EVM User's Guide: LMX1214EVM

LMX1214 Evaluation Module

Description

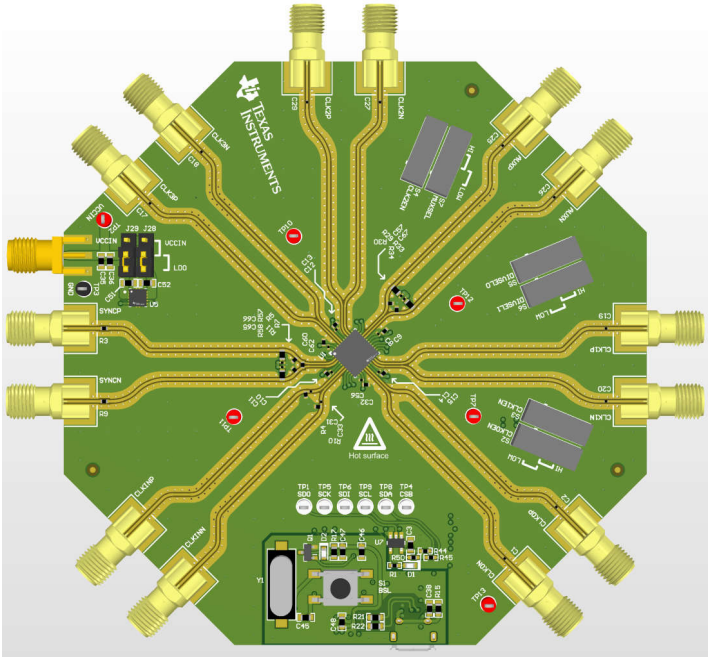
The LMX1214 evaluation module (EVM) is designed to evaluate the performance of the LMX1214 which is a four-output, ultra-low additive jitter radio-frequency (RF) buffer & divider. The device can buffer RF frequencies up to 16GHz and divide outputs by up to 6.4GHz. This board consists of an LMX1214 device and an integrated USB2ANY programmer.

Features

- 300MHz to 16GHz output frequency
- 4 high-frequency clocks
  - Shared divide by 2, 3, 4, 5, 6, 7 and 8
- 2.5V operating voltage
- –40ºC to +85ºC operating temperature
- Optional pin mode control without register programming

Applications

- General purpose:
  - Data converter clocking
  - Clock distribution/multiplication/division
- Aerospace and defense:
  - Radar
  - Electronic warfare
  - Seeker front end
  - Phased array antenna/beam forming



1 Evaluation Module Overview

1.1 Introduction

The LMX1214 EVM is an ultra-low additive-jitter RF buffer and divider. The device can buffer RF frequencies up to 16GHz and divide outputs by up to 6.4GHz. A separate auxiliary clock divider can be used for FPGAs or other logic ICs. The device runs from a single 2.5V supply, and is programmed by a digital SPI from a 1.8V, 2.5V, or 3.3V bus controller.

The EVM can be operated with a 3.3V supply voltage when the onboard LDO is utilized. The LDO can be bypassed, in this case the supply voltage is 2.5V. The EVM contains LMX1214, one LDO, a microcontroller and an IO expander.

1.2 Kit Contents

Included within each evaluation kit is:

- One LMX1214EVM board (DC302) with integrated USB2ANY controller
- One micro USB cable

1.3 Specification

Table 1-1. LMX1214 EVM Specification

Parameter	Value	Conditions
Supply voltage (VCCIN SMA)	3.1V to 3.5V	On-board voltage regulator outputs are 2.5V
Supply current	700mA max	Various configurations
Input clock frequency	300MHz to 16GHz	Buffer mode
	300MHz to 12.8GHz	Divider mode

1.4 Device Information

The high-frequency capability and extremely low jitter of this device makes a great design to clock precision, high-frequency data converters without degradation to the signal-to-noise ratio. LMX1214 contains four high-frequency clock outputs and an additional AUXCLK output with a larger divider range than all clock outputs. Having the jitter of the clock be less than the aperture jitter of the data converter is critical. In applications where more than four data converters must be clocked, a variety of cascading architectures can be developed using multiple devices to distribute all the high-frequency clocks required. With low jitter and noise floor, this device combined with an ultra-low noise reference clock source is an exemplary design for clocking data converters, especially when sampling above 3GHz.

2 Hardware

2.1 Evaluation Setup Requirement

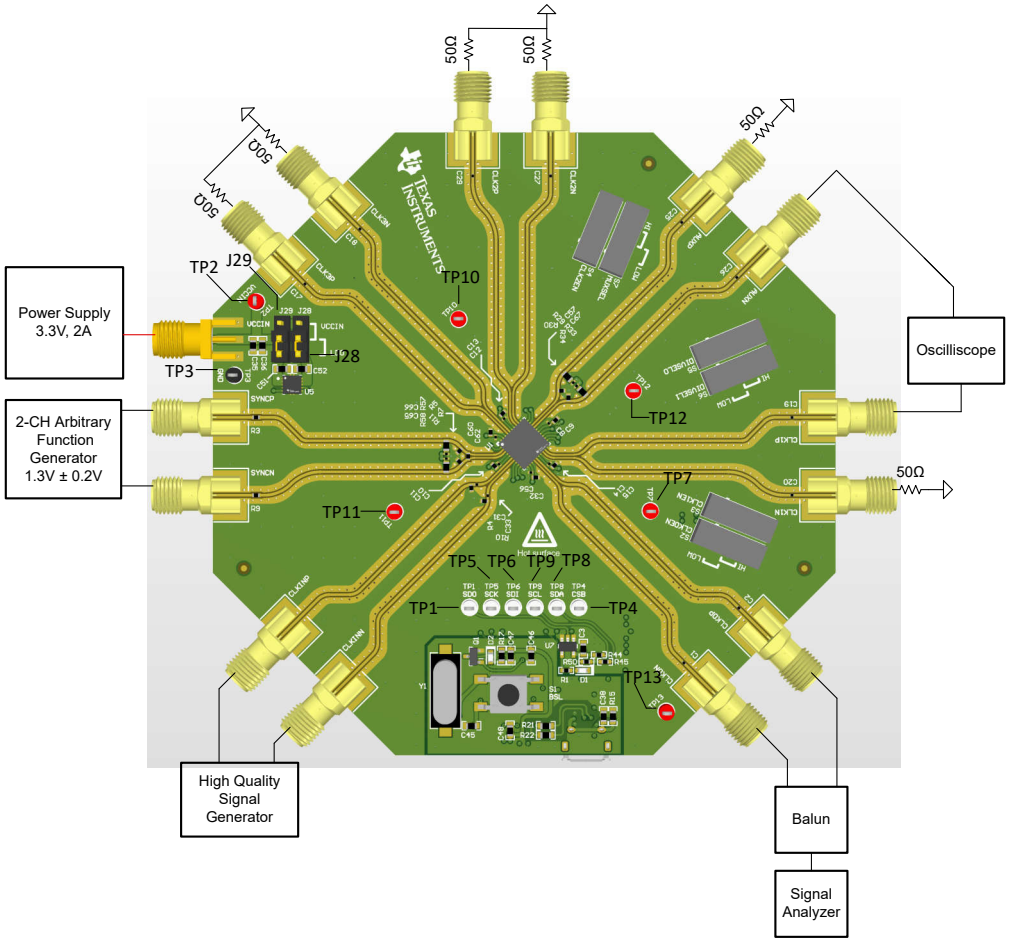
At a minimum, evaluation of the buffer mode requires:

- A DC power supply capable of 3.3V, 2A
- A high-quality signal source such as an SMA100B
- A spectrum analyzer or signal analyzer
- A PC with a USB port running Windows 7 or a more recent version of Windows
- Texas Instruments Clocks and Synthesizers TICS Pro software

Full evaluation requires the following additional hardware:

- A high-speed 4-CH oscilloscope
- A 2-CH arbitrary function generator or other pulse source capable of outputting complementary LVDS pulses and DC levels (1.25V ± 0.2V, differential, into a 100Ω DC load)
- A phase noise analysis system capable of measuring at up to 16GHz

2.2 Connection Diagram



The on board TCA9555 IO expander allows the user to change pin states without manually needing to flip the position of the switches. This allows users to toggle pin modes via the GUI as well.

