

Using the LMX2485E & LMX2478E Evaluation Board

User's Guide



Literature Number: SNAU114A
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1 Introduction

The Texas Instruments LMX2485E-EVM/LMX2487E-EVM helps designers evaluate the operation and performance of any of the devices in the LMX248x family. Although only two options are offered, the other members in the family are all pinout compatible and program compatible to one of these existing board options. They would be expected to have similar performance, just different in the maximum frequency of operation.

Table 1. Evaluation Device and Package Configurations

Device	RF PLL Frequency Range	Evaluation Vehicle
LMX2485E	50 to 3000 MHz	LMX2485E EVAL
LMX2485	500 to 3000 MHz	
LMX2486	1000 to 4500 MHz	LMX2487E EVAL
LMX2487	1000 to 6000 MHz	
LMX2487E	3000 to 7500 MHz	

The EVM contains one Frequency Synthesizer (See [Table 1](#)).

Table 2. Evaluation Device and Package Configurations

Board Version	Designator	IC	Package	VCO Model	VCO Frequency Range
LMX2485E-EVM	U1	LMX2485E	QFN24	Crystek CVCO55CL	60-80 MHz
LMX2487E-EVM	U1	LMX2487E	QFN24	Crystek CVCO44BH	4100-4300 MHz

Although the devices are very broadband, the VCO is ultimately what limits the frequency range of the evaluation board. These VCOs were chosen primarily availability, standard footprint, and for lower risk of being obsoleted.

2 Setup

Input/Output Connector Description

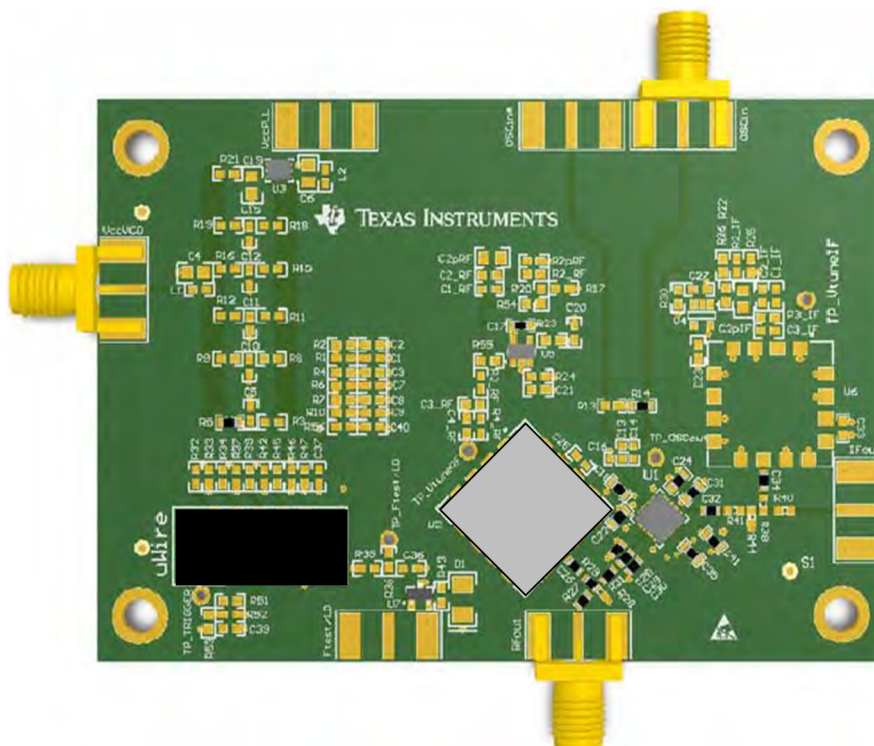


Figure 1. Evaluation Board Setup

VccVCO

Connect this to a 5 V Power supply.

OSCin

Connect this to a signal generator at +4 dBm. Default frequency is 50 MHz for the LMX2485E-EVM and 100 MHz for the LMX2487E-EVM.

RFout

Connect this to a spectrum analyzer. The board has DC blocking capacitors, so the signal is AC coupled.

uWire

Hook this to the programming interface.

2.1 Loop Filter Values

TI's Clock Design Tool can be used to optimize PLL phase noise/jitter for given specifications. See <http://www.ti.com/tool/codeloader>.

2.2 RF PLL Loop Filter

Table 3. RF PLL Loop Filter Parameters

	LMX2485E	LMX2487E
VCO Used	Crystek CVCO55CL	Crystek CVCO55BH
VCO Gain	8 MHz/V	100 MHz/V
VCO Input Capacitance	330 pF	10 pF
Nominal Output Frequency	60 to 80 MHz	4100 to 4300 MHz
Phase Margin	44	50
Loop Bandwidth	8.7	15
Reference Clock Frequency	50 MHz	100 MHz

