C2000 F28P55x Series LaunchPad Development Kit

Texas Instruments

Description

The LAUNCHXL-F28P55X is a low-cost development board for the Texas Instruments C2000™ Real-Time Microcontroller series of F28P55x devices. The LAUNCHXL-F28P55X is designed around the TMS320F28P550SJ9 real-time MCU and highlights the control, analog, and communications peripherals, as well as the integrated nonvolatile memory. The LaunchPad™ also features two independent BoosterPack™ XL expansion connectors (80-pins), on-board Controller Area Network (CAN) transceiver supporting CAN-FD (MCAN), two 5V encoder interface (eQEP) connectors, FSI connector, three PGA interface connectors, power-domain isolation, and an on-board XDS110 debug probe.

Get Started

1. Order LAUNCHXL-F28P55X from ti.com.
2. Download the latest libraries.
3. Download the comprehensive reference design files.
4. See the latest device support files.

Features

- C2000 Series F28P550SJ9PZ (100-pin) microcontroller:
  - With Configurable Logic Block (CLB) capability

- Onboard XDS110 debug probe
- Two user-controlled LEDs
- One microcontroller reset switch
- Selectable power domains:
  - USB (isolated)
  - BoosterPack
  - External power supply
- CAN connector with on-board CAN transceiver
  - Supports CAN-FD (MCAN)
- Two independent Enhanced Quadrature Encoder Pulse (QEP)-based encoder connectors
- Three Programmable Gain Amplifier (PGA)-based connectors
- FSI peripheral connector
- Two independent BoosterPack XL standard connectors (80-pins) featuring stackable headers to maximize expansion through the BoosterPack ecosystem

Applications

- Motor drives
- Appliances
- Hybrid, electric and powertrain systems
- Solar and EV charging
- Digital power
- Body electronics and lighting
- Test and measurement
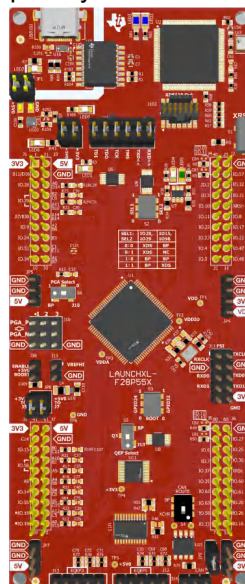
1 Evaluation Module Overview

1.1 Introduction

The F28P55x LaunchPad (LAUNCHXL-28P55X) from Texas Instruments (TI) provides a great way to learn and experiment with the F28P55x devices. The F28P55x device is a member of TI's C2000 family of microcontrollers (MCUs). This 100-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 F28P55x LaunchPad and explains the functions, locations of jumpers, and connectors present on the board.

Note

This kit is designed to explore the functionality of the F28P55x microcontroller. The LaunchPad can be treated as a good reference design and is not intended to be a complete customer design. Full compliance to safety, EMI/EMC, and other regulations are left to the designer of the customer's system.

1.2 Kit Contents

The F28P55x Series LaunchPad Development Kit contains these items:

- C2000 F28P55x Series LaunchPad development board (LAUNCHXL-F28P55X)
- USB Type-A male to USB Type-C® male cable
- Pinout map

1.3 Specifications

Table 1-1 summarizes the F28P55x LaunchPad specifications.

Table 1-1. LAUNCHXL-F28P55X Specifications

Parameter	Value
Board supply voltage	$5V_{DC}$ from one of the following sources: • USB Connector (USB101) - USB Type-C cable connected to PC or other compatible power source. • BoosterPack 1 • BoosterPack 2 • Auxiliary power connectors
Dimensions	5.5in x 2.3in x .425in (13.97cm x 5.84cm x 10.8mm) (L x W x H)
Break-out power output	• $3.3V_{DC}$ to BoosterPacks, limited by output of TPS7A3701 LDO. This 3.3V plane is shared with on-board components. Total output power limit of TPS7A3701 is 1 Amp.
Assumed operating conditions	This kit is assumed to run at standard room conditions. The EVM runs at approximately standard ambient temperature and pressure (SATP) with moderate-to-low humidity.

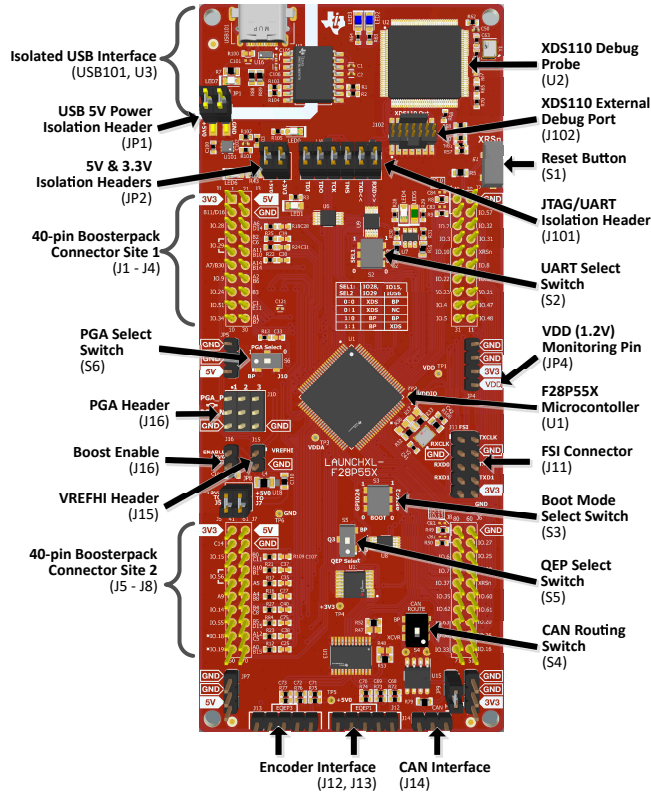Figure 1-1 highlights the key features of the F28P55x LaunchPad.

Figure 1-1. F28P55x LaunchPad Board Overview

1.4 Device Information

The TMS320F28P550SJ9PZ is a 32-bit floating-point microcontroller with 1088KB Flash memory, 133KB RAM, a programmable Control Law Accelerator (CLA) for offloading tasks, and operates at 150MHz. The TMS320F28P550SJ9PZ includes advanced control peripherals, differentiated analog, and various communications peripherals. The device has been optimized for high-performance real-time control applications. For more details, see the TMS320F28P55x Real-Time Microcontrollers data sheet.

Most of the signals of the microcontroller are routed to 0.1 inch (2.54mm) pitch headers laid out to comply with the TI BoosterPack standards, with a few exceptions. The F28P55x internal multiplexer of the MCU allows different peripheral functions to be assigned to each of the General-Purpose Input/Output (GPIO) pins. The multiplexing options can be found in the device-specific data sheet. When adding external circuitry, consider the additional load on the development board's power rails.

