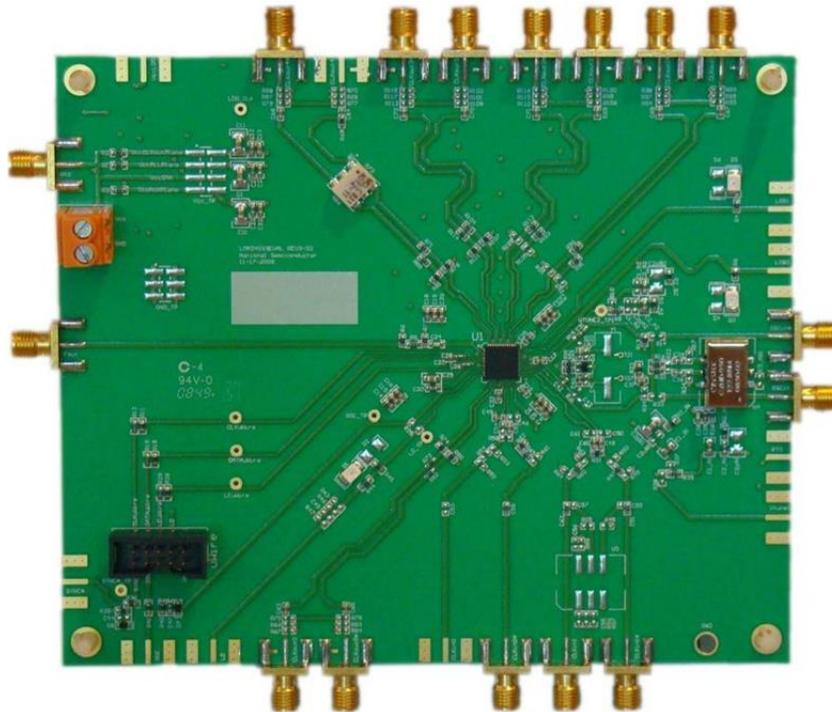


LMK04100, LMK04101, LMK04102, LMK04110, LMK04111, LMK04131, and LMK04133 User's Guide

This user's guide describes how to set up and operate the LMK041xx evaluation modules (EVMs). The LMK041xx Evaluation Board simplifies evaluation of the LMK041xxB Precision Clock Conditioner with Dual PLLs and Integrated VCO. Configuring and controlling the board is accomplished using Texas Instruments' TICS Pro software, which can be downloaded from TI's website: <http://www.ti.com/tool/ticspro-sw>.



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1 Quick Start

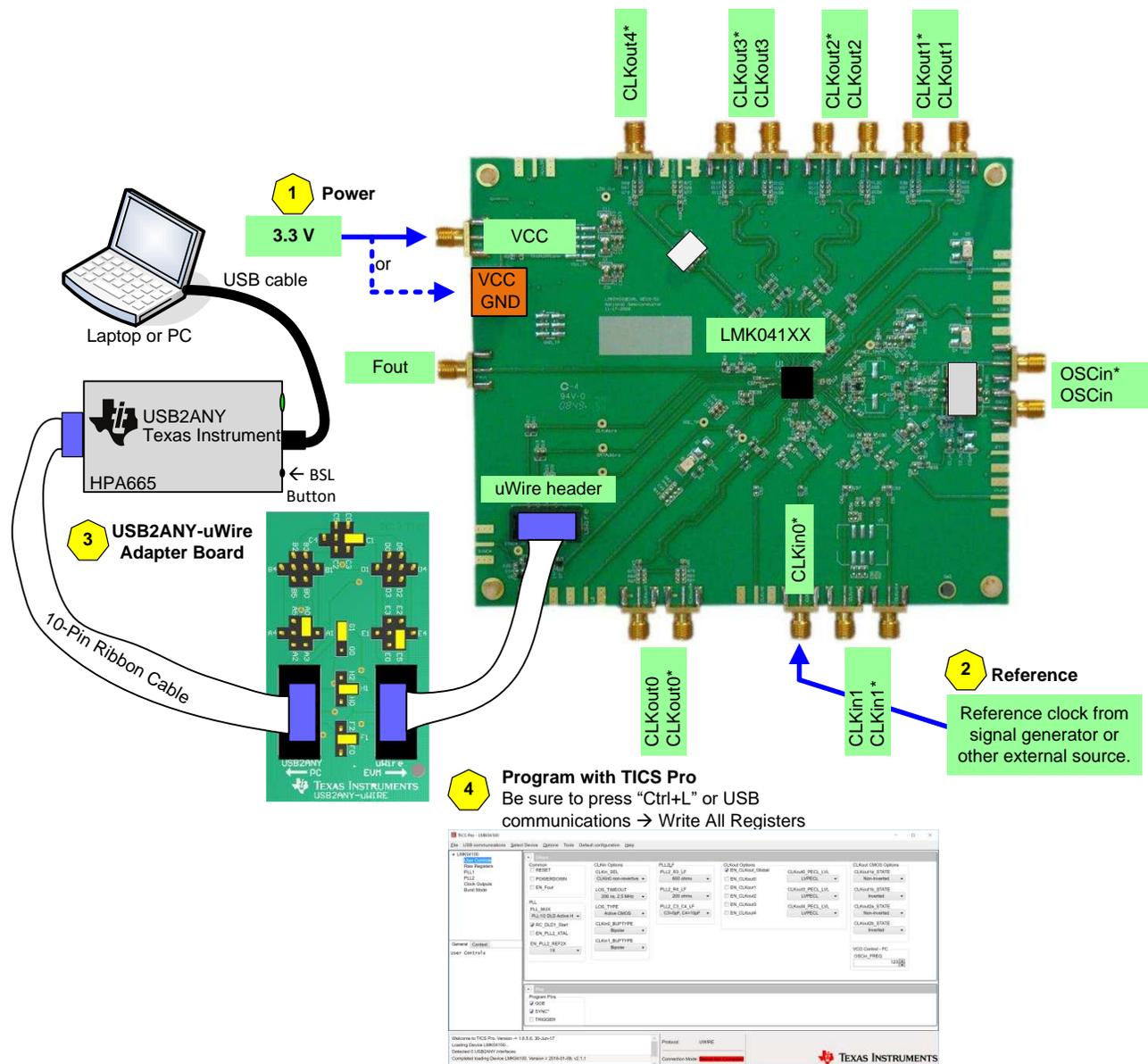


Figure 1. Quick Start Diagram

1.1 Quick Start Description

Full evaluation board instructions with data are downloadable from the product folder of the device at Texas Instruments' website, www.ti.com.

1. Connect a voltage of **3.3 V** to either the V_{CC} SMA connector or the alternate terminal block.
2. Connect a reference clock from a signal generator or other source. Exact frequency depends on programming. Default modes use a **122.88 MHz** reference.
3. Connect the PC to USB2ANY. Connect the USB2ANY-uWire Adapter Board from USB2ANY with a 10-pin ribbon cable. Install jumpers as shown in [Figure 1](#) and connect another 10-pin ribbon cable to the uWire header on the EVM.
4. Program the device with TICS Pro. TICS Pro is available for download at <http://www.ti.com/tool/ticspro-sw>.
 - (a) Select **USB2ANY mode** from the Communication Setup window. To access this, select "USB communications" → "Interface". Confirm PC to USB communications by clicking "Identify" to see blinking green LED on USB2ANY.
 - (b) Select any LMK041xx device from the "Select Device" Menu. Click "Select Device" → "Clock Generator/Jitter Cleaner (Dual Loop)" → "LMK041xx".
 - (c) Select a default mode from the "Default configuration" Menu. For the quick start, use "122.88 MHz VCXO Default".
 - (d) "**Ctrl+L**" must be pressed at least once to load all registers. Alternatively click "USB communications" → "Write All Registers" or the "Write All Registers" button on the **Raw Registers** page.
5. Measurements may be made at any CLKout or Fout port via its SMA connector if enabled by programming.

2 Using TICS Pro to Program the LMK041xx

The purpose of this section is to walk the user through using TICS Pro to make some measurements with the LMK041xx device. For more information on TICS Pro, refer to [Appendix A](#). TICS Pro is available for download at <http://www.ti.com/tool/ticspro-sw>.

Another option is to use CodeLoader4. The tool page for CodeLoader4 is located at <http://www.ti.com/tool/codeloader/>.

Before proceeding, be sure to follow the Quick Start section above to ensure proper connections.

2.1 Start TICS Pro Application

Click “Start” → “Programs” → “Texas Instruments” → “TICS Pro”

The TICS Pro program is installed by default to the Texas Instruments application group.

2.2 Select Device

Click “Select Device” → “Clock Generator/Jitter Cleaner (Dual Loop)” → “LMK041xx” → “LMK04100”.

Once started, TICS Pro will load the last used device. To load a new device click “Select Device” from the menu bar, then select the subgroup “Clock Generator/Jitter Cleaner (Dual Loop)”, then “LMK041xx”, and finally the device to load. For this example, the LMK04100 is chosen. Selecting the device does cause the device to be programmed. However, it is advisable to press “Ctrl+L” to ensure programming.

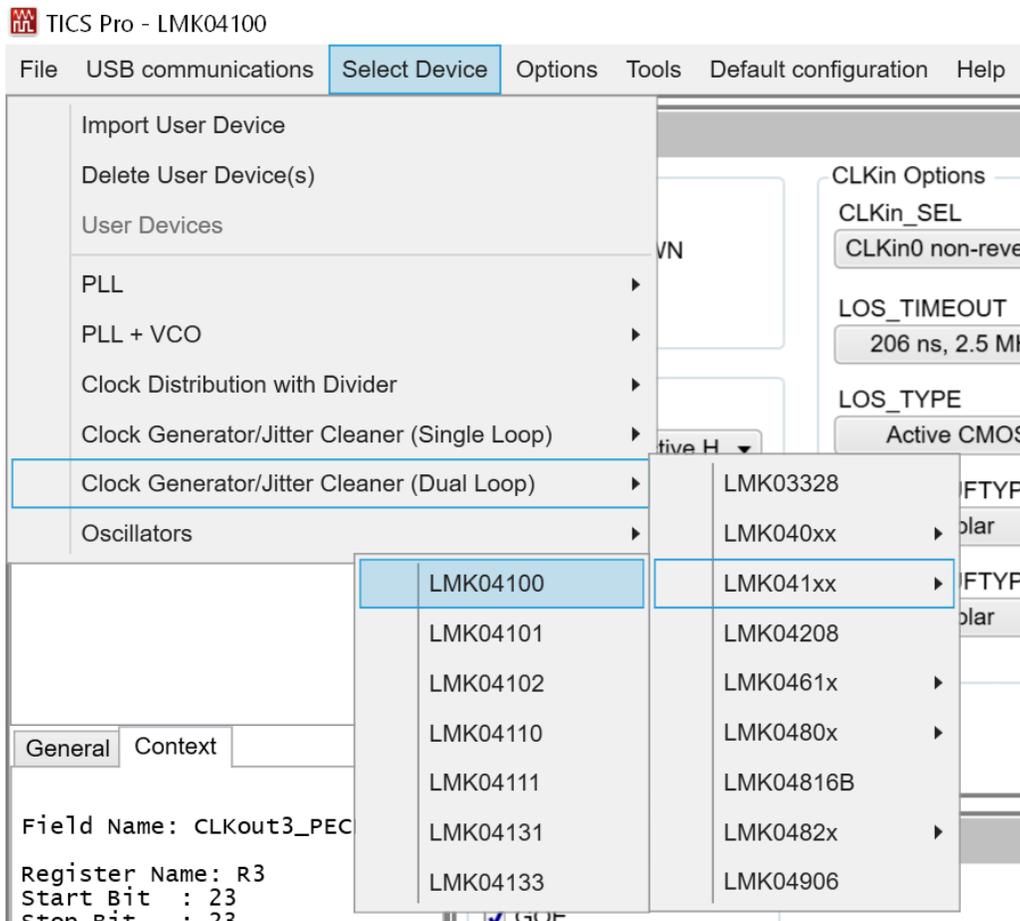


Figure 2. Selecting the LMK041xx

2.3 Program/Load Device

Press “Ctrl+L”

Alternatively, click “USB communications” → “Write All Registers” from the menu to program the device to the current state of the newly loaded LMK041xx file. “Ctrl+L” is the accelerator key assigned to the “Write All Registers” option and is very convenient.

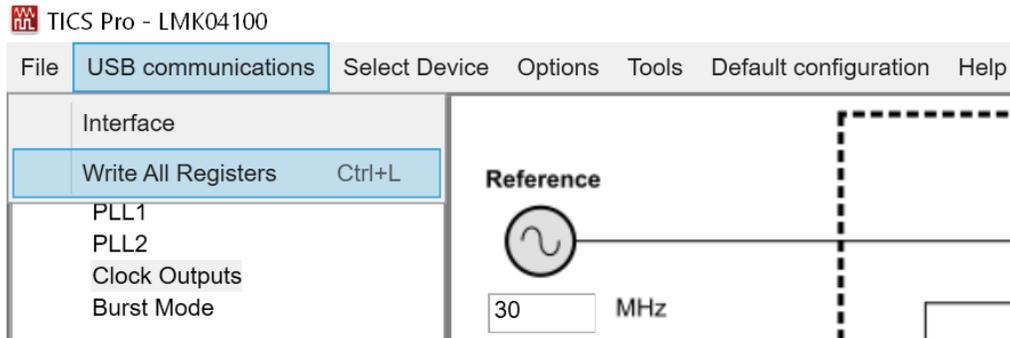


Figure 3. Loading the Device

Once the device has been initially loaded, TICS Pro will automatically program changed registers, so it is not necessary to reload the device upon subsequent changes in the device configuration. It is possible to disable this functionality by ensuring there is no checkmark by the “Options” → “AutoUpdate”

Since a default mode will be restored in the next step, this step isn’t really needed but is included to emphasize the importance of pressing “Ctrl+L” to load the device at least once after starting TICS Pro, restoring a mode, or restoring a saved setup using the File menu.

