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Tiva™ C Series TM4C1294 Connected LaunchPad Evaluation Kit

EK-TM4C1294XL

User's Guide

Literature Number: SPMU365A
March 2014–Revised March 2014

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Board Overview

The Tiva™ C Series TM4C1294 Connected LaunchPad Evaluation Board (EK-TM4C1294XL) is a low-cost evaluation platform for ARM® Cortex™-M4F-based microcontrollers. The Connected LaunchPad design highlights the TM4C1294NCPDT microcontroller with its on-chip 10/100 Ethernet MAC and PHY, USB 2.0, hibernation module, motion control pulse-width modulation and a multitude of simultaneous serial connectivity. The Connected LaunchPad also features two user switches, four user LEDs, dedicated reset and wake switches, a breadboard expansion option and two independent BoosterPack XL expansion connectors. The pre-programmed quickstart application on the Connected LaunchPad also enables remote monitoring and control of the evaluation board from an internet browser anywhere in the world. The web interface is provided by 3rd party, Exosite. Each Connected LaunchPad is enabled on the Exosite platform allowing users to create and customize their own Internet-of-Things applications.

Figure 1-1 shows a photo of the Connected LaunchPad with key features highlighted.

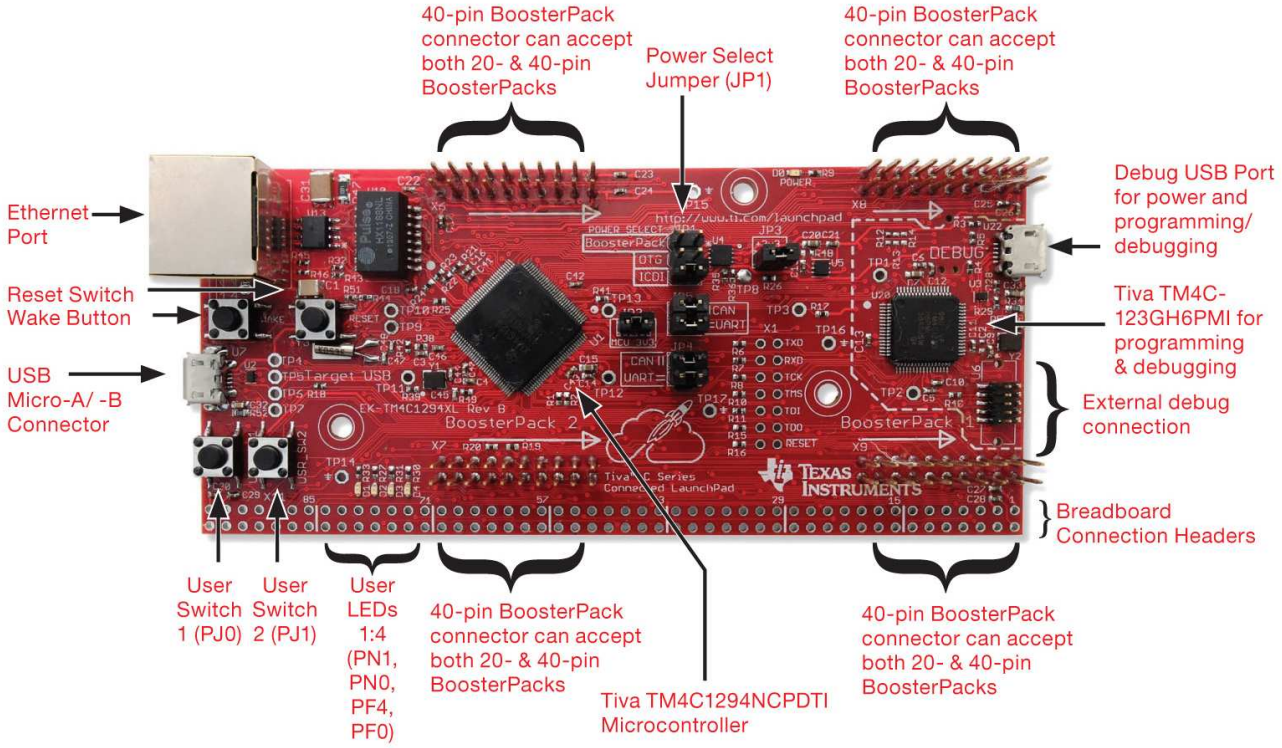


Figure 1-1. Tiva C Series Connected LaunchPad Evaluation Board

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1.1 Kit Contents

The Connected LaunchPad Evaluation Kit contains the following items:

- Tiva™ C Series TM4C1294 Evaluation Board (EK-TM4C1294XL)
- Retractable Ethernet cable
- USB Micro-B plug to USB-A plug cable
- README First document

1.2 Using the Connected LaunchPad

The recommended steps for using the Connected LaunchPad Evaluation Kit are:

1. **Follow the README First document included in the kit.** The README First helps you get the Connected LaunchPad up and running in minutes. Within just a few minutes you can be controlling and monitoring the Connected LaunchPad through the internet using Exosite and the pre-programmed quickstart application.
2. **Experiment with BoosterPacks.** This evaluation kit conforms to the latest revision of the BoosterPack pinout standard. It has two independent BoosterPack connections to enable a multitude of expansion opportunities.
3. **Take the first step towards developing your own applications.** The Connected LaunchPad is supported by TivaWare for C Series. After installing TivaWare, look in the installation directory for *examples\boards\ek-tm4c1294xl*. You can find pre-configured example applications for this board as well as for this board with selected BoosterPacks. Alternately, use Energīa for a wiring framework-based cross-platform, fast-prototyping environment that works with this and other TI LaunchPads. See Chapter 3 of this document for more details about software development. TivaWare can be downloaded from the TI website at http://www.ti.com/tool/sw-tm4c. Energīa can be found at http://energia.nu.
4. **Customize and integrate the hardware to suit your end application.** This evaluation kit can be used as a reference for building your own custom circuits based on Tiva C microcontrollers or as a foundation for expansion with your custom BoosterPack or other circuit. This manual can serve as a starting point for this endeavor.
5. **Get Trained.** You can also download hours of written and video training materials on this and related LaunchPads. Visit the Tiva C Series LaunchPad Workshop Wiki for more information.
6. **More Resources.** See the TI MCU LaunchPad web page for more information and available BoosterPacks. (http://www.ti.com/tiva-c-launchpad)

1.3 Features

Your Connected LaunchPad includes the following features:

- Tiva TM4C1294NCPDTI microcontroller
- Ethernet connectivity with fully integrated 10/100 Ethernet MAC and PHY Motion Control PWM
- USB 2.0 Micro A/B connector
- 4 user LEDs
- 2 user buttons
- 1 independent hibernate wake switch
- 1 independent microcontroller reset switch
- Jumper for selecting power source:
  - ICDI USB
  - USB Device
  - BoosterPack
- Preloaded Internet-of-Things Exosite quickstart application
- I/O brought to board edge for breadboard expansion
- Two independent BoosterPack XL standard connectors featuring stackable headers to maximize expansion through BoosterPack ecosystem

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– For a complete list of BoosterPacks, see the TI MCU LaunchPad web page: http://www.ti.com/launchpad

1.4 BoosterPacks

The Connected LaunchPad provides an easy and inexpensive way to develop applications with the TM4C1294NCPDTI microcontroller. BoosterPacks are add-on boards that follow a pin-out standard created by Texas Instruments. The TI and third-party ecosystem of BoosterPacks greatly expands the peripherals and potential applications that you can easily explore with the Connected LaunchPad.

You can also build your own BoosterPack by following the design guidelines on TI's website. Texas Instruments even helps you promote your BoosterPack to other members of the community. TI offers a variety of avenues for you to reach potential customers with your solutions.

1.5 Energīa

Energīa is an open-source electronics prototyping platform started in January of 2012 with the goal of bringing the Wiring and Arduino framework to the TI LaunchPad community. Energīa includes an integrated development environment (IDE) that is based on Processing.

Together with Energīa, LaunchPads can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. LaunchPad projects can be stand-alone (only run on the target board, i.e. your LaunchPad), or they can communicate with software running on your computer (Host PC). Energīa projects are highly portable between supported LaunchPad platforms. Projects written for your Connected LaunchPad can be run on other LaunchPads with little or no modifications.

More information is available at http://energia.nu.

1.6 Specifications

Table 1-1 summarizes the specifications for the Connected LaunchPad.

Table 1-1. EK-TM4C1294XL Specifications

Parameter	Value
Board Supply Voltage	4.75 V_{DC} to 5.25 V_{DC} from one of the following sources: • Debug USB U22 (ICDI) USB Micro-B cable connected to PC or other compatible power source. • Target USB (U7) USB Micro-B cable connected to PC or other compatible power source. • BoosterPack 1 (X8-4) • BoosterPack 2 (X6-4) • Breadboard expansion header (X11-2 or X11-97). See schematic symbol JP1 for power input selection.
Dimensions	4.9 in x 2.2 in x .425 in (12.45 cm x 5.59 cm x 10.8 mm) (L x W x H)
Break-out Power Output	• 5 V_{DC} to BoosterPacks, current limited by TPS2052B. Nominal rating 1 Amp. Board input power supply limitations may also apply. • 3.3 V_{DC} to BoosterPacks, limited by output of TPS73733 LDO. This 3.3-V plane is shared with on-board components. Total output power limit of TPS73733 is 1 Amp.
RoHS Status	Compliant

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Hardware Description

The Connected LaunchPad includes a TM4C1294NCPDTI microcontroller with an integrated 10/100 Ethernet MAC and PHY. This advanced ARM® Cortex™ M4F MCU has a wide range of peripherals that are made available to users via the on-board accessories and the BoosterPack connectors. This chapter explains how those peripherals operate and interface to the microcontroller.

Figure 2-1 provides a high-level block diagram of the Connected LaunchPad.

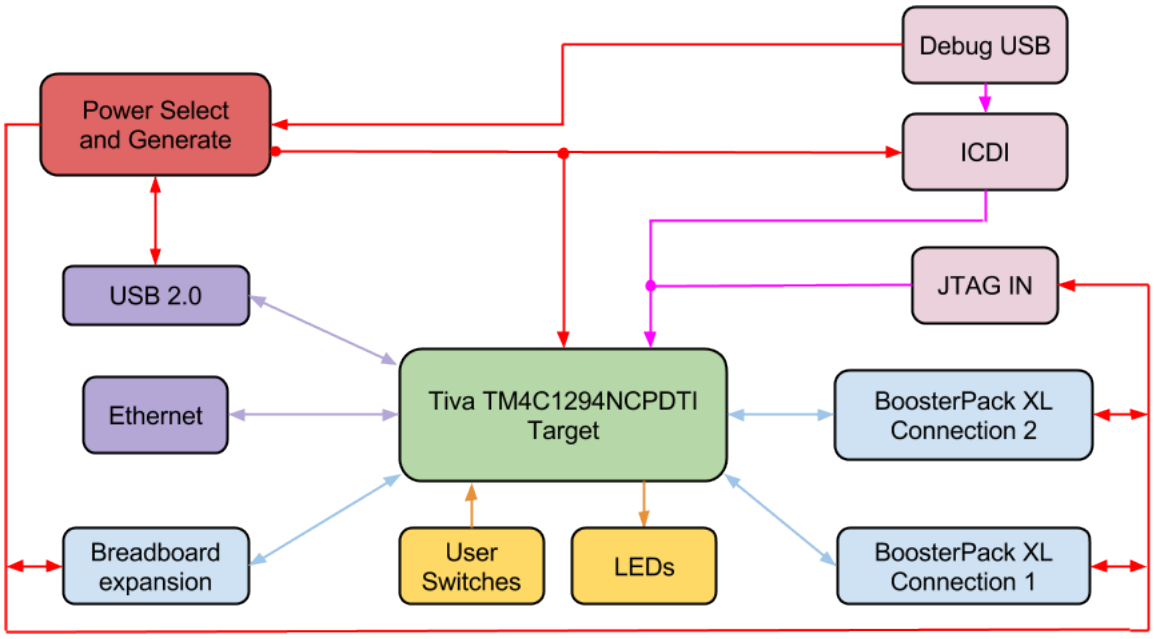


Figure 2-1. Tiva Connected LaunchPad Evaluation Board Block Diagram

2.1 Functional Description

2.1.1 Microcontroller

The TM4C1294NCPDTI is a 32-bit ARM Cortex-M4F based microcontroller with 1024-kB Flash memory, 256-kB SRAM, 6-kB EEPROM, and 120 MHz operation; integrated 10/100 Ethernet MAC and PHY; integrated USB 2.0 connectivity with external high-speed USB 3.0 PHY capability; a hibernation module, a multitude of serial connectivity and motion control PWM; as well as a wide range of other peripherals. See the TM4C1294NCPDTI microcontroller data sheet for more complete details.