Table 2-1. SPI Test Points

Test Point	Net
TP1	SDO
TP5	SCK
TP6	SDI
TP9	SCL
TP8	SDA
TP4	CSB

Table 2-2. I2C Test Points for IO Expander

Test Point	Net
TP8	SDA
TP9	SCL

Table 2-3. Supply Voltage Test Points

Test Point	Net
TP2	VCCIN
TP3	GND
TP7	VCC01
TP10	VCC23
TP11	VCLK
TP12	VAUX
TP13	VPINM

Table 2-4. VCC Power Jumpers

Header	Net	Short Position	Configuration
J28	Use LDO or VCCIN bypassing LDO	1-2	Bypass LDO and use VCCIN directly
		2-3 (EVM Default)	Use on-board LDO
J29	VCC_BYP or VCC_LDO	1-2	Bypass LDO
		2-3 (EVM default)	Use on-board LDO

Table 2-5. Switches

Switch	Net	Switch Position	Configuration	Result
S2	CLK0_EN	High	Pulled High to VPINM via 10kOhm pull up	CLK0 Enabled - can be disabled via SPI
		Low	Shorted to GND via 10kOhm pull down	CLK0 Disabled & cannot be enabled via SPI
S3	CLK1_EN	High	Pulled High to VPINM via 10kOhm pull up	CLK1 Enabled - can be disabled via SPI
		Low	Shorted to GND via 10kOhm pull down	CLK1 Disabled & cannot be enabled via SPI
S4	CLK23_EN	High	Pulled High to VPINM via 10kOhm pull up	CLK2 & CLK3 Enabled - can be disabled via SPI
		Low	Shorted to GND via 10kOhm pull down	CLK2 & CLK3 Disabled & cannot be enabled via SPI
S5	DIVSEL0	High	Pulled High to VPINM via 10kOhm pull up	Set to 1
		Low	Shorted to GND via 10kOhm pull down	Set to 0
S6	DIVSEL1	High	Pulled High to VPINM via 10kOhm pull up	Set to 1
		Low	Shorted to GND via 10kOhm pull down	Set to 0
S7	MUXSEL	High	Pulled High to VPINM via 10kOhm pull up	Sets device to divider mode
		Low	Shorted to GND via 10kOhm pull down	Sets device to buffer mode

Table 2-6. Pin Mode Strapping

Mode	Switch Position	DIVSELx Position	Divider Value
Buffer Mode	MUXSEL[1] = Low MUXSEL[0] = Low	N/A	N/A
Divider Mode	MUXSEL[1] = High MUXSEL[0] = Low	DIVSEL[1] = Low DIVSEL[0] = Low	SPI control
		DIVSEL[1] = Low DIVSEL[0] = High	Div by 2
		DIVSEL[1] = High DIVSEL[0] = Low	Div by 3
		DIVSEL[1] = High DIVSEL[0] = High	Div by 4

Note

Only divider values of 2/3/4 are available in pin mode. Divider values of 5 , 6 , 7 & 8 are valid divider values only when in SPI mode.

2.3 Power Requirements

Apply 3.3V to VCCIN SMA connector. The acceptable supply voltage range is 3.1V to 3.5V. The board can draw up to 700mA during operation, so the resistance of the cable matters. The on-board LDOs draw about 20mA of ground current for converting 3.3V to 2.5V supply. Furthermore, enabling or disabling various system functions can reduce current consumption.

2.4 How to Enable Full SPI Control

Table 2-7. Switch Positions for Full SPI Control

Switch	Switch Position	Configuration
S2 (CLK0_EN)	High	CLK0 enabled and can be disabled via SPI
S3 (CLK1_EN)	High	CLK1 enabled and can be disabled via SPI
S4 (CLK23_EN)	High	CLK2 & CLK3 enabled and can be disabled via SPI
S5 (DIVSEL0)	Low	Divider value controlled via SPI
S6 (DIVSEL1)	Low	Divider value controlled via SPI
S7 (MUXSEL)	Low	Device mode controlled via SPI

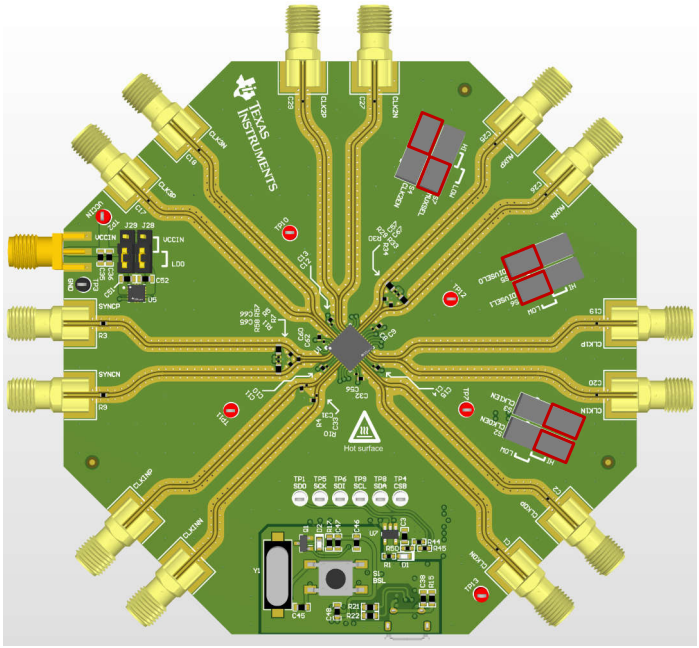


Figure 2-1. Full SPI Control

2.5 Reference Clock

Connect the CLKINP SMA connector to a high-quality signal source such as an SMA100B signal generator. Both CLKIN inputs are terminated internally with 50Ω to AC-GND (that is, GND connection is formed by an internal capacitor), thus no external termination is required or recommended. The input can be driven differentially; for example, connect both CLKINP and CLKINN SMA connectors to a balun or a differential clock source.

The default EVM profile configures the device in buffer mode. The input frequency can be modified per the operating range of mode of operation desired. This EVM setup guide and related plots assume a 3200MHz input at CLKIN.

The EVM connections for the SYNC input are DC-coupled and provide internal 100Ω termination with several biasing options.

To evaluate SYNC mode it's critical to have a SYNC input source capable of consistently meeting the setup and hold requirements for a single cycle of the input clock. This can become very challenging at higher frequencies where setup and hold requirements can be < 50ps. Another device capable of picosecond precise timed pulses, such as LMX2820 or LMX2594, can be used as a reference input to both CLKIN and SYNC for evaluating these features.

2.6 Output Connections

All CLKOUT connections are AC-coupled and can be connected directly to RF instruments with 0VDC requirements; an additional DC block is not required. If using CLKOUT single ended, then the unused CLKOUT SMA connector must be terminated with a 50Ω load. A differential connection for CLKOUT can be used if a balun with a proper frequency range is available.

Recommended oscilloscope connections include one CLKOUT and AUXOUT.

Other unused CLKOUT SMA connectors needs to be terminated with 50Ω single-ended or 100Ω differential load, or alternately needs to be disabled in software, to minimize unterminated output effects on performance.

2.7 Switch Information

The LMX1214 EVM can be operated in either pin mode or SPI mode. Pin mode allows basic configuration of the LMX1214 device without the need of a microcontroller. SPI mode provides full access to the LMX1214 device. Mode of operation is set via on-board switches SW2 to SW7. Headers are used to select power supply source.

2.8 Default Configuration

The LMX1214 EVM default mode configures the device in buffer mode. AUXCLK is also disabled in this mode with a fixed divider value of 128.

2.9 Divider Mode Example

To set LMX1214 to divider mode via SPI do the following:

Set CLK_MUX (R25[2:0] = Divider (0x2).

