

LMX2492 Evaluation Instructions Ultra Low Noise Frequency Synthesizer with Integrated VCO Evaluation Board Operating Instructions

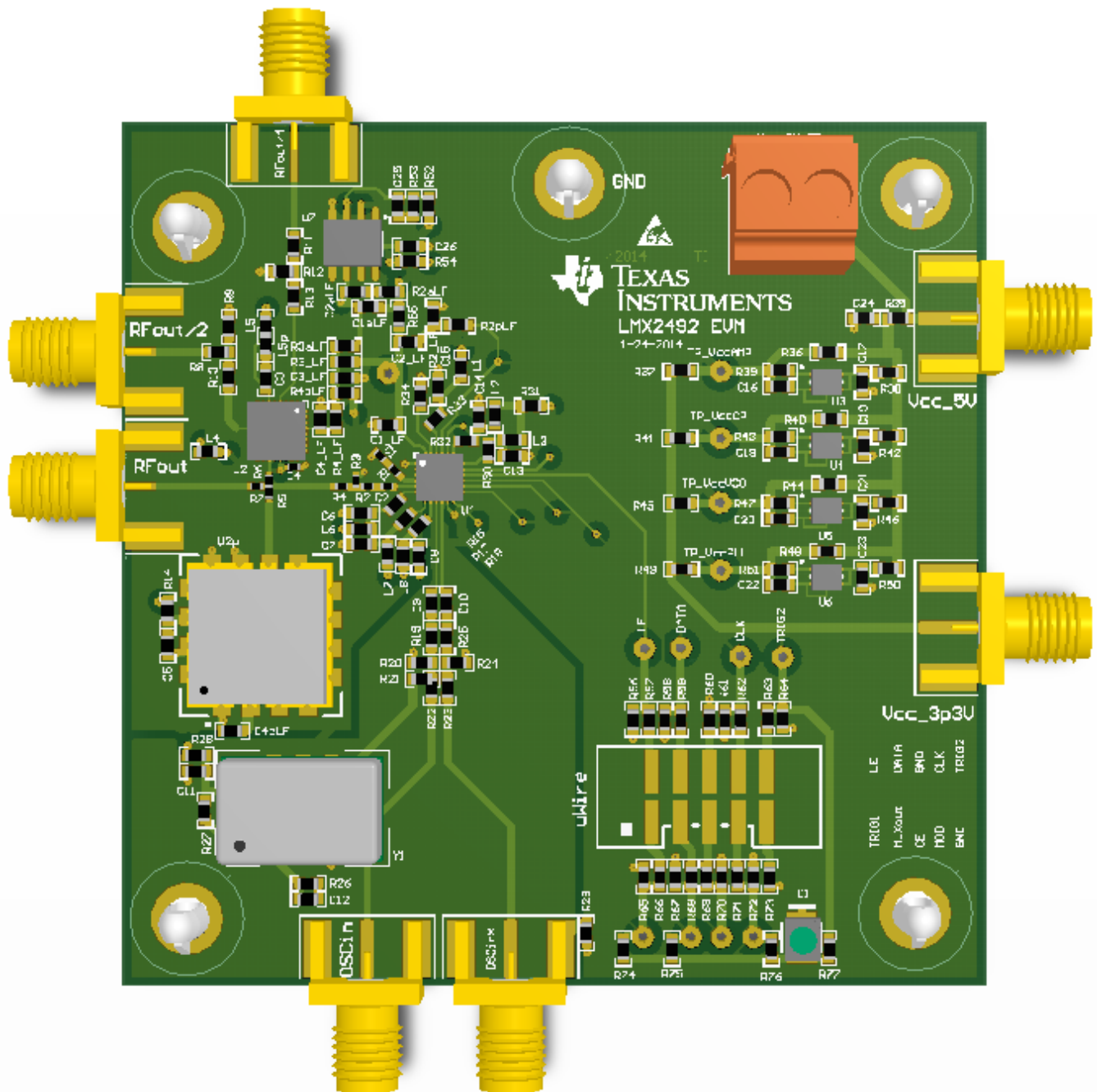
User's Guide



Literature Number: SNAU160A
March 2014–Revised May 2014

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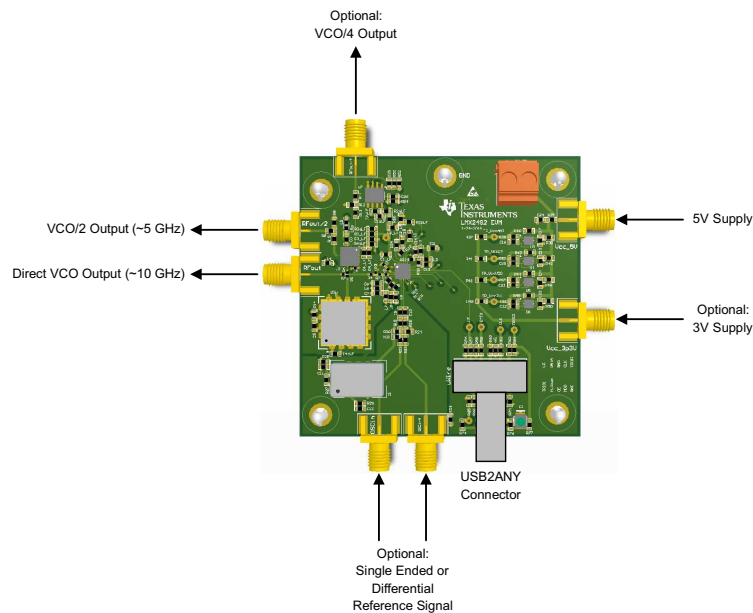
Evaluation Board Operating Instructions



Evaluation Board Setup

1.1 Evaluation Board Setup Diagram and Connections

Figure 1-1. Evaluation Board Connection Diagram



1.1.1 VCO Outputs

The LMX2492 operates at 10 GHz, but this can be a problem for some test equipment. If it is, use the VCO/2 output or the VCO/4 output. The VCO/4 output is powered down by default, but can be configured if necessary.

1.1.2 VCC 5V

The board operates on 5V and regulates this down to 3.3 V for the PLL. The board can be configured to operate with separate

1.1.3 VCC 3P3V

This is actually supplied from the regular off the 5V supply, but can also be run from a 3.3 V supply if the regulator is disconnected and a few resistors are changed.

1.1.4 USB2ANY Connector

Connect the board to the computer using the USB2ANY connector.

1.1.5 OSCin/OSCin*

The board has an on board XO, but the OSCin pins can be run either single-ended or differentially.