Most of the microcontroller's signals are routed to 0.1-in (2.54-mm) pitch headers or through-hole solder pads. An internal multiplexor 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 TM4C1294NCPDTI 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. The quickstart application automatically connects to http://ti.exosite.com when an internet connection is provided through the RJ45 Ethernet jack on the evaluation board.

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2.1.2 Ethernet Connectivity

The Connected LaunchPad is designed to connect directly to an Ethernet network using RJ45 style connectors. The microcontroller contains a fully integrated Ethernet MAC and PHY. This integration creates a simple, elegant and cost-saving Ethernet circuit design. Example code is available for both the uIP and LwIP TCP/IP protocol stacks. The embedded Ethernet on this device can be programmed to act as an HTTP server, client or both. The design and integration of the circuit and microcontroller also enable users to synchronize events over the network using the IEEE1588 precision time protocol.

When configured for Ethernet operation, it is recommended that the user configure LED D3 and D4 to be controlled by the Ethernet MAC to indicate connection and transmit/receive status.

2.1.3 USB Connectivity

The Connected LaunchPad is designed to be USB 2.0 ready. A TPS2052B load switch is connected to and controlled by the microcontroller USB peripheral, which manages power to the USB micro A/B connector when functioning in a USB host. When functioning as a USB device, the entire Connected LaunchPad can be powered directly from the USB micro A/B connector. Use JP1 to select the desired power source.

USB 2.0 functionality is provided and supported directly out of the box with the target USB micro A/B connector. High-speed USB 3.0 functionality can be enabled by adding an external USB PHY. The USB external PHY control and data signals are provided on the breadboard expansion header X11.

2.1.4 Motion Control

The Connected LaunchPad includes the Tiva C Series Motion Control PWM technology, featuring a PWM module capable of generating eight PWM outputs. The 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.

A quadrature encoder interface (QEI) is also available to provide motion control feedback.

See the BoosterPacks and Headers section of this document for details about the availability of these signals on the BoosterPack interfaces.

2.1.5 User Switches and LED's

Two user switches are provided for input and control of the TM4C1294NCPDTI software. The switches are connected to GPIO pins PJ0 and PJ1.

A reset switch and a wake switch are also provided. The reset switch initiates a system reset of the microcontroller whenever it is pressed and released. Pressing the reset switch also asserts the reset signal to the BoosterPack and Breadboard headers. The wake switch is one way to bring the device out of hibernate mode.

Four user LEDs are provided on the board. D1 and D2 are connected to GPIOs PN1 and PN0. These LEDs are dedicated for use by the software application. D3 and D4 are connected to GPIOs PF4 and PF0, which can be controlled by user's software or the integrated Ethernet module of the microcontroller.

A power LED is also provided to indicate that 3.3 volt power is present on the board.

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2.1.6 BoosterPacks and Headers

2.1.6.1 BoosterPack 1

The Connected LaunchPad features two fully independent BoosterPack XL connectors. BoosterPack 1, located around the ICDI portion of the board, is fully compliant with the BoosterPack standard with the single exception of GPIO pin PA6 (X8-16), which does not provide analog capability. PA6 is located near the bottom of the inner left BoosterPack XL header.

I2C is provided in both the original BoosterPack standard configuration as well as the updated standard location. Use of I2C on the bottom left of the BoosterPack connections per the updated standard is highly encouraged whenever possible.

Motion control advanced PWM connections are provided on the inner right connector for motion control applications.

Table 2-1 provides a complete listing of the BoosterPack pins and the GPIO alternate functions available on each pin. The TM4C1294NCPDTI GPIO register GPIOPCTL values are shown for each configuration. The headers in this table are labeled from left to right in ten pin columns. 'A' and 'D' make up the outer BoosterPack standard pins, 'B' and 'C' make up the inner BoosterPack XL standard pins.

Table 2-1. BoosterPack 1 GPIO and Signal Muxing

Header	Pin	Standard Function	GPIO	MCU Pin	Analog	Digital Function (GPIOPCTL Bit Encoding)										
						1	2	3	5	6	7	8	11	13	14	15
A1	1	+3.3 volts	3.3V													
A1	2	Analog	PE4	123	AIN9	U1RI	-	-	-	-	-	-	-	-	-	SSI1XDAT0
A1	3	UART RX	PC4	25	C1-	U7Rx	-	-	-	-	-	-	-	-	-	EPI0S7
A1	4	UART TX	PC5	24	C1+	U7Tx	-	-	-	-	RTCCLK	-	-	-	-	EPI0S6
A1	5	GPIO	PC6	23	C0+	U5Rx	-	-	-	-	-	-	-	-	-	EPI0S5
A1	6	Analog	PE5	124	AIN8	-	-	-	-	-	-	-	-	-	-	SSIXDAT1
A1	7	SPI CLK	PD3	4	AIN12	-	I2C8SDA	T1CCP1	-	-	-	-	-	-	-	SSI2CLk
A1	8	GPIO	PC7	22	C0-	U5Tx	-	-	-	-	-	-	-	-	-	EPI0S4
A1	9	I2C SCL	PB2	91	-	-	I2C0SCL	T5CCP0	-	-	-	-	-	-	USB0STP	EPI0S27
A1	10	I2C SDA	PB3	92	-	-	I2C0SDA	T5CCP1	-	-	-	-	-	-	USB0CLK	EPI0S28
B1	1	+5 volts	5V													
B1	2	ground	GND													
B1	3	Analog	PE0	15	AIN3	U1RTS	-	-	-	-	-	-	-	-	-	-
B1	4	Analog	PE1	14	AIN2	U1DSR	-	-	-	-	-	-	-	-	-	-
B1	5	Analog	PE2	13	AIN1	U1DCD	-	-	-	-	-	-	-	-	-	-
B1	6	Analog	PE3	12	AIN0	U1DTR	-	-	-	-	-	-	-	-	-	-
B1	7	Analog	PD7	128	AIN4	U2CTS	-	T4CCP1	USB0PFLT	-	-	NMI	-	-	-	SSI2XDAT2
B1	8	Analog	PA6	40	-	U2Rx	I2C6SCL	T3CCP0	USB0EPEN	-	-	-	-	SSI0XDAT2	-	EPI0S8
B1	9	A out	PM4	74	TMPR3	U0CTS	-	T4CCP0	-	-	-	-	-	-	-	-
B1	10	A out	PM5	73	TMPR2	U0DCD	-	T4CCP1	-	-	-	-	-	-	-	-

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Table 2-1. BoosterPack 1 GPIO and Signal Muxing (continued)

Header	Pin	Standard Function	GPIO	MCU Pin	Analog	Digital Function (GPIOPCTL Bit Encoding)										
						1	2	3	5	6	7	8	11	13	14	15
C1	1	PWM	PF1	43	-	-	-	-	EN0LED2	M0PWM1	-	-	-	-	SSI3XDAT0	TRD1
C1	2	PWM	PF2	44	-	-	-	-	-	M0PWM2	-	-	-	-	SSI3Fss	TRD0
C1	3	PWM	PF3	45	-	-	-	-	-	M0PWM3	-	-	-	-	SSI3Clk	TRCLK
C1	4	PWM	PG0	49	-	-	I2C1SCL	-	EN0PPS	M0PWM4	-	-	-	-	-	EPI0S11
C1	5	Capture	PL4	85	-	-	-	T0CCP0	-	-	-	-	-	-	USB0D4	EPI0S26
C1	6	Capture	PL5	86	-	-	-	T0CCP1	-	-	-	-	-	-	USB0D5	EPI0S33
C1	7	GPIO	PL0	81	-	-	I2C2SDA	-	-	M0FAULT3	-	-	-	-	USB0D0	EPI0S16
C1	8	GPIO	PL1	82	-	-	I2C2SCL	-	-	PhA0	-	-	-	-	USB0D1	EPI0S17
C1	9	GPIO	PL2	83	-	-	-	-	C0o	PhB0	-	-	-	-	USB0D2	EPI0S18
C1	10	GPIO	PL3	84	-	-	-	-	C1o	IDX0	-	-	-	-	USB0D3	EPI0S19
D1	1	ground	GND													
D1	2	PWM	PM3	75	-	-	-	T3CCP1	-	-	-	-	-	-	-	EPI0S12
D1	3	GPIO	PH2	31	-	U0DCD	-	-	-	-	-	-	-	-	-	EPI0S2
D1	4	GPIO	PH3	32	-	U0DSR	-	-	-	-	-	-	-	-	-	EPI0S3
D1	5	reset	RESET													
D1	6	SPI MOSI	PD1	2	AIN14	-	I2C7SDA	T0CCP1	C1o	-	-	-	-	-	-	SSI2XDAT0
D1	7	SPI MISO	PD0	1	AIN15	-	I2C7SCL	T0CCP0	C0o	-	-	-	-	-	-	SSI2XDAT1
D1	8	GPIO	PN2	109	-	U1DCD	U2RTS	-	-	-	-	-	-	-	-	EPI0S29
D1	9	GPIO	PN3	110	-	U1DSR	U2CTS	-	-	-	-	-	-	-	-	EPI0S30
D1	10	GPIO	PP2	103	-	U0DTR	-	-	-	-	-	-	-	-	USB0NXT	EPI0S29

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2.1.6.2 BoosterPack 2

The second BoosterPack XL interface is located near the middle of the board. This interface is fully compliant with the BoosterPack standard, and adds features not covered by the BoosterPack standard that enable operation with additional BoosterPacks.

An additional analog signal is provided on the outer left header (X6-9). This signal can be used to monitor the touch panel on the popular Kentec EB-LM4F120-L35 BoosterPack.

Using the jumpers JP4 and JP5, Controller Area Network (CAN) digital receive and transmit signals can be optionally routed to the BoosterPack 2 interface. The location of these signals is consistent with the CAN interface on the Tiva C Series TM4C123G LaunchPad and the Stellaris LM4F120 LaunchPad. In the default configuration, UART0 is used for the ICDI virtual UART and CAN is not present on the BoosterPack headers. In this configuration, the ROM serial bootloader can be used over the ICDI virtual UART. When the jumpers are configured for CAN on the BoosterPack, then UART4 must be used for the ICDI virtual UART.

To comply with both the original and the new BoosterPack standard, I2C is provided on both sides of the BoosterPack connection. Use of I2C on the bottom left of the BoosterPack connection is highly encouraged where possible, to be in compliance with the new BoosterPack standard. To provide I2C capability on the right side of the connector, per the original standard, two zero-ohm resistors (R19 and R20) are used to combine the SPI and I2C signals. These signals are not shared with any other pins on the LaunchPad and therefore removal of these zero-ohm resistors should not be required. Software should be certain that unused GPIO signals are configured as inputs.

Table 2-2 provides a complete listing of the BoosterPack pins and the GPIO alternate functions available at each pin. The TM4C1294NCPDT GPIO register GPIOPCTL values are shown for each configuration. The headers in this table are labeled from left to right in ten pin columns. ‘A’ and ‘D’ make up the outer BoosterPack standard pins, ‘B’ and ‘C’ make up the inner BoosterPack XL standard pins.

