

EVM User's Guide: TXE81XXEVM

TXE81XX 评估模块



说明

通过 TXE81XXEVM，可评估 TXE81XX 系列 SPI I/O 扩展器。该 EVM 支持采用引线封装类型 DGS (24 和 32) 的 TXE8116 和 TXE8124 (分别为 16 位和 24 位)。该 EVM 提供了多个测试点和接头，可配合每个扩展器提供的大量 I/O 使用。配备了公头和母头混合接头，便于轻松完成并联连接。

开始使用

1. 订购 TXE81XXEVM。
2. 下载最新的 USB2ANY 固件。
3. 下载最新版本的 GUI。

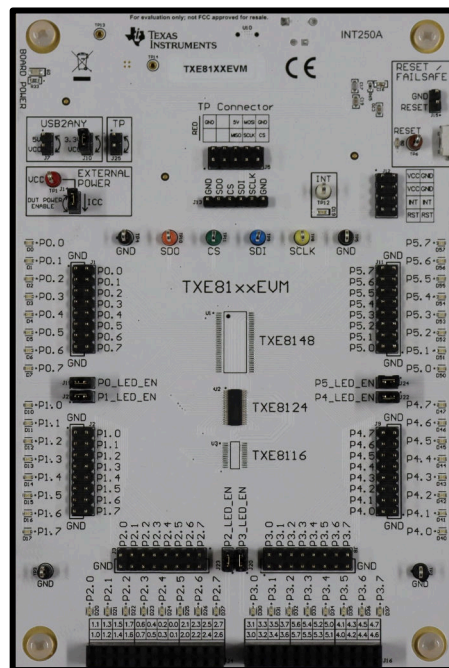
特性

- USB 电源 3.3V
- 外接电源选项
- ICC 电流测量接头 (用于电流消耗测量)
- 各种公头和母头连接接头 + 测试点，可实现快速测试

- 板载 USB2ANY，可尽量减少 SPI 驱动程序设置
- 板载 USB2ANY 支持云端在线 GUI，也可下载至桌面使用
- 用于视觉反馈的 LED (端口、/RESET、/INT)
- LED 启用/禁用接头
- 用于 SPI 连接 (SDI/SDO/SCLK/CS) 的附加测试点和接头
- 可与 MSPM0、TP Aardvark、TP Cheetah、TP Promira、Arduino、ESP32 等外部驱动程序配合使用
- 用于将 SPI 复位到 I/O 扩展器的手动复位切换开关
- 多个 TXE81XXEVM 之间支持菊花链

应用

- 扩展 MCU 的 GPIO
- 传感器控制
- 驱动 LED 和阵列
- 键盘/矩阵处理



TXE81XXEVM

1 评估模块概述

1.1 简介

本指南帮助评估 TI 用于通用输入/输出 (GPIO) 扩展器的串行外设接口 (SPI) 系列，包括 TXE8116 和 TXE8124 (16 位 / 24 位)。本指南详细介绍了如何刷写板载 USB2ANY 电路、访问在线 TXE GUI、将 MSPM0 用作外部 SPI 驱动程序，并介绍了如何将第三方 SPI 驱动程序与 ESP32、Arduino、Total Phase SPI 驱动程序等通用平台结合使用。

TXE81XXEVM 评估套件具有多个测试点，公头和母头接头以及 LED 指示器，可对 TXE81XX 进行直观的基准测试。该电路板在设计上旨在便于访问每个 GPIO，并提供许多使用示波器的连接。该电路板可由外部电源或来自标准 PC 的 USB 连接供电。

1.2 套件内容

- TXE81XXEVM
- Mini USB 电缆

1.3 规格

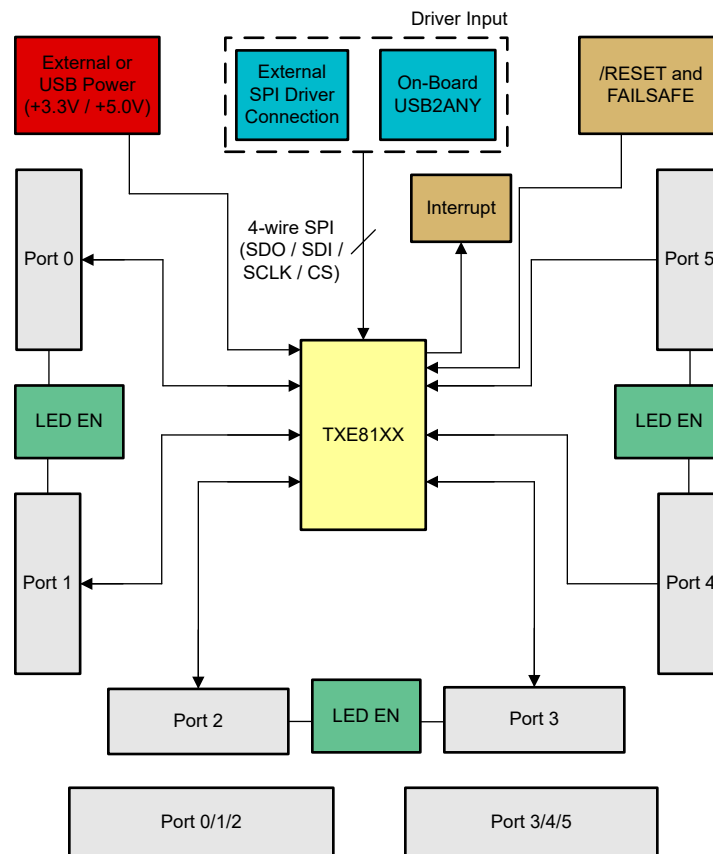


图 1-1. 简化版方框图

1.4 器件信息

TXE81XX 系列包括由 SPI 协议驱动的 16 位和 24 位 I/O 扩展器。这些 IC 符合面向汽车应用的 AEC-Q100 标准，SPI SCLK 频率最高可达 10MHz，采用低电平有效复位输入，可配置失效防护 I/O 寄存器来实现冗余，具有漏极开路低电平有效中断引脚、内部上拉/下拉电阻器、漏极开路与推挽输出、可编程的驱动强度、可闭锁总线保持输入和可屏蔽中断。该 EVM 上使用了引线式封装类型，以方便焊接。

2 硬件

2.1 其他图像

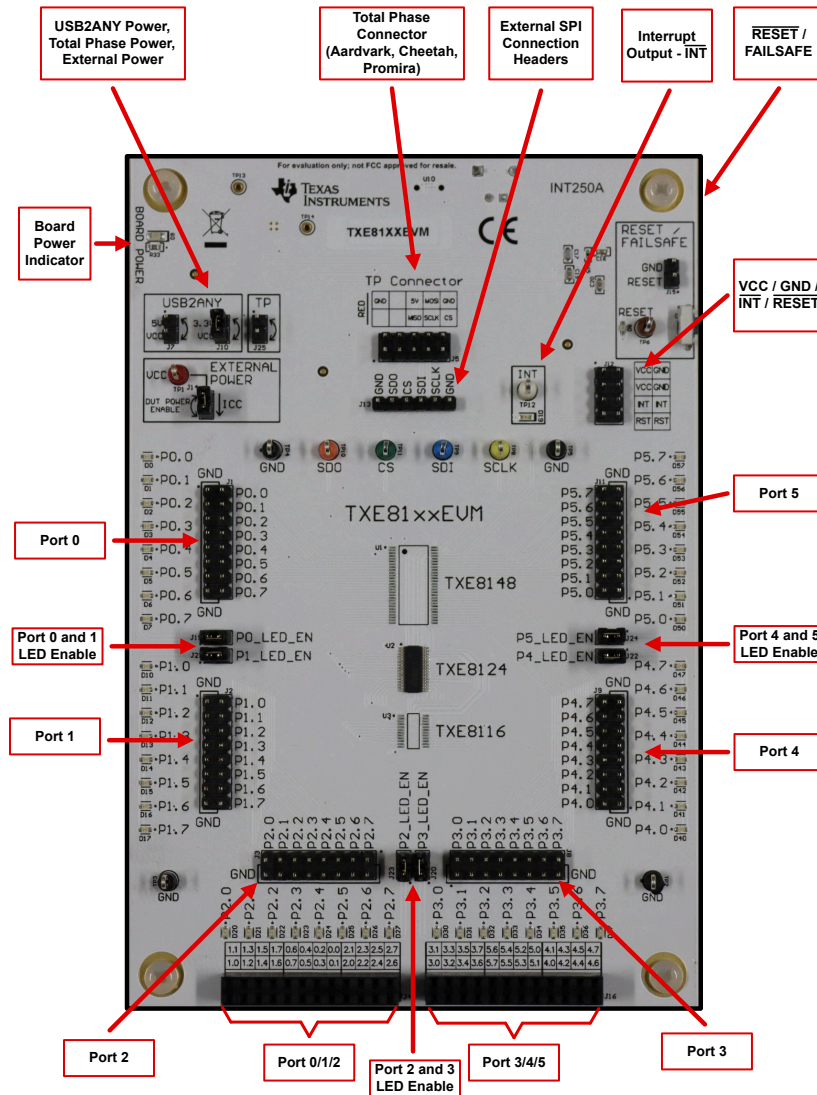


图 2-1. 电路板顶部

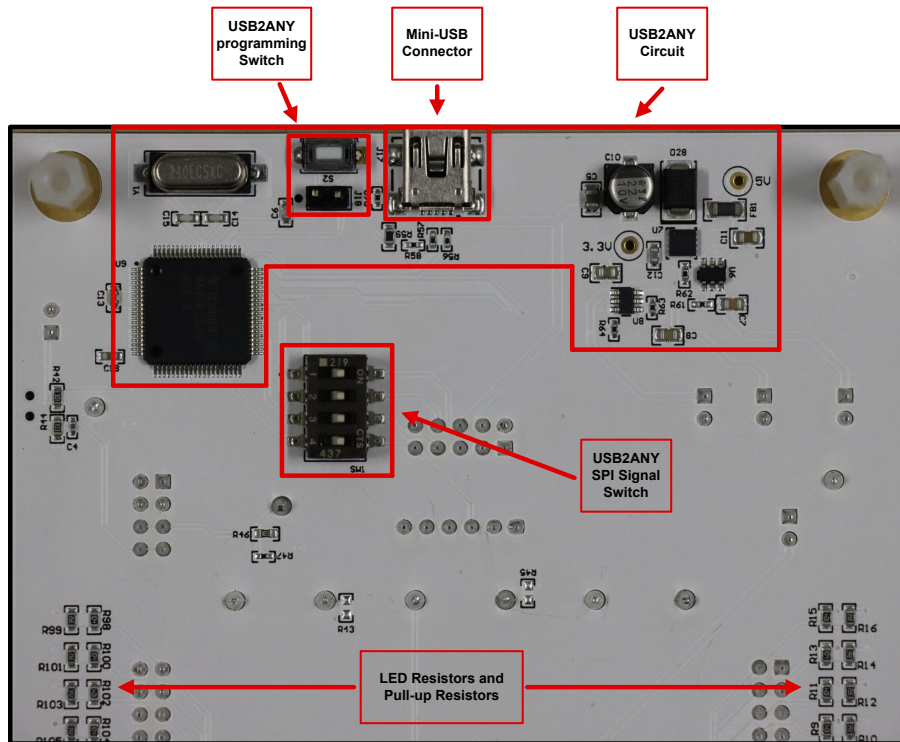


图 2-2. 电路板底部

2.2 电源要求

TXE81XXEVM 具有几种不同的电路板供电选项。TXE81XX 通电后，“BOARD POWER”指示器 D9 亮起。这意味着已为电路板通电。但不一定意味着 DUT 此时已通电。要确认 DUT 已通电，必须将 J14 短接。该电路板通过 USB2ANY Explorer GUI 支持 3.3V USB 电源。Total Phase 或“TP”跳线 J25 连接所列 Total Phase 产品的电源：SPI Aardvark、Cheetah SPI、Promira Serial Platform。TXE81XXEVM 允许通过独立电源进行外部电源连接。

在进行电源跳线连接时，请参阅表 2-1 中的指南。一次只能将 1 个电源选项短接至 VCC。这包括 3.3V USB2ANY、5V USB2ANY、TP 电源或测试点 TP1 处的外部电源连接。

备注

一次只能启用 1 个跳线选项电缆。可单独选择 5V、3.3V 或 TP，不能一起选择。这还包括来自 VCC 测试点 (TP1) 上的外部电源的电源。选择电源连接后，短接电源接头 J14 以启用 DUT 电源。