Evaluation Board Configuration

2.1 Loop Filter Configuration

Table 2-1. Loop Filter Values

PARAMETER	LMX2492
VCO Frequency	9.4 – 10.1 GHz
VCO Gain (MHz/V)	200 MHz/V
C1_LF	68 pF
C2_LF	3.9 nF
C3_LF	150 pF
C4_LF	Open
R2	390 Ω
R3_LF	150 Ω
R4_LF	0 Ω
Charge Pump Gain	3.1 mA
Phase Detector Frequency	100 MHz
OSCin Frequency	100 MHz

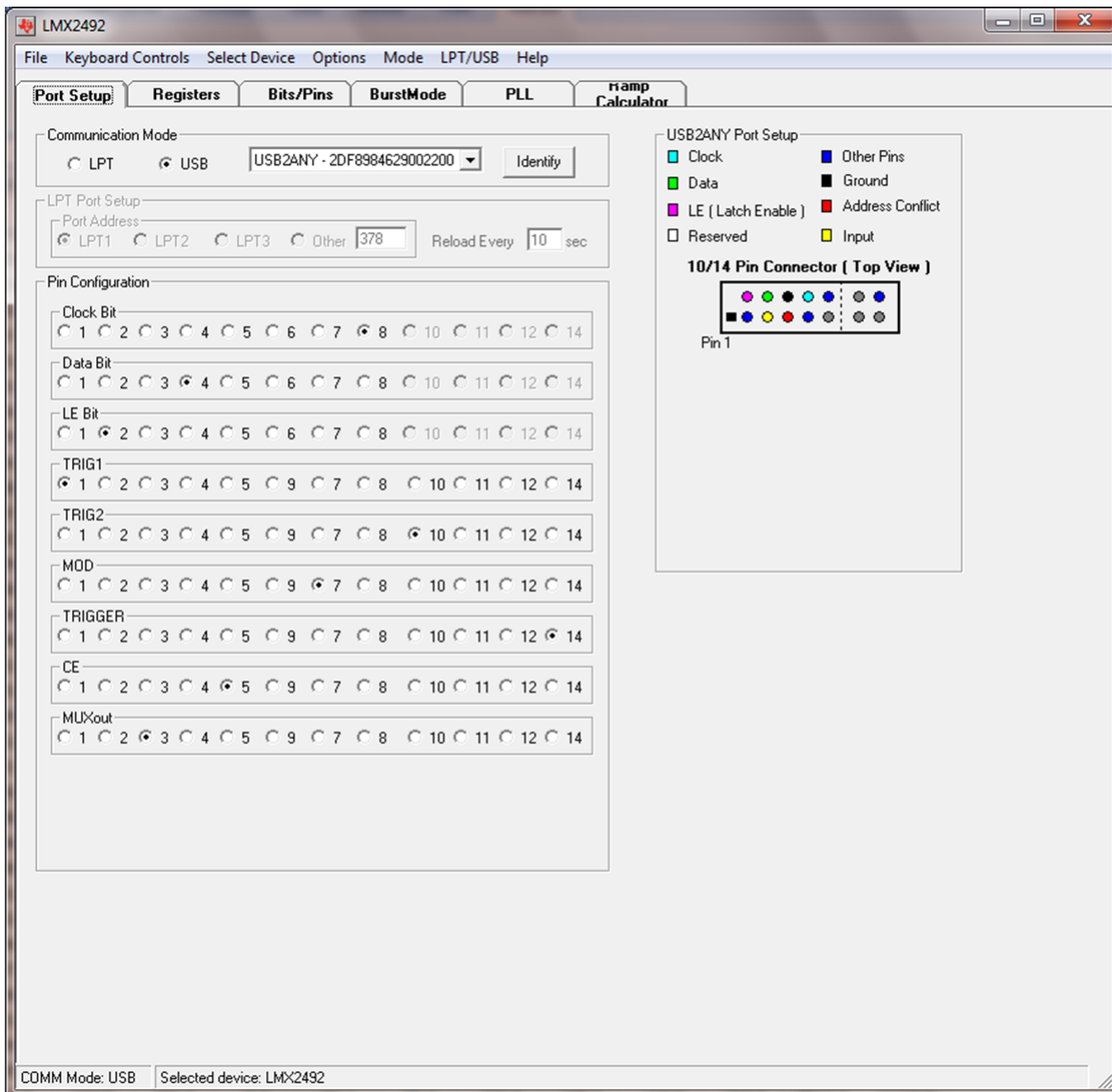
2.2 CodeLoader Software Settings

The CodeLoader software is used for programming this device and is available at www.ti.com/codeloader.

2.2.1 Port Setup

The port setup shows which pins are sent to the pins of the header. If using the USB2ANY board, it is recommended to click the "Identify" button and ensure the LED light is blinking to ensure that this is working correctly. Note that position 3 is MUXout, which can be used for readback. In order to do this, the MUXout pin needs to be programmed to Readback and also resistor R68 needs to be placed.