2.4 Restoring a Default Mode

Click “Default configuration” → “122.88 MHz VCXO Default”; then

Press “Ctrl+L”

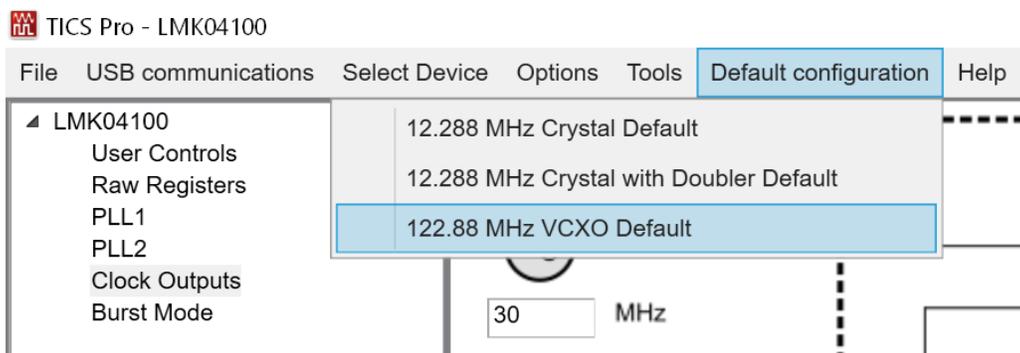


Figure 4. Setting the Default Mode

For the purposes of this walkthrough a default mode will be loaded to ensure a common starting point. This is important because TICS Pro saves the state of the selected LMK04100 device when exiting the software.

NOTE: Loading a mode does not automatically program the device, so it is necessary to press “Ctrl+L” again to program the device.

2.5 Enable Clock Outputs

To measure phase noise at the clock outputs:

1. Click on the **Clock Outputs** page.
2. Enable an output.
3. Set Bypass div or Clock Divider as desired for device clock frequency.

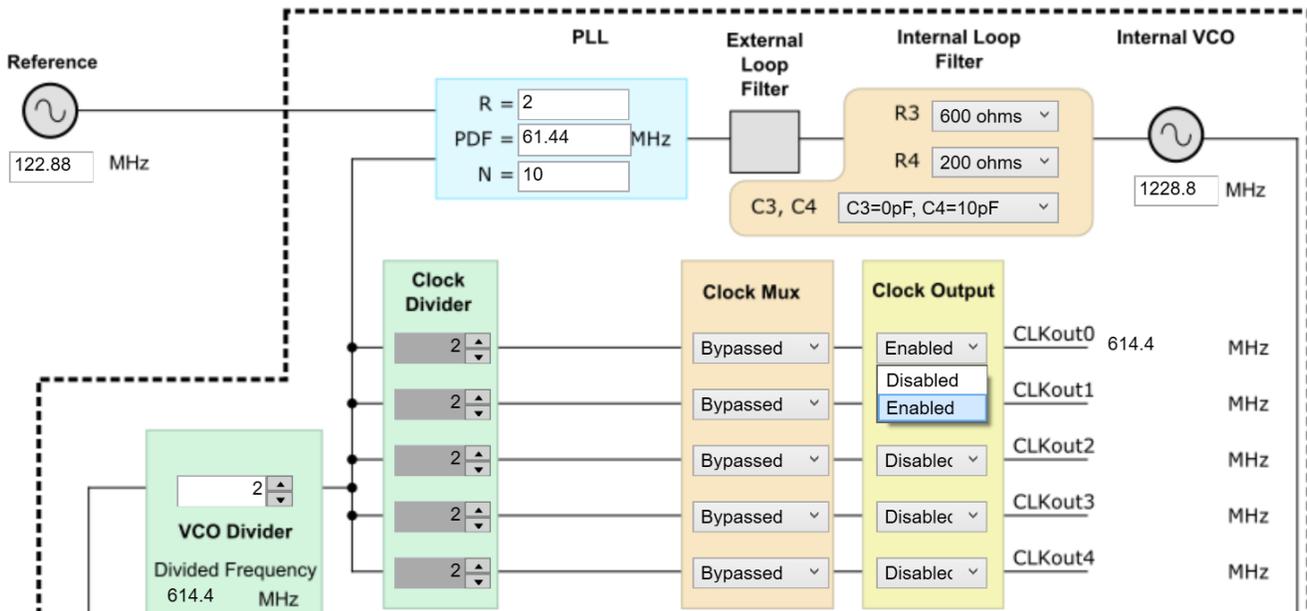


Figure 5. Setting Divider, CLKout_TYPE, Enabled for CLKoutX on “Bank A” Page

NOTE: This CLKoutX frequency value is only valid if the correct clock in value is specified. It may not necessarily represent the actual frequency unless manually entered. This is a mathematical calculation only, not a measured value.

4. Connect the clock output SMAs to a spectrum analyzer or signal source analyzer.
5. The phase noise may be measured with a spectrum analyzer or signal source analyzer

See [Appendix B](#) for phase noise plots of the clock outputs

3 PLL Loop Filters and Loop Parameters

The loop filters on the LMK041xx evaluation board are setup using the approach above. The loop filter for PLL1 has been configured for a narrow loop bandwidth (< 100 Hz), while the loop filter of PLL2 has been configured for a wide loop bandwidth (> 100 kHz). The specific loop bandwidth values depend on the phase noise performance of the oscillator mounted on the board. The following tables contain the parameters for PLL1 and PLL2 for each oscillator option.

Texas Instruments' Clock Design Tool can be used to optimize PLL phase noise and jitter for given specifications. See: <http://www.ti.com/tool/clockdesigntool>.

Table 1. PLL1 Loop Filter⁽¹⁾

| | | | |
|---------------------------|----------------|---------------------|-----------------------|
| Phase Margin | 50° K_{ϕ} | (Charge Pump) | 100- μ A Loop |
| Bandwidth | 12 Hz | Phase Detector Freq | 1.024 MHz |
| | | VCO Gain | 2.5 kHz/Volt |
| Reference Clock Frequency | 122.88 MHz | Output Frequency | 122.88 MHz (To PLL 2) |
| Loop Filter Components | C1 = 100 nF | C2 = 680 nF | R2 = 39 k Ω |

⁽¹⁾ PLL1 Loop Filter Parameters for Crystek 122.88-MHz VCXO and 12.288-MHz Vectron Crystal

Table 2. PLL2 Loop Filter⁽¹⁾

| | LMK041x0B | LMK041x1B | LMK041x2B | LMK041x3B | UNITS |
|---------------------------------|-----------|-----------|-----------|-----------|------------|
| C1 | Open | | | | |
| C2 | 12 | | | | nF |
| C3 | 0 | | | | nF |
| C4 | 0.01 | | | | nF |
| R2 | 1.8 | | | | k Ω |
| R3 | 0.6 | | | | k Ω |
| R4 | 0.2 | | | | k Ω |
| Charge Pump Current, K_{ϕ} | 3.2 | | | | mA |
| Phase Detector Frequency | 61.44 | | | | MHz |
| Frequency | 1228.8 | 1474.56 | 1720.32 | 1966.08 | MHz |
| K_{VCO} | 8 | 9 | 13 | 19 | MHz/V |
| N | 20 | 24 | 28 | 32 | |
| Phase Margin | 85.5 | 85.5 | 85.0 | 84.0 | degrees |
| Loop Bandwidth | 366 | 343 | 424 | 542 | kHz |

⁽¹⁾ 122.88-MHz VCXO (Reference Input)

NOTE: PLL Loop Bandwidth is a function of K_{ϕ} , K_{VCO} , N as well as loop components. Changing K_{ϕ} and N will change the loop bandwidth.

4 Evaluation Board Inputs/Outputs

The following table contains descriptions of the various inputs and outputs for the evaluation board.

Table 3. LMK041xx Evaluation Board I/O

| CONNECTOR NAME | INPUT/OUTPUT | DESCRIPTION | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--------------|--|-------|-----------------|-----|-----|------|--------------|---------|------|---|-----------------|--------------|-----|------|---|-----------------|--------------|---------|-----|-----|-----------------|--------------|-----|-----|-----|-----------------|
| CLKout0 / CLKout0*, CLKout1 / CLKout1*, CLKout2 / CLKout2*, CLKout3 / CLKout3*, CLKout4 / CLKout4* | Output | Populated connectors. Differential clock output pairs. See Table 8 for format of the output depending on part number. If an LVCMOS output, each output can be independently configured (noninverted, inverted, tri-state, and LOW). On the evaluation board, all clock outputs are AC-coupled to allow safe testing with RF test equipment. All LVPECL/2VPECL clock outputs are terminated to GND with a 120-Ω resistor, one on each output pin of the pair. CLKout4 is configured with an on board balun. Part number is Mini-circuits" ADT2-1T. According to the ADT2-1T datasheet, the 3-dB frequency range is 0.4 to 450 MHz. See Appendix F for more detail. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fout | Output | Populated connector. When enabled, buffered VCO output. AC-coupled. The default configuration on the board contains a 3-dB attenuator on the Fout signal. V _{CC} Input Populated connector. DC power supply for the PCB. Removing R1, R2, or R3 allow for splitting the power to various devices on the board. For example, the VCXO is powered from the V _{CC} AUXPlane connected through R3. Note: The LMK04100 Family contains internal voltage regulators for the VCO, PLL, and related circuitry. The clock outputs do not have an internal regulator. A clean power supply is required for best performance. V _{CC} LDO Input Unpopulated connector. V _{CC} input for LDOs on bottom of PCB. Refer to schematics for more information. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Vcc | Input | Populated connector. DC power supply for the PCB. Removing R1, R2, or R3 allow for splitting the power to various devices on the board. For example, the VCXO is powered from the V _{CC} AUXPlane connected through R3. Note: The LMK04100 Family contains internal voltage regulators for the VCO, PLL, and related circuitry. The clock outputs do not have an internal regulator. A clean power supply is required for best performance. | | | | | | | | | | | | | | | | | | | | | | | | | |
| VccLDO | Input | Unpopulated connector. V _{CC} input for LDOs on bottom of PCB. Refer to schematics for more information. | | | | | | | | | | | | | | | | | | | | | | | | | |
| CLKin0/CLKin0*, CLKin1/CLKin1* | Input | <p>Populated connectors. Reference clock inputs for PLL1. The default board configuration is setup for a single-ended reference source at CLKin0* (CLKin0 pin is AC-coupled to ground). The mode of the clock input buffer is programmable in CodeLoader on the User Controls tab, and may be either bi-polar junction mode or MOS mode. The input level for the various modes is as in the data sheet:</p> <p>AC-Coupled Input Clock Voltage Levels</p> <table border="1"> <thead> <tr> <th>Input</th> <th>Mode</th> <th>Min</th> <th>Max</th> <th>Unit</th> </tr> </thead> <tbody> <tr> <td>Differential</td> <td>Bipolar</td> <td>0.25</td> <td>2</td> <td>V_{PP}</td> </tr> <tr> <td>Differential</td> <td>MOS</td> <td>0.25</td> <td>2</td> <td>V_{PP}</td> </tr> <tr> <td>Single-Ended</td> <td>Bipolar</td> <td>0.5</td> <td>3.1</td> <td>V_{PP}</td> </tr> <tr> <td>Single-Ended</td> <td>MOS</td> <td>0.5</td> <td>3.1</td> <td>V_{PP}</td> </tr> </tbody> </table> <p>If a DC-coupled clock is used to drive either of the inputs, the high voltage level must be at least 2 volts and the low voltage no greater than 0.4 volts. By default CLKin0 is the active input in either of the auto- switching modes (CLKin0 non-revertive, CLKin0 revertive). When loss of CLKin0 is detected, the device automatically switches to CLKin1 if an active reference clock is attached. See the data sheet for further explanation.</p> | Input | Mode | Min | Max | Unit | Differential | Bipolar | 0.25 | 2 | V _{PP} | Differential | MOS | 0.25 | 2 | V _{PP} | Single-Ended | Bipolar | 0.5 | 3.1 | V _{PP} | Single-Ended | MOS | 0.5 | 3.1 | V _{PP} |
| Input | Mode | Min | Max | Unit | | | | | | | | | | | | | | | | | | | | | | | |
| Differential | Bipolar | 0.25 | 2 | V _{PP} | | | | | | | | | | | | | | | | | | | | | | | |
| Differential | MOS | 0.25 | 2 | V _{PP} | | | | | | | | | | | | | | | | | | | | | | | |
| Single-Ended | Bipolar | 0.5 | 3.1 | V _{PP} | | | | | | | | | | | | | | | | | | | | | | | |
| Single-Ended | MOS | 0.5 | 3.1 | V _{PP} | | | | | | | | | | | | | | | | | | | | | | | |
| LOS0, LOS1 | Output | Unpopulated connectors. Loss-of-Signal indicator (when LOS_TYPE = Active CMOS, default) for CLKin0/0* and CLKin1/1*. The LEDs D5 and D3 are light red when no signal is detected according to the data sheet specification for LOS pins. User Controls, LOS_TYPE = Active CMOS for default operation. | | | | | | | | | | | | | | | | | | | | | | | | | |
| OSCin/OSCin* | Input | Populated connectors. By altering the PCB an external VCXO may be attached to the OSCin/OSCin* SMA connectors. Either a differential or single-ended device may be used. If a single-end device is used, OSCin* should be tied to GND through a capacitor that matches the AC-coupling capacitor value used for the OSCin pin. See the data sheet for OSCin port signal specifications. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Vtune1 | Output | Unpopulated connector. Tuning voltage output from the loop filter for PLL1. If an external VCXO is used, this tuning voltage should be connected to the voltage control pin of the external VCXO. Note: Resistor R38 must be populated with a 0-Ω resistor to control an off-board VCXO. | | | | | | | | | | | | | | | | | | | | | | | | | |

| | | |
|-------|--------------|--|
| uWire | Input/Output | Populated connector. 10-pin header programming interface for the board. Of Most important are the CLKuWire, DATAuWire, and LEuWire programming lines from this header. Each of these signals, GEO, and SYNC* can be monitored through test points on the board. |
| LD | Output | Unpopulated connector. The LD pin is attached to a multiplexer inside the device and may be programmed with a variety of internal signals for monitoring internal device functions and troubleshooting. See the data sheet for further explanation. The lock detect signal is accessible through this pin. |
| LD_TP | Output | Test point attached to the LD pin of the device. See the LD above for more information. |
| GOE | Input | Unpopulated connector. Access to GOE of device. |
| SYNC* | Input | Unpopulated connector. Access to SYNC* of device. |
| PTO | Output | Unpopulated connector. V_{CC} SMA located close to OSCin SMAs for powering external oscillator boards. |

TICS Pro Usage

TICS Pro is the recommended program to program the evaluation board with the USB2ANY interface adapter and the USB2ANY-uWire Adapter Board. TICS Pro can also be used to generate register maps for programming the device. This appendix outlines the basic purpose and usage of each page. TICS Pro is available for download at <http://www.ti.com/tool/ticspro-sw>.