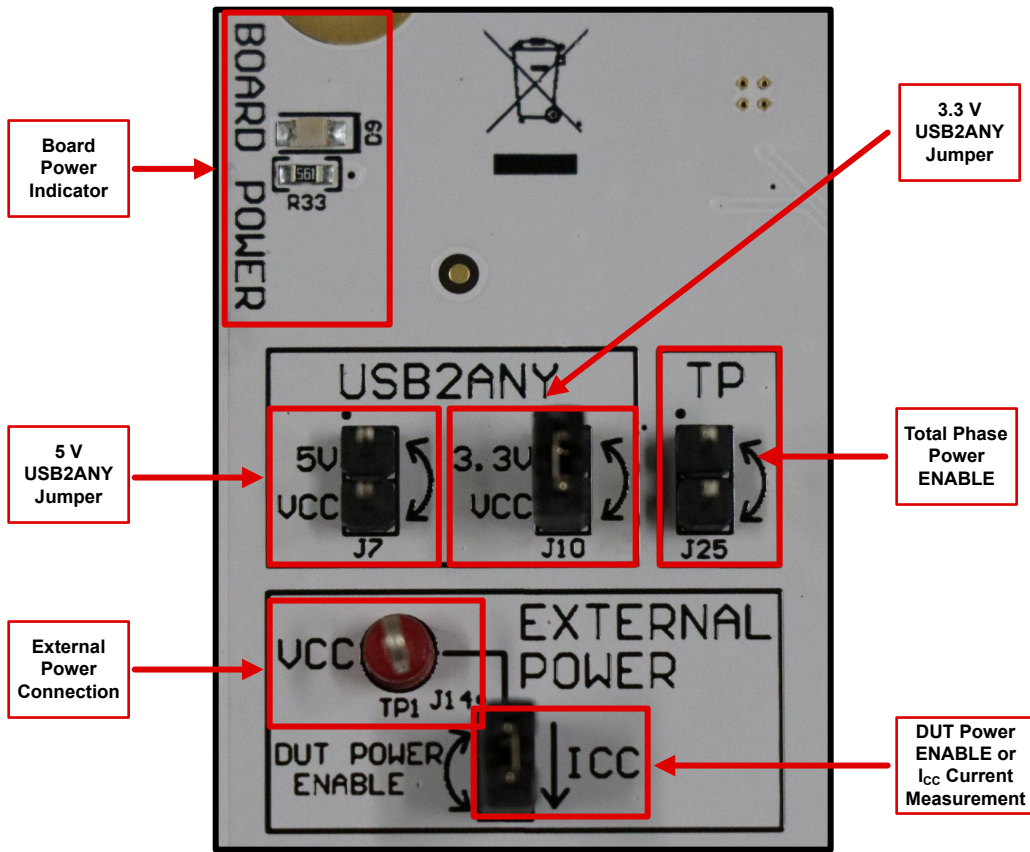


图 2-3. 电源选项

表 2-1. 电源跳线连接

位号	说明
J7	USB2ANY 5V 至 V _{CC} 连接
J10	USB2ANY 3.3V 至 V _{CC} 连接
J25	Total Phase 电源连接 (+3.3V)
J14	将来自 USB2ANY、Total Phase 产品积或外部电源接头的电源连接到 DUT。此接头可用于测量流入 TXE81xx 的电流。

2.3 设置和连接 EVM

TXE81XXEVM 随附了一根 mini-USB 电缆。通过 USB 3.0 端口将 TXE81XXEVM 连接到台式机或笔记本电脑。

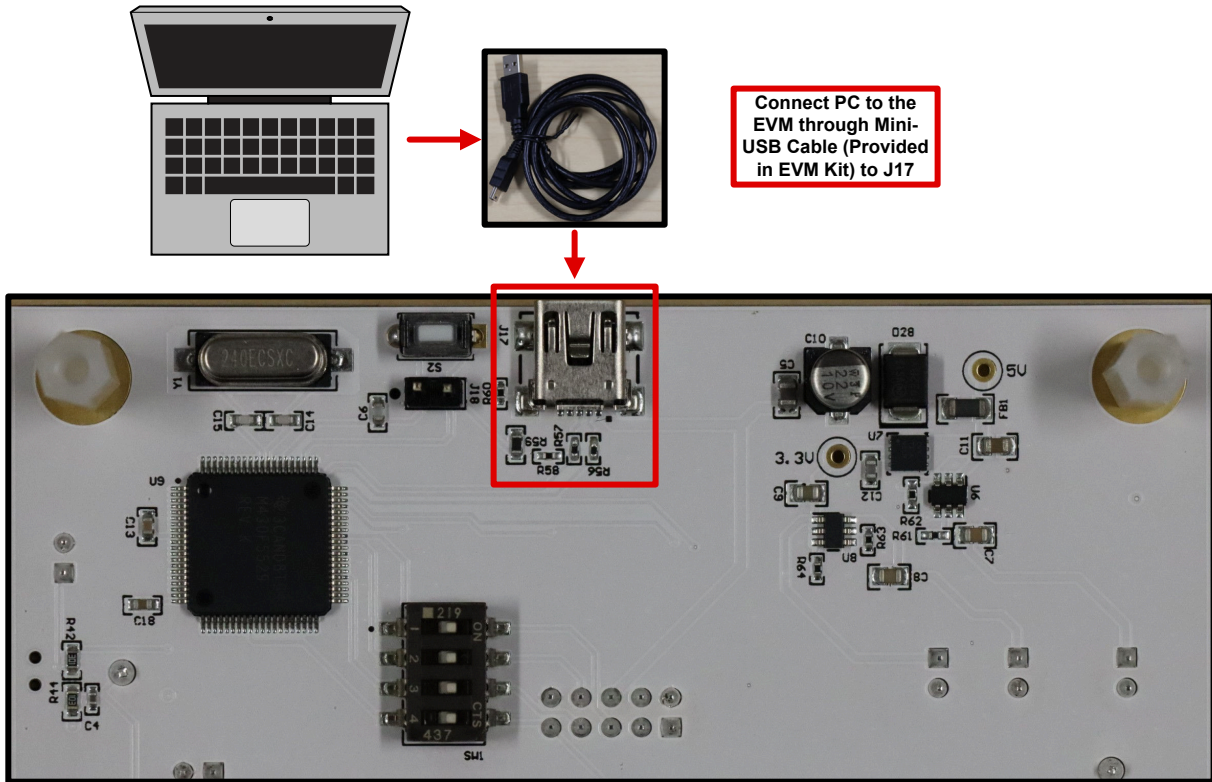


图 2-4. 通过连接到 EVM 背面的 Mini-USB 转 J17 端口连接到 TXE81XXEVM

连接后，按照节 3.2.1 中的步骤操作。

2.4 接头和跳线信息

下一节完整总结了 TXE81XXEVM 上的各种接头和跳线连接。

图 2-5 展示了 LED 使能跳线。如果接头未插入，则会禁用特定端口的 LED。

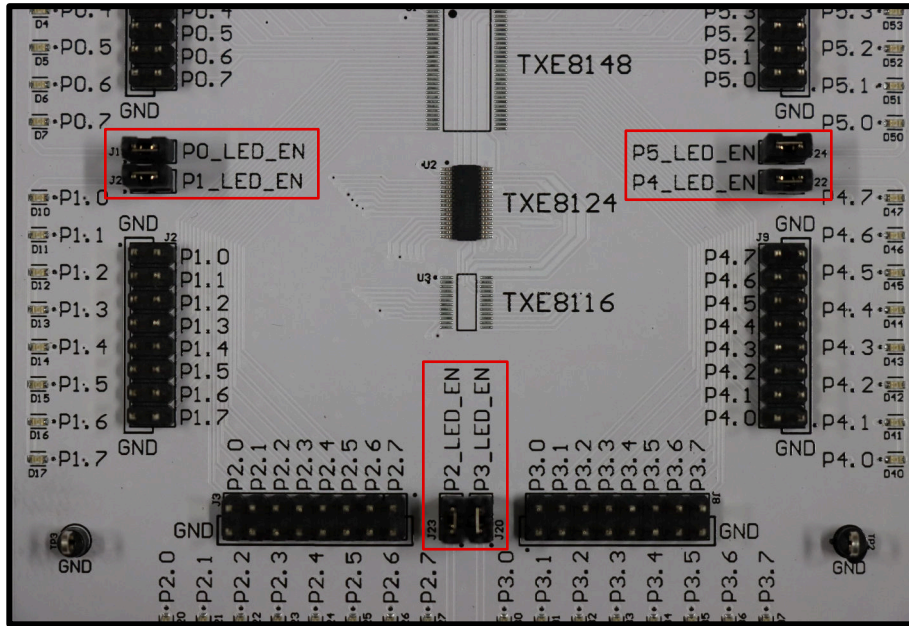


图 2-5. 端口 0 - 端口 5 LED 使能跳线位置

表 2-2. LED 使能

位号	端口编号
J19	端口 0 - LED 使能
J21	端口 1 - LED 使能
J23	端口 2 - LED 使能
J20	端口 3 - LED 使能
J22	端口 4 - LED 使能
J24	端口 5 - LED 使能

接头 J18 用于对板载 USB2ANY 电路进行编程。如需了解更多详情，请参阅图 2-6。

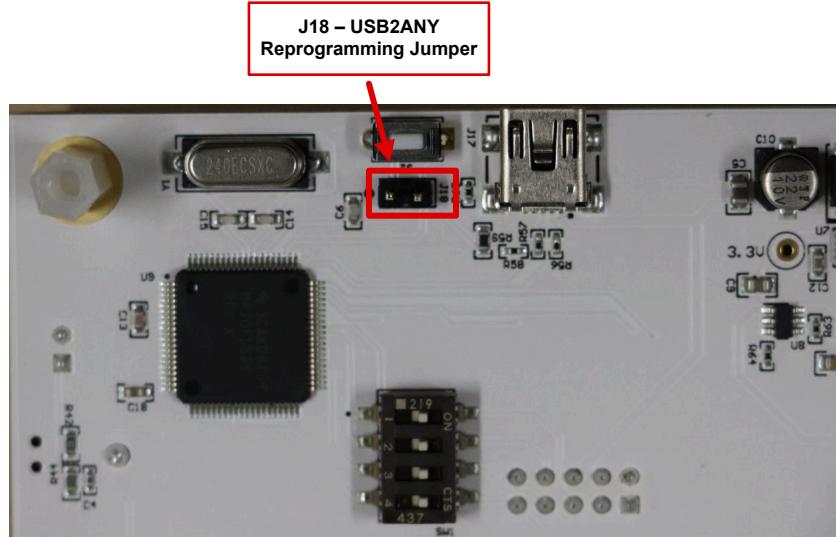


图 2-6. USB2ANY 电路编程跳线 (J18)

2.5 按钮和开关

本节将介绍 EVM 上的各种按钮和开关位置。

SW1 将 USB2ANY 驱动程序 SPI 信号连接到 EVM 上的 SDO / SDI / SCLK / CS。此开关的“ON”位置在最右侧。

连接 Total Phase 产品或外部 SPI 驱动程序时，请禁用 SW1 上的 4 个 SPI 信号。

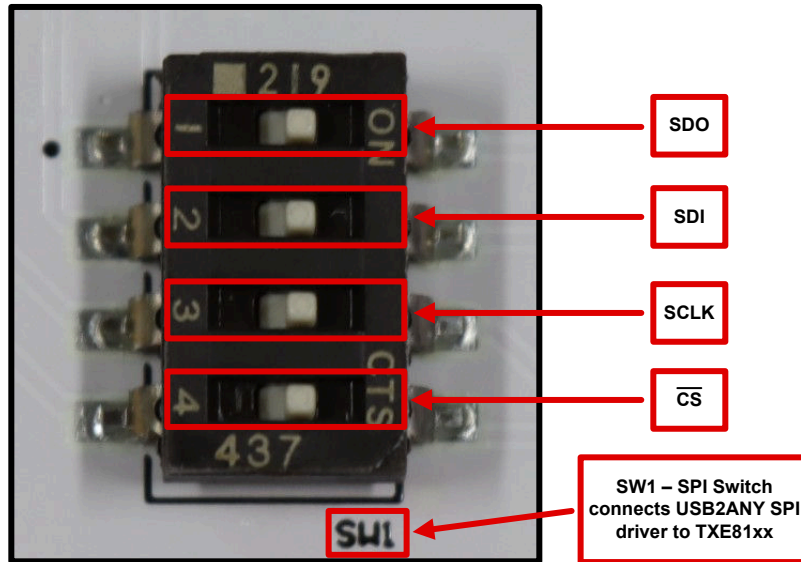


图 2-7. SPI 开关 (SW1)

插入 TXE81XXEVM 后按下按钮 S2 可将 USB2ANY 电路置于编程模式。这是对 USB2ANY 电路进行编程的替代方法。更简单的方法是短接 J18。如果不对 USB2ANY 电路进行编程，则 S2 没有其他用途。

