EVM User's Guide: LP-MSPM0G5187

MSPM0G5187 Evaluation Module

Description

The MSPM0G5187 LaunchPad™ development kit is an easy-to-use evaluation module for the MSPM0G511x and MSPM0G5187 microcontroller (MCU). The LaunchPad kit contains everything needed to start development on the MSPM0G511x and MSPM0G5187 microcontroller platform, including an onboard debug probe for programming, debugging, and EnergyTrace™ technology. The board includes three buttons, two LEDs (one is an RGB LED), two USB-C connectors (one is for the MSPM0 USB interface), one microSD™ slot, one microphone, one audio ADC, and 40+ pins. The board can improve analog results with ADC low-pass filter placeholders placed in strategic positions and external reference options available on the launchpad.

Get Started

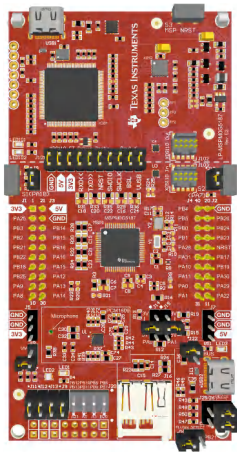
1. Order the LP-MSPM0G5187 from ti.com.
2. Navigate to dev.ti.com to browse for code examples.
3. Plug LP-MSPM0G5187 into a PC with the provided USB cable (USB1).
4. Download code directly from the browser to the MSPM0G5187 with CCS Cloud.
5. Download Code Composer Studio™ IDE for a desktop integrated development environment.
6. Download the MSPM0 SDK for desktop stored examples, demos, and software libraries.

Features

- Onboard XDS110 debug probe (USB Type-C™ connector)
- Backchannel UART through USB to PC
- USB-powered
- 40-pin BoosterPack™ headers
- Hardware user interfaces
  - Two buttons, 1 RGB LED, and 1 RED LED
  - 1 USB-C™ connector supports for USB 2.0 FS
  - 1 Microphone and 1 Audio ADC
- External clock crystals
  - 40MHz HFXT | 32KHz LFXT

Applications

- Appliance
- Factory automation
- Personal electronics
- Medical and healthcare
- Infotainment and cluster
- Body electronics and lighting



LP-MSPM0G5187

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1 Evaluation Module Overview

1.1 Introduction

The MSPM0G5187 is an Arm® Cortex® -M0+ based 32-bit CPU with dual-bank flash and enhanced security features and a frequency up to 80MHz. The device can be used in a variety of tasks from a small module of personal electronics with the USB 2.0 FS and serial audio interface (SAI), to a full-application utilizing LIN interface, flash ECC, and SRAM ECC to fulfill automotive applications. In addition, the device integrates a neural-network processing unit (NPU) to support edge AI within M0+ platform. The easiest way to get started with the MSPM0G5187 is with the LP-MSPM0G5187 LaunchPad™ . The LaunchPad™ has all the features to load code, debug, and prototype right out of the box.

The device features 128kB of dual-bank flash with 32kB of SRAM and 8kB of data flash memory. The device also has internal analog such as a internal 12-bit ADC, two voltage references, a high speed comparator with 8-bit reference DAC. The MSPM0G5187 is the first MSPM0 device that features USB 2.0 FS, SAI, and NPU.

Rapid prototyping is simplified by the 40-pin BoosterPack™ plug-in module headers, which support a wide range of available BoosterPack™ plug-in modules. Users can quickly add features like wireless connectivity, graphical displays, environmental sensing and much more. Design you own BoosterPack™ plug-in module or choose among many already available from TI and third-party developers.

To make prototyping easier, TI provides the MSPM0 software development kit (SDK), which has a variety of code examples to demonstrate how to use the internal peripherals.

Free software development tools are also available, such as TI's Code Composer Studio™ IDE. TI also supports 3rd party IDEs, such as IAR Embedded Workbench® and Arm® Kiel® µVision® IDE. Code Composer Studio IDE supports EnergyTrace™ software technology with the MSPM0G5187 LaunchPad™ development kit. More information about the LaunchPad™ development kit, the supported BoosterPack™ plug-in modules, and the available resources can be found at TI's LaunchPad™ development kit portal. To get started quickly and find available resources in the MSPM0 software development kit (SDK), visit the TI Developer Zone. The MSPM0 MCUs are also supported by extensive online collateral, training with MSPM0 Academy and online support through the TI E2E™ support forums.

1.2 Kit Contents

- LP-MSPM0G5187 LaunchPad™ Development Kit
- USB-A to USB-C™ cable
- Quick-start guide

1.3 Specification

LP-MSPM0G5187 is designed to be used in conjunction with a PC, Mac® , or Linux® workstation running the Code Composer Studio™ (CCS). The CCS IDE can run as a stand-alone version on a workstation or be accessed through the web (CCS Cloud) without the need for a software installation. Alternatively, LP-MSPM0G5187 ships with an example loaded, which can be controlled by a GUI. See the out-of-box description below.

The device can be powered from a power supply other than the built-in USB power supply. This feature allows the user to forgo the PC connection. Power can be applied either directly or to the 3.3V rail. When using an external power supply, do not exceed 3.3V. Programming can be done externally with a separate XDS110 external debugger by utilizing the on-board 10-pin Arm® connector.

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1.4 Device Information

LP-MSPM0G5187 uses the following devices from Texas Instruments.

Table 1-1. Device Information

Device Name	Description	Purpose
MSP432E401YTPDT	SimpleLink™ 32-bit Arm® Cortex® -M4F MCU with Ethernet, CAN, 1MB Flash and 256kB RAM	XDS110 Host Device
MSPM0G5187SPMR	Mixed-Signal Microcontroller with 80MHz Arm® Cortex® 32-bit-M0+ CPU, 128kB flash, and 32kB SRAM	Evaluation device
MSP430G2452IRSA16R	Mixed-Signal Microcontroller with 16-bit RISC CPU, 8kB Flash, and 256B SRAM	DC/DC controller for EnergyTrace™ Technology
TPD4E004RSER	ESD-protection array for high-speed data interfaces, 4 channels	Protect LP-MSPM0G5187 from ESD damage through USB connector
TPS73533DRBT	500mA, adjustable, low quiescent current, low-noise, high-PSRR, single-output LDO regulator	3.3V power XDS110 and MSPM0G5187
TPS2102DBVR	2.7V to 4V power MUX, dual-input, single-output power switch	Switches XDS110 power
PCM1809IRTER	Low power audio analog-to-digital converter (ADC) that supports simultaneous sampling of up to two analog channels	Sampling the voice data from microphone

