EVM User's Guide: LP-AM13E230

AM13E230x LaunchPad™ Development Kit

Description

The LP-AM13E230 EVM is a cost-optimized evaluation module (EVM) specifically designed for the Texas Instruments AM13E230x real-time microcontroller (MCU) series. This board utilizes the 64-pin AM13E23019GTPMR device and showcases key peripherals such as control, analog, and communications interfaces along with integrated nonvolatile memory. It also features a BoosterPack-compatible expansion connector (40-pins), a 5V encoder interface (eQEP) connector, power-domain isolation, CAN-FD transceiver, and an on-board XDS110 debug probe. This EVM serves a streamlined development platform for all variants within the AM13E230x device series.

Get Started

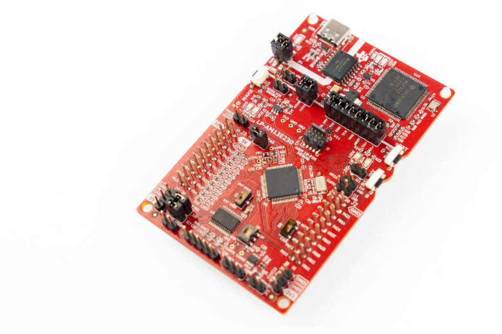
1. Order LP-AM13E230 from TI.com
2. Download the latest Code Composer Studio integrated development environment (IDE) and MCU SDK software development kit.

Features

- AM13E23019GTPM (64-pin, 512KB flash) real-time microcontroller
- Onboard XDS110 debug probe
- 2x user-controlled LEDs
- 3x pushbutton switches: MCU reset, MCU wake, BSL invoke
- Selectable power domains:
  - USB (isolated)
  - BoosterPack
  - External power supply
  - Wide Vin (7-12V)
- Enhanced Quadrature Encoder Pulse (QEP)-based encoder connector
- Onboard TCAN3414 CAN-FD transceiver
- BoosterPack standard connectors (40-pins) featuring stackable headers to maximize expansion through the BoosterPack ecosystem

Applications

- Dual Motor Drive + PFC (Power Factor Correction)
- Multiple Motor Control
- 3-Phase Motor
- Industrial Drive
- Fan/Pump Drive
- Power Tools
- HVAC
- Appliances
- Industrial Automation
- Robotics
- Medical & Healthcare
- Building Automation
- Test & Measurement



1 Evaluation Module Overview

1.1 Introduction

The AM13E230x LaunchPad (LP-AM13E230) from Texas Instruments (TI) provides a great way to learn and experiment with the AM13E230x device. The AM13E230x device is a member of TI's family of real-time microcontrollers (MCUs). This 40-pin LaunchPad is intended to provide a well-filtered, robust design capable of working in most environments. This document provides the hardware details of the AM13E230x LaunchPad and explains the functions, locations of jumpers, and connectors present on the board.

1.2 Kit Contents

The AM13E230x series LaunchPad™ Development Kit contains the following items:

- AM13E230x Series LaunchPad Development Board (LP-AM13E230)
- USB Type-A male to USB Type-C® male cable
- Pinout Map

1.3 Specification

Table 1-1 summarizes the AM13E230x LaunchPad specifications.

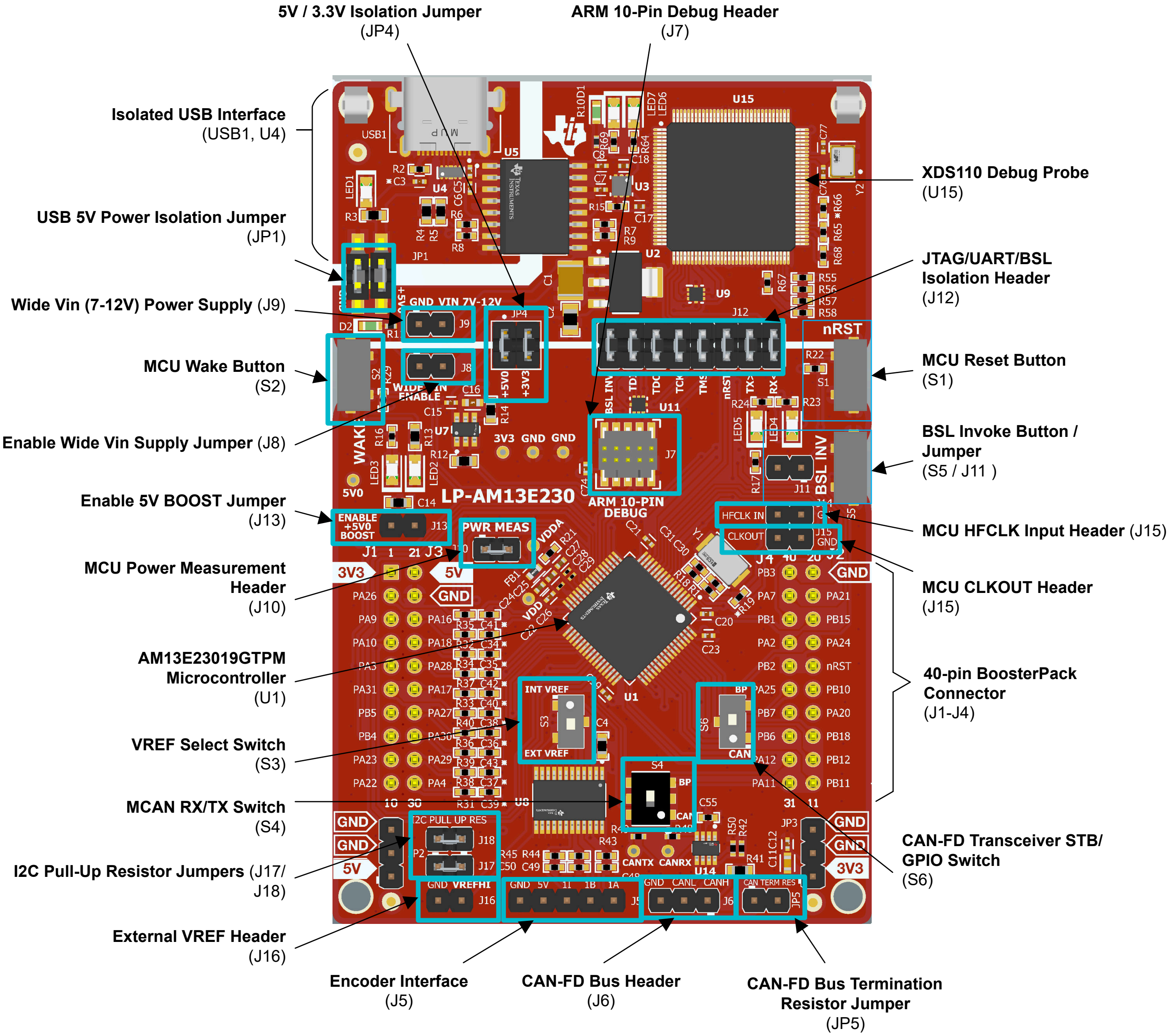
Table 1-1. LP-AM13E230 Specifications

Parameter	Value
EVM Supply Voltage	$5V_{DC}$ from one of the following sources: • USB Connector (USB1) - USB Type-C cable connected to PC or other compatible power source • BoosterPack™ 1 • Auxiliary power connectors $3.3V_{DC}$ from one of the following sources: • BoosterPack 1 • Auxiliary power connectors $7V\text{-}12V_{DC}$ from: • Auxiliary power connectors
Dimensions	3.6 in x 2.3 in x 0.925 in (9.14 cm x 5.84 cm x 2.35 cm) (L x W x H)
Break-out Power Output	• $3.3V_{DC}$ to BoosterPacks, limited by output of TLV75733 LDO. This 3.3V plane is shared with on-board components. Total output power limit of TLV75733 is 1.0A.
Assumed Operating Conditions	This kit is assumed to run at standard room conditions. The EVM can run at approximately standard ambient temperature and pressure (SATP) with moderate-to-low humidity.

Feature and Component Identification

Figure 1-1 highlights the key features and components of the AM13E230x LaunchPad.

Figure 1-1. AM13E230x LaunchPad EVM Overview



1.4 Device Information

The AM13E23019GTPM microcontroller (MCU) is part of the AM13x highly integrated, low-cost 32-bit MCU family based on the Arm® Cortex®-M33 32-bit CPU operating at up to 200MHz frequency. These real-time control optimized MCUs offer high-performance analog, control, and digital peripheral integration. The AM13E230x MCUs provide up to 512KB of embedded flash program memory (2 banks of 256KB) with built-in error correction code (ECC) and up to 128KB SRAM with hardware parity. For more details, see the *AM13E230 Microcontrollers* data sheet.

The majority of the microcontroller signals are routed to 0.1 inch (2.54mm) pitch headers laid out to comply with the TI BoosterPack standards, with a few exceptions to accommodate targeted BoosterPack compatibility with this LaunchPad. The AM13E230x MCU internal pin multiplexer (PinMux) allows for flexibility in configuring different peripheral functions to be assigned to each of the device pins. PinMux options can be found in the device-specific data sheet. When adding external circuitry, consider the additional load on the development board power rails.