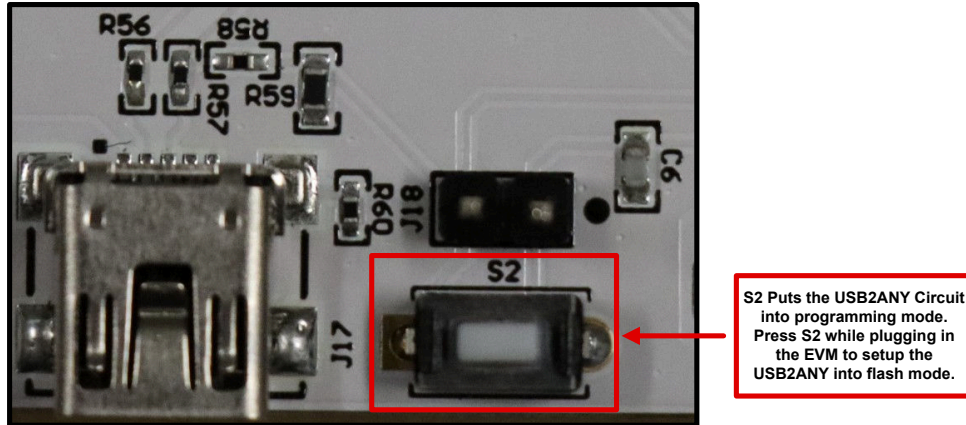


图 2-8. 编程按钮 S2

S1 是用于手动复位 TXE81XX 的侧边按钮。按下 S1 会将 TXE81XX 的 RESET 短接至 GND。使用了一个上拉电阻器将 RESET 上的电压恢复到 V_{CC} 。

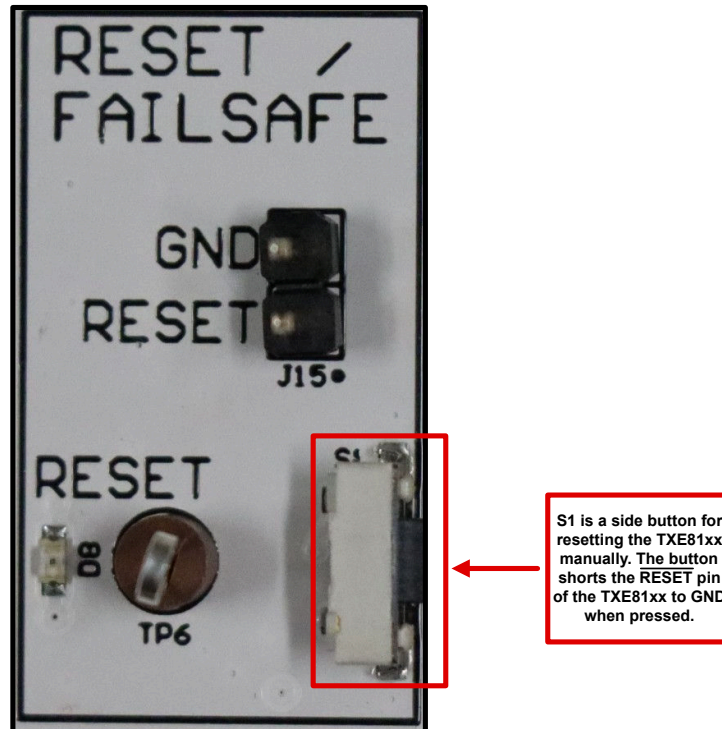


图 2-9. 复位按钮 S1

2.6 驱动器接口

TXE81XXEVM 可在 V_{CC} 介于 3.3V 至 5.5V 之间时使用高达 10MHz 的 SPI 时钟信号运行，或者在 V_{CC} 介于 1.65V 至 5.5V 之间时使用 5MHz 的 SPI 时钟信号运行。

TXE81XXEVM 具有多个用于 SPI 驱动器接口的选项。板载 USB2ANY 电路位于 EVM 底部，可用于快速访问 SPI 驱动器，该驱动器可使用高达 8MHz 的 SPI 与 TXE81XX 通信。

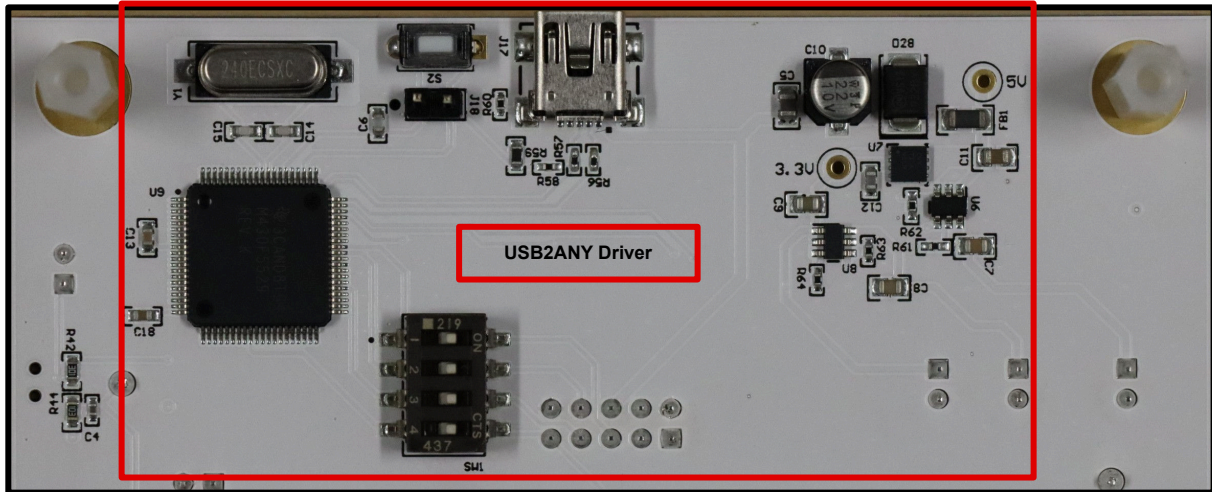


图 2-10. USB2ANY 驱动程序

该 EVM 可与外部 MCU (如 MSPM0) 配对，以便在 EVM 上对 TXE81XX 进行编程。有关更多信息，请参阅[如何对 TXE81XX SPI I/O 扩展器系列进行编程](#)。

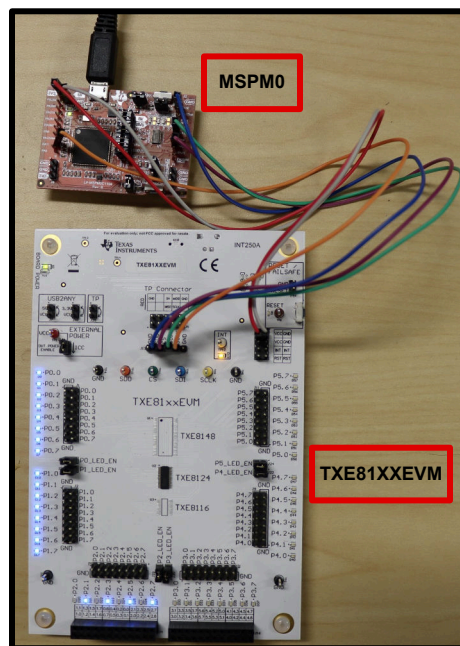


图 2-11. 使用 MSPM0 对器件进行编程

该 EVM 还通过 J5 为第三方工具 (如 [Total Phase Aardvark](#)、[Total Phase SPI Cheetah](#) 或 [Total Phase Promira Serial Platform](#)) 提供了专用连接器。

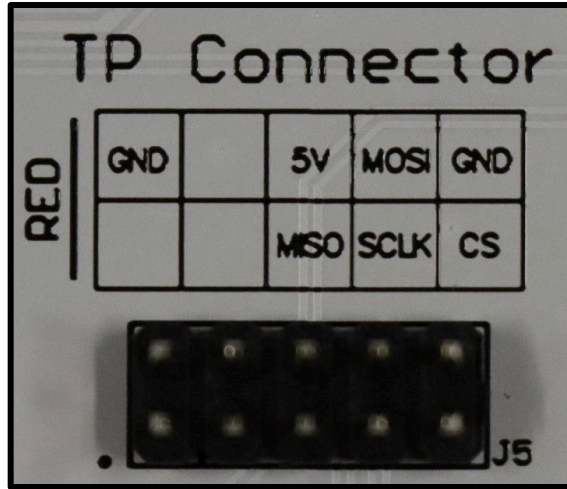


图 2-12. Total Phase 产品连接到 EVM 的 J5

也可通过 J13 上的 4 线 SPI 外部接头连接来使用 [Arduino](#) 或 [ESP32](#) 等常见微控制器板。

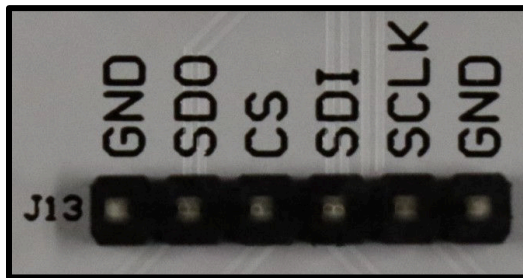


图 2-13. Arduino 和 ESP32 产品等常见开发板通过 SPI 接头与 TXE81XXEVM 兼容

2.7 测试点

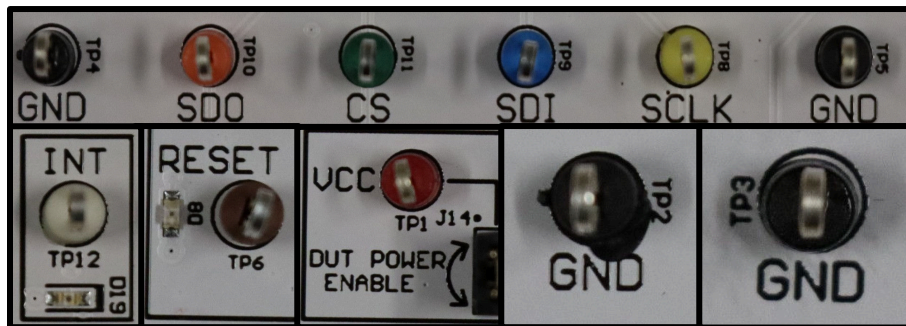


图 2-14. 测试点

表 2-3 说明了 EVM 上的各种测试点。

表 2-3. 测试点指示符

测试点指示符	说明
TP1	V _{CC} 外部电源电压输入
TP2、TP3、TP4、TP5	GND
TP6	复位
TP8	SCLK - 时钟
TP9	SDI - 数据输入
TP10	SDO - 数据输出
TP11	CS - 芯片选择
TP12	INT - 中断

3 软件

3.1 软件说明

有关向 TXE81XXEVM 刷入正确固件的操作说明，请[点击此处](#)

有关使用 USB2ANY Explorer GUI 的操作说明，请[点击此处](#)

3.2 软件安装

3.2.1 下载 USB2ANY 固件 (适用于 USB2ANY Explorer 或 TXE81XXEVM-GUI)

需要下载 USB2ANY 固件版本 2.8.2.0 或更高版本，USB2ANY Explorer 和 TXE81XXEVM-GUI 才能正常工作。

备注

TXE81XXEVM 出厂时已刷入最新固件版本 (2.8.2.0)。如果 EVM 未连接到 USB2ANY Explorer，或全功能 GUI 出现连接问题，请按照以下步骤重新刷写器件：

要检查 EVM 是否有固件更新，请执行下面第 1 - 4 步。

1. 从 [TI.com](#) 下载 [USB2ANY Explorer 软件 \(SLVC695\)](#)。
2. 运行“USB2ANY Explorer-2.8.2.0 Setup”应用程序文件并安装 Explorer GUI。
3. 安装完成后，打开 USB2ANY Explorer。
4. USB2ANY Explorer GUI 在“Adapter Connection”下方显示了类型、序列号和固件版本。固件版本显示为 2.8.2.0。如果“Firmware Version”显示 2.8.2.0，则该电路板可供 USB2ANY Explorer GUI 或 TXE81XXEVM GUI 使用。否则，请按照第 5 步操作。