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2 Hardware

2.1 Hardware Overview

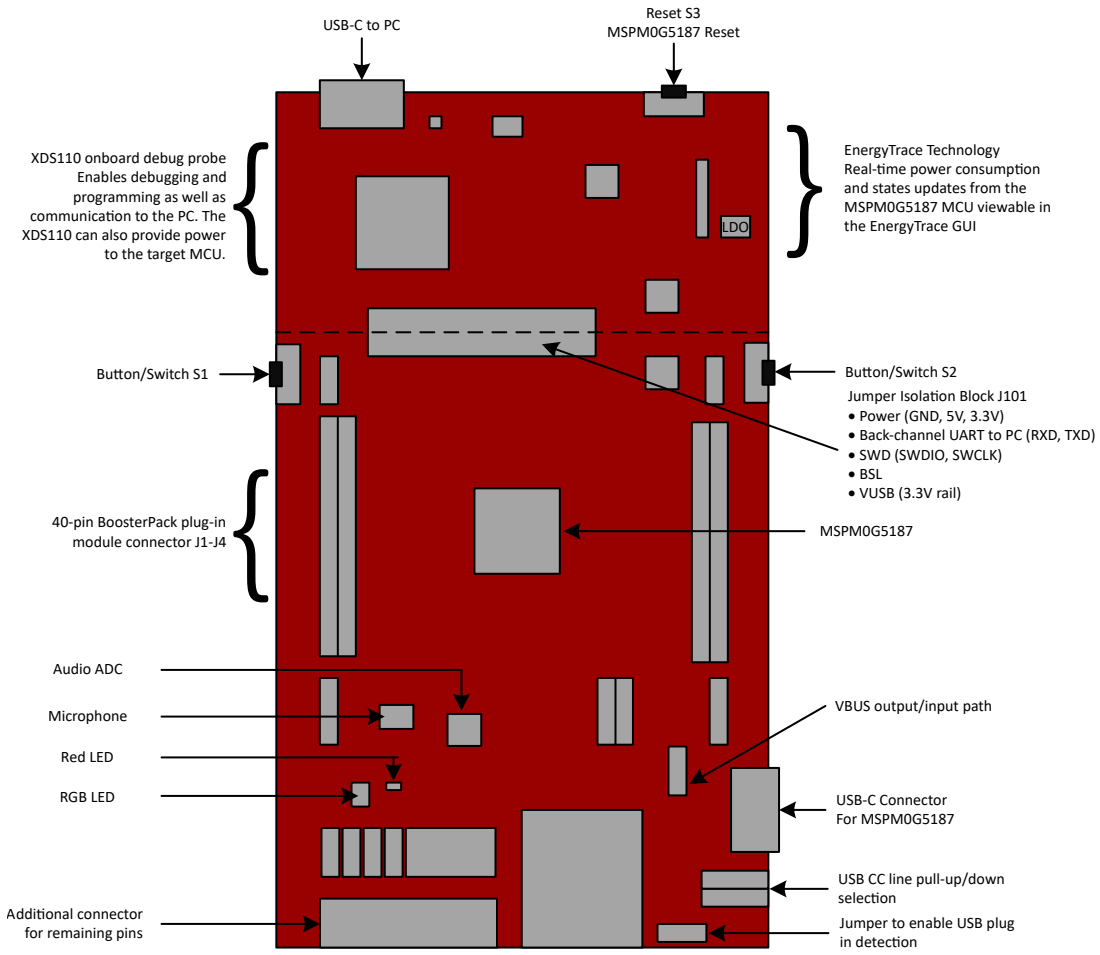

Figure 2-1. Diagram of LP-MSPM0G5187 Jumpers and Connections

LP-MSPM0G5187 has many hardware features, which allow the user full access to the MSPM0G5187 pins, while still providing onboard connectivity for easy use. Shunt connections provide a way for the user to easily change the LaunchPad™ configuration. The location of these shunts is shown in Figure 2-1. The connection of each shunt is described in Table 2-1. The default configuration is to have all shunts populated.

Table 2-1. Jumper Information

Jumper	Description	Default Setting	Connected Signal
J1-J4	BoosterPack™ header block	Unpopulated	BoosterPack™ standard connection for pins 1-40, see schematic for details
J5	3.3V power header	Unpopulated	Additional pin connections for GND and 3.3V
J6	Analog power header	Unpopulated	OFF to disconnect power to SD slot, microphone, and audio ADC (PCM1809)
J7	5V power header	Unpopulated	Additional pin connections for GND and 5V
J8	BSL invoke	Populated	Connects PA18 to the S1 button
J9	Red LED	Populated	Connects PA0 to the Red LED
J10	S2 jumper	Populated	Connects PA7 to the S2 button

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Table 2-1. Jumper Information (continued)

Jumper	Description	Default Setting	Connected Signal
J11	RGB (Blue) LED	Populated	Connects PB13 to the RGB (Blue) LED
J12	RGB (Red) LED	Populated	Connects PBA17 to the RGB (Red) LED
J13	RGB (Green) LED	Populated	Connects PA24 to the RGB (Green) LED
J14	Open drain pullup selector	Populated: Top and center (1-2)	Pullup selector for 3.3 or 5V connection for PA0
J15	Open drain pullup selector	Populated: Top and center (1-2)	Pullup selector for 3.3 or 5V connection for PA1
J17-J19	LP-MSPM0G5187 pin extension header (unlabeled – bottom of board)	N/A	See schematic for details
J20	LP-MSPM0G5187 pin extension header (unlabeled – bottom of board)	Unpopulated	See schematic for details
J21	LP-MSPM0G5187 pin extension header (unlabeled – bottom of board)	N/A	See schematic for details
J22	USB2 power header	Unpopulated	Connects to enable USB2 VBUS from on-board 5V (only applicable in USB HOST mode)
J23	USB2 VBUS detection header	Unpopulated	Connects PB21 to USB2 VBUS (with 2/5 voltage divider resistor circuit)
J24, J25	USB2 CC Line pull-up or pulldown selector	Populated: Right and center (1-2)	Pullup and pulldown selector for USB CC line, default is pulldown with 5.11KΩ
J101	XDS110-ET isolation block	Populated	GND, 5V, 3V3, RXD, TXD, NRST, SWDIO, SWCLK, BSL, VUSB
J102	XDS110-ET OUT	Unpopulated	GND, 3V3, SWDIO, SWCLK, NRST
J103	XDS110-ET IN	Unpopulated	GND, 3V3, SWDIO, SWCLK, NRST

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2.2 Power Requirements

The LP-MSPM0G5187 only needs the USB plugged in and the debugger jumper block populated to power the device. With the onboard LDO, the 5V USB supply is converted to 3.3V with a supply of 500mA. The LaunchPad™ can also be powered by the 3.3V or 5V headers using an external supply. The VUSB is used for MSPM0 USB PHY power, which is 3.3V rail. Do not exceed 3.3V on the 3.3V rail or 5V on the 5V rail.

In the lower right corner, there is a second USB-C™ connector, which supports USB 2.0 FS on MSPM0G5187. The USB-C connector has a 5V-rail VBUS. Use the 5V target in J22 to generate VBUS only if MSPM0G5187 works in host mode. Otherwise, keep the J22 disconnected.

Note

Do not connect J22 if USB1 (XDS side) and USB2 (MCU side) connect to different power supplies.

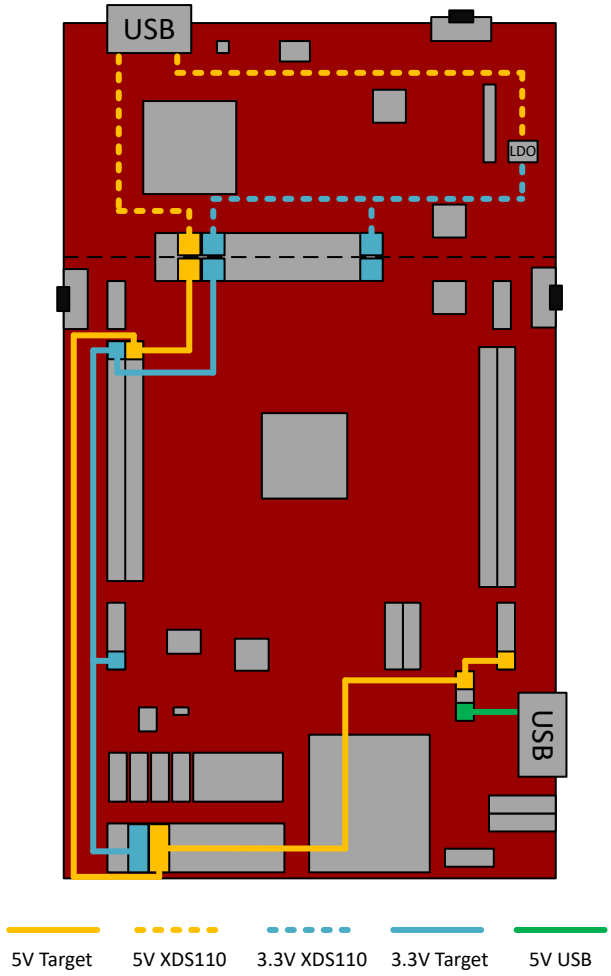

Figure 2-2. LP-MSPM0G5187 Power Connections

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2.3 XDS110 Debug Probe

LP-MSPM0G5187 features an onboard debug probe to streamline prototyping. The debugger used on this LaunchPad™ is the XDS110 variant, which supports all MSPM0 device derivatives. The integrated XDS110 debug probe is separated from the rest of the MSPM0G5187 circuitry, which is shown by the dashed silkscreen on the LaunchPad. The XDS110 is only connected through signals that pass through J101, in addition to a common ground.

Isolation Jumper Block

The isolation jumper block J101 allows the user to connect or disconnect signals that cross from the XDS110 domain into the MSPM0G5187 target domain. This includes XDS110 SWD signals, application UART signals, 3.3V and 5V power, USB PHY power, and reset.

Jumper	Description
5V	5V rail from the USB
3V3	3.3V rail from the LDO
RXD<<	Backchannel UART: The target MSPM0G5187 receives data through this signal. The arrows indicate the direction of the signal.
TXD>>	Backchannel UART: The target MSPM0G5187 sends data through this signal. The arrows indicate the direction of the signal.
NRST	Reset signal
SWDIO	Serial wire debug: SWDIO data signal.
SWCLK	Serial wire debug: SWCLK clock signal.
BSL	Invoke pin for bootstrap loader. Allows the XDS110 to invoke BSL.
VUSB	MSPM0G5187 USB PHY power, 3.3V rail

2.4 Measure Current Draw of the MSPM0G5187

To measure the current draw of the MSPM0G5187 MCU using a multimeter, use the 3V3 jumper on the J101 jumper isolation block. The current measured includes the target device, LaunchPad™ circuits, and any current drawn through the BoosterPack™ plug-in module headers. To measure ultra-low power, follow these steps:

1. Remove the 3V3 and VUSB jumper in the J101 isolation block, and attach an ammeter across the 3V3 jumper.
2. Consider the effects that the VUSB channel (which supplies the power to the MSPM0 USB PHY), backchannel UART, and any circuitry attached to the MSPM0G5187 have on the current draw. Consider disconnecting the backchannel UART at the isolation jumper block, or at least consider the current sinking and sourcing capability in the final measurement. Connect the VUSB to 3V3 if USB interface is used with the MSPM0G5187.
3. Remove the jumper in J6 to disconnect the on-board analog component, including the SD card, microphone, and audio ADC.
4. Make sure there are no floating inputs or outputs (I/Os) on the MSPM0G5187. This causes unnecessary extra current draw. Every I/O is either driven or, if the I/O is an input, is pulled or driven to a high or low level.
5. Begin target execution.
6. For the most accurate current measurements, place the device in *free run* mode and disconnect programming signals between the MSPM0G5187 and the debug portion of the board (header J101).
7. Measure the current. Remember that if the current levels are fluctuating, then getting a stable measurement can be difficult. Measuring the quiescent states is easier.

