LMX2541-xxxx Evaluation Board

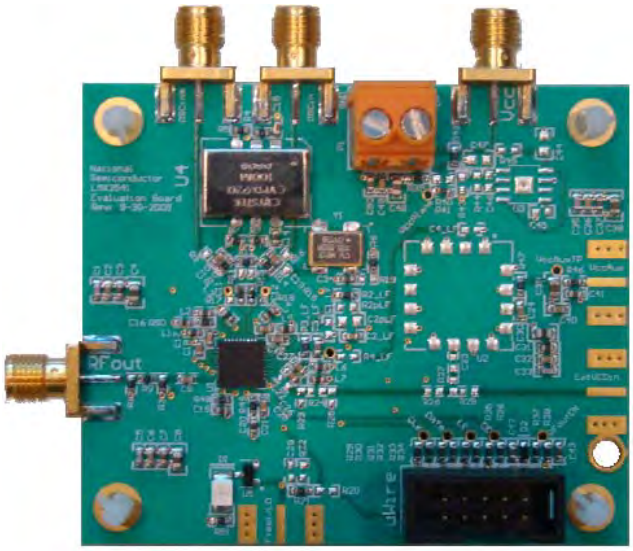
User's Guide

November 2013

SNAU067A

LMX2541xxxx

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



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Equipment

Power Supply

The Power Supply should be a low noise power supply. An Agilent 6623A Triple power supply with LC filters on the output to reduce noise was used in creating these evaluation board instructions.

Signal Generator

The Signal Generator should be capable of frequencies and power level required for the part. A Rohde & Schwarz SML03 was used in creating these evaluation board instructions.

Phase Noise / Spectrum Analyzer

For measuring phase noise an Agilent E5052A is recommended. An Agilent E4445A PSA Spectrum Analyzer with the Phase Noise option is also usable although the architecture of the E5052A is superior for phase noise measurements. At frequencies less than 100 MHz the local oscillator noise of the PSA is too high and measurements will be of the local oscillator, not the device under test.

Oscilloscope

The oscilloscope and probes should be capable of measuring the output frequencies of interest when evaluating this board. The Agilent Infiniium DSO81204A was used in creating these evaluation board instructions.

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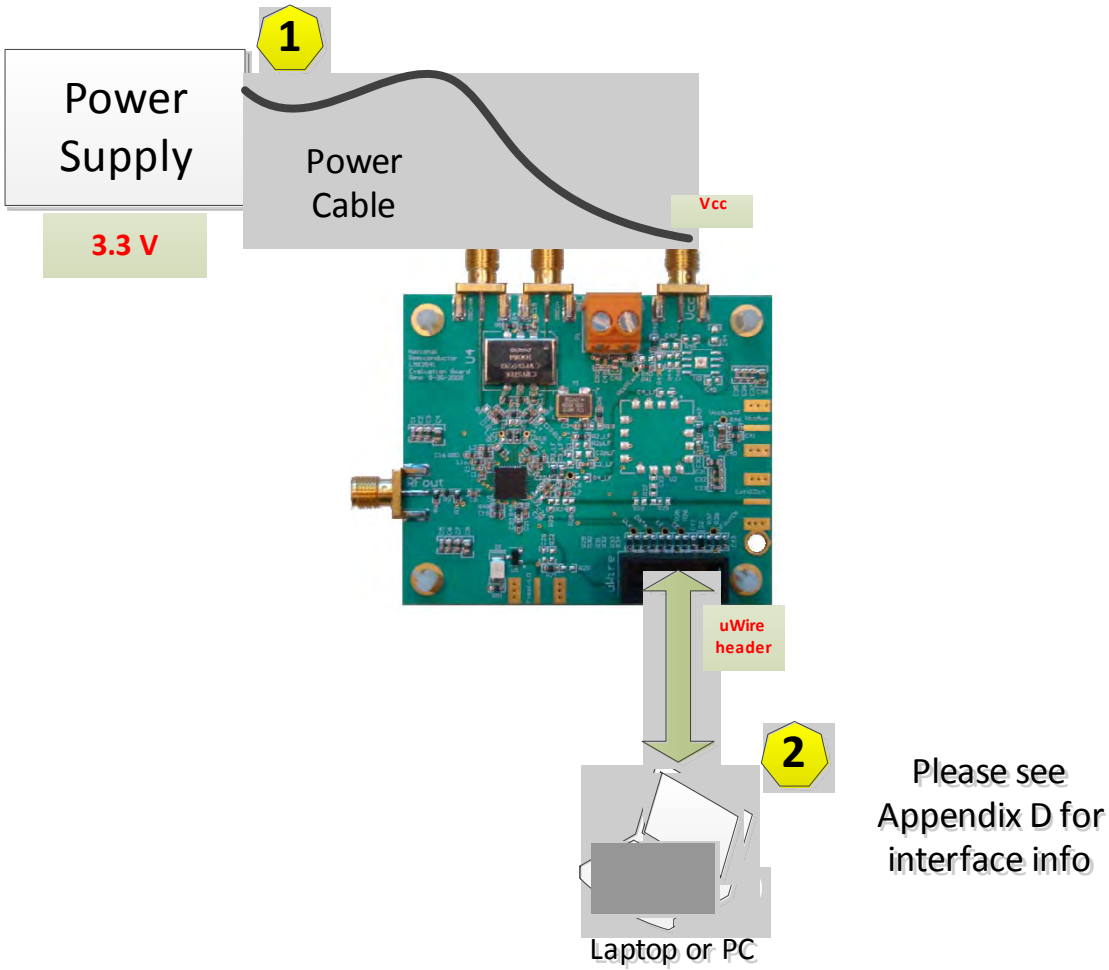
Basic Operation

1. Connect a low noise **3.3 V** power supply to the **Vcc** connector located at the top left of the board.
2. Please see **Appendix D** for quick start on interfacing the board. Connect PC to the **uWire** header.



