Tiva™ C Series TM4C123G LaunchPad Evaluation Board

User's Guide

Literature Number: SPMU296
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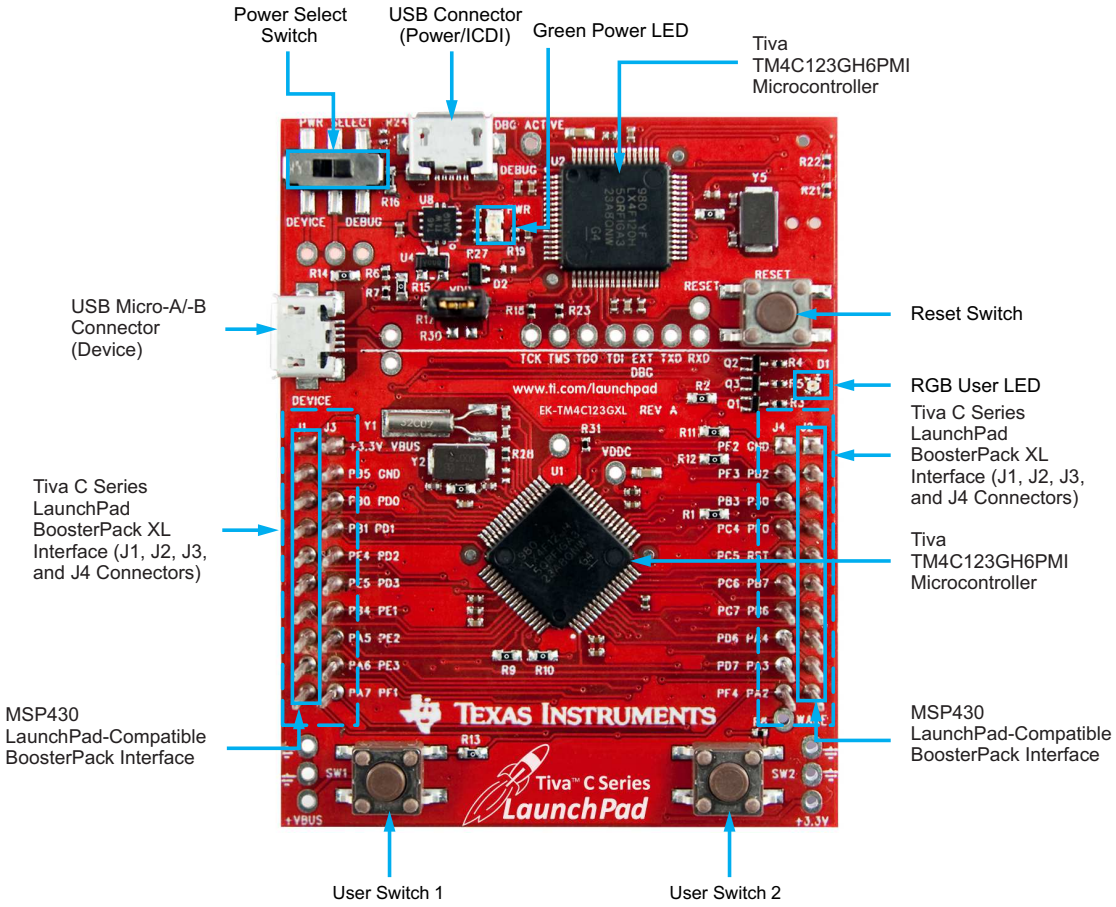
Board Overview

The Tiva™ C Series TM4C123G LaunchPad Evaluation Board (EK-TM4C123GXL) is a low-cost evaluation platform for ARM® Cortex™-M4F-based microcontrollers. The Tiva C Series LaunchPad design highlights the TM4C123GH6PMI microcontroller USB 2.0 device interface, hibernation module, and motion control pulse-width modulator (MC PWM) module. The Tiva C Series LaunchPad also features programmable user buttons and an RGB LED for custom applications. The stackable headers of the Tiva C Series TM4C123G LaunchPad BoosterPack XL interface demonstrate how easy it is to expand the functionality of the Tiva C Series LaunchPad when interfacing to other peripherals on many existing BoosterPack add-on boards as well as future products. Figure 1-1 shows a photo of the Tiva C Series LaunchPad.

Figure 1-1. Tiva C Series TM4C123G LaunchPad Evaluation Board



1.1 Kit Contents

The Tiva C Series TM4C123G LaunchPad Evaluation Kit contains the following items:

- Tiva C Series LaunchPad Evaluation Board (EK-TM4C123GXL)
- On-board In-Circuit Debug Interface (ICDI)
- USB micro-B plug to USB-A plug cable
- README First document

1.2 Using the Tiva C Series LaunchPad

The recommended steps for using the Tiva C Series TM4C123G LaunchPad Evaluation Kit are:

1. **Follow the README First document included in the kit.** The README First document will help you get the Tiva C Series LaunchPad up and running in minutes. See the Tiva C Series LaunchPad web page for additional information to help you get started.
2. **Experiment with LaunchPad BoosterPacks.** A selection of Tiva C Series BoosterPacks and compatible MSP430™ BoosterPacks can be found at the TI MCU LaunchPad web page.
3. **Take your first step toward developing an application with Project 0 using your preferred ARM tool-chain and the Tiva C Series TivaWare Peripheral Driver Library.** Software applications are loaded using the on-board In-Circuit Debug Interface (ICDI). See Chapter 3, ***Software Development***, for the programming procedure. The TivaWare for C Series Peripheral Driver Library Software Reference Manual contains specific information on software structure and function. For more information on Project 0, go to the Tiva C Series LaunchPad wiki page.
4. **Customize and integrate the hardware to suit an end application.** This user's manual is an important reference for understanding circuit operation and completing hardware modification.

You can also view and download almost six hours of training material on configuring and using the LaunchPad. Visit the Tiva C Series LaunchPad Workshop for more information and tutorials.

1.3 Features

Your Tiva C Series LaunchPad includes the following features:

- Tiva TM4C123GH6PMI microcontroller
- Motion control PWM
- USB micro-A and micro-B connector for USB device, host, and on-the-go (OTG) connectivity
- RGB user LED
- Two user switches (application/wake)
- Available I/O brought out to headers on a 0.1-in (2.54-mm) grid
- On-board ICDI
- Switch-selectable power sources:
  - ICDI
  - USB device
- Reset switch
- Preloaded RGB quickstart application
- Supported by TivaWare for C Series software including the USB library and the peripheral driver library
- Tiva C Series TM4C123G LaunchPad BoosterPack XL Interface, which features stackable headers to expand the capabilities of the Tiva C Series LaunchPad development platform
  - For a complete list of available BoosterPacks that can be used with the Tiva C Series LaunchPad, see the LaunchPad web page.

1.4 BoosterPacks

The Tiva C Series LaunchPad provides an easy and inexpensive way to develop applications with the TM4C123GH6PM microcontroller. Tiva C Series BoosterPacks and MSP430 BoosterPacks expand the available peripherals and potential applications of the Tiva C Series LaunchPad. BoosterPacks can be used with the Tiva C Series LaunchPad or you can simply use the on-board TM4C123GH6PM microcontroller as its processor. See Chapter 2 for more information.

