TSW4806EVM

The TSW4806 evaluation module (EVM), one of the new Texas Instruments (TI) low-cost evaluation tools, uses an LMK04806 dual-PLL clock-jitter cleaner and generator, providing a low cost, low-noise, portable clocking solution for use with TI's high-speed data converter EVMs. Together with the accompanying Labview-based Graphical User Interface (GUI), it is a complete clocking tool used with the other low-cost TI evaluation tools providing a complete system that captures and evaluates data samples from ADC EVM's and generates test patterns to DAC EVM's. The EVM's on-board EEPROM comes with several pre-programmed register settings so the board can begin running without using the GUI interface. The EEPROM provides the memory necessary for saving up to eight custom LMK04806 configuration settings. These settings are quickly loaded using on-board switches.

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1 Introduction

1.1 Overview

The EVM provides several programmable output clock sources. Four SMA outputs (J1, J4, J6 and J17) are configured as CMOS outputs. Configure the two other output pairs (J2, J3) and (J7, J15) for CMOS, LVDS, or LVPECL output levels.

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An option for installing a commercial-quality voltage-controlled crystal oscillator (VCXO) is available on the board, providing a known reference point for evaluation of the device performance in dual-PLL mode.

The board features an on-board 10-MHz reference oscillator for internal clock reference and output reference source.

The on-board EEPROM programs the LMK04806, providing several factory pre-programmed settings. The board provides 491.52-, 245.76-, 122.88-, and 61.44-MHz outputs after power up (or after pushing the RESET button) if the four dip switches are in their default *0000* position (all up). A software GUI is also provided allowing custom configuration of the LMK04806.

The EVM supports any of the four devices offered in the LMK04800 family with the default device being the LMK04806.

Table 1. Available LMK04800 Family Devices

Device	VCO Frequency
LMK04803B	1840 to 2030 MHz
LMK04805B	2148 to 2370 MHz
LMK04806B(1)	2370 to 2600 MHz
LMK04808B	2750 to 3072 MHz

(1) Board default installed device

Figure 1 shows a block diagram of the EVM.