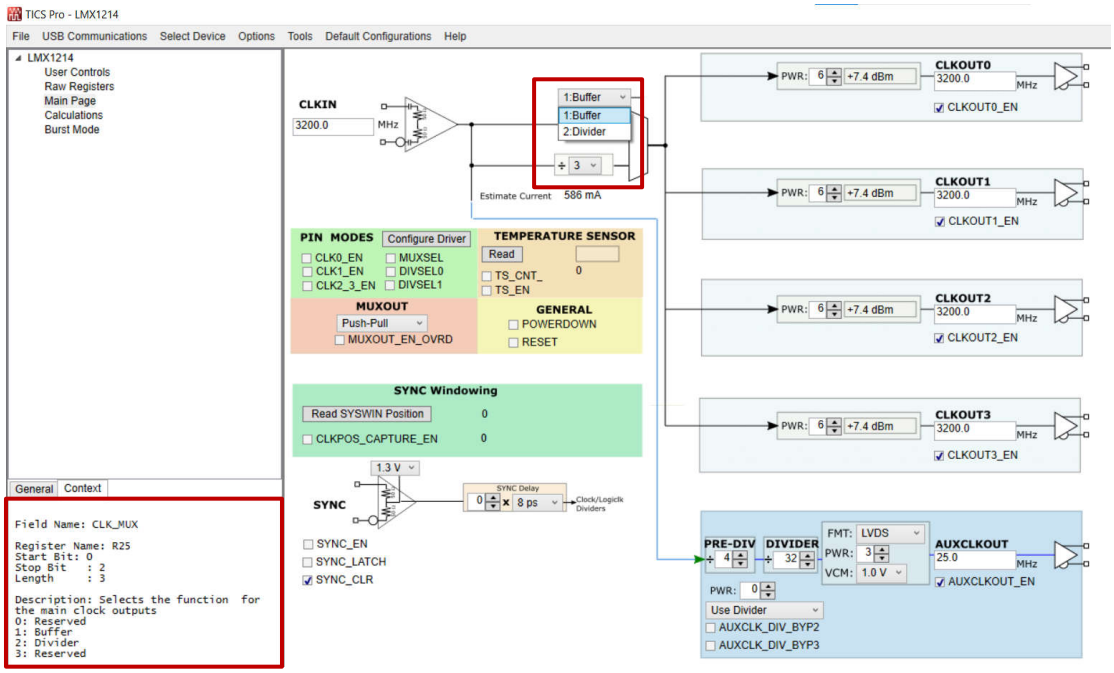


Figure 2-2. Setting Mode

Set CLK_DIV (R25[5:3]) to appropriate divider value for respective CLKIN frequency.

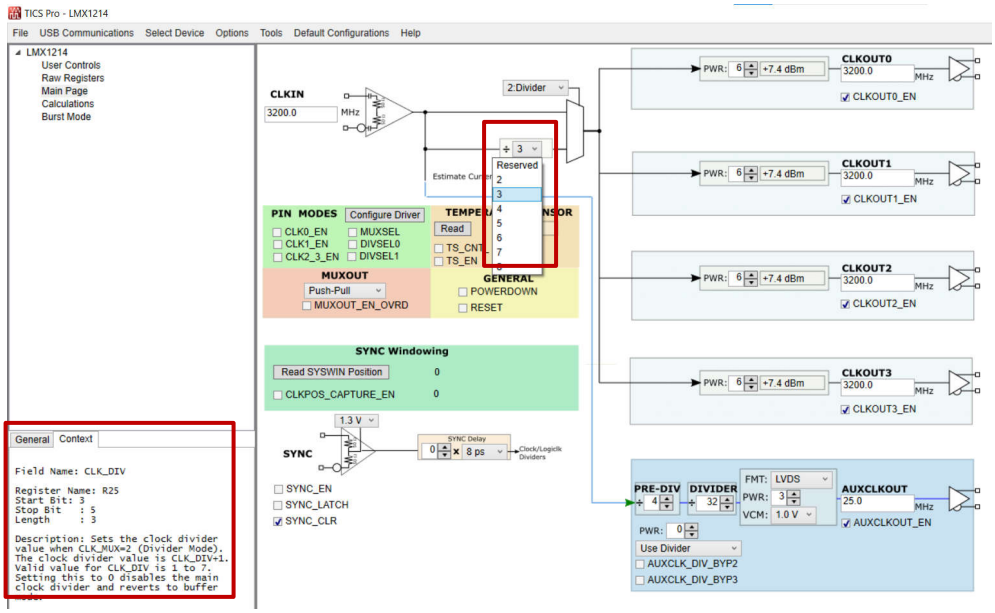


Figure 2-3. Divider Value

The CLKIN frequency divided by respective divider value at CLKOUTx is now available for viewing.

2.10 Hybrid Mode: SPI and Pin Mode

The user must first set ALL switches to *Low*.

The user must next configure the IO expander. This is done by pressing the *Configure Driver* button in the GUI under the light green PIN MODES section.

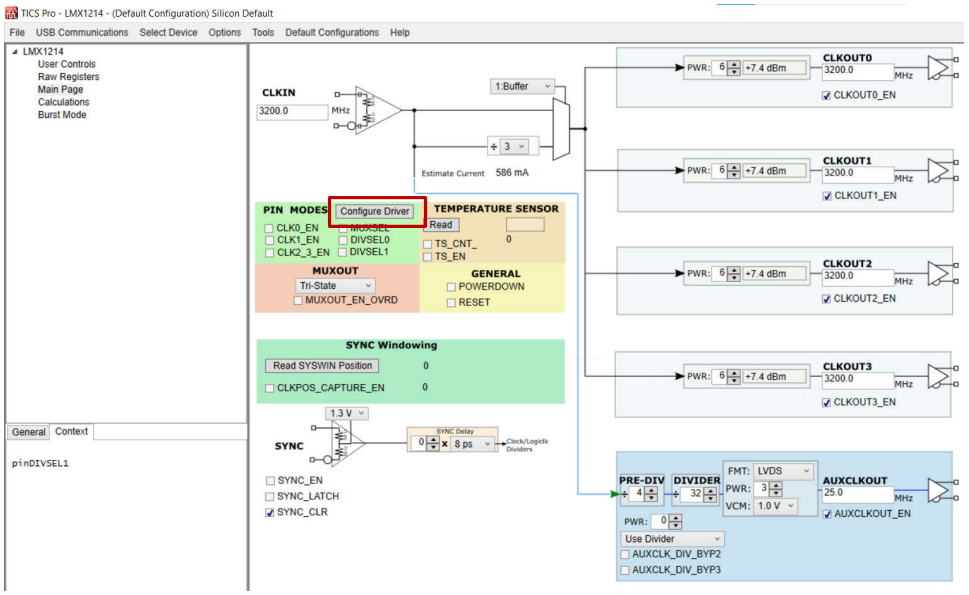


Figure 2-4. How to Configure IO Expander

Successful configuration of the IO expander returns a confirmation message.