3 SCHEMATIC

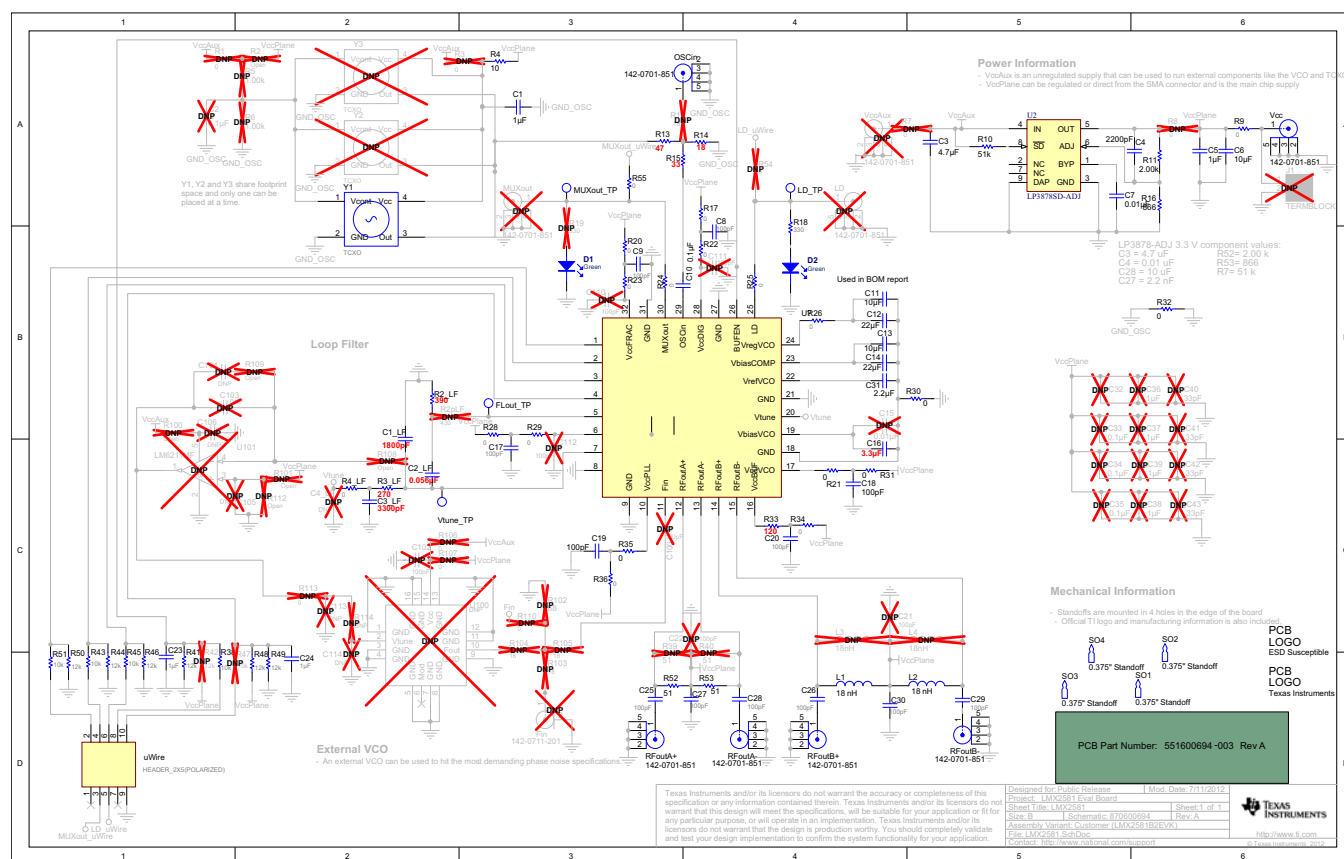


Figure 3. LMX2485E/87EEVM Schematic

View [Section 4](#) Bill of Materials for actual component values.

4 BILL OF MATERIALS

Table 4. Bill of Materials

Item	Designator	Description	Manufacturer	Part Number	Qty
1	AA1	Printed Circuit Board	TBD by TI	551600806-001 REV A	1
2	C18, C22, C24, C26, C30, C31, C35, C41	CAP, CERM, 100pF, 25V, +/- 10%, X7R, 0603	AVX	06033C101KAT2A	8
3	C5, C10, C11, C14, C16, C17, C25, C28, C29, C36	CAP, CERM, 0.1uF, 16V, +/- 10%, X7R, 0603	Kemet	C0603C104K4RACTU	10
4	C1, C2, C3, C7, C8, C9, C37, C40	CAP, CERM, 1uF, 16V, +/-10%, X5R, 0603	Kemet	C0603C105K4PACTU	8
5	C4, C19	CAP, CERM, 10uF, 10V, +/- 10%, X5R, 0805	Kemet	C0805C106K8PACTU	2
6	D1		Lumex	1594540000	1
7	L1	FB, 120 ohm, 500mA, 0603	Murata	BLM18AG121SN1D	1
8	OSCin, RFout, VccVCO	Connector, SMT, End launch SMA 50 ohm	Emerson Network Power	142-0701-851	3
9	R3, R20, R21, R23, R55	RES, 0 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06030000Z0EA	5
10	R1, R2, R4, R6, R7, R9, R10, R12, R56	RES, 10.0 ohm, 1%, 0.1W, 0603	Vishay-Dale	CRCW060310R0FKEA	9
11	R27, R29, R31	RES, 18 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW060318R0JNEA	3
12	R14	RES, 51 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW060351R0JNEA	1
13	R43	RES, 270 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW0603270RJNEA	1
14	R24, C21	RES, 1k ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW060310K0JNEA	1
15	R32, R34, R35, R36, R39	RES, 15k ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW060315K0JNEA	5
16	R33, R37, R42, R47	RES, 27k ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW060327K0JNEA	4
17	S1, S2, S3, S4	0.375" Standoff	Voltrex	SPCS-6	4
18	U3	Ultra Low Noise, 150mA Linear Regulator for RF/Analog Circuits Requires No Bypass Capacitor, 6-pin LLP	Texas Instruments	LP5900SDX-3.3	1
19	U5	Low Noise, RRO Op Amp with CMOS Input	Texas Instruments	LM6211MF	1
20	U7		Fairchild	BSS138	1
21	uWire		FCI	52601-G10-8LF	1
22	S1, TP_Ftest/LD, TP_OSCout, TP_TRIGGER, TP_VtuneIF, TP_VtuneRF	Open	Open	None	6
23	FID1, FID2, FID3	Fiducial mark. There is nothing to buy or mount.	N/A	N/A	3
24					
25					
26					
27	C2_RF	CAP, CERM, 0.68uF, 10V, +/- 10%, X5R, 0603	Kemet	C0603C684K8PAC	1
28	C3_RF	CAP, CERM, 0.015uF, 100V, +/- 10%, X7R, 0603	Kemet	C0603C153K1RACTU	1

Table 4. Bill of Materials (continued)

Item	Designator	Description	Manufacturer	Part Number	Qty
29	C4_RF	CAP, CERM, 1000pF, 50V, +/- 5%, C0G/NP0, 0603	Kemet	C0603C102J5GAC	1
30	R2_RF	RES, 180 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW0603180RJNEA	1
31	R3_RF	RES, 220 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW0603220RJNEA	1
32	R4_RF	RES, 3.3k ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06033K30JNEA	1