Build your own BoosterPack and take advantage of Texas Instruments' website to help promote it! From sharing a new idea or project, to designing, manufacturing, and selling your own BoosterPack kit, TI offers a variety of avenues for you to reach potential customers with your solutions.

1.5 Specifications

Table 1-1 summarizes the specifications for the Tiva C Series LaunchPad.

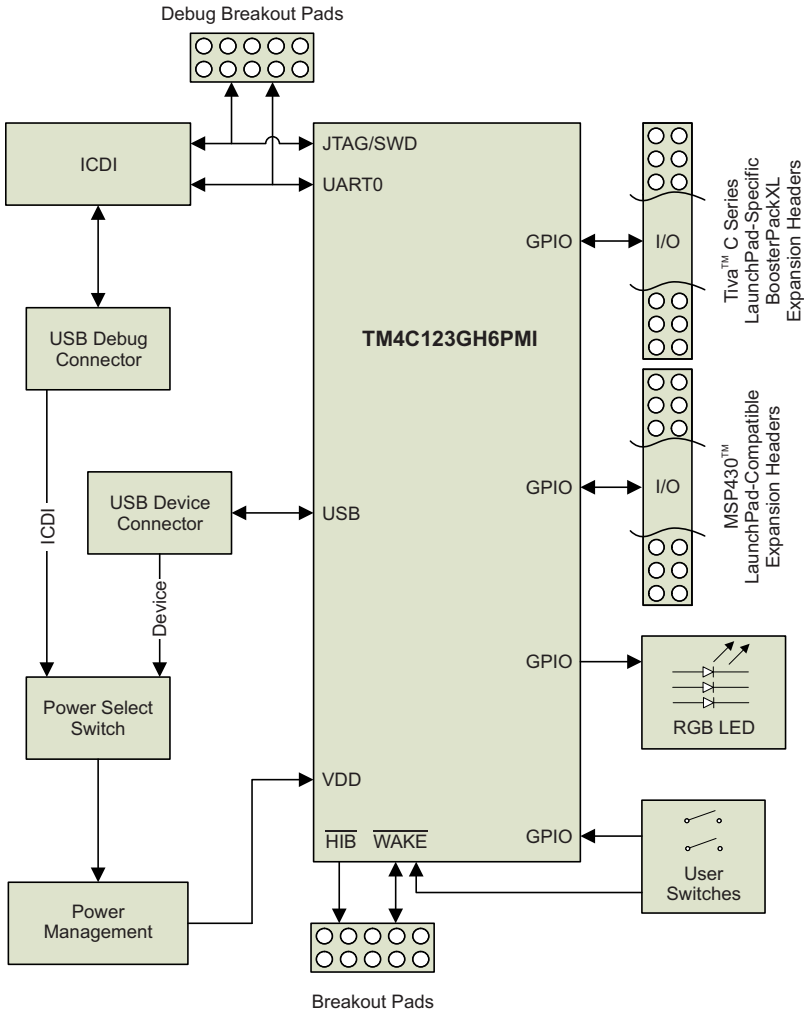
Table 1-1. EK-TM4C123GXL Specifications

Parameter	Value
Board supply voltage	4.75 V_{DC} to 5.25 V_{DC} from one of the following sources: • Debugger (ICDI) USB Micro-B cable (connected to a PC) • USB Device Micro-B cable (connected to a PC)
Dimensions	2.0 in x 2.25 in x 0.425 in (5.0 cm x 5.715 cm x 10.795 mm) (L x W x H)
Break-out power output	• 3.3 V_{DC} (300 mA max) • 5.0 V_{DC} (depends on 3.3 V_{DC} usage, 23 mA to 323 mA)
RoHS status	Compliant

Hardware Description

The Tiva C Series LaunchPad includes a TM4C123GH6PM microcontroller and an integrated ICDI as well as a range of useful peripheral features (as the block diagram in Figure 2-1 shows). This chapter describes how these peripherals operate and interface to the microcontroller.

Figure 2-1. Tiva C Series LaunchPad Evaluation Board Block Diagram



2.1 Functional Description

2.1.1 Microcontroller

The TM4C123GH6PM is a 32-bit ARM Cortex-M4-based microcontroller with 256-kB Flash memory, 32-kB SRAM, and 80-MHz operation; USB host, device, and OTG connectivity; a Hibernation module and PWM; and a wide range of other peripherals. See the TM4C123GH6PM microcontroller data sheet (literature number SPMS376) for complete device details.

Most of the microcontroller signals are routed to 0.1-in (2.54-mm) pitch headers. An internal multiplexer allows different peripheral functions to be assigned to each of these GPIO pads. When adding external circuitry, consider the additional load on the evaluation board power rails.

The TM4C123GH6PM microcontroller is factory-programmed with a quickstart demo program. The quickstart program resides in on-chip Flash memory and runs each time power is applied, unless the quickstart application has been replaced with a user program.

2.1.2 USB Connectivity

The EK-TM4C123GXL is designed and functions as a USB device without hardware modification. The USB device signals are dedicated to USB functionality and are not shared with the BoosterPack headers. The USB device signals are listed in Table 2-1.

Table 2-1. USB Device Signals

GPIO Pin	Pin Function	USB Device
PD4	USB0DM	D–
PD5	USB0DP	D+

The TM4C123GH6PM target device is also capable of USB embedded host and on-the-go (OTG) functions. OTG functionality can be enabled by populating R25 and R29 with 0-Ω resistors. These resistors connect the USB ID and USB V_{BUS} signals to PB0 and PB1. When these resistors are populated, PB0 and PB1 must remain in the respective USB pin mode configurations to prevent device damage. PB0 and PB1 are also present on the J1 BoosterPack header. Therefore, if R25 or R29 are populated, care must be taken not to conflict these signals with BoosterPack signals.

USB embedded host operation can be enabled in the same way for USB devices that are self-powered. Providing power when acting as a USB host requires a BoosterPack with power switching and appropriate connectors. All USB host signals are available on the BoosterPack interface except D+ and D–, which are only available on the USB micro-A/-B connector and the two adjacent test points.

When connected as a USB device, the evaluation board can be powered from either the ICDI or the USB Device connectors. The user can select the power source by moving the POWER SELECT switch (SW3) to the Device position. See the *Power Management* schematic (appended to this document).

2.1.3 Motion Control

The EK-TM4C123GXL includes the Tiva C-Series Motion Control PWM technology, featuring two PWM modules capable of generating 16 PWM outputs. Each PWM module provides a great deal of flexibility and can generate simple PWM signals—for example, those required by a simple charge pump—as well as paired PWM signals with dead-band delays, such as those required by a half-H bridge driver. Three generator blocks can also generate the full six channels of gate controls required by a 3-phase inverter bridge.

Two quadrature encoder interfaces (QEI) are also available to provide motion control feedback. See the Headers and BoosterPacks section of this document for details about the availability of these signals on the BoosterPack interface.

2.1.4 User Switches and RGB User LED

The Tiva C Series LaunchPad comes with an RGB LED. This LED is used in the preloaded RGB quickstart application and can be configured for use in custom applications.

