EVM User's Guide: LP-MSPM0G3708

MSPM0G3708 LaunchPad™ 开发套件

说明

MSPM0G3708 LaunchPad™ 开发套件是用于评估 MSPM0G3708 微控制器 (MCU) 的评估模块。LaunchPad 套件包含 MSPM0Gx70x 和 MSPM0Gx73x 微控制器平台上开始开发所需要的全部资源，包括用于编程、调试和 EnergyTrace™ 技术的板载调试探针。该电路板配备三个按钮、一个 RGB LED、外部晶振以及板载低通滤波器，可与 MSPM0G3708 的 Σ-Δ ADC 配合使用。

开始使用

1. 从 ti.com 订购 LP-MSPM0G3708。
2. 转到 dev.ti.com 浏览代码示例。
3. 使用提供的 USB 电缆将 LP-MSPM0G3708 插入 PC。
4. 使用 CCS Cloud 将代码直接从浏览器下载到 MSPM0G3708。

或

1. 从 ti.com 订购 LP-MSPM0G3708。
2. 转到 dev.ti.com 浏览代码示例。
3. 使用提供的 USB 电缆将 LP-MSPM0G3708 插入 PC。
4. 下载用于桌面集成开发环境的 CCS。
5. 下载用于桌面存储示例、演示和软件库的 MSPM0 SDK。

特性

- Δ-Σ ADC 输入端排针接口。
- 板载 XDS110 调试探针
- 通过 USB 供电，并使用板载 LDO 将 5V 转换为 3.3V
- 40 引脚 BoosterPack™ 接头
- 硬件用户界面
  - 两个按钮；1 个 RGB LED
- 外部时钟晶体
- 反向通道 UART，通过 USB 连接到 PC

应用

- 电表：商业电表和住宅电表
- 电网基础设施
- 电器
- 电能质量监测仪
- 电池测试设备
- 电池管理系统
- 测试和测量
- 工厂自动化与控制
- 楼宇自动化

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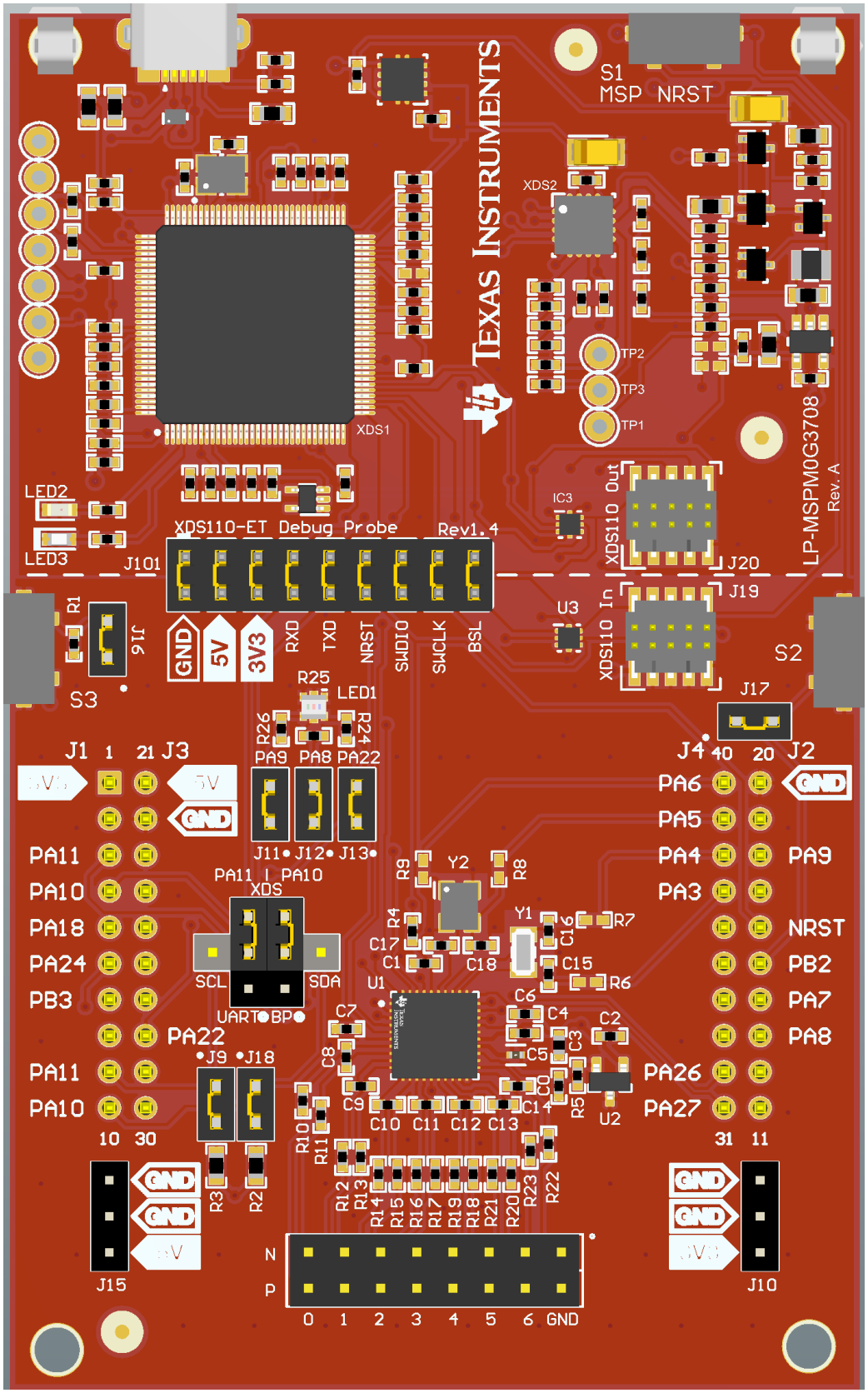


图 1-1. LP-MSPM0G3708

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1 评估模块概述

1.1 简介

MSPM0G3708 是一款 Arm® Cortex® M0+ 32 位 CPU，具有双组闪存和增强的安全功能，支持高达 80MHz 的频率。该器件具有多个 24 位 Σ — Δ ADC，用于同时将模拟信号精确转换为数字代码。开始使用 MSPM0G3708 的简单方法是使用 LP-MSPM0G3708 LaunchPad™。该 LaunchPad 具有加载代码、调试和原型设计所需的所有开箱即用功能。

该器件采用 256kB 双组闪存、32kB SRAM 和 8kB 数据闪存存储器。该器件包含内部模拟外设，例如两个 12 位 SAR ADC、内部电压基准、多达八个 24 位 Σ-Δ ADC，以及两个具有 8 位基准 DAC 的比较器。MSPM0G3708 是首款采用 Σ-Δ ADC 进行高精度测量的 MSPM0 器件。

40 引脚 BoosterPack™ 插件模块接头简化了快速原型设计，支持市面上的多种 BoosterPack 插件模块。用户可以快速添加无线连接、图形显示、环境检测等功能。您还可以设计您自己的 BoosterPack 插件模块，或者从 TI 和第三方开发商已提供的众多插件模块中进行选择。底部接头行具有 Σ-Δ ADC 信号链的输入，包括用于 ADC 信号调节的无源器件。

为使原型设计更加轻松，TI 提供了 MSPM0 软件开发套件 (SDK)，该套件包含各种用于演示如何使用内部外设的代码示例。

还提供免费的软件开发工具，例如 TI 的 Code Composer Studio IDE™。TI 还支持 IAR Embedded Workbench® IDE 和 Arm®Keil® µ Vision® IDE 等第三方 IDE。在与 MSPM0G3708 LaunchPad 开发套件配套使用时，Code Composer Studio IDE 支持 EnergyTrace™ 技术。有关 LaunchPad 开发套件、配套 BoosterPack 插件模块和可用资源的更多信息，请访问 TI LaunchPad 开发套件门户。要快速入门并了解 MSPM0 软件开发套件 (SDK) 中的可用资源，请访问 TI 开发人员专区。MSPM0 MCU 还有各种在线配套资料、MSPM0 Academy 培训，以及通过 TI E2E™ 支持论坛提供的在线支持。

1.2 套件内容

- LP-MSPM0G3708 LaunchPad 开发套件
- USB 电缆
- 快速入门指南

1.3 规格

LP-MSPM0G3708 旨在与运行 Code Composer Studio™ (CCS) 的 PC、Mac® 或 Linux® 工作站配合使用。CCS 可以在工作站上独立运行，也可通过 Web (CCS Cloud) 访问，无需安装软件。或者，可以使用 TI Energy Metrology Studio GUI 对 LP-MSPM0G3708 进行配置和编程。

该器件可以由内置 USB 电源以外的电源供电。此设计允许用户放弃 PC 连接。电源可直接施加到 3.3V 电压轨。使用外部电源时，请确保不能超过 3.3V。利用板载 Arm 10 引脚连接器，可以使用单独的 XDS110 外部调试器从外部完成编程，也可以通过将 ARM M0+ 编程器连接到 SDWIO 和 SWCLK 引脚来完成。

