EVM User's Guide: XDS110ISO-EVM
# XDS110 Isolated Plug-in Board

Description

The XDS110 isolated plug-in board is a real-time debug and flash programming design for C2000™ and Sitara™ controlSOMs. The board can connect to C2000 and Sitara controlSOMs through a non-isolated 120-pin connector or through an electrically isolated 16-pin connector. Both connectors feature JTAG, cJTAG, SWD support, and a full duplex UART port. The board supports two additional features for use in target board debug: a serial peripheral interface (SPI) to four isolated digital-to-analog converter (DAC) channels, and up to six digital and four analog non-isolated channels. The embedded emulation logic allows for emulation and debugging using standard development tools such as Code Composer Studio™.

Get Started

1. Order the XDS110ISO-EVM from ti.com.
2. Download the comprehensive reference design files.

Features

- 1x USB 2.0 Type-C interface
- XDS110 onboard emulator
- 16-pin isolated emulator connector
- 5-pin DAC header
- 12-pin debug header
- 120-pin high density connector
- Adapter boards : 10-pin, 14-pin, and 20-pin
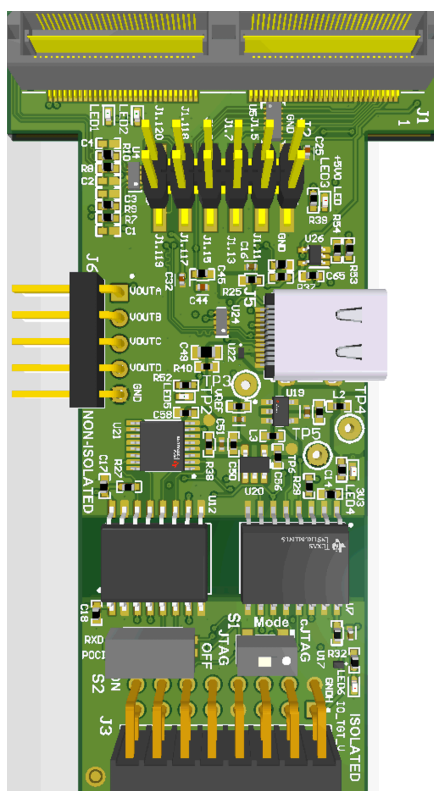
1 Evaluation Module Overview

1.1 Introduction

The XDS110 board supports isolated and non-isolated debugging of C2000 and Sitara controlSOMs. The embedded emulation logic allows for emulation and debugging using standard development tools such as Code Composer Studio from TI.

1.2 Kit Contents

The XDS110ISO-EVM Kit contains these items:

• XDS110 plug-in board
• USB Type-A to USB Type-C® cable
• TI 14-pin adapter
• Compact TI 20-pin adapter
• ARM 10-pin adapter
• Quick start guide

