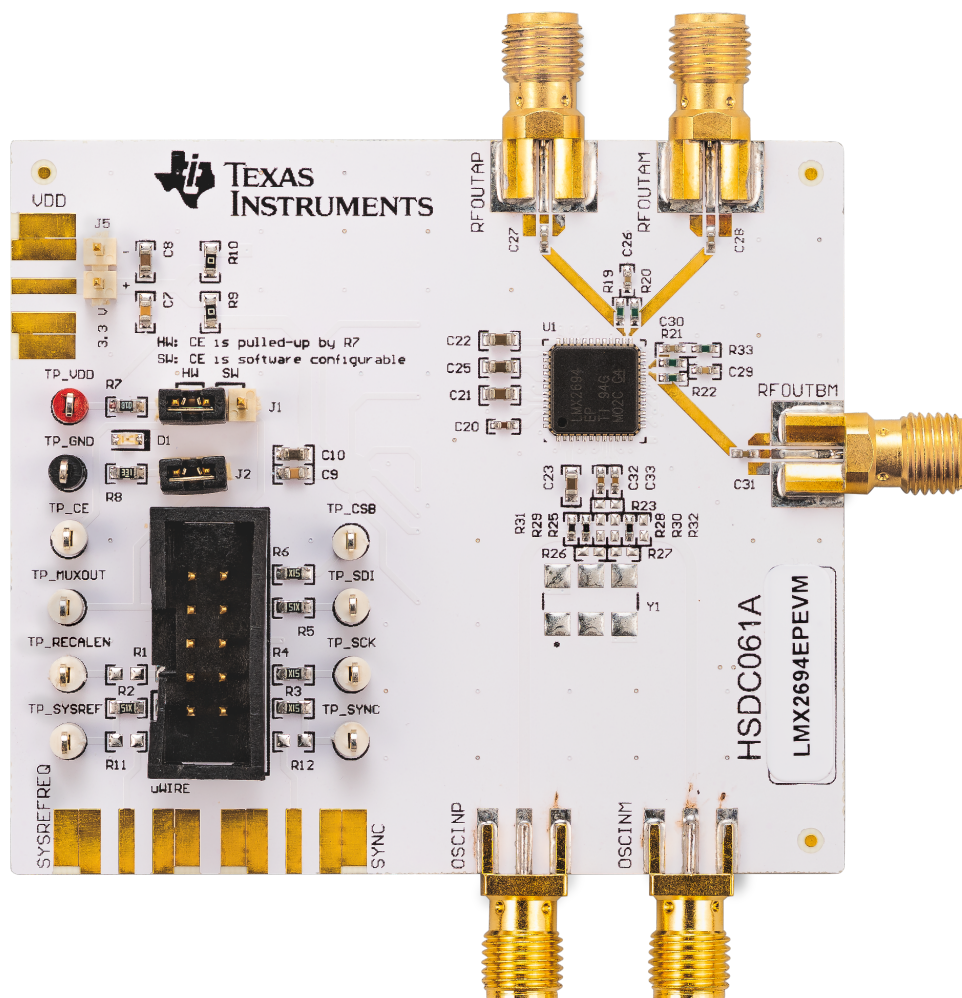![Texas Instruments logo]

LMX2694EPEVM Evaluation Instructions

The LMX2694EPEVM is designed to evaluate the performance of LMX2694-EP. This board consists of a LMX2694-EP device.

The LMX2694-EP is a high-performance, wideband synthesizer that can generate any frequency from 39.3 MHz to 15.1 GHz without using an internal VCO doubler. The device runs from a single 3.3-V supply and has integrated LDOs that eliminate the need for on-board low noise LDOs.

Contents

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Trademarks

All trademarks are the property of their respective owners.

1   LMX2694EPEVM Evaluation Module

1.1   Evaluation Module Contents

The box contains:
*   One LMX2694EPEVM board (HSDC061-001)
*   One USB2ANY (HPA665)
*   One USB cable
*   One 10-pin ribbon cable

1.2   Evaluation Setup Requirement

The evaluation requires the following hardware and software:
*   A DC power supply
*   A spectrum analyzer or a signal analyzer
*   A PC running Windows 7 or more recent version
*   A high quality signal generator
*   An oscilloscope (optional)
*   Texas Instruments Clocks and Synthesizers TICS Pro software
*   Texas Instruments PLLatinum Simulator Tool (optional)

1.3   Resources

Related evaluation and development resources are as follows:
*   *LMX2694-EP data sheet*
*   *TICS Pro software*
*   *PLLatinum Simulator Tool* (PLL Sim)