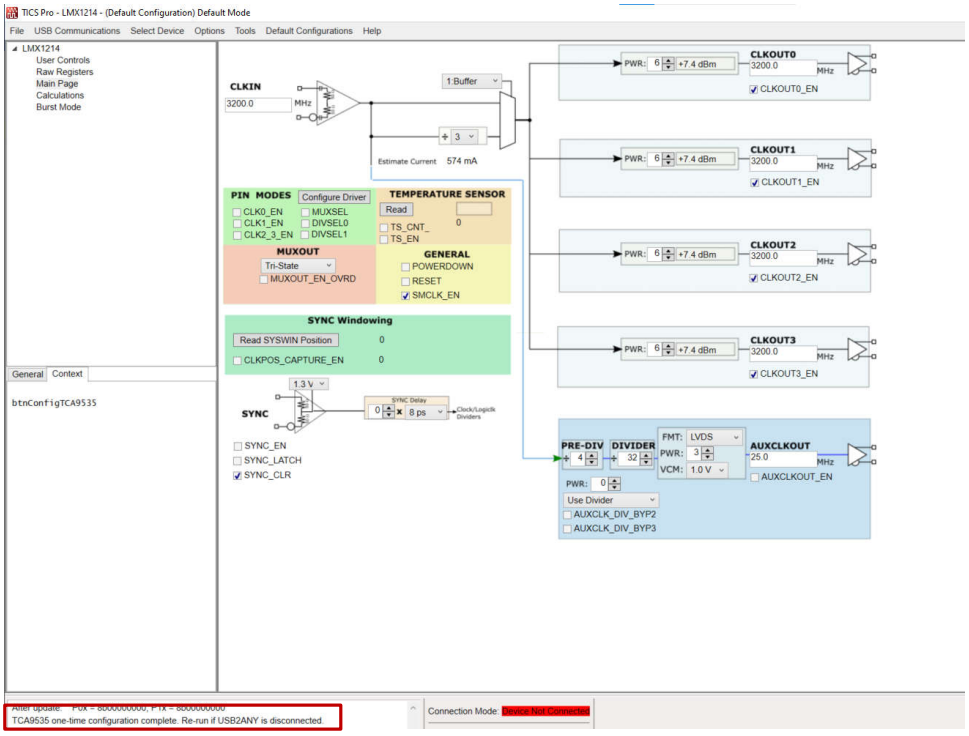


Figure 2-5. Successful IO Expander Confirmation Message

The user is now able to change the states of the pin mode headers via the IO expander by pulling pins either LOW or HIGH directly without physically needing to move the switches.

3 Software

3.1 Software Installation

Download and install TICS Pro software from www.ti.com/tool/ticspro-sw.

3.2 Software Description

Texas Instruments Clocks and Synthesizers (TICS) Pro software is used to program this evaluation module (EVM) through the on-board USB2ANY interface.

3.3 USB2ANY Interface

The on-board USB2ANY interface provides a bridge between TICS Pro software and the LMX1214 device. When the on-board USB2ANY controller is first connected to a PC, or if the firmware revision for the controller does not match with the version used by TICS Pro, a firmware update to the controller is required.

1. Connect the USB cable from the PC to the EVM. The USB interface provides the necessary power to enable the on-board USB2ANY controller.
2. After Windows has set up a USB device, run TICS Pro in the PC.
3. A pop-up window can appear as shown below..

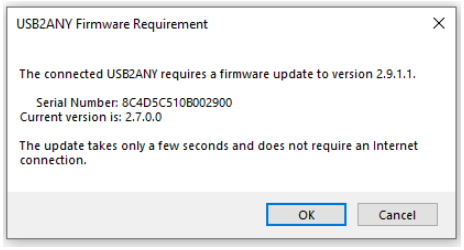


Figure 3-1. Firmware Update

4. Click *OK*, and the next window appears as shown below. Click *Update Firmware*.

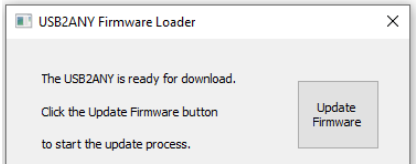


Figure 3-2. Firmware Loader

5. Then, the next window appears as shown below.

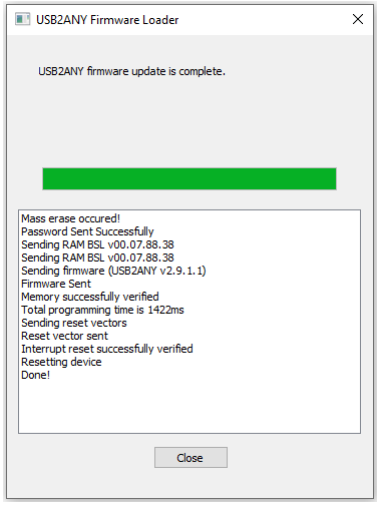


Figure 3-3. Firmware Update Complete

6. Click the *Close* button to close the window.

7. A TICS Pro default device pops up. Check to make sure that a green light is on the Connection Mode at the bottom of the GUI.

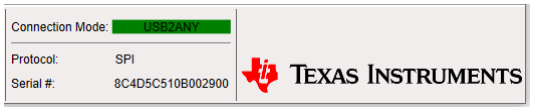


Figure 3-4. Connection Mode

8. Go to the menu bar, click *USB Communications*, then select *Interface*.

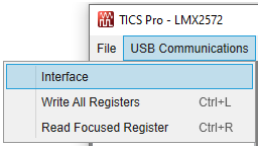


Figure 3-5. USB Communications

9. Click the *Identify* button and the LED in the USB2ANY interface starts to flash.

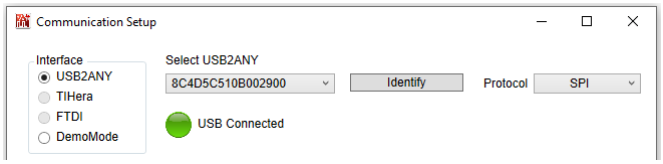


Figure 3-6. Identify USB2ANY Controller

10. Now the USB2ANY is ready to use. Click the *Close* button to close the window.

4 Implementation Results

4.1 Evaluation Setup

4.1.1 Buffer and Divider Mode

From the top-menu, click *Default Configuration*. This automatically loads the buffer mode profile.

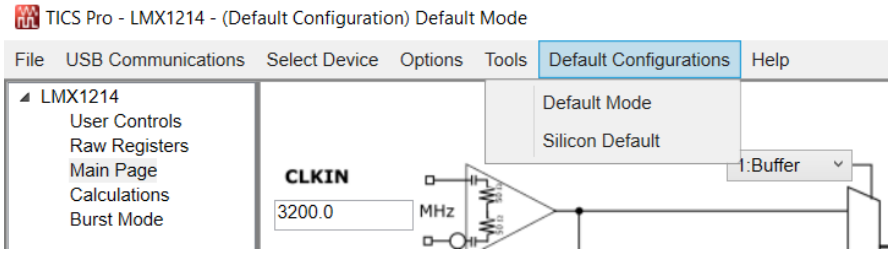


Figure 4-1. Loading the Default Configuration

If termination is not applied on all output pins, then manually disable the unused outputs using the CLKOUTx_EN/AUXCLKOUT_EN fields. Powering down unused channels greatly reduces current consumption and for the logic clocks in particular can reduce spurious interference.

After the profile is loaded and any changes required have been made, the signal analyzer has an 3200MHz signal at around +6-dBm single-ended, or +9-dBm differential.

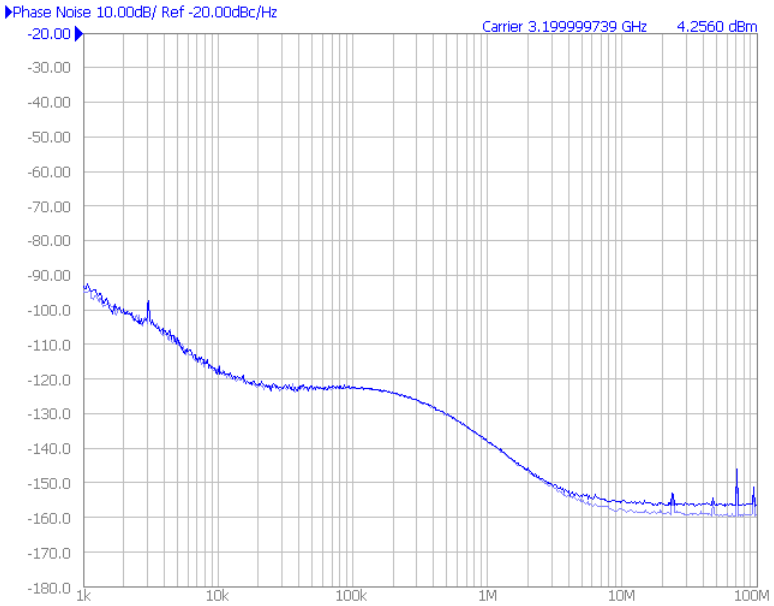


Figure 4-2. 3200MHz Buffer Mode Signal Analyzer Plot

To activate divider mode, change the CLK_MUX field to specify divider and change the CLK_DIV field to specify the frequency scaling factor. To make sure the device enters each mode cleanly, the desired configuration must be prepared in the GUI. Then, from the *User Controls* page, reset the device by toggling the RESET field. Finally, the registers must be reloaded using the USB Communications → Write All Registers menu option, or by pressing the accelerator keys, CTRL + L.

