参考文献

EVM User's Guide: TPS25752AEVM

TPS25752A 评估模块

说明

TPS25752AEVM 评估模块 (EVM) 支持仅供电模式下的单端口 USB Type-C® 和电力输送 (PD) 应用。EVM 允许用户为 TPS25752A 开发各种功率分布并调试现有系统。直观的网页 GUI 通过清晰的方框图和简单的下拉选择问题，向用户询问几个有关应用需求的简单问题。GUI 会为用户的应用创建配置映像，从而不像同类 USB PD 设计那么复杂。

开始使用

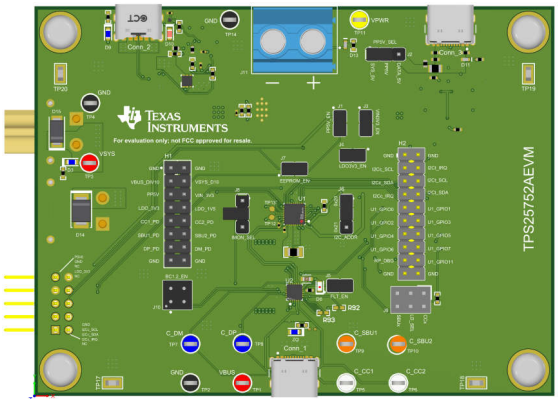
1. 订购 TPS25752AEVM 这款高度集成的 USB Type-C 和 USB PD 控制器评估模块 (EVM)
2. 阅读 TPS25752AEVM 用户指南
3. 使用应用程序自定义工具开始开发
4. 如有疑问或需要支持，请参阅数据表、技术参考手册，也可访问 E2E™ 论坛

特性

- 高达 100W (20V/5A) 源应用
- 易于使用的 GUI，附带预配置的固件，可配置电压范围、充电协议以及连接的 TPS25752A USB-PD 控制器的各个方面
- 多个测试点和接头可实现快速轻松的调试信号，例如 VBUS、CCx 和 ADCINx 线路

应用

- 无绳电动工具电池包
- 移动电源
- 零售自动化和支付
- 无线音箱
- 无线真空吸尘器
- 个人或便携式电子产品
- 医疗和保健



TPS25752A

1 评估模块概述

1.1 简介

TPS25752AEVM 评估模块是一款全功能评估模块，用于评估 TPS25752A USB-PD 控制器。该电路板包含利用 TPS25752A 控制器，评估支持 SPR (标准功率范围) 仅供电应用的 USB-SPR 应用所需的一切资源。板上集成预烧录的嵌入式微控制器，可轻松与连接至 TPS25752A 器件的 EEPROM 通信并对其进行编程，无需外部编程器或调试程序。提供了功能齐全的 GUI 来与器件交互，支持初始配置、导出编程与补丁文件、动态读取 TPS25752A 器件的诊断或故障信息等功能。

1.2 套件内容

- TPS25752AEVM
- EVM 免责声明自述文件

1.3 规格

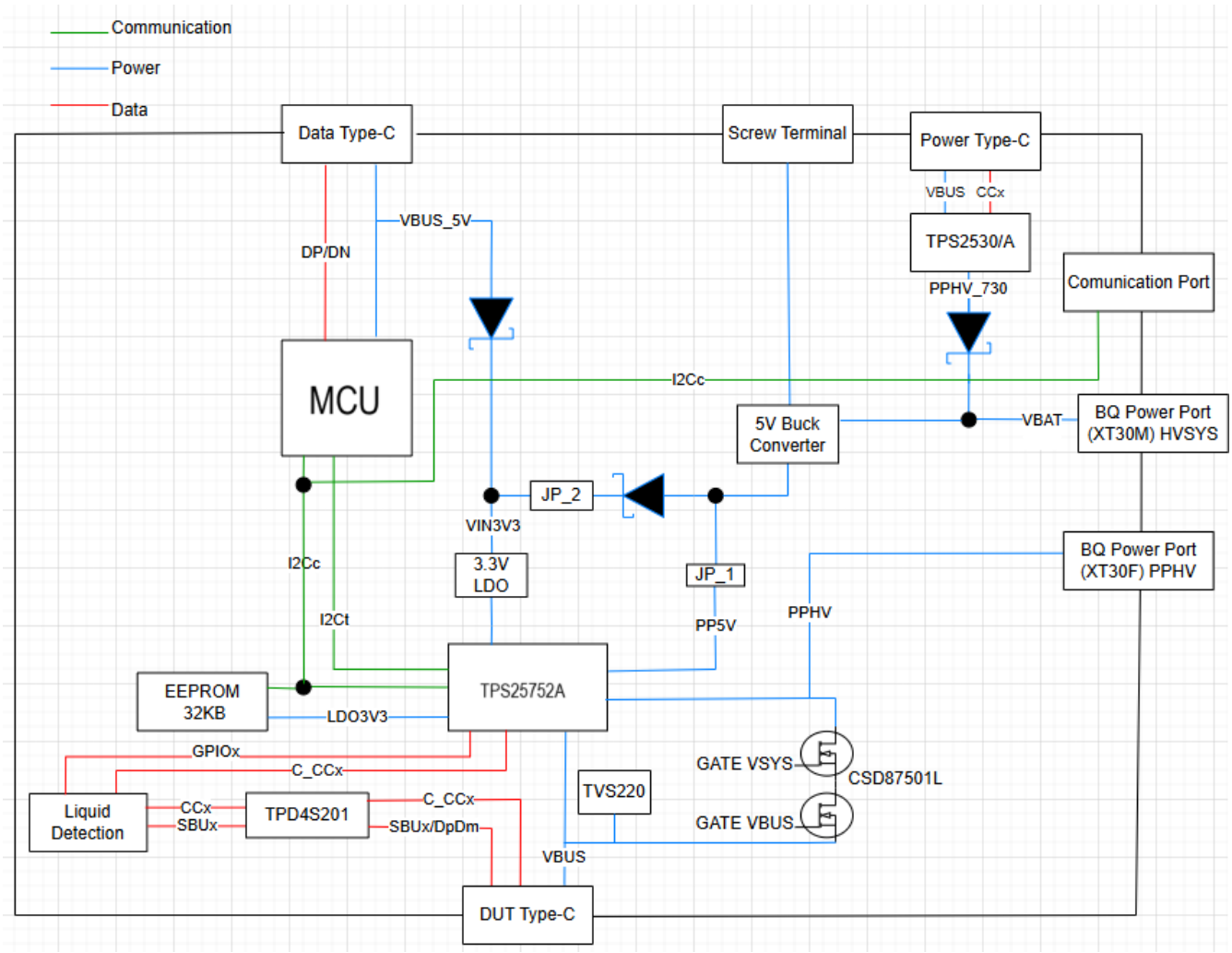


图 1-1. TPS25752AEVM 方框图

1.4 器件信息

TPS25752A 器件是一款单端口 USB Type-C® PD 控制器，具有外置的高压电源路径，适用于仅供电应用。TPS25752AEVM 评估模块用于评估 TPS25752A PD 控制器的功能等效 TPS25752AD（内部高压电源路径）版本。TPS25752A PD 控制器是在标准功率范围 (SPR) 下运行的单端口电源应用的理想选择，适用于高达 100W (20V/5A) 的仅供电应用。

TPS25752AEVM 评估模块包括多个用于对电压保护、电源拓扑和电流感应进行完整评估的器件，另搭载一个 TPS25730A PD 控制器，用于替代桶形插孔。有关 TPS25752AEVM 上每个器件的更多详细信息，请参阅表 1-1。

表 1-1. TPS25752AEVM 上的器件

位号	器件名称	说明
U1	TPS25752A	USB Type-C SPR 仅供电 PD 控制器
U2	TPD4S201	20V 端口保护，带 VBUS 短路保护
U5	TPS25730A	USB Type-C 纯受电 PD 控制器，直流桶形插孔替代产品

2 硬件

2.1 电源要求

对于独立 PD 评估，TPS25752AEVM 评估模块的主电源是通过 USB Type-C 仅受电端口 (Conn_2) 提供的，该端口可接受 45W USB Type-C PD 电源（15V 至 20V）。如果 Type-C 适配器不能提供最小 15V 的电压，则 TPS25752AEVM 不能正确加电。或者，也可以使用连接到 VSYS 测试点 (TP3) 的外部台式电源为 EVM 供电，台式电源提供 15V 至 20V 的电压范围。

备注

VSYS (TP3) 的绝对最大额定值为 48V，建议的最大值为 42V。如果施加的电压高于最大电压，可能会导致 EVM 损坏。

对于电源，在向连接到 TPS25752A 器件的受电端供电时，可以将外部 DC/DC EVM 连接到 TPS25752AEVM。TPS55288、TPS55289 和 LM251772 DC/DC 器件可以与 TPS25752AEVM 连接。相应的 DC/DC EVM 直接通过 J12、J13 和 J14 连接，无需单独的排线连接即可无缝对接。

2.2 设置

在开箱即用状态下，TPS25752AEVM 评估模块配置为采用 15W (5V/3A) 的供电功率。如果需要不同的配置来测试系统，请使用应用程序自定义工具创建配置或加载不同的配置模板。有关使用应用自定义工具的详细说明，请参阅 GUI 用户指南。

