EVM User's Guide: LMH13000RQEEVM

LMH13000RQE Evaluation Module

Description

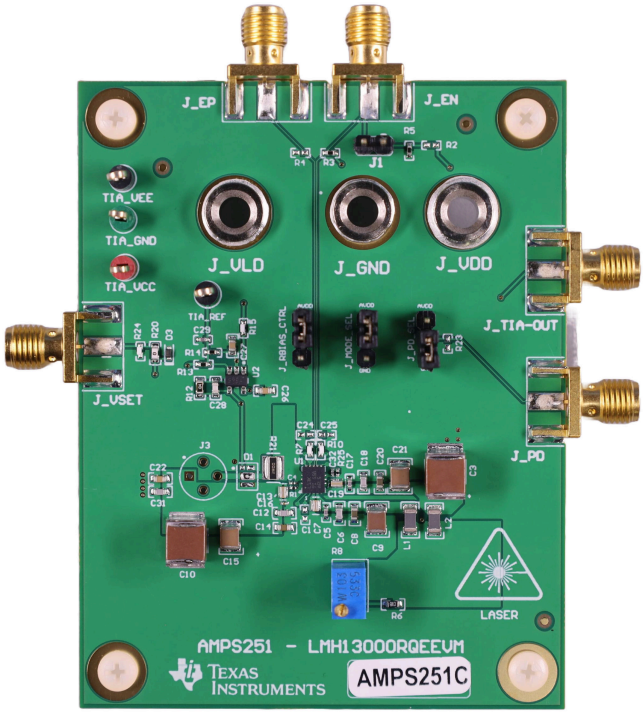
The LMH13000RQEEVM is the evaluation module (EVM) for the LMH13000, a high-speed output current driver in a 13-pin WQFN-HR (HotRod™) package. This EVM is designed to quickly and easily demonstrate the functionality and versatility of the amplifier. The EVM is ready to connect to power, signal sources, and test instruments through the use of onboard connectors. The EVM comes configured for easy connection with common 50Ω laboratory equipment on the inputs/outputs, banana connectors for the supplies, and jumpers to easily disable, enable, or configure different modes of operation. The layout is also optimized to reduce the parasitic to get a fast rise-and-fall time of the output current.

Features

- Single supply operating range 3V to 5.5V
- Easy-to-use SMA connectors for all input and output signals
- Easy-to-use banana connector for device and laser supply
- SMD VCSEL and TO-CAN laser footprint
- Onboard transimpedance amplifier (TIA) for laser power calibration
- Jumper to configure device at different modes
- Layout configured to minimize parasitic and noise

Applications

- TOF range finders
- Industrial optical sensors
- 3D scanning and gesture recognition
- OTDR
- High speed current loads
- Industrial safety light curtains
- Medical IVD and flow cytometry
- LiDAR Module



LMH13000RQEEVM Board (Top View)

1 Evaluation Module Overview

1.1 Introduction

The LMH13000 is a high-speed, output current driver designed for precise and rapid current control, making this device an excellent choice for applications that demand fast and accurate current pulses. With rise and fall times of < 1ns, this device is designed for use in industrial optical sensors, optical time-domain reflectometers (OTDR), high-speed current loads, and medical applications such as in-vitro diagnostics (IVD) and flow cytometry. The device supports continuous currents up to 1A and pulsed currents up to 5A, limited on factors such as frequency, duty cycle, and heat dissipation. The LMH13000 operates within a 3V to 5.5V voltage range, with LVDS inputs enabling precise control over output parameters such as on time, frequency, and duty cycle. These features make this device a reliable, efficient option for high-speed, high-precision current-driving applications.

The LMH13000RQEEVM is designed to evaluate the performance of the LMH13000. The EVM includes SMA connector for all inputs and output pins, and a banana connector for supplies. This user's guide provides device and connector descriptions, a schematic, a bill of materials, and the printed circuit board (PCB) layout.

1.2 Kit Contents

The package includes:

- LMH13000RQEEVM
- EVM disclaimer read me

1.3 Specification

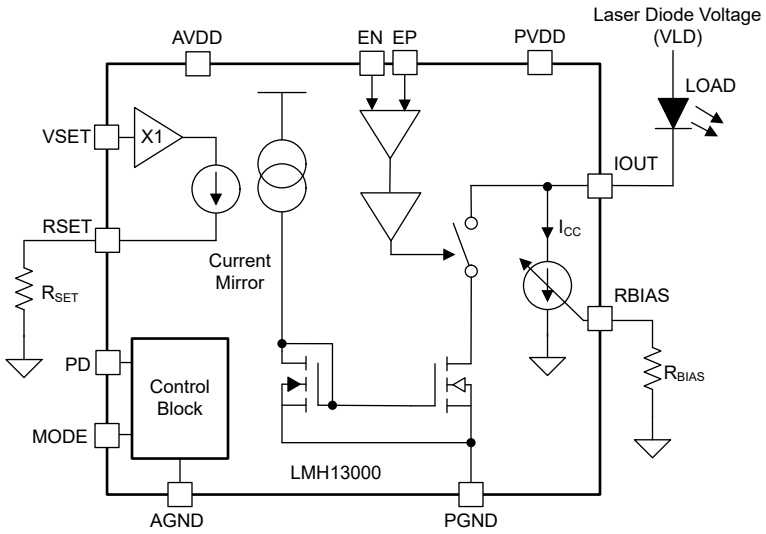


Figure 1-1. LMH13000 Functional Block Diagram

1.4 Device Information

The LMH13000 is a voltage-controlled current source that enables accurate current control coupled with LVDS input to support fast rise-and-fall times (< 1ns) for pulsed- and square-wave applications. The accurate output-current control helps adjust load currents on-the-fly to compensate against variations in temperature and aging, for loads like lasers, LEDs, optical amplifiers, and more. The LMH13000 supports up to a 1A continuous current or 5A pulsed current, depending on frequency, duty cycle, and heat dissipation.

