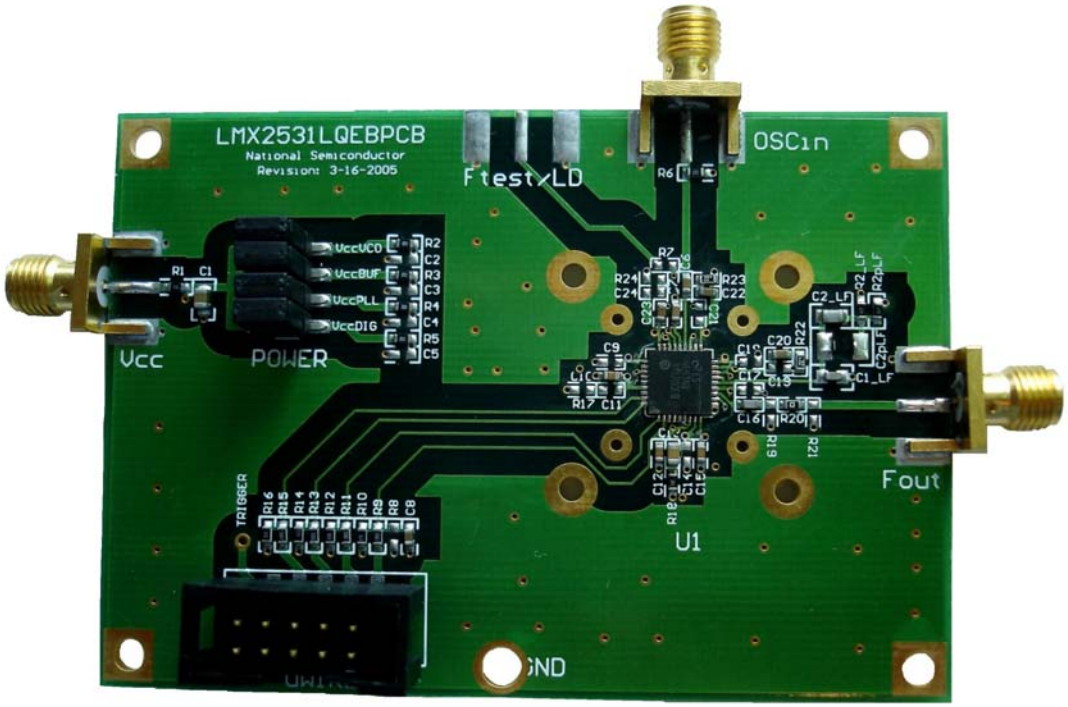
National Semiconductor

LMX2531LQ1910E

Evaluation Board Operating Instructions



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Wireless Communications, RF Products Group

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Santa Clara, CA, 95052-8090

LMX2531LQ1910EFPEB Rev 1.20.2006

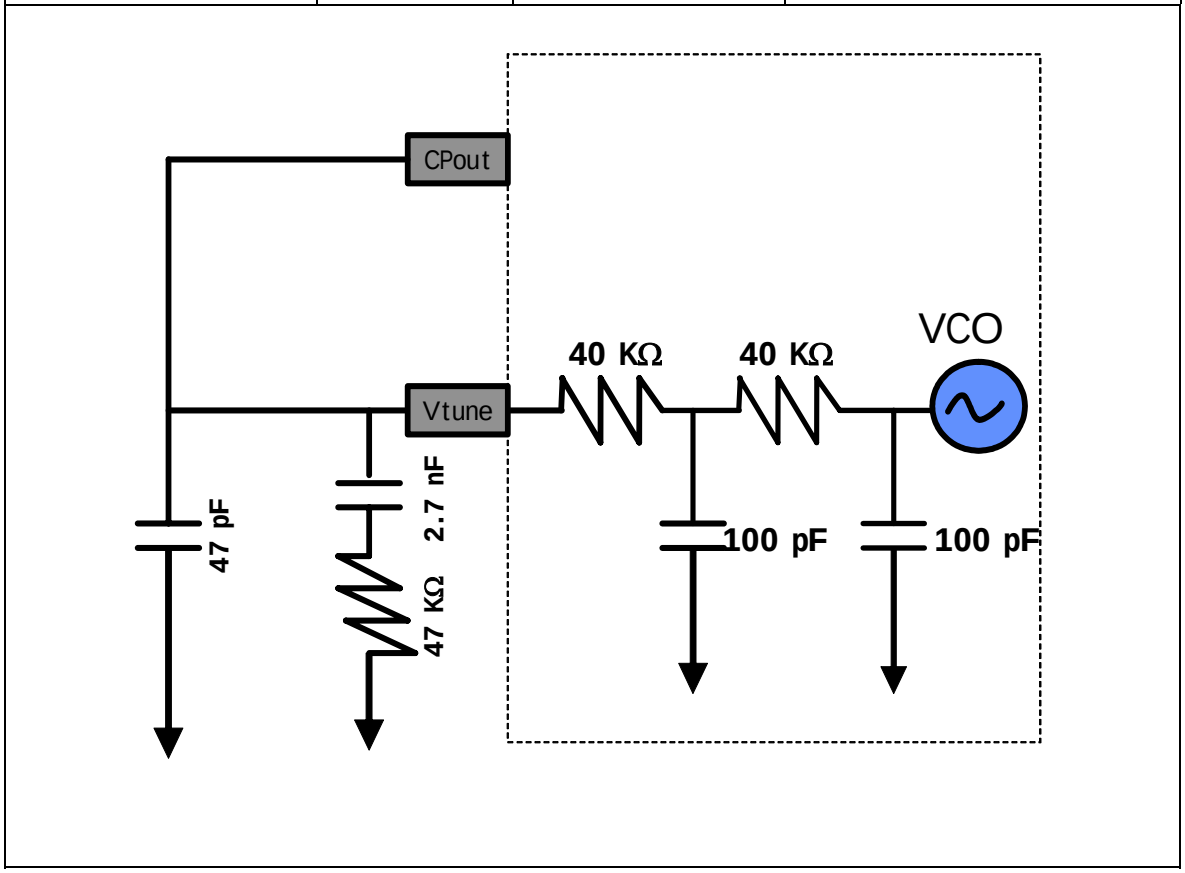
TABLE OF CONTENTS

General Description

The LMX2531LQ1910E Evaluation Board simplifies evaluation of the LMX2531LQ1910E PLL/VCO synthesizer system. The board enables all performance measurements with no additional support circuitry. The evaluation board consists of a LMX2531LQ1910E device, and a cable assembly.

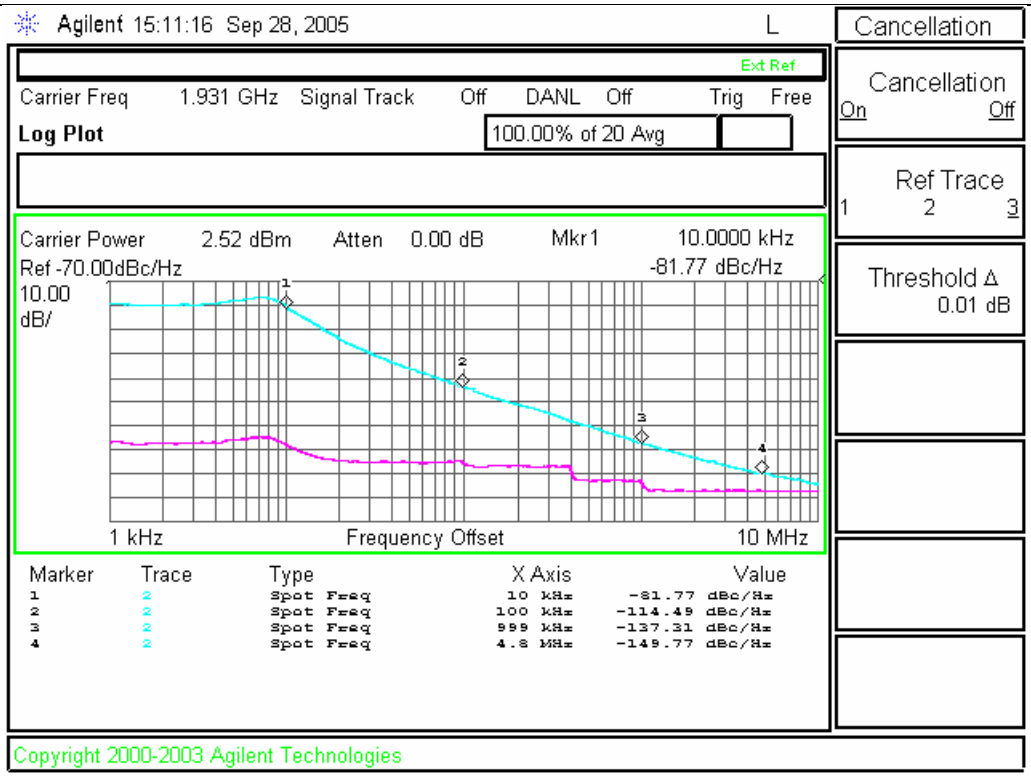
The cable assembly is bundled with the evaluation board for connecting to a PC through the parallel printer port. By means of ***MICROWIRE***^{TM} serial port emulation, the *CodeLoader* software included can be run on a PC to facilitate the LMX2531LQ1910E internal register programming for the evaluation and measurement. In addition to this cable assembly, there is a microwire buffer board that ensures that the proper voltage levels are provided to the microwire inputs and also this reduces digital noise from computers through the parallel port.