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1.4 器件信息

器件名称	说明	用途
MSP432E401YTPDTR	具有以太网连接、CAN、1MB 闪存和 256kB RAM 的 SimpleLink™ 32 位 ARM Cortex®-M4F MCU	XDS110 主机器件
MSPM0G3708SZFUR	具有 80MHz Arm® 32 位 Cortex® M0+ CPU、256kB 闪存、32kB SRAM 和集成 Σ-Δ ADC 的混合信号微控制器	评估器件
MSP430G2452IRSA16R	具有 16 位 RISC CPU、8kB 闪存和 256B SRAM 的混合信号微控制器	用于 EnergyTrace 技术的直流/直流控制器
TPD6E004RSER	用于高速数据接口的 6 通道 ESD 保护阵列	通过编程接口保护 LP-MSPM0G3708 免受 ESD 损坏
TPS73533DRBT	500mA、可调节、低静态电流、低噪声、高 PSRR、单路输出 LDO 稳压器	3.3V 电源 XDS110 和 MSPM0G3708
TPS2102DBVR	2.7V 至 4V 电源多路复用器、双输入、单输出电源开关	切换 XDS110 电源
TPD4E004DYR	用于高速数据接口的 4 通道 ESD 保护阵列	通过 USB 连接器保护 LP-MSPM0G3708 免受 ESD 损坏
LM4040C25IDCKR	高精度微功耗并联电压基准	为 MSP432E401Y 提供基准
REF3012AIDBZT	1.2V 电压基准	为 MSPM0G708 上的 Σ-Δ ADC 提供外部基准选项

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2 硬件

2.1 硬件概述

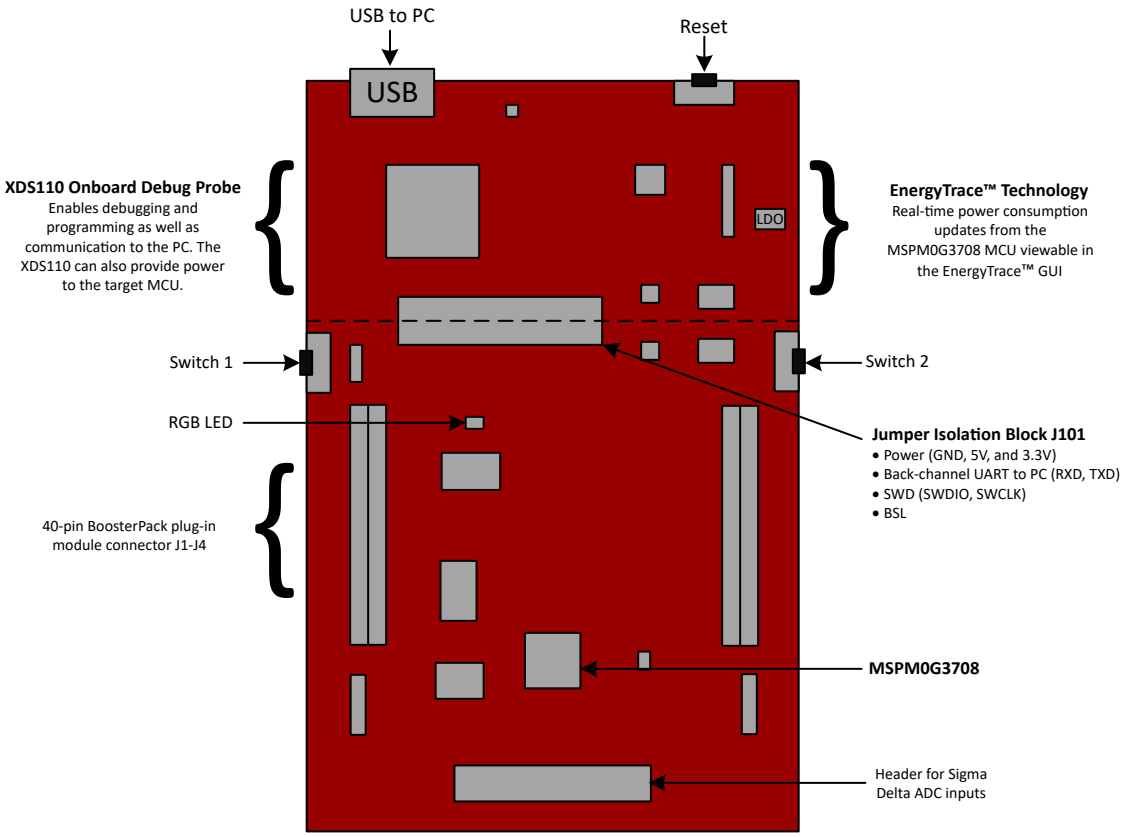


图 2-1. LP-MSPM0G3708 跳线和连接图

LP-MSPM0G3708 具有硬件特性，允许用户完全访问 MSPM0G3708 引脚，同时仍提供板载连接以方便使用。分流连接为用户提供了一种更改 LaunchPad 连接的方法。图 2-1 展示了这些功能块的位置。节 2.2 描述了每个分流器的连接和默认放置位置。

2.2 跳线信息

表 2-1. 跳线表

跳线	说明	默认设置	连接的信号
J1-J4	BoosterPack 接头	未组装	40 引脚接头的 BoosterPack 标准连接
J13	RGB LED（蓝色）	已组装	将 PA22 连接到 RGB（蓝色）LED
J12	RGB LED（红色）	已组装	将 PA8 连接到 RGB（红色）LED
J11	RGB LED（绿色）	已组装	将 PA9 连接到 RGB（绿色）LED
J16	BSL 调用	已组装	将 PA18 连接到 S1 按钮
J15	5V 电源接头	未组装	5V 和 GND 的附加引脚连接
J10	3.3V 电源接头	未组装	3.3V 到 GND 的附加引脚连接
J9	I2C 上拉	已组装	PA10 的 I2C SDA 上拉
J18	I2C 上拉	已组装	PA11 的 I2C SCL 上拉
PA11 | PA10 跳线连接点	PA11 和 PA10 操作的多选接口	已填充，PA11 和 PA10 连接到 UART XDS 操作	请参阅 节 2.2.1。
底部 N P 接头块	Σ-Δ ADC 输入端排针接口	未组装	请参阅 节 2.2.2。

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表 2-1. 跳线表（续）

跳线	说明	默认设置	连接的信号
J101	XDS110 与评估器件之间的隔离桥	已组装	将板的 XDS110 部分连接到 MSPM0G3708，用于编程、供电和调试。
J102	XDS110 输出	未组装	用于将 Arm 10 引脚连接器连接到 XDS110 板载调试器输出的接头接口。
J103	XDS110 输入	未组装	用于将 Arm 10 引脚连接器连接到 MSPM0G3708 的接头接口。

2.2.1 PA10 和 PA11 连接端子

PA10 和 PA11 使用 4 路连接端子进行连接。中心右侧引脚是 PA10 与 MSPM0G3708 的连接，中心左侧引脚是 PA11 与 MSPM0G3708 的连接。连接块的顶部引脚将 PA10 和 PA11 连接到用于 UART 的 BoosterPack™ 引脚，底部引脚通过 J101 将 PA10 和 PA11 连接到 XDS110 UART，外侧左引脚或右引脚将 PA10 和 PA11 连接到 I2C 连接。

PA10 跳线连接	PA11 跳线连接	功能
中心右侧：底部右侧	中间左侧：底部左侧	BoosterPack™ UART（引脚 3 和 4）。
中心右侧：顶部右侧	中心左侧：顶部左侧	XDS110 UART，需要填充 J101 RXD 和 TXD。
中心右侧：中间右侧	中心左侧：中间左侧	I2C 连接
中心右侧：中心左侧	中心左侧：中心右侧	短接 PA10 和 PA11（用于 UART 回显）

2.2.2 底部 Σ-Δ 接头块

底部接头块为 Σ-Δ ADC 提供输入连接。各行是特定输入的连接，N 行用于 SD24xN 输入，P 行用于 SD24xP 输入。列表示该输入用于哪个 Σ-Δ ADC 实例。例如，列 0 具有 SD240N 的 N 连接和 SD240P 的 P 连接。

	0	1	2	3	4	5	6	7	GND
N	SD24.0N	SD24.1N	SD24.2N	SD24.3N	SD24.4N	SD24.5N	SD24.6N	SD24.7N	GND
P	SD24.0P	SD24.1P	SD24.2P	SD24.3P	SD24.4P	SD24.5P	SD24.6P	SD24.7P	GND

