User's Guide
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SimpleLink™ Ethernet MSP432E401Y Microcontroller LaunchPad™ Development Kit (MSP-EXP432E401Y)

The SimpleLink™ Ethernet MSP432E401Y Microcontroller LaunchPad™ Development Kit is a low-cost evaluation platform for SimpleLink Arm® Cortex®-M4F-based Ethernet microcontrollers. The Ethernet LaunchPad development kit highlights the MSP432E401Y 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.

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1 Board Overview

The SimpleLink Ethernet MSP432E401Y Microcontroller LaunchPad Development Kit is a low-cost evaluation platform for SimpleLink Arm Cortex-M4F-based Ethernet microcontrollers. The Ethernet LaunchPad development kit design highlights the MSP432E401Y 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 Ethernet LaunchPad development kit 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 preprogrammed quick start application on the Ethernet LaunchPad development kit also enables remote monitoring and control of the evaluation board from an internet browser anywhere in the world. The web interface is provided by a third party, Exosite. Each Ethernet LaunchPad development kit is enabled on the Exosite platform allowing users to create and customize their own Internet-of-Things applications.

Figure 1 shows the Ethernet LaunchPad development kit with key features highlighted.

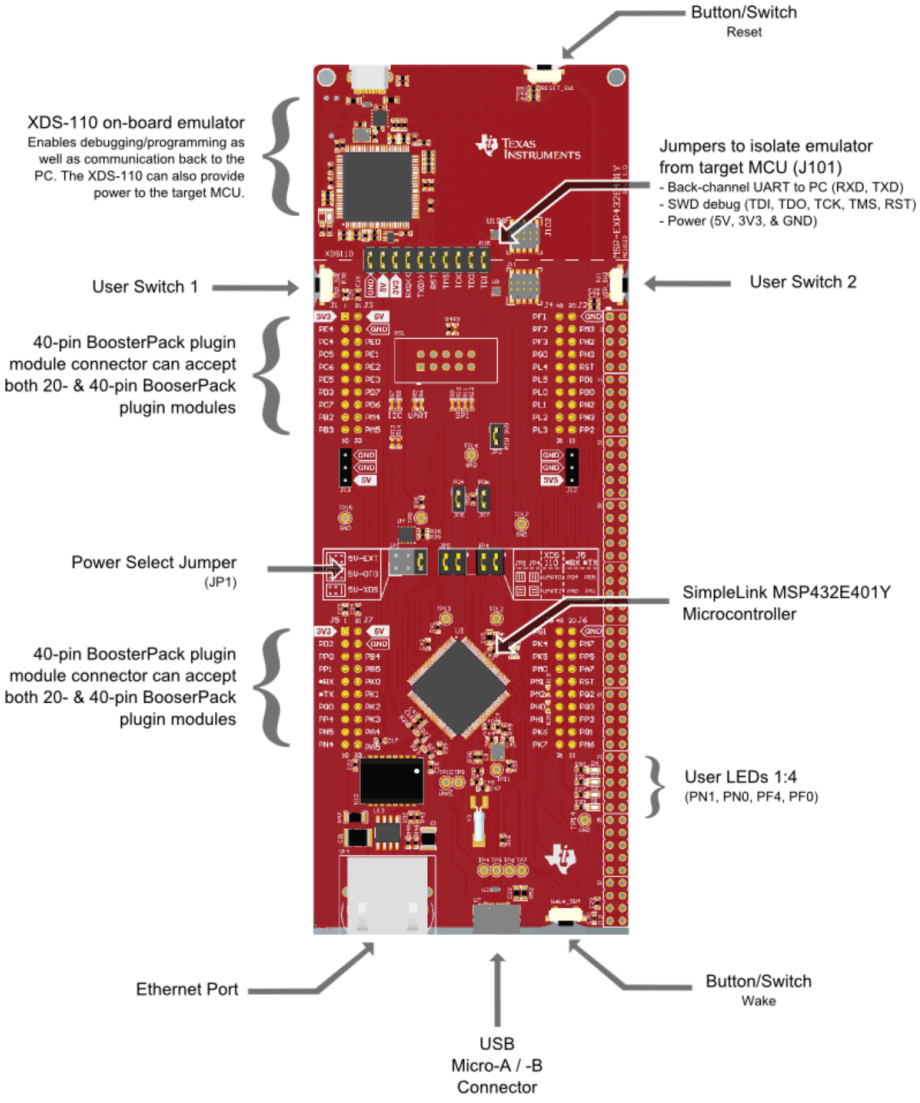

Figure 1. SimpleLink Ethernet MSP432E401Y LaunchPad Development Kit

1.1 Kit Contents

The Ethernet LaunchPad development kit contains the following items:

- SimpleLink Ethernet MSP432E401Y LaunchPad Development Board (MSP-EXP432E401Y)
- USB Micro-B plug to USB-A plug cable
- Quick Start Guide

1.2 Using the Ethernet LaunchPad Development Kit

The recommended steps for using the Ethernet LaunchPad development kit are:

1. Run the Out of Box demo software. For detailed instruction on how to run the out of box demo, visit this SimpleLink Academy tutorial.
2. Take the first step towards developing your own applications. The Ethernet LaunchPad development kit is supported by the SimpleLink MSP432E4 SDK. After installing the SDK, look in the following installation directories for bare metal and rtos based examples
   a. examples\nortos\MSP_EXP432E401Y\
   b. examples\rtos\MSP_EXP432E401Y\

   See Section 3 for more details about software development.
3. Experiment with BoosterPack plug-in modules. This development kit conforms to the latest revision of the BoosterPack plug-in module pinout standard. It has two independent BoosterPack plug-in module connections to enable a multitude of expansion opportunities.
4. Customize and integrate the hardware to suit your end application. This development kit can be used as a reference for building your own custom circuits based on SimpleLink microcontrollers or as a foundation for expansion with your custom BoosterPack plug-in module or other circuit. This manual can serve as a starting point for this endeavor.
5. More Resources. See the TI MCU LaunchPad web page for more information and available BoosterPack modules.

1.3 Features

The Ethernet LaunchPad development kit includes the following features:

- SimpleLink MSP432E401Y 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 switches
- 1 independent hibernate wake switch
- 1 independent microcontroller reset switch
- Jumper for selecting power source:
  – XDS-110 USB
  – USB Device
  – BoosterPack
- Preloaded Internet-of-Things application
- I/O brought to board edge for breadboard expansion
- Two independent BoosterPack XL standard connectors featuring stackable headers to maximize expansion through BoosterPack plug-in module ecosystem

1.4 BoosterPack Plug-in Modules

The Ethernet LaunchPad development kit provides an easy and inexpensive way to develop applications with the MSP432E401YPDT microcontroller. BoosterPack plug-in modules are add-on boards that follow a pinout standard created by TI. The TI and third-party ecosystem of BoosterPack plug-in modules greatly expands the peripherals and potential applications that you can easily explore with the Ethernet LaunchPad development kit.

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

1.5 Specifications

Table 1 summarizes the specifications for the Ethernet LaunchPad.