A.1 TICS Pro Tips

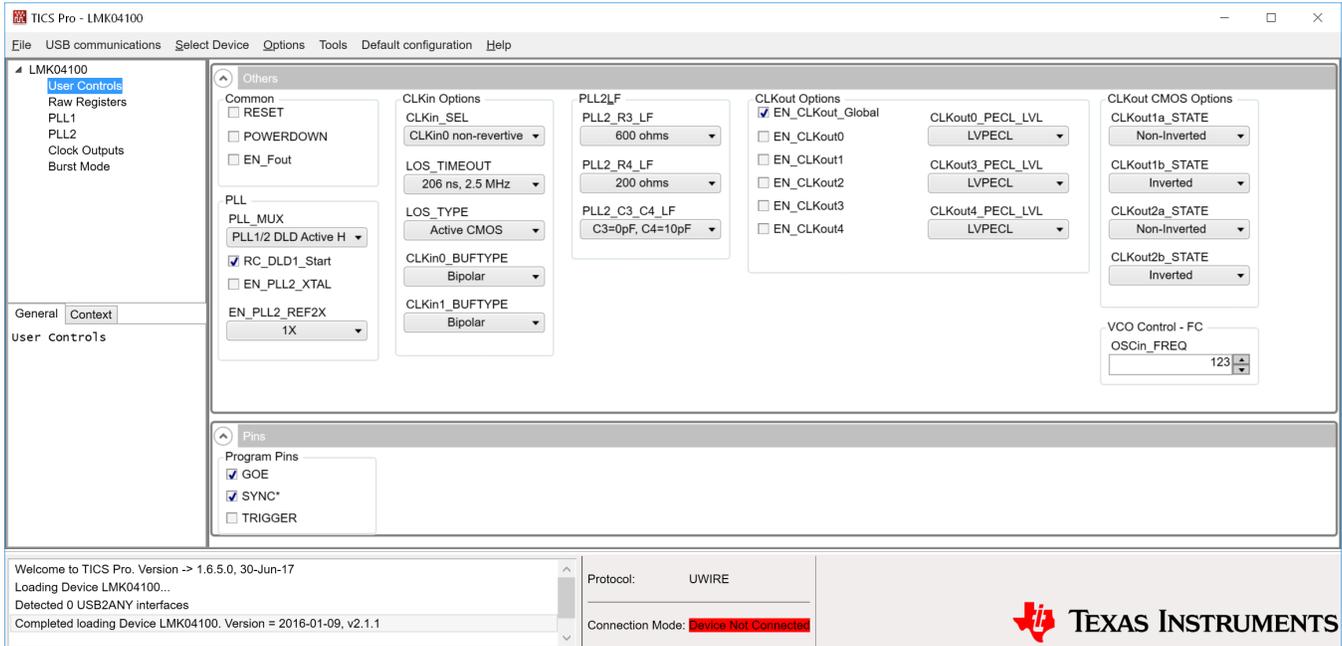
- Mousing over different controls will display some help prompt with the register address, data bit location/length, and a brief register description in the lower left Context help pane.

A.2 Communication Setup

The USB communications window allows the USB2ANY or DemoMode to be selected. In case multiple evaluation boards are to be connected and run with multiple instances of TICS Pro, the drop-down box will allow specific USB2ANY devices to be selected. Pressing the identify button will identify which USB2ANY is currently selected. Devices used by other instances of TICS Pro won't display in this list.

A.3 User Controls Page

The **User Controls** page has controls not included on one of the later discussed dedicated pages.



The screenshot displays the TICS Pro software interface for the LMK04100 device. The main window is titled 'TICS Pro - LMK04100' and features a menu bar with 'File', 'USB communications', 'Select Device', 'Options', 'Tools', 'Default configuration', and 'Help'. A left sidebar contains a tree view with 'LMK04100' expanded, showing sub-items like 'User Controls', 'Raw Registers', 'PLL1', 'PLL2', 'Clock Outputs', and 'Burst Mode'. The 'User Controls' page is active, showing several configuration panels:

- Common:** Includes checkboxes for 'RESET', 'POWERDOWN', and 'EN_Fout'.
- PLL:** Includes 'PLL_MUX' (set to 'PLL1/2 DLD Active H'), 'RC_DLD1_Start' (checked), 'EN_PLL2_XTAL', and 'EN_PLL2_REF2X' (set to '1X').
- CLKin Options:** Includes 'CLKin_SEL' (set to 'CLKin0 non-revertive'), 'LOS_TIMEOUT' (set to '206 ns, 2.5 MHz'), 'LOS_TYPE' (set to 'Active CMOS'), 'CLKin0_BUFTYPE' (set to 'Bipolar'), and 'CLKin1_BUFTYPE' (set to 'Bipolar').
- PLL2_LF:** Includes 'PLL2_R3_LF' (set to '600 ohms'), 'PLL2_R4_LF' (set to '200 ohms'), and 'PLL2_C3_C4_LF' (set to 'C3=0pF, C4=10pF').
- CLKout Options:** Includes 'EN_CLKout_Global' (checked) and checkboxes for 'EN_CLKout0' through 'EN_CLKout4'.
- CLKout PECL Levels:** Includes dropdowns for 'CLKout0_PECCL_LVL', 'CLKout3_PECCL_LVL', and 'CLKout4_PECCL_LVL', all set to 'LVPECL'.
- CLKout CMOS Options:** Includes dropdowns for 'CLKout1a_STATE', 'CLKout1b_STATE', 'CLKout2a_STATE', and 'CLKout2b_STATE', all set to 'Non-Inverted' or 'Inverted'.
- VCO Control - FC:** Includes 'OSCin_FREQ' set to '123'.
- Pins:** Includes 'Program Pins' with checkboxes for 'GOE' (checked), 'SYNC*' (checked), and 'TRIGGER'.

The bottom status bar shows 'Welcome to TICS Pro. Version -> 1.6.5.0, 30-Jun-17', 'Loading Device LMK04100...', 'Detected 0 USB2ANY interfaces', and 'Completed loading Device LMK04100. Version = 2016-01-09, v2.1.1'. The 'Protocol' is 'UWIRE' and the 'Connection Mode' is 'Device Not Connected'. The Texas Instruments logo is visible in the bottom right corner.

Figure 6. TICS Pro - User Controls Page

NOTE: The value entered in the **VCO** frequency field on the **PLL1** page must match the **Reference Oscillator** frequency entered on the **PLL2** page and the **OSCin_FREQ** on the **User Controls** page. Updating the **PLL2** page Reference Oscillator frequency will automatically update the value of **OSCin_FREQ** on the **User Controls** page. The only time that the Reference Oscillator frequency of **PLL2** page will be different from the VCO frequency of **PLL1** is when the **EN_PLL2_REF2X** mode is enabled.

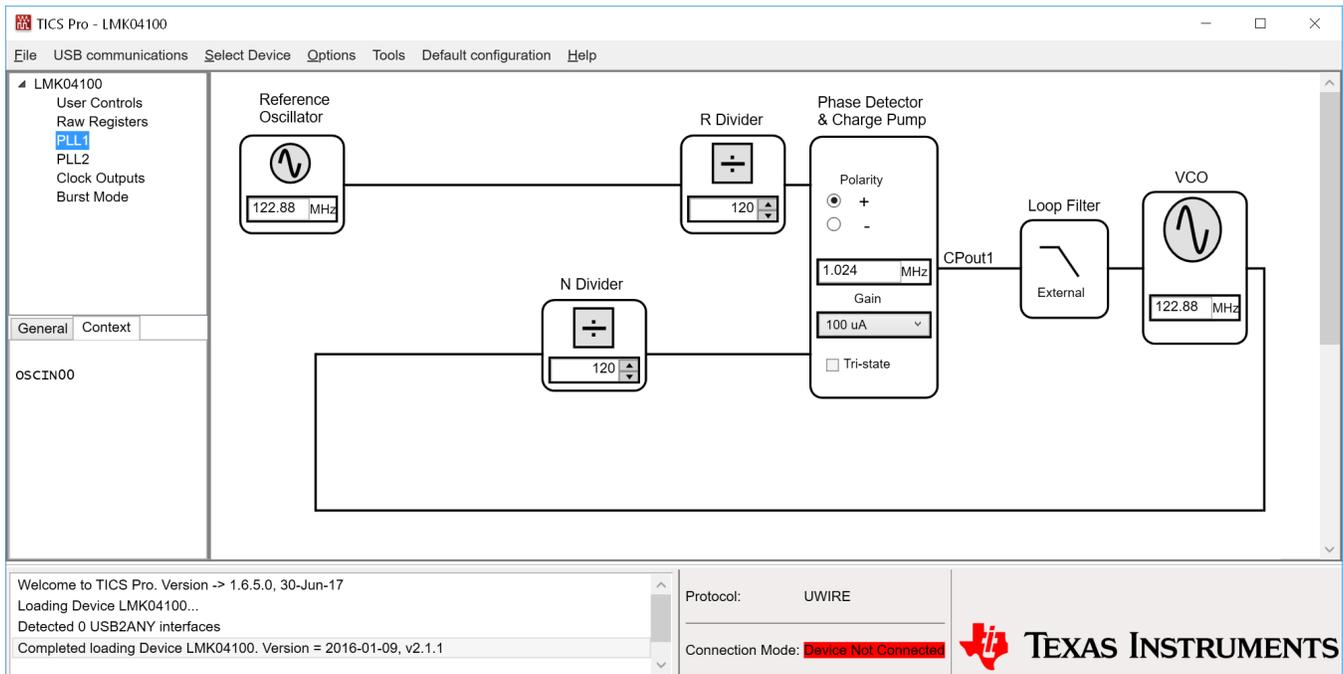


Figure 8. TICS Pro - PLL1 Page

A.6 PLL2 Page

The **PLL2** page allows the user to change:

- VCO frequency.
- PLL2 Phase detector frequency.
- PLL2 R Divider value.
- PLL2 N Divider value.
- VCO Divider value.
- The frequency of the external VCXO (or crystal oscillator).

NOTE: This value must be entered in both the **PLL1** and **PLL2** pages.

- PLL2 Charge pump gain.
- PLL2 Charge pump state.

Any changes made on this page are reflected in the **Clock Outputs** page.

The PLL2 Phase Detector polarity is fixed and cannot be changed by the user.

The VCO frequency should conform to the specified frequency range for the device.

NOTE: The value entered in the **VCO** frequency field on the **PLL1** page must match the **Reference Oscillator** frequency entered on the **PLL2** page and the **OSCin_FREQ** on the **User Controls** page. Updating the **PLL2** page Reference Oscillator frequency will automatically update the value of **OSCin_FREQ** on the **User Controls** page. The only time that the Reference Oscillator frequency of **PLL2** page will be different from the VCO frequency of **PLL1** is when the **EN_PLL2_REF2X** mode is enabled.

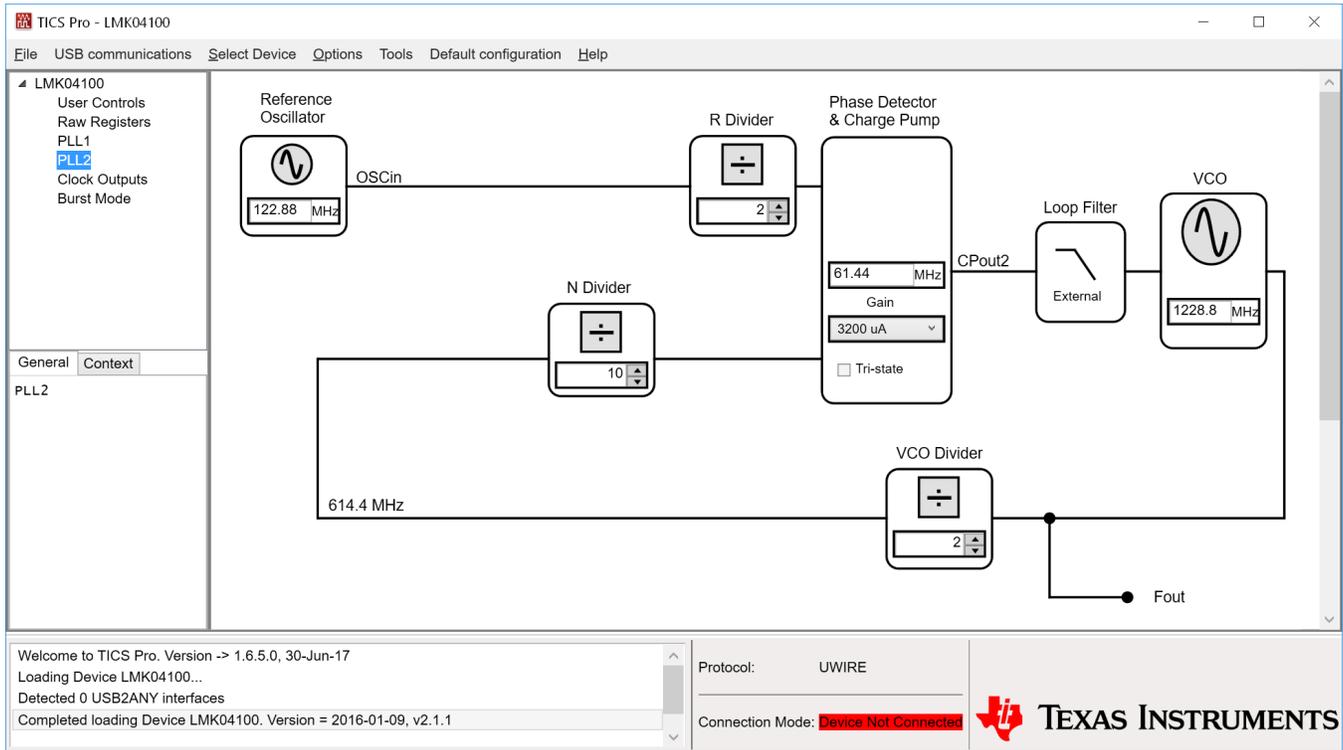


Figure 9. TICS Pro - PLL2 Page

A.7 Clock Outputs Page

The **Clock Outputs** page allows the user to enable or disable individual clock outputs, select the clock mode (Bypass/Divided/Delayed/Divided & Delayed), set the clock output delay value (if delay is enabled), and set the clock output divider value (2, 4, 6, ..., 510).