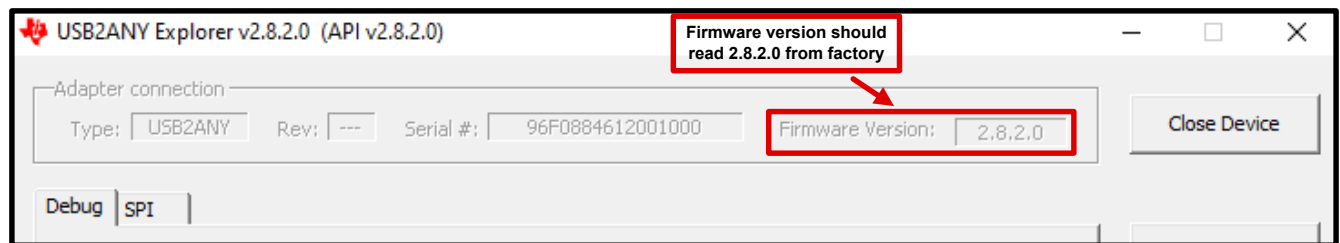


图 3-1. 检查电路板的固件版本 - 如果固件不是最新的，请执行第 5 步

5. 断开 TXE81XXEVM 与计算机的连接。

- 将 EVM 底侧的跳线 J18 短接。这会将 USB2ANY 电路设置为编程模式。

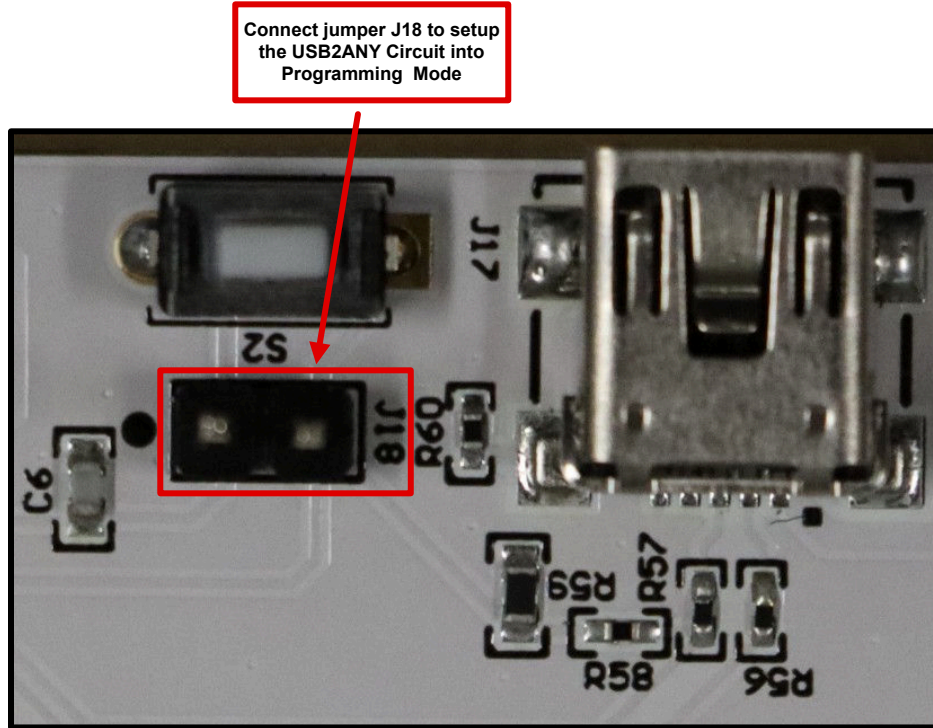


图 3-2. 通过使用跳线短接 J18，将 USB2ANY 电路设置为编程模式

- 连接 EVM。
- 移除 J18 上的跳线。
- 在 USB2ANY Explorer GUI 中选择“Open Device”，然后选择“Yes”。

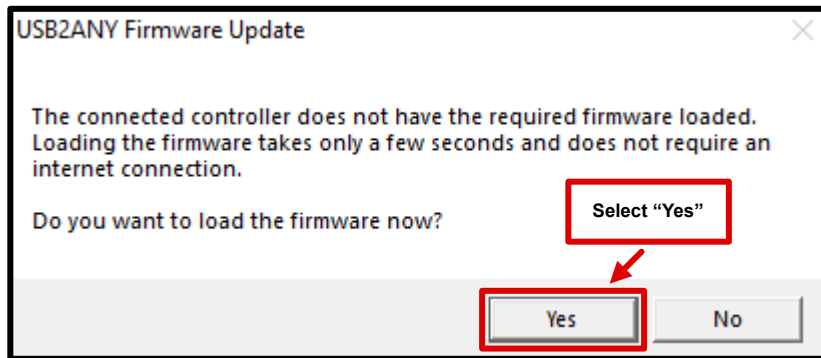


图 3-3. 选择“Yes”

10. 选择“Update Firmware”。

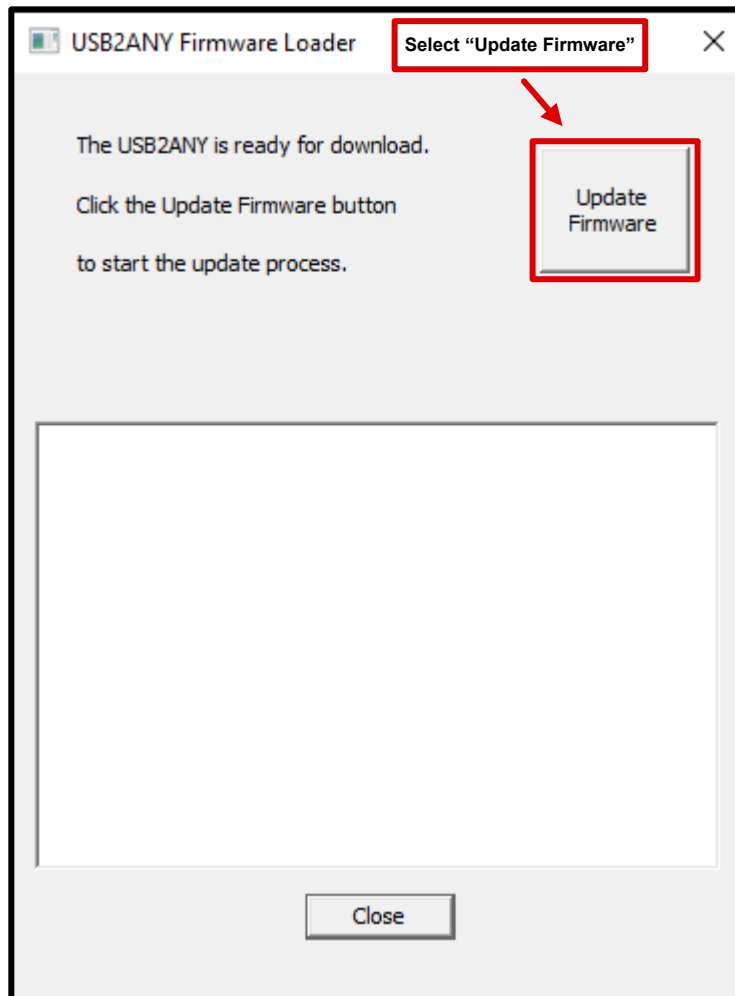


图 3-4. 选择“Update Firmware”

11. 当最后一条消息显示“Done!”时，表明固件刷写完成

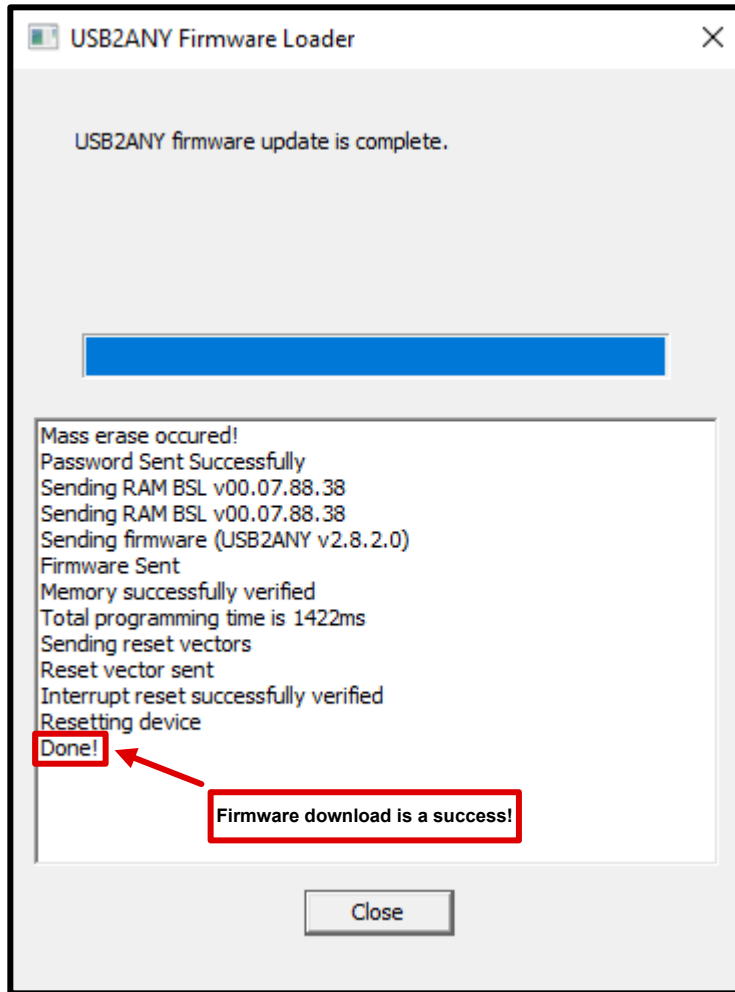


图 3-5. 控制台显示“Done!”时，表明固件更新成功

12. “Adapter Connection”下方的固件版本现在显示为 2.8.2.0。EVM 底侧的 USB2ANY 电路现在已正确刷写，可在 USB2ANY Explorer GUI 或 TXE81XXEVM GUI 中使用了。

3.3 GUI 安装

3.3.1 USB2ANY Explorer GUI

按照以下步骤，使用 USB2ANY Explorer GUI 从 TXE81XX 写入和读取 SPI 命令。

1. 将 TXE81XXEVM 连接到安装了 USB2ANY Explorer v2.8.2.0 的台式机/笔记本电脑。
2. 打开 USB2ANY Explorer v2.8.2.0 ([有关下载说明](#)，请按照“[下载 USB2ANY 固件](#)”中的第 1 - 3 步操作)。

3. 在 TXE81XXEVM 的底部，确保已启用 SDO/SDI/CS/SCLK 的 SPI 开关。

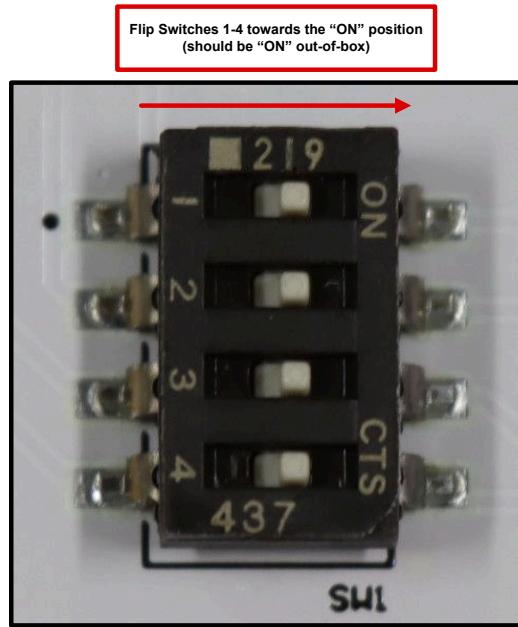


图 3-6. 确保 SPI 开关 (SW1) 处于 “ON” 位置

4. 确保 TXE81XXEVM 上的 5V 或 3.3V 电源跳线 (分别为 J7 或 J10) 已经短接。这与 USB2ANY Explorer GUI 中启用的电源 (本例中为 5V) 相匹配。

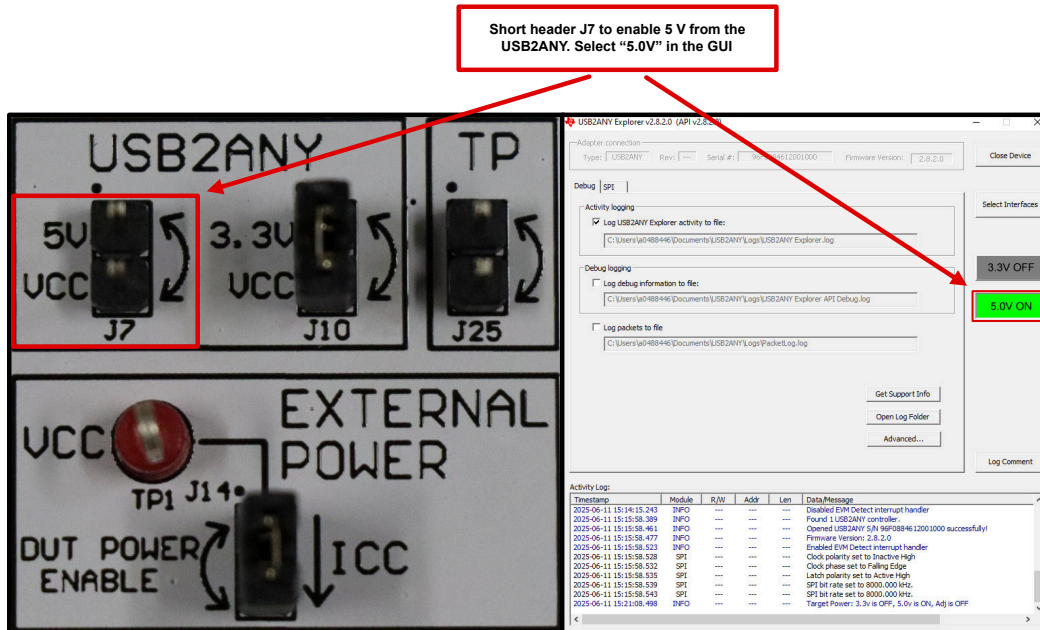


图 3-7. 将相应的接头跳变与所需的电压电平 (3.3V 或 5V) 匹配

备注

不要同时短接 J7 和 J10。如果 USB2ANY Explorer GUI 中同时启用了两个电源，这会将 5V 电源短接至 3.3V 电源，可能产生过流事件。

