参考文献

EVM User's Guide: TAS67524Q1EVM

TAS67524Q1EVM 评估模块

说明

TAS67524Q1EVM 展示了具有 1L 调制功能的 4 通道数字输入闭环 D 类汽车音频放大器 TAS67524-Q1，该放大器每个通道减少了 1 个电感器，从而将 4 个通道的电感器成本降低了 50%。该 EVM 使用 PurePath™ Console (PPC3) 图形用户界面进行编程和 I2C 配置，以评估 TAS67524-Q1 器件的特性、功能和性能。

开始使用

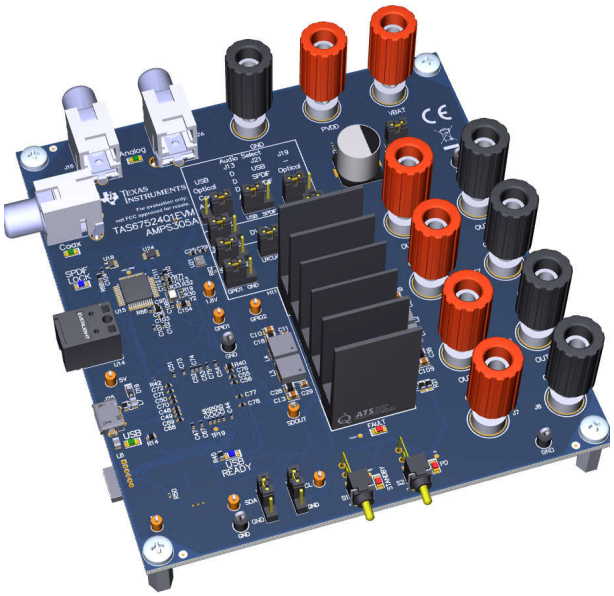
1. 通过 ti.com 上的 TAS67524Q1EVM 产品页面申请访问数据表和 EVM。
2. 申请访问 PurePath Console 3
3. 申请访问 TAS67524-Q1 软件
4. 有关该器件的详细信息，请参阅 TAS67524-Q1 数据表，而如需任何其他技术支持，请使用 E2E™ 论坛

特性

- 板载 USB 转 I²C 控制器，可通过 PPC3 GUI 进行器件评估并配置实时负载诊断、热增益和 PVDD 折返以及低延迟信号路径等功能
- 新的 1L 调制技术每个通道仅需要一个电感器，与传统设计相比，可节省成本并减小 PCB 尺寸
- 通过 I2C 读取全局温度、通道温度和 PVDD 值，便于进行系统级热管理
- 具有光学、SPDIF、USB 和 PSIA（外部 I2S/TDM）输入选项

应用

- 汽车音响主机
- 车载外部放大器
- 声学车辆警报系统 (AVAS)



1 评估模块概述

1.1 简介

此手册介绍了如何使用 TAS67524Q1EVM，TAS67524Q1EVM 是一款独立式 EVM。PurePath™ Control Console 3 GUI (PPC3) 负责初始化和操作该 EVM。本文档的主题主要包括：

- 硬件实现和说明
- 软件实现和说明
- TAS67524Q1EVM 操作（硬件和软件）

需要的设备和附件：

1. TAS67524Q1EVM
2. USB-A 公口转 Micro B 公口线缆
3. 支持最高 18V、大于 10A 的电源单元 (PSU)
4. 1-4 个电阻负载或扬声器负载
5. 2-6 对两端剥离的电线
6. 光学音频源（可选）
7. 光学 SPDIF 电缆（可选）
8. 使用 Microsoft® Windows® 10 或更高版本操作系统的台式机或笔记本电脑

1.2 套件内容

此 EVM 套件包含一个 TAS67524Q1EVM。

1.3 规格

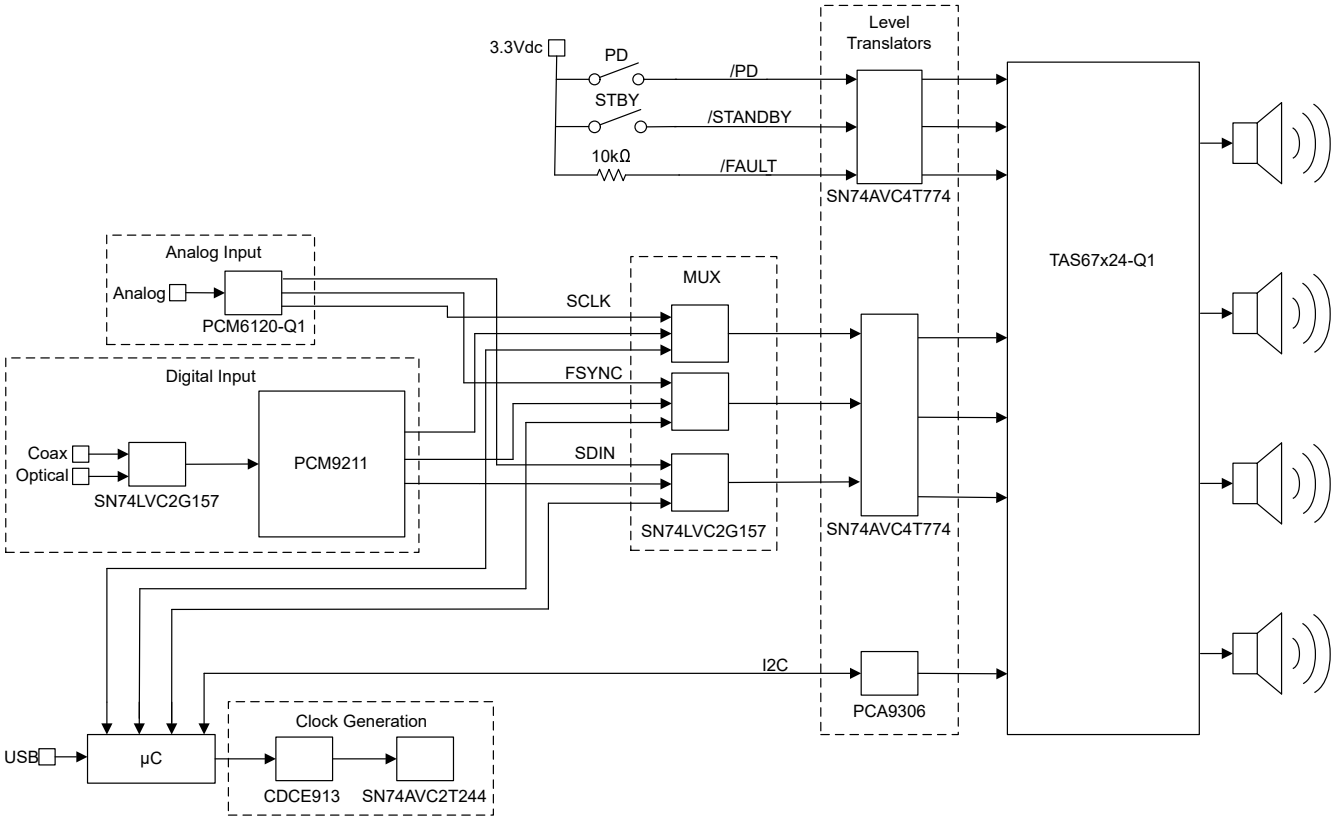


图 1-1. 规格

1.4 器件信息

此 EVM 中使用的 TI 器件

- TAS67524-Q1：具有 1L 调制功能的四通道汽车音频放大器
- SN74LVC1GU04：单路 1.65V 至 5.5V 反相器
- TPSM82903：具有集成电感器的高效降压转换器模块
- TPS76833QDR：低压降稳压器
- TCA9406：2 位双向 1MHz I2C/SMBus 电压电平转换器
- CDCE913：可编程 1-PLL VCXO 时钟合成器
- SN74AVC2T244：双位双电源总线收发器
- SN74LVC2G07：具有开漏输出的 2 通道、1.65V 至 5.5V 缓冲器
- TPS3897：单通道可调监控器
- SN74LVC2G157：单路 2 线路至 1 线路数据选择器/多路复用器
- PCM9211：216kHz 数字音频接口收发器
- SN74LVC1G14：具有施密特触发输入的单路 1.65V 至 5.5V 反相器
- SN74AVC4T774：四位双电源总线收发器
- PCM6120-Q1：汽车类、立体声、123dB SNR、768kHz 音频 ADC
- LMK6C：固定频率 LVCMOS 振荡器
- LMR51450：36V、5A 同步降压转换器

2 硬件

2.1 说明

TAS67524Q1 EVM 是一款独立式 EVM。这需要三个电源，通过 Purepath Control Console 3 (PPC3) 进行 USB 控制，还需要一个数字音频输入。数字音频输入可通过 USB、光学输入、同轴输入或直接通过 I2S/TDM 接头提供。

2.2 设置

本节介绍了 TAS67524Q1EVM 的启动过程。准备好本文档第一页列出的设备和附件。

硬件连接：

1. 将扬声器或电阻负载连接到 J1/J5、J18/J27、J28/J29、J7/J8
2. 使用 USB Micro 电缆将 PC 与 EVM 连接起来
3. 连接电源 PVDD 和 VBAT
4. 设置开关 S1 和 S2，以拉低 STANDBY 和 PD，同时红色 LED 将亮起
5. 选择 Audio Source 并提供时钟
6. 打开 VBAT 和 PVDD 电源。
7. 在 PC 上启动 TAS67524 EVM PPC3 插件
8. 正确设置器件并按照屏幕说明进行操作

2.3 接头和跳线信息

电源：

- PVDD 和 VBAT 电压工作范围均为 4.5V 至 19V。J3 跳线可用于将 EVM 上的 PVDD 和 VBAT 连接在一起，这允许两个电源轨由单个汽车电池或电压电源驱动
- 默认情况下，IOVDD 根据由 5V USB 输入驱动的 3.3V 或 1.8V LDO 生成，但也可以使用引脚 2 直接在 J10 上驱动 IOVDD 引脚，或者如果需要监测 DVDD 电流消耗，则可以通过 J30 引脚 2 直接驱动 TAS67524-Q1 DVDD 电压轨
- 请参阅表 2-1，了解连接器、跳线和接头的说明：

表 2-1. 电源连接器

编号	名称	说明
J2	IC PVDD	将 IC PVDD 电压连接到连接器提供的电压
J3	PVDD 至 VBAT	用于将 EVM 上的 PVDD 和 VBAT 连接在一起，因此只需一个电源即可运行 EVM。
J10	IOVDD	在 3.3V 或 1.8V 之间选择 IOVDD/DVDD 电压。默认值：3.3V
J12	VBAT	电池电压输入
J17	PVDD	PVDD 电压输入
J20	GND	电源地
J25	USB	器件的 USB 连接器，5V USB 电源轨用于驱动 EVM 上的 1.8V 和 3.3V LDO
J30	DVDD_IO	将 IOVDD 电源轨连接到 TAS67524-Q1 IC 的 DVDD

音频端口：

- USB 连接器可用作音频端口，Window Media Player 或等效播放器可用于从 PC 流式传输音频
- 同轴电缆和光学输入连接器可接受 SPDIF（Sony/Philips 数字接口）音频格式，可以使用 DVD 播放器或 AP 设备等源来流式传输音频
- 模拟输入连接器可接受来自媒体播放器或 Audio Precision 设备的音频输入。满量程输入电压为 0.5Vrms。
- J11/J14/J15 用于连接外部 PSIA（可编程串行接口适配器），以驱动 I2S 或 TDM 输入。

请参阅表 2-2，了解如何选择不同类型的音频输入：

表 2-2. 音频选择

J13	J21	J19	J11/J14/J15	
USB	D	USB	-	IN
光学	D	SPDIF	光学	IN
同轴电缆	D	SPDIF	同轴电缆	IN
模拟	A	-	-	IN
PSIA	-	-	-	OUT