The F28P55x LaunchPad is factory-programmed with a quick start demo program. The quick start program resides in the on-chip flash memory and executes each time power is applied, unless the application has been replaced with a user program. For details on the demo program of the LaunchPad, see Section 3.1.2.

2 Hardware

2.1 Hardware Description

The F28P55x LaunchPad includes a F28P550SJ9PZ MCU, which is an excellent choice for advanced real-time control applications. A large number of these peripherals are made available to users via the on-board accessories and the BoosterPack connectors. This section explains how those peripherals operate and interface to the MCU.

Figure 2-1 shows a high-level block diagram of the F28P55x LaunchPad:
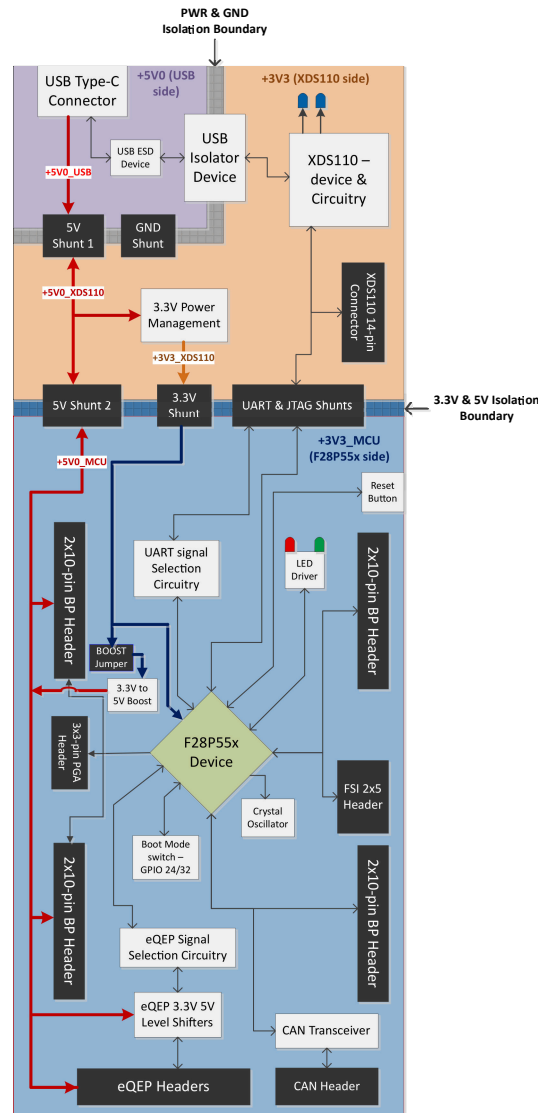

Figure 2-1. F28P55x LaunchPad Development Kit Block Diagram

2.1.1 Functional Description and Connections

2.1.1.1 Power Domains

The F28P55x LaunchPad has several power domains that can be connected or isolated from each other with removable shunts. The different 3.3V and 5V power domains are further described in Figure 2-2 and Figure 2-3.
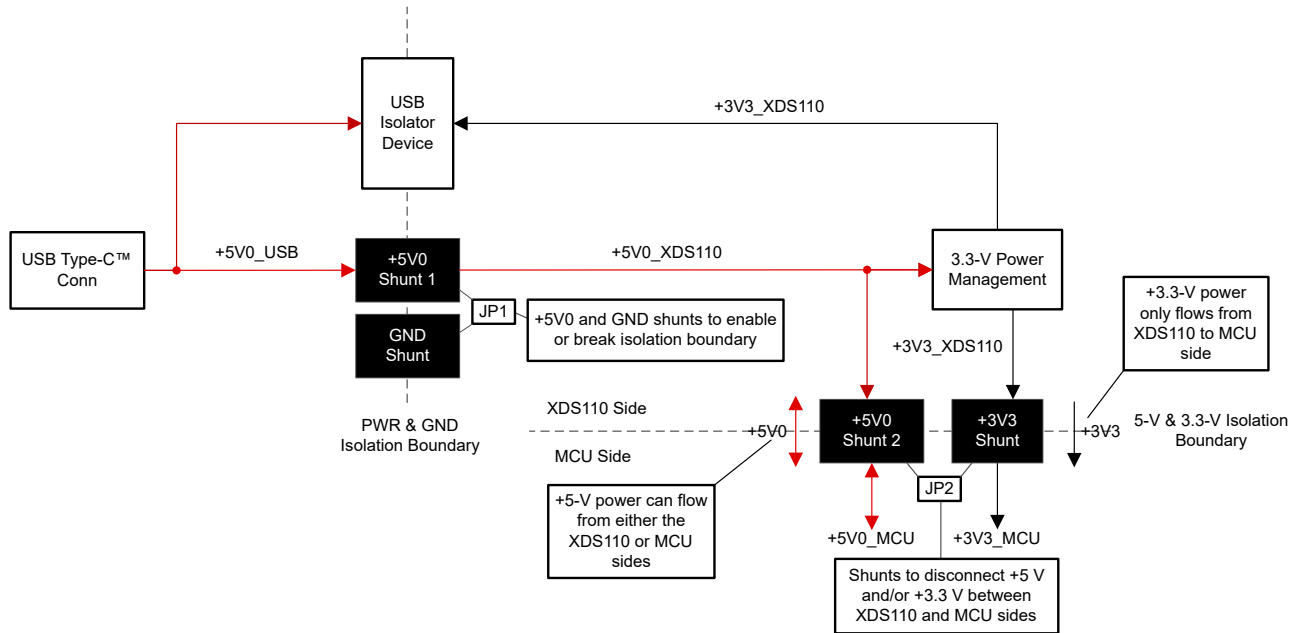
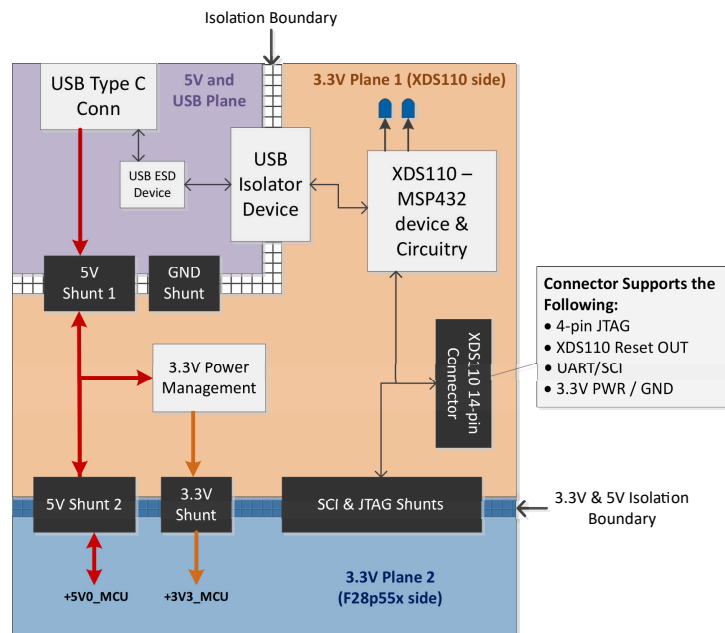**Figure 2-2. LaunchPad Power Distribution Diagram**

Figure 2-3. LaunchPad Power Plane Diagram

Table 2-1 describes the usage of the different removable shunts on the LaunchPad board.