5. 单击“Select Interfaces”，选择“SPI”，然后点击“close”。

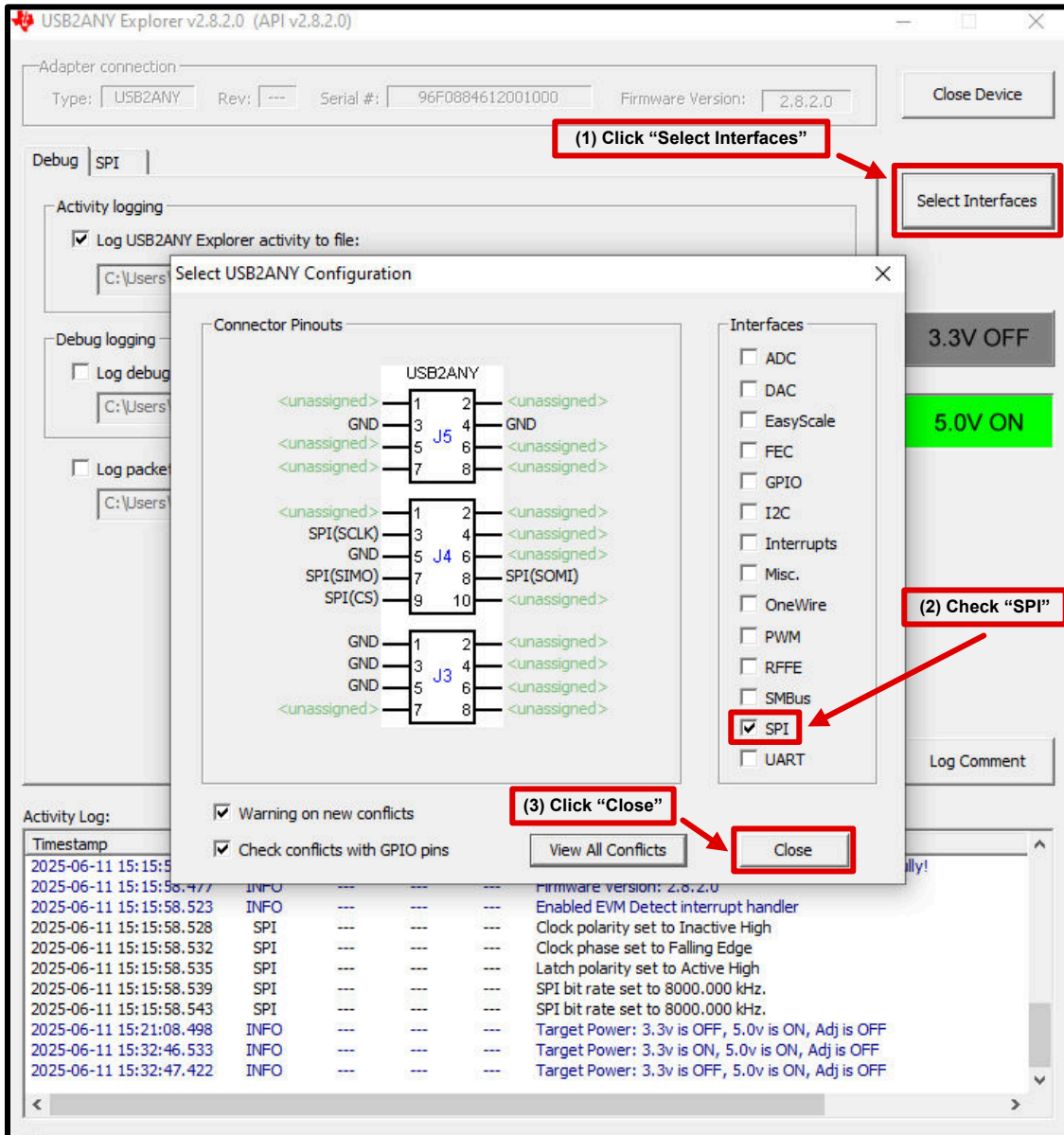


图 3-8. 选择“SPI”接口

6. 打开“SPI”选项卡并选择以下 SPI 通信配置：
 - a. Clock Polarity = Inactive Low
 - b. Clock Phase = Leading Edge
 - c. CS Polarity = Active Low
 - d. Bit Direction = MSB First
 - e. 长度 = 8 位
 - f. Bit Rate = user preference
 - g. Slave Device = 0
 - h. CS Type = per packet
 - i. # of Bytes = 3

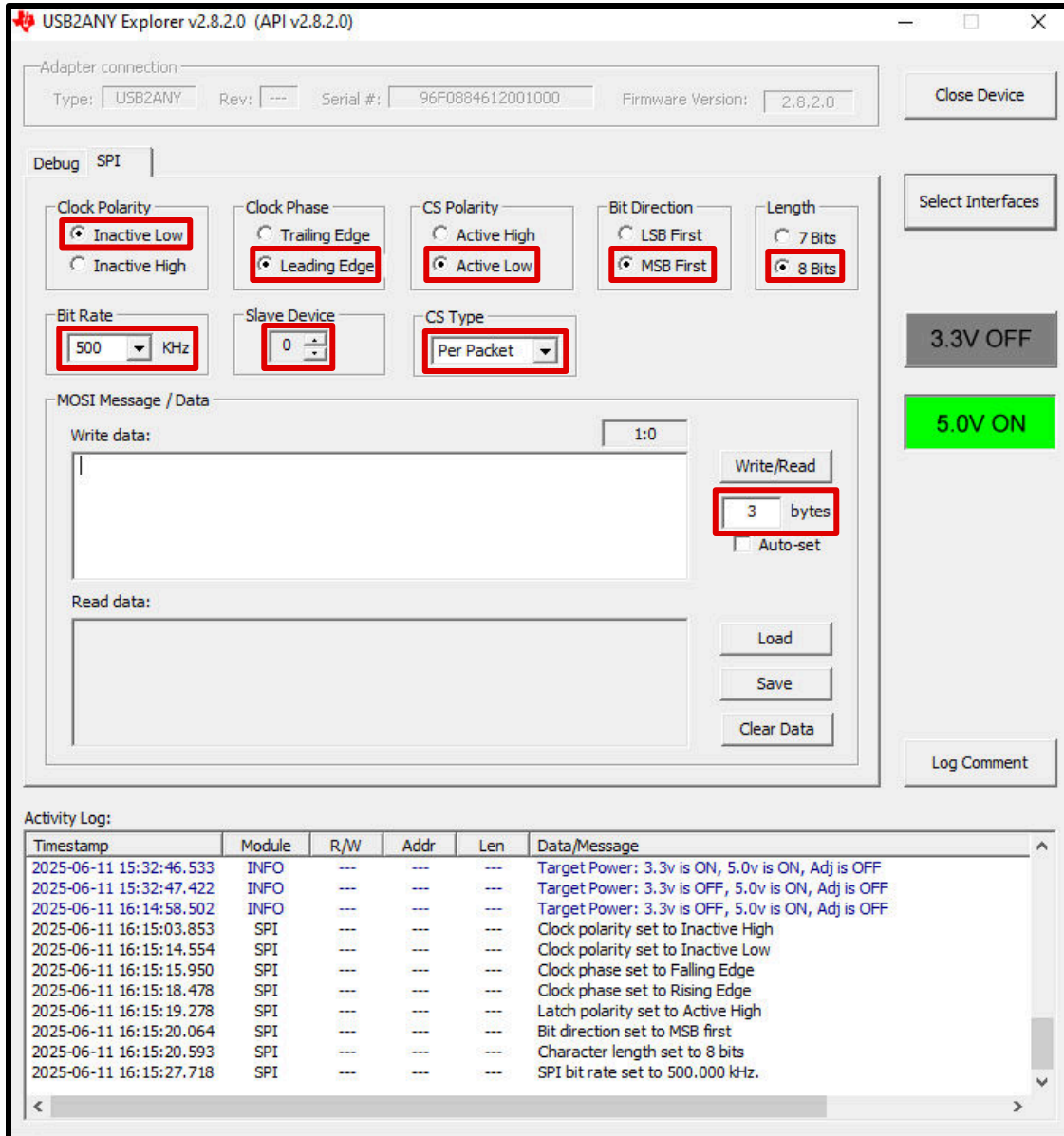


图 3-9. 在 SPI 窗口中选择以下要求

7. 开始写入/读取 SPI 数据。

- a. 例如，通过方向控制寄存器 (0x04) 将端口 0 GPIO 设置为输出。Write data = 04 00 FF。

USB2ANY Explorer v2.8.2.0 (API v2.8.2.0)

Adapter connection: Type: USB2ANY Rev: --- Serial #: D36E98461E000500 Firmware Version: 2.8.2.0

Debug | SPI

Clock Polarity: Inactive Low Inactive High

Clock Phase: Trailing Edge Leading Edge

CS Polarity: Active High Active Low

Bit Direction: LSB First MSB First

Length: 7 Bits 8 Bits

Bit Rate: 500 KHz

Slave Device: 0

CS Type: Per Packet

MOSI Message / Data

Write data: 04 00 FF

Read data: C1 00 FF

From TXE81XX-Q1 Datasheet

Figure 7-3. TXE81xx-Q1 SPI Word Address

00000100 00000000 11111111

Activity Log:

Timestamp	Module	R/W	Addr	Len	Data/Message
2025-06-27 16:09:48.427	SPI	Write	0x0000	3	Data: 03 00 00
2025-06-27 16:09:48.442	SPI	Read	0x0000	3	Data: C1 00 00
2025-06-27 16:09:52.621	SPI	---	---	---	SPI write/read count set to 3
2025-06-27 16:09:52.624	SPI	Write	0x0000	3	Data: 04 00 FF
2025-06-27 16:09:52.644	SPI	Read	0x0000	3	Data: C1 00 00
2025-06-27 16:10:04.342	SPI	---	---	---	SPI write/read count set to 3
2025-06-27 16:10:04.347	SPI	Write	0x0000	3	Data: 03 00 00
2025-06-27 16:10:04.367	SPI	Read	0x0000	3	Data: C1 00 00
2025-06-27 16:10:35.987	SPI	---	---	---	SPI write/read count set to 3
2025-06-27 16:10:35.994	SPI	Write	0x0000	3	Data: 04 00 FF
2025-06-27 16:10:36.004	SPI	Read	0x0000	3	Data: C1 00 FF

图 3-10. Write Data = 04 00 FF，将端口 0 的 GPIO 设置为“输出”