Table 2-2. BoosterPack 2 GPIO and Signal Muxing

Header	Pin	Standard Function	GPIO	MCU Pin	Analog	Digital Function (FPIOPCTL Bit Encoding)										
						1	2	3	5	6	7	8	11	13	14	15
A2	1		3.3V													
A2	2	Analog	PD2	3	AIN13	-	I2C8SCL	T1CCP0	C2o	-	-	-	-	-	-	SSI2Fss
A2	3	UART RX	PP0	118	C2+	U6Rx	-	-	-	-	-	-	-	-	-	SSI3XDAT2
A2	4	UART TX	PP1	119	C2-	U6Tx	-	-	-	-	-	-	-	-	-	SSI3XDAT3
A2	5	GPIO (See JP4)	PD4	125	AIN7	U2Rx	-	T3CCP0	-	-	-	-	-	-	-	SSI1XDAT2
			PA0	33	-	U0Rx	I2C9SCL	T0CCP0	-	-	CANORx	-	-	-	-	-
A2	6	Analog (See JP5)	PD5	126	AIN6	U2Tx	-	T3CCP1	-	-	-	-	-	-	-	SSI1XDAT3
			PA1	34	-	U0Tx	I2C9SDA	T0CCP1	-	-	CAN0Tx	-	-	-	-	-
A2	7	SPI CLK	PQ0	5	-	-	-	-	-	-	-	-	-	-	SSI3Clk	EPI0S20
A2	8	GPIO	PP4	105	-	U3RTS	U0DSR	-	-	-	-	-	-	-	USB0D7	-
A2	9	I2C SCL	PN5	112	-	U1RI	U3CTS	I2C2SCL	-	-	-	-	-	-	-	EPIO0S35
A2	10	I2C SDA	PN4	111	-	U1DTR	U3RTS	I2C2SDA	-	-	-	-	-	-	-	EPIO0S34
B2	1		5V													
B2	2		GND													
B2	3	Analog	PB4	121	AIN10	U0CTS	I2C5SCL	-	-	-	-	-	-	-	-	SSI1Fss

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Table 2-2. BoosterPack 2 GPIO and Signal Muxing (continued)

Header	Pin	Standard Function	GPIO	MCU Pin	Analog	Digital Function (FPIOPCTL Bit Encoding)										
						1	2	3	5	6	7	8	11	13	14	15
B2	4	Analog	PB5	120	AIN11	U0RTS	I2C5SDA	-	-	-	-	-	-	-	-	SSI1Clk
B2	5	Analog	PK0	18	AIN16	U4Rx	-	-	-	-	-	-	-	-	-	EPI0S0
B2	6	Analog	PK1	19	AIN17	U4Tx	-	-	-	-	-	-	-	-	-	EPI0S1
B2	7	Analog	PK2	20	AIN18	U4RTS	-	-	-	-	-	-	-	-	-	EPI0S2
B2	8	Analog	PK3	21	AIN19	u4CTS	-	-	-	-	-	-	-	-	-	EPI0S3
B2	9	A out	PA4	37	-	U3Rx	I2C7SCL	T2CCP0	-	-	-	-	-	-	-	SSI0XDAT0
B2	10	A out	PA5	38	-	U3Tx	I2C7SDA	T2CCP1	-	-	-	-	-	-	-	SSI0XDAT1
C2	1	PWM	PG1	50	-	-	I2C1SDA	-	-	M0PWM5	-	-	-	-	-	EPI0S10
C2	2	PWM	PK4	63	-	-	I2C3SCL	-	EN0LED0	M0PWM6	-	-	-	-	-	EPI0S32
C2	3	PWM	PK5	62	-	-	I2C3SDA	-	EN0LED2	M0PWM7	-	-	-	-	-	EPI0S31
C2	4	PWM	PM0	78	-	-	-	T2CCP0	-	-	-	-	-	-	-	EPI0S15
C2	5	Capture	PM1	77	-	-	-	T2CCP1	-	-	-	-	-	-	-	EPI0S14
C2	6	Capture	PM2	76	-	-	-	T3CCP0	-	-	-	-	-	-	-	EPI0S13
C2	7	GPIO	PH0	29	-	U0RTS	-	-	-	-	-	-	-	-	-	EPI0S0
C2	8	GPIO	PH1	30	-	U0CTS	-	-	-	-	-	-	-	-	-	EPI0S1
C2	9	GPIO	PK6	61	-	-	I2C4SCL	-	EN0LED1	M0FAULT1	-	-	-	-	-	EPI0S25
C2	10	GPIO	PK7	60	-	U0RI	I2C4SDA	-	RTCCLK	M0FAULT2	-	-	-	-	-	EPI0S24
D2	1		GND													
D2	2	PWM	PM7	71	TMPR0	U0RI	-	T5CCP1	-	-	-	-	-	-	-	-
D2	3	GPIO	PP5	106	-	U3CTS	I2C2SDL	-	-	-	-	-	-	-	USB0D6	-
D2	4	GPIO	PA7	41	-	U2Tx	I2C6SDA	T3CCP1	USB0PFLT	-	-	-	USB0EPEN	SSI0XDAT3	-	EPI0S9
D2	5		RESET													
D2	6	SPI MOSI	PQ2	11	-	-	-	-	-	-	-	-	-	-	SSI3XDAT0	EPI0S22
		I2C	PA3	36	-	U4Tx	I2C8SDA	T1CCP1	-	-	-	-	-	-	-	SSI0Fss
D2	7	SPI MISO	PQ3	27	-	-	-	-	-	-	-	-	-	-	SSI3XDAT1	EPI0S23
		I2C	PA2	35	-	U4Rx	I2C8SCL	T1CCP0	-	-	-	-	-	-	-	SSI0Clk
D2	8	GPIO	PP3	104	-	U1CTS	U0DCD	-	-	-	-	-	-	-	USB0DIR	EPI0S30
D2	9	GPIO	PQ1	6	-	-	-	-	-	-	-	-	-	-	SSI3Fss	EPI0S21
D2	10	GPIO	PM6	72	TMPR1	U0DSR	-	T5CCP0	-	-	-	-	-	-	-	-

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2.1.6.3 Breadboard Connection

The breadboard adapter section of the board is a set of 98 holes on a 0.1 inch grid. Properly combined with a pair of right angle headers, the entire Connected LaunchPad can be plugged directly into a standard 300 mil (0.3 inch) wide solder-less breadboard. The right angle headers and breadboard are not provided with this kit. Suggested part numbers are Samtec TSW-149-09-L-S-RE and TSW-149-08-L-S-RA right angle pin headers and Twin industries TW-E40-1020 solder-less breadboard. Samtec TSW-149-09-F-S-RE and TSW-149-09-F-S-RA may be substituted.

A detailed explanation of how to install the headers is available on the TI LaunchPad Wiki or at http://users.ece.utexas.edu/~valvano/EE345L/Labs/Fall2011/LM3S1968soldering.pdf.

Nearly all microcontroller signals are made available at the breadboard adapter holes (X11). These signals are grouped by function where possible. For example, all EPI signals are grouped on one side of the connector. Many of the analog signals are grouped near VREF, and UART, SSI and I2C signals are grouped by peripheral to make expansion and customization simpler.

Table 2-3 and Table 2-4 show the GPIO pin and signal muxing for the X11 breadboard adapter pads.

Table 2-3. X11 Breadboard Adapter Odd-Numbered Pad GPIO and Signal Muxing

Pin	Port	MCU PIN	Analog	Digital Function (GPIOPCTL Bit Encoding)										
				1	2	3	5	6	7	8	11	13	14	15
1	3V3													
3	GND													
5	PB4	121	AIN10	U0CTS	I2C5SCL	-	-	-	-	-	-	-	-	SSI1Fss
7	PB5	120	AIN11	U0RTS	I2C5SDA	-	-	-	-	-	-	-	-	SSI1Clk
9	PH0	29	-	U0RTS	-	-	-	-	-	-	-	-	-	EPI0S0
11	PH1	30	-	U0CTS	-	-	-	-	-	-	-	-	-	EPI0S1
13	PH2	31	-	U0DCD	-	-	-	-	-	-	-	-	-	EPI0S2
15	PH3	32	-	U0DSR	-	-	-	-	-	-	-	-	-	EPI0S3
17	PC7	22	C0-	U5Tx	-	-	-	-	-	-	-	-	-	EPI0S4
19	PC6	23	C0+	U5Rx	-	-	-	-	-	-	-	-	-	EPI0S5
21	PC5	24	C1+	U7Tx	-	-	-	-	RTCCLK	-	-	-	-	EPI0S6
23	PC4	25	C1-	U7Rx	-	-	-	-	-	-	-	-	-	EPI0S7
25	PA6	40	-	U2Rx	I2C6SCL	T3CCP0	USB0EPEN	-	-	-	-	SSI0XDAT2	-	EPI0S8
27	PA7	41	-	U2Tx	I2C6SDA	T3CCP1	USB0PFLT	-	-	-	USB0EPEN	SSI0XDAT3	-	EPI0S9
29	PG1	50	-	-	I2C1SDA	-	-	M0PWM5	-	-	-	-	-	EPI0S10
31	PG0	49	-	-	I2C1SCL	-	EN0PPS	M0PWM4	-	-	-	-	-	EPI0S11
33	PM3	75	-	-	-	T3CCP1	-	-	-	-	-	-	-	EPI0S12
35	GND													
37	PM2	76	-	-	-	T3CCP0	-	-	-	-	-	-	-	EPI0S13
39	PM1	77	-	-	-	T2CCP1	-	-	-	-	-	-	-	EPI0S14
41	PM0	78	-	-	-	T2CCP0	-	-	-	-	-	-	-	EPI0S15

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Table 2-3. X11 Breadboard Adapter Odd-Numbered Pad GPIO and Signal Muxing (continued)

Pin	Port	MCU PIN	Analog	Digital Function (GPIOPCTL Bit Encoding)										
				1	2	3	5	6	7	8	11	13	14	15
43	PL0	81	-	-	I2C2SDA	-	-	M0FAULT3	-	-	-	-	USB0D0	EPI0S16
45	PL1	82	-	-	I2C2SCL	-	-	PhA0	-	-	-	-	USB0D1	EPI0S17
47	PL2	83	-	-	-	-	C0o	PhB0	-	-	-	-	USB0D2	EPI0S18
49	PL3	84	-	-	-	-	C1o	IDX0	-	-	-	-	USB0D3	EPI0S19
51	PQ0	5	-	-	-	-	-	-	-	-	-	-	SSI3Clk	EPI0S20
53	PQ1	6	-	-	-	-	-	-	-	-	-	-	SSI3Fss	EPI0S21
55	PQ2	11	-	-	-	-	-	-	-	-	-	-	SSI3XDAT0	EPI0S22
57	PQ3	27	-	-	-	-	-	-	-	-	-	-	SSI3XDAT1	EPI0S23
59	PK7	60	-	U0RI	I2C4SDA	-			-	-	-	-	-	EPI0S24
61	GND													
63	PK6	61	-	-	I2C4SCL	-	EN0LED1	M0FAULT1	-	-	-	-	-	EPI0S25
65	PL4	85	-	-	-	T0CCP0	-	-	-	-	-	-	USB0D4	EPI0S26
67	PB2	91	-	-	I2C0SCL	T5CCP0	-	-	-	-	-	-	USB0STP	EPI0S27
69	PB3	92	-	-	I2C0SDA	T5CCP1	-	-	-	-	-	-	USB0CLK	EPI0S28
71	PP2	103	-	U0DTR	-	-	-	-	-	-	-	-	USB0NXT	EPI0S29
73	PP3	104	-	U1CTS	U0DCD	-	-	-	RTCCLK	-	-	-	USB0DIR	EPI0S30
75	PK5	62	-	-	I2C3SDA	-	EN0LED2	M0PWM7	-	-	-	-	-	EPI0S31
77	PK4	63	-	-	I2C3SCL	-	EN0LED0	M0PWM6	-	-	-	-	-	EPI0S32
79	PL5	86	-	-	-	T0CCP1	-	-	-	-	-	-	USB0D5	EPI0S33
81	PN4	111	-	U1DTR	U3RTS	I2C2SDA	-	-	-	-	-	-	-	EPI0S34
83	PN5	112	-	U1RI	U3CTS	I2C2SCL	-	-	-	-	-	-	-	EPI0S35
85	PN0	107	-	U1RTS	-	-	-	-	-	-	-	-	-	-
87	PN1	108	-	U1CTS	-	-	-	-	-	-	-	-	-	-
89	PN2	109	-	U1DCD	U2RTS	-	-	-	-	-	-	-	-	EPI0S29
91	PN3	110	-	U1DSR	U2CTS	-	-	-	-	-	-	-	-	EPI0S30
93	PQ4	102	-	U1Rx	-	-	-	-	-	DIVSCLK	-	-	-	-
95	WAKE													
97	5V													