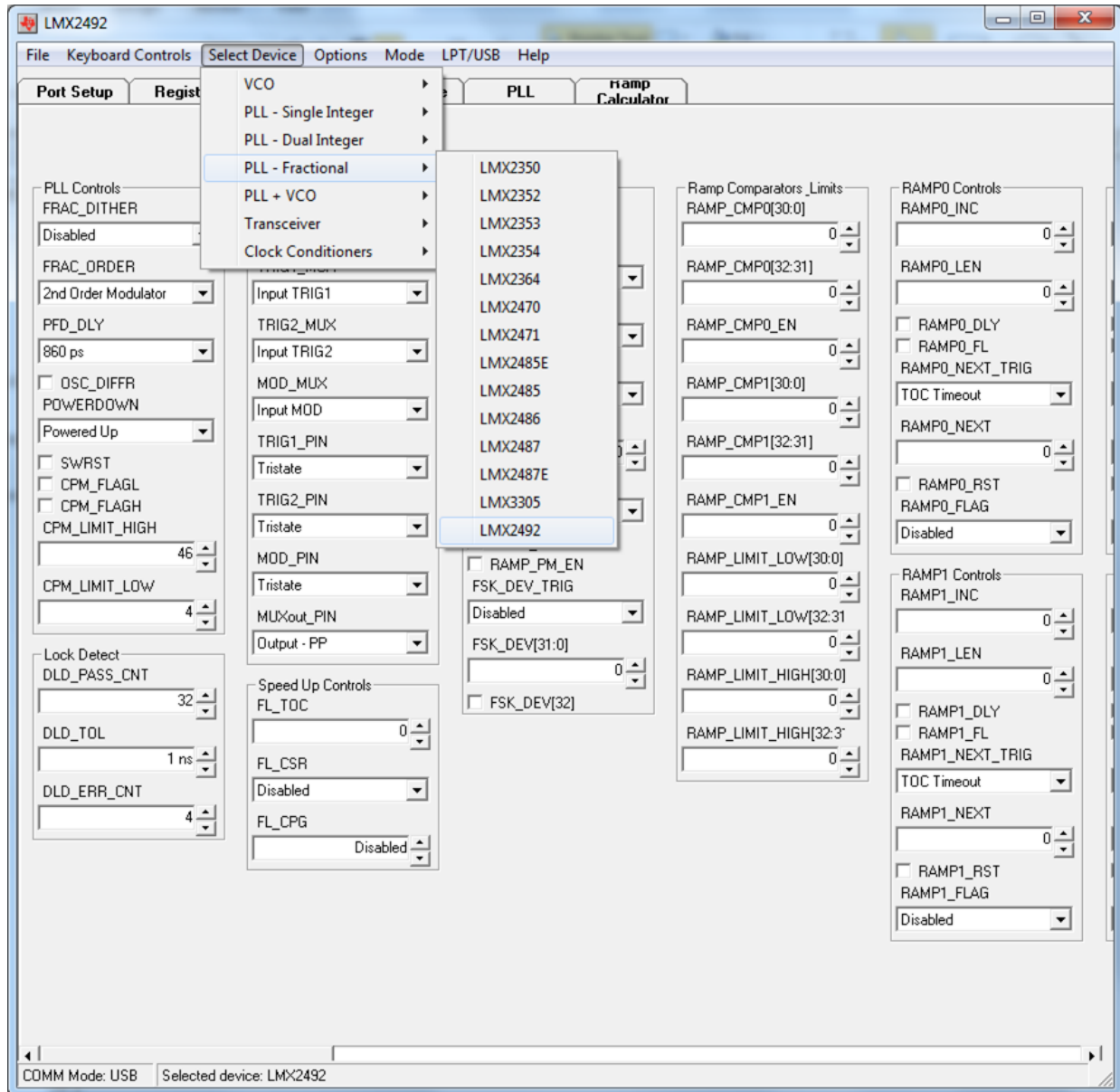
Figure 2-1. LMX2492 Port Setup



2.2.2 Device Selection

Go to “Select Device” → “PLL–Fractional” → LMX2492

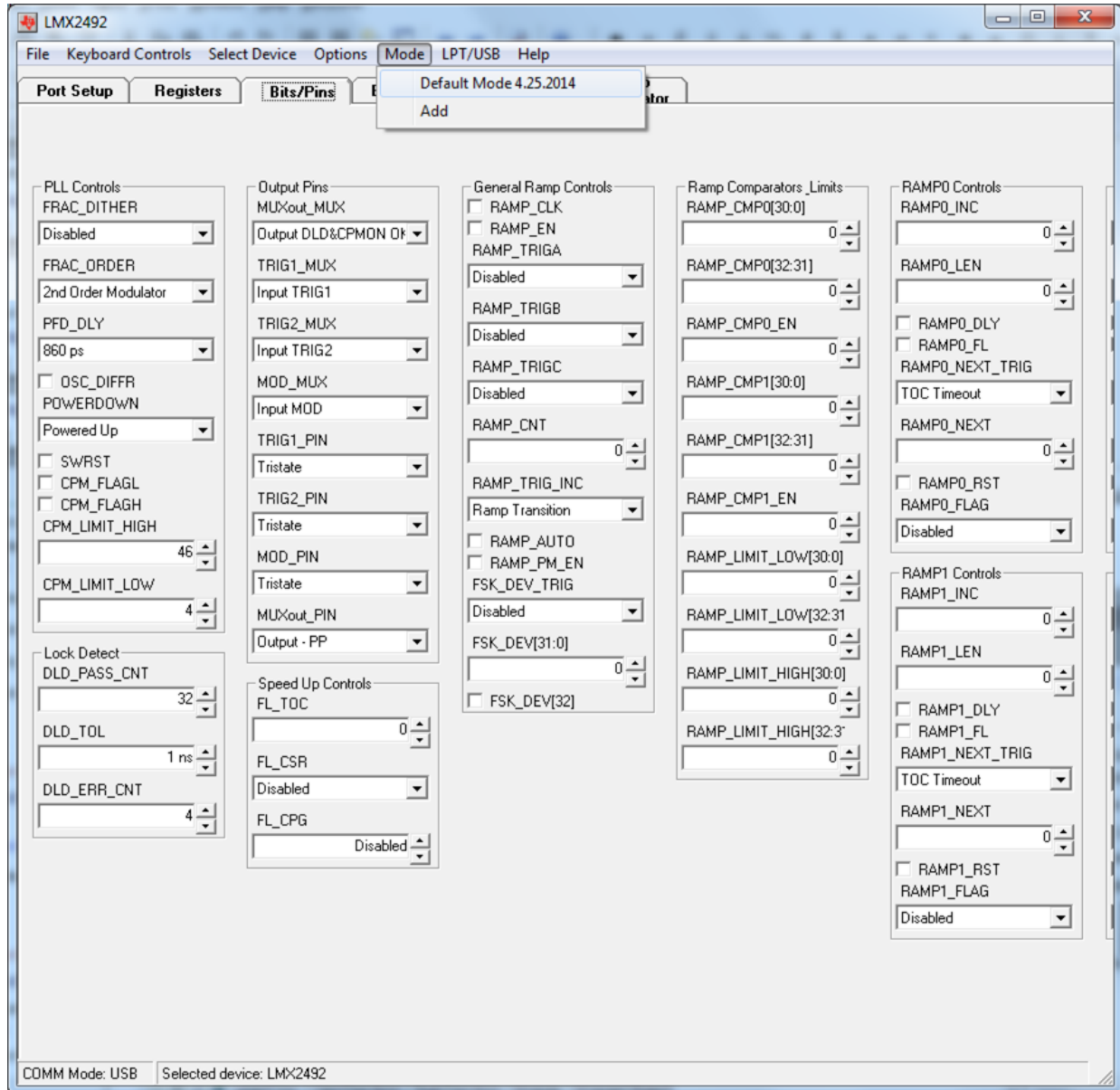
Figure 2-2. Part Selection



2.2.3 Bits/Pins Tab and Restoring the Default Configuration

The Bits/Pins tab shows the state of the programming fields. Note the scroll bar at the bottom. One can right mouse click on any field for a short description of what it does. To restore the part to the original software configuration, one can select the default mode as shown.