3. Start CodeLoader4.exe.
4. Select USB or LPT Communication Mode on the Port Setup tab as appropriate.

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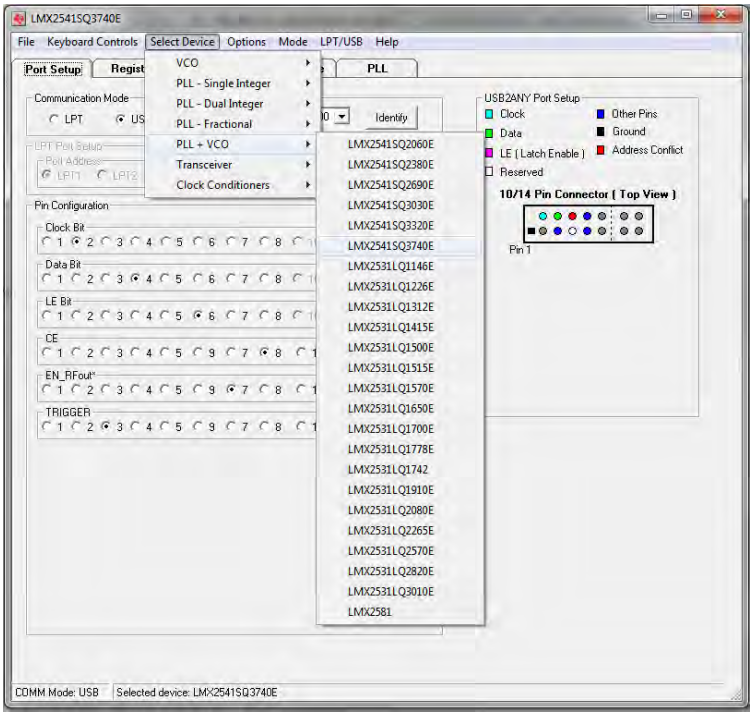
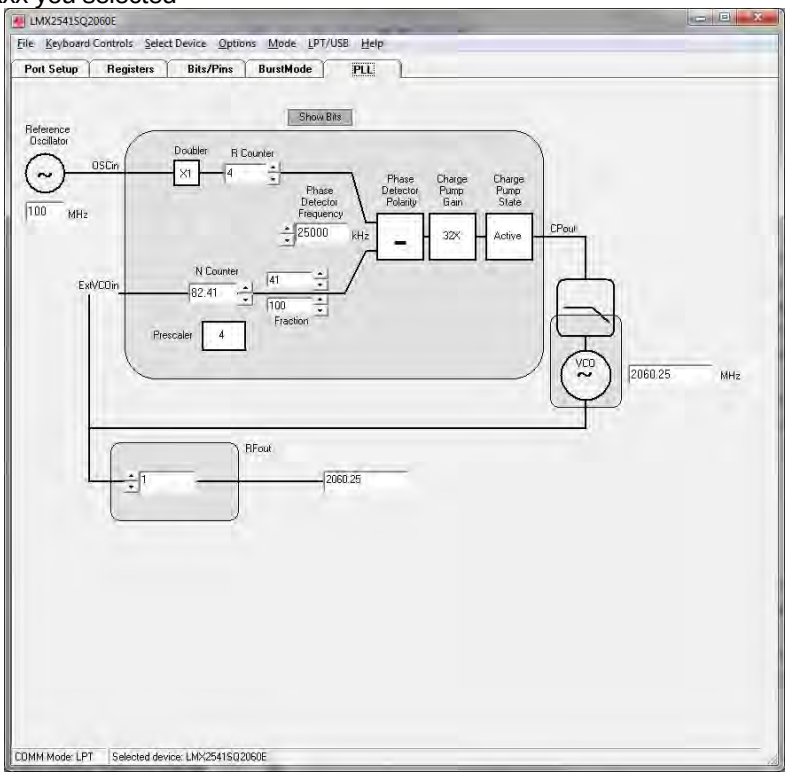
5. Click “Select Device” → “PLL-VCO” → LMX2531xxxx depending on which chip is on your board.



6. Check your window with “PLL/VCO” Tab screenshot, 100 MHz input, but VCO output will be different depending on which LMX2541xxxx you selected



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LMX2541-xxxx Board Information

VCO Frequency Ranges

The following table illustrates the VCO Frequency options for the LMX2541 family. Note that frequency range for some options is less than the datasheet. The reason for this is for the alpha samples, some of the center frequencies were off from their design targets. These frequencies will be shifted back to their correct values in later revisions of silicon.

Part	Frequency Range (MHz)	
	Datasheet	Evaluation Board Instructions
LMX2541SQ2060E	1990 – 2310	**2100** – 2310
LMX2541SQ2690E	2490 - 2895	2490 – 2895
LMX2541SQ3320E	3080 - 3570	3080 – **3450**
LMX2541SQ3470E	3495 - 4030	3495 – 4030

***Note on Testing Over Temperature:**
This board has a clampdown socket and it has been found during our characterization that the contact sets in these clampdown fixtures are not reliable for testing over temperature and yield erroneous results. During our characterization, we have used some different contact sets to ensure that the issue was with the contact sets and not the LMX2541. Also, some evaluation boards do not have the clampdown socket, but have a part hand soldered directly to this footprint, which was not designed to have a part soldered down to it. Although these boards are tested at room temperature, these solder joints are not always reliable at temperature either. So in conclusion, if issues are encountered with testing over temperature, it is probably due to the socket/soldering and not the part.

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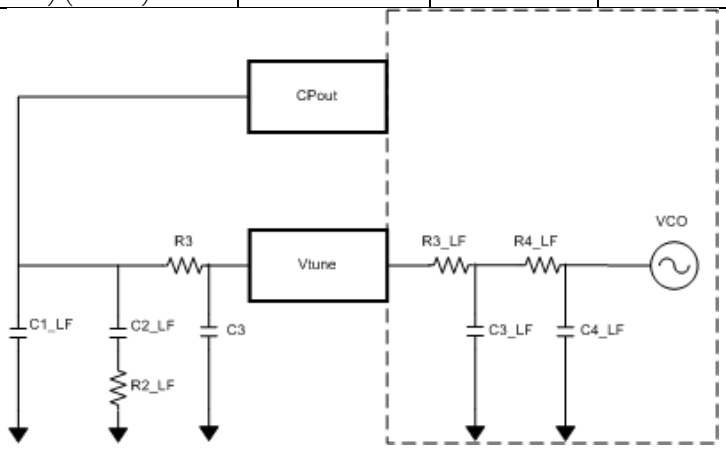
Loop Filter Values