1.3 Specification
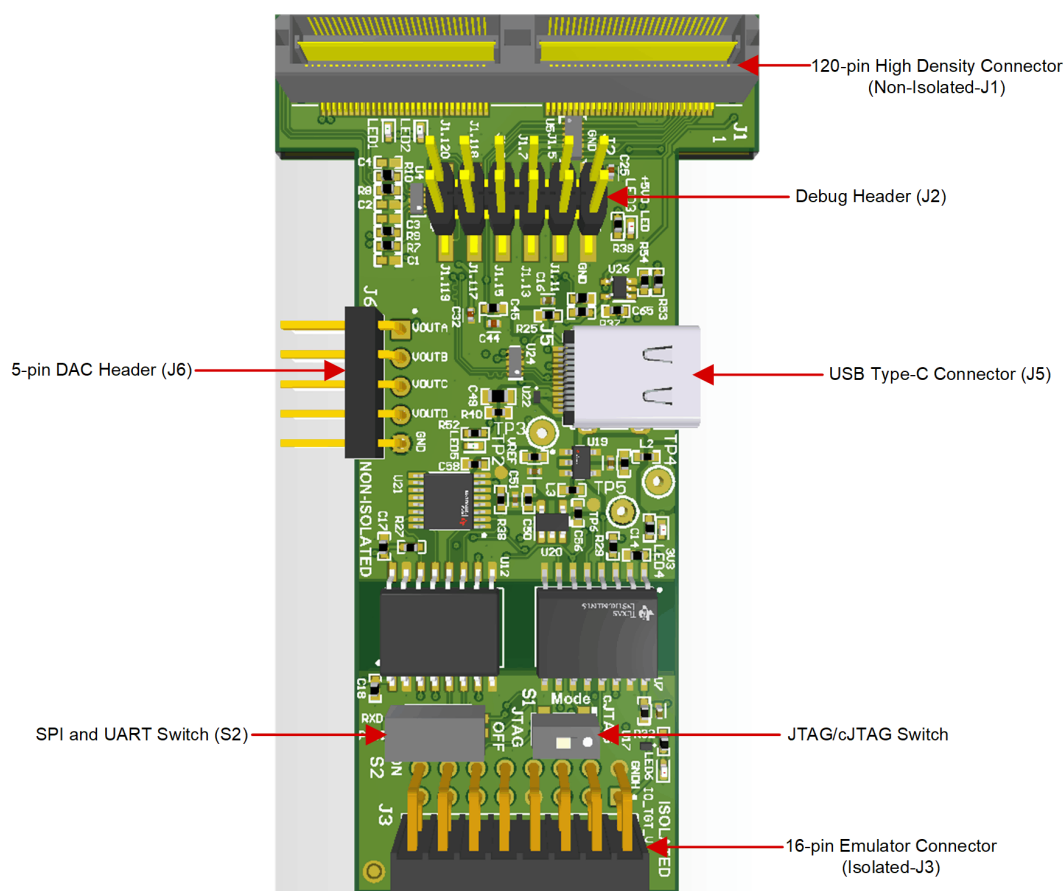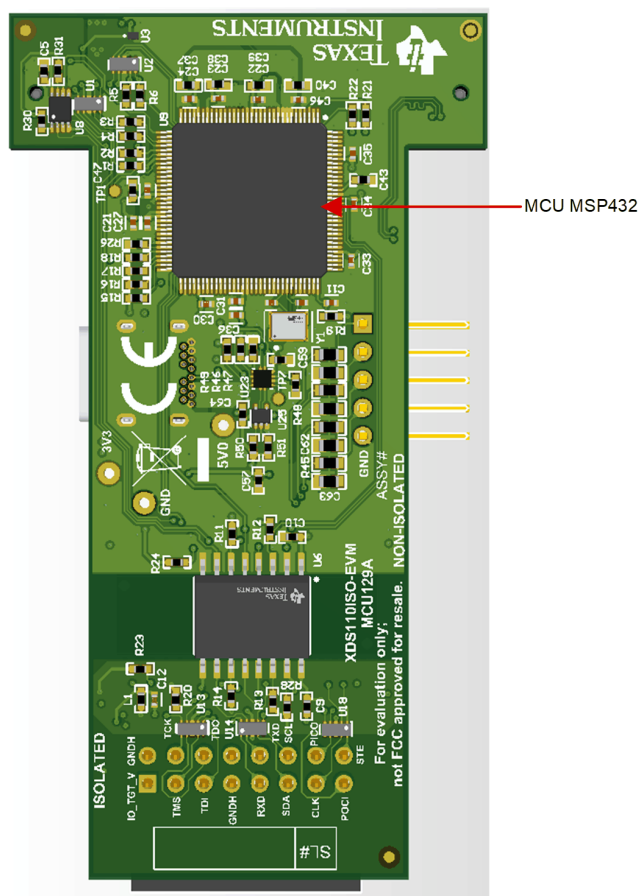

Figure 1-1. PCBA (Top Side)

Figure 1-2. PCBA (Bottom Side)

1.4 Device Information

The SimpleLink™ MSP432E401Y Arm® Cortex®-M4F microcontrollers provide top performance and advanced integration. The product family is positioned for cost-effective applications requiring significant control processing and connectivity capabilities.

The MSP432E401Y microcontrollers integrate a large variety of rich communication features to enable a new class of highly connected designs with the ability to allow critical real-time control between performance and power. The microcontrollers feature integrated communication peripherals along with other high-performance analog and digital functions to offer a strong foundation for many different target uses, spanning from human-machine interface (HMI) to networked system management controllers. More information about the device can be found in MSP432E401Y SimpleLink™ Ethernet Microcontroller data sheet.

2 Hardware

2.1 Key Features

The XDS110 board provides a hardware platform to give power and JTAG debug capability to C2000 and Sitara controlSOMs.

The following sections discuss the XDS110 Board's key features.

2.1.1 Microcontroller

• MSP432E401YTPDT, 16mm x 16mm x 1.2mm, 128-pin TQFP.

2.1.2 Power Supply

XDS110 board is powered through USB Type-C connector. The same connector is used to negotiate the power role and data role with the source device. The block diagram depicts the power flow of the XDS110 board.
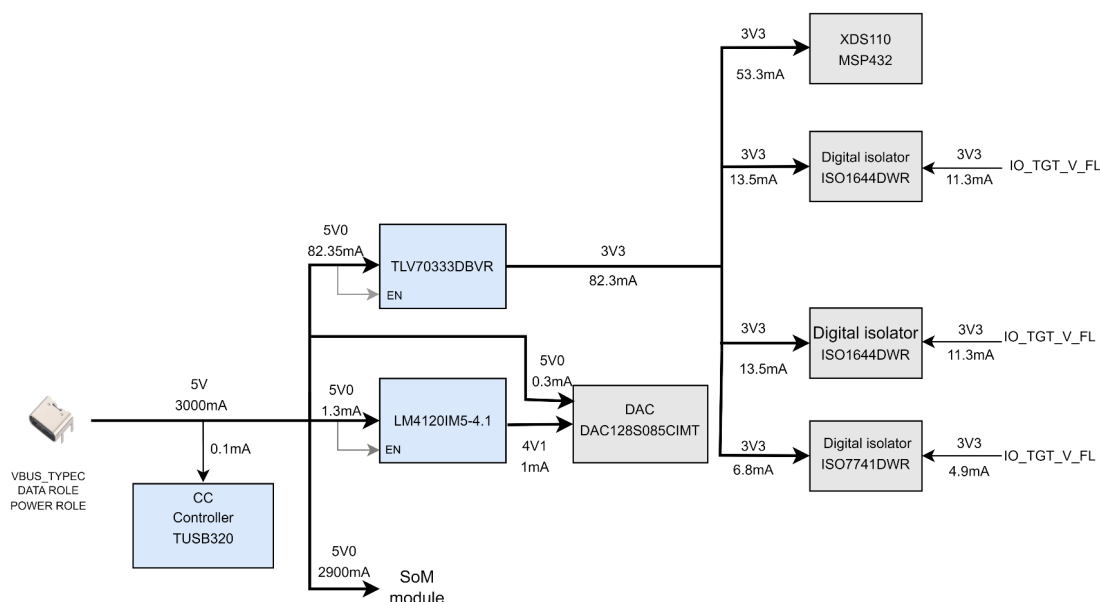
Figure 2-1. Power Architecture of XDS110

The following sections describe the power distribution network topology that supplies the XDS110 board, supporting components and reference voltages.

The XDS110 board includes a power design based on discrete power supply components. The initial stage of the power supply is VBUS voltage from the USB Type-C connectors J5. USB Type-C CC controller of Mfr. Part# TUSB320LIRWBR is used for negotiation of the required power to the system, role detection, cable orientation.

The DAC reference generator, DAC IC and CC Controller gets power from the 5V input source.

XDS110 board receives the 5V from the type C Connector. TUSB320 CC controller is used to authenticate the 5V/3A source connected. One LDO is used to generate 3V3 from 5V0 for powering the XDS110 MCU MSP432 and digital isolators. Another LDO is used to generate 4V1 from 5V0 for providing reference voltage to the DAC IC. Discrete regulators and LDOs used onboard are:

• TUSB320LIRWBR – To authenticate 5V/3A source connected.
• LM4120IM5-4.1/NOPB – To generate VREF (4V1) reference voltage for DAC IC.
• TLV70333DBVR – To generate VCC_3V3 rail for XDS110 MCU MSP432 and digital isolators.

Additionally, IO_TGT_V_FL is generated by the SOM board for providing 3V3 to digital isolators.

2.1.3 JTAG and Emulator

- XDS110 onboard emulator
- Supports JTAG connection through 16-pin emulator connector

2.1.4 Expansion Connectors/Headers to Support Application Specific Add-On Boards

- 16-pin isolated emulator connector
- 5-pin DAC header
- USB 2.0 Type C connector
- 12-pin debug header
- 120-pin high density connector

2.1.5 Adapter Boards

Adapter boards are added to the XDS110ISO-EVM kit to support the JTAG connections for 10-pin, 14-pin, and 20-pin connectors. The boards pinout is shown in Table 2-1 below.

