

# EVM User's Guide: LMH13000RQEEVM

## LMH13000RQE Evaluation Module



### Description

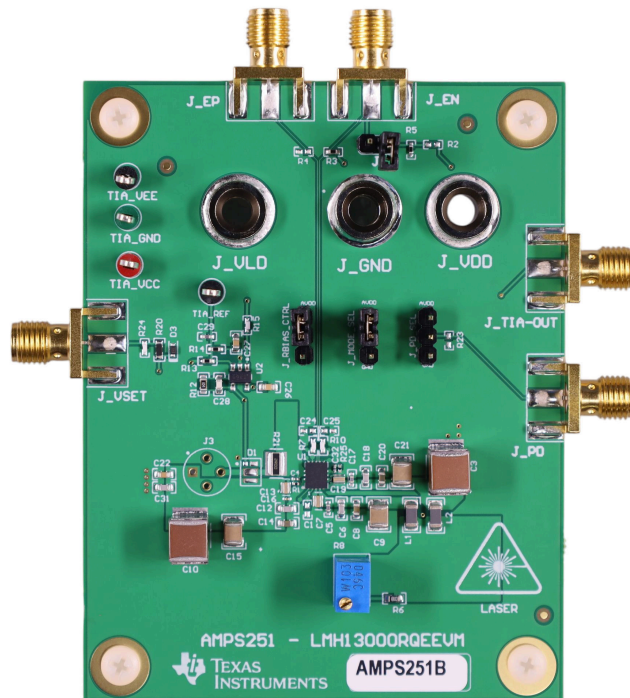
The LMH13000RQEEVM is the evaluation module (EVM) for the LMH13000, a high-speed output current driver in a 13-pin WQFN-HR (HotRod™) package. This EVM is designed to quickly and easily demonstrate the functionality and versatility of the amplifier. The EVM is ready to connect to power, signal sources, 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  $< 1\text{ns}$ , 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

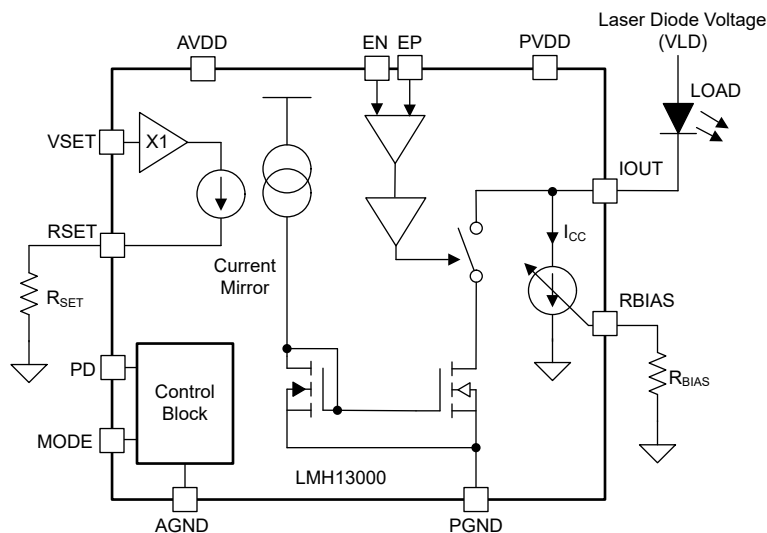


Figure 1-1. LMH13000 Functional Block Diagram

## 1.4 Device Information

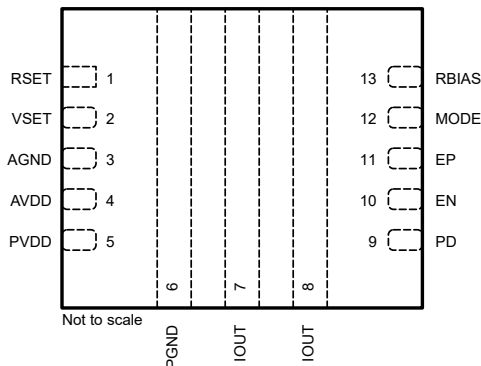
The LMH13000 is a voltage-controlled current source that enables accurate current control coupled with LVDS input to support fast rise-and-fall times ( $< 1\text{ns}$ ) for pulsed- and square-wave applications. The accurate output-current control helps adjust load currents on-the-fly to compensate against 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  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$  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, both connectors are terminated with 50Ω resistors to match source impedance of the instruments. If the device must be driven by an LVDS drive that requires 100Ω termination, remove R22. Alternatively, to operate the device and the EVM on a single-ended input, short jumper J1 and remove R10. This configuration biases the EN pin 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 (1 $\Omega$  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.