Loop Filter			
Phase Margin	34.4 deg	**Kϕ**	90 uA
Loop Bandwidth	6.8 kHz	**Fcomp**	2.5 MHz
Crystal Frequency	10 MHz	**Output Frequency**	1834 – 2028 MHz (DIV2=0) 917 – 1014 MHz (DIV2=1)
Supply Voltage	3.0 Volts	**VCO Gain**	11 MHz/Volt

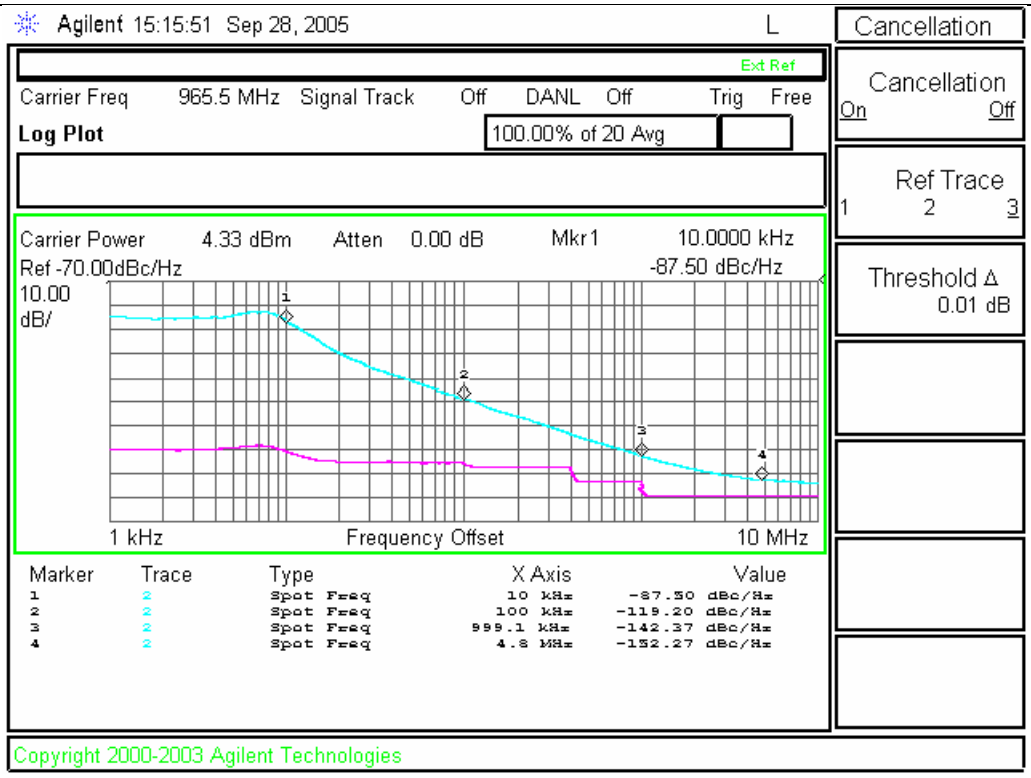


Phase Noise

Output Frequency = 1931 MHz
Internal Divide by 2 Disabled (DIV2=0)

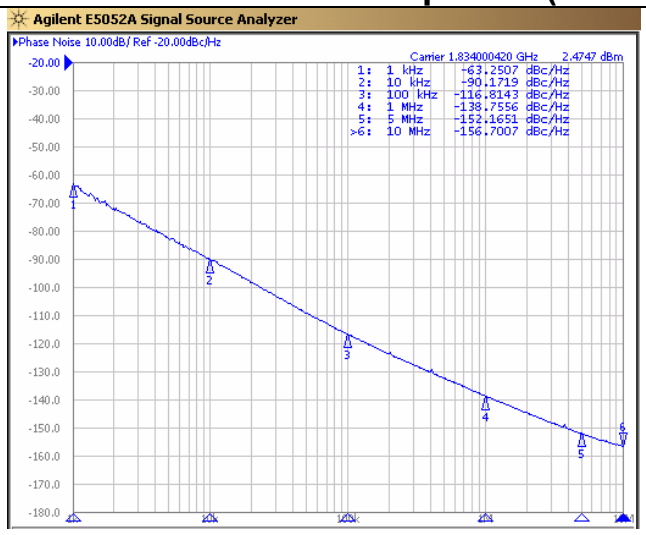


Output Frequency = 965.5 MHz
Internal Divide by 2 Enabled (DIV2=1)

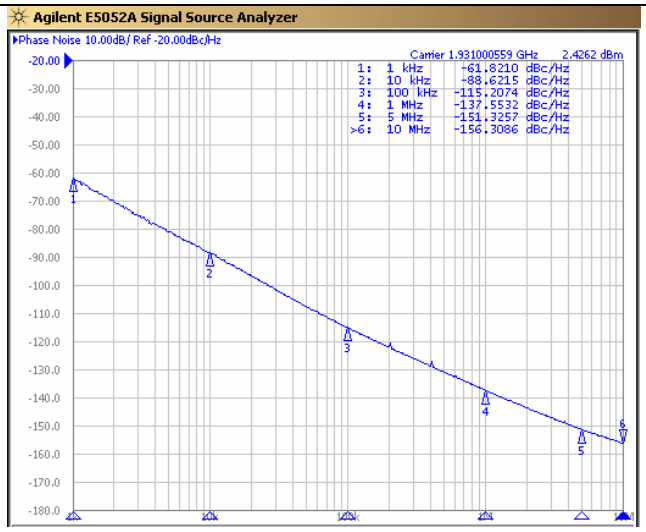


Phase Noise with Narrow Loop Filter (Internal Divide by 2 Disabled)

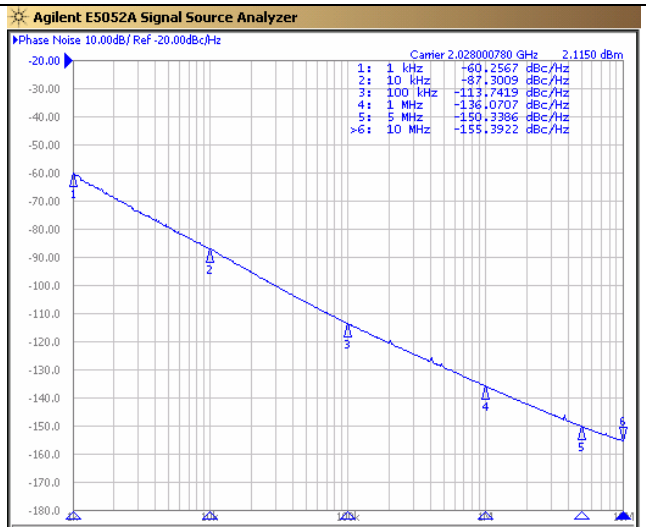
Fout = 1834 MHz



Fout = 1931 MHz



Fout = 2028 MHz

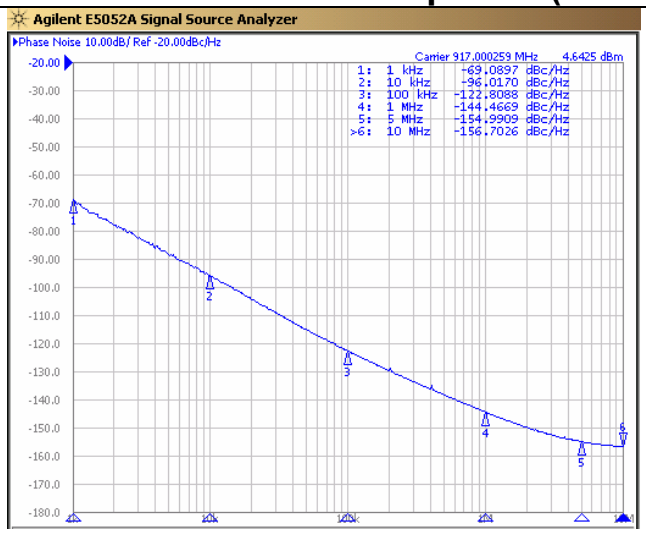


The plots to the left show the true phase noise capability of the VCO. In order to take these plots, a 20 Hz loop bandwidth was used with the E5052 spectrum analyzer. This is the most accurate and state of the art equipment.

