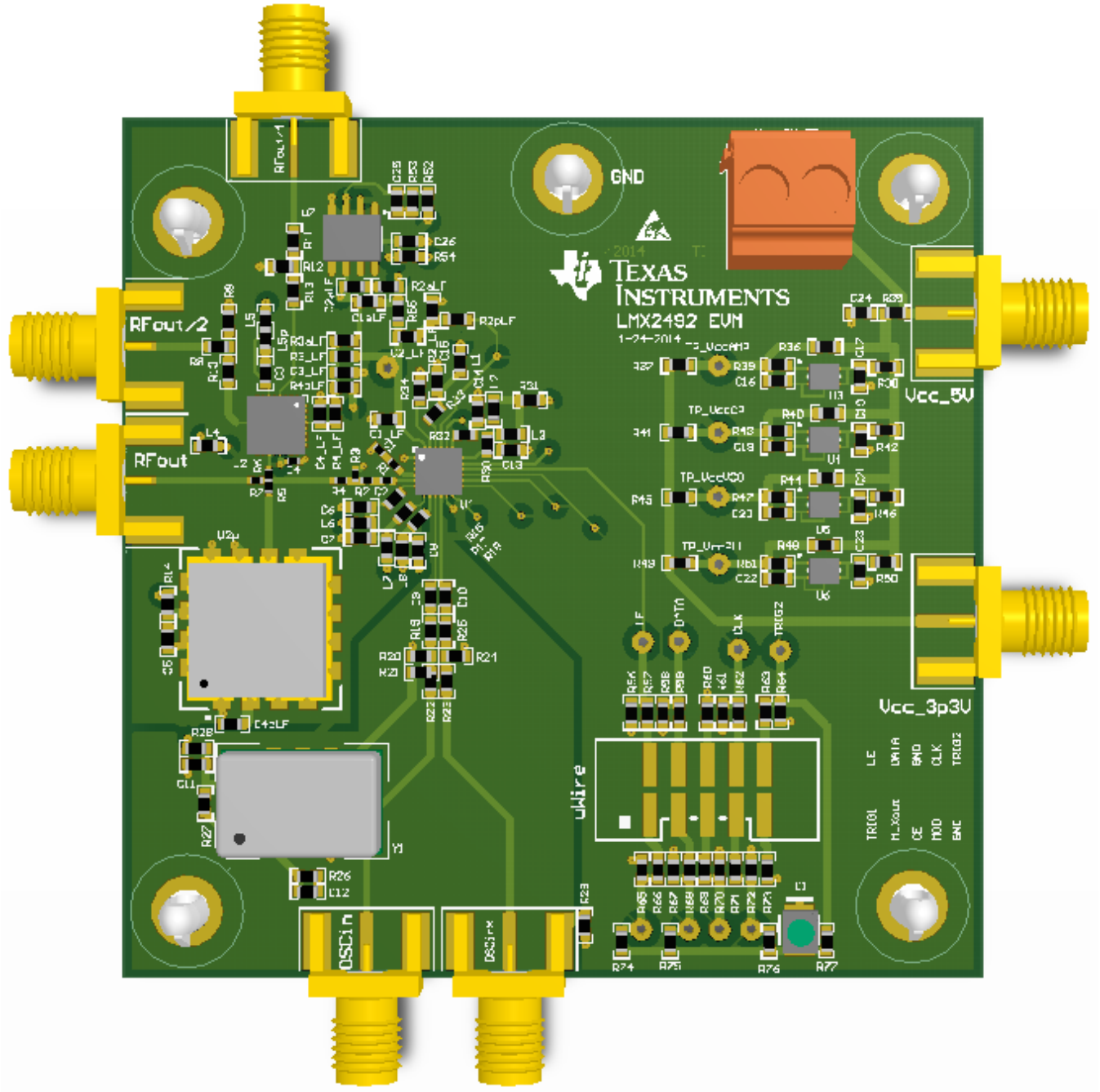
LMX2492 Evaluation Instructions
Ultra Low Noise Frequency Synthesizer with Integrated VCO Evaluation Board Operating Instructions

User's Guide

Literature Number: SNAU160D
March 2014–Revised September 2015

Contents

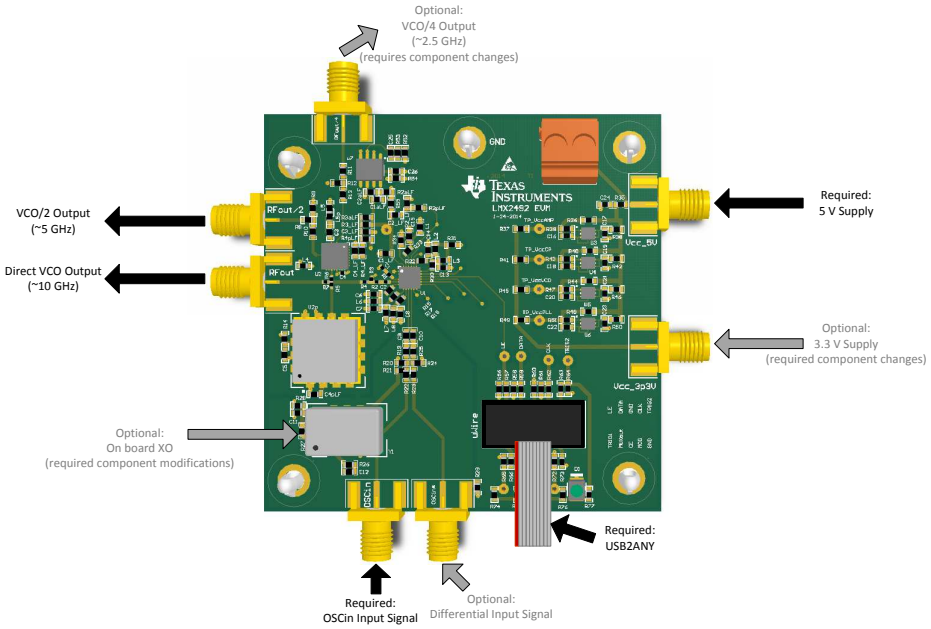
Evaluation Board Operating Instructions



Evaluation Board Setup

2.1 Evaluation Board Setup Diagram and Connections

Figure 2-1. Evaluation Board Connection Diagram



2.1.1 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.

2.1.2 VCC 5V

The board operates on a single 5V and regulates this down to 3.3 V for the PLL. The board can also be re-configured to operate with separate supplies.

2.1.3 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.