This page also allows the user to select the VCO Divider value (2, 3, ..., 8). Note that the total PLL2 N divider value is composed of both the VCO Divider value and the N value shown in the blue box in the image, and is given by: $N_TOTAL = VCO\ Divider \times N$.

Clicking on the blue box that contains R, PDF, and N values takes the user to the **PLL2** page where these values may be changed.

Clicking on the components in the box containing the Internal Loop Filter values allows the user to change these component values.

The Reference Oscillator value field may be changed in either the **Clock Outputs** page or the **PLL2** page. Note this value should match the value of the onboard VCXO or Crystal. **When using the EN_PLL2_REF2X = 1**, Reference Oscillator field should be twice the VCXO or Crystal frequency.

The screenshot displays the TICS Pro software interface for configuring the LMK04100 clock outputs. The main configuration area is divided into several sections:

- Reference:** A sine wave icon representing a 122.88 MHz reference clock.
- PLL (Phase-Locked Loop):** Configured with R = 2, PDF = 61.44 MHz, and N = 10.
- External Loop Filter:** A grey box representing the external loop filter.
- Internal Loop Filter:** Configured with R3 = 600 ohms, R4 = 200 ohms, and capacitors C3 = 0pF, C4 = 10pF.
- Internal VCO (Voltage-Controlled Oscillator):** A sine wave icon representing a 1228.8 MHz internal VCO.
- VCO Divider:** A green box showing a divider of 2, resulting in a Divided Frequency of 614.4 MHz.
- Clock Divider:** A vertical stack of five dividers, each set to 2.
- Clock Mux:** A vertical stack of five multiplexers, all set to 'Bypassed'.
- Clock Output:** A vertical stack of five outputs, all set to 'Disablec' (disabled).

The output labels on the right are CLKout0 through CLKout4, each followed by 'MHz'. The status bar at the bottom indicates the device is not connected: 'Connection Mode: Device Not Connected'. The Texas Instruments logo is visible in the bottom right corner of the status bar.

Figure 10. TICS Pro - Clock Outputs Page

A.8 Burst Page

The **Burst** page allows the user to program sequences of register programming or pin control.

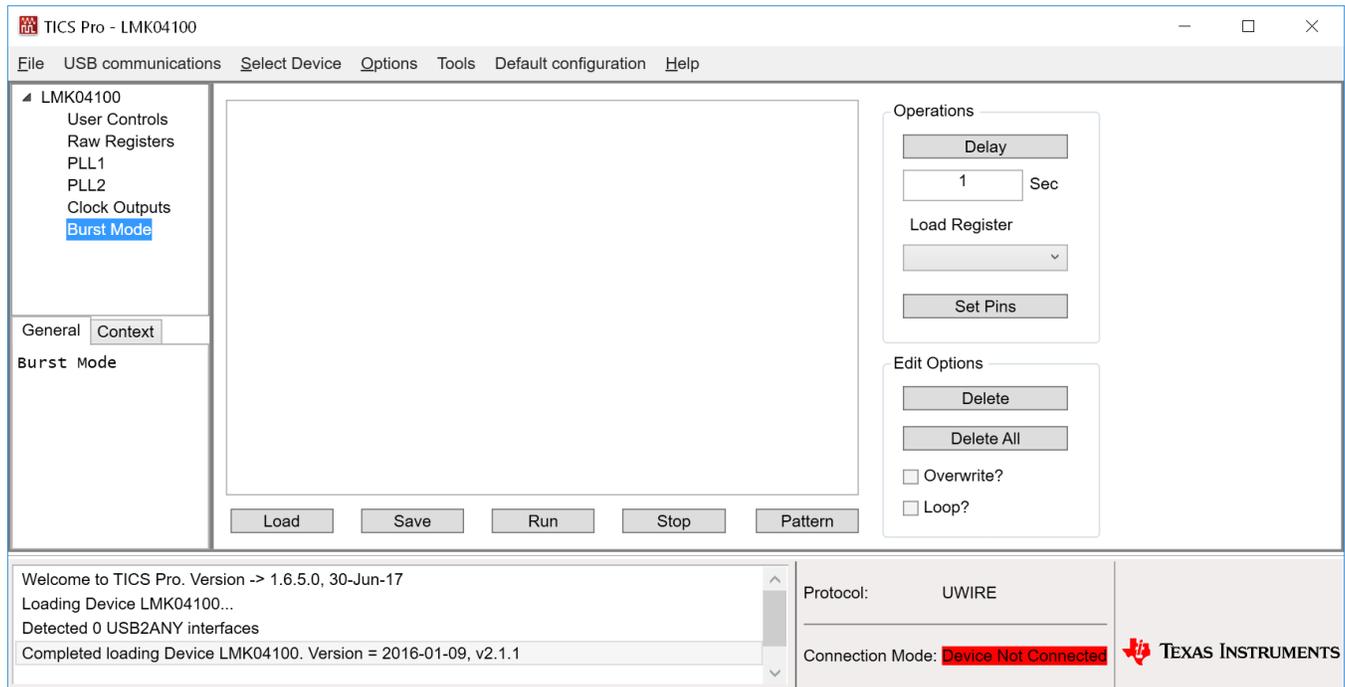


Figure 11. TICS Pro - Burst Page

Typical Phase Noise Performance Plots

B.1 PLL1

The two stage jitter cleaning process of the LMK041xx involves masking the reference noise with a VCXO or Crystal. Therefore, the phase noise performance of the VCXO or Crystal of PLL1 is a very important contributor to the final phase noise of the system.

B.1.1 Crystek 122.88 MHz VCXO

The phase noise of the reference is masked by the phase noise of this VCXO by using a narrow loop bandwidth. This VCXO sets the reference noise to PLL2. Figure 12 shows the open-loop typical phase noise performance of the CVHD-950-122.88 Crystek VCXO.

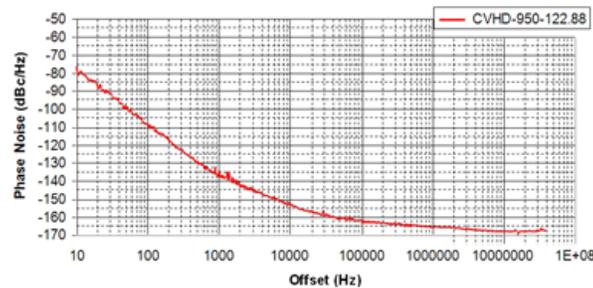


Figure 12. CVHD-950-122.88-MHz VCXO Phase Noise at 122.88 MHz

Table 4. VCXO Phase Noise at 122.88 MHz (dBc/Hz)

| OFFSET | PHASE NOISE |
|---------|-------------|
| 10 Hz | -76.6 |
| 100 Hz | -108.9 |
| 1 kHz | -137.4 |
| 10 kHz | -153.3 |
| 100 kHz | -162 |
| 1 MHz | -165.7 |
| 10 MHz | -168.1 |
| 40 MHz | -168.1 |

Table 5. VCXO RMS Jitter to High Offset of 20 MHz at 122.88 MHz (rms fs)

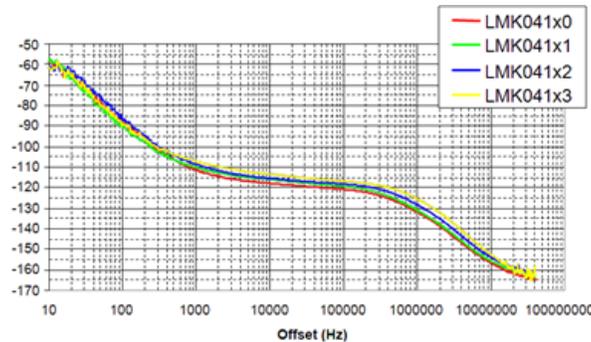
| LOW OFFSET | JITTER |
|------------|--------|
| 10 Hz | 515.4 |
| 100 Hz | 60.5 |
| 1 kHz | 36.2 |
| 10 kHz | 35 |
| 100 kHz | 34.5 |
| 1 MHz | 32.9 |

Table 5. VCXO RMS Jitter to High Offset of 20 MHz at 122.88 MHz (rms fs) (continued)

| LOW OFFSET | JITTER |
|------------|--------|
| 10 MHz | 22.7 |

B.2 PLL2

The closed-loop performance of the system as measured at the VCO output Fout. Fout phase noise performance of the various LMK options is plotted in Figure 13. Table 6 and Table 7 summarize the phase noise and jitter of Fout.


Figure 13. LMK041xx PLL2 Phase Noise (Fout)
Table 6. LMK041x0 Phase Noise (dBc/Hz)

| OFFSET | LMK041x0 | LMK041x1 | LMK041x2 | LMK041x3 |
|---------|----------|----------|----------|----------|
| 10 Hz | -58.7 | -58.3 | -61.3 | -61.1 |
| 100 Hz | -88.0 | -88.3 | -85.7 | -90.4 |
| 1 kHz | -111.6 | -110.2 | -108.9 | -107.5 |
| 10 kHz | -118.2 | -116.3 | -115.7 | -113.5 |
| 100 kHz | -121.1 | -119.5 | -118.4 | -117.0 |
| 1 MHz | -132.0 | -131.1 | -128.6 | -125.6 |
| 10 MHz | -157.1 | -155.8 | -154.0 | -152.7 |
| 40 MHz | -165.9 | -164.2 | -162.3 | -160.8 |

Table 7. LMK041x0 RMS Jitter; Integrated From Low Limit to 20 MHz (rms fs)

| LOW OFFSET | LMK041x0 | LMK041x1 | LMK041x2 | LMK041x3 |
|------------|----------|----------|----------|----------|
| 10 Hz | 580 | 506.6 | 443.4 | 356 |
| 100 Hz | 127.2 | 117.5 | 124.5 | 132.8 |
| 1 kHz | 114.8 | 111.3 | 114.9 | 128.1 |
| 10 kHz | 111.7 | 108 | 112 | 125 |
| 100 kHz | 97.3 | 92.7 | 99.2 | 112.2 |
| 1 MHz | 39.7 | 36.2 | 41.6 | 50.9 |
| 10 MHz | 6 | 5.9 | 6 | 5.5 |

B.3 Clock Outputs

The LMK04100 Family features LVDS, LVPECL, 2VPECL, and LVCMOS types of outputs. Included below are various phase noise measurements for each output.

Table 8. Device Output Format Information

| DEVICE(NSID) | CLKout0 | CLKout1 | CLKout2 | CLKout3 | CLKout4 | VCO FREQUENCY |
|--------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------------|
| LMK04100SQ | 2VPECL / LVPECL | LVC MOS x 2 | LVC MOS x 2 | 2VPECL / LVPECL | 2VPECL / LVPECL | 1185 to 1296 MHz |
| LMK04101SQ | 2VPECL / LVPECL | LVC MOS x 2 | LVC MOS x 2 | 2VPECL / LVPECL | 2VPECL / LVPECL | 1430 to 1570 MHz |
| LMK04102SQ | 2VPECL / LVPECL | LVC MOS x 2 | LVC MOS x 2 | 2VPECL / LVPECL | 2VPECL / LVPECL | 1566 to 1724 MHz |
| LMK04110SQ | 2VPECL / LVPECL | 1185 to 1296 MHz |
| LMK04111SQ | 2VPECL / LVPECL | 1430 to 1570 MHz |
| LMK04131SQ | LVDS | 2VPECL / LVPECL | LVC MOS x 2 | 2VPECL / LVPECL | LVDS | 1430 to 1570 MHz |
| LMK04133SQ | LVDS | 2VPECL / LVPECL | LVC MOS x 2 | 2VPECL / LVPECL | LVDS | 1840 to 2160 MHz |

B.3.1 Clock Output Measurement Technique

The measurement technique for each output type varies.

LVDS – measured with an ADT2-1T balun to test equipment.

LVPECL/2VPECL – Measured by terminating complementary output with 50-Ω load, then taking output to test equipment.

LVC MOS – Measured by enabling only one side of the LVC MOS output and taking the operating output to test equipment.

The following table lists the test conditions used for the phase noise measurements for the VCXO option:

Table 9. LMK041xx Test Conditions

| PARAMETER | VALUE |
|--------------------------------|--|
| PLL1 Reference clock input | CLKin0* single-ended input, CLKin0 AC-coupled to GND |
| PLL1 Reference Clock frequency | 122.88 MHz |
| PLL1 Phase detector frequency | 1024 kHz |
| PLL1 Charge Pump Gain | 100 uA |
| VCXO frequency | 122.88 MHz |
| PLL2 phase detector frequency | 61.44 MHz |
| PLL2 Charge Pump Gain | 3200 uA |
| PLL2 REF2X mode | Disabled |

B.4 LMK041x0 Phase Noise

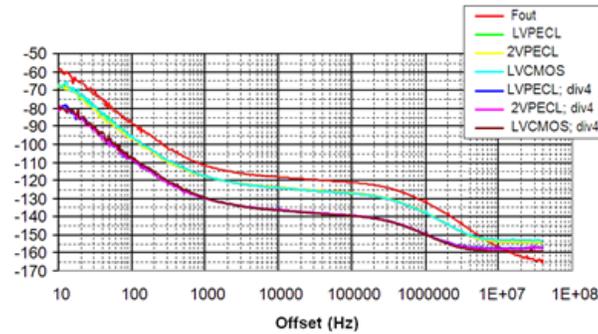


Figure 14. LMK041x0B Phase Noise

The Fout frequency is 1228.8 MHz. The clock out frequency is 614.4 MHz, and the clock out div 4 frequency is 153.6 MHz.