The LMH13000 comes in a TI proprietary HotRod package. The HotRod package eliminates the internal bond wires that help achieve a very low inductance in the high-current path. This package enables the design to achieve faster current rise-and-fall times. The integrated thermal shutdown protects the die in case of excessive die temperature. The LVDS input enables control of the output current frequency and duty cycle, and helps achieve flexibility of pulse and square waveforms. The LMH13000 operates between 3V to 5.5V, with a –40°C to +125°C specified ambient temperature range.

2 Hardware

2.1 Additional Images

2.1.1 Pin Configuration

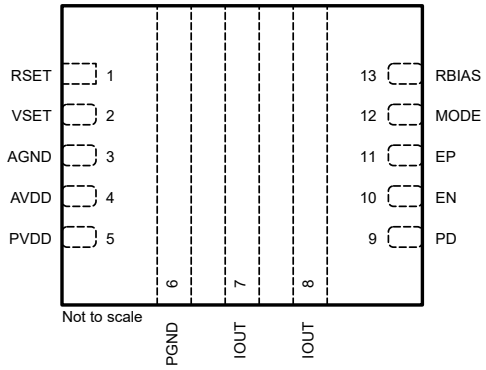


Figure 2-1. RQE Package, 13-pin WQFN-HR (Top View)

2.2 Power Requirements

The EVM is equipped with three banana connectors (J_GND, J_AVDD and J_VLD) for easy connection of ground, device power, and laser power, respectively. The device, and therefore, the EVM cannot work in a split-supply configuration.

Both the AVDD and PVDD pins of the device are powered up using the AVDD connector of the EVM, but have separate sets of decoupling capacitors. For proper operation, power the device with the supply between the range of 3V to 5.5V.

The VLD connector connects to the anode of the laser diode. The VLD connector also has a series of capacitor banks to provide a high-frequency current when the laser is pulsing.

2.3 Header Information

J_EP and J_EN: These two SMA connectors are for the positive (EP) and negative (EN) LVDS inputs of the device, respectively. By default in Rev.C EVM (AMPS251C), these connectors are terminated with 100Ω resistor (R7+R10) differentially as per the LVDS standard. To operate the device and the EVM on a single-ended input, short jumper J1 and short resistor R22, and depopulate R10. In this configuration, the EN pin get biased to midsupply. A single-ended signal with a voltage level that crosses the midsupply voltage can then be provided to the EP pin to switch the device output current.

J_VSET: This SMA connector is used to provide voltage to the VSET pin of the device, and thus sets the current value at the output. Apply an appropriate voltage between 0.2V to 2V to this connector to control IOUT. Alternatively, remove R20 and connect R11 to control the voltage at VSET from the onboard resistor divider by adjusting potentiometer R8.

J_PD: This SMA connector connects to the power-down pin (PD) of the device. To power down the device, pull the PD pin to greater than AVDD – 1.2V. To enable the device, pull the PD pin voltage to less than AGND + 1.2V.

J_TIA_OUT: The onboard TIA (U2) outputs to this SMA connector. The TIA senses current from the back facet diode of the laser and converts the current to a voltage-level based on the gain set by R12.

2.4 Jumper Information

J1: Short this jumper to bias the EN pin to midsupply.

J_PD_SEL: This jumper connects to the power-down pin (PD) of the device. To power down the device using this jumper, short pins 1 and 2. To enable the device, short pins 2 and 3 of J_PD_SEL.

J_MODE_SEL: This jumper toggles between the high-current and low-current modes. Shorting pins 1 and 2 enables high-current mode. Shorting pins 2 and 3 enables low-current mode.

J_RBIAS_CTRL: This jumper sets the constant bias current using resistor R28. To enable the constant bias current, short pins 2 and 3. To disable this bias feature, short pins 1 and 2.

2.5 Laser Diode

There are two footprints to connect the laser diode: SMD (D1) and TO-CAN (J3). Use either of the two footprints to connect the laser. Resistor R21 (2Ω by default) is connected in series with the laser. This resistor acts as snubber, and therefore dampens the transient behavior of the laser current. R21 can be tweaked to change the output overshoot and ringing.

2.6 Snubber

Resistors R1 and R25 and capacitors C4 and C32 act as a snubber, and can be tweaked to control the overshoot and settling behavior of the output laser current waveform. By default, R1 and R25 are 5Ω, and C4 and C32 are 300pF. The snubber can be removed to get the fastest rise-and-fall time, but removal can cause overshoot and undershoot in the current waveform. See the device data sheet for the recommended RC value for the snubber.

3 Hardware Design Files

3.1 Schematics

The following figure shows the LMH13000RQEEVM schematic diagram.