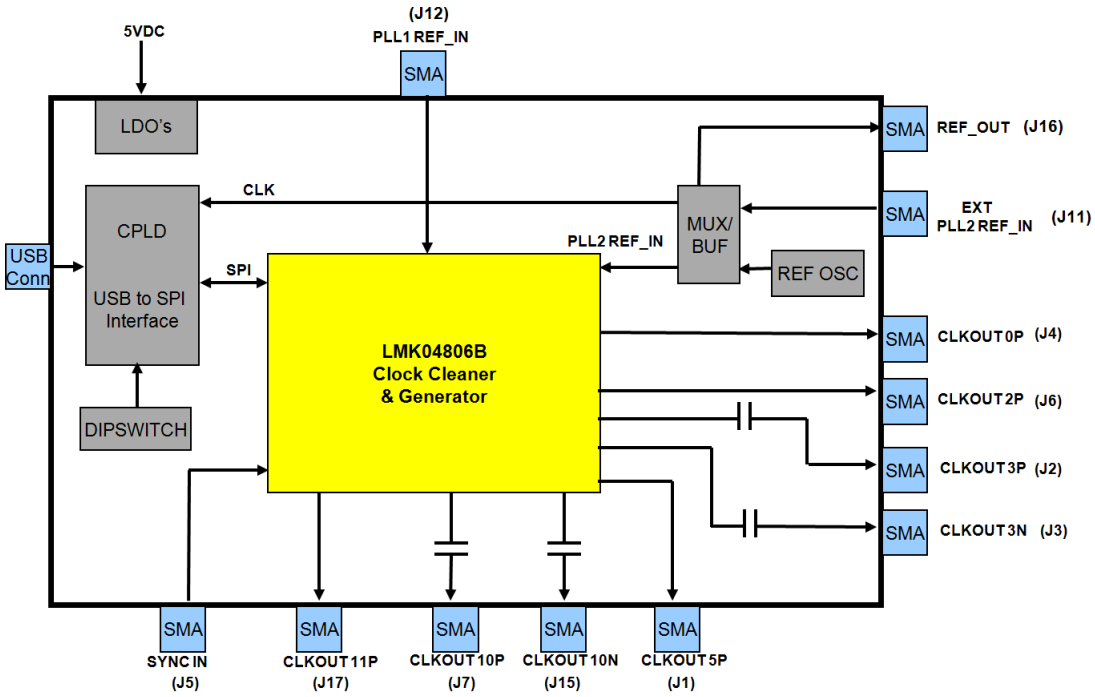

Figure 1. TSW4806EVM Block Diagram

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Quick-Start Setup Procedure

1.1.1 Hardware Setup

1. Connect one end of the provided 5-VDC power cable to the barrel connector (J8) of the TSW4806. Connect the other end to a +5 VDC power supply capable of providing 3 amps. If using the banana jacks, connect the positive end to J10 and the negative end to J9.
2. Make sure the four dip switches (SW1) are in the factory default position (all up). This corresponds to an address of *0000* and is also indicated by four LED's, all of which indicate *OFF*. The address for the on-board EEPROM is selected by the CPLD, dependant upon the switch settings.
3. Turn on the +5 VDC power supply. After power-up, the 5-VDC LED illuminates. The on-board CPLD automatically loads the LMK04806 from the configuration file stored in the EEPROM at the location determined by DIPSWITCH, SW1. After the LMK is configured, the green *LOCK* LED turns on. This indicates that the PLL of the LMK04806 is locked to the 10-MHz on-board reference source. The output SMA's now provide the following frequencies:

   J7 – 61.44-MHz CMOS output. AC coupled, from CLKOUT10P of LMK04806.
   J15 – 61.44-MHz CMOS output. AC coupled, from CLKOUT10N of LMK04806.
   J17 – 61.44-MHz CMOS output from CLKOUT11P of LMK04806.

   J4 – 122.88-MHz CMOS output from CLKOUT0P of LMK04806.

   J1 – 245.76-MHz CMOS output from CLKOUT5P of LMK04806.

   J2 – 491.52-MHz CMOS output. AC coupled, from CLKOUT3P of LMK04806.
   J3 – 491.52-MHz CMOS output. AC coupled, from CLKOUT3N of LMK04806.
   J6 – 491.52-MHz CMOS output from CLKOUT2P of LMK04806.

   Note: If the *LOCK* LED does not turn on after power up, ensure the four dip switches are set to *0000* (all in the up position) and push the reset button (SW2).

2 Software Control

This section provides installation instructions and explanations of the TSW4806 GUI. Enable the GUI control by connecting the provided mini-USB cable between the host PC and J13 of the EVM.

2.1 Installation Instructions

1. Download the software from the EVM product page on www.ti.com. Find the page by searching for *TSW4806EVM*. The software is listed under the *Related Products* section on the *TI Software* tab.
2. Extract the files from the zip file titled *TSW4806 GUI vXpY Installer.zip* where *XpY* represents the version number.
3. Run *setup.exe* and follow the installation prompts.
4. Start the GUI by going to *Start menu → All Programs → TSW4806 GUI vxpx*. Double click on TSW4806 GUI.exe.
5. When plugging the board into the computer through the USB cable for the first time, the USB drivers must be installed.

Microsoft® Windows® XP: If Windows XP does not automatically install the drivers, follow the on-screen prompts and install them. Do not let Windows XP search Microsoft Updates for the drivers, but do let Windows XP install the drivers automatically.

Windows 7: After installing the TSW4806 GUI, Windows 7 automatically installs the drivers for the EVM.

- If not already connected, connect the provided 5-VDC power supply to J8 and the other end to 110-120 VAC source.

2.2 Software Operation

The TSW4806 GUI programs the LMK04806 to desired outputs other than the default power up condition described in Section 2.1. The on-board EEPROM is also programmed from the GUI, including custom setting options. The GUI controls are split between different tabs for a simplified interface. Detailed descriptions for each tab are given below.

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2.2.1 LMK04800 Main Tab

After starting the GUI, the LMK04800 Main tab is selected by default and the display looks as shown in Figure 2.