Table 2-1. Adapter Boards Pinout

JTAG Adapter Pin Number	14-Pin	10-Pin	20-Pin
1	TMS	VTRef	TMS
2	KEY	TMS	KEY
3	TDI	GND	TDI
4	GND	TCK	GND
5	VTRef	GND	VTRef
6	KEY	TDO	KEY
7	TDO	KEY	TDO
8	GND	TDI	GND
9	TCK	GND	TCK
10	GND	KEY	GND
11	TCK		TCK
12	GND		GND
13	KEY		KEY
14	KEY		KEY
15			KEY
16			GND
17			KEY
18			KEY
19			GND
20			GND

2.2 Important Usage Notes

### 2.2.1 Electrostatic Discharge (ESD) Compliance

Components installed on the product are sensitive to Electrostatic Discharge (ESD). TI recommends this product be used in ESD controlled environment. This can include a temperature and/or humidity controlled environment to limit the buildup of ESD. TI also recommends to use ESD protection such as wrist straps and ESD mats when interfacing with the product.

2.2.2 IO Cable Length

The maximum length of all the IO cables must not exceed 3 meters.

2.3 Functional Block Diagram

The functional block diagram of the XDS110 Board is shown below.
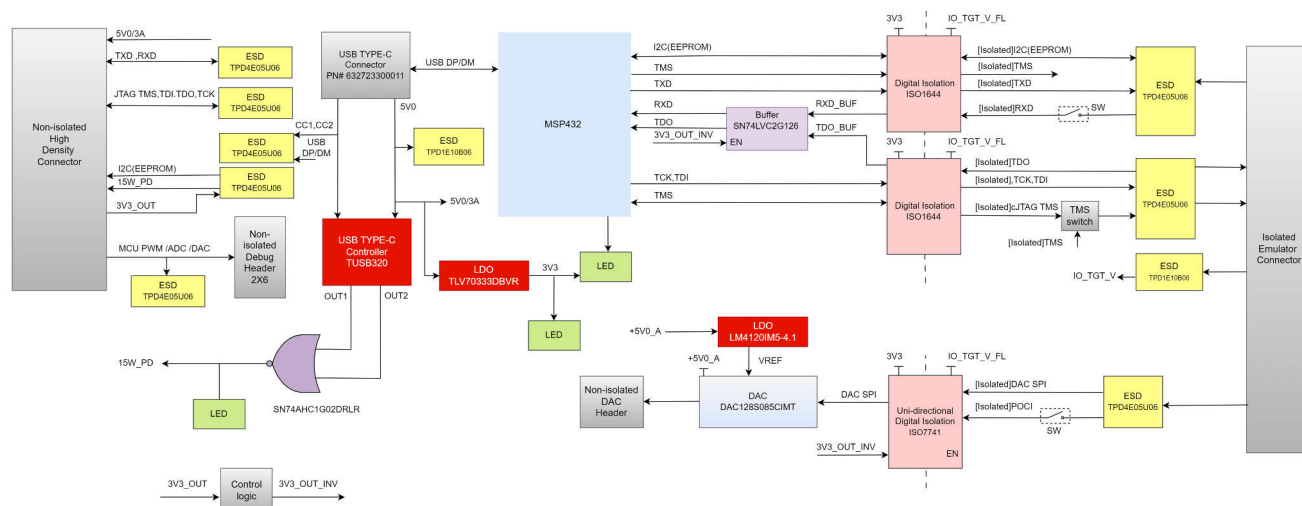
Figure 2-2. Block Diagram

2.4 Power ON/OFF Procedures

Power to the XDS110 Board is provided through an external USB type-C port power supply.

2.4.1 Power-On Procedure

1. Attach the USB Type-C cable to the XDS110 Board Type-C (J5) Connector.
2. Connect the other end of the Type-C cable to the source, Type-C source device (such as a Laptop computer). Visually inspect that LED3 is illuminated.

2.4.2 Power-Off Procedure

1. Remove the USB Type-C cable from the XDS110 Board.

2.4.3 Power Test Points

Test points for each power output on the board are mentioned in Table 2-2.

Table 2-2. Power Test Points

Voltage Measurement				
Points on Top Side				
Power Supply	**Probe Point**	**Ground**	**Probe Point**	**Expected Voltage (V) +/- 10% tolerance**
+5V0	TP3	GND	TP5	5.0
VCC_3V3	TP4	GND	TP5	3.3
DAC	TP2	GND	TP5	4.0
+5V0_A	TP6	GND	TP5	5.0

2.5 Peripheral and Major Component Description

The following sections provide an overview of the different interfaces and circuits on the XDS110 Board.