Parameter	LMX2541 SQ2060E	LMX2541 SQ2690E	LMX2541 SQ3320E	LMX2541 SQ3470E
VCO Frequency (MHz)	2100 – 2310	2490 – 2895	3080 – 3450	3495 - 4030
VCO Gain (MHz/V)	18 – 21	21 – 27	24 – 31	27 - 35
Charge Pump Gain (mA)	2.0	2.0	2.0	2.0
Phase Detector Frequency (MHz)	10	10	10	10
OSCin Frequency (MHz)	100	100	100	100
Loop Bandwidth (kHz)	34	35	34	36
Phase Margin (deg)	38	37	38	36
C1 (nF)	1	1	1	1
C2 (nF)	56	56	56	56
C3 (nF)	0.82	0.82	0.82	0.82
C3_LF (Internal) (nF)	0.02	0.02	0.02	0.02
C4_LF (Internal) (nF)	0.16	0.16	0.16	0.16
R2 (Kohm)	1.8	1.8	1.8	1.8
R3 (Kohm)	0.22	0.22	0.22	0.22
R3_LF (Internal) (Kohm)	4	4	4	4
R4_LF (Internal) (Kohm)	0.2	0.2	0.2	0.2



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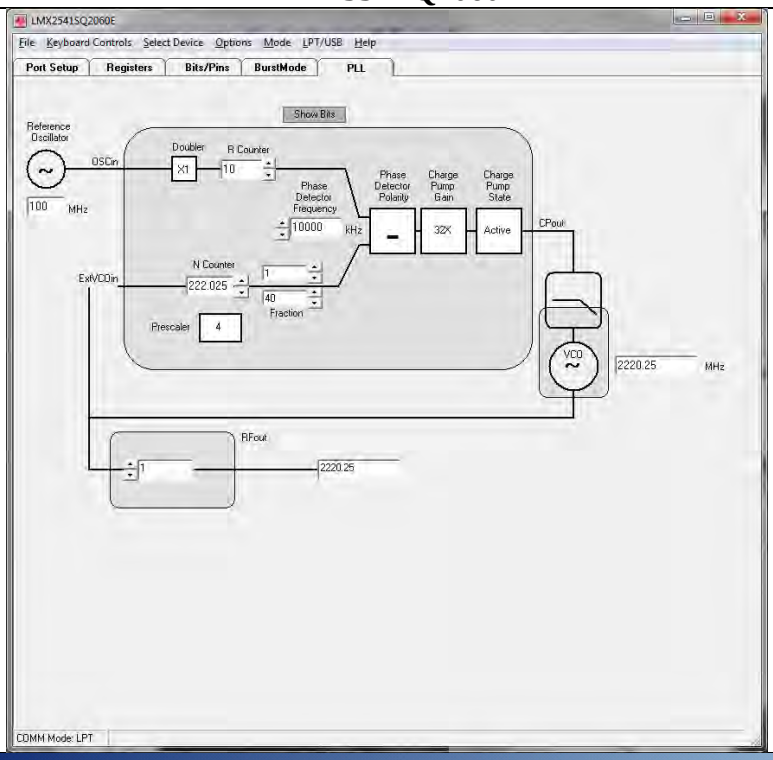
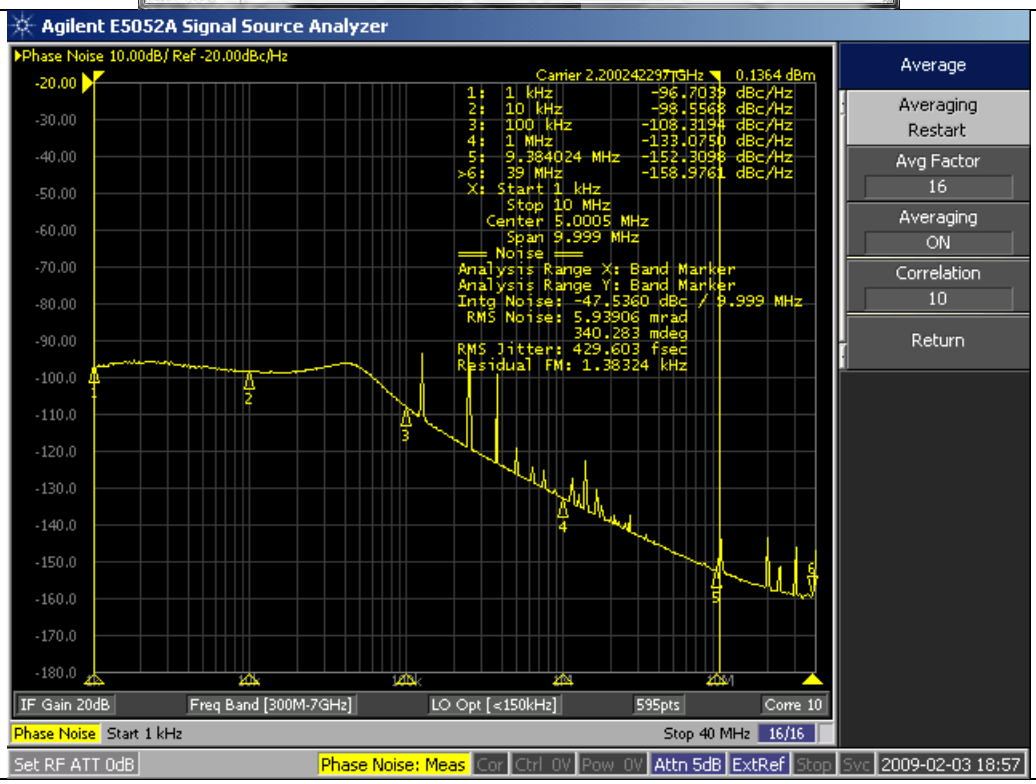
Phase Noise Data