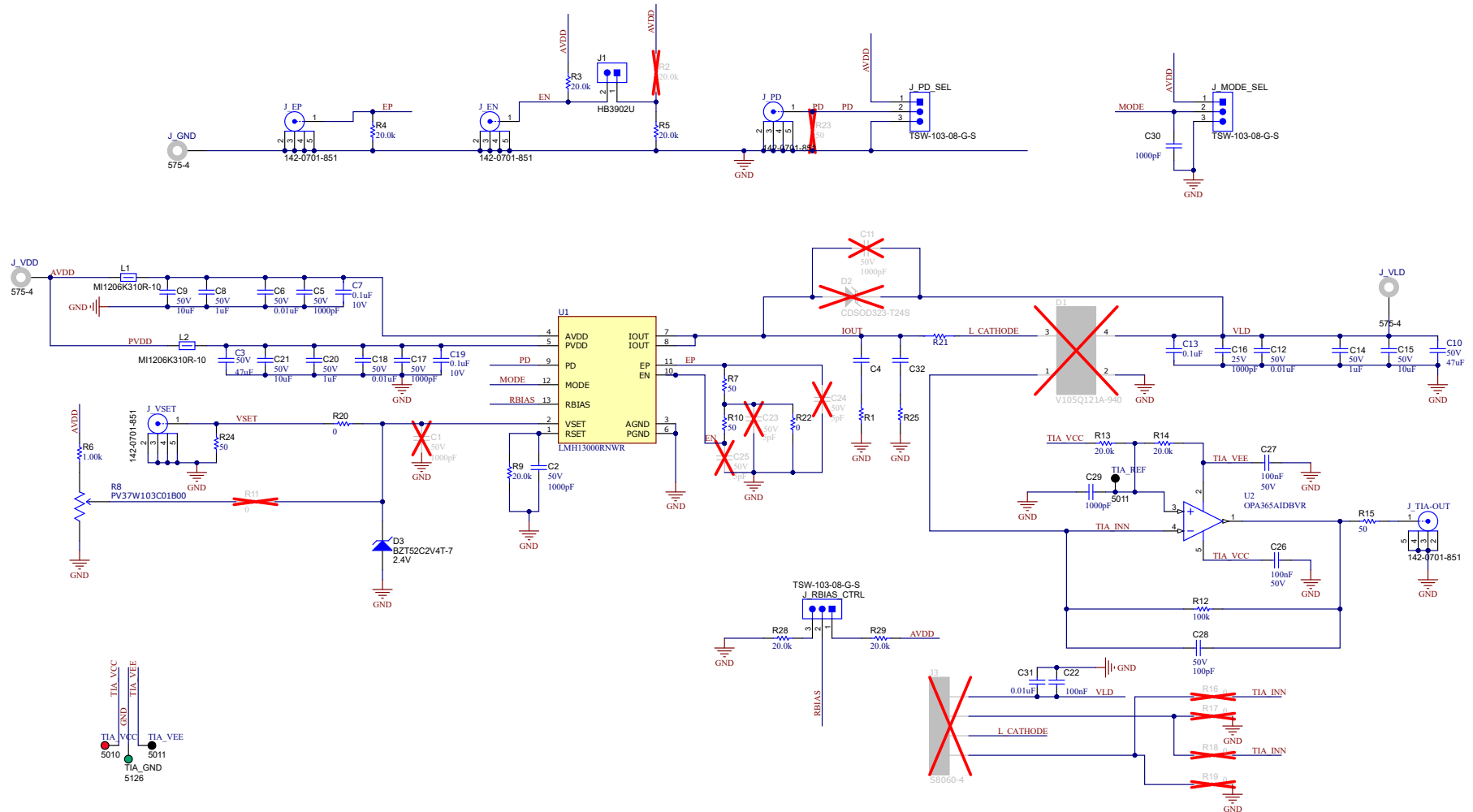
## 2.6 Snubber

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 5 $\Omega$ , 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 Schematic**

Note: Remove C2 in case the device shows unexpected oscillation or instability in performance.