2.5.1 UART Interface

The MSP432 is supporting the UART port which is connected to the bi-directional digital isolator ISO1644 to provide isolation and connected to the emulator connector for interfacing with the controlSOM. The same UART interface also connects directly to the controlSOM through high density connector.
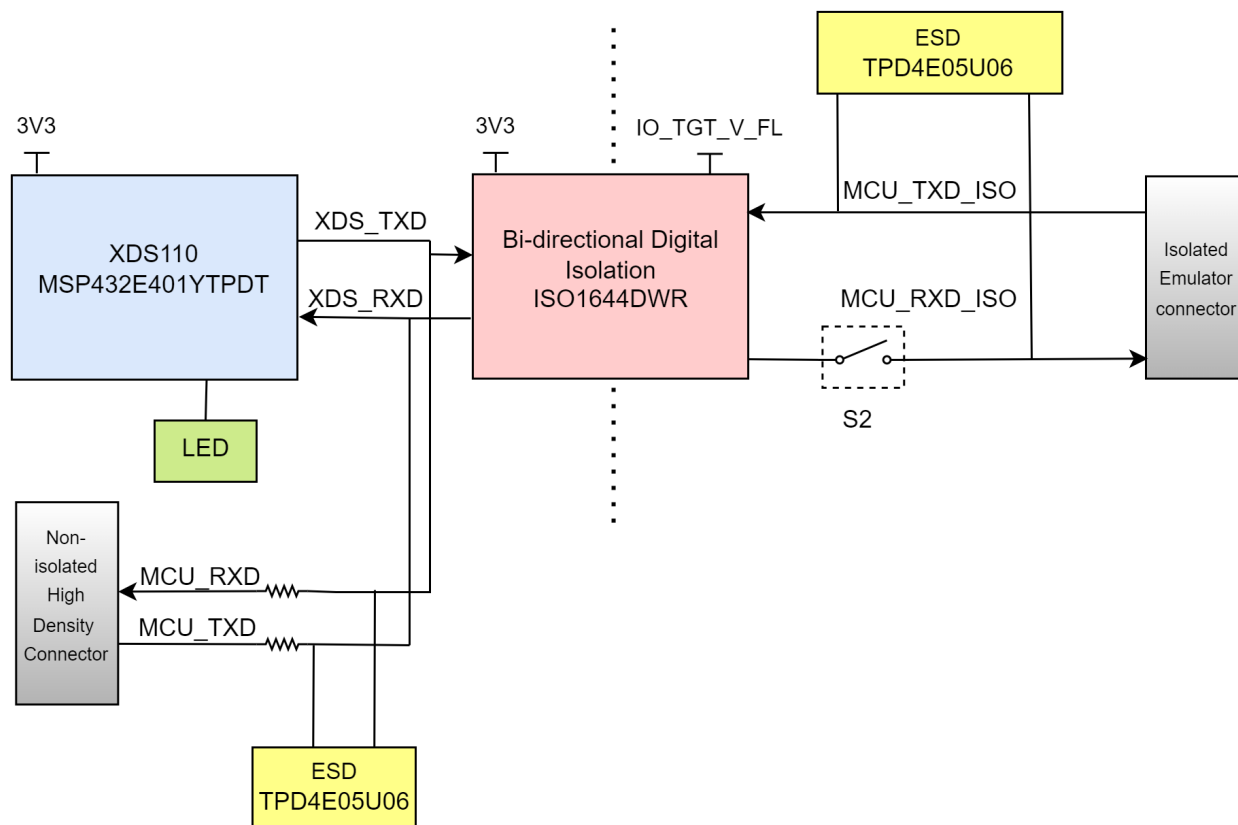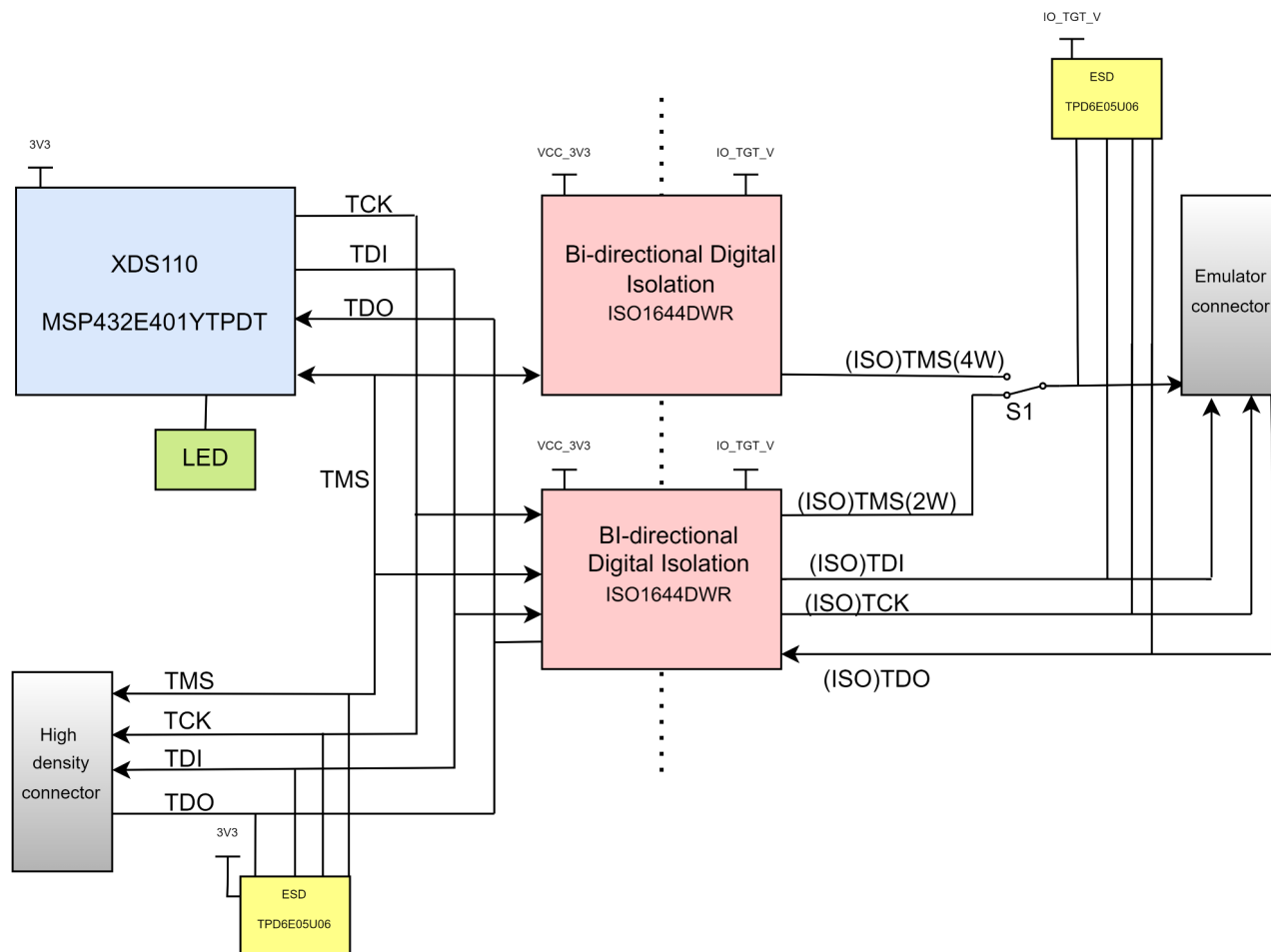

Figure 2-3. UART Block Diagram

2.5.2 JTAG Interface

The XDS110 board includes an emulation header and High-density connector to interface with the controlSOM. The XDS110 board includes the circuitry needed for XDS110 emulation.

The unidirectional pins of the ISO1644 digital isolator are used to isolate the JTAG signals of the XDS110 circuit from the isolated emulator connector. For implementation of cJTAG mode, the TMS signal is also routed through a slower, bidirectional input on a second ISO1644. A switch (S1) is used to select between JTAG and cJTAG mode.

Figure 2-4. JTAG Interface Block Diagram

2.5.3 DAC Interface

The DAC128S085CIMT part is used to generate the four channel analog outputs. The DAC128S085CIMT IC interfaces to the controlSOM through a SPI.

The ISO7741DBQR part is used to provide the electric isolation between SOM MCU and XDS110 emulator section.