Table 1. MSP-EXP432E401Y Specifications

Parameter	Value
Board Supply Voltage	4.75 VDC to 5.25 VDC from one of the following sources: • XDS-110 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 Interface (J3-21) • BoosterPack 2 Interface (J7-21) • 5-V Power header (J13-1) • Breadboard expansion header (J10-2 or J10-97). See schematic symbol JP1 for power input selection.
Dimensions	6.85 in × 2.5 in × .425 in (17.4 cm × 6.35 cm × 10.8 mm) (L × W × H)
Break-out Power Output	• 5 VDC to BoosterPack modules, current limited by TPS2052B. Nominal rating is 1 A. Board input power supply limitations may also apply. • 3.3 VDC to BoosterPack modules, limited by output of TPS79601 LDO. This 3.3-V plane is shared with onboard components. Total output power limit of TPS79601 is 1 A.
RoHS Status	Compliant

2 Hardware Description

The Ethernet LaunchPad development kit includes an MSP432E401YPDT 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 through the onboard accessories and the BoosterPack plug-in module connectors. This chapter explains how those peripherals operate and interface to the microcontroller.

Figure 2 shows a high-level block diagram of the Ethernet LaunchPad development kit.

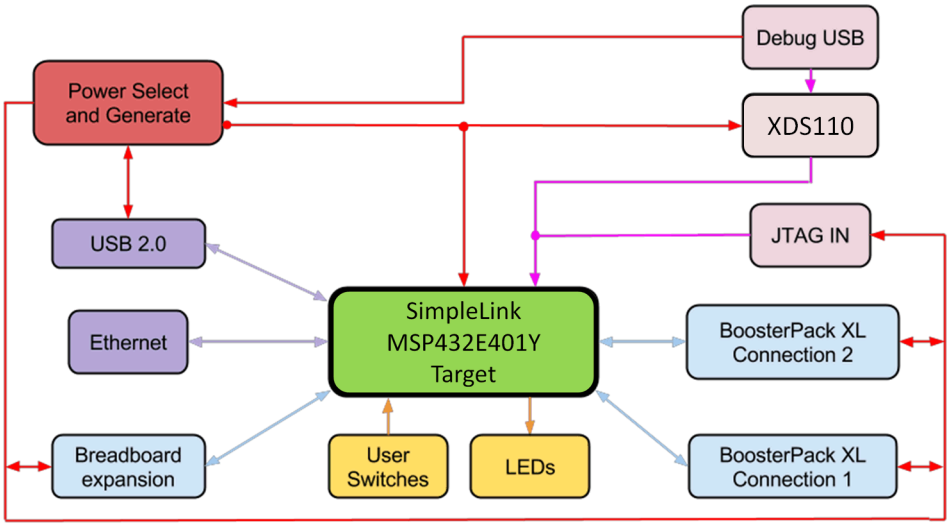

Figure 2. SimpleLink Ethernet LaunchPad Development Kit Block Diagram

2.1 Functional Description

2.1.1 Microcontroller

The MSP432E401Y is a 32-bit Arm Cortex-M4F based microcontroller with 1024KB of flash memory, 256KB of SRAM, 6KB of 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 MSP432E401Y microcontroller data sheet for more complete details.

Most of the microcontroller 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 MSP432E401Y microcontroller is factory-programmed with a quick start demo program. The quick start program resides in on-chip Flash memory and runs each time power is applied, unless the quick start application has been replaced with a user program. The quick start application automatically connects to http://ti.exosite.com when an internet connection is provided through the RJ45 Ethernet jack on the evaluation board.

2.1.2 Ethernet Connectivity

The Ethernet LaunchPad development kit 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 LwIP TCP/IP protocol stack. 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 PHY to indicate connection and transmit or receive status.

2.1.2.1 RJ-45 Connections

To improve EMI performance, use a metal-shielded RJ-45 connector with the shield connected to chassis ground.

Bob Smith termination to the RJ-45 connector involves 75-Ω termination resistors connected to the unused differential pair connections on the RJ-45 connector. Bob Smith termination is used to reduce noise that results from common-mode current flows and to reduce susceptibility to noise from unused wire pairs on the RJ-45.

NOTE: Power Over Ethernet (PoE) applications require a modified Bob Smith termination, which consists of DC-blocking capacitors in series with the 75-Ω termination resistors.

2.1.3 USB Connectivity

The Ethernet LaunchPad development kit 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 Ethernet LaunchPad development kit 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 J10.

2.1.4 Motion Control

The Ethernet LaunchPad development kit includes motion control functionality through the use of 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 Section 2.1.6 for details about the availability of these signals on the BoosterPack interfaces.

2.1.5 User Switches and LEDs

Two user switches are provided for input and control of the MSP432E401Y 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 plug-in module 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-V power is present on the board.

2.1.6 BoosterPack Plug-in Modules and Headers

2.1.6.1 BoosterPack Plug-in Module Interface 1

The Ethernet LaunchPad development kit features two fully independent BoosterPack XL connectors. BoosterPack Plug-in Module Interface 1, located near the XDS110 emulator, is fully compliant with the BoosterPack plug-in module standard.

I^2C is provided in both the original BoosterPack plug-in module standard configuration as well as the updated standard location. Use of I^2C on the bottom left of the BoosterPack plug-in module 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 lists the BoosterPack plug-in module pins and the GPIO alternate functions available on each pin. The MSP432E401Y GPIO register GPIOPCTL values are shown for each configuration. The headers in this table are labeled from left to right in ten pin columns. J1 and J2 make up the outer BoosterPack plug-in module standard pins, and J3 and J4 make up the inner BoosterPack XL standard pins.