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Table 2-4. X11 Breadboard Adapter Even-Numbered Pad GPIO and Signal Muxing

Pin	Port	MCU PIN	Analog	Digital Function (GPIOPCTL Bit Encoding)										
				1	2	3	5	6	7	8	11	13	14	15
2	5V													
4	GND													
6	PA2	35	-	U4Rx	I2C8SCL	T1CCP0	-	-	-	-	-	-	-	SSI0Clk
8	PA3	36	-	U4Tx	I2C8SDA	T1CCP1	-	-	-	-	-	-	-	SSI0Fss
10	PA4	37	-	U3Rx	I2C7SCL	T2CCP0	-	-	-	-	-	-	-	SSI0XDAT0
12	PA5	38	-	U3Tx	I2C7SDA	T2CCP1	-	-	-	-	-	-	-	SSI0XDAT1
14	PE0	15	AIN3	U1RTS	-	-	-	-	-	-	-	-	-	-
16	PE1	14	AIN2	U1DSR	-	-	-	-	-	-	-	-	-	-
18	PE2	13	AIN1	U1DCD	-	-	-	-	-	-	-	-	-	-
20	PE3	12	AIN0	U1DTR	-	-	-	-	-	-	-	-	-	-
22	PE4	123	AIN9	U1RI	-	-	-	-	-	-	-	-	-	SSI1XDAT0
24	PE5	124	AIN8	-	-	-	-	-	-	-	-	-	-	SSI1XDAT1
26	PK0	18	AIN16	U4Rx	-	-	-	-	-	-	-	-	-	EPI0S0
28	PK1	19	AIN17	U4Tx	-	-	-	-	-	-	-	-	-	EPI0S1
30	PK2	20	AIN18	U4RTS	-	-	-	-	-	-	-	-	-	EPI0S2
32	PK3	21	AIN19	U4CTS	-	-	-	-	-	-	-	-	-	EPI0S3
34	VREF													
36	GND													
38	PD5	126	AIN6	U2Tx	-	T3CCP1	-	-	-	-	-	-	-	SSI1XDAT3
40	PD4	125	AIN7	U2Rx	-	T3CCP0	-	-	-	-	-	-	-	SSI1XDAT2
42	PD7	128	AIN4	U2CTS	-	T4CCP1	USB0PFLT	-	-	NMI	-	-	-	SSI1XDAT2
44	PD6	127	AIN5	U2RTS	-	T4CCP0	USB0EPEN	-	-	-	-	-	-	SSI1XDAT3
46	PD3	4	AIN12	-	I2C8SDA	T1CCP1	-	-	-	-	-	-	-	SSI2Clk
48	PD1	2	AIN14	-	I2C7SDA	T0CCP1	C1o	-	-	-	-	-	-	SSI1XDAT0
50	PD0	1	AIN15	-	I2C7SCL	T0CCP0	C0o	-	-	-	-	-	-	SSI1XDAT1
52	PD2	3	AIN13	-	I2C8SCL	T1CCP0	C2o	-	-	-	-	-	-	SSI2Fss
54	PP0	118	C2+	U6Rx	-	-	-	-	-	-	-	-	-	SSI1XDAT2
56	PP1	119	C2-	U6Tx	-	-	-	-	-	-	-	-	-	SSI1XDAT3
58	PB0	95	USB0ID	U1Rx	I2C5SCL	T4CCP0	-	-	CAN1Rx	-	-	-	-	-
60	PB1	96	USB0VBUS	U1Tx	I2C5SDA	T4CCP1	-	-	CAN1Tx	-	-	-	-	-
62	GND													
64	PF4	46	-	-	-	-	EN0LED1	M0FAULT0	-	-	-	-	SSI3XDAT2	TRD3
66	PF0	42	-	-	-	-	EN0LED0	M0PWM0	-	-	-	-	SSI3XDAT1	TRD2

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Table 2-4. X11 Breadboard Adapter Even-Numbered Pad GPIO and Signal Muxing (continued)

Pin	Port	MCU PIN	Analog	Digital Function (GPIOPCTL Bit Encoding)										
				1	2	3	5	6	7	8	11	13	14	15
68	PF1	43	-	-	-	-	EN0LED2	M0PWM1	-	-	-	-	SSI3XDAT0	TRD1
70	PF2	44	-	-	-	-	-	M0PWM2	-	-	-	-	SSI3Fss	TRD0
72	PF3	45	-	-	-	-	-	M0PWM3	-	-	-	-	SSI3Clk	TRCLK
74	PA0	33	-	U0Rx	I2C9SCL	T0CCP0	-	-	CAN0Rx	-	-	-	-	-
76	PA1	34	-	U0Tx	I2C9SDA	T0CCP1	-	-	CAN0Tx	-	-	-	-	-
78	PP4	105	-	U3RTS	U0DSR	-	-	-	-	-	-	-	USB0D7	-
80	PP5	106	-	U3CTS	I2C2SCL	-	-	-	-	-	-	-	USB0D6	-
82	PJ0	116	-	U3Rx	-	-		-	-	-	-	-	-	-
84	PJ1	117	-	U3Tx	-	-	-	-	-	-	-	-	-	-
86	PM7	71	TMPR0	U0RI	-	T5CCP1	-	-	-	-	-	-	-	-
88	PM6	72	TMPR1	U0DSR	-	T5CCP0	-	-	-	-	-	-	-	-
90	PM5	73	TMPR2	U0DCD	-	T4CCP1	-	-	-	-	-	-	-	-
92	PM4	74	TMPR3	U0CTS	-	T4CCP0	-	-	-	-	-	-	-	-
94	RESET													
96	GND													
98	3V3													

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2.1.6.4 Other Headers and Jumpers

JP1 is provided to select the power input source for the Connected LaunchPad. The top position is for BoosterPack power; this position also disconnects both USB voltages from the board's primary 5-volt input. In the top position, the TPS2052B does not limit current so additional care should be exercised. The middle position draws power from the USB connector on the left side of the board near the Ethernet jack. The bottom position is the default, in which power is drawn from the ICDI (Debug) USB connection.

JP2 separates the MCU 3.3-volt power domain from the rest of the 3.3-volt power on the board allowing an ammeter to be used to obtain more accurate measurements of microcontroller power consumption.

JP3 isolates the output of the TPS73733 LDO from the board's 3.3-V power domain.

JP4 and JP5 are used to configure CAN signals to the BoosterPack 2 interface. In the default horizontal configuration, CAN is not present on the BoosterPack. UART 4 goes to the BoosterPack and UART 0 goes to the ICDI virtual serial port to provide ROM serial bootloader capability. In the vertical CAN-enabled configuration, UART 4 goes to the ICDI virtual serial port and CAN signals are available on the BoosterPack. The ROM serial bootloader is not available to the ICDI virtual serial port while the jumpers are in the CAN position.

Figure 2-2 shows the default configuration and relative location of the jumpers on the board.

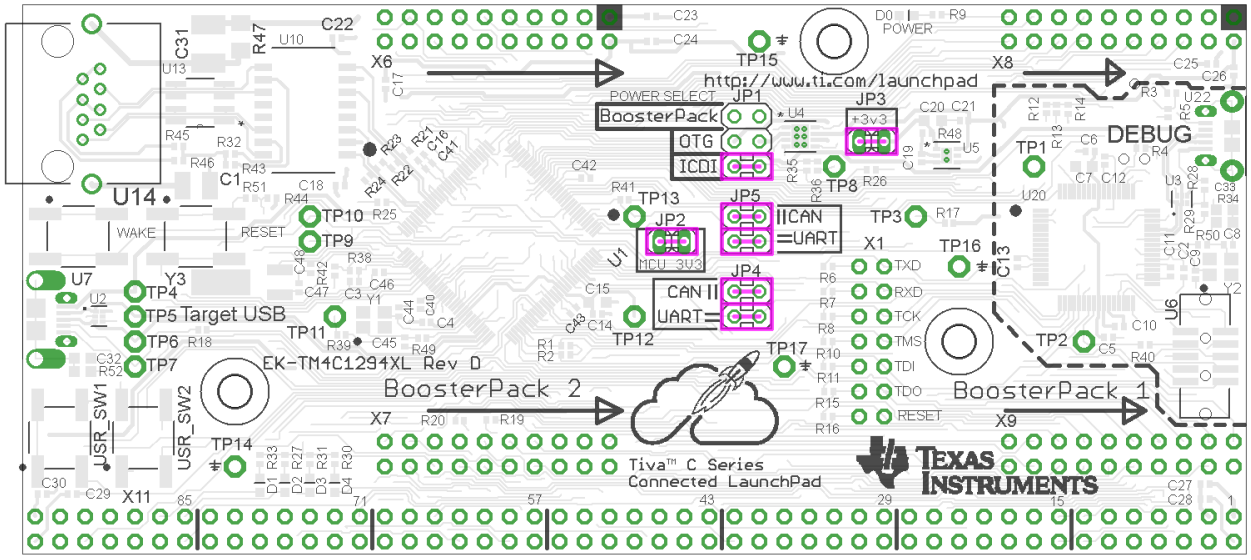


Figure 2-2. Default Jumper Locations

2.2 Power Management

2.2.1 Power Supplies

The Connected LaunchPad can be powered from three different input options:

- On-board ICDI USB cable (Debug, Default)
- Target USB cable
- BoosterPack or Breadboard adapter connection

The JP1 power-select jumper is used to select one of the power sources.

In addition, the JP3 power jumper can be used to isolate the 3.3-volt output of the TPS73733 from the board's 3.3-volt rail.

A TPS2052B load switch is used to regulate and control power to the Target USB connector when the microcontroller is acting in USB host mode. This load switch also limits current to the BoosterPack and Breadboard adapter headers when the JP1 jumper is in the ICDI position.

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2.2.2 Low Power Modes

The Connected LaunchPad demonstrates several low power microcontroller modes. In run mode, the microcontroller can be clocked from several sources such as the internal precision oscillator or an external crystal oscillator. Either of these sources can then optionally drive an internal PLL to increase the effective frequency of the system up to 120 MHz. In this way, the run mode clock speed can be used to manage run mode current consumption.

The microcontroller also provides sleep and deep sleep modes and internal voltage adjustments to the flash and SRAM to further refine power consumption when the processor is not in use but peripherals must remain active. Each peripheral can be individually clock gated in these modes so that current consumption by unused peripherals is minimized. A wide variety of conditions from internal and external sources can trigger a return to run mode.

The lowest power setting of the microcontroller is hibernation, which requires a small amount of supporting external circuitry available on the Connected LaunchPad. The Connected LaunchPad can achieve microcontroller current consumption modes under 2 micro-Amps using hibernate VDD3ON mode. Hibernation with VDD3ON mode is not supported on this board. The Connected LaunchPad can be woken from hibernate by several triggers including the dedicated wake button, the reset button, an internal RTC timer and a subset of the device GPIO pins. The hibernation module provides a small area of internal SRAM that can preserve data through a hibernate cycle.

