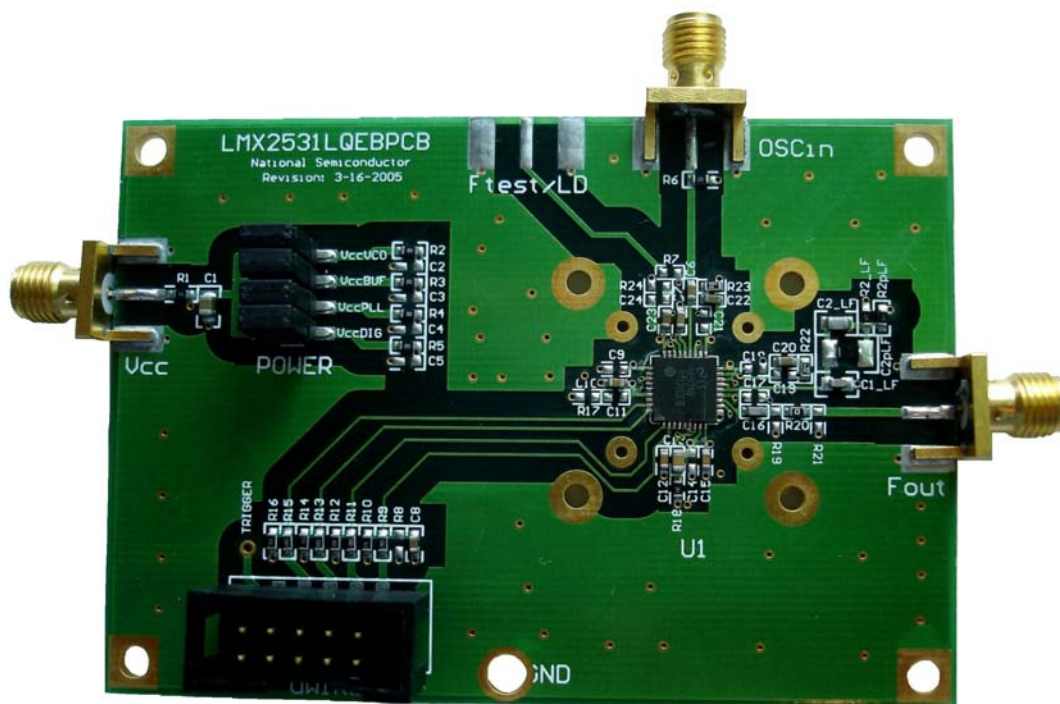




LMX2531LQ1910E

Evaluation Board Operating Instructions



National Semiconductor Corporation
Wireless Communications, RF Products Group

2900 Semiconductor Dr.
Santa Clara, CA, 95052-8090

LMX2531LQ1910EFPEB Rev 1.20.2006

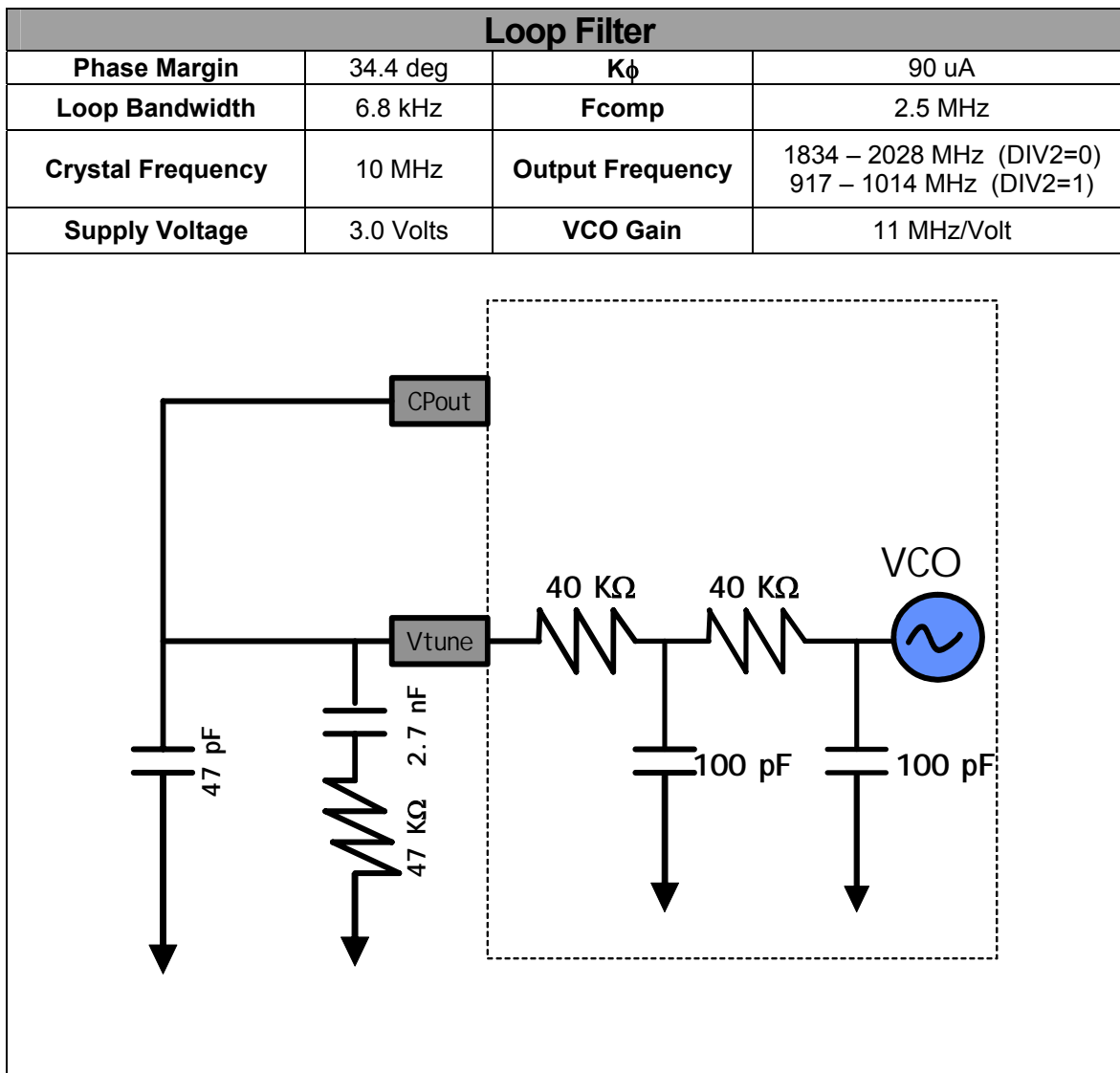
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General Description