2.3 电源要求

LP-MSPM0G3708 只需插入 USB 并填充调试器跳线块即可为器件供电。通过板载 LDO，5V USB 电源转换为 3.3V，并提供 500mA 电源电流。也可以通过外部电源并使用 3.3V 或 5V 接头为 LaunchPad 供电。3.3V 轨上的电压不能超过 3.3V，5V 轨上的电压不能超过 5V。

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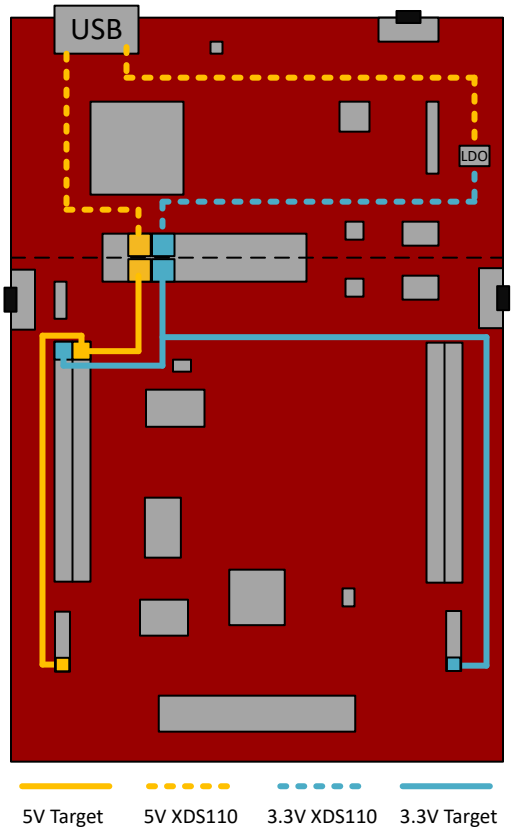


图 2-2. LP-MSPM0G3708 电源接头

2.4 XDS110 调试探针

LP-MSPM0G3708 具有板载调试探针，可简化原型设计。此 LaunchPad 上使用的调试器是 XDS110 型号，它支持所有 MSPM0 器件衍生产品。集成式 XDS110 调试探针与 MSPM0G3708 电路的其余部分分离，如 LaunchPad 上的虚线丝印所示。除了公共接地之外，XDS110 只能通过经过 J101 的信号进行连接。

2.4.1 隔离跳线块

利用隔离跳线块 J101，用户可以连接或断开从 XDS110 域进入 MSPM0G3708 目标域的信号。这包括 XDS110 SWD 信号、应用 UART 信号、3.3V 和 5V 电源以及复位信号。

跳线	说明
5V	来自 USB 的 5V 电源轨。
3V3	来自 LDO 的 3.3V 电源轨。
RXD<<	反向通道 UART：目标 MSPM0G3708 通过该信号接收数据。箭头指示信号的方向。
TXD>>	反向通道 UART：目标 MSPM0G3708 通过该信号发送数据。箭头指示信号的方向。
NRST	复位信号。
SWDIO	串行线调试：SWDIO 数据信号。
SWCLK	串行线调试：SWCLK 时钟信号。
BSL	为引导加载程序调用引脚。允许 XDS110 调用 BSL。

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2.5 测量 MSPM0G3708 的电流消耗

要使用万用表测量 MSPM0G3708 MCU 的电流消耗，请使用 J101 跳线隔离块上的 3V3 跳线。测量的电流包括目标器件和 LaunchPad 电路消耗的电流以及任何通过 BoosterPack 插件模块接头消耗的电流。要测量超低功耗，请按照下列步骤操作：

1. 拆下 J101 隔离块中的 3V3 跳线，并在该 3V3 跳线上连接一个电流表。
2. 应考虑反向通道 UART 和任何连接到 MSPM0G3708 的电路可能对电流消耗产生的影响。考虑在隔离跳线块上断开反向通道 UART，或者至少在最终测量中考虑灌电流和拉电流能力。
3. 确保 MSPM0G3708 上没有悬空输入或输出 (I/O)。悬空输入或输出会引起不必要的额外电流消耗。每个 I/O 都会进行驱动，如果 I/O 是输入，则将其拉或驱动至高电平或低电平。
4. 开始执行目标。
5. 要实现更准确的电流测量，请将器件置于“Free Run”模式，并断开 MSPM0G3708 与电路板调试部分（接头 J101）之间的编程信号。
6. 测量电流。请记住，如果电流出现波动，则可能难以获得稳定的测量结果。在静态状态下进行测量会更轻松。

2.6 时钟

内部 SYSOSC 默认为 32MHz（精度为 2.5%）。默认情况下，MCLK 由 SYSOSC 提供。SYSPLL 可用于生成高达 80MHz 的时钟信号，从而为 MCLK 提供时钟源。CPUCLK 在 RUN 模式下直接以 MCLK 为源，在其他模式下禁用。低功耗时钟 (ULPCLK) 可以 MCLK 为源，并通过配置在 RUN 和 SLEEP 模式下激活。该器件还包含内部 32kHz 振荡器 LFOSC，这是默认的低频源。该 LaunchPad 包含两个时钟晶体选项，一个选项是高频 40MHz 晶体 (HFXT)，另一个选项是低频 32.768kHz 晶体 (LFXT)。在应用程序编程期间，应选择晶体作为高频和低频时钟的时钟源。有关时钟树的更多详细信息，请参阅 *MSPM0 G 系列 80MHz 微控制器* 技术参考手册的*时钟模块 (CKM)* 一节。

2.7 BoosterPack 插接模块引脚布局

LaunchPad 开发套件遵循 40 引脚 LaunchPad 开发套件引脚排列标准（如果引脚可用）。对于 TI 生态系统而言，标准化 LaunchPad 开发套件引脚排列可实现 LaunchPad 开发套件与 BoosterPack 插件模块之间的兼容性。虽然大多数 BoosterPack 插接模块符合该标准，但仍有些不符合标准。如果 BoosterPack 插件模块的经销商或所有者没有明确指出该模块与 MSPM0G3708 LaunchPad 开发套件的兼容性，请将候选 BoosterPack 插件模块的原理图与 LaunchPad 开发套件进行比较，以验证兼容性。通过在软件中更改 MSPM0G3708 器件的引脚功能配置来解决冲突。

2.8 Σ-Δ ADC 输入

MSPM0G3708 具有 Σ-Δ ADC。用于 Σ-Δ ADC 的专用跳线块提供了一个集中放置关键信号的位置。每个 Σ-Δ ADC 都有 RC 滤波器以获得更好的结果，用户可以更换无源元件以将滤波器更改为相应的输入信号频率。该板基于 LaunchPad 生态系统创建，因此 Σ-Δ ADC 的性能可能不如针对用户应用专门设计的板。

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3 软件

3.1 软件开发选项

使用 LP-MSPM0G3708 进行原型设计的方法有多种。使用任何非云端选项时，TI 建议安装 MSPM0 SDK。

1. Code Composer Studio Cloud — 选择此选项可开始使用 MSPM0，只需极少的安装
   a. 需要 TI Cloud Agent
2. Code Composer Studio IDE — 选择此选项可脱机工作并拥有对调试功能的完全访问权限
3. TI Energy Metrology Studio — 选择此选项用于电能计量特定应用，允许用户配置器件并使用 TI 的电能计量代码。

3.2 TI Energy Metrology Studio

TI Energy Metrology Studio 是一个 GUI，可帮助用户为计量功能配置 MSPM0G3708。用户可以使用该 GUI 配置、校准和查看结果。

有关 TI Energy Metrology Studio 的完整详细信息，请参阅 TI Energy Metrology Studio 用户指南。

3.3 软件开发：CCS

以下说明适用于 Code Composer Studio IDE。

1. 安装 Code Composer Studio（CCS）和 MSPM0 SDK。
2. 安装完成后，打开 CCS，导航到左上角，然后选择“File”
3. 选择“Import Project”
4. 点击“browse”，然后导航到 MSPM0 SDK 安装目录，默认路径为 C:\ti\mspm0_sdk_x_xx_xx_xx，其中 x 为版本号。
5. 依次导航到 examples > nortos > LP_MSPM0G3708 > riverlib，点击 gpio_toggle_output，然后选择文件夹
6. 点击该示例的 ticlang 版本并点击“finish”，示例即被导入。
7. 使用 USB 电缆将 LP-MSPM0G3708 插入 PC。
8. 右键点击 gpio_toggle_output 示例并选择“debug project”或“flash project”，此操作会启动器件编程。
9. 刷写完成后，运行程序并观察板上的闪烁灯。