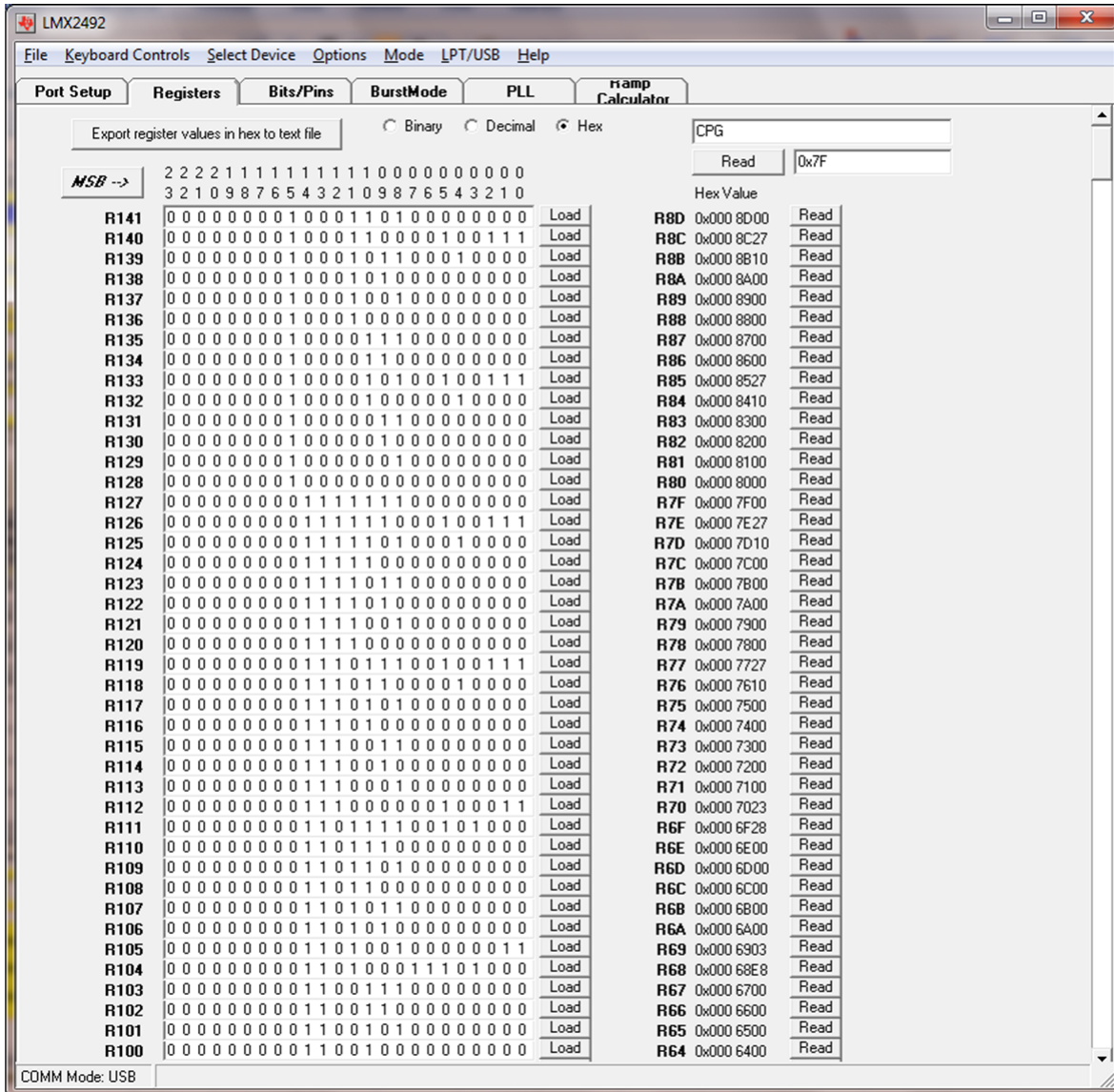
Figure 2-3. Restoring Default Mode



2.2.4 Registers Tab

The registers tab is not necessary to program the part, but it does show the registers. The LMX2492 also supports readback. To use this, set the MUXout pin to readback and attach resistor R68 to connect this pin back to the programming header. Once this is done entire registers can be read, or a specific field can be typed in to read the value. Realize that some fields of the LMX2492 are read only and therefore might not be the same as written to.

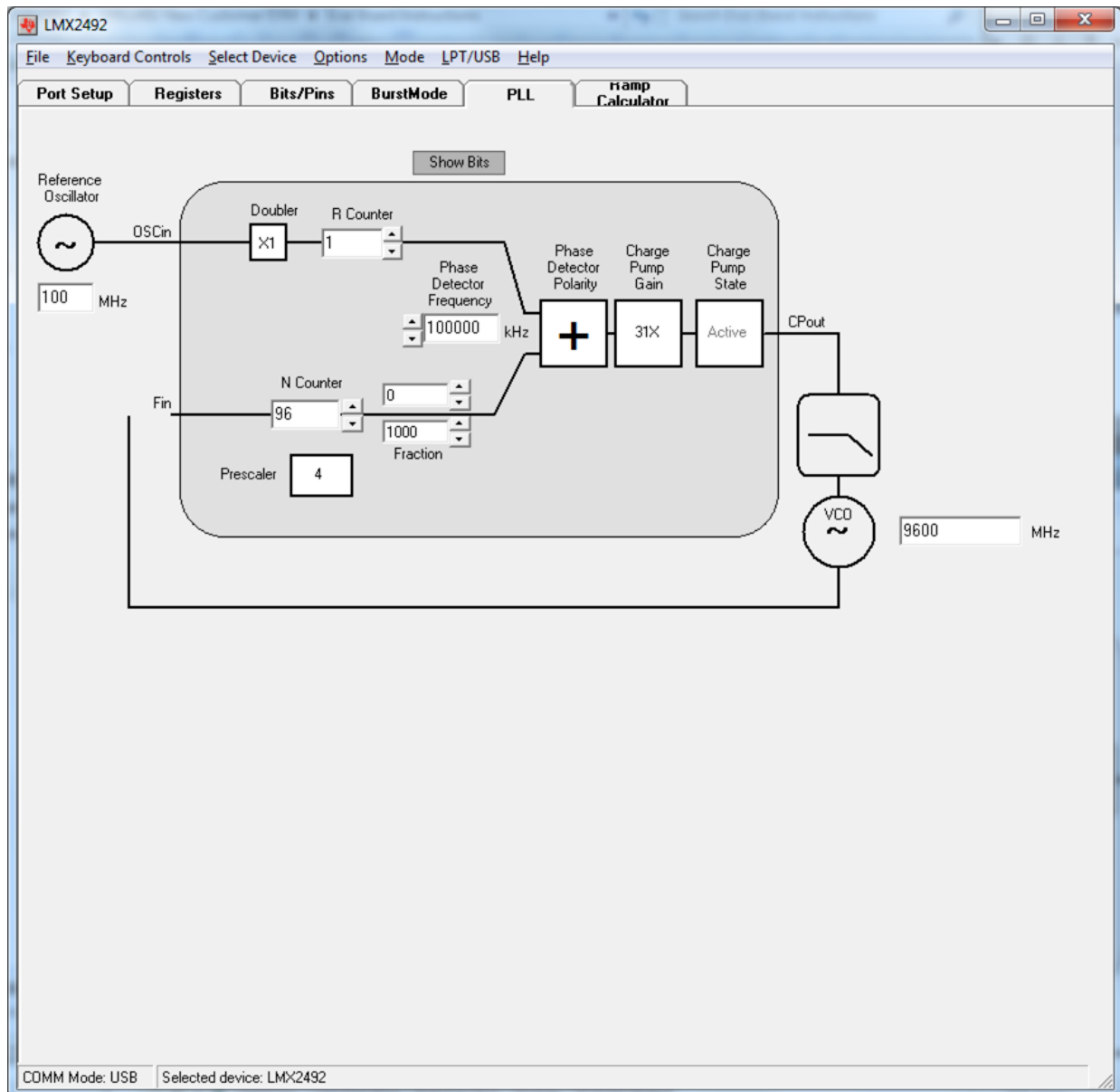
Figure 2-4. Registers Tab



2.2.5 PLL Frequency Tab

Verify your “PLL” Tab looks like below:

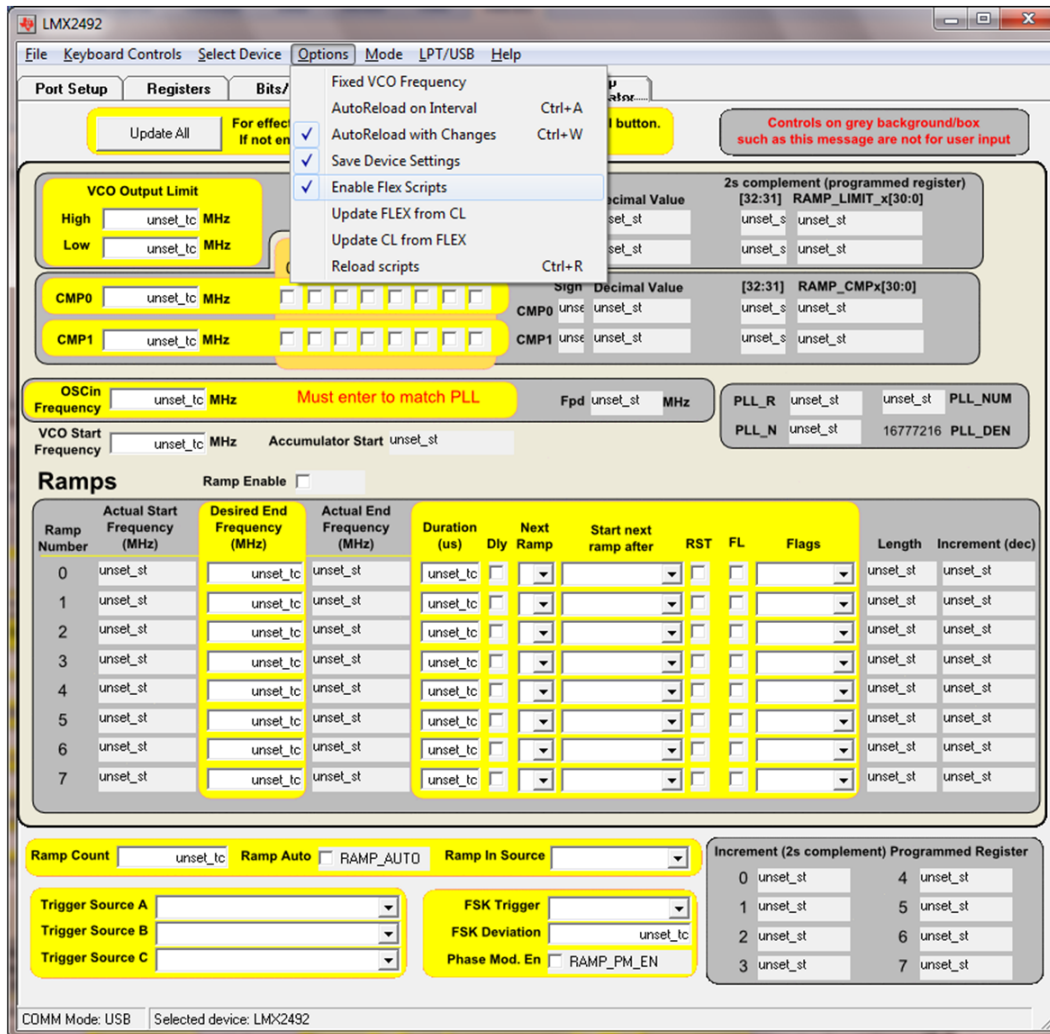
Figure 2-5. PLL Frequency Tab



2.2.6 Ramp Generator Tab

Verify your “Ramp Calculator” Tab looks like below. If not using the ramping features, or when just getting the device up and running, it is advised not to Enable the Flex Scripts as they slow the software down. Once the part is running, then enable the flex scripts as shown below and calculations the Ramp Generator Tab will become active.

Figure 2-6. Enabling the Flex Scripts for the Ramp Generator GUI

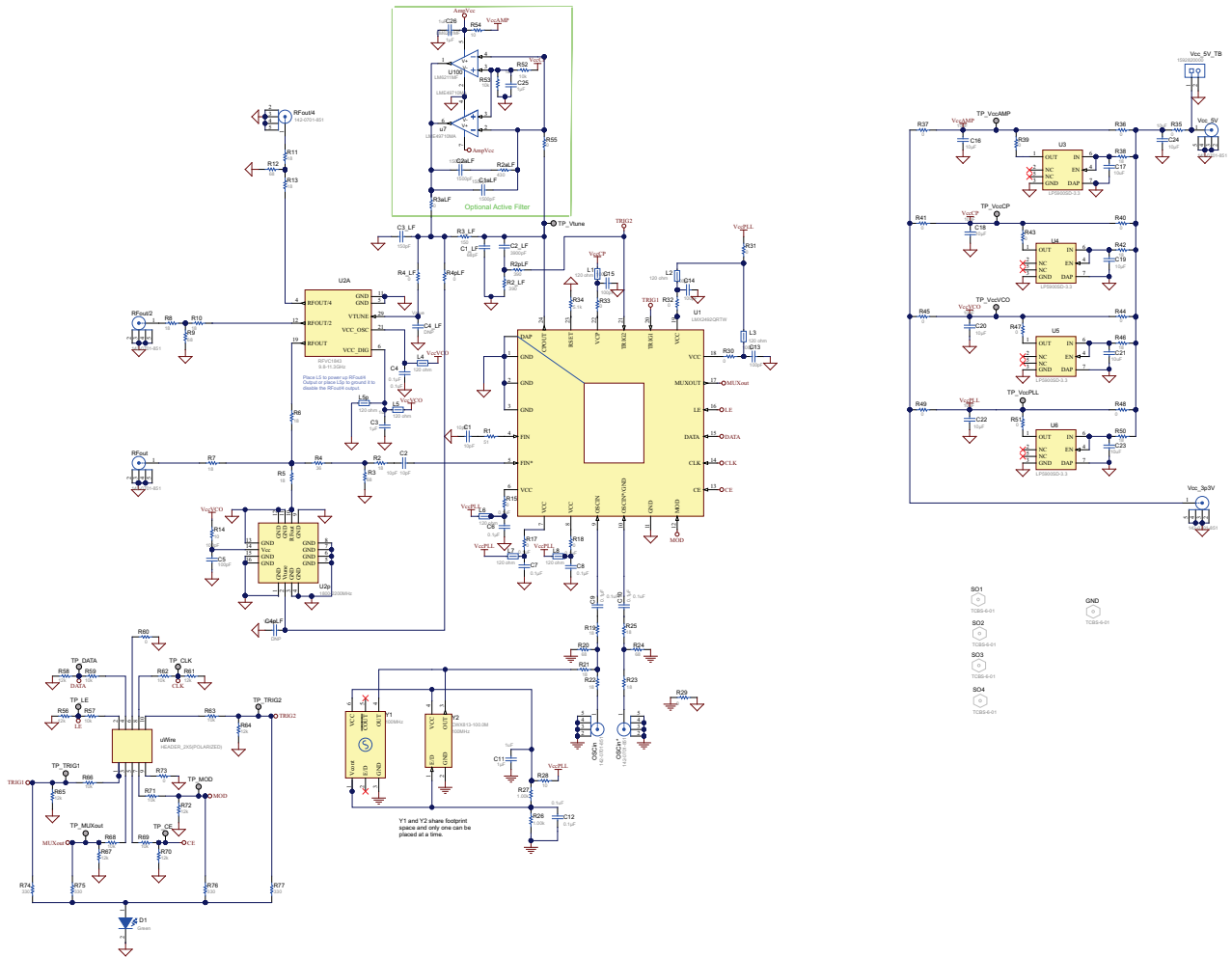


Then Click on “Update All” and wait until you see your screen populate to below:

Notes for Ramp Calculator tab:

- Manually change the OSCin Frequency in the “Ramp Calculator” tab when you change the value in the “PLL” tab
- Click “Update All” whenever you change values in the frequency section
- Only modify values in "Yellow" regions
- Click and unclick “RST” to clear the accumulator after modifying a row in Ramps