Table 2-1. Power Domain Shunts

Shunt Identifier	Usage Description
JP1, +5V0	Connects the +5 V power from the USB-C connector (+5V0_USB) to the +5 V power on the XDS110 side of the board (+5V0_XDS110). Bridges the power and ground isolations between the two board sides.
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 power and ground isolations between the two board sides.
JP2, +5V0	Connects the +5 V power on the XDS110 side of the board (+5V0_XDS110) to the +5 V power on the F28P55X side of the board (+5V0_MCU).
JP2, +3V3	Connects the +3.3 V power on the XDS110 side of the board (+3V3_XDS110) to the +3.3 V power on the F28P55X side of the board (+3V3_MCU).

2.1.1.2 LEDs

Power indicator LEDs (red) are included on the F28P55x LaunchPad board. Table 2-2 shows descriptions of each LED.

Table 2-2. Power LED Indication Descriptions

LED NO.	Indication Description:
LED7	+5 V power from the USB Type-C connector
LED0	+3.3 V power on the XDS110 side of the PCB
LED1	+3.3 V power on the F28P55x side of the PCB
LED6	+5 V power on the F28P55x side of the PCB

Two user LEDs are provided on the board: LED4 (red) and LED5 (green). These user LEDs are connected to GPIO20 and GPIO21 of the F28P55X, respectively. The signals are connected to the SN74LVC2G07DBVR LED driver IC and are connected in an active low configuration; that is, drive the GPIO low to turn on the LED and high to turn off. These LEDs are dedicated for use by the software application.

Two blue LEDs, LED2 and LED3, are connected to the XDS110 debug probe. These indicate debugger activity and are not controllable by any application software.

2.1.1.3 Encoder Connectors

The F28P55x LaunchPad includes two headers, J12 and J13, which are used for connecting linear or rotary incremental encoders. These headers take 5V input signals that are stepped down to 3.3V and wired to the F28P550SJ9 MCU. These signals are connected to the eQEP modules on the device when switch S5 is set appropriately, see Table 2-5. Each header has the EQEPA, EQEPB, and EQEPI signals available for each eQEP module (1 and 3) as well as pins for GND and 5V.

Note

If present, the EQEP2 on the LaunchPad silk screen corresponds to the EQEP module 3.

2.1.1.4 FSI

The F28P55x MCU features the Fast Serial Interface (FSI) communications peripheral. The FSI enables robust high-speed communications and is intended to increase the amount of information transmitted while reducing the cost to communicate over an isolation barrier. The FSI signals TXCLK, TXD0, TXD1, RXCLK, RXD0, and RXD1 are available on J11. This header is set up in such a way that adding jumpers on the pins connects the TX to RX channels for external loopback and evaluation. Additionally, there are two GND signals on the connector that can be used for a wrapped-pair connection to an external board with FSI. The GPIOs connected to this header are only routed to the J11 FSI connector on this board, and not routed to the Boosterpack headers.

The LAUNCHXL-F28P55X does not include any on-board isolation devices for the FSI signals. If interested in evaluating the FSI peripheral with isolation devices, or differential drivers and receivers, then see the TMDSFSIADAPEVM plug on board.

2.1.1.5 PGA

The Programmable Gain Amplifier (PGA) is used to amplify an input voltage for the purpose of increasing the effective resolution of the downstream ADC and CMPSS modules. The integrated PGA helps to reduce cost and design effort for many control applications that traditionally require external, stand-alone amplifiers. On-chip integration verifies that the PGA is compatible with the downstream ADC and CMPSS modules. Software-selectable gain and filter settings make the PGA adaptable to various performance needs.

Three PGA signals are available at the device pins: PGA_INP (positive input), PGA_INM (negative input), and PGA_OUT (output). PGA_OUT supports op-amp output filtering with RC components. The filtered signal is available for sampling and monitoring by on-chip ADC and CMPSS modules. The F28P55x LaunchPad includes 3x3 PGA header, J10. PGA signals are connected to the PGA modules on the device when switch S6 is set appropriately, see Table 2-6. J10 header has the PGA_INP, PGA_INM, and GND signals available for each of three PGA modules.

2.1.1.6 CAN

The F28P55x LaunchPad includes a connector (J14) for a CAN network. GPIO4 and GPIO5 are routed from the F28P550SJ9 to J14 through the on-board CAN Transceiver. CAN-FD (MCAN) is used on these F28P55x device pins. Switch S4 is used to route GPIO4 and GPIO5 to either the CAN transceiver and connector or the Boosterpack headers. For more details, see Section 2.1.3.4.

2.1.1.7 CLB

The configurable logic block (CLB) is a collection of blocks that can be interconnected using software to implement custom digital logic functions or enhance existing on-chip peripherals. The CLB is able to enhance existing peripherals through a set of interconnections, which provide a high level of connectivity to existing control peripherals such as enhanced pulse width modulators (ePWM), enhanced capture modules (eCAP), and enhanced quadrature encoder pulse modules (eQEP). The crossbars also allow the CLB to be connected to other internal peripheral signals of the device or external GPIO pins. In this way, the CLB can be configured to perform small logical functions to augment device peripheral inputs and outputs. Through the CLB, functions that are otherwise accomplished using external logic devices, such as FPGAs or CPLDs, can now be implemented inside the C2000 MCU.

For more information on the CLB see the C2000 Configurable Logic Block (CLB) Training Series.

2.1.1.8 Boot Modes

The F28P550SJ9 boot ROM contains bootloading software that executes every time the device is powered on or reset. Two pins, GPIO24 and GPIO32, are wired to the boot select switch (S3). By default, both pins are set HIGH (1) so the device boots from Flash. For more information on the F28P55x boot modes, see the TMS320F28P55x Real-Time Microcontrollers data sheet.

Table 2-3. Boot Select Switch Table - S3

Boot Mode	GPIO24 (LEFT)	GPIO32 (RIGHT)
Boot from parallel GPIO	0	0
Boot from SCI / wait boot	0	1
Boot from CAN	1	0
Boot from flash (default)	1	1

2.1.1.9 BoosterPack Sites

The F28P55x LaunchPad features two fully independent BoosterPack XL connectors. Both BoosterPack sites 1 and 2 are compliant with the BoosterPack standard. To expand the functions available to the user on this LaunchPad, some signals are also routed to alternate locations on the board. These alternate routes can be selected by manipulating the onboard switches or by adding and removing 0Ω resistors. This is described in Section 2.1.3.