Two user buttons are included on the board. The user buttons are both used in the preloaded quickstart application to adjust the light spectrum of the RGB LED as well as go into and out of hibernation. The user buttons can be used for other purposes in the user's custom application.

The evaluation board also has a green power LED. Table 2-2 shows how these features are connected to the pins on the microcontroller.

Table 2-2. User Switches and RGB LED Signals

GPIO Pin	Pin Function	USB Device
PF4	GPIO	SW1
PF0	GPIO	SW2
PF1	GPIO	RGB LED (Red)
PF2	GPIO	RGB LED (Blue)
PF3	GPIO	RGD LED (Green)

2.1.5 Headers and BoosterPacks

The two double rows of stackable headers are mapped to most of the GPIO pins of the TM4C123GH6PM microcontroller. These rows are labeled as connectors J1, J2, J3, and J4. Connectors J3 and J4 are located 0.1 in (2.54 mm) inside of the J1 and J2 connectors. All 40 header pins of the J1, J2, J3, and J4 connectors make up the Tiva C Series TM4C123G LaunchPad BoosterPack XL Interface. Table 2-3 through Table 2-6 show how these header pins are connected to the microcontroller pins and which GPIO functions can be selected.

NOTE: To configure the device peripherals easily and intuitively using a graphical user interface (GUI), see the Tiva C Series Pinmux Utility found at www.ti.com/tool/lm4f_pinmux. This easy-to-use interface makes setting up alternate functions for GPIOs simple and error-free.

Table 2-3. J1 Connector[(1)]

J1 Pin	GPIO	Analog Function	On-board Function	Tiva C Series MCU Pin	GPIOPCTL Register Setting										
		GPIO AMSEL			1	2	3	4	5	6	7	8	9	14	15
1.01	3.3 V														
1.02	PB5	AIN11	–	57	–	SSI2Fss	–	M0PWM3	–	–	T1CCP1	CAN0Tx	–	–	–
1.03	PB0	USB0ID	–	45	U1Rx	–	–	–	–	–	T2CCP0	–	–	–	–
1.04	PB1	USB0VBUS	–	46	U1Tx	–	–	–	–	–	T2CCP1	–	–	–	–
1.05	PE4	AIN9	–	59	U5Rx	–	I2C2SCL	M0PWM4	M1PWM2	–	–	CAN0Rx	–	–	–
1.06	PE5	AIN8	–	60	U5Tx	–	I2C2SDA	M0PWM5	M1PWM3	–	–	CAN0Tx	–	–	–
1.07	PB4	AIN10	–	58	–	SSI2Clk	–	M0PWM2	–	–	T1CCP0	CAN0Rx	–	–	–
1.08	PA5	–	–	22	–	SSI0Tx	–	–	–	–	–	–	–	–	–
1.09	PA6	–	–	23	–	–	I2C1SCL	–	M1PWM2	–	–	–	–	–	–
1.10	PA7	–	–	24	–	–	I2C1SDA	–	M1PWM3	–	–	–	–	–	–

(1) Shaded cells indicate configuration for compatibility with the MSP430 LaunchPad.

Table 2-4. J2 Connector[(1)]

J2 Pin	GPIO	Analog Function / GPIO AMSEL	On-board Function	Tiva C Series MCU Pin	GPIOPCTL Register Setting										
					1	2	3	4	5	6	7	8	9	14	15
2.01	GND														
2.02	PB2	–	–	47	–	–	I2C0SCL	–	–	–	T3CCP0	–	–	–	–
2.03	PE0	AIN3	–	9	U7Rx	–	–	–	–	–	–	–	–	–	–
2.04	PF0	–	USR_SW2/ WAKE (R1)	28	U1RTS	SSI1Rx	CAN0Rx	–	M1PWM4	PhA0	T0CCP0	NMI	C0o	–	–
2.05	RESET														
2.06	PB7	–	–	4	–	SSI2Tx	–	M0PWM1	–	–	T0CCP1	–	–	–	–
	PD1	AIN6	Connected for MSP430 Compatibility (R10)	62	SSI3Fss	SSI1Fss	I2C3SDA	M0PWM7	M1PWM1	–	WT2CCP1	–	–	–	–
2.07	PB6	–	–	1	–	SSI2Rx	–	M0PWM0	–	–	T0CCP0	–	–	–	–
	PD0	AIN7	Connected for MSP430 Compatibility (R9)	61	SSI3Clk	SSI1Clk	I2C3SCL	M0PWM6	M1PWM0	–	WT2CCP0	–	–	–	–
2.08	PA4	–	–	21	–	SSI0Rx	–	–	–	–	–	–	–	–	–
2.09	PA3	–	–	20	–	SSI0Fss	–	–	–	–	–	–	–	–	–
2.10	PA2	–	–	19	–	SSI0Clk	–	–	–	–	–	–	–	–	–

(1) Shaded cells indicate configuration for compatibility with the MSP430 LaunchPad.

Table 2-5. J3 Connector[(1)]

J3 Pin	GPIO	Analog Function / GPIO AMSEL	On-board Function	Tiva C Series MCU Pin	GPIOPCTL Register Setting										
					1	2	3	4	5	6	7	8	9	14	15
3.01	5.0 V														
3.02	GND														
3.03	PD0	AIN7	–	61	SSI3Clk	SSI1Clk	I2C3SCL	M0PWM6	M1PWM0	–	WT2CCP0	–	–	–	–
	PB6	–	Connected for MSP430 Compatibility (R9)	1	–	SSI2Rx	–	M0PWM0		–	T0CCP0	–	–	–	–
3.04	PD1	AIN6	–	92	SSI3Fss	SSI1Fss	I2C3SDA	M0PWM7	M1PWM1	–	WT2CCP1	–	–	–	–
	PB7	–	Connected for MSP430 Compatibility (R10)	4	–	SSI2Tx	–	M0PWM1	–	–	T0CCP1	–	–	–	–
3.05	PD2	AIN5		63	SSI3Rx	SSI1Rx	–	M0FAULT0	–	–	WT3CCP0	USB0EPEN			
3.06	PD3	AIN4	–	64	SSI3Tx	SSI1Tx	–	–	–	–	WT3CCP1	USB0PFLT	–	–	–
3.07	PE1	AIN2	–	8	U7Tx	–	–	–	–	–		–	–	–	–
3.08	PE2	AIN1	–	7	–	–	–	–	–	–	–	–	–	–	–
3.09	PE3	AIN0	–	6	–	–	–	–	–	–	–	–	–	–	–
3.10	PF1	–	–	29	U1CTS	SSI1Tx	–	–	M1PWM5	–	T0CCP1	–	C1o	TRD1	–

(1) Shaded cells indicate configuration for compatibility with the MSP430 LaunchPad.