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2.5 Clocking

The internal SYSOSC is 32MHz by default with an accuracy of 2.5%. The MCLK is sourced by the SYSOSC by default. The SYSPLL can be used to generate a clock signal up to 80MHz, which can be used to source MCLK. CPUCLK is sourced directly from MCLK in run mode and disabled in other modes. The low-power clock (ULPCLK) can be sourced by MCLK and active in *run* and *sleep* mode by configuration. The part also includes an internal 32kHz oscillator, LFOSC, which is the default low frequency source. The part additionally supports FLL which is used to generate the accurate 60MHz clock (FLLCLK) for USB peripheral.

Included on the LaunchPad™ are two clock crystal options, one high-frequency 40MHz crystal (HFXT), and one low-frequency 32.768kHz crystal (LFXT). The crystals can be selected during application programming as the clock source for the high frequency and low frequency clocks.

For more clock tree details, see the *Clock Module (CKM)* section of the *MSPM0 G-Series Microcontrollers Technical Reference Manual.*.

2.6 BoosterPack Plug-in Module Pinout

The LaunchPad™ development kit adheres to the 40-pin LaunchPad development kit pinout standard, where pins are available. A standard was created to aid compatibility between LaunchPad development kits and BoosterPack™ plug-in modules across the TI ecosystem.

While most BoosterPack plug-in modules are compliant with the standard, some are not. If the reseller or owner of the BoosterPack plug-in module does not explicitly indicate compatibility with the MSPM0G5187 LaunchPad development kit, then compare the schematic of the candidate BoosterPack plug-in module with the LaunchPad development kit to verify compatibility. Conflicts can be resolved by changing the MSPM0G5187 device pin function configuration in software.

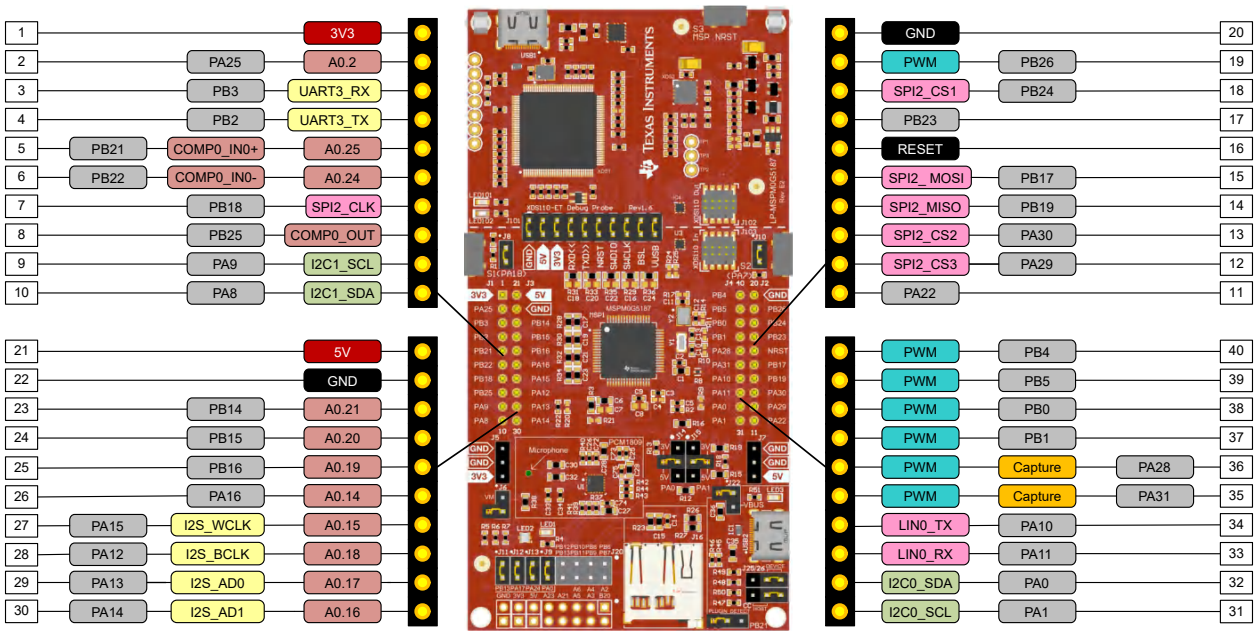

Figure 2-3. BoosterPack Plug-in Module Connector Pinout

3 Software

3.1 Software Development Options

There are multiple ways to prototype with LP-MSPM0G5187:

1. Out-of-box GUI – Choose this option for an easy demo of the LP-MSPM0G5187.
2. CCS Cloud – Choose this option to get started quickly with minimal installation.

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3. CCS Theia – Choose this option to work offline and have full access to debug features.
4. CCS Eclipse – This option is supported but is a legacy tool and is not covered in this guide.

3.2 Out-of-Box GUI

Get started with the out-of-box example on LP-MSPM0G5187. Simply navigate to the *Out-of-Box* GUI and plug in LP-MSPM0G5187 to a PC, Mac® , or Linux® workstation. This GUI provides control of the build in LED and a dashboard of the current state of LP-MSPM0G5187. The *TI Cloud Agent* browser extension can be necessary for GUI functionality.

More GUI information is available at full release and can be found on TI Developer Zone.

3.3 CCS Cloud

1. Navigate to dev.ti.com. Users are required to install the CCS Cloud Agent. If CCS Cloud Agent is not installed yet, then follow the steps to complete this installation.
2. Plug in LP-MSPM0G5187 using a micro-USB cable. The TI Developer Zone automatically detects that LP-MSPM0G5187 has been plugged in.
3. Click *Browse Software And Examples*, which opens the MSPM0 SDK in a new window. In the left bar, navigate to Arm-based microcontrollers > Embedded Software > MSPM0 SDK > Examples > Development Tools > DriverLib > gpio_toggle_output > No RTOS > TI Clang Compiler > gpio_toggle_output.
4. Click the *Import* button at the top right corner of the screen. This action imports the project into the CCS Cloud and opens in a new window.
5. In CCS Cloud, click the *debug* icon in the left bar to open the debug view.
6. Click the *play* button to deploy the code to the device and open a debug session. By default, the debugger pauses the first line of code.
7. Click the blue *play* button to start the application.
8. The RGB LED on LP-MSPM0G5187 needs to be blinking.

Now, users are ready to begin prototyping by modifying the code or by importing a different example code.