The GPIO pin numbers as well as the BoosterPack compliant features can be viewed in the LAUNCHXL-F28P55X Pinout Map (SPAZ056). Each GPIO has multiple functions available through the GPIO mux of the F28P55x device. Some specific functions have been listed in the pinout map; the full GPIO mux table can be found in the TMS320F28P55x Real-Time Microcontrollers data sheet.

All of the analog signals (denoted ADCIN) of the F28P55x MCU are routed to the J1/J3 and J5/J7 BoosterPack headers on the left side of the board. Close to the respective BoosterPack header each ADC input signal has component pads for a series resistor and parallel capacitor to create an RC filter. By default, a 0 ohm resistor is populated and the capacitor is left un-populated. Users can populate these components with specific values to filter out noise arriving at the ADC input of the device.

2.1.1.10 Analog Voltage Reference Header

The analog subsystem of the F28P55x allows for flexible voltage reference sources. The ADC modules are referenced to the VREFHIx and VREFLOx pin voltages. VREFHIx can either be driven externally or can be generated by an internal band-gap voltage reference. An external voltage can be supplied to header J15 as an external voltage source for VREFHIx. Note that there is no signal conditioning circuitry in place for the voltage reference. For best performance, some additional circuitry can be required.

Note

The two VREFHI pins on F28P550SJ9PZ MCU are shorted together, which is also the case for VREFLO pins.

2.1.1.11 Other Headers and Jumpers

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.

2.1.1.11.1 USB Isolation Block

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 in 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 F28P55x 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 F28P55x MCU regions. If power isolation is desired, then 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 (TPS7A3701), which provides 3.3V to the XDS110 and F28P55x MCU regions of the board.
- An external 3.3V supply to power the XDS110 and F28P55x MCU regions of the board.

Some applications do not require 5V to be supplied to the MCU region. In an isolated power application with JP1 shunts removed, supplying 5V to the XDS110 and F28P55x MCU regions is optional.

2.1.1.11.2 BoosterPack Site 2 Power Isolation

JP8 is included to isolate 3.3V and 5V from the BoosterPack site 2 headers. This can be required if two BoosterPacks are simultaneously connected to the LaunchPad and both provide power to the LaunchPad. If this is the case, then power can be isolated by removing the shunts on JP8 and there is no contention between the two BoosterPacks.

2.1.1.11.3 Alternate Power

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.

- JP4 and JP6 are provided as extra connection points for a 3.3V supply to be connected to the LaunchPad.

- JP5 and JP7 are provided as extra connection points for a 5V supply to be connected to the LaunchPad.

> **CAUTION**
> The F28P55x LaunchPad features a VDD pin located on header JP4 that can only be used to monitor the voltage of the 1.2V VDD rail of the TMS320F28P550SJ9PZ device. This pin can not be used to supply power to an external device nor connected to an external supply.

2.1.2 Debug Interface

2.1.2.1 XDS110 Debug Probe

The F28P55x LaunchPad includes an on-board XDS110 Debug Probe. The XDS110 allows for the programming and debugging of the F28P55X using Code Composer Studio™ (CCS), or any other supported tool chains. In the default configuration, the XDS110 is only wired to support 2-pin cJTAG mode. This uses only the TMS and TCK JTAG pins and allows the TDI and TDO pins of the F28P55x device to be reallocated for other application needs. TDI and TDO are available on GPIO35 and GPIO37. These pins are not routed to the debug probe by default, but can be connected by populating resistors R44 and R45.

2.1.2.2 XDS110 Output

The connector J102 is provided to debug an external target with the on-board XDS110 debug probe. This connector allows the LaunchPad to be used as a stand-alone XDS110 debug probe. For mating connector and cable, see Samtec FFSD or equivalent.

If the LaunchPad is being used in this manner, then make sure that all of the jumpers are removed from J101. This isolates the JTAG signals from going to the F28P550SJ9 MCU. UART TX and RX signals from the XDS110 device are also included on this connector.

2.1.2.3 Virtual COM Port

When plugged into a USB host, the XDS110 enumerates as both a debugger and a virtual COM port. J101 allows the user to connect the SCI UART from the F28P550SJ9 to the debug probe to be passed on to the USB host. By default the F28P55x SCIA maps to the virtual COM port of the XDS110 using GPIO28 and GPIO29. Alternately, GPIO15 and GPIO56 can be used for SCIB. This is accomplished by manipulating the on-board switch S2. For the appropriate switch settings, see Section 2.1.3.2.

2.1.3 Alternate Routing

2.1.3.1 Overview

The F28P550SJ9 MCU is a very versatile device in a mid-size package. To balance compatibility with BoosterPack standards, as well as showcasing the versatility of the F28P550SJ9, some complexity was added to the design. Most features aligning with the BoosterPack standard are available by default. The additional functions are configured using switches or static resistors, which can be added or removed. This section covers the alternate functions and how to enable switches or static resistors. Note that by enabling certain alternate features, standard BoosterPack functionality can be lost. The switches and resistors are configured such that connecting multiple functions to the same header is not possible.

2.1.3.2 UART Routing

This LaunchPad allows for one of two sets of pins to be used for the SCIA UART routed to the virtual COM port of the XDS110. By default, GPIO28 (SCIA_RX) and GPIO29 (SCIA_TX) are routed to the virtual COM port and not available on the BoosterPack connector. Alternately, GPIO15 (SCIB_RX) and GPIO56 (SCIB_TX) can be routed to the virtual COM port. When UART functionality is not needed at the virtual COM port, the GPIOs can be routed to the BoosterPack connectors for BoosterPack standard functions.

The routing destination of these signal pairs are selected using the on-board switch S2, as described below in Table 2-4.

Table 2-4. SCI UART Select - S2

SEL1 (Left)	SEL2 (Right)	GPIO28/29	GPIO15/56
0	0	XDS110 COM Port	BP Headers
0	1	XDS110 COM Port	No Connect
1	0	BP Headers	BP Headers
1	1	BP Headers	XDS110 COM Port

2.1.3.3 EQEP Routing

The LaunchPad has the ability to connect to two independent linear or rotary encoders through the F28P55x on-chip eQEP interfaces; header J12 is connected to eQEP1 and header J13 is connected to eQEP3. By default, this connection is not active and the GPIOs are routed to the BoosterPack connectors. The 5V eQEP input signals from the J12 and J13 connectors are stepped down through a TI SN74LVC8T245 level translator (U13) to 3.3V. The eQEP1 signals are connected to J12 header by default. The eQEP3 signals are routed through TI SN74LV4053A triple 2-channel analog multiplexer/demultiplexer IC (U11). Switch S5 controls the select inputs of the IC to configure the eQEP3 signal destinations to be either the J13 connectors or BoosterPack headers, as described below in Table 2-5.