Table 2-6. J4 Connector

J4 Pin	GPIO	Analog Function	On-board Function	Tiva C Series MCU Pin	GPIOPCTL Register Setting										
		GPIO AMSEL			1	2	3	4	5	6	7	8	9	14	15
4.01	PF2	–	Blue LED (R11)	30	–	SSI1Clk	–	M0FAULT0	M1PWM6	–	T1CCP0	–	–	–	TRD0
4.02	PF3	–	Green LED (R12)	31	–	SSI1Fss	CAN0Tx	–	M1PWM7	–	T1CCP1	–	–	–	TRCLK
4.03	PB3	–	–	48	–	–	I2C0SDA	–	–	–	T3CCP1	–	–	–	–
4.04	PC4	C1–	–	16	U4Rx	U1Rx	–	M0PWM6	–	IDX1	WT0CCP0	U1RTS	–	–	–
4.05	PC5	C1+	–	15	U4Tx	U1Tx	–	M0PWM7	–	PhA1	WT0CCP1	U1CTS	–	–	–
4.06	PC6	C0+	–	14	U3Rx	–	–	–	–	PhB1	WT1CCP0	USB0EPEN	–	–	–
4.07	PC7	C0–	–	13	U3Tx	–	–	–	–	–	WT1CCP1	USB0PFLT	–	–	–
4.08	PD6	–	–	53	U2Rx	–	–	–	–	PhA0	WT5CCP0	–	–	–	–
4.09	PD7	–	–	10	U2Tx	–	–	–	–	PhB0	WT5CCP1	NMI	–	–	–
4.10	PF4	–	USR_SW 1 (R13)	5	–	–	–	–	M1FAULT0	IDX0	T2CCP0	USB0EPEN	–	–	–

Connectors J1 and J2 of the Tiva C Series TM4C123G LaunchPad BoosterPack XL Interface provide compatibility with MSP430 LaunchPad BoosterPacks. Highlighted functions (shaded cells) in Table 2-3 through Table 2-5 indicate configuration for compatibility with the MSP430 LaunchPad.

A complete list of Tiva C Series BoosterPacks and Tiva C Series LaunchPad-compatible MSP430 BoosterPacks is available at www.ti.com/tm4c123g-launchpad.

2.2 Power Management

2.2.1 Power Supplies

The Tiva C Series LaunchPad can be powered from one of two power sources:

- On-board ICDI USB cable (Debug, Default)
- USB device cable (Device)

The POWER SELECT switch (SW3) is used to select one of the two power sources. Select only one source at a time.

2.2.2 Hibernate

The Tiva C Series LaunchPad provides an external 32.768-kHz crystal (Y1) as the clock source for the TM4C123GH6PM Hibernation module clock source. The current draw while in Hibernate mode can be measured by making some minor adjustments to the Tiva C Series LaunchPad. This procedure is explained in more detail later in this section.

The conditions that can generate a wake signal to the Hibernate module on the Tiva C Series LaunchPad are waking on a Real-time Clock (RTC) match and/or waking on assertion of the $\overline{\text{WAKE}}$ pin. (1) The second user switch (SW2) is connected to the $\overline{\text{WAKE}}$ pin on the microcontroller. The $\overline{\text{WAKE}}$ pin, as well as the V_{DD} and $\overline{\text{HIB}}$ pins, are easily accessible through breakout pads on the Tiva C Series LaunchPad. See the appended schematics for details.

(1) If the board does not turn on when you connect it to a power source, the microcontroller might be in Hibernate mode (depending on the programmed application). You must satisfy one of the programmed wake conditions and connect the power to bring the microcontroller out of Hibernate mode and turn on the board.

There is no external battery source on the Tiva C Series LaunchPad Hibernation module, which means the VDD3ON power control mechanism should be used. This mechanism uses internal switches to remove power from the Cortex-M4 processor as well as to most analog and digital functions while retaining I/O pin power.

To measure the Hibernation mode current or the Run mode current, the VDD jumper that connects the 3.3 V pin and the MCU_PWR pin must be removed. See the complete schematics (appended to this document) for details on these pins and component locations. An ammeter should then be placed between the 3.3 V pin and the MCU_PWR pin to measure I_{DD} (or I_{HIB_VDD3ON}). The TM4C123GH6PM microcontroller uses V_{DD} as its power source during V_{DD3ON} Hibernation mode, so I_{DD} is the Hibernation mode (VDD3ON mode) current. This measurement can also be taken during Run mode, which measures I_{DD} the microcontroller running current.

2.2.3 Clocking

The Tiva C Series LaunchPad uses a 16.0-MHz crystal (Y2) to complete the TM4C123GH6PM microcontroller main internal clock circuit. An internal PLL, configured in software, multiples this clock to higher frequencies for core and peripheral timing.

The Hibernation module is clocked from an external 32.768-KHz crystal (Y1).

2.2.4 Reset

The $\overline{\text{RESET}}$ signal into the TM4C123GH6PM microcontroller connects to the RESET switch and to the ICDI circuit for a debugger-controlled reset.

External reset is asserted (active low) under any of three conditions:

- Power-on reset (filtered by an R-C network)
- RESET switch held down
- By the ICDI circuit when instructed by the debugger (this capability is optional, and may not be supported by all debuggers)

2.3 In-Circuit Debug Interface (ICDI)

The Tiva C Series LaunchPad evaluation board comes with an on-board In-Circuit Debug Interface (ICDI). The ICDI allows for the programming and debug of the TM4C123GH6PM using the LM Flash Programmer and/or any of the supported tool chains. Note that the ICDI supports only JTAG debugging. An external debug interface can be connected for Serial Wire Debug (SWD) and SWO (trace).

Table 2-7 shows the pins used for JTAG and SWD. These signals are also mapped out to easily accessible breakout pads and headers on the board.

Table 2-7. In-Circuit Debug Interface (ICDI) Signals

GPIO Pin	Pin Function
PC0	TCK/SWCLK
PC1	TMS/SWDIO
PC2	TDI
PC3	TDO/SWO

2.3.1 Virtual COM Port

When plugged in to a PC, the device enumerates as a debugger and a virtual COM port. Table 2-8 shows the connections for the COM port to the pins on the microcontroller.

Table 2-8. Virtual COM Port Signals

GPIO Pin	Pin Function
PA0	U0RX
PA1	U0TX

Software Development

This chapter provides general information on software development as well as instructions for Flash memory programming.

3.1 Software Description

The TivaWare software provided with the Tiva C Series LaunchPad provides access to all of the peripheral devices supplied in the design. The Tiva C Series Peripheral Driver Library is used to operate the on-chip peripherals as part of TivaWare.

TivaWare includes a set of example applications that use the TivaWare Peripheral Driver Library. These applications demonstrate the capabilities of the TM4C123GH6PM microcontroller, as well as provide a starting point for the development of the final application for use on the Tiva C Series LaunchPad evaluation board.

3.2 Source Code

The complete source code including the source code installation instructions are provided at www.ti.com/tm4c123g-launchpad. The source code and binary files are installed in the DriverLib tree.

3.3 Tool Options

The source code installation includes directories containing projects and/or makefiles for the following tool-chains:

- Keil ARM RealView® Microcontroller Development System
- IAR Embedded Workbench for ARM
- Sourcery CodeBench
- Texas Instruments' Code Composer Studio™ IDE

Download evaluation versions of these tools from the TI website. Due to code size restrictions, the evaluation tools may not build all example programs. A full license is necessary to re-build or debug all examples.

