

EVM User's Guide: LMH13000RQEEVM

LMH13000RQE 评估模块



说明

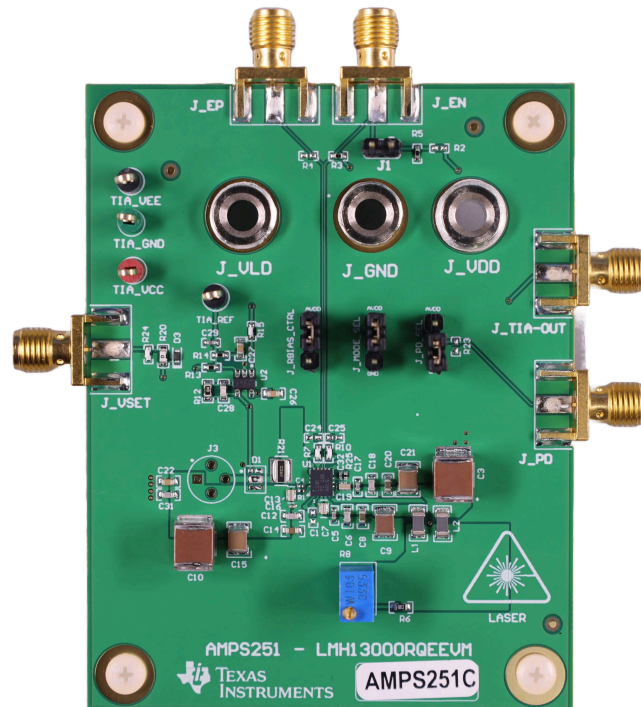
LMH13000RQEEVM 是 LMH13000 的评估模块 (EVM)，后者是采用 13 针 WQFN-HR (HotRod™) 封装的高速输出电流驱动器。该 EVM 旨在快速简便地演示放大器的功能和实用性。该 EVM 可随时通过板载连接器与电源、信号源和测试仪表连接。此 EVM 已配置为可轻松连接常见的 $50\ \Omega$ 实验室设备 (位于输入/输出端)、电源的香蕉连接器和跳线 (用于轻松禁用、启用或配置不同的工作模式)。布局经过优化，还可以减少寄生效应，从而实现输出电流的较短上升和下降时间。

特性

- 单电源工作电压范围为 3V 至 5.5V
- 易于使用的 SMA 连接器，适用于所有输入和输出信号
- 适合器件和激光电源的易于使用的香蕉连接器
- SMD VCSEL 和 TO-CAN 激光器封装
- 用于激光功率校准的板载互阻抗放大器 (TIA)
- 用于在不同模式下配置器件的跳线
- 布局配置为更大限度地减少寄生和噪声

应用

- TOF 测距仪
- 工业光学传感器
- 3D 扫描和手势识别
- OTDR
- 高速电流负载
- 工业安全光幕
- 医疗 IVD 和流式细胞仪
- 激光雷达模块



LMH13000RQEEVM 电路板 (顶视图)

1 评估模块概述

1.1 简介

LMH13000 是一款高速输出电流驱动器，专为精确和快速的电流控制而设计，因此非常适合需要快速和准确电流脉冲的应用。该器件的上升和下降时间为 $<1\text{ns}$ ，专为工业光学传感器、光学时域反射仪 (OTDR)、高速电流负载以及体外诊断 (IVD) 和流式细胞仪等医疗应用而设计。该器件支持高达 1A 的连续电流和高达 5A 的脉冲电流，受限于频率、占空比和热耗散等因素。LMH13000 可在 3V 至 5.5V 的电压范围内运行，通过 LVDS 输入实现对导通时间、频率和占空比等输出参数的精确控制。这些特性使该器件成为高速、高精度电流驱动应用的可靠且高效的选择。

LMH13000RQEEVM 设计用于评估 LMH13000 的性能。该 EVM 包括用于所有输入和输出引脚的 SMA 连接器，以及用于电源的香蕉连接器。本用户指南介绍了器件和连接器，并提供了原理图、物料清单和印刷电路板 (PCB) 布局。