Table 2-5. QEP Select - S5

QEP3 SEL	QEP1 Signals (GPIO40/41/59)	QEP3 Signals (GPIO25/26/30)
0 (down)	J12	J13
1 (up)	J12	BP Headers

2.1.3.4 CAN Routing

The LaunchPad can be connected to a CAN bus through J14. GPIO4 and GPIO5 are routed to the on-board TI TCAN332GDR 3.3V CAN Transceiver, U15. By setting S4 to DOWN (on), GPIO4 and GPIO5 are routed to the transceiver. If S4 is set to UP (off), the GPIOs are routed to the BoosterPack connectors (default case).

2.1.3.5 PGA Routing

The PGAs on the LaunchPad are connected to J10 header. Some of the PGA signals (PGA1/2/3_INP and PGA3_INM) can be accessed through the BoosterPack header as well when the switch is pulled to 1. All PGAs are initially connected to J10 header by default when the switch is pulled to 0 as described below in Table 2-6.

Table 2-6. PGA Select - S6

PGA SEL	0 (right)	1 (left)
PGA1_INP	J10	BP Headers
PGA1_INM	J10	GND
PGA2_INP	J10	BP Headers
PGA2_INM	J10	GND
PGA3_INP	J10	BP Headers
PGA3_INM	J10	BP Headers

2.1.3.6 FSI Routing

One set of GPIOs with available FSI functionality are directly connected to the FSI header, J11. The traces from the device to the FSI header are made short to verify higher signal integrity, as FSI signals can switch at frequencies up to 150MHz on F28P55x devices.

2.1.3.7 X1/X2 Routing

The F28P550SJ9 crystal oscillator output signal, X2, is multiplexed with GPIO18 and the crystal oscillator input, X1, is multiplexed with GPIO19. By default, the Launchpad uses an on-board crystal oscillator, Y2, as the clock source for the on-chip Phase-Locked Loop (PLL) that requires both X1 and X2 signals of the MCU. To balance the requirement of having cleanly routed oscillator signals and bringing all possible GPIOs to the BoosterPack connectors, both GPIO18/X2 and GPIO19/X1 can be routed to the BoosterPack connectors through 0Ω resistors. If GPIO18 or GPIO19 are needed at the BoosterPack connectors, then the on-chip zero-pin oscillators must be used as the clock source for the on-chip PLL. For more information on the X1/X2 configurations, see the TMS320F28P55x Real-Time Microcontrollers data sheet.

If GPIO18 functionality is needed at the BoosterPack connector, then

1. Remove R32 to separate GPIO18 from Y2.
2. Populate R36 to connect GPIO18 to the BoosterPack connector

If GPIO19 functionality is needed at the BoosterPack Connector, then

1. Remove R33 to separate GPIO19 from Y2.
2. Populate R37 to connect GPIO19 to the BoosterPack connector.

2.1.3.8 PWM DAC

The LaunchPad provides up to four PWM DAC signals at the BoosterPack headers using GPIO0 (BP pin 40) and GPIO1 (BP pin 39) on site 1 and GPIO12 (BP pin 80) and GPIO13 (BP pin 79) on site 2. The intended purpose of the PWM DAC signals are to utilize PWMs of the F28P55x device as digital-to-analog converters (DAC). This method involves low-pass filtering the PWM signal to remove the high-frequency components and preferably leaves only the DC component. For more information, see the *Using PWM Output as a Digital-to-Analog Converter on a TMS320F280x Digital Signal Control*.

By default, the RC filter is not populated. A 0 ohm resistor is populated and the capacitor is left unpopulated.

2.2 Using the F28P55x LaunchPad

The recommended steps for using the F28P55x LaunchPad are:

1. *Follow the instructions in Section 3.1.2 to begin running the LaunchPad demo program:* Within just a few minutes, users can control and monitor the F28P55x LaunchPad with the pre-programmed quick start application. Additionally, Section 5.1 is helpful if there are any issues that can quickly be addressed.
2. *Experiment with BoosterPacks:* This development kit conforms to the latest revision of the BoosterPack pinout standard. The kit has two independent BoosterPack sites to enable a variety of expansion opportunities, such as two Boosterpacks being used simultaneously. For more information about the TI LaunchPad and BoosterPack standard, see the TI LaunchPad web page at LaunchPad.
3. *Take the first step towards developing your own control applications:* The F28P55x LaunchPad is supported by the C2000Ware development package. After C2000Ware is installed, look for \F28P55x\examples\launchxl_F28P55X in the installation directory to find the pre-configured example applications for this board. Any of the other examples found within the \F28P55x\examples directory can be used with minor modifications to run on the LaunchPad as well. For more details about software development, see Section 3.1.
   a. Refer to a technical article featuring C2000 Real-Time Microcontrollers about how developers can take advantage of the scalability and sustainability benefits these devices bring.
4. *Customize and integrate the hardware to align to your end application:* This development kit can be used as a reference for building your own custom boards and circuits based on C2000 F28P55x series microcontrollers. The LaunchPad also functions as a foundation for expansion with custom BoosterPacks and other circuits. This document can serve as a starting point for such projects.

5. *Get trained:* Review and download hours of written and video training materials on C2000 Real-time Microcontrollers and related LaunchPads.
   a. See Getting Started With C2000 Real-Time Control Microcontrollers (MCUs).
   b. See the TI Training and Videos page.
   c. See the *C2000 Academy* page.

2.3 BoosterPacks

The LAUNCHXL-F28P55X provides a simple and inexpensive way to develop applications with the F28P55x series microcontroller. BoosterPacks are pluggable add-on boards for the LaunchPad ecosystem 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 explore with the F28P55x LaunchPad.

Some examples of BoosterPacks that are compatible with the F28P55x LaunchPad are listed in Table 2-7. Please note that this is not an exhaustive list of hardware supported BoosterPacks.

Table 2-7. Featured BoosterPacks for the F28P55x LaunchPad

BoosterPack/Board	Application and Usage
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-DRV8323RS BOOSTXL-DRV8323RH	DRV8323RS/H three-phase, 15A smart gate driver with buck, shunt amps (SPI or hardware interface) evaluation module.
TMDSFSIADAPEVM	FSI adapter board assists in understanding the functionality of the FSI communications peripheral of the C2000. Enables evaluation of the peripheral for decentralized and point-to-point real-time control system use cases, such as those in industrial drives, servo, sensing networks, and solar system and industrial power.
DRV8353RS-EVM	15A, 3-phase brushless DC drive stage based on the DRV8353RS gate driver and CSD19532Q5B NexFET™ MOSFETs.
DRV8316REVM	DRV8316REVM provides three half-H-bridge integrated MOSFET drivers for driving a three-phase brushless DC (BLDC) motor with 8A Peak current drive, for 12V/24V DC rails or battery powered applications.
BOOSTXL-BUCKCONV	Digital Power Buck Converter BoosterPack for learning the basics of digital power control with C2000 microcontrollers. The buck converter power stage supports dynamic loads and converts an external 9-VDC power supply to a configurable DC output voltage.
BOOSTXL-POSMGR	Position Manager BoosterPack is a flexible low voltage platform intended for evaluating interfaces to absolute encoders and analog sensors like resolvers and SinCos transducers.
BOOSTXL-SHARP128	Sharp® 128x128 Memory LCD and microSD Card BoosterPack, controlled using SPI. Display sensor readings, time, graphics, or other information using the LCD screen.