### 3.2 PCB Layouts

The following figures show the PCB layout for the LMH13000RQEEVM.

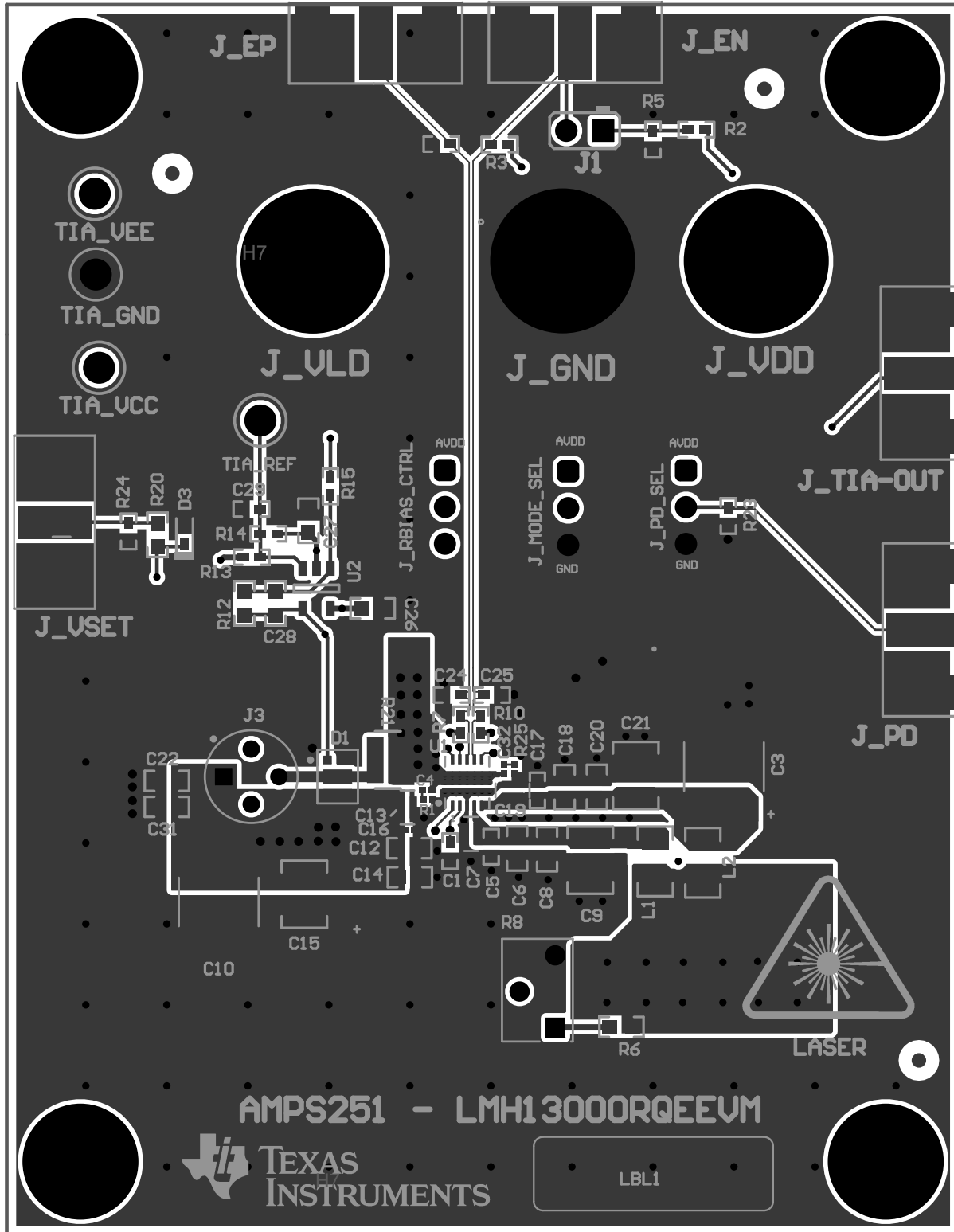