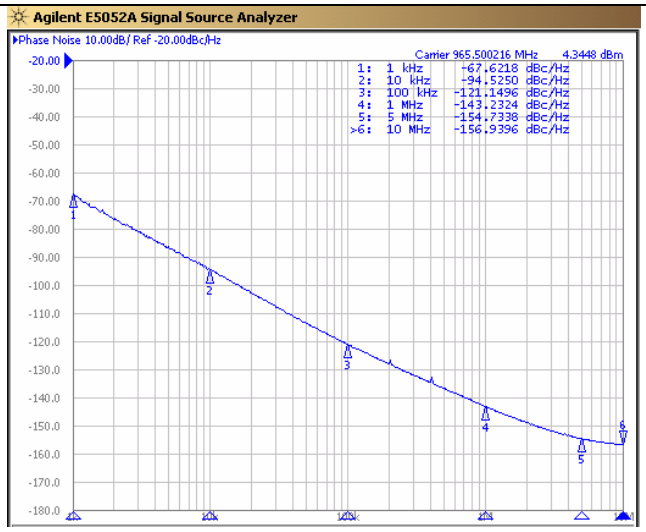
At lower offsets, the measurements are more accurate because the impact of the PLL is removed. At higher offsets, the measurements are also more accurate because the E5052 spectrum analyzer has a much lower noise floor than the E4445A spectrum analyzer. Even though the E4445A has a noise cancellation feature, it only cancels out thermal noise and not cancel out the phase noise if the LO inside this equipment.

Phase Noise with Narrow Loop Filter (Internal Divide by 2 Enabled)

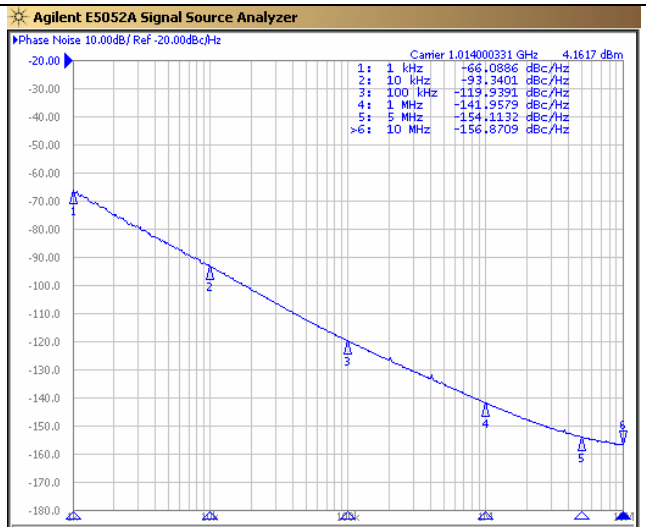
Fout = 917 MHz



Fout = 965.5 MHz



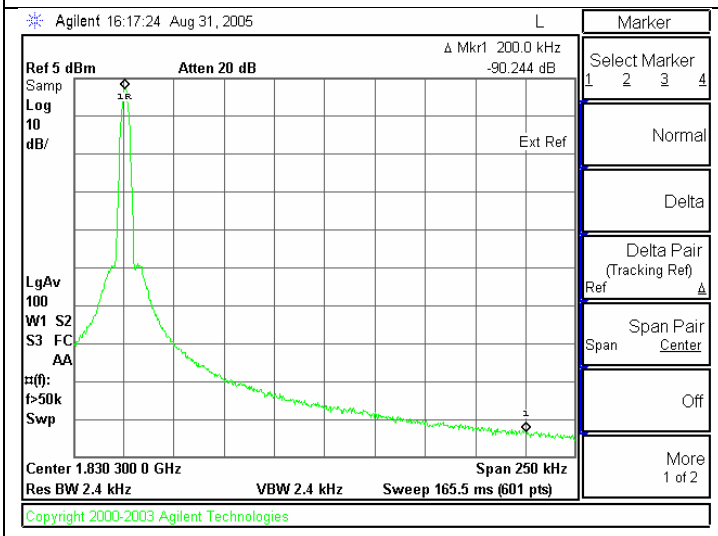
Fout = 1014 MHz



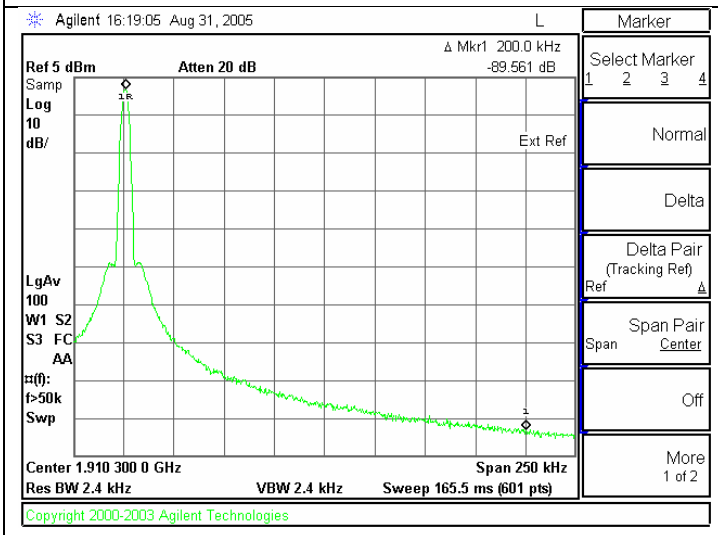
The plots to the left show the true phase noise capability of the VCO. In order to take these plots, a 20 Hz loop bandwidth was used with the E5052 spectrum analyzer. This is the most accurate and state of the art equipment.

At lower offsets, the measurements are more accurate because the impact of the PLL is removed. At higher offsets, the measurements are also more accurate because the E5052 spectrum analyzer has a much lower noise floor than the E4445A spectrum analyzer. Even though the E4445A has a noise cancellation feature, it only cancels out thermal noise and not cancel out the phase noise if the LO inside this equipment.

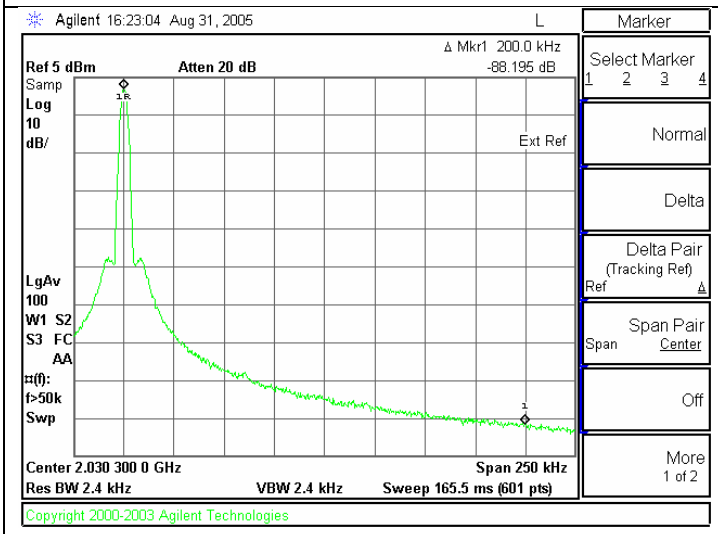
Spurs (Internal Divide by 2 Disabled)



Spur at 200 kHz offset at a worst case frequency of 1830.2 MHz is -90.2 dBc. Worst case channels occur at exactly one channel spacing above or below a multiple of the crystal frequency (10 MHz).

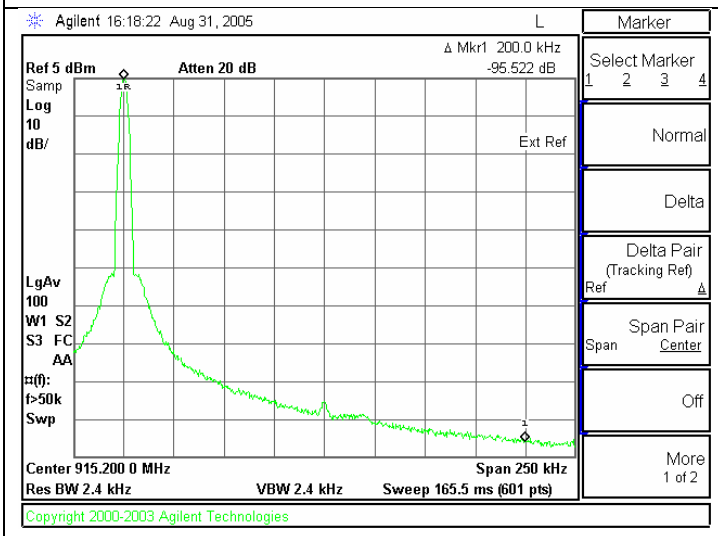


Spur at 200 kHz offset at a worst case frequency of 1910.2 MHz is -89.5 dBc.