2.2.3 Clocking

The Connected LaunchPad uses a 25 MHz crystal (Y1) to drive the main TM4C1294NCPDTI internal clock circuit. Most software examples use the internal PLL to multiply this clock to higher frequencies up to 120 MHz for core and peripheral timing. The 25-MHz crystal is required when using the integrated Ethernet MAC and PHY.

The Hibernation module is clocked from an external 32.768-KHz crystal (Y3).

2.2.4 Reset

The RESET signal to the TM4C1294NCPDTI microcontroller connects to the RESET switch, BoosterPack connectors, Breadboard adapter and to the ICDI circuit for a debugger-controller reset.

External reset is asserted (active low) under the following conditions:

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

2.3 Debug Interface

2.3.1 In-Circuit Debug Interface (ICDI)

The Connected LaunchPad comes with an on-board ICDI. The ICDI allows for the programming and debugging of the TM4C1294NCPDTI using LM Flash Programmer and/or any of the supported tool chains. Note that ICDI only supports JTAG debugging at this time. It is possible to use other JTAG emulators instead of the on board ICDI, by connecting to U6. When the ICDI detects an external debug adapter connection on the JTAG connector U6 and disables the ICDI outputs to allow the external debug adapter to drive the debug circuit. For more information, see Section 2.3.2.

Debug out of the ICDI is possible by removing resistors R6, R7, R8, R10, R11, R15, R16 and R40 from the Connected LaunchPad and use the ICDI to drive JTAG signals out on U6 for the purpose of programming or debugging other boards. To restore the connection to the on-board TM4C1294NCPDTI microcontroller, install jumpers from the odd to even pins of X1 or re-install the resistors. Removal of R40 disables the detection of an attached external debugger. R40 must be installed to use an external debug adapter to program or debug the Connected LaunchPad.

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2.3.2 External Debugger

The connector U6 is provided for the attachment of an external debug adapter such as the IAR J-Link or Keil ULINK. This connector follows the ARM standard 10-pin JTAG pinout. This interface can use either JTAG or SWD if supported by the external debug adapter.

2.3.3 Virtual COM Port

When plugged into a USB host, the ICDI enumerates as both a debugger and a virtual COM port. JP4 and JP5 control the selection of which UART from the TM4C1294NCPDTI is connected to the virtual COM port. In the default configuration, UART0 maps to the virtual COM port of the ICDI. In the CAN jumper configuration, UART4 maps to the virtual COM port of the ICDI.

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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 provides drivers for 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 TM4C1294NCPDTI microcontroller, as well as provide a starting point for the development of the final application for use on the Connected LaunchPad evaluation board. Example applications are also provided for the Connected LaunchPad when paired with selected BoosterPacks.

3.2 Source Code

The complete source code including the source code installation instructions are provided at http://www.ti.com/tool/sw-tm4c. The source code and binary files are installed in the TivaWare software tree.

3.3 Tool Options

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

- Keil ARM RealView® Microcontroller Development System
- IAR Embedded Workbench for ARM
- Sourcery Codebench
- Generic GNU C Compiler
- Texas Instruments' Code Composer Studio™ IDE

Download evaluation versions of these tools from the Tools & Software section of www.ti.com/tiva. 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.

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

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3.4 Programming the Connected LaunchPad

The Connected LaunchPad software package includes pre-built binaries for each of the example applications. If you installed the TivaWare™ software 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-tm4c129xl*. The on-board ICDI is used with the LM Flash Programmer tool to program applications on the Connected LaunchPad.

Follow these steps to program example applications into the Connected LaunchPad evaulation board using the ICDI:

1. Install LM Flash Programmer on a PC running Microsoft Windows.
2. Place JP1 into the ICDI position on the Connected LaunchPad.
3. Connect the USB-A cable plug in to an available USB port on the PC and plug the Micro-B plug to the Debug USB port (U22) on the Connected LaunchPad.
4. Verify that LED D0 at the top of the board is illuminated.
5. Install Windows ICDI and Virtual COM Port drivers if prompted. Installation instructions can be found at http://www.ti.com/lit/pdf/spmu287.
6. Run the LM Flash Programmer application on the PC.
7. In the Configuration tap, use the Quick Set control to select “TM4C1294XL LaunchPad”.
8. 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-tm4c1294xl*)
9. Each example application has its own directory. Navigate to the example directory that you want to load and then into the sub-directory for one of the supported tool chains which contains the binary (*.bin) file. Select the binary file and click Open.
10. Set the Erase Method to Erase Necessary Pages, check the Verify After Program box, and check Reset MCU After Program. The example program starts execution once the verify process is complete.

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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.

- TivaWare for C Series (http://www.ti.com/tool/sw-tm4c)
- TivaWare Peripheral Driver Library Users' Guide (literature number SPMU298)
- EK-TM4C1294XL Getting Started Guide (literature number SPMZ858)
- LM Flash Programmer Tool (http://www.ti.com/lmflashprogrammer)
- TPS73733 Low-Dropout Regulator with Reverse Current Protection (http://www.ti.com/product/tps79733)
- Texas Instruments Code Composer Studio website (http://www.ti.com/ccs)
- Tiva C Series TM4C1294NCPDT Microcontroller Data Sheet (http://www.ti.com/lit/gpn/tm4c1294ncpdt)
- Build Your Own BoosterPack information regarding the BoosterPack standard (http://www.ti.com/byob)
- ICDI Driver Installation Guide (literature number SPMU287)

Additional Support:

- Keil RealView MDK-ARM (http://www.keil.com/arm/mdk.asp)
- IAR Embedded Workbench for ARM (http://iar.com/ewarm/)
- Sourcery CodeBench development tools (http://www.mentor.com/embedded-software/sourcery-tools/sourcery-codebench/overview)
- Exosite (http://ti.exosite.com)

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4.2 Component Locations

Figure 4-1 is a dimensioned drawing of the Connected LaunchPad. This figure shows the location of selected features of the board as well as the component locations.

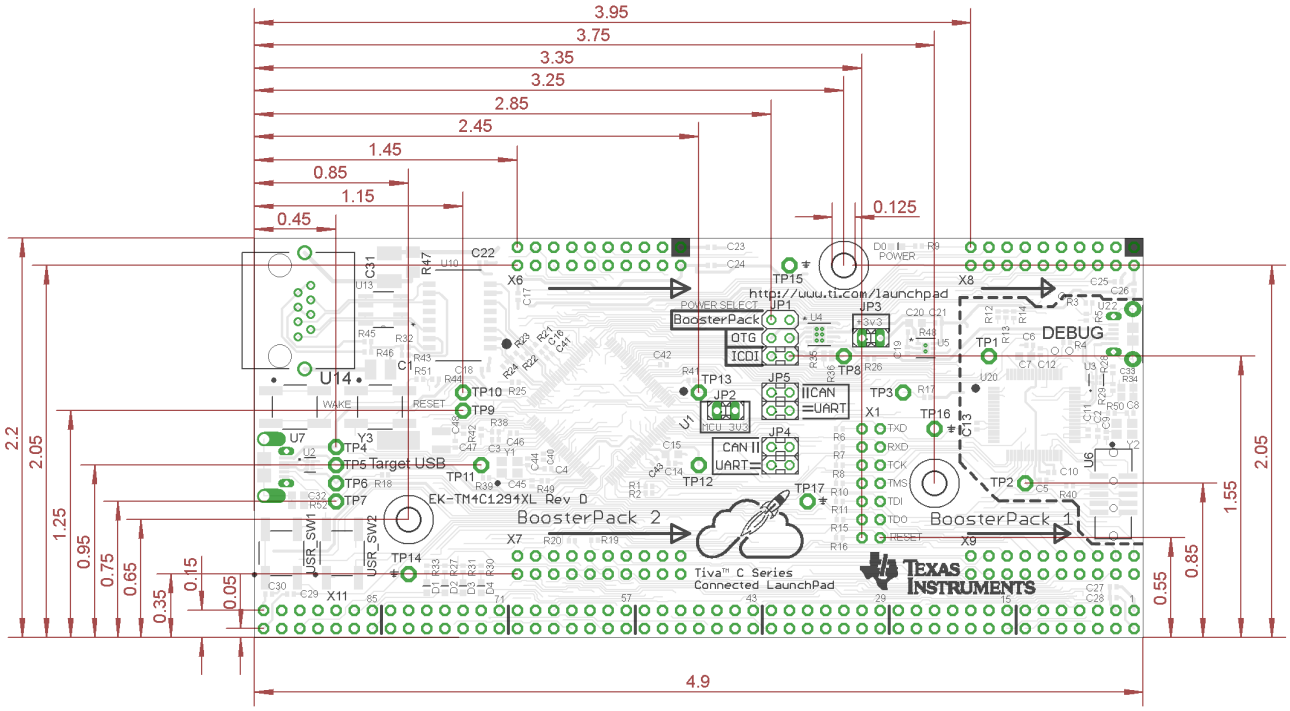


Figure 4-1. Connected LaunchPad Dimensions and Component Locations

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4.3 Bill of Materials

Table 4-1 is the Connected LaunchPad bill of materials list.

Table 4-1. Connected LaunchPad Bill of Materials

Item	Ref	Qty	Description	Mfg	Part Number
1	C1	1	Capacitor, 1000pF, 2kV, 20%, X7R, 1210	Kemet	C1210C102MGRACTU
2	C3, C4, C5, C10, C11, C12, C13, C16, C17, C18, C19, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C40, C41, C42, C43, C46	26	Capacitor, 0.1uF 16V, 10%,0402 X7R	Taiyo Yuden	EMK105B7104KV-F
3	C31	1	Capacitor, 4700pF, 2kV, 10%,X7R, 1812	AVX	1812GC472KAT1A
4	C32, C33	2	Capacitor, 3300pF, 50V, 10%, X7R, 0603	TDK	C1608X7R1H332K
5	C6, C14	2	Capacitor, 1uF , X5R, 10V, Low ESR, 0402	Johanson Dielectrics Inc	100R07X105KV4T
6	C7, C15, C20	3	Capacitor, 2.2uF, 16V, 10%, 0603, X5R	Murata	GRM188R61C225KE15D
7	C8, C9, C44, C45, C47, C48	6	Capacitor, 12pF, 50V, 5%, 0402, COG	Murata	GRM1555C1H120JZ01D
8	D0, D1, D2, D3, D4	5	Green LED 0603	Everlight	19-217/G7C-AL1M2B/3T
9	J1, J2, J3, J4, J5, J6, J7	7	Jumper, 0.100, Gold, Black, Open	3M	969102-0000-DA
				Kobiconn	151-8000-E
10	JP1	1	Header, 2x3, 0.100, T-Hole, Vertical Unshrouded, 0.230 Mate, gold	FCI	67996-206HLF
11	JP2, JP3	2	Header, 1x2, 0.100, T-Hole, Vertical Unshrouded, 0.220 Mate	3M	961102-6404-AR
				FCI	68001-102HLF
				Anyone	1x2-head
12	JP4, JP5	2	Header, 2x2, 0.100, T-Hole, Vertical Unshrouded, 0.230 Mate	FCI	67997-104HLF
				4UCON	00998
13	R1, R2, R3, R4, R5, R29, R35, R44	8	Resistor, 10k ohm, 1/10W, 5%, 0402 Thick Film	Yageo	RC0402FR-0710KL
14	R17, R26, R36	3	100k 5% 0402 resistor smd	Rohm	MCR01MRTJ104
15	R18, R51	2	Resistor 0402 100 ohm 5%	Rohm	MCR1MRTJ101
16	R23, R21, R22, R24	4	Resistor 49.9 ohm 0402. 1 %	Rohm	MCR01MRTF49R9
17	R25	1	Resistor 4.87k 1% 0402 smd	Rohm	MCR01MRTF4871
18	R28	1	Resistor, 5.6k ohm, 1/10W, 5%, 0402	Panasonic	ERJ-2GEJ562X
19	R32, R43, R45, R46	4	resistor 75 ohm 0402 5%	Rohm	MCR01MRTJ750
20	R34, R52	2	Resistor, 1M OH, 1/10W, 5% 0603 SMD	Panasonic	ERJ-3GEYJ105V
21	R38	1	Resistor, 51 ohm, 1/10W, 5%, 0402	Panasonic	ERJ-2GEJ510X
22	R42	1	Resistor, 1M Ohm, 1/10W, 5%, 0402	Rohm	MCR01MRTF1004
23	R47	1	RES 1M OHM 5% 1206 TF	Panasonic	ERJ-8GEYJ105V
24	R49, R50	2	Resistor, 2.0k ohm, 1/10W, 5%, 0402	Panasonic	ERJ-3GEYJ202V
25	R6, R7, R8, R10, R11, R15, R16, R19, R20, R39, R40, R41	12	Resistor, 0 ohm, 1/10W, 5%, 0402	Panasonic	ERJ-2GE0R00X
26	R9, R27, R30, R31, R33	5	Resistor, 330 ohm, 1/10W, 5%, 0402	Yageo	RC0402FR-07330RL

