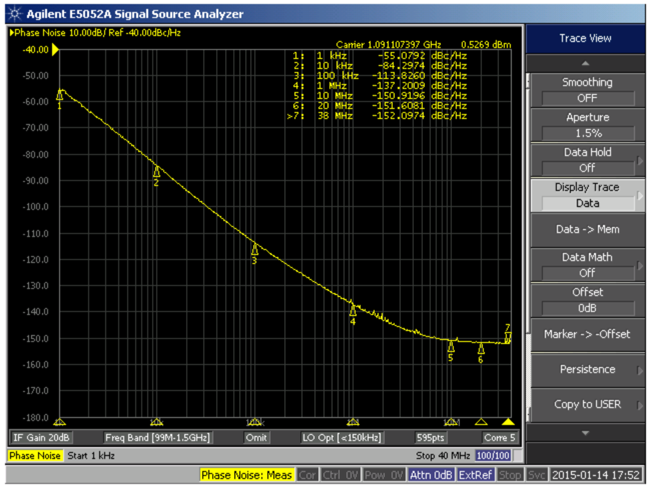

Figure 17. VCO Phase Noise
Fvco = 4800 MHz/4

5.2.2 Fvco = 4800 MHz/4

Figure 18 shows the phase noise of just the VCO at 4800 MHz and divided by 4. To take this measurement, the charge pump was set to tri-state and this is why the frequency is off.

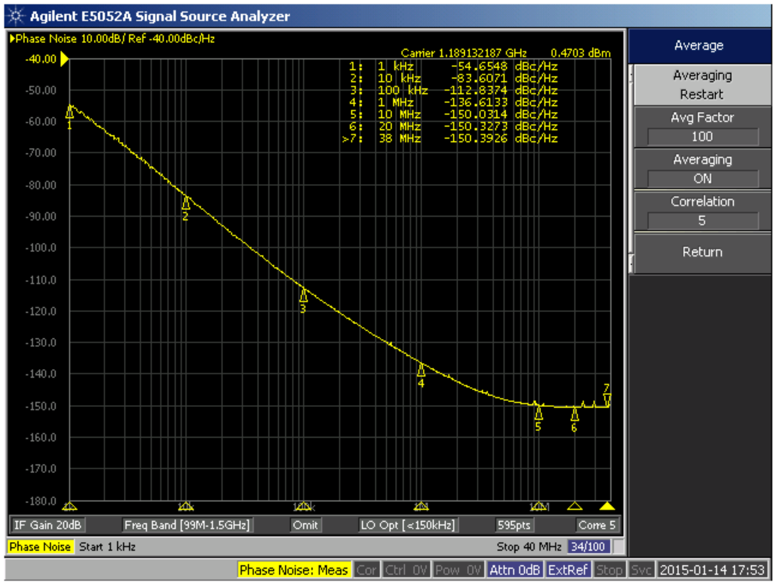

**Figure 18. VCO Phase Noise
Fvco = 4800 MHz/4**

5.2.3 Fvco = 5200 MHz/4

Figure 19shows the phase noise of just the VCO at 5200 MHz and divided by 4. To take this measurement, the charge pump was set to tri-state and this is why the frequency is off.