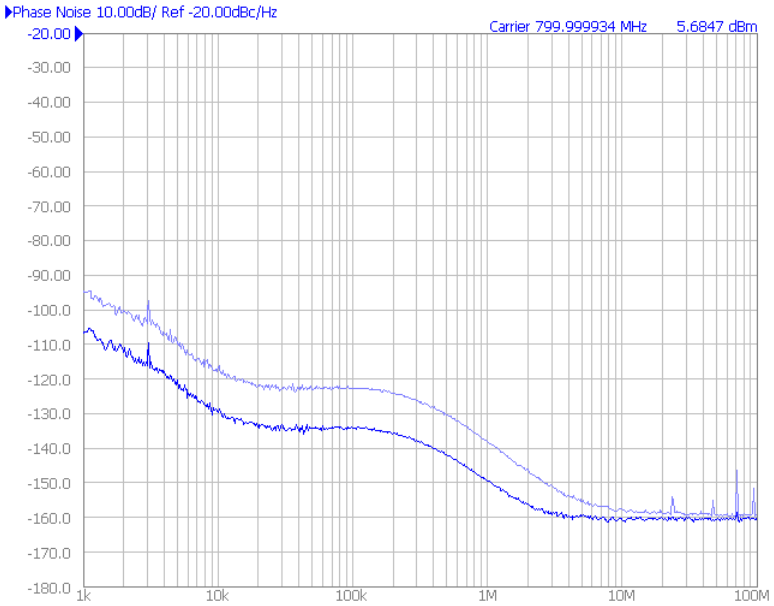


Figure 4-3. 3200MHz Divide by 2 Mode Signal Analyzer Plot

5 Hardware Design Files

5.1 Schematic

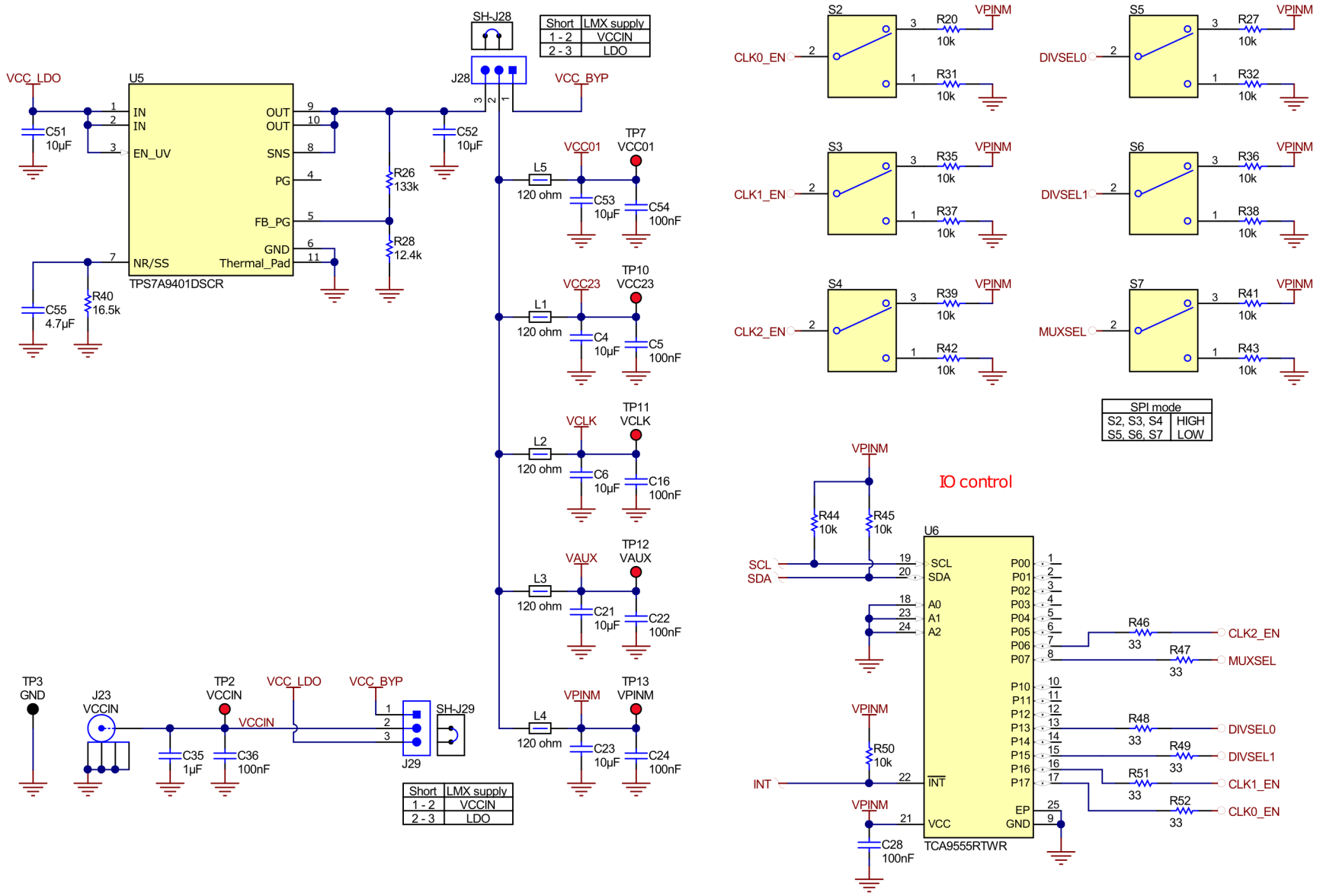


Figure 5-1. Power Supply, IO Control, Switches

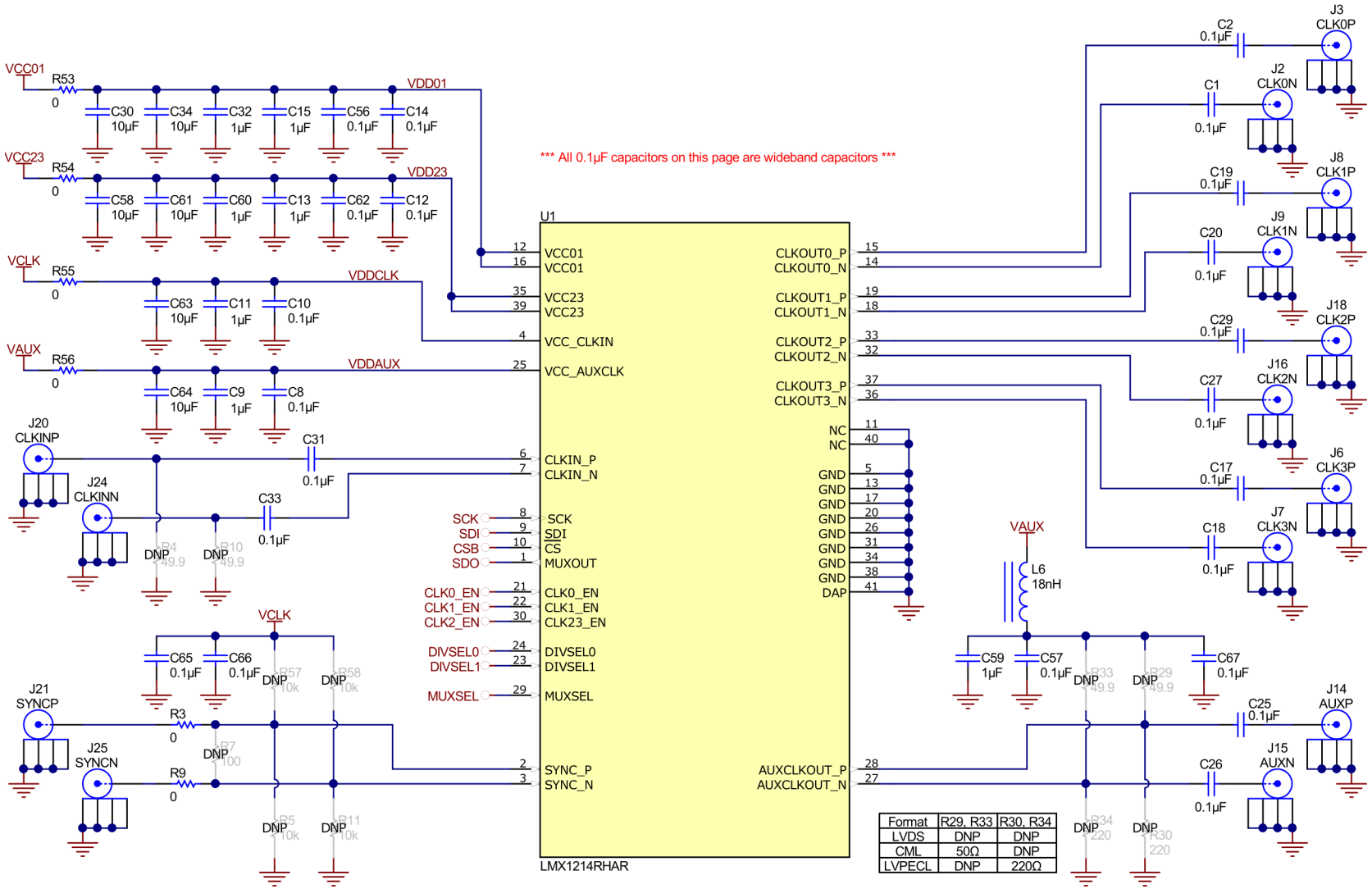


Figure 5-2. LMX1214

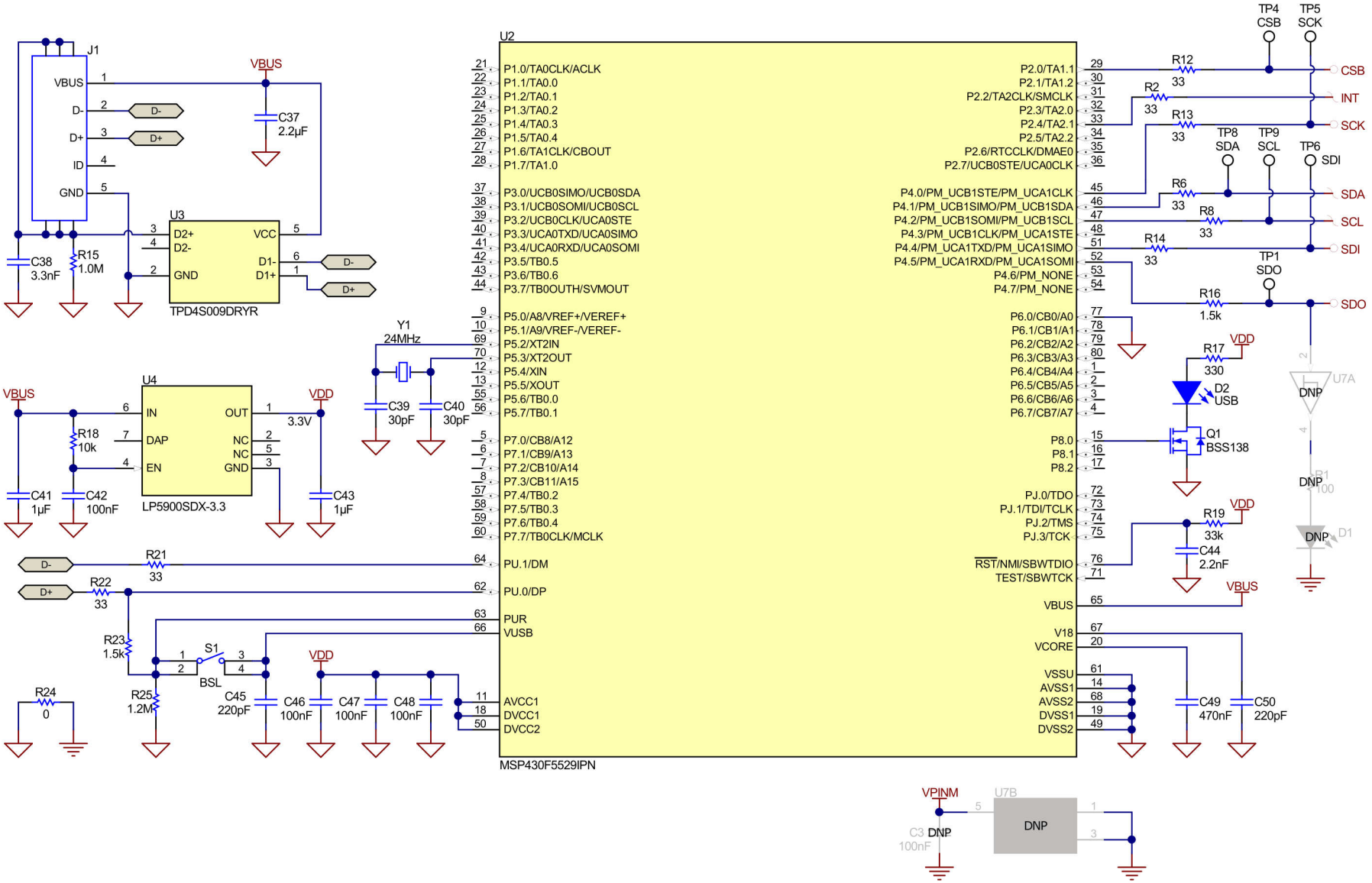


Figure 5-3. USB2ANY Interface

5.2 PCB Layout

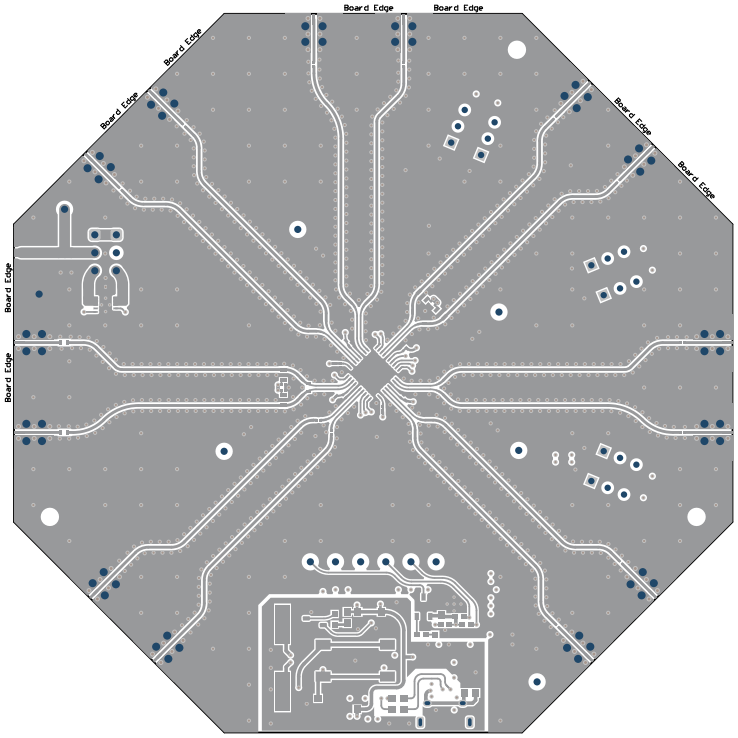


Figure 5-4. Top Layer

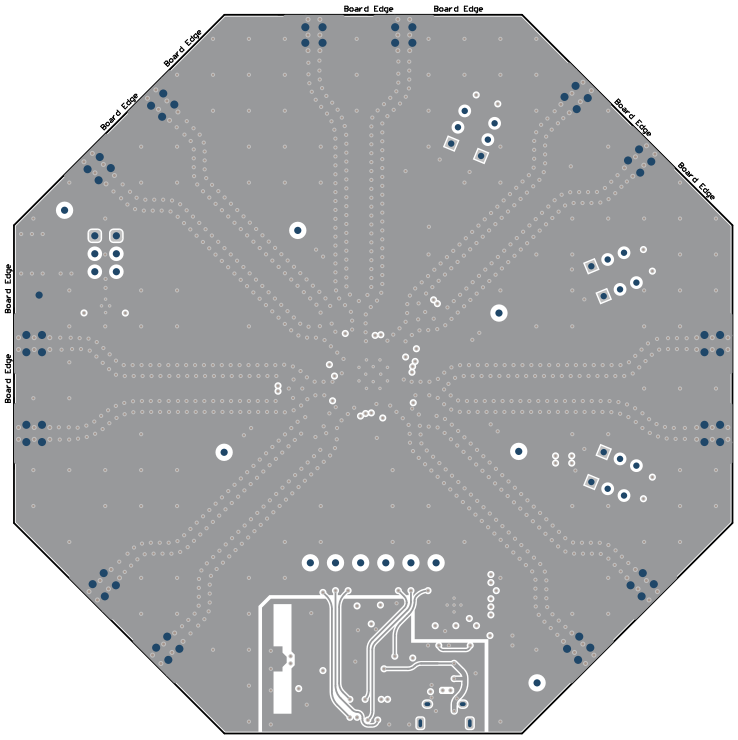


Figure 5-5. Layer 2 (RF GND)

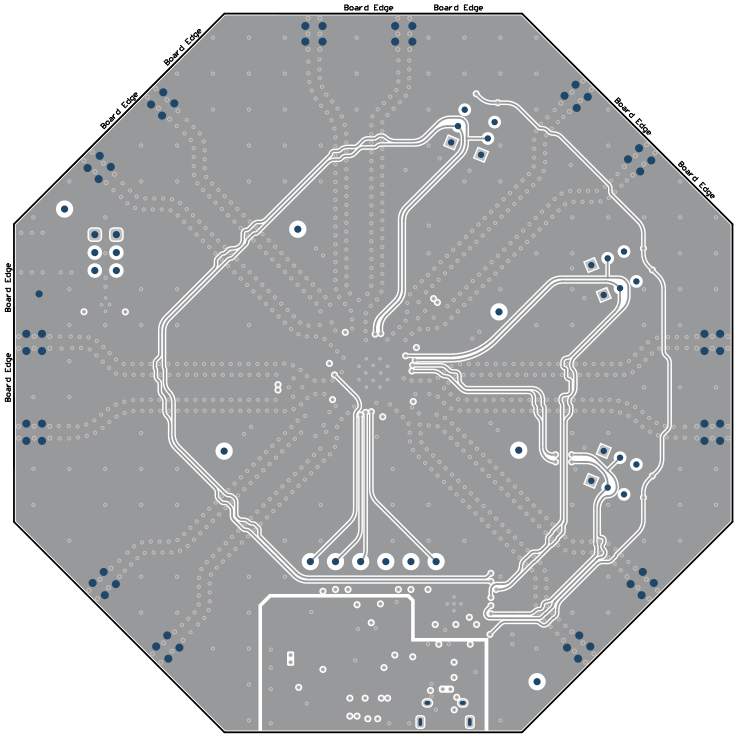


Figure 5-6. Layer 3 (Signal)

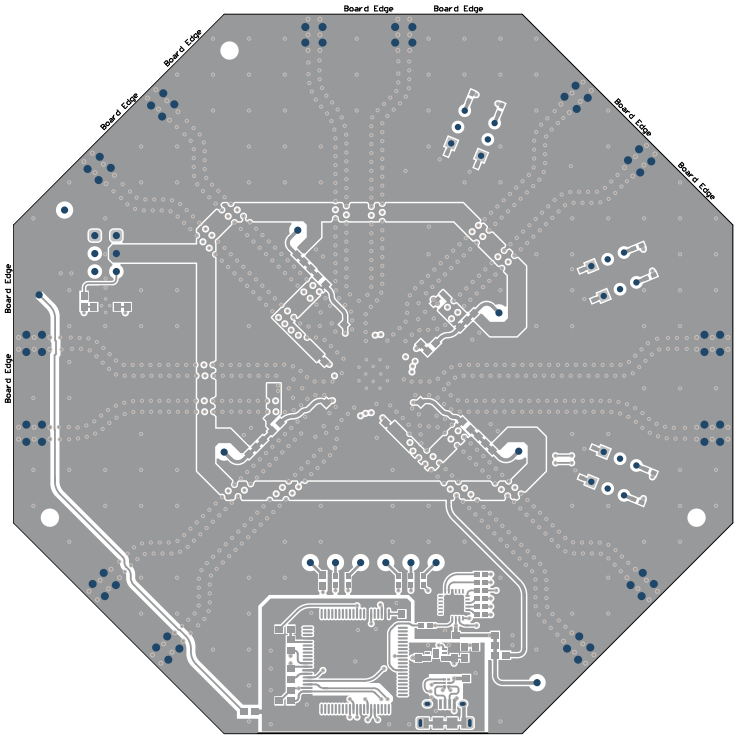


Figure 5-7. Bottom Layer

5.2.1 PCB Layer Stack-Up

The top layer is 2oz. copper.

#	Name	Material	Type	Weight	Thickness	Dk
	Top Overlay		Overlay			
	Top Solder	Solder Resist	Solder Mask		0.4mil	3.5
1	Top Layer		Signal	2oz	2.8mil	
	Dielectric 1	RO4350B	Prepreg		8mil	3.48
2	RF GND		Signal	1oz	1.4mil	
	Dielectric 2	FR-4 High Tg	Core		37.2mil	4.2
3	Signal Layer		Signal	1oz	1.4mil	