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Table 4-1. Connected LaunchPad Bill of Materials (continued)

Item	Ref	Qty	Description	Mfg	Part Number
27	RESET, USR_SW1, USR_SW2, WAKE	4	Switch, Tact 6mm SMT, 160gf	Omron	B3S-1000
28	U1	1	Tiva, MCU TM4C1294NCPDT 128 QFP with Ethernet MAC + PHY	Texas Instruments	TM4C1294NCPDT
				Texas Instruments	XM4C1294NCPDT
29	U10	1	Transformer, ethernet, 1 to 1. SOIC 16	Pulse Electronics	HX1198FNL
30	U13	1	Diode, 8 chan, +/-15KV, ESD Protection Array, SO-8	Semtech	SLVU2.8-4.TBT
31	U14	1	Connector, RJ45 NO MAG, shielded THRU HOLE	TE Connectivity	1-406541-5
32	U2, U3	2	IC 4CH ESD SOLUTION W/CLAMP 6SON	Texas Instruments	TPD4S012DRYR
33	U20	1	Stellaris TIVA MCU TM4C123GH6PMI	Texas Instruments	TM4C123GH6PMI
34	U22	1	USB Micro B receptacle right angle with guides	FCI	10118194-0001LF
35	U4	1	Fault protected power switch, dual channel, 8-SON	Texas Instruments	TPS2052BDRBR
36	U5	1	3.3V LDO TI TPS73733DRV fixed out 5V in	Texas Instruments	TPS73733DRV
37	U6	1	Header 2x5, 0.050, SM, Vertical Shrouded	Samtec	SHF-105-01-S-D-SM
				Don Connex Electronics	C44-10BSA1-G
38	U7	1	USB Micro AB receptacle. Right angle with through guides	Hirose	ZX62D-AB-5P8
39	X6, X7, X8, X9	4	Header, 2x10, T-Hole Vertical unshrouded stacking	Samtec	SSW-110-23-S-D
				Major League Electronics	SSHQ-110-D-08-F-LF
40	Y1	1	Crystal 25 MHz 3.2 x 2.5 mm	NDK	nx3225ga-25.000m-std-crg-2
41	Y2	1	Crystal 16 MHz 3.2 x 2.5 mm 4 pin	NDK	NX3225GA-16.000M-STD-CRG-2
42	Y3	1	Crystal, 32.768 KHz Radial Can	Citizen Finetech Miyota	CMR200T-32.768KDZY-UT
PCB Do Not Populate List (Shown for information only)					
43	C2	1	Capacitor, 0.1uF 16V, 10%, 0402 X7R	Taiyo Yuden	EMK105B7104KV-F
44	H1, H4, H6	3	Screw, #4 x 0.625" Pan Head, Sheet Metal, Phillips/Slotted (for fan)	McMaster	90077A112
45	R12, R13, R14	3	Resistor, 5.6k ohm, 1/10W, 5%, 0402	Panasonic	ERJ-2GEJ562X
46	R48	1	Resistor 0402 1% 52.3k	Rohm	TRR01MZPF5232
47	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17	17	Terminal, Test Point Miniature Loop, Red, T-Hole	Keystone	5000
48	X1	1	Header, 2x7, 0.100, T-Hole, Vertical, Unshrouded, 0.230 Mate	FCI	67997-114HLF
49	X11A	1	Valvano style bread board connect. Right Angle extended, 1 x 49 0.100 pitch.	Samtec	TSW-149-09-F-S-RE
50	X11B	1	valvano style breadboard header.	Samtec	TSW-149-08-F-S-RA

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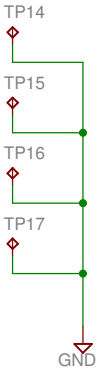
Schematic

This section contains the complete schematics for the Tiva C Series TM4C1294 Connected LaunchPad.

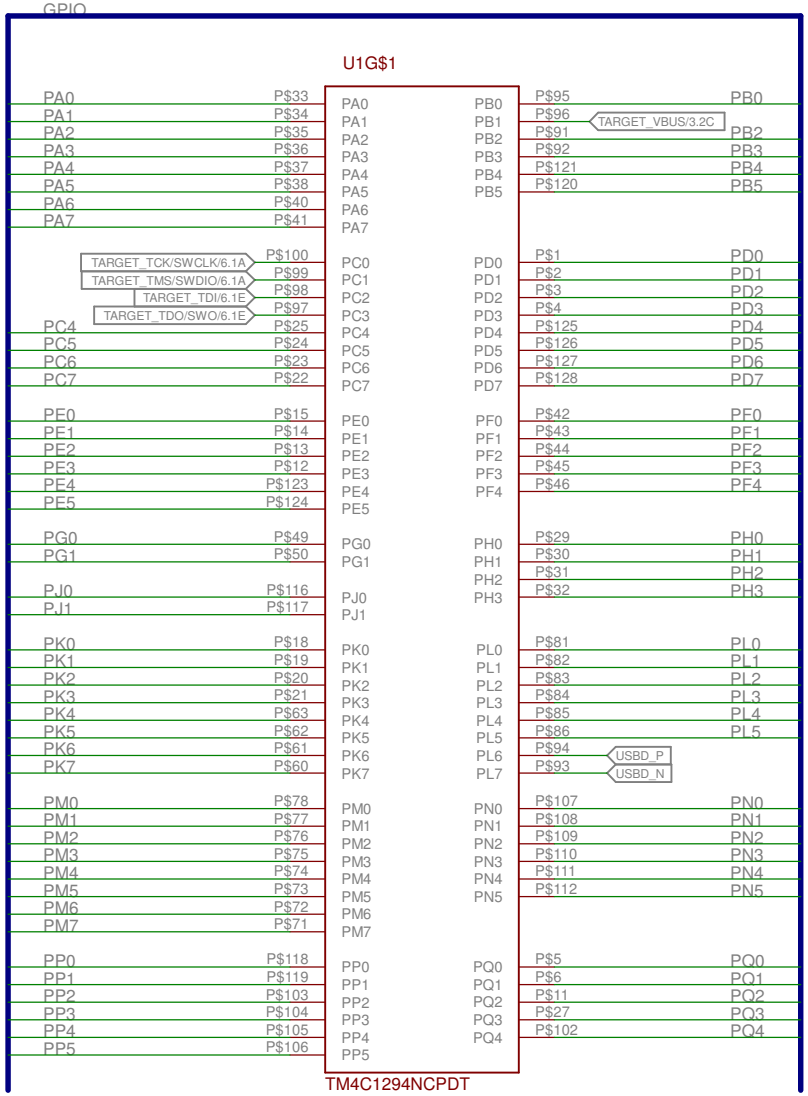
- Microcontroller, USB, Buttons, and LED's
- BoosterPack connectors
- Breadboard connector
- Ethernet and Ethernet LED's
- Power
- In-Circuit Debug Interface

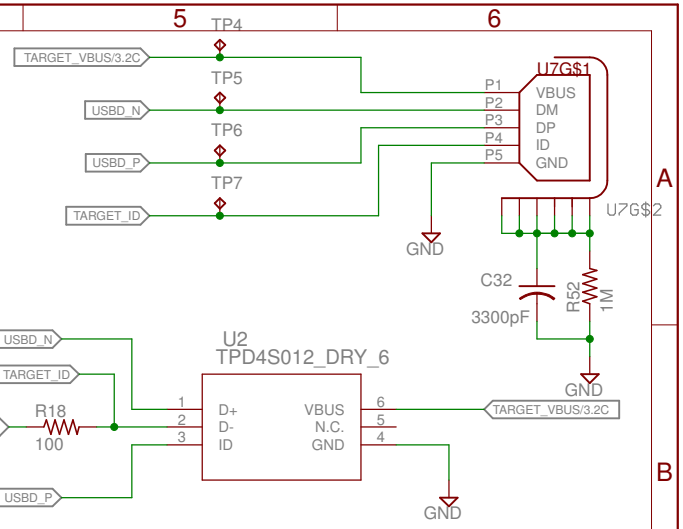
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convienence test points for ground

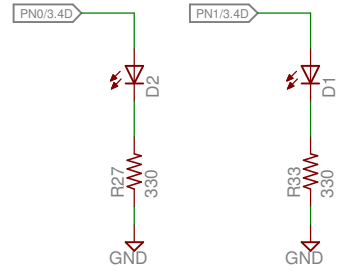


GPIO

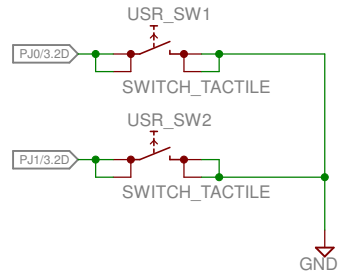




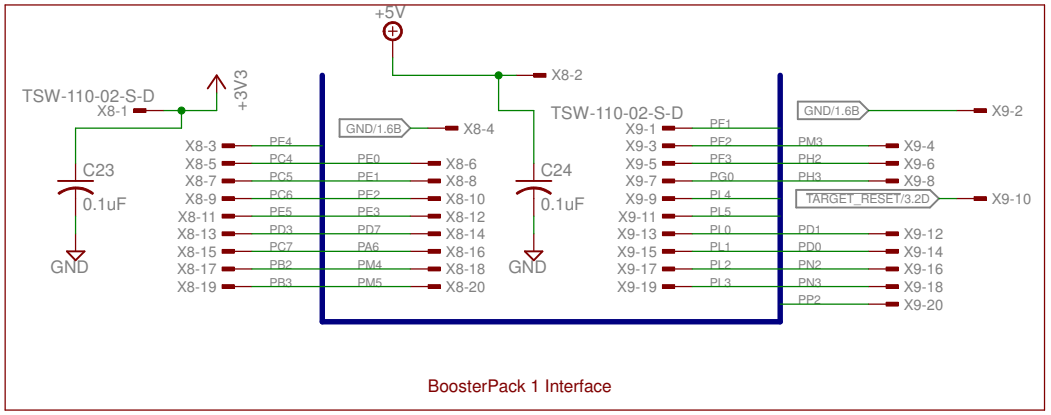
NOTE: TPD4S012 all protection circuits are identical.
Connections chosen for simple routing.