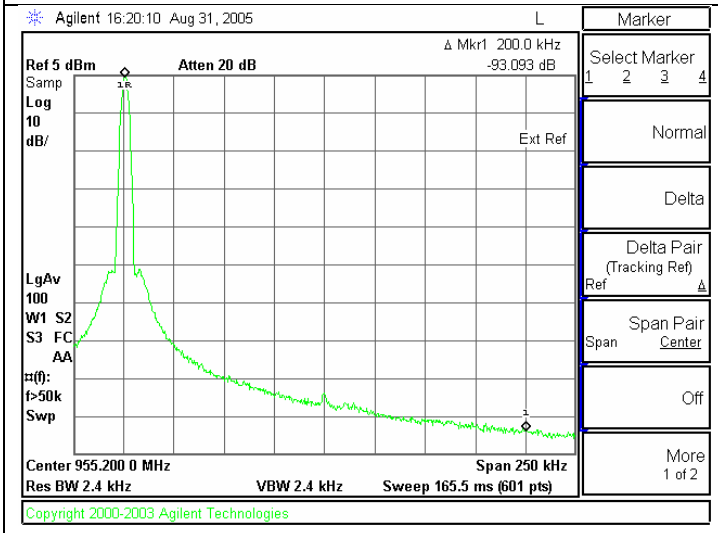


Spur at 200 kHz offset at a worst case frequency of 2030.2 MHz is -88.1 dBc.

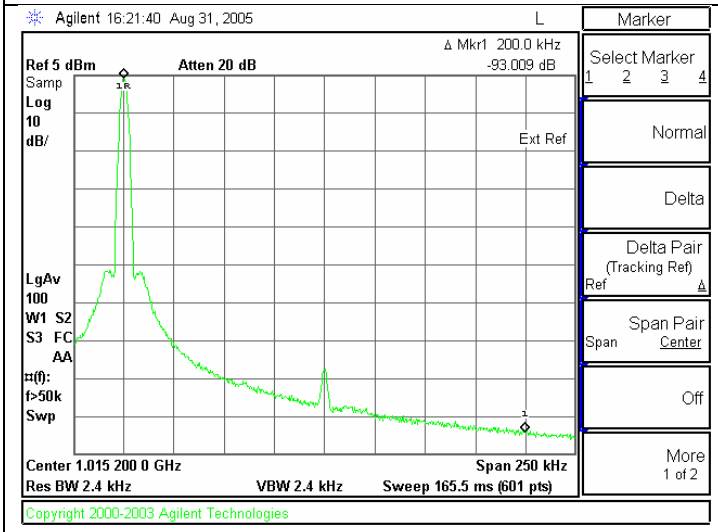
Spurs (Internal Divide by 2 Enabled)



Spur at 200 kHz offset at a frequency of 915.1 MHz is –95.5 dBc. Since this mode uses the divide by 2 mode, the channel spacing here is actually 100 kHz. The spur at 100 kHz could be eliminated by doubling the channel spacing before the divider. The reason that the spur at 200 kHz is shown is to illustrate theoretical 6 dB impact of the divider.

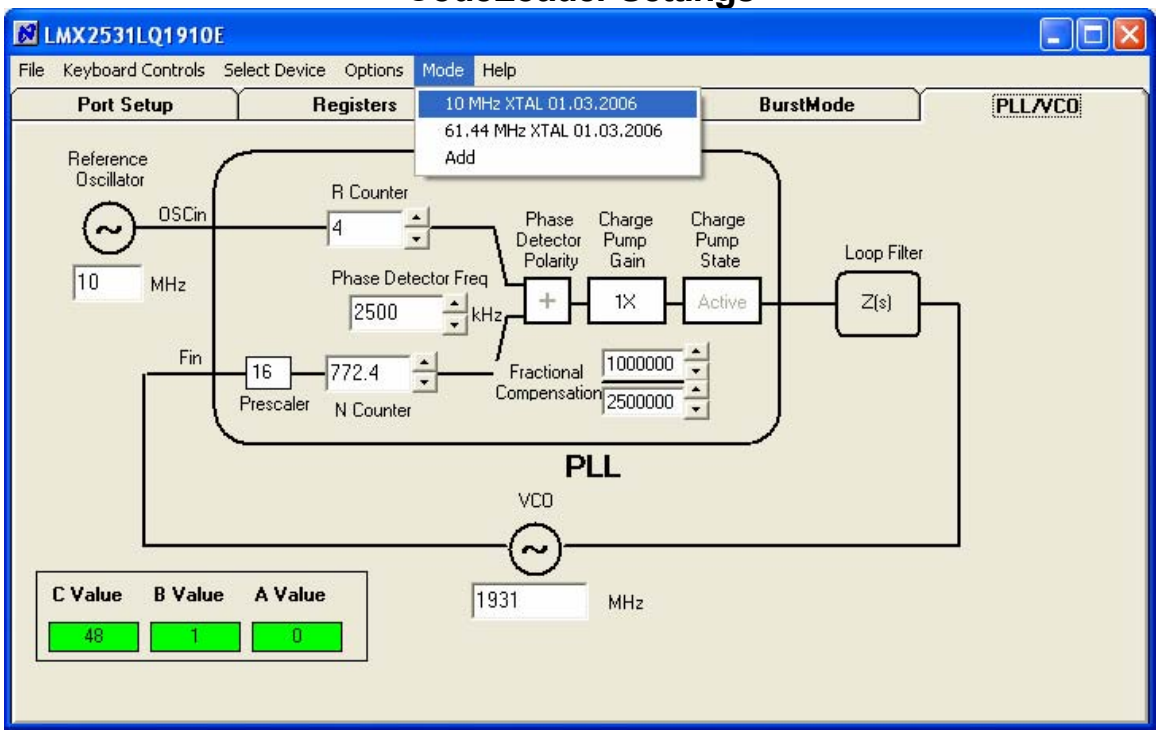


Spur at 200 kHz offset for a frequency of 955.1 MHz is -93.0 dBc.

