LMK02000 Evaluation Board

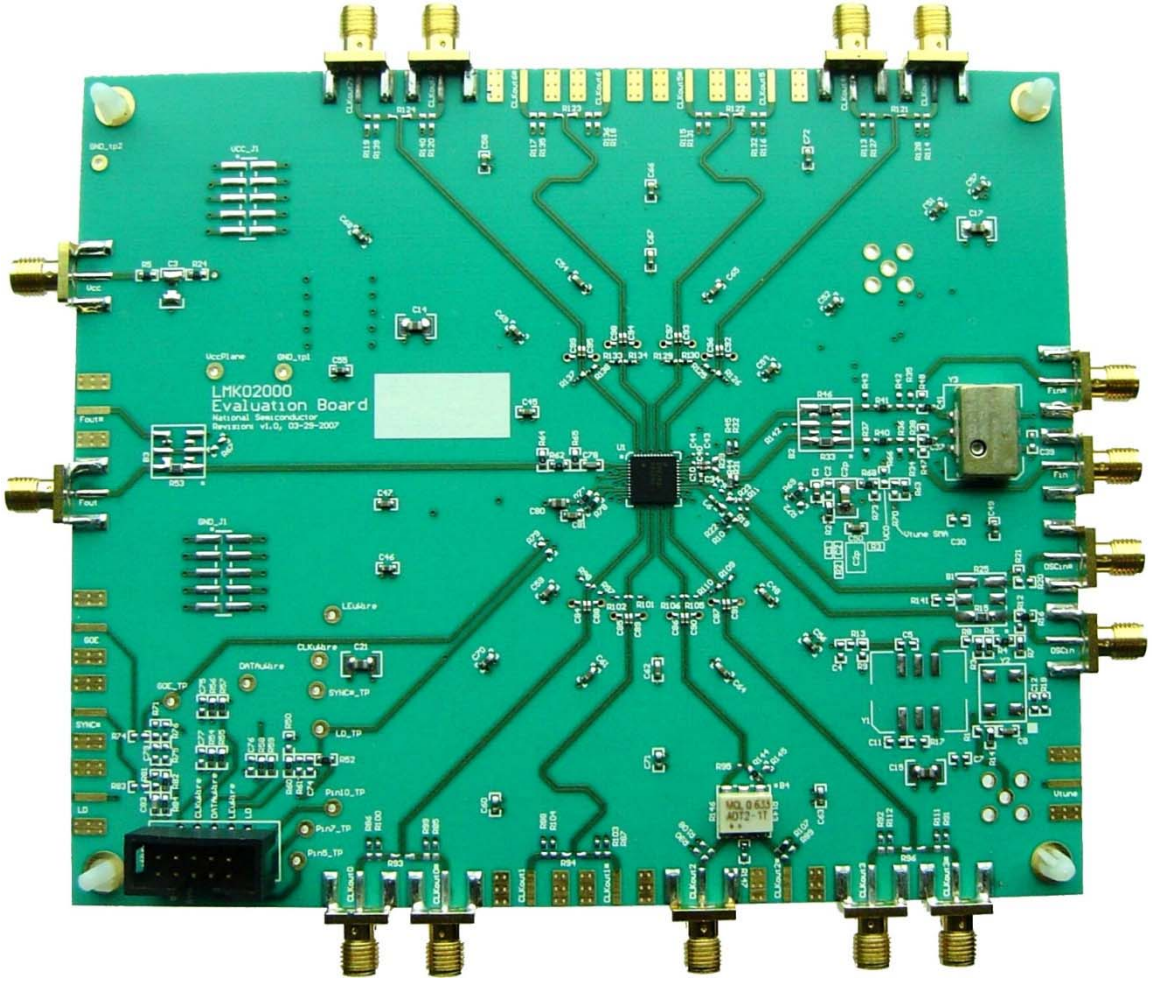
User's Guide

November 2013

SNAU039A

LMK02000

Precision Clock Conditioner
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.

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.

Reference Oscillator

The on board crystal oscillator will provide a low noise reference signal to the device at offsets greater than 1 kHz.

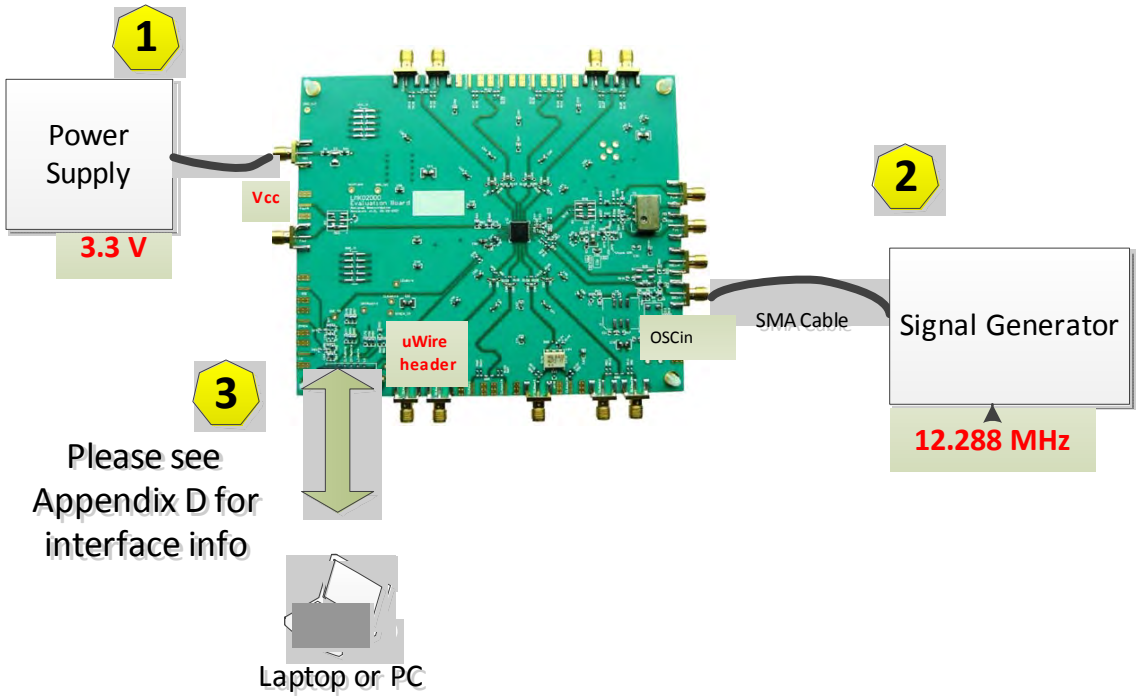
Note: The default loop filter has a loop bandwidth of ~60 kHz. Inside the loop bandwidth of a PLL the noise is greatly affected by any noise on the reference oscillator (OSCin). Therefore any noise on the oscillator less than 60 kHz will be passed through and seen on the outputs. For this reason the main output of a Signal Generator is not recommended for driving OSCin in this setup.

Basic Operation

1) Connect a low noise **3.3 V** power supply to the **Vcc** connector located at the top left of the board.