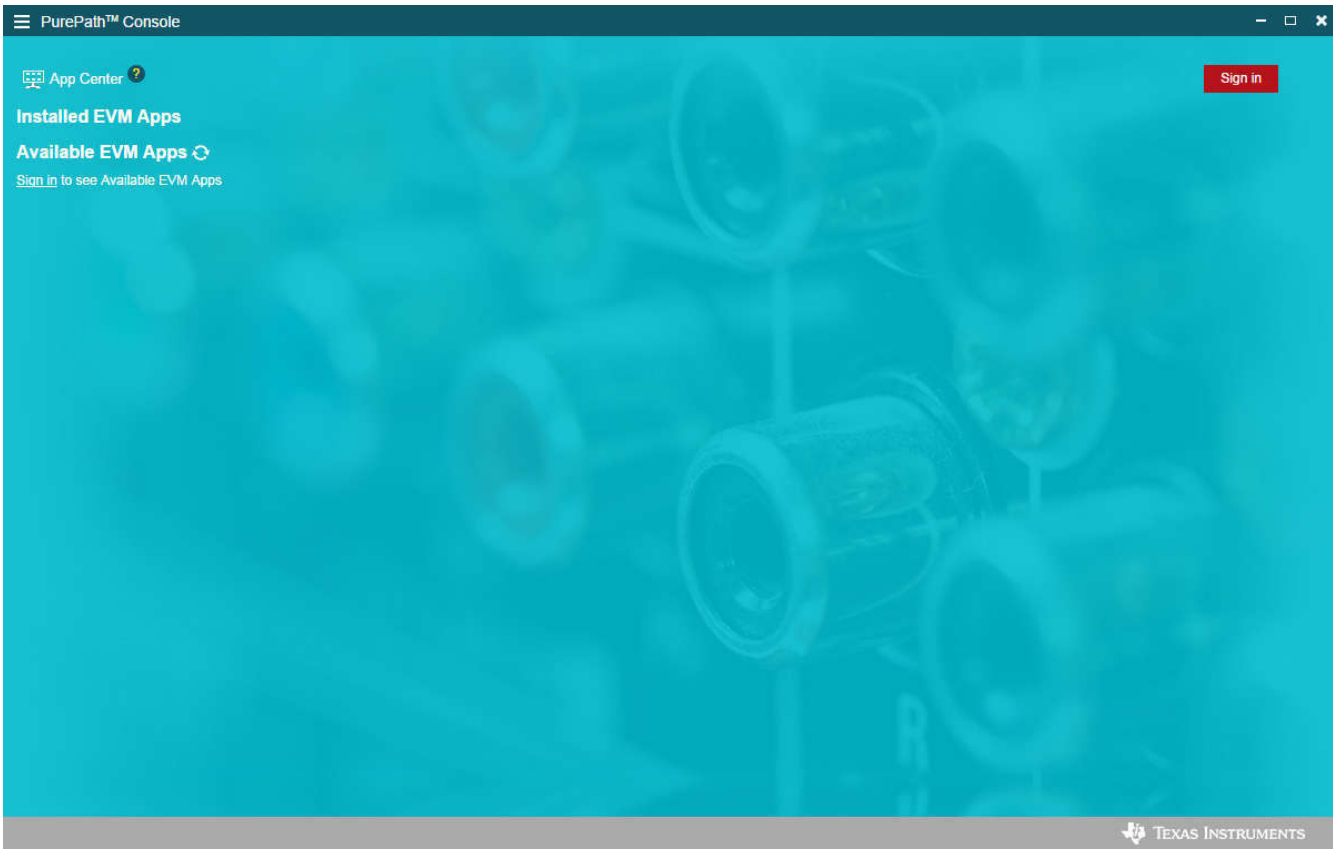
3 软件

3.1 PurePath Console 3 (PPC3) 访问和说明

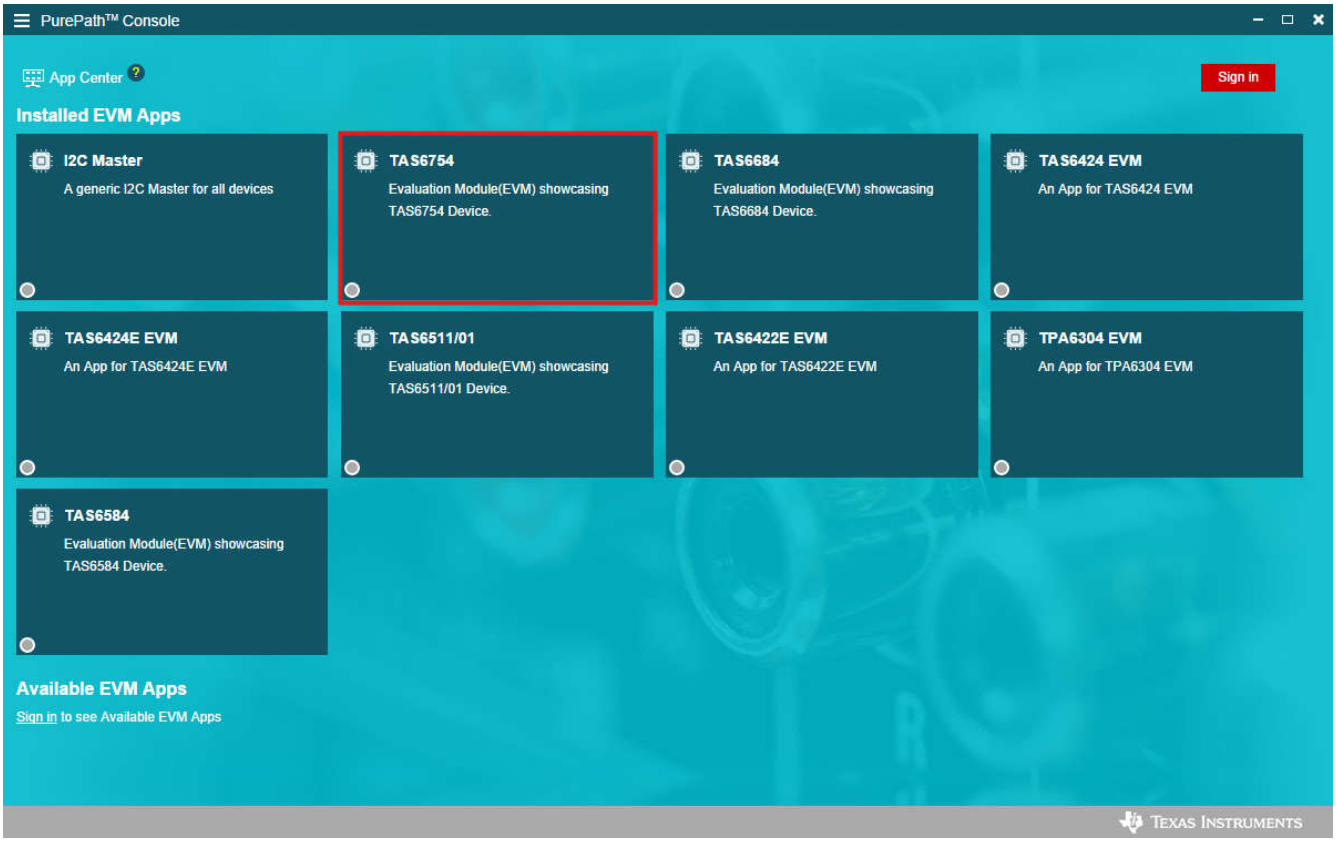
PPC3 是一款基于服务器的工具。必须申请 PPC3 软件和 TAS67524 应用的访问权限。获得批准后，您可以在 ti.com/secureresources 上找到经过批准的 PPC3 应用程序。

打开批准电子邮件中的 URL 或转至器件安全资源文件夹。点击并下载“Downloads”下的 tar.gz 文件。

下载完成后，打开 PPC3 GUI。点击侧边菜单中的“Open”，然后打开下载的 tar.gz 文件。（在 Open file 对话框中选择“All Files”）。有关其他详细信息，请参阅 E2E 上的安装常见问题解答，链接在此处。

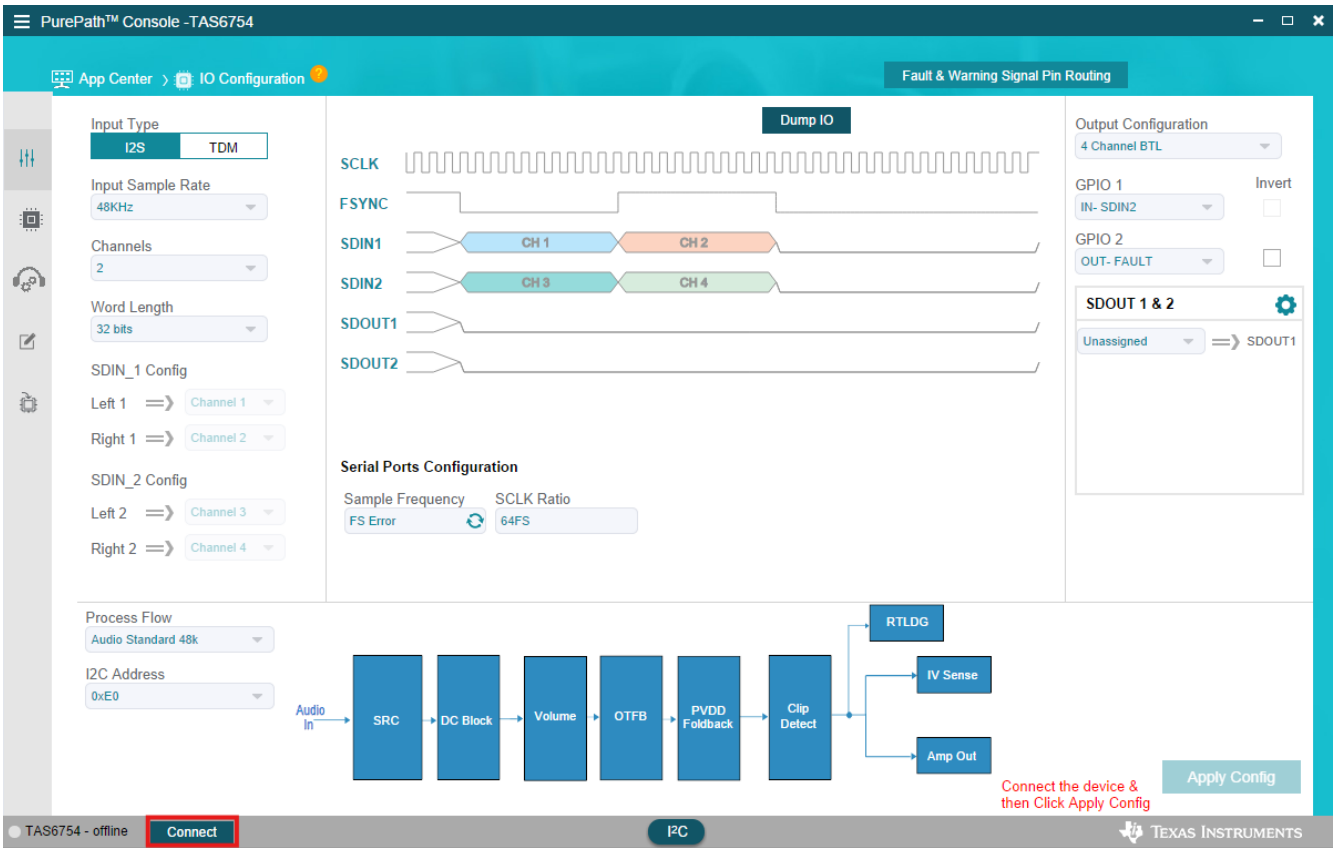


点击 TAS67524 应用程序框下载应用程序。将弹出一个安装窗口。点击“Install”按钮。TAS67524 EVM 框将出现在“Installed EVM Apps”部分。点击 TAS67524 框以启动 TAS67524 应用。



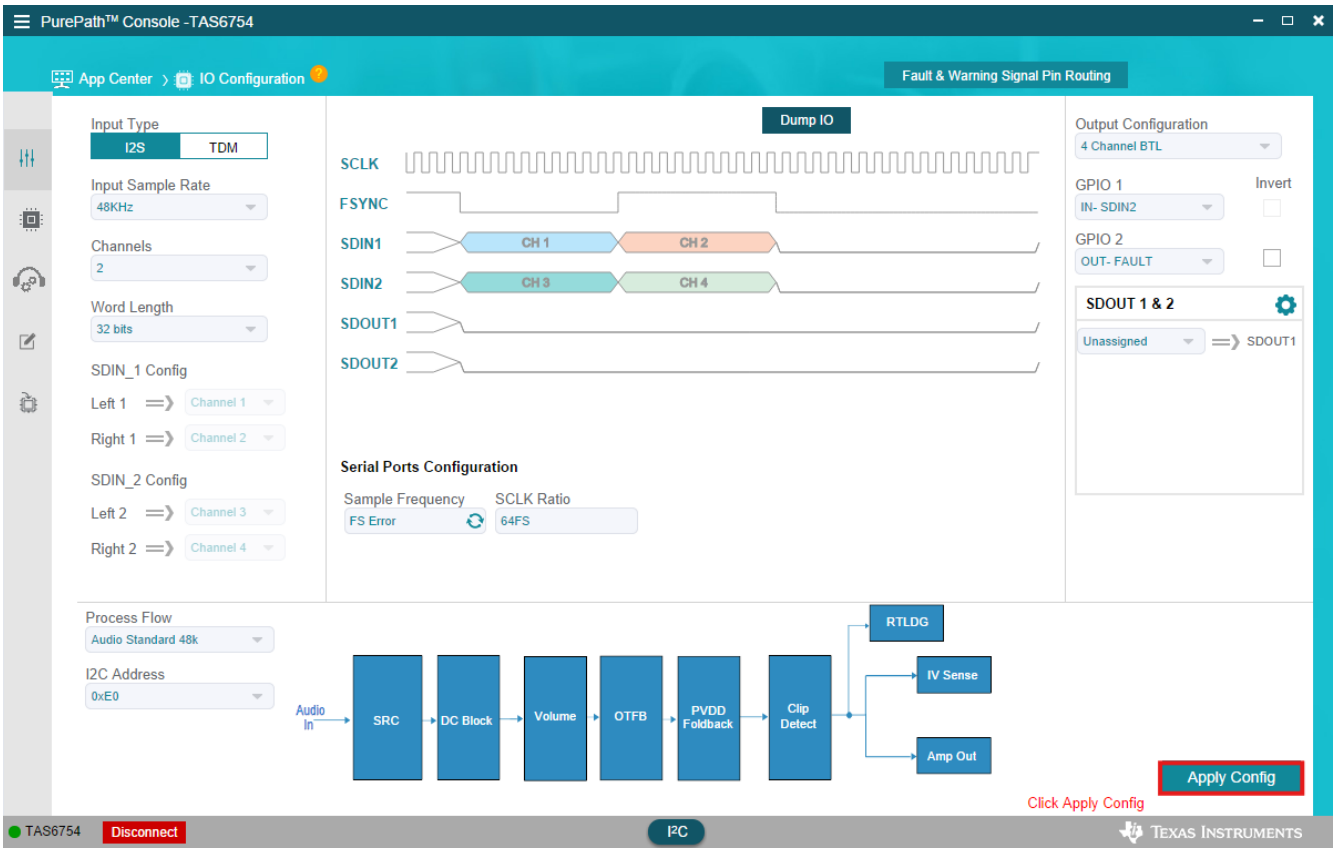
3.2 PurePath Console – TAS67524 EVM 条目窗口