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4 Hardware Design Files

4.1 Schematics

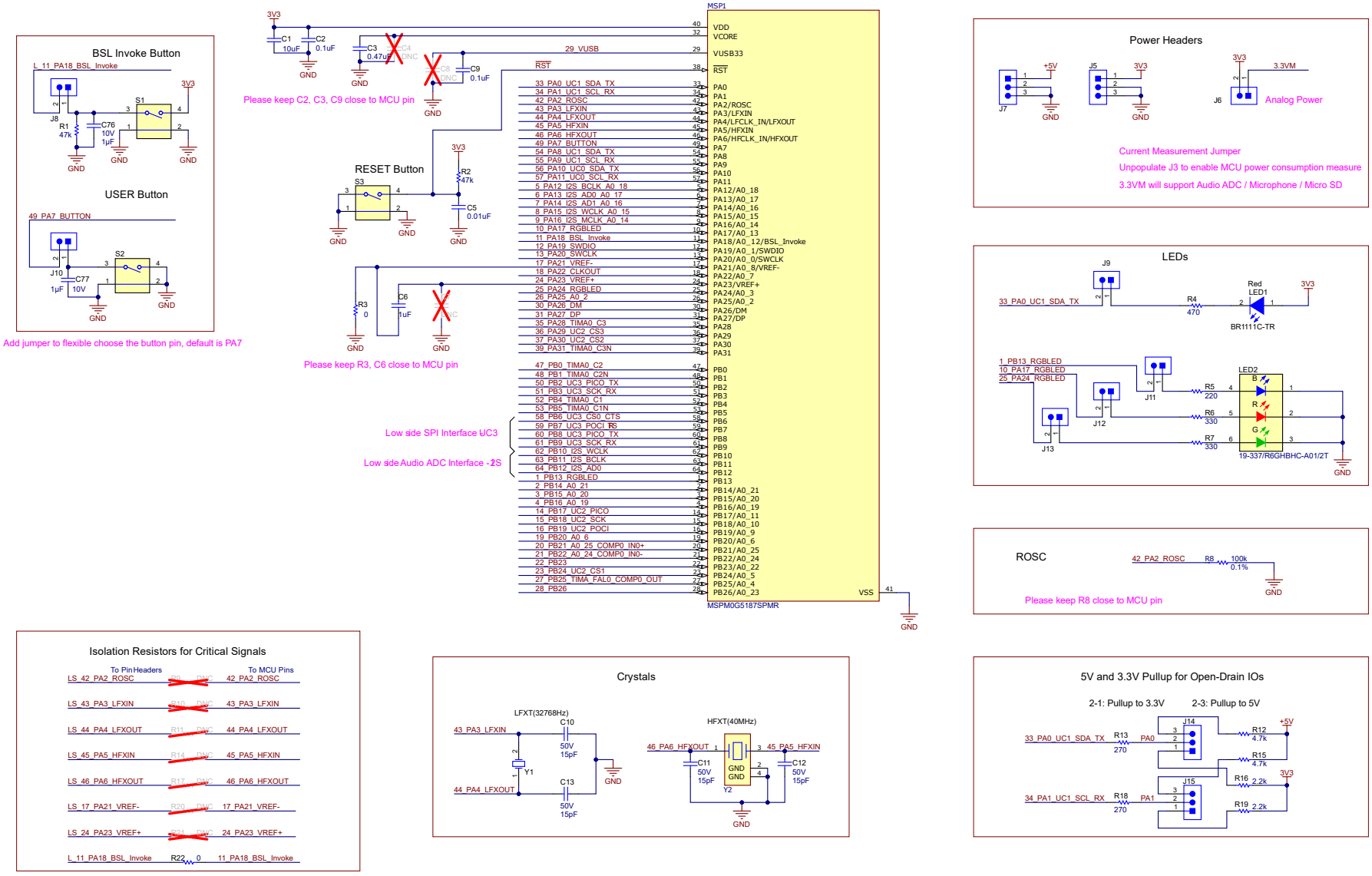

Figure 4-1. MSPM0G5187 Target Device Schematic

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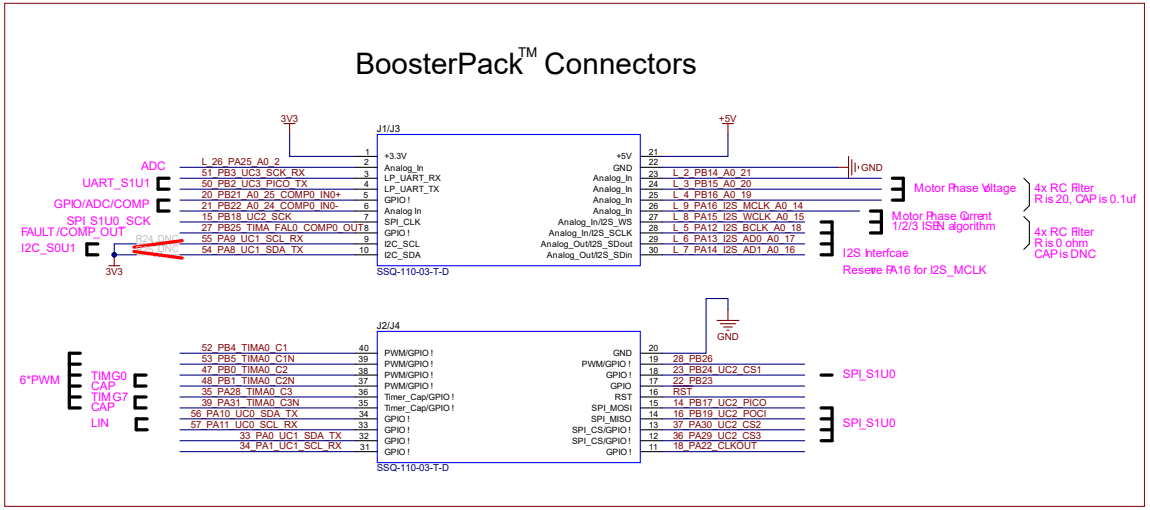