TPS25752AEVM 支持液体检测和腐蚀缓解，可保护系统免受 USB Type-C 端口意外短路（液体、潮湿及碎屑）的影响。在液体检测状态下，TPS25752A 器件会监控 SBU 或 CC 线路上是否存在意外的接地短路或高电压（5V 及以上）。用户可以选择用于液体检测的引脚配置。TPS25752A 器件可在检测到短路时自动禁用 Type-C 端口，从而支持腐蚀缓解。当监测引脚之间不再检测到短路时，TPS25752A 器件会恢复正常运行。要选择对哪些引脚的液体检测进行监测，可以在接头 J9 上添加跳线，以选择使用 SBUx 线路或 CCx 线路进行监测。

2.2.1 与 TPS55288 连接

TPS25752AEVM 能够与具有 PPS 控制的 TPS55288 36V、16A 降压/升压转换器连接。可以使用通用 TPS55288EVM-045 评估板或直接与 TPS25752AEVM 连接的 USB-PD 特定连接器板完成连接。

连接到通用 TPS55288EVM-045 评估板时，必须进行以下信号连接和跳线配置：

- TPS55288EVM-045 (J3) 的 VOUT 连接到 TPS25752AEVM (J11) 的 VSYS
- TPS55288EVM-045 的 SDA/SCL 信号（J5 和 J6 的引脚 2）连接到 TPS25752AEVM 的 I2Cc_SDA 和 I2Cc_SCL
  - 关于 TPS25752AEVM 的早期版本，I2Cc_SDA 和 I2Cc_SCL 引脚在丝印上标记错误。在电路板的早期版本（用白色 PCB 颜色表示）上，电路板上标记的 I2Cc_SDA 信号实际上为 I2Cc_SCL，电路板上标记的 I2Cc_IRQ 信号实际上为 I2Cc_SCL。
- 电路板之间的参考 GND 信号连接
- 将适当的外部电压电源连接到 TPS55288-045 EVM 的 VIN (J1)
- TPS55288EVM-045 的使能跳线 (JP1) 必须设置为 EN 位置
- 在 USBPD Application Customization Tool 中，TPS55288 的从机地址必须设置为 0x74，因为 TPS55288EVM-045 上的 MODE 电阻已将该地址硬编码为 0x74

另请注意，系统电源还必须通过 USB-PD 电源端口 (Conn_2) 或 VPWR (J11) 上的外部电源提供，以确保 TPS25752A 具有足够的系统电源可供运行。Conn_2 USB 连接器上需要一个支持 65W 的 PD 控制器，或者 VPWR 需要一个 20V 电位才能提供足够的功率。下面的图 2-1 中显示了使用 TPS25752AEVM 和 TPS55288EVM-045 的示例连接：

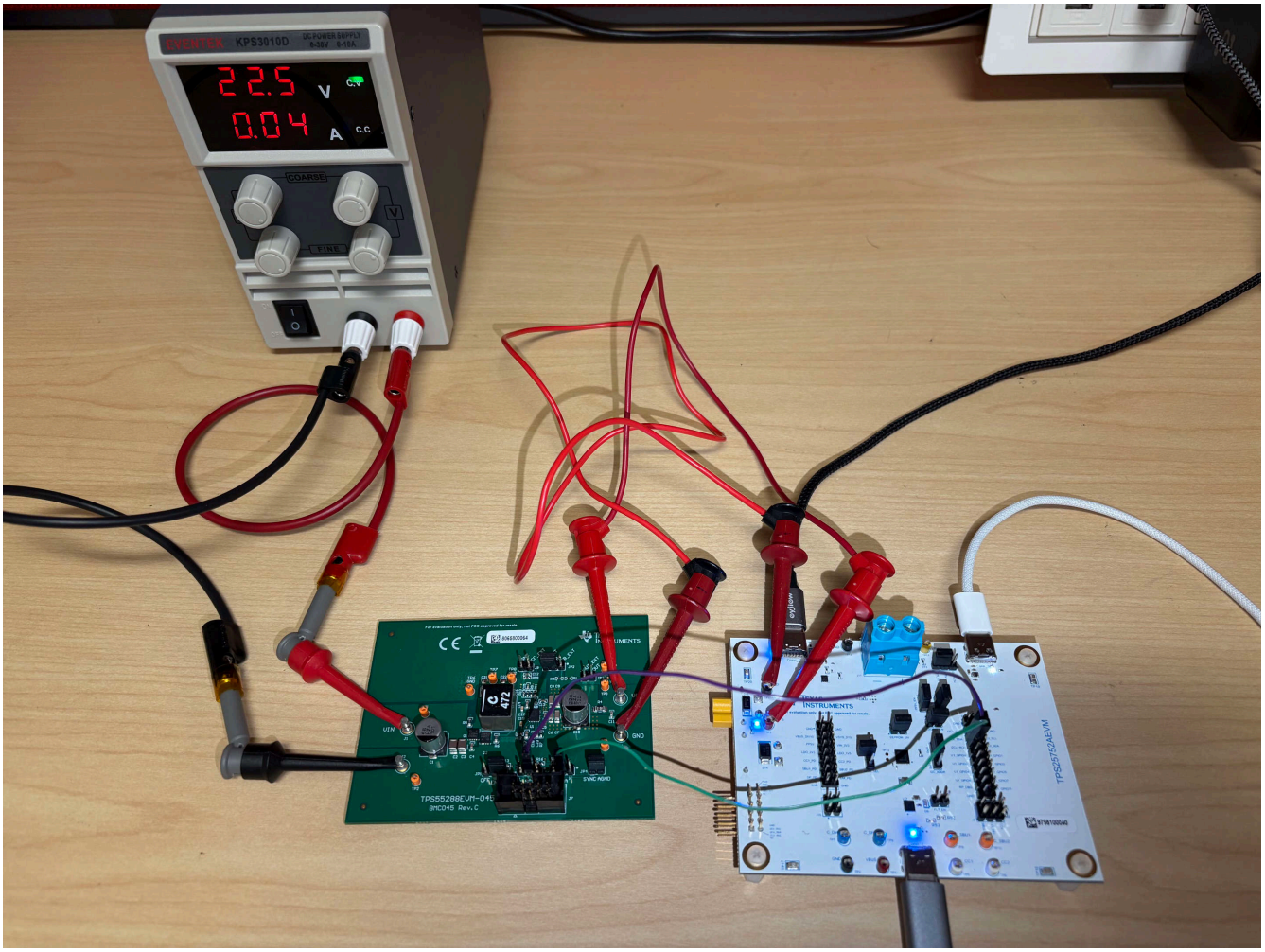


图 2-1. TPS5528EVM-045 连接到 TPS25752AEVM

或者，存在直接连接到 TPS25752AEVM 上的外部电路板接口连接器（J12、J13 和 J14）的专用电路板。此电路板可通过联系相关 TI 支持团队获取，可减少将 TPS55288 连接至 TPS25752AEVM 所需的外部线缆数量。下面的图 2-2 中显示了一个示例连接：

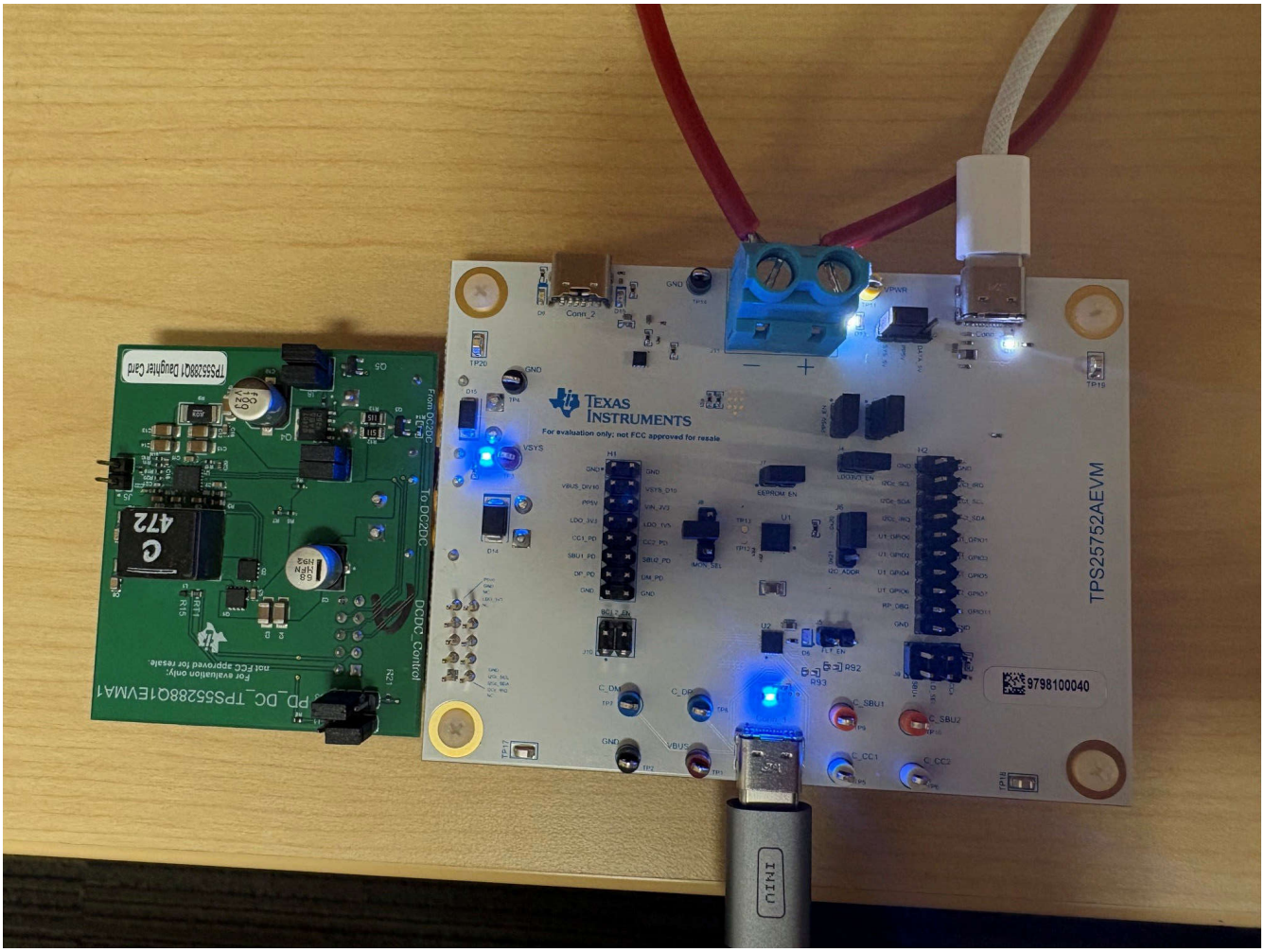


图 2-2. 集成 TPS55288 电路板和 TPS25752AEVM

请注意，在此设置中，TPS55288 的从器件地址配置为 0x75，并且必须正确反映在使用 USBPD Application Customization Tool 生成的 TPS25752A 的应用程序配置中。