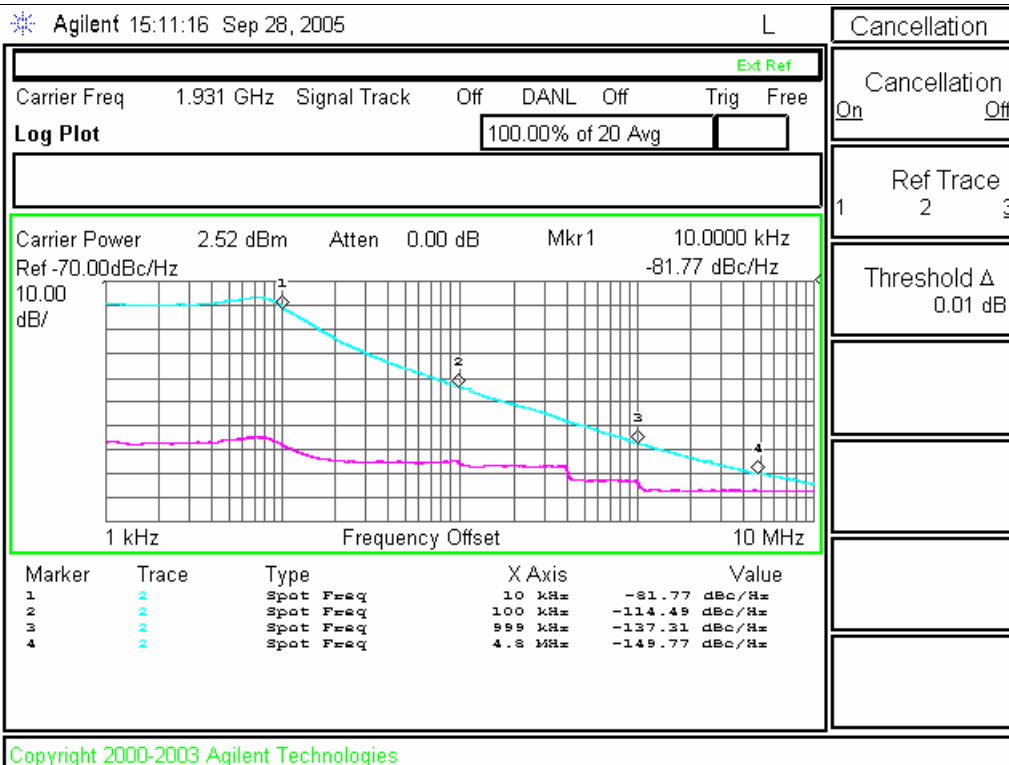
The LMX2531LQ1910E Evaluation Board simplifies evaluation of the LMX2531LQ1910E PLL/VCO synthesizer system. The board enables all performance measurements with no additional support circuitry. The evaluation board consists of a LMX2531LQ1910E device, and a cable assembly.

The cable assembly is bundled with the evaluation board for connecting to a PC through the parallel printer port. By means of **MICROWIRE™** 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.

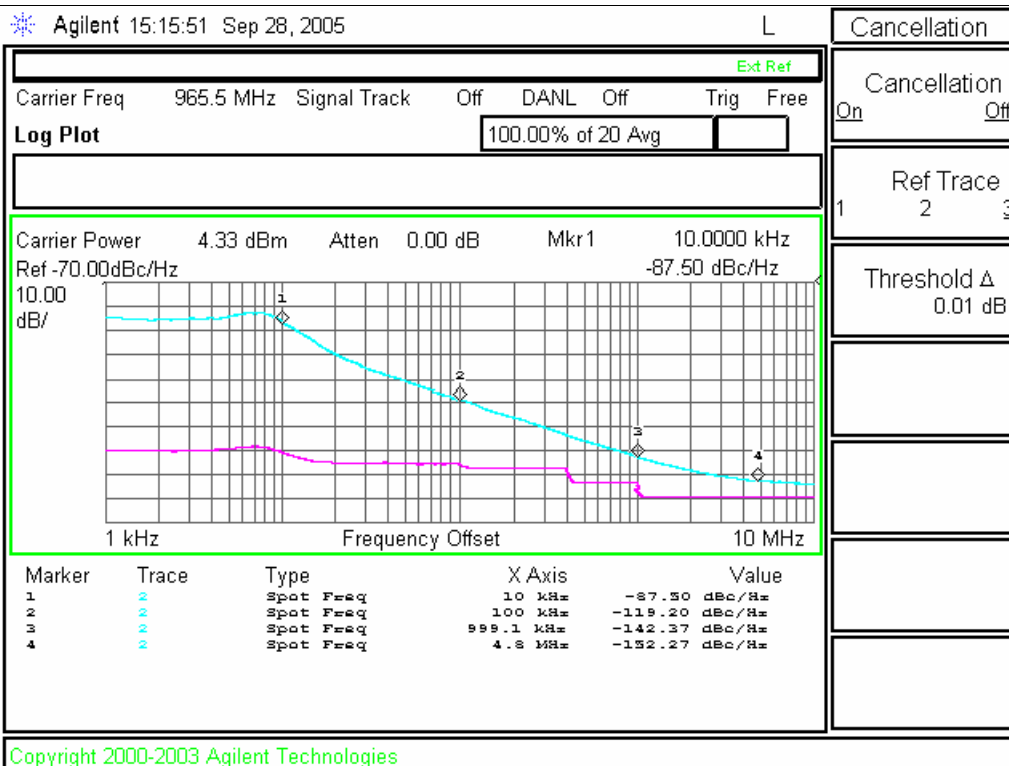


Phase Noise

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

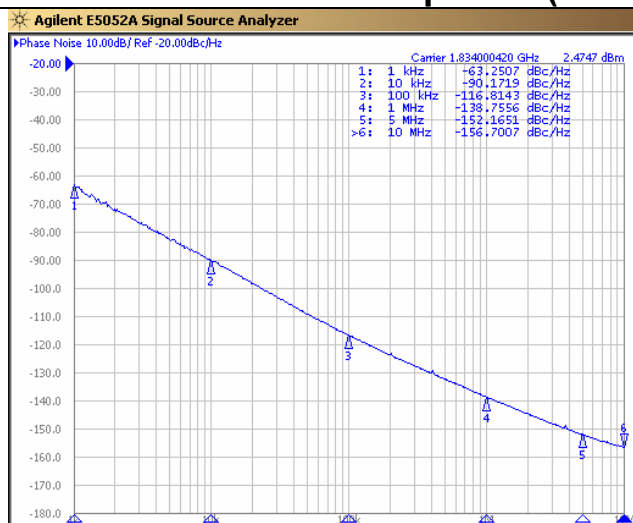


Output Frequency = 965.5 MHz
Internal Divide by 2 Enabled (DIV2=1)

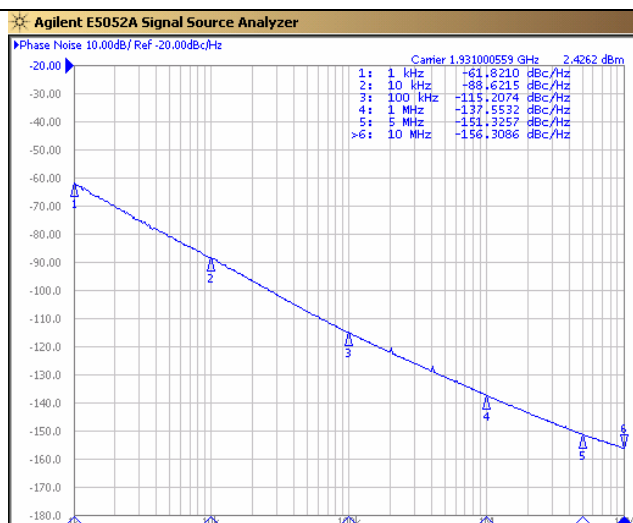


Phase Noise with Narrow Loop Filter (Internal Divide by 2 Disabled)