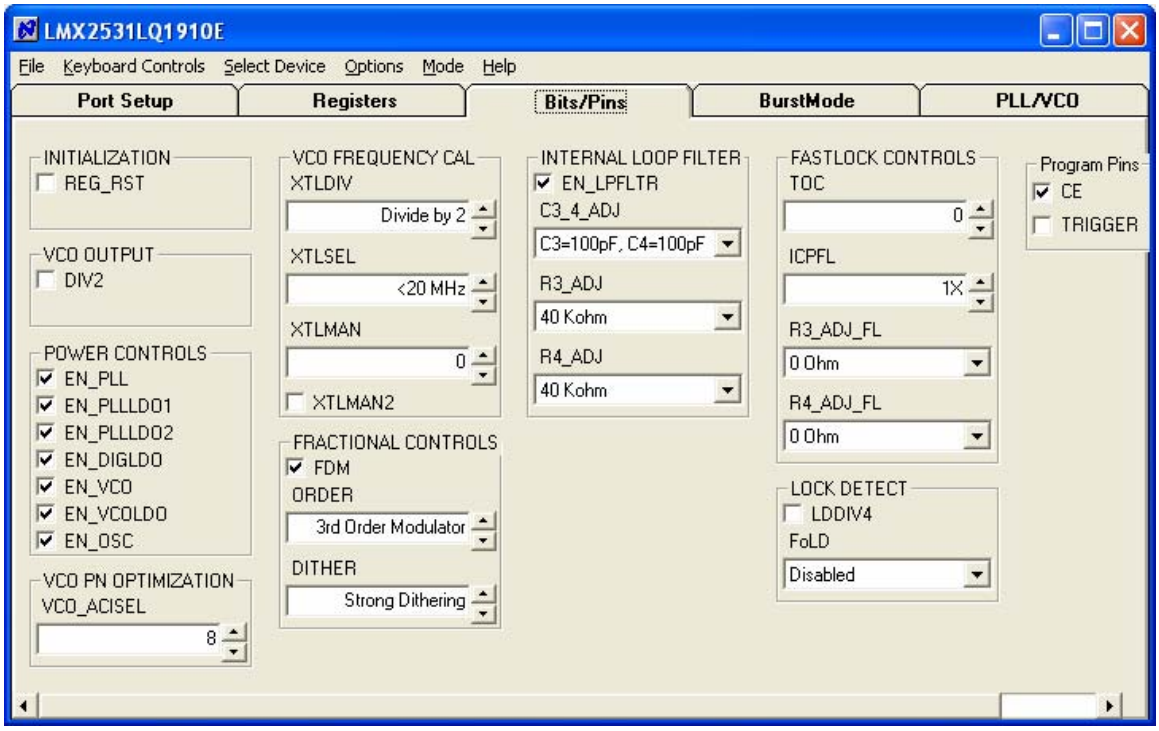


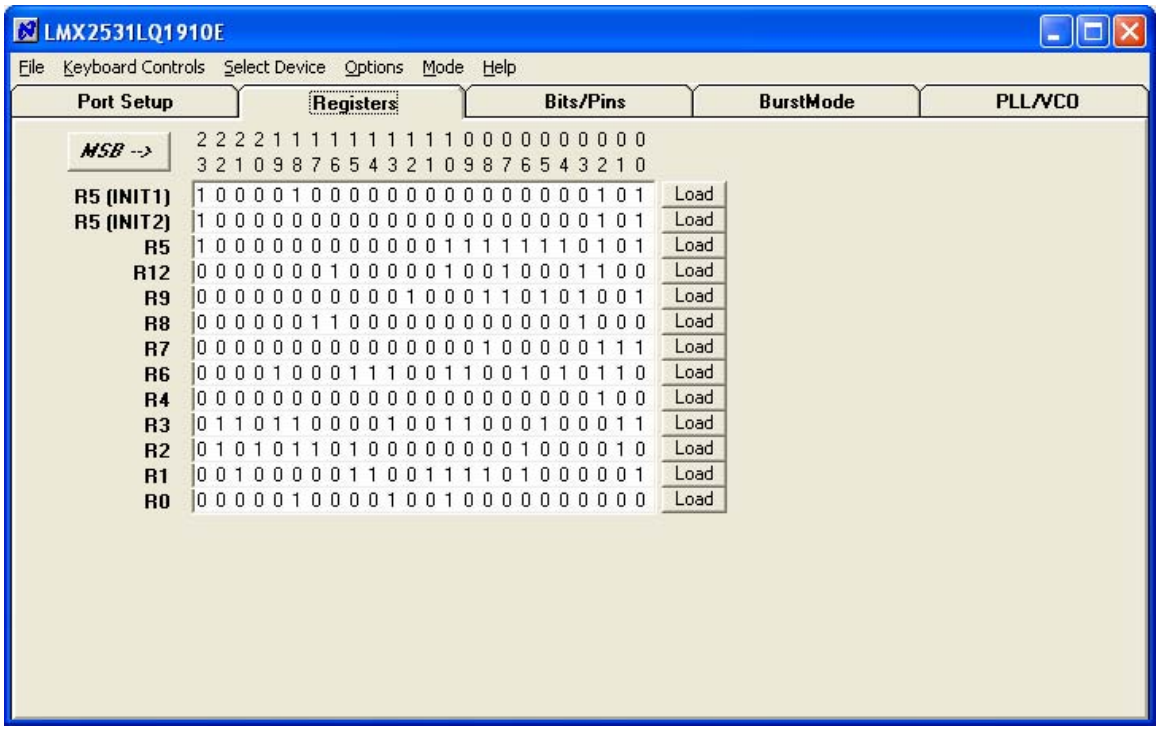
Spur at 200 kHz offset for a frequency of 1015.1 MHz is –93.0 dBc.

CodeLoader Settings

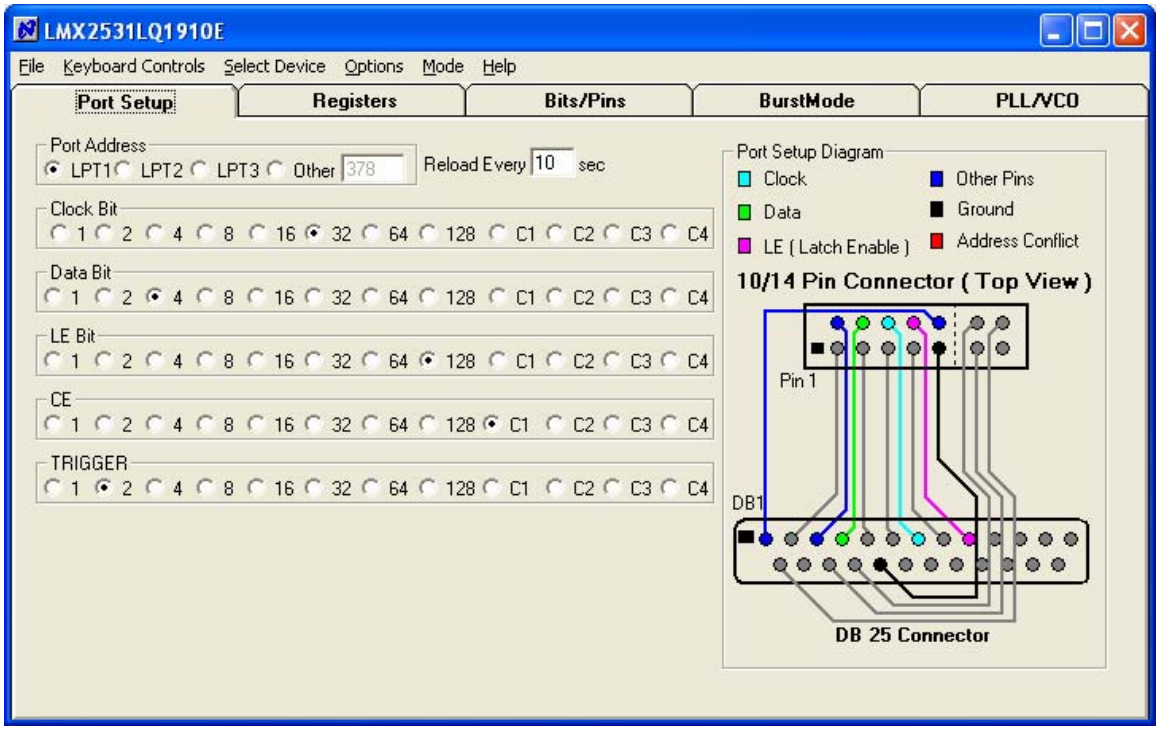


For the CodeLoader program, the default reference oscillator used for these instructions was 10 MHz, but there is a mode for a 61.44 MHz oscillator as well. If the bits become scrambled, their original state may be recalled by choosing the appropriate mode. Note that if the internal divide by 2 is enabled, the VCO frequency still reflects the VCO frequency before the divide by 2.