2.2.2 与 LM251772 连接

TPS25752AEVM 完全集成并无缝连接到 LM251772EVM-PD。两个评估板可以连接在一起，如图 2-3 所示：

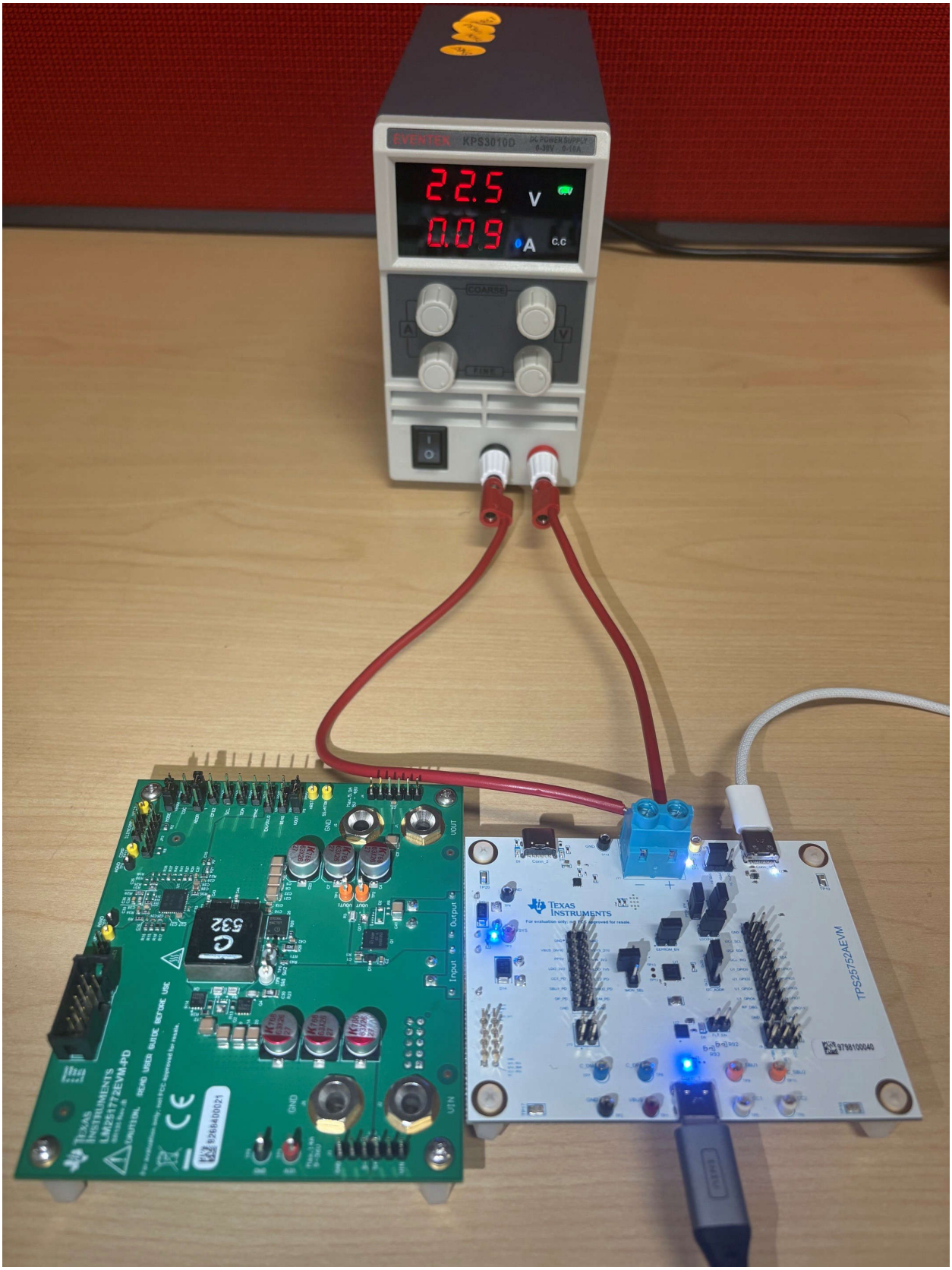


图 2-3. LM251772EVM-PD 连接到 TPS25752AEVM

请注意，在此配置中，必须在 USBCPD Application Customization Tool 中适当地设置 LM251772EVM-PD 的 I2C 地址。LM251772EVM-PD 上的 ADDR 接头 (JP9) 必须设置为在定制工具中配置的相应地址。将 JP9 跳线设置为 Pin1 和 Pin2 位置会将 I2C 地址设置为 0x6A，将跳线设置为 Pin2 到 Pin3 位置会将其设置为 0x6B。

2.3 跳线信息

表 2-1. 跳线信息

跳线网络名称	跳线位号	引脚说明
PP5V_EN	J1	PD 控制器 PP5V 的 5V 输入。移除跳线可断开 PP5V 的 5V 电源。
PP5V_Sel	J2	从以下任一项中选择 PP5V 5V 电源： • 板载 5V 降压电源（由 USB Type-C 电源接口供电） • PICO 端口（直接来自计算机 USB 端口的 5V 电源）
VIN3V3	J3	PD 控制器 VIN_3V3 的 3.3V 输入。移除跳线可断开 PD 控制器的 3.3V 电源。
LDO3V3	J4	PD 控制器 LDO_3V3 的 3.3V 输出。移除跳线可断开连接到 EEPROM 的 3.3V 电源轨和连接到 I2Cc/I2Ct 线路的 3.3V 上拉电阻（消除 PD LDO_3V3 引脚的所有功耗）。
FLT_EN	J5	使能来自保护器件并输入到 TPS25752A 的故障输出信号。
I2C_ADDR	J6	在 0x20 和 0x21 之间配置 I2C 目标地址。
EEPROM_EN	J7	PD 控制器和 EEPROM 之间的 I2Cc 数据线。移除跳线可禁用从 EEPROM 加载 I2C 配置（PD 保持 PTCH 状态）。
LD SEL	JP9	选择用于液体检测的引脚（CCx 或 SBUx）。
BC1.2_EN	JP10	使能 BC1.2 功能，以为传统设备供电。

2.4 LED 信息

表 2-2. LED 信息

位号	网标签	说明
D1	不适用	不适用
D2	VBUS	蓝色 LED，指示 BQ 电池连接到 VBUS。
D3	VSYS	蓝色 LED，指示 VSYS 已上电。
D6	FLT	红色 LED，指示保护器件发生故障。
D9	系统功耗	蓝色 LED，指示已向 Conn_2（桶形插口替代电源）供电。
D10	能力不匹配	红色 LED，指示 CONN_2 连接存在能力不匹配问题（请确保已连接功率足够的电源）。
D11	MCU 电源	指示正在向 PICO MCU 供电。
D13	系统电源（接头）	此 LED 指示已由 J11 系统电源连接器供电。

2.5 测试点

表 2-3. 测试点信息

位号	网标签	说明
VBUS	TP1	PD 控制器 VBUS 电压基准。
GND	TP2、TP4、TP14、TP17 至 TP20	EVM 的接地基准。
VSYS	TP3	PD 控制器 VSYS 电压基准。

表 2-3. 测试点信息（续）

位号	网标签	说明
C_CC1	TP5	PD 控制器的 CC1 的连接器侧，位于保护器件与 USB-C/PD 端口之间。
C_CC2	TP6	PD 控制器的 CC2 的连接器侧，位于保护器件与 USB-C/PD 端口之间。
C_DP	TP7	PD 控制器的 DP 的连接器侧，位于保护器件与 USB-C/PD 端口之间。
C_DM	TP8	PD 控制器的 DM 的连接器侧，位于保护器件与 USB-C/PD 端口之间。
C_SBU1	TP9	PD 控制器的 SBU1 的连接器侧，位于保护器件与 USB-C/PD 端口之间。
C_SBU2	TP10	PD 控制器的 SBU2 的连接器侧，位于保护器件与 USB-C/PD 端口之间。
GATE_VBUS	TP12	连接至供电端连接到 VBUS 的 N 沟道 MOSFET。
GATE_VSYS	TP13	连接至供电端连接到 VSYS 的 N 沟道 MOSFET。
电流检测	TP21、TP22	电流传感分流电阻器的测试点。