1.2 套件内容

包装中包含：

- LMH13000RQEEVM
- EVM 免责声明自述文件

1.3 规格

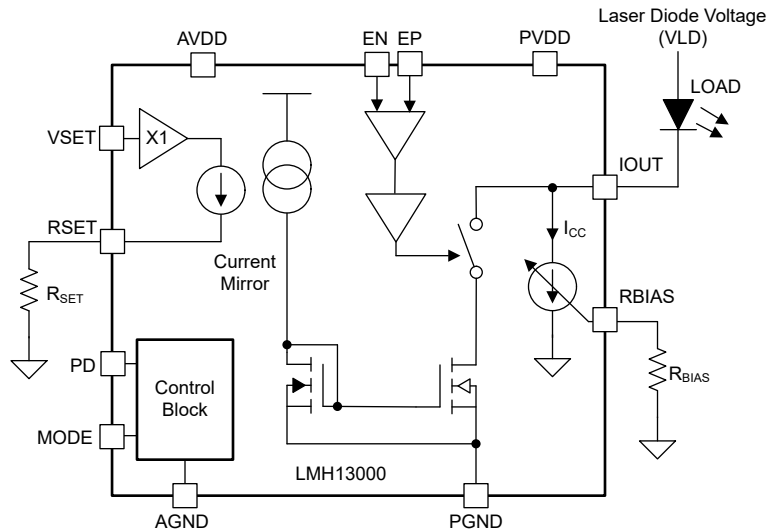


图 1-1. LMH13000 功能方框图

1.4 器件信息

LMH13000 是电压控制电流源，可实现与 LVDS 输入耦合的精确电流控制，从而支持脉冲和方波应用的较短上升和下降时间 ($<1\text{ns}$)。精确的输出电流控制有助于为激光、LED、光学放大器等负载即时调节负载电流，以补偿温度和老化的变化。LMH13000 支持高达 1A 的连续电流或 5A 脉冲电流，具体取决于频率、占空比和热耗散。

LMH13000 采用 TI 专有 HotRod 封装。HotRod 封装消除了内部键合线，有助于在高电流路径中实现非常低的电感。该封装可使设计实现更短的电流上升和下降时间。集成式热关断功能可在裸片温度过高时保护芯片。LVDS 输入可控制输出电流频率和占空比，并有助于实现脉冲和方波的灵活性。LMH13000 的工作电压范围为 3V 至 5.5V，具有 -40°C 至 $+125^{\circ}\text{C}$ 的额定环境温度范围。

2 硬件

2.1 其他图像

2.1.1 引脚配置

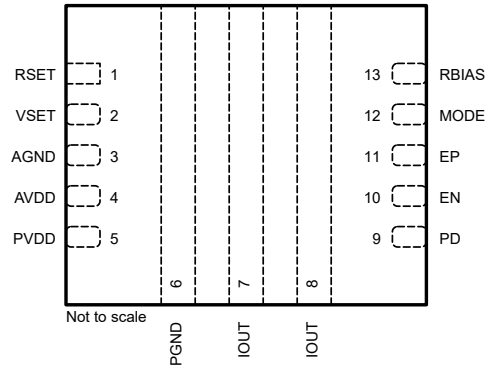


图 2-1. RQE 封装，13 引脚 WQFN-HR (顶视图)

2.2 电源要求

该 EVM 配有三个香蕉连接器 (J_GND、J_AVDD 和 J_VLD)，可分别轻松接地，连接器件电源和激光电源。因此，EVM 无法在双电源配置下工作。

该器件的 AVDD 和 PVDD 引脚均使用 EVM 的 AVDD 连接器上电，但具有一组单独的去耦电容器。为确保正常工作运行，请使用 3V 至 5.5V 范围内的电源为器件供电。

VLD 连接器连接到激光二极管的阳极。VLD 连接器还具有一系列电容器组，可在激光脉冲时提供高频电流。

2.3 接头信息

J_EP 和 J_EN：这两个 SMA 连接器分别用于器件的正极 (EP) 和负极 (EN) LVDS 输入。默认情况下，在 C 版 EVM (AMPS251C) 中，这些连接器根据 LVDS 标准与 100 Ω 电阻器 (R7+R10) 差分端接。要在单端输入端操作器件和 EVM，应短接跳线 J1 和电阻器 R22，并移除 R10。在此配置中，EN 引脚偏置为 1/2 Vs。然后，可将电压电平超过中间电源电压的单端信号提供给 EP 引脚，以开关器件输出电流。

J_VSET：此 SMA 连接器用于向器件的 VSET 引脚提供电压，从而设置输出端的电流值。对此连接器施加 0.2V 至 2V 之间的适当电压来控制 IOUT。或者，可以移除 R20 并连接 R11，通过调整电位器 R8 来从板载电阻分压器控制 VSET 电压。

J_PD：此 SMA 连接器连接到器件的断电引脚 (PD)。要将器件断电，请将 PD 引脚拉至大于 AVDD - 1.2V。要启用器件，请将 PD 引脚电压拉至小于 AGND + 1.2V。

J_TIA_OUT：板载 TIA (U2) 输出到此 SMA 连接器。TIA 感应来自激光器背面二极管的电流，并根据通过 R12 设置的增益将该电流转换为电压电平。

2.4 跳线信息

J1：短接此跳线可将 EN 引脚偏置至中间电源。

J_PD_SEL：此跳线连接到器件的断电引脚 (PD)。要使用此跳线关断器件，请短接引脚 1 和 2。要启用器件，请短接 J_PD_SEL 的引脚 2 和 3。

J_MODE_SEL：此跳线可在高电流模式和低电流模式之间切换。将引脚 1 和 2 短接可启用高电流模式。将引脚 2 和 3 短接可启用低电流模式。

J_RBIAS_CTRL：此跳线使用电阻器 R28 设置恒定偏置电流。要启用恒定偏置电流，请短接引脚 2 和 3。要禁用此偏置功能，请短接引脚 1 和 2。

2.5 激光二极管

有两个用于连接激光二极管的封装：SMD (D1) 和 TO-CAN (J3)。使用两个封装中的任何一个连接激光二极管。电阻器 R21 (默认为 $2\ \Omega$) 与激光器串联。此电阻器充当缓冲器，因此可抑制激光电流的瞬态行为。调整 R21 可以改变输出过冲和振铃。