2 Hardware

2.1 Hardware Description

The AM13E230x LaunchPad includes an AM13E23019GTPM MCU, which is designed for advanced real-time control applications. Most of the MCU peripherals are made available to the user through on-board hardware interfaces and BoosterPack connectors.

Figure 2-1 shows a high-level block diagram of the AM13E230x LaunchPad:

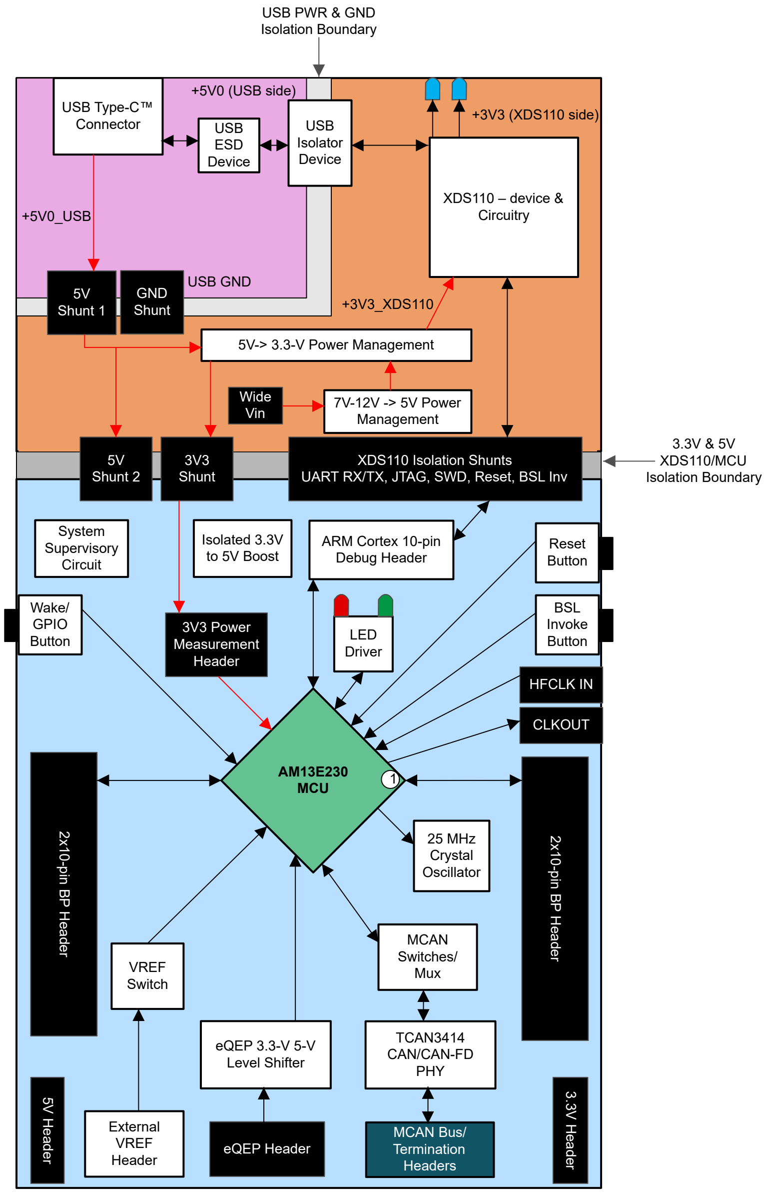


Figure 2-1. AM13E230x LaunchPad Block Diagram

2.2 Power Requirements

The AM13E230x LaunchPad has several power domains that can be connected or isolated from each other with removable shunts on the EVM. The power domains are described in Figure 2-2.

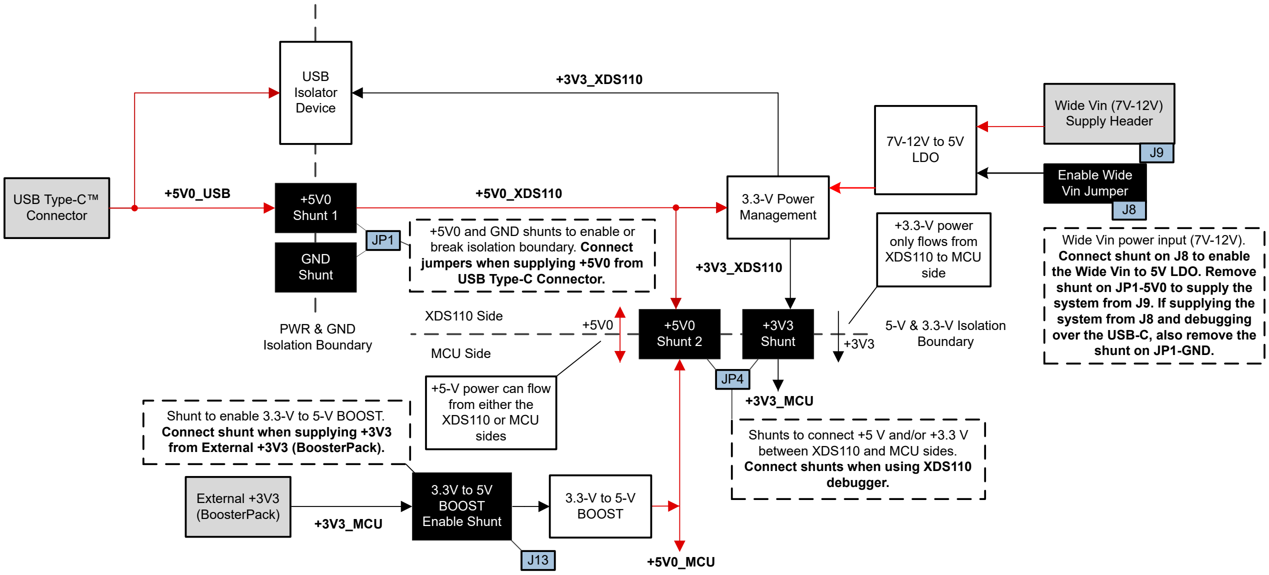


Figure 2-2. LP-AM13E230 Power Input and Distribution Diagram

Table 2-1 describes the usage of different removable shunts on the LaunchPad to connect or isolate different power domains.

Table 2-1. LP-AM13E230 Power Domain Shunts

Shunt Designator	Usage Description
JP1, +5V0	Connects the +5V power from the USB-C connector (+5V0_USB) to the +5-V power on the XDS side of the board (+5V0_XDS110). Bridges the power isolation between the USB and XDS planes
JP1, GND	Connects the board Ground on the isolated USB-C connector side of the board (USB_GND) to the rest of the board ground (GND). Bridges the ground isolation between the USB side and the rest of the board.
JP4, +5V0	Connects the +5-V power from the XDS side of the board (+5V0_XDS110) to the +5-V power on the MCU side of the board (+5V0_MCU).
JP4, +3V3	Connects the +3.3-V power from the XDS side of the board (+3V3_XDS110) to the +3.3-V power on the MCU side of the board (+3V3_MCU).
J13	Enables the onboard 3.3V to 5V BOOST regulator to convert the +3.3V power rail to a +5V power rail.
J8	Enables the onboard 7V-12V to 5V LDO to convert the Wide Vin power input on J9 to a +5V power rail

The AM13E230x LaunchPad features a flexible power domain that allows users to supply power to the board in a variety of configurations and power input sources. Table 2-2 shows the different power input configurations and the required shunts that need to be populated or removed to supply power throughout the EVM.