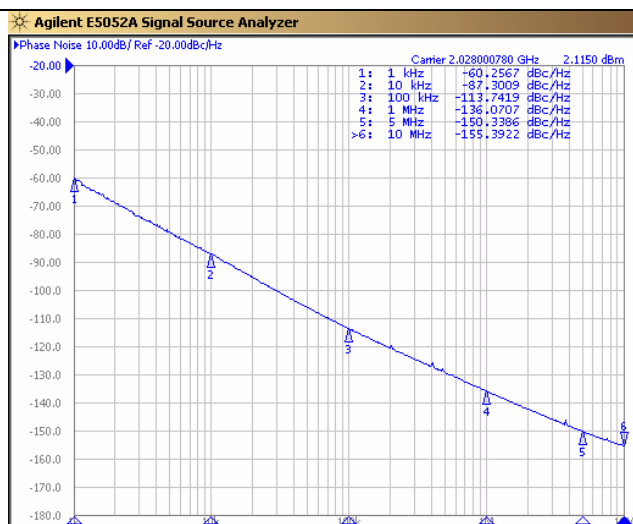
Fout = 1834 MHz



Fout = 1931 MHz



Fout = 2028 MHz

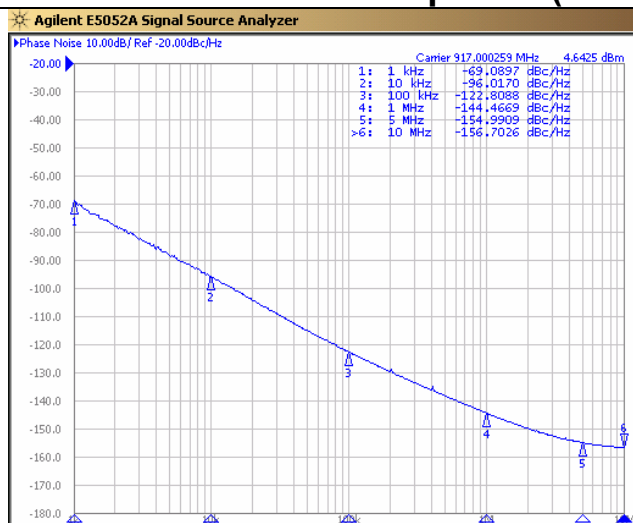


The plots to the left show the true phase noise capability of the VCO. In order to take these plots, a 20 Hz loop bandwidth was used with the E5052 spectrum analyzer. This is the most accurate and state of the art equipment.

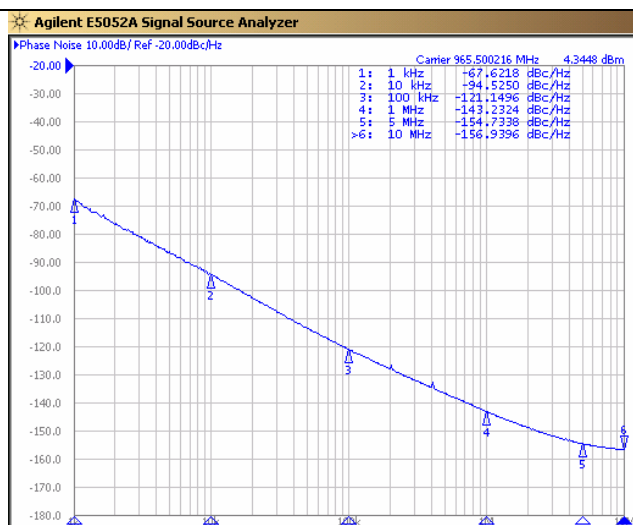
At lower offsets, the measurements are more accurate because the impact of the PLL is removed. At higher offsets, the measurements are also more accurate because the E5052 spectrum analyzer has a much lower noise floor than the E4445A spectrum analyzer. Even though the E4445A has a noise cancellation 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)

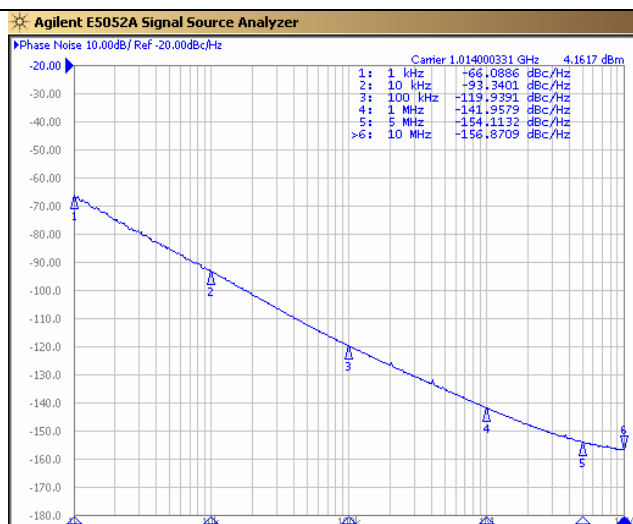
Fout = 917 MHz



Fout = 965.5 MHz



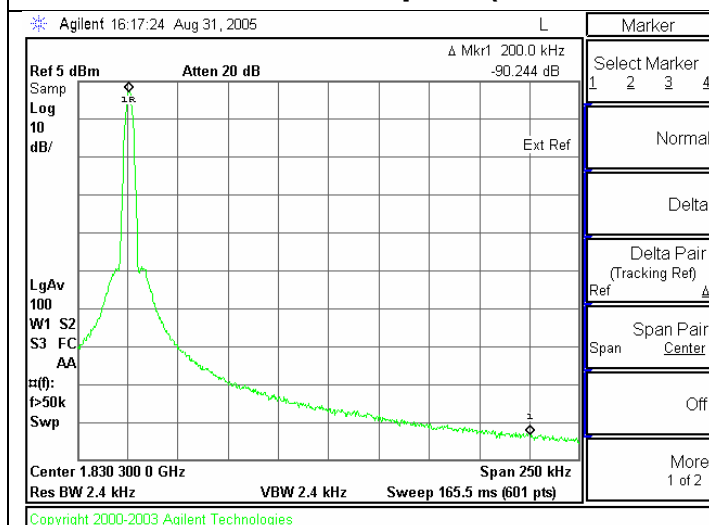
Fout = 1014 MHz



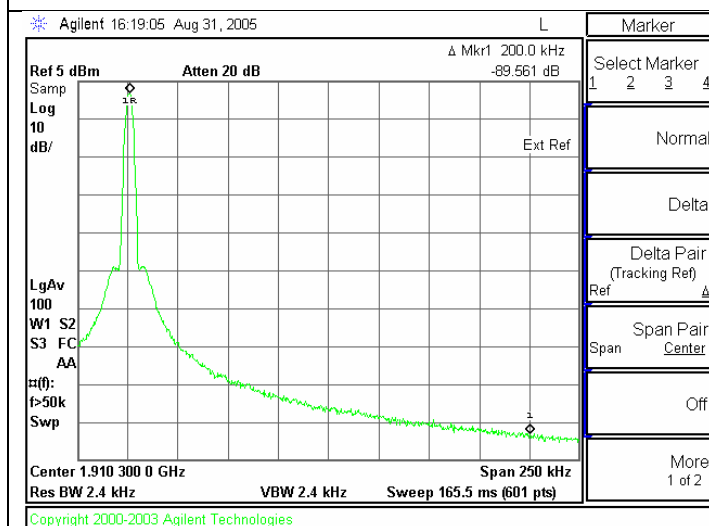
The plots to the left show the true phase noise capability of the VCO. In order to take these plots, a 20 Hz loop bandwidth was used with the E5052 spectrum analyzer. This is the most accurate and state of the art equipment.