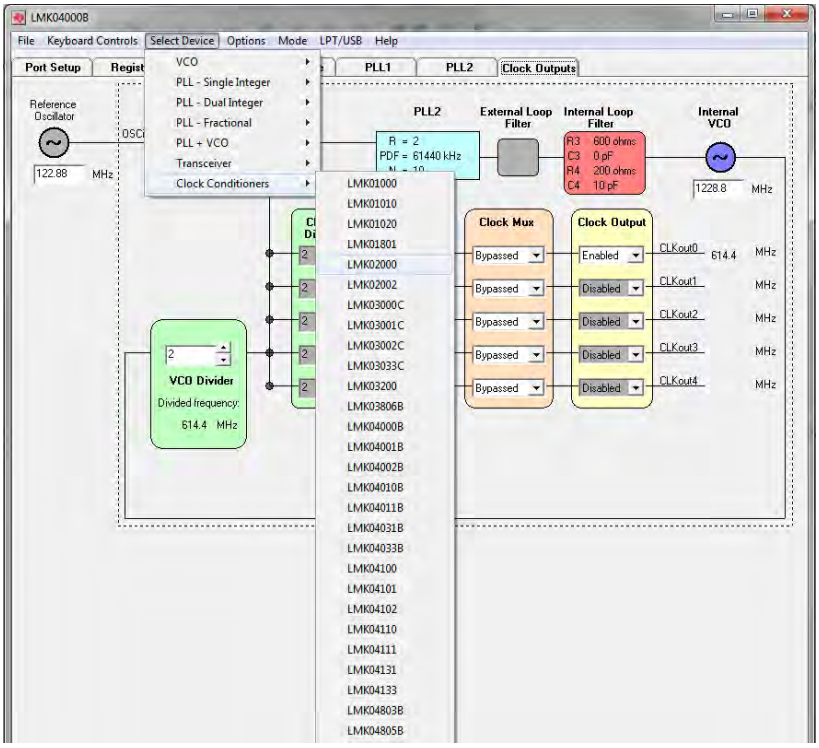
2) Connect **12.288 MHz** @ **+8dBm** signal from signal generator output to OSCin of board

3) Please see **Appendix D** for quick start on interfacing the board. Connect PC to the **uWire** header.

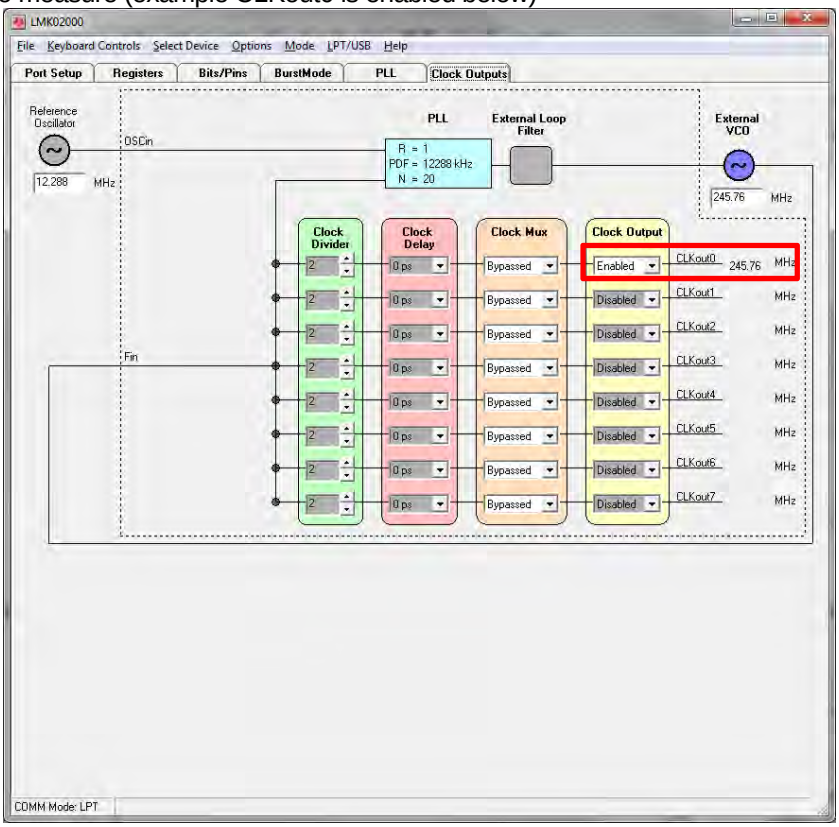


4) Start CodeLoader4.exe.

5) Select the device by "Select Device" → "Clock Conditioners"



6) Enable the output to measure (example CLKout0 is enabled below)



7) **Program** the part by clicking "Keyboard Controls" → "Load Device" or by pressing **Ctrl+L**.

Program Bits	
POWERDOWN	Powers the part down.
PLL_MUX	Programmable to many different values to support Lock Detect or aid troubleshooting.
DIV4	Shall be checked for PDF frequencies greater than 20 MHz.
RESET	The registers can be defaulted by checking and unchecking RESET. Software bits will not reflect this.
EN_CLKout0..7	Enable CLKout bits from CLKout0 to CLKout7. Also accessible from Clock Outputs tab.
EN_CLKout_Global	Enable all clock outs. If unselected then the EN_CLKouts are overridden and the outputs are all disabled.

Program Pins	
GOE	Set Global Output Enable to high or low logic level.
SYNC*	Set SYNC* pin to high or low logic level.
TRIGGER	Set auxiliary trigger pin to high or low logic level.

Board Information

The LMK02000 Evaluation Board is to be used for evaluation of LMK02000 devices. The LMK02000 has 3 LVDS outputs connected to SMAs labeled CLKout0 to CLKout2, and 5 LVPECL outputs connected to SMAs labeled CLKout3 to CLKout7.

Loop Filter #1			
Phase Margin	64º	**Kϕ**	400 uA
Loop Bandwidth	20 Hz	**Fcomp**	1.2288 MHz
Crystal Frequency	12.288 MHz	**Output Frequency**	246.76 MHz
Supply Voltage	3.3 Volts	**VCO Gain**	20 kHz/Volt

Loop filter #1 is selected by placing a 0 ohm resistor on pads R68 and R69.

Loop filter #2 is selected by placing a 0 ohm resistor on pads R72 and R73 and is provided for user convenience. That is, to experiment with a new loop filter while not changing the factory default.

OSCin

By default the board is configured to use an off board reference. It is also possible to use the board with a single ended or differential reference source at the OSCin port. Below are several possible configurations for driving OSCin.

Single ended OSCin using off board reference [default]	
0 ohm	R15, R16
51 ohm	R22
0.1 uF	C6, C10 (C9 is a 0.1 uF 0402 cap which may be moved to C10)
Open	C9 R12 R9, R13, R1, R14 (if a TCXO is placed, open these resistors to remove power from on-board oscillator for noise reasons)
No Effect	R3, R4, R6, R7, R8

Differential OSCin using off board reference	
0 ohm	R15, R16, R20, R25
100 ohm	R23 (other termination options are possible with R10, R11, R19, R22)
0.1 uF	C6, C9 (C10 is a 0.1 uF 0402 cap which may be moved to C6)
Open	C4, C36 R11, R12, R14, R15, R16, R79 R9, R13, R1, R14 (if a TCXO is placed, open these resistors to remove power from on-board oscillator for noise reasons)
No Effect	R3, R4, R6, R7, R8

Loop Filter

The PCB allows for two separate loop filters to be placed. Loop Filter #1 is the factory default. Loop Filter #2 allows for experimentation with a new loop filter while not altering the factory default loop filter. Four resistors switch loop filter #1 or #2 into the circuit.