Instructions on installing and using each of the evaluation tools can be found in the Quickstart guides (for example, Quickstart-Keil, Quickstart-IAR) which are available for download from the evaluation kit section of the TI website at www.ti.com/tiva-c.

For detailed information on using the tools, see the documentation included in the tool chain installation or visit the respective web site of the tool supplier.

3.4 Programming the Tiva C Series LaunchPad Evaluation Board

The Tiva C Series LaunchPad software package includes pre-built binaries for each of the example applications. If you have installed TivaWare to the default installation path of *C:\ti\TivaWare_C_Series_<version>*, you can find the example applications in *C:\ti\TivaWare_C_Series_<version>\examples\boards\ek-tm4c123gxl* . The on-board ICDI is used with the LM Flash Programmer tool to program applications on the Tiva C Series LaunchPad.

Follow these steps to program example applications into the Tiva C Series LaunchPad evaluation board using the ICDI:

1. Install LM Flash Programmer on a PC running Microsoft® Windows®.
2. Switch the **POWER SELECT** switch to the right for Debug mode.
3. Connect the USB-A cable plug to an available port on the PC and the Micro-B plug to the **Debug** USB port on the board.
4. Verify that the POWER LED D4 on the board is lit.
5. Run the LM Flash Programmer.
6. In the Configuration tab, use the Quick Set control to select the EK-TM4C123GXL evaluation board.
7. Move to the Program tab and click the **Browse** button. Navigate to the example applications directory (the default location is *C:\ti\TivaWare_C_Series_<version>\examples\boards\ek-tm4c123gxl*).
8. Each example application has its own directory. Navigate to the example directory that you want to load and then into the directory which contains the binary (*.bin) files. Select the binary file and click **Open**.
9. Set the ***Erase Method*** to *Erase Necessary Pages*, check the **Verify After Program** box, and check **Reset MCU After Program**.

   Program execution starts once the Verify process is complete.

References, PCB Layout, and Bill of Materials

4.1 References

In addition to this document, the following references are available for download at www.ti.com:

- Tiva C Series TM4C123GH6PM Microcontroller Data Sheet (literature number SPMS376).
- LM Flash Programmer tool. Available for download at www.ti.com/tool/lmflashprogrammer.
- TivaWare for C Series Driver Library. Available for download at www.ti.com/tool/sw-tm4c-drl.
- TivaWare for C Series Driver Library User's Manual (literature number SPMU298).
- TPS73633 Low-Dropout Regulator with Reverse Current Protection Data Sheet (literature number SBVS038)
- Texas Instruments' Code Composer Studio IDE website: www.ti.com/ccs

Additional support:

- RealView MDK (www.keil.com/arm/rvmdkkit.asp)
- IAR Embedded Workbench (www.iar.com).
- Sourcery CodeBench development tools (www.codesourcery.com/gnu_toolchains/arm).

4.2 Component Locations

Plots of the top-side component locations are shown in Figure 4-1 and the board dimensions are shown in Figure 4-2.

Figure 4-1. Tiva C Series LaunchPad Component Locations (Top View)

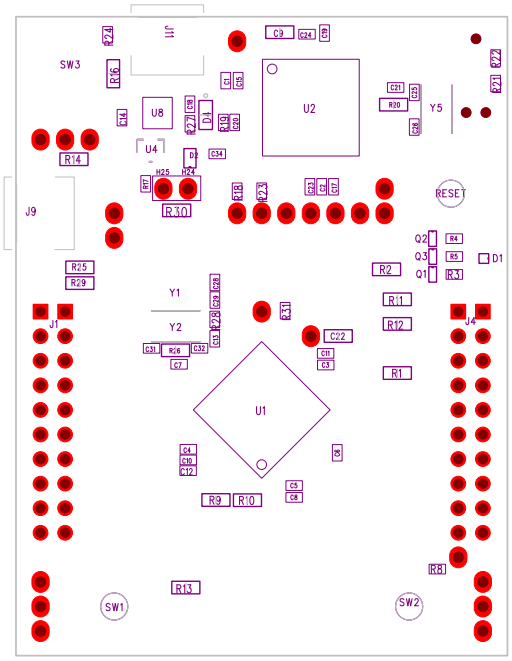
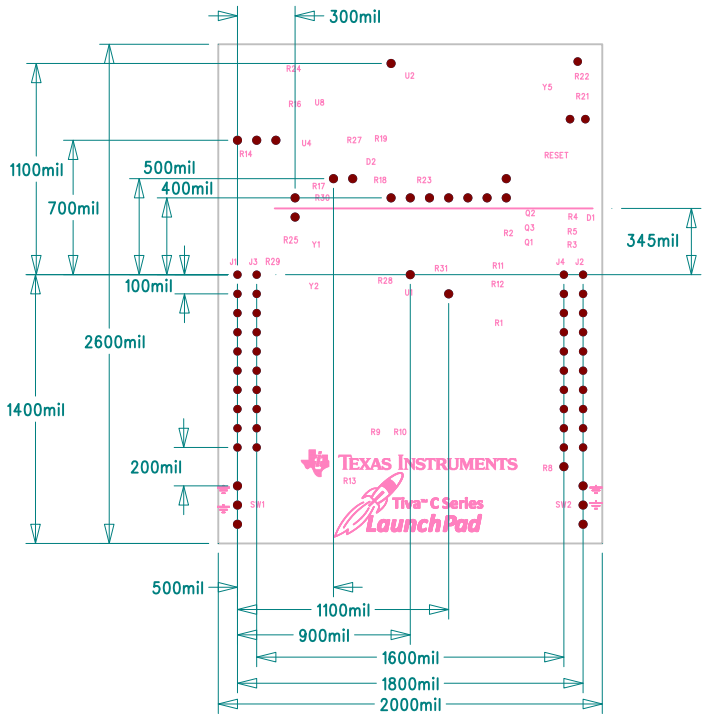


Figure 4-2. Tiva C Series LaunchPad Dimensions



NOTE: Units are in mils (one thousandth of an inch): 1 mil = 0.001 inch (0.0254 mm).

4.3 Bill of Materials (BOM)

Table 4-1 shows the bill of materials for the EK-TM4C123GXL evaluation board.

Table 4-1. EK-TM4C123GXL Bill of Materials

Item	Ref Des	Qty	Description	Manufacturer	Manufacturer Part No
1	C1-2, C7, C12, C14	5	Capacitor, 0402, X5R, 10 V, Low ESR	Johanson Dielectrics Inc	100R07X105KV4T
2	C25-26, C31-32	4	Capacitor, 10 pF, 50 V, 5%, NPO/COG, 0402	Murata	GRM1555C1H100JZ01D
3	C28-29	2	Capacitor, 24 pF, 50 V, 5%, NPO/COG, 0402	TDK	C1005C0G1H240J
4	C3, C5, C8, C15, C18-19, C21	7	Capacitor, 0.01 µF 25 V, 10% 0402 X7R	Taiyo Yuden	TMK105B7103KV-F
5	C4, C6, C10-11, C17, C20, C23-24	8	Capacitor, 0.1 µF 16 V, 10% 0402 X7R	Taiyo Yuden	EMK105B7104KV-F
6	C9, C22	2	Capacitor, 2.2 µF, 16 V, 10%, 0603, X5R	Murata	GRM188R61C225KE15D
7	D1	1	LED, Tri-Color RGB, 0404 SMD Common Anode	Everlight	18-038/RSGHBHC1-S02/2T
8	D4	1	LED, Green 565 nm, Clear 0805 SMD	Lite-On	LTST-C171GKT
9	H24	1	Header, 1x2, 0.100, T-Hole, Vertical Unshrouded, 0.220 Mate	3M	961102-6404-AR
				FCI	68001-102HLF
10	H25	1	Jumper, 0.100, Gold, Black, Closed	Sullins	SPC02SYAN
11	J1, J3	2	Header, 2x10, T-Hole Vertical unshrouded stacking	Samtec	SSW-110-23-S-D