Schematic



Board Layers Stackup

Layers of the 4 layer evaluation board shall include: Blue is dielectrics

- Top layer for high priority high frequency signals (GTL)
 - 1 oz CU
- RO4003 Dielectric, 16 mils
- Ground plane (GP1)
- FR4, 18 mils thick.
- Power plane – VccCLK (GP2)
- FR4, 22 mils
- Bottom layer copper clad for thermal relief (GBL)

Table 4-1. Top to Bottom Layer Order:

LMX2492.GTL	(1)	Top Layer
LMX2492.GP1	(2)	GND Plane
LMX2492.G1	(3)	Power
LMX2492.GBL	(4)	Bottom Layer

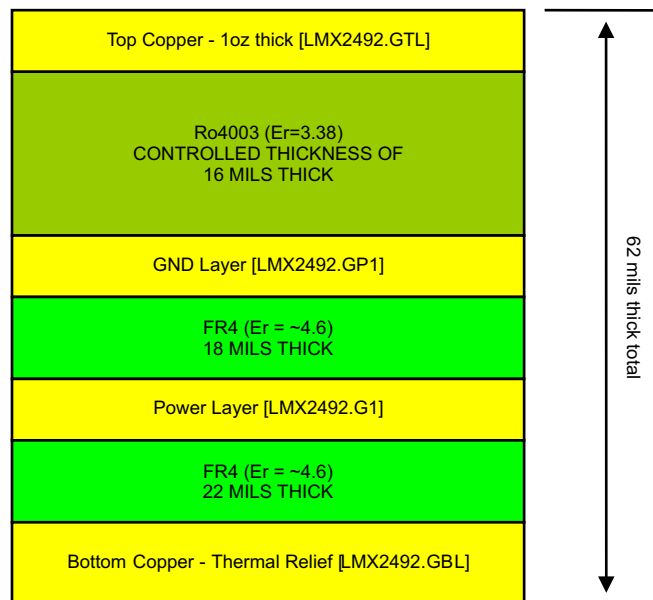


Figure 4-1. Board Layers Stackup

Bill of Materials

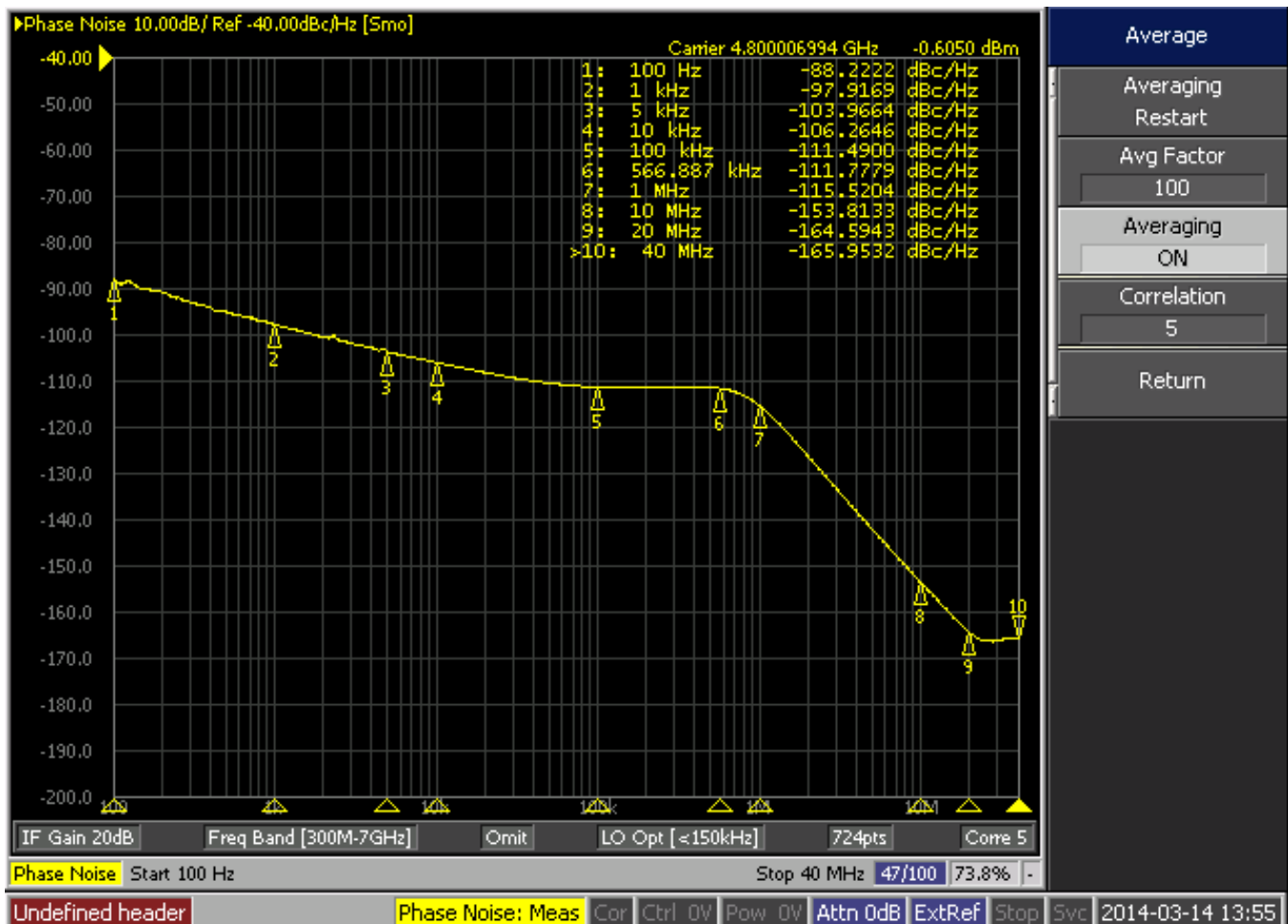
ITEM	DESIGNATOR	DESCRIPTION	RoHS	MANUFACTURER	PART NUMBER	QTY
1	AA1	Printed Circuit Board	O	TBD	Used in BOM Report	1
2	C1, C2	CAP, CERM, 10pF, 50V, +/-5%, COG/NP0, 0402	Y	Johanson Technology	500R07S100JV4T	2
3	C1_LF	CAP, CERM, 68pF, 50V, +/-5%, COG/NP0, 0603	Y	Kemet	C0603C680J5GACTU	1
4	C2_LF	CAP, CERM, 3900pF, 50V, +/-5%, COG/NP0, 0603	Y	MuRata	GRM1885C1H392JA01D	1
5	C3, C11	CAP, CERM, 1uF, 16V, +/-10%, X7R, 0603	Y	TDK	C1608X7R1C105K	2
6	C3_LF	CAP, CERM, 150pF, 50V, +/-5%, COG/NP0, 0603	Y	Kemet	C0603C151J5GACTU	1
7	C4	CAP, CERM, 0.1uF, 50V, +/-10%, COG/NP0, 0402	Y	TDK	C1005X7R1H104K	1
8	C5, C13, C14, C15	CAP, CERM, 100pF, 50V, +/-5%, COG/NP0, 0603	Y	Kemet	C0603C101J5GACTU	4
9	C6, C7, C8, C9, C10	CAP, CERM, 0.1uF, 16V, +/-5%, X7R, 0603	Y	AVX	0603YC104JAT2A	5
10	C16, C18, C20, C22, C23, C24	CAP, CERM, 10uF, 6.3V, +/-20%, X5R, 0603	Y	Kemet	C0603C106M9PACTU	6
11	D1	LED, Green, SMD	Y	Lumex	SML-LX2832GC-TR	1
12	L1, L2, L3, L4, L5p, L6, L7, L8	3A Ferrite Bead, 120 ohm @ 100MHz, SMD	Y	MuRata	BLM18SG121TN1D	8
13	OSCin, RFout, RFout/2, Vcc_5V	Connector, SMT, End launch SMA 50 ohm	Y	Emerson	142-0701-851	4
14	R1	RES, 51 ohm, 5%, 0.063W, 0402	Y	Vishay-Dale	CRCW040251R0JNED	1
15	R2, R6, R7	RES, 18 ohm, 5%, 0.063W, 0402	Y	Vishay-Dale	CRCW040218R0JNED	3
16	R2_LF	RES, 390 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW0603390RJNEA	1
17	R3	RES, 68 ohm, 5%, 0.063W, 0402	Y	Vishay-Dale	CRCW040268R0JNED	1
18	R3_LF	RES, 150 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW0603150RJNEA	1
19	R4	RES, 36 ohm, 5%, 0.063W, 0402	Y	Vishay-Dale	CRCW040236R0JNED	1
20	R4_LF, R15, R17, R18, R29, R30, R31, R32, R33, R35, R40, R44, R49, R51, R60	RES, 0 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW06030000Z0EA	15
21	R8, R10, R11, R13, R19, R22, R23, R25, R50	RES, 18 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060318R0JNEA	9
22	R9, R12, R20, R24	RES, 68 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060368R0JNEA	4
23	R14	RES, 10 ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060310R0JNEA	1
24	R56, R58, R61, R64, R65, R70, R72	RES, 12k ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060312K0JNEA	7