LMX2531LQ2060E





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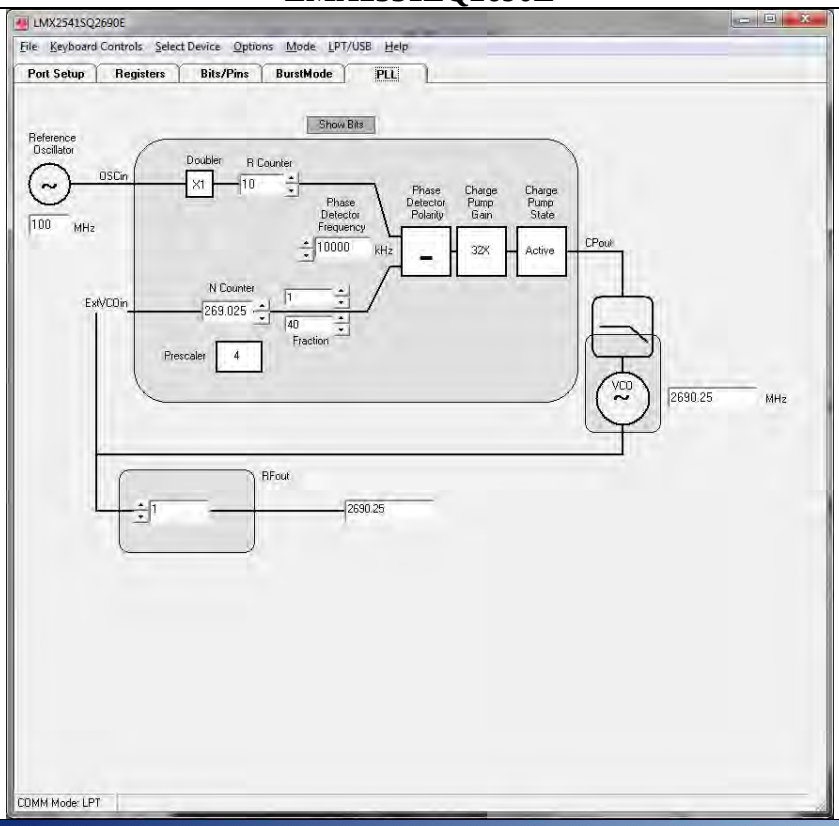
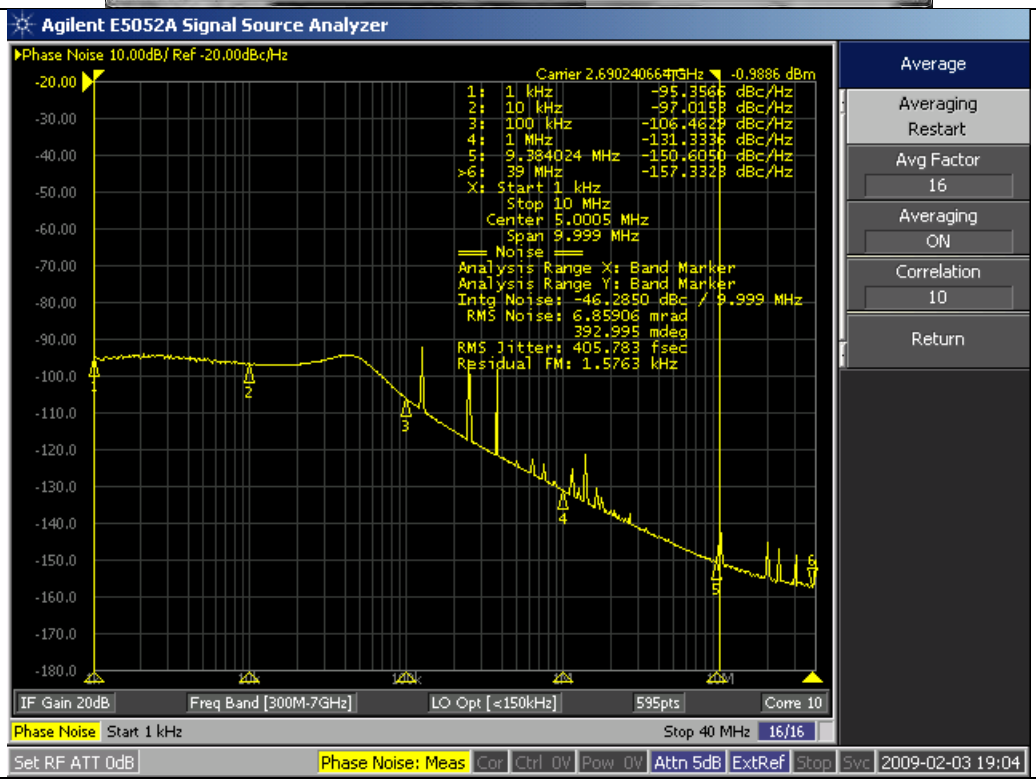
LMX2531LQ2690E