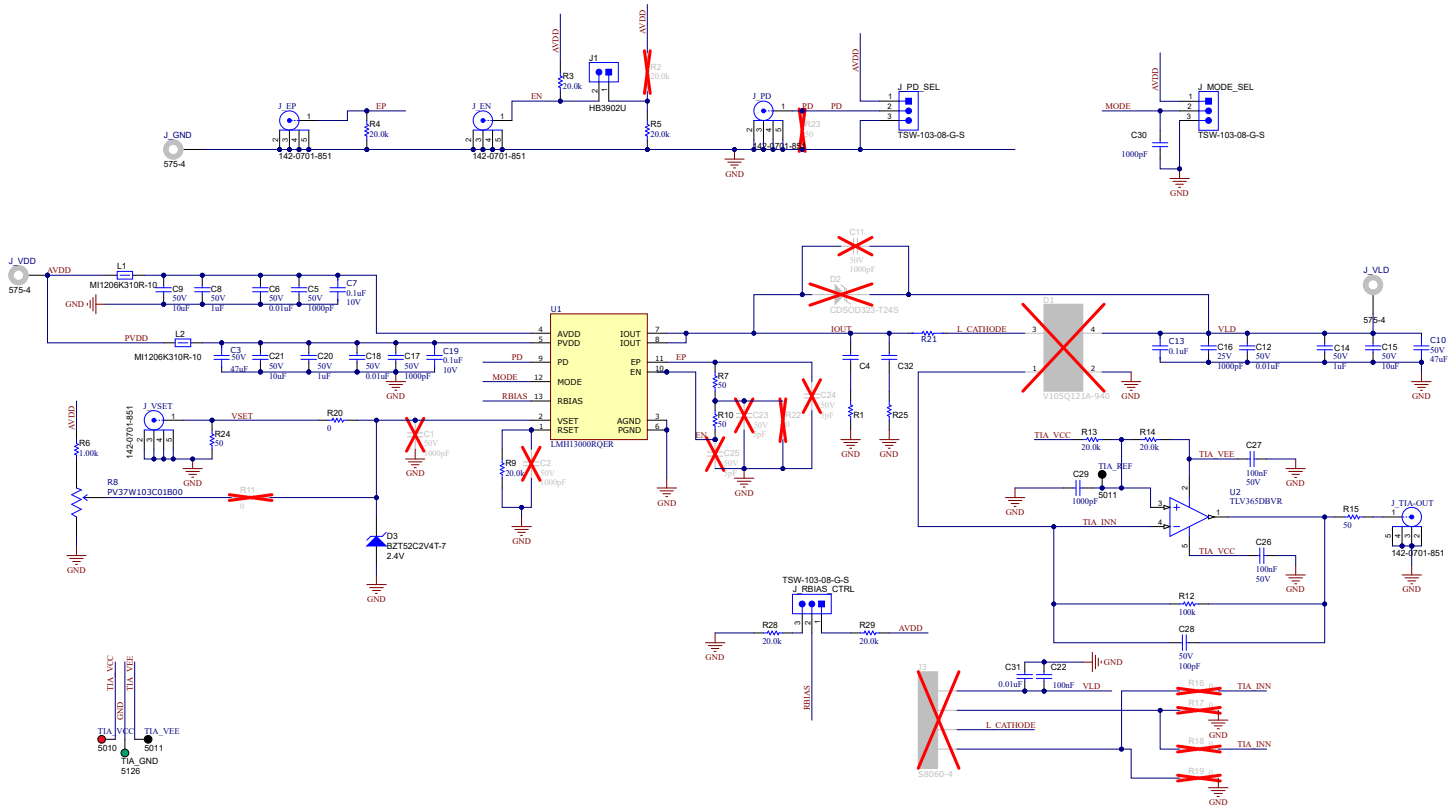


Figure 3-1. LMH13000RQEEVM Rev.C (AMPS251C) Schematic

Note:

1. C2 and R22 by default is populated in AMPS251B (previous revision of EVM, Rev.B) EVM. In the latest revision (AMPS251C) they are made DNI. If using AMPS251B, remove C2 to avoid any instability in the IOUT waveform. Also, R22 is short in AMPS251B EVM, remove it to operate the EVM in LVDS input mode
2. The RC snubber networks (R1–C4 and R25–C32), along with the damping resistor R21, may be adjusted by the user to optimize performance based on the required output current (IOUT) and desired transient response characteristics. By default, the components value are set as follows: R1 = R25 = 5 Ω, C4 = C32 = 300 pF, and R21 = 2 Ω.

3.2 PCB Layouts

The following figures show the PCB layout for the LMH13000RQEEVM.