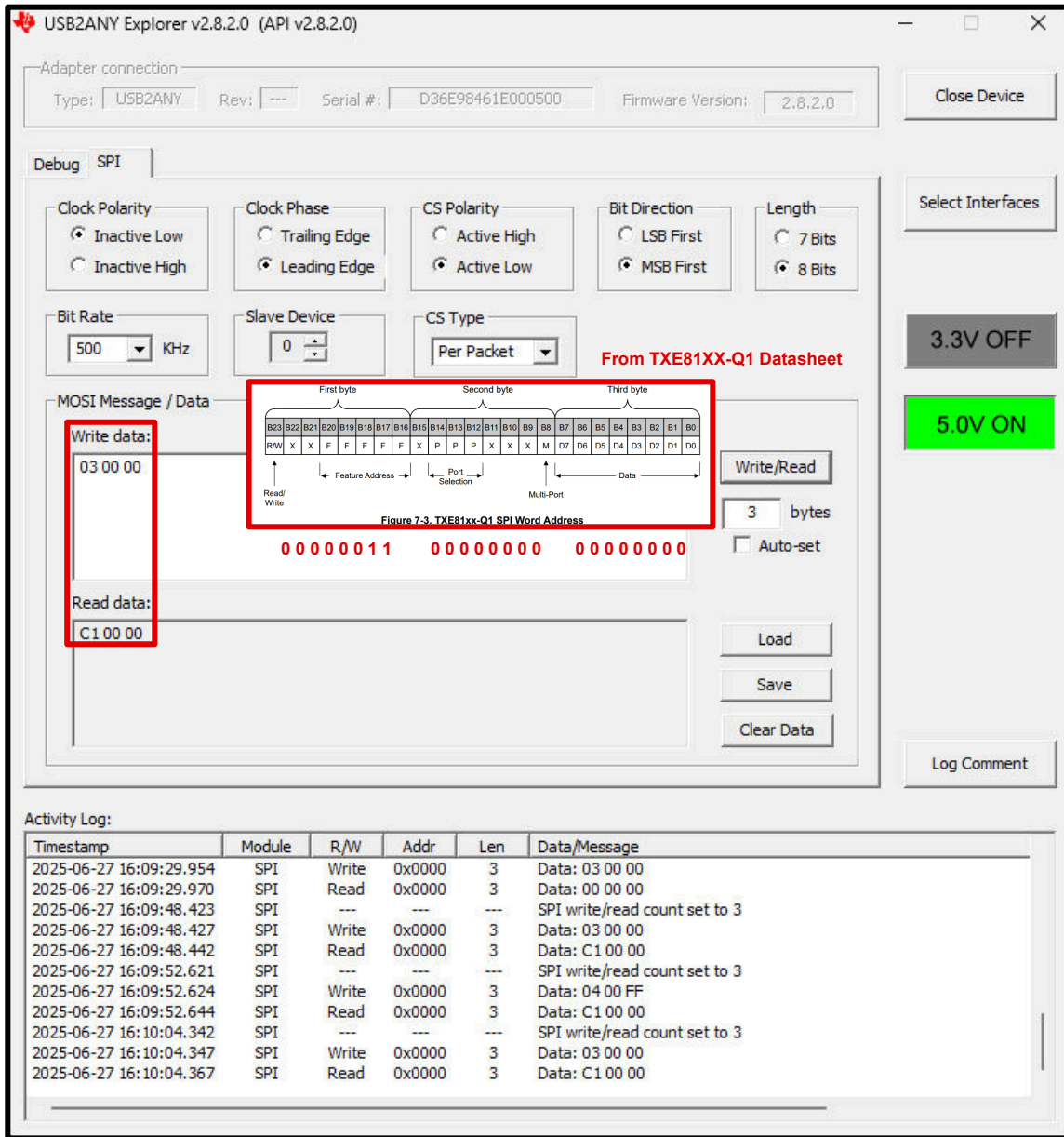


图 3-11. Write Data = 03 00 00，将端口 0 的输出设置为“低电平”