2.6 开关和按钮

表 2-4. 开关和按钮信息

位号	标签	说明
SW1	复位	用于拉动 Raspberry Pi® PICO 器件的 RST 引脚的按钮。按下时，RST 引脚变为低电平。

3 软件

3.1 软件说明

所需软件可从 TI Gallery 获取，并可通过网络浏览器运行（需要使用 Google Chrome®、Firefox® 或 Safari® 网络浏览器）。如需使用该软件，还必须在 PC 上安装 TI Cloud Agent 作为浏览器扩展。该应用程序启动后，将显示安装 TI Cloud Agent 的说明。该软件也可以在 PC 上本地运行。如果希望在 PC 本地运行该软件，则必须在本地安装 GUI Composer Runtime。若要安装 GUI Composer Runtime，请点击 TI Gallery 中所列应用之一内的向下箭头，然后查看显示的底部链接集。在选择本机操作系统后，打开安装程序并按照提示安装程序。有关如何安装 GUI 并将其用于 TPS25752AEVM 评估模块的更多信息，请参阅 GUI 用户指南。

4 硬件设计文件

4.1 原理图

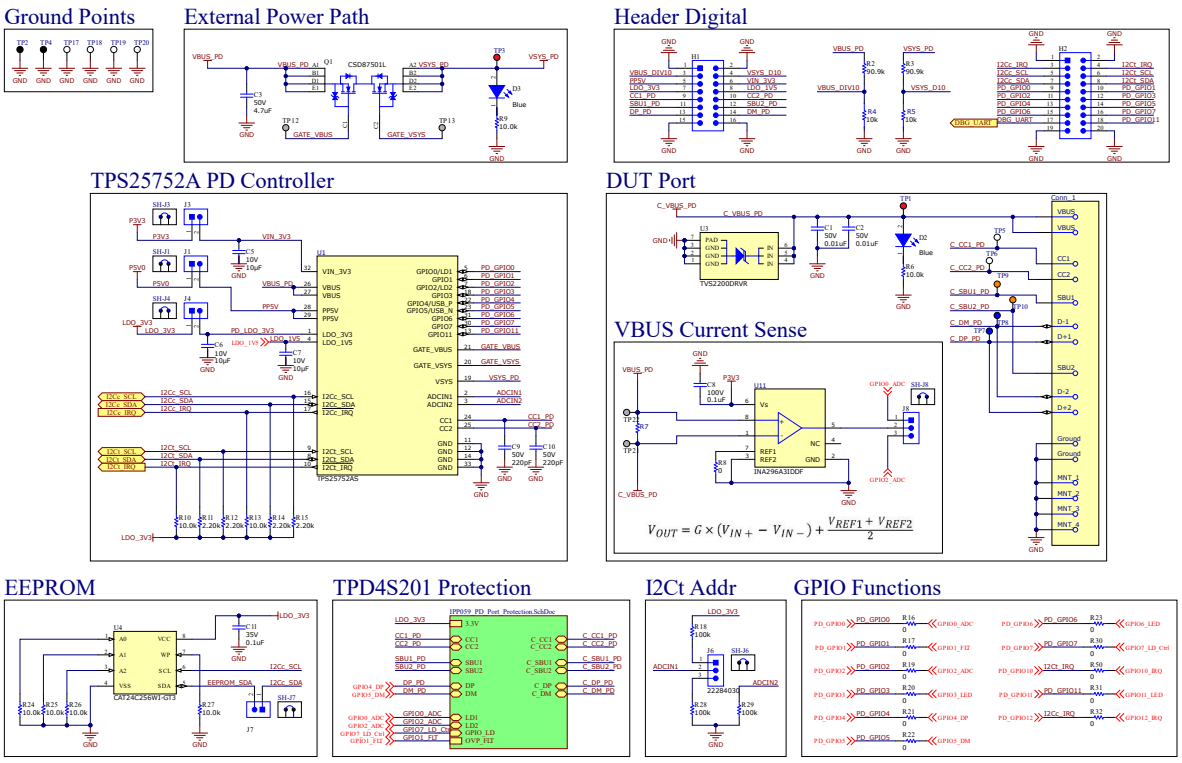


图 4-1. PD 控制器原理图

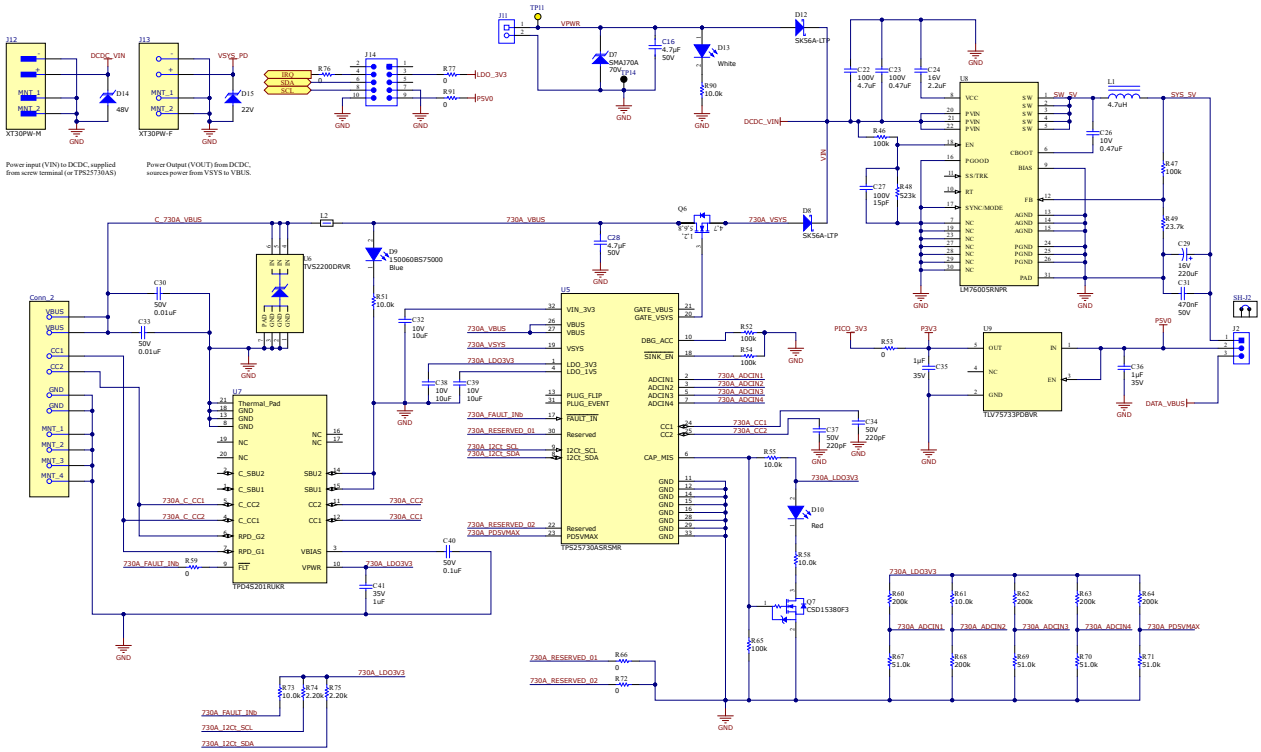