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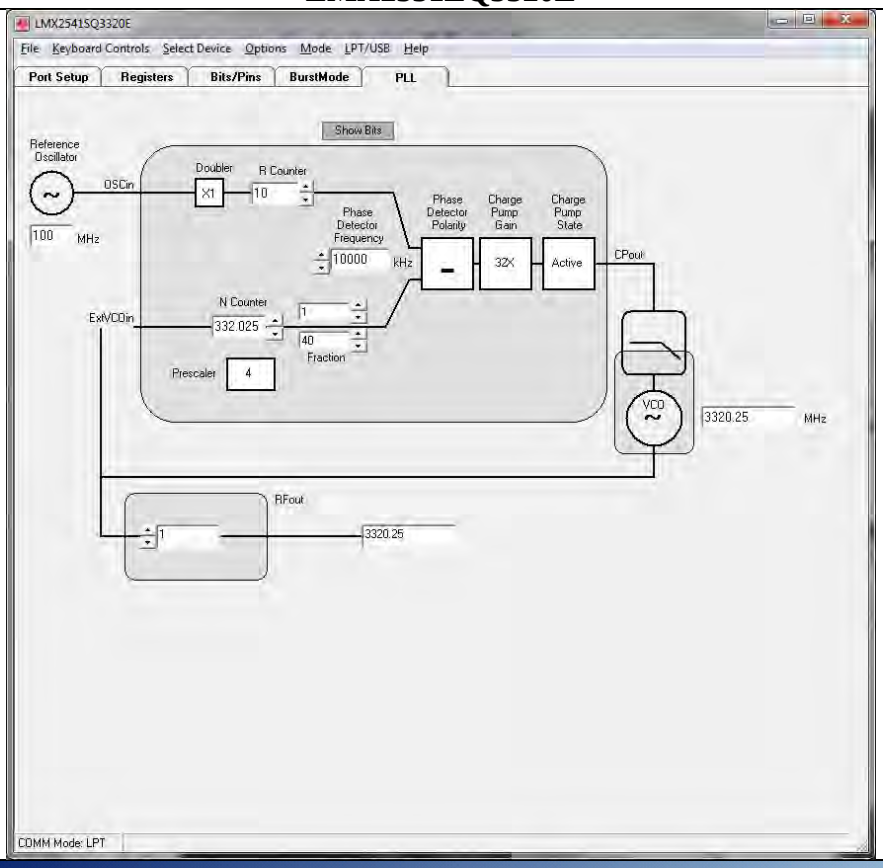
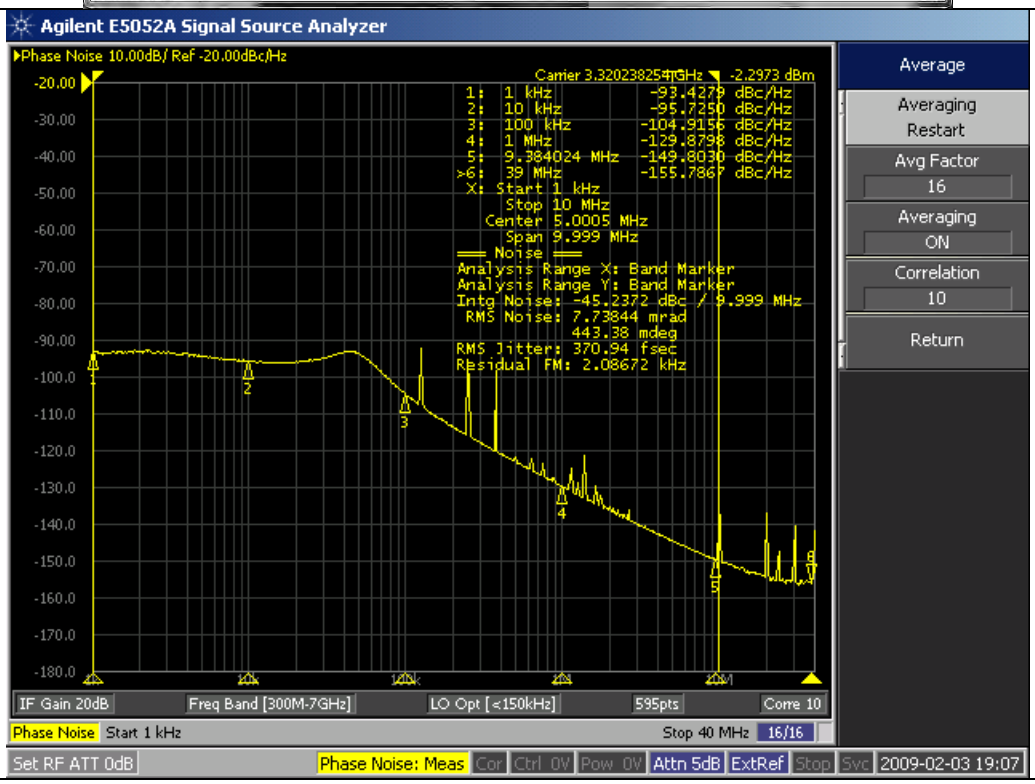
LMX2531LQ3320E





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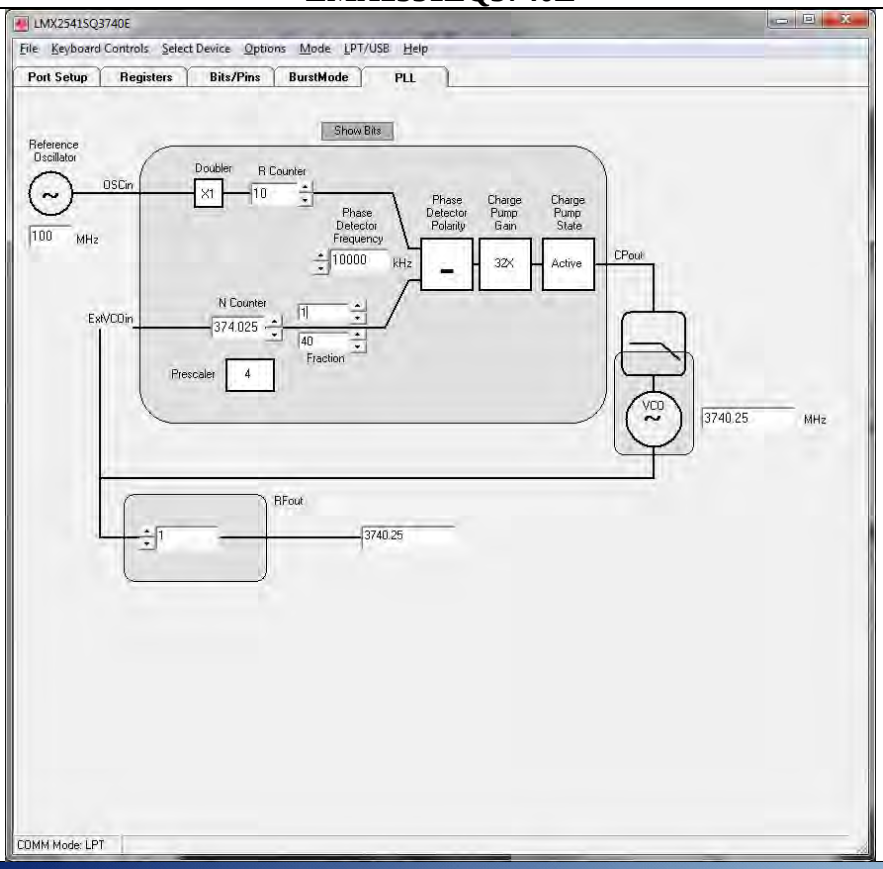
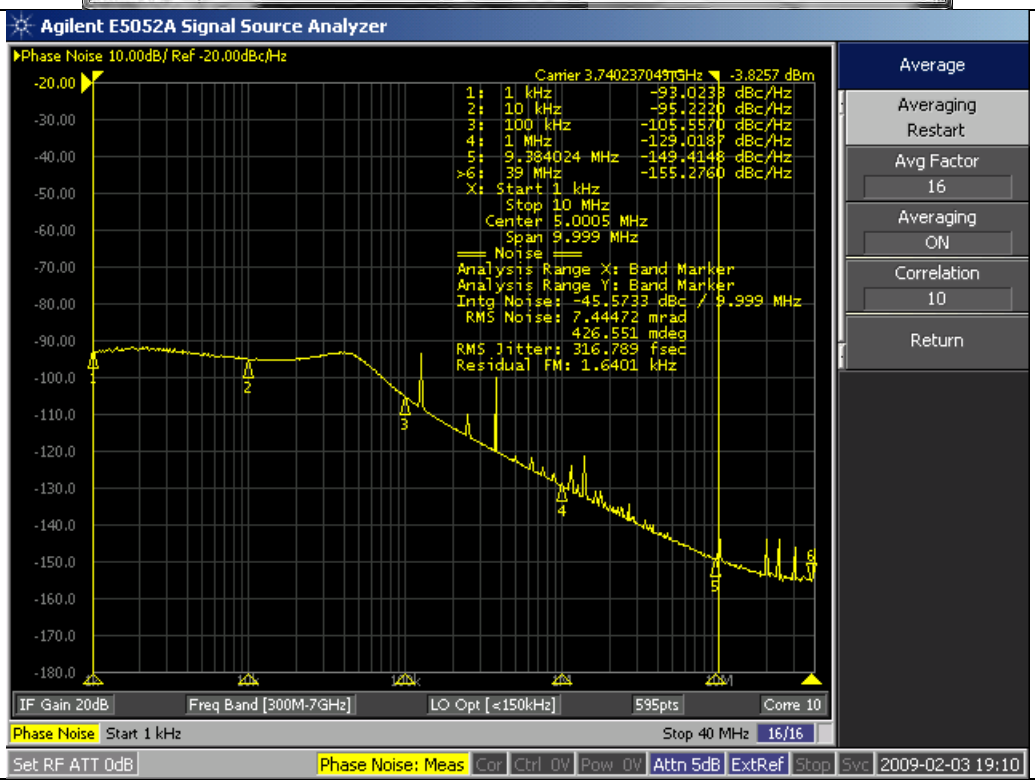
LMX2531LQ3740E