Table 10. LMK041x0 Phase Noise (dBc/Hz)

| OFFSET | Fout | LVPECL | 2VPECL | LVC MOS | LVPECL div4 | 2VPECL div4 | LVC MOS div4 |
|---------|--------|--------|--------|---------|-------------|-------------|--------------|
| 10 Hz | -58.7 | -67.1 | -67.1 | -66.3 | -79.8 | -81.5 | -79.7 |
| 100 Hz | -88 | -95.8 | -96.8 | -94.8 | -107.5 | -109.1 | -106.6 |
| 1 kHz | -111.6 | -117.6 | -117.7 | -117.9 | -129.5 | -130.2 | -129.4 |
| 10 kHz | -118.2 | -123.8 | -123.8 | -124.2 | -134.8 | -135.2 | -136 |
| 100 kHz | -121.1 | -127 | -127 | -127.3 | -139.4 | -139.3 | -139.6 |
| 1 MHz | -132 | -137.9 | -137.8 | -138.1 | -149.5 | -149.6 | -150 |
| 10 MHz | -157.1 | -153.8 | -153.8 | -152.8 | -157.4 | -158.1 | -159.2 |
| 40 MHz | -165.9 | -154.8 | -154.8 | -153.6 | -157.3 | -158 | -159.7 |

Table 11. LMK041x0 RMS Jitter; Integrated From Low Limit to 20 MHz (rms fs)

| LOW LIMIT | Fout | LVPECL | 2VPECL | LVC MOS | LVPECL div4 | 2VPECL div4 | LVC MOS div4 |
|-----------|-------|--------|--------|---------|-------------|-------------|--------------|
| 10 Hz | 580 | 474.7 | 449.2 | 522.4 | 493.9 | 466.5 | 493.5 |
| 100 Hz | 127.2 | 128.3 | 127.9 | 127.1 | 148.9 | 145.6 | 139.4 |
| 1 kHz | 114.8 | 119.9 | 120.4 | 117.9 | 141.8 | 138.7 | 129.9 |
| 10 kHz | 111.7 | 116.8 | 117.3 | 114.9 | 139.3 | 136.2 | 127.3 |
| 100 kHz | 97.3 | 102.9 | 103.3 | 101.6 | 128.8 | 125.3 | 116.3 |
| 1 MHz | 39.7 | 50.5 | 50.6 | 52.4 | 94.3 | 89.5 | 79.5 |

B.5 LMK041x1 Phase Noise

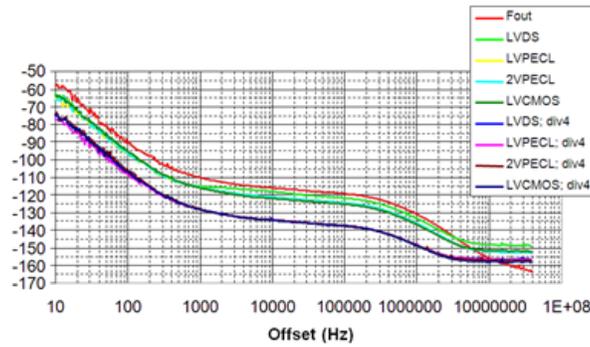


Figure 15. LMK041x1 Phase Noise

The Fout frequency is 1474.56 MHz. The clock out frequency is 737.28 MHz, and the clock out div 4 frequency is 184.32 MHz. Note that the LVDS performance at 737.28 MHz is degraded because it is outside of the operational bandwidth of the balun.

Table 12. LMK041x1 Phase Noise (dBc/Hz)

| OFFSET | Fout | LVDS | LVPECL | 2VPECL | LVCMOS | LVDS div4 | LVPECLdiv4 | 2VPECL div4 | LVCMOS div4 |
|---------|--------|--------|--------|--------|--------|-----------|------------|-------------|-------------|
| 10 Hz | -58.3 | -62 | -65.4 | -66.4 | -63.4 | -74.8 | -76.7 | -73.8 | -74.6 |
| 100 Hz | -88.3 | -96.4 | -95.9 | -96 | -94.8 | -106.7 | -107.7 | -105.3 | -106.7 |
| 1 kHz | -110.2 | -115.3 | -115.7 | -115.8 | -116.2 | -128.3 | -128.3 | -128.1 | -128.3 |
| 10 kHz | -116.3 | -118.1 | -121.2 | -121.3 | -122 | -132.8 | -134 | -134.3 | -134.7 |
| 100 kHz | -119.5 | -122 | -124.7 | -124.7 | -125.5 | -137.7 | -137.7 | -137.8 | -137.9 |
| 1 MHz | -131.1 | -133.5 | -136.2 | -136.2 | -137 | -148.5 | -148.7 | -148.7 | -148.9 |
| 10 MHz | -155.8 | -148.2 | -152.3 | -152.3 | -151.7 | -156.9 | -157.1 | -157.5 | -158.3 |
| 40 MHz | -164.2 | -149.5 | -153.5 | -153.6 | -152.5 | -157.5 | -157.3 | -158 | -158.8 |

Table 13. LMK041x1 RMS Jitter; Integrated From Low Limit to 20 MHz (rms fs)

| LOW LIMIT | Fout | LVDS | LVPECL | 2VPECL | LVCMOS | LVDS div4 | LVPECL div4 | 2VPECL div4 | LVCMOS div4 |
|-----------|-------|-------|--------|--------|--------|-----------|-------------|-------------|-------------|
| 10 Hz | 506.6 | 538.4 | 425.5 | 458.5 | 501.9 | 532.2 | 445.6 | 591 | 544.1 |
| 100 Hz | 117.5 | 178.3 | 132.4 | 131.8 | 123.1 | 141 | 138.6 | 139.1 | 132.5 |
| 1 kHz | 111.3 | 174.2 | 127 | 126.4 | 116.2 | 135.1 | 133.3 | 131.4 | 125.5 |
| 10 kHz | 108 | 169.5 | 123.4 | 122.8 | 113 | 132.4 | 130.7 | 128.7 | 122.8 |
| 100 kHz | 92.7 | 147.7 | 107.2 | 106.7 | 98.7 | 120.7 | 119 | 116.8 | 110.8 |
| 1 MHz | 36.2 | 72.9 | 50.4 | 50.1 | 49.1 | 85.2 | 83.4 | 80.3 | 73.4 |

B.6 LMK041x2 Phase Noise

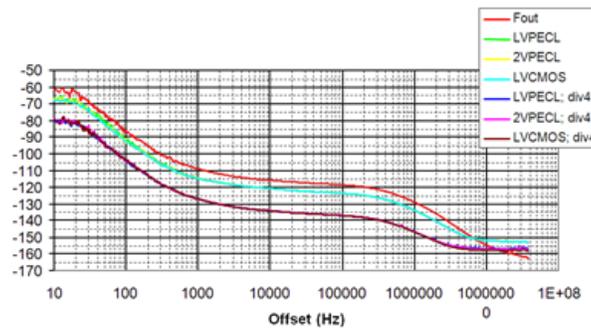


Figure 16. LMK041x2 Phase Noise

The Fout frequency is 1720.32 MHz. The clock out frequency is 860.16 MHz, and the clock out div 4 frequency is 215.04 MHz.

Table 14. LMK041x2 Phase Noise (dBc/Hz)

| OFFSET | Fout | LVPECL | 2VPECL | LVCMOS | LVPECL div4 | 2VPECL div4 | LVCMOS div4 |
|---------|--------|--------|--------|--------|-------------|-------------|-------------|
| 10 Hz | -61.3 | -66.6 | -67.3 | -67.7 | -80.1 | -78.7 | -78.9 |
| 100 Hz | -85.7 | -91.5 | -90.4 | -91.9 | -103.3 | -103.2 | -103.8 |
| 1 kHz | -108.9 | -114.3 | -114.2 | -114.6 | -126.7 | -127.2 | -126.5 |
| 10 kHz | -115.7 | -120.7 | -120.7 | -120.6 | -133.5 | -133.7 | -134.1 |
| 100 kHz | -118.4 | -123.5 | -123.5 | -123.5 | -136.7 | -136.7 | -136.8 |
| 1 MHz | -128.6 | -133.4 | -133.4 | -133.4 | -146.2 | -146.3 | -146.5 |
| 10 MHz | -154 | -151.5 | -151.5 | -151.6 | -156.7 | -157 | -157.7 |
| 40 MHz | -162.3 | -153 | -153.2 | -153.2 | -157 | -157.3 | -158.2 |

Table 15. LMK041x2 RMS Jitter; Integrated From Low Limit to 20 MHz (rms fs)

| LOW LIMIT | Fout | LVPECL | 2VPECL | LVCMOS | LVPECL div4 | 2VPECL div4 | LVCMOS div4 |
|-----------|-------|--------|--------|--------|-------------|-------------|-------------|
| 10 Hz | 443.4 | 498.1 | 477.3 | 450.5 | 439.3 | 473.4 | 458.5 |
| 100 Hz | 124.5 | 143.1 | 140.8 | 140.4 | 141 | 140.7 | 136.6 |
| 1 kHz | 114.9 | 132.7 | 132.1 | 132 | 132.3 | 131.1 | 126.6 |
| 10 kHz | 112 | 129.6 | 129 | 129 | 130 | 128.7 | 124.2 |
| 100 kHz | 99.2 | 115.7 | 115.2 | 115.2 | 119.7 | 118.3 | 113.7 |
| 1 MHz | 41.6 | 54.9 | 54.8 | 54.7 | 79.2 | 77.1 | 71.8 |

B.7 LMK041x3 Phase Noise

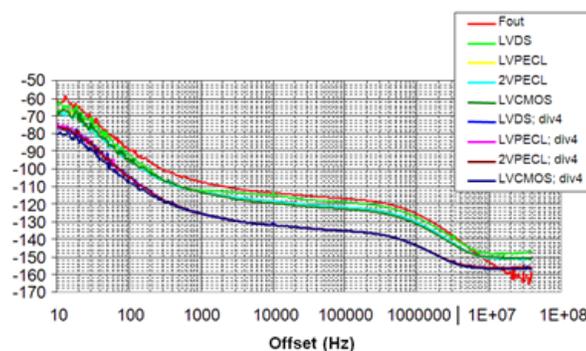


Figure 17. LMK041x3 Phase Noise

The Fout frequency is 1966.08 MHz. The clock out frequency is 983.04 MHz, and the clock out div 4 frequency is 245.76 MHz. Note that the LVDS performance at 737.28 MHz is degraded because it is outside of the operational bandwidth of the balun.

Table 16. LMK041x3 Phase Noise (dBc/Hz)

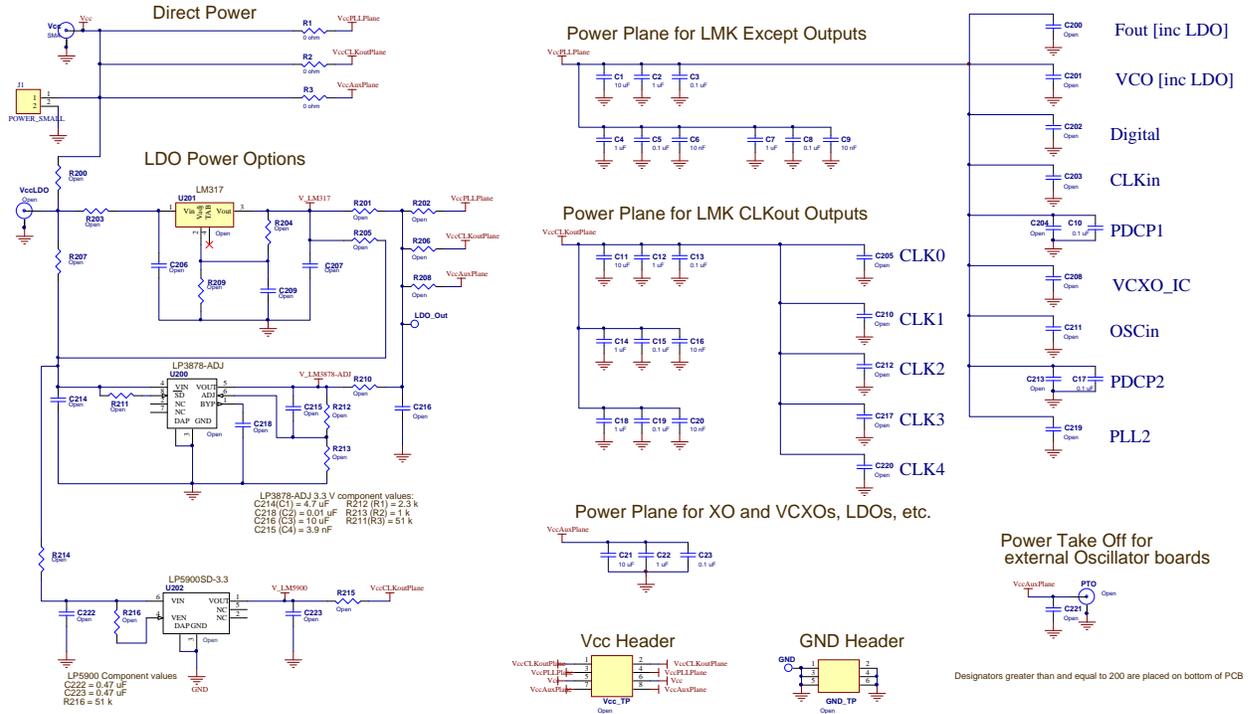
| OFFSET | Fout | LVDS | LVPECL | 2VPECL | LVC MOS | LVDS div4 | LVPECL div4 | 2VPECL div4 | LVC MOS div4 |
|---------|--------|--------|--------|--------|---------|-----------|-------------|-------------|--------------|
| 10 Hz | -61.1 | -63.9 | -66.2 | -67.6 | -67 | -76.1 | -75.2 | -75.9 | -80.1 |
| 100 Hz | -90.4 | -92.1 | -94.6 | -93.9 | -94.3 | -103.5 | -103.7 | -104.4 | -106.3 |
| 1 kHz | -107.5 | -112.2 | -112.8 | -112.8 | -113.6 | -125.5 | -125.8 | -125.5 | -125.4 |
| 10 kHz | -113.5 | -115.1 | -118.1 | -118.2 | -119.7 | -130.3 | -131.4 | -131.5 | -132 |
| 100 kHz | -117 | -119.1 | -121.8 | -121.9 | -123 | -135.2 | -135.3 | -135.3 | -135.3 |
| 1 MHz | -125.6 | -127.6 | -130.4 | -130.4 | -131.5 | -143.5 | -143.6 | -143.6 | -143.7 |
| 10 MHz | -152.7 | -148 | -150.6 | -150.6 | -150 | -156.3 | -156.1 | -156.3 | -156.8 |
| 40 MHz | -160.8 | -147.2 | -151.9 | -151.9 | -151.2 | -156.8 | -156.4 | -156.6 | -157.3 |