图 4-2. 电源树原理图

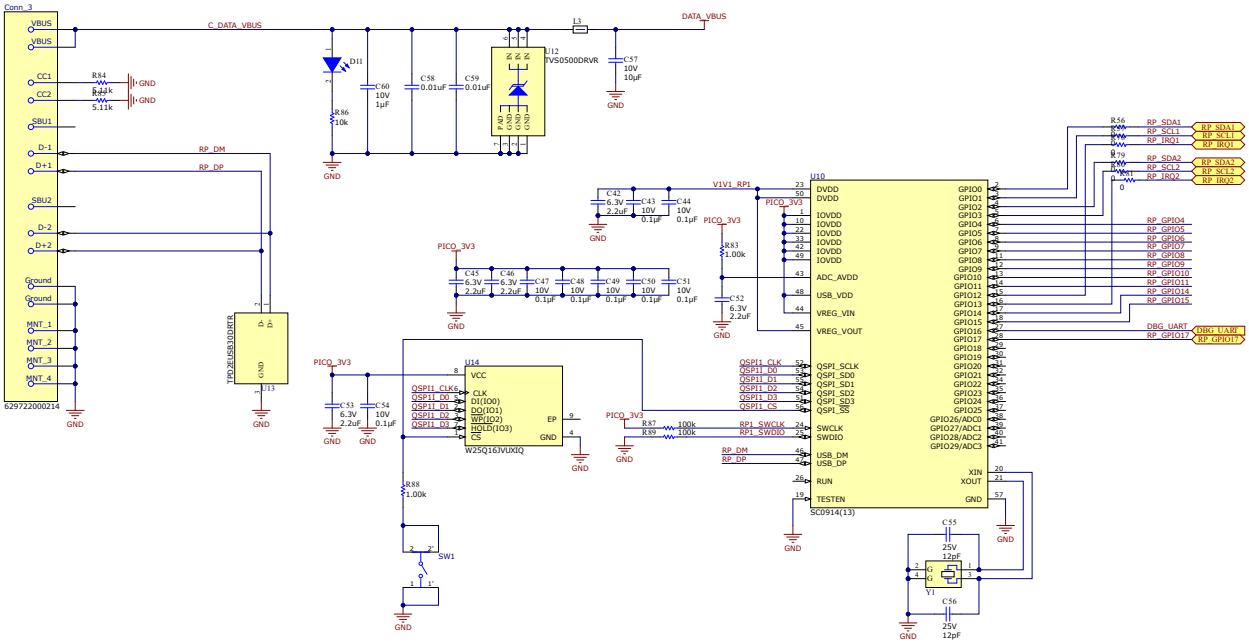


图 4-3. MCU 原理图

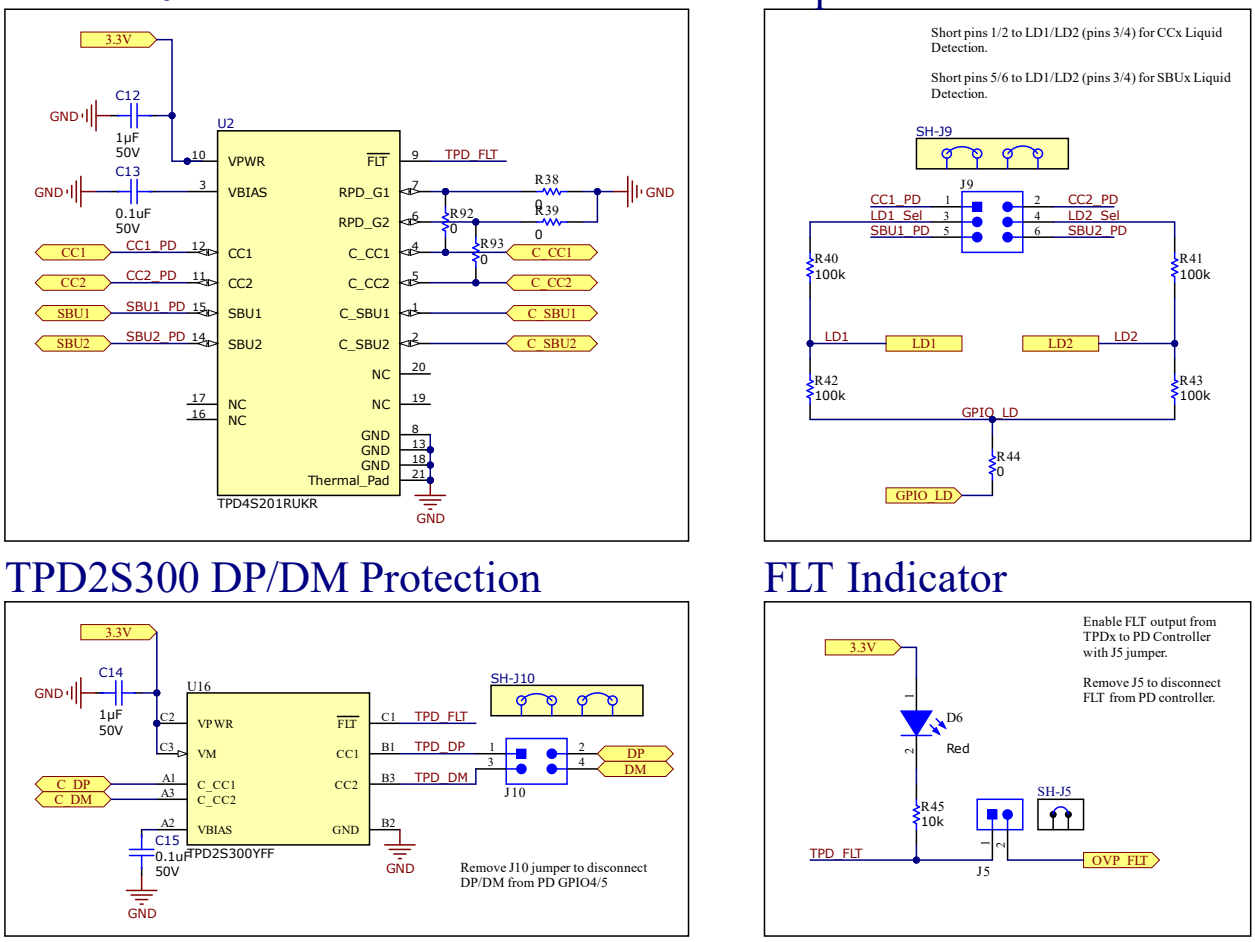


图 4-4. 端口保护原理图

4.2 PCB 布局

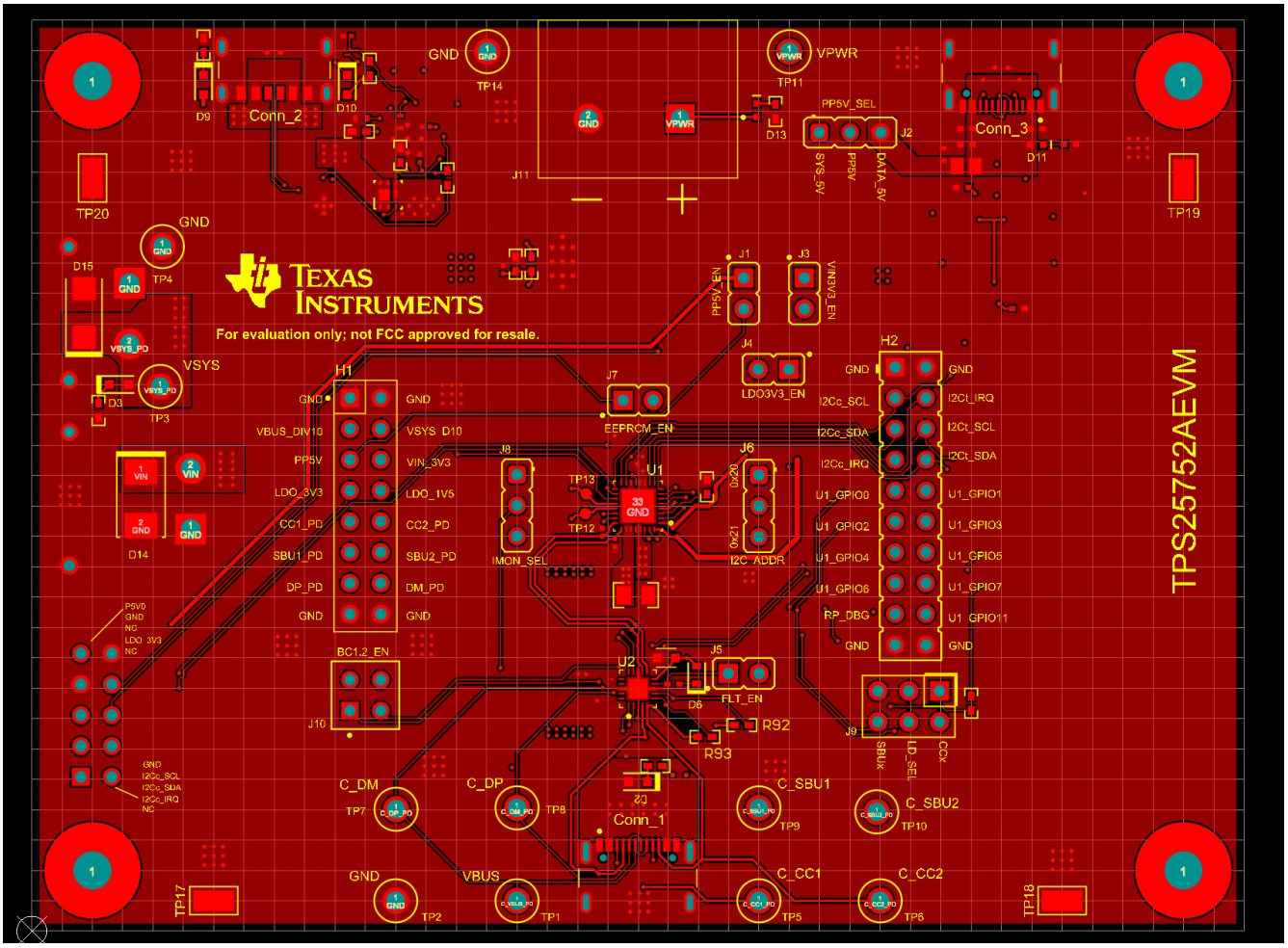


图 4-5. 顶层

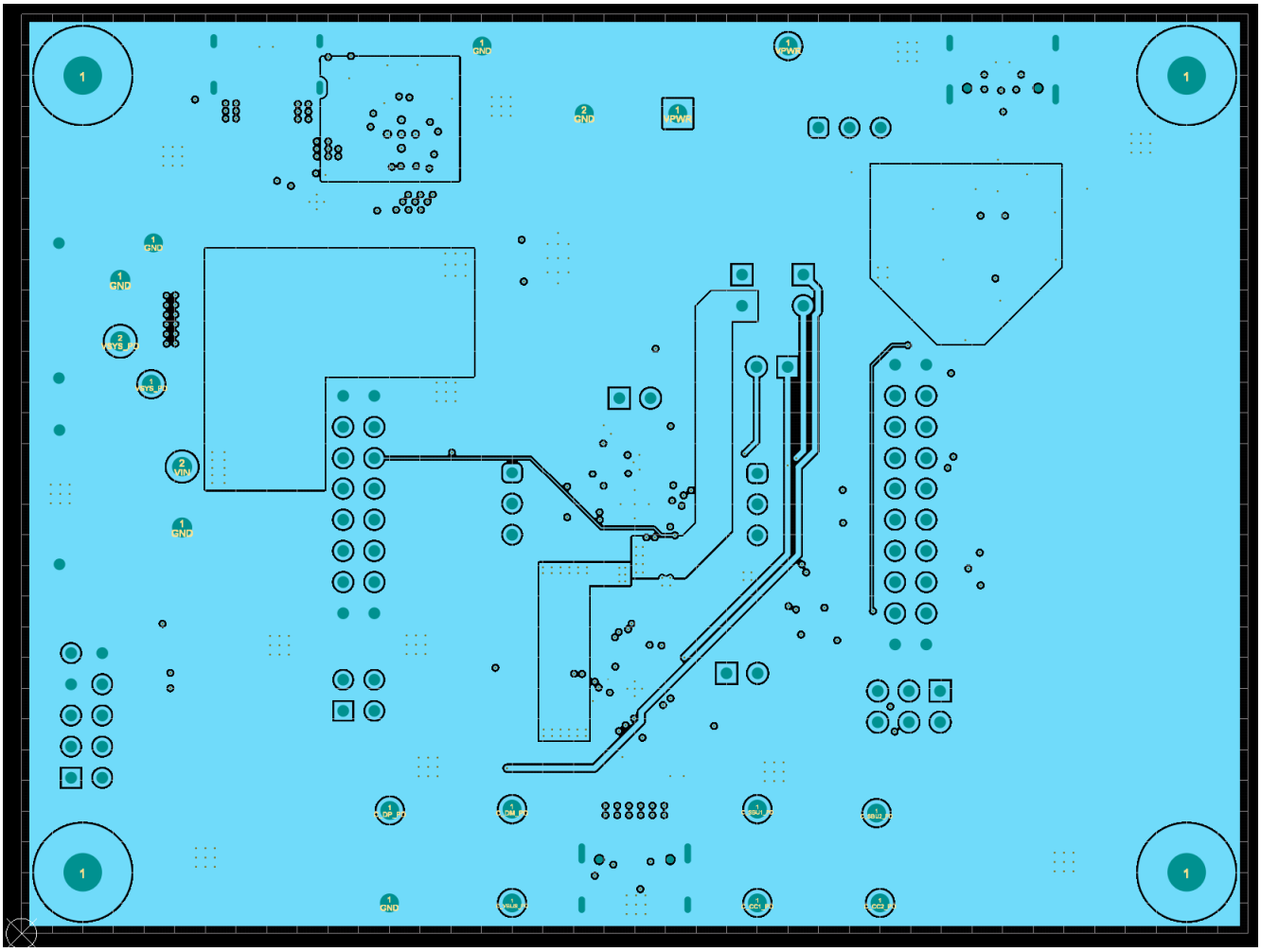


图 4-6. 电源层

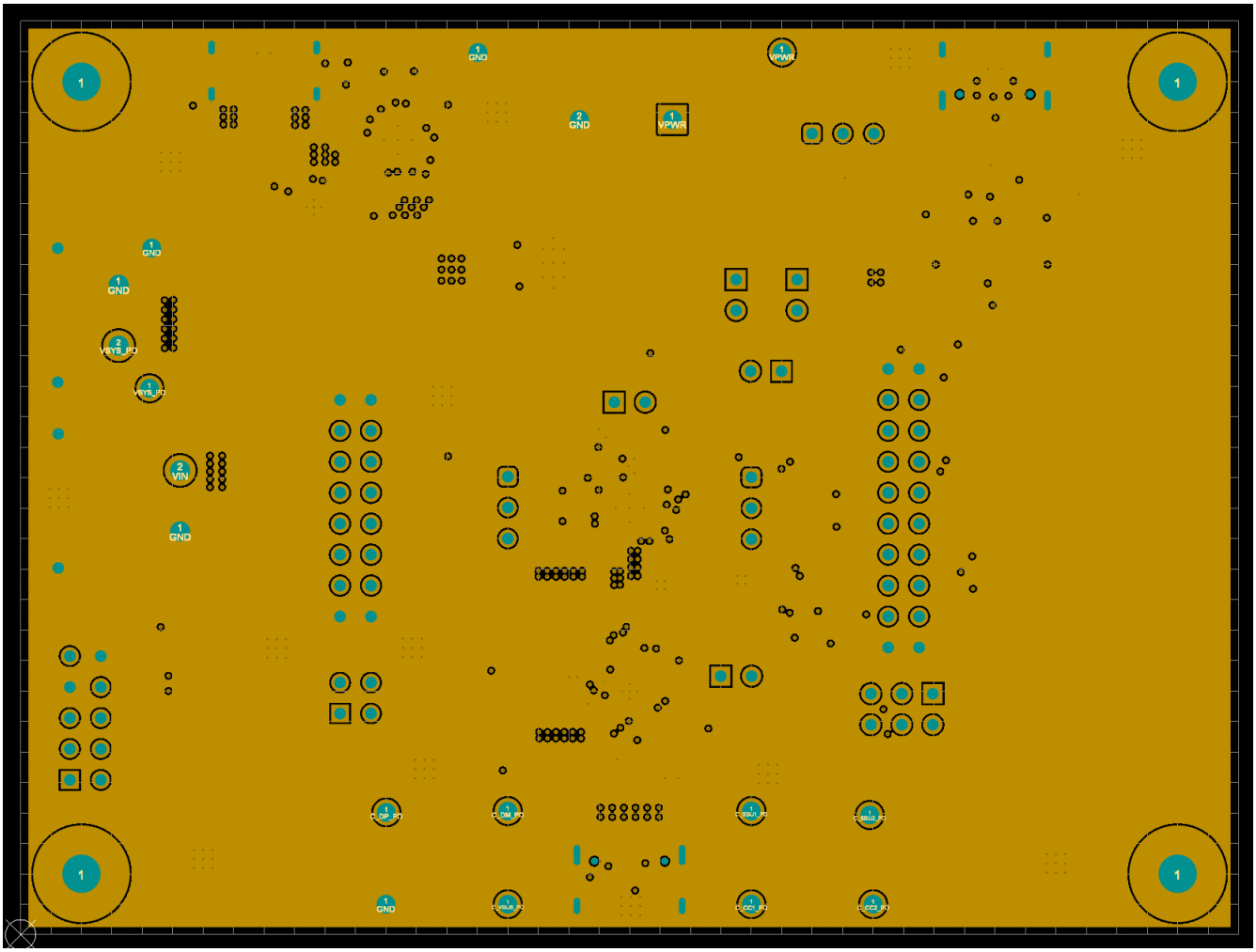


图 4-7. 接地层 (GND)