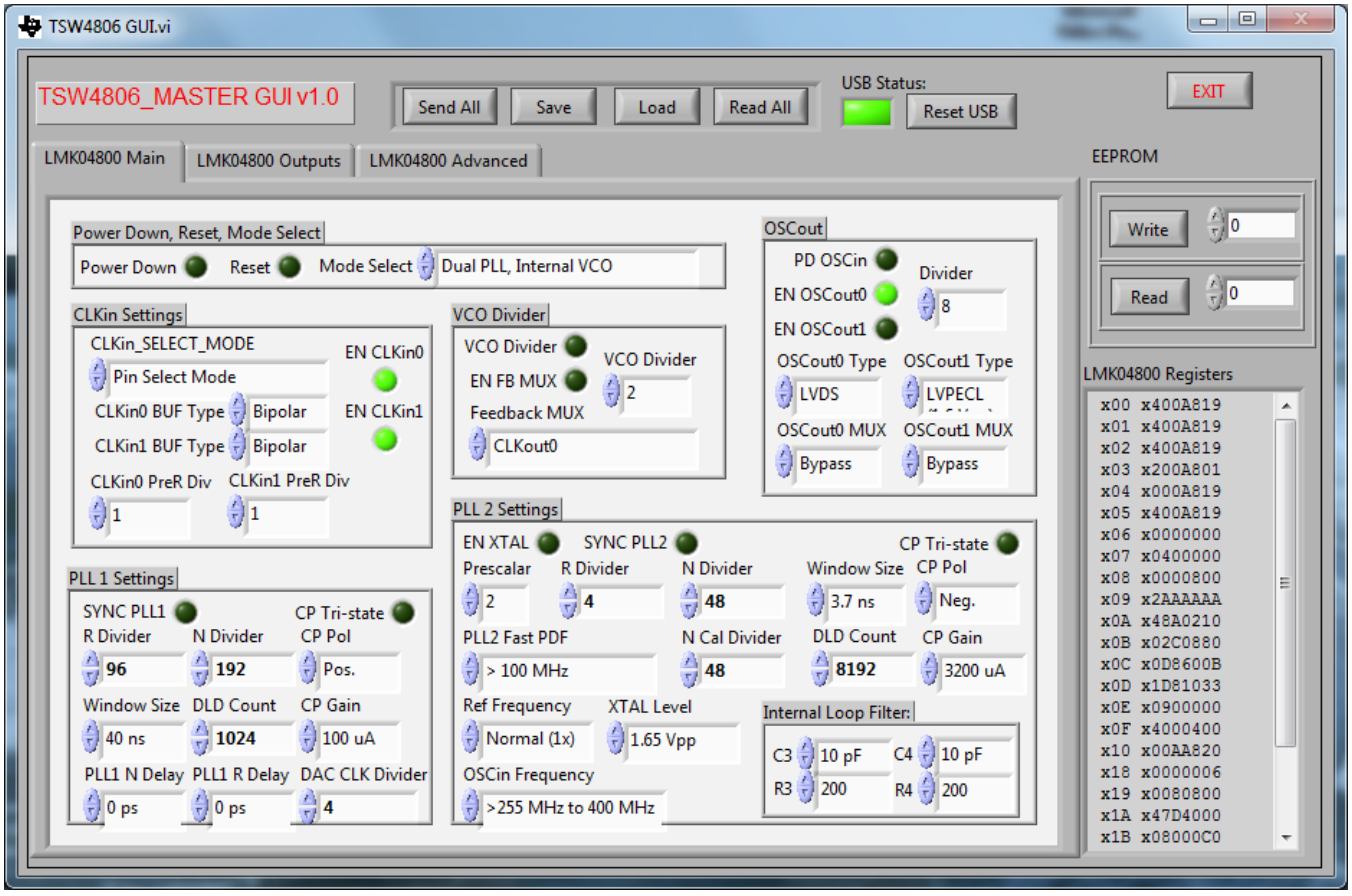

Figure 2. LMK04800 Main Tab Window

If the GUI connects to the board properly, the USB Status indicator turns green. If the indicator is not bright green (as shown in Figure 2), check that the board is powered up and the USB cable is installed. Press the **Reset USB** button a few times. If this still does not establish the connection, cycle power to the board and host PC. If this still does not correct the problem, make sure the USB drivers were installed properly using the Device Manager tool on the PC.

Table 2. Main Window Description

Section	Description
Reset USB	Issues a software reset to the FTDI USB controller.
Send All	Sends all current displayed GUI values to the LMK internal registers.
Save	Saves all of the current displayed GUI values to a file.
Load	Opens a browser for loading a custom register file into the GUI. The values are not loaded into the LMK until the **Send All** button is clicked.
Read All	Currently not used.
EXIT	Closes the GUI
EEPROM[(1)]	Writes and reads the GUI register values to the on-board EEPROM. The writable address range is from 8 to 15. The readable range is from 0 to 15. Addresses 0-7 are factory programmed and read only.
LMK04800 Registers	Displays the address and data values of the LMK.

(1) The EEPROM Read only works properly with the Windows 7 OS by opening the GUI using the *Run as Administrator* option.

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Table 2. Main Window Description (continued)

Section	Description
Power Down, Reset, Mode Select	Allows for powering down and resetting the part. Also controls the mode of the LMK04800.
CLKin Settings	Enabled and select the input clock source, input buffer types, and dividers.
VCO Divider	Set the VCO divider to reduce the frequency on the clock distribution path. Use the VCO directly.
OSCout	Control power to the OSCin port. Also enable and change parameters of the OSCout pins.
PLL 1 Settings	Configure PLL 1 settings when using the dual PLL mode.
PLL 2 Settings	Configure PLL 2 settings for both dual and single PLL mode.

2.2.2 LMK04800 Outputs Tab

After clicking on the LMK04800 Outputs tab, the display looks as shown in Figure 3.