Table 5. Additional LMX2485E-EVM Specific Components

Item	Designator	Description	Manufacturer	Part Number	Qty
24	U1	LMX2485E	Texas Instruments		1
25	U2	VCO	Crystek	CVCO55CL-0060-0110	1
26	C1_RF	CAP, CERM, 0.01uF, 100V, +/- 5%, X7R, 0603	Kemet	C0603C103J1RACTU	1
27	C2_RF	CAP, CERM, 0.68uF, 10V, +/- 10%, X5R, 0603	Kemet	C0603C684K8PAC	1
28	C3_RF	CAP, CERM, 0.015uF, 100V, +/- 10%, X7R, 0603	Kemet	C0603C153K1RACTU	1
29	C4_RF	CAP, CERM, 1000pF, 50V, +/- 5%, C0G/NP0, 0603	Kemet	C0603C102J5GAC	1
30	R2_RF	RES, 180 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW0603180RJNEA	1
31	R3_RF	RES, 220 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW0603220RJNEA	1
32	R4_RF	RES, 3.3k ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06033K30JNEA	1

Table 6. Additional LMX2487E-EVM Specific Components

Item	Designator	Description	Manufacturer	Part Number	Qty
33	U1	LMX2487E	Texas Instruments		1
34	U2		Crystek	CVCO55BH-4100-4300	1
35	C1_RF	CAP, CERM, 5600pF, 100V, +/-5%, X7R, 0603	AVX	06031C562JAT2A	1
36	C2_RF	CAP, CERM, 0.12uF, 10V, +/- 10%, X5R, 0603	MuRata	GRM188R61A124KA01D	1
37	C3_RF	CAP, CERM, 220pF, 100V, +/- 10%, X7R, 0603	AVX	06031C221KAT2A	1
38	C4_RF	CAP, CERM, 1000pF, 50V, +/- 5%, C0G/NP0, 0603	Kemet	C0603C102J5GAC	1
39	R2_RF	RES, 270 ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW0603270RJNEA	1
40	R3_RF	RES, 1.2k ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06031K20JNEA	1
41	R4_RF	RES, 1.2k ohm, 5%, 0.1W, 0603	Vishay-Dale	CRCW06031K20JNEA	1

5 PCB LAYERS STACKUP

6-layer PCB Stackup includes:

- Top Layer for high-priority high-frequency signals (2 oz.)
- FR4 Dielectric, 10 mils
- RF Ground plane (1 oz.)
- FR4, 23 mils
- Power plane #1 (1 oz.)
- FR4, 23 mils
- Bottom Layer copper clad for thermal relief (2 oz.)