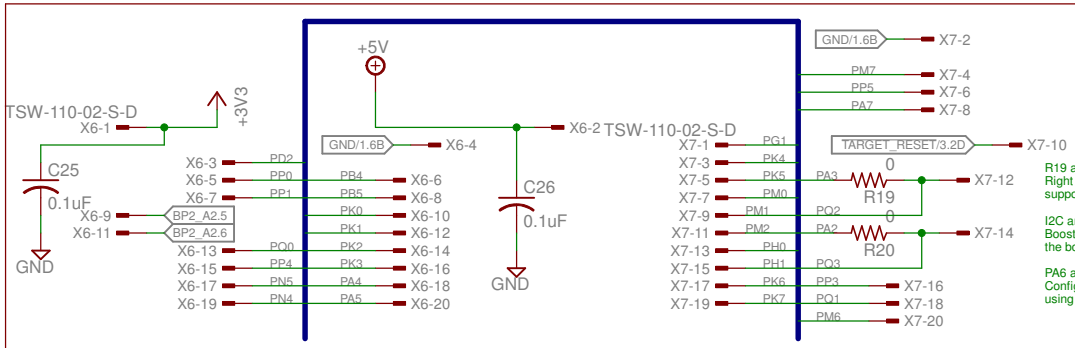
See PF0 and PF4 for additional LED's used for Ethernet or user application



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BoosterPack 1 Interface



BoosterPack 2 Interface

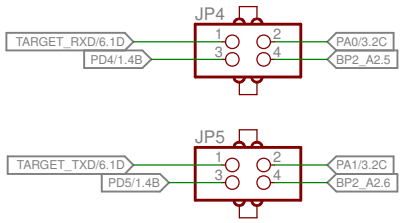
R19 and R20 can be populated to enable I2C on Right side of BP2 interface. This is for legacy support and the Sensor Hub BoosterPack.

I2C and SSI are available on the corresponding BoosterPack 1 interface pins without modification to the board.

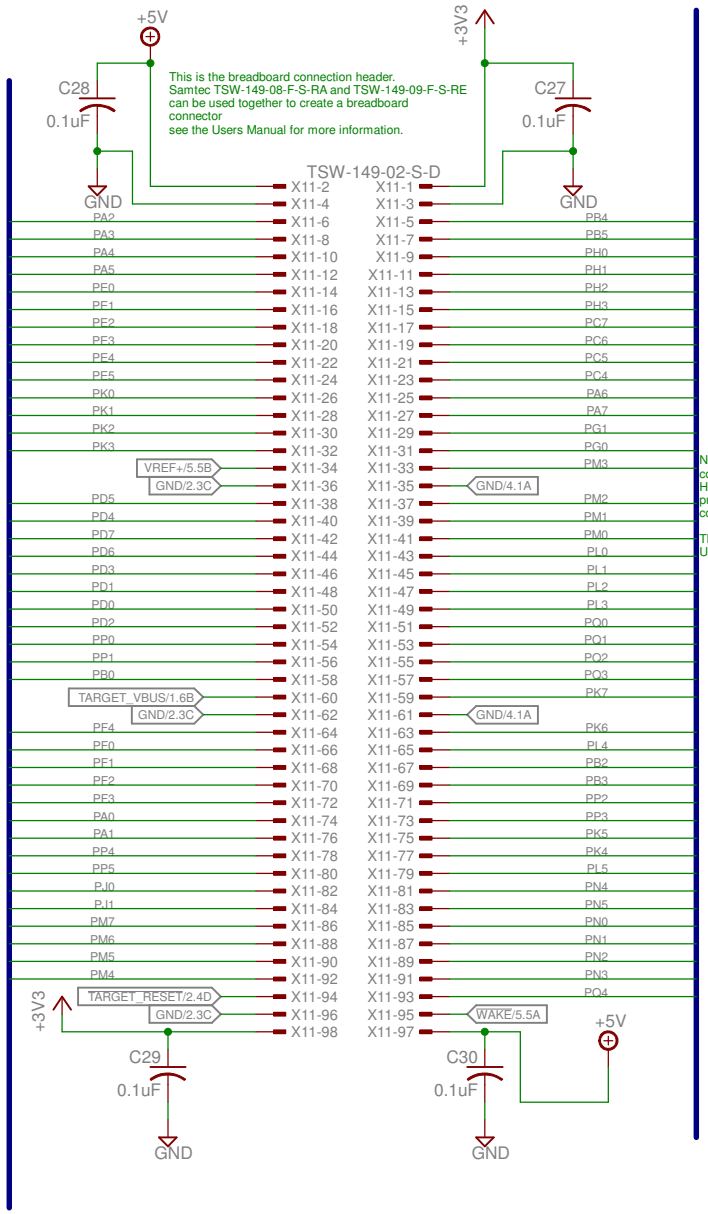
PA6 and PA7 are also used by the onboard radio. Configure the radio to tri-state these GPIO before using them on the boosterpack interface.

JP4 and JP5 CAN and ICDI UART Selection:
Populate Jumpers from 1-2 and 3-4 for Default Mode
This enables ROM UART boot loader. UART 0 to ICDI

Populate from 1-3 and 2-4 for controller area network on the boosterpack. UART2 is then availabe to ICDI.



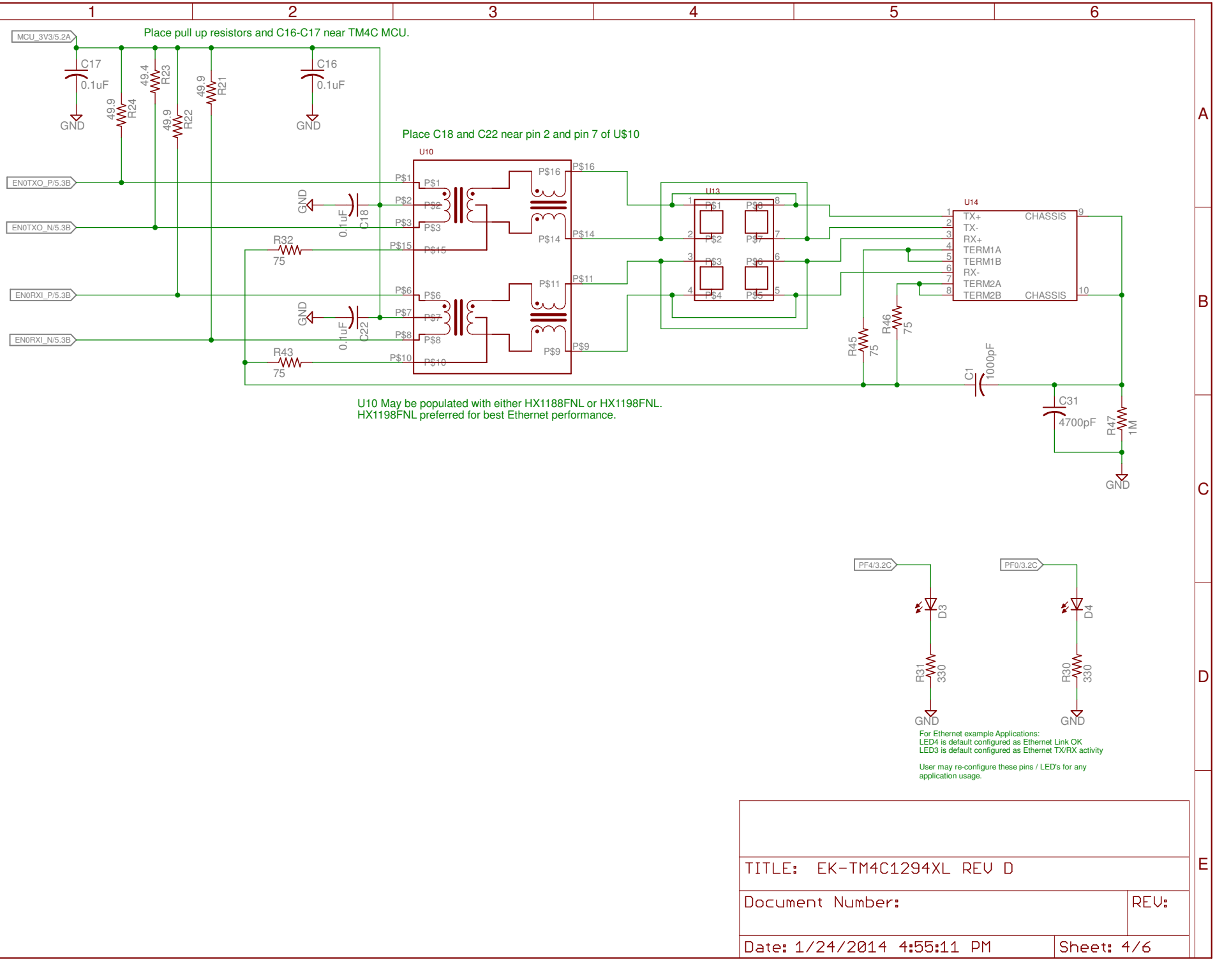
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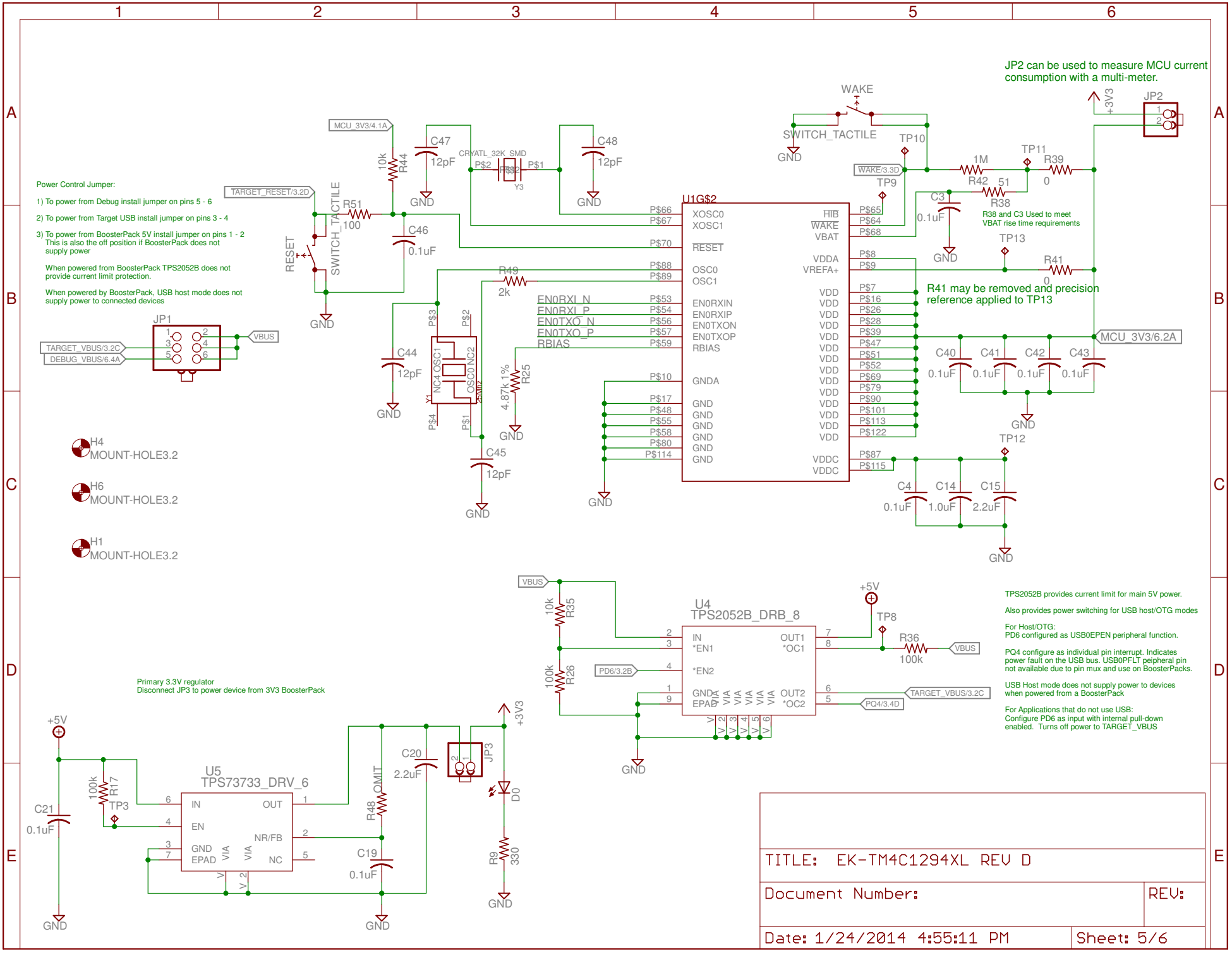