探索任何其他代码示例和 .sysconfig 文件以开始开发。

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4 硬件设计文件

4.1 原理图

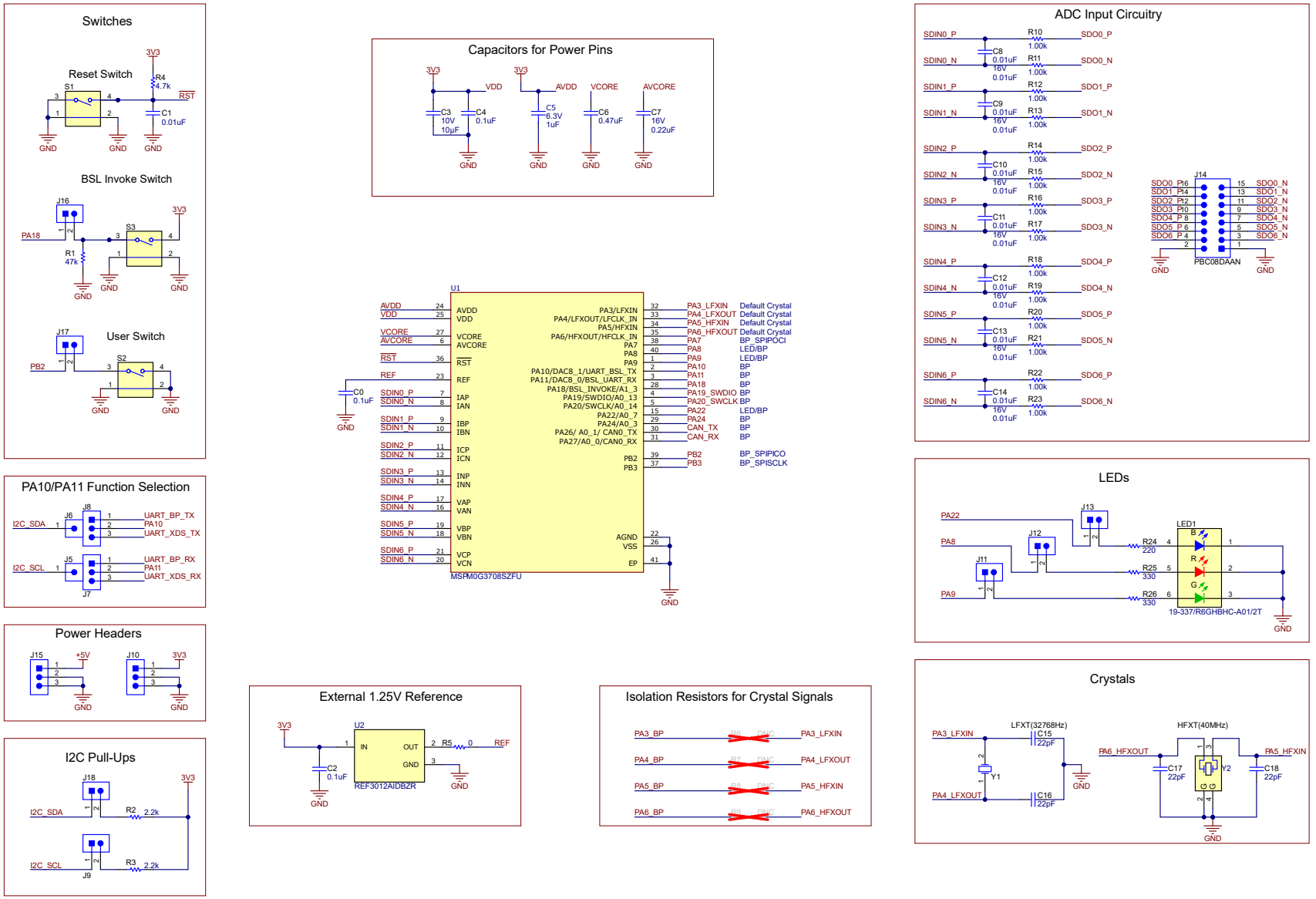


图 4-1. MSPM0G3708 目标器件原理图

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BoosterPack Connectors

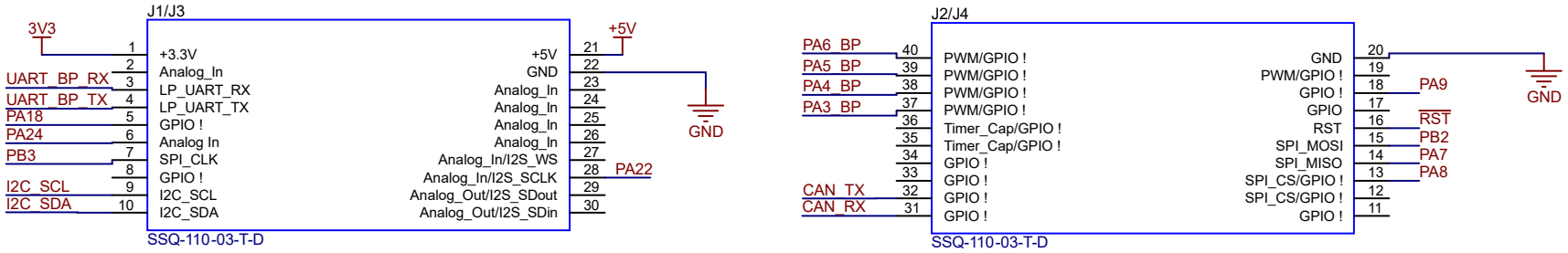


图 4-2. BoosterPack 连接器

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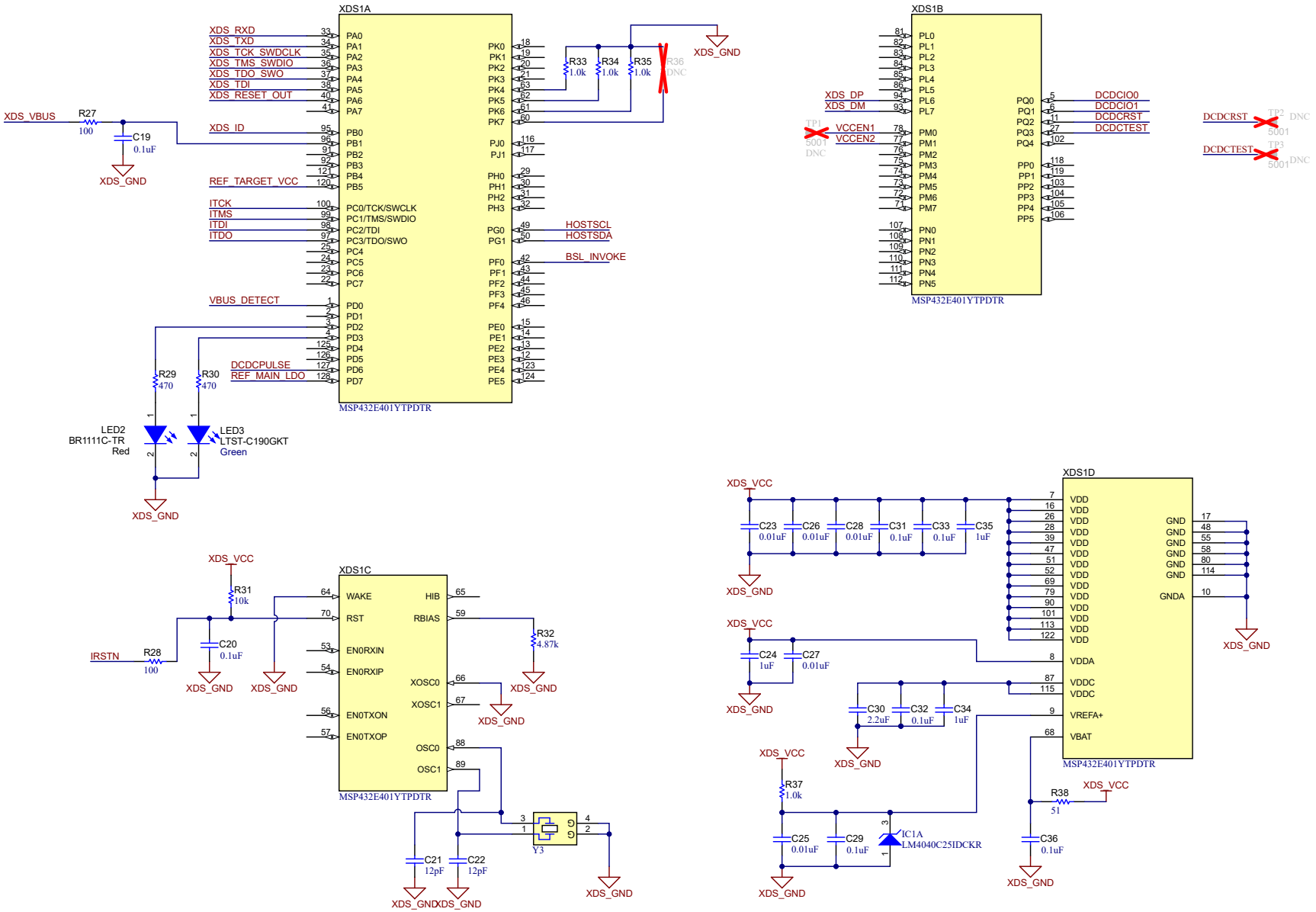