Table 2. BoosterPack Plug-in Module Interface 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
J1	1	3.3 V	3.3 V													
J1	2	Analog	PE4	123	AIN9	U1RI	–	–	–	–	–	–	–	–	–	SSI1XDAT0
J1	3	UART RX	PC4	25	C1-	U7Rx	–	–	–	–	–	–	–	–	–	EPI0S7
J1	4	UART TX	PC5	24	C1+	U7Tx	–	–	–	–	RTCCLK	–	–	–	–	EPI0S6
J1	5	GPIO	PC6	23	C0+	U5Rx	–	–	–	–	–	–	–	–	–	EPI0S5
J1	6	Analog	PE5	124	AIN8	–	–	–	–	–	–	–	–	–	–	SSIXDAT1
J1	7	SPI CLK	PD3	4	AIN12	–	I2C8SDA	T1CCP1	–	–	–	–	–	–	–	SSI2CLk
J1	8	GPIO	PC7	22	C0-	U5Tx	–	–	–	–	–	–	–	–	–	EPI0S4
J1	9	I2C SCL	PB2	91	–	–	I2C0SCL	T5CCP0	–	–	–	–	–	–	USB0STP	EPI0S27
J1	10	I2C SDA	PB3	92	–	–	I2C0SDA	T5CCP1	–	–	–	–	–	–	USB0CLK	EPI0S28
J3	21	5 V	5 V													
J3	22	ground	GND													
J3	23	Analog	PE0	15	AIN3	U1RTS	–	–	–	–	–	–	–	–	–	–
J3	24	Analog	PE1	14	AIN2	U1DSR	–	–	–	–	–	–	–	–	–	–
J3	25	Analog	PE2	13	AIN1	U1DCD	–	–	–	–	–	–	–	–	–	–
J3	26	Analog	PE3	12	AIN0	U1DTR	–	–	–	–	–	–	–	–	–	–
J3	27	Analog	PD7	128	AIN4	U2CTS	–	T4CCP1	USB0PFLT	–	–	NMI	–	–	–	SSI2XDAT2
J3	28	Analog	PD6	127	AIN5	U2RTS	–	T4CCP0	–	USB0EPEN	–	–	–	–	–	SSI2XDAT3
J3	29	A out	PM4	74	TMPR3	U0CTS	–	T4CCP0	–	–	–	–	–	–	–	–
J3	30	A out	PM5	73	TMPR2	U0DCD	–	T4CCP1	–	–	–	–	–	–	–	–
J4	40	PWM	PF1	43	–	–	–	–	EN0LED2	M0PWM1	–	–	–	–	SSI3XDAT0	TRD1
J4	39	PWM	PF2	44	–	–	–	–	–	M0PWM2	–	–	–	–	SSI3Fss	TRD0
J4	38	PWM	PF3	45	–	–	–	–	–	M0PWM3	–	–	–	–	SSI3Clk	TRCLK
J4	37	PWM	PG0	49	–	–	I2C1SCL	–	EN0PPS	M0PWM4	–	–	–	–	–	EPI0S11
J4	36	Capture	PL4	85	–	–	–	T0CCP0	–	–	–	–	–	–	USB0D4	EPI0S26
J4	35	Capture	PL5	86	–	–	–	T0CCP1	–	–	–	–	–	–	USB0D5	EPI0S33
J4	34	GPIO	PL0	81	–	–	I2C2SDA	–	–	M0FAULT3	–	–	–	–	USB0D0	EPI0S16
J4	33	GPIO	PL1	82	–	–	I2C2SCL	–	–	PhA0	–	–	–	–	USB0D1	EPI0S17
J4	32	GPIO	PL2	83	–	–	–	–	C0o	PhB0	–	–	–	–	USB0D2	EPI0S18
J4	31	GPIO	PL3	84	–	–	–	–	C1o	IDX0	–	–	–	–	USB0D3	EPI0S19
J2	11	ground	GND													
J2	12	PWM	PM3	75	–	–	–	T3CCP1	–	–	–	–	–	–	–	EPI0S12
J2	13	GPIO	PH2	31	–	U0DCD	–	–	–	–	–	–	–	–	–	EPI0S2
J2	14	GPIO	PH3	32	–	U0DSR	–	–	–	–	–	–	–	–	–	EPI0S3
J2	15	reset	RESET													
J2	16	SPI MOSI	PD1	2	AIN14	–	I2C7SDA	T0CCP1	C1o	–	–	–	–	–	–	SSI2XDAT0
J2	17	SPI MISO	PD0	1	AIN15	–	I2C7SCL	T0CCP0	C0o	–	–	–	–	–	–	SSI2XDAT1
J2	18	GPIO	PN2	109	–	U1DCD	U2RTS	–	–	–	–	–	–	–	–	EPI0S29
J2	19	GPIO	PN3	110	–	U1DSR	U2CTS	–	–	–	–	–	–	–	–	EPI0S30

Table 2. BoosterPack Plug-in Module Interface 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
J2	20	GPIO	PP2	103	–	U0DTR	–	–	–	–	–	–	–	–	USB0NXT	EPI0S29

2.1.6.2 BoosterPack Plug-in Module Interface 2

The second BoosterPack XL interface is located near the bottom of the board. This interface is fully compliant with the BoosterPack plug-in module standard, and adds features not covered by the BoosterPack plug-in module standard that enable operation with additional BoosterPack plug-in modules.

Using the jumpers JP4 and JP5, Controller Area Network (CAN) digital receive and transmit signals can be optionally routed to the BoosterPack Plug-in Module Interface 2 connector. In the default configuration, UART0 is used for the XDS-110 backchannel UART and CAN is not present on the BoosterPack plug-in module headers. In this configuration, the ROM serial bootloader can be used over the XDS-110 backchannel UART. When the jumpers are configured for CAN on the BoosterPack plug-in module interface, then UART2 must be used for the XDS-110 backchannel UART.

To comply with both the original and the new BoosterPack plug-in module standard, I^2C is provided on both sides of the BoosterPack plug-in module connection. Use of I^2C on the bottom left of the BoosterPack plug-in module connection is highly encouraged where possible, to be in compliance with the new BoosterPack plug-in module standard. To provide I^2C capability on the right side of the connector, per the original standard, two 0-Ω resistors (R19 and R20) are used to combine the SPI and I^2C signals. These signals are not shared with any other pins on the LaunchPad development kit 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 3 lists the BoosterPack plug-in module pins and the GPIO alternate functions available at each pin. The MSP432E401Y GPIO register GPIOPCTL values are shown for each configuration. The headers in this table are labeled from left to right in ten pin columns. J5 and J6 make up the outer BoosterPack standard pins, J7 and J8 make up the inner BoosterPack XL standard pins.

Table 3. 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
J5	1		3.3 V													
J5	2	Analog	PD2	3	AIN13	–	I2C8SCL	T1CCP0	C2o	–	–	–	–	–	–	SSI2Fss
J5	3	UART RX	PP0	118	C2+	U6Rx	–	–	–	–	–	–	–	–	–	SSI3XDAT2
J5	4	UART TX	PP1	119	C2-	U6Tx	–	–	–	–	–	–	–	–	–	SSI3XDAT3
J5	5	GPIO (See JP4)	PD4	125	AIN7	U2Rx	–	T3CCP0	–	–	–	–	–	–	–	SSI1XDAT2
			PA0	33	–	U0Rx	I2C9SCL	T0CCP0	–	–	CANORx	–	–	–	–	–
J5	6	Analog (See JP5)	PD5	126	AIN6	U2Tx	–	T3CCP1	–	–	–	–	–	–	–	SSI1XDAT3
			PA1	34	–	U0Tx	I2C9SDA	T0CCP1	–	–	CAN0Tx	–	–	–	–	–
J5	7	SPI CLK	PQ0	5	–	–	–	–	–	–	–	–	–	–	SSI3Clk	EPI0S20
J5	8	GPIO	PP4	105	–	U3RTS	U0DSR	–	–	–	–	–	–	–	USB0D7	–
J5	9	I2C SCL	PN5	112	–	U1RI	U3CTS	I2C2SCL	–	–	–	–	–	–	–	EPIO0S35
J5	10	I2C SDA	PN4	111	–	U1DTR	U3RTS	I2C2SDA	–	–	–	–	–	–	–	EPIO0S34
J7	21		5 V													
J7	22		GND													
J7	23	Analog	PB4	121	AIN10	U0CTS	I2C5SCL	–	–	–	–	–	–	–	–	SSI1Fss
J7	24	Analog	PB5	120	AIN11	U0RTS	I2C5SDA	–	–	–	–	–	–	–	–	SSI1Clk
J7	25	Analog	PK0	18	AIN16	U4Rx	–	–	–	–	–	–	–	–	–	EPI0S0
J7	26	Analog	PK1	19	AIN17	U4Tx	–	–	–	–	–	–	–	–	–	EPI0S1
J7	27	Analog	PK2	20	AIN18	U4RTS	–	–	–	–	–	–	–	–	–	EPI0S2
J7	28	Analog	PK3	21	AIN19	u4CTS	–	–	–	–	–	–	–	–	–	EPI0S3
J7	29	A out	PA4	37	–	U3Rx	I2C7SCL	T2CCP0	–	–	–	–	–	–	–	SSI0XDAT0
J7	30	A out	PA5	38	–	U3Tx	I2C7SDA	T2CCP1	–	–	–	–	–	–	–	SSI0XDAT1
J8	40	PWM	PG1	50	–	–	I2C1SDA	–	–	M0PWM5	–	–	–	–	–	EPI0S10
J8	39	PWM	PK4	63	–	–	I2C3SCL	–	EN0LED0	M0PWM6	–	–	–	–	–	EPI0S32
J8	38	PWM	PK5	62	–	–	I2C3SDA	–	EN0LED2	M0PWM7	–	–	–	–	–	EPI0S31
J8	37	PWM	PM0	78	–	–	–	T2CCP0	–	–	–	–	–	–	–	EPI0S15
J8	36	Capture	PM1	77	–	–	–	T2CCP1	–	–	–	–	–	–	–	EPI0S14
J8	35	Capture	PM2	76	–	–	–	T3CCP0	–	–	–	–	–	–	–	EPI0S13
J8	34	GPIO	PH0	29	–	U0RTS	–	–	–	–	–	–	–	–	–	EPI0S0
J8	33	GPIO	PH1	30	–	U0CTS	–	–	–	–	–	–	–	–	–	EPI0S1
J8	32	GPIO	PK6	61	–	–	I2C4SCL	–	EN0LED1	M0FAULT1	–	–	–	–	–	EPI0S25
J8	31	GPIO	PK7	60	–	U0RI	I2C4SDA	–	RTCCLK	M0FAULT2	–	–	–	–	–	EPI0S24
J6	11		GND													
J6	12	PWM	PM7	71	TMPR0	U0RI	–	T5CCP1	–	–	–	–	–	–	–	–
J6	13	GPIO	PP5	106	–	U3CTS	I2C2SDL	–	–	–	–	–	–	–	USB0D6	–
J6	14	GPIO	PA7	41	–	U2Tx	I2C6SDA	T3CCP1	USB0PFLT	–	–	–	USB0EPEN	SSI0XDAT3	–	EPI0S9
J6	15		RESET													
J6	16	SPI MOSI	PQ2	11	–	–	–	–	–	–	–	–	–	–	SSI3XDAT0	EPI0S22