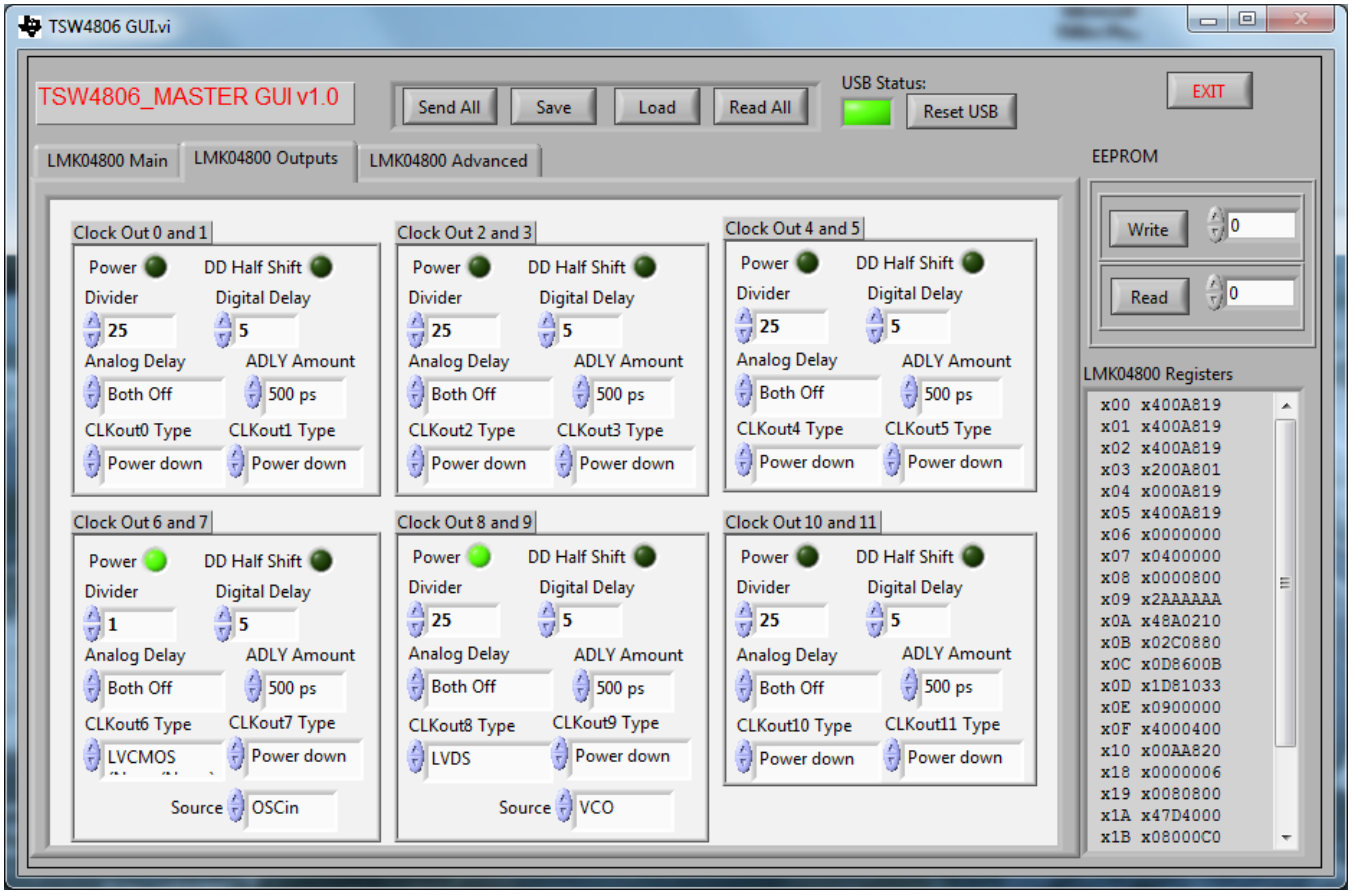

Figure 3. LMK04800 Output Tab

Table 3. LMK04800 Output Tab Description

Section	Description
Clock Out 0 and 1	Configure Clock Out 0 and 1 outputs. Enable the outputs and set the divider, delay, and output buffer.
Clock Out 2 and 3	Configure Clock Out 2 and 3 outputs. Enable the outputs and set the divider, delay, and output buffer.
Clock Out 4 and 5	Configure Clock Out 4 and 5 outputs. Enable the outputs and set the divider, delay, and output buffer.
Clock Out 6 and 7	Configure Clock Out 6 and 7 outputs. Enable the outputs and set the divider, delay, and output buffer. Also select the source for the output.

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Table 3. LMK04800 Output Tab Description (continued)

Section	Description
Clock Out 8 and 9	Configure Clock Out 8 and 9 outputs. Enable the outputs and set the divider, delay, and output buffer. Also select the source for the output.
Clock Out 10 and 11	Configure Clock Out 10 and 11 outputs. Enable the outputs and set the divider, delay, and output buffer.

2.2.3 LMK04800 Advanced

After clicking on the LMK04800 Advanced tab, the display looks as shown in Figure 4.