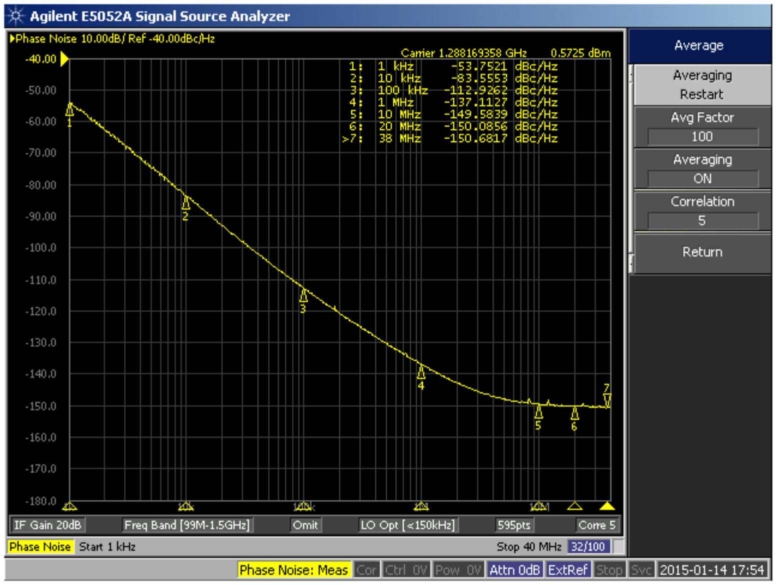

Figure 19. VCO Phase Noise Fvco = 5200 MHz/4

5.3 Fractional Spurs and Spur-b-Gone

This plot is for a VCO frequency of 4881 MHz, which is very close to the integer boundary of 4880 MHz. Note the 1 MHz spur and also we see 1 MHz/4 = 250 kHz from the output divider