2.1.4 USB2ANY Connector

Connect the board to the computer using the USB2ANY connector, which comes supplied with the kit.

2.1.5 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

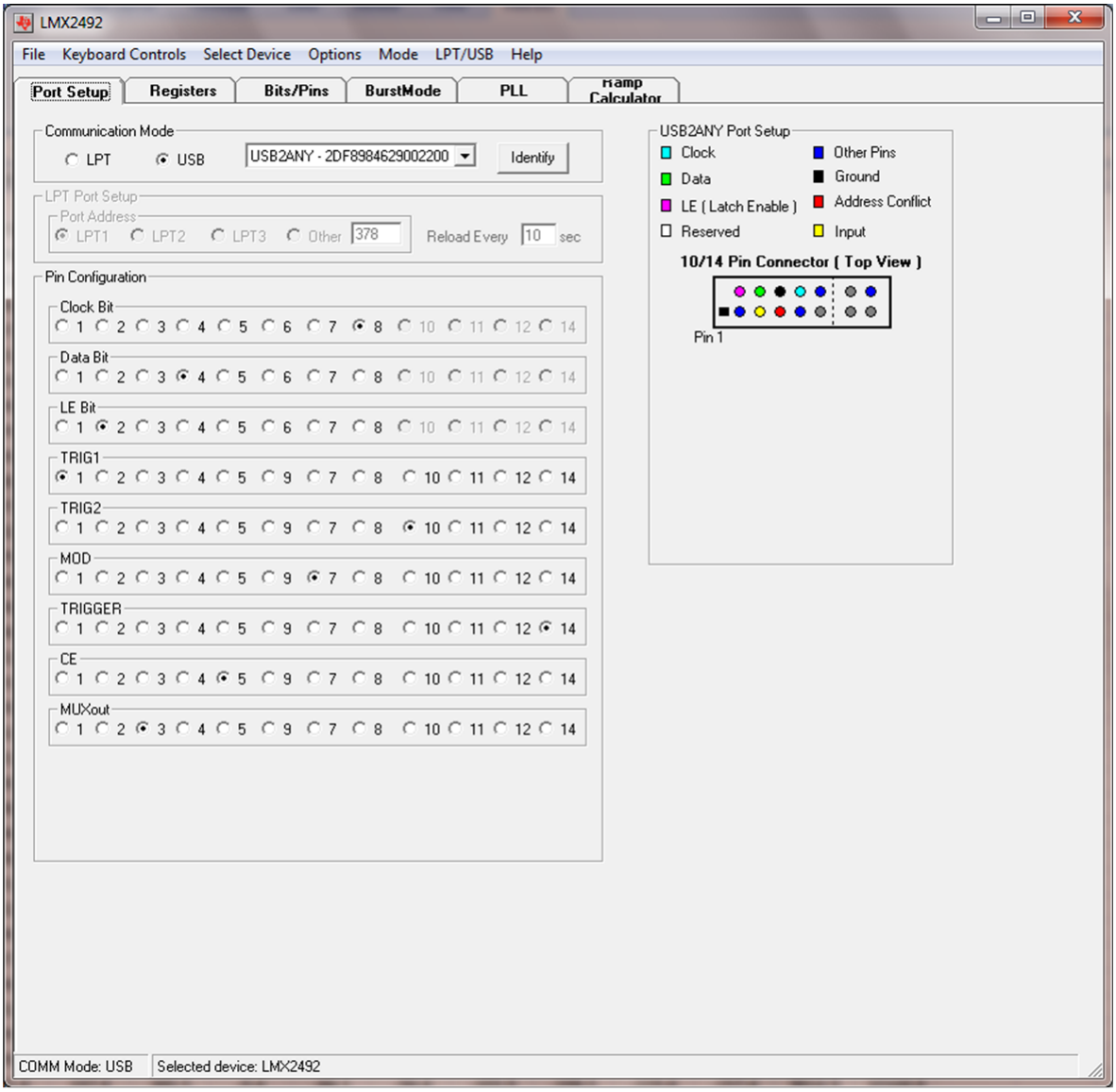
2.2 CodeLoader Software Settings

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.