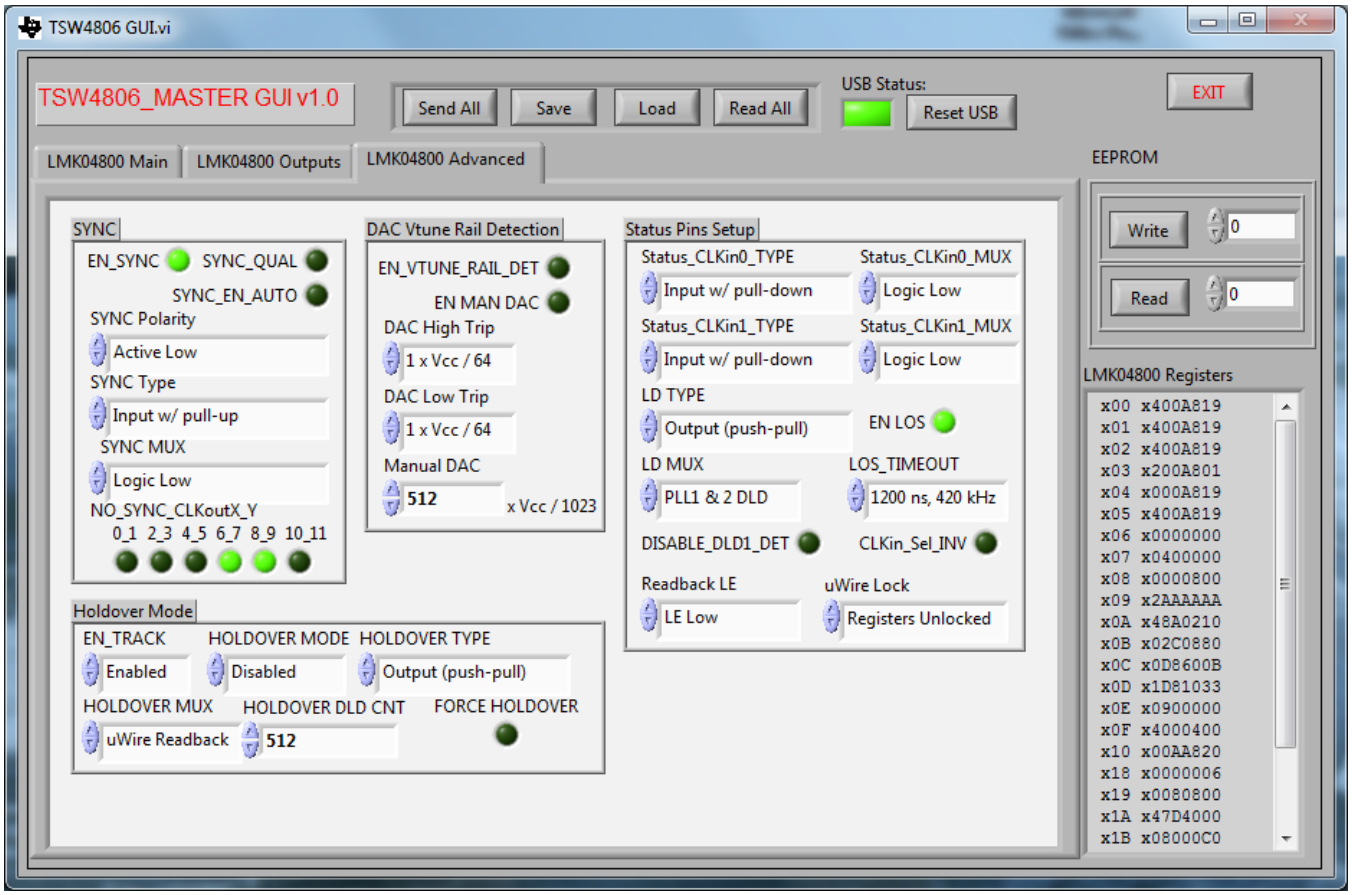

Figure 4. LMK04800 Advanced Tab

Table 4. LMK04800 Advanced Tab Description

Section	Description
SYNC	Enable and configure the sync functionality.
DAC Vtune Rail Detection	Enable and control the internal DAC settings.
Status Pins Setup	Setup the status pins for various outputs as well as control some miscellaneous functions.
Holdover Mode	Enable and configure holdover mode.

See the LMK04800 Family Data Sheet (http://www.ti.com/product/lmk04800) for a much more detailed explanation of all of the internal registers and operation of the device.

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3 TSW4806 GUI Operation

1. Apply 5 V to the board. Start the TSW4806 GUI by going to the *Start Menu → All Programs → Texas Instruments ADCs → TSW4806 GUI*.
2. Make sure the USB Status green indicator lights.
3. Click the **Load** button and select the file named *122.88_61.44.txt*. Click **OK**.
4. Click **Send All**. At this point, the LED labeled *D1* on the TSW4806 lights, indicating a PLL lock.
5. Configure the board such that a 122.88-MHz clock is present on SMA's J2, J3, J4, and J6. SMA's J1, J7, J15 and J17 have 61.44-MHz clock outputs.