Note

Software support for the BoosterPacks and boards listed vary.

Users can also design BoosterPacks for the F28P55x LaunchPad. Make sure that compatibility requirements are met by referencing the signal pin mapping in the LAUNCHXL-F28P55X Pinout Map or LAUNCHXL-F28P55X Schematic.

2.4 Hardware Revisions

This section contains an abbreviated revision history of the LAUNCHXL-F28P55X as well as known issues with each revision.

2.4.1 Revision A

The first production revision of the LAUNCHXL-F28P55X was released in February 2023. This revision can be identified by the *MCU133A* silkscreen labeling on the back side of the EVM between the BoosterPack Connector site 1 towards the top of the board.

Issues and concerns that have been identified on the EVM are listed below:

Known issues:

• No issues to report at this time of initial release.

Special notes and considerations to be aware of:

• Some of the F28P55X LaunchPads come with indicated "EQEP2" label on the silkscreen instead of "EQEP3" one. Beware that EQEP2 on the silkscreen corresponds to the EQEP3 module.

3 Software

3.1 Software Development

This section provides general information about software development, as well as instructions for programming the LaunchPad. Software tools and packages for C2000 real-time controllers, like the F28P55x, are listed in the C2000 Evaluation & Development page.

3.1.1 Software Tools and Packages

Code Composer Studio (CCS) is a free integrated development environment (IDE) that supports TI's Microcontroller and Embedded Processors portfolio. Code Composer Studio (CCS) provides a feature rich environment for developing, programming, and debugging code on the C2000 family of MCUs.

C2000WARE is a repository of device-specific drivers, bit-field support files, libraries, peripheral examples, utilities, hardware files, and documentation for C2000 MCUs. C2000WARE provides a solid foundation to begin development and evaluation of the F28P55x device on the LAUNCHXL-F28P55X and minimize software development time.

Software Development Kits (SDKs) are provided to make evaluating C2000 MCUs easier within specific system use cases and reduce overall development time. The Motor Control SDK (C2000WARE-MOTORCONTROL-SDK) is targeted for various motor control applications, such as industrial drives. The Digital Power SDK (C2000WARE-DIGITALPOWER-SDK) is targeted for digital power system development for various AC-DC, DC-DC and DC-AC power supply applications.

3.1.2 F28P55x LaunchPad Demo Program

The LAUNCHXL-F28P55X includes a TMSF28P550SJ9PZ device pre-programmed with a demo program. When the LaunchPad is powered on the demo program begins with an LED blink sequence on LED4 and LED5. After a few seconds the device switches into an ADC sampling mode.

Every 1 second the ADC samples pin ADCINA6 and the sampled value is represented as follows: If the sample is above mid-scale (2048), then the red LED4 illuminates. If the sample is below mid-scale, then the green LED5 illuminates.

In addition to the LED indicators, ADC sample results are also displayed on your PC through the USB/UART connection. To view the UART information on your PC, first determine the COM port associated with the LaunchPad. To do this in Windows open the *Device Manager*. Look for an entry under Ports (COM and LPT) titled *XDS110 Class Application/User UART (COMX)*, where *X* is a number. Remember this number for opening a serial terminal.
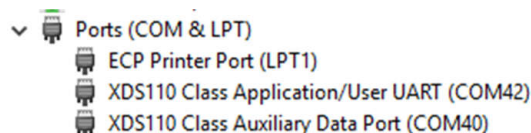

Figure 3-1. LaunchPad XDS110 COM Port

The demo application's UART data was tested using PuTTY, which is a free and open-source terminal emulator. To view the UART data in a serial terminal program open the COM port found using the Windows *Device Manager* with the following settings.

```
115200 Baud, 8 data bits, no parity, 1 stop bit.
```

After properly opening the serial port in your serial terminal, reset the LaunchPad by pressing the S1 reset button and observe the serial terminal to see the TI logo in ASCII art.

Figure 3-2. LaunchPad Demo Serial Terminal - TI Logo

After a few moments, the ADC value sampled on the ADCINA6 pin appears in the bottom right corner of the terminal and be updated each second. Using a jumper wire connect the ADCINA6 header to a 3.3V, GND, or other 0-3.3V signal to see the on-screen value change.

Figure 3-3. LaunchPad Demo Serial Terminal - ADC Sampling

3.1.3 Programming and Running Other Software on the F28P55x LaunchPad

The software packages described in Section 3.1.1 include example projects that can be loaded and run on the F28P55x LaunchPad. If you installed the C2000WARE software to the default installation path of *C:\ti\c2000\C2000Ware_<version>*, you can find driverLib based example applications in *C:\ti\c2000\C2000Ware_<version>\examples\F28P55x*. The on-board XDS110 is used with the On-Chip Flash Programmer tool to program applications to the F28P55x LaunchPad.

Follow these steps to program example applications onto the F28P55x LaunchPad development kit using the on-board XDS110 debug probe:

1. Install Code Composer Studio (CCS) 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 USB Type-C plug to the port (USB101) on the F28P55x LaunchPad.
3. Verify the following LEDs are illuminated:
    a. LED7, at the top left of the board, indicating 5V USB power.
    b. LED0 indicating 3.3V power to the XDS110 debug probe.
    c. LED1 indicating 3.3V power to the F28P55X MCU.
4. Install Windows XDS110 and Virtual COM Port drivers if prompted. Installation instructions can be found at XDS110 Product Page.
5. Run CCS on the PC.
6. Import a F28P55x project from C2000WARE, or another installed software package, into the CCS workspace.
7. Add the *_LAUNCHXL_F28P55X* predefined symbol to the imported DriverLib example project for the software to use relevant F28P55x LaunchPad signals.
    a. Open the projects Properties → Expand the *Build* tab → Expand the *C2000 Compiler* tab → Select *Predefined Symbol* → Add *_LAUNCHXL_F28P55X* predefined NAME.
8. Right click the project name and select *Rebuild Project* in CCS.
9. Launch the LAUNCHXL-F28P55X Target Configuration file and connect to the F28P55x device. Make sure that the Target Configuration file is configured to use the 2-pin cJTAG advanced configuration. For additional details, see Section 5.1.
10. Click *Load Program* and select the binary of the program to load. The binary is loaded onto the device and can now be run and debugged.