启动 TAS67524 EVM 应用，将显示 IO 配置窗口，其中包含默认器件选择。

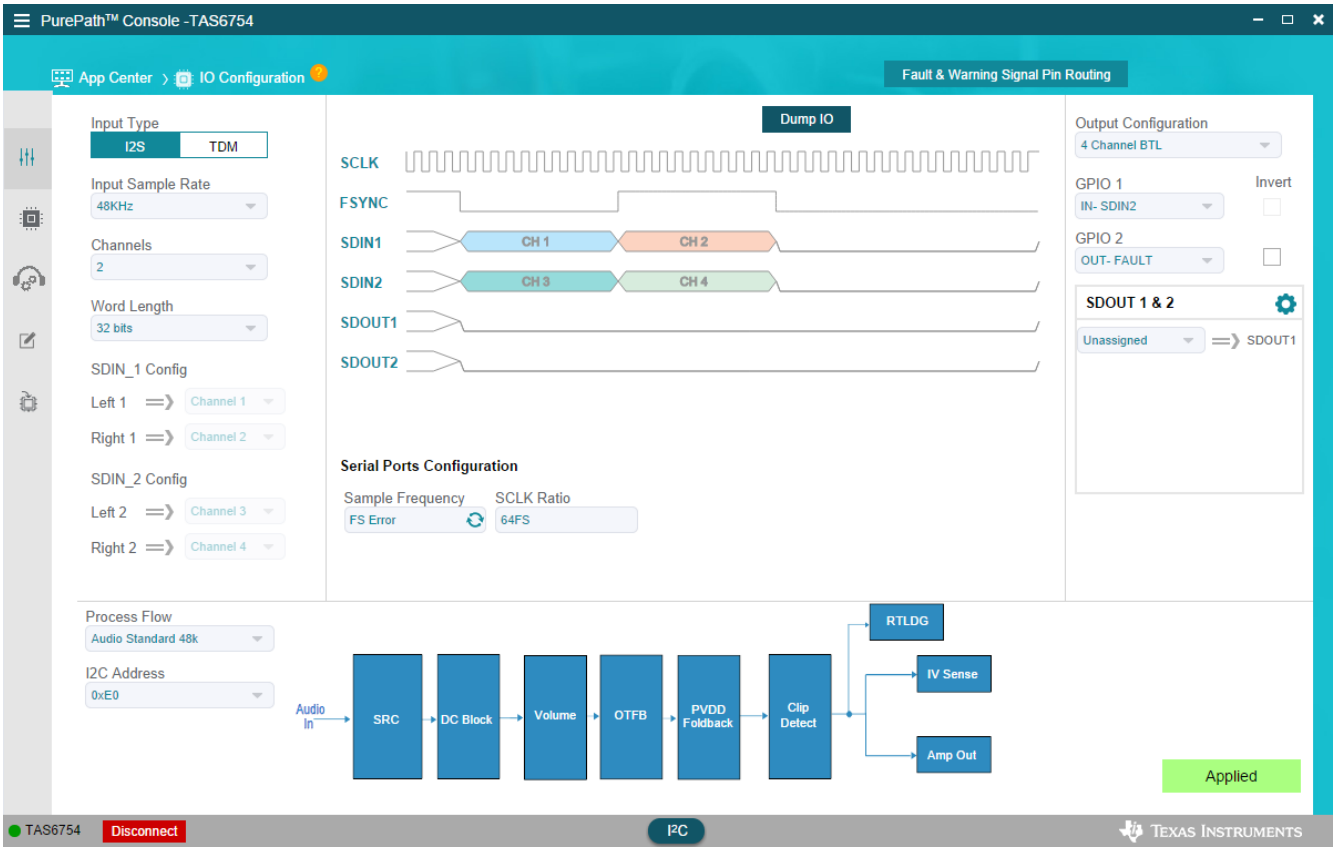


在 EVM 连接到 PC 并通电后，可在 PPC3 窗口的左下角找到“Connect”按钮。点击此按钮即可连接 EVM。成功连接后，该按钮将变为红色，而灰色圆圈将变为绿色。要断开连接，请再次点击该按钮。

默认器件地址为 0xE0。为设置选择适当的值。完成选择后，点击 *Apply Config* 按钮。



点击 Apply Config 后，IO 配置会通过 I2C 将所选配置写入器件，然后该按钮将变为 Applied。

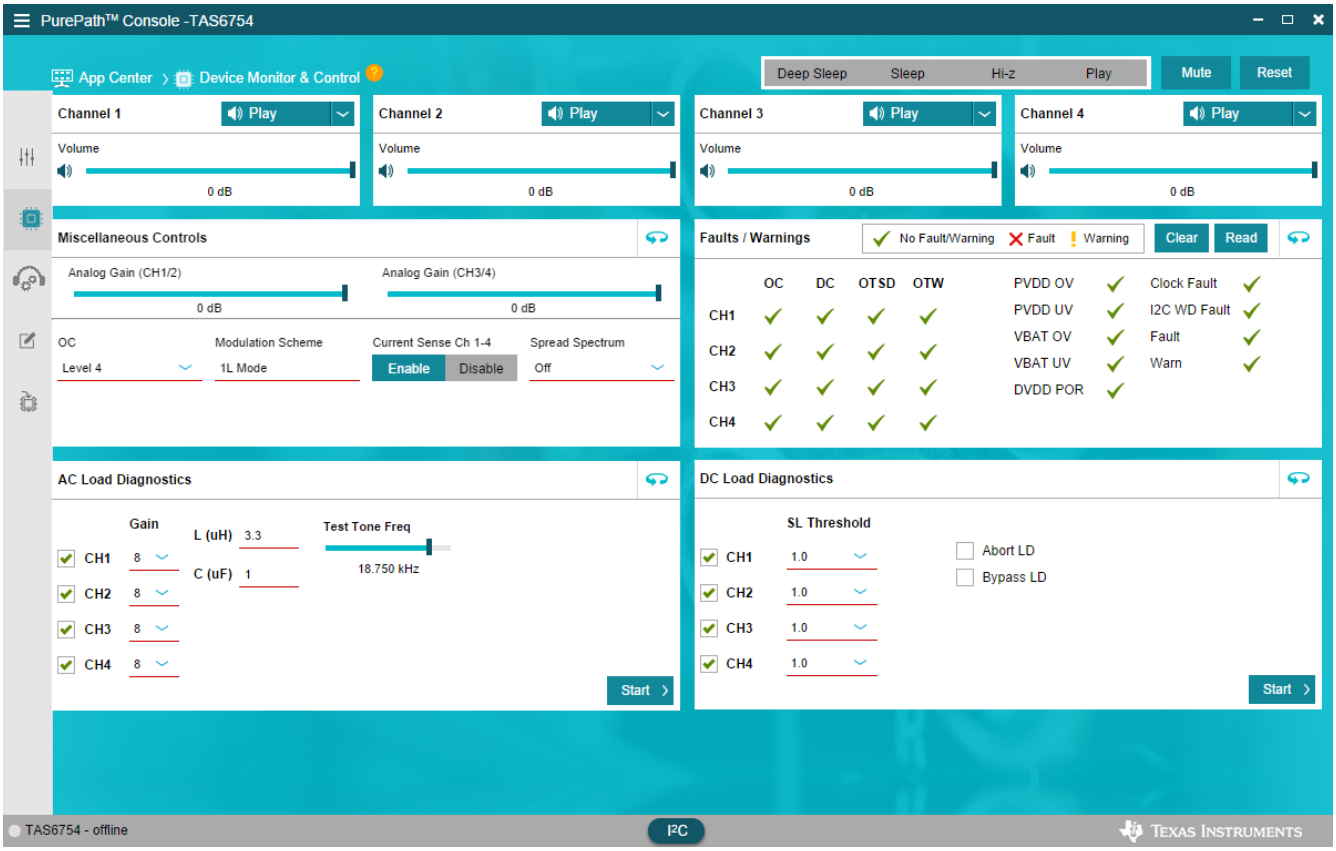


有 4 个控制窗口可用于控制和配置 TAS67524-Q1。

- 器件监测与控制
- 音频处理选项
- IO 配置
- 寄存器映射

3.3 器件监测与控制窗口

TAS67524 器件与控制窗口在器件设置完成后提供可操作的寄存器控制。点击窗口左列中的 *Device Monitor & Control* 图标，将显示以下窗口。

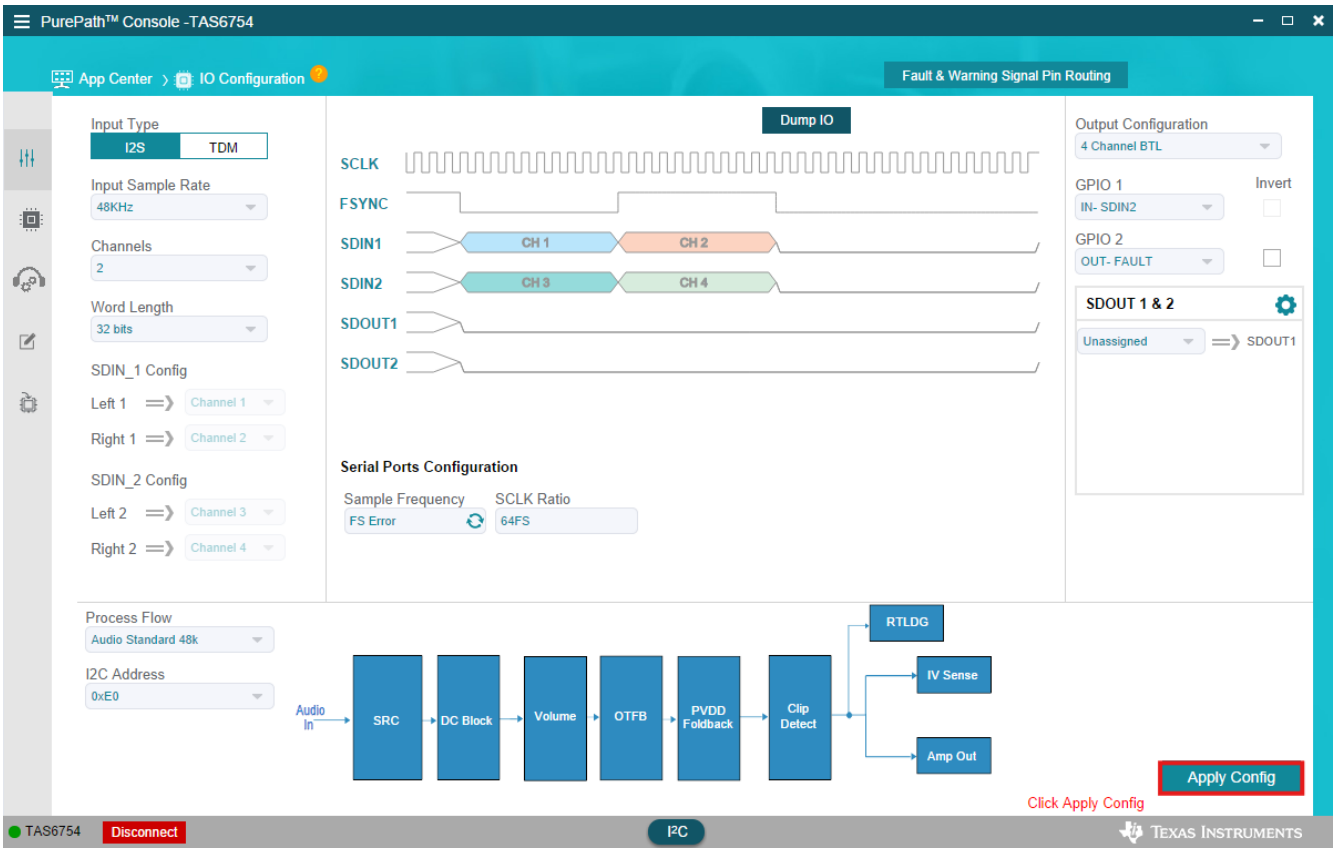


此窗口可用于控制 TAS67524/64-Q1 的多个功能。

- 各个通道状态和音量。
- 全局通道状态。
- 混合控制
  - 过流电平：建议根据需要更改电平。
  - 电流检测
  - 展频控制
  - 模拟增益
  - 数字音量斜坡速率
- 故障和警告监控
- 交流负载诊断
- 直流负载诊断

3.4 IO 配置

点击窗口左列中的 *IO Configuration* 图标，将显示以下窗口。



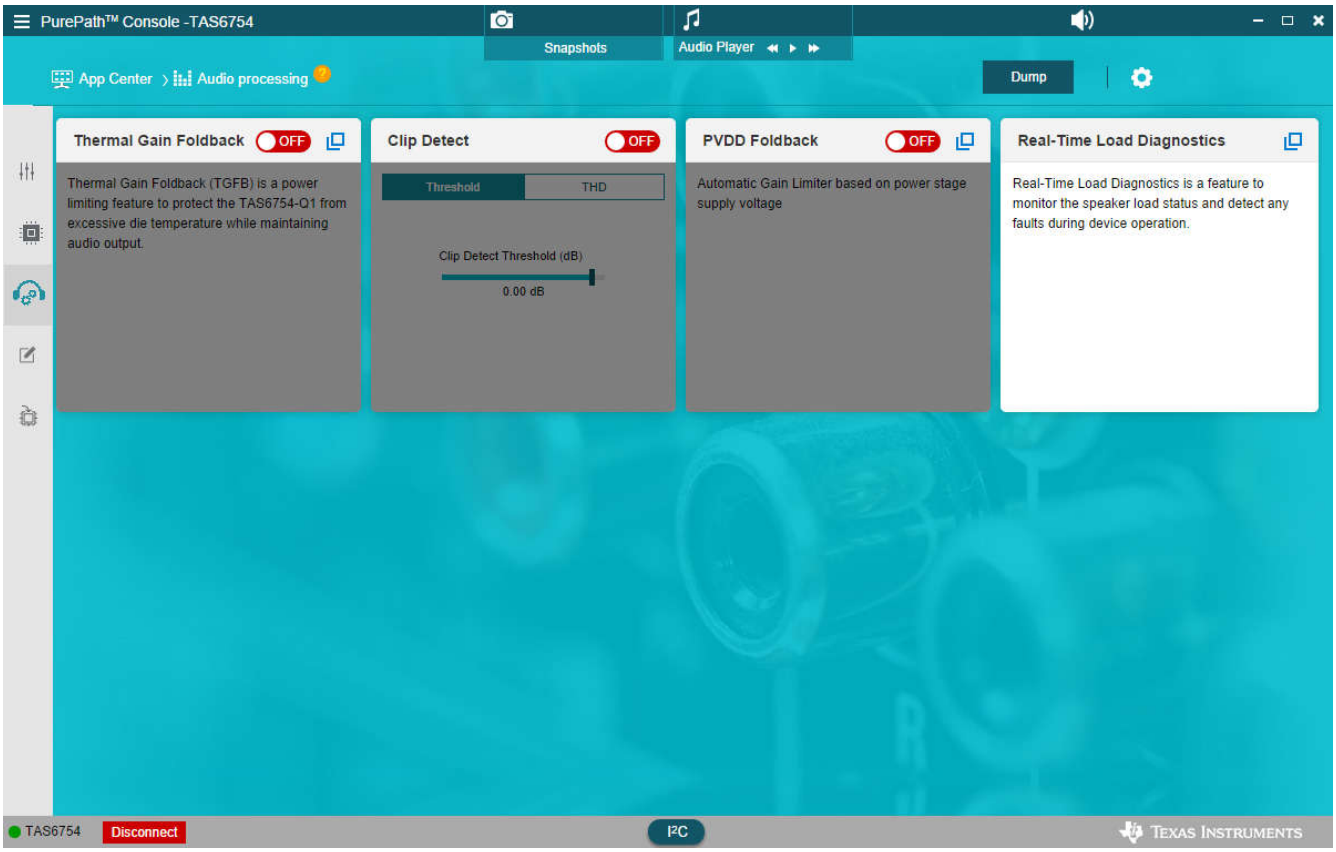
IO 配置窗口包含默认设置。SPDIF 输入和 USB 输入都需要 I2S 输入。