Table 2-2. LP-AM13E230 Power Configurations

Power Source	Installed Shunts	Description of Power Sources
USB Type-C	JP1, JP4	• **+5V0_USB:** supplied from the USB-C connector • **+5V0_XDS110:** +5V0_USB passes through JP1 and is the same supply as +5V0_XDS110 • **+5V0_MCU:** +5V0_XDS110 passes through JP4 and is the same supply as +5V0_MCU • **+3V3_XDS110:** generated by the XDS-side 5V to 3.3V LDO regulator • **+3V3_MCU:** +3V3_XDS110 passes through JP4 and is the same supply as +3V3_MCU
External +3.3V (connected to BoosterPack header)	JP4 +5V0 (optional), J13	• **+5V0_USB:** If debugging the device, then connect JP2 +5V0 shunt to provide power to the XDS110 debugger. +5V0_USB is supplied through the USB-C connector and is isolated from the MCU side +5V0 rail. Else if not debugging, +5V0_USB is not required and JP2 +5V0 can be disconnected • **+5V0_XDS110:** Required only if debugging the device. +5V0_MCU passes through JP4 and is the same supply as +5V0_XDS110 • **+5V0_MCU:** generated by the 3.3V to 5V BOOST regulator • **+3V3_XDS110:** Required only if debugging the device. +3V3_XDS110 is generated by the XDS-side 5V to 3.3V LDO regulator. Make sure JP4 +3V3 shunt is disconnected to prevent contention on the 3.3V power rail • **+3V3_MCU:** supplied by external +3.3V source
External +5.0V (connected to BoosterPack header)	JP4	• **+5V0_USB:** If debugging the device, +5V0_USB is supplied through the USB-C connector and is isolated from the MCU side +5V0 rail. Else if not debugging, +5V0_USB is not required. • **+5V0_XDS110:** 5V0_XDS110 passes through JP4 and is the same supply as +5V0_MCU • **+5V0_MCU:** supplied by external +5.0V source • **+3V3_XDS110:** +3V3_XDS110 passes through JP4 and is the same supply as +3V3_MCU • **+3V3_MCU:** generated by the XDS-side 5V to 3.3V LDO regulator
Wide Vin (+7V-12V)	J8, JP4	• **+5V0_USB:** If debugging the device, +5V0_USB is supplied through the USB-C connector and is isolated from the MCU side +5V0 rail. Else if not debugging, +5V0_USB is not required. • **+5V0_XDS110:** 5V0_XDS110 is supplied by the 7V-12V to 5V LDO • **+5V0_MCU:** +5V0_XDS110 passes through JP4 and is the same supply as +5V0_MCU • **+3V3_XDS110:** generated by the XDS-side 5V to 3.3V LDO regulator • **+3V3_MCU:** +3V3_XDS110 passes through JP4 and is the same supply as +3V3_MCU

2.2.1 Power Tree

Figure 2-3 shows the full power tree and all connected hardware to each power rail on the LP-AM13E230.

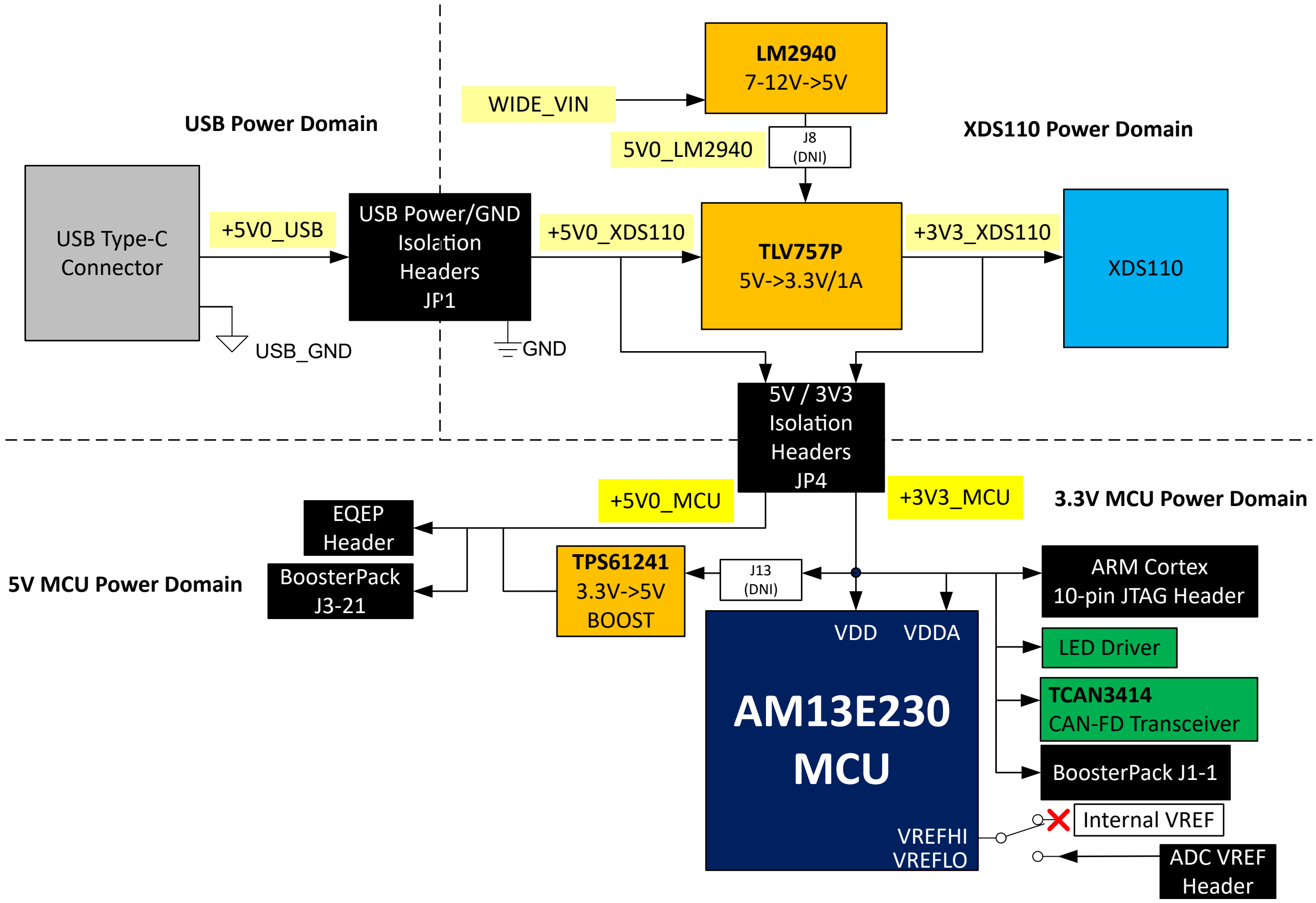


Figure 2-3. LP-AM13E230 Power Tree

2.2.1.1 On-Board Power Supplies

There are several on-board power ICs that help to convert voltage levels and regulate power nets on the LP-AM13E230.

Table 2-3. LP-AM13E230 On-board Power Supplies

Part Number	Reference Designator	Input	Output	Description
TLV75733PDRVR	U3	5V	3.3V @ 1A	5V to 3.3V LDO
LM2940IMPX-5.0/NOPB	U2	• 7V at 1A • 8V at 800mA • 9V at 600mA • 10V at 490mA • 11V at 400mA • 12V at 250mA	5V	7V-12V to 5V LDO from Wide Vin
TPS61241YFFR	U6	3.3V	5V @ 500mA	3.3V to 5V BOOST converter

2.2.1.2 Analog Voltage Reference

The analog subsystem of the LP-AM13E230 allows for flexible voltage reference sources. The ADC modules are referenced to the VREFHI and VREFLO pin voltages. VREFHI can either be driven externally or can be generated by an internal bandgap voltage reference. Switch S3 selects the source of the voltage reference. The direction of the switch and selected VREF is indicated by the on-board silkscreen text. The default position of the switch is for INTERNAL VREF.

Table 2-4. LP-AM13E230 Analog VREF Switch

Switch Position	Selected VREF
1-2 (UP)	Internal VREF
2-3 (DOWN)	External VREF

An external voltage can be supplied to header J16 as an external voltage source for VREFHI. Note that there is no signal conditioning circuitry in place for an external voltage reference. For best performance, some additional circuitry can be required.

2.2.1.3 Alternative Power Sources

The LaunchPad has multiple jumpers to select different power sources for the board. This LaunchPad also provides a way to isolate the connected USB from the device, allowing for safe operation and debugging in higher voltage applications.

2.2.1.3.1 USB Isolation

JP1 is provided to enable isolation between the device and the connected USB in higher-voltage applications. The area of isolation is defined by the white outline on the upper-left corner of the LaunchPad. JP1 has two removable shunts to separate the GND and 5V power of the USB region and the XDS110 and AM13E230x MCU region of the LaunchPad. By default, both shunts are populated and the power is supplied by the connected USB, meaning that the USB is NOT isolated from the XDS110 and AM13E230x MCU regions. If power isolation is desired, remove the supplied shunts from JP1. In this configuration, one of the two external power options below are required:

- An external 5V supply to power the 3.3V LDO (TLV75733), which provides 3.3V to the XDS110 and AM13E230x MCU regions of the board.
- An external 3.3V supply to power the AM13E230x MCU region of the board. 5V is generated using the onboard 5V BOOST (TPS61241).

In an isolated power application with JP1 shunts removed, make sure the proper shunts on the AM13E230x MCU region of the board are populated. Refer to Section 2.2 for greater detail.

2.2.1.3.2 External Power Connections

Additional jumpers are provided outside of the BoosterPack connector for additional external power connections for 3.3V or 5V. These can be used to supply an external board or for powering the LaunchPad with an external supply. When using these connection points, make sure that no other power supplies are connected.

- JP3 is provided as an extra connection point for a 3.3V supply to be connected to the LaunchPad.
- JP2 is provided as an extra connection point for a 5V supply to be connected to the LaunchPad.
- J9 is provided as an extra connection point for a 7V-12V supply to be connected to the LaunchPad.