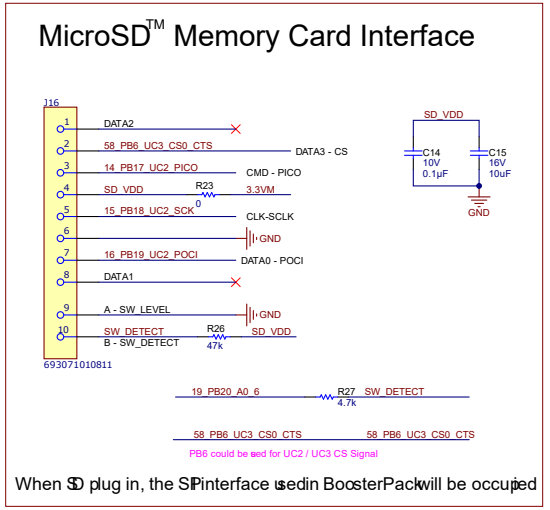

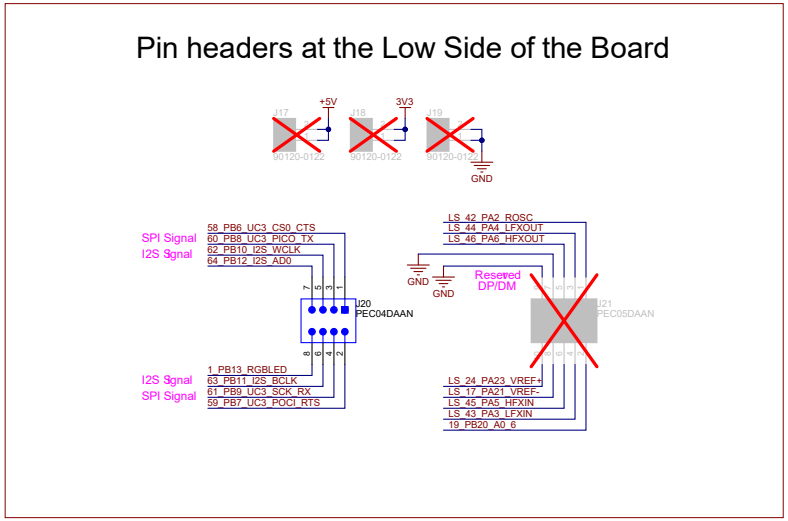

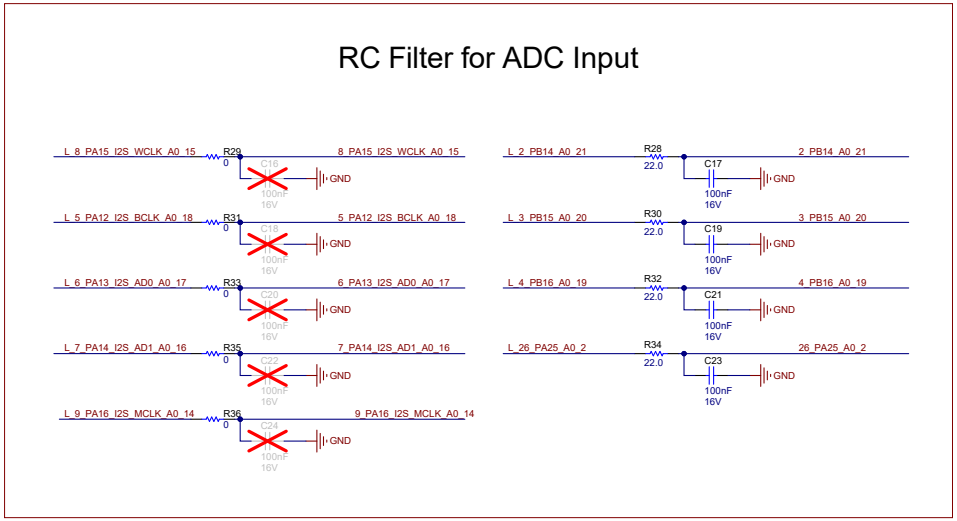

Figure 4-2. BoosterPack™ Connectors

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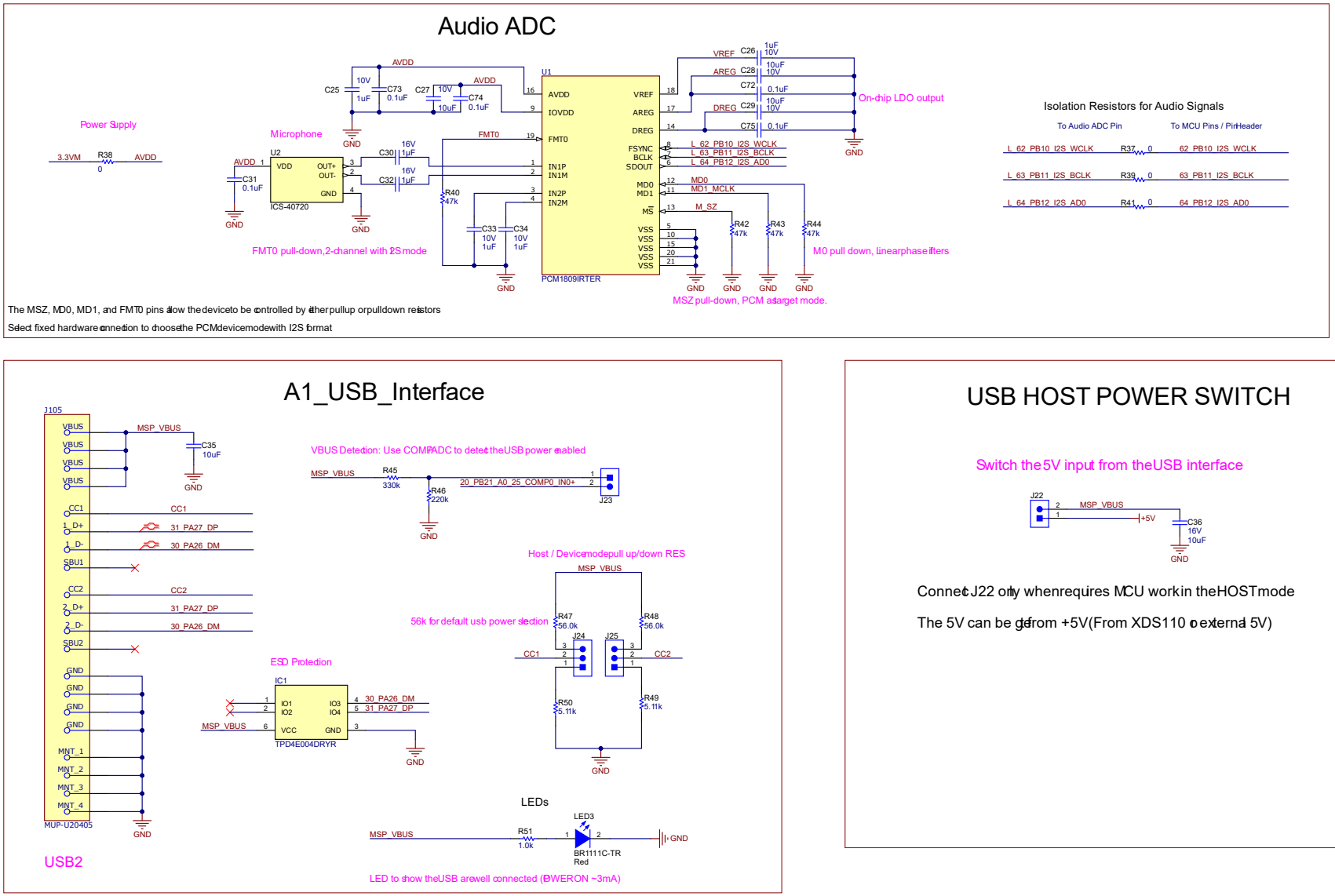

Figure 4-3. MSPM0G5187 Target Interface

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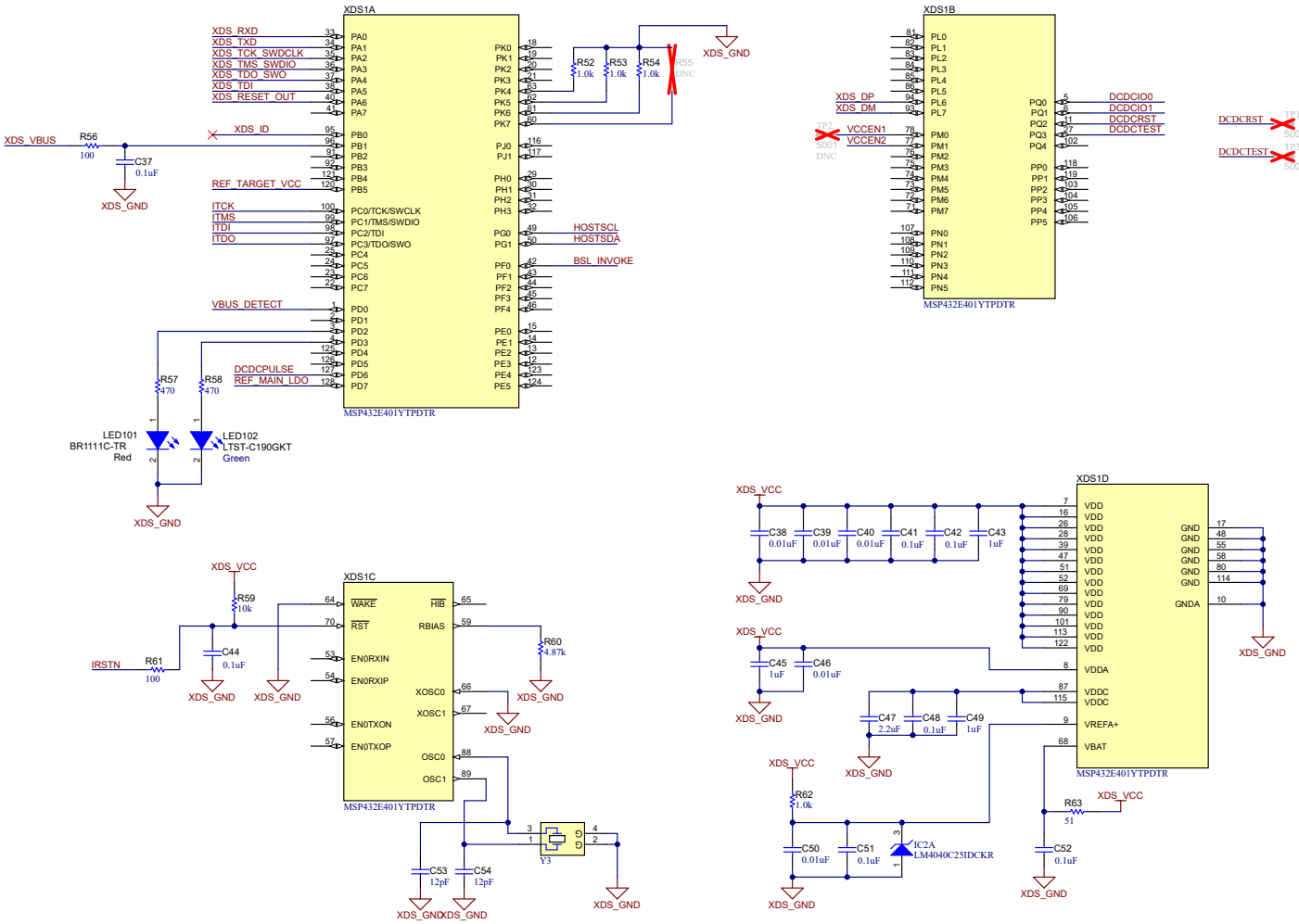

Figure 4-4. XDS110 Debug Probe Emulator Schematic

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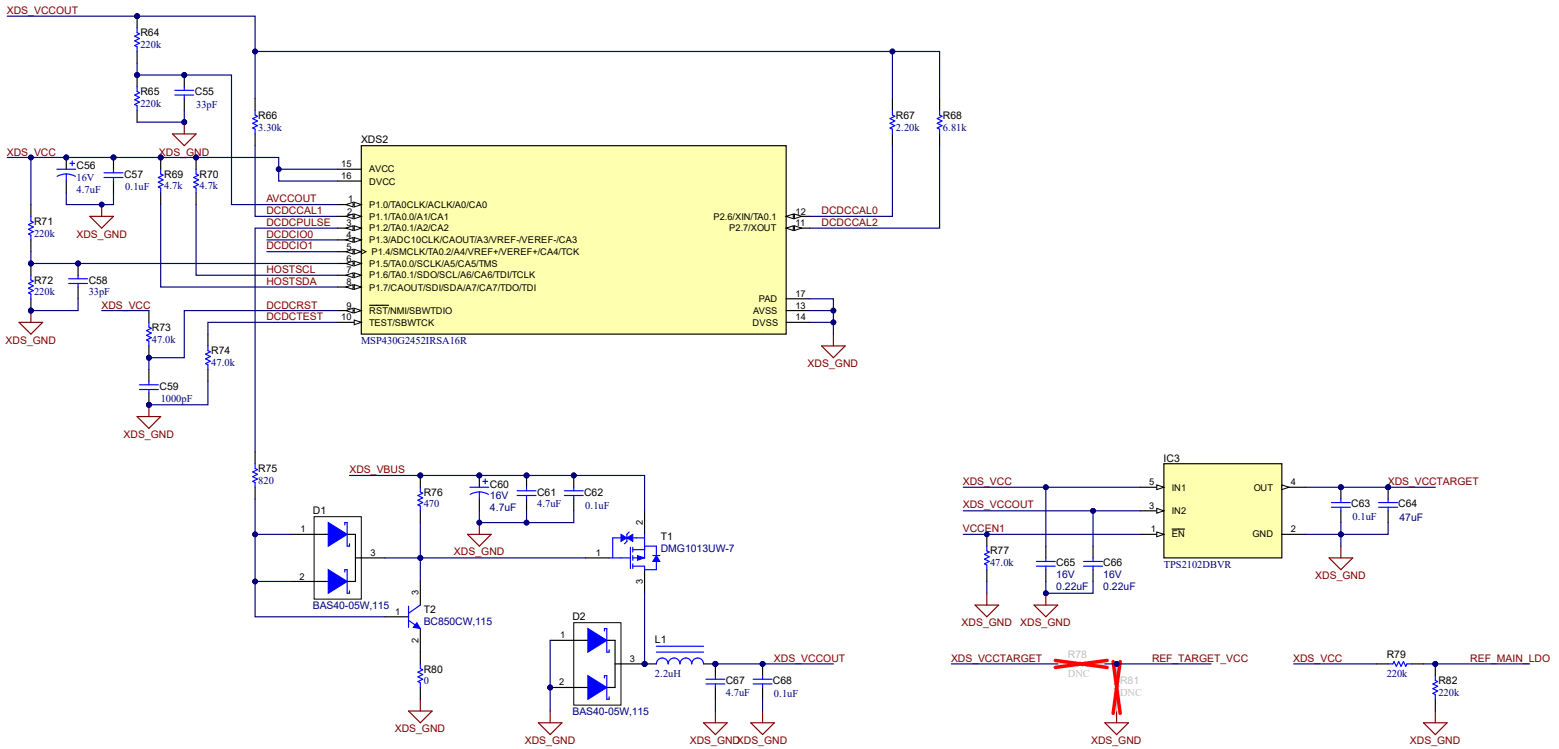