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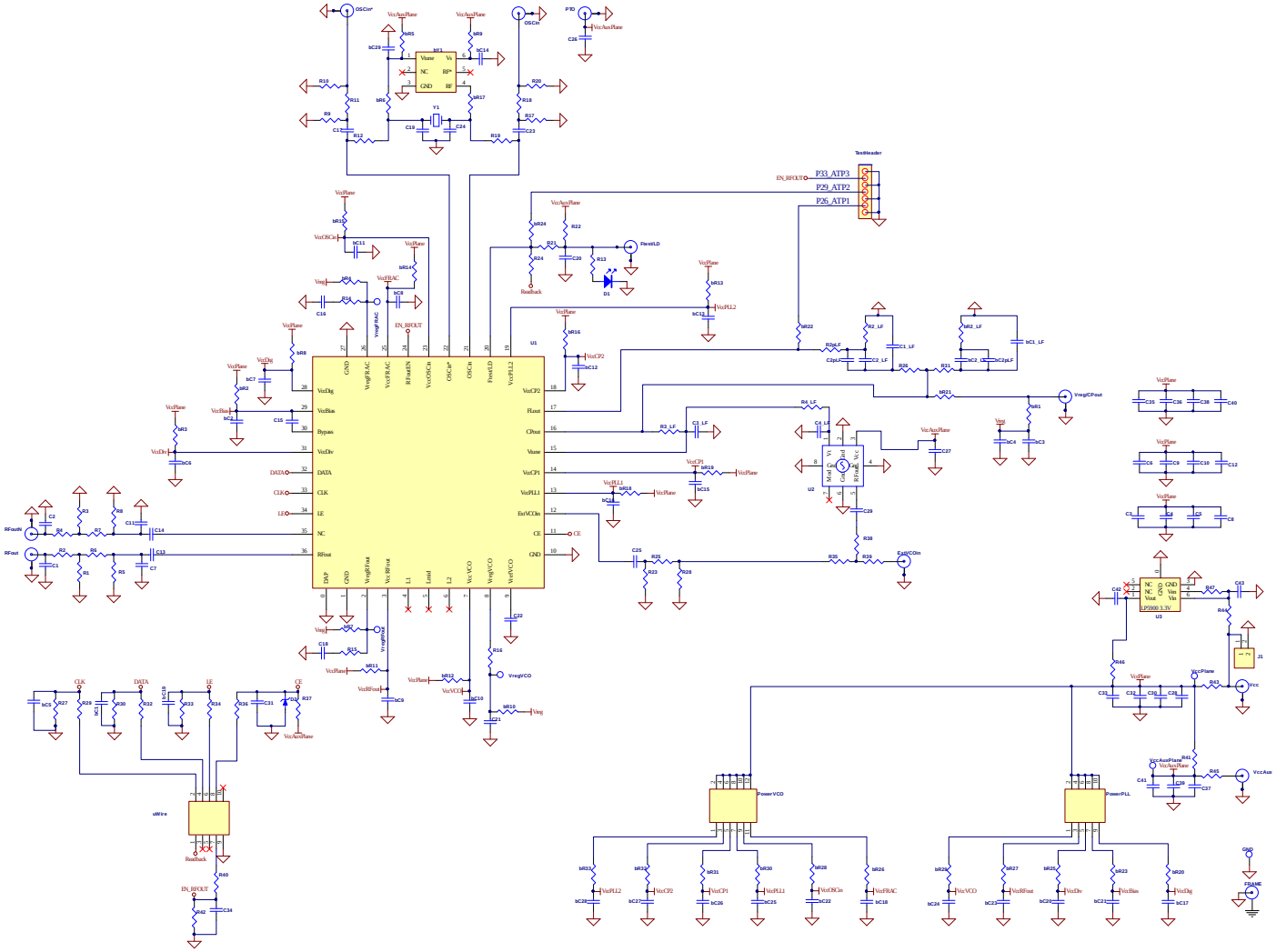
Appendix A: Schematics