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.

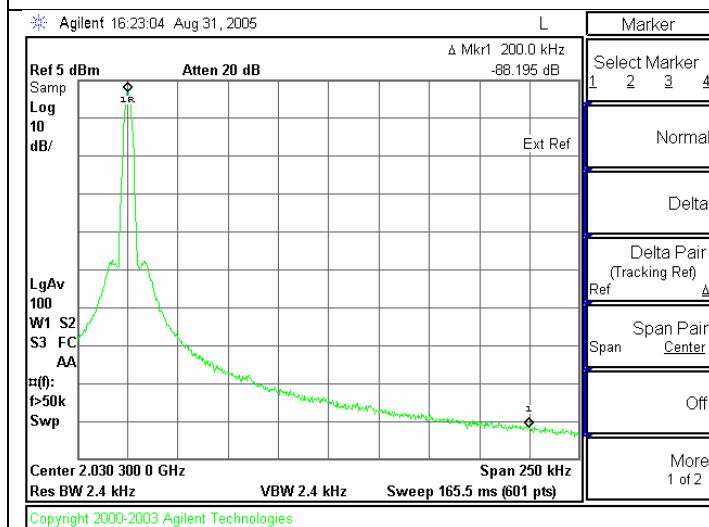
Spurs (Internal Divide by 2 Disabled)



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).

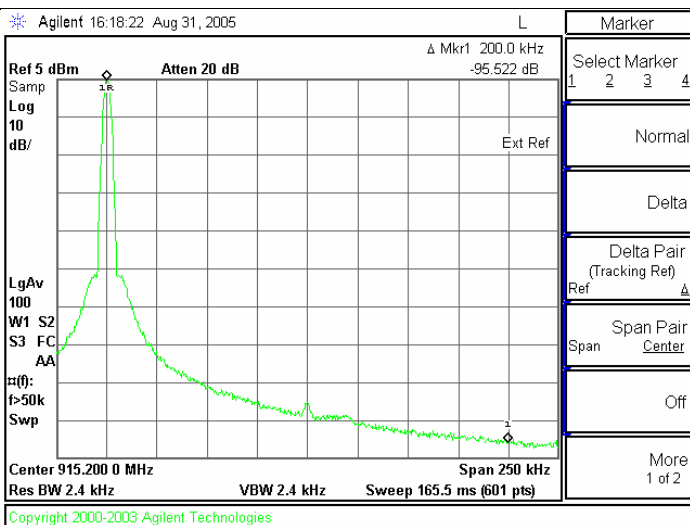


Spur at 200 kHz offset at a worst case frequency of 1910.2 MHz is -89.5 dBc.

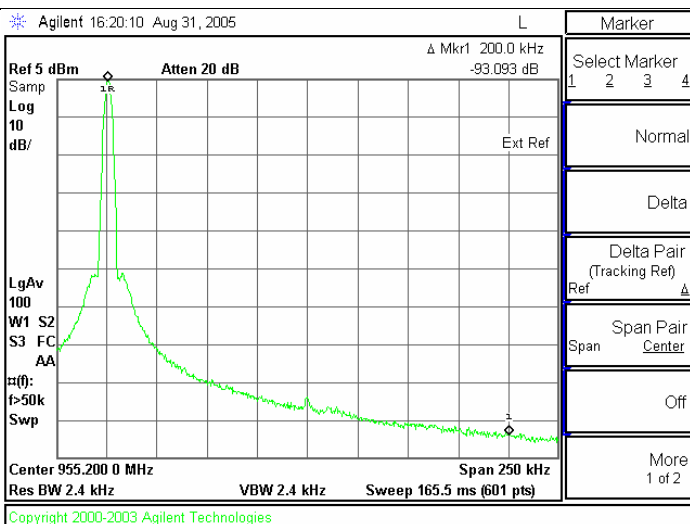


Spur at 200 kHz offset at a worst case frequency of 2030.2 MHz is -88.1 dBc.

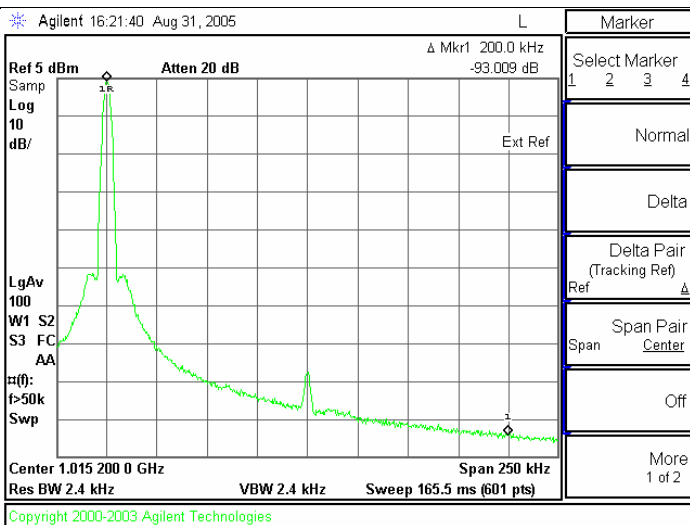
Spurs (Internal Divide by 2 Enabled)



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.

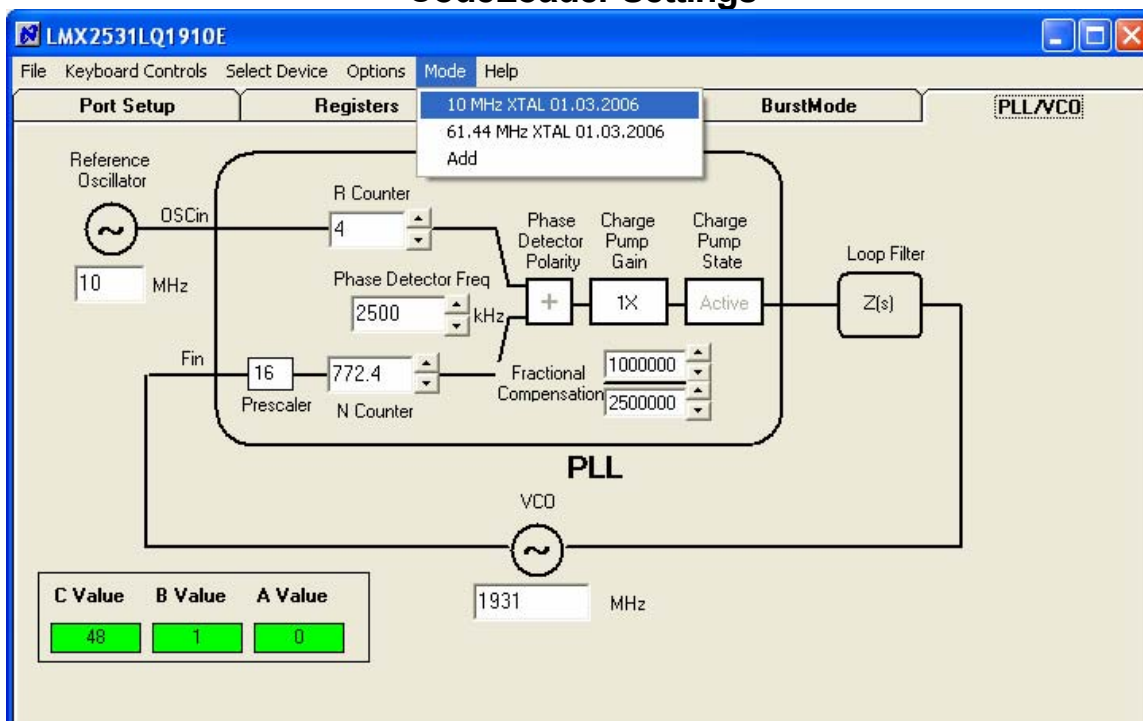


Spur at 200 kHz offset for a frequency of 955.1 MHz is -93.0 dBc.