2   Setup

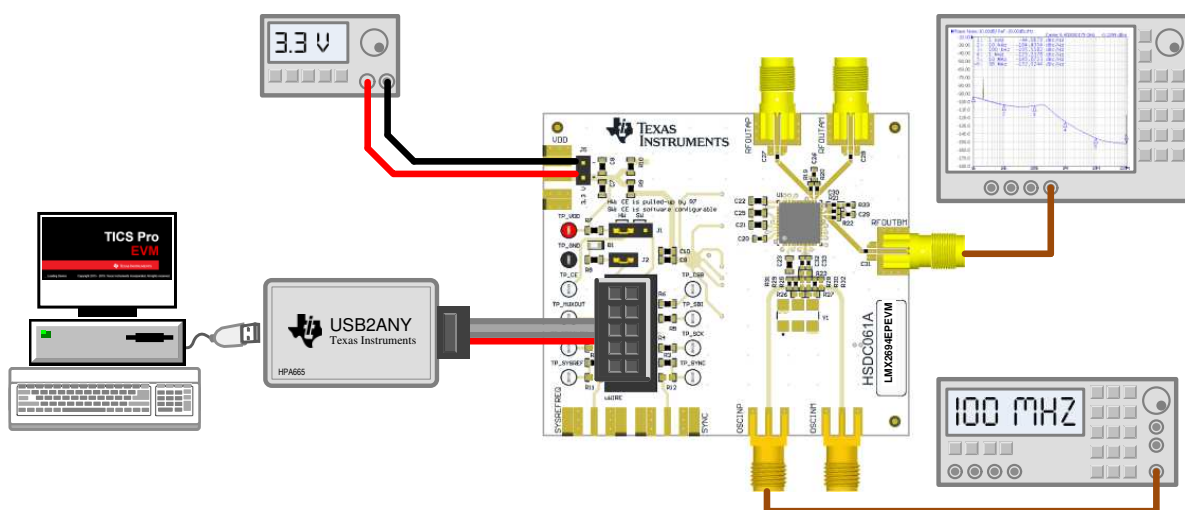## 2.1   Connection Diagram

Figure 1. EVM Connection Diagram

2.2 Power Supply

Apply a 3.3 V to J5 header. The acceptable supply voltage range is 3.2 V to 3.5 V. The maximum current consumption in the most extreme configuration must not exceed 600 mA.

2.3 Reference Clock

Connect the OSCINP SMA connector to a high quality 100 MHz signal source. The OSCINM SMA connector can be left open because it is not connected to LMX2694-EP.

The EVM is configured for single-ended input. The OSCIN_P pin connected to the OSCINP SMA connector and the OSCIN_M pin 50-Ω terminated onboard. If required, the EVM can be modified to operate with a different clock source in a different configuration. See *Appendix A* for more details.

2.4 RF Output

Connect the RFOUTBM SMA connector to a signal analyzer. Output frequency is 14 GHz and the amplitude is about 1 dBm.

By default, the TICS Pro evaluation software has RFOUTA power down. These SMA connectors can be left open.

2.5 Programming

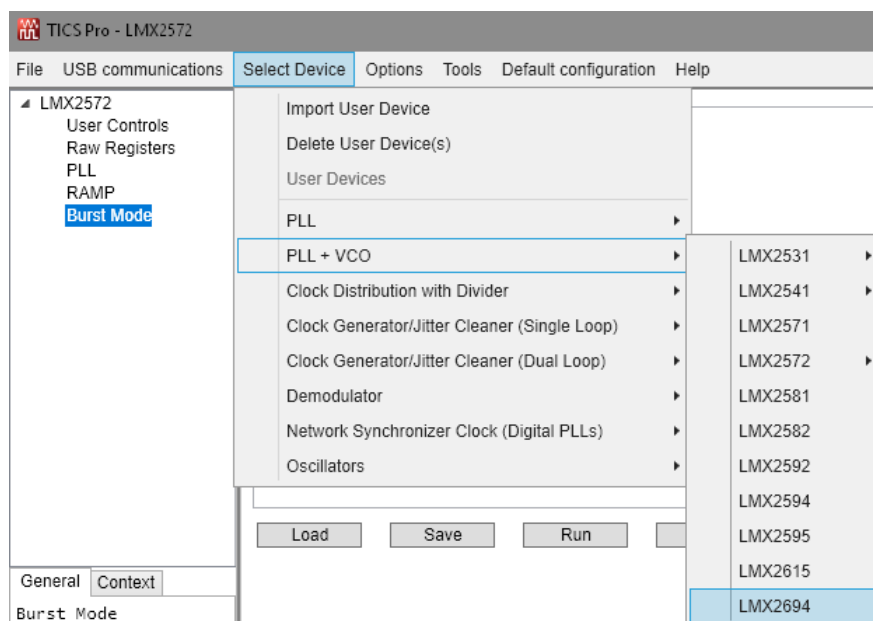Connect the ribbon cable from the USB2ANY to the LMX2694EPEVM .

Connect the USB cable from a PC to USB port in the USB2ANY. This provides power supply to the USB2ANY and communication with the TICS Pro. A firmware update may be required. See *Appendix B* for more details.

2.6 Evaluation Software

Download and install TICS Pro to a PC.

Run the software and follow these steps to start the program.
1. Go to "Select Device" → "PLL + VCO" → "LMX2694".

Figure 2. Select Device in TICS Pro

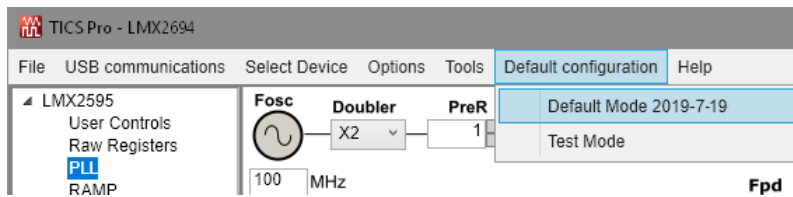2. Go to "Default Configuration" → "Default Mode YYYY-MM-DD".

Figure 3. Default Mode

2.7 EVM Strap Options

2.7.1 J1 Header

Pin 2 of J1 is connected to the CE pin. Put a short to the "HW" position, this will connect the CE pin to VDD via resistor R7. If the short is placed in the "SW" position, the status of CE pin is configurable through TICS Pro.