Features of the DAC128S085CIMT:

• INL: ±8 LSB maximum at 12-bit resolution
• Dual reference voltages with range of 0.5V to VA
• Power supply: 2.7V to 5.5V
• 40MHz, SPI-compatible serial interface
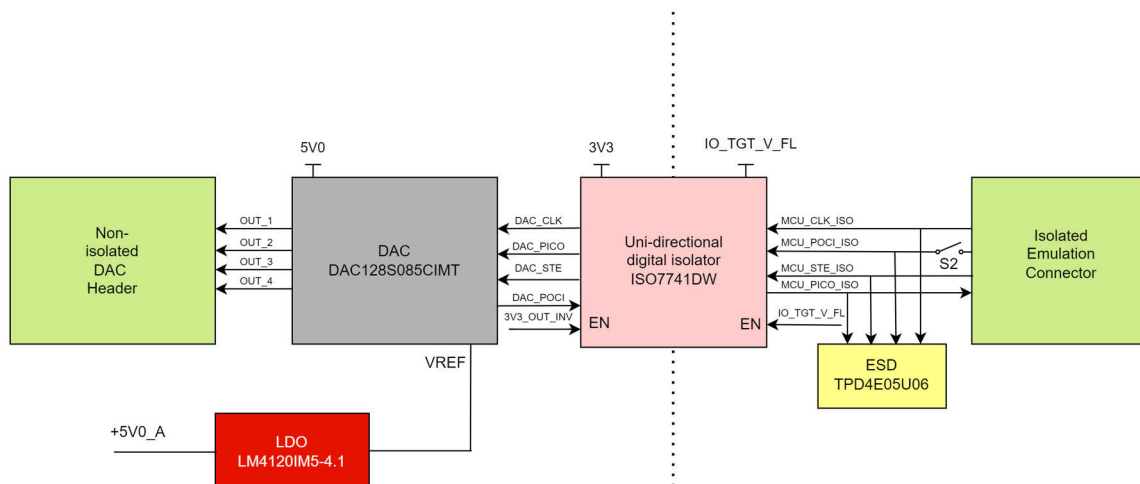
Figure 2-5. DAC Interface Block Diagram

2.5.4 USB Interface

The USB Type-C connector is used for power and data communication with the XDS110 board. The USB 2.0 supports the 480Mbps data rate.

The required power is negotiated between the source device and XDS110 using the TUSB320LAIRWBR CC controller.
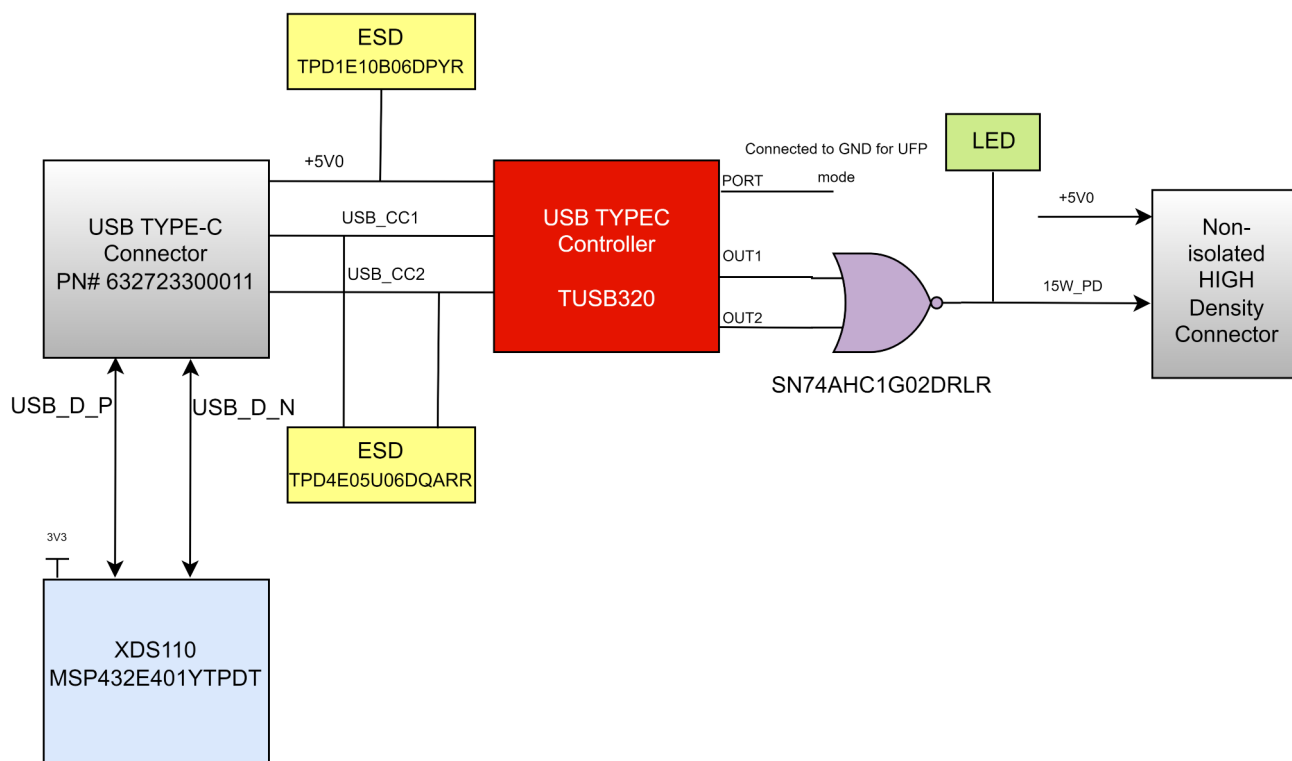

Figure 2-6. USB Interface block diagram

2.5.4.1 CC Controller

The TUSB320LAIRWBR CC controller is capable of negotiating up to the 5V at 3A power and advertises the current sourcing capability through CC1 and CC2 signals.

The ADDR pin is left floating to configure the OUT1 and OUT2 signals in GPIO mode. In GPIO mode, OUT1 and OUT2 pins shows the advertised current as per the below mentioned table. The OUT1 and OUT2 pins are connected to NOR gate to represent the high current 3A configuration meaning that 15W delivery power configuration. One green LED is used to represent the status of the 3A Configuration. The output of the NOR gate is connected to the controlSOM through high density connector.

Table 2-3. Simplied Operation for OUT1 and OUT2

OUT1	OUT2	ADVERTISMENT
H	H	Default current in unattached state
H	L	Default current in attached state
L	H	Medium current(1.5A) in attached state
L	L	High current(3.0A) in attached state

2.5.5 I2C Interface

An EEPROM is used on C2000 and Sitara controlSOMs to store board ID contents. The XDS110 board reads the EEPROM through an I2C interface.