如果提供了外部 I2S 或 TDM 信号，则将在此窗口中配置输入和输出。

当 PPC3 连接到 EVM 时，将设置串行端口配置。

3.5 音频处理窗口

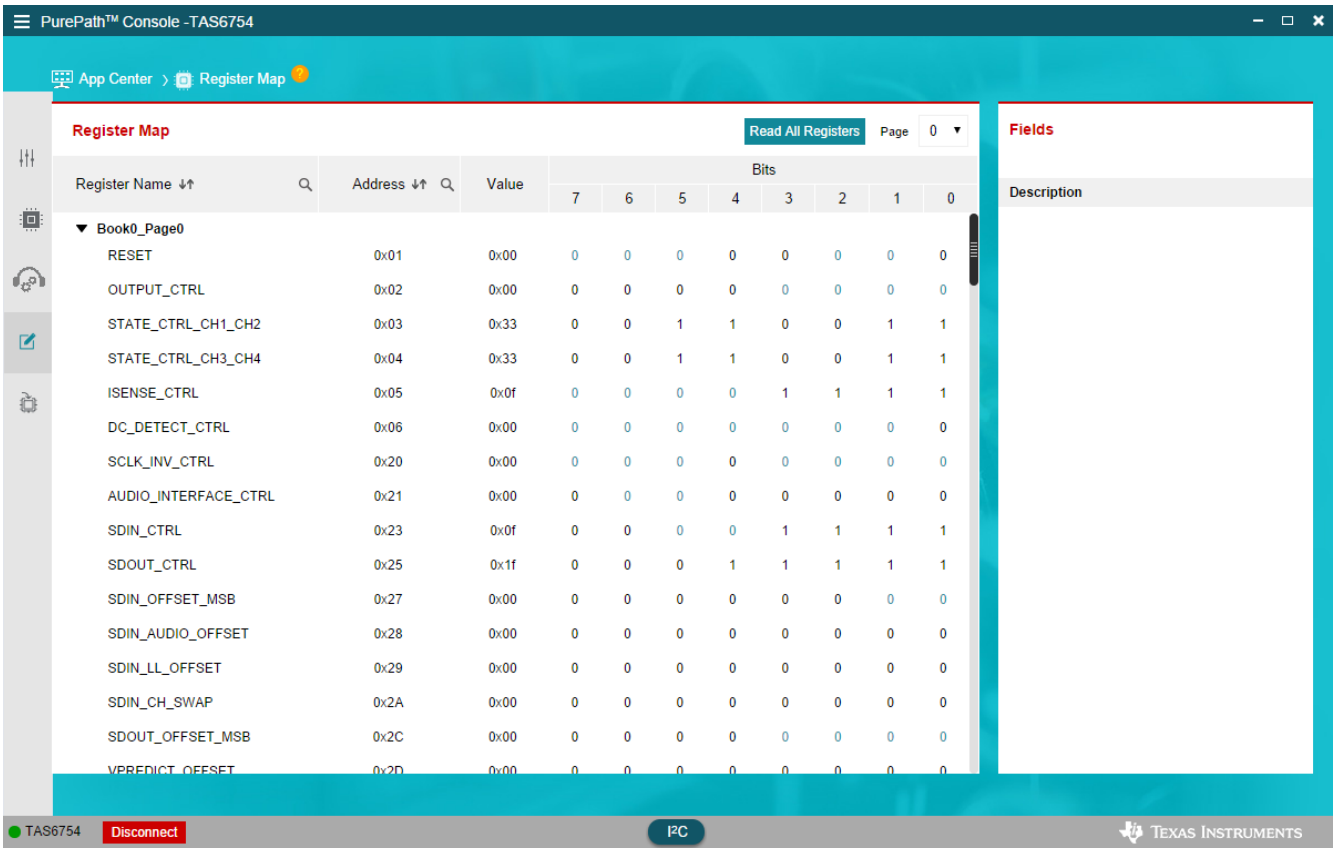
点击窗口左列中的 *Audio Processing Options* 图标，将显示以下窗口。



每个框有一个定义的流程。点击 *on/off* 滑块可以打开或关闭流程。可以打开每个框来修改流程。“Clip Detect”框是在“Audio Processing”窗口级别修改的。

3.6 寄存器映射

点击窗口左列中的 *Register Map* 图标，将显示以下窗口。



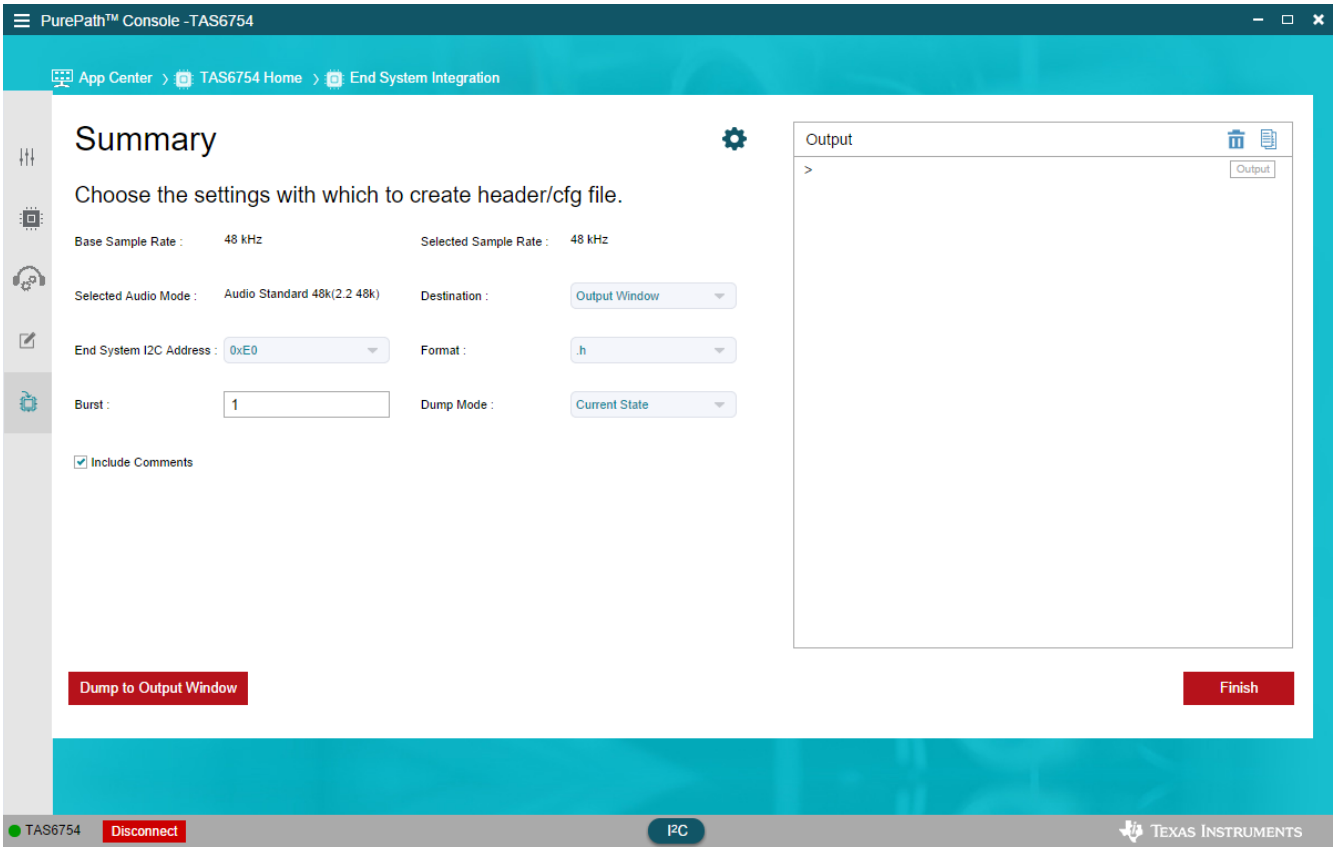
寄存器映射可以按字母顺序或数字顺序（寄存器编号）排序。选择寄存器后，将显示十六进制值以及各个位的值。每个位的名称和描述显示在右侧的“Fields”框中。双击时，位会改变状态。第二次点击结束时，状态更改会发送到 EVM。

3.7 I2C 监控器窗口

寄存器映射可以按字母顺序或数字顺序（寄存器编号）排序。选择寄存器后，将显示十六进制值以及各个位的值。每个位的名称和描述显示在右侧的“Fields”框中。双击时，位会改变状态。第二次点击结束时，状态更改会发送到 EVM。

3.8 终端系统集成

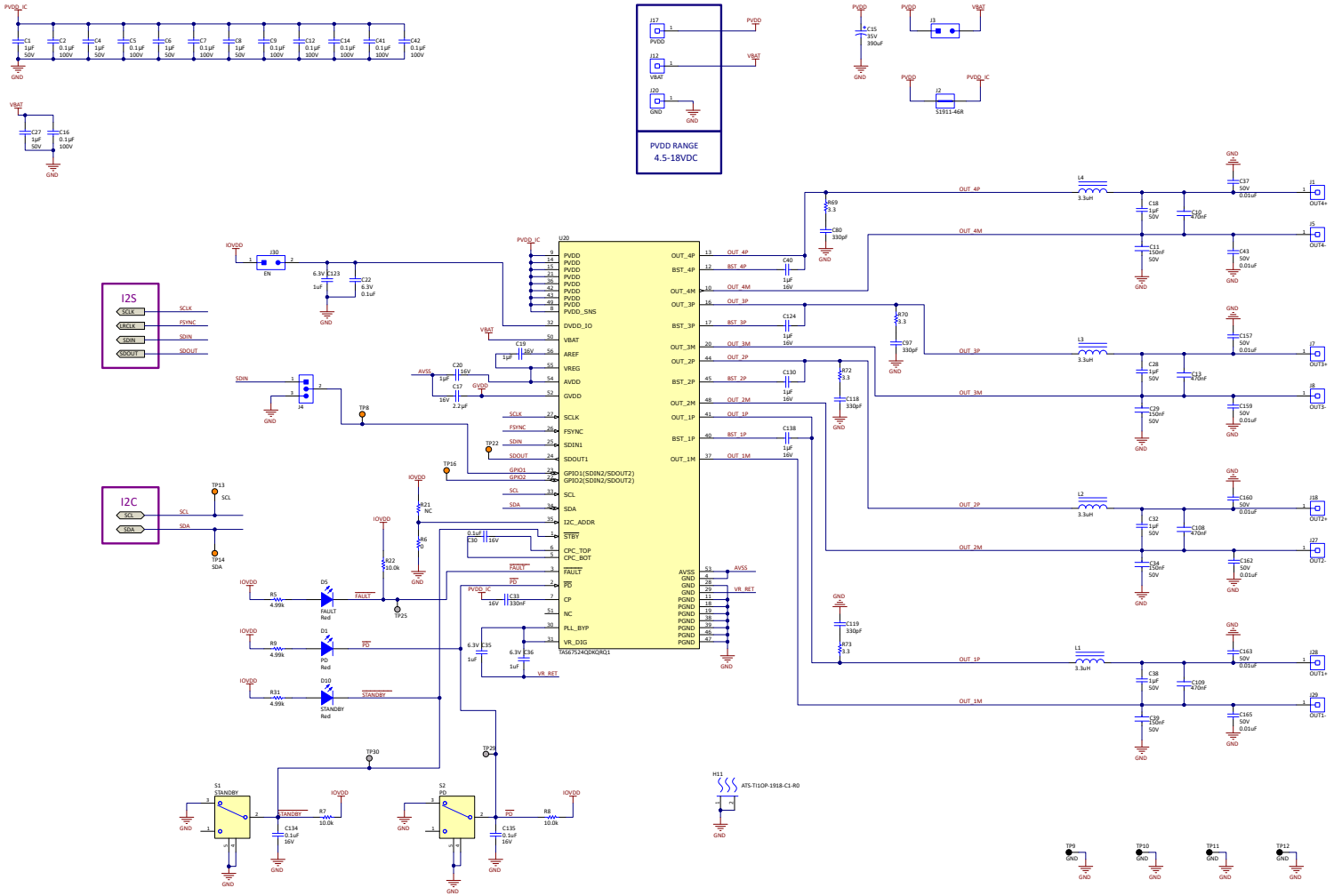
点击窗口左列中的 *End System Integration* 图标，将显示以下窗口。

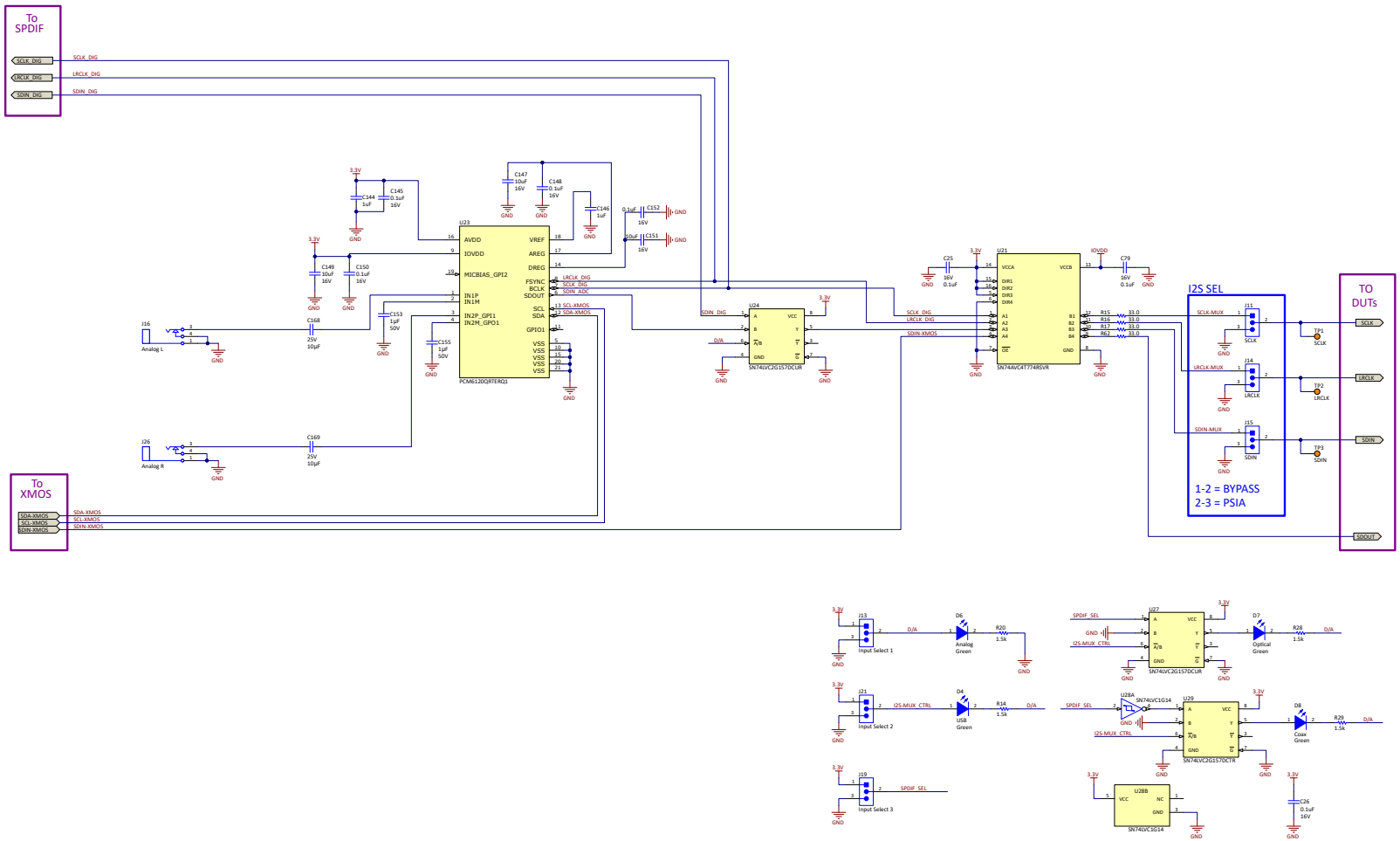


要生成终端系统集成配置文件，需配置下拉菜单选项，然后点击 Dump to Output Window 按钮。查看输出文件信息，如果满意，点击 Finish 按钮。