2.7.2 J2 Header

Pin 1 of J2 is connected to the MUXOUT pin. Put a short in J2, this will connect the MUXOUT pin to the LED D1. If MUXOUT is configured as lock detect output, the LED will lite when the PLL is locked. During register read back, if the LED slows down the edge of the read back data, remove the short.
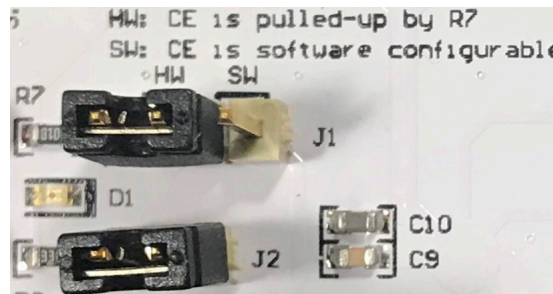

Figure 4. J1, J2 Header

3 Typical Measurement

3.1 Default Configuration

3.1.1 Loop Filter

The loop filter is populated on the bottom side of the board. The parameters for the loop filter are listed in Table 1.
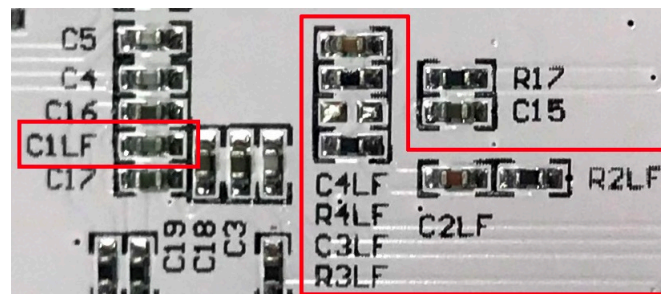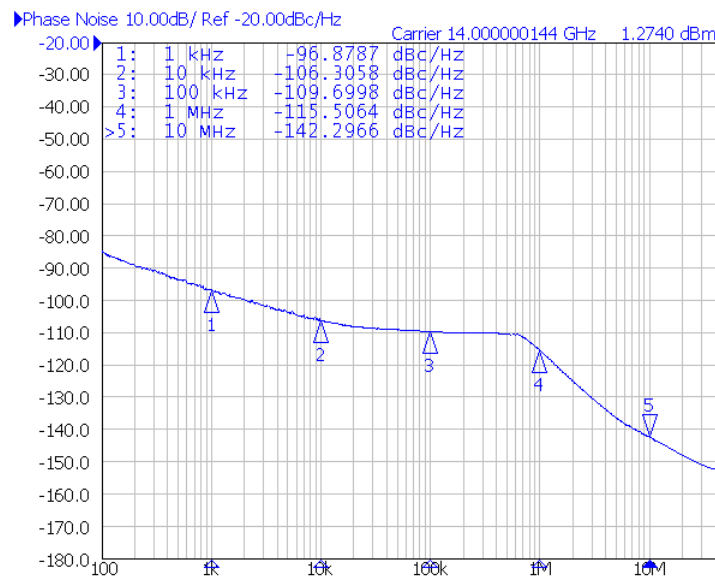

Figure 5. Loop Filter

Table 1. Loop Filter Configuration

PARAMETER	VALUE
VCO frequency	Designed for 15 GHz, but works over the whole frequency range
VCO gain	213 MHz/V
Effective charge pump gain	15 mA
Phase detector frequency	200 MHz
Loop bandwidth	430 kHz
Phase margin	58 degrees
C1LF	470 pF
C2LF	68 nF
C3LF	Open
C4LF	1.8 nF
R2LF	68 Ω
R3LF	0 Ω
R4LF	18 Ω

3.1.2 Typical Output

1. Follow Section 2 to set up the evaluation.
2. Click "Write All Registers" to write all the registers to LMX2694-EP. The default output is 14 GHz.

Figure 6. Default Output

3.2 Additional Tests

3.2.1 Phase Adjustment

Use Equation 1 to adjust the phase of the RF output signal.

Phase shift in degree = 360° × (MASH_SEED / PLL_DEN) × (IncludedDivide / CHDIV)

where

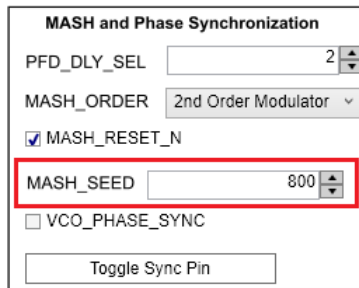- Included Divide = 4 or 6 when VCO_PHASE_SYNC = 1, otherwise it is equal to 1   (1)

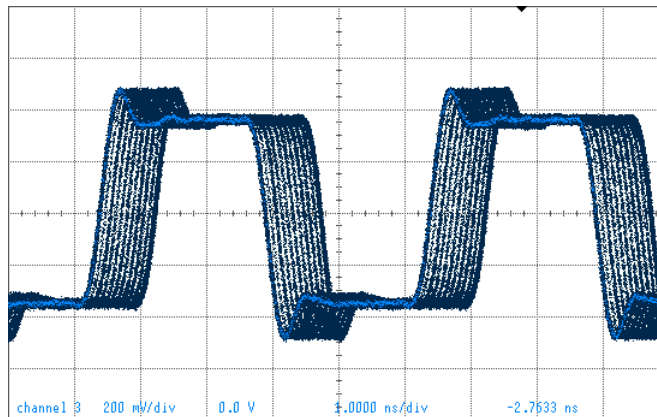Table 2 and Equation 2 show an example.