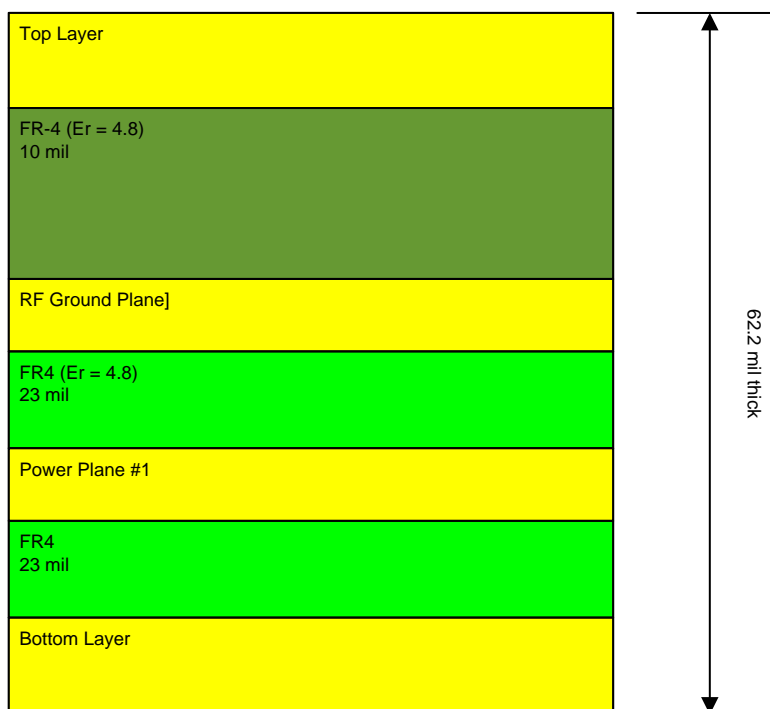


Figure 4. PCB Layers

6 PCB LAYOUT

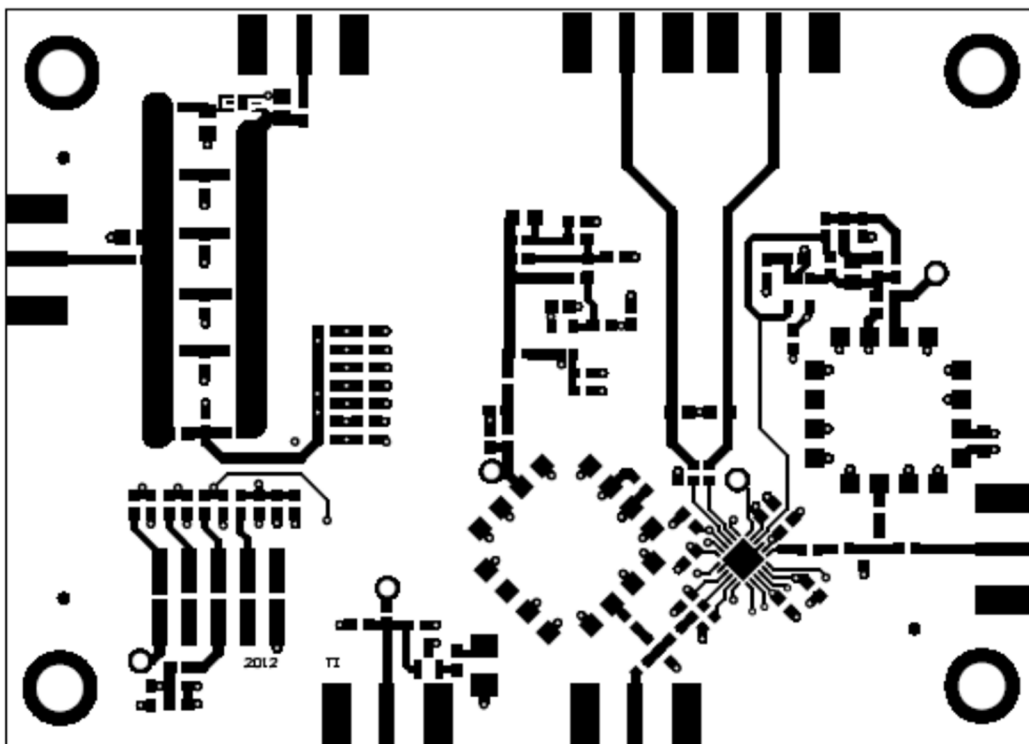


Figure 5. Layer #1 – Top

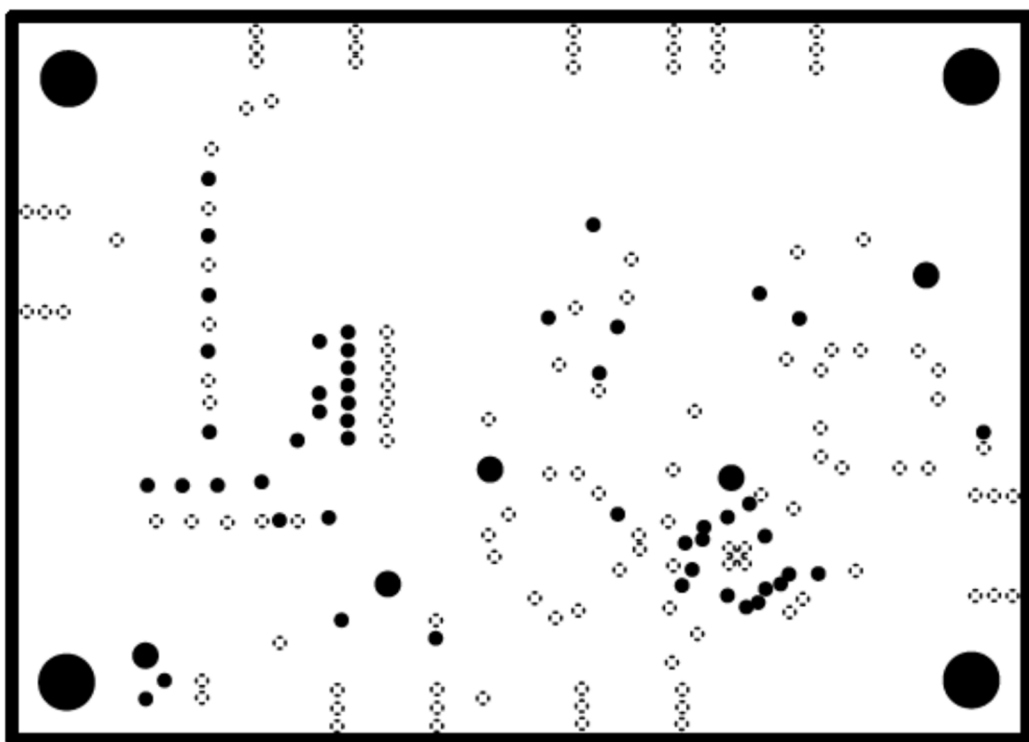