Table 3. 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
		I2C	PA3	36	–	U4Tx	I2C8SDA	T1CCP1	–	–	–	–	–	–	–	SSI0Fss
J6	17	SPI MISO	PQ3	27	–	–	–	–	–	–	–	–	–	–	SSI3XDAT1	EPI0S23
		I2C	PA2	35	–	U4Rx	I2C8SCL	T1CCP0	–	–	–	–	–	–	–	SSI0Clk
J6	18	GPIO	PP3	104	–	U1CTS	U0DCD	–	–	–	–	–	–	–	USB0DIR	EPI0S30
J6	19	GPIO	PQ1	6	–	–	–	–	–	–	–	–	–	–	SSI3Fss	EPI0S21
J6	20	GPIO	PM6	72	TMPR1	U0DSR	–	T5CCP0	–	–	–	–	–	–	–	–

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 Ethernet LaunchPad development kit can be plugged directly into a standard 300-mil (0.3-in) wide solderless 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 solderless breadboard. Samtec TSW-149-09- F-S-RE and TSW-149-09-F-S-RA may be substituted.

Most microcontroller signals are made available at the breadboard adapter holes (J10). 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 I^2C signals are grouped by peripheral to make expansion and customization simpler.

Table 4 and Table 5 list the GPIO pin and signal muxing for the X11 breadboard adapter pads.

Table 4. 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
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

Table 4. 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
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	5 V													

Table 5. 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	5 V													
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	–	–	–	SSI2XDAT2
44	PD6	127	AIN5	U2RTS	–	T4CCP0	USB0EPEN	–	–	–	–	–	–	SSI2XDAT3
46	PD3	4	AIN12	–	I2C8SDA	T1CCP1	–	–	–	–	–	–	–	SSI2Clk
48	PD1	2	AIN14	–	I2C7SDA	T0CCP1	C1o	–	–	–	–	–	–	SSI2XDAT0

Table 5. 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
50	PD0	1	AIN15	–	I2C7SCL	T0CCP0	C0o	–	–	–	–	–	–	SSI2XDAT1
52	PD2	3	AIN13	–	I2C8SCL	T1CCP0	C2o	–	–	–	–	–	–	SSI2Fss
54	PP0	118	C2+	U6Rx	–	–	–	–	–	–	–	–	–	SSI3XDAT2
56	PP1	119	C2-	U6Tx	–	–	–	–	–	–	–	–	–	SSI3XDAT3
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
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													

2.1.6.4 Other Headers and Jumpers

JP1 is provided to select the 5-V power input source for the Ethernet LaunchPad development kit. The left position is for BoosterPack plug-in module power; this position also disconnects both USB voltages from the board's primary 5-V input. In the left position, the TPS2052B does not limit current so additional care should be exercised. The middle position draws power from the USB connector on the bottom of the board near the Ethernet jack. The right position is the default, in which power is drawn from the XDS-110 USB connection through J101. If JP1 is in the left or middle position, which selects the BoosterPack headers or the USB OTG connector, respectively, externally provide 3.3 V to the board, and remove the 3V3 jumper on J101.

JP2 separates the MCU 3.3-V power domain from the rest of the 3.3-V power on the board allowing an ammeter to be used to obtain more accurate measurements of microcontroller power consumption. JP4 and JP5 are used to configure CAN signals to the BoosterPack Plug-in Module Interface 2 connector. In the default vertical configuration, CAN is not present on the BoosterPack plug-in module connector. UART2 goes to the BoosterPack plug-in module connector and UART 0 goes to the XDS-110 backchannel serial port and can also be used for the ROM serial bootloader. In the horizontal CAN-enabled configuration, UART2 goes to the XDS-110 backchannel serial port and CAN signals are available on the BoosterPack Plug-in Module Interface 2 connector. The ROM serial bootloader is not available to the XDS-110 backchannel serial port while the jumpers are in the CAN position.

Figure 3 shows the default configuration and relative location of the jumpers on the board.