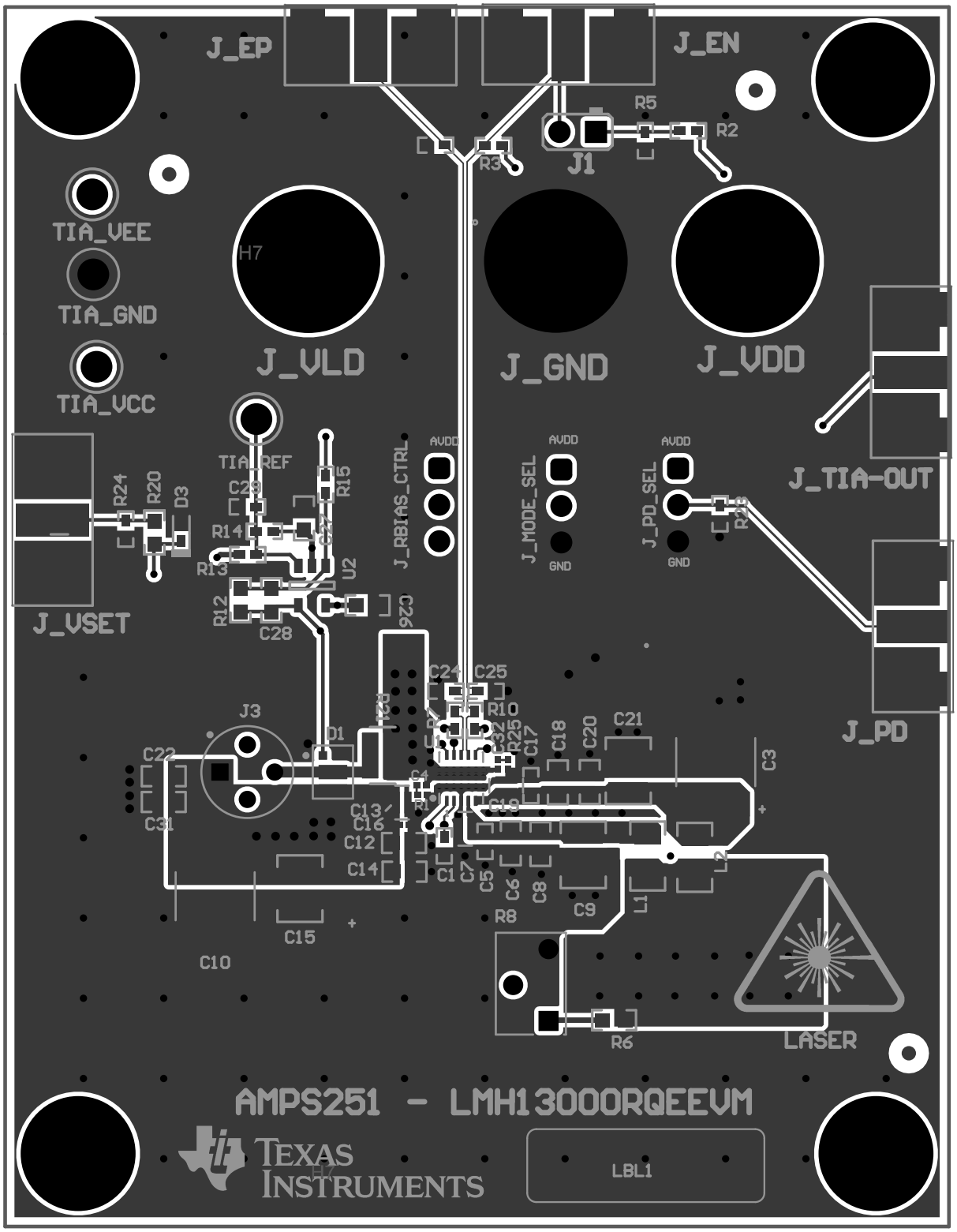


Figure 3-2. LMH13000RQEEVM Top Layer

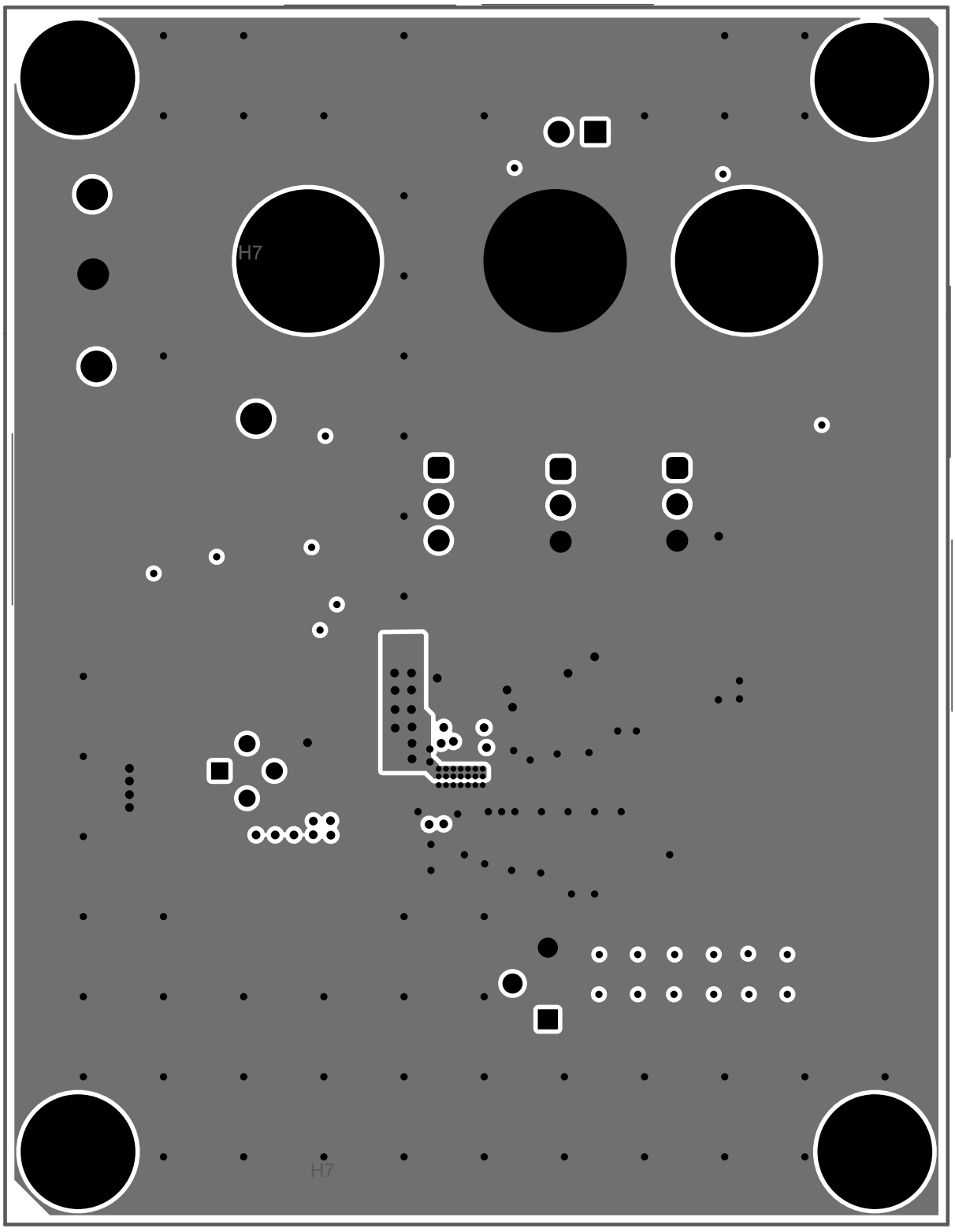