图 4-3. XDS110 调试探针仿真器原理图

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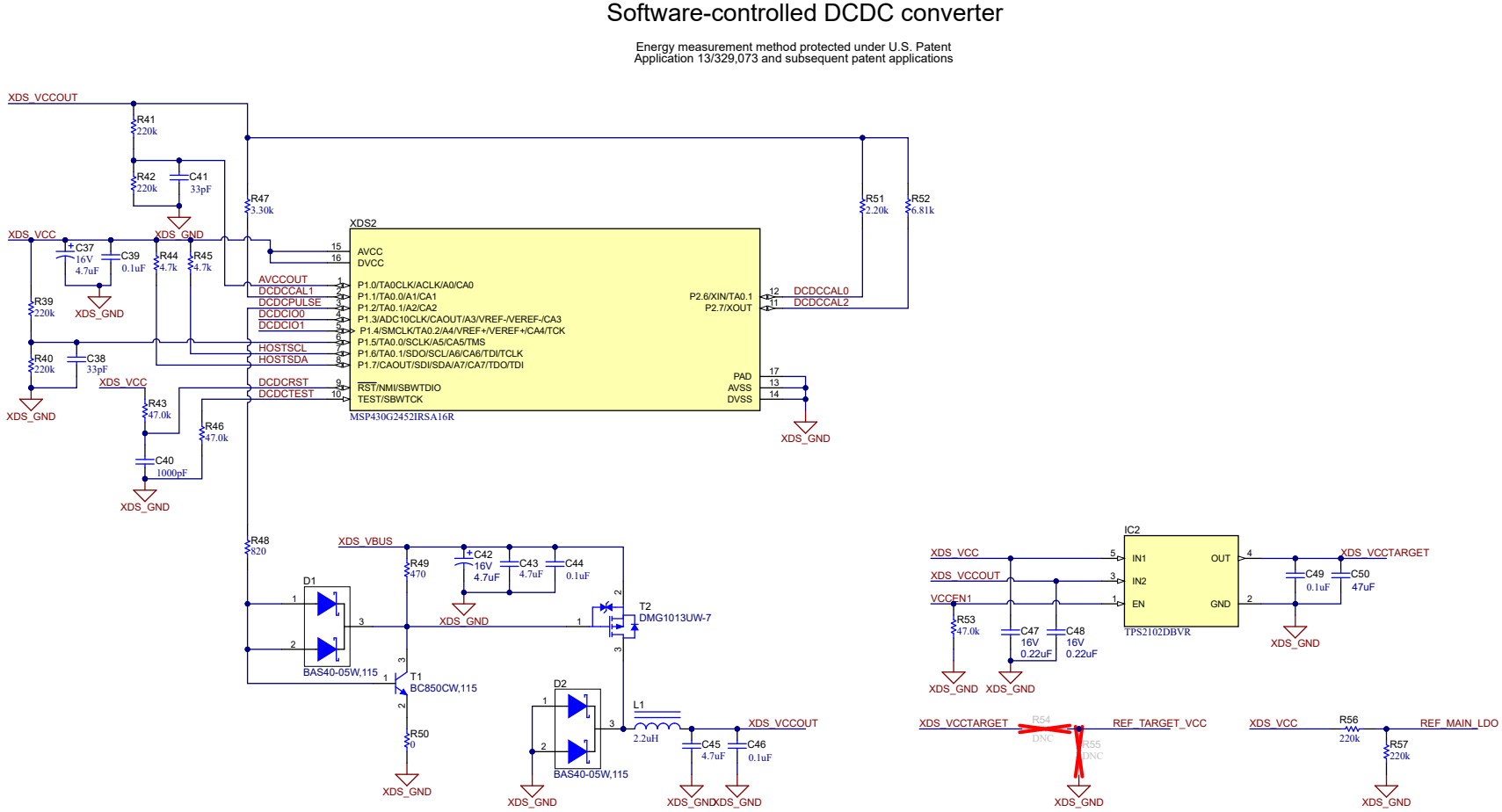


图 4-4. XDS110 EnergyTrace 原理图

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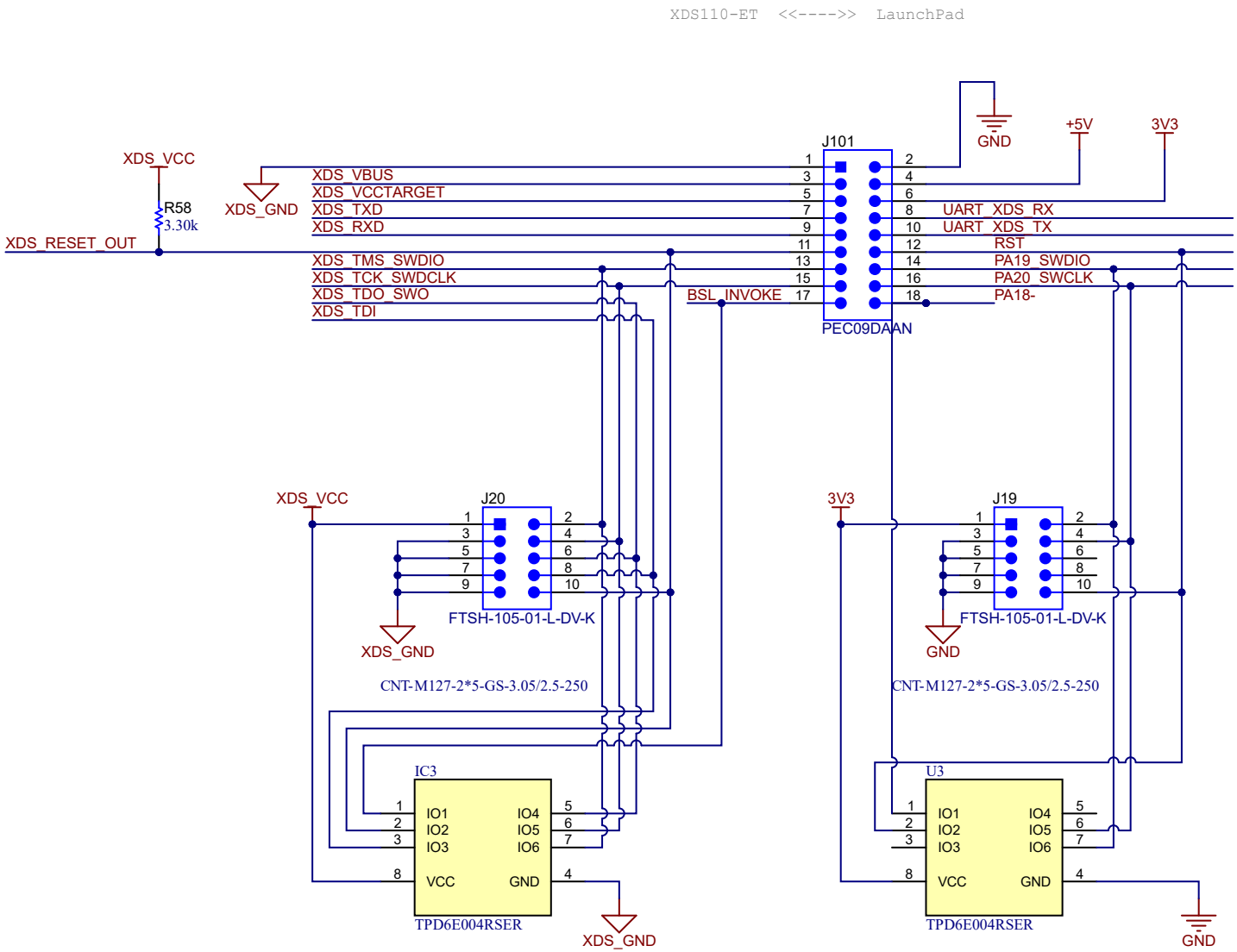