Table 2. Phase Adjustment Setting

PARAMETER	EXAMPLE VALUE
MASH_SEED	800
PLL_DEN	1000
CHDIV	48
VCO_PHASE_SYNC	0
IncludedDivide	1

$$\text{Phase shift} = 360° \times (800 / 1000) \times (1 / 48) = 6° \qquad (2)$$

The user can write 800 to MASH_SEED 60 times to get a 360° phase shift.

Figure 7. Phase Adjustment Setting

Figure 8. Phase Adjustment

3.2.2   SYSREF Example

RFOUTB of LMX2694-EP can be used to generate or duplicate the SYSREF signal. The output of RFOUTB can be a single pulse, series of pulses, or a continuous stream of pulses. These pulses are synchronous with the RFOUTA signal with an adjustable delay. To use the SYSREF capability, the PLL must be in SYNC mode with VCO_PHASE_SYNC = 1. Here is an example of Pulsed mode.
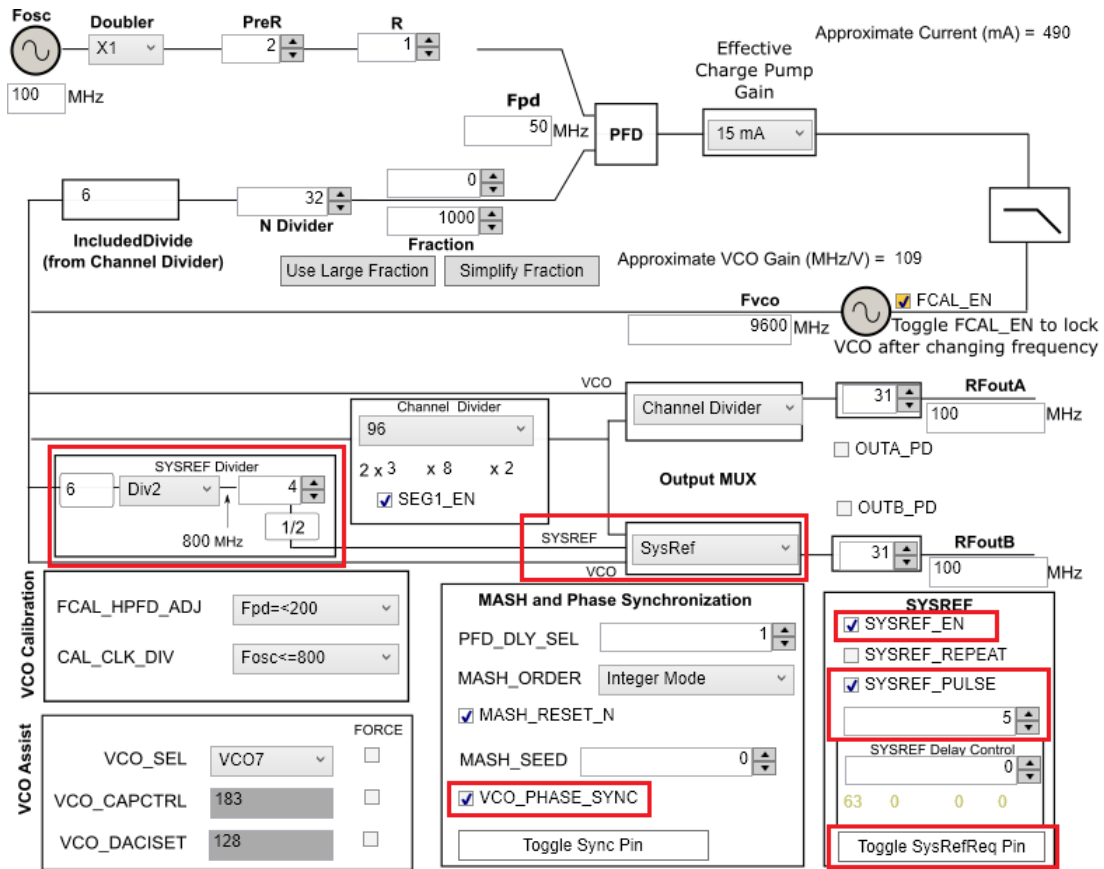
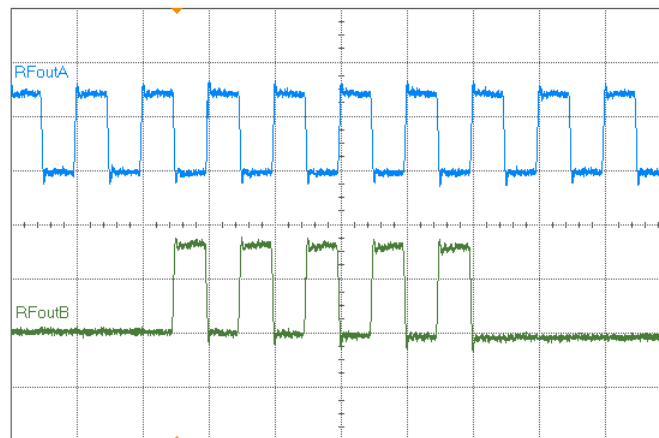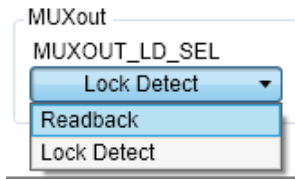**Figure 9. SYSREF Pulsed Mode Setting**

Figure 10. SYSREF Pulsed Mode

3.2.3   Register Readback

To read back the written register values, follow these steps:

1. Set MUXOUT_LD_SEL to *Readback* in TICS Pro.

Figure 11. Readback Setting

2. Click on the Register Name that you want to read back.
3. Click the Read Register button to read back the register value.