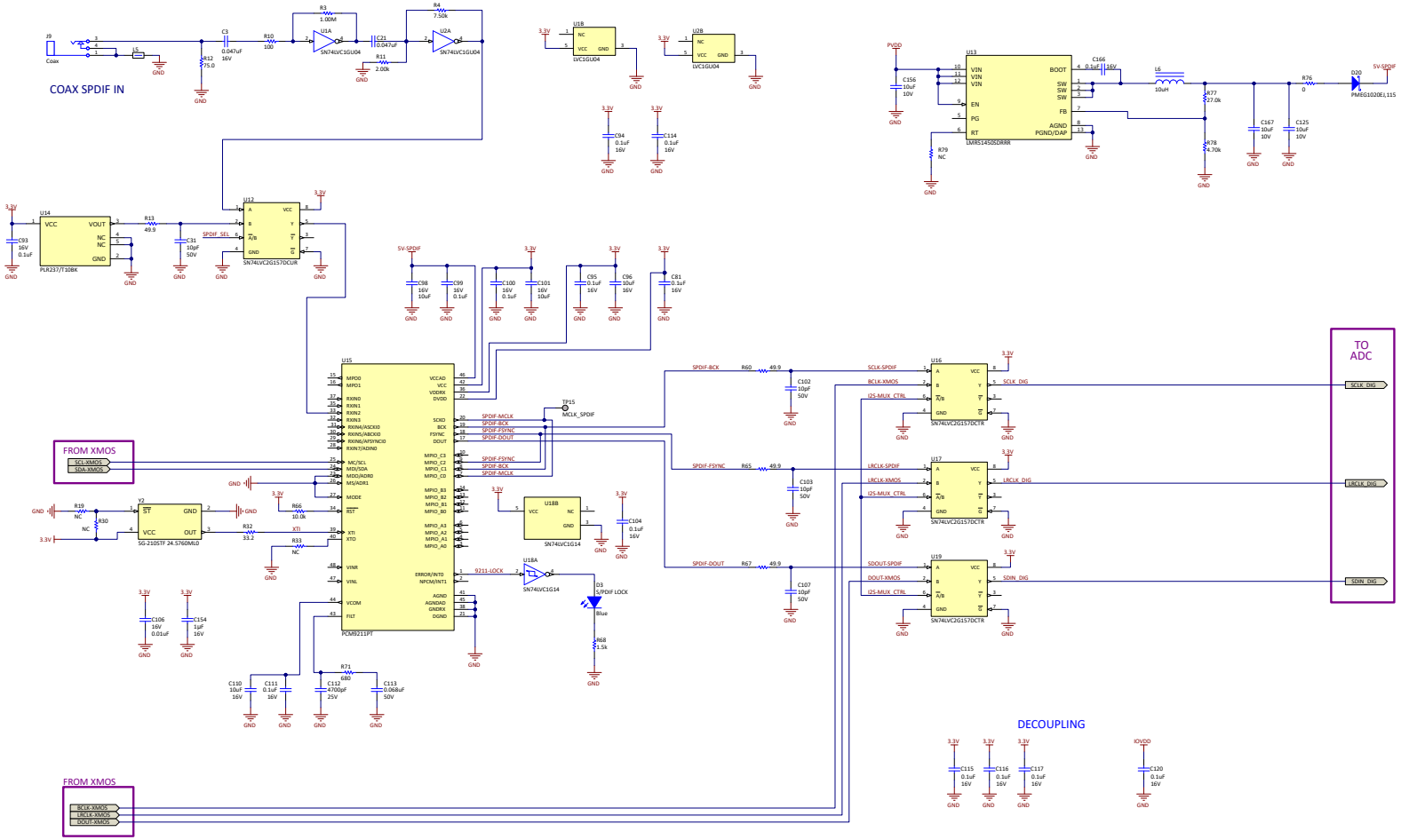
4 硬件设计文件

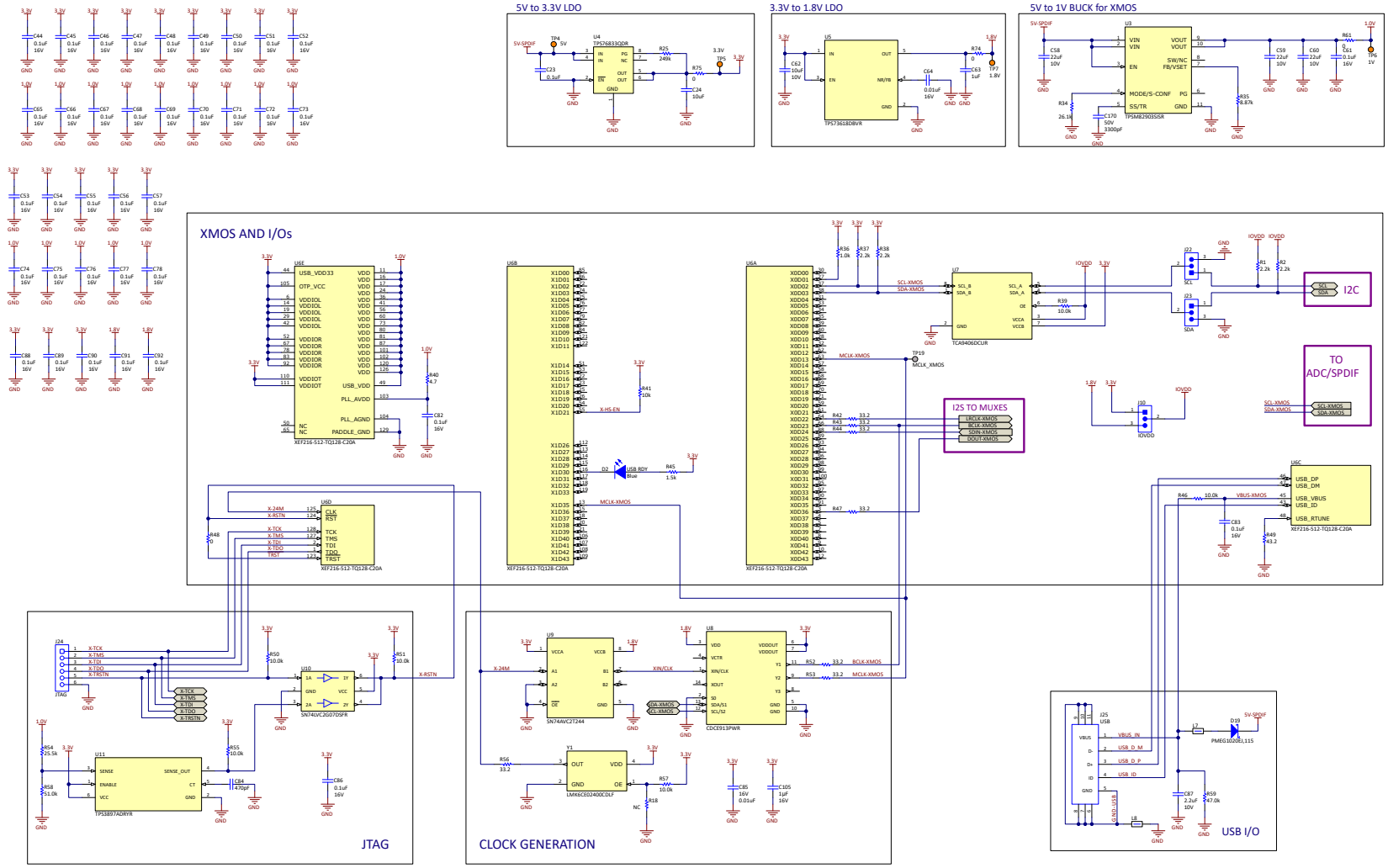
4.1 原理图





English Document: SLVUDM1





English Document: SLVUDM1

4.2 PCB 布局

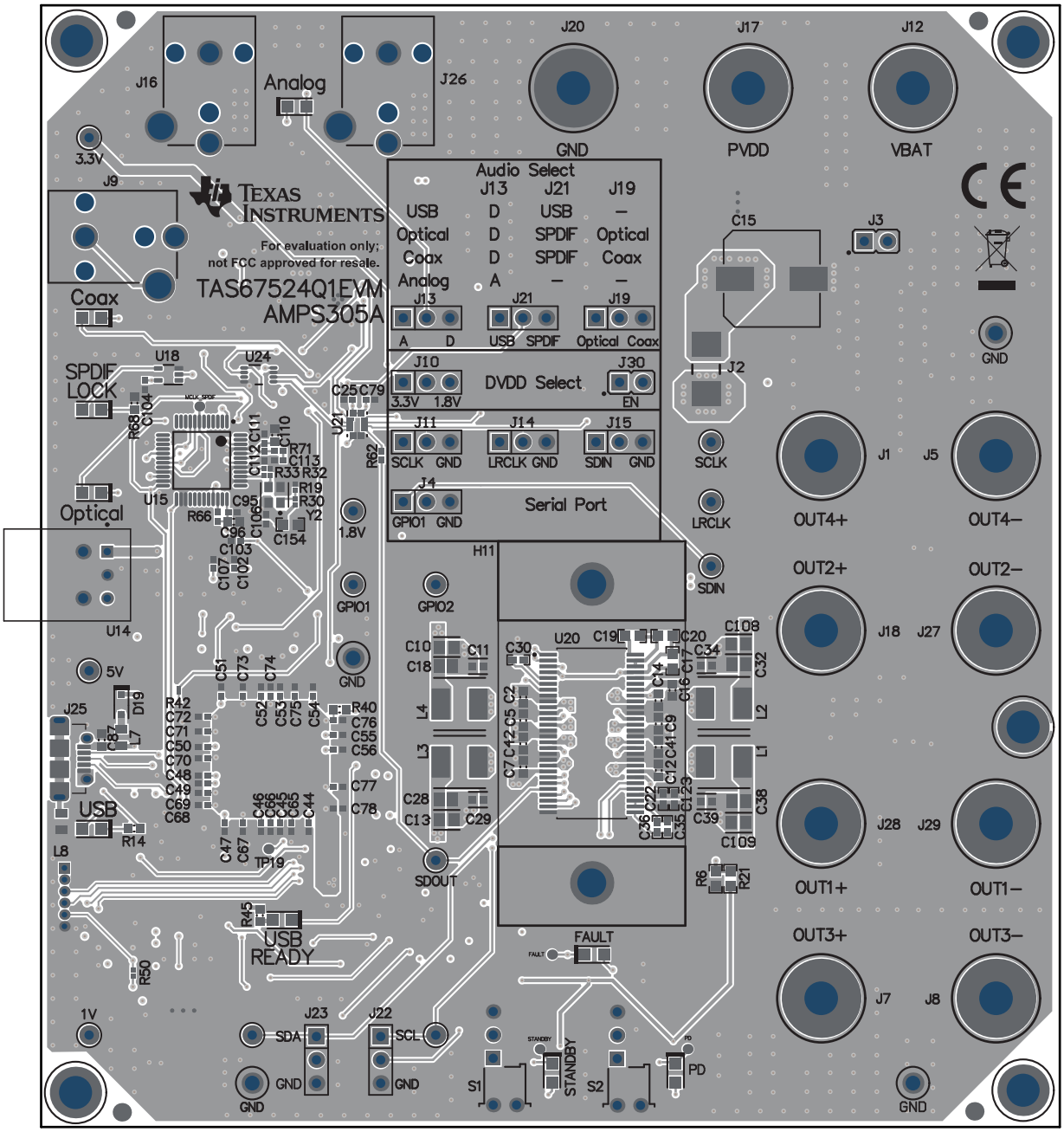


图 4-1. 顶复合视图

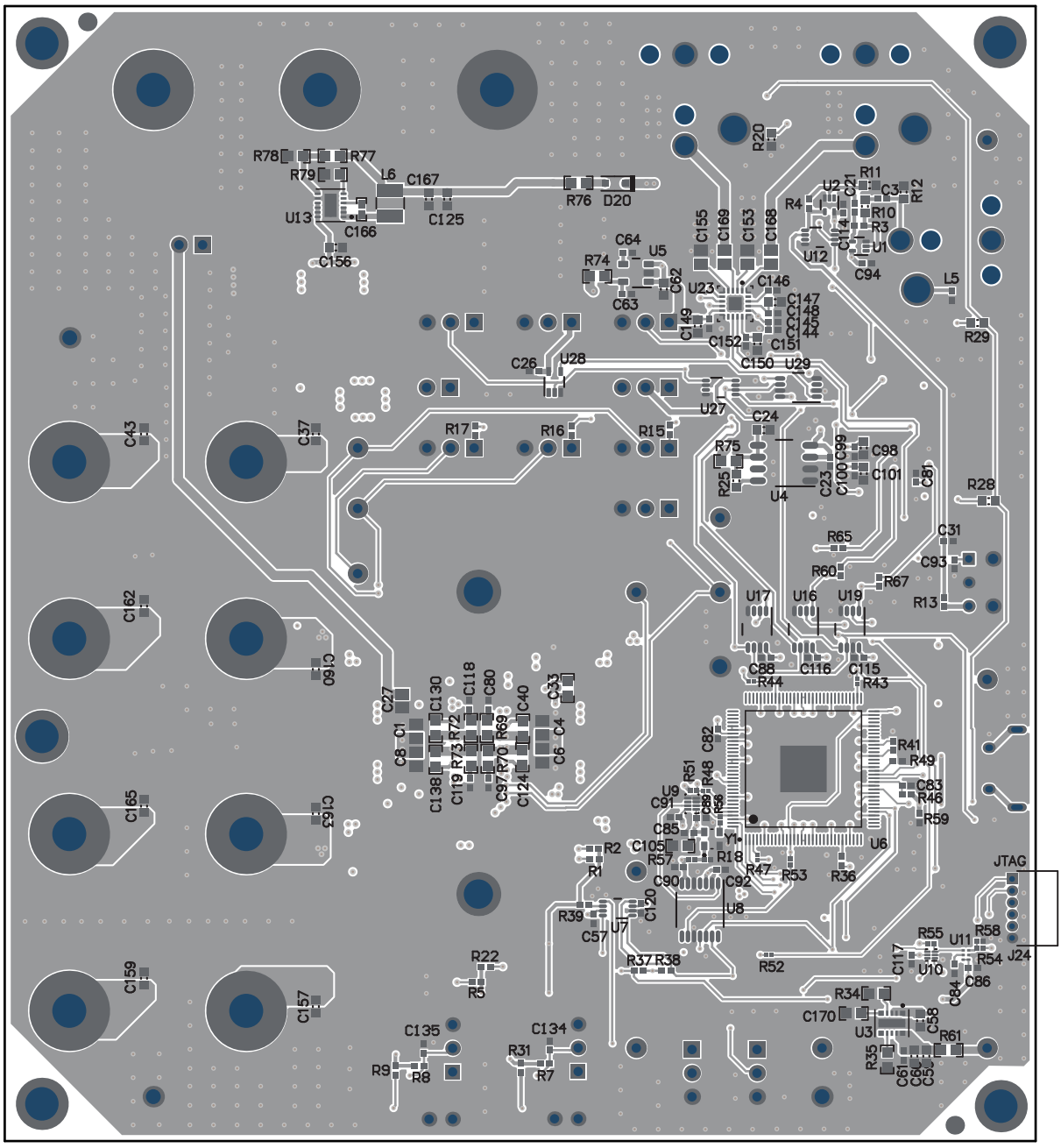


图 4-2. 底复合视图

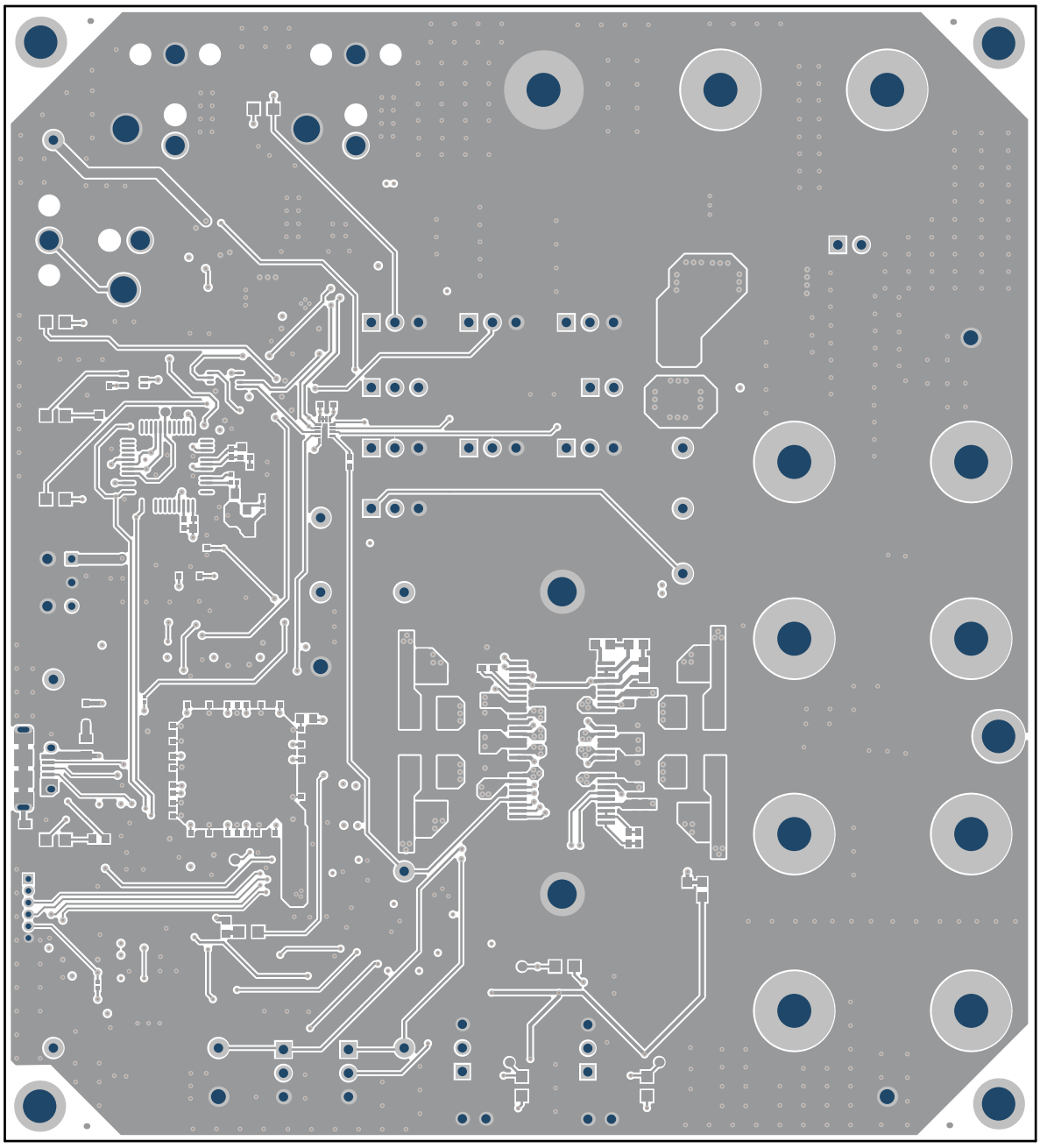


图 4-3. 顶层

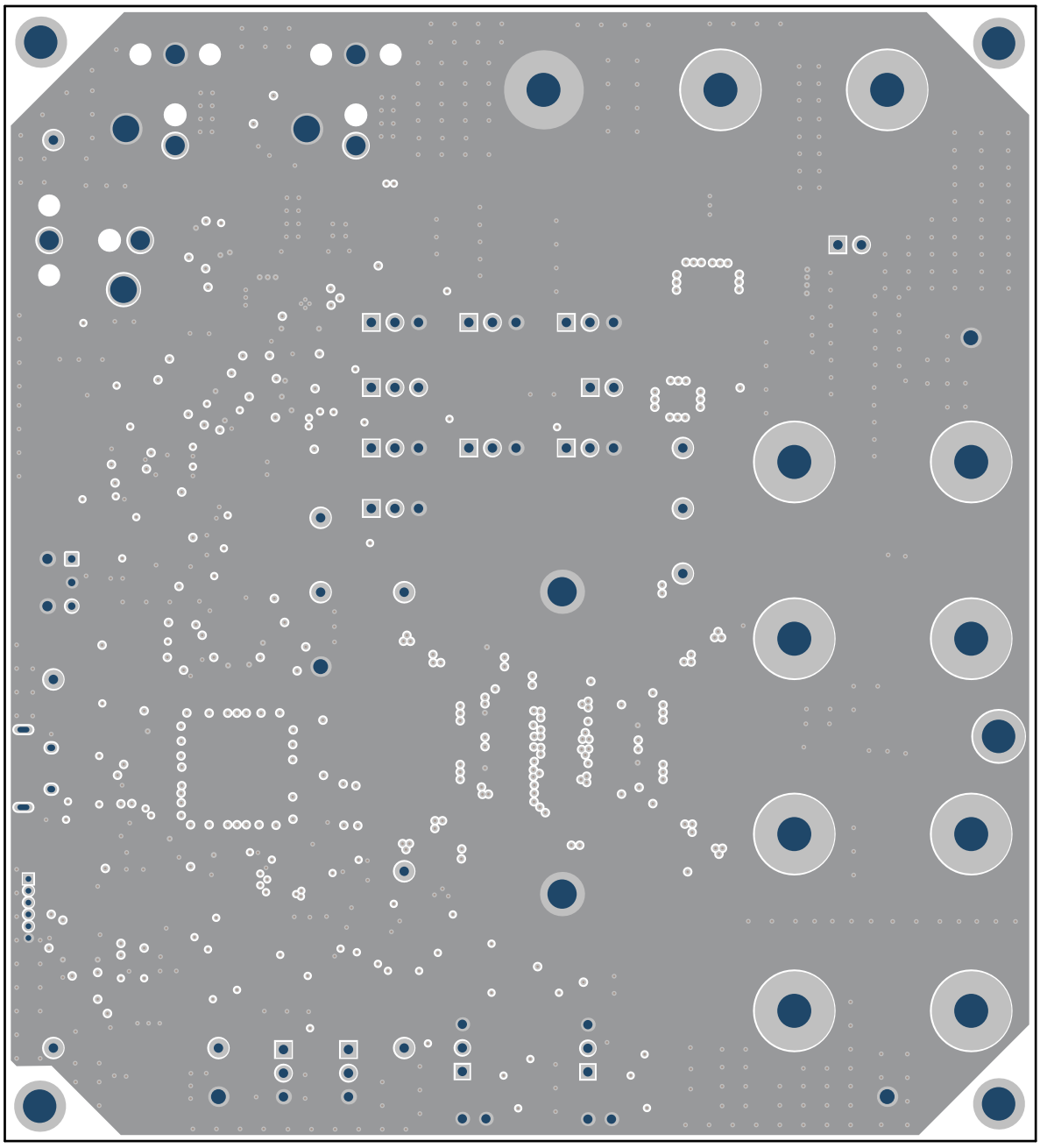


图 4-4. 信号层 1

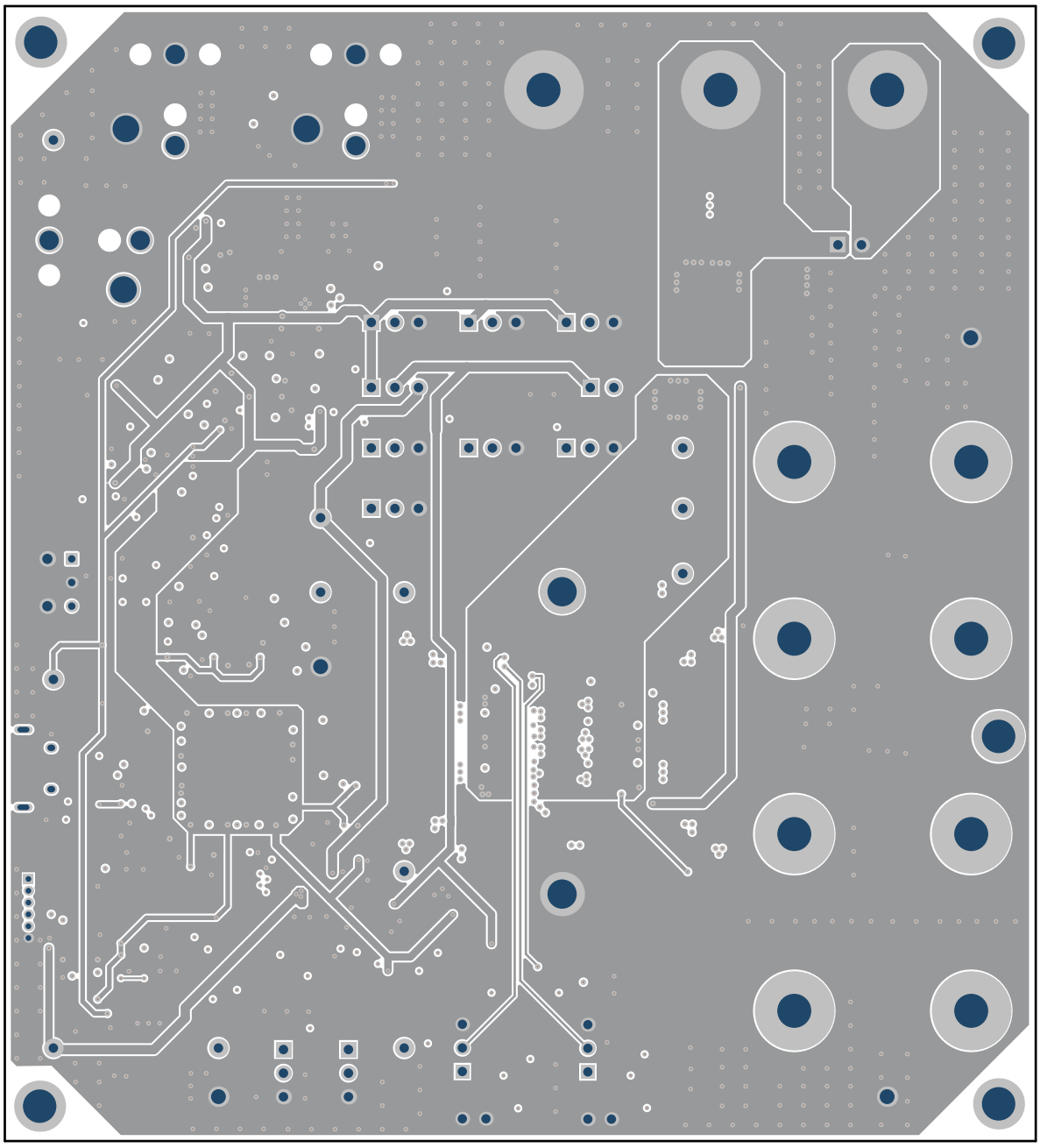


图 4-5. 信号层 2

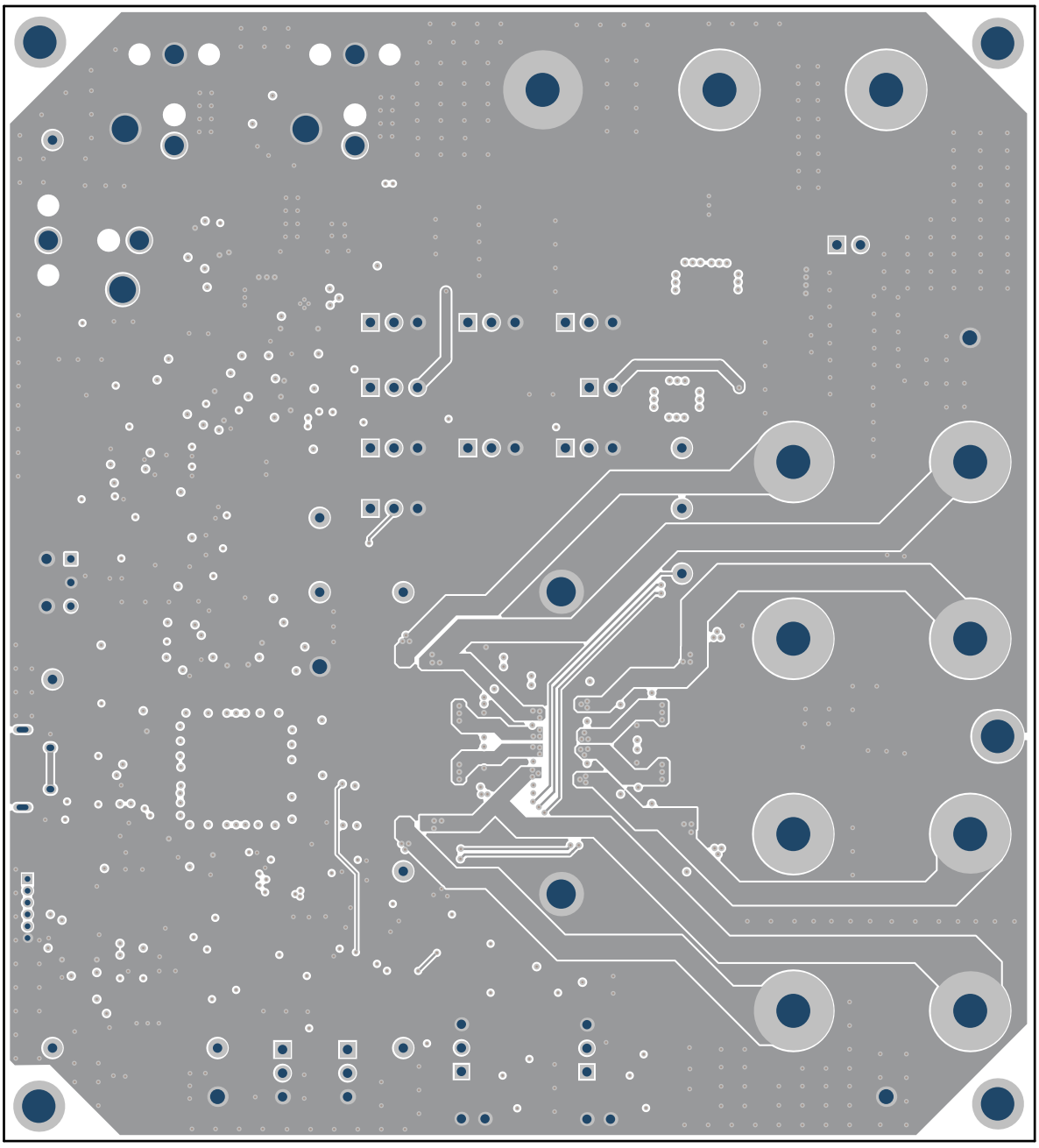


图 4-6. 信号层 3

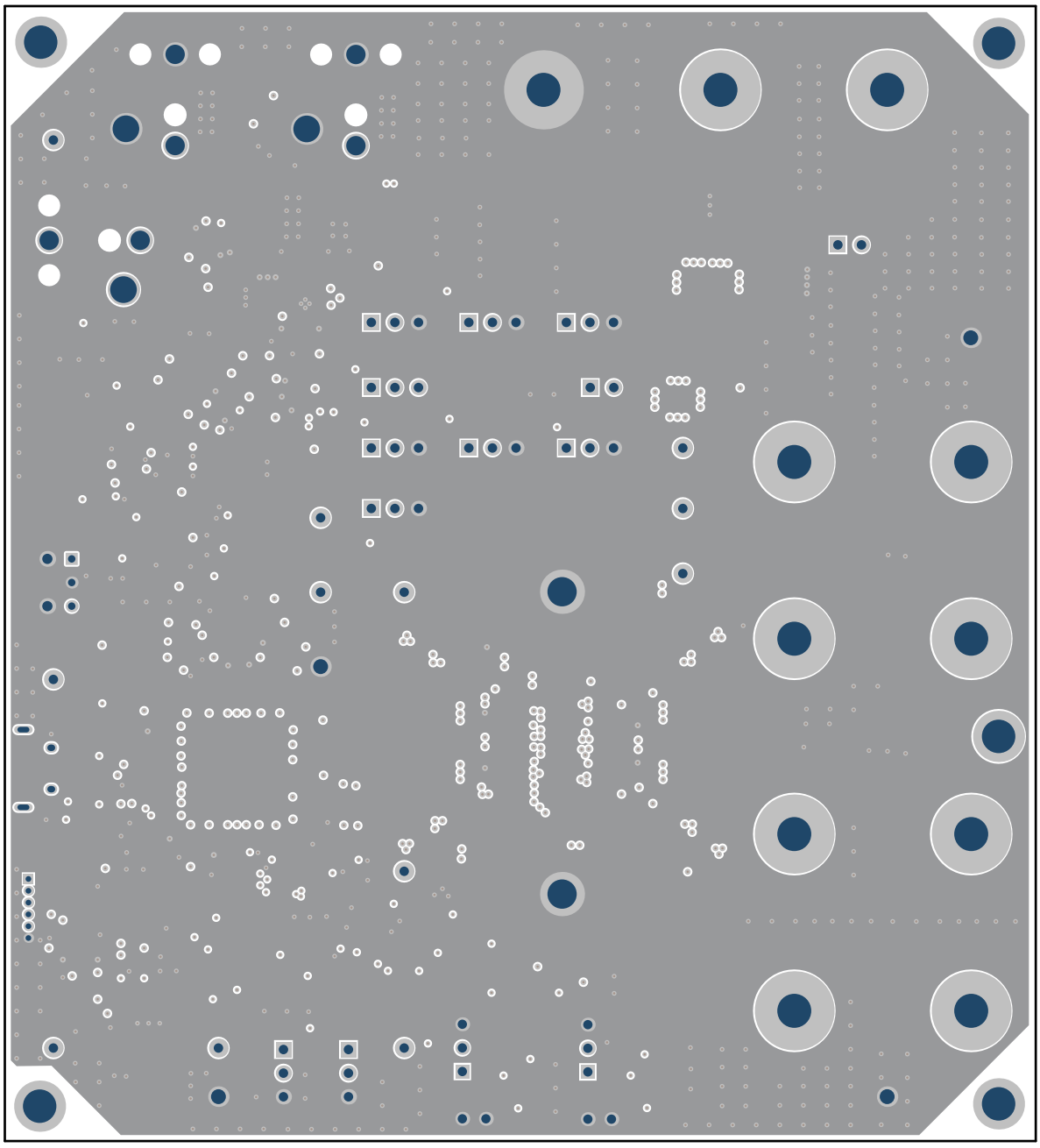


图 4-7. 信号层 4

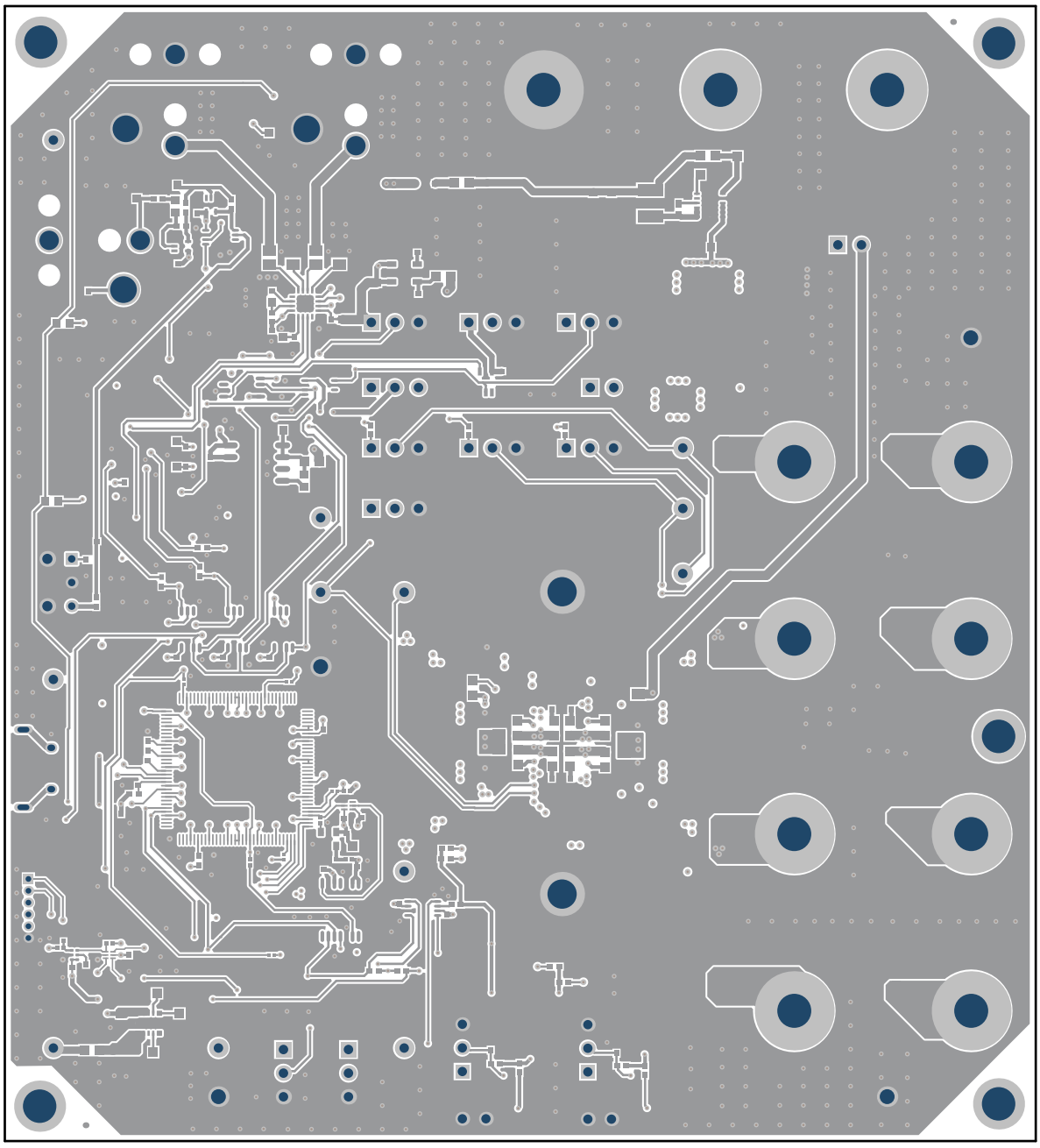


图 4-8. 底层

4.3 物料清单 (BOM)

表 4-1. 物料清单

位号	数量	值	说明	封装	器件型号	制造商
C1、C4、C6、C8、C27	5	1μF	电容，陶瓷，1μF，50V，+/-20%，X7R，AEC-Q200 1 级，0805	0805	GCJ21BR71H105MA01L	MuRata