Loop Filter	**Resistor Switch**	**Loop Filter Components**	**Default Loop Bandwidth**
Loop Filter #1 [default]	R68 & R69 shorted	C1, C2, C2p, R2	20 Hz
Loop Filter #2 [aux]	R72 & R73 shorted	C1_AUX, C2_AUX, C2p_AUX, R2_AUX	No filter placed

Global Output Enable (GOE) pin

The evaluation board has removed the resistors connecting GOE to the CodeLoader cable so the clock outputs are defaulted on all the time, therefore the GOE pin in CodeLoader has no effect. This way the CodeLoader cable can be removed from the board to reduce noise for measurements. To add GOE functionality, place a 15 k resistor on R76 and a 27 k resistor on R75.

Features of the board

- Either one of two loop filters can be selected by shorting either (R68 & R69 or R72 & R73).
- Test points for each of the uWire lines are scattered in the lower left corner of the board and include: GOE_TP, DATAuWire, CLKuWire, LEuWire, SYNC_TP, and LD_TP.

- **Ground** is located on the unstuffed 10 pin header on the left side of the board.
- **Ground** is located on the GND_tp2 in the upper left corner of the board and GND_tp1 located to the right of the Vcc SMA connector.
- **Ground** is located on the bottom side of the board on each pad of the unstuffed 10 pin header GND_J2.

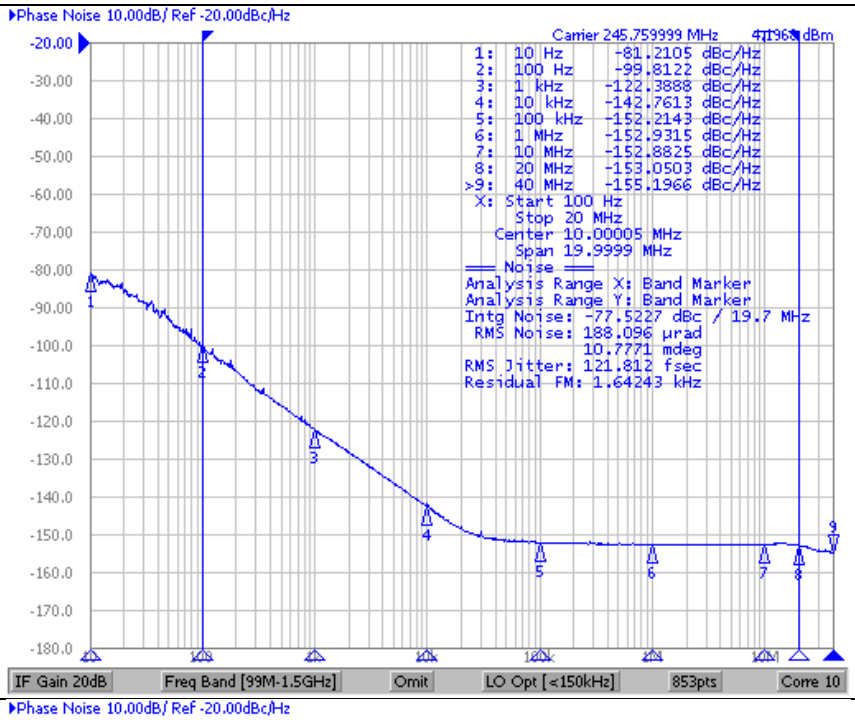
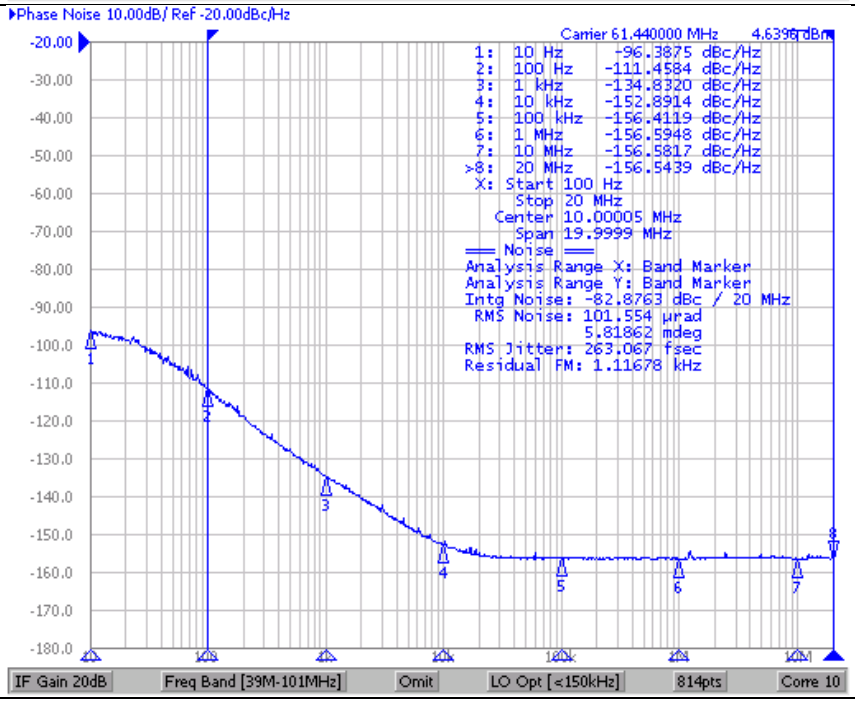
- **Vcc** is located on the unstuffed 10 pin header on the upper left side of the board.
- **Vcc** is located on VccPlane test point located to the right of the Vcc SMA.
- **Vcc** is located on the bottom side of the board on each pad of the unstuffed 10 pin header VCC_J2

Other Important Notes

- Board v1.0, 3-29-2007 ERRATA: B4 pin 1 is flipped. Pin 1 should be next to CLKout2 SMA. Not B4 label as shown.
- Toggle the SYNC* pin to synchronize the clock outputs when in divided mode.
- For both loop filters, a helper silkscreen is offset from the loop filters to help identify the components according to National Semiconductor's traditional reference designators associated with loop filters.