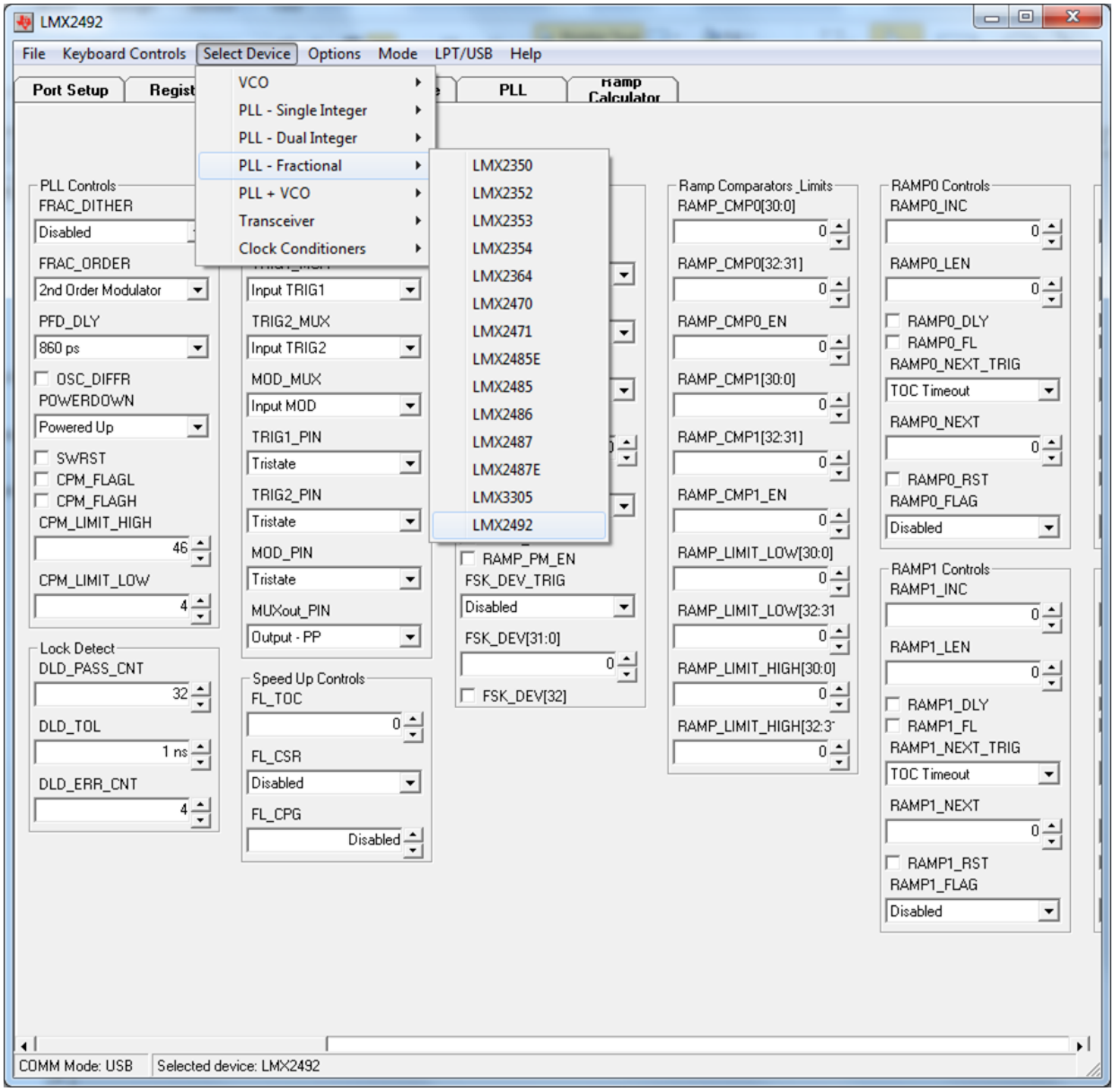
Figure 2-1. LMX2492 Port Setup



2.2.2 Device Selection

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

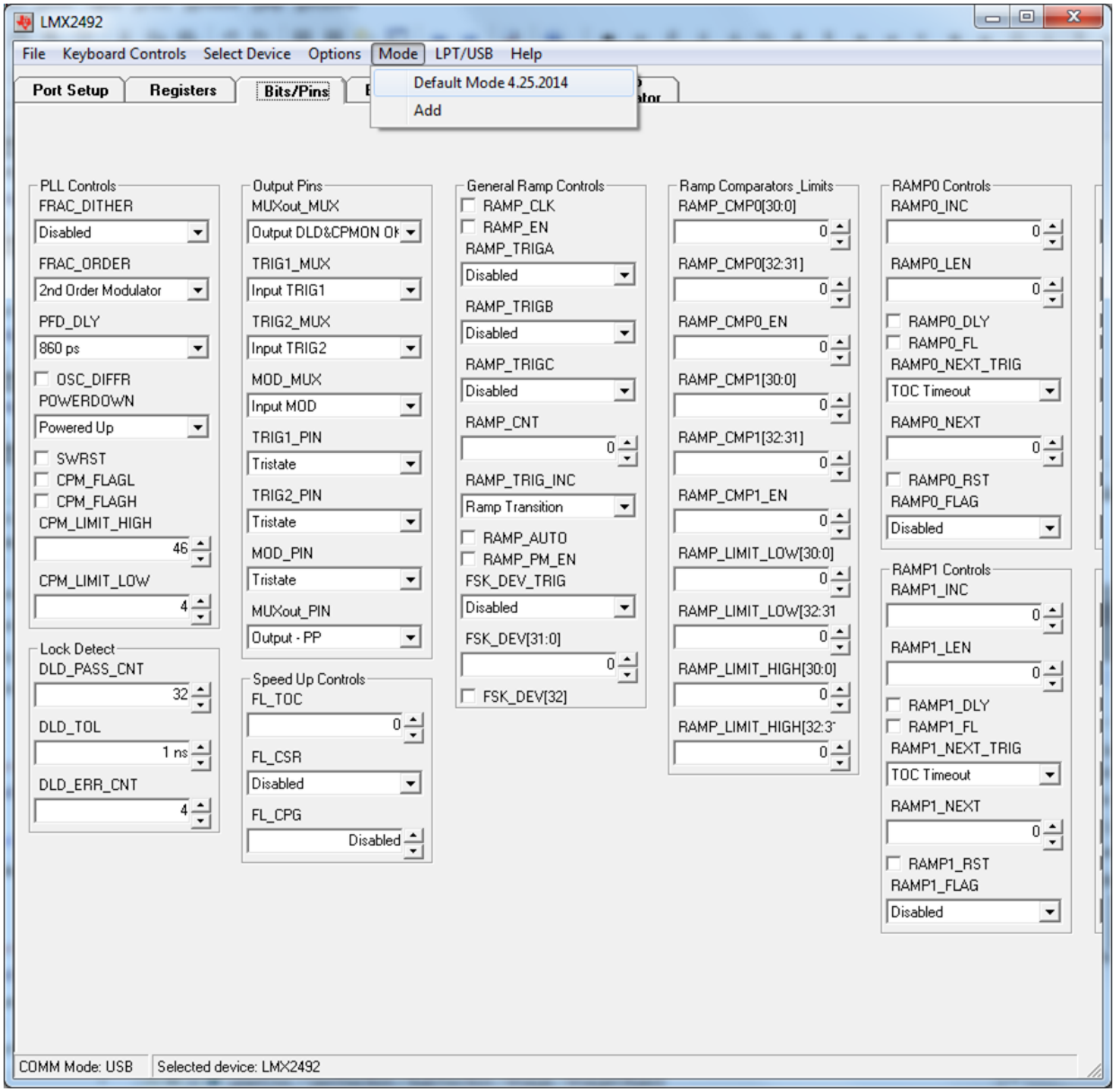
Figure 2-2. Part Selection



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, on can select the default mode as shown.