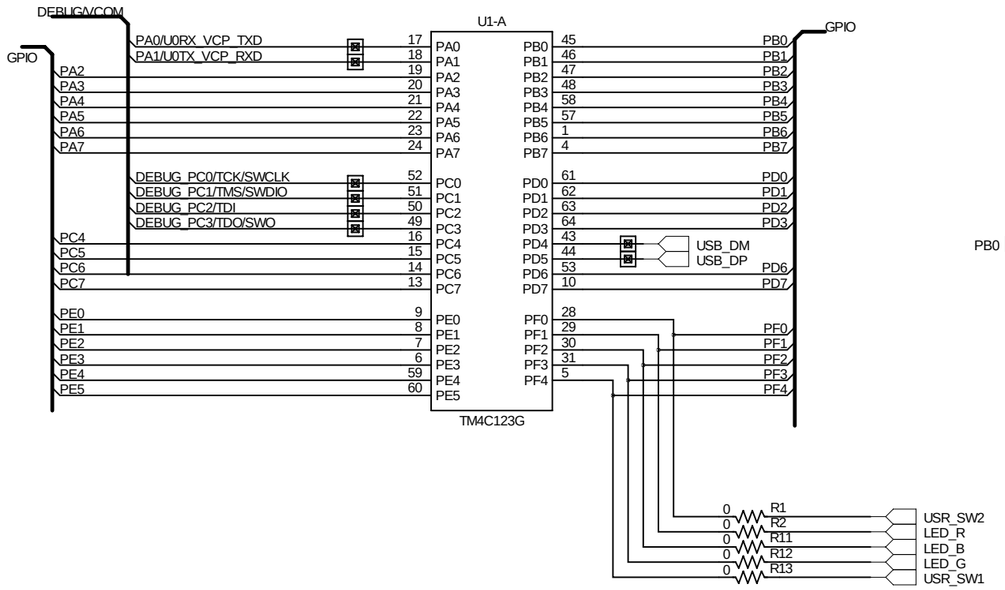
Table 4-1. EK-TM4C123GXL Bill of Materials (continued)

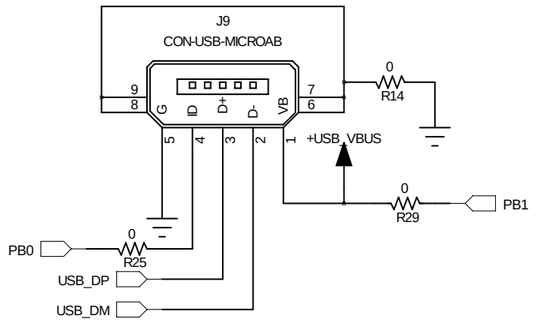
Item	Ref Des	Qty	Description	Manufacturer	Manufacturer Part No
12	J11	1	USB Connector, Micro B Recept RA SMT BTTM MNT	Hirose	ZX62-B-5PA
13	J2, J4	2	Header, 1x2, 0.100, SMT, Horizontal Unshrouded, 0.230 Mate	Samtec	TSM-110-01-S-DH-A-P-TR
				4UCON	10995
				Major League Electronics	TSHSM-110-D-02-T-H-AP-TR-P-LF
14	J9	1	USB Connector, Micro A/B Receptacle SMD	Hirose	ZX62-AB-5PA
15	Q1-3	3	NPN SC70 pre-biased	Diodes Inc	DTC114EET1G
16	R1-2, R9-16, R20, R26	12	Resistor, 0 Ω 1/10W 0603 SMD	Panasonic	ERJ-3GEY0R00V
17	R18-19, R21-23, R28	6	Resistor, 10 kΩ, 1/10W, 5%, 0402 Thick Film	Yageo	RC0402FR-0710KL
18	R3-5, R8, R27	5	Resistor, 330 Ω, 1/10W, 5%, 0402	Yageo	RC0402FR-07330RL
19	R31	1	Resistor, 1 MΩ 1/10W, 5%, 0402	Rohm	MCR01MRTF1004
20	RESET SW1, SW2	3	Switch, Tact 6 mm SMT, 160gf	Omron	B3S-1000
21	SW3	1	Switch, DPDT, SMT 300 mA × 2 at 6 V	C K Components	JS202011SCQN
22	U1, U2	2	Tiva C Series MCU TM4C123GH6PM	Texas Instruments	TM4C123GH6PMI
23	U8	1	Regulator, 3.3 V, 400 mA, LDO	Texas Instruments	TPS73633DRBT
24	Y1	1	Crystal, 32.768 kHz Radial Can	Abracon	AB26TRB-32.768KHZ- T
25	Y2, Y5	2	Crystal, 16.00 MHz 5.0x3.2mm SMT	NDK	NX5032GA-16.000000 MHz
				Abracon	ABM3-16.000 MHz-B2- T
PCB Do Not Populate List (Shown for information only)					
26	C31, C34	2	Capacitor, 0.1 µF 16 V, 10% 0402 X7R	Taiyo Yuden	EMK105B7104KV-F
27	D2	1	Diode, Dual Schottky, SC70, BAS70 Common Cathode	Diodes Inc	BAS70W-05-7-F
28	R17	1	Resistor, 10 kΩ 1/10W 5%, 0402 Thick Film	Yageo	RC0402FR-0710KL
29	R24	1	Resistor, 330 Ω, 1/10W, 5%, 0402	Yageo	RC0402FR-07330RL
30	R25, R29-30	3	Resistor, 0 Ω, 1/10W 0603	Panasonic	ERJ-3GEY0R00V
31	U4	1	IC, Single Voltage Supervisor, 5V, DBV	Texas Instruments	TLV803MDBZR

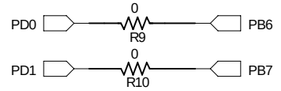
Schematics

This section contains the complete schematics for the Tiva C Series LaunchPad board.