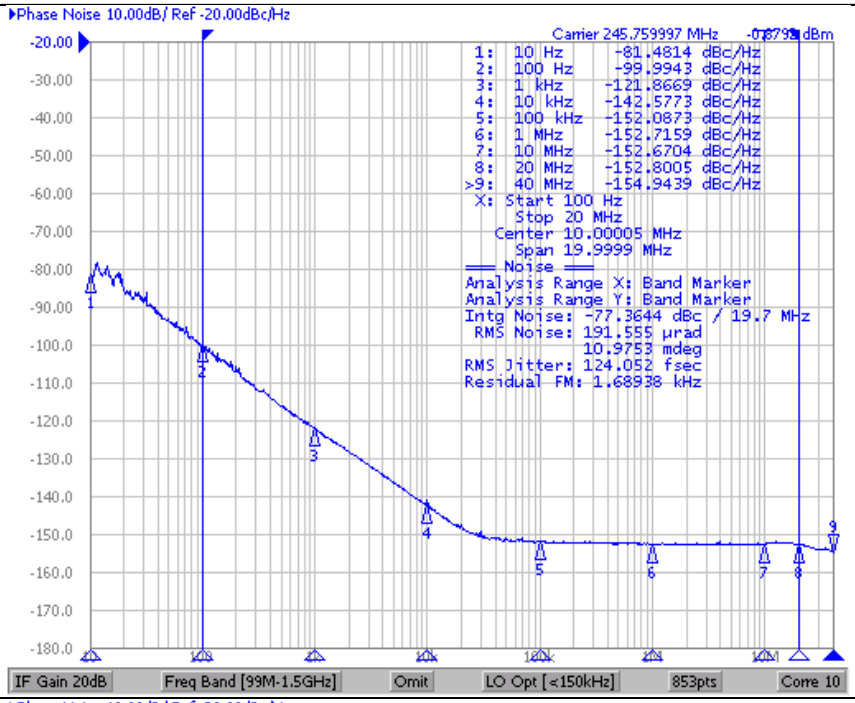
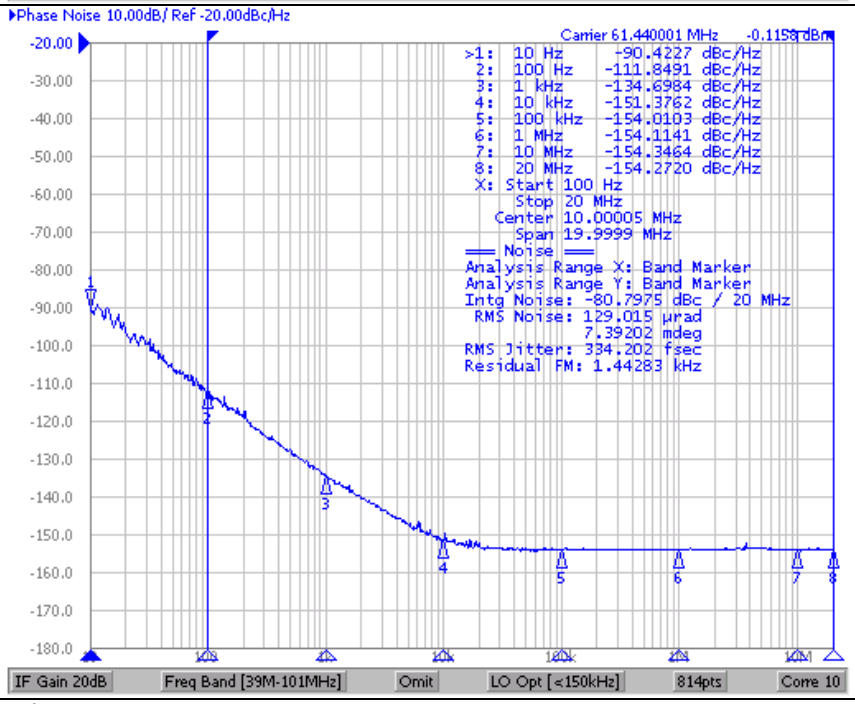
Phase Noise

In the phase noise measurements below, the phase noise of the VCXO plus some small amount of additive jitter is being measured. Total jitter will vary depending on phase noise performance of the VCXO used.

CLKout4 LVPECL output, Bypass, 245.76 MHz TCO-2111-AA, 245.76 VCXO		Reference source signal generator at 12.288 MHz at 10 dBm 10 Hz – 20 MHz integrated RMS jitter = 300.8 fs **100 Hz – 20 MHz integrated RMS jitter = 121.8 fs** 1 kHz – 20 MHz integrated RMS jitter = 96.1 fs 10 kHz – 20 MHz integrated RMS jitter = 93.8 fs 100 kHz – 20 MHz integrated RMS jitter = 93.5 fs
LVPECL output CLKout4 VCXO Frequency = 245.76 MHz, CLKout4_div=4 LVPECL output (61.44 MHz)		Reference source signal generator at 12.288 MHz at 10 dBm 10 Hz – 20 MHz integrated RMS jitter = 360.8 fs **100 Hz – 20 MHz integrated RMS jitter = 263.1 fs** 1 kHz – 20 MHz integrated RMS jitter = 251.9 fs 10 kHz – 20 MHz integrated RMS jitter = 251.0 fs 100 kHz – 20 MHz integrated RMS jitter = 250.4 fs

A note on jitter measurements between 245.76 MHz and 61.44 MHz

Theoretically jitter after a divider will be the same as the jitter before the divider because the benefit gained from a lower phase noise curve will be offset by the lower frequency. In the plots above the jitter for 245.76 MHz from 100 Hz to 20 MHz is 121.8 fs. The jitter for 61.44 MHz (after a divide by 4) from 100 Hz to 20 MHz is 263.1 fs. The reason the 61.44 MHz jitter is not also ~121.8 fs is the phase noise curve didn't gain 12 dB along the entire integrated bandwidth because the residual noise floor of the outputs was reached.

CLKout4 LVDS output, Bypass, 245.76 MHz TCO-2111-AA, 245.76 VCXO		Output is measured with a Minicircuits ADT2-1T balun. Reference source signal generator at 12.288 MHz at 10 dBm 10 Hz – 20 MHz integrated RMS jitter = 335.8 fs **100 Hz – 20 MHz integrated RMS jitter = 124.7 fs** 1 kHz – 20 MHz integrated RMS jitter = 98.8 fs 10 kHz – 20 MHz integrated RMS jitter = 96.6 fs 100 kHz – 20 MHz integrated RMS jitter = 96.2 fs
LVDS output CLKout2 VCXO Frequency = 245.76 MHz, CLKout2_div=4 LVDS output (61.44 MHz)		Output is measured with a Minicircuits ADT2-1T balun. Reference source signal generator at 12.288 MHz at 10 dBm 10 Hz – 20 MHz integrated RMS jitter = 483.8 fs **100 Hz – 20 MHz integrated RMS jitter = 334.2 fs** 1 kHz – 20 MHz integrated RMS jitter = 326.1 fs 10 kHz – 20 MHz integrated RMS jitter = 325.3 fs 100 kHz – 20 MHz integrated RMS jitter = 324.6 fs

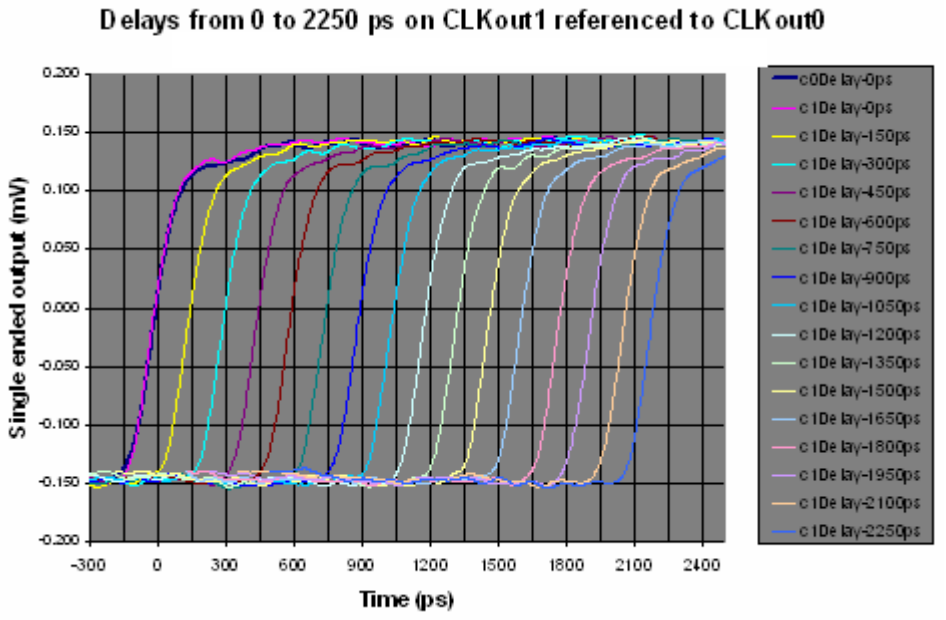
A note on LVDS phase noise

LVDS drivers expect a 100 ohm differential load for optimal phase noise performance. We recommended that a balun be used when making single ended (unbalanced) measurements (like the phase noise measurements above).