4 Hardware Design Files

The entire LAUNCHXL-F28P55X design files are available for download at this link: LAUNCHXL-F28P55X design files.

4.1 Schematic

The schematic for the LaunchPad can be found at this link: LAUNCHXL-F28P55X Schematic.

4.2 PCB Layout

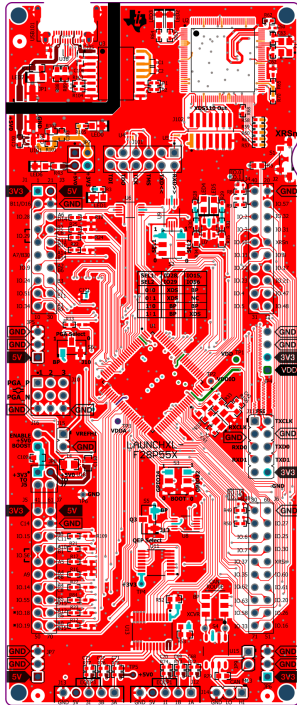The layout source files for the LAUNCHXL-F28P55X are included in the LAUNCHXL-F28P55X design files download.
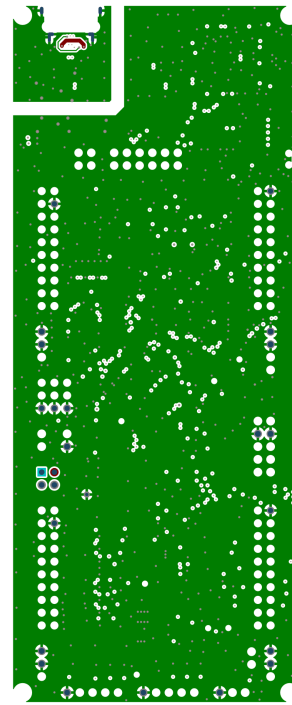

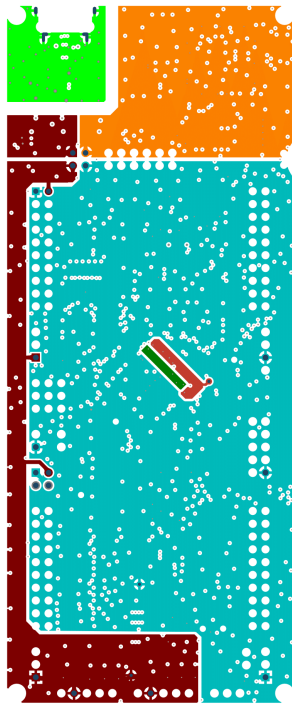**Figure 4-1. Top Signal - Layer 1**

Figure 4-2. GND - Layer 2

Figure 4-3. PWR - Layer 3
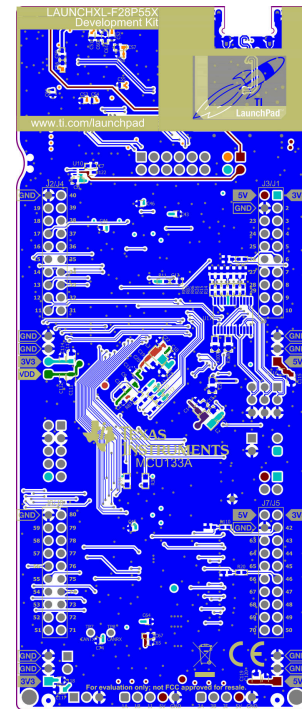
Figure 4-4. Bottom Signal - Layer 4

4.2.1 LAUNCHXL-F28P55X Board Dimensions

Figure 4-5 is a dimensional drawing of the F28P55x LaunchPad that shows the location of selected features of the board as well as the component locations.
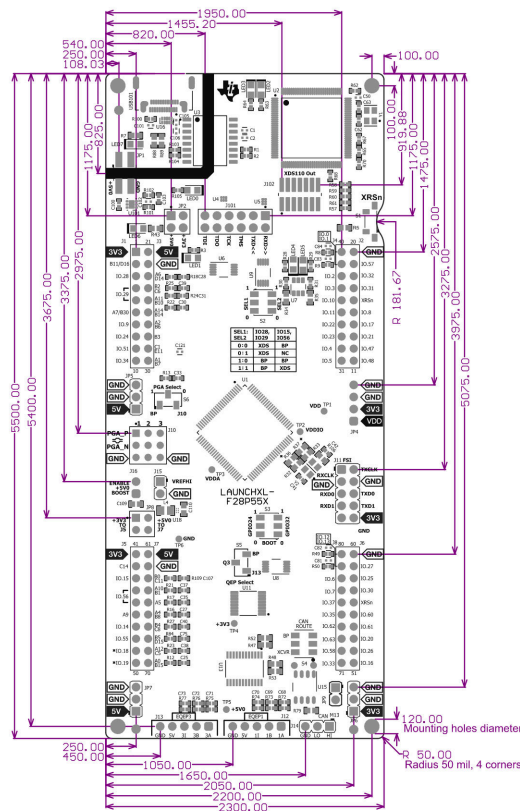
Figure 4-5. F28P55x LaunchPad Dimensions and Component Locations

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4.3 Bill of Materials (BOM)

The bill of materials for the LAUNCHXL-F28P55X is included in the LAUNCHXL-F28P55X design files download.