2.6 缓冲器

电阻器 R1 和 R25 以及电容器 C4 和 C32 用作缓冲器，可进行调整以控制输出激光电流波形的过冲和稳定行为。默认情况下，R1 和 R25 为 $5\ \Omega$ ，C4 和 C32 为 300pF 。可以移除缓冲器以获得最快的上升和下降时间，但移除可能导致电流波形出现过冲和下冲。请参阅器件数据表，了解缓冲器的建议 RC 值。

3 硬件设计文件

3.1 原理图

下图为 LMH13000RQEEVM 原理图。

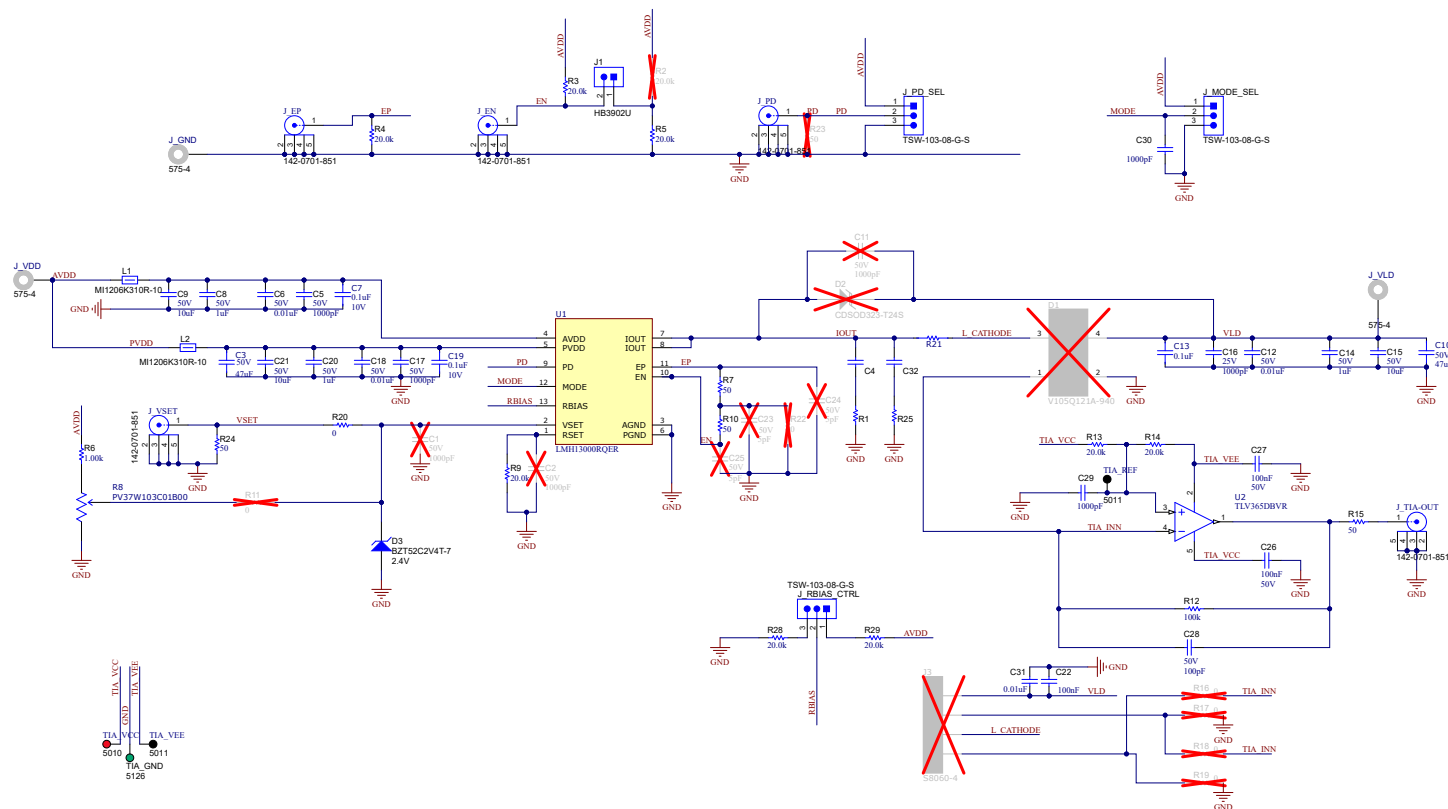


图 3-1. LMH13000RQEEVM C 版电路板 (AMPS251C) 原理图

注意：

1. 默认情况下，AMPS251B (EVM 的上一版本，即 B 版) EVM 中组装了 C2 和 R22。在最新版本 (AMPS251C) 中，这两个器件为 DNI。如果使用 AMPS251B，应移除 C2，避免 IOUT 波形出现不稳定情况。此外，R22 在 AMPS251B EVM 中短接，应移除该器件，以便在 LVDS 输入模式下运行 EVM
2. 用户可以调整 RC 缓冲器网络 (R1 - C4 和 R25 - C32) 以及阻尼电阻器 R21，从而根据所需的输出电流 (IOUT) 和所需的瞬态响应特性优化性能。默认情况下，元件值设置如下：R1 = R25 = 5 Ω，C4 = C32 = 300pF，R21 = 2 Ω。