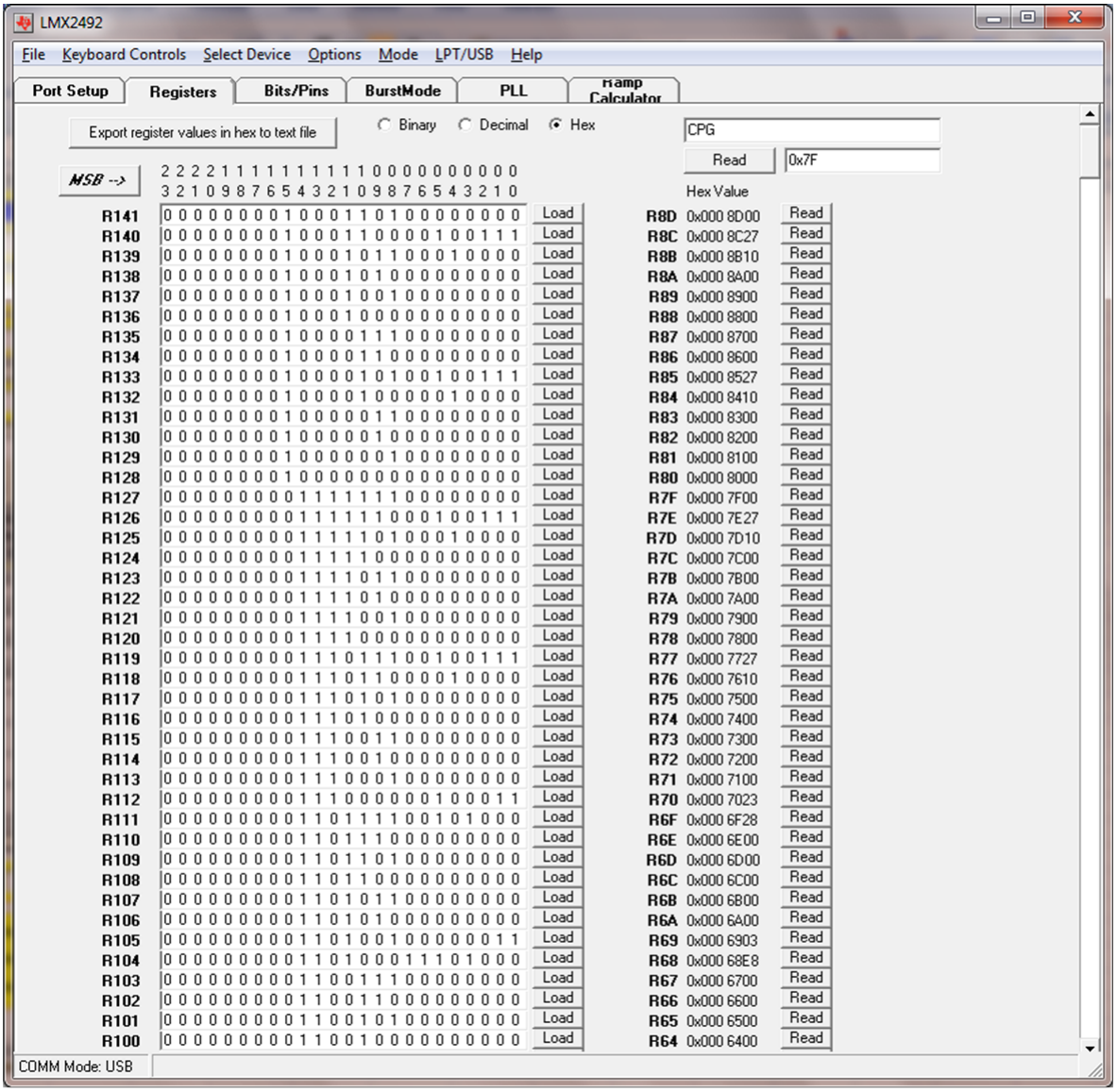
Figure 2-3. Restoring Default Mode



2.2.4 Registers Tab

The registers tab is not necessary to program the part, but it does show the regsiters. 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.

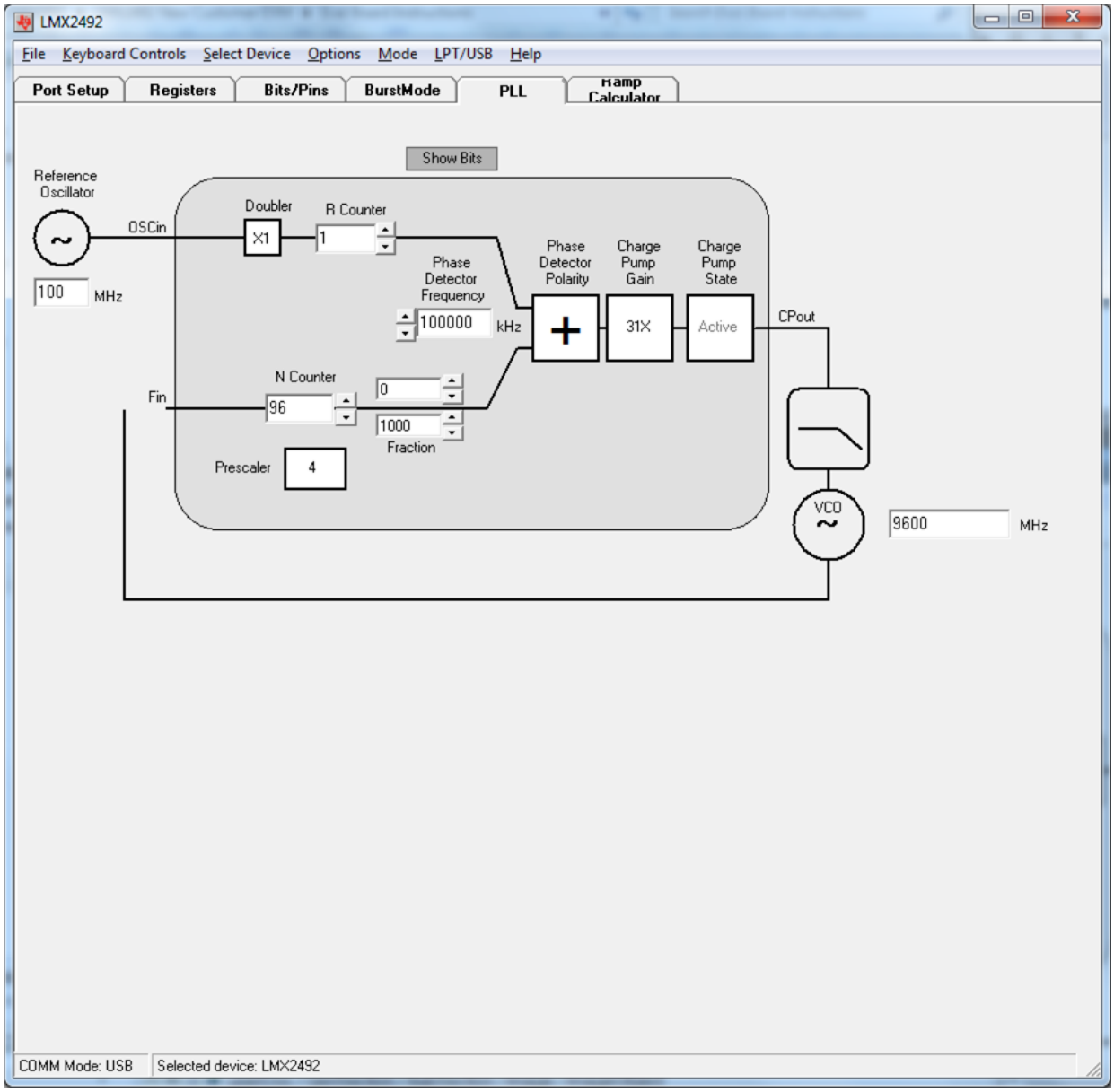
Figure 2-4. Registers Tab



2.2.5 PLL Frequency Tab

Verify your “PLL” Tab looks like below:

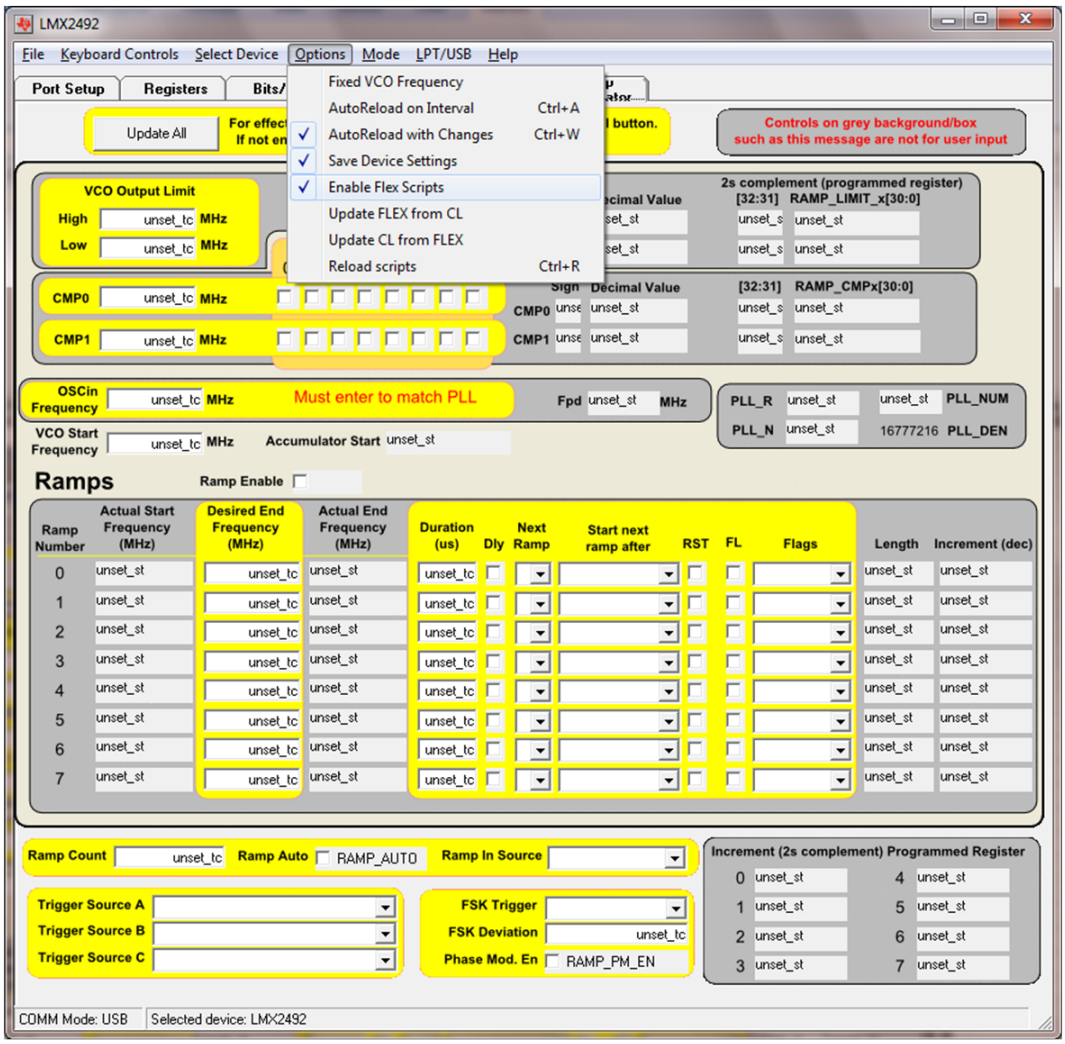
Figure 2-5. PLL Frequency Tab



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

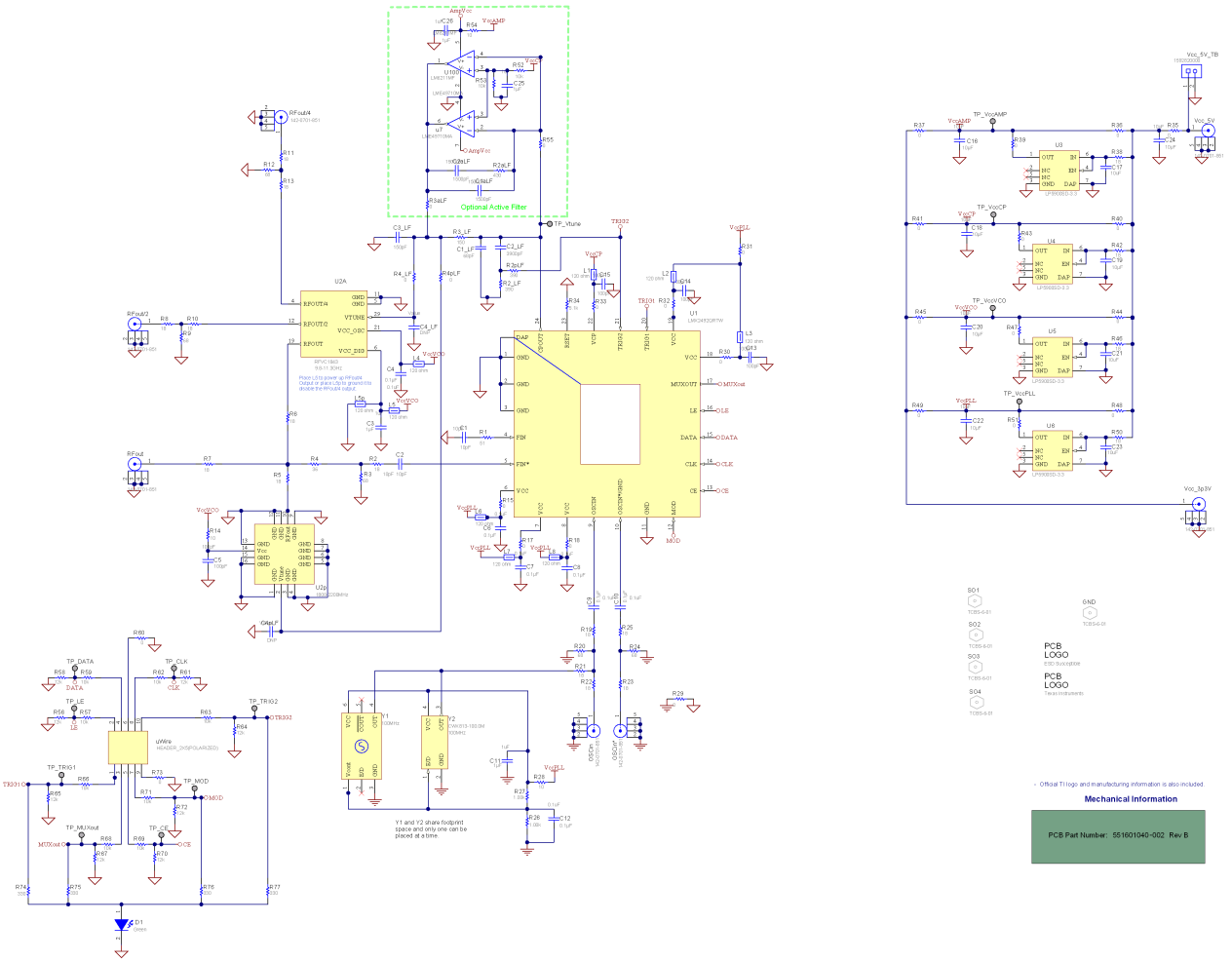


Then Click on “Update All” and wait until you see your screen populate to below:

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



Refer to Chapter 5 for actual component values. Also realize that not all components are placed on this board.

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

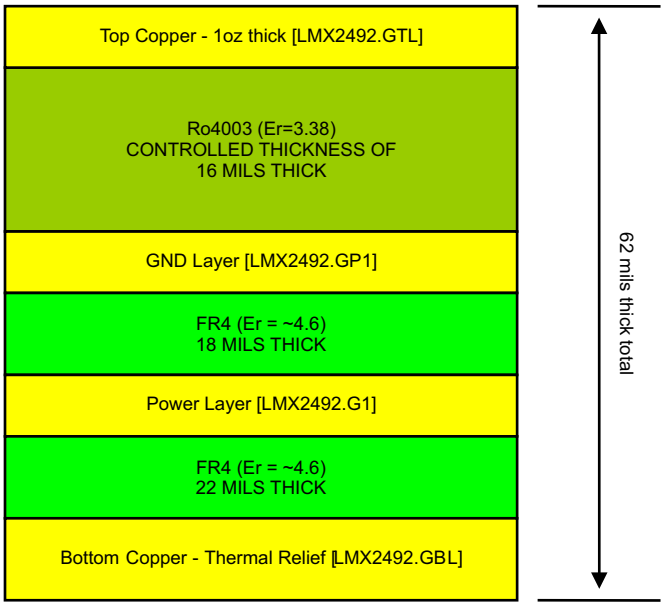


Figure 4-1. Board Layers Stackup

Bill of Materials

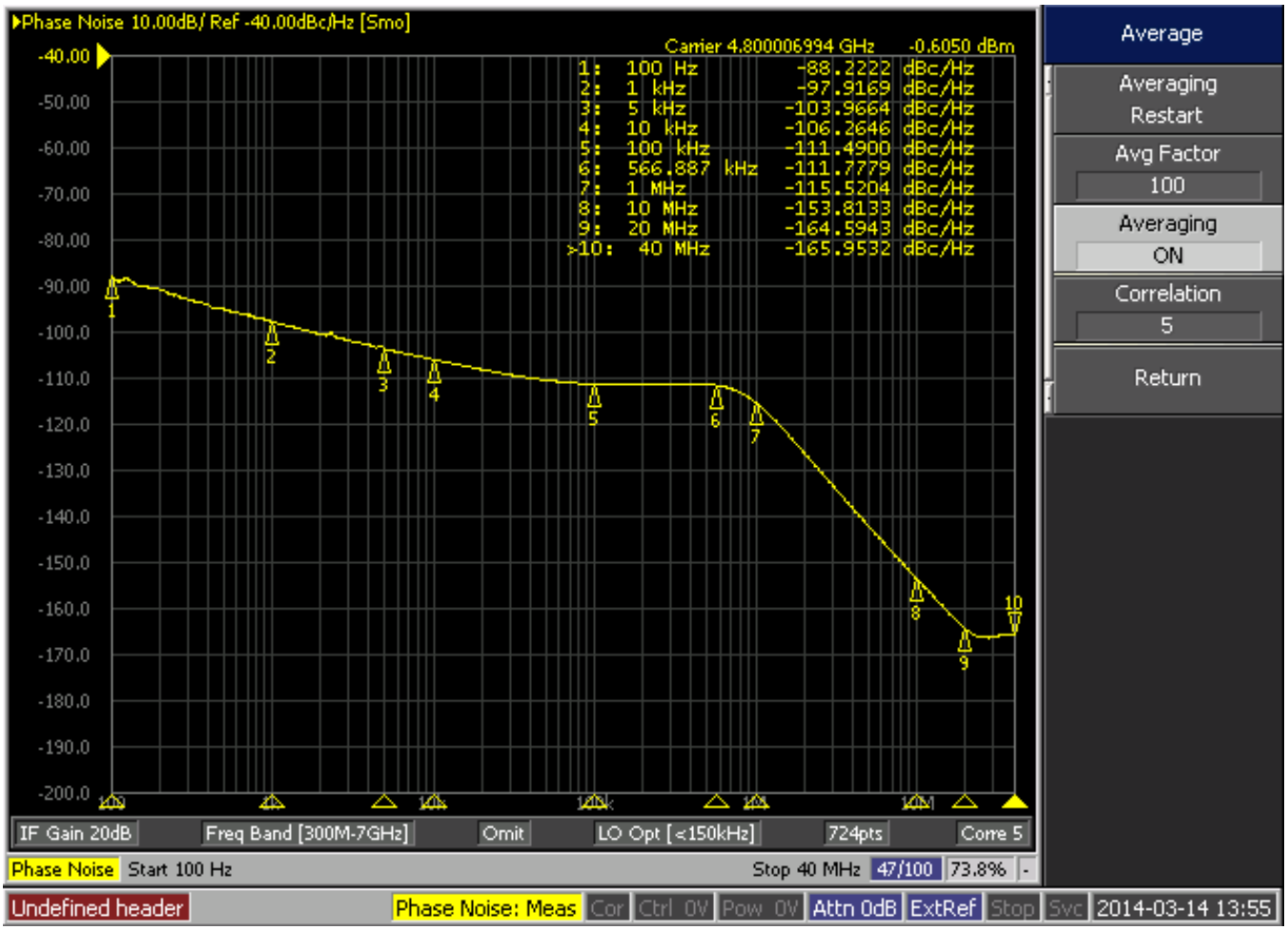
ITEM	DESIGNATOR	DESCRIPTION	RoHS	MANUFACTURER	PART NUMBER	QTY
1	AA1	Printed Circuit Board	O	TBD	Used in BOM Report	1
2	C1, C2	CAP, CERM, 10pF, 50V, +/-5%, C0G/NP0, 0402	Y	Johanson Technology	500R07S100JV4T	2
3	C1_LF	CAP, CERM, 68pF, 50V, +/-5%, C0G/NP0, 0603	Y	Kemet	C0603C680J5GACTU	1
4	C2_LF	CAP, CERM, 3900pF, 50V, +/-5%, C0G/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%, C0G/NP0, 0603	Y	Kemet	C0603C151J5GACTU	1
7	C4	CAP, CERM, 0.1uF, 50V, +/-10%, C0G/NP0, 0402	Y	TDK	C1005X7R1H104K	1
8	C5, C13, C14, C15	CAP, CERM, 100pF, 50V, +/-5%, C0G/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