ITEM	DESIGNATOR	DESCRIPTION	RoHS	MANUFACTURER	PART NUMBER	QTY
25	R57, R59, R62, R63, R66, R69, R71	RES, 10k ohm, 5%, 0.1W, 0603	Y	Vishay-Dale	CRCW060310K0JNEA	7
26	R75	RES, 330 ohm, 5%, 0.1W, 0603	Y	Yageo America	RC0603JR-07330RL	1
27	SO1, SO2, SO3, SO4	HEX STANDOFF SPACER, 9.53 mm	Y	Richco Plastics	TCBS-6-01	4
28	U1	13.5 GHz Low Phase Noise Fractional N PLL with Ramp/Chirp Generation, RTW0024A	Y	Texas Instruments	LMX2492QRTW	1
29	U2	VCO, 9.8-11.3GHz, SMD	Y	RF Micro Devices	RFVC1843	1
30	U6	Ultra Low Noise, 150mA Linear Regulator for RF/Analog Circuits Requires No Bypass Capacitor, 6-pin LLP	N	Texas Instruments	LP5900SD-3.3	1
31	uWire	Connector		FCI	52601-G10-8LF	1
32	Y2	OSC 100.0000MHZ 3.3V +- 25PPM SMD	Y	Connor-Winfield	CWX813-100.0M	1