2.2.1.3.3 5V Step-Up Converter

J8 cuts off the power to the on-board boost converter and prevents the TPS61241 step-up DC/DC converter (U6) from powering the 5V power domain of the LaunchPad. This voltage regulator can step up 3.3V to 5V if no other 5V supply is connected. Do not place a shunt on J8 unless JP4 +5V0 is open and no other 5V supply is connected to the LaunchPad.

2.2.2 Power Indicator LEDs

Five Power Indicator LEDs are included on the LP-AM13E230 to indicate the status of each power net. Table 2-5 describes each LED.

Table 2-5. Power LEDs

LED Designator	Color	Description
LED1	RED	+5V power from the USB Type-C connector
LED2	RED	+5V power on the AM13E230 side of the PCB
LED3	RED	+3.3V power on the AM13E230 side of the PCB
D1	GREEN	+3.3V power on the XDS110 side of the PCB
D2	GREEN	+5V power on the XDS110 side of the PCB

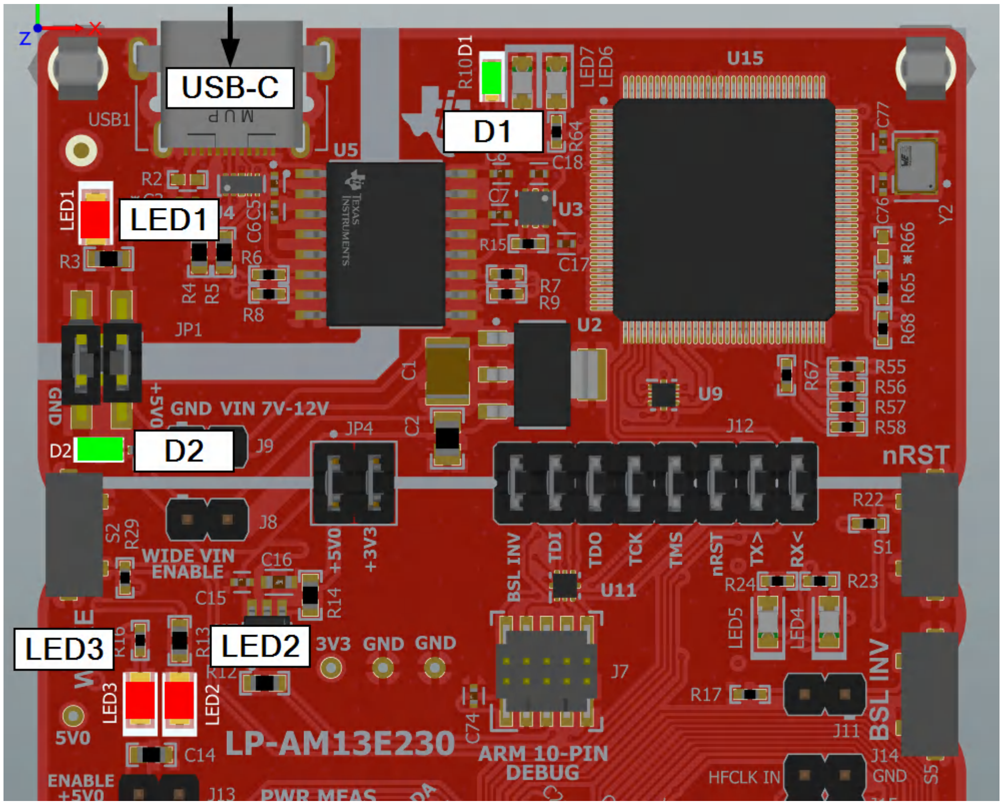


Figure 2-4. Power Indicator LEDs on LP-AM13E230

2.3 Reset

nRST

The AM13E230x MCU reset is controlled by the nRST pushbutton S1. The nRST net is also connected to BoosterPack header J2-16 so the MCU reset can be controlled by an external circuit if desired. The nRST input to the AM13E230x MCU is an active low signal.

BSL Invoke

An additional reset pin can also be user-controlled on the LaunchPad. The BSL (Boot Strap Loader) Invoke signal triggers a system reset and allows the Boot Configuration Routine (BCR) to run the Bootstrap Loader. The BSL Invoke pin assignment is user configurable, and has been assigned to pin PA6 (GPIO6). BSL Invoke is configured as active high on the LaunchPad.

By default, the BSL Invoke signal is generated by the XDS110 firmware as part of the boot routine and is output from the XDS110 (U15) pin PF0. To disconnect this signal from the XDS110 and use the on-board pushbutton S5 to generate the BSL Invoke signal, the following jumpers must be removed and installed:

1. Remove the jumper on J12 connecting the BSL Invoke net from the XDS110 to the AM13E230x MCU (denoted by **BSL INV** on the PCB silkscreen).
2. Populate a jumper on J11 to connect the output of the pushbutton S5 to the AM13E230x MCU

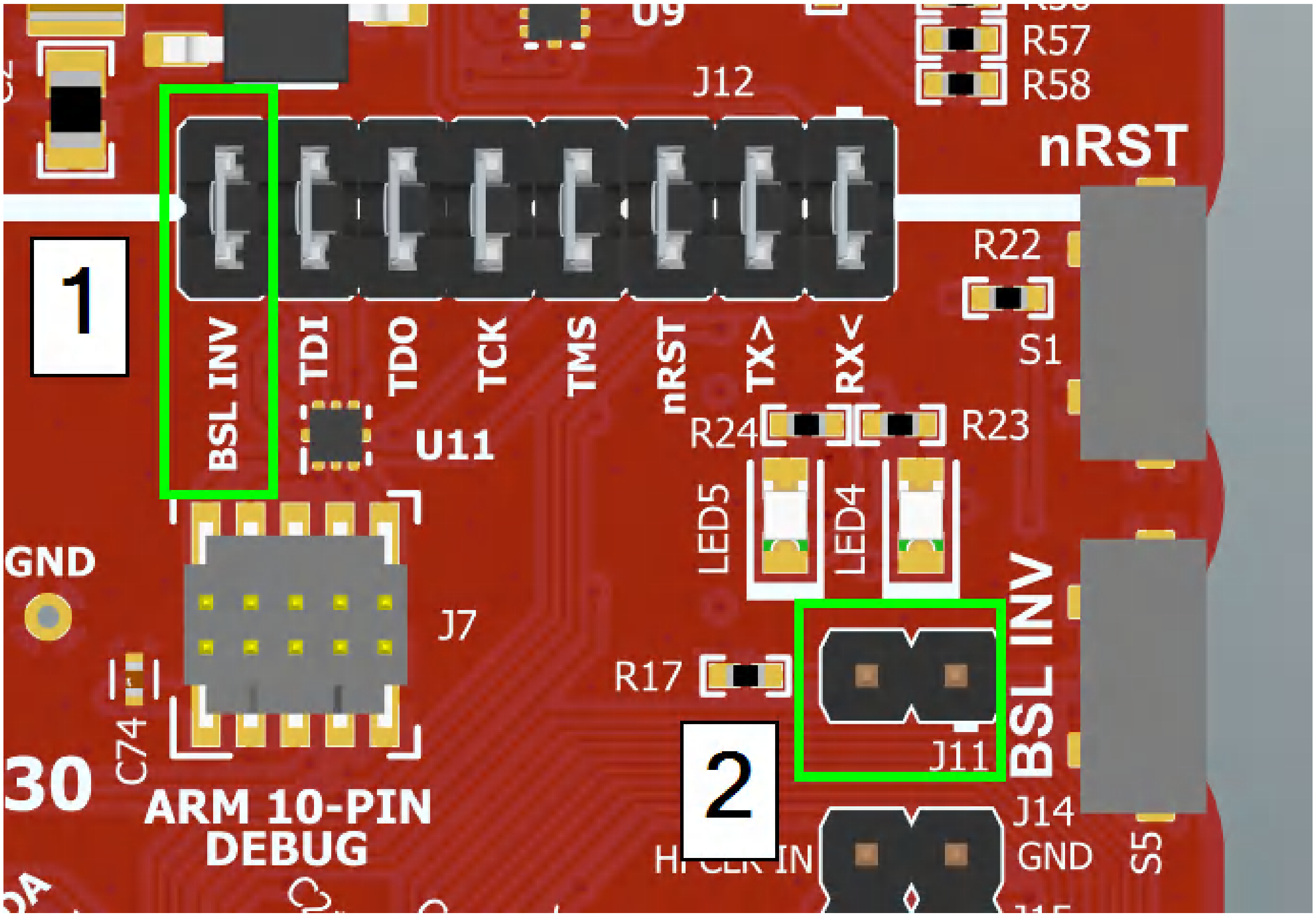


Figure 2-5. Changing BSL INV to Pushbutton

GPIO Wake

A dedicated GPIO used to wake the AM13E230x MCU from low power modes is connected to push button S2. This push button can also be used for a user GPIO input to the AM13E230x MCU. GPIO45 (PB13) is assigned as the WAKE GPIO as it can wake up the MCU from SHUTDOWN mode, the lowest power consumption mode on the device. MCU WAKE is configured as an active low signal on the LaunchPad.