Figure 3-2. LMH13000RQEEVM Top Layer

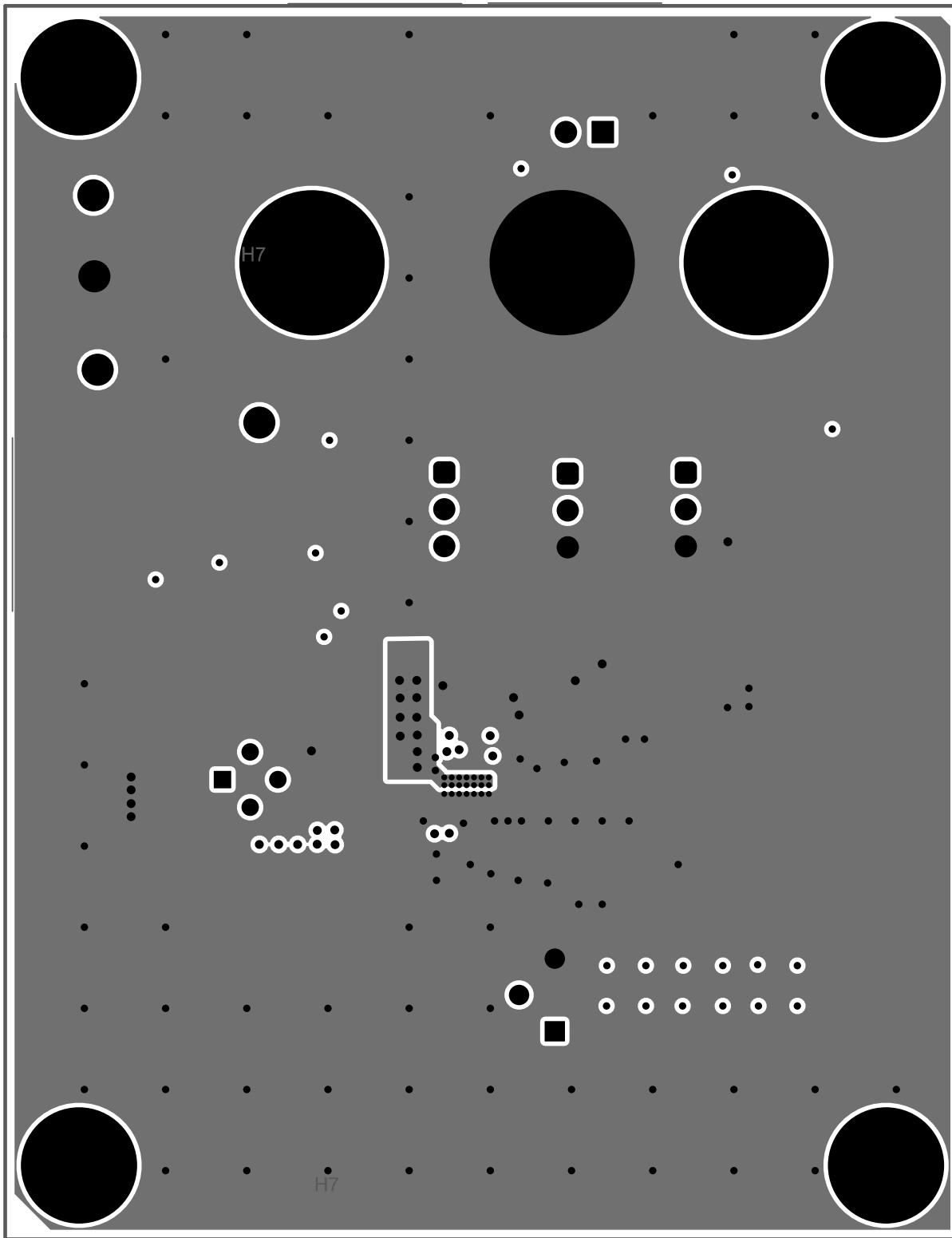


Figure 3-3. LMH13000RQEEVM Second Layer (Ground Plane)