Figure 4-5. XDS110 EnergyTrace™ Schematic

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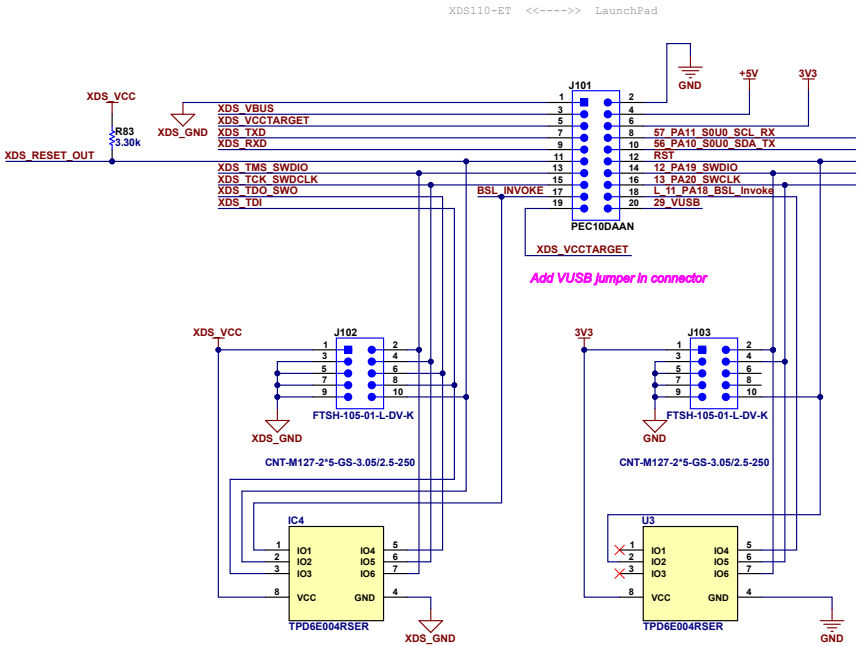

Figure 4-6. XDS110 Target Interface Schematic

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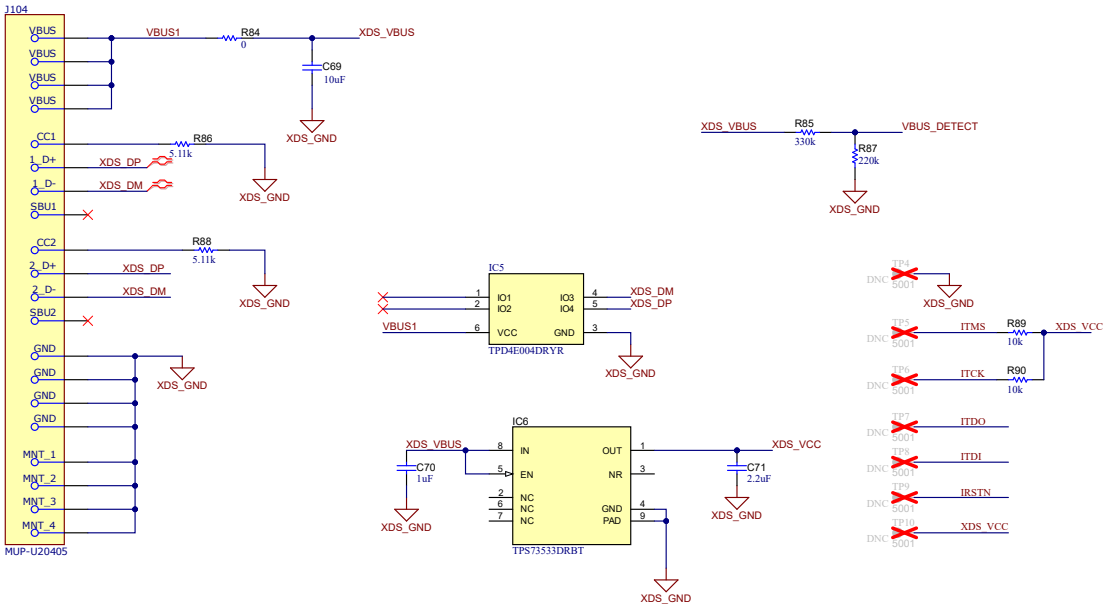

Figure 4-7. XDS110 USB Power Schematic

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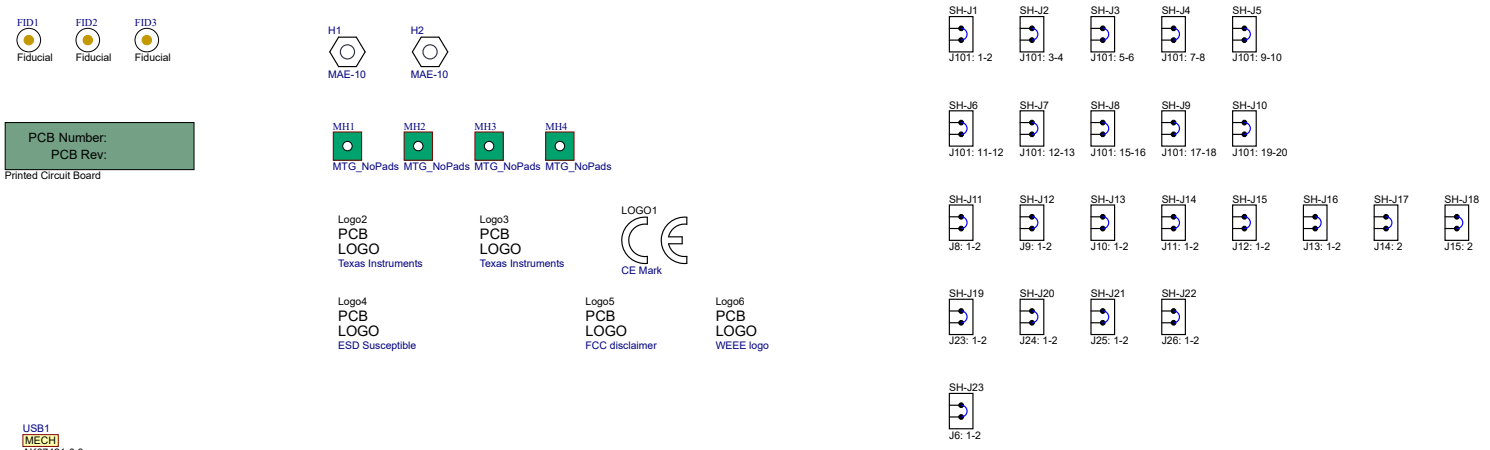

Figure 4-8. Jumpers and Standoffs

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4.2 PCB Layouts

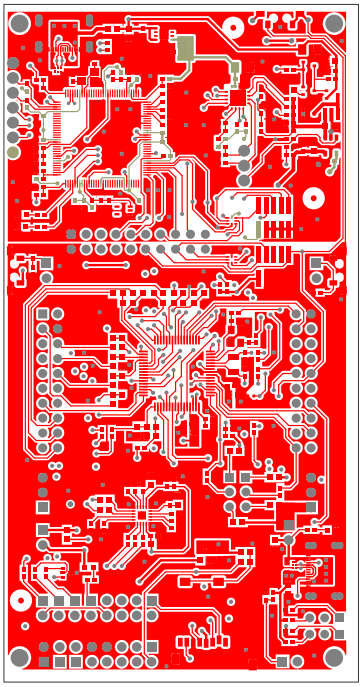

Figure 4-9. Top Layer and Overlay (1st Layer)

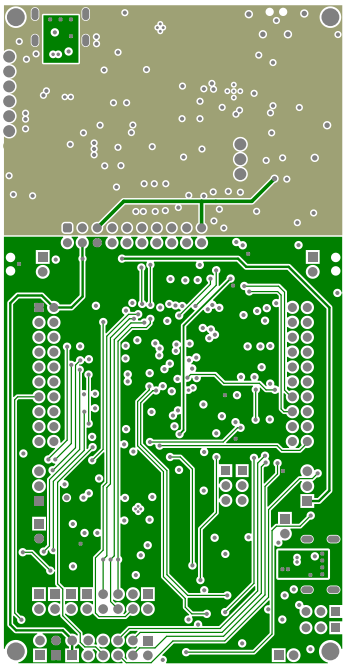

Figure 4-10. VCC Plane (2nd Layer)