2.4 Clock

Input Clock

The AM13E230x MCU default clock source on the LaunchPad is a 25MHz crystal oscillator (Y1) connected to the X1 and X2 pins of the MCU, and is referred to as XTAL. Alternatively, a high frequency digital clock input ranging from 4-48MHz can be connected to J14, and is referred to as HFCLK_IN.

In order for HFCLK_IN to be the main external oscillator input, there are a few hardware modifications required to the LaunchPad:

1. Remove R1 and R18 to disconnect the XTAL (Y1) from the X1 and X2 pins of the MCU
2. Populate R19 to connect the HFCLK_IN header (J14) to the X1 pin of the MCU
3. Connect a high frequency digital clock input to J14

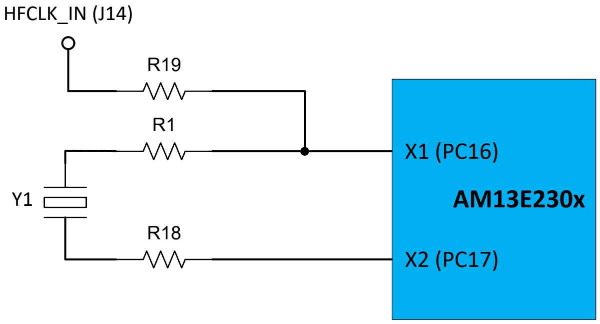


Figure 2-6. LP-AM13E230 Clock Input

Output Clock

The AM13E230x MCU CLKOUT pin is accessible on header J15. The external clock output is useful for clocking external circuitry such as an external ADC that does not have a clock source. The clock output unit on the AM13E230x MCU has several sources and a programmable clock divider. For information on configuring the CLKOUT unit, refer to the *Technical Reference Manual.*

2.5 Interfaces

This section details the hardware interfaces present on the LP-AM13E230.

2.5.1 User LEDs

Two user-controllable LEDs are provided on the EVM: LED4 (RED) and LED5 (GREEN). The LEDs are driven by an LED Driver IC SN74LVC2G07 (U10). LED4 is connected to pin PA5, and LED5 is connected to pin PB0. The LEDs are connected in an active-low configuration; when the MCU GPIO is driven low, the LED turns on, and when the GPIO is driven high, the LED turns off. These LEDs are dedicated for use by software applications.

Table 2-6. User LEDs

LED Designator	Description
LED4	Active-low user-configurable RED LED controlled by PA5
LED5	Active-low user-configurable GREEN LED controlled by PB0

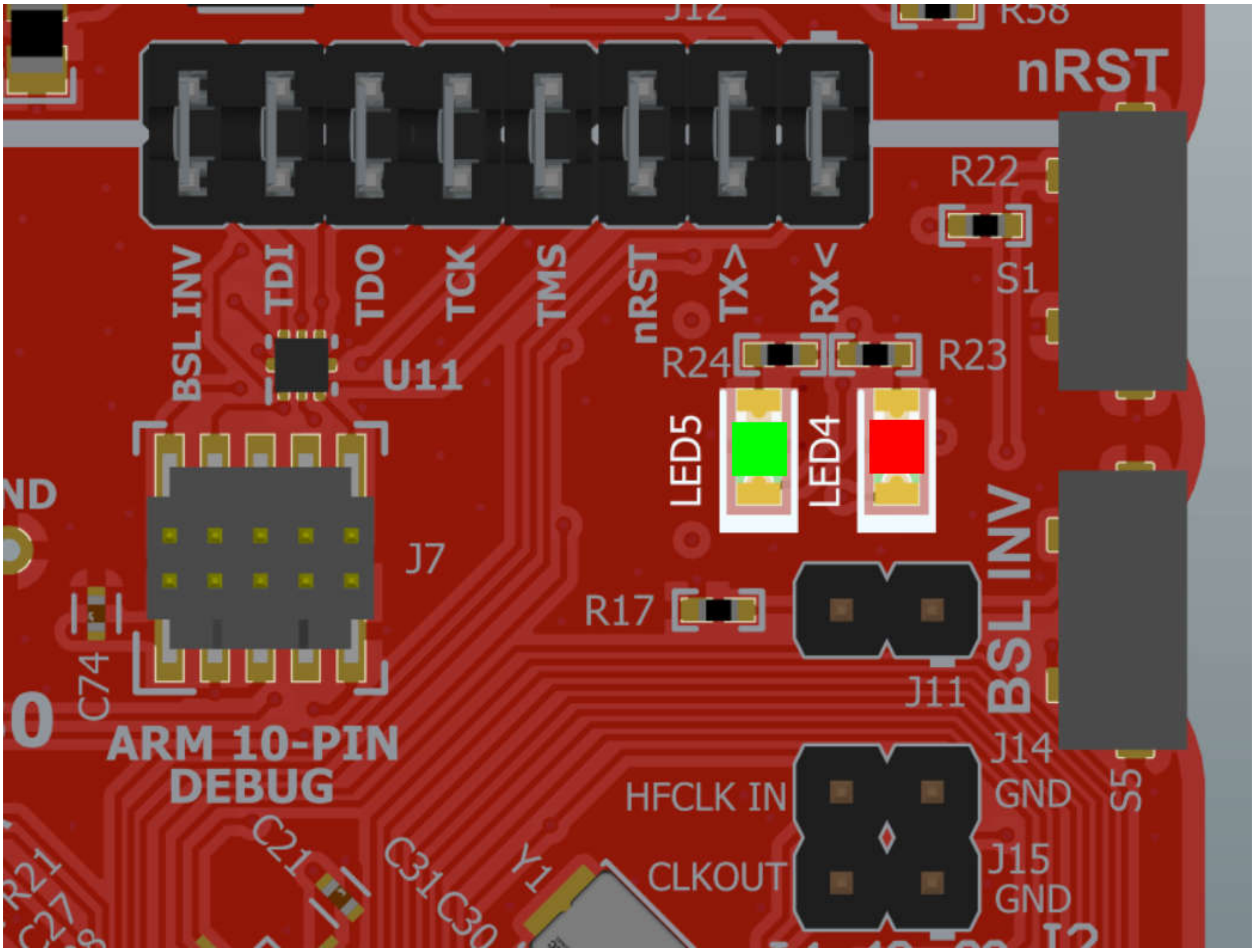


Figure 2-7. LP-AM13E230 User LEDs

2.5.2 MCAN

The LP-AM13E230 has a CAN-FD interface connected to the MCAN peripheral on the AM13E230x MCU. The MCAN0 RX and TX nets are connected to a TCAN3414 CAN-FD transceiver (U14). The CAN bus signals are brought out to a 3-pin header (J6) for connecting the LaunchPad to a CAN bus.

In order to use the CAN-FD interface, on-board switches S4 and S6 must be configured to route the appropriate signals to the CAN-FD transceiver.

Table 2-7. S4 - CAN RX/TX Switch Settings

Switch Position	PA24 / MCAN RX Routing	PA25 / MCAN TX Routing
UP (2-3/5-6, DEFAULT)	BoosterPack J4-31	BoosterPack J4-32
DOWN (1-2/4-5)	TCAN3414 RXD	TCAN3414 TXD

Table 2-8. S6 - CAN STB Switch Settings

Switch Position	PB0 / GPIO32 Routing
UP (2-3. DEFAULT)	BoosterPack J2-17
DOWN (1-2)	TCAN3414 STB

Note

The TCAN3414 standby control signal (STB) is active high and is pulled down by a resistor to have the transceiver operate in normal mode by default.

The switch position corresponds with the PCB silkscreen text indicating the routing of the signals - **BP** for BoosterPack and **CAN** for the TCAN3414 CAN-FD transceiver.

CAN Bus Termination Impedance

A 120Ω resistor is included on the CAN bus output from the TCAN3414, and is disconnected by default. The split termination on the CAN bus improves the electromagnetic emissions behavior of the CAN network by eliminating fluctuations in the bus common-mode voltages at the start and end of message transmissions. To enable the 120Ω split termination, populate a jumper across JP5 (denoted as **CAN TERM RES** on the PCB silkscreen).

2.5.3 Encoder Connectors

The AM13E230x LaunchPad includes a 5-pin header (J5) for connecting a linear or rotary incremental encoder. 5V input signals on the header are level translated to 3.3V (via U8) and fed into the AM13E230x MCU pins designated for use with the eQEP peripheral. Because the eQEP peripheral does not have dedicated pinmux mode options for these signals, the following GPIOs are configured to supply the eQEP inputs by using the AM13E230x Input XBAR.

Table 2-9. AM13E230x GPIO-eQEP Assignments

eQEP Signal	MCU Pin	GPIO#
EQEP_A	PB8	GPIO40
EQEP_B	PB9	GPIO41
EQEP_I	PA8	GPIO8

The header has pins designated for EQEPA, EQEPB, and EQEPI, as well as GND and 5V connections.