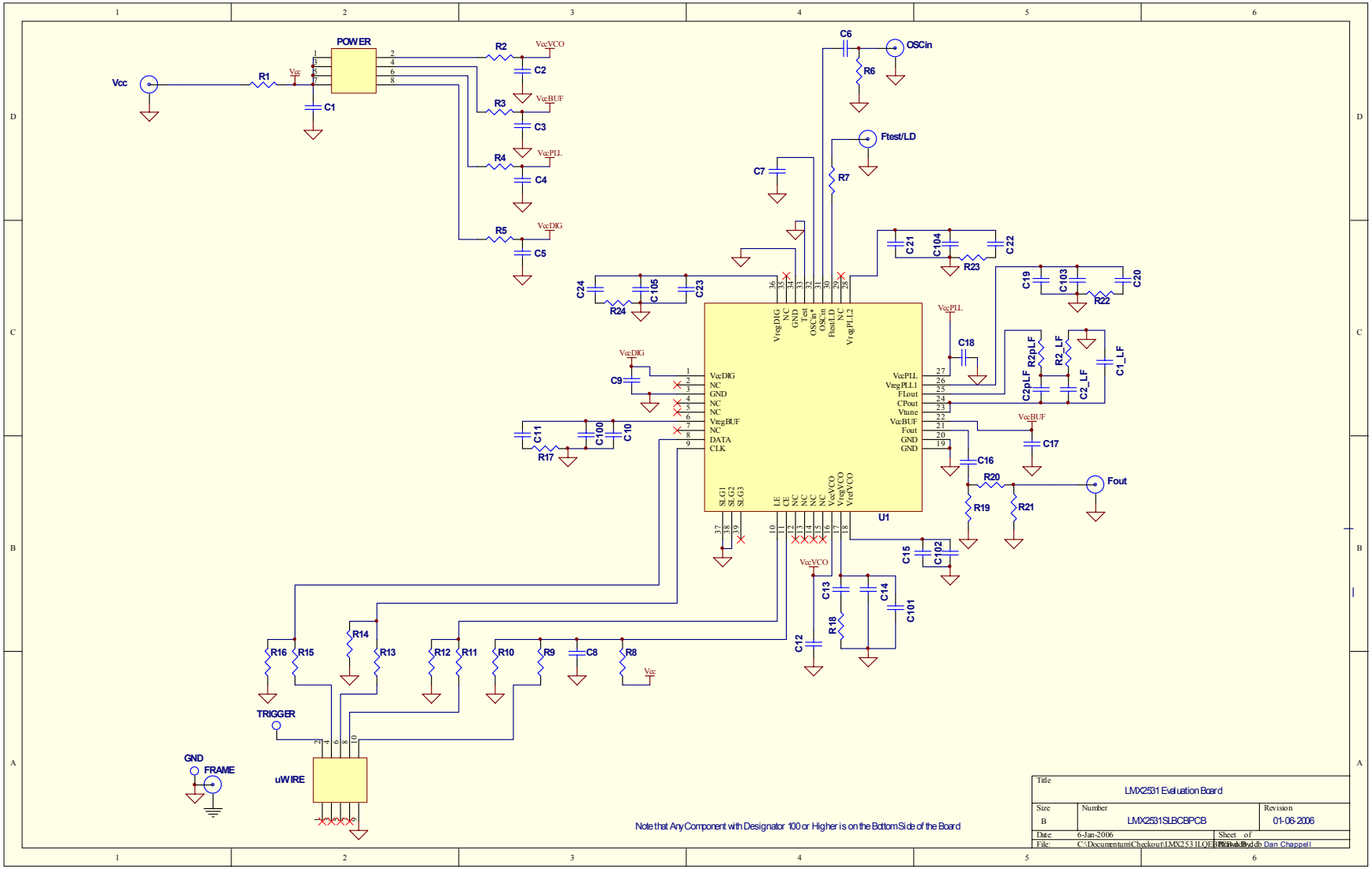


CodeLoader is set up to load the registers and initialize the part in the correct way. R5 (INIT1) and R5 (INIT 2) are just the R5 register being used to properly initialize the part. So a single CNT+L should load the part.



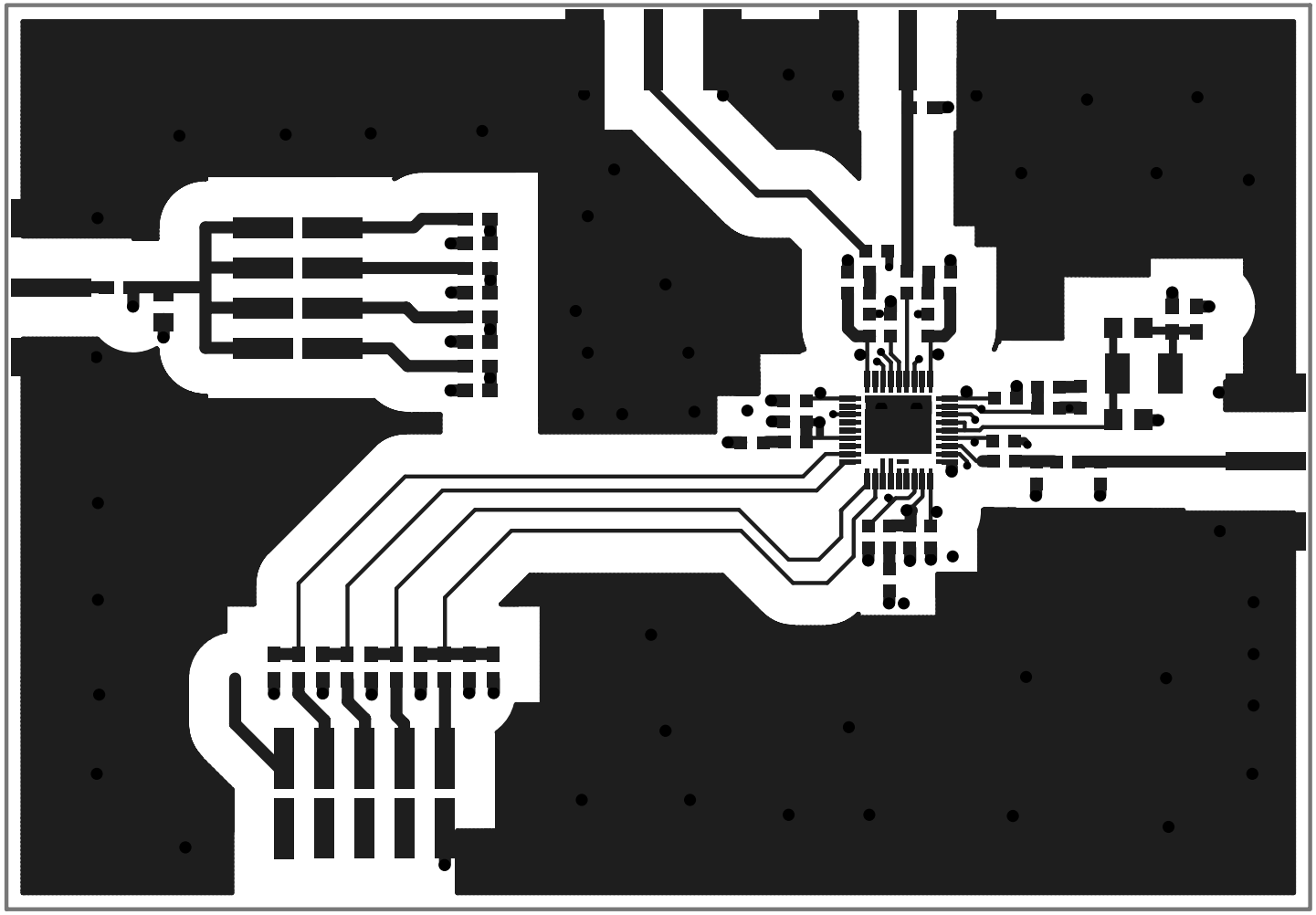
The port setup tells CodeLoader what information goes where. If this is wrong, the part will not program. Although LPT1 is usually correct, CodeLoader does not autodetect the correct port. On some laptops, it may be LPT3.