Figure 6. Layer #2 – RF Ground Plane

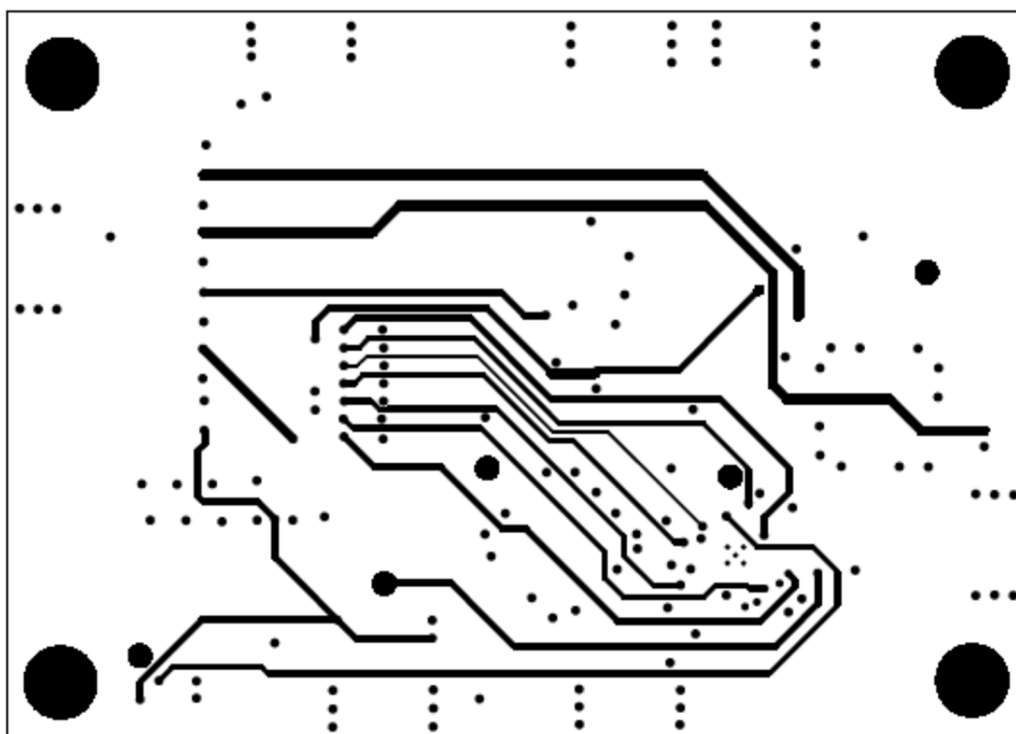


Figure 7. Layer #3 – Power

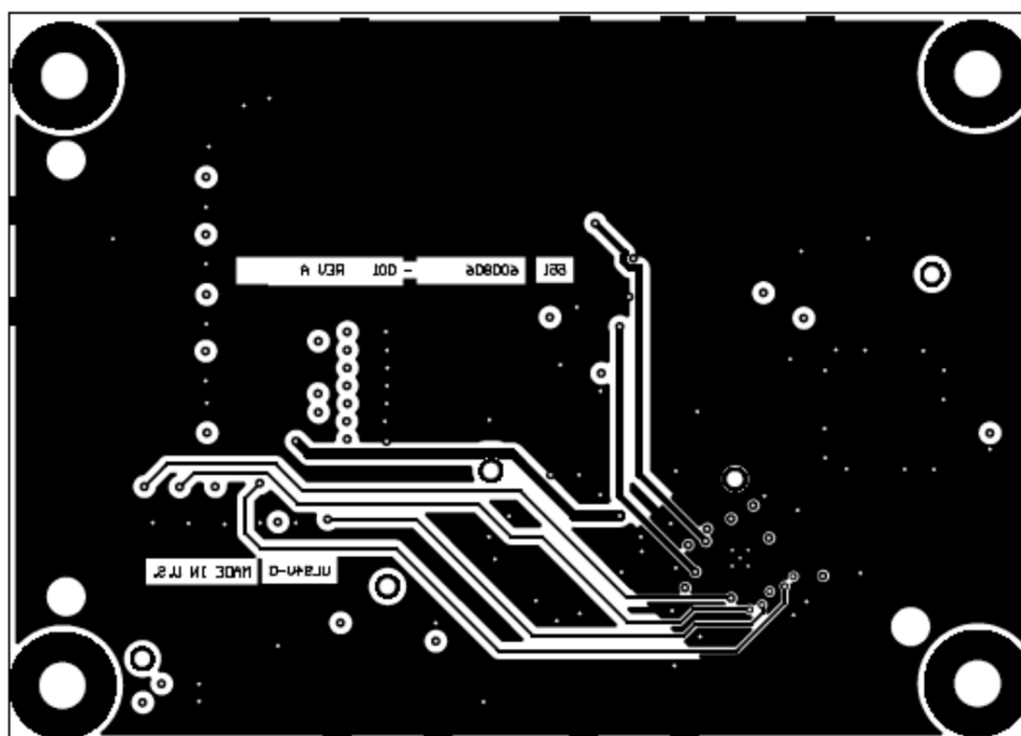


Figure 8. Layer #3 – Bottom Layer

7 TYPICAL PHASE NOISE PERFORMANCE PLOTS