Figure 12. Register Readback

4 Schematic

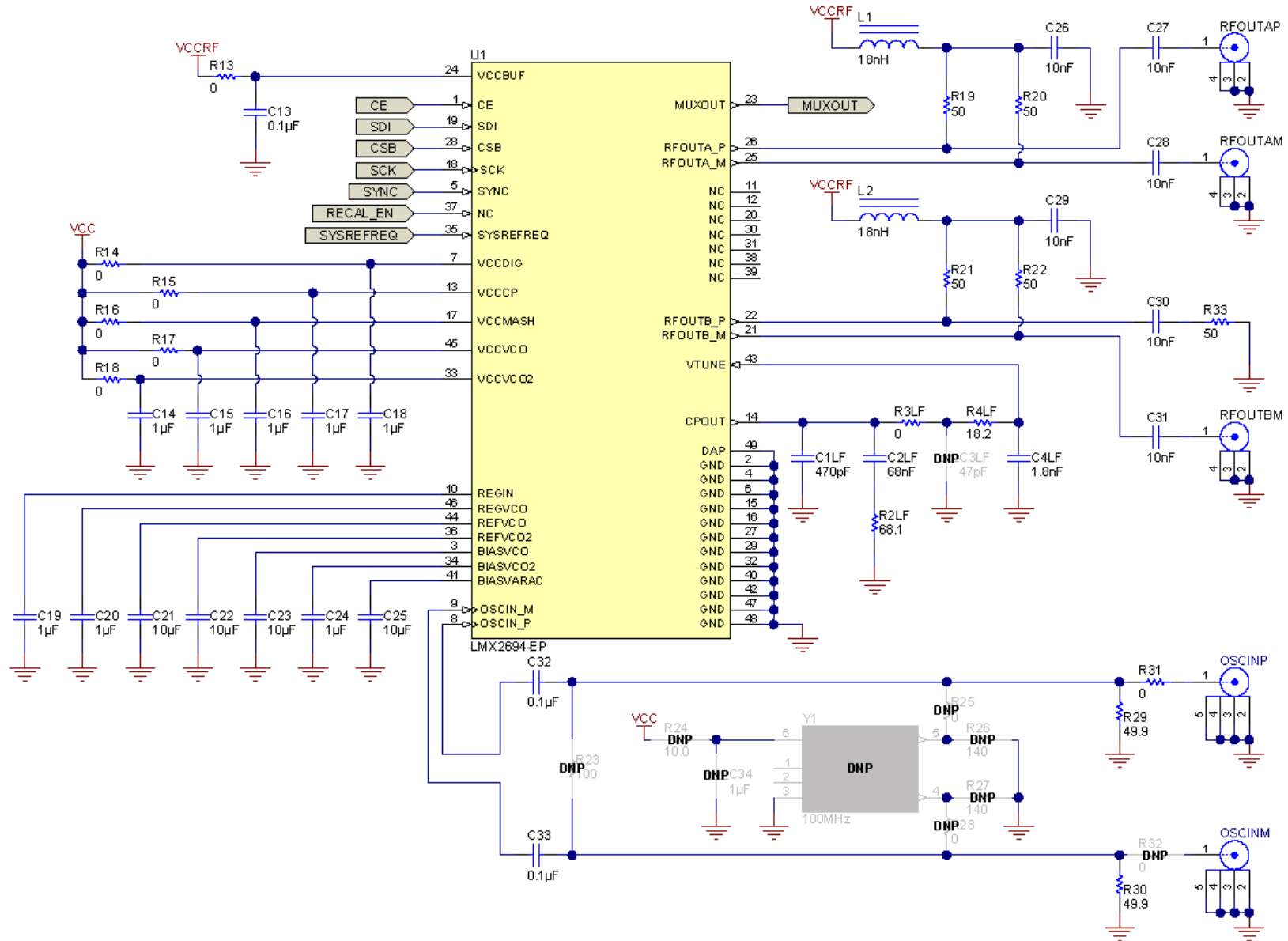**Figure 13. LMX2694EPEVM Schematic (Page 1)**

Figure 14. LMX2694EPEVM Schematic (Page 2)

5 PCB Layout and Layer Stack-Up
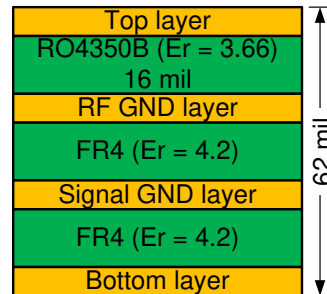
5.1 PCB Layer Stack-Up

The top layer is 1-oz. copper.