Figure 3-3. LMH13000RQEEVM Second Layer (Ground Plane)

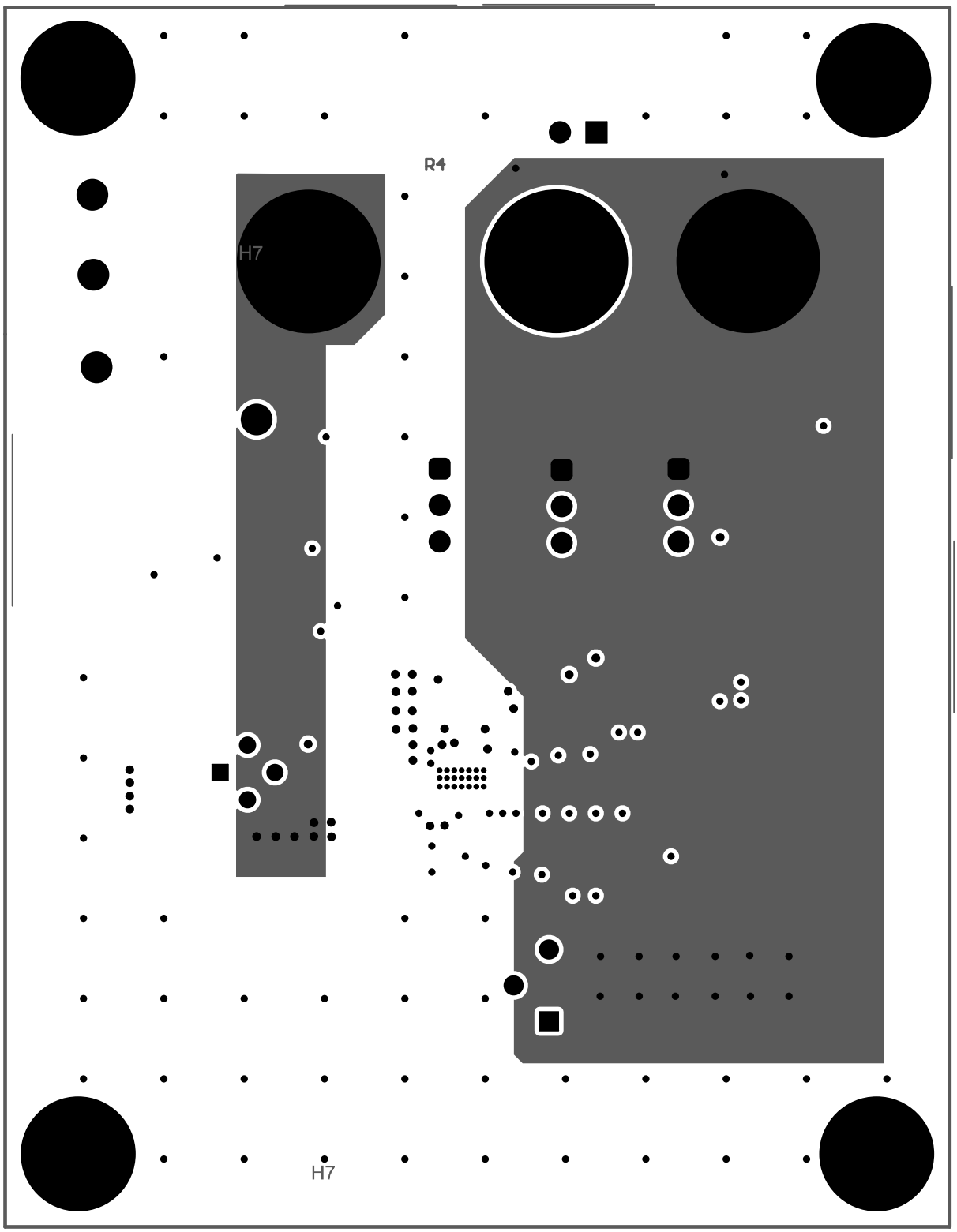


Figure 3-4. LMH13000RQEEVM Third Layer (Power Plane)