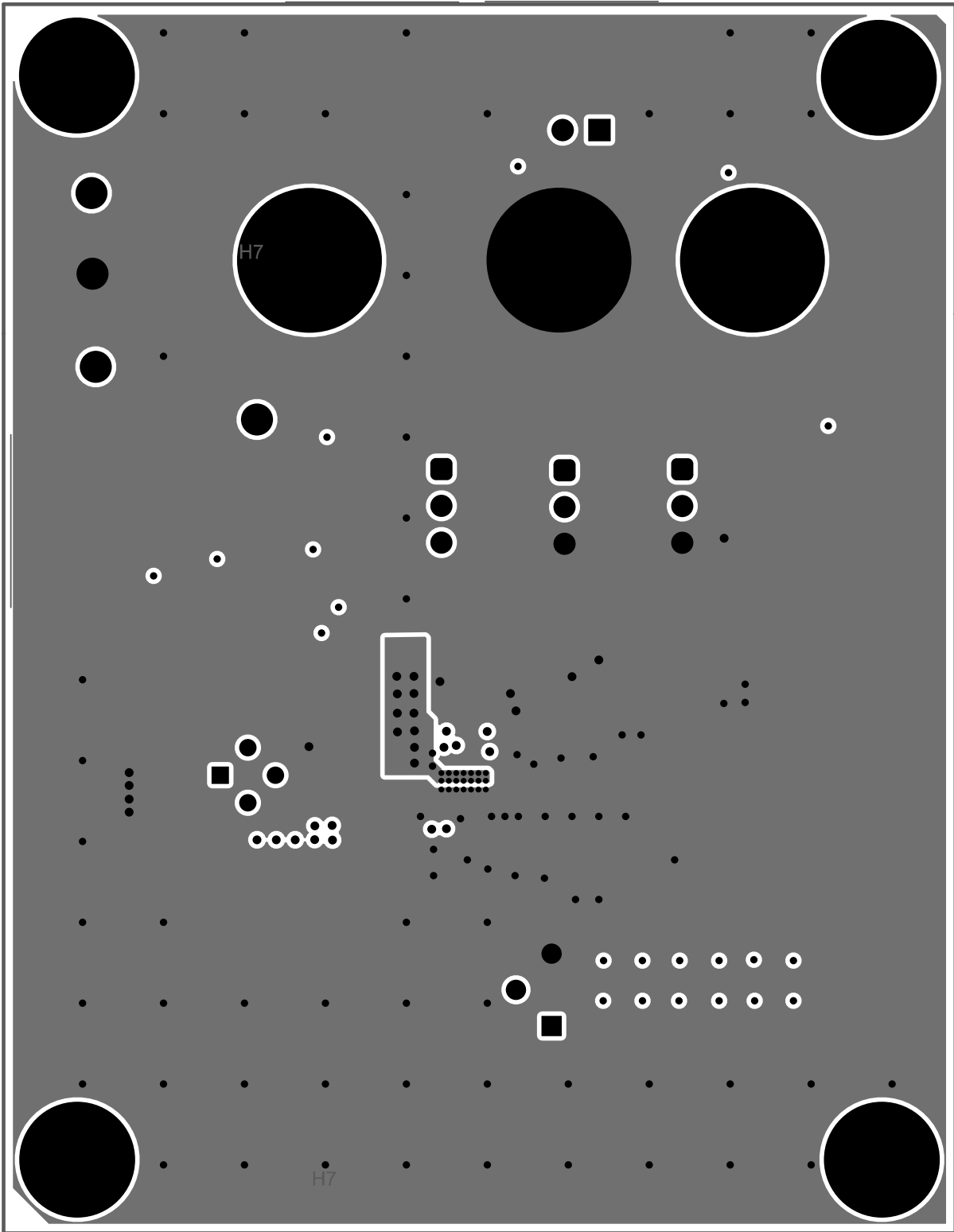


图 3-3. LMH13000RQEEVM 第二层 (接地平面)