Figure 15. PCB Layer Stack-Up
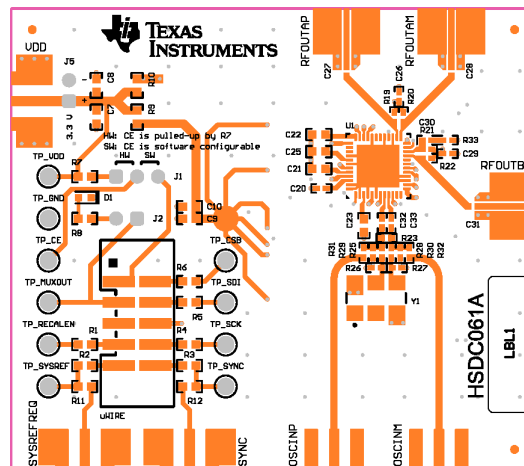
5.2 PCB Layout
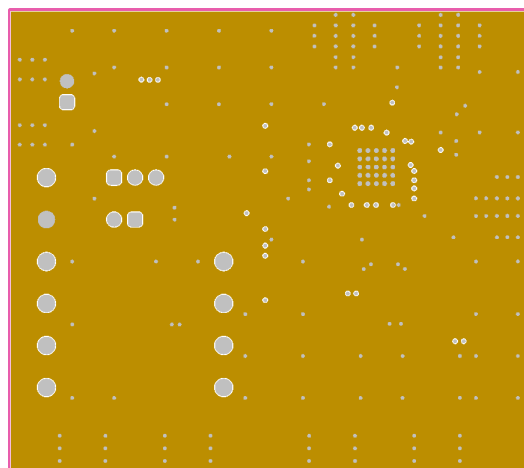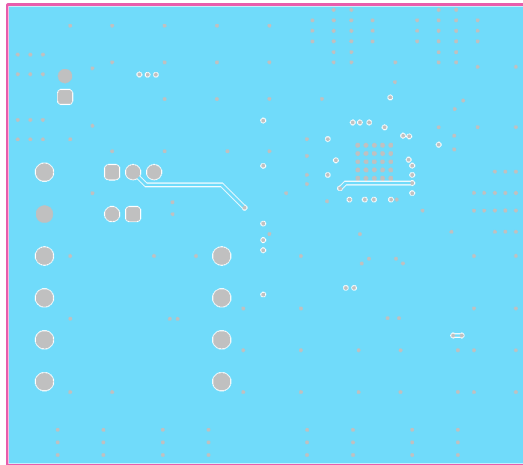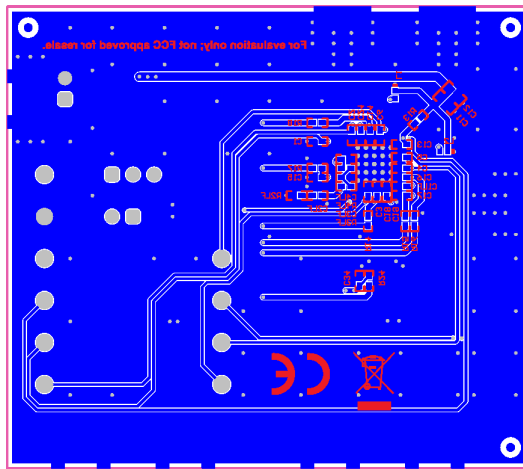

Figure 16. Top Layer

Figure 17. RF GND Layer

Figure 18. Signal GND Layer

Figure 19. Bottom Layer

6   Bill of Materials

Table 3. Bill of Materials

DESIGNATOR	QUANTITY	DESCRIPTION	PART NUMBER	MANUFACTURER
C1, C2, C3, C4, C5, C6	6	CAP, CERM, 47 pF, 50 V, +/-5%, C0G/NP0, 0402	885012005044	Wurth Elektronik
C1LF	1	CAP, CERM, 470 pF, 50 V,+/-10%, C0G/NP0, 0402	C0402C471K5GAC7867	Kemet
C2LF	1	CAP, CERM, 68 nF, 50 V, +/-10%, X7R, 0402	CGA2B3X7R1H683K050BB	TDK
C4LF	1	CAP, CERM, 1.8 nF, 50 V,+/-5%, X7R, 0402	C0402C182J5RACTU	Kemet
C7, C9, C11	3	CAP, CERM, 0.1 µF, 16 V, +/-10%, X7R, 0603	885012206046	Wurth Elektronik
C8, C10, C12, C21, C22, C23, C25	7	CAP, CERM, 10 µF, 10 V,+/-10%, X5R, 0603	GRM188R61A106KAALD	MuRata
C13, C32, C33	3	CAP, CERM, 0.1 µF, 16 V, +/-10%, X7R, 0402	885012205037	Wurth Elektronik
C14, C15, C16, C17, C18, C19, C20, C24	8	CAP, CERM, 1 µF, 25 V, +/-10%, X5R, 0402	GRM155R61E105KA12D	MuRata
C26, C27, C28, C29, C30, C31	6	CAP, CERM, 10 nF, 16 V, +/-10%, X7R, 0402	520L103KT16T	AT Ceramics
D1	1	LED, Green, SMD	LTST-C190GKT	Lite-On
J1	1	Header, 100mil, 3x1, Gold, TH	TSW-103-07-G-S	Samtec
J3	1	Header (shrouded), 100mil, 5x2, Gold, SMT	52601-S10-8LF	FCI
J2, J5	2	Header, 100mil, 2x1, Gold, TH	TSW-102-07-G-S	Samtec
J8, J9, J10	3	JACK, SMA, 50 Ohm, Gold, Edge Mount	142-0771-831	Cinch Connectivity
J12, J13	2	CONN SMA JACK STR EDGE MNT	CON-SMA-EDGE-S	RF Solutions Ltd.
L1, L2	2	Inductor, Multilayer, Air Core, 18 nH, 0.3 A, 0.36 ohm, SMD	LQG15HS18NJ02D	MuRata
R2, R3, R4, R5, R6	5	RES, 33, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW060333R0JNEA	Vishay-Dale
R2LF	1	RES, 68.1, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW040268R1FKED	Vishay-Dale
R3LF, R13, R14, R15, R16, R17, R18, R31	8	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW04020000Z0ED	Vishay-Dale
R4LF	1	RES, 18.2, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW040218R2FKED	Vishay-Dale
R7	1	RES, 1.0 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW06031K00JNEA	Vishay-Dale
R8	1	RES, 330, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW0603330RJNEA	Vishay-Dale
R9, R10	2	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW06030000Z0EA	Vishay-Dale
R19, R20, R21, R22, R33	5	RES, 50, 0.1%, 0.05 W, 0402	FC0402E50R0BST1	Vishay-Dale
R29, R30	2	RES, 49.9, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW040249R9FKED	Vishay-Dale
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8	8	Test Point, Miniature, White, TH	5002	Keystone
TP9	1	Test Point, Miniature, Black, TH	5001	Keystone
TP10	1	Test Point, Miniature, Red, TH	5000	Keystone
U1	1	15-GHz Wideband RF Synthesizer	LMX2694-EP	Texas Instruments