Each eQEP net is pulled up to 5V between J5 and U8 with 1kΩ resistors.

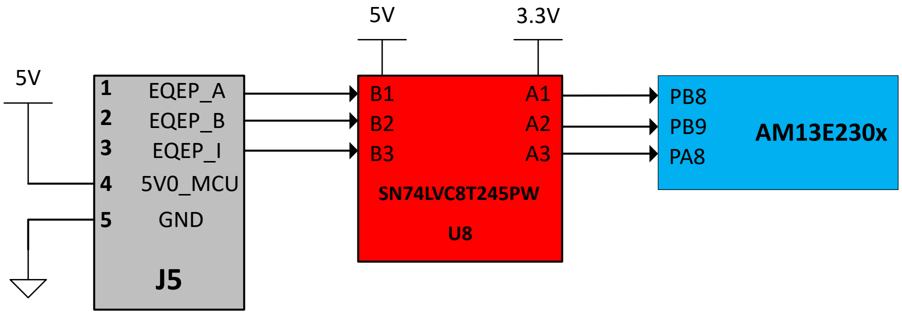


Figure 2-8. LP-AM13E230 Encoder Interface

2.6 Debug Interface

2.6.1 XDS110 Debug Probe

The AM13E230x LaunchPad has an on-board XDS110 Debug Probe. The XDS110 allows for the programming and debugging of the AM13E230x device using the Code Composer Studio (CCS) IDE or any other supported tool chains. In the default configuration, the XDS110 is wired to support 4-pin JTAG and 2-wire ARM Serial Wire Debug (SW-DP).

2.6.2 Virtual COM Port

When plugged into a USB host, the XDS110 enumerates as both a debugger and virtual COM port. Jumpers on J12 allow the user to connect the UART peripheral configured on the UNICOMM0 port from the AM13E230x to the debug probe, and to the USB host. The jumpers on J12 for UART communication are denoted by **TX>** and **RX<** on the PCB silkscreen. By default, the AM13E230x UC4 UART maps to the virtual COM port of the XDS110 using PA1 (UC4_RX_SCL_SCLK) and PA0 (UC4_TX_SDA_PICO).

Note

PA0 and PA1 are configured by the AM13E230x Boot ROM as the default UART pins for boot.

2.6.3 ARM 10-Pin Debug Header

An ARM 10-pin Debug Header (J7) is included on the LP-AM13E230 for connecting an isolated JTAG debugger to the AM13E230x MCU. This allows for flexibility in debugger hardware if an emulator other than the on-board XDS110 is desired.

To debug the AM13E230x MCU using an external emulator, the corresponding jumpers on J12 (denoted on the PCB silkscreen) must be removed in order to isolate the ARM 10-pin Debug header signals from the on-board XDS110:

- TDI
- TDO
- TCK
- TMS
- Optional: RX and TX - still can be used to enable a serial interface to the connected USB host if needed

The pinout of the ARM-10 Header is as follows:

Table 2-10. ARM 10-Pin Debug Header (J7) Pinout

MCU Connection	Signal	Pin #	Pin #	Signal	MCU Connection
+3V3_MCU	VCC	1	2	SWDIO / TMS	PA13
	GND	3	4	SWDCLK / TCK	PA14
	GND	5	6	SWO / TDO	PA19
	KEY	7	8	TDI	PA15
	GNDDetect	9	10	nRST	nRST

2.7 Test Points

This section details the test points included on the PCB for probing and debugging. Many of the test point net connections are labeled on the PCB silkscreen, and are documented in the table below:

Table 2-11. LP-AM13E230 Test Points

TP Designator	Net	Description
TP1	+3V3_MCU	3.3V power rail on MCU side
TP2	+5V0_MCU	5V power rail on MCU side
TP3	GND	
TP4	GND	
TP5	VDD_3V3	3.3V digital supply to the MCU
TP6	VDDA_3V3	3.3V analog supply to the MCU
TP7	TCAN_MCAN0_RX	CAN RX signal
TP8	TCAN_MCAN0_TX	CAN TX signal

2.8 BoosterPacks

The LP-AM13E230 provides a simple and inexpensive way to develop applications with the AM13E230x series microcontroller. BoosterPacks are pluggable add-on boards for the LaunchPad ecosystem that follow a standard pinout created by Texas Instruments. The standard pinout and pin assignments on the LP-AM13E230 are shown below.

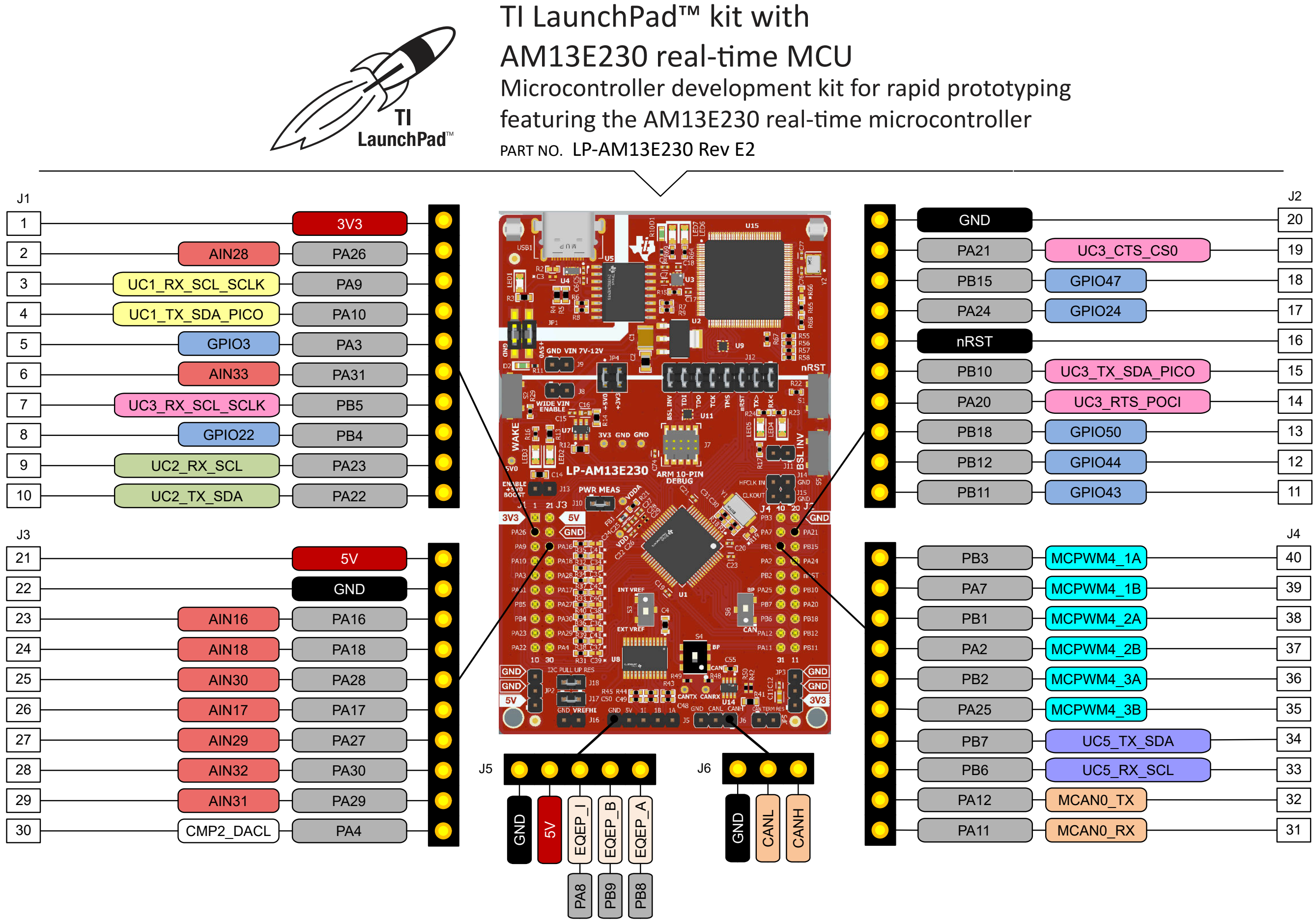


Figure 2-9. LP-AM13E230 BoosterPack Header Pinout

The TI and third-party ecosystem of BoosterPacks greatly expands on the peripherals and potential applications that can be explored and implemented using the AM13E230x LaunchPad.

BoosterPacks compatible with the AM13E230x LaunchPad are listed in the table below. Note that this is not an exhaustive list of hardware supported BoosterPacks.

Table 2-12. LP-AM13E230 Compatible BoosterPacks

BoosterPack Orderable Part Number	Application and Usage
BOOSTXL-DRV8320RS	DRV8320RS 15A, 3-phase brushless DC drive stage. Features individual DC bus and phase voltage sense, making this evaluation module good for sensorless BLDC algorithms
BOOSTXL-DRV8323RS	DRV8323RS Three-Phase, 15A smart gate driver with buck, shunt amps (SPI or Hardware Interface) Evaluation Module.
BOOSTXL-3PHGANINV	Features a 48V/10A three-phase GaN inverter with precision in-line shunt-based phase current sensing for accurate control of precision drives such as servo drives
BOOSTXL-LMG2100-MD	Implements a GaN inverter with precision in-line shunt-based phase current sensing for accurate control of precision drives such as servo drives.