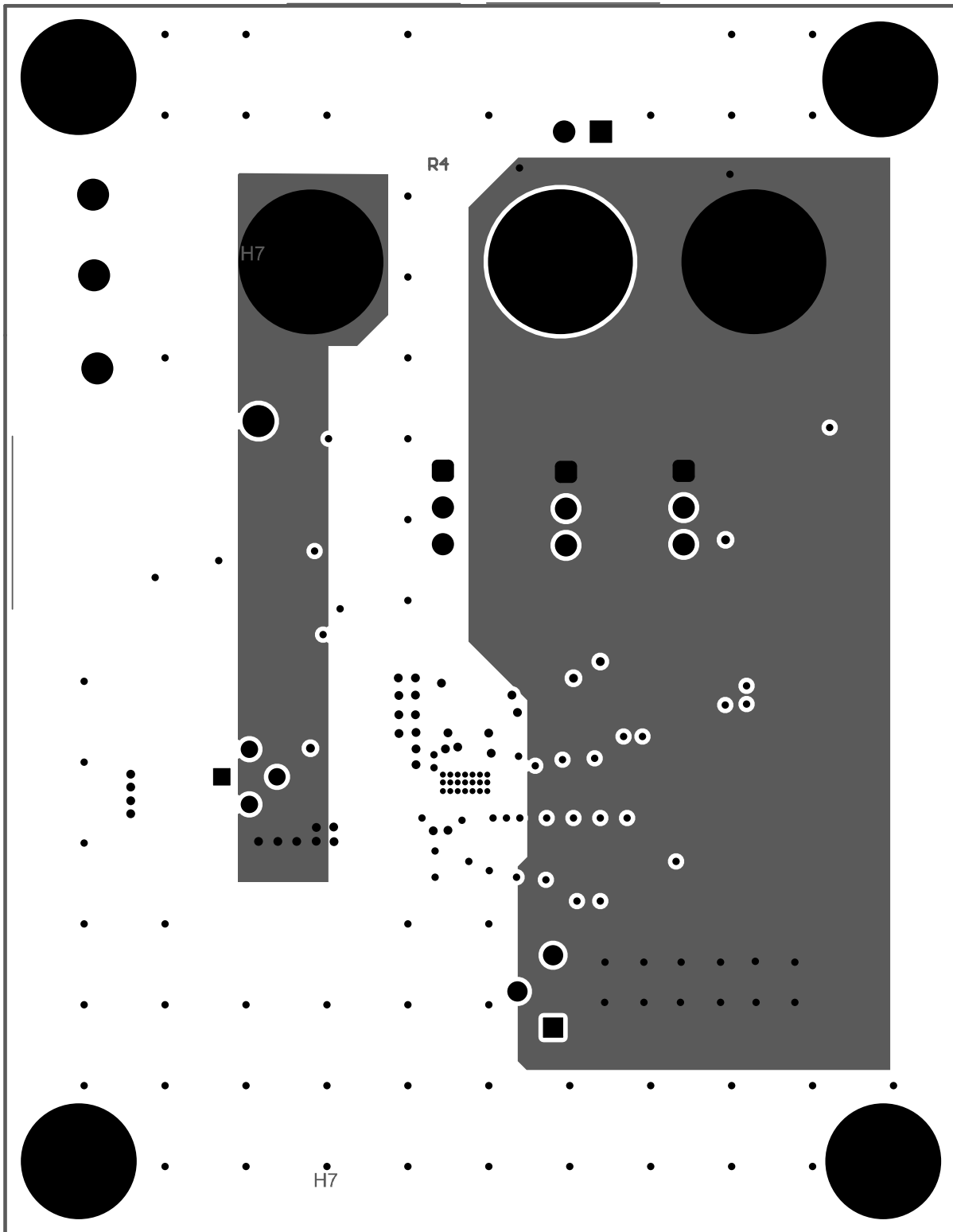


图 3-4. LMH13000RQEEVM 第三层 (电源平面)