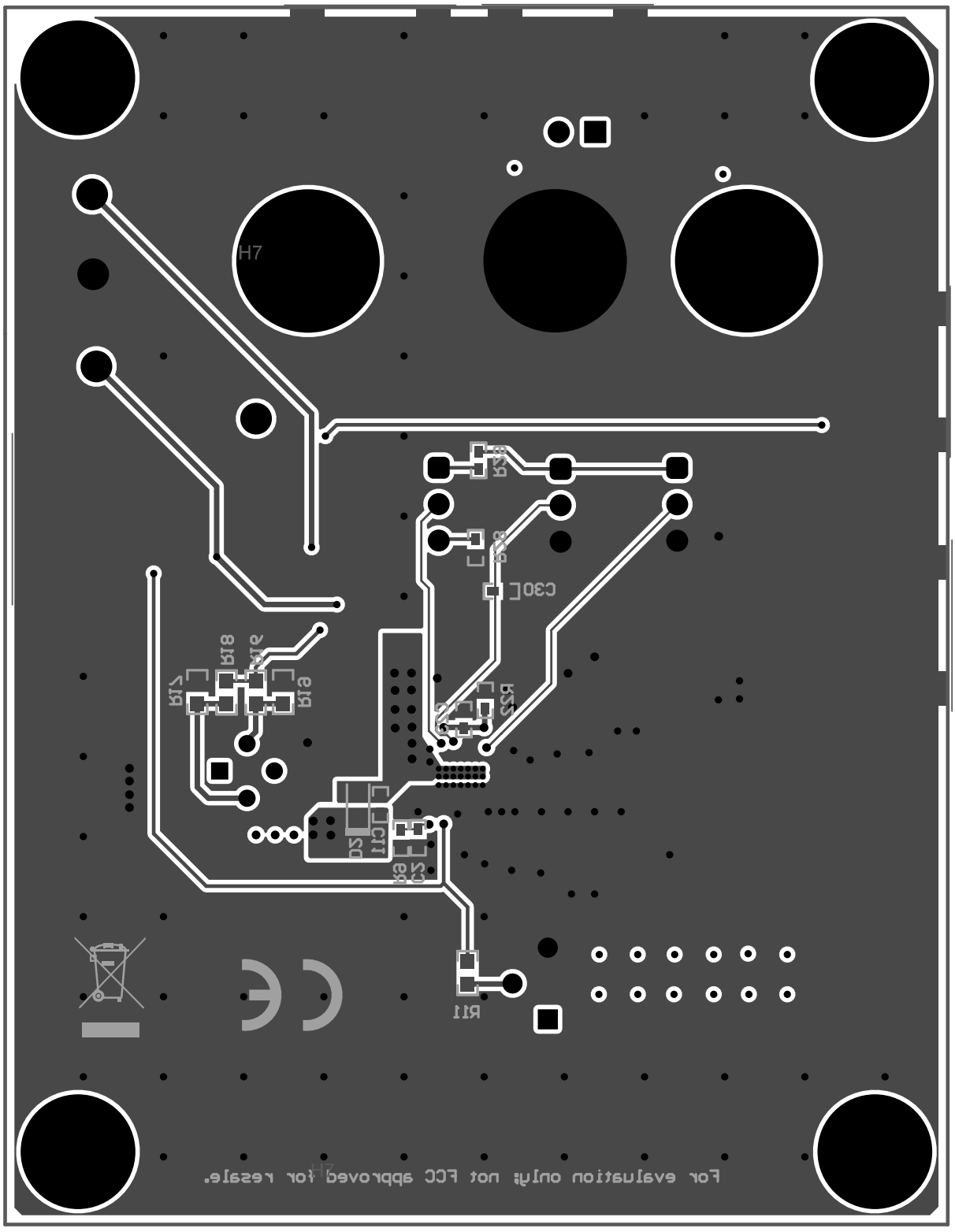


Figure 3-5. LMH13000RQEEVM Bottom Layer

3.3 Bill of Materials (BOM)

Table 3-1. LMH13000RQEEVM BOM

Item	Designator	Quantity	Description	Part Number	Manufacturer
1	!PCB	1	Printed Circuit Board	AMPS251B	Any
2	C3	1	47 µF ±20% 50V Ceramic Capacitor X7R Stacked SMD, 2 J-Lead	CKG57NX7R1H476M500JH	TDK
3	C4	1	CAP CER 300PF 25V C0G/NP0 0201	TMK063CG301JT-F	Taiyo Yuden
4	C5	1	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
5	C6	1	CAP, CERM, 0.01 uF, 50 V, +/- 5%, C0G/NP0, 0603	C1608NP01H103J080AA	TDK
6	C7	1	0.1µF ±10% 10V Ceramic Capacitor X7R 0306 (0816 Metric)	0306ZC104KAT2A	AVX
7	C8	1	CAP, CERM, 1 uF, 50 V, +/- 10%, X5R, 0603	C1608X5R1H105K080AB	TDK
8	C9	1	CAP, CERM, 10 uF, 50 V, +/- 20%, X7R, 1210	GRM32ER71H106MA12	MuRata
9	C10	1	47 µF ±20% 50V Ceramic Capacitor X7R Stacked SMD, 2 J-Lead	CKG57NX7R1H476M500JH	TDK
10	C12	1	CAP, CERM, 0.01 uF, 50 V, +/- 5%, C0G/NP0, 0603	C1608NP01H103J080AA	TDK
11	C13	1	0.1µF ±10% 10V Ceramic Capacitor X7R 0306 (0816 Metric)	0306ZC104KAT2A	AVX
12	C14	1	CAP, CERM, 1 uF, 50 V, +/- 10%, X5R, 0603	C1608X5R1H105K080AB	TDK
13	C15	1	CAP, CERM, 10 uF, 50 V, +/- 20%, X7R, 1210	GRM32ER71H106MA12	MuRata
14	C16	1	CAP, CERM, 1000 pF, 25 V, +/- 10%, X5R, 0201	C0603X5R1E102K030BA	TDK
15	C17	1	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
16	C18	1	CAP, CERM, 0.01 uF, 50 V, +/- 5%, C0G/NP0, 0603	C1608NP01H103J080AA	TDK
17	C19	1	0.1µF ±10% 10V Ceramic Capacitor X7R 0306 (0816 Metric)	0306ZC104KAT2A	AVX
18	C20	1	CAP, CERM, 1 uF, 50 V, +/- 10%, X5R, 0603	C1608X5R1H105K080AB	TDK
19	C21	1	CAP, CERM, 10 uF, 50 V, +/- 20%, X7R, 1210	GRM32ER71H106MA12	MuRata
20	C22	1	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	8.85E+11	Wurth Elektronik
21	C26	1	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	8.85E+11	Wurth Elektronik
22	C27	1	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	8.85E+11	Wurth Elektronik
23	C28	1	CAP, CERM, 100 pF, 50 V,+/- 1%, C0G/NP0, 0603	C0603C101F5GACTU	Kemet
24	C29	1	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
25	C30	1	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
26	C31	1	CAP, CERM, 0.01 uF, 50 V, +/- 5%, C0G/NP0, 0603	C1608NP01H103J080AA	TDK
27	C32	1	CAP CER 300PF 25V C0G/NP0 0201	TMK063CG301JT-F	Taiyo Yuden
28	D3	1	Diode, Zener, 2.4 V, 300 mW, SOD-523	BZT52C2V4T-7	Diodes Inc.
29	H1	1	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	NY PMS 440 0025 PH	B&F Fastener Supply
30	H2	1	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	NY PMS 440 0025 PH	B&F Fastener Supply