	Dielectric 3	FR-4 High Tg	Prepreg		8mil	4.2
4	Bottom Layer		Signal	2oz	2.8mil	
	Bottom Solder	Solder Resist	Solder Mask		0.4mil	3.5

Figure 5-8. PCB Layer Stack-Up

5.3 Bill of Materials

Table 5-1. Bill of Materials

Designator	Quantity	Description	Package Reference	Part Number	Manufacturer
C1, C2, C8, C10, C12, C14, C17, C18, C19, C20, C25, C26, C27, C29, C31, C33, C56, C57, C62, C65, C66, C67	22	CAP, CERM, 0.1µF, 10V,+/- 10%, X5R, 0201	0201	530Z104KT10T	American Technical Ceramics
C4, C6, C21, C23, C30, C34, C51, C52, C53, C58, C61, C63, C64	13	CAP, CERM, 10µF, 10V,+/- 10%, X5R, 0603	0603	GRM188R61A106KAALD	MuRata
C5, C16, C22, C24, C28, C36, C42, C46, C47, C48, C54	11	CAP, CERM, 0.1uF, 16V, +/- 10%, X7R, 0603	0603	885012206046	Wurth Elektronik
C9, C11, C13, C15, C32, C59, C60	7	CAP, CERM, 1µF, 25V, +/- 10%, X5R, 0402	0402	GRM155R61E105KA12D	MuRata
C35, C41, C43	3	CAP, CERM, 1uF, 16V, +/- 10%, X7R, 0603	0603	885012206052	Wurth Elektronik
C37	1	CAP, CERM, 2.2uF, 16V, +/- 20%, X5R, 0603	0603	885012106018	Wurth Elektronik