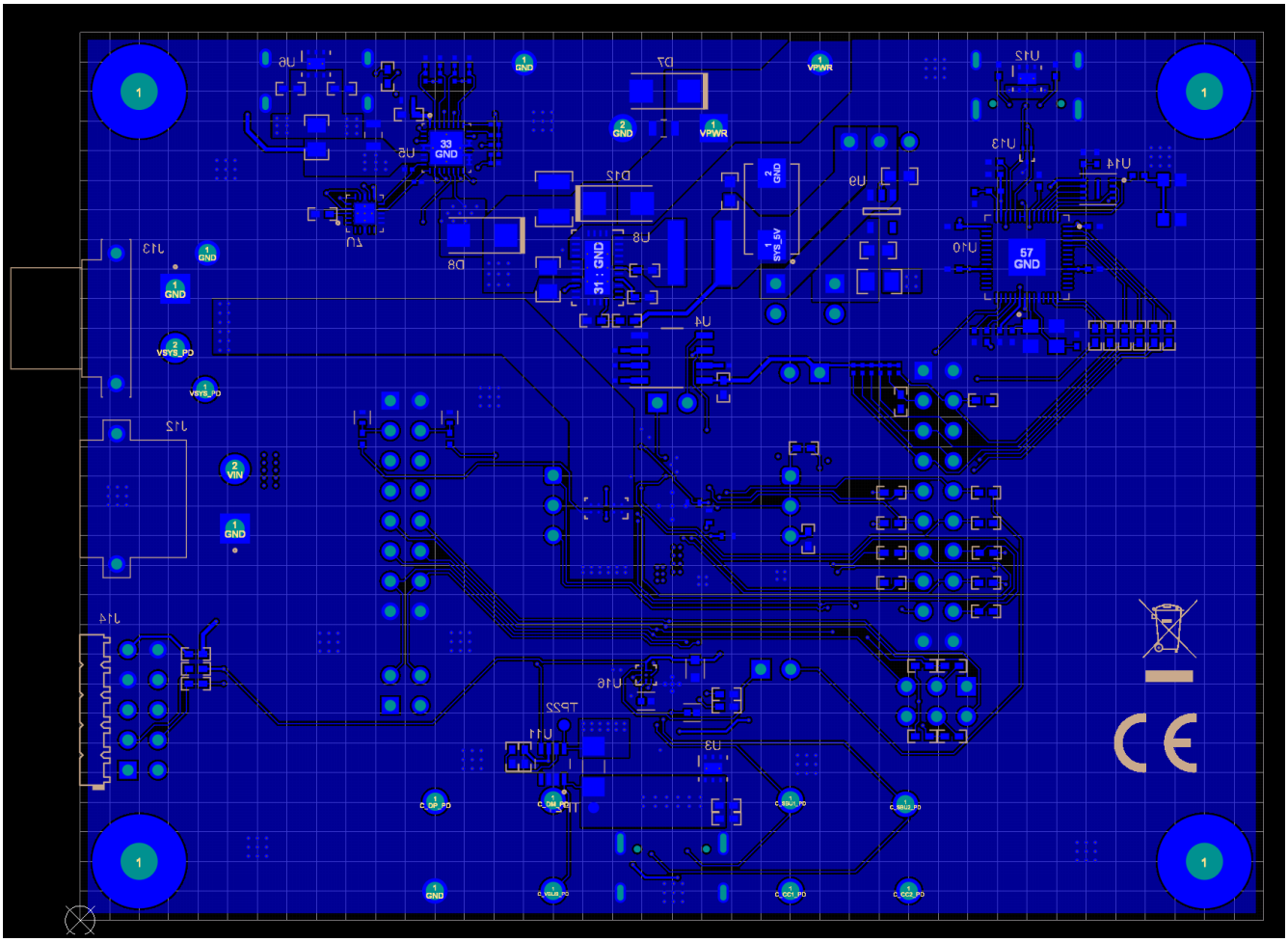


图 4-8. 底层

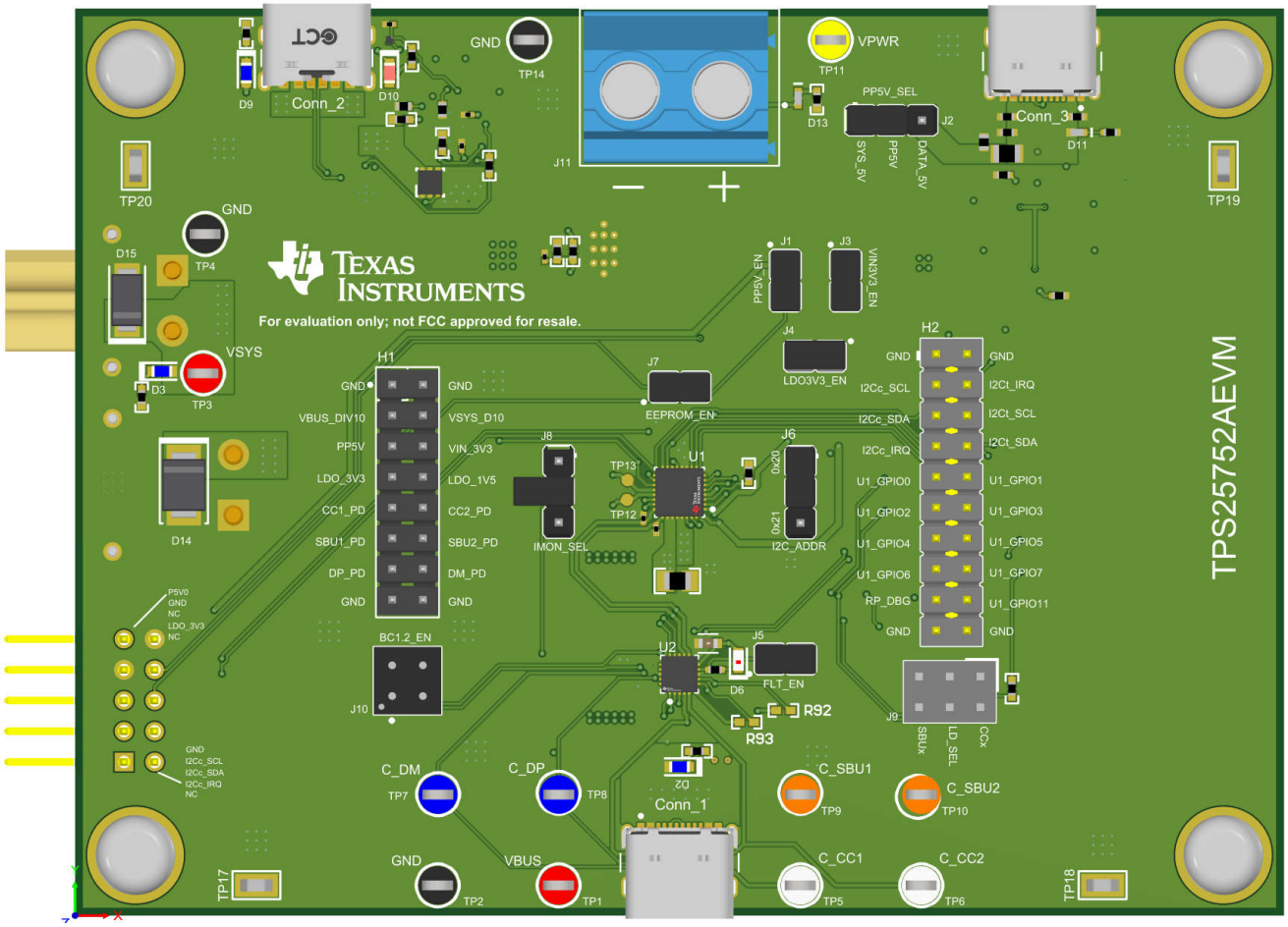


图 4-9. 3D 视图

4.3 物料清单 (BOM)

表 4-1. 物料清单 (BOM)

位号	说明	器件型号	制造商
C1、C2、C30、C33、C58、C59	电容，陶瓷，0.01µF，50V，±5%，X7R，0402	C0402C103J5RACTU	Kemet
C3	电容，陶瓷，4.7µF，50V，±10%，X5R，0805	C2012X5R1H475K125AB	TDK
C5、C6、C7	电容，陶瓷，10µF，10V，±20%，X5R，0402	CC0402MRX5R6BB106	Yageo
C8	电容，陶瓷，0.1µF，100V，±10%，X5R，0402	GRM155R62A104KE14D	MuRata
C9、C10、C34、C37	电容，陶瓷，220pF，50V，±10%，X7R，AEC-Q200 1 级，0201	CGA1A2X7R1H221K030BA	TDK
C11	电容，陶瓷，0.1µF，35V，±10%，X5R，0402	GMK105BJ104KV-F	Taiyo Yuden
C12、C14	1µF ±10% 50V 陶瓷电容器 X7R 0603（公制 1608）	8.85012E+11	Wurth Electronics
C13、C15	100nF ±10% 50V 陶瓷电容器 X7R 0402（公制 1005）	0402B104K500HI	NextGen Components
C16、C28	通用片状多层陶瓷电容器，0805，4.7µF，X7R，15%，10%，50V	GRM21BZ71H475KE15L	Murata
C22	电容，陶瓷，4.7µF，100V，±10%，X7S，1210	C3225X7S2A475K200AE	TDK
C23	电容，陶瓷，0.47µF，100V，±10%，X7S，0805	C2012X7S2A474K125AB	TDK
C24	电容，陶瓷，2.2µF，16V，±10%，X6S，0402	C1005X6S1C225K050BC	TDK
C26	电容，陶瓷，0.47µF，10V，±10%，X5R，0402	GRM155R61A474KE15D	MuRata
C27	电容，陶瓷，15pF，100V，±5%，C0G/NP0，0201	GRM0335C2A150JA01D	MuRata
C29	电容，钽，220µF，16V，±20%，0.1Ω，SMD	TPSE227M016R0100	AVX
C31	电容，陶瓷，0.47µF，50V，±10%，X7R，0603	C1608X7R1H474K080AC	TDK
C32、C38、C39	电容，陶瓷，10µF，10V，±20%，X5R，0402	CL05A106MP5NUNC	Samsung Electro-Mechanics
C35、C36	电容，陶瓷，1µF，35V，±10%，X7R，AEC-Q200 1 级，0603	CGA3E1X7R1V105K080AC	TDK
C40	电容，陶瓷，0.1µF，50V，±10%，X5R，0402	C1005X5R1H104K050BB	TDK
C41	电容，陶瓷，1µF，35V，±10%，X5R，0402	GRM155R6YA105KE11D	MuRata
C42、C45、C46、C52、C53	电容，陶瓷，2.2µF，6.3V，±20%，X5R，0402	JMK105BJ225MV-F	Taiyo Yuden
C43、C44、C47、C48、C49、C50、C51、C54	电容，陶瓷，0.1µF，10V，±10%，X7R，AEC-Q200 1 级，0402	C0402C104K8RACAUTO	Kemet
C55、C56	电容，陶瓷，12pF，25V，±5%，C0G/NP0，0402	GRM1555C1E120JA01D	MuRata
C57	电容，陶瓷，10µF，10V，±20%，X5R，0402	0402ZD106MAT2A	AVX
C60	电容，陶瓷，1µF，10V，±20%，X5R，0402	CC0402MRX5R6BB105	Yageo America
Conn_1、Conn_3	连接器 USB 2.0 Type-C 水平 SMT	6.29722E+11	Wurth Electronics
Conn_2	24（6+18 虚拟）位置 USB-C (USB TYPE-C) USB 2.0 插座连接器	USB4125-GF-A-0190	GCT
D2、D3、D9	LED，蓝色，SMD	150060BS75000	Wurth Elektronik
D6	LED，红色，SMD	TLMS1000-GS08	Vishay-Semiconductor
D7	二极管，TVS，单向，70V，113Vc，400W，3.5A，SMA	SMAJ70A	Littelfuse