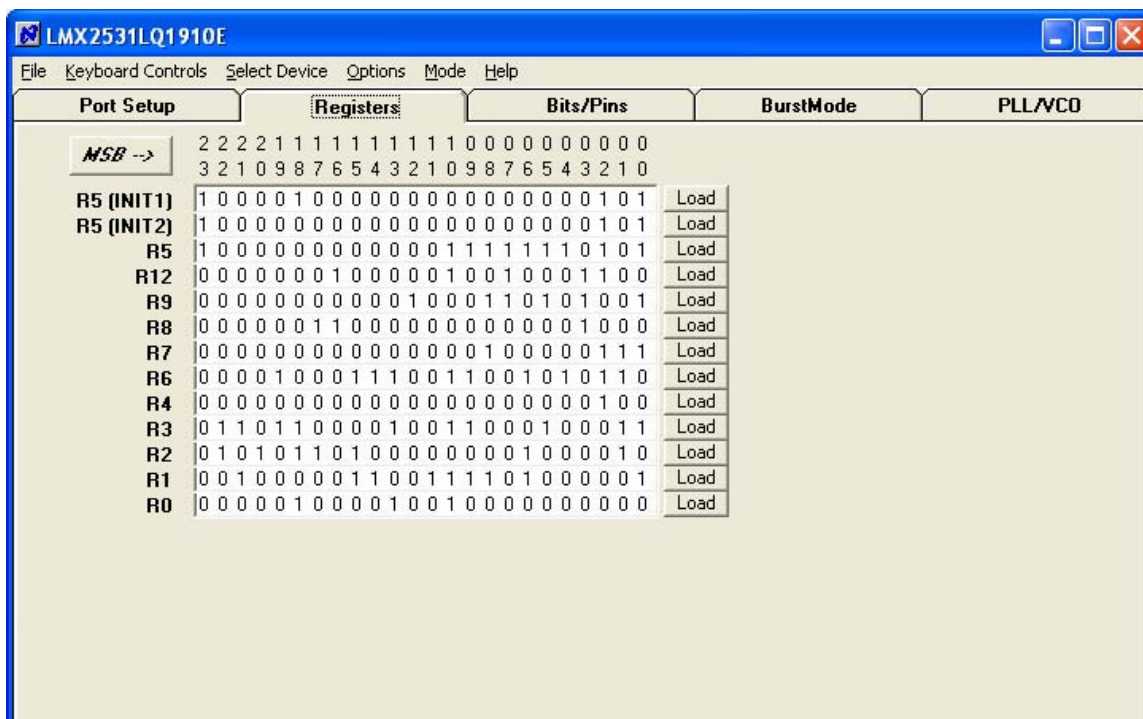
Spur at 200 kHz offset for a frequency of 1015.1 MHz is -93.0 dBc.

CodeLoader Settings

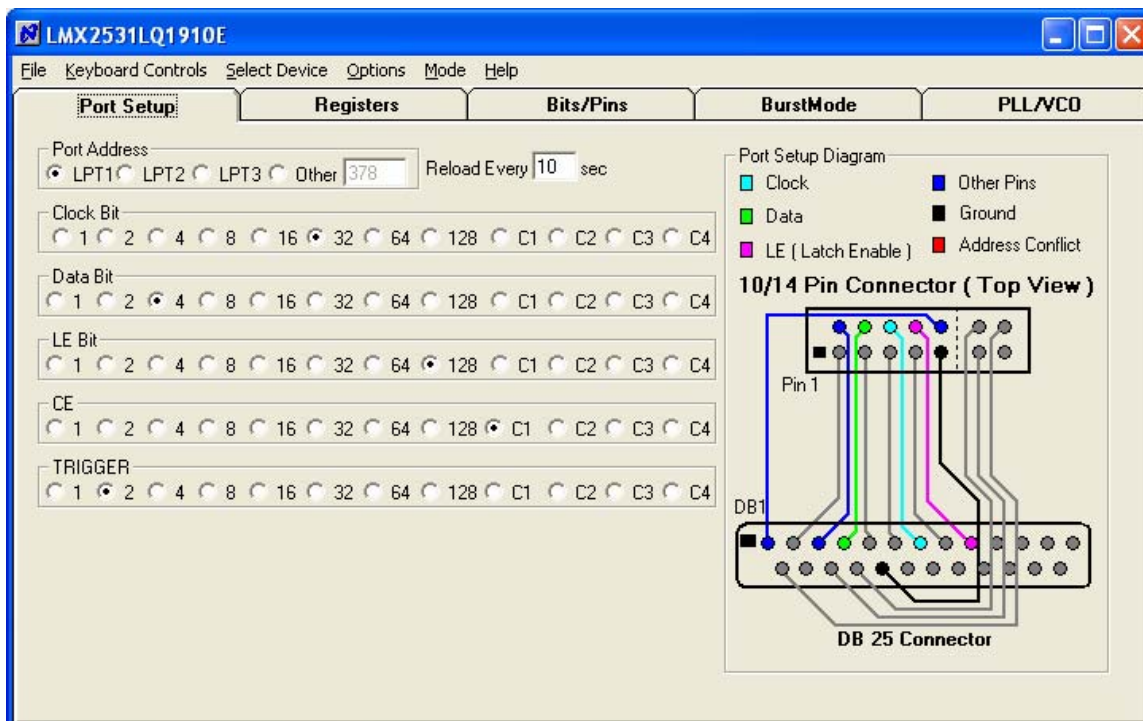


For the CodeLoader program, the default reference oscillator used for these instructions was 10 MHz, but there is a mode for a 61.44 MHz oscillator as well. If the bits become scrambled, their original state may be recalled by choosing the appropriate mode. Note that if the internal divide by 2 is enabled,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

The screenshot shows the LMX2531LQ1910E CodeLoader Settings window with the 'Bits/Pins' tab selected. The 'INITIALIZATION' section has 'REG_RST' checked. The 'VCO OUTPUT' section has 'DIV2' checked. The 'POWER CONTROLS' section has 'EN_PLL', 'EN_PLLLD01', 'EN_PLLLD02', 'EN_DIGLDO', 'EN_VCO', 'EN_VCOLDO', and 'EN_OSC' checked. The 'VCO PN OPTIMIZATION' section has 'VCO_ACISEL' set to 8. The 'VCO FREQUENCY CAL' section has 'XTLDIV' set to 'Divide by 2', 'XTLSEL' set to '<20 MHz', and 'XTLMAN' set to 0. The 'INTERNAL LOOP FILTER' section has 'EN_LPFILTER' checked, 'C3_4_ADJ' set to 'C3=100pF, C4=100pF', 'R3_ADJ' set to '40 Kohm', and 'R4_ADJ' set to '40 Kohm'. The 'FASTLOCK CONTROLS' section has 'TOC' set to 0, 'ICPFL' set to '1X', 'R3_ADJ_FL' set to '0 Ohm', and 'R4_ADJ_FL' set to '0 Ohm'. The 'LOCK DETECT' section has 'LDDIV4' set to 'Disabled'. The 'Program Pins' section has 'CE' checked and 'TRIGGER' unchecked.