C2、C5、C7、C9、C12、C14、C16、C41、C42	9	0.1uF	电容，陶瓷，0.1μF，100V，+/-10%，X8L，0603	0603	GCJ188L8EL104KA07D	MuRata
C3、C21	2	0.047μF	电容，陶瓷，0.047uF，16V，+/-10%，X7R，0402	0402	GRM155R71C473KA01D	MuRata
C11、C29、C34、C39	4	150nF	汽车级，150nF，±10%，50VDC，X7R，0603，纸质 T/R	0603	GCM188R71H154KA64D	MuRata
C15	1	390uF	电容，铝，390uF，35V，+/-20%，0.08Ω，SMD	10x10	UCL1V391MNL1GS	Nichicon
C17	1	2.2uF	电容，陶瓷，2.2uF，16V，+/-10%，X7R，0603	0603	EMK107BB7225KA-T	Taiyo Yuden
C18、C28、C32、C38	4	1μF	电容，陶瓷，1μF，50V，+/－ 10%，X7R，AEC-Q200 1 级	0805	GCM21BR71H105KA03K	MuRata
C19、C20、C105、C154	4	1μF	电容，陶瓷，1μF，16V，+/- 20%，X7R，AEC-Q200 1 级	0603	GCM188R71C105MA64D	MuRata
C22	1	0.1uF	电容，陶瓷，0.1μF，6.3V，+/- 10%，X7R，0402	0402	GRM155R70J104KA01D	MuRata