7   Troubleshooting Guide

If the EVM does not work as expected, use Figure 20 to identify potential root causes. Consider the following:

- Do not make modifications to the EVM or change the default settings until AFTER it is verified to be working.
- Register readback requires the correct hardware and software setup. See Section 3.2.3 for details.
- The POR current of the LMX2694EPEVM is approximately 140 mA.
- The power-down current of the LMX2694EPEVM is approximately 5 mA.
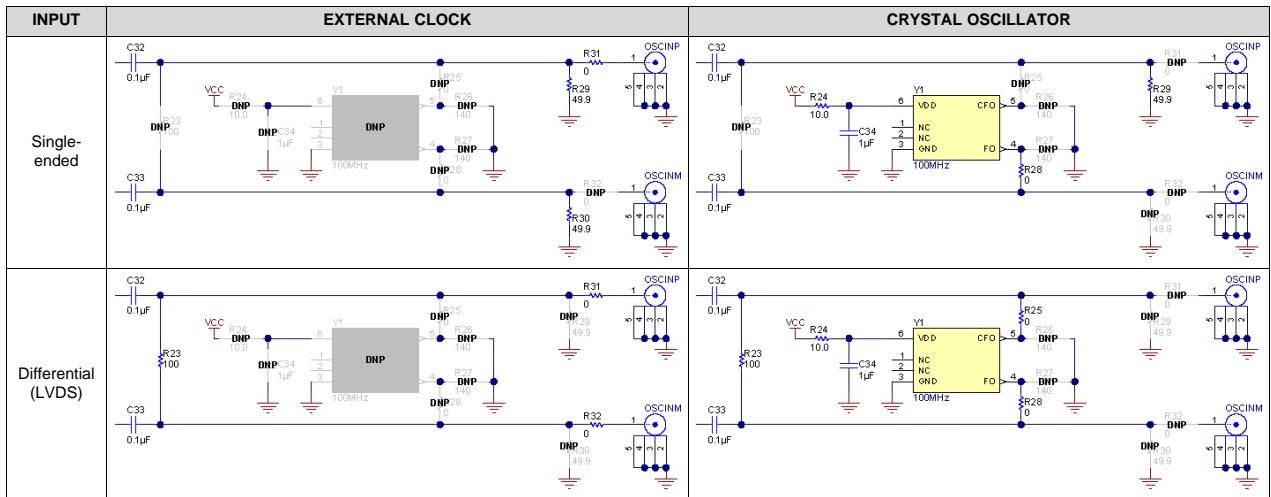

Figure 20. Troubleshooting Guide

Using Different Reference Clock

These are the different options to provide a reference clock to LMX2694EPEVM. By default, the EVM is configured for an external single-ended clock.

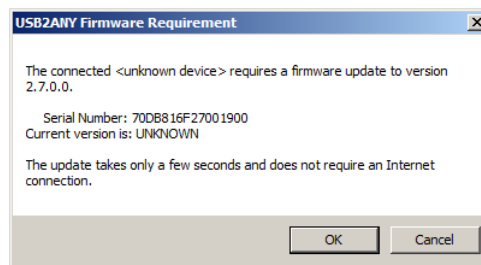**Table 4. Reference Clock Input Configuration**
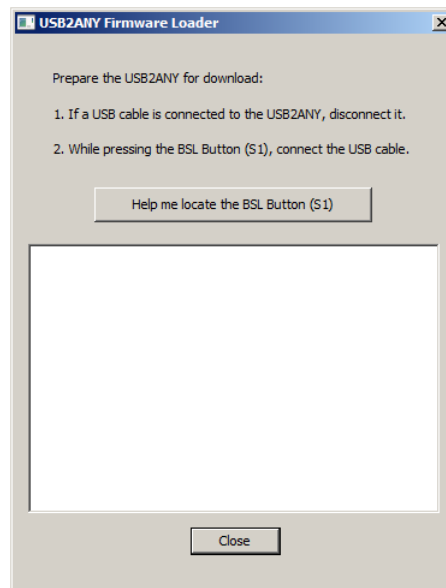
USB2ANY Firmware Upgrade

Usually when the USB2ANY module is used the first time, TICS Pro will request a firmware update. Follow the pop-up instructions to complete the update. This is necessary to ensure that the USB connection between the PC and the USB2ANY module is properly setup, otherwise the programming to LMX2694EPEVM will not be successful.