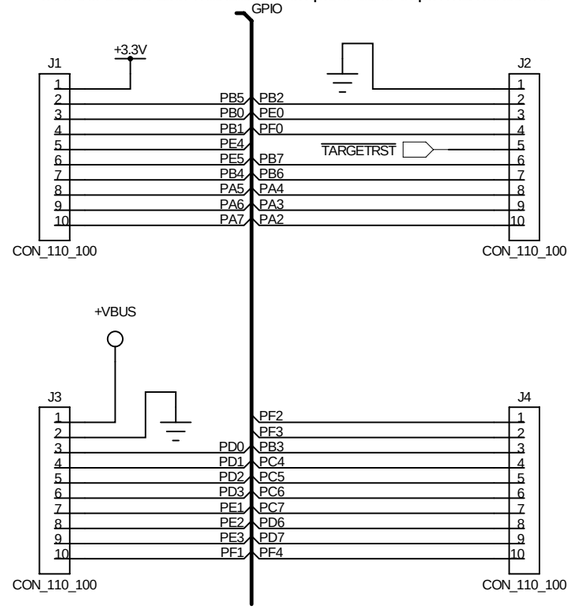
- Microcontroller, USB, Expansion, Buttons, and LED
- Power Management
- In-Circuit Debug Interface

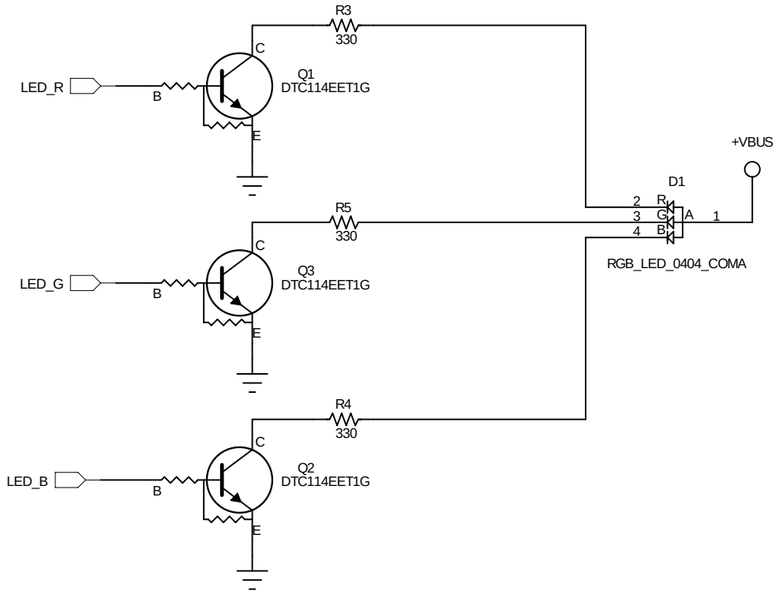


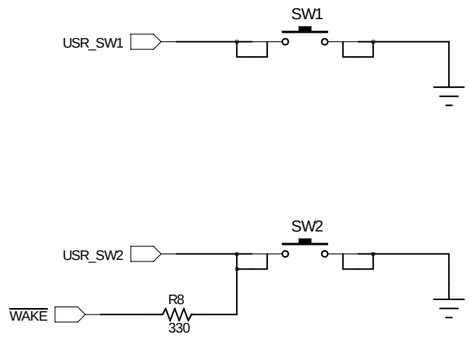




J1 and J2 provide compatability with
Booster Packs designed for MSP430 Launchpad
J3 and J4 sit 100 mils inside J1 and J2 to provide
extended functions specific to this board.
See the board user manual for complete table of pin mux functions







DESIGNER	REVISION	DATE
DGT	0.3	2/20/2013

PROJECT
Tiva TM4C123G LaunchPad

DESCRIPTION
Microcontroller, USB, Expansion, Buttons and LED

FILENAME
EK-TM4C123GXL Rev A.sch

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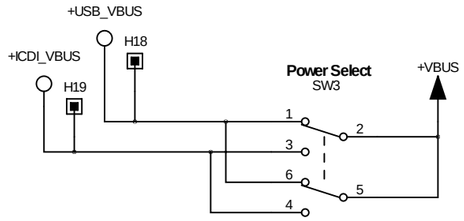
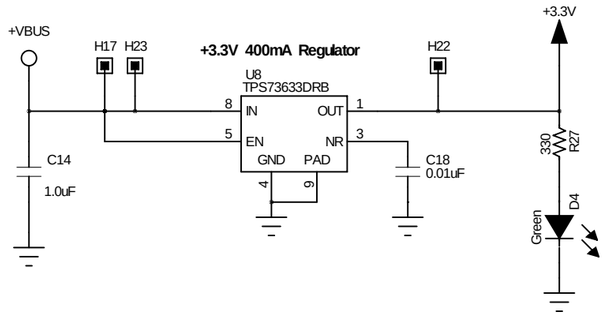
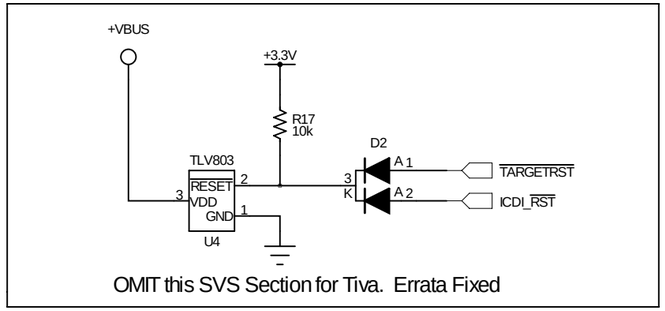
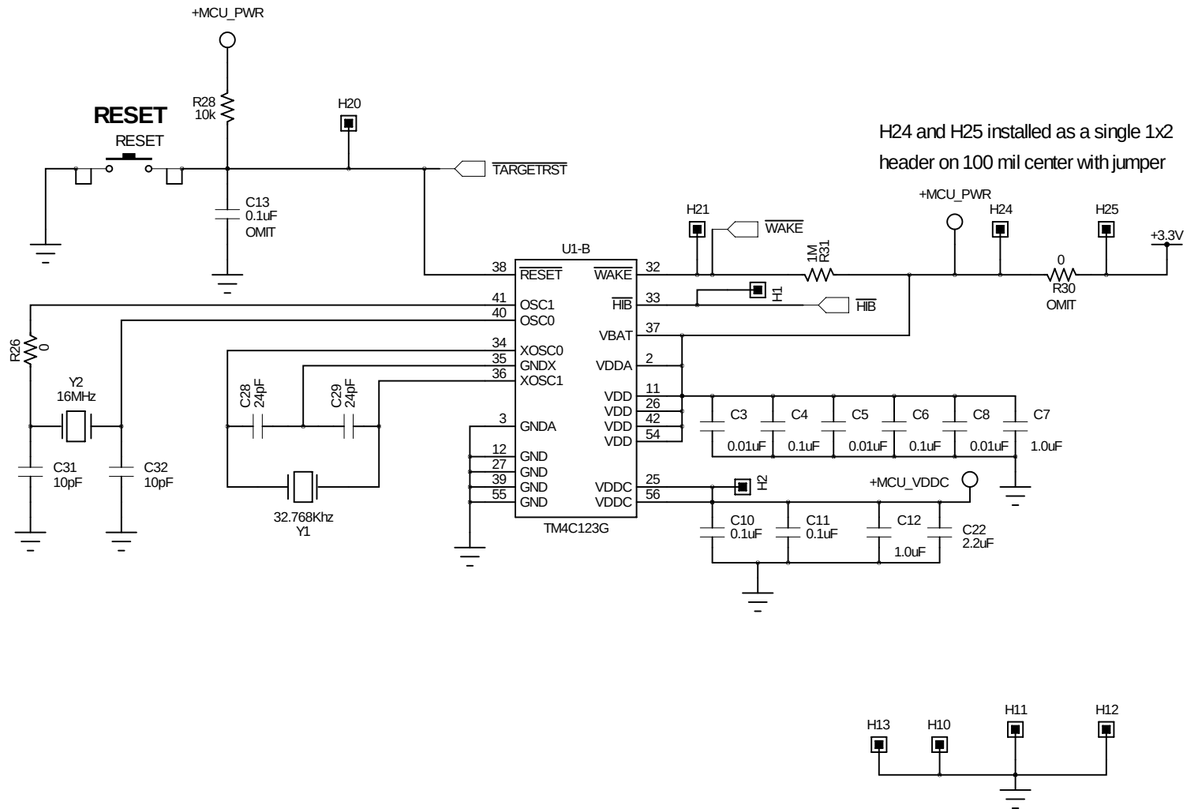
PART NO.	SHEET
EK-TM4C123GXL	1 OF 3