图 4-5. XDS110 目标接口原理图

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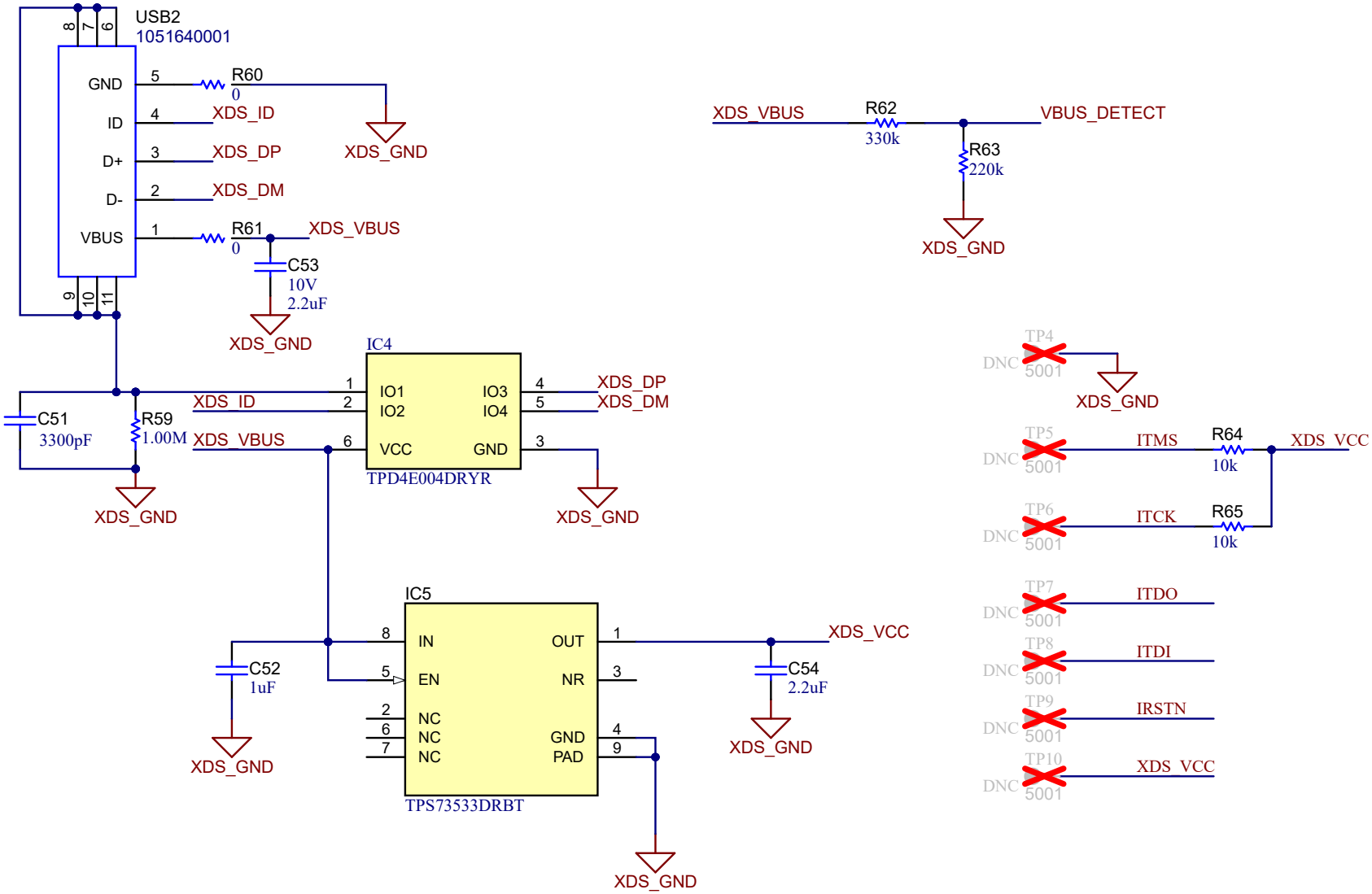