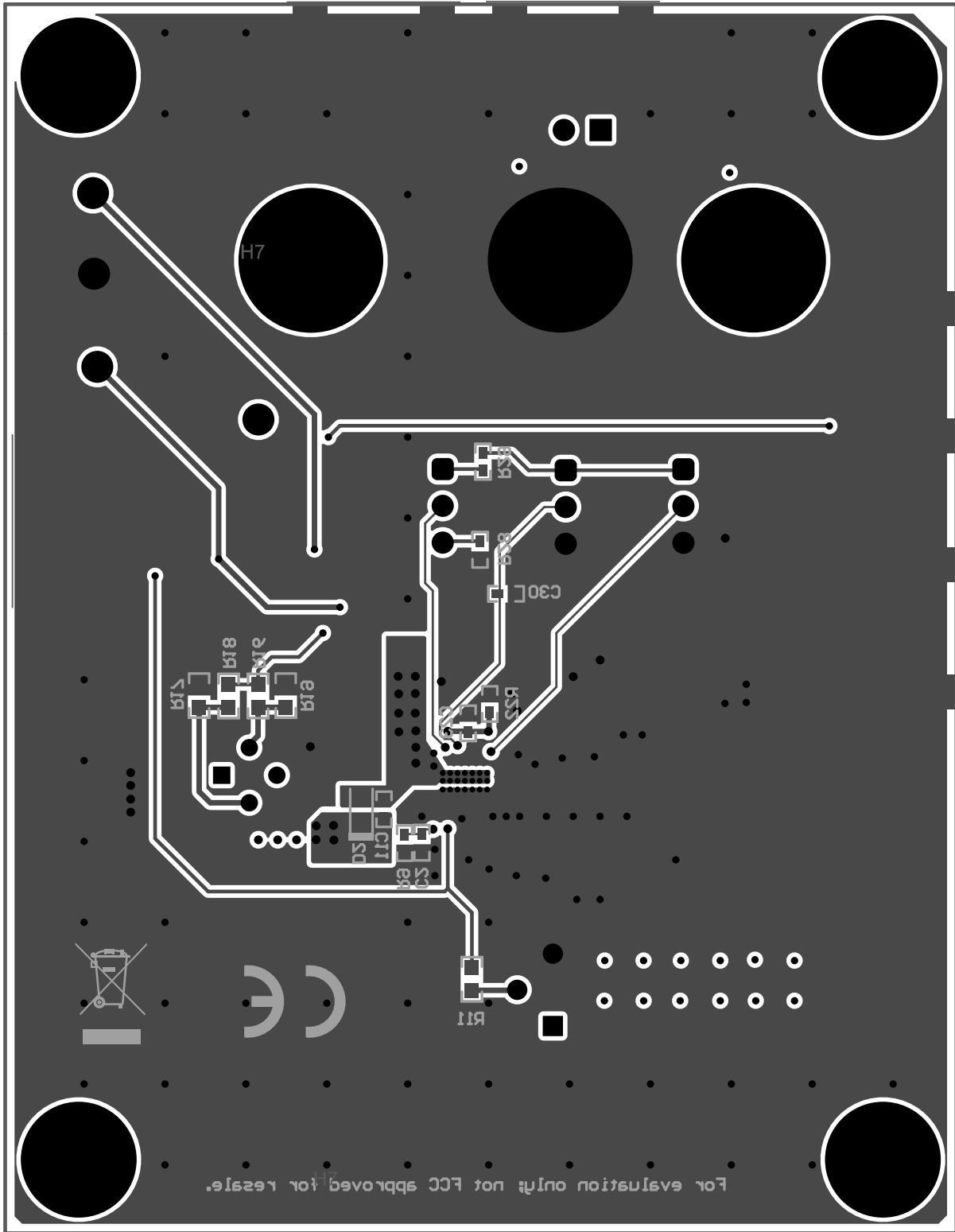


图 3-5. LMH13000RQEEVM 底层

3.3 物料清单 (BOM)

表 3-1. LMH13000RQEEVM BOM

条目	位号	数量	说明	器件型号	制造商
1	!PCB	1	印刷电路板	AMPS251B	不限
2	C3	1	47 μ F \pm 20% 50V 陶瓷电容器 X7R 堆叠 SMD, 2 个 J 形引线	CKG57NX7R1H476M500JH	TDK
3	C4	1	电容, 陶瓷, 300PF, 25V, C0G/NP0, 0201	TMK063CG301JT-F	Taiyo Yuden
4	C5	1	电容, 陶瓷, 1000pF, 50V, +/-5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
5	C6	1	电容, 陶瓷, 0.01 μ F, 50V, +/-5%, C0G/NP0, 0603	C1608NP01H103J080AA	TDK
6	C7	1	0.1 μ F \pm 10% 10V 陶瓷电容器 X7R 0306 (公制 0816)	0306ZC104KAT2A	AVX
7	C8	1	电容, 陶瓷, 1 μ F, 50V, +/-10%, X5R, 0603	C1608X5R1H105K080AB	TDK
8	C9	1	电容, 陶瓷, 10 μ F, 50V, +/-20%, X7R, 1210	GRM32ER71H106MA12	MuRata
9	C10	1	47 μ F \pm 20% 50V 陶瓷电容器 X7R 堆叠 SMD, 2 个 J 形引线	CKG57NX7R1H476M500JH	TDK
10	C12	1	电容, 陶瓷, 0.01 μ F, 50V, +/-5%, C0G/NP0, 0603	C1608NP01H103J080AA	TDK
11	C13	1	0.1 μ F \pm 10% 10V 陶瓷电容器 X7R 0306 (公制 0816)	0306ZC104KAT2A	AVX
12	C14	1	电容, 陶瓷, 1 μ F, 50V, +/-10%, X5R, 0603	C1608X5R1H105K080AB	TDK
13	C15	1	电容, 陶瓷, 10 μ F, 50V, +/-20%, X7R, 1210	GRM32ER71H106MA12	MuRata
14	C16	1	电容, 陶瓷, 1000pF, 25V, +/-10%, X5R, 0201	C0603X5R1E102K030BA	TDK
15	C17	1	电容, 陶瓷, 1000pF, 50V, +/-5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
16	C18	1	电容, 陶瓷, 0.01 μ F, 50V, +/-5%, C0G/NP0, 0603	C1608NP01H103J080AA	TDK
17	C19	1	0.1 μ F \pm 10% 10V 陶瓷电容器 X7R 0306 (公制 0816)	0306ZC104KAT2A	AVX
18	C20	1	电容, 陶瓷, 1 μ F, 50V, +/-10%, X5R, 0603	C1608X5R1H105K080AB	TDK
19	C21	1	电容, 陶瓷, 10 μ F, 50V, +/-20%, X7R, 1210	GRM32ER71H106MA12	MuRata
20	C22	1	电容, 陶瓷, 0.1 μ F, 50V, +/-10%, X7R, 0603	8.85E+11	Wurth Elektronik
21	C26	1	电容, 陶瓷, 0.1 μ F, 50V, +/-10%, X7R, 0603	8.85E+11	Wurth Elektronik
22	C27	1	电容, 陶瓷, 0.1 μ F, 50V, +/-10%, X7R, 0603	8.85E+11	Wurth Elektronik
23	C28	1	电容, 陶瓷, 100pF, 50V, +/-1%, C0G/NP0, 0603	C0603C101F5GACTU	Kemet
24	C29	1	电容, 陶瓷, 1000pF, 50V, +/-5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
25	C30	1	电容, 陶瓷, 1000pF, 50V, +/-5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
26	C31	1	电容, 陶瓷, 0.01 μ F, 50V, +/-5%, C0G/NP0, 0603	C1608NP01H103J080AA	TDK
27	C32	1	电容, 陶瓷, 300PF, 25V, C0G/NP0, 0201	TMK063CG301JT-F	Taiyo Yuden
28	D3	1	二极管, 齐纳, 2.4V, 300mW, SOD-523	BZT52C2V4T-7	Diodes Inc.
29	H1	1	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
30	H2	1	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