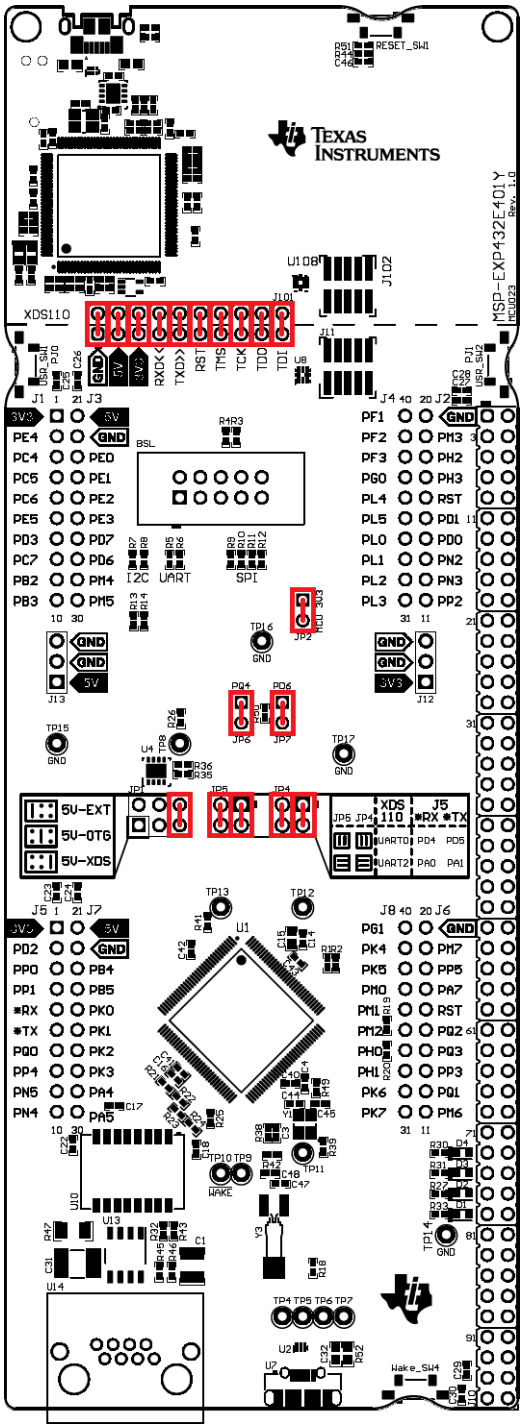

Figure 3. Default Jumper Locations

2.1.7 Serial Bootloader

The Ethernet LaunchPad development kit enables the serial boot loader on the MSP432E401Y through the BSL header for connecting to an external BSL host interface, such as the BSL Rocket. The BSL header supports three communication protocols to the serial boot loader: SPI, UART, and I^2C. To use the serial bootloader, a shrouded 100mil header (such as the AWHW-10G-0202-T from Assman WSW) should be soldered into the top side of the PCB, paying careful attention to make sure pin 1 of the connector lines up to pin one of the PCB (denoted by a square pad).

Because several of the pins for different communication protocols are shared on the header, the Ethernet LaunchPad development kit enables support for all three protocols by using 0-Ω resistor bridges for each of the signals. See Figure 4 for the location of the header and resistors on the PCB. To connect a specific protocol, populate the designated resistors with 0-Ω resistors and remove the resistors for the others protocols (see Table 6). When using I^2C, populate R13 and R14 with the pullup resistors if no I^2C pullups are on the external host. Typically the I^2C pullup resistors should be 3.3 kΩ.

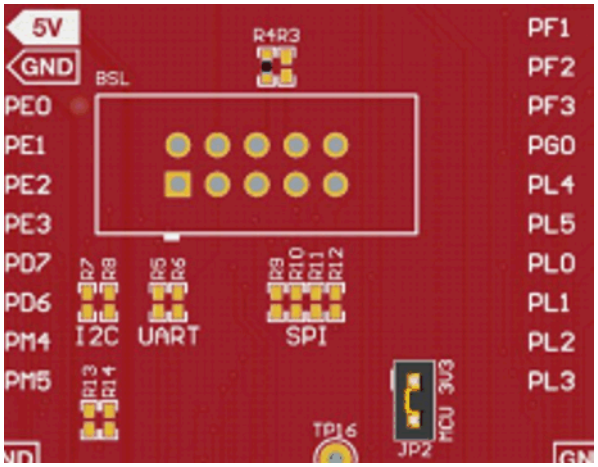

Figure 4. BSL Header and Resistors

Table 6. Resistors for Serial Bootloader Protocols

Serial Bootloader Protocol	Resistors Populated With 0-Ω Resistors	Resistors Left Unpopulated
I^2C	R7 R8	R5 R6 R9 R10 R11 R12
UART	R5 R6	R7 R8 R9 R10 R11 R12
SPI	R9 R10 R11 R12	R5 R6 R7 R8

2.2 Power Management

2.2.1 Power Supplies

The Ethernet LaunchPad development kit can be powered from three different input options:

- Onboard XDS-110 USB cable (Debug, Default)
- Target USB cable
- BoosterPack plug-in module or Breadboard adapter connections

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

In addition, the 3V3 Jumper on J101 power jumper can be used to isolate the 3.3-V output of the TPS79601 in the XDS-110 emulator from the 3.3-V rail of the target side.

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 plug-in module and Breadboard adapter headers when the JP1 jumper is in the XDS-110 position.

2.2.2 Low Power Modes

The Ethernet LaunchPad development kit 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 Ethernet LaunchPad development kit. The Ethernet LaunchPad development kit can achieve microcontroller current consumption modes under 2 µA using hibernate VDD3ON mode. Hibernation with VDD3ON mode is not supported on this board. The Ethernet 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 battery backed register bank that can preserve data through a hibernate cycle.

2.2.3 Clocking

The Ethernet LaunchPad uses a 25-MHz crystal (Y1) to drive the main MSP432E401Y 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 MSP432E401Y microcontroller connects to the RESET switch, BoosterPack plug-in module connectors, breadboard adapter, and the XDS-110 target reset line.

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

- Power-on reset (filtered by an RC network)
- RESET switch held down
- By the XDS-110 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 plug-in module or breadboard connectors

2.3 Debug Interface

2.3.1 XDS-110 Debug Interface

The Ethernet LaunchPad development kit comes with an onboard XDS-110. The XDS-110 allows for the programming and debugging of the MSP432E401Y using Code Composer Studio™ IDE or any of the supported tool chains. Note that XDS-110 only supports JTAG debugging at this time.

Debugging external boards using the XDS-110 is possible by removing the TDI, TDO, TCK, TMS, and RST jumpers from JP101 on the Ethernet LaunchPad development kit and using the XDS-110 to drive JTAG signals out on J102. To restore the connection to the onboard MSP432E401Y microcontroller, reinstall the jumpers on JP101.

2.3.2 External Debugger

The connector J11 is provided for the attachment of an external debug adapter such as the IAR I-Jet, Segger J-Link or Keil® ULINK. This connector follows the Arm 10-pin mini JTAG pinout. To use an external debugger, make sure the TDI, TDO, TCK, TMS, RST, and 3V3 jumpers are disconnected from J101. Many external debuggers do not provide a 3.3-V power rail through this adapter and require an external 3.3-V source to power the LaunchPad development kit.

2.3.3 Virtual COM Port

When plugged into a USB host, the XDS-110 enumerates as both a debugger and a virtual COM port referred to as the backchannel UART. JP4 and JP5 control the selection of which UART from the MSP432E401Y is connected to the backchannel UART virtual COM port. In the default configuration, UART0 maps to the backchannel UART of the XDS-110. In the CAN jumper configuration, UART2 maps to the backchannel UART of the XDS-110.

3 Software Development

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

3.1 Software Description

The SimpleLink MSP432E4 Software Development Kit (SDK) provides drivers for all of the peripheral devices supplied in the design. The Peripheral Driver Library is required to operate the on-chip peripherals as part of SDK.

The SDK includes a set of example applications that use the Peripheral Driver Library. These applications demonstrate the capabilities of the MSP432E401Y microcontroller, as well as provide a starting point for the development of the final application for use on the Ethernet LaunchPad development kit.

3.2 Source Code

The source code is provided as part of the SimpleLink MSP432E4 SDK.

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
- TI Code Composer Studio IDE for Arm and GCC compilers.

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

3.4 Programming the Ethernet LaunchPad Development Kit

The SimpleLink MSP432E4 SDK includes projects for each of the example applications for the different supported tool chains. If you installed the SimpleLink MSP432E4 SDK to the default installation path of `C:\ti\`, you can find the example applications in `C:\ti\simplelink_msp432e4_sdk_<version>\examples\`. The onboard XDS-110 is used with the supported toolchain to program applications on the MSP-EXP432E401Y LaunchPad development kit.