C23、C25、C26、C44、C45、C46、C47、C48、C49、C50、C51、C52、C53、C54、C55、C56、C57、C61、C65、C66、C67、C68、C69、C70、C71、C72、C73、C74、C75、C76、C77、C78、C79、C81、C82、C83、C86、C88、C89、C90、C91、C92、C93、C94、C95、C99、C100、C104、C111、C114、C115、C116、C117、C120、C145、C148、C150、C152	58	0.1uF	电容，陶瓷，0.1μF，16V，+/- 10%，X7R，0402	0402	8.85012E+11	Wurth Elektronik
C24、C62、C125、C156、C167	5	10μF	电容，陶瓷，10uF，10V，+/-20%，X5R，0603	0603	C1608X5R1A106M080AC	TDK
C30、C166	2	0.1uF	电容，陶瓷，0.1μF，16V，+/- 10%，X7R，0402	0402	GCM155R71C104KA55D	MuRata
C31	1	10pF	电容，陶瓷，10pF，50V，+/-5%，C0G/NP0，0402	0402	GRM1555C1H100JA01D	MuRata
C33	1	0.33 uF	电容，陶瓷，0.33uF，16V，+/-10%，X7R，0603	0603	GRM188R71C334KA01D	MuRata
C35、C36、C123	3	1μF	电容，陶瓷，1uF，6.3V，+/-10%，X7R，0402	0402	GRM155R70J105KA12D	MuRata