图 4-6. XDS110 USB 电源原理图

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4.2 PCB 布局

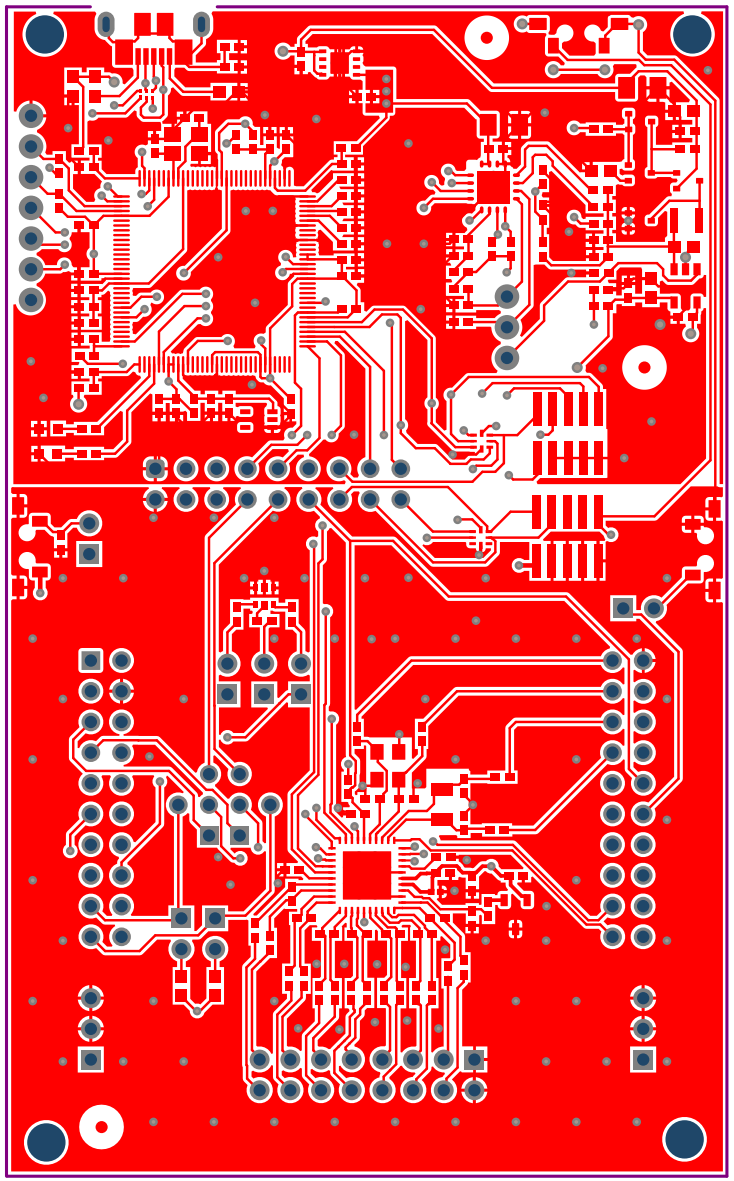


图 4-7. 顶层

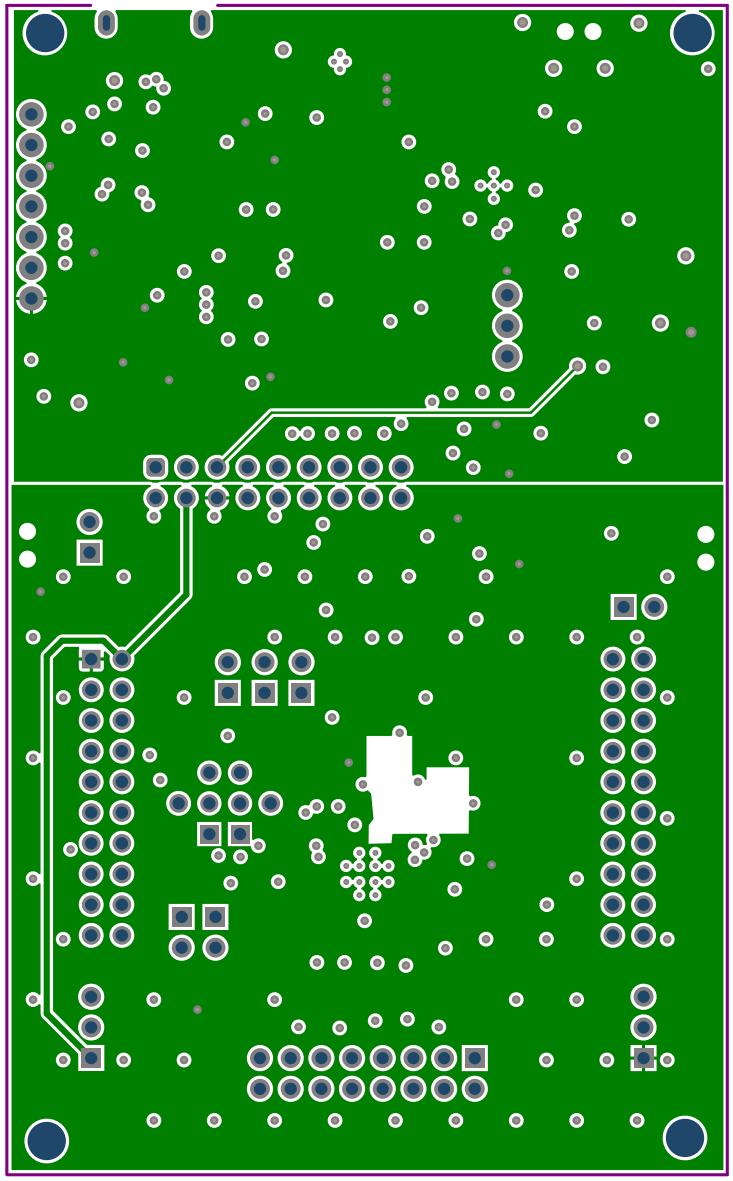


图 4-8. VCC 层

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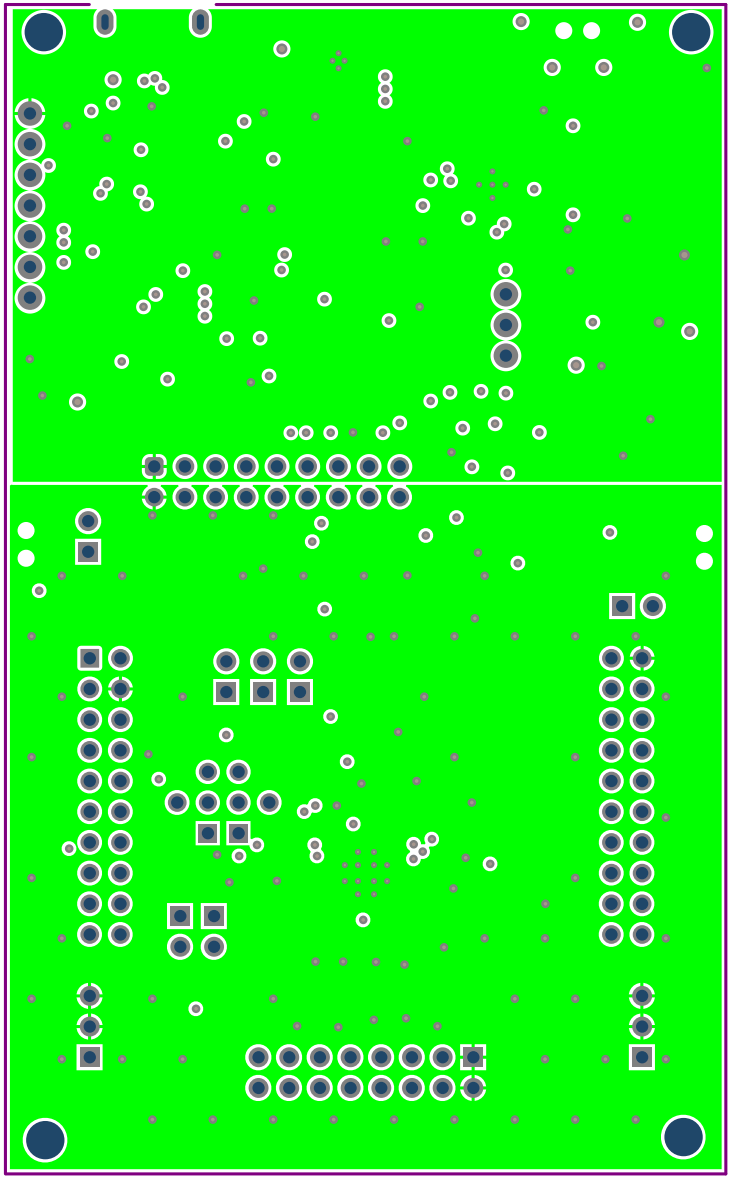


图 4-9. GND 层

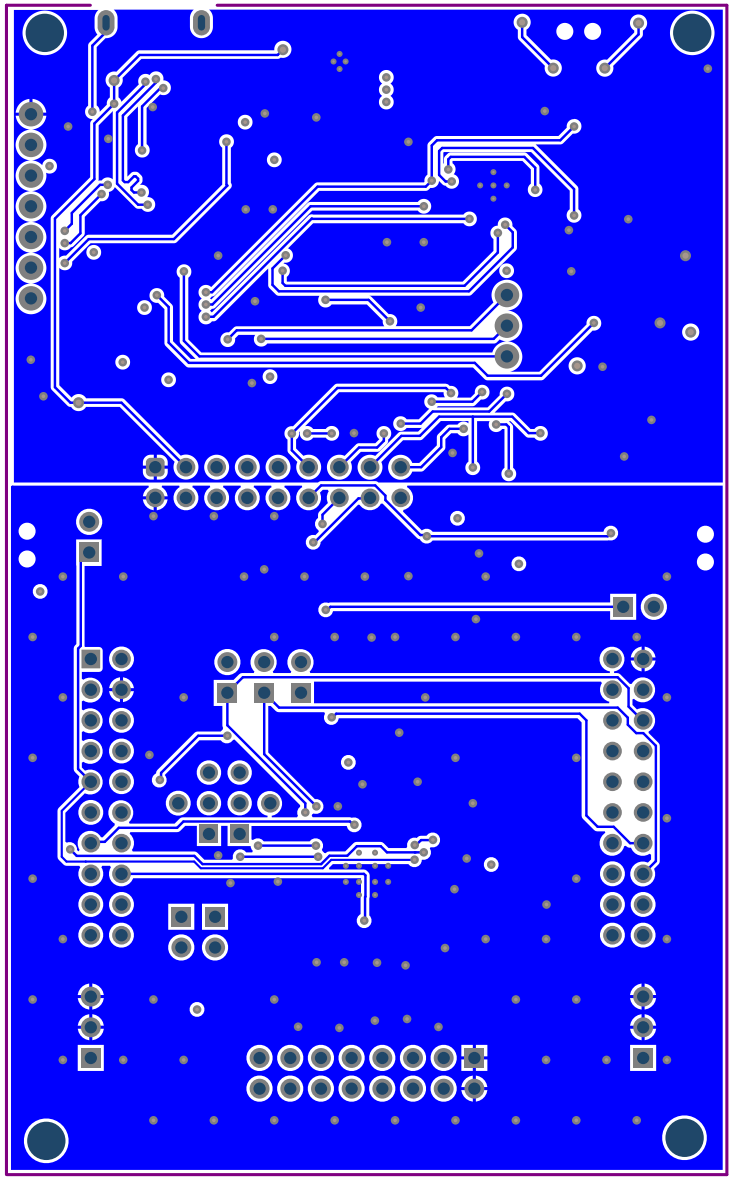


图 4-10. 底层

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4.3 物料清单 (BOM)

指示符	数量	值	说明	封装参考	器件型号
!PCB1	1		印刷电路板		LP-MSPM0G3708
C0、C2、C4	3	0.1 µF	电容，陶瓷，0.1 µF，50V，±20%，X5R，0402	0402	GRM155R61H104ME14D
C1、C8、C9、C10、C11、C12、C13、C14	8	0.01 µF	电容，陶瓷，0.01 µF，16V，±10%，X5R，0402	0402	GRM155R61C103KA01D
C3	1	10 µF	电容，陶瓷，10µF，10V，±20%，X5R，0402	0402	0402ZD106MAT2A
C5	1		电容，陶瓷，1 µF，6.3V，X7R，0402	0402	CL05B105KQ5NQNC
C6	1	0.47 µF	电容，陶瓷，0.47 µF，6.3V，±10%，X5R，0402	0402	GRM155R60J474KE19D
C7	1	0.22 µF	电容，陶瓷，0.22 µF，16V，±10%，X7R，0402	0402	C1005X7R1C224K050BC
C15、C16、C17、C18	4	22pF	电容，陶瓷，22pF，50V，±5%，C0G/NP0，0402	0402	GRM1555C1H220JA01D
C19、C20、C29、C31、C32、C33、C36、C39、C44、C46、C49	11	0.1 µF	电容，陶瓷，0.1 µF，6.3V，±10%，X7R，0402	0402	GRM155R70J104KA01D
C21、C22	2	12pF	电容，陶瓷，12pF，50V，±5%，C0G/NP0，0402	0402	GRM1555C1H120JA01D
C23、C25、C26、C27、C28	5	0.01 µF	电容，陶瓷，0.01 µF，25V，±10%，X7R，0402	0402	GRM155R71E103KA01D
C24、C34、C35、C52	4	1 µF	电容，陶瓷，1 µF，25V，±10%，X5R，0402	0402	C1005X5R1E105K050BC
C30、C54	2	2.2 µF	电容，陶瓷，2.2 µF，6.3V，±10%，X5R，0402	0402	GRM155R60J225KE95D
C37、C42	2	4.7 µF	电容，钽，4.7 µF，16V，±10%，4Ω，SMD	3216-18	TAJA475K016RNJ
C38、C41	2	33pF	电容，陶瓷，33pF，50V，±5%，C0G/NP0，0402	0402	GRM1555C1H330JA01D
C40	1	1000pF	电容，陶瓷，1000pF，50V，±10%，X7R，AEC-Q200 1 级，0402	0402	GCM155R71H102KA37D
C43、C45	2	4.7 µF	电容，陶瓷，4.7 µF，16V，±10%，X5R，0603	0603	GRM188R61C475KAAJ
C47、C48	2	0.22 µF	电容，陶瓷，0.22 µF，16V，±10%，X7R，0402	0402	GRM155R71C224KA12D
C50	1	47 µF	电容，陶瓷，47 µF，6.3V，±20%，X5R，0603	0603	GRM188R60J476ME15D
C51	1	3300pF	电容，陶瓷，3300pF，50V，±10%，X7R，0402	0402	GRM155R71H332KA01D
C53	1	2.2 µF	电容，陶瓷，2.2 µF，10V，±10%，X5R，0603	0603	C0603C225K8PACTU
D1、D2	2	40V	二极管，肖特基，40V，0.12A，AEC-Q101，SOT-323	SOT-323	BAS40-05W,115
FID1、FID2、FID3	3		基准标记。 没有需要购买或安装的元件。	不适用	不适用
H1、H2	2		垫片支架，尼龙 66	垫片尼龙支架	MAE-10
IC1	1		精密微功耗并联电压基准、0.5% 精度、2.5V、15ppm/℃、15mA、-40°C 至 85°C、5 引脚 SC70 (DCK)、绿色环保（RoHS，无锑/溴）	DCK0005A	LM4040C25IDCKR
IC2	1		2.7V-4V 双路输入/单路输出 MOSFET，0.5A 主输入/0.1A 辅助输入，低电平有效使能端，通信温度，DBV0005A (SOT-23-5)	DBV0005A	TPS2102DBVR