Delays

These delay measurements illustrate how skew errors due to different length traces may be tuned out.
The delay may be adjusted in steps of 150 ps.

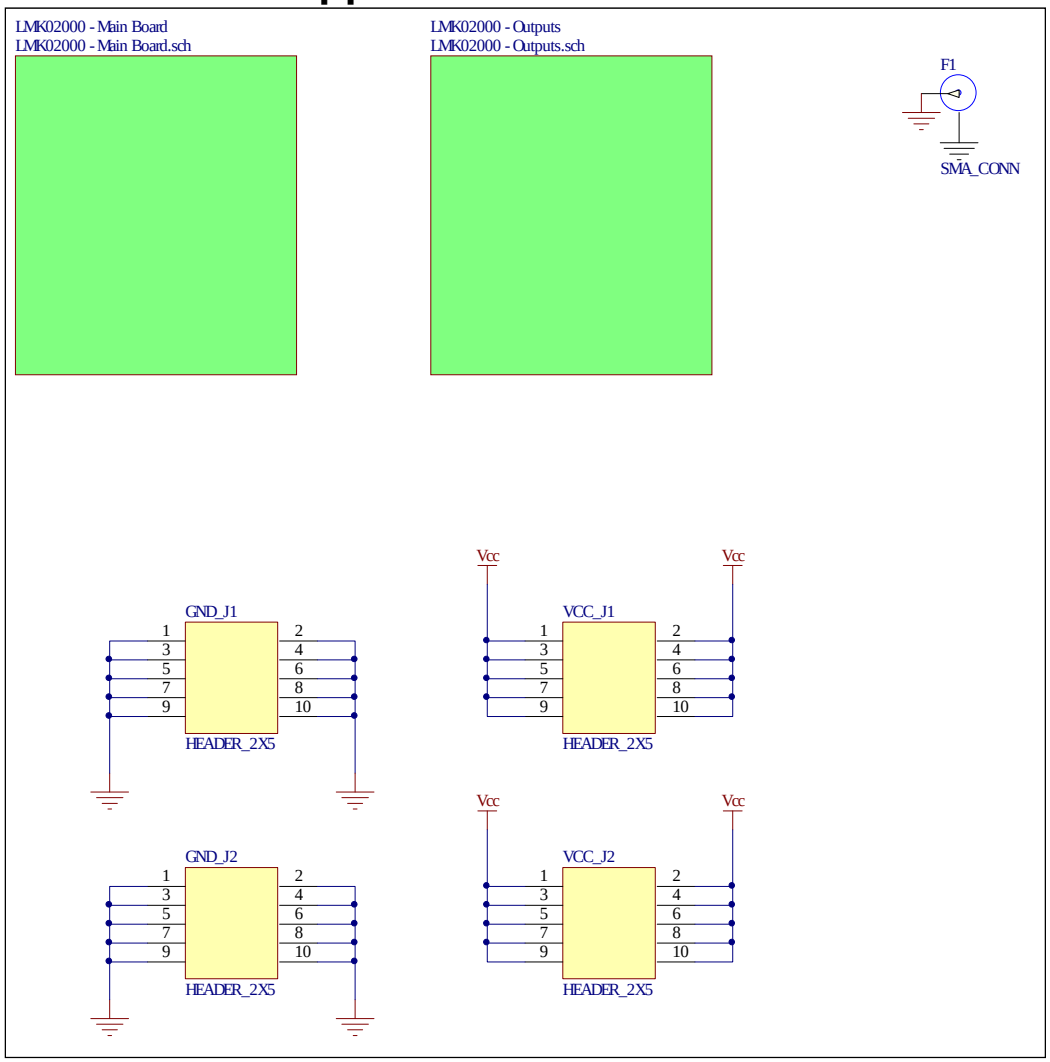
Delays 150, 300, 450, 600, 750