LMX2485E Phase Noise Plots

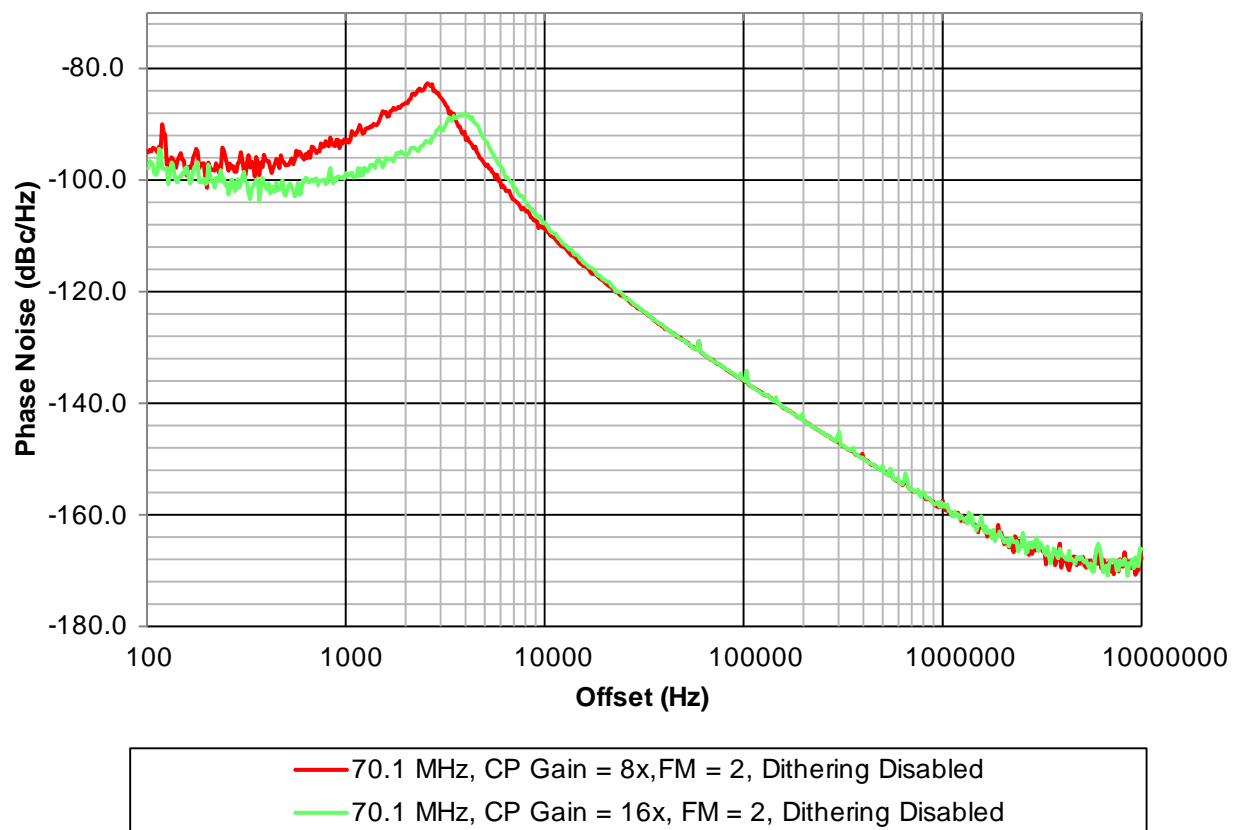


Figure 9. Impact of CPG on Phase Noise

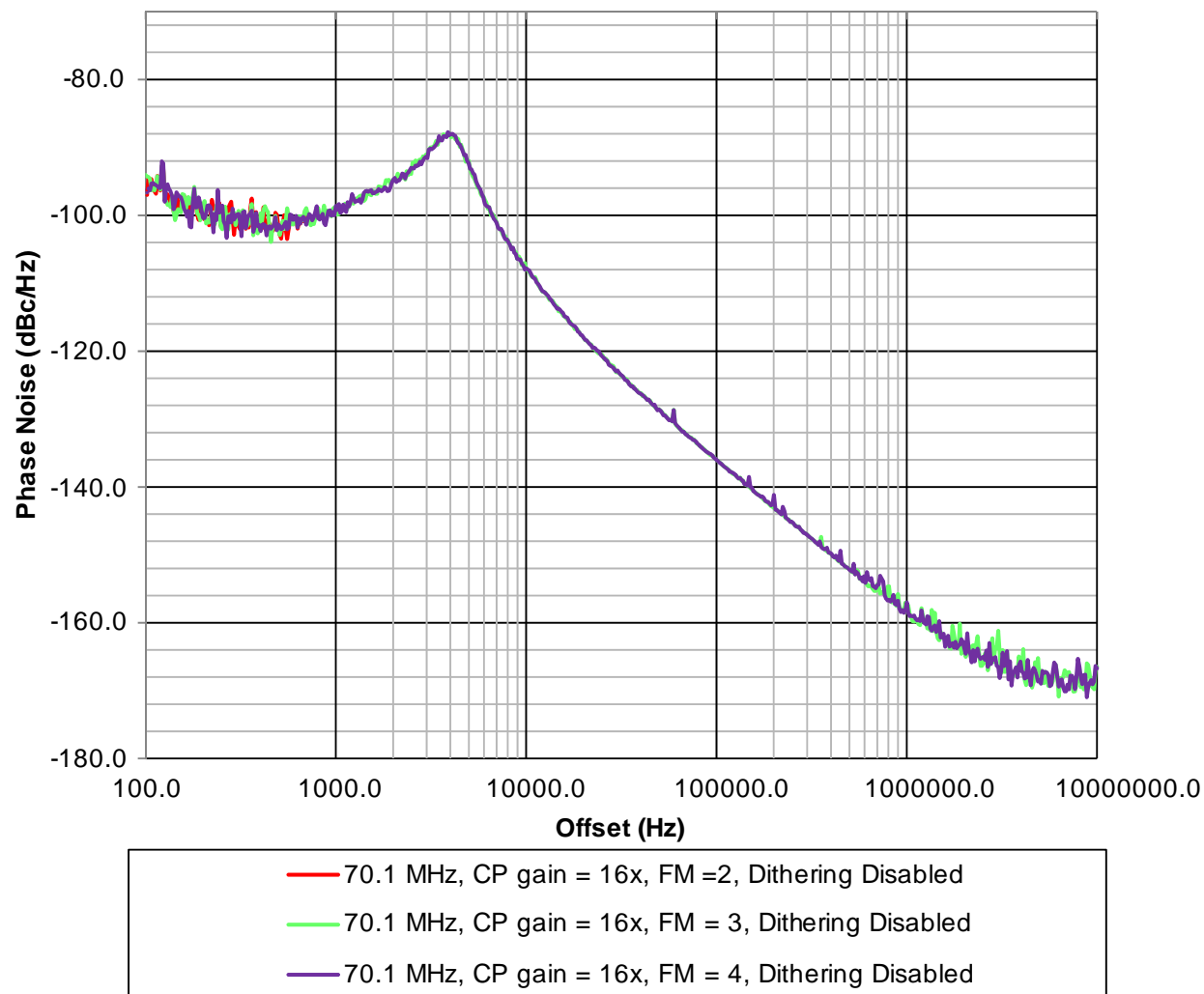