Schematic

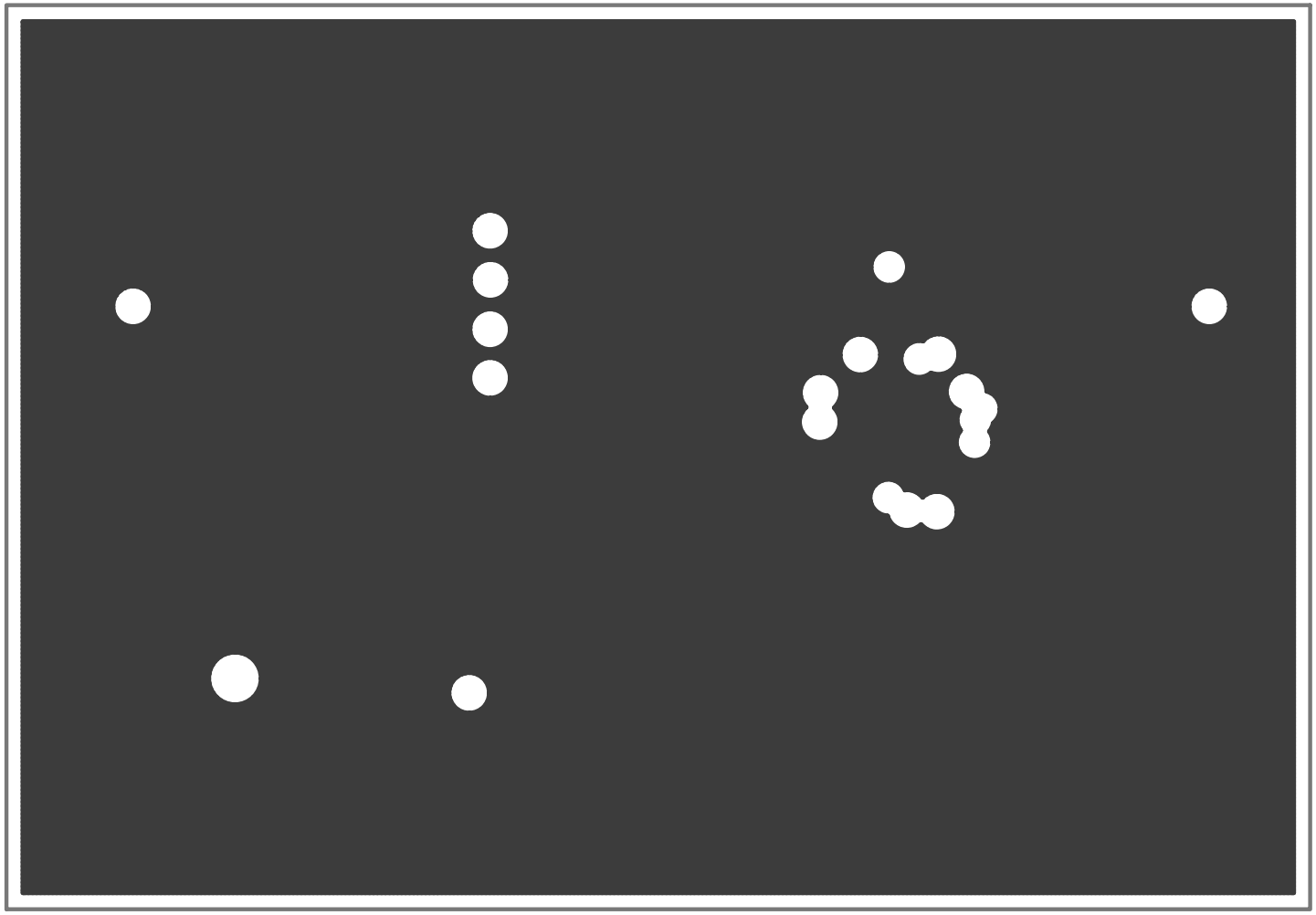

POWER
Vcc
R1
C1
R2
VccVCO
C2
R3
VccBUF
C3
R4
VccPLL
C4
R5
VccDIG
C5
C6
OSCin
R6
Ftest/LD
C7
R7
C21
C104
C22
R23
C24
C105
C23
R24
C19
C103
C20
R22
VccPLL
C18
R2pLF
R2_LF
C1_LF
C2pLF
C2_LF
VccDIG
C9
C11
C100
C10
R17
VccBUF
C17
C16
R20
Fout
R19
R21
C15
C102
VccVCO
C13
C14
C101
R18
C12
R16
R15
R14
R13
R12
R11
R10
R9
C8
R8
TRIGGER
GND
FRAME
uWIRE
U1
VregDIG
NC
GND
Test
OSCout
OSCin
FtestLD
NC
VregPLL2
VccDIG
NC
GND
NC
NC
VregBUF
NC
DATA
CLK
VccPLL
VregPLL1
FLout
CPout
Vtune
VccBUF
Fout
GND
GND
SLG1
SLG2
SLG3
LE
CE
NC
NC
NC
NC
VccVCO
VregVCO
VregVCO
Note that Any Component with Designator 100 or Higher is on the Bottom Side of the Board
Title
LMX2531 Evaluation Board
Size
B
Number
LMX2531SLBCBPCB
Revision
01-06-2006
Date:
6-Jan-2006
Sheet of
File:
C:\Documentum\Checkout\LMX2531LQEB\Rev1.0\db
Dan Chappell

Bill of Materials				LMX2531EB					Revision 1/3/2006
Item	**QTY**	**Manufacturer**	**Part #**	**Size**	**Tol**	**Voltage**	**Material**	**Value**	**Designators**
0	19	n/a						Open Capacitors	C2pLF, C2, C3, C4, C5, C9, C11, C14, C17, C18, C19, C21, C24, C100, C101, C102, C103, C104, C105
	6							Open Resistors	R7, R8, R17, R19, R21, R24
	1							Open Miscellaneous	Ftest/LD
1	1	Kemet	C0603C470J5GAC	603	5%	50V	C0G	47pF	C1_LF
2	1	Kemet	C0603C101J5GAC	603	5%	50V	C0G	100pF	C16
3	1	Kemet	C0805C272J3GAC	805	5%	25V	C0G	2.7nF	C2_LF
4	2	Kemet	C0603C103J5RAC	603	5%	50V	X7R	10nF	C10, C23
5	4	Kemet	C0603C104J3RAC	603	5%	25V	X7R	100nF	C6, C7, C12, C15
6	2	Kemet	C0603C474K4RAC	603	10%	16V	X7R	470nF	C20, C22
7	1	Kemet	C0603C105K4RAC	603	10%	16V	X5R	1uF	C8
8	1	Kemet	C0603C475K9PAC	603	10%	6.3V	X5R	4.7uF	C13
9	1	Kemet	C0805C106K8PAC	805	10%	10V	X5R	10uF	C1
10	1	Vishay	CRCW0603000ZRT1	603	5%	0.1W	Thick Film	0Ω	R20
11	2	Panasonic	P.22AHCT-ND	603	10%	0.1W	Thick Film	0.22Ω	R22, R23
12	2	Vishay	CRCW06033R3JRT1	603	5%	0.1W	Thick Film	3.3Ω	R1, R18
13	4	Vishay	CRCW0603100JRT1	603	5%	0.1W	Thick Film	10Ω	R2, R3, R4, R5
14	1	Vishay	CRCW0603510JRT1	603	5%	0.1W	Thick Film	51Ω	R6
15	4	Vishay	CRCW0603103JRT1	603	5%	0.1W	Thick Film	10KΩ	R9, R11, R13, R15
16	5	Vishay	CRCW0603123JRT1	603	5%	0.1W	Thick Film	12KΩ	R2pLF, R10, R12, R14, R16
17	1	Vishay	CRCW0603473JRT1	603	5%	0.1W	Thick Film	47KΩ	R2_LF
18	1	Comm Con Connectors	HTSM3203-8G2	2X4	n/a	n/a	Metal/Plastic	Header	POWER
19	1	FCI Electronics	52601-S10-8	2X5	n/a	n/a	Metal/Plastic	Header	uWire
20	3	Johnson Components	142-0701-851	SMA	n/a	n/a	Metal	SMA	Fout, OSCin, Vcc
21	1	National Semiconductor	LMX2531LQEBPCB	n/a	n/a	n/a	FR4 62 mil Thick	PCB Board 1st Layer 10 mils	n/a
22	1	National Semiconductor	LMX2531	LLP36	n/a	2.7	Silicon	LMX2531	U1
23	4	Com Con Connectors	CCIJ255G	2-Pin	n/a	n/a	Metal/Plastic	Shunt	Place Across: POWER: 1-2, 3-4, 5-6, 7-8
24	4	SPC Technology	SPCS-8	0.156"	n/a	n/a	Nylon	Nylon Standoffs	Place in 4 Holes in Corners of Board