表 3-1. LMH13000RQEEVM BOM (续)

条目	位号	数量	说明	器件型号	制造商
31	H3	1	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
32	H4	1	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
33	H5	1	六角螺柱, 0.5"L #4-40, 尼龙	1902C	Keystone
34	H6	1	六角螺柱, 0.5"L #4-40, 尼龙	1902C	Keystone
35	H7	1	六角螺柱, 0.5"L #4-40, 尼龙	1902C	Keystone
36	H8	1	六角螺柱, 0.5"L #4-40, 尼龙	1902C	Keystone
37	J1	1	接头, 2.54mm, 2x1, 金, TH	HB3902U	Foxconn (富士康)
38	J_EN	1	连接器, 末端发射 SMA, 50Ω, SMT	142-0701-851	Cinch Connectivity
39	J_EP	1	连接器, 末端发射 SMA, 50Ω, SMT	142-0701-851	Cinch Connectivity
40	J_GND	1	标准香蕉插头, 非绝缘, 5.5mm	575-4	Keystone
41	J_MODE_SEL	1	接头, 2.54mm, 3x1, 金, TH	TSW-103-08-G-S	Samtec
42	J_PD	1	连接器, 末端发射 SMA, 50Ω, SMT	142-0701-851	Cinch Connectivity
43	J_PD_SEL	1	接头, 2.54mm, 3x1, 金, TH	TSW-103-08-G-S	Samtec
44	J_RBIAIS_CTRL	1	接头, 2.54mm, 3x1, 金, TH	TSW-103-08-G-S	Samtec
45	J_TIA-OUT	1	连接器, 末端发射 SMA, 50Ω, SMT	142-0701-851	Cinch Connectivity
46	J_VDD	1	标准香蕉插头, 非绝缘, 5.5mm	575-4	Keystone
47	J_VLD	1	标准香蕉插头, 非绝缘, 5.5mm	575-4	Keystone
48	J_VSET	1	连接器, 末端发射 SMA, 50Ω, SMT	142-0701-851	Cinch Connectivity
49	L1	1	铁氧体磁珠, 31Ω (100MHz 时), 1.5A, 1206	MI1206K310R-10	Laird-Signal Integrity Products
50	L2	1	铁氧体磁珠, 31Ω (100MHz 时), 1.5A, 1206	MI1206K310R-10	Laird-Signal Integrity Products
51	LBL1	1	热转印打印标签, 0.650" (宽) x 0.200" (高) - 10,000/卷	THT-14-423-10	Brady
52	R1	1	电阻 4.99Ω 1% 1/20W 0201	RC0201FR-074R99L	Yageo America
53	R3	1	电阻, 20.0k, 0.1%, 0625W, 0402	RT0402BRD0720KL	Yageo America
54	R5	1	电阻, 20.0k, 0.1%, 0625W, 0402	RT0402BRD0720KL	Yageo America
55	R6	1	电阻, 1.00k, 1%, 0.1W, 0603	ERJ-3EKF1001V	Panasonic
56	R7	1	电阻, 50, 0.1%, 0.05W, 0402	FC0402E50R0BST1	Vishay-Dale
57	R8	1	10kΩ、0.25W、1/4W PC 引脚通孔微调电位器金属陶瓷 12 转顶部调节	PV37W103C01B00	Bourns
58	R9	1	电阻, 20.0k, 0.1%, 0625W, 0402	RT0402BRD0720KL	Yageo America
59	R10	1	电阻, 50, 0.1%, 0.05W, 0402	FC0402E50R0BST1	Vishay-Dale
60	R12	1	电阻, 100k, 0.1%, 0.1W, 0603	RT0603BRD07100KL	Yageo America
61	R13	1	电阻, 20.0k, 0.1%, 0625W, 0402	RT0402BRD0720KL	Yageo America

表 3-1. LMH13000RQEEVM BOM (续)