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指示符	数量	值	说明	封装参考	器件型号
IC3、U3	2		用于高速数据接口的低电容 ±15kV ESD 保护阵列，6 通道，-40 至 +85°C，8 引脚 UQFN (RSE)，绿色环保（符合 RoHS 标准，无锑/无溴）	RSE0008A	TPD6E004RSER
IC4	1		用于高速数据接口的 ESD 保护阵列，4 通道，-40°C 至 +85°C，6 引脚 SON (DRY)，绿色环保（符合 RoHS 标准，无锑/溴）	DRY0006A	TPD4E004DRYR
IC5	1		500mA、可调节、低静态电流、低噪声、高 PSRR、单路输出 LDO 稳压器、DRB0008A (VSON-8)	DRB0008A	TPS73533DRBT
J1/J3、J2/J4	2		插座，2.54mm，10x2，锡，TH	10x2 插座	SSQ-110-03T-D
J5、J6	2		接头，2.54mm，1x1，金，TH	接头，2.54mm，1x1，TH	HTSW-101-07G-S
J7、J8、J10、J15	4		接头，100mil，3x1，锡，TH	接头，3 引脚，100mil，锡	PEC03SAAN
J9、J11、J12、J13、J16、J17、J18	7		接头，100mil，2x1，锡，TH	接头 2x1	90120-0122
J14	1		接头，100mil，8x2，金，TH	PBC08DAAN	PBC08DAAN
J19、J20	2		接头（有罩），1.27mm，5x2，金，SMT	接头（有罩），1.27mm，5x2，SMT	FTSH-105-01L-DV-K
J101	1		接头，2.54mm，9x2，锡，TH	接头，2.54mm，9x2，TH	PEC09DAAN
L1	1	2.2 µH	电感，绕线型，陶瓷，2.2 µH，0.89A，0.13Ω，SMD	2.5 × 1.8 × 1.8mm	CBC2518T2R2M
LED1	1	Rgb	LED，RGB，SMD	1.6 × 1.6mm	19-337/R6GHBHC-A01/2T
LED2	1	红色	LED，红色，SMD	1.6 × 0.8mm	BR1111C-TR
LED3	1	绿色	LED，绿色，SMD	1.6 × 0.8 × 0.8mm	LTST-C190GKT
R1	1	47k	电阻，47k，5%，0.063W，0402	0402	CRCW040247K0JNED
R2、R3	2	2.2k	电阻，2.2k，5%，0.1W，0603	0603	RC0603JR-072K2L
R4	1	4.7k	电阻，4.7k，5%，0.063W，AEC-Q200 0 级，0402	0402	CRCW04024K70JNED
R10、R11、R12、R13、R14、R15、R16、R17、R18、R19、R20、R21、R22、R23	14	1.00k	电阻，1.00k，1%，0.0625W，0402	0402	RC0402FR-071KL
R24	1	220	电阻，220，5%，0.063W，0402	0402	CRCW0402220RJNED

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指示符	数量	值	说明	封装参考	器件型号
R25、R26	2	330	电阻，330，5%，0.063W，0402	0402	CRCW0402330RJNED
R27	1	100	电阻，100，5%，0.063W，AEC-Q200 0 级，0402	0402	CRCW0402100RJNED
R28	1	100	电阻，100，5%，0.063W，0402	0402	CRCW0402100RJNED
R29、R30、R49	3	470	电阻，470，5%，0.063W，0402	0402	CRCW0402470RJNED
R31、R64、R65	3	10k	电阻，10k，5%，0.063W，0402	0402	CRCW040210K0JNED
R32	1	4.87k	电阻，4.87k，1%，0.063W，AEC-Q200 0 级，0402	0402	CRCW04024K87FKED
R33、R34、R35、R37	4	1.0k	电阻，1.0k，5%，0.063W，0402	0402	CRCW04021K00JNED
R38	1	51	电阻，51，5%，0.063W，AEC-Q200 0 级，0402	0402	CRCW040251R0JNED
R39、R40、R41、R42、R56、R57、R63	7	220k	电阻，220k，1%，0.0625W，0402	0402	RC0402FR-07220KL
R43、R46、R53	3	47.0k	电阻，47.0k，1%，0.0625W，0402	0402	RC0402FR-0747KL
R44、R45	2	4.7k	电阻，4.7k，5%，0.063W，0402	0402	CRCW04024K70JNED
R47、R58	2	3.30k	电阻，3.30k，1%，0.1W，AEC-Q200 0 级，0402	0402	ERJ-2RKF3301X
R48	1	820	电阻，820，1%，0.063W，0402	0402	RC0402FR-07820RL
R50、R60、R61	3	0	电阻，0，5%，0.1W，0603	0603	RC0603JR-070RL
R51	1	2.20k	电阻，2.20k，1%，0.063W，0402	0402	CRCW04022K20FKED
R52	1	6.81k	电阻，6.81k，1%，0.063W，0402	0402	CRCW04026K81FKED
R59	1	1.00Meg	电阻，1.00M，1%，0.063W，0402	0402	CRCW04021M00FKED
R62	1	330k	电阻，330k，1%，0.0625W，0402	0402	RC0402FR-07330KL
S1、S2、S3	3		开关，SPST，0.05A，12VDC，SMD	7.8 × 3.5mm	1188E-1K2V-TR
SH-J1、SH-J2、SH-J3、SH-J4、SH-J5、SH-J6、SH-J7、SH-J8、SH-J9、SH-J10、SH-J11、SH-J12、SH-J13、SH-J14、SH-J15、SH-J16、SH-J17、SH-J18	18	1x2	分流器，100mil，镀金，黑色	分流器	SNT-100-BK-G
T1	1	45V	晶体管，NPN，45V，0.1A，SOT-323	SOT-323	BC850CW,115
T2	1	-20V	MOSFET，P 沟道，-20V，-0.82A，SOT-323	SOT-323	DMG1013UW-7
U1	1		MSPM0G3708SZFU	LGA40	MSPM0G3708SZFU
U2	1		1.25V、50ppm/°C、50 µA 串联（带隙）电压基准，-40°C 至 125°C，3 引脚 SOT-23 (DBZ)，绿色环保（RoHS，无锑/溴）	DBZ0003A	REF3012AIDBZR
USB1	1		电缆，USB-A 至微型 USB-B，0.3m		AK67421-0.3

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指示符	数量	值	说明	封装参考	器件型号
USB2	1		插座，USB 2.0，Micro B，5 个位置，R/A，SMT	插座，USB 2.0，Micro B，5 位，0.65mm 间距，R/A，SMT	1051640001
XDS1	1		MSP432E401YTPDT、PDT0128A (TQFP-128)	PDT0128A	MSP432E401YTPDTR
XDS2	1		MSP430G2x52、MSP430G2x12 混合信号微控制器，RSA0016B (VQFN-16)	RSA0016B	MSP430G2452IRSA16R
Y1	1		晶振，32.768KHz，12.5pF，SMD	SMD，2 引线，封装 3.2 × 1.5mm	FC-135 32.7680KA-A3
Y2	1		晶振，40MHz，12pF，SMD	2.5 × 3.2mm	ECS-400-12-33Q-JES-TR
Y3	1		晶振，16MHz，8pF，SMD	3.2 × 0.75 × 2.5mm	NX3225GA-16.000M-STD-CRG-1

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5 其他信息

5.1 合规性和认证

可应要求提供 LP-MSPM0G3708 EU DoC

5.2 商标

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

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.

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

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

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

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西新宿三井ビル

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

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

3.4 *European Union*

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

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

4 *EVM Use Restrictions and Warnings:*

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

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

4.3 *Safety-Related Warnings and Restrictions:*

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

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

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

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

6. *Disclaimers:*

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

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

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

8. *Limitations on Damages and Liability:*

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

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

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

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

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最后更新日期：2025 年 10 月