The bi-directional digital isolator is used to provide digital isolation to the I2C interface. The I2C interface is also directly connected with the controlSOM through the high-density connector.
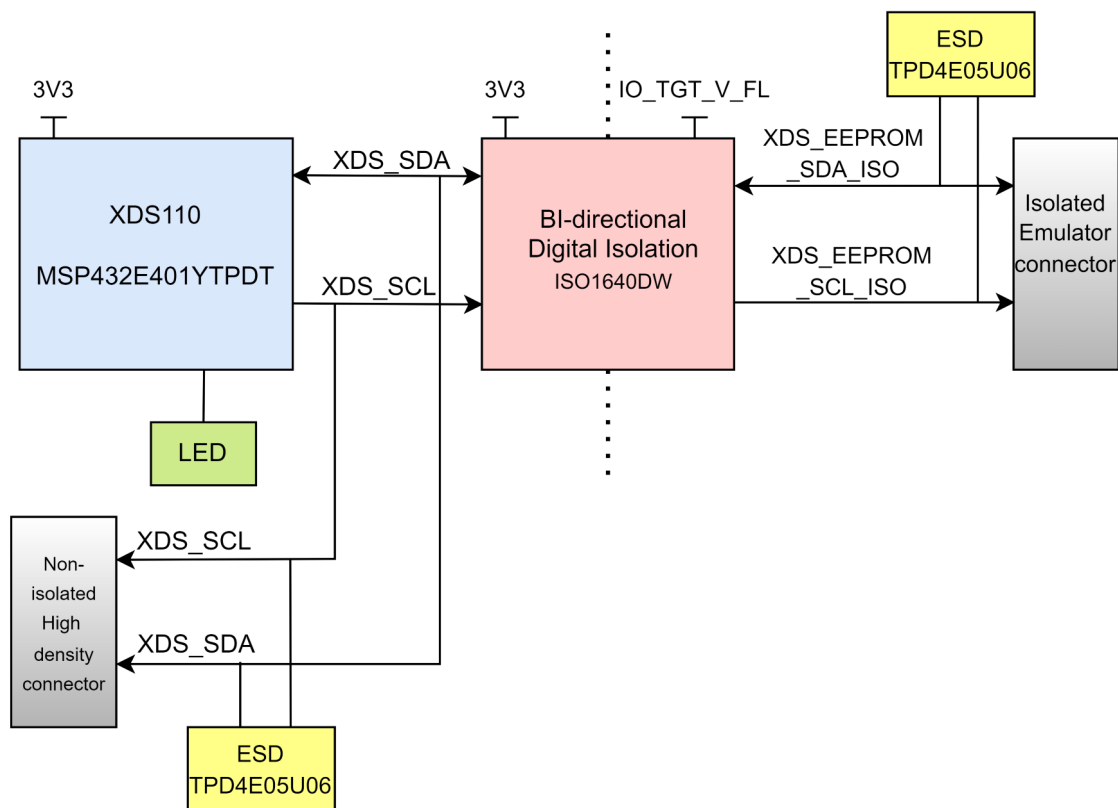
Figure 2-7. I2C Interface Block Diagram

2.5.6 Power

2.5.6.1 Power Requirement

XDS110 board is powered through the USB Type C Connector (J5) - Power role – UFP, Data role – USB2.0 DRP.

The XDS110 board supports voltage input ranges of 5V and 3A of current. A USB CC controller Mfr. Part# TUSB320LIRWBR is used to negotiate the required power to the system upon cable detection to get the necessary power required for the board. J5 Connector is configured to be an UFP port.

External power supply or accessory requirements:

- Nominal output voltage: 5 VDC
- Maximum output current: 3A
- Efficiency level V

Note

TI recommends using an external power supply or power accessory that complies with applicable regional safety standards such as (by example) UL, CSA, VDE, CCC, PSE, and so on.

2.5.6.2 Power Input

USB Type-C Connector (VBUS and CC lines) are connected to a CC controller Mfr Part# TUSB320LIRWBR. The TUSB320LIRWBR is a stand-alone USB Type-C and Configuration Channel (CC) controller providing cable plug and orientation detection for the USB Type-C Connectors.

The TUSB320 devices use the CC pins to determine port attach and detach, cable orientation, role detection, and port control for Type-C current mode. The TUSB320 devices can be configured as a downstream facing port (DFP), upstream facing port (UFP), or a dual role port (DRP) making the devices an excellent choice for any application. The CC logic block monitors the CC1 and CC2 pins for pullup or pulldown resistances to determine when a USB port has been attached, the orientation of the cable, and the role detected. The CC logic detects the Type-C current mode as default, medium, or high depending on the role detected.
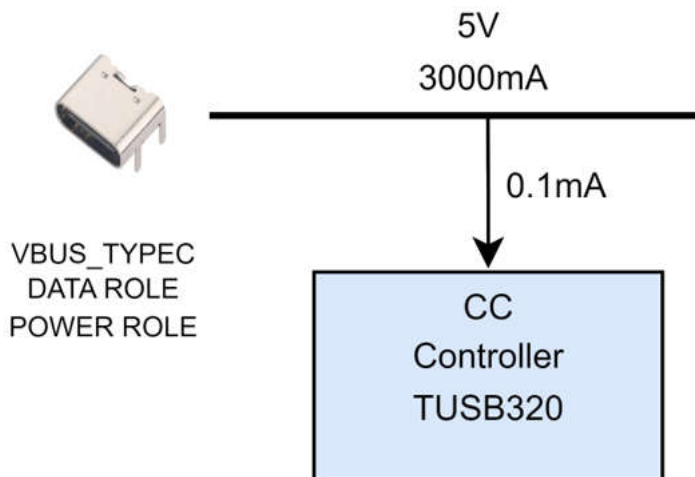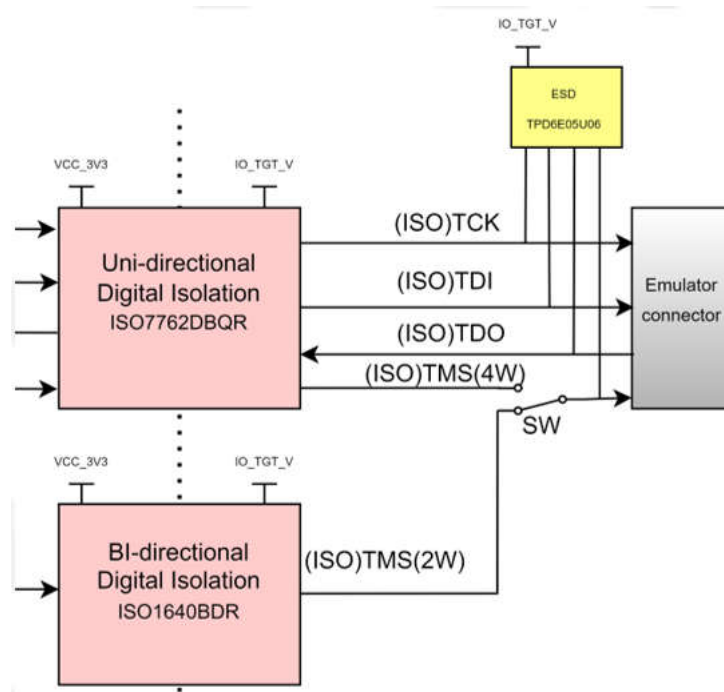