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.



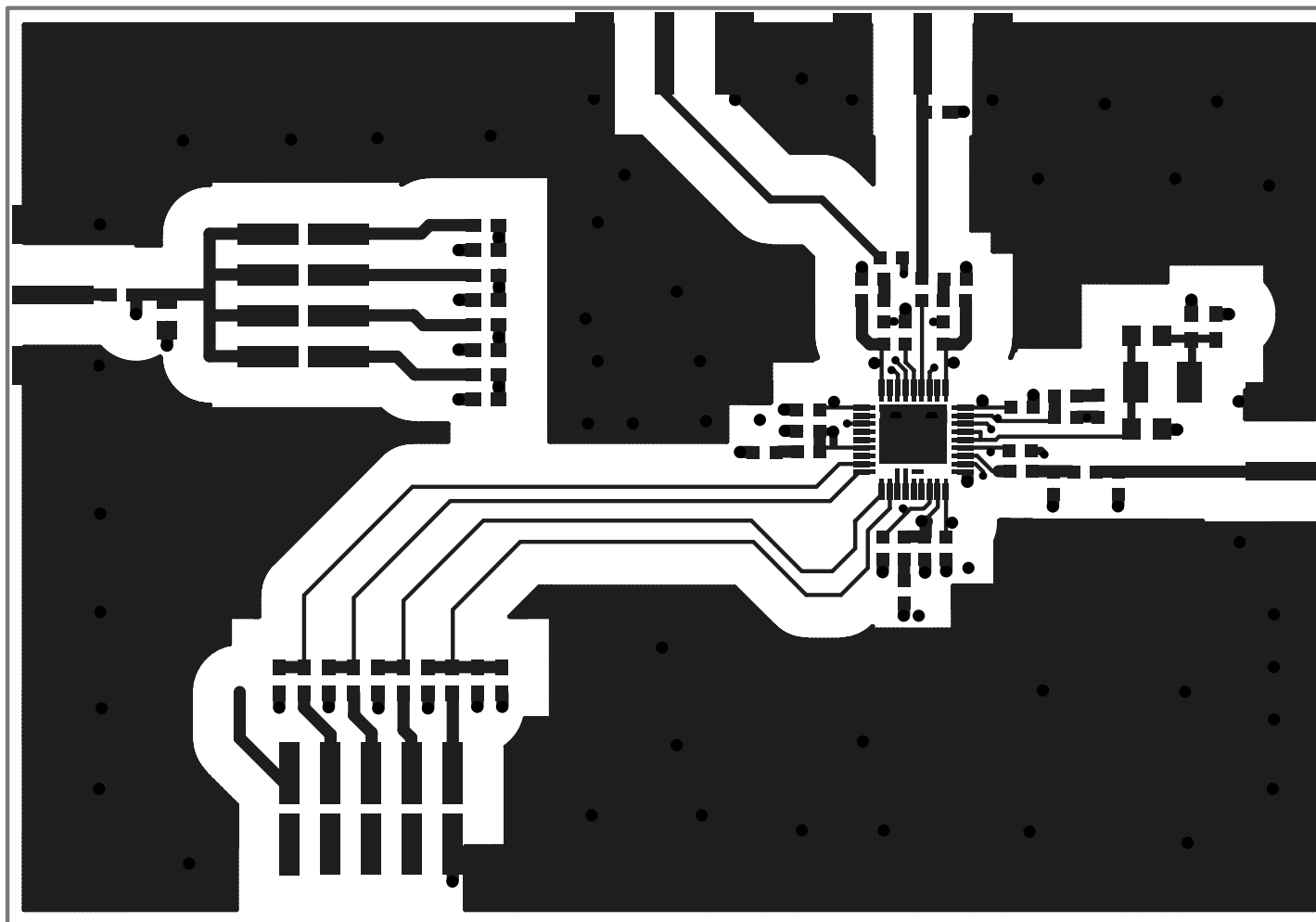
The port setup tells CodeLoader what information goes where. If this is wrong, the part will not program. Although LPT1 is usually correct, CodeLoader does not autodetect the correct port. On some laptops, it may be LPT3.