5 Additional Information

5.1 Frequently Asked Questions

1. Can other programming and debug tools (such as an XDS200 debug probe) be used with the F28P55x LaunchPad?
   a. The F28P55x LaunchPad utilizes an on-board XDS110 debug probe in a 2-pin cJTAG configuration. cJTAG only uses the TMS and TCK pins of the debug probe. TDI and TDO are present on J101 and can be connected to a debug probe through jumper wires, if necessary.
2. What versions of Code Composer Studio can be used to develop software for the F28P55x LaunchPad?
   a. The on-board XDS110 debug probe is compatible with Code Composer Studio development environment version 6.1.0 and later.
3. Can users not connect to the LaunchPad in Code Composer Studio?
   a. Are shunts present on J101 for TCK and TMS?
   b. Is the XDS110 and the F28P55X MCU powered? Are LED0 and LED1 illuminated? For further details on powering the LaunchPad, see Section 2.1.1.1.
      i. If JP1 shunts are disconnected, then the power provided through the USB is isolated from the rest of the board. Make sure that 3.3V is supplied to any of the available connectors on the target side of the isolation.
   c. Is the USB-C cable connected to the PCB and is the USB region receiving power? Is LED7 illuminated?
      i. The USB region must be powered with the 5V from the USB cable. LED7 illuminates when 5V USB power is connected. The USB isolation chip requires 5V on the USB side to operate and pass the signals across the isolation barrier.
   d. Make sure that the target configuration is set up to use cJTAG in 2-pin advanced mode. Open the *Target Configuration* file (.ccxml) in Code Composer Studio. Click on the *Advanced* tab and select cJTAG (1149.7) 2-pin advanced modes from the drop-down labeled JTAG/SWD/cJTAG Mode. Leave the Target Scan Format as OSCAN2 format. Alternately, a working Target configuration file is included in the launcxl_ex1_F28P55X_demo project *TMS320F28P55X_LaunchPad.ccxml*. Users can use this without modifications.
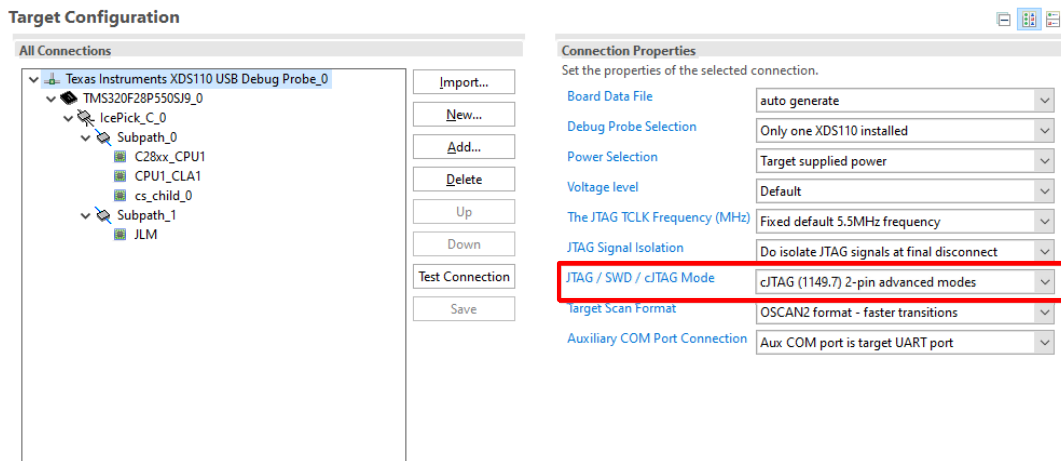

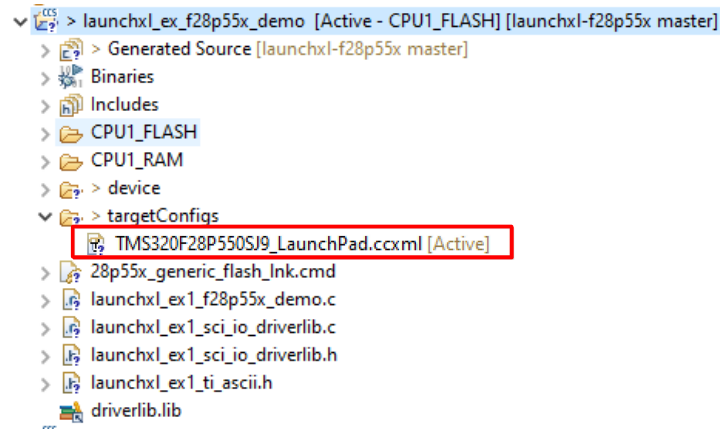**Figure 5-1. Target Configuration Advanced Options**

Figure 5-2. Target Configuration Included in the Demo Project

4. Why is the serial connection not working?

    a. Are shunts present on J101 for TXD and RXD?

    b. Are you using the correct COM port?

        i. Right-click on *My Computer* and select *Properties*. Navigate to the *Hardware* tab in the dialog box and open the device manager. Scroll to *Ports* (COM & LPT) and expand this entry. Is XDS110 Class Application/User UART listed? If so, then read the COM number to the right of the entry; this is the COM number to be used.

    c. Is the user using the correct baud rate? Most, if not all, of the examples are configured for a baud rate of 115200 when the CPU is running at 150MHz. If the PLL settings have been changed or the user developed a code, then users have to recalculate the baud rate for the specific application. For information on how to do this, see the TMS320F28P55x C2000 Real-Time Microcontrollers technical reference manual.

    d. Does the UART channel wired to the debug probe match the UART channel configured in software?

        i. The F28P55x LaunchPad provides an option for one of two possible UART channels to be routed to the debug probe through J101. Make sure that S2 is configured to the appropriate UART channel for the application software. For details, see Section 2.1.3.2.

5.2 Trademarks

C2000™, LaunchPad™, BoosterPack™, Code Composer Studio™, NexFET™, and SimpleLink™ are trademarks of Texas Instruments.

USB Type-C® is a registered trademark of USB Implementers Forum.

Sharp® is a registered trademark of Sharp Microelectronics.

All trademarks are the property of their respective owners.

6 References

6.1 Reference Documents

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

*   *TMS320F28P55x C2000 Real-Time Microcontrollers*
*   Texas Instruments: *TMS320F28P55x C2000 Real-Time Microcontrollers* data sheet
*   Texas Instruments: *TMS320F28P55x C2000 Real-Time Microcontrollers* Technical Reference Manual
*   Texas Instruments: *Getting Started With C2000 Real-Time Control Microcontrollers (MCUs)*
*   Texas Instruments: *The Essential Guide for Developing with C2000 Real-Time Microcontrollers*
*   Texas Instruments: *TMS320F28P55x C2000 Real-Time Microcontrollers Silicon Errata*
*   Texas Instruments: *LAUNCHXL-F28P55X LaunchPad Pinout Map*
*   C2000Ware for C2000 MCUs
*   Application Specific Designs & Evaluation with C2000 Real-Time Microcontrollers
*   C2000WARE Quick Start Guide
*   Texas Instruments Code Composer Studio
*   Texas Instruments LaunchPad Development Environment

6.2 Other TI Components Used in This Design

This LaunchPad uses various other TI components for functions. A consolidated list of these components with links to the TI product pages is shown below.

- MSP432E401Y SimpleLink™ 32-bit Arm Cortex-M4F MCU
- TCAN332 3.3V CAN Transceiver
- SN74LV4053A Triple 2-Channel Analog Multiplexer/Demultiplexer IC
- SN74LVC2G07 Dual Buffer/Driver With Open-Drain Output
- TPD4E004 4-Channel ESD Protection Array for High-Speed Data Interfaces
- *TPD4E05U06* 4-Channel ESD Protection Array for USB, HDMI & High Speed Interfaces
- TPS3702 High-Accuracy, Fixed-Threshold OV/UV Monitor
- TPS7A37 1A, High-Accuracy, Ultra-Low-Dropout Voltage Regulator with Reverse Current Protection and Enable
- SN74LVC8T245 8-Bit Dual-Supply Bus Transceiver with Configurable Voltage-Level Shifting and Three-State Outputs

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