The output clocks are determined by the value the internal VCO is running at and the divide value selected for the output. In this example, the VCO is operating in single PLL mode and locked to the on-board 10-MHz oscillator. The value the PLL2 is setting the VCO too is determined as follows:

REF CLK / R divider = VCO / N divider / Prescaler

10MHz / 125 = VCO / 3840 / 8

VCO = 2457.6MHz

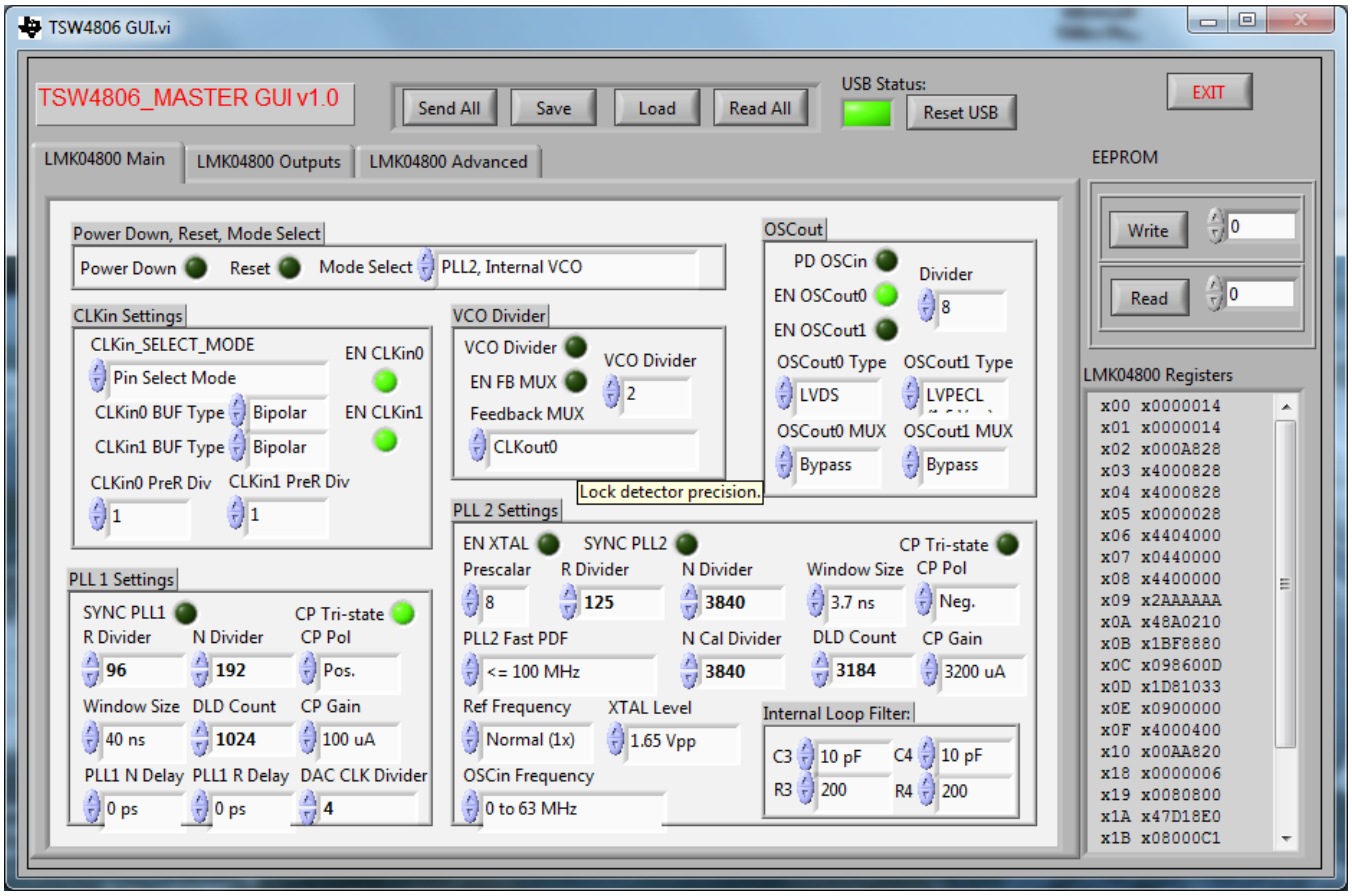

Figure 5. PLL2 Settings

Using the divided values shown in Figure 6 results in the following for Clock Out 0, 1, 2, and 3: 2457.6 / 20 = 122.88 MHz.

Using the divided values shown in Figure 6 results in the following for Clock Out 6, 7, 8, 9, 10 and 11: 2457.6 / 40 = 61.44 MHz.