3 Additional Information

3.1 Revision E1 Appendix

3.1.1 Revision E1 Known Issues

This section details the following issues and workarounds for Revision E1 of the LP-AM13E230.

Note

Revision E1 boards can be identified by the silkscreen text '**MCU178E1**' on the back side of the PCB.

Non-default Bootloader Interfaces

The AM13E230x Bootloader (also referred to as the BSL) provides a method to program and verify the device flash memory through UART, I2C, and MCAN serial interfaces. The device boot ROM configures specific pins for this interface that have non-default connections on the LaunchPad. The following workarounds solve this issue:

UART Pins

AM13E230x pins PA0 and PA1 are configured by the boot ROM for UART TX (UC4_TX_SDA_PICO) and UART RX (UC4_RX_SCL_SCLK) respectively. To connect the UART pins with the on-board XDS110 for booting over UART and interfacing with the XDS110 debug probe:

1. Remove the shunt jumpers on the J12 RX/TX headers
2. Connect/solder a jumper wire from J4-38 (PA0) to the XDS110 side of the J12-TX header
3. Connect/solder a jumper wire from J4-39 (PA1) to the XDS110 side of the J12-RX header

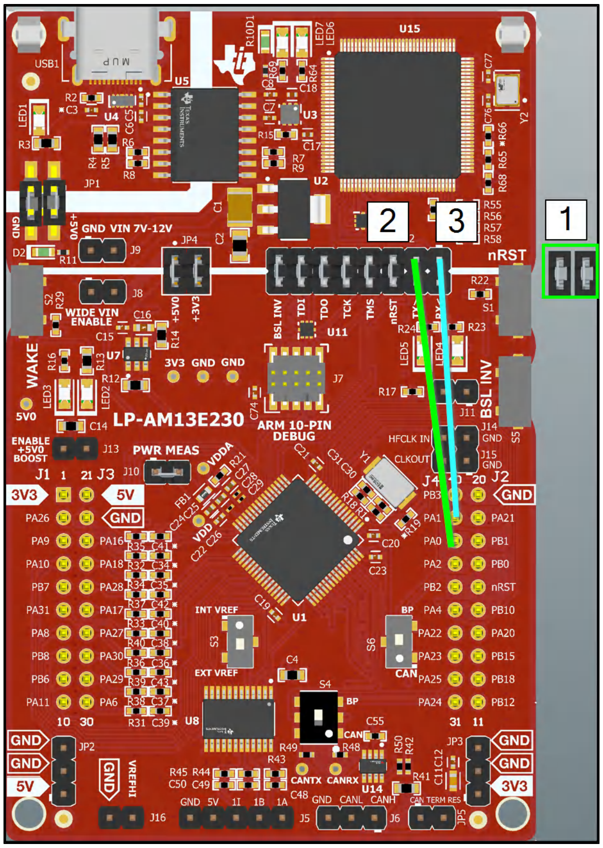


Figure 3-1. LP-AM13E230 Rev E1 UART Fix

I2C Pins

AM13E230x pins PA22 and PA23 are configured by the boot ROM for I2C SDA (UC2_TX_SDA) and I2C SCL (UC2_RX_SCL) respectively. The designated BoosterPack pin locations for I2C signals are J1-9 (I2C SCL) and J1-10 (I2C SDA). On Revision E1 of the LP-AM13E230, PA22 is routed to J4-34 and PA23 is routed to J4-35.

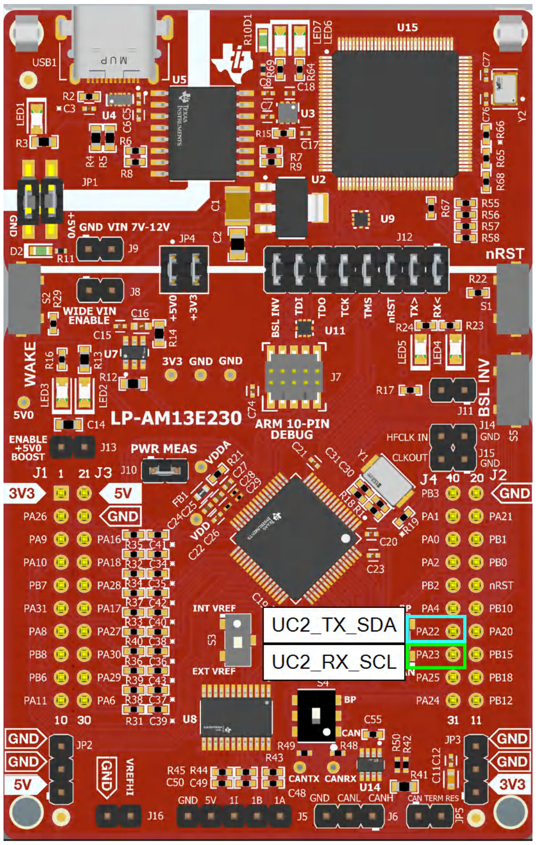


Figure 3-2. LP-AM13E230 Rev E1 I2C Fix

MCAN Pins

AM13E230x pins PA11 and PA12 are configured by the boot ROM for MCAN RX (MCAN0_RX) and MCAN TX (MCAN0_TX) respectively. Because PA12 is not accessible at a board-level header, the BSL configuration can be modified to change the default MCAN pins to PA25 for MCAN0_TX and PA24 for MCAN0_RX. Any MCAN0-configurable pin can be used in the BSL configuration.

Non-Default BSL INVOKE Pin

The AM13E230x Boot ROM configures pin PA6 as the input GPIO for the BSL Invocation signal. Revision E1 of the LP-AM13E230 connects pin PA3 to the BSL invoke circuit, which can be triggered from either an output IO from the XDS110 or from the BSL INV push button (S5). To workaround this issue there are two options:

1. Software: Re-configure the BL_INVOKE_PIN in the BSL to PA3
2. Hardware:
    a. **XDS110 IO:** Remove the shunt jumper on the J12 BSL INV header and connect/solder a jumper wire from J3-30 to the XDS110 side of the J12 BSL INV header

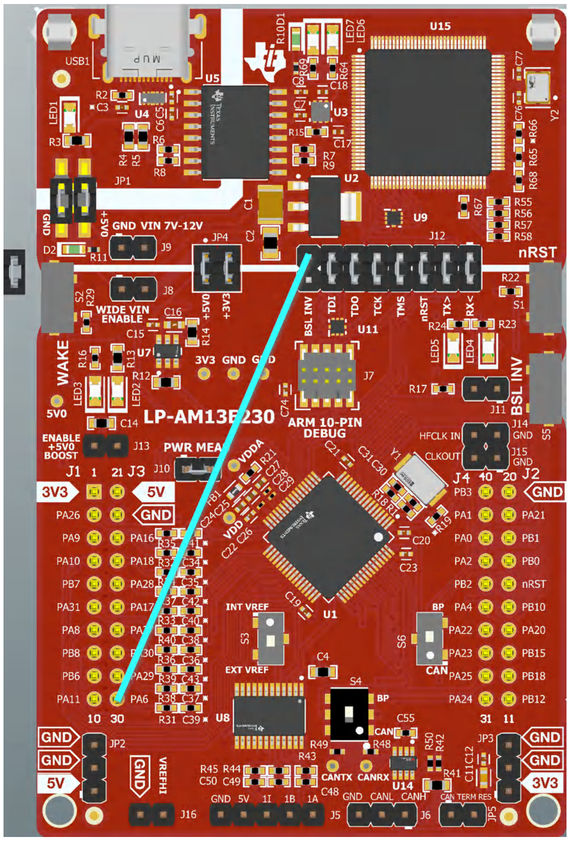


Figure 3-3. XDS110 - BSL INVOKE Fix

    b. **Pushbutton IO:** Remove the shunt jumper on the J12 BSL INV header and connect/solder a jumper wire from J11 (switch side) to J3-30

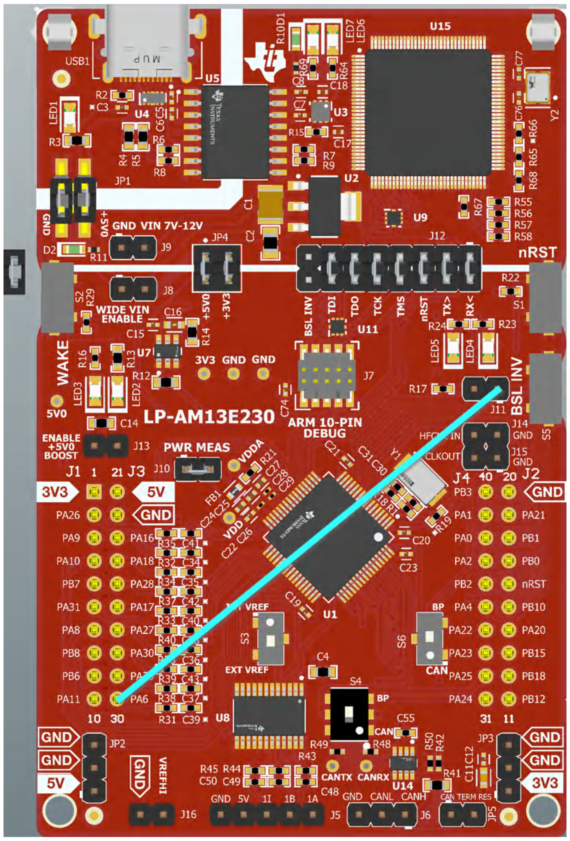


Figure 3-4. Pushbutton - BSL INV Fix

No Pull-up Resistors on Default I2C Nets

The default I2C nets configured on PB6 (J1-9) and PA11 (J1-10) do not have pull-up resistors present on this revision of the PCB. If using these pins for I2C communication, the external PCB will require pull-up resistors on these nets.