Table 17. LMK041x3 RMS Jitter; Integrated From Low Limit to 20 MHz (rms fs)

| LOW LIMIT | Fout | LVDS | LVPECL | 2VPECL | LVC MOS | LVDS div4 | LVPECL div4 | 2VPECL div4 | LVC MOS div4 |
|-----------|-------|-------|--------|--------|---------|-----------|-------------|-------------|--------------|
| 10 Hz | 356 | 531.5 | 367.7 | 339 | 367.6 | 471.8 | 499.6 | 464 | 338.9 |
| 100 Hz | 132.8 | 210 | 153.3 | 153.4 | 137.4 | 147.1 | 146.5 | 146.2 | 141.5 |
| 1 kHz | 128.1 | 205.5 | 149.2 | 149.5 | 132.6 | 140.7 | 140.5 | 140.2 | 137.1 |
| 10 kHz | 125 | 200.9 | 145.8 | 146.1 | 129.6 | 138.1 | 137.9 | 137.6 | 134.4 |
| 100 kHz | 112.2 | 181.2 | 131.6 | 131.9 | 117.3 | 127.2 | 127.1 | 126.7 | 123.5 |
| 1 MHz | 50.9 | 88.9 | 64.4 | 64.5 | 59.5 | 79.6 | 80.6 | 79.7 | 75.8 |

Schematics

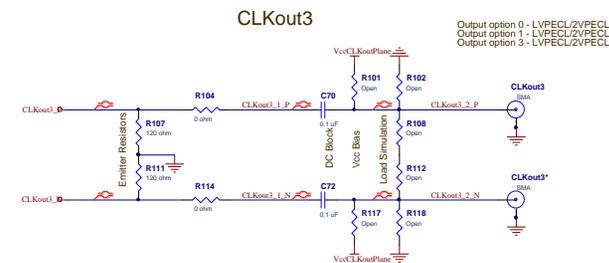
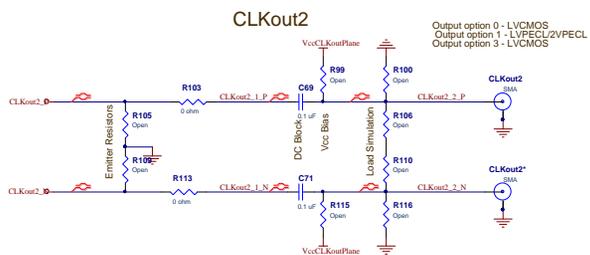
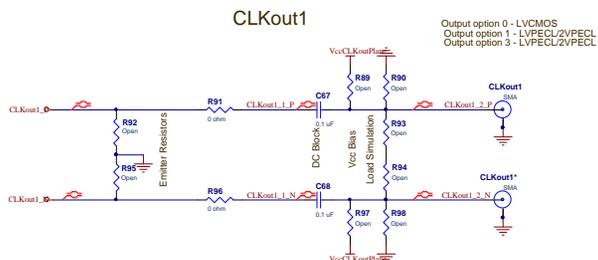
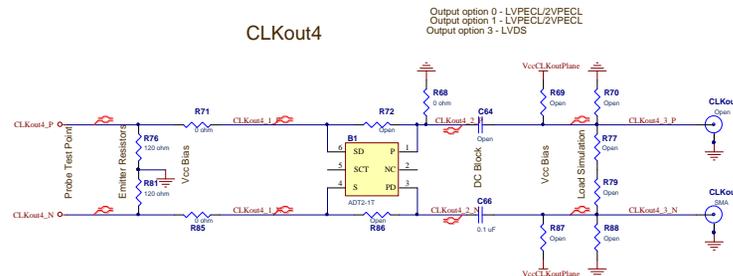
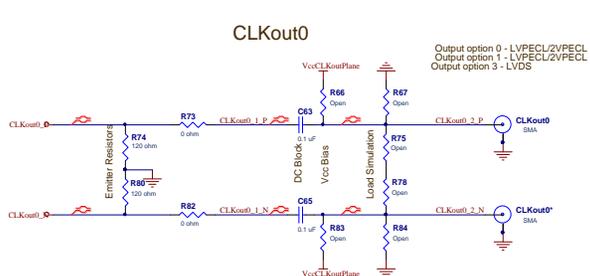
C.1 Power Supply



10 Jan 2017

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C.3 Clock Outputs



Notes:

1. A stub will be placed near all CLKout SMA connectors to test the effects of capacitive loading.
2. CLKout0 and CLKout4 are both the same type and never CMOS.
3. CLKout1, CLKout2 and CLKout3 can be made LVPECL or CMOS via metal mask.

Designators greater than and equal to 200 are placed on bottom of PCB
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Board Layers Stackup

Layers of the 6 layer evaluation board include (Dielectrics are green):

| | | |
|---|--|---|
| <ul style="list-style-type: none"> • Top layer for high priority high frequency signals <ul style="list-style-type: none"> – 1 oz CU • RO4003 Dielectric, 16 mils • Ground plane • FR4, 2.5 mils thick. • Power plane #1 – V_{cc}CLK • FR4, xx mils • middle ground plane • FR4, xx mils • V_{cc}PLL, V_{cc}Aux • FR4, xx mils • Bottom layer copper clad for thermal relief | <p>Top Copper. 1-oz thick [LMK04100.GTL] RO4003 (Er = 3.38) CONTROLLED THICKNESS of 16 mils thick</p> <p>GND plane [LMK04100.GP1] FR4 (Er = ~4.6) CONTROLLED THICKNESS: 2.5 mils</p> <p>V_{cc}CLK plane [LMK04100.GP2] FR4 xx mils</p> <p>Middle Ground Plane FR4 xx mils</p> <p>V_{cc} mixed plane [LMK04100.G1] FR4 xx mils</p> <p>Bottom Copper – Thermal relief [LMK04100.GBL]</p> |  <p>62 mils thick total</p> |
|---|--|---|

Top to bottom layer order:

1. LMK04100.GTL (top copper)
2. LMK04100.GP1 (gnd)
3. LMK04100.GP2 (vcc)
4. LMK04100.GP3 (gnd)
5. LMK04100.G1 (vcc)
6. LMK04100.GBL (bottom copper)

Bill of Materials

E.1 Common Bill of Materials for Evaluation Boards

Table 18. Common Bill of Materials for Evaluation Boards

| PART | MANUFACTURER | PART NUMBER | QNT | IDENTIFIER |
|-------------------|--------------|------------------|-----|--|
| CAPACITORS | | | | |
| 2.0 pF | Kemet | C0603C209C5GAC | 2 | C33, C41 |
| 33 pF | Kemet | C0402C330J5GAC | 3 | C26, C27, C28 |
| 100 pF | Kemet | C0603C101J5GAC | 2 | C24, C38 |
| 1 nF | Kemet | C0603C102J5GAC | 1 | C37 |
| 2.2 nF | Kemet | C0603C222K5RAC | 2 | C35, C40 |
| 6.8 nF | Kemet | C0603C682K1RACTU | 1 | C2_B2 |
| 10 nF | Kemet | C0603C103K1RACTU | 4 | C6, C9, C16, C20 |
| 12 nF | Panasonic | ECH-U01123JX5 | 1 | C2_A2 |
| 0.1 uF | Kemet | C0603C104J3RAC | 25 | C3, C5, C8, C10, C13, C15, C17, C19, C23, C30, C34, C36, C45, C48, C59, C60, C63, C65, C66, C67, C68, C69, C70, C71, C72 |
| 100 nF | Kemet | C0603C104J3RAC | 1 | C1_A1 |
| 330 nF | Kemet | C0603C334K4RACTU | 1 | C1_B1 |
| 0.47 uF | Kemet | C0603C474K8PACTU | 1 | C32 |
| 680 nF | Kemet | C0603C684K8PAC | 1 | C2_A1 |
| 1 uF | Kemet | C0603C105K8PAC | 10 | C2, C4, C7, C12, C14, C18, C22, C25, C39, C47 |
| 10 uF | Kemet | C0805C106K9PAC | 5 | C1, C2pB1, C11, C21, C29 |
| | | | | C51, C58, C62 |
| RESISTORS | | | | |
| 0 ohm | Vishay/Dale | CRCW06030000Z0EA | 23 | R1, R2, R3, R26, R32, R44, R47, R60, R65, R68, R71, R73, R82, R85, R91, R96, R103, R104, R113, R114 |
| 18 ohm | Vishay/Dale | CRCW060318R0JNEA | 1 | R5 |
| 51 ohm | Vishay/Dale | CRCW060351R0JNEA | 2 | R13, R62 |
| 100 ohm | Vishay/Dale | CRCW0603100RJNEA | 2 | R16, R51 |
| 120 ohm | Vishay/Dale | CRCW0603120RJNEA | 2 | R107, R111 |
| 180 ohm | Vishay/Dale | CRCW0603180RJNEA | 2 | R36, R41 |
| 270 ohm | Vishay/Dale | CRCW0603270RJNEA | 5 | R4, R6, R7, R8, R45 |
| 1.8 k | Vishay/Dale | CRCW06031K80JNEA | 1 | R2_A2 |
| 2.2 k | Vishay/Dale | CRCW06032K20JNEA | 2 | R35, R40 |
| 2.7 k | Vishay/Dale | CRCW06032K70JNEA | 1 | R2_B2 |
| 3.9 k | Vishay/Dale | CRCW06033K90JNEA | 1 | R2_B1 |

Table 18. Common Bill of Materials for Evaluation Boards (continued)

| PART | MANUFACTURER | PART NUMBER | QNT | IDENTIFIER |
|-----------------------|------------------------|------------------|-----|---|
| 4.7 k | Vishay/Dale | CRCW06034K70JNEA | 2 | R20, R30 |
| 10 k | Vishay/Dale | CRCW060310K0JNEA | 1 | R23 |
| 15 k | Vishay/Dale | CRCW060315K0JNEA | 3 | R12, R19, R29 |
| 27 k | Vishay/Dale | CRCW060327K0JNEA | 3 | R11, R18, R28 |
| 39 k | Vishay/Dale | CRCW060339K0JNEA | 1 | R2_A1 |
| Other | | | | |
| POWER_SMALL | Weidmuller | 1594540000 | 1 | J1 |
| SMA | Johnson Components | 142-0701-851 | 14 | CLKin0*, CLKin1, CLKin1*, CLKout0*, CLKout0, CLKout1*, CLKout1, CLKout2*, CLKout2, CLKout3*, CLKout3, CLKout4*, Fout, Vcc |
| SMA_FRAME | Printed Circuits Corp. | PCB | 1 | F1 |
| Red LED | Lumex | SML-LX2832IC-TR | 2 | D3, D5 |
| Green LED | Lumex | SML-LX2832GC-TR | 1 | D1 |
| 0.875" Standoff | SPC Technology | SPCS-14 | 4 | S1, S2, S3, S4 |
| ADT2-1T | Minicircuits | ADT2-1T+ | 1 | B1 |
| HEADER_2X5(POLARIZED) | FCI Electronics | 52601-S10-8 | 1 | uWire |
| 3.3 V zener | Comchip | CZRU52C3V3 | 2 | D7, D8 |
| SMV-1249-074 | Skyworks | SMV1249-074LF | 1 | D9 |
| Open | | | | |
| Open | R | | 78 | R14, R17, R21, R22, R24, R25, R27, R33, R34, R38, R42, R43, R46, R48, R49, R50, R52, R53, R54, R55, R56, R57, R58, R59, R61, R63, R64, R66, R67, R69, R70, R72, R75, R77, R78, R79, R83, R84, R86, R87, R88, R89, R90, R93, R94, R97, R98, R99, R100, R101, R102, R105, R106, R108, R109, R110, R112, R115, R116, R117, R118, R200, R201, R202, R203, R204, R205, R206, R207, R208, R209, R210, R211, R212, R213, R214, R215, R216 |
| Open | C | | 44 | C1_A2, C1_B2, C2pB2, C2pA2, C2pA1, C2_B1, C3_AB1, C43, C44, C46, C49, C50, C52, C53, C54, C55, C56, C57, C61, C64, C200, C201, C202, C203, C204, C205, C206, C207, C208, C209, C210, C211, C212, C213, C214, C215, C216, C217, C218, C219, C220, C221, C222, C223 |

Table 18. Common Bill of Materials for Evaluation Boards (continued)

| PART | MANUFACTURER | PART NUMBER | QNT | IDENTIFIER |
|------|--------------|-------------|-----|---|
| Open | U | | 4 | U3, U200, U201, U202 |
| Open | SMA | | 12 | OSCin*, OSCin, LOS0, LOS1, VccLDO, LD, PTO, GOE, SYNC*, CLKout4, Vtune1, CLKin0 |
| Open | Y | | 1 | Y200 |
| Open | D | | 3 | D2, D4, D6 |