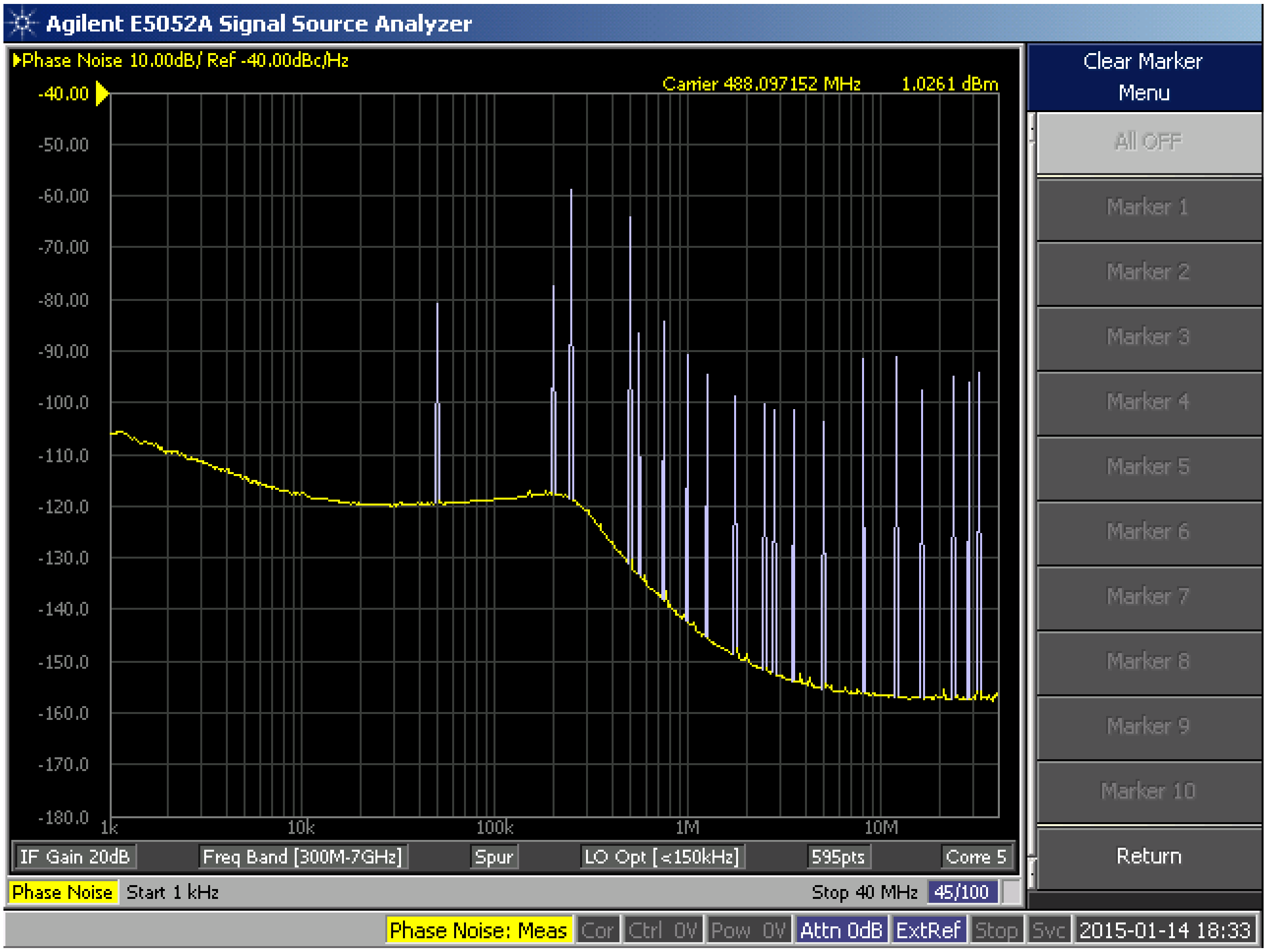

Figure 20. No Spur-b-Gone
Fvco = 4881 MHz/10,
Fpd = 80 MHz

After using Spur-B-Gone, the phase detector changes from 80 to 110 MHz and we see that the spurs are substantially reduced.