4 硬件设计文件

4.1 原理图

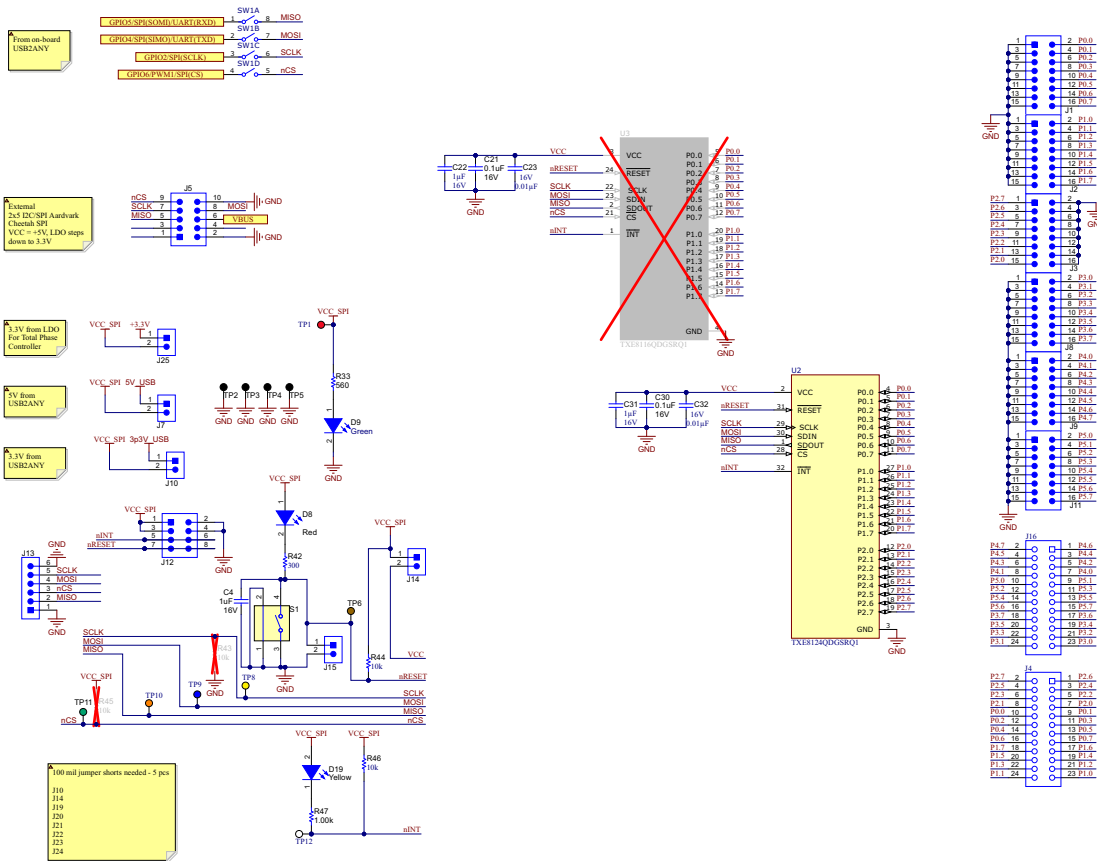


图 4-1. 原理图第 1 页 - TXE81XX 接口

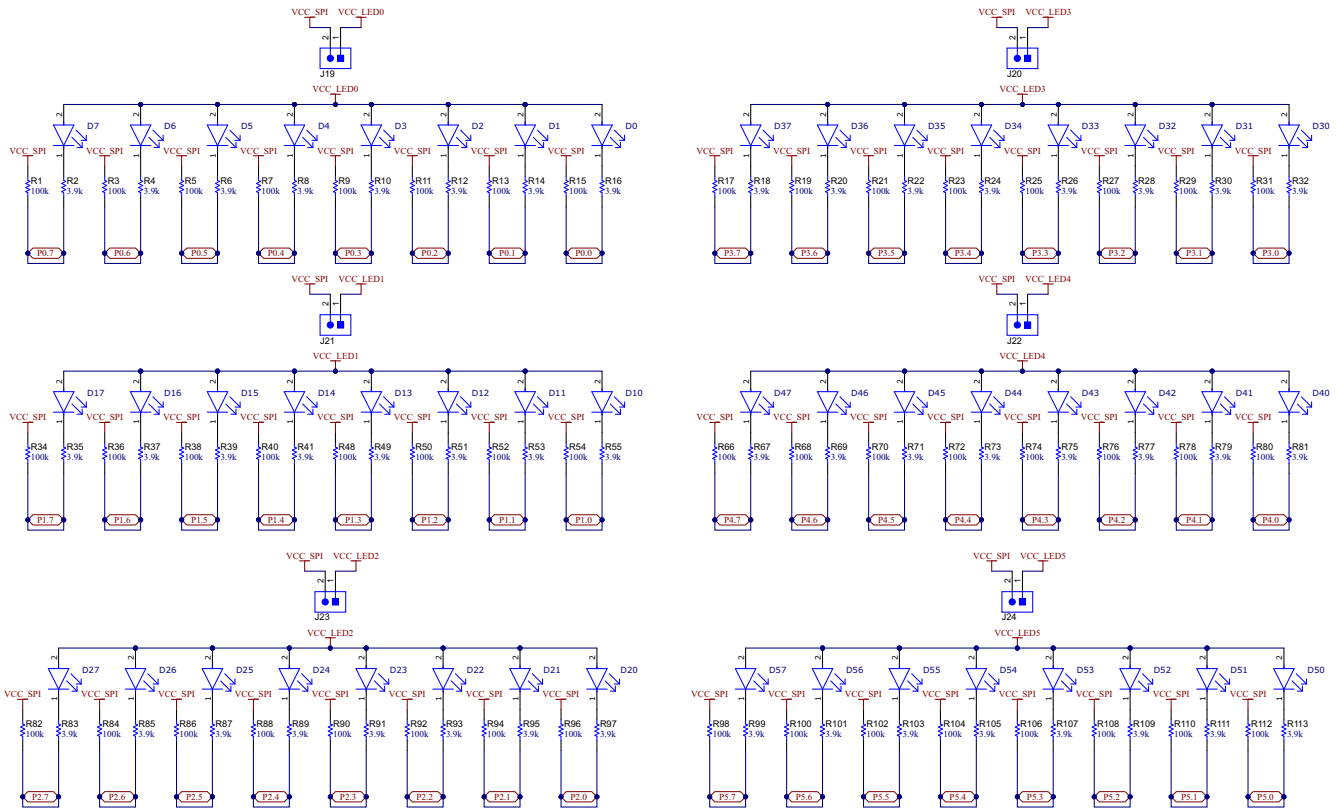


图 4-2. 原理图第 2 页 - LED 灯组

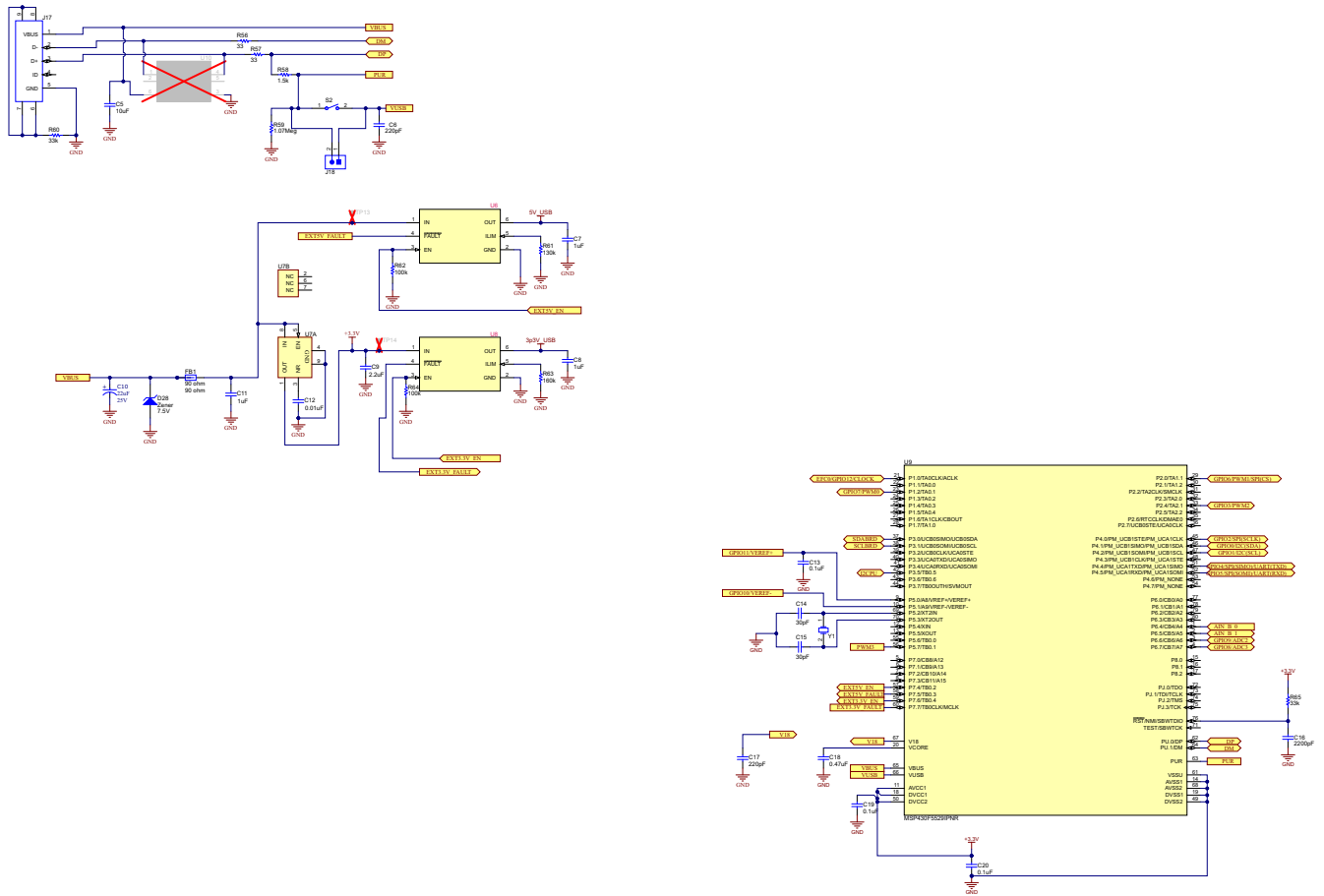


图 4-3. USB2ANY 电路

4.2 PCB 布局

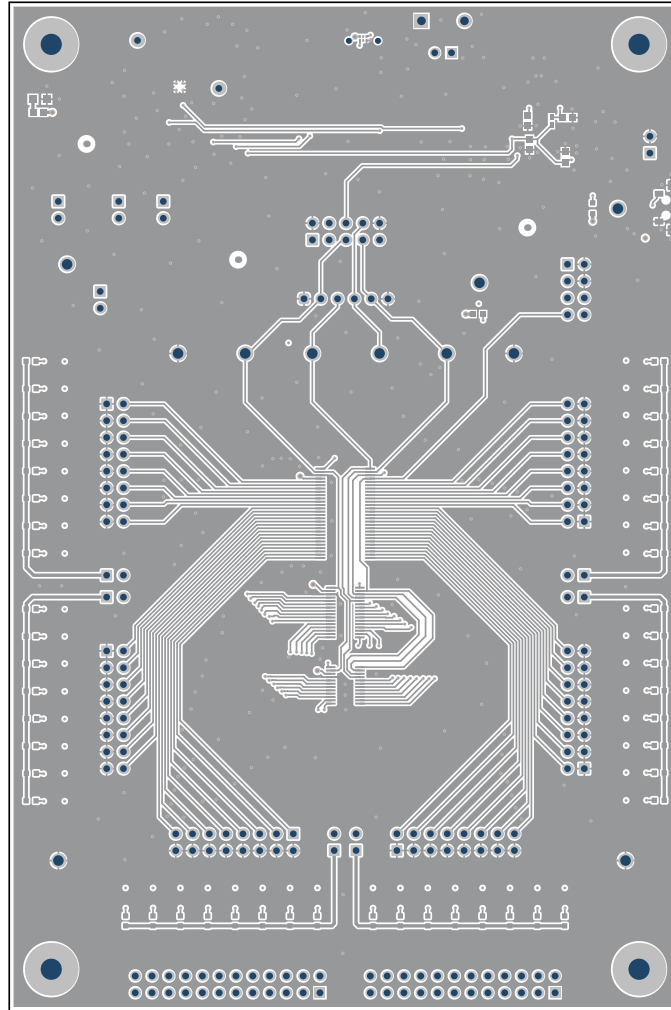


图 4-4. 顶层

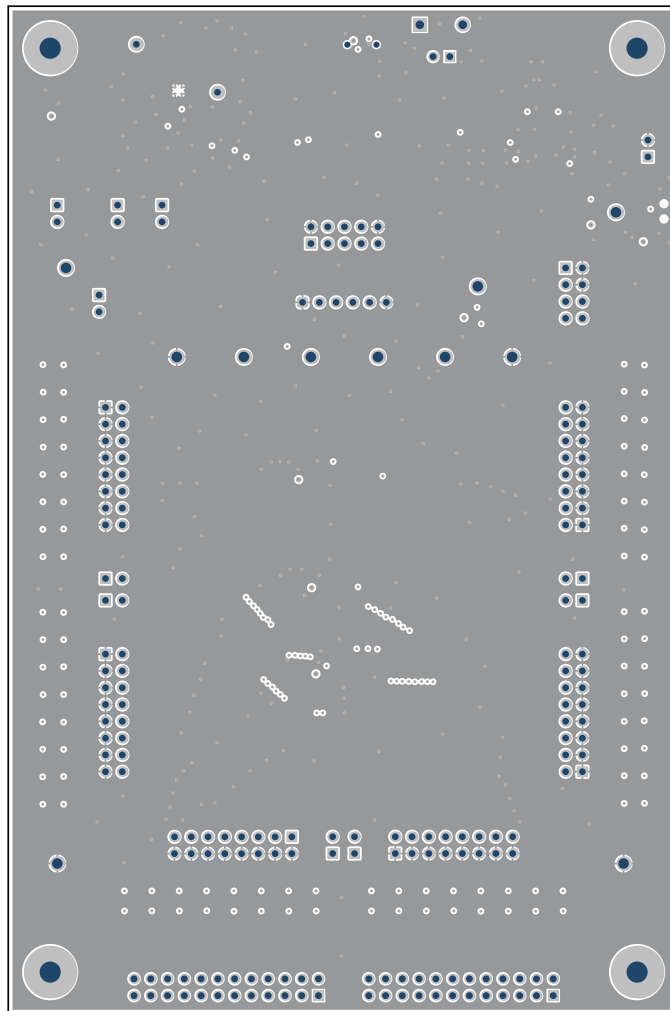


图 4-5. 第 2 层 — GND

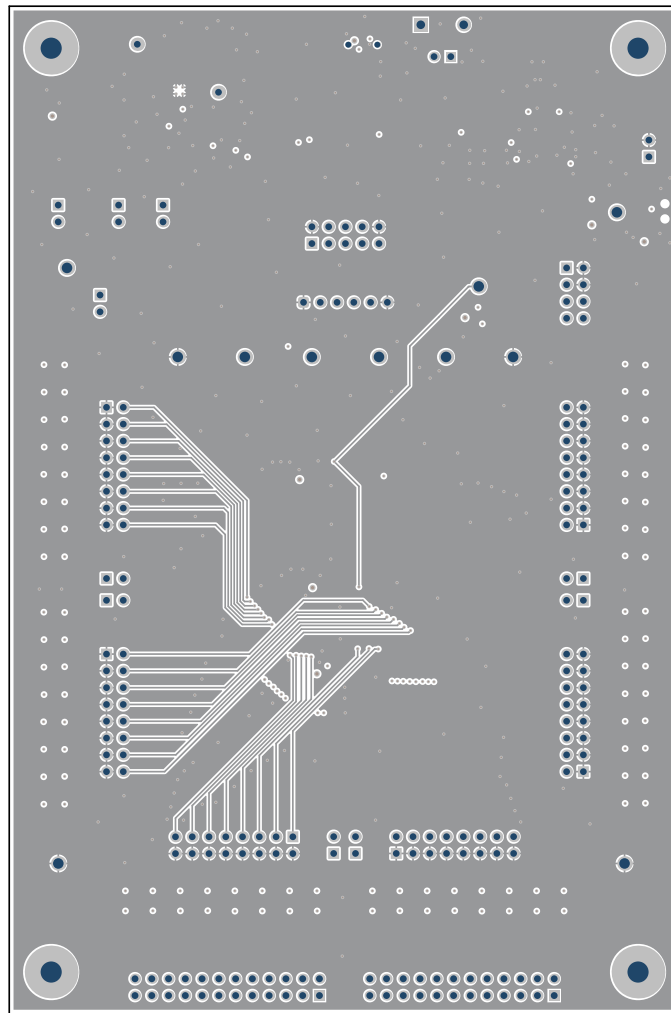


图 4-6. 第 3 层 — 信号

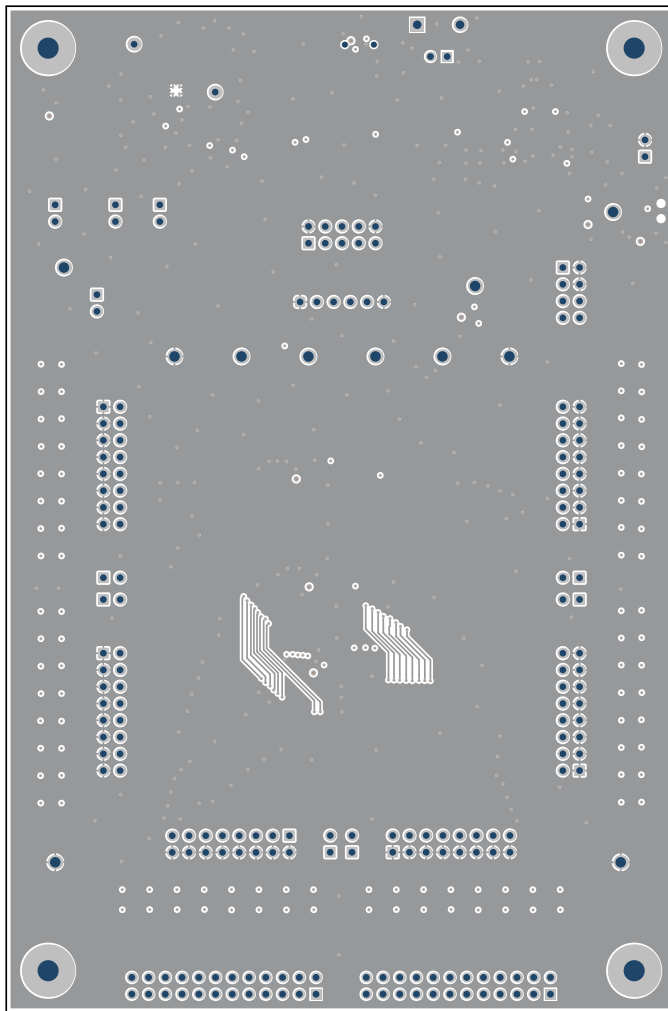


图 4-7. 第 4 层 — 信号

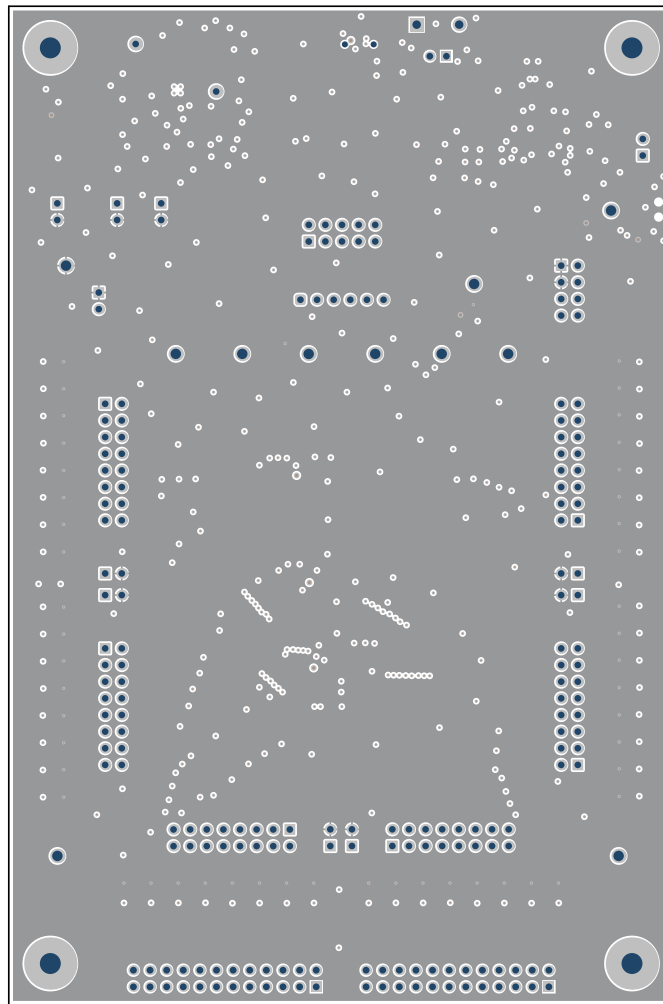


图 4-8. 第 5 层 — V_{CC}

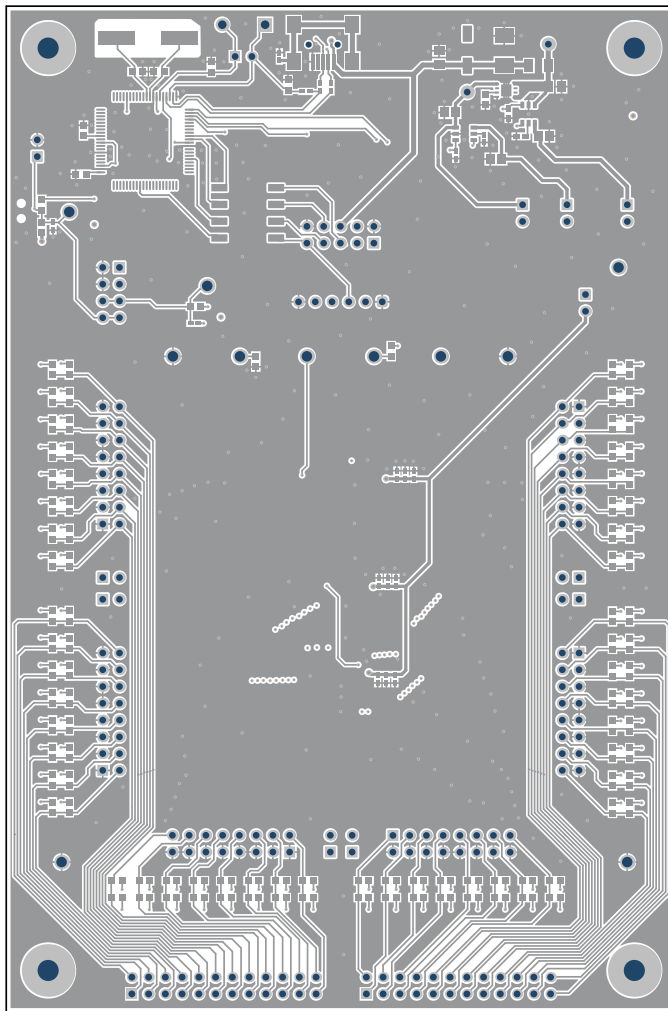


图 4-9. 底层

4.3 物料清单 (BOM)