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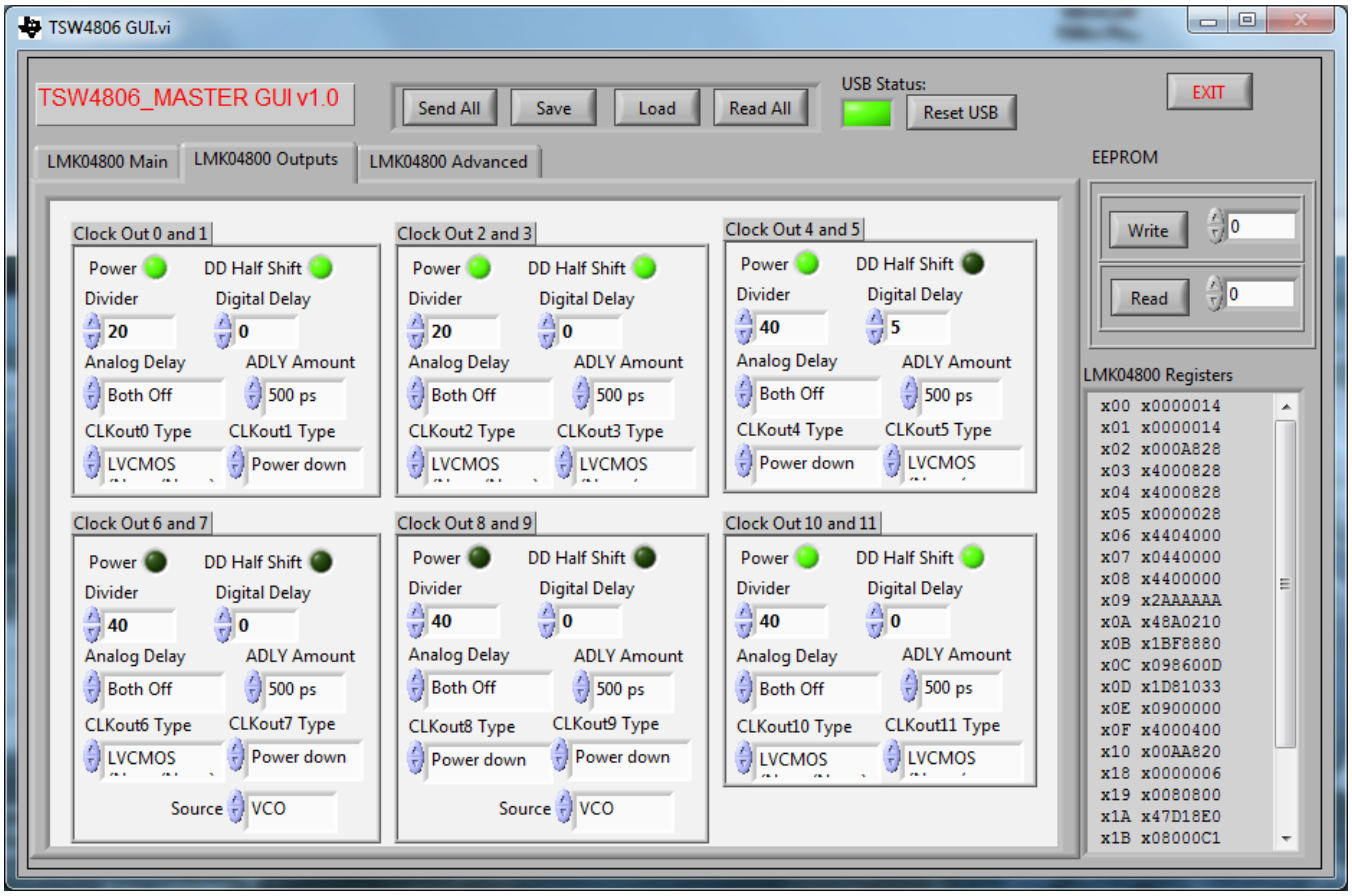

Figure 6. Clock Divider Settings

Note that clock pairs share the same dividers. This example also shows that Clocks 1, 4, 7, 8 and 9 are powered down. These outputs are not used on the EVM.

4 EEPROM

Saving the custom configuration settings from the TSW4806 GUI (Figure 7) is possible with the on-board EEPROM. With the settings saved, the LMK04806 is programmed without using the GUI. The EEPROM saves up to eight user-defined settings, starting from address 8. The EVM comes from the factory with two pre-loaded configurations stored in address locations 0 and 1.

Writing to the EEPROM

Write to the EEPROM with the following steps:

(a) Configure the GUI to the desired setting.

(b) Select an address from 8 to 15 in the EEPROM section of the GUI.

(c) When the **Write** button is pushed, the current GUI settings are saved to the selected EEPROM address.

Note: Read from the EEPROM by selecting the desired read address and pressing the **Read** button.