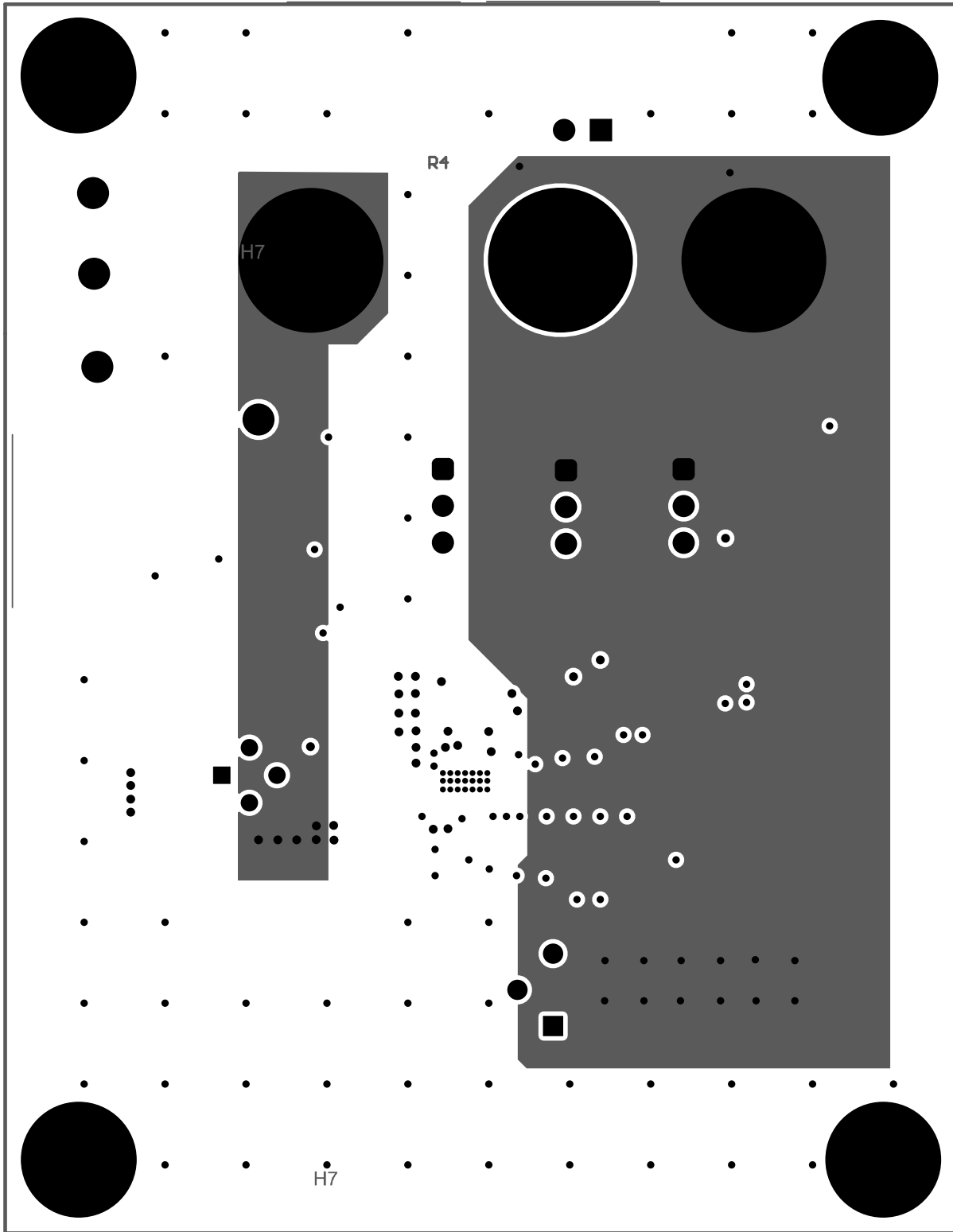


Figure 3-4. LMH13000RQEEVM Third Layer (Power Plane)