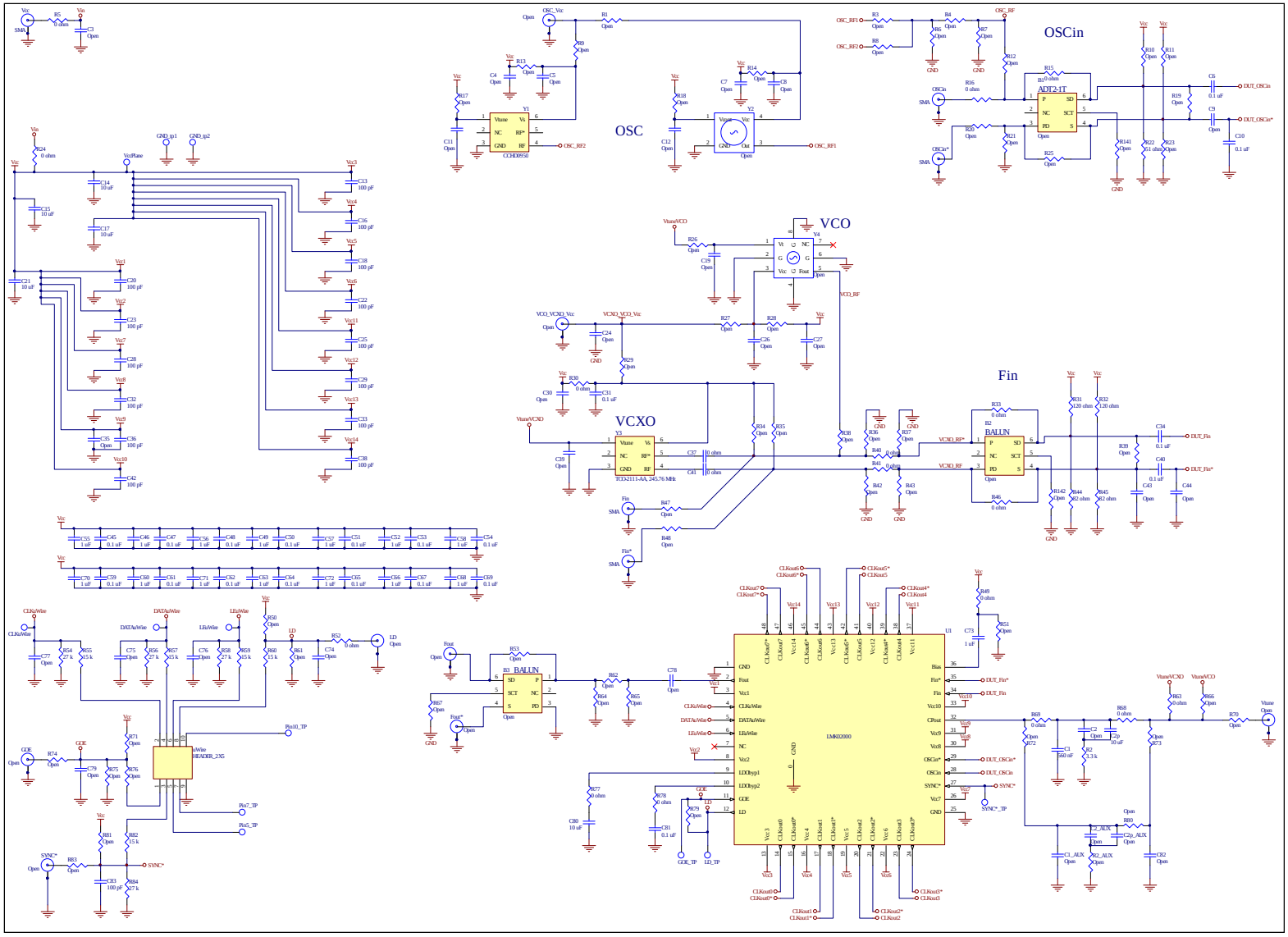


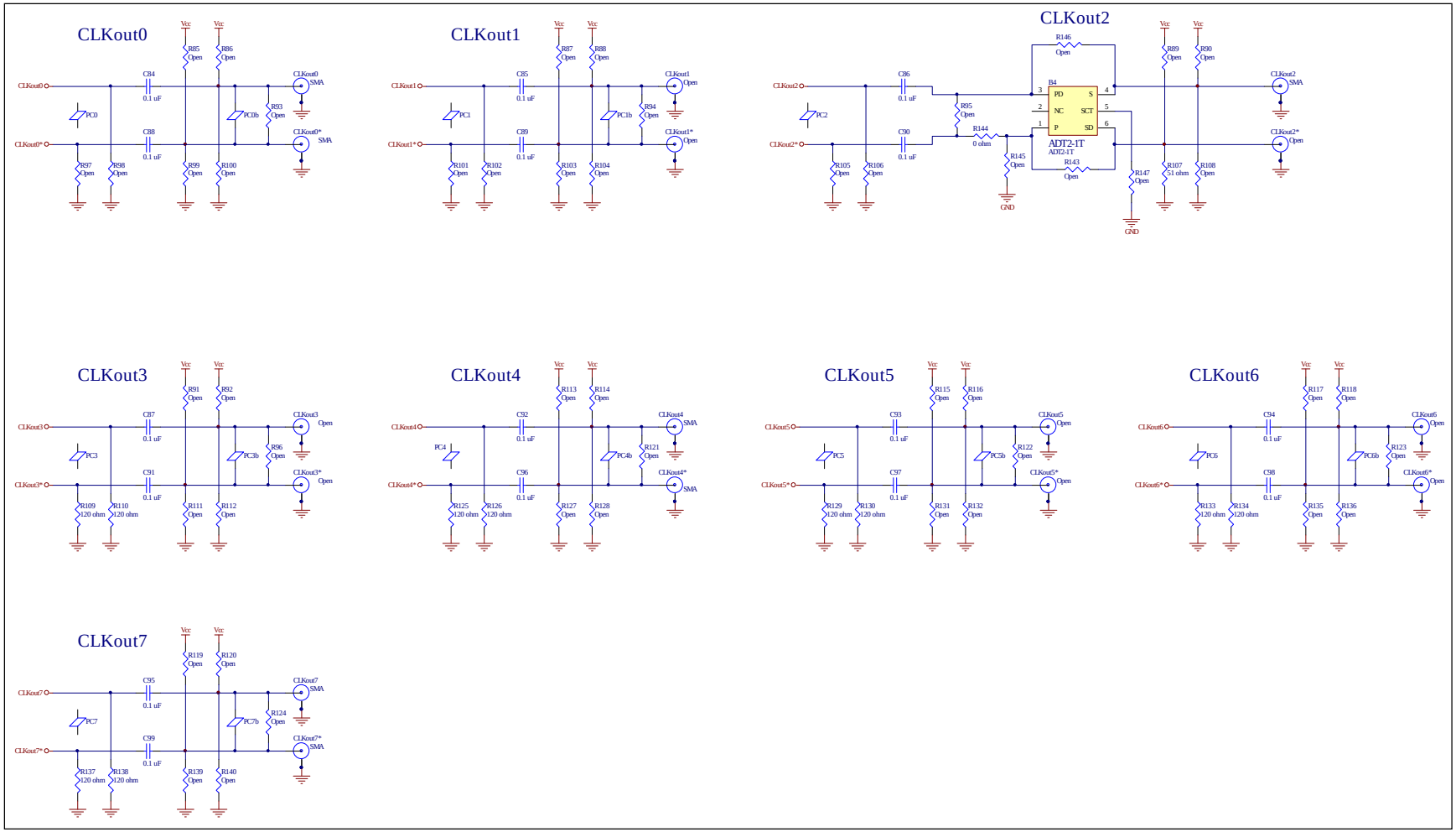
CLKout0_DLY = 0 ps

CLKout1_DLY = all delays programmed: 0, 150, 300, 450, 600, 750, 900, 1050, 1200, 1350, 1500, 1650, 1800, 1950, 2100, and 2250 ps