Figure 10. LMX2485E Impact of Fractional Modulator Order

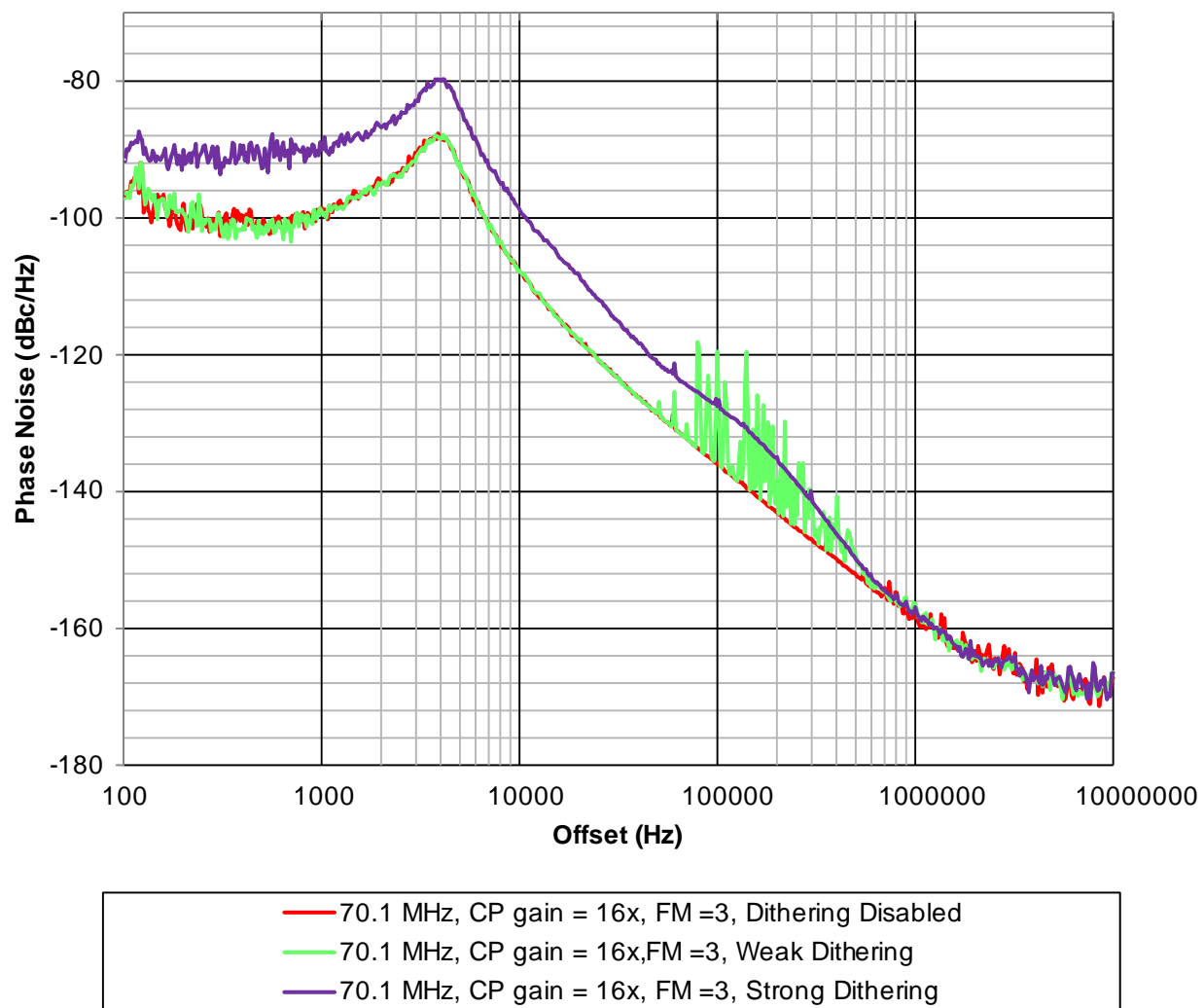


Figure 11. LMK2485E Impact of Dithering

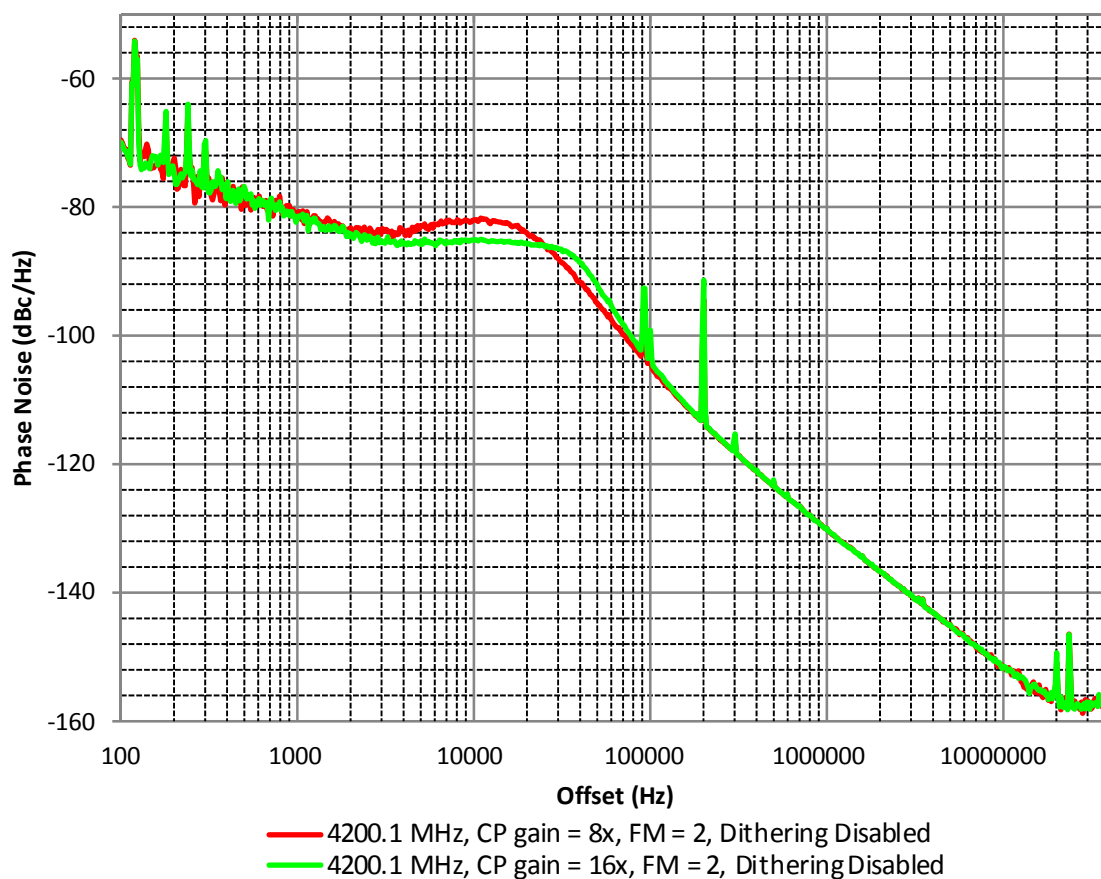
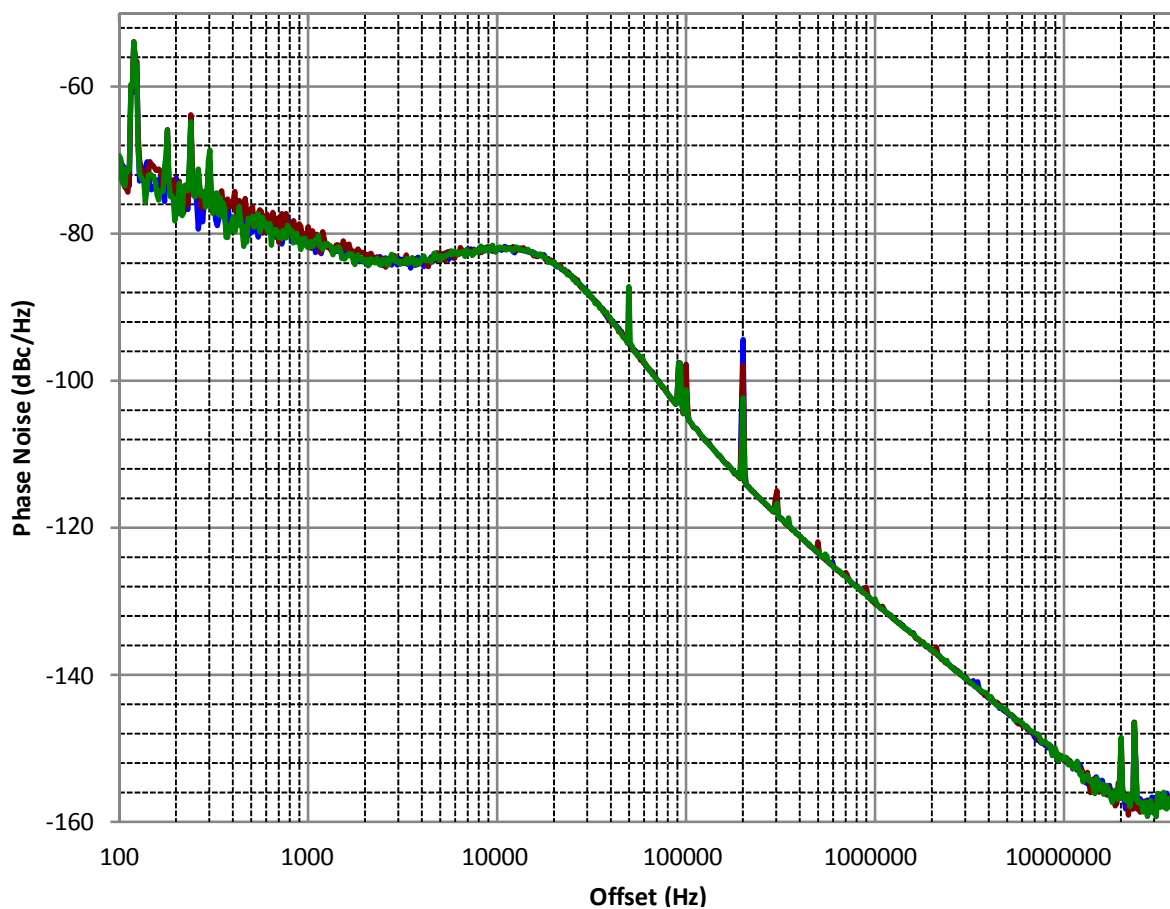