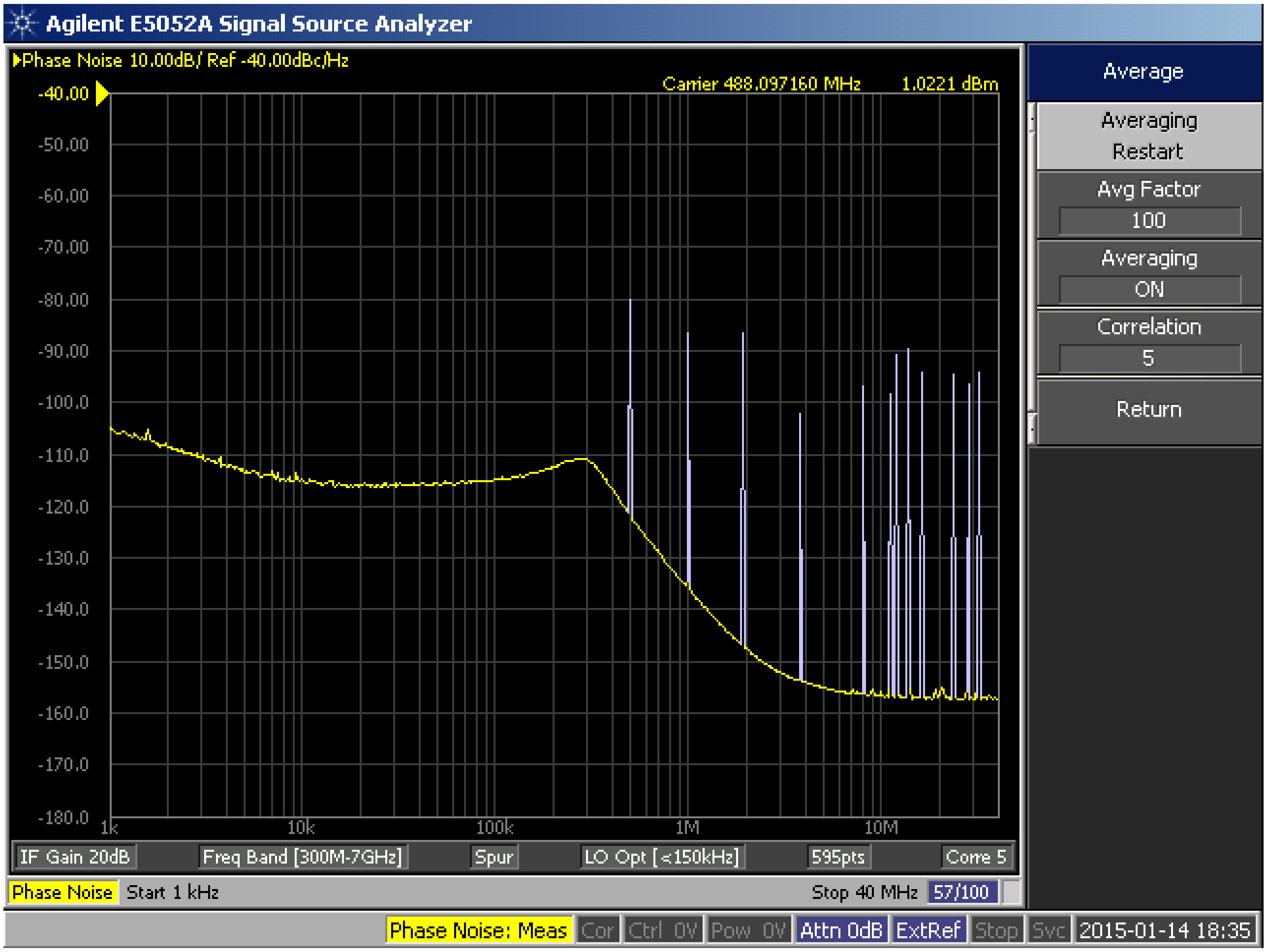

Figure 21. With Spur-b-Gone:
Fvco = 4881 MHz/10,
Fpd = 110 MHz

6 Bill of Materials

Table 3. LMX2571 Bill of Materials

Item	Designator	Description	RoHS	Manufacturer	PartNumber	Quantity
1	C1, C20, C24, C25, C26, C33	CAP, CERM, 1 µF, 16 V, +/- 10%, X7R, 0603	Y	MuRata	GRM188R71C105KA12D	6
2	C1LFA	CAP, CERM, 390pF, 50V, +/-5%, C0G/NP0, 0603	Y	AVX	06035A391JAT2A	1
3	C2, C3, C4, C5, C6, C7, C14, C16, C19, C21, C22, C23, C29, C31	CAP, CERM, 0.1uF, 16V, +/-5%, X7R, 0603	Y	AVX	0603YC104JAT2A	14
4	C2LFA	CAP, CERM, 4700pF, 100V, +/-5%, X7R, 0603	Y	AVX	06031C472JAT2A	1
5	C12, C13	CAP, CERM, 100pF, 50V, +/-5%, C0G/NP0, 0603	Y	Kemet	C0603C101J5GACTU	2
6	C15	CAP, CERM, 2.2uF, 10V, +/-10%, X5R, 0603	Y	Kemet	C0603C225K8PACTU	1
7	C17, C18	CAP, CERM, 1000pF, 100V, +/-5%, X7R, 0603	Y	AVX	06031C102JAT2A	2
8	C27	CAP, CERM, 0.01uF, 50V, +/-10%, X5R, 0603	Y	MuRata	GRM188R61H103KA01D	1
9	C28, C30, C32	CAP, CERM, 10 µF, 25 V, +/- 20%, X5R, 0603	Y	MuRata	GRM188R61E106MA73	3
10	D1	LED, Green, SMD	Y	Lumex	SML-LX2832GC-TR	1
11	Fin, OSCin, RFoutRx, RFoutTx, Vcc3p3	Connector, End launch SMA, 50 ohm, SMT	Y	Emerson Network Power	142-0701-851	5
12	R1, R30	RES, 10 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060310R0JNEA	2
13	R2LFA	RES, 680 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW0603680RJNEA	1
14	R3, R8, R9, R10, R11, R13, R14, R21, R22, R26, R27, R28, R29, R32, R33, R35, R40, R41, R46, R52, R53	RES, 0 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW06030000Z0EA	21
15	R12	RES, 330 ohm, 5%, 0.1W, 0603	Y	Yageo America	RC0603JR-07330RL	1
16	R15, R17, R18, R20	RES, 330 ohm, 1%, 0.1W, 0603	Y	Yageo America	RC0603FR-07330RL	4
17	R16, R19, R23, R24, R25	RES, 18 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060318R0JNEA	5
18	R36	RES, 41.2 k, 1%, 0.1 W, 0603	Y	Vishay-Dale	CRCW060341K2FKEA	1
19	R37	RES, 13k ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060313K0JNEA	1
20	R42, R44, R48, R50, R55	RES, 10k ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060310K0JNEA	5
21	R43, R45, R47, R54	RES, 12k ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060312K0JNEA	4
22	S1, S2, S3, S4	HEX STANDOFF SPACER, 9.53 mm	Y	Richco Plastics	TCBS-6-01	4
23	U1	Low Power Synthesizer with FSK Modulation, RHH0036C		Texas Instruments	LMX2571RHHR	1
24	U3	Ultra Low Noise, 150mA Linear Regulator for RF/Analog Circuits Requires No Bypass Capacitor, 6-pin LLP, Pb-Free	Y	National Semiconductor	LP5900SD-3.3/NOPB	1