Schematic

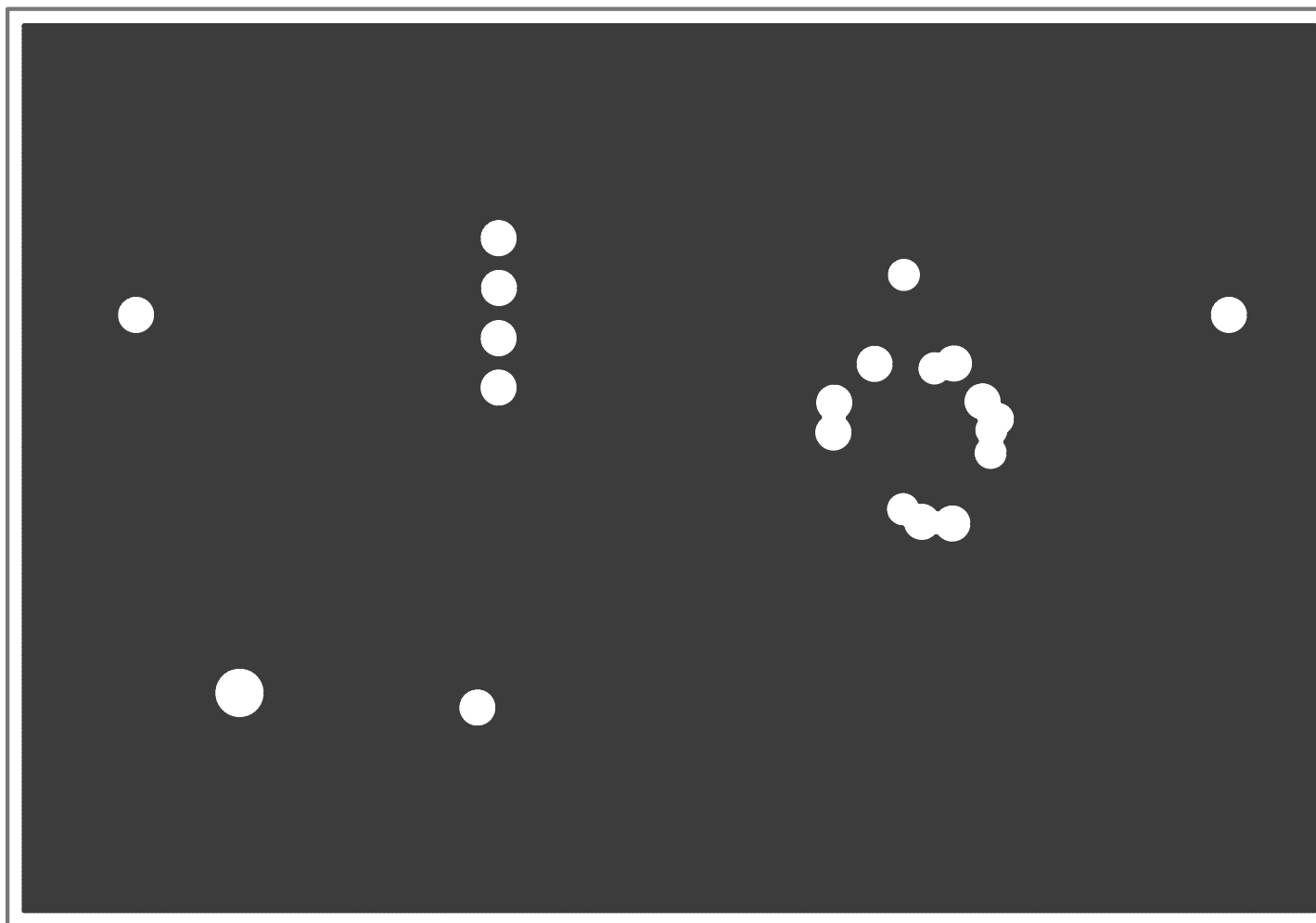


Bill of Materials				LMX2531EB					Revision 1/3/2006
Item	QTY	Manufacturer	Part #	Size	Tol	Voltage	Material	Value	Designators
0	19	n/a						Open Capacitors	C2pLF, C2, C3, C4, C5, C9, C11, C14, C17, C18, C19, C21, C24, C100, C101, C102, C103, C104, C105
	6							Open Resistors	R7, R8, R17, R19, R21, R24
	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