Typical Performance Measurements

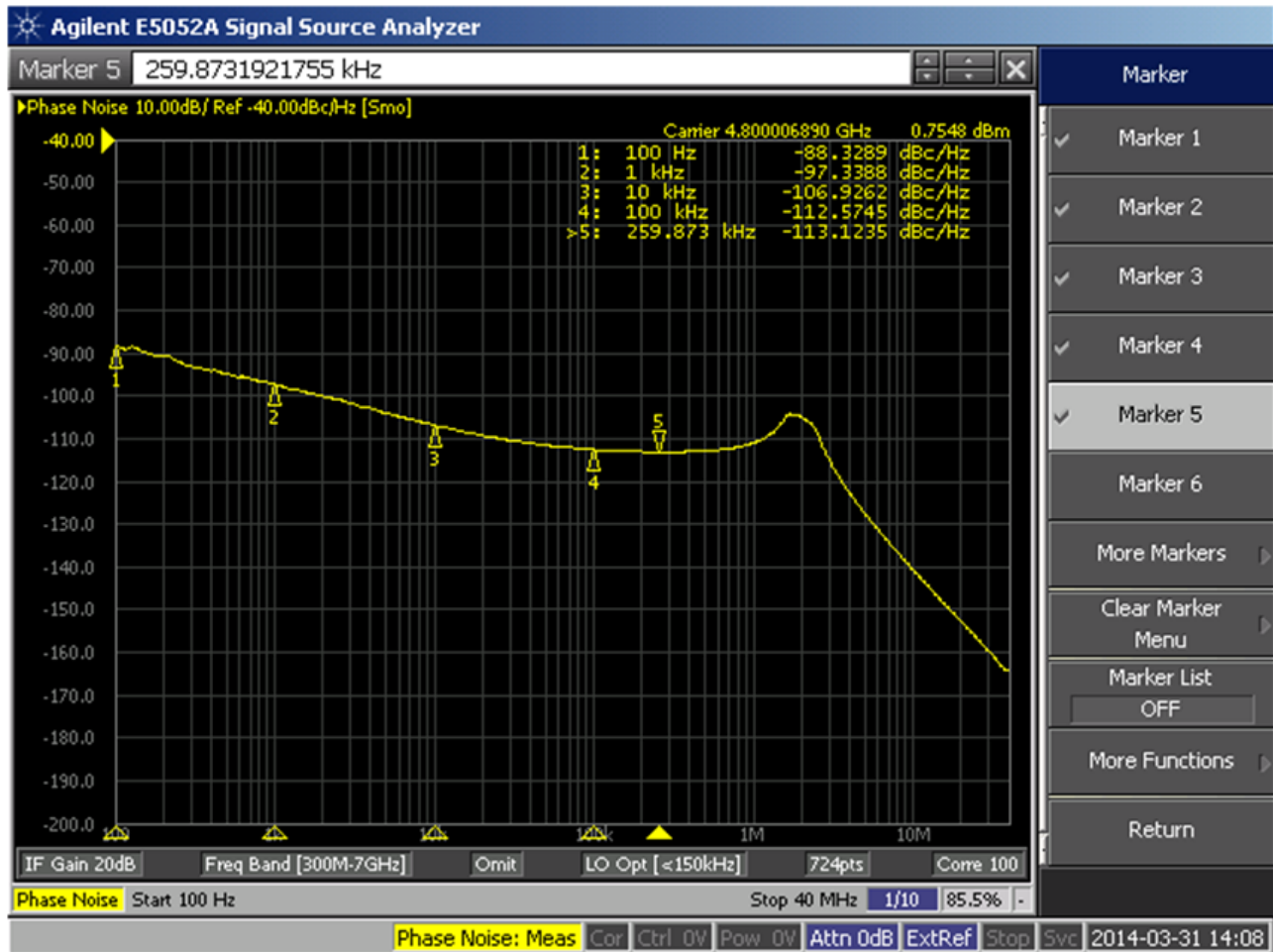
6.1 PLL Phase Noise

Figure 6-1. Phase Noise in Default Mode

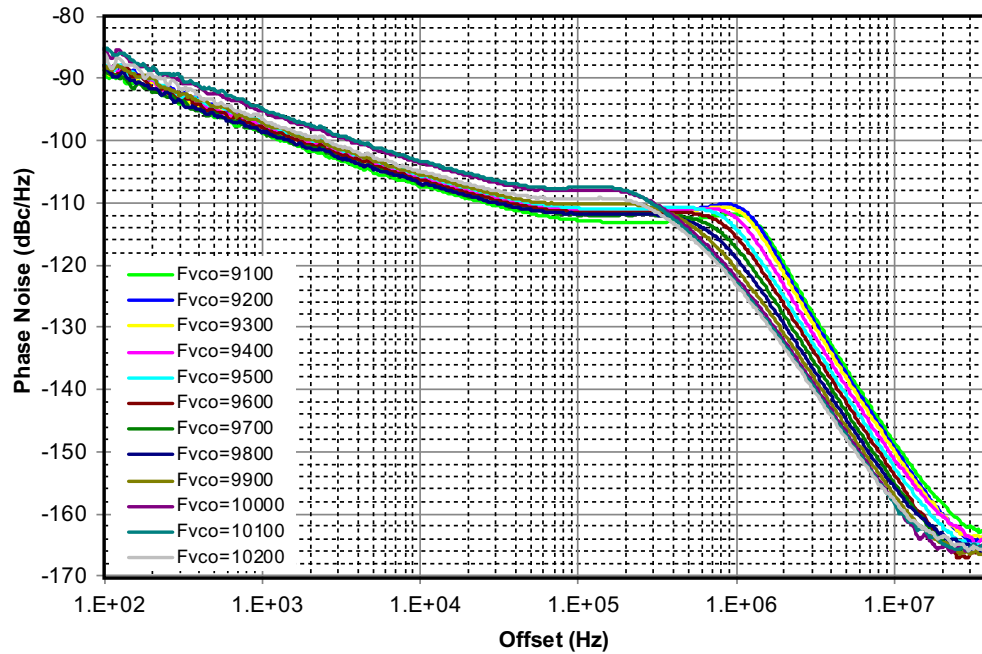


The above figure shows the phase noise in default for mode. Note that this is $\frac{1}{2}$ the VCO frequency as it was observed on the Fout/2 output.

Figure 6-2. Phase Noise with a Wide Loop Bandwidth



The figure above shows phase noise with a wide loop bandwidth and 100 MHz phase detector frequency. At about 260 kHz, the phase noise is -113.1 dBc/Hz, which is actually being degraded by 0.5 dB by the 1/f noise. This implies a figure of merit of -227.2 dBc/Hz.

Figure 6-3. Phase Noise vs Tuning Voltage


The phase noise of the LMX2492 does vary somewhat with tuning voltage with the best performance typically near lower tuning voltages.

Table 6-1. Phase Noise

FVCO	Vtune
9000	0.04
9100	0.18
9200	0.338
9300	0.518
9400	0.726
9500	0.973
9600	1.26
9700	1.602
9800	2.014
9900	2.483
10000	3.01
10100	3.562
10200	4.158
10300	4.792

6.2 Ramping Example

Below is an example that can be used to generate the waveform shown later in this document.

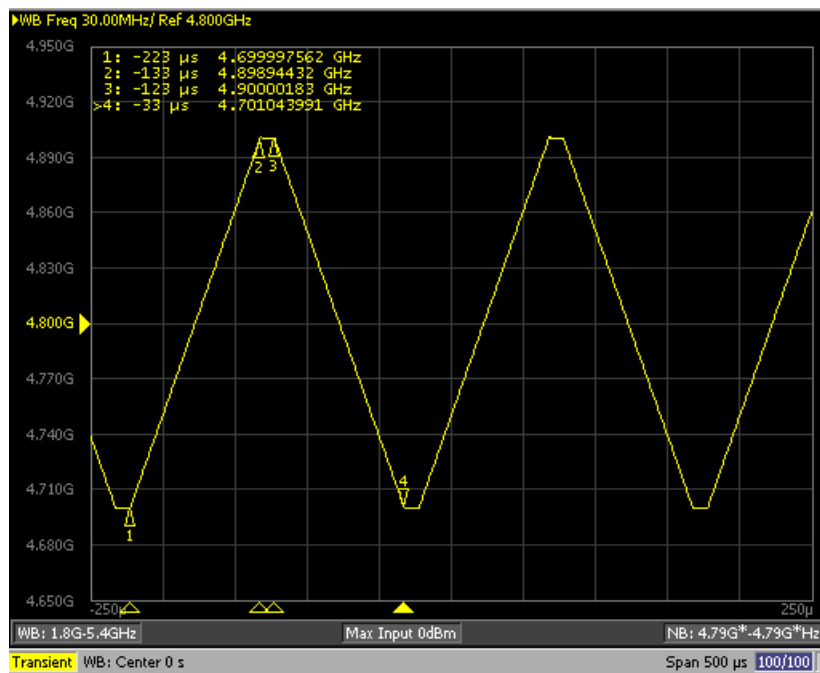
Figure 6-4. Setup for Ramping Example

The screenshot shows the LMUX2492 software interface. The 'Ramp Calculator' tab is selected. Key settings include:

- VCO Output Limit:** High = 12000 MHz, Low = 9000 MHz.
- CMP0:** 9800 MHz
- CMP1:** 9400 MHz
- OSCI_n Frequency:** 100 MHz
- VCO Start Frequency:** 9400 MHz
- Ramps Table:**

Ramp Number	Actual Start Frequency (MHz)	Desired End Frequency (MHz)	Actual End Frequency (MHz)	Duration (us)	Dly	Next Ramp	Start next ramp after	RST	FL	Flags	Length	Increment (dec)
0	9400	9400	9400	10	1	TOC Timeout				Flag0	1000	0
1	9400	9800	9800.024652481	90	2	TOC Timeout				Disabled	9000	7457
2	9800.024652481	9800.024652481	9800.024652481	10	3	TOC Timeout				Disabled	1000	0
3	9800.024652481	9400	9400	90	0	TOC Timeout				Disabled	9000	-7457
4	-1	10500	-1	100	0	TOC Timeout				Disabled	10000	0
5	-1	10500	-1	100	0	TOC Timeout				Disabled	10000	0
6	-1	10500	-1	100	0	TOC Timeout				Disabled	10000	0
7	-1	10500	-1	100	0	TOC Timeout				Disabled	10000	0

Figure 6-5. Generated Waveform at VCO/2 Output



Revision History

Changes from Original (March 2014) to A Revision	Page
• Changed Section Numbering	4
• Changed Loop Filter	5
• Changed CodeLoader Diagrams	6
• Added Ramping Section	11

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Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at its own expense.

FCC Interference Statement for Class B EVM devices

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Industry Canada Compliance (English)

For EVMs Annotated as IC – INDUSTRY CANADA Compliant:

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Concerning EVMs Including Radio Transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concerning EVMs Including Detachable Antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Canada Industry Canada Compliance (French)

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

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If user uses EVMs in Japan, user is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after user obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after user obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless user gives the same notice above to the transferee. Please note that if user does not follow the instructions above, user will be subject to penalties of Radio Law of Japan.

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