Table 3. LMX2571 Bill of Materials (continued)

25	U4	Ultra Low Noise, 800 mA Linear Voltage Regulator for RF/Analog Circuits, DNT0012B	Y	Texas Instruments	LP38798SD-ADJ/NOPB	1
26	U5	0.75-O DUAL SPST ANALOG SWITCH WITH 1.8-V COMPATIBLE INPUT LOGIC, DCU0008A	Y	Texas Instruments	TS5A21366DCUR	1
27	uWire	Header (shrouded), 100mil, 5x2, Gold plated, SMD	Y	FCI	52601-S10-8LF	1
28	Vcc5V_TB	Terminal Block, 10.76x17x11 mm, 2POS, 26-12AWG, TH	Y	Weidmuller	1592820000	1
29	Y1	Oscillator, 20MHz, 3.3 V, SMD	Y	Connor-Winfield	CWX813-020.0M	1
30	C1LFB	CAP, CERM, 0.47uF, 16V, +/-10%, X7R, 0603	Y	Kemet	C0603C474K4RACTU	0
31	C2ALFB, C2BLFB, C2LFB	CAP, CERM, 4.7uF, 16V, +/-10%, X5R, 0603	Y	MuRata	GRM188R61C475KAAJ	0
32	C3LFB, C4LFB	CAP, CERM, 0.039uF, 100V, +/-10%, X7R, 0603	Y	Kemet	C0603C393K1RACTU	0
33	C8, C9	CAP, CERM, 100pF, 50V, +/-5%, C0G/NP0, 0603	Y	Kemet	C0603C101J5GACTU	0
34	C10, C11	CAP, CERM, 1000pF, 100V, +/-5%, X7R, 0603	Y	AVX	06031C102JAT2A	0
35	C34	CAP, CERM, 0.1uF, 16V, +/-5%, X7R, 0603	Y	AVX	0603YC104JAT2A	0
36	ExtFSKin, OSCin*, Vcc5V	Connector, End launch SMA, 50 ohm, SMT	Y	Emerson Network Power	142-0701-851	0
37	FSK	Header (shrouded), 100mil, 5x2, Gold plated, SMD	Y	FCI	52601-S10-8LF	0
38	L1, L2	Inductor, Ferrite, 1uH, 0.7A, 0.15 ohm, SMD	Y	MuRata	LQM18PN1R0MFH	0
39	R2, R5, R6, R7, R31, R34, R38, R39, R56, R59, R60, R61, R62	RES, 0 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW06030000Z0EA	0
40	R2LFB, R3LFB, R4LFB	RES, 10 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060310R0JNEA	0
41	R4	RES, 51.0 ohm, 1%, 0.1W, 0603	Y	Yageo America	RC0603FR-0751RL	0
42	R24b	RES, 68 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060368R0JNEA	0
43	R49	RES, 10k ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060310K0JNEA	0
44	R51	RES, 12k ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060312K0JNEA	0
45	R57, R58	RES, 1.0k ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW06031K00JNEA	0
46	U2	VCO, 1800-2200MHz, SMD	Y	Crystek Corporation	CVCO55BE-1800-2200	0
47	Vcc3p3_TB	Terminal Block, 10.76x17x11 mm, 2POS, 26-12AWG, TH	Y	Weidmuller	1592820000	0
48	Y1x	Crystal, 10.000MHz, 10pF, SMD	Y	TXC Corporation	7B-10.000MEEQ-T	0

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

This Revision History highlights the technical changes made to this document

SNAU136 Revisions

SEE	ADDITIONS/MODIFICATIONS/DELETIONS
SNAU136	**General Comments:** Initial Document Revision