Follow these steps to program example applications into the Ethernet LaunchPad development kit using the XDS-110:

1. Install a toolchain on a PC running Microsoft Windows.
2. Connect the USB-A cable plug in to an available USB port on the PC and plug the Micro-B plug to the XDS-110 USB port at the top of the MSP-EXP432E401Y LaunchPad development kit.
3. Verify the RED LED on the left side of the XDS-110 is illuminated.
4. Run the toolchain and import the project. Build the project to generate the toolchain specific output file.
5. Press on the download and debug button for the toolchain to download the code.
6. After the code has been downloaded to the MSP-EXP432E401Y LaunchPad development kit, run the code.

4 PCB Schematics

The following figures show the schematics of the Ethernet LaunchPad development kit.

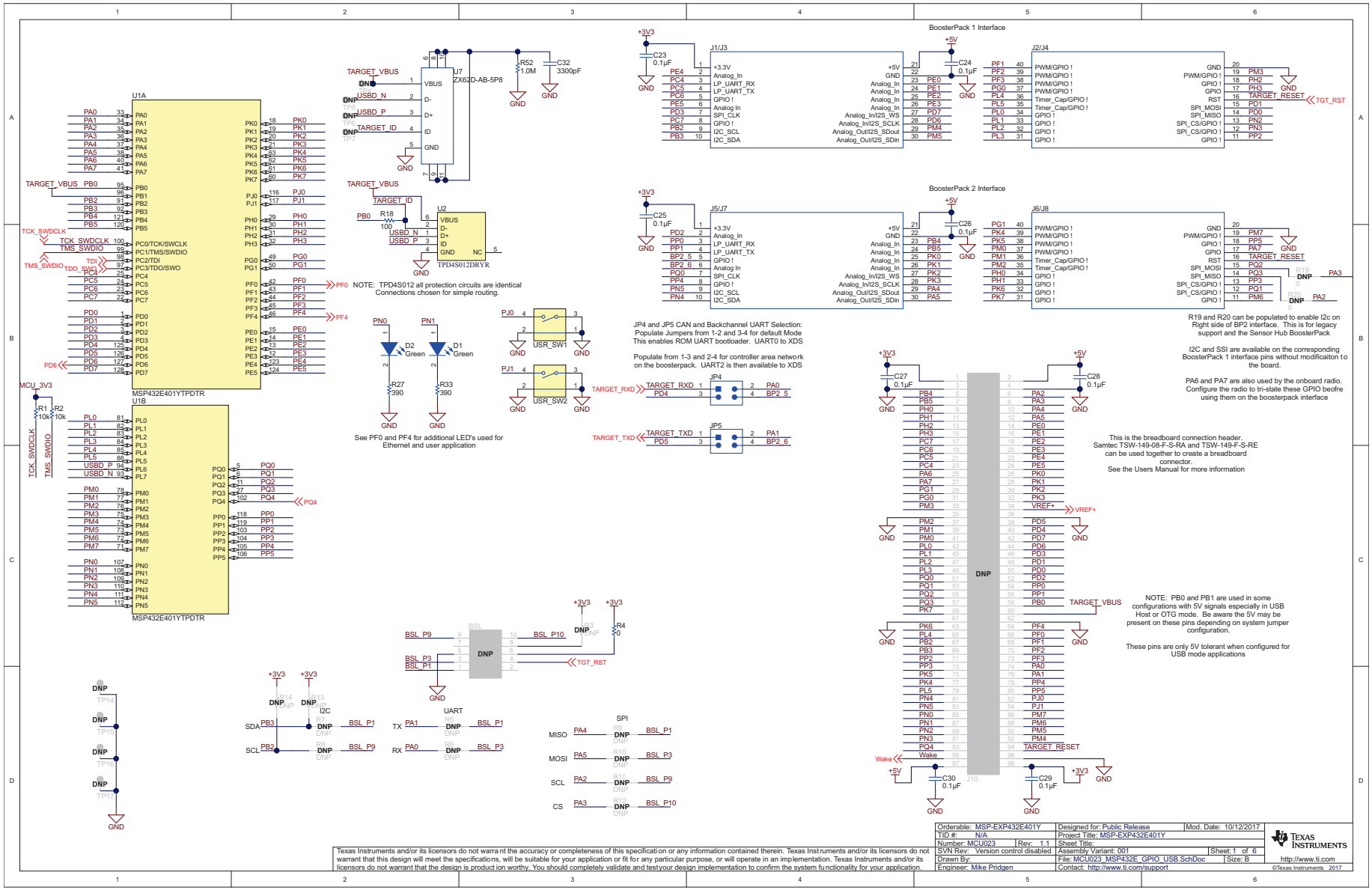

Figure 5. Ethernet LaunchPad Development Kit Schematics (1 of 5)