条目	位号	数量	说明	器件型号	制造商
62	R14	1	电阻, 20.0k, 0.1%, 0625W, 0402	RT0402BRD0720KL	Yageo America
63	R15	1	电阻, 50, 0.1%, 0.05W, 0402	FC0402E50R0BST1	Vishay-Dale
64	R20	1	电阻, 0, 0%, 0.25W, AEC-Q200 0 级, 0603	PMR03EZPJ000	R Ω
65	R21	1	2 Ω ±1% 0.75W, 3/4W 片上电阻器, 宽, 1206 (公制 3216), 0612 汽车 AEC-Q200, 可承受脉冲, 厚膜	LTR18EZPF2R00	R Ω Semiconductor
66	R24	1	电阻, 50, 0.1%, 0.05W, 0402	FC0402E50R0BST1	Vishay-Dale
67	R25	1	电阻 4.99 Ω 1% 1/20W 0201	RC0201FR-074R99L	Yageo America
68	R28	1	电阻, 20.0k, 0.1%, 0625W, 0402	RT0402BRD0720KL	Yageo America
69	R29	1	电阻, 20.0k, 0.1%, 0625W, 0402	RT0402BRD0720KL	Yageo America
70	TIA_GND	1	测试点, 通用, 绿色, TH	5126	Keystone
71	TIA_REF	1	测试点, 多用途, 黑色, TH	5011	Keystone Electronics
72	TIA_VCC	1	测试点, 多用途, 红色, TH	5010	Keystone Electronics
73	TIA_VEE	1	测试点, 多用途, 黑色, TH	5011	Keystone Electronics
74	U1	1	LMH13000RNWR	LMH13000RNWR	德州仪器 (TI)
75	U2	1	CMOS 放大器 1 电路轨至轨 SOT-23-5	TLV365DBVR	德州仪器 (TI)
76	C1	0	电容, 陶瓷, 1000pF, 50V, +/-5%, COG/NP0, 0402	C1005NP01H102J050BA	TDK
77	C2	0	电容, 陶瓷, 1000pF, 50V, +/-5%, COG/NP0, 0402	C1005NP01H102J050BA	TDK
78	C11	0	电容, 陶瓷, 1000pF, 50V, +/-5%, COG/NP0, 0402	C1005NP01H102J050BA	TDK
79	C23	0	电容, 陶瓷, 5pF, 50V, +/-5%, COG/NP0, 0402	GRM1555C1H5R0CA01D	MuRata
80	C24	0	电容, 陶瓷, 5pF, 50V, +/-5%, COG/NP0, 0402	GRM1555C1H5R0CA01D	MuRata
81	C25	0	电容, 陶瓷, 5pF, 50V, +/-5%, COG/NP0, 0402	GRM1555C1H5R0CA01D	MuRata
82	D1	0	激光二极管 940nm 3.2W 2.3V 4-SMD, 无引线	V105Q121A-940	Ams-OSRAM
83	D2	0	二极管, TVS, 单向, 24V, 49Vc, SOD-323	CDSOD323-T24S	Bourns
84	FID1	0	基准标记。没有需要购买或安装的元件。	不适用	不适用
85	FID2	0	基准标记。没有需要购买或安装的元件。	不适用	不适用
86	FID3	0	基准标记。没有需要购买或安装的元件。	不适用	不适用
87	J3	0	Ø9mm 激光用激光二极管插座, 4 引脚	S8060-4	Thorlabs
88	R2	0	电阻, 20.0k, 0.1%, 0625W, 0402	RT0402BRD0720KL	Yageo America
89	R4	0	电阻, 20.0k, 0.1%, 0625W, 0402	RT0402BRD0720KL	Yageo America
90	R11	0	电阻, 0, 0%, 0.25W, AEC-Q200 0 级, 0603	PMR03EZPJ000	R Ω
91	R16	0	电阻, 0, 0%, 0.25W, AEC-Q200 0 级, 0603	PMR03EZPJ000	R Ω
92	R17	0	电阻, 0, 0%, 0.25W, AEC-Q200 0 级, 0603	PMR03EZPJ000	R Ω

表 3-1. LMH13000RQEEVM BOM (续)

条目	位号	数量	说明	器件型号	制造商
93	R18	0	电阻, 0, 0%, 0.25W, AEC-Q200 0 级, 0603	PMR03EZPJ000	R Ω
94	R19	0	电阻, 0, 0%, 0.25W, AEC-Q200 0 级, 0603	PMR03EZPJ000	R Ω
95	R22	1	电阻, 0, 5%, 0.063W, 0402	CRCW04020000Z0ED	Vishay-Dale
96	R23	0	电阻, 50, 0.1%, 0.05W, 0402	FC0402E50R0BST1	Vishay-Dale

4 其他信息

4.1 商标

HotRod™ is a trademark of Texas Instruments.

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5 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 A (April 2025) to Revision B (May 2026)	Page
• 将 EVM 图像更新为 C 版电路板 (AMPS251C).....	1
• 更新了关于默认 EP 和 EN 配置更改为 100 Ω 差分 LVDS 输入的文本.....	3
• 将默认 R21 值更正为 2 Ω.....	4
• 更新了图 3-1 C 版电路板 (AMPS251C) 的 <i>LMH13000RQEEVM</i> 原理图，并更新了注释以通知 C2 和 R22 DNI 状态的更改。此外还添加了有关缓冲器元件默认值的注释.....	5
• 更新了表 3-1 物料清单中 C2 和 R22 的 DNI 状态.....	10

Changes from Revision * (February 2025) to Revision A (April 2025)	Page
• 更新了简介和器件信息部分的持续电流能力值.....	2
• 更新了跳线信息中有关 J_PD_SEL 和 J_RBIAS_CTRL 的文本.....	4
• 更新了已安装的缓冲器 R 和 C 值.....	4
• 更新了图 3-2 至图 3-5.....	6

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.

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2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/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.

-
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.
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 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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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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