Appendix A: Schematic





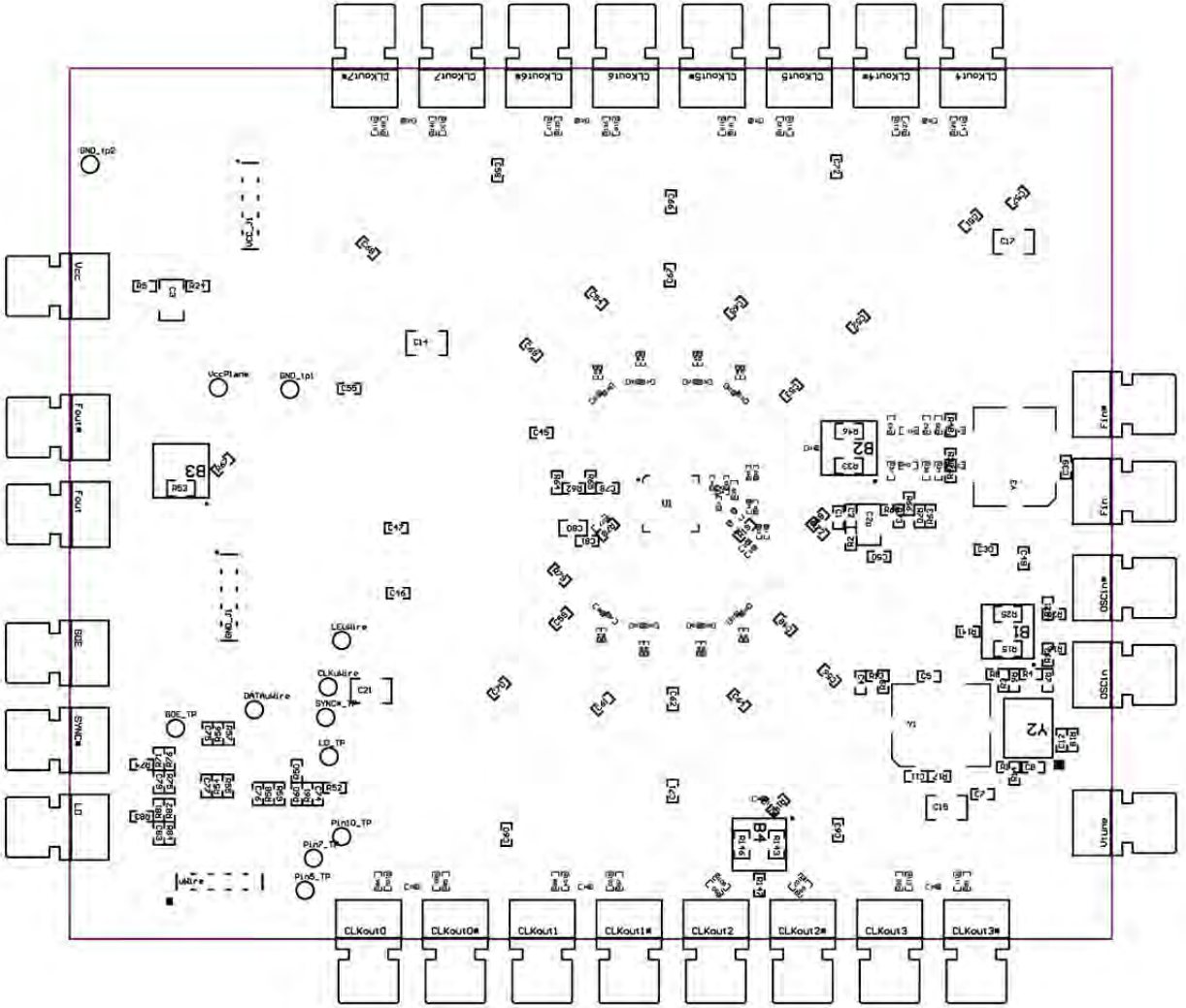


Appendix B: Bill of Materials

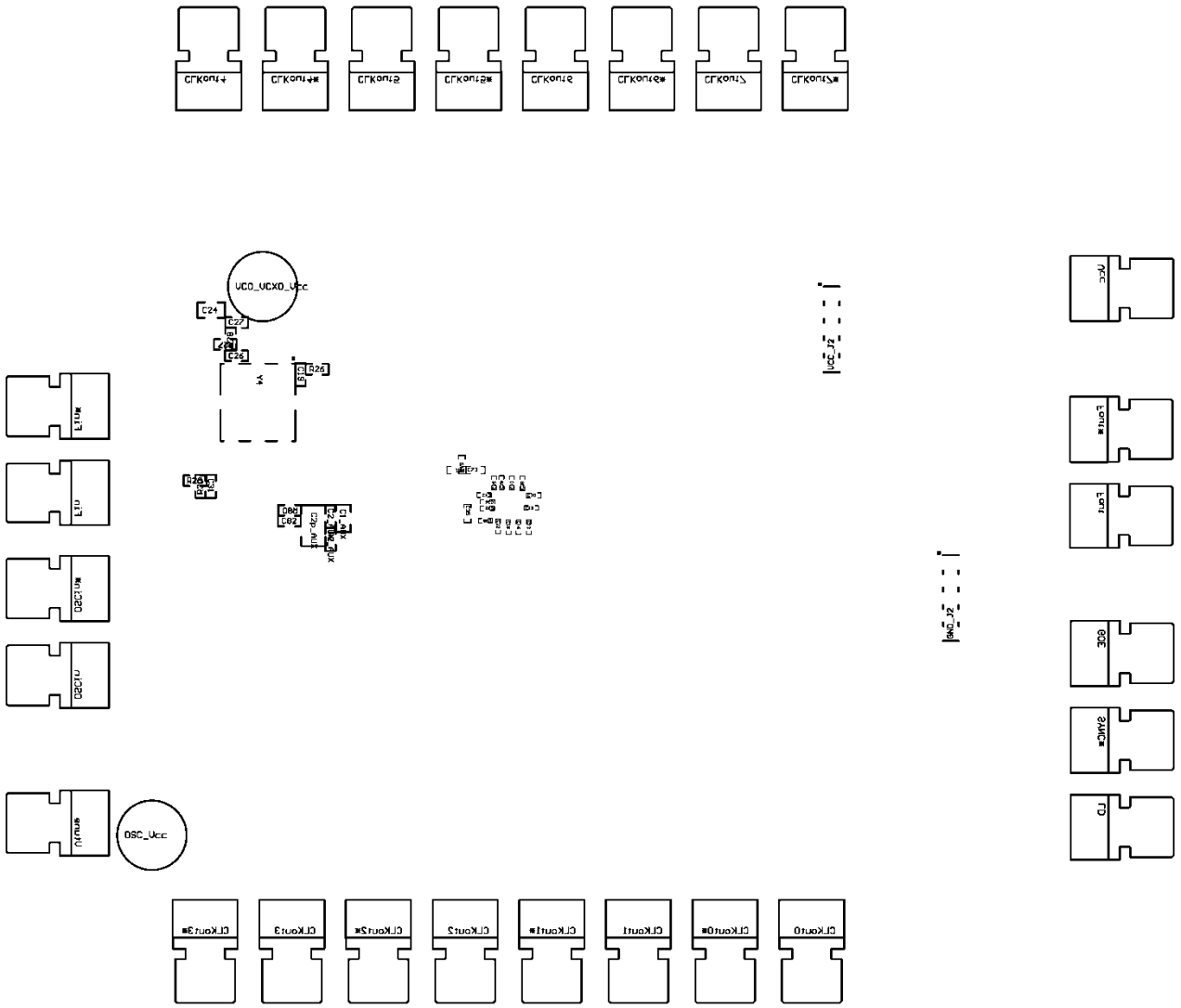
Part	Manufacturer	Part Number	Qnt	Identifier
Capacitors				
100 pF	Kemet	C0402C101J5GAC	14	C13, C16, C18, C20, C22, C23, C25, C28, C29, C32, C33, C36, C38, C42
100 pF	Kemet	C0603C101J5GAC	1	C83
0.1 uF	Kemet	C0402C104J4RAC	20	C6, C10, C34, C40, C84, C85, C86, C87, C88, C89, C90, C91, C92, C93, C94, C95, C96, C97, C98, C99
0.1 uF	Kemet	C0603C104J3RAC	16	C31, C45, C47, C48, C50, C51, C53, C54, C59, C61, C62, C64, C65, C67, C69, C81
560 nF	Kemet	C0603C564K8PACTU	1	C1
1 uF	Kemet	C0603C105K8VAC	14	C46, C49, C52, C55, C56, C57, C58, C60, C63, C66, C68, C70, C71, C72
1 uF	Kemet	C0603C105K8VAC	1	C73
10 uF	Kemet	C0805C106K9PAC	5	C2p, C14, C15, C17, C21
10 uF	Kemet	C0805C106K9PAC	1	C80
Resistors				
0 ohm	Vishay	CRCW0603000ZRT1	7	C37, C41, R40, R41, R49, R77, R144
0 ohm	Vishay	CRCW0603000ZRT1	9	R5, R16, R24, R30, R52, R63, R68, R69, R78
0 ohm	Yageo	RC0805JR-070RL	3	R15, R33, R46
51 ohm	Yageo	CRCW040251R0FKED	1	R22
51 ohm	Vishay/Dale	CRCW060351R0JNEA	1	R107
82 ohm	Vishay/Dale	CRCW040282R0JNED	2	R44, R45
120 ohm	Vishay	CRCW0402120RJNED	12	R31, R32, R109, R110, R125, R126, R129, R130, R133, R134, R137, R138
3.3 k	Vishay/Dale	CRCW06034K70JNEA	1	R2
15 k	Vishay	CRCW0603153JRT1	5	R55, R57, R59, R60, R82
27 k	Vishay	CRCW0603273JRT1	4	R54, R56, R58, R84