表 4-1. 物料清单 (BOM) （续）

位号	说明	器件型号	制造商
D8、D12	二极管，肖特基，60V，5A，SMA	SK56A-LTP	Micro Commercial Components
D10	LED，红色，SMD	150060RS75000	Wurth Elektronik
D11、D13	LED，白色，SMD	LW QH8G-Q2S2-3K5L-1	OSRAM
D14	二极管，TVS，单向，48V，77.4Vc，SMB	SMBJ48A-13-F	Diodes Inc.
D15	二极管，TVS，单向，22V，35.5Vc，400W，11.3A，SMA	SMAJ22A	Littelfuse
H1	连接器接头穿孔 16 位 0.100" (2.54mm)	TSW-108-07-T-D	Samtec
H2	接头，10x2，2.54mm，锡，TH	TSW-110-07-T-D	Samtec
H3、H4、H5、H6	机械螺钉，圆头，#4-40 x 1/4，尼龙，飞利浦盘形头	NY PMS 440 0025 PH	B&F Fastener Supply
H7、H8、H9、H10	六角螺柱，0.5"L #4-40，尼龙	1902C	Keystone
J1、J3、J4、J5、J7	接头，100mil，2x1，金，TH	PBC02SAAN	Sullins Connector Solutions
J2、J6、J8	接头，2.54mm，3x1，锡，TH	22284030	Molex
J9	接头，100mil，3x2，锡，TH	PEC03DAAN	Sullins Connector Solutions
J10	接头，100mil，2x2，锡，TH	PEC02DAAN	Sullins Connector Solutions
J11		TB005-762-02BE	CUI 器件
J12	插座，直流电源，XT30，公头，引脚：2，在 PCB 上，THT，黄色，15A，500V	XT30PW-M	Amass
J13	插座，直流电源，XT30，母头，引脚：2，在 PCB 上，THT，黄色，15A	XT30PW-F	Amass
J14	接头，2.54mm，5x2，金，R/A，TH	TSW-105-09-G-D-RA	Samtec
L1	电感，屏蔽，复合，4.7µH，10.5A，0.0144Ω，AEC-Q200 1 级，SMD	XAL6060-472MEB	Coilcraft
L2、L3	铁氧体磁珠，22Ω（在 100MHz 时），6A，0805	742792021	Wurth Elektronik
Q1	MOSFET，2 沟道，N 沟道，30V，A，YJG0010A (PICOSTAR-10)	CSD87501L	德州仪器 (TI)
Q6	MOSFET，N 沟道，30V，22A，DQK0006C (WSON-6)	CSD17571Q2	德州仪器 (TI)
Q7	MOSFET，N 沟道，20V，0.5A，YJM0003A (PICOSTAR-3)	CSD15380F3	德州仪器 (TI)
R2、R3	电阻，90.9k，1%，0.063W，AEC-Q200 0 级，0402	CRCW040290K9FKED	Vishay-Dale
R4、R5	10kΩ ±1% 0.063W，1/16W 片上电阻 0402（公制 1005）厚膜	CRCW040210K0FKEDC	Vishay
R6、R9、R51、R55、R58、R90	电阻，10.0k，1%，0.063W，AEC-Q200 0 级，0402	CRCW040210K0FKED	Vishay-Dale
R7	6.5mΩ ±1% 1W 片上电阻 1206（公制 3216）抗硫化，汽车级 AEC-Q200，电流检测，可承受脉冲，防潮金属元件	WSLP12066L500FEA	Vishay
R8、R16、R17、R19、R20、R21、R22、R23、R30、R31、R32、R38、R39、R44、R50、R56、R57、R59、R66、R72、R78、R79、R80、R81	电阻，0，5%，0.063W，AEC-Q200 0 级，0402	CRCW04020000Z0ED	Vishay-Dale
R10、R13、R24、R25、R26、R27	电阻，10.0k，1%，0.05W，0201	CRCW020110K0FKED	Vishay-Dale

表 4-1. 物料清单 (BOM) （续）

位号	说明	器件型号	制造商
R11、R12、R14、R15、R74、R75	电阻，2.20k，1%，0.05W，0201	CRCW02012K20FKED	Vishay-Dale
R18、R28、R29	电阻，100k，1%，0.1W，0402	ERJ-2RKF1003X	Panasonic
R40、R41、R42、R43	电阻，100k，1%，0.063W，0402	RC1005F104CS	Samsung Electro-Mechanics
R45、R86	电阻，10k，5%，0.063W，AEC-Q200 0 级，0402	CRCW040210K0JNED	Vishay-Dale
R46、R47	电阻，100k，1%，0.063W，AEC-Q200 0 级，0402	CRCW0402100KFKED	Vishay-Dale
R48	电阻，523k，1%，0.063W，AEC-Q200 0 级，0402	CRCW0402523KFKED	Vishay-Dale
R49	电阻，23.7k，1%，0.1W，AEC-Q200 0 级，0402	ERJ-2RKF2372X	Panasonic
R52、R54、R65	电阻，100k，1%，0.05W，0201	RC0201FS-7D100KL	Yageo America
R53	电阻，0，5%，0.125W，AEC-Q200 0 级，0805	ERJ-6GEY0R00V	Panasonic
R60、R62、R63、R64、R68	电阻，200k，1%，0.05W，0201	CRCW0201200KFKED	Vishay-Dale
R61、R73	电阻，10.0k，1%，0.05W，0201	RC0201FR-0710KL	Yageo America
R67、R69、R70、R71	电阻，51.0k，1%，0.05W，0201	RC0201FR-0751KL	Yageo America
R83、R88	电阻，1.00k，1%，0.0625W，0402	RC0402FR-071KL	Yageo America
R84、R85	电阻，5.11k，1%，0.063W，AEC-Q200 0 级，0402	CRCW04025K11FKED	Vishay-Dale
R87、R89	电阻，100k，1%，0.0625W，0402	RC0402FR-07100KL	Yageo America
SH-J1、SH-J2、SH-J3、SH-J4、SH-J5、SH-J6、SH-J7、SH-J8	分流器，100mil，镀金，黑色	SPC02SYAN	Sullins Connector Solutions
SH-J9、SH-J10	4 位 (2 x 2) 定位分流连接器，黑色，顶部敞口式，0.100" (2.54mm) 间距，镀金	60910213421	Wurth Electronics
SW1	触控式开关，单刀单掷-常开 0.02A/15V	EVPAAM02W	Panasonic
TP1、TP3	测试点，紧凑，红色，TH	5005	Keystone Electronics
TP2、TP4、TP14	测试点，紧凑型，黑色，TH	5006	Keystone Electronics
TP5、TP6	测试点，紧凑型，白色，TH	5007	Keystone Electronics
TP7、TP8	测试点，紧凑型，蓝色，TH	5122	Keystone Electronics
TP9、TP10	测试点，紧凑型，橙色，TH	5008	Keystone Electronics
TP11	测试点，紧凑，黄色，TH	5009	Keystone Electronics
TP17、TP18、TP19、TP20	测试点，微型，SMT	5015	Keystone Electronics
U1	针对电源应用进行了优化且具有集成电源开关的 USB Type-C® 和 USB PD 控制器	TPS25752AS	德州仪器 (TI)
U2、U7	USB Type-C® 28V SPR 端口保护器：VBUS 短路过压和 IEC ESD 保护	TPD4S201RUKR	德州仪器 (TI)
U3、U6	22V 精密浪涌保护钳位器，DRV0006A (WSON-6)	TVS2200DRVR	德州仪器 (TI)
U4	256kb I2C CMOS 串行 EEPROM，SOIC-8	CAT24C256WI-GT3	ON Semiconductor
U5	针对电源应用进行了优化且具有集成电源开关的 USB Type-C® 和 USB PD 控制器	TPS25730ASRSMR	德州仪器 (TI)
U8	3.5V 至 60V 5A 同步降压稳压器，RNP0030A (WQFN-30)	LM76005RNPR	德州仪器 (TI)

表 4-1. 物料清单 (BOM) （续）

位号	说明	器件型号	制造商
U9	500mA、低 IQ、小型低压降稳压器，DBV0005A (SOT-23-5)	TLV75733PDBVR	德州仪器 (TI)
U10	ARM® Cortex®-M0+ — 微控制器 IC 32 位双核 133MHz 外部程序存储器 56-QFN (7x7)	SC0914(13)	Raspberry Pi
U11	-4V 至 110V、双向、1MHz、5V/μs、超精密电流检测放大器，SOT23-8	INA296A3IDDF	德州仪器 (TI)
U12	5V 精密浪涌保护钳位器，DRV0006A (WSON-6)	TVS0500DRVR	德州仪器 (TI)
U13	用于超高速 (6Gbps) USB 3.0 接口的 ESD 解决方案，2 通道，-40 至 +85°C，3 引脚 SOT (DRT)，环保（符合 Rohs 标准，无锑/溴）	TPD2EUSB30DRTR	德州仪器 (TI)
U14	闪存 — NOR 存储器 IC，16Mb (2M x 8)；SPI — 四通道 I/O 接口，133MHz，6ns 访问时间，8 引脚 USON 封装 (2x3)	W25Q16JVUXIQ	Winbond
U16	用于 CC 引脚的 USB Type C 短接至 VBUS 和 IEC ESD 保护器，YFF0009ALAL (DSBGA-9)	TPD2S300YFF	德州仪器 (TI)
Y1	晶振，12MHz，30ppm，SMD	7M-12.000MAHE-T	TXC Corporation
R76、R77、R91、R92、R93	电阻，0，5%，0.063W，AEC-Q200 0 级，0402	CRCW04020000Z0ED	Vishay-Dale

5 其他信息

5.1 已知硬件或软件问题

- 电流检测电路目前尚未组装，待 GUI 配置工具添加相应支持后将进行修订

5.2 商标

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 * (June 2026) to Revision A (August 2026)	Page
• 添加了与 TPS55288 连接	4
• 添加了与 LM251772 连接	6
• 添加了端口保护原理图	11

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 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.

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