Figure 12. LMX2487E Impact of CPG on Phase Noise



- 4200.1 MHz, CP gain = 8x, FM = 2, Dithering Disabled
- 4200.1 MHz, CP gain = 8x, FM = 3, Dithering Disabled
- 4200.1 MHz, CP gain = 8x, FM = 4, Dithering Disabled

Figure 13. LMX2487E Impact on Fractional Modulator

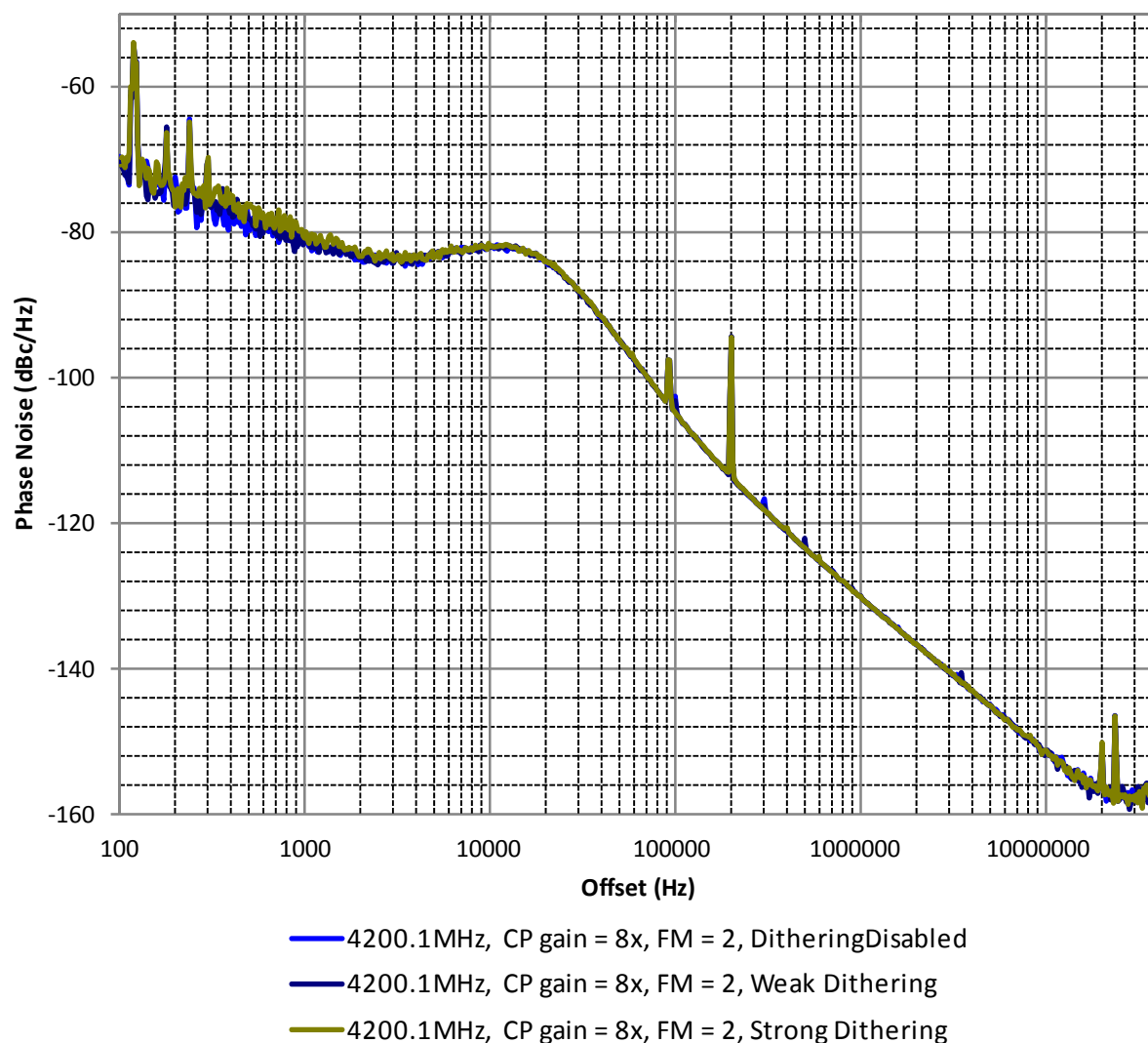


Figure 14. LMX2487E Impact of Dithering

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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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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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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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