表 4-1. 物料清单 (BOM)

位号	数量	值	器件型号	制造商	说明
C4	1	1uF	EMK105BJ105KVHF	Taiyo Yuden	电容, 陶瓷, 1uF, 16V, ±10%, X5R, 0402
C5	1	10uF	CC0805MKX5R7BB106	YAGEO	电容, 陶瓷, 10uF, 16V, ±20%, X5R, 080
C6、C17	2	220pF	CC0603FRNPO9BN221	YAGEO	电容, 陶瓷, 220pF, 50V, ±1%, C0G/NP0, 060
C7、C8	2	1uF	CC0805KRX5R7BB105	YAGEO	电容, 陶瓷, 1uF, 16V, ±10%, X5R, 0805
C9	1	2.2 μ F	CC0805KRX5R7BB225	YAGEO	电容, 陶瓷, 2.2uF, 16V, ±10%, X5R, 0805
C10	1	22uF	EDH226M025S9DAA	KEMET	电容, 铝制, 22uF, 25V, ±20%, SMD
C11	1	1uF	CC0805KX7R7BB105	YAGEO	电容, 陶瓷, 1uF, 16V, ±10%, X7R, 0805
C12	1	0.0uF	CC0603JRNPO9BN103	YAGEO	电容, 陶瓷, 0.01uF, 50V, ±5%, C0G/NP0, 0603
C13、C19、C20	3	0.1uF	CC0603JRX7R7BB104	YAGEO	电容, 陶瓷, 0.1uF, 16V, ±5%, X7R, 0603
C14、C15	2	30pF	CC0603JRNPO9BN300	YAGEO	电容, 陶瓷, 30pF, 50V, ±5%, C0G/NP0, 0603
C16	1	2200pF	CC0603KRX7R9BB222	YAGEO	电容, 陶瓷, 2200pF, 50V, ±10%, X7R, 0603
C18	1	0.47uF	CC0603KRX7R6BB474	YAGEO	电容, 陶瓷, 0.47uF, 10V, ±10%, X7R, 0603
C21、C24、C30	3	0.1uF	CC0402JRX7R7BB104	YAGEO	电容, 陶瓷, 0.1uF, 16V, ±5%, X7R, 0402
C22、C25、C31	3	1uF	GRM155R61C105MA12D	MuRata	电容, 陶瓷, 1μF, 16V, ±20%, X5R, 0402
C23、C26、C32	3	0.01uF	CC0402KRX7R7BB103	YAGEO	电容, 陶瓷, 0.01μF, 16V, ±10%, X7R, 0402

表 4-1. 物料清单 (BOM) (续)

位号	数量	值	器件型号	制造商	说明
D0、D1、D2、 D3、D4、D5、 D6、D7、D10、 D11、D12、 D13、D14、 D15、D16、 D17、D20、 D21、D22、 D23、D24、 D25、D26、 D27、D30、 D31、D32、 D33、D34、 D35、D36、 D37、D40、 D41、D42、 D43、D44、 D45、D46、 D47、D50、 D51、D52、 D53、D54、 D55、D56、D57	48		LTST-C190TBKT	Lite-On	LED 蓝色单色 468nm 2 引脚贴片 LED T/R
D8	1	红色	LTST-C190KRKT	Lite-On	LED, 红色, SMD
D9	1	绿色	LG R971-KN-1	OSRAM	LED, 绿色, SMD
D19	1	黄色	150060YS75000	Wurth Elektronik	LED, 黄色, SMD
D28	1	7.5V	1SMB5922BT3G	ON Semiconductor	二极管, 齐纳, 7.5V, 550mW, SMB
FB1	1	90 Ω	MI1206K900R-10	Laird-Signal Integrity Products	铁氧体磁珠, 90Ω (在 100MHz 时), 1.5A, 1206
H1、H2、H3、H4	4		CPF-306A	WEICHIMEI	机械螺钉, 圆头, #4-40 x 1/4, 尼龙, 飞利浦盘形头
H5、H6、H7、H8	4		0239 BTH-312	WEICHIMEI	六角螺柱, 0.5"L #4-40, 尼龙
J1、J2、J3、J8、 J9、J11	6		NS-201-SH0384-201S-2*8P(F)	NS-TECH	接头, 100mil, 8x2, 金, TH
J4、J16	2		NS-203-SH0002-203S-Y-2x12P(F)	NS-TECH	插座, 12x2, 2.54mm, 金, TH
J5	1		NS-201-SH0384-201S-2*5P(F)	NS-TECH	接头, 100mil, 5x2, 金, TH
J7、J10、J14、 J15、J19、J20、 J21、J22、J23、 J24、J25	11		NS-201-SH0385-201S-1*2P(F)	NS-TECH	接头, 100mil, 2x1, 金, TH
J12	1		NS-201-SH0384-201S-2*4P(F)	NS-TECH	接头, 100mil, 4x2, 金, TH

表 4-1. 物料清单 (BOM) (续)

位号	数量	值	器件型号	制造商	说明
J13	1		NS-201-SH0385-201S-1*6P(F)	NS-TECH	接头, 100mil, 6x1, 金, TH
J17	1		1734035-2	TE Connectivity	连接器, 插口, Mini-USB Type B, R/A, 顶部安装 SMT
J18	1		NS-201-SH0385-201S-1*2P(F)	NS-TECH	接头, 100mil, 2x1, 金, TH
R1、R3、R5、 R7、R9、R11、 R13、R15、 R17、R19、 R21、R23、 R25、R27、 R29、R31、 R34、R36、 R38、R40、 R48、R50、 R52、R54、 R66、R68、 R70、R72、 R74、R76、 R78、R80、 R82、R84、 R86、R88、 R90、R92、 R94、R96、 R98、R100、 R102、R104、 R106、R108、 R110、R112	48	100k	AC0603JR-07100KL	YAGEO	电阻, 100k, 5%, 0.1W, AEC-Q200 0级, 0603

表 4-1. 物料清单 (BOM) (续)

位号	数量	值	器件型号	制造商	说明
R2、R4、R6、 R8、R10、R12、 R14、R16、 R18、R20、 R22、R24、 R26、R28、 R30、R32、 R35、R37、 R39、R41、 R49、R51、 R53、R55、 R67、R69、 R71、R73、 R75、R77、 R79、R81、 R83、R85、 R87、R89、 R91、R93、 R95、R97、 R99、R101、 R103、R105、 R107、R109、 R111、R113	48	3.9k	AC0603JR-073K9L	YAGEO	电阻, 3.9k Ω , 5%, 0.1W, AEC-Q200 0 级, 0603
R33	1	560	AC0603JR-07560RL	YAGEO	电阻, 560, 5%, 0.1W, 0603
R42	1	300	RC0603JR-07300RL	Yageo	电阻, 300, 5%, 0.1W, 0603
R44、R46	2	10k	AC0603JR-0710KL	YAGEO	电阻, 10k, 5%, 0.1W, AEC-Q200 0 级, 0603
R47	1	1.00k	RC0402FR-071KL	Yageo America	电阻, 1.00k, 1%, 0.0625W, 0402
R56、R57	2	33	AC0402JR-0733RL	YAGEO	电阻, 33, 5%, 0.063W, AEC-Q200 0 级, 0402
R58	1	1.5k	AC0402JR-071K5L	YAGEO	电阻, 1.5k, 5%, 0.063W, AEC-Q200 0 级, 0402
R59	1	1.07Meg	AC0603FR-071M07L	YAGEO	电阻, 1.07M, 1%, 0.1W, AEC-Q200 0 级, 0603
R60、R65	2	33k	AC0402JR-0733KL	YAGEO	电阻, 33k, 5%, 0.063W, AEC-Q200 0 级, 0402
R61	1	130k	AC0402JR-07130KL	YAGEO	电阻, 130k, 5%, 0.063W, AEC-Q200 0 级, 0402
R62、R64	2	100k	AC0402JR-07100KL	YAGEO	电阻, 100k, 5%, 0.063W, AEC-Q200 0 级, 0402

表 4-1. 物料清单 (BOM) (续)

位号	数量	值	器件型号	制造商	说明
R63	1	160k	AC0402JR-07160KL	YAGEO	电阻, 160k, 5%, 0.063W, AEC-Q200 0 级, 0402
S1	1		THBM02-LAB	宏聚	开关, SPST, 0.05A, 12VDC, SMD
S2	1		FSMH	TE Connectivity Alcoswitch 开关	开关, 触控式, 单刀单掷-常开, 0.05A, 12V, TH
SW1	1		219-4MSTR	CTS Electrocomponents	DIP 开关 SPST 4 档表面贴装滑动 (标准) 执行器 100mA 20VDC
TP1	1		Test Point-1P-DIP-H8.1-Φ3.2-Red	FuZhou XiXiang	测试点, 多用途, 红色, TH
TP2、TP3、TP4、TP5	4		Test Point-1P-DIP-H8.1-Φ3.2-BLACK	FuZhou XiXiang	测试点, 多用途, 黑色, TH
TP6	1		5125	Keystone Electronics	测试点, 通用, 棕色, TH
TP8	1		Test Point-1P-DIP-H8.1-Φ3.2-Yellow	FuZhou XiXiang	测试点, 通用, 黄色, TH
TP9	1		5127	Keystone	测试点, 通用, 蓝色, TH
TP10	1		Test Point-1P-DIP-H8.1-Φ3.2-Orange	FuZhou XiXiang	测试点, 通用, 橙色, TH
TP11	1		5126	Keystone	测试点, 通用, 绿色, TH
TP12	1		Test Point-1P-DIP-H8.1-Φ3.2-White	FuZhou XiXiang	测试点, 通用, 白色, TH
U2	1		TXE8124QDGSRQ1	德州仪器 (TI)	TXE8124QDGSRQ1
U6、U8	2		TPS2553DBVT-1	德州仪器 (TI)	可调节, 高电平有效, 闭锁, 限流配电开关, 0.075A 至 1.7A 限流, -40°C 至 85°C, 6 引脚 SOT-23 (DBV), 绿色环保 (符合 RoHS 标准, 无镉/溴)
U7	1		TPS73533DRBT	德州仪器 (TI)	单路输出高 PSRR LDO, 500mA, 固定 3.3V 输出, 2.7V 至 6.5V 输入, 具有低 IQ, 采用 8 引脚 SON (DRB) 封装, -40°C 至 125°C, 绿色环保 (符合 RoHS 标准, 无镉/溴)
U9	1		MSP430F5529IPNR	德州仪器 (TI)	25MHz 混合信号微控制器, 具有 128KB 闪存、8192B SRAM 和 63 个 GPIO, -40°C 至 85°C, 80 引脚 QFP (PN), 绿色环保 (符合 RoHS 标准, 无镉/溴)
Y1	1		ECS-240-20-5PX-TR	ECS Inc.	晶振, 24.000MHz, 20pF, SMD
R43、R45	0	10k	CRCW060310K0JNEA	Vishay-Dale	电阻, 10k, 5%, 0.1W, AEC-Q200 0 级, 0603
TP13、TP14	0		5000	Keystone	测试点, 微型, 红色, TH
U3	0		TXE8116QDGSRQ1	德州仪器 (TI)	TXE8116QDGSRQ1

表 4-1. 物料清单 (BOM) (续)

位号	数量	值	器件型号	制造商	说明
U10	0		TPD4E004DRYR	德州仪器 (TI)	适用于高速数据接口的 4 通道 ESD 保护阵列, DRY0006A (USON-6)

5 其他信息

5.1 商标

所有商标均为其各自所有者的财产。

5.2 术语

SPI 术语更改

6 修订历史记录

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision * (August 2025) to Revision A (May 2026)	Page
• 删除了文档中的 TXE8148.....	1

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
 - 1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM ("Software") shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software
 - 1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.
2. *Limited Warranty and Related Remedies/Disclaimers:*
 - 2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.
 - 2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.
 - 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 DEGRADATION 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/lstds/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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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lstds/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.

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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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