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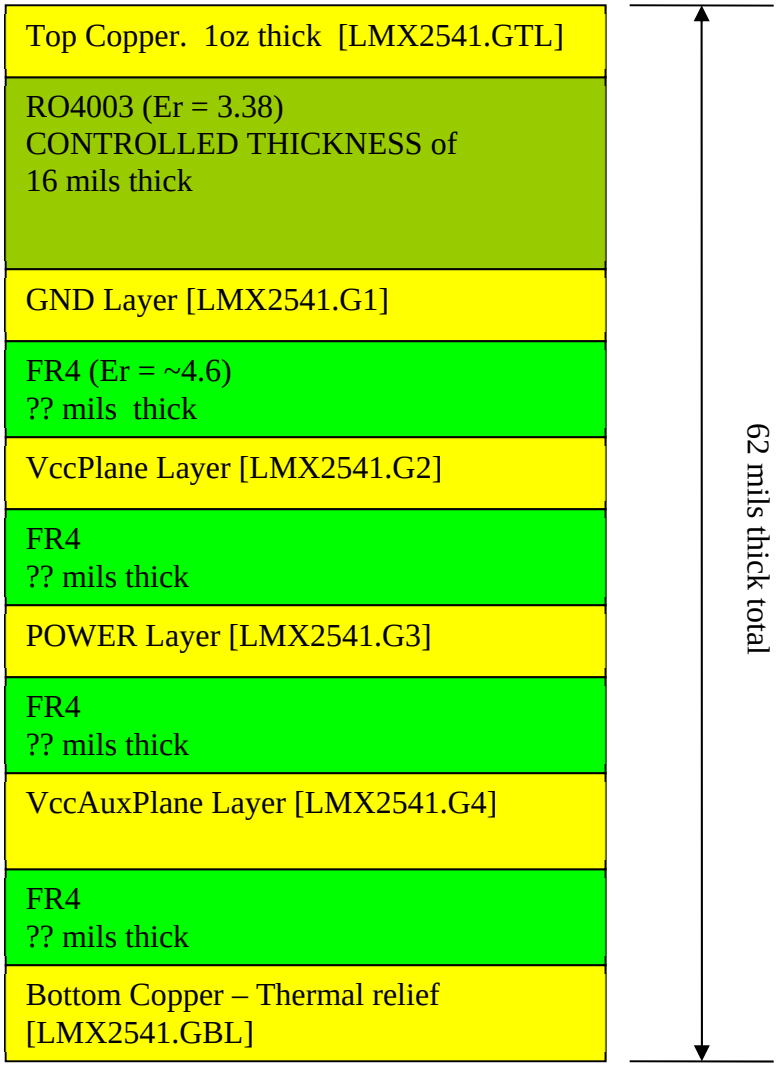
Appendix B: Board Layer Stackup

Layers of the 6 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, **xx mils** thick.
- Power plane #1 – VccCLK (GP2)
- FR4, xx mils
- middle ground plane (GP3)
- FR4, xx mils
- VccPLL, VccAux (G1)
- FR4, xx mils
- Bottom layer copper clad for thermal relief (GBL)

Top to bottom layer order:

LMX2541.GTL	(1)	Top Layer
LMX2541.G1	(2)	GND Layer
LMX2541.G2	(3)	VccPlane
LMX2541.G3	(4)	POWER
LMX2541.G4	(5)	VccAuxPlane
LMX2541.GBL	(6)	Bottom Layer



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Appendix C: Bill of Materials

Part	Manufacturer	Part Number	Qnt	Identifier
Capacitors				
100 pF	Kemet	C0603C101J5GAC	7	C3, C6, C25, C29, C33, C35, bC13
120 pF	Kemet	C0603C121J5GAC	1	C1_LF
6.8 nF	Kemet	C0603C682J5GAC	1	C2_LF
0.1 uF	Kemet	C0603C104J3RAC	8	C4, C9, C13, C15, C27, C32, C36, C41
100 nF	Kemet	C0603C104J3RAC	3	C17, C22, C23
680 nF	Kemet	C0603C684K8PAC	1	bC1_LF
1 uF	Kemet	C0603C105K8VAC	10	C5, C10, C16, C18, C26, C30, C31, C34, C38, C39
4.7 uF	Kemet	C0603C475K9PAC	1	C21
10 uF	Kemet	C0805C106K9PAC	6	C8, C12, C28, C37, C40, bC2pLF
Resistors				
0 ohm	Vishay/Dale	CRCW06030000Z0EA	22	R2, R3_LF, R9, R14, R15, R16, R21, R25, R26, R41, R43, R45, bR2, bR3, bR8, bR11, bR12, bR14, bR15, bR16, bR18, bR19
18 ohm	Vishay/Dale	CRCW060318R0JNEA	5	R6, R18, R35, R38, R39
180 ohm	Vishay/Dale	CRCW0603180RJNEA	1	R36
330 ohm	Vishay/Dale	CRCW0603330RJNEA	5	R1, R5, R13, R17, R20
680 ohm	Vishay/Dale	CRCW0603680RJNEA	1	bR2_LF
1 k	Vishay/Dale	CRCW06031K0RJNEA	1	R2_LF
2.2 k	Vishay/Dale	CRCW06032K20JNEA	1	R37
10 k	Vishay/Dale	CRCW060310K0JNEA	1	R47
15 k	Vishay/Dale	CRCW060315K0JNEA	4	R24, R29, R32, R34
27 k	Vishay/Dale	CRCW060327K0JNEA	5	R27, R30, R33, R40, R42
Other				
SMA	Johnson Components	142-0701-851	6	ExtVCOin, Ftest/LD, OSCin, PTO, RFout, Vcc
Green LED	Lumex	SML-LX2832GC-TR	1	D1
HEADER_2X5 (POLARIZED)	FCI Electronics	52601-S10-8	1	uWire
3.3 V zener	Comchip	CZRU52C3V3	1	D2
Standoffs	SPC Technology	SPCS-6	4	Place in 4 holes at edge of the board

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Part	Manufacturer	Part Number	Qnt	Identifier
Open				
Open	n/a		1	TestHeader
Open			16	R2pLF, R3, R4_LF, R4, R7, R8, R10, R11, R12, R19, R22, R23, R28, R31, R44, R46
Open			23	bR1, bR4, bR5, bR6, bR7, bR9, bR10, bR13, bR17, bR20, bR21, bR22, bR23, bR24, bR25, bR26, bR27, bR28, bR29, bR30, bR31, bR32, bR33
Open			13	C1, C2, C2pLF, C3_LF, C4_LF, C7, C11, C14, C19, C20, C24, C42, C43
Open			1	J1
Open			3	U1, U2, U3
Open			6	OSCin*, VccAux, PowerPLL, PowerVCO, RFoutN, Vreg/CPout
Open			29	bC1, bC2_LF, bC2, bC3, bC4, bC5, bC6, bC7, bC8, bC9, bC10, bC11, bC12, bC14, bC15, bC16, bC17, bC18, bC19, bC20, bC21, bC22, bC23, bC24, bC25, bC26, bC27, bC28, bC29
Open			2	bY1, Y1