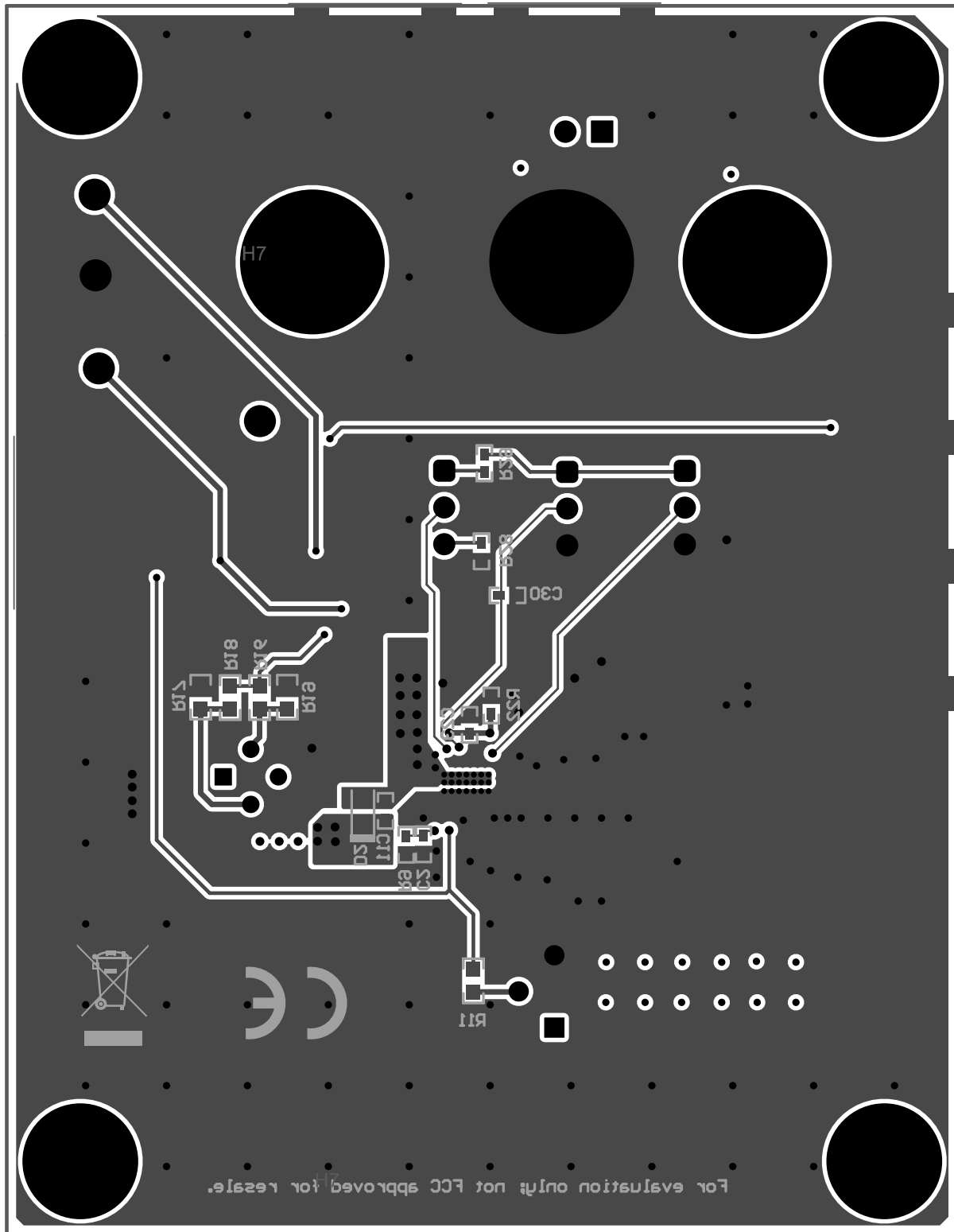


Figure 3-5. LMH13000RQEEVM Bottom Layer

### 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	C2	1	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
3	C3	1	47 $\mu$ F $\pm$ 20% 50V Ceramic Capacitor X7R Stacked SMD, 2 J-Lead	CKG57NX7R1H476M500JH	TDK
4	C4	1	CAP CER 300PF 25V C0G/NP0 0201	TMK063CG301JT-F	Taiyo Yuden
5	C5	1	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
6	C6	1	CAP, CERM, 0.01 $\mu$ F, 50 V, +/- 5%, C0G/NP0, 0603	C1608NP01H103J080AA	TDK
7	C7	1	0.1 $\mu$ F $\pm$ 10% 10V Ceramic Capacitor X7R 0306 (0816 Metric)	0306ZC104KAT2A	AVX
8	C8	1	CAP, CERM, 1 $\mu$ F, 50 V, +/- 10%, X5R, 0603	C1608X5R1H105K080AB	TDK
9	C9	1	CAP, CERM, 10 $\mu$ F, 50 V, +/- 20%, X7R, 1210	GRM32ER71H106MA12	MuRata
10	C10	1	47 $\mu$ F $\pm$ 20% 50V Ceramic Capacitor X7R Stacked SMD, 2 J-Lead	CKG57NX7R1H476M500JH	TDK
11	C12	1	CAP, CERM, 0.01 $\mu$ F, 50 V, +/- 5%, C0G/NP0, 0603	C1608NP01H103J080AA	TDK
12	C13	1	0.1 $\mu$ F $\pm$ 10% 10V Ceramic Capacitor X7R 0306 (0816 Metric)	0306ZC104KAT2A	AVX
13	C14	1	CAP, CERM, 1 $\mu$ F, 50 V, +/- 10%, X5R, 0603	C1608X5R1H105K080AB	TDK
14	C15	1	CAP, CERM, 10 $\mu$ F, 50 V, +/- 20%, X7R, 1210	GRM32ER71H106MA12	MuRata
15	C16	1	CAP, CERM, 1000 pF, 25 V, +/- 10%, X5R, 0201	C0603X5R1E102K030BA	TDK
16	C17	1	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
17	C18	1	CAP, CERM, 0.01 $\mu$ F, 50 V, +/- 5%, C0G/NP0, 0603	C1608NP01H103J080AA	TDK
18	C19	1	0.1 $\mu$ F $\pm$ 10% 10V Ceramic Capacitor X7R 0306 (0816 Metric)	0306ZC104KAT2A	AVX
19	C20	1	CAP, CERM, 1 $\mu$ F, 50 V, +/- 10%, X5R, 0603	C1608X5R1H105K080AB	TDK