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Program the LMK04806 Device from EEPROM

Program the LMK04806 from a saved configuration setting on the EEPROM:

(a) Power up the board with a 5-V supply

(b) Set the DIPSWITCH (SW1) to the address where the configuration settings were saved. For example, if the settings were saved to address 9, set DIPSWITCH to *1001*.

Note: Red LED *On* indicates a high bit (or bit 1).
Switch 4 is MSB and Switch 1 is LSB

(c) Program the EVM by pushing the Reset button (SW2)

Figure 7. EEPROM Programming Interface

The EVM comes with two configurations stored in the EEPROM from the factory. The first configuration is loaded under address *0000* and the second resides in address *0001*. When loaded with address *0000*, the outputs are as described in Section 1.1.1. When loaded with the settings from address *0001*, the outputs are as follows:

J7 – 76.8-MHz CMOS output. AC coupled, from CLKOUT10P of LMK04806.
J15 – 76.8-MHz CMOS output. AC coupled, from CLKOUT10N of LMK04806.
J17 – 76.8-MHz CMOS output from CLKOUT11P of LMK04806.

J4 – 153.6-MHz CMOS output from CLKOUT0P of LMK04806.

J1 – 307.2-MHz CMOS output from CLKOUT5P of LMK04806.

J2 – 614.4-MHz CMOS output. AC coupled, from CLKOUT3P of LMK04806.
J3 – 614.4-MHz CMOS output. AC coupled, from CLKOUT3N of LMK04806.
J6 – 614.4-MHz CMOS output from CLKOUT2P of LMK04806.

Table 5 shows all of the available factory-set frequencies stored inside the EEPROM and the DIPSWITCH settings required to load them.

Output SMA's

DIPSWITCH Setting MSB - LSB	J1	J2, J3, J6	J4	J7, J15, J17
0000	245.76 MHz	491.52 MHz	122.88 MHz	61.44 MHz
0001	307.2 MHz	614.4 MHz	153.6 MHz	76.8 MHz
0010	Factory only, not used	Factory only, not used	Factory only, not used	Factory only, not used
. . .	"	"	"	"
0111	Factory only, not used	Factory only, not used	Factory only, not used	Factory only, not used
1000	User configuration 8	User configuration 8	User configuration 8	User configuration 8
. . .	"	"	"	"
1111	User configuration 15	User configuration 15	User configuration 15	User configuration 15

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5 Optional Features and Configurations

5.1 Clocking

The EVM board comes with the LMK04806 device which has an internal VCO frequency range of 2370–2600 MHz. If the desired clock is not derived from this frequency range using integer dividers, then swap this device out for another LMK04800 with a different VCO range. Determine which LMK04800 works for the desired frequency range by consulting the LMK04800 data sheet (SNAS489).

Set up the LMK04800 in clock distribution mode or as a clock generator using single or dual PLL mode. The different modes of operation are listed below.

1. **External Clock Mode:** Setting up the LMK4806 in clock distribution mode permits the use of an external clock source. This allows for coherent sampling by providing a clock that is synchronized to the other signal sources. The TSW4806 GUI includes a configuration file for the external clock mode. This file is located in the GUI installation directory in the folder *Configuration Files* and is named *external_clock.txt*. Load the file by clicking the **Load** button, navigating to the correct folder, selecting the file, and clicking **OK**. Provide an external clock through the *CLKIN1* SMA J12 connector on the TSW4806 board.
2. **On-board Clock using Single PLL Mode:** This is the default mode of operation for the TSW4806. The 10-MHz on-board oscillator acts as the reference for the PLL and the divided down internal VCO acts as the clock source. All of the factory provided configurations stored in the EEPROM and the provided files in the *Configuration Files* folder not mentioned elsewhere in this document operate in this mode. Use an external reference (2 Vp-p min) in place of the on-board oscillator. Operate in this mode by providing a clock source to SMA J11, and moving the shunt on jumper JP5 to pins 2-3. The 10-MHz oscillator is now disabled by moving the shunt on jumper JP4 to pins 2-3.
3. **On-board Clock using Dual PLL Mode:** In this mode of operation, providing a low-frequency reference generates a synchronized sampling clock at a higher frequency. The reference comes from any source, such as a 10-MHz reference from a piece of test equipment, this allows synchronization between all signal sources and is used for coherent sampling. Installing a VCXO at Y2 allows the use of this mode. Update the loop filters if there is a change in reference or VCXO. Use the Clock Design Tool (http://www.ti.com/tool/clockdesigntool) for designing the loop filters and PLL settings based on the reference, VCXO, and output frequencies.

Revision History

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

Changes from Original (July 2012) to A Revision	Page
• Made changes to step 1 and 3 in the *Hardware Setup* section.	3

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

      This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

      3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

      CAUTION

      This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

      Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

      FCC Interference Statement for Class A EVM devices

      NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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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.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

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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.

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

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http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

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If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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

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4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

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

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

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

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