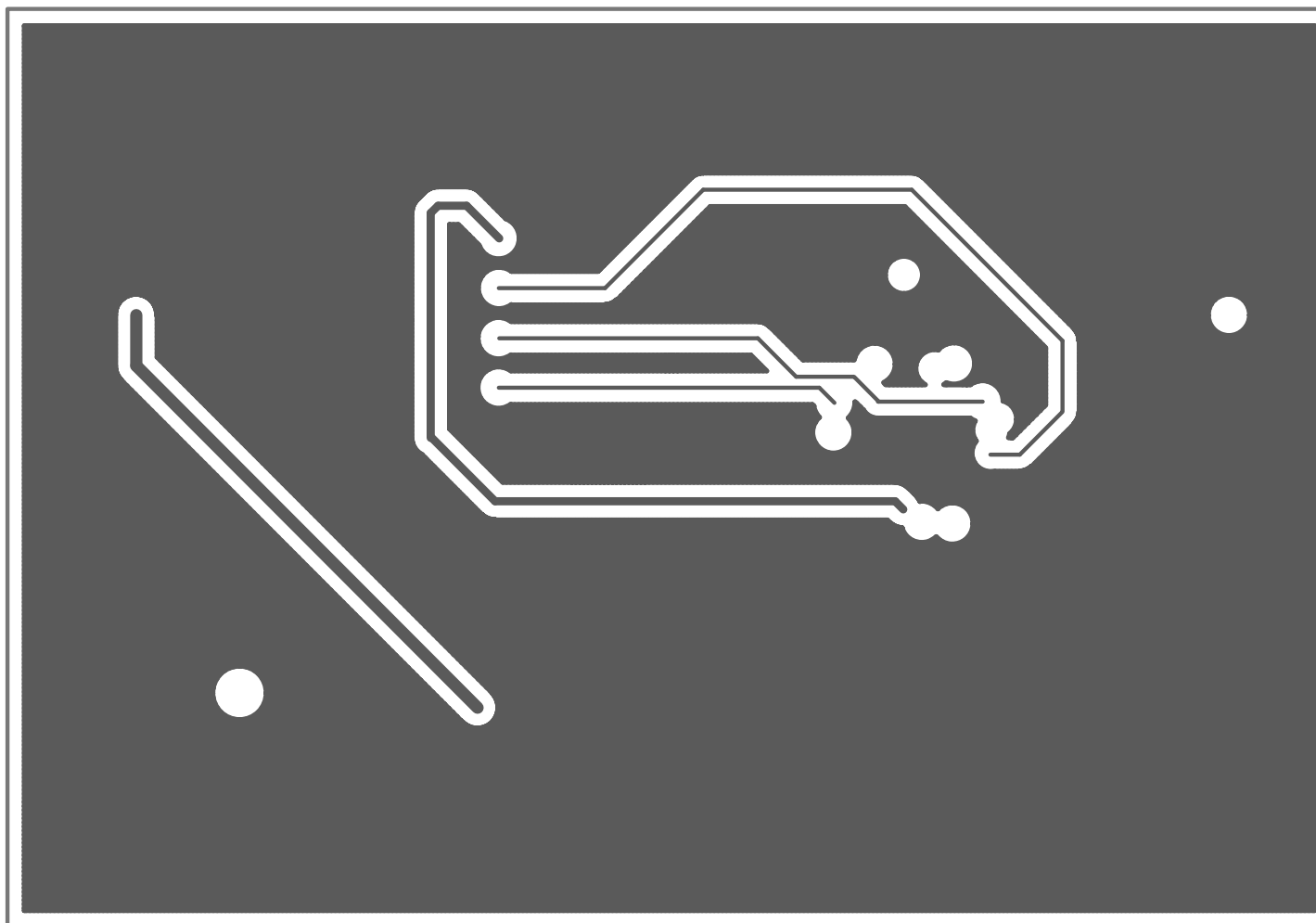
Top Layer



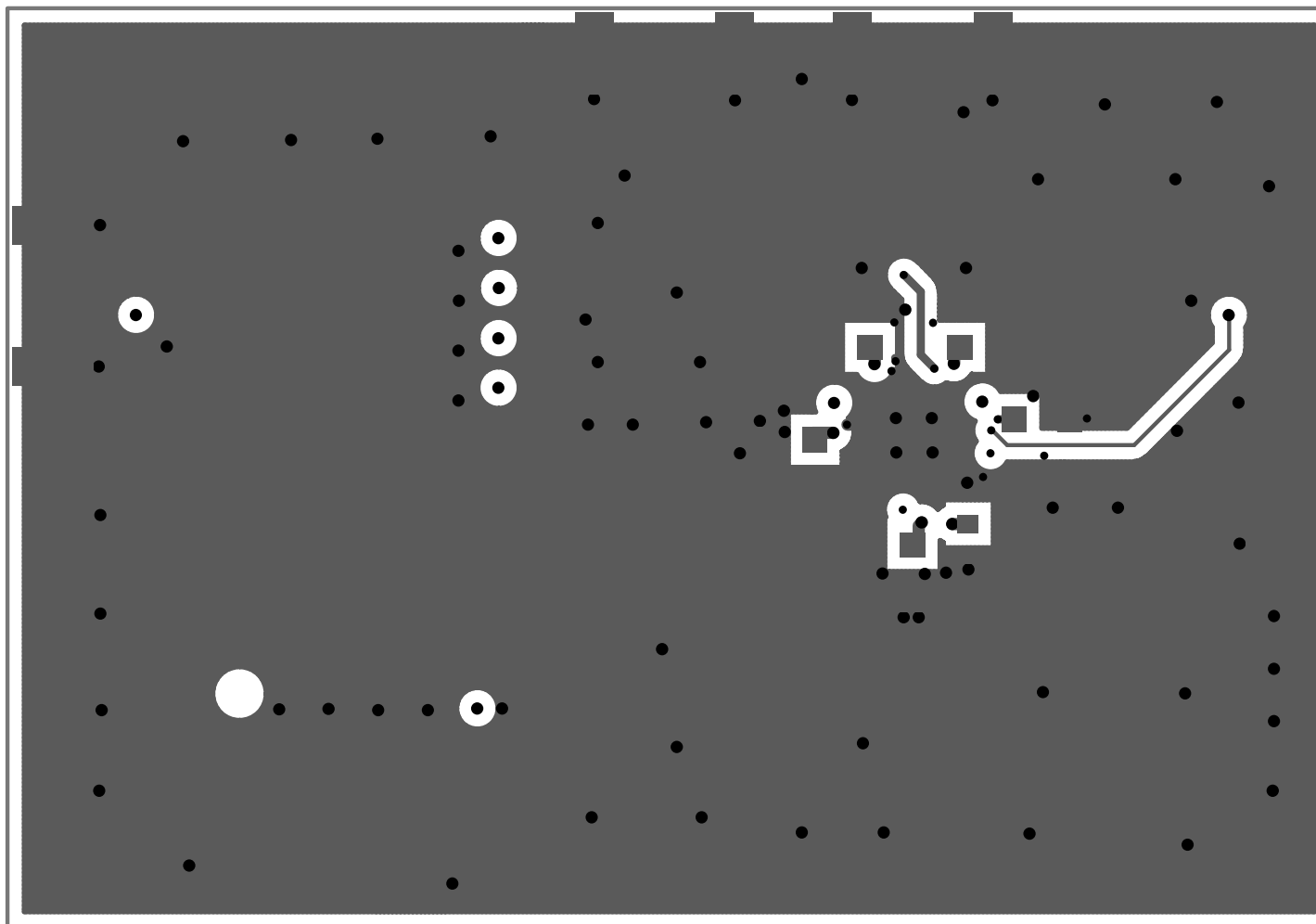
Mid Layer 1 "Ground Plane" (15 Mils Down FR4)



Mid Layer 2 "Power"

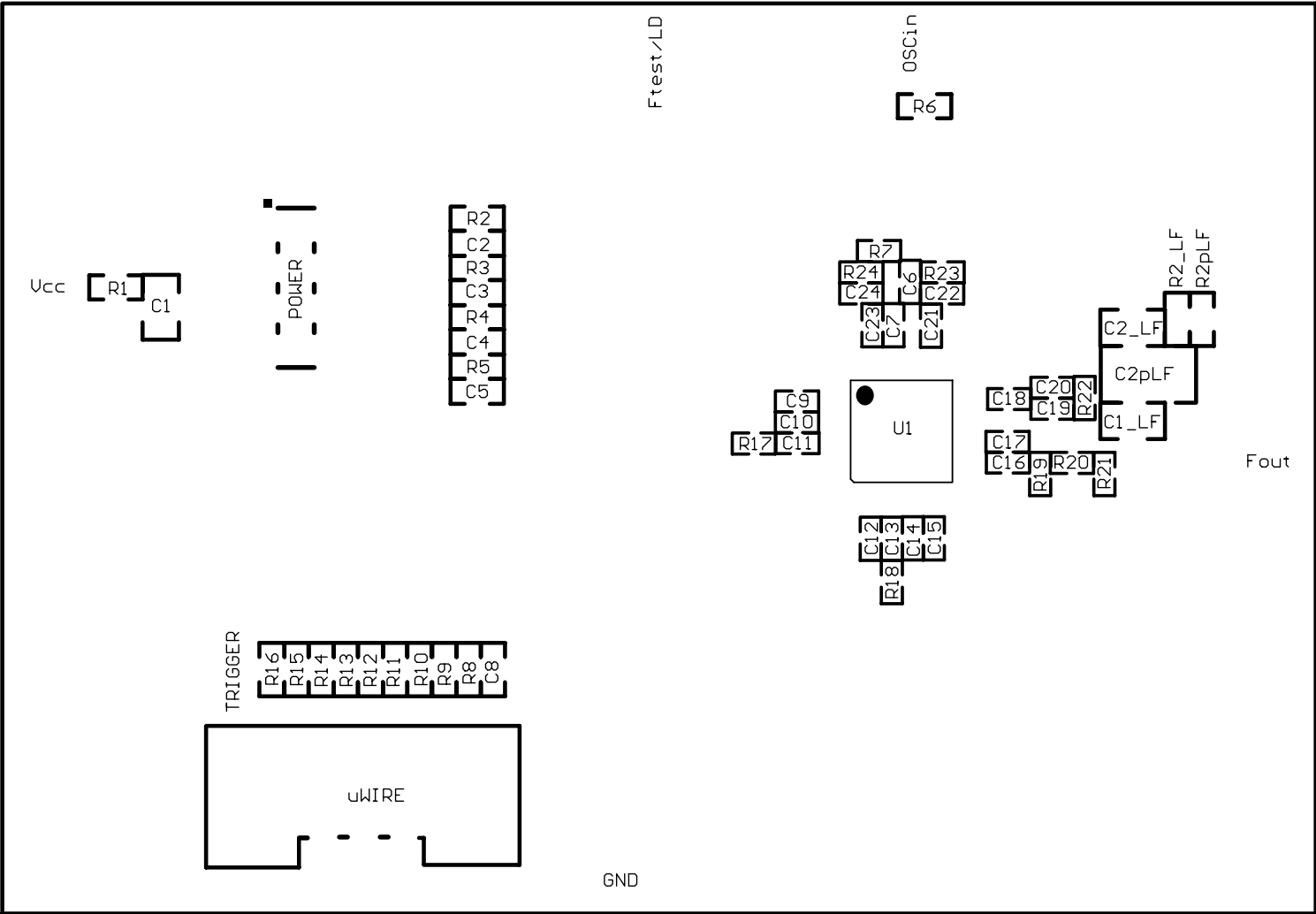


Bottom Layer "Signal"



Note: Total Board Thickness = 61 mils

Top Build Diagram



STANDARD TERMS AND CONDITIONS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, or documentation (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms and conditions set forth herein. Acceptance of the EVM is expressly subject to the following terms and conditions.

- 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms and conditions that accompany such Software
- 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

- 2 *Limited Warranty and Related Remedies/Disclaimers:*

- 2.1 These terms and conditions do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
- 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI. Moreover, TI shall not be liable for any defects that result from User's design, specifications or instructions for such EVMs. Testing and other quality control techniques are used to the extent TI deems necessary or as mandated by government requirements. TI does not test all parameters of each EVM.
- 2.3 If any EVM fails to conform to the warranty set forth above, TI's sole liability shall be at its option to repair or replace such EVM, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

- 3 *Regulatory Notices:*

- 3.1 *United States*

- 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.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of 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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1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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西新宿三井ビル

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電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_02.page

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:*

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