Other				
ADT2-1T	Minicircuits	ADT2-1T	1	B4
SMA	Johnson Components	142-0701-851	12	CLKout0, CLKout0*, CLKout2, CLKout4, CLKout4*, CLKout7, CLKout7*, Fin, Fin*, OSCin, OSCin*, Vcc
LMK02000	National Semiconductor	LMK02000 I	1	U1
245.76 VCXO	Epson-Toyocom	TCO-2111-AA, 245.76 MHz	1	Y3
PCB	Printed Circuits Corp	LMK02000_EB_PCB	1	F1
HEADER_2X5	FCI Electronics	52601-S10-8	1	uWire
Open				
Open	-	Open	3	B1, B2, B3
Open	-	0603	64	C2, C2_AUX, C4, C5, C7, C8, C11, C12, C19, C26, C27, C30, C39, C74, C75, C76, C77, C78, C79, C82, R1, R2_AUX, R3, R4, R6, R7, R8, R9, R12, R13, R14, R17, R18, R19, R20, R21, R26, R27, R28, R29, R38, R47, R48, R50, R61, R62, R64, R65, R66, R67, R70, R71, R72, R73, R74, R75, R76, R79, R80, R81, R83, R141, R145, R147
Open	-	Open	4	C1_AUX, C2p_AUX, C3, C24
Open	-	0603	40	C35, R34, R35, R36, R37, R39, R42, R43, R51, R85, R86, R87, R88, R89, R90, R91, R92, R99, R100, R103, R104, R108, R111, R112, R113, R114, R115, R116, R117, R118, R119, R120, R127, R128, R131, R132, R135, R136, R139, R140
Open	-	0402	21	C9, C43, C44, R10, R11, R23, R93, R94, R95, R96, R97, R98, R101, R102, R105, R106, R121, R122, R123, R124, R142
Open	-	Open	15	CLKout1, CLKout1*, CLKout2*, CLKout3, CLKout3*, CLKout5, CLKout5*, CLKout6, CLKout6*, Fout, Fout*, GOE, LD, SYNC*, Vtune
Open	-	Open	4	GND_J1, GND_J2, VCC_J1, VCC_J2
Open	-	Open	2	OSC_Vcc, VCO_VCXO_Vcc
Open	-	0805	4	R25, R53, R143, R146
Open	-	Open	1	Y1, Y2, Y4

Appendix C: Build Diagram



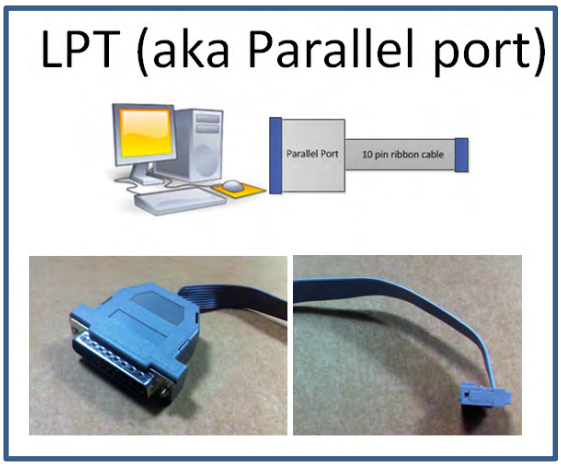
Bottom Build Diagram



Appendix D: Quick Start on EVM Communications

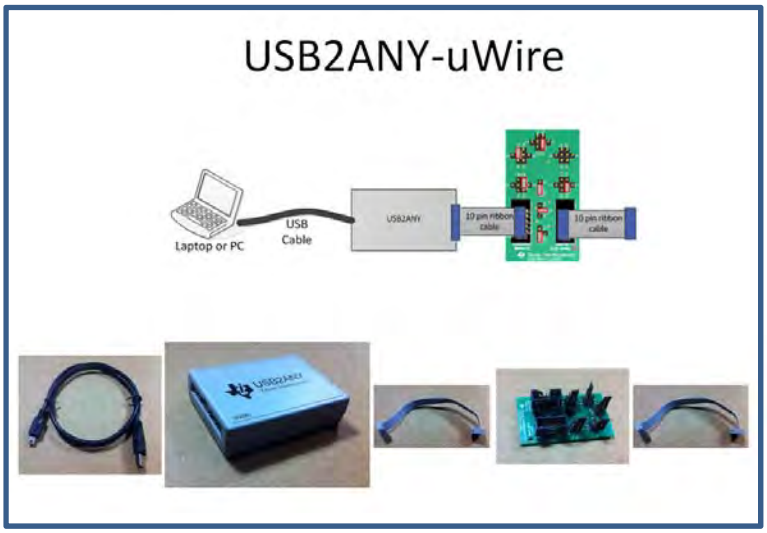
Codeloader is the software used to communicate with the EVM (Please download the latest version from TI.com - http://www.ti.com/tool/codeloader). This EVM can be controlled through the uWire interface on board. There are two options in communicating with the uWire interface from the computer.

OPTION 1



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

OPTION 2

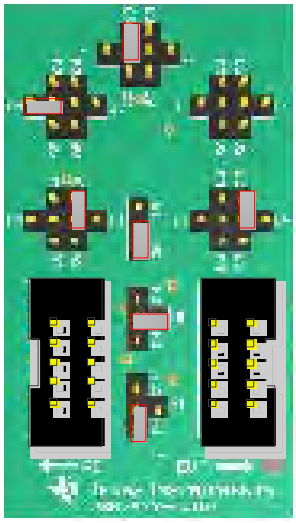


The Adapter Board

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.*

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.

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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/lsds/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/lsds/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。
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西新宿三井ビル

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

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/lsds/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:*

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

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

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

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

   6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY WRITTEN DESIGN MATERIALS PROVIDED WITH THE EVM (AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

   6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS AND CONDITIONS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT MADE, CONCEIVED OR ACQUIRED PRIOR TO OR AFTER DELIVERY OF THE EVM.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL 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 HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS AND CONDITIONS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS ANDCONDITIONS OR THE USE OF THE EVMS PROVIDED HEREUNDER, REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN ONE YEAR AFTER THE RELATED CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY WARRANTY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS AND CONDITIONS, OR ANY USE OF ANY TI EVM PROVIDED HEREUNDER, EXCEED THE TOTAL AMOUNT PAID TO TI FOR THE PARTICULAR UNITS SOLD UNDER THESE TERMS AND CONDITIONS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM AGAINST THE PARTICULAR UNITS SOLD TO USER UNDER THESE TERMS AND CONDITIONS SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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