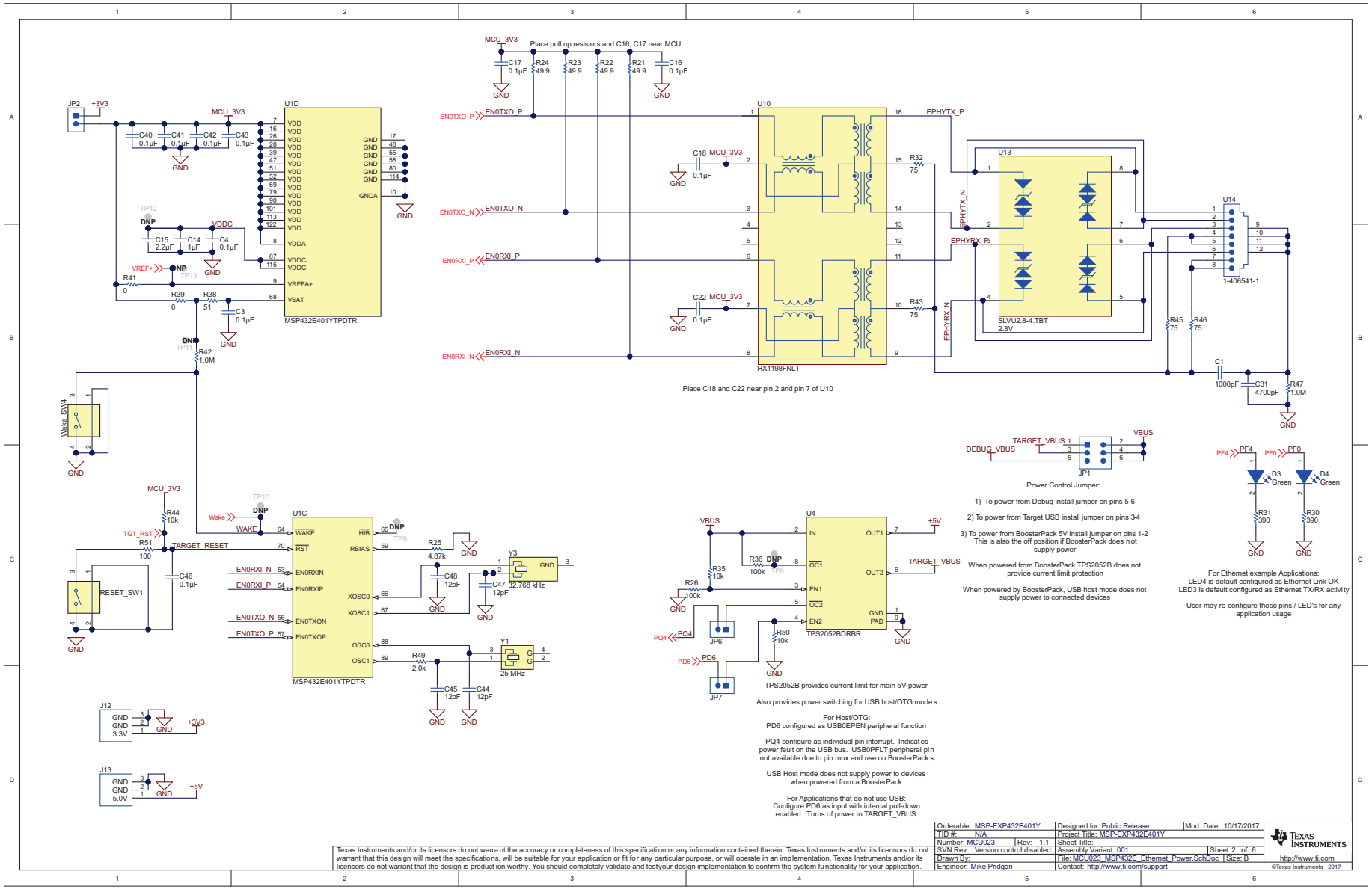

Figure 6. Ethernet LaunchPad Development Kit Schematics (2 of 5)

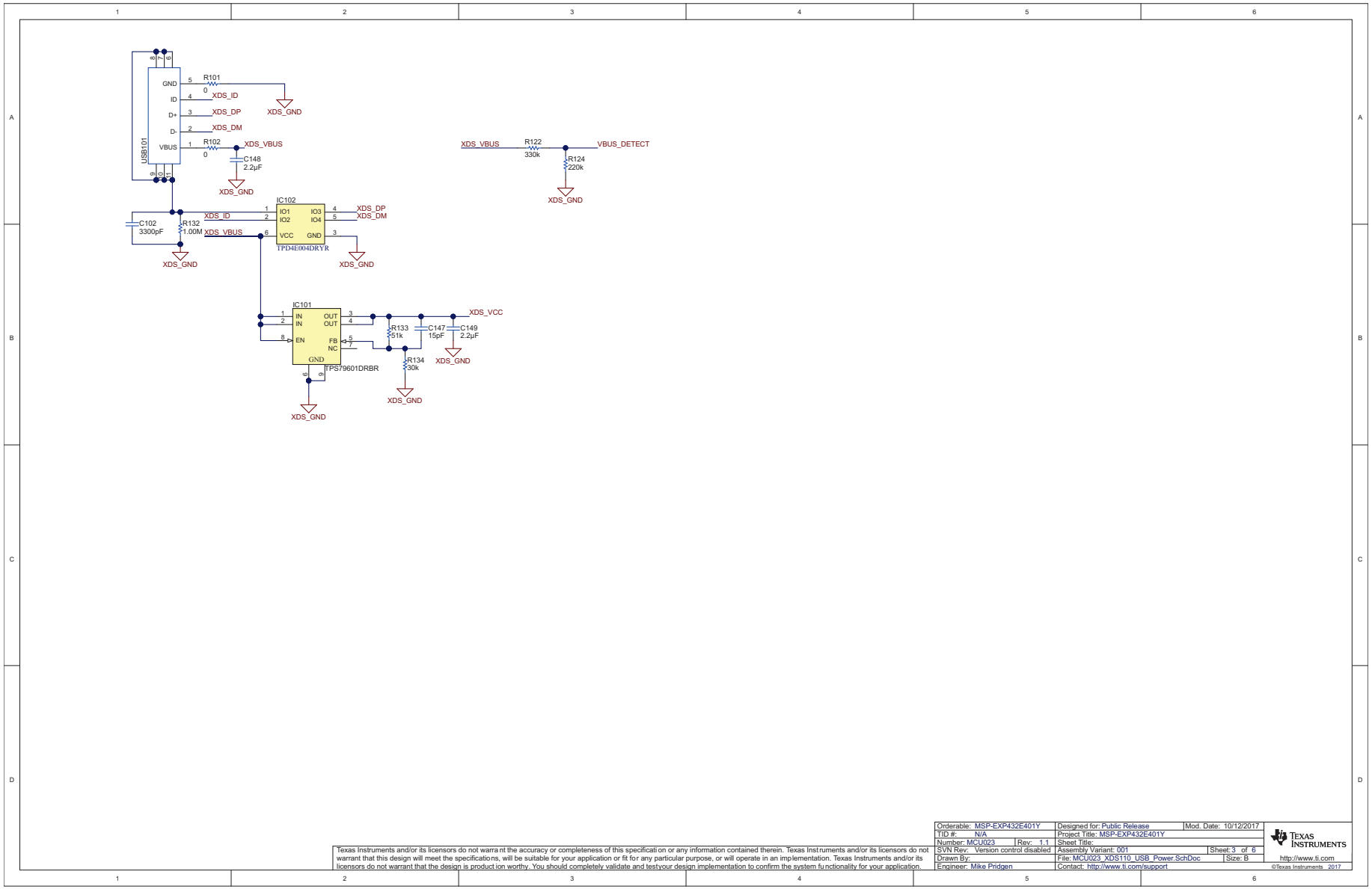

Figure 7. Ethernet LaunchPad Development Kit Schematics (3 of 5)