表 4-1. 物料清单（续）

位号	数量	值	说明	封装	器件型号	制造商
C37、C43、C157、C159、C160、C162、C163、C165	8	0.01 uF	电容，陶瓷，0.01 µF，50V，+/- 5%，C0G/NP0，0603	0603	GRM1885C1H103JA01D	MuRata
C40、C124、C130、C138	4	1µF	电容，陶瓷，1µF，16V，+/- 10%，X7R，AEC-Q200 1 级	0603	GCM188R71C105KA64D	MuRata
C58、C59、C60	3	22uF	电容，陶瓷，22uF，10V，+/-20%，X5R，0603	0603	C1608X5R1A226M080AC	TDK
C63、C144、C146	3	1µF	电容，陶瓷，1uF，6.3V，+/-20%，X5R，0402	0402	GRM152R60J105ME15D	MuRata
C64、C85、C106	3	0.01 uF	电容，陶瓷，0.01uF，16V，+/-10%，X7R，0402	0402	8.85012E+11	Wurth Elektronik
C80、C97、C118、C119	4	330pF	电容，陶瓷，330pF，50V，+/-10%，X7R，0402	0402	GRM155R71H331KA01D	MuRata
C84	1	470pF	电容，陶瓷，470pF，50V，+/-5%，C0G/NP0，0402	0402	GRM1555C1H471JA01D	MuRata
C87	1	2.2uF	电容，陶瓷，2.2uF，10V，+/-10%，X7R，0603	0603	GRM188R71A225KE15D	MuRata
C96、C98、C101、C110、C147、C149、C151	7	10µF	电容，陶瓷，10uF，16V，+/-20%，X5R，0603	0603	EMK107BBJ106MA-T	Taiyo Yuden
C102、C103、C107	3	10pF	电容，陶瓷，10pF，50V，+/-5%，C0G/NP0，0402	0402	8.85012E+11	Wurth Elektronik
C112	1	4700pF	电容，陶瓷，4700pF，25V，+/-10%，X7R，0402	0402	CC0402KRX7R8BB472	Yageo
C113	1	0.068uF	电容，陶瓷，0.068uF，50V，+/– 10%，X7R，AEC-Q200 1 级，0402	0402	CGA2B3X7R1H683K050BB	TDK
C134、C135	2	0.1uF	电容，陶瓷，0.1µF，16V，+/- 10%，X7R，AEC-Q200 1 级	0402	C0402C104K4RACAUTO	Kemet
C153、C155	2	1µF	电容，陶瓷，1µF，50V，+/-10%，X7R，0805	0805	8.85012E+11	Wurth Elektronik
C168、C169	2	10µF	电容，陶瓷，10µF，25V，+/-20%，X6S，0805	0805	GRM21BC81E106ME51L	MuRata
C170	1	3300pF	电容，陶瓷，3300pF，50V，+/-5%，C0G/NP0，0603	0603	GRM1885C1H332JA01D	MuRata
D1、D5、D10	3	红色	LED，红色，SMD	红色 0805 LED	LTST-C170KRKT	Lite-On
D2、D3	2	蓝色	LED，蓝色，SMD	LED_0805	LTST-C170TBKT	Lite-On
D4、D6、D7、D8	4	绿色	LED，绿色，SMD	0805 LED	LTST-C171GKT	Lite-On
D19、D20	2	10V	二极管，肖特基，10V，2A，SOD-323F	SOD-323F	PMEG1020EJ,115	Nexperia
H1、H2、H3、H4、H5	5		机械螺钉盘 PHILLIPS M3	M3 螺钉	RM3X8MM 2701	APM HEXSEAL

表 4-1. 物料清单（续）

位号	数量	值	说明	封装	器件型号	制造商
H6、H7、H8、H9、H10	5		六角螺柱，12mm，M3，铝	铝质 M3 12mm 六角螺柱	24434	Keystone
H11	1		20.0mm x 41.4mm x 32.8mm BGA 散热器 - 特定于高性能器件 - TI	HTSNK_41MM4_20MM0	ATS-TI1OP-1918-C1-R0	Advanced Thermal Solutions
J1、J7、J12、J17、J18、J28	6		接线柱、红色、TH	11.4x27.2mm	7006	Keystone
J2	1		跳线 TIN SMD	6.85mm x 0.97mm x 2.51mm	S1911-46R	Harwin
J3、J30	2		接头，100mil，2x1，金，TH	Sullins 100mil，1x2，绝缘体上方 230mil	PBC02SAAN	Sullins Connector Solutions
J4、J6、J10、J11、J13、J14、J15、J19、J21、J22、J23	11		接头，100mil，3x1，金，TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions
J5、J8、J20、J27、J29	5		接线柱、黑色、TH	11.4x27.2mm	7007	Keystone
J9、J16、J26	3		RCA 插孔，白色，R/A，TH	唱机插孔 — 白色	970	Keystone
J24	1		插座，50mil，6x1，金，R/A，TH	6x1 插座	LPPB061NGCN-RC	Sullins Connector Solutions
J25	1		连接器，插座，Micro-USB Type AB，R/A，底部安装 SMT	5.6mm x 2.5mm x 8.2mm	475890001	Molex
L1、L2、L3、L4	4	3.3uH	电感器，3.3 µ H，4.5A，0.038 Ω ，AEC-Q200 0 级，SMD	5.45x5.25x3.0mm	VCMV053T-3R3MN22M	Cyntec
L5	1	120 Ω	铁氧体磁珠，120 Ω @ 100MHz，0.4A，0402	0402	MMZ1005Y121CT000	TDK
L6	1	10uH	电感器，绕线型，10 µ H，0.9A，0.1729 Ω ，SMD	3.2x2.5x2.5mm	CBC3225T100MR	Taiyo Yuden
L7、L8	2	600 Ω	铁氧体磁珠，600 Ω（100MHz 时），2A，0805	0805	MPZ2012S601AT000	TDK
R1、R2、R37、R38	4	2.2k	电阻，2.2k，5%，0.063W，AEC-Q200 0 级，0402	0402	CRCW04022K20JNED	Vishay-Dale
R3	1	1.00Meg	电阻，1.00M，1%，0.1W，0402	0402	ERJ-2RKF1004X	Panasonic
R4	1	7.50k	电阻，7.50k，1%，0.063W，AEC-Q200 0 级，0402	0402	CRCW04027K50FKED	Vishay-Dale
R5、R9、R31	3	4.99k	电阻，4.99k，1%，0.063W，AEC-Q200 0 级，0402	0402	CRCW04024K99FKED	Vishay-Dale
R6、R61、R74、R75、R76	9	0	电阻，0，1%，0.1W，AEC-Q200 0 级，0603	0603	RMCF0603ZT0R00	Stackpole Electronics Inc
R7、R8、R22	3	10.0k	电阻，10.0k，1%，0.063W，AEC-Q200 0 级，0402	0402	RMCF0402FT10K0	Stackpole Electronics Inc

表 4-1. 物料清单（续）

位号	数量	值	说明	封装	器件型号	制造商
R10	1	100	电阻，100，1%，0.1W，AEC-Q200 0 级，0603	0603	CRCW0603100RFKEA	Vishay-Dale
R11	1	2.00k	电阻，2.00k，1%，0.1W，AEC-Q200 0 级，0603	0603	CRCW06032K00FKEA	Vishay-Dale
R12	1	75	电阻，75.0，1%，0.1W，AEC-Q200 0 级，0603	0603	CRCW060375R0FKEA	Vishay-Dale
R13、R60、R65、R67	4	49.9	电阻，49.9，1%，0.063W，AEC-Q200 0 级，0402	0402	CRCW040249R9FKED	Vishay-Dale
R14、R20、R28、R29、R45、R68	6	1.5k	电阻，1.5k，5%，0.1W，AEC-Q200 0 级，0603	0603	CRCW06031K50JNEA	Vishay-Dale
R15、R16、R17、R62	4	33	电阻，33.0，1%，0.1W，0402	0402	ERJ-2RKF33R0X	Panasonic
R25	1	249k	电阻，249k，1%，0.1W，0603	0603	RC0603FR-07249KL	Yageo
R32、R42、R43、R44、R47、R52、R53、R56	8	33.2	电阻，33.2，1%，0.05W，0201	0201	RC0201FR-0733R2L	Yageo America
R34	1	26.1k	电阻，26.1k，0.1%，0.1W，0603	0603	RT0603BRD0726K1L	Yageo America
R35	1	8.87k	电阻，8.87k，1%，0.1W，0603	0603	CRCW06038K87FKEA	Vishay-Dale
R36	1	1.0k	电阻，1.0k，5%，0.063W，AEC-Q200 0 级，0402	0402	CRCW04021K00JNED	Vishay-Dale
R39、R46	2	10.0k	电阻，10.0k，1%，0.1W，0402	0402	ERJ-2RKF1002X	Panasonic
R40	1	4.7	电阻，4.7，5%，0.1W，AEC-Q200 0 级，0603	0603	CRCW06034R70JNEA	Vishay-Dale
R41	1	10k	电阻，10k，5%，0.063W，AEC-Q200 0 级，0402	0402	CRCW040210K0JNED	Vishay-Dale
R48	1	0	电阻，0，5%，0.05W，AEC-Q200 0 级，0201	0201	ERJ-1GN0R00C	Panasonic
R49	1	43.2	电阻，43.2，1%，0.1W，AEC-Q200 0 级，0402	0402	ERJ-2RKF43R2X	Panasonic
R50、R51、R55、R57	4	10.0k	电阻，10.0k，1%，0.05W，0201	0201	CRCW020110K0FKED	Vishay-Dale
R54	1	25.5k	电阻，25.5k，1%，0.05W，0201	0201	RC0201FR-0725K5L	Yageo America
R58	1	51.0k	电阻，51.0k，1%，0.05W，0201	0201	RC0201FR-0751KL	Yageo America
R59	1	47.0k	电阻，47.0k，1%，0.0625W，0402	0402	RC0402FR-0747KL	Yageo America
R66	1	10.0k	电阻，10.0k，1%，0.063W，AEC-Q200 0 级，0402	0402	CRCW040210K0FKED	Vishay-Dale
R69、R70、R72、R73	4	3.3	电阻，3.3，5%，0.1W，AEC-Q200 0 级，0603	0603	CRCW06033R30JNEA	Vishay-Dale

表 4-1. 物料清单（续）

位号	数量	值	说明	封装	器件型号	制造商
R71	1	680	电阻，680，5%，0.063W，AEC-Q200 0 级，0402	0402	CRCW0402680RJNED	Vishay-Dale
R77	1	27.0k	电阻，27.0k，1%，0.1W，0603	0603	RC0603FR-0727KL	Yageo
R78	1	4.70k	电阻，4.70k，1%，0.1W，0603	0603	RC0603FR-074K7L	Yageo
S1、S2	2		开关，SPDT，On-On，1 Pos，0.4A，28VDC，TH	5.6x5.4mm	FT1D-4M-Z	Copal Electronics
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	13	1x2	分流器，100mil，镀金，黑色	分流器	SNT-100-BK-G	Samtec
TP1、TP2、TP3、TP4、TP5、TP6、TP7、TP8、TP13、TP14、TP16、TP22	12		测试点，微型，橙色，TH	橙色微型测试点	5003	Keystone
TP9、TP10、TP11、TP12	4		测试点，紧凑型，黑色，TH	黑色紧凑型测试点	5006	Keystone
U1、U2	2		单路反相门，DRL0005A，LARGE T&R	DRL0005A	SN74LVC1GU04DRLR	德州仪器 (TI)
U3	1		3V 至 17V 高效和低 IQ 降压转换器	uSiL11	TPSM82903SISR	德州仪器 (TI)
U4	1		快速瞬态响应 LDO，1A，固定 3.3V 输出，	D0008A	TPS76833QDR	德州仪器 (TI)
U5	1		单路输出 LDO，400mA，可调节电压（1.2 至 5.5V），无电容器	DBV0005A	TPS73618DBVR	德州仪器 (TI)
U6	1		XCore XEF 微控制器 IC 32 位 16 核 2,000MIP	TQFP128	XEF216-512-TQ128-C20A	XMOS
U7	1		1MHz I2C 总线和 SMBus 电压电平移位器	DCU0008A	TCA9406DCUR	德州仪器 (TI)
U8	1		1-PLL VCXO 时钟合成器	PW0014A	CDCE913PWR	德州仪器 (TI)
U9	1		双位双电源总线收发器，DQM0008A	DQM0008A	SN74AVC2T244DQMR	德州仪器 (TI)
U10	1		具有漏极开路输出的单缓冲器/驱动器，DCK0006A	DSF0006A	SN74LVC2G07DSFR	德州仪器 (TI)
U11	1		带高电平有效漏极开路功能的可调节监控电路	DRY0006A	TPS3897ADRYR	德州仪器 (TI)
U12、U24、U27	3		单路 2 线路至 1 线路数据选择器/多路复用器	DCU0008A	SN74LVC2G157DCUR	德州仪器 (TI)
U13	1		4V 至 36V、5A 同步降压 DC/DC 转换器	WSON12	LMR51450SDRRR	德州仪器 (TI)
U14	1		光学接收器 25Mbps 单路 650nm	PTH_9MM70_13MM50	PLR237/T10BK	Everlight Electronics
U15	1		216kHz 数字音频接口收发器 (DIX)	PT0048A	PCM9211PT	德州仪器 (TI)
U16、U17、U19、U29	4		单路 2 线路至 1 线路数据选择器/多路复用器	DCT0008A	SN74LVC2G157DCTR	德州仪器 (TI)
U18、U28	2		单路施密特触发逆变器，DCK0005A	DCK0005A	SN74LVC1G14DCKR	德州仪器 (TI)

表 4-1. 物料清单（续）

位号	数量	值	说明	封装	器件型号	制造商
U20	1		26.4V、7.5A、4 通道 D 类音频放大器	HSSOP56	TAS67524QDKQRQ1	德州仪器 (TI)
U21	1		4 位双电源总线收发器	RSV0016A	SN74AVC4T774RSVR	德州仪器 (TI)
U23	1		2 通道，768kHz，Burr-Brown 音频 ADC	WQFN20	PCM6120QRTERQ1	德州仪器 (TI)
Y1	1		高性能 BAW 振荡器，LVCMOS	VSON4	LMK6CE02400CDLF	德州仪器 (TI)
Y2	1		24.576MHz XO（标准）CMOS 振荡器 1.6V ~ 3.6V	SMT_OSC_2MM5_2MM0	SG-210STF 24.5760ML0	Epson

商标

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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

東京都新宿区西新宿 6 丁目 2 4 番 1 号

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