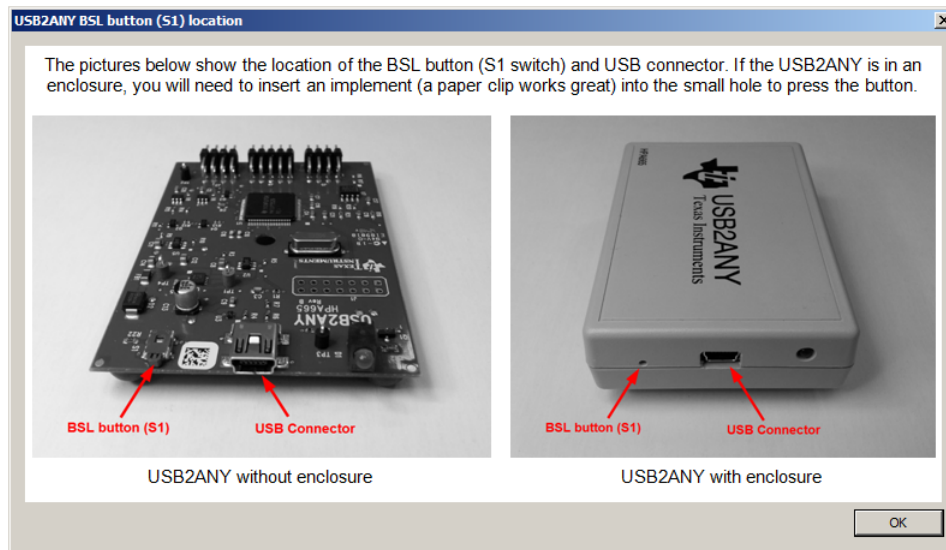1. When you see this message, click the "OK" button.

Figure 21. Firmware Requirement
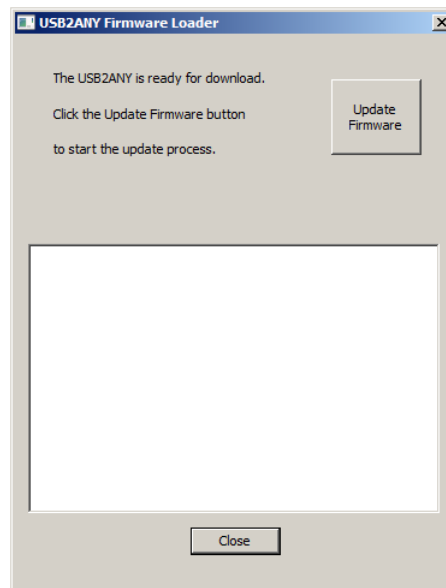
2. Next, follow the on-screen procedure.

Figure 22. Firmware Loader

3. If you don't know the location of the BSL button, click the long button in the middle of the screen.
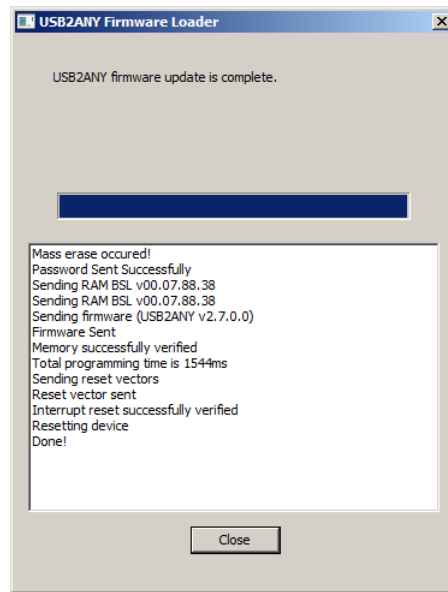
Figure 23. BSL Button

4. Click the "OK" button to go back to the previous screen. Follow the on-screen procedure until this screen is appears.

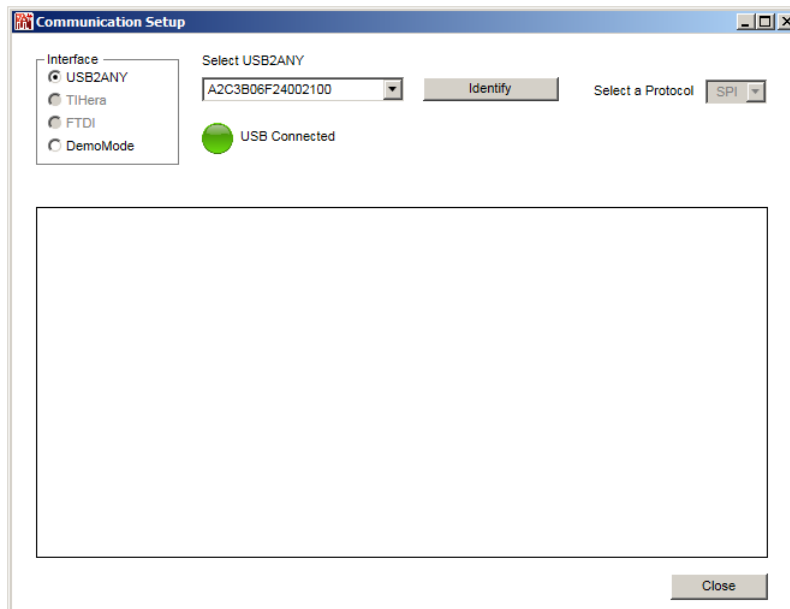**Figure 24. Update Firmware**

5. Click the "Upgrade Firmware" button, the firmware will be upgrading. Click the "Close" button after it is complete.

Figure 25. Firmware Update Completed

6. Check the USB connection in TICS Pro by clicking USB communications → Interface. Make sure the USB Connected button is green.

Figure 26. USB Communications

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