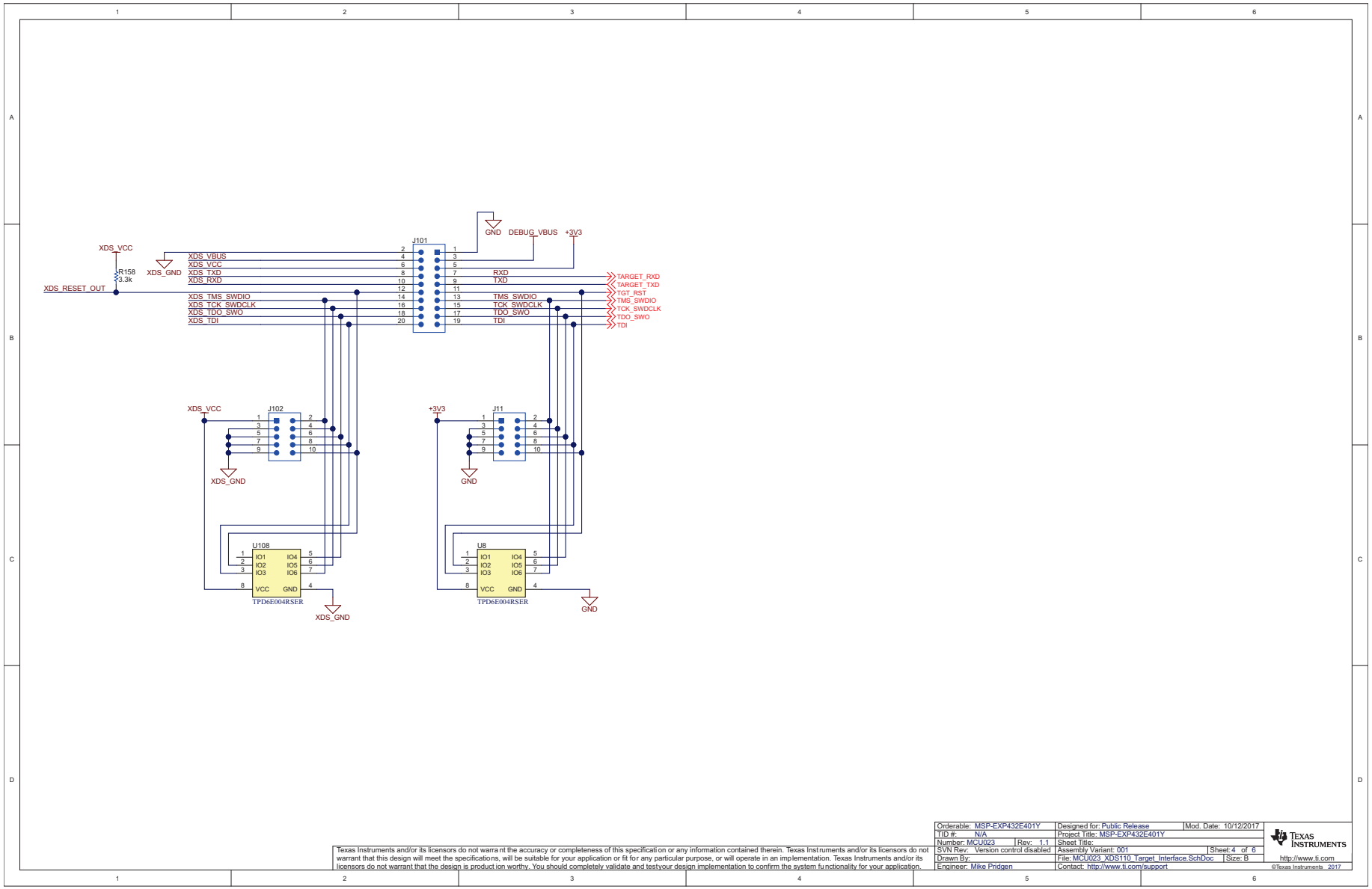

Figure 8. Ethernet LaunchPad Development Kit Schematics (4 of 5)

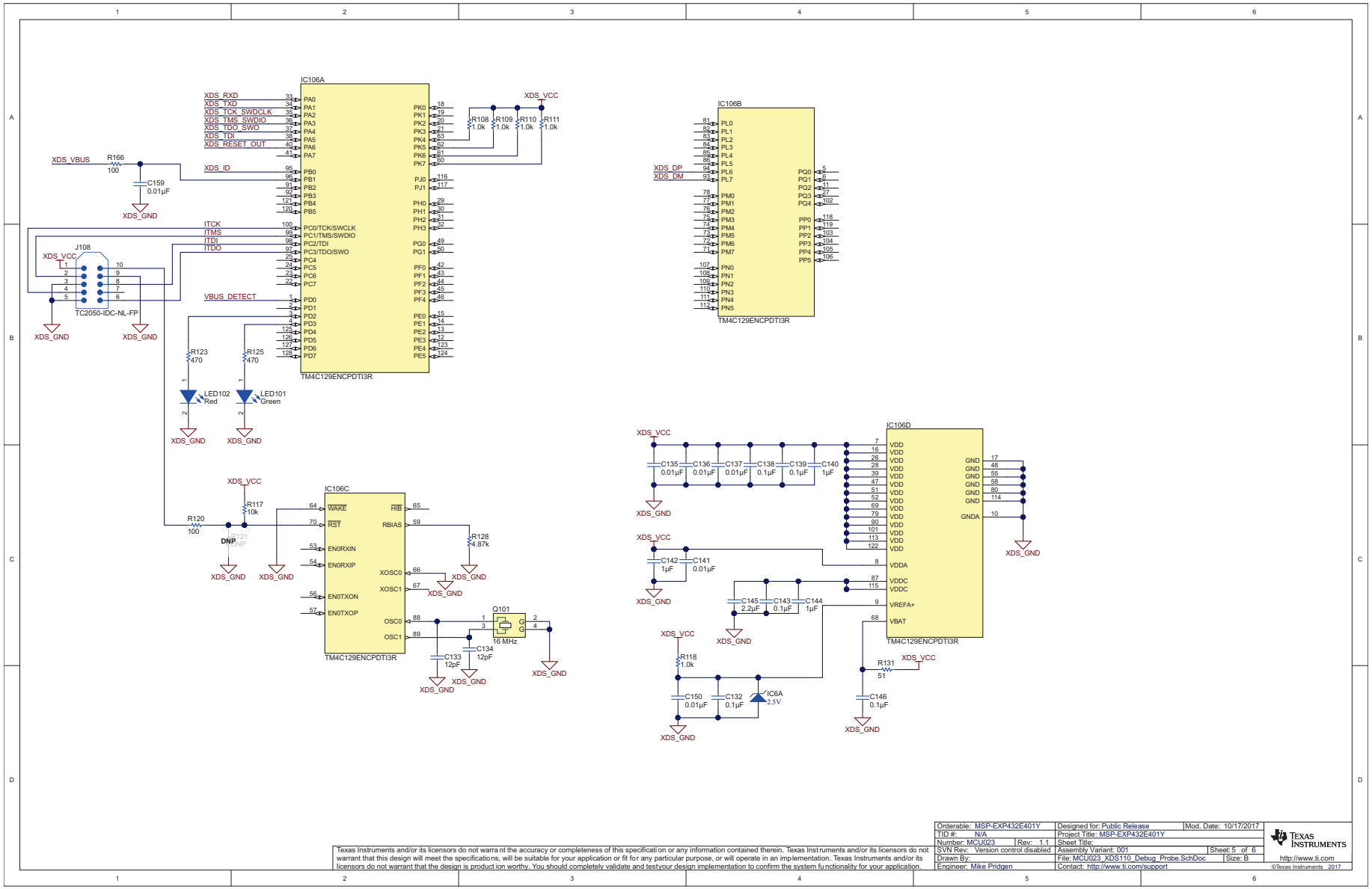

Figure 9. Ethernet LaunchPad Development Kit Schematics (5 of 5)

Revision History

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

Changes from July 20, 2018 to September 11, 2018	Page
• Clarified function of JP1 in the first paragraph of Section 2.1.6.4, *Other Headers and Jumpers*	17
• Added the last sentence in Section 2.3.2, *External Debugger*	21

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2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

3 *Regulatory Notices:*

   3.1 *United States*

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

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

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

      CAUTION

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

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

      FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

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

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.

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

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

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

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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東京都新宿区西新宿６丁目２４番１号

西新宿三井ビル

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

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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

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

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

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. *Disclaimers:*

   6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

   6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

7. *USER'S INDEMNITY OBLIGATIONS AND REPRESENTATIONS.* USER WILL DEFEND, INDEMNIFY AND HOLD TI, ITS LICENSORS AND THEIR REPRESENTATIVES HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, DAMAGES, LOSSES, EXPENSES, COSTS AND LIABILITIES (COLLECTIVELY, "CLAIMS") ARISING OUT OF OR IN CONNECTION WITH ANY HANDLING OR USE OF THE EVM THAT IS NOT IN ACCORDANCE WITH THESE TERMS. THIS OBLIGATION SHALL APPLY WHETHER CLAIMS ARISE UNDER STATUTE, REGULATION, OR THE LAW OF TORT, CONTRACT OR ANY OTHER LEGAL THEORY, AND EVEN IF THE EVM FAILS TO PERFORM AS DESCRIBED OR EXPECTED.

8. *Limitations on Damages and Liability:*

   8.1 *General Limitations*. IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

   8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

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