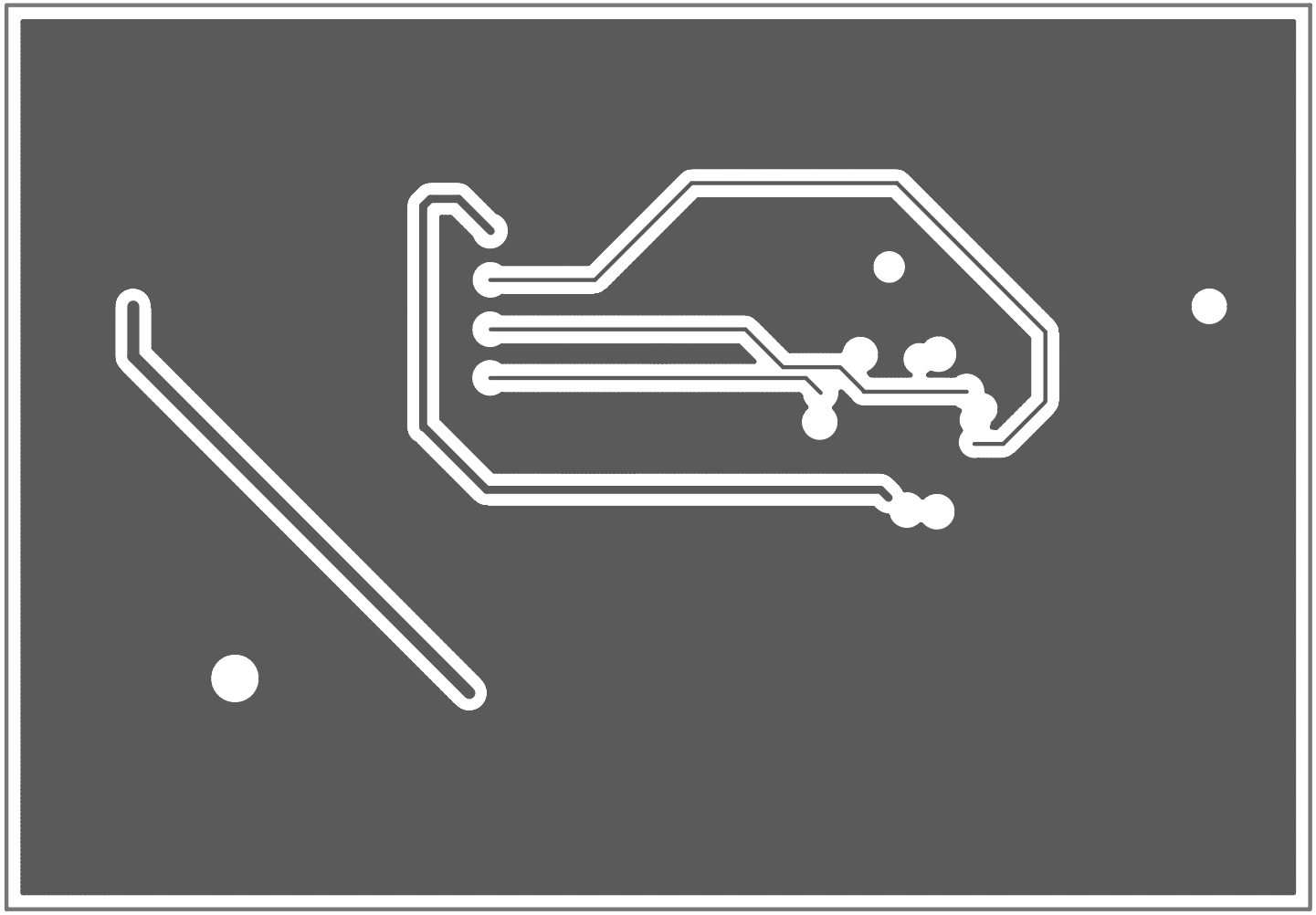
Top Layer



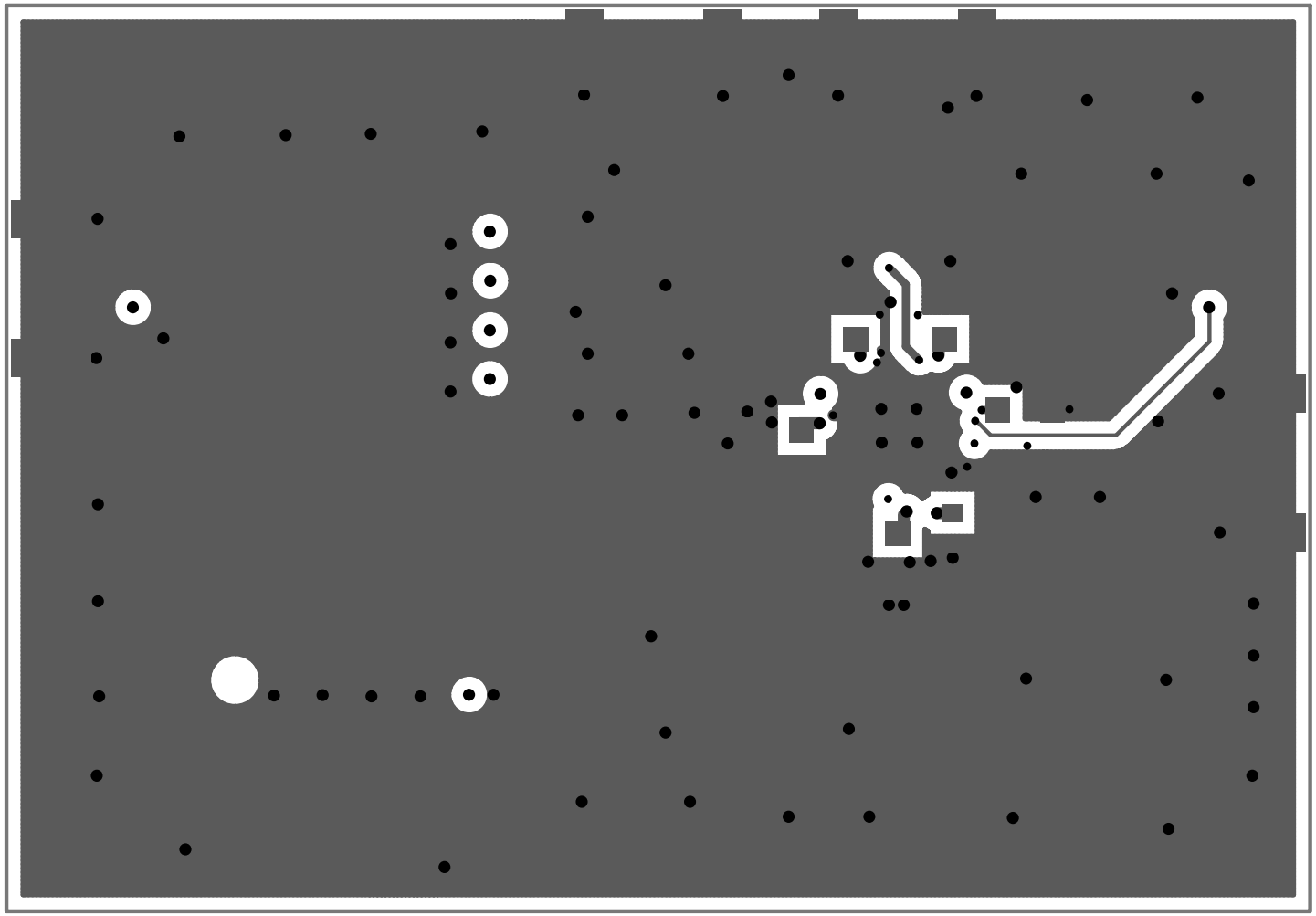
Mid Layer 1 "Ground Plane" (15 Mils Down FR4)



Mid Layer 2 "Power"

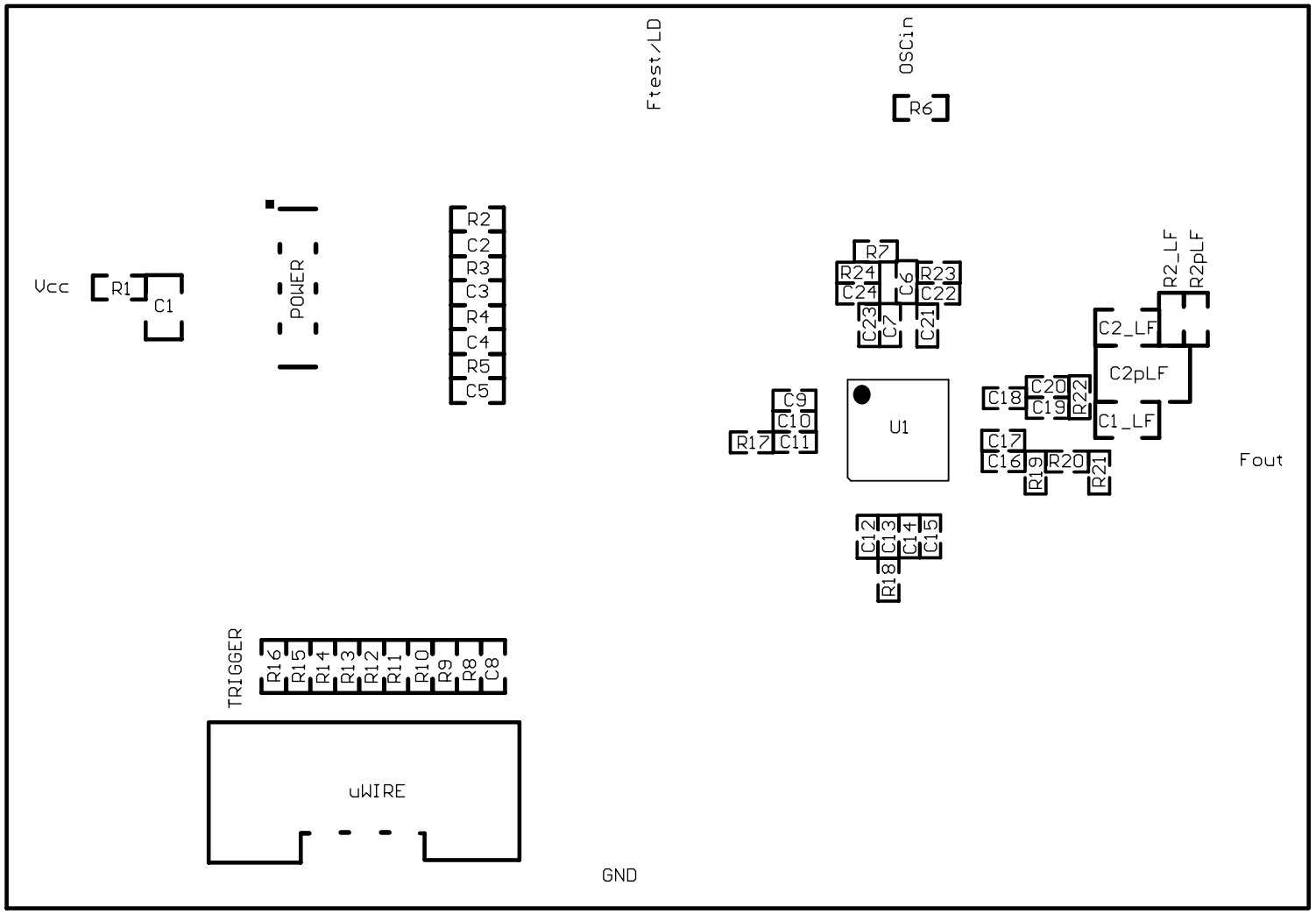


Bottom Layer "Signal"



Note: Total Board Thickness = 61 mils

Top Build Diagram



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.

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please visit www.ti.com/esh or contact TI.

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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 this Product 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. 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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