H24 and H25 installed as a single 1x2 header on 100 mil center with jumper

DESIGNER	REVISION	DATE
DGT	0.3	2/20/2013

PROJECT: Tiva Launchpad

DESCRIPTION: Power Management

FILENAME: EK-TM4C123GXL Rev A.sch

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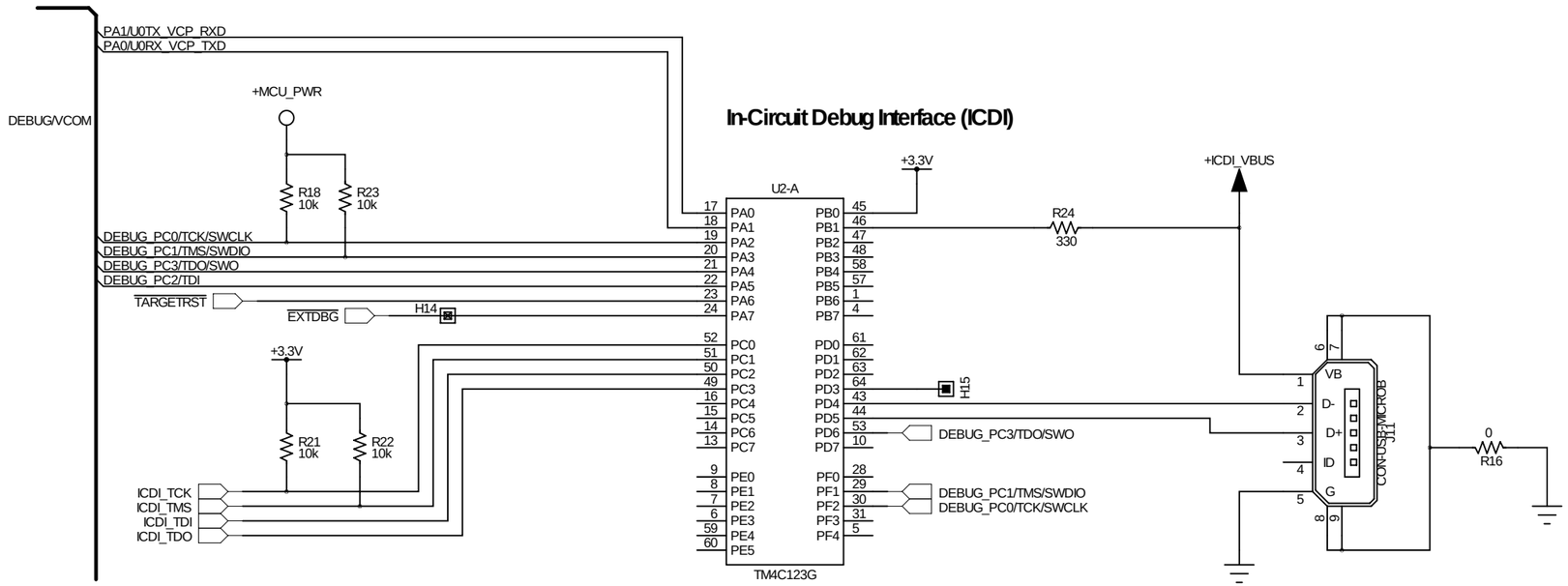
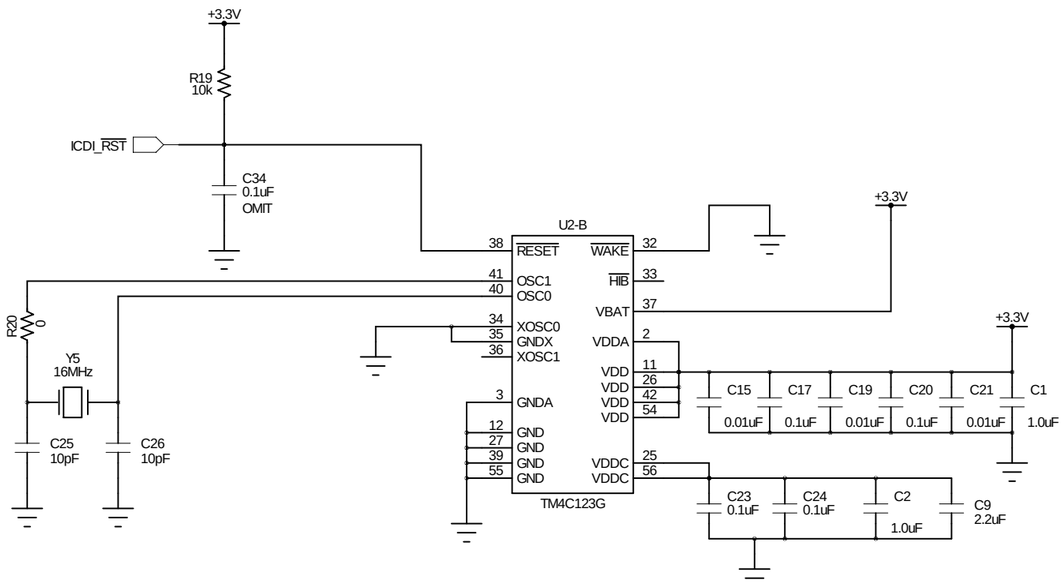
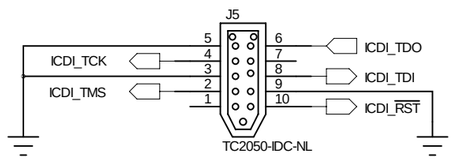
PART NO. EK-TM4C123GXL

In-Circuit Debug Interface (ICDI)





ICDI JTAG



DESIGNER	REVISION	DATE
DGT	0.3	2/20/2013

PROJECT
Tiva TM4C123G LaunchPad

DESCRIPTION
In Circuit Debug Interface

FILENAME
EK-TM4C123GXL Rev A.sch

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PART NO.	SHEET
EK-TM4C123GXL	3 OF 3

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General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

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

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

FCC Interference Statement for Class B EVM devices

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.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

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

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-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.

Concerning EVMs including detachable antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

【Important Notice for Users of this Product in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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http://www.tij.co.jp

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1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

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