Figure 2-8. Power Input Block Diagram

2.5.7 XDS110 Board User Setup and Configuration

2.5.7.1 JTAG/cJTAG Switch

The XDS110 board has one SPDT switch (S1) to select the TMS signal as either 2-wire cJTAG or 4-wire JTAG to the emulator connector.

**Figure 2-9. TMS Switch**

Table 2-4. TMS Switch Selection

S1.1	S1.3	TMS Signal Selected
ON	OFF	2-wire cJTAG TMS signal
OFF	ON	4-wire JTAG TMS signal

2.5.7.2 UART and SPI Switch

XDS110 board has one SPST, 2 position DIP Switch (S2) to set the SPI and UART signals to the emulator connector. POCI signal from digital isolator is connected to the emulator connector, when the switch (S2.1) is set to ON condition. Similarly, the receiver (Rx) signal of UART from digital isolator is connected to the emulator connector, when the switch (S2.2) is set to ON condition.

Table 2-5. UART and SPI Switch Selection

Switch State	Switch Position	UART and SPI Signal Selected
S2.1-S2.4	ON	SPI – POCI signal
S2.2-S2.3	ON	UART – RX signal
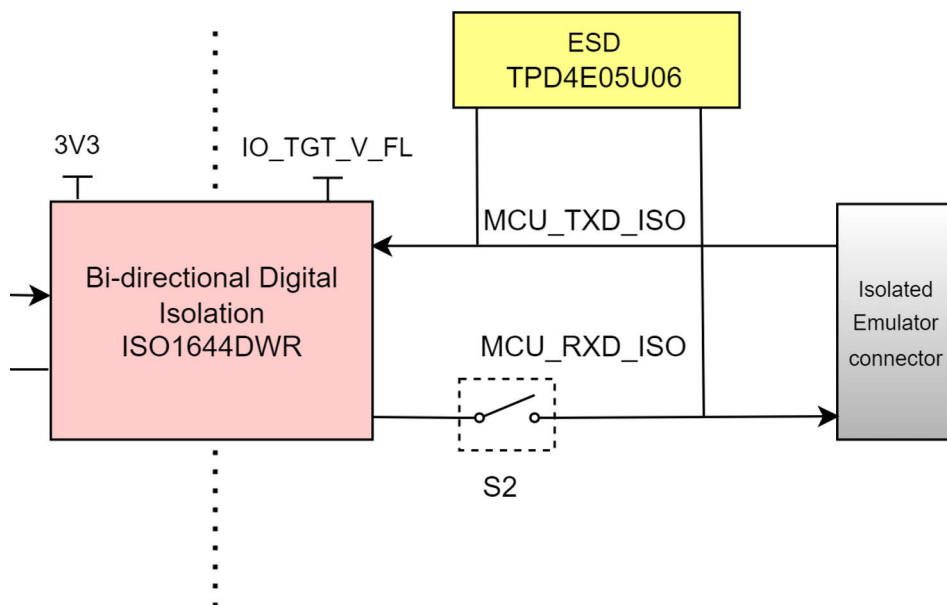
Figure 2-10. UART Switch
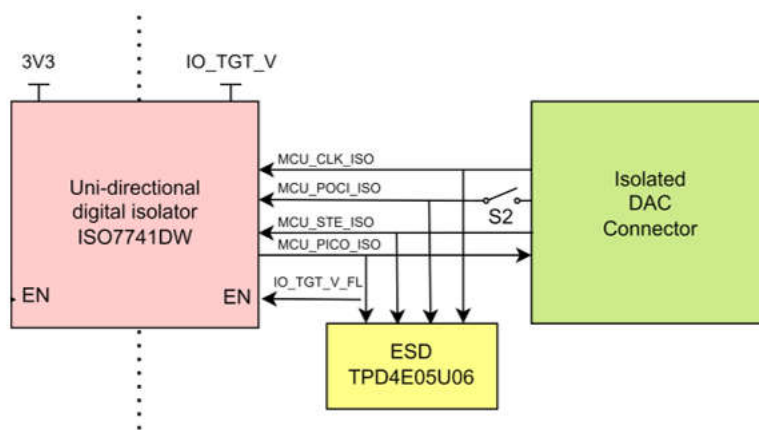
Figure 2-11. SPI Switch

2.5.8 Expansion Headers

The XDS110 board features three expansion headers, the 16-pin emulator connector, and the 12- pin debug header.

2.5.8.1 Emulator Connector

The XDS110 board has a 16-pin isolated emulator connector which offers JTAG, I2C, SPI and UART interfaces and is compatible with C2000 and Sitara controlSOMs. The I2C of the MSP432 MCU is connected to EEPROM on the controlSOM through the 16-pin emulator connector and high-density connector. The MSP432 MCU UART port is connected to the bi-directional digital isolator ISO1644DWR to provide isolation and connected to the emulator connector for interfacing with the controlSOM. The DAC IC interfaces with the controlSOM MCU through the SPI on the emulator connector. The controlSOM provides a 3.3V supply to the digital isolators on the target side through the IO_TGT_V pin. Signals routed from the emulator connector are listed in Table 2-6.

Table 2-6. 16-Pin Emulator Connector (J3) Pinout

Sl. No	Pin Description
1	IO_TGT_V
2	GND
3	MCU_TMS_ISO
4	MCU_TCK_ISO
5	MCU_TDI_ISO
6	MCU_TDO_ISO
7	GNDH
8	KEY
9	MCU_RXD_ISO
10	MCU_TXD_ISO
11	XDS_EEPROM_SDA_ISO
12	XDS_EEPROM_SCL_ISO
13	MCU_CLK_ISO
14	MCU_PICO_ISO
15	MCU_POCI_ISO
16	MCU_STE_ISO

2.5.8.2 DAC Header

The 5-pin DAC header gives the output from the DAC IC DAC128S085CIMT. See the DAC output header signal details in the table below.