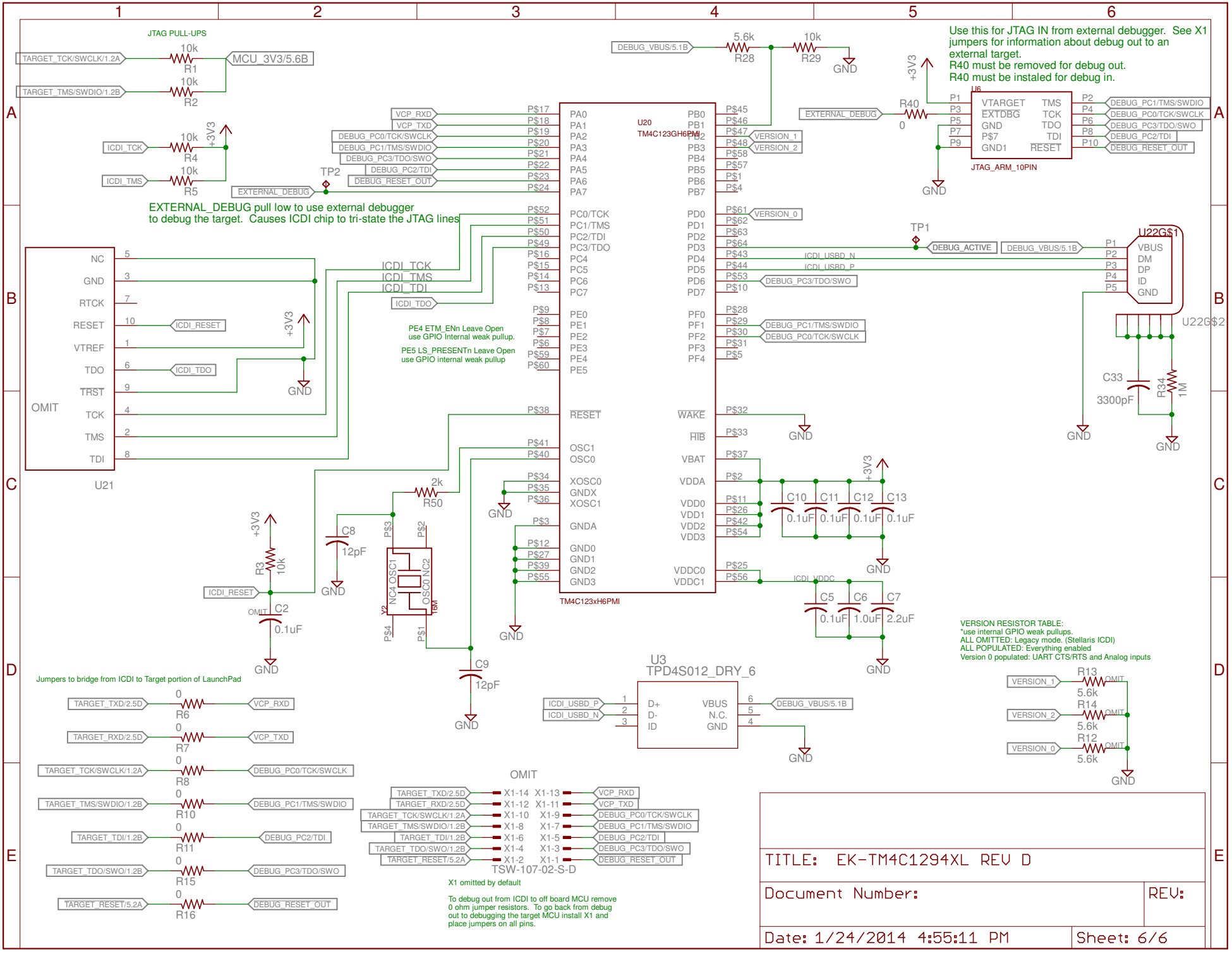
NOTE: PB0 and PB1 are used in some configurations with 5V signals especially in USB Host or OTG mode. Be aware the 5V may be present on these pins depending on system jumper configuration

These pins are only 5V tolerant when configured for USB mode applications.

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Place pull up resistors and C16-C17 near TM4C MCU.
MCU_3V3/5.2A
C17
0.1uF
GND
49.9
R24
49.4
R23
49.9
R22
49.9
R21
C16
0.1uF
GND
Place C18 and C22 near pin 2 and pin 7 of U$10
U10
EN0TXO_P/5.3B
EN0TXO_N/5.3B
EN0RXI_P/5.3B
EN0RXI_N/5.3B
GND
0.1uF
C18
R32
75
GND
0.1uF
C22
R43
75
P$1
P$2
P$3
P$15
P$6
P$7
P$8
P$10
P$16
P$14
P$11
P$9
U13
U14
TX+
TX-
RX+
TERM1A
TERM1B
RX-
TERM2A
TERM2B
CHASSIS
CHASSIS
R45
75
R46
75
C1
1000pF
C31
4700pF
R47
1M
GND
U10 May be populated with either HX1188FNL or HX1198FNL.
HX1198FNL preferred for best Ethernet performance.
PF4/3.2C
D3
R31
330
GND
PF0/3.2C
D4
R30
330
GND
For Ethernet example Applications:
LED4 is default configured as Ethernet Link OK
LED3 is default configured as Ethernet TX/RX activity
User may re-configure these pins / LED's for any application usage.
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JP2 can be used to measure MCU current consumption with a multi-meter.
Power Control Jumper:
1) To power from Debug install jumper on pins 5 - 6
2) To power from Target USB install jumper on pins 3 - 4
3) To power from BoosterPack 5V install jumper on pins 1 - 2
This is also the off position if BoosterPack does not supply power
When powered from BoosterPack TPS2052B does not provide current limit protection.
When powered by BoosterPack, USB host mode does not supply power to connected devices
R38 and C3 Used to meet VBAT rise time requirements
R41 may be removed and precision reference applied to TP13
U1G$2
XOSC0
XOSC1
RESET
OSC0
OSC1
EN0RXIN
EN0RXIP
EN0TXON
EN0TXOP
RBIAS
GNDA
HIB
WAKE
VBAT
VDDA
VREFA+
VDD
VDDC
MCU_3V3/6.2A
WAKE
SWITCH_TACTILE
TARGET_RESET/3.2D
WAKE/3.3D
MCU_3V3/4.1A
CRYATL_32K_SMD
JP1
JP2
TARGET_VBUS/3.2C
DEBUG_VBUS/6.4A
VBUS
H4 MOUNT-HOLE3.2
H6 MOUNT-HOLE3.2
H1 MOUNT-HOLE3.2
Primary 3.3V regulator
Disconnect JP3 to power device from 3V3 BoosterPack
U5
TPS73733_DRV_6
U4
TPS2052B_DRB_8
TPS2052B provides current limit for main 5V power.
Also provides power switching for USB host/OTG modes
For Host/OTG:
PD6 configured as USB0EPEN peripheral function.
PQ4 configure as individual pin interrupt. Indicates power fault on the USB bus. USB0PFLT peipheral pin not available due to pin mux and use on BoosterPacks.
USB Host mode does not supply power to devices when powered from a BoosterPack
For Applications that do not use USB:
Configure PD6 as input with internal pull-down enabled. Turns off power to TARGET_VBUS
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JTAG PULL-UPS
TARGET_TCK/SWCLK/1.2A
TARGET_TMS/SWDIO/1.2B
10k
R1
R2
MCU_3V3/5.6B
ICDI_TCK
ICDI_TMS
R4
R5
+3V3
TP2
EXTERNAL_DEBUG
EXTERNAL_DEBUG pull low to use external debugger
to debug the target. Causes ICDI chip to tri-state the JTAG lines
U21
OMIT
NC
GND
RTCK
RESET
VTREF
TDO
TRST
TCK
TMS
TDI
ICDI_RESET
ICDI_TDO
ICDI_TCK
ICDI_TMS
ICDI_TDI
U20
TM4C123GH6PMI
TM4C123xH6PMI
PE4 ETM_ENn Leave Open
use GPIO Internal weak pullup.
PE5 LS_PRESENTn Leave Open
use GPIO internal weak pullup
DEBUG_VBUS/5.1B
5.6k
R28
10k
R29
GND
Use this for JTAG IN from external debugger. See X1
jumpers for information about debug out to an
external target.
R40 must be removed for debug out.
R40 must be instaled for debug in.
R40
0
U6
VTARGET
EXTDBG
GND
P$7
GND1
TMS
TCK
TDO
TDI
RESET
JTAG_ARM_10PIN
DEBUG_PC1/TMS/SWDIO
DEBUG_PC0/TCK/SWCLK
DEBUG_PC3/TDO/SWO
DEBUG_PC2/TDI
DEBUG_RESET_OUT
VERSION_1
VERSION_2
VERSION_0
TP1
DEBUG_ACTIVE
ICDI_USBD_N
ICDI_USBD_P
U22G$1
U22G$2
VBUS
DM
DP
ID
C33
3300pF
R34
1M
2k
R50
R3
10k
C2
0.1uF
C8
12pF
C9
12pF
Y2
16M
C10
C11
C12
C13
0.1uF
C5
C6
C7
1.0uF
2.2uF
ICDI_VDDC
U3
TPD4S012_DRY_6
D+
D-
ID
VBUS
N.C.
GND
ICDI_USBD_P
ICDI_USBD_N
Jumpers to bridge from ICDI to Target portion of LaunchPad
TARGET_TXD/2.5D
TARGET_RXD/2.5D
TARGET_TCK/SWCLK/1.2A
TARGET_TMS/SWDIO/1.2B
TARGET_TDI/1.2B
TARGET_TDO/SWO/1.2B
TARGET_RESET/5.2A
VCP_RXD
VCP_TXD
DEBUG_PC0/TCK/SWCLK
DEBUG_PC1/TMS/SWDIO
DEBUG_PC2/TDI
DEBUG_PC3/TDO/SWO
DEBUG_RESET_OUT
R6
R7
R8
R10
R11
R15
R16
OMIT
X1-14
X1-13
X1-12
X1-11
X1-10
X1-9
X1-8
X1-7
X1-6
X1-5
X1-4
X1-3
X1-2
X1-1
TSW-107-02-S-D
X1 omitted by default
To debug out from ICDI to off board MCU remove
0 ohm jumper resistors. To go back from debug
out to debugging the target MCU install X1 and
place jumpers on all pins.
VERSION RESISTOR TABLE:
*use internal GPIO weak pullups.
ALL OMITTED: Legacy mode. (Stellaris ICDI)
ALL POPULATED: Everything enabled
Version 0 populated: UART CTS/RTS and Analog inputs
R13
R14
R12
5.6k
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Revision History

This history highlights the changes made to the SPMU365 user's guide to make it an SPMU365A revision.

Table 6-1. Revision History

SEE	ADDITIONS/MODIFICATIONS/DELETIONS
Section 2.1.6.3 Breadboard Connection	Table 2-3, X11 Breadboard Adapter Odd-Numbered Pad GPIO and Signal Muxing: • Updated/Changed Pin 1 **from** "5V" **to** "3V3" • Updated/Changed Pin 25 **from** "PC4" **to** "PA6" • Updated/Changed Pin 27 **from** "PA6" **to** "PA7" • Updated/Changed Pin 29 **from** "PA7" **to** "PG1" • Updated/Changed Pin 61 **from** "EPI0S12" **to** "GND" Table 2-4, X11 Breadboard Adapter Even-Numbered Pad GPIO and Signal Muxing: • Updated/Changed Pin 2 **from** "3V3" **to** "5V"

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Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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