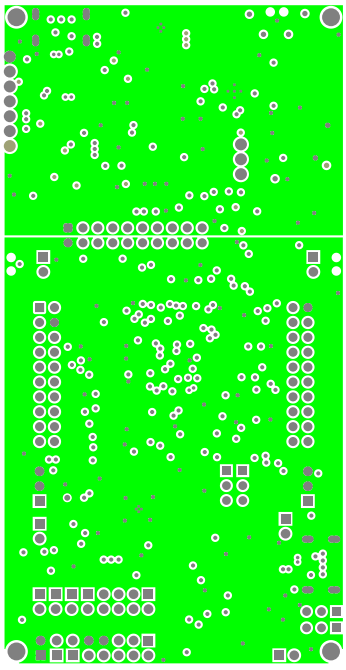

Figure 4-11. Ground Plane (3rd Layer)

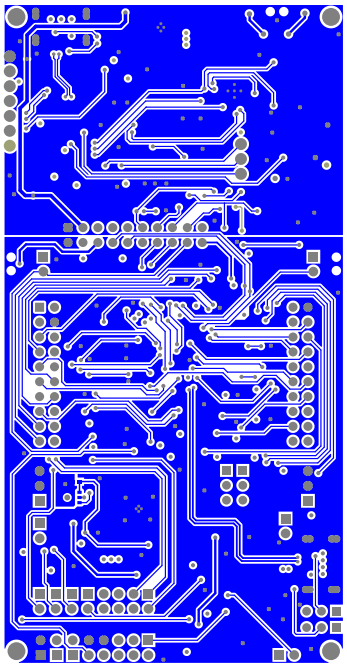

Figure 4-12. Bottom Layer and Overlay (4th Layer)

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4.3 Bill of Materials (BOM)

Table 4-1. Bill of Materials

Designator	Quantity	Value	Description	Part Number	Package Reference	Manufacturer
!PCB1	1		Printed Circuit Board	MCU170		Any
C1, C35, C69	3	10µF	CAP, CERM, 10µF, 6.3V, ±20%, X5R, 0603	CC0603MRX5R5BB106	0603	Yageo
C2, C9, C31, C72, C73, C74, C75	7	0.1µF	CAP, CERM, 0.1µF, 50V, ±20%, X5R, 0402	CC0402KRX5R9BB104	0402	Yageo
C3	1	0.47µF	CAP, CERM, 0.47µF, 6.3V, ±10%, X5R, 0402	CC0402KRX5R5BB474	0402	Yageo
C5	1	0.01µF	CAP, CERM, 0.01µF, 16V, ±10%, X5R, 0402	CC0402KRX7R7BB103	0402	Yageo
C6	1	1µF	CAP, CERM, 1µF, 25V, ±10%, X5R, 0603	CC0603KRX5R8BB105	0603	Yageo
C10, C11, C12, C13	4	15pF	CAP, CERM, 15pF, 50V, ±5%, C0G/NP0, 0402	CC0402JRNPO9BN150	0402	Yageo
C14	1	0.1µF	CAP, CERM, 0.1µF, 10V, ±10%, X7R, 0402	CC0402KRX7R6BB104	0402	Yageo
C15, C36	2	10µF	CAP, CERM, 10µF, 16V, ±20%, X5R, 0603	EMK107BBJ106MA-T	0603	Taiyo Yuden
C17, C19, C21, C23	4	0.1µF	CAP, CERM, 0.1µF, 16V, ±10%, X7R, AEC-Q200 Grade 1, 0603	AC0603KRX7R7BB104	0603	MuRata
C25, C26, C33, C34	4	1µF	CAP, CERM, 1µF, 10V, ±10%, X5R, 0402	CC0402KRX5R6BB105	0402	MuRata
C27, C28, C29	3	10µF	CAP, CERM, 10µF, 10V, ±10%, X6S, 0603	CC0603KRX5R7BB106	0603	TDK
C30, C32	2	1µF	CAP, CERM, 1µF, 16V, ±10%, X7R, 0603	CC0603KRX7R7BB105	0603	TDK
C37, C41, C42, C44, C48, C51, C52, C57, C62, C63, C68	11	0.1µF	CAP, CERM, 0.1µF, 6.3V, ±10%, X7R, 0402	CC0402KRX7R5BB104	0402	MuRata
C38, C39, C40, C46, C50	5	0.01µF	CAP, CERM, 0.01µF, 25V, ±10%, X7R, 0402	CC0402KRX7R8BB103	0402	MuRata
C43, C45, C49, C70	4	1µF	CAP, CERM, 1µF, 25V, ±10%, X5R, 0402	CC0402KRX5R8BB105	0402	TDK
C47, C71	2	2.2µF	CAP, CERM, 2.2µF, 6.3V, ±10%, X5R, 0402	CC0402KRX5R5BB225	0402	MuRata
C53, C54	2	12pF	CAP, CERM, 12pF, 50V, ±5%, C0G/NP0, 0402	CC0402JRNPO9BN120	0402	MuRata
C55, C58	2	33pF	CAP, CERM, 33pF, 50V, ±5%, C0G/NP0, 0402	CC0402JRNPO9BN330	0402	MuRata
C56, C60	2	4.7µF	CAP, TA, 4.7µF, 16V, ±10%, 4Ω, SMD	TAJA475K016RNJ	3216-18	AVX
C59	1	1000pF	CAP, CERM, 1000pF, 50V, ±10%, X7R, AEC-Q200 Grade 1, 0402	AC0402KRX7R9BB102	0402	Yageo
C61, C67	2	4.7µF	CAP, CERM, 4.7µF, 16V, ±10%, X5R, 0603	CC0603KRX5R7BB475	0603	Yageo
C64	1	47µF	CAP, CERM, 47µF, 6.3V, ±20%, X5R, 0603	CL10A476MQ8QRNC	0603	Samsung
C65, C66	2	0.22µF	CAP, CERM, 0.22µF, 16V, ±10%, X7R, 0402	CC0402KRX7R7BB224	0402	Yageo
C76, C77	2	1µF	CAP, CERM, 1µF, 10V, ±20%, X5R, 0402	CC0402MRX5R6BB105	0402	Yageo America
D1, D2	2	40V	Diode, Schottky, 40V, 0.12A, AEC-Q101, SOT-323	BAS40-05W,115	SOT-323	Nexperia
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	Fiducial	Fiducial10-30	N/A

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Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Part Number	Package Reference	Manufacturer
H1, H2	2		Spacer Support, Nylon 66	MAE-10	KY_MAE-10	Kang Yang
IC1, IC5	2		ESD-Protection Array for High-Speed Data Interfaces, 4 Channels, -40 to +85°C, 6-pin SON (DRY), Green (RoHS and no Sb/Br)	TPD4E004DRYR	DRY0006A	Texas Instruments
IC2	1		Precision Micropower Shunt Voltage Reference, 0.5% accuracy, 2.5V, 15ppm/°C, 15mA, -40 to 85°C, 5-pin SC70 (DCK), Green (RoHS and no Sb/Br)	LM4040C25IDCKR	DCK0005A_N	Texas Instruments
IC3	1		2.7-4V Dual In/Single Out MOSFET, 0.5A Main/ 0.1A Aux Input, Act-Low Enable, Comm. Temp., DBV0005A (SOT-23-5)	TPS2102DBVR	DBV0005A_N	Texas Instruments
IC4, U3	2		Low-Capacitance ±15kV ESD Protection Array for High-Speed Data Interfaces, 6 Channels, -40 to +85 degC, 8-pin UQFN (RSE), Green (RoHS and no Sb/Br)	TPD6E004RSER	RSE0008A	Texas Instruments
IC6	1		500mA, Adjustable, Low Quiescent Current, Low-Noise, High-PSRR, Single-Output LDO Regulator, DRB0008A (VSON-8)	TPS73533DRBT	DRB0008A	Texas Instruments
J1/J3	1		Receptacle, 2.54mm, 10x2, Tin, TH	NS-203-SH0135-203S-Y-2*10P(F)	BoosterPack_40pin_J1J3	NS-TECH
J2/J4	1		Receptacle, 2.54mm, 10x2, Tin, TH	NS-203-SH0135-203S-Y-2*10P(F)	BoosterPack_40pin_J2J4	NS-TECH
J5	1		Header, 100mil, 3x1, Tin, TH	NS-201-SH0385-201S-1*3P(F)	PEC03SAAN_Launchpad_3V3	NS-TECH
J6, J8, J9, J10, J11, J12, J13, J22, J23	9		Header, 100mil, 2x1, Tin, TH	NS-201-SH0386-201S-1*2P(F)	CONN_90120-0122	NS-TECH
J7	1		Header, 100mil, 3x1, Tin, TH	NS-201-SH0385-201S-1*3P(F)	PEC03SAAN_Launchpad_5V0	NS-TECH
J14, J15, J24, J25	4		Header, 100mil, 3x1, Tin, TH	NS-201-SH0385-201S-1*3P(F)	CONN_PEC03SAAN	NS-TECH
J16	1		9 (8 + 1) Position Card Connector Secure Digital – microSD™ Surface Mount, Right Angle Gold	TF CFARD 1.85H PUSH_PUSH	FP-693071010811_CONN_SMT_MEMORY-MFG	ZEGECC
J20	1		Header, 100mil, 4x2, Tin, TH	NS-201-SH0384-201S-2*4P(F)	CONN_PEC04DAAN	NS-TECH
J101	1		Header, 2.54mm, 10x2, Tin, TH	NS-201-SH0384-201S-2*10P(F)	SULLINS_PEC10DAAN	NS-TECH
J102, J103	2		Header(Shrouded), 1.27mm, 5x2, Gold, SMT	FTSH-105-01-L-DV-K	Samtec_FTSH-105-01-x-DV-K	Samtec
J104, J105	2		16PIN USB C connectors in chargers TOP mount type CH 1.63 and L=6.9 USB Type C connectors	MUP-U20405	FP-MUP-U20405_USB_CONN-MFG	MUP