31	H3	1	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	NY PMS 440 0025 PH	B&F Fastener Supply
32	H4	1	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	NY PMS 440 0025 PH	B&F Fastener Supply

Table 3-1. LMH13000RQEEVM BOM (continued)

Item	Designator	Quantity	Description	Part Number	Manufacturer
33	H5	1	Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Keystone
34	H6	1	Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Keystone
35	H7	1	Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Keystone
36	H8	1	Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Keystone
37	J1	1	Header, 2.54mm, 2x1, Gold, TH	HB3902U	Foxconn
38	J_EN	1	Connector, End launch SMA, 50 Ω, SMT	142-0701-851	Cinch Connectivity
39	J_EP	1	Connector, End launch SMA, 50 Ω, SMT	142-0701-851	Cinch Connectivity
40	J_GND	1	Standard Banana Jack, Uninsulated, 5.5mm	575-4	Keystone
41	J_MODE_SEL	1	Header, 2.54mm, 3x1, Gold, TH	TSW-103-08-G-S	Samtec
42	J_PD	1	Connector, End launch SMA, 50 Ω, SMT	142-0701-851	Cinch Connectivity
43	J_PD_SEL	1	Header, 2.54mm, 3x1, Gold, TH	TSW-103-08-G-S	Samtec
44	J_RBIAS_CTRL	1	Header, 2.54mm, 3x1, Gold, TH	TSW-103-08-G-S	Samtec
45	J_TIA-OUT	1	Connector, End launch SMA, 50 Ω, SMT	142-0701-851	Cinch Connectivity
46	J_VDD	1	Standard Banana Jack, Uninsulated, 5.5mm	575-4	Keystone
47	J_VLD	1	Standard Banana Jack, Uninsulated, 5.5mm	575-4	Keystone
48	J_VSET	1	Connector, End launch SMA, 50 Ω, SMT	142-0701-851	Cinch Connectivity
49	L1	1	Ferrite Bead, 31 Ω @ 100 MHz, 1.5 A, 1206	MI1206K310R-10	Laird-Signal Integrity Products
50	L2	1	Ferrite Bead, 31 Ω @ 100 MHz, 1.5 A, 1206	MI1206K310R-10	Laird-Signal Integrity Products
51	LBL1	1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10	Brady
52	R1	1	RES 4.99 Ω 1% 1/20W 0201	RC0201FR-074R99L	Yageo America
53	R3	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
54	R5	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
55	R6	1	RES, 1.00 k, 1%, 0.1 W, 0603	ERJ-3EKF1001V	Panasonic
56	R7	1	RES, 50, 0.1%, 0.05 W, 0402	FC0402E50R0BST1	Vishay-Dale
57	R8	1	10kΩ, 0.25W, 1/4W PC Pins Through Hole Trimmer Potentiometer Cermet 12 Turn Top Adjustment	PV37W103C01B00	Bourns
58	R9	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
59	R10	1	RES, 50, 0.1%, 0.05 W, 0402	FC0402E50R0BST1	Vishay-Dale
60	R12	1	RES, 100 k, 0.1%, 0.1 W, 0603	RT0603BRD07100KL	Yageo America
61	R13	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
62	R14	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
63	R15	1	RES, 50, 0.1%, 0.05 W, 0402	FC0402E50R0BST1	Vishay-Dale
64	R20	1	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	PMR03EZPJ000	RΩ