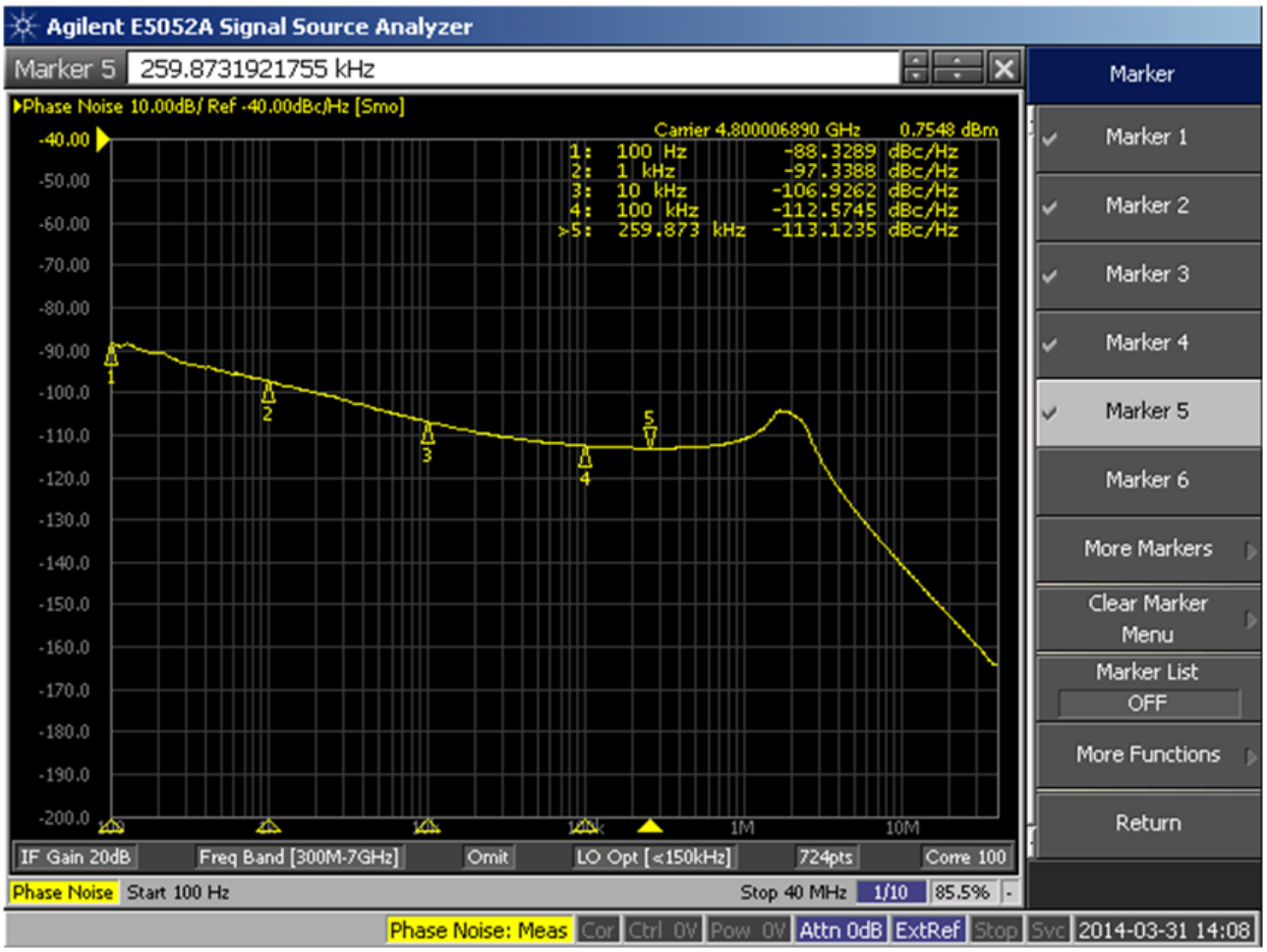
6.1 PLL Phase Noise

Figure 6-1. Phase Noise in Default Mode



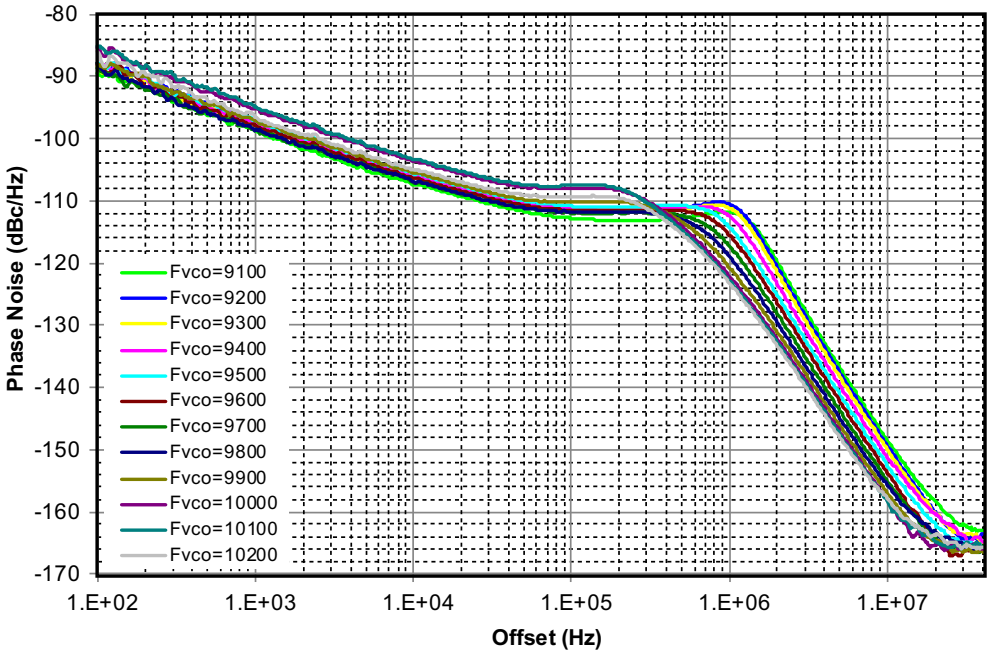
The above figure shows the phase noise in default for mode. Note that this is ½ the VCO frequency as it was observed on the Fout/2 output.

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

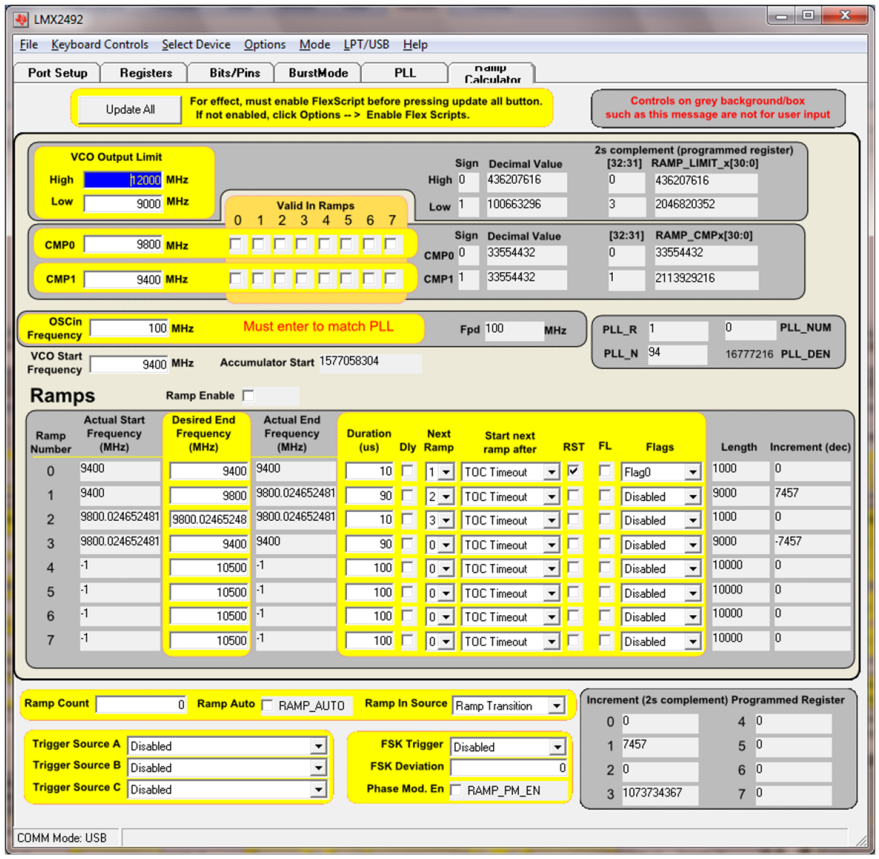
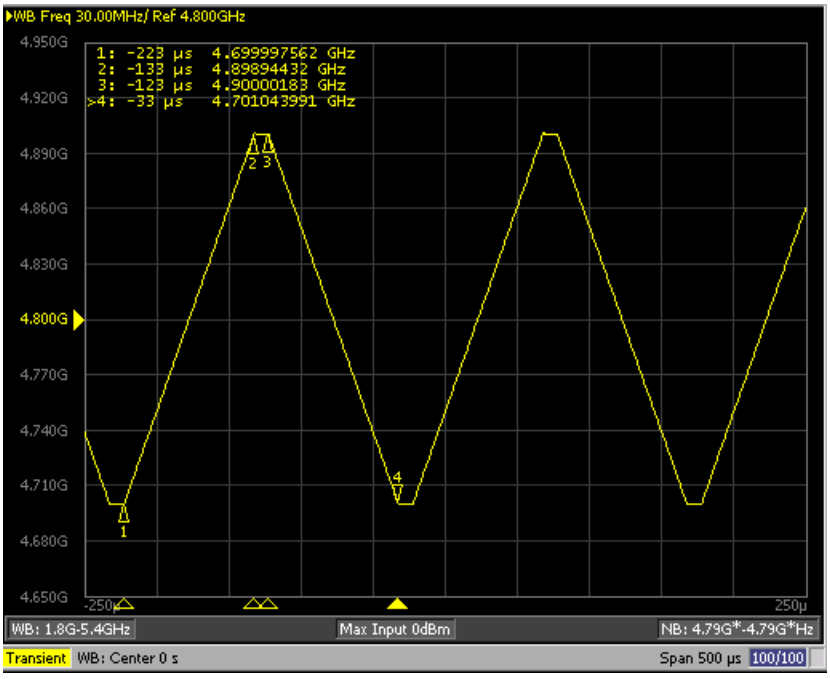


Figure 6-5. Generated Waveform at VCO/2 Output



Revision History

Changes from C Revision (November 2014) to D Revision	Page
• Changed Updated setup diagram to clarify that OSCin signal IS required.	4

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      3.1.1 *Notice applicable to EVMs not FCC-Approved:*

      This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

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

      FCC Interference Statement for Class A EVM devices

      NOTE: 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 his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: 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.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-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.

Concernant les EVMs avec appareils radio:

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.

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.

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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http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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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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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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