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Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Part Number	Package Reference	Manufacturer
L1	1	2.2µH	Inductor, Wirewound, Ceramic, 2.2µH, 0.89A, 0.13Ω, SMD	CBC2518T2R2M	CBC2518	Taiyo Yuden
LED1, LED3, LED101	3	Red	LED, Red, SMD	LTST-C190KRKT	1111C_Red	Lite-On
LED2	1	RGB	LED, RGB, SMD	19-337/R6GHBHC-A01/2T	19-337_RGB	Everlight
LED102	1	Green	LED, Green, SMD	LTST-C190GKT	LED_LTST-C190	Lite-On
MSP1	1		Mixed-Signal Microcontrollers With USB 2.0-FS Interface	MSPM0G5187SPMR	PM0064A-MFG	Texas Instruments
R1, R2, R40, R42, R43, R44	6	47k	RES, 47k, 5%, 0.063W, 0402	AC0402JR-0747KL	0402	Yageo
R3, R23, R29, R31, R33, R35, R36, R38, R80, R84	10	0	RES, 0, 5%, 0.1W, 0603	RC0603JR-070RL	0603	Yageo
R4, R57, R58, R76	4	470	RES, 470, 5%, 0.063W, 0402	AC0402JR-07470RL	0402	Yageo
R5	1	220	RES, 220, 5%, 0.063W, 0402	AC0402JR-07220RL	0402	Yageo
R6, R7	2	330	RES, 330, 5%, 0.063W, 0402	AC0402JR-07330RL	0402	Yageo
R8	1		Res Thin Film 0402 100KΩ 0.1% 1/16W ±25ppm/°C Molded SMD SMD Punched Carrier T/R	AT0402BRD07100KL	FP-ERA-2AEB104X_0402-MFG	Yageo
R12, R15, R27	3	4.7k	RES, 4.7k, 5%, 0.1W, 0603	RC0603JR-074K7L	0603	Yageo
R13, R18	2	270	RES, 270, 5%, 0.063W, 0402	CRCW0402270RJNED	0402	Vishay-Dale
R16, R19	2	2.2k	RES, 2.2k, 5%, 0.1W, 0603	RC0603JR-072K2L	0603	Yageo
R22, R37, R39, R41	4	0	RES, 0, 5%, 0.063W, 0402	RC0402JR-070RL	0402	Yageo America
R26	1	47k	RES, 47k, 5%, 0.1W, 0603	RC0603JR-0747KL	0603	Yageo
R28, R30, R32, R34	4	22.0	RES, 22.0, 1%, 0.1W, 0603	RC0603FR-0722RL	0603	Yageo
R45, R85	2	330k	RES, 330k, 1%, 0.0625W, 0402	RC0402FR-07330KL	0402	Yageo America
R46, R64, R65, R71, R72, R79, R82, R87	8	220k	RES, 220k, 1%, 0.0625W, 0402	RC0402FR-07220KL	0402	Yageo America
R47, R48	2	56.0k	RES, 56.0k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	RK73H1ETTP5602F	0402	PANASONIC
R49, R50, R86, R88	4	5.11k	RES, 5.11k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	AC0402FR-075K11L	0402	Yageo
R51	1	1.0k	RES, 1.0k, 5%, 0.1W, AEC-Q200 Grade 0, 0402	ERJ-2GEJ102X	0402	Panasonic
R52, R53, R54, R62	4	1.0k	RES, 1.0k, 5%, 0.063W, 0402	AC0402JR-071KL	0402	Yageo
R56, R61	2	100	RES, 100, 5%, 0.063W, AEC-Q200 Grade 0, 0402, RES, 100, 5%, 0.063W, 0402	AC0402JR-07100RL	0402	Yageo
R59, R89, R90	3	10k	RES, 10k, 5%, 0.063W, 0402	AC0402JR-0710KL	0402	Yageo

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Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Part Number	Package Reference	Manufacturer
R60	1	4.87k	RES, 4.87k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	AC0402FR-074K87L	0402	Yageo
R63	1	51	RES, 51, 5%, 0.063W, AEC-Q200 Grade 0, 0402	AC0402JR-0751RL	0402	Yageo
R66, R83	2	3.30k	RES, 3.30k, 1%, 0.1W, AEC-Q200 Grade 0, 0402	AC0402FR-073K3L	0402	Yageo
R67	1	2.20k	RES, 2.20k, 1%, 0.063W, 0402	RMCF0402FT2K20	0402	Stackpole
R68	1	6.81k	RES, 6.81k, 1%, 0.063W, 0402	AC0402FR-076K81L	0402	Yageo
R69, R70	2	4.7k	RES, 4.7k, 5%, 0.063W, 0402	AC0402JR-074K7L	0402	Yageo
R73, R74, R77	3	47.0k	RES, 47.0k, 1%, 0.0625W, 0402	RC0402FR-0747KL	0402	Yageo America
R75	1	820	RES, 820, 1%, 0.063W, 0402	RC0402FR-07820RL	0402	Yageo America
S1, S2, S3	3		Switch, SPST, 0.05A, 12 VDC, SMD	THBM02-LAB	SW_1188E	HONGJU
T1	1	-20V	MOSFET, P-CH, -20V, -0.82A, SOT-323	DMG1013UW-7	SOT-323	Diodes Inc.
T2	1	45V	Transistor, NPN, 45V, 0.1A, SOT-323	BC850CW,115	SOT-323	NXP Semiconductor
U1	1		Stereo Channel, 32-Bit, 192kHz, Burr-Brown Audio ADC	PCM1809IRTER	RTE0020A-MFG	Texas Instruments
U2	1		Ultra-Low Noise Microphone with Differential Output, LGA-4	ICS-40720	LGA_CAV-4	InvenSense
XDS1	1		MSP432E401YTPDT, PDT0128A (TQFP-128)	MSP432E401YTPDTR	PDT0128A	Texas Instruments
XDS2	1		MSP430G2x52, MSP430G2x12 Mixed Signal Microcontroller, RSA0016B (VQFN-16)	MSP430G2452IRSA16R	RSA0016B	Texas Instruments
Y1	1		Crystal, 32.768KHz, 12.5pF, SMD	X1A0001410014	Epson_FC-135	Epson
Y2	1		Crystal 40MHz ±10ppm (Tol) ±20ppm (Stability) 12pF FUND 40Ohm 4-Pin Mini-CSMD T/R	ECS-400-12-33Q-JEN-TR	FP-X1E0000210179_TSX-3225-MFG	ECS
Y3	1		Crystal, 16MHz, 8pF, SMD	NX3225GA-16.000M-STD-CRG-1	NDK_NX3225GA	NDK
SH-J1	1	J101: 1-2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J2	1	J101: 3-4	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J3	1	J101: 5-6	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J4	1	J101: 7-8	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J5	1	J101: 9-10	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J6	1	J101: 11-12	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J7	1	J101: 12-13	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J8	1	J101: 15-16	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J9	1	J101: 17-18	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron

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Table 4-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	Part Number	Package Reference	Manufacturer
SH-J10	1	J101: 19-20	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J11	1	J8: 1-2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J12	1	J9: 1-2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J13	1	J10: 1-2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J14	1	J11: 1-2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J15	1	J12: 1-2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J16	1	J13: 1-2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J17	1	J14: 2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J18	1	J15: 2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J19	1	J23: 1-2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J20	1	J24: 1-2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J21	1	J25: 1-2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J22	1	J26: 1-2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron
SH-J23	1	J6: 1-2	Shunt, 100mil, Gold plated, Black	2228CG	SNT-100-BK-G	Nextron

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5 Additional Information

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6 Related Documentation

6.1 Supplemental Content

The following items are important learning materials to get started with MSPM0.

- MSPM0 Academies
- MSPM0-SDK Code examples
- TI Precision Labs

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WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

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

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

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

CAUTION

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

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

FCC Interference Statement for Class A EVM devices

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

FCC Interference Statement for Class B EVM devices

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

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

3.2 *Canada*

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

Concerning EVMs Including Radio Transmitters:

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

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

Concernant les EVMs avec appareils radio:

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

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

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

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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

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

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

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

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

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3.4 *European Union*

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

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

4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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

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

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

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

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