Table 3-1. LMH13000RQEEVM BOM (continued)

Item	Designator	Quantity	Description	Part Number	Manufacturer
65	R21	1	2 Ωs ±1% 0.75W, 3/4W Chip Resistor Wide 1206 (3216 Metric), 0612 Automotive AEC-Q200, Pulse Withstanding Thick Film	LTR18EZPF2R00	RΩ Semiconductor
66	R24	1	RES, 50, 0.1%, 0.05 W, 0402	FC0402E50R0BST1	Vishay-Dale
67	R25	1	RES 4.99 Ω 1% 1/20W 0201	RC0201FR-074R99L	Yageo America
68	R28	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
69	R29	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
70	TIA_GND	1	Test Point, Multipurpose, Green, TH	5126	Keystone
71	TIA_REF	1	Test Point, Multipurpose, Black, TH	5011	Keystone Electronics
72	TIA_VCC	1	Test Point, Multipurpose, Red, TH	5010	Keystone Electronics
73	TIA_VEE	1	Test Point, Multipurpose, Black, TH	5011	Keystone Electronics
74	U1	1	LMH13000RNWR	LMH13000RNWR	Texas Instruments
75	U2	1	CMOS Amplifier 1 Circuit Rail-to-Rail SOT-23-5	TLV365DBVR	Texas Instruments
76	C1	0	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
77	C2	0	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
78	C11	0	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
79	C23	0	CAP, CERM, 5 pF, 50 V, +/- 5%, C0G/NP0, 0402	GRM1555C1H5R0CA01D	MuRata
80	C24	0	CAP, CERM, 5 pF, 50 V, +/- 5%, C0G/NP0, 0402	GRM1555C1H5R0CA01D	MuRata
81	C25	0	CAP, CERM, 5 pF, 50 V, +/- 5%, C0G/NP0, 0402	GRM1555C1H5R0CA01D	MuRata
82	D1	0	Laser Diode 940nm 3.2W 2.3V 4-SMD, No Lead	V105Q121A-940	Ams-OSRAM
83	D2	0	Diode, TVS, Uni, 24 V, 49 Vc, SOD-323	CDSOD323-T24S	Bourns
84	FID1	0	Fiducial mark. There is nothing to buy or mount.	N/A	N/A
85	FID2	0	Fiducial mark. There is nothing to buy or mount.	N/A	N/A
86	FID3	0	Fiducial mark. There is nothing to buy or mount.	N/A	N/A
87	J3	0	Laser Diode Socket for Ø9 mm Laser, 4 Pin	S8060-4	Thorlabs
88	R2	0	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
89	R4	0	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
90	R11	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	PMR03EZPJ000	RΩ
91	R16	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	PMR03EZPJ000	RΩ
92	R17	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	PMR03EZPJ000	RΩ
93	R18	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	PMR03EZPJ000	RΩ
94	R19	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	PMR03EZPJ000	RΩ
95	R22	1	RES, 0, 5%, 0.063 W, 0402	CRCW04020000Z0ED	Vishay-Dale
96	R23	0	RES, 50, 0.1%, 0.05 W, 0402	FC0402E50R0BST1	Vishay-Dale

4 Additional Information

4.1 Trademarks

HotRod™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

5 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (April 2025) to Revision B (May 2026)	Page
• Updated the EVM image to revision C board (AMPS251C)	1
• Updated text regarding change in default EP and EN configuration to 100Ω differential LVDS input	3
• Corrected the default R21 value to 2Ω	4
• Updated Figure 3-1, *LMH13000RQEEVM Schematic* for Revision C board (AMPS251C) and updated note informing the change in the C2 and R22 DNI status. Also added note regarding the default value of snubber's components	5
• Updated DNI status of the C2 and R22 in Table 3-1, *Bill of Materials*	10

Changes from Revision * (February 2025) to Revision A (April 2025)	Page
• Updated continuous current capability value in *Introduction* and *Device Information* sections	2
• Updated text for J_PD_SEL and J_RBIAS_CTRL in *Jumper Information*	4
• Updated installed snubber R and C values	4
• Updated Figure 3-2 to Figure 3-5	6

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