3.2 Revision E2 Appendix

3.2.1 Revision E2 Changes from E1

The following updates were made to the PCB for LP-AM13E230 Revision E2.

Schematic Symbol Updates

The XAM13E23019GTPM schematic symbol (U1) is updated to reflect changes in device pad layout/pin assignments:

Table 3-1. XAM13E23019GTPM Symbol Changes

Pin	Revision E1	Revision E2
16	VDD	VDDA
31	VSSA	VSS

- The decoupling capacitor associated with pin 16 (C21) is moved from VDD_3V3 to VDDA_3V3 net
- PCB routing updated to connect AM13E230x pin 16 to the VDDA_3V3 net

AM13E230x / BoosterPack Pin Assignments

To align with the default pin configuration defined in the AM13E230x bootloader, the following device/ BoosterPack pin assignments are changed:

Note

Signal names in **bold** are the default pins configured in the bootloader

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Table 3-2. LP-AM13E230 MCU/BoosterPack Pin Assignment Changes

Pin Name	Pin Number	E1 Signal	E1 BP/Header	E2 Signal	E2 BP/Header
PB15	4	GPIO47	J2-13	GPIO47	J2-18
PB0	8	GPIO32	J2-17	USER_LED1	
PB1	9	GPIO33	J2-18	MCPWM4_2A	J4-38
PA0	12	MCPWM4_2A	J4-38	**UC4_TX_SDA_PICO** (UART TX)	XDS110 Interface
PA1	13	MCPWM4_1B	J4-39	**UC4_RX_SCL_SCLK** (UART RX)	XDS110 Interface
PA3	17	BSL INVOKE		GPIO3	J1-5
PA4	18	MCPWM4_3B	J4-35	CMP2_DACL	J3-30
PA6	20	CMP3_DACL	J3-30	**BSL INVOKE**	
PA7	21	USER_LED1		MCPWM4_1B	J4-39
PB4	22	UC0_TX_SDA_PICO (UART TX)	XDS110 Interface	GPIO22	J1-8
PB5	23	UC0_RX_SCL_SCLK	XDS110 Interface	UC3_RX_SC_SCLK (SPI CLK)	J1-7
PB6	38	UC5_RX_SCL (I2C SCL)	J1-9	UC5_RX_SCL (LIN RX)	J4-33
PB7	39	GPIO39	J1-5	UC5_TX_SDA (LIN TX)	J4-34
PB8	40	GPIO40	J1-8	EQEP_A	J5-1
PB9	41	EQEP_I	J5-3	EQEP_B	J5-2
PA8	42	UC3_RX_SCL_SCLK (SPI CLK)	J1-7	EQEP_I	J5-3
PA11	45	UC5_TX_SDA (I2C SDA)	J1-10	**MCAN0_RX**	J4-31
PA12	46	EQEP_B	J5-2	**MCAN0_TX**	J4-32
PB11	53	EQEP_A	J5-1	GPIO43	J2-11
PB12	54	GPIO44	J2-11	GPIO44	J2-12
PB18	55	GPIO50	J2-12	GPIO50	J2-13
PA22	59	UC2_TX_SDA (LIN TX)	J4-34	**UC2_TX_SDA** (I2C SDA)	
PA23	60	UC2_RX_SCL (LIN RX)	J4-33	**UC2_RX_SCL** (I2C SDA)	J1-9
PA24	61	MCAN0_RX	J4-31	GPIO24	J2-17
PA25	62	MCAN0_TX	J4-32	MCPWM4_3B	J4-35

Pull-ups on I2C Nets

2.2kΩ resistors are added to the I2C nets configured on PA22 and PA23. The shunt jumpers on J17 (SCL) and J18 (SDA) can be removed to disconnect the pull resistors from the I2C nets in order to use these pins in a different PinMux mode.

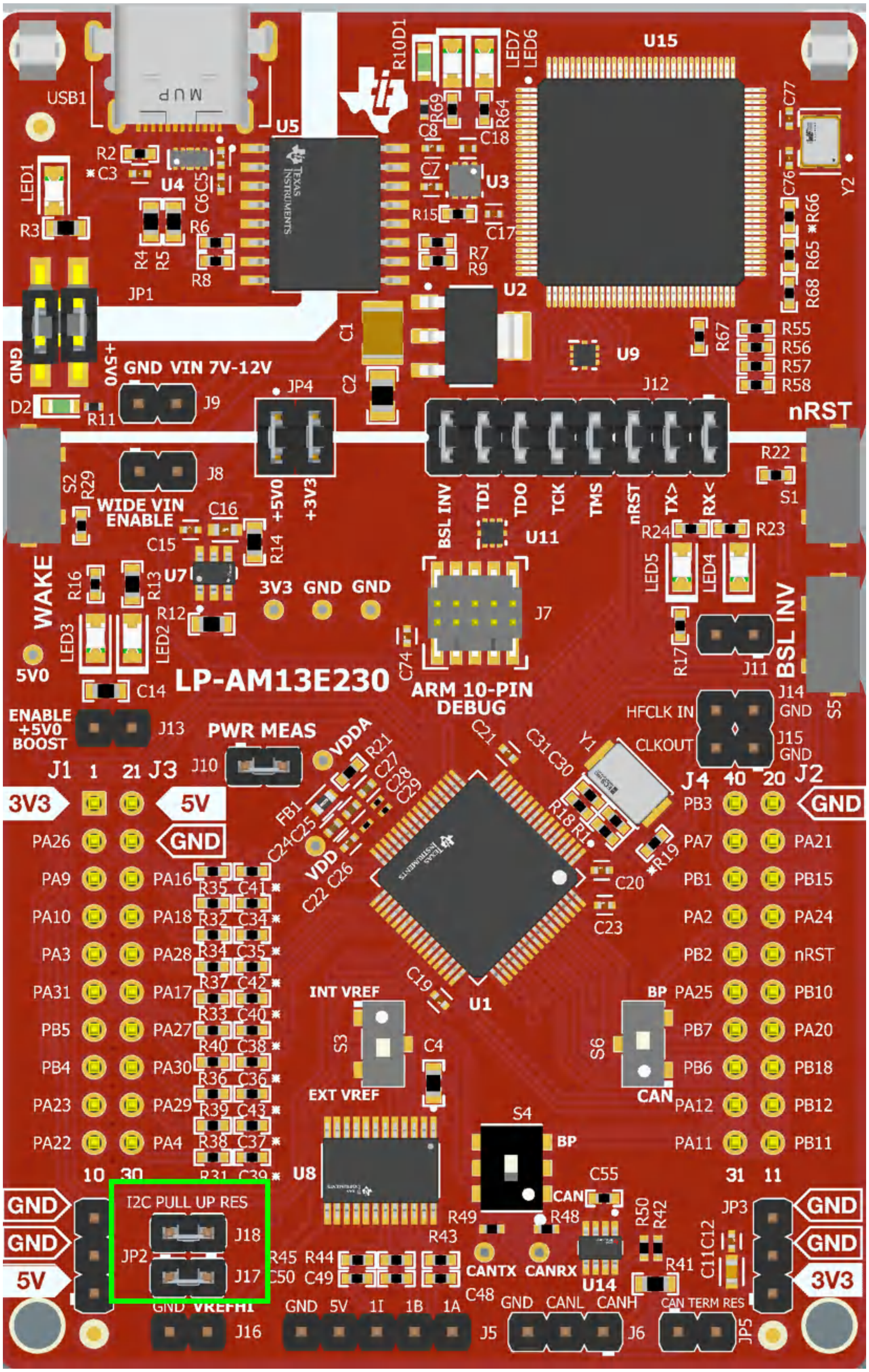

Figure 3-5. LP-AM13E230 Revision E2 - I2C Pull Up Resistors

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