C38	1	CAP, CERM, 3300pF, 50V,+/- 10%, X7R, 0603	0603	885012206086	Wurth Elektronik
C39, C40	2	CAP, CERM, 30pF, 50V, +/- 5%, C0G/NP0, 0603	0603	06035A300JAT2A	AVX
C44	1	CAP, CERM, 2200pF, 16V, +/- 10%, X7R, 0603	0603	885012206036	Wurth Elektronik
C45, C50	2	CAP, CERM, 220pF, 50V, +/- 5%, C0G/NP0, 0603	0603	C0603C221J5GACTU	Kemet
C49	1	CAP, CERM, 0.47uF, 16V, +/- 10%, X7R, 0603	0603	GRM188R71C474KA88D	MuRata
C55	1	CAP, CERM, 4.7uF, 16V,+/- 10%, X7R, 0603	0603	GRM188Z71C475KE21D	MuRata
D2	1	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
H1, H2, H3, H4	4	BUMPER CYLIN 0.312" DIA	0.312" DIA	SJ61A6	3M
J1	1	Receptacle, USB 2.0, Micro-USB Type B, R/A, SMT	USB-micro B USB 2.0, 0.65mm, 5 Pos, R/A, SMT	10118194-0001LF	FCI
J2, J3, J6, J7, J8, J9, J14, J15, J16, J18, J20, J21, J24, J25	14	Connector, End launch SMA 50 ohm, TH	Connector, TH, End launch SMA	142-0761-881	Cinch Connectivity
J23	1	CONN SMA JACK STR EDGE MNT	CONN_JACK	CON-SMA-EDGE-S	RF Solutions Ltd.