Table 2-7. 5-Pin DAC Header (J6) Pinout

Sl. No	Pin Description
1	OUT_0
2	OUT_1
3	OUT_2
4	OUT_3
5	GND

2.5.8.3 Debug Header

The 12-pin debug header provides access to 10 analog and digital I/O signals of the controlSOM MCU. Table 2-13 lists the controlSOM pins that are accessible on this header. Refer to the controlSOM documentation for details on the functions supported on these controlSOM pins.
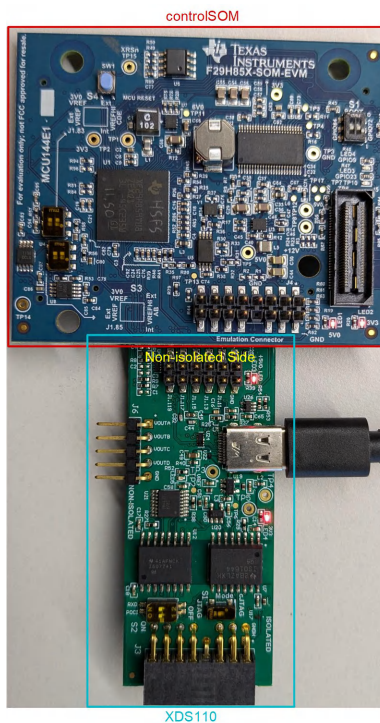
Table 2-8. Debug Header (J2)

Sl. No	Pin Description
1	J1.119
2	J1.120
3	J1.117
4	J1.118
5	J1.15
6	J1.9
7	J1.13
8	J1.7
9	J1.11
10	J1.5
11	GND
12	GND

2.5.9 Use Cases

2.5.9.1 Case 1: Non-Isolated XDS110 and controlSOM

XDS110 non-isolated plugs into bottom of controlSOM using High density connector (J1).

Figure 2-12. Non-Isolated XDS110 and SOM

2.5.9.2 Case 2: Isolated XDS110, controlSOM, Baseboard

The controlSOM plugs into the HSEC adapter (through four high density connectors J1, J2, J3, J4), 180-pin edge connector of HSEC adapter plugs into the docking station and XDS110 isolated connector (J3 and J4) plugs vertically into emulation header (J7) and DAC header (J10) of HSEC adapter board.
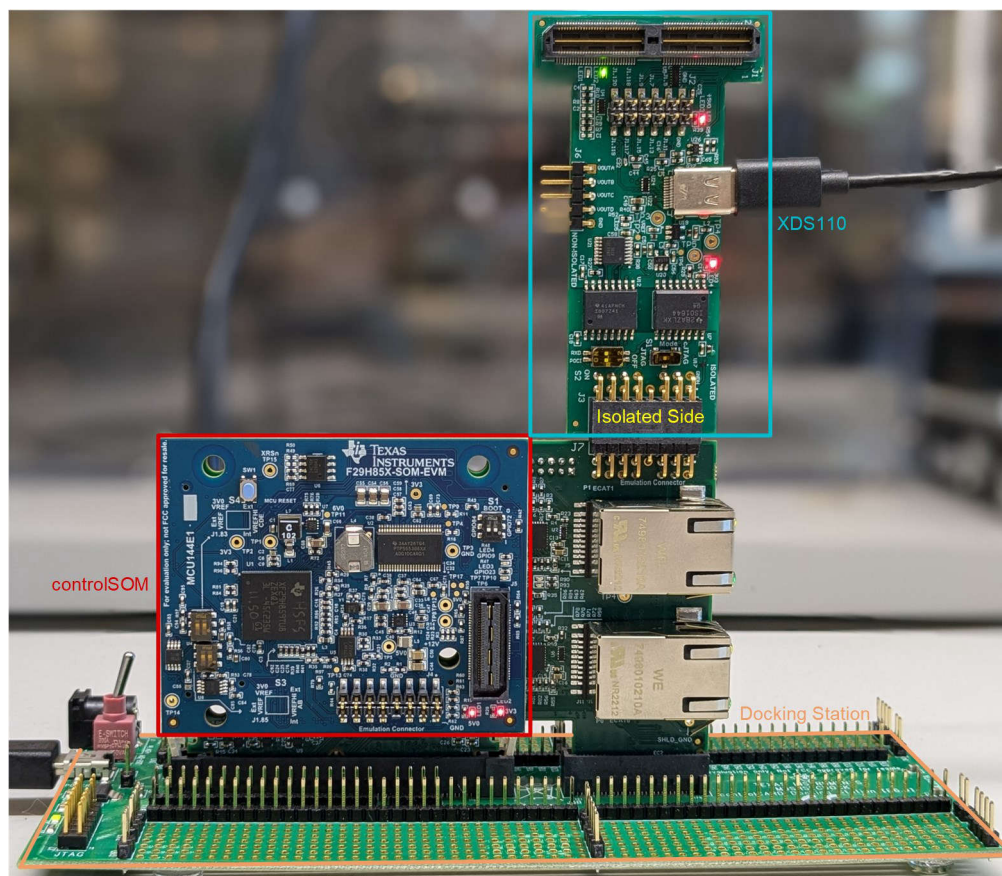
Figure 2-13. Isolated XDS110 + SOM + Baseboard

3 Hardware Design Files

The entire XDS110ISO-EVM design files are available for download at this link: XDS110ISOEVM design files.

3.1 Schematics

The schematic for the LaunchPad™ can be found at this link: XDS110ISO-EVM Schematic.

3.2 Bill of Materials (BOM)

The bill of materials for the LAUNCHXL-F28P55X is included in the XDS110ISO-EVM design files download.

4 Compliance Information

4.1 Compliance and Certifications

The EVM is REACH and RoHS compliant. The EU Declaration of Conformity (DoC) for XDS110ISO-EVM can be found here.

5 Additional Information

5.1 Trademarks

C2000™, Sitara™, Code Composer Studio™, SimpleLink™, and LaunchPad™ are trademarks of Texas Instruments.
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6 Related Documentation

6.1 Supplemental Content

Texas Instruments, MSP432E401Y SimpleLink™ Ethernet Microcontroller data sheet.

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