E.2 Bill of Material Custom to LMK04100BEVAL
Table 19. Bill of Material Custom to LMK04100BEVAL

| PART | MANUFACTURER | PART NUMBER | QNT | IDENTIFIER |
|-------------------|-------------------|------------------|-----|------------------------------|
| CAPACITORS | | | | |
| 0.1 uF | Kemet | C0603C104J3RAC | 2 | C31, C42 |
| RESISTORS | | | | |
| 0 ohm | Vishay/Dale | CRCW06030000Z0EA | 2 | R9, R39 |
| 120 ohm | Vishay/Dale | CRCW0603120RJNEA | 4 | R74, R76, R80, R81 |
| Other | | | | |
| LMK04100B | Texas Instruments | LMK04100B | 1 | U1 |
| CVHD-950-122.88 | Crystek | CVHD-950-122.88 | 1 | U4 |
| Open | | | | |
| Open | | | 6 | R10, R15, R31, R37, R92, R95 |
| Open | | | 1 | Y1 |

E.3 Bill of Material Custom to LMK04100BEVAL-XO
Table 20. Bill of Material Custom to LMK04100BEVAL-XO

| PART | MANUFACTURER | PART NUMBER | QNT | IDENTIFIER |
|-------------------|-------------------|------------------|-----|--------------------|
| CAPACITORS | | | | |
| RESISTORS | | | | |
| 0 ohm | Vishay/Dale | CRCW06030000Z0EA | 4 | R10, R15, R31, R37 |
| 120 ohm | Vishay/Dale | CRCW0603120RJNEA | 4 | R74, R76, R80, R81 |
| Other | | | | |
| LMK04100B | Texas Instruments | LMK04100B | 1 | U1 |
| 12.288 MHz XTAL | Vectron | VXB1-1127-12M288 | 1 | Y1 |
| Open | | | | |
| Open | | | 2 | C31, C42 |
| Open | | | 4 | R9, R39, R92, R95 |
| Open | | | 1 | U4 |

E.4 Bill of Material Custom to LMK04131BEVAL

Table 21. Bill of Material Custom to LMK04131BEVAL

| PART | MANUFACTURER | PART NUMBER | QNT | IDENTIFIER |
|-------------------|-------------------|------------------|-----|---|
| CAPACITORS | | | | |
| 0.1 uF | Kemet | C0603C104J3RAC | 2 | C31, C43 |
| RESISTORS | | | | |
| 0 ohm | Vishay/Dale | CRCW06030000Z0EA | 2 | R9, R39 |
| 120 ohm | Vishay/Dale | CRCW0603120RJNEA | 2 | R92, R95 |
| Other | | | | |
| LMK04131B | Texas Instruments | LMK04131B | 1 | U1 |
| CVHD-950-122.88 | Crystek | CVHD-950-122.88 | 1 | U4 |
| Open | | | | |
| Open | | | 8 | R10, R15, R31, R37, R74, R76, R80, R81 |
| Open | | | 1 | Y1 |

E.5 Bill of Material Custom to LMK04131BEVAL-XO**Table 22. Bill of Material Custom to LMK04131BEVAL-XO**

| PART | MANUFACTURER | PART NUMBER | QNT | IDENTIFIER |
|-------------------|-------------------|------------------|-----|--------------------------------|
| CAPACITORS | | | | |
| RESISTORS | | | | |
| 0 ohm | Vishay/Dale | CRCW06030000Z0EA | 4 | R10, R15, R31, R37 |
| 120 ohm | Vishay/Dale | CRCW0603120RJNEA | 2 | R92, R95 |
| Other | | | | |
| LMK04131B | Texas Instruments | LMK04131B | 1 | U1 |
| 12.288 MHz XTAL | Vectron | VXB1-1127-12M288 | 1 | Y1 |
| Open | | | | |
| Open | | | 2 | C31, C42 |
| Open | | | 6 | R9, R39, R74, R76, R80, R81 |
| Open | | | 1 | U4 |

E.6 Bill of Material Custom to LMK04102BEVAL**Table 23. Bill of Material Custom to LMK04102BEVAL**

| PART | MANUFACTURER | PART NUMBER | QNT | IDENTIFIER |
|-------------------|-------------------|------------------|-----|--------------------|
| CAPACITORS | | | | |
| 0.1 uF | Kemet | C0603C104J3RAC | 2 | C31, C42 |
| RESISTORS | | | | |
| 0 ohm | Vishay/Dale | CRCW06030000Z0EA | 2 | R9, R39 |
| 120 ohm | Vishay/Dale | CRCW0603120RJNEA | 4 | R74, R76, R80, R81 |
| Other | | | | |
| LMK04102B | Texas Instruments | LMK04102B | 1 | U1 |
| CVHD-950-122.88 | Crystek | CVHD-950-122.88 | 1 | U4 |

Table 23. Bill of Material Custom to LMK04102BEVAL (continued)

| PART | MANUFACTURER | PART NUMBER | QNT | IDENTIFIER |
|-------------|--------------|-------------|-----|------------------------------|
| Open | | | | |
| Open | | | 6 | R10, R15, R31, R37, R92, R95 |
| Open | | | 1 | Y1 |

E.7 Bill of Material Custom to LMK04133BEVAL
Table 24. Bill of Material Custom to LMK04133BEVAL

| PART | MANUFACTURER | PART NUMBER | QNT | IDENTIFIER |
|-------------------|-------------------|------------------|-----|--|
| CAPACITORS | | | | |
| 0.1 uF | Kemet | C0603C104J3RAC | 2 | C31, C42 |
| RESISTORS | | | | |
| 0 ohm | Vishay/Dale | CRCW06030000Z0EA | 2 | R9, R39 |
| 120 ohm | Vishay/Dale | CRCW0603120RJNEA | 2 | R92, R95 |
| Other | | | | |
| LMK04133B | Texas Instruments | LMK04133B | 1 | U1 |
| CVHD-950-122.88 | Crystek | CVHD-950-122.88 | 1 | U4 |
| Open | | | | |
| Open | | | 8 | R10, R15, R31, R37, R74, R76, R80, R81 |
| Open | | | 1 | Y1 |

Balun Information

F.1 Typical Balun Frequency Response

Figure 18 shows the typical frequency response of the ADT2-1T balun in the Mini-circuit.

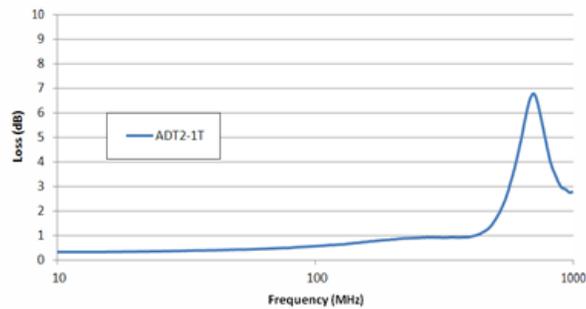


Figure 18. Typical Balun Frequency Response

VCXO/Crystal changes

This appendix contains instructions for changing the active onboard oscillator for PLL1.

G.1 Changing from Crystal Resonator to VCXO

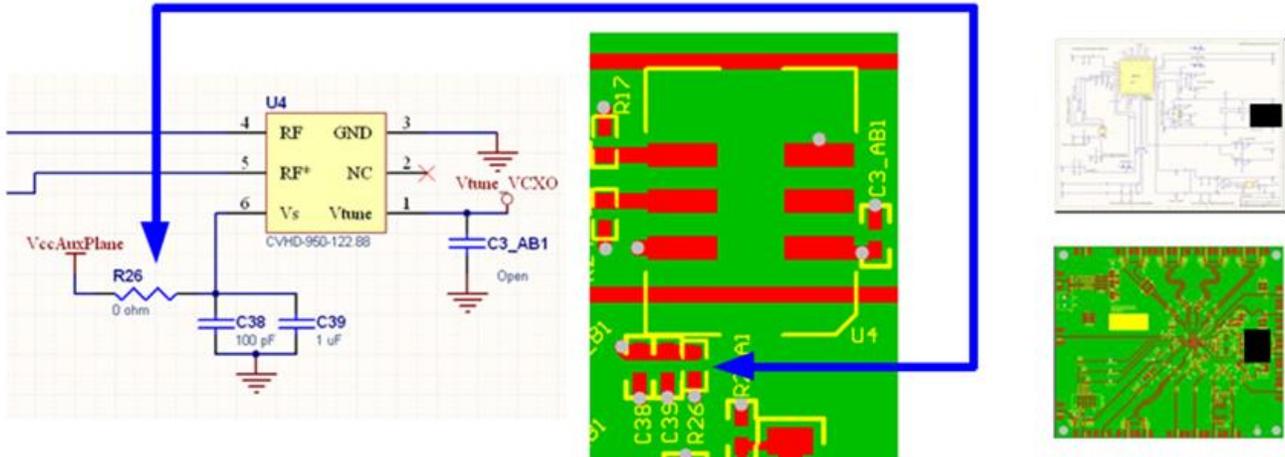
If the board has been setup to use the crystal-based oscillator with PLL1, the crystal may be disabled and the VCXO enabled as described on the following pages:

Summary

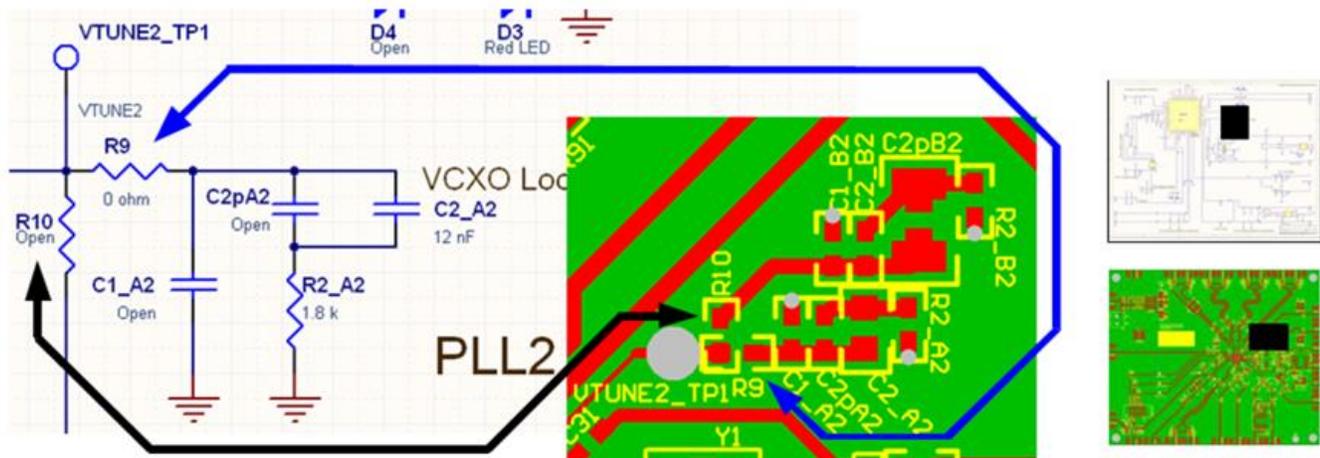
1. Connect power to VCXO
2. Disconnect Crystal RF path and connect VCXO RF path
3. Connect charge pump output from PLL1 to VCXO Loop Filter (A1) and VCXO.
4. Connect charge pump output from PLL2 to VCXO Loop filter (A2).

Procedures

1. Connect power to VCXO
 - (a) Install a 0-Ω resistor in R26 (near the VCXO)



2. Disconnect Crystal RF path and connect VCXO RF path
 - (a) Remove resistors R15 and R31.
 - (b) Install 0.1-μF capacitors in C31 and C43.



G.2 Changing from VCXO to Crystal Resonator

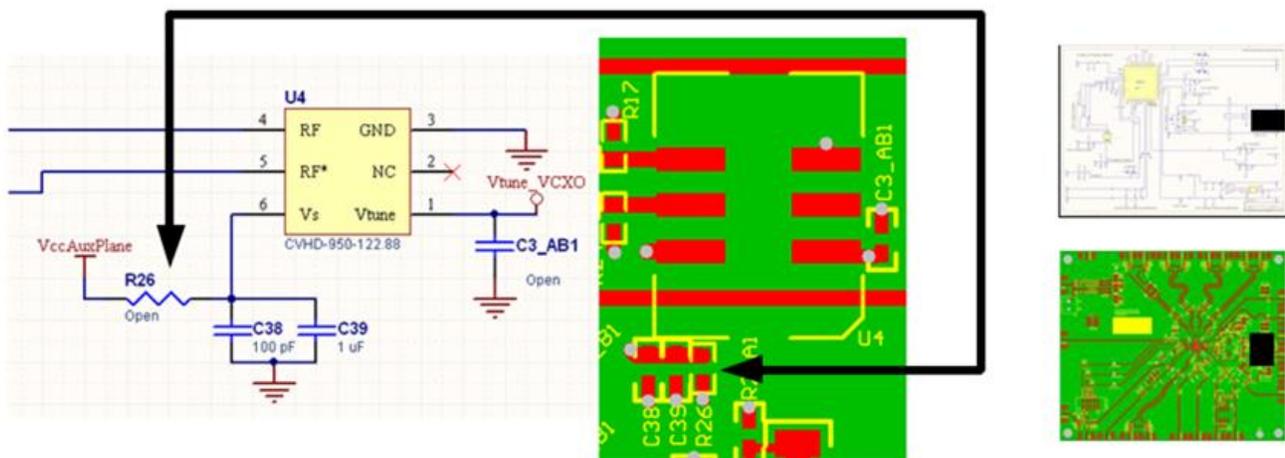
If the board has been setup to use the VCXO for PLL1, the VCXO may be disabled and the crystal enabled as described on the following pages:

Summary

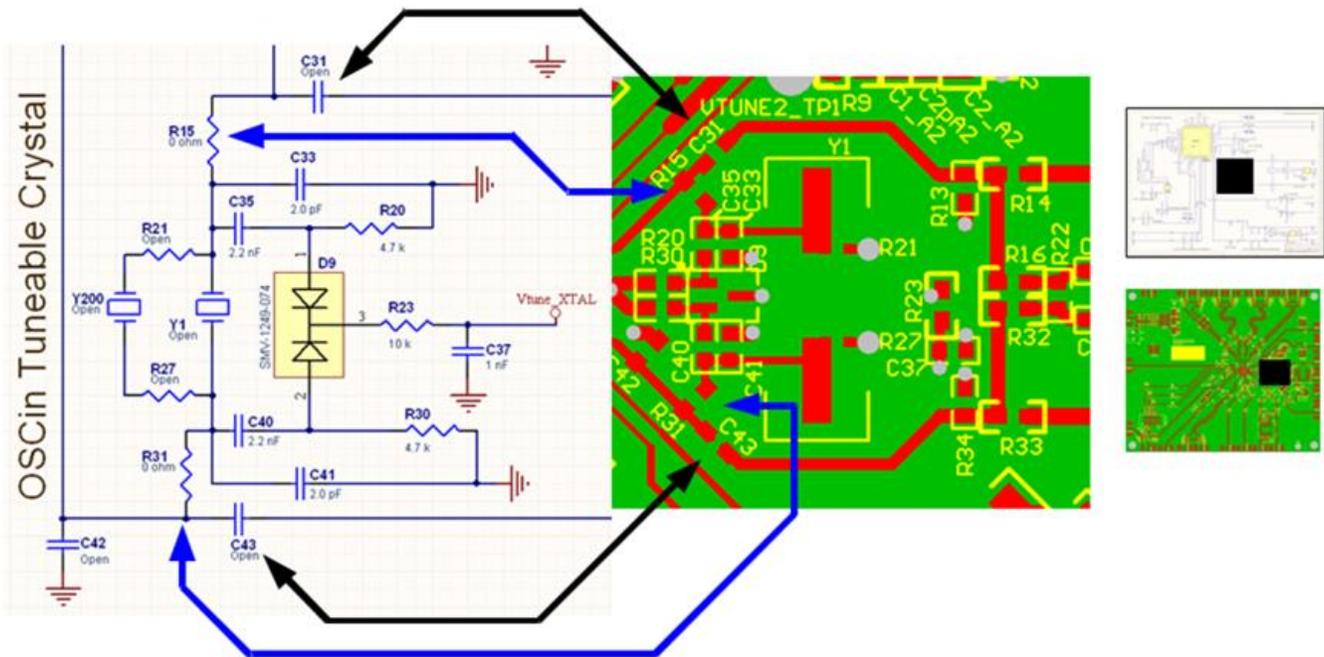
1. Remove power from VCXO
2. Disconnect VCXO RF path and connect Crystal RF path
3. Connect charge pump output from PLL1 to Crystal Loop Filter (B1) and Crystal
4. Connect charge pump output from PLL2 to Crystal Loop filter (B2)

Procedures

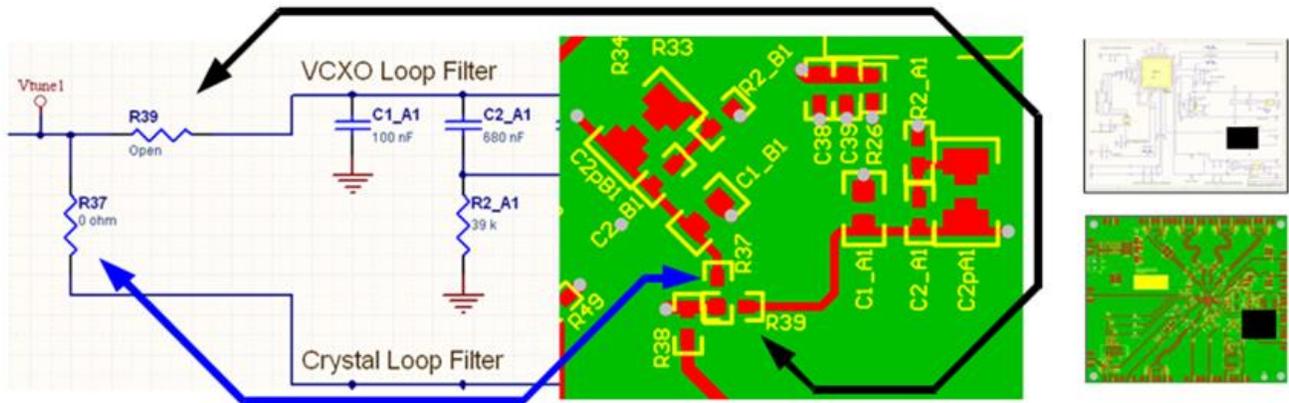
1. Remove power from VCXO
 - (a) Remove 0 ohm resistor in R26 (near the VCXO)



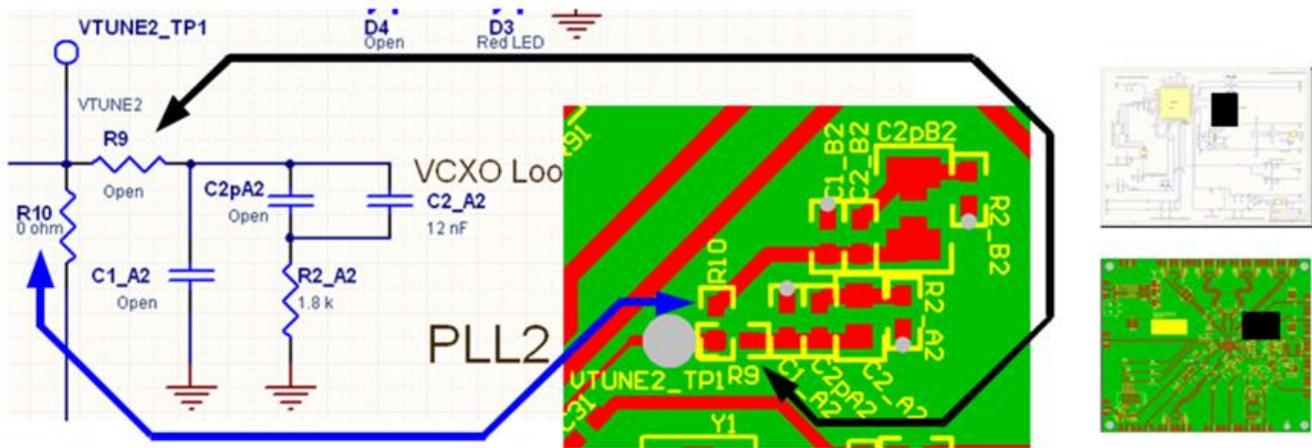
2. Disconnect VCXO RF path and connect Crystal RF path
 - (a) Install 0- Ω resistors R15 and R31.
 - (b) Remove 0.1- μ F capacitors in C31 and C43.



3. Connect charge pump output from PLL1 to Crystal Loop Filter (B1) and Crystal
 - (a) Remove R39 and install a 0-Ω resistor in R37. This resistor can be *switched* between the two footprints.



4. Connect charge pump output from PLL2 to Crystal Loop filter (B2)
 - (a) Remove R9 and install a 0-Ω resistor in R10. This resistor can be *switched* between the two footprints.



LMK04100

Figure 19 shows the functional architecture of the LMK041xx clock conditioner. It features a cascaded, dual PLL arrangement, available internal loop filter components for PLL2, internal VCO with PLL2 for frequency synthesis, and clock distribution section with individual clock output dividers and delay adjustment blocks. The dual reference clock input to PLL1 provides fail-safe redundancy for phase-locked loop operation. The cascaded PLL architecture allows PLL1 to be used as a jitter cleaner for an incoming reference clock that contains excessive phase noise. This requires the user to select an external oscillator (VCXO or crystal) that provides the desired phase noise performance at the clock output. This external oscillator becomes the reference clock for PLL2 and along with the phase noise characteristics of PLL2 and the internal VCO, determines the final phase noise performance at F_{OUT} and the output of the clock distribution section.

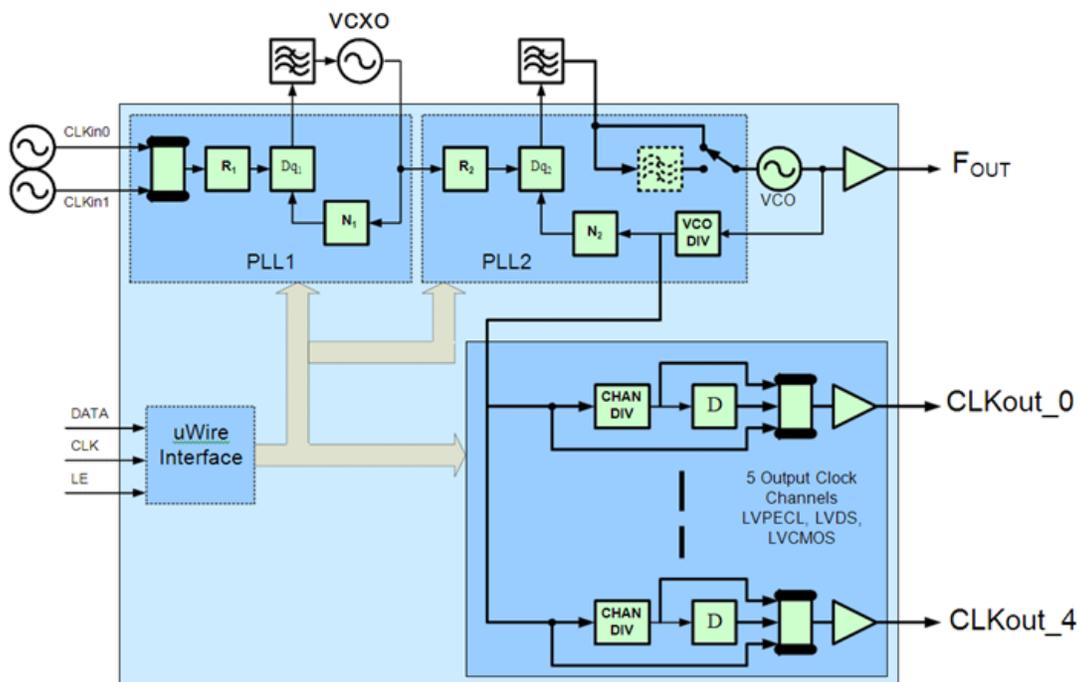


Figure 19. Functional Block Diagram of the LMK041xx Dual PLL Precision Clock Conditioner With External VCXO Module

PLL1 has been designed to work with either an off-the-shelf VCXO package or with a user-designed discrete implementation that employs a crystal resonator and associated tuning components. Figure 20 shows an example of a discretely implemented VCXO using a crystal resonator.

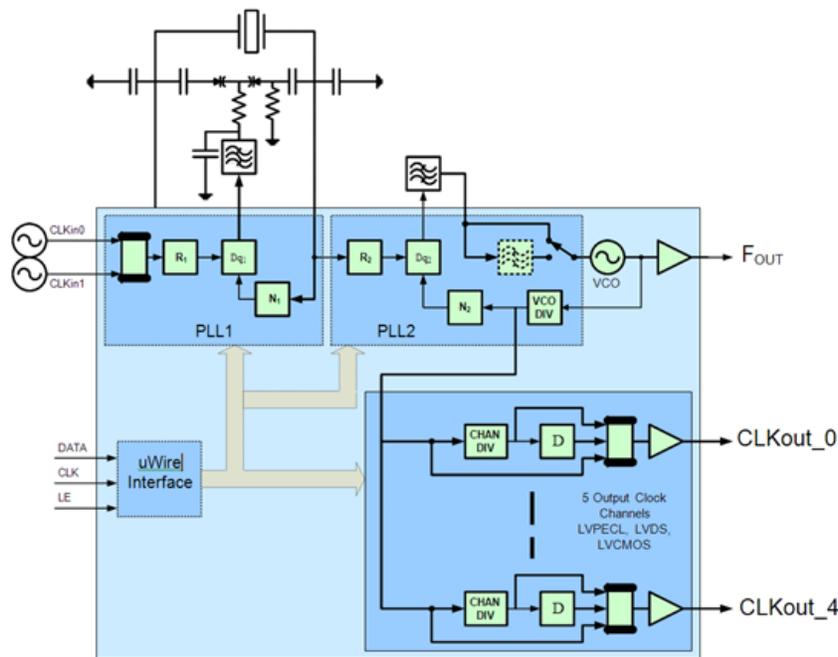


Figure 20. LMK041xx With the XTAL Resonator Option and Tuning Circuit

LMK04100 Family evaluation boards are configured with either a VCXO or Crystal (-XO) on board. It is possible to place a VCXO on a Crystal board or a Crystal on a VCXO board by removing and replacing certain components on the board. Instructions for modifying the board are presented in Appendix G: VCXO/Crystal changes.

Figure 21 shows the crystal oscillator circuit diagram.

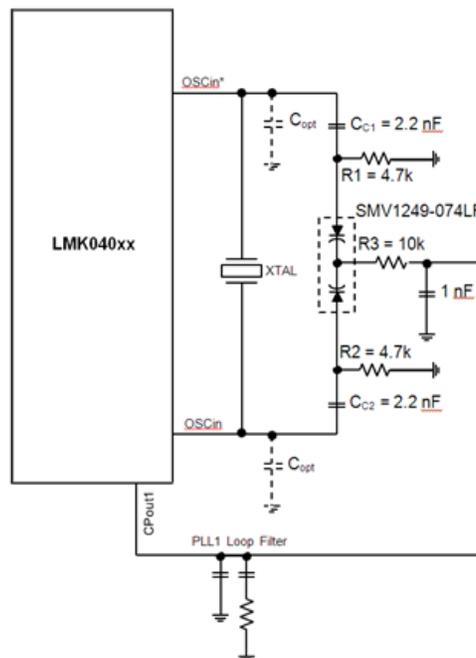


Figure 21. Crystal Oscillator Circuit Diagram

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from A Revision (Januart 2015) to B Revision | Page |
|---|-------------|
| • Changed document format from Word to xml. | 1 |

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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

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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.

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Concerning EVMs Including Radio Transmitters:

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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.

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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.

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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.

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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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