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Description	Package Reference	Part Number	Manufacturer
J28, J29	2	Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
L1, L2, L3, L4, L5	5	Ferrite Bead, 120 ohm @ 100MHz, 2A, 0603	0603	742792625	Wurth Elektronik
L6	1	Inductor, Multilayer, Air Core, 18 nH, 0.3A, 0.36 ohm, SMD	0402 polarized	LQG15HS18NJ02D	MuRata
LBL1	1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady
Q1	1	MOSFET, N-CH, 50V, 0.22A, SOT-23	SOT-23	BSS138	Fairchild Semiconductor
R2, R6, R8, R12, R13, R14, R46, R47, R48, R49, R51, R52	12	RES, 33, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040233R0JNED	Vishay-Dale
R3, R9	2	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R15	1	RES, 1.0M, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06031M00JNEA	Vishay-Dale
R16, R23	2	RES, 1.5 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06031K50JNEA	Vishay-Dale
R17	1	RES, 330, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603330RJNEA	Vishay-Dale
R18	1	RES, 10 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310K0JNEA	Vishay-Dale
R19	1	RES, 33 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060333K0JNEA	Vishay-Dale
R20, R27, R31, R32, R35, R36, R37, R38, R39, R41, R42, R43, R44, R45, R50	15	RES, 10 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0JNED	Vishay-Dale
R21, R22	2	RES, 33, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060333R0JNEA	Vishay-Dale
R24, R53, R54, R55, R56	5	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
R25	1	RES, 1.2M, 5%, 0.1W, AEC-Q200 Grade 0, 0603	0603	CRCW06031M20JNEA	Vishay-Dale
R26	1	RES, 133 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603133KFKEA	Vishay-Dale
R28	1	RES, 12.4 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060312K4FKEA	Vishay-Dale
R40	1	RES, 16.5 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060316K5FKEA	Vishay-Dale
S1	1	Switch, Tactile, SPST-NO, 0.05A, 12V, SMT	SW, SPST 6x6 mm	FSM4JSMA	TE Connectivity
S2, S3, S4, S5, S6, S7	6	Switch, SPDT, Slide, On-On, 2 Pos, TH	4x11.6mm	EG1218	E-Switch
SH-J28, SH-J29	2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec

Table 5-1. Bill of Materials (continued)

Designator	Quantity	Description	Package Reference	Part Number	Manufacturer
TP1, TP4, TP5, TP6, TP8, TP9	6	Test Point, Miniature, White, TH	White Miniature Testpoint	5002	Keystone Electronics
TP2, TP7, TP10, TP11, TP12, TP13	6	Test Point, Miniature, Red, TH	Red Miniature Testpoint	5000	Keystone Electronics
TP3	1	Test Point, Miniature, Black, TH	Black Miniature Testpoint	5001	Keystone Electronics
U1	1	Low-Noise, High-Frequency Buffer and Divider	VQFN40	LMX1214RHAR	Texas Instruments
U2	1	25MHz Mixed Signal Microcontroller with 128 KB Flash, 8192 B SRAM and 63 GPIOs, -40 to 85 degC, 80-pin QFP (PN), Green (RoHS & no Sb/Br)	PN0080A	MSP430F5529IPN	Texas Instruments
U3	1	4-Channel ESD Solution for High-Speed Differential Interface, DRY0006A (USON-6)	DRY0006A	TPD4S009DRYR	Texas Instruments
U4	1	Ultra Low Noise, 150mA Linear Regulator for RF/ Analog Circuits Requires No Bypass Capacitor, 6-pin LLP, Pb-Free	NGF0006A	LP5900SDX-3.3/NOPB	Texas Instruments
U5	1	Linear Voltage Regulator IC Positive Adjustable 1 Output 1A 10-WSON (3x3)	WSON10	TPS7A9401DSCR	Texas Instruments
U6	1	Remote 16-Bit I2C and SMBus I/O Expander with Interrupt Output and Configuration Registers, 1.65 to 5.5V, -40 to 85 degC, 24-pin QFN (RTW), Green (RoHS & no Sb/Br)	RTW0024B	TCA9555RTWR	Texas Instruments
Y1	1	Crystal, 24.000MHz, 20pF, SMD	Crystal, 11.4x4.3x3.8mm	ECS-240-20-5PX-TR	ECS Inc.

6 Additional Information

6.1 Troubleshooting Guide

6.1.1 General Guidance

- Do not make modifications to the EVM or change the default settings until after verified to be working.
- Register readback requires programming MUXOUT_SEL = 1. The GUI also prompts to configure this register before attempting any readback operation.
- The POR current of the LMX12 EVM is approximately 296mA with the LDOs bypassed & 456mA with LDOs enabled.
  - **Note**
    Default mode is buffer mode with all outputs enabled.
  - CLKIN is not available.
- The power-down current of the EVM is approximately 15mA with LDOs bypassed and 33mA with LDOs enabled.

6.1.2 If Output Is Not Seen on CLKOUT

CLKOUT must oscillate after POR when CLKIN is powered and enabled given EVM default is buffer mode with all outputs enabled. No EVM programming is required to get output from CLKOUT.

- Confirm the EVM is connected to 3.3V, and draws approximately 480mA before CLKIN is applied.
- Confirm the reference input is connected to CLKIN and the reference source is powered and enabled.
- Confirm reference frequency is at least 300MHz, and input power is at least 0dBm.
- Confirm enabling CLKIN increases the EVM current to approximately 630mA.

6.1.3 If Device Features Are Not Active

- Confirm the USB cable is connected to the EVM.
- Confirm the connection mode is SPI and the USB2ANY interface is indicated in green on the bottom bar in TICSpro.
- If multiple USB2ANY boards are connected, then confirm the correct USB2ANY is connected from USB Communications → Interface pop-up using the *Identify* button.
- Make sure all registers have been loaded (Ctrl+L), and that the device current has changed proportional to the number of functional blocks enabled in the device.
- If a communication issue with the device is suspected, then try toggling the POWERDOWN bit from the *User Controls* page and observe the EVM current. Note that the first write to R0 after POR is ignored. If the EVM current does not drop to about 33mA after POWERDOWN is set, then a communication issue can be preventing programming, or the IC can be damaged.

6.1.4 If Divider Frequency Is Not Accurate

The main clock output divider is designed with the expectation that the register settings is loaded only once after POR. In some cases, the main clock output divider does not always cleanly transition between divide values if the value is changed after POR. To change the divider value, toggle the RESET bit on the *User Controls* page and load all registers again (Ctrl+L).

- This more challenging to debug in pin mode given there is no GUI to indicate whether the clock input frequency is valid. Refer to the data sheet (SNAS866) to make sure the proper input frequency is being used.

6.2 Trademarks

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WARNING

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NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: 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 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. 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。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

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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3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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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.

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