Modifications			
Block	**Designator**	**Original**	**New**
Device	U1	Open	Clampdown socket with LMX2541 Device
OSCin	R20	330 ohms	open
	R18	18 ohms	0 ohms
	R17	330 ohms	51 ohms
OSCin*	R9	0 ohms	220 ohms
	C17	0.1 uF	100 pF
Vcc Pins	bC11	Open	1 nF
	bR13	Open	0 ohm
	bC13	100 pF	0.1 uF
Oscillator	bY1	Open	Connor-Winfield CWX813 100 MHz TCXO
	bR17, bR9	Open	0 ohm
	C32	0.1 uF	Flip this to make R19 0.1 uF
	bC14	Open	0.1 uF

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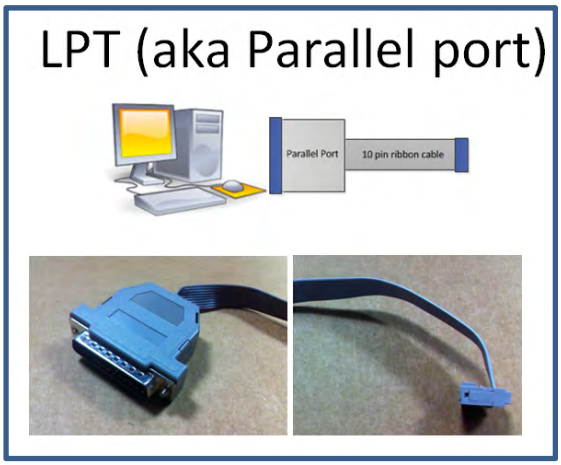
Appendix D: Quick Start on EVM Communication

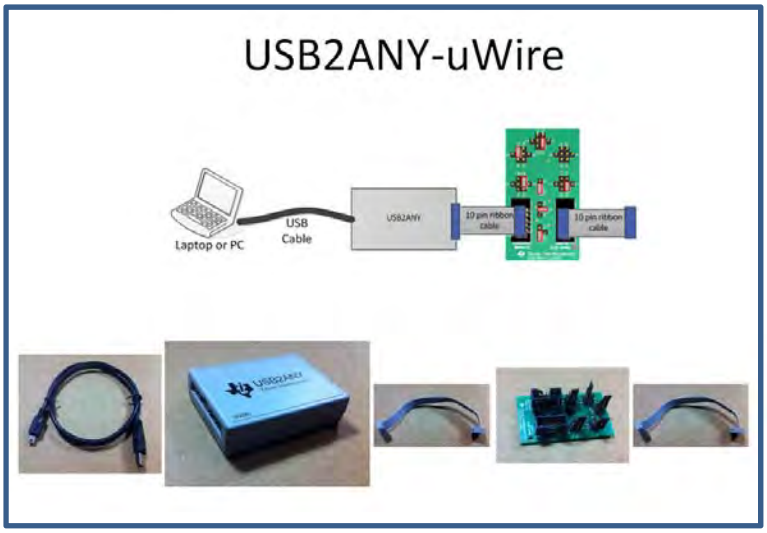
Codeloader is the software used to communicate with the EVM (Please download the latest version from TI.com - http://www.ti.com/tool/codeloader). This EVM can be controlled through the uWire interface on board. There are two options in communicating with the uWire interface from the computer.

OPTION 1



Open Codeloader.exe → Click “Select Device” → Click “Port Setup” tab → Click “LPT” (in Communication Mode)

OPTION 2



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The Adapter Board

This table describes the pins configuration on the adapter board for each EVM board (See examples below table)

EVM	Jumper Bank								Code Loader Configuration
	A	B	C	D	E	F	G	H	
LMX2581	A4	B1	C2		E5	F1	G1	H1	BUFEN (pin 1), Trigger (pin 7)
LMX2541	A4		C3		E4	F1	G1	H1	CE (pin 1), Trigger (pin 10)
LMK0400x	A0		C3		E5	F1	G1	H1	GOE (pin 7)
LMK01000	A0		C1		E5	F1	G1	H1	GOE (pin 7)
LMK030xx	A0		C1		E5	F1	G1	H1	SYNC (pin 7)
LMK02000	A0		C1		E5	F1	G1	H1	SYNC (pin 7)
LMK0480x	A0	B2	C3		E5	F0	G0	H1	Status_CLKin1 (pin 3)
LMK04816/4906	A0	B2	C3		E5	F0	G0	H1	Status_CLKin1 (pin 3)
LMK01801	A0	B4	C5		E2	F0	G0	H1	Test (pin 3), SYNC0 (pin 10)
LMK0482x (prelease)	A0	B5	C3	D2	E4	F0	G0	H1	CLKin1_SEL (pin 6), Reset (pin 10)
LMX2531	A0				E5	F2	G1	H2	Trigger (pin 1)
LMX2485/7	A0		C1		E5	F2	G1	H0	ENOSC (pin 7), CE (pin 10)
LMK03200	A0				E5	F0	G0	H1	SYNC (pin 7)
LMK03806	A0		C1		E5	F0	G0	H1	
LMK04100	A0		C1		E5	F1	G1	H1	

Example adapter configuration (LMK01801)

Open Codeloader.exe → Click “Select Device” → Click “Port Setup” Tab → Click “USB” (in Communication Mode)
**Remember to also make modifications in “Pin Configuration” Section according to Table above.*

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EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY 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 THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

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REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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

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.

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.

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.

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.

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.

【Important Notice for Users of EVMs for RF Products in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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EVALUATION BOARD/KIT/MODULE (EVM)
WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. Since the EVM is not a completed product, it may not meet all applicable regulatory and safety compliance standards (such as UL, CSA, VDE, CE, RoHS and WEEE) which may normally be associated with similar items. You assume full responsibility to determine and/or assure compliance with any such standards and related certifications as may be applicable. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM’s electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI’s recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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