20	C21	1	CAP, CERM, 10 $\mu$ F, 50 V, +/- 20%, X7R, 1210	GRM32ER71H106MA12	MuRata
21	C22	1	CAP, CERM, 0.1 $\mu$ F, 50 V, +/- 10%, X7R, 0603	8.85E+11	Wurth Elektronik
22	C26	1	CAP, CERM, 0.1 $\mu$ F, 50 V, +/- 10%, X7R, 0603	8.85E+11	Wurth Elektronik
23	C27	1	CAP, CERM, 0.1 $\mu$ F, 50 V, +/- 10%, X7R, 0603	8.85E+11	Wurth Elektronik
24	C28	1	CAP, CERM, 100 pF, 50 V, +/- 1%, C0G/NP0, 0603	C0603C101F5GACTU	Kemet
25	C29	1	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
26	C30	1	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
27	C31	1	CAP, CERM, 0.01 $\mu$ F, 50 V, +/- 5%, C0G/NP0, 0603	C1608NP01H103J080AA	TDK
28	C32	1	CAP CER 300PF 25V C0G/NP0 0201	TMK063CG301JT-F	Taiyo Yuden
29	D3	1	Diode, Zener, 2.4 V, 300 mW, SOD-523	BZT52C2V4T-7	Diodes Inc.
30	H1	1	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	NY PMS 440 0025 PH	B&F Fastener Supply
31	H2	1	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	NY PMS 440 0025 PH	B&F Fastener Supply
32	H3	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	H4	1	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	NY PMS 440 0025 PH	B&F Fastener Supply
34	H5	1	Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Keystone
35	H6	1	Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Keystone
36	H7	1	Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Keystone
37	H8	1	Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Keystone
38	J1	1	Header, 2.54mm, 2x1, Gold, TH	HB3902U	Foxconn
39	J_EN	1	Connector, End launch SMA, 50 Ω, SMT	142-0701-851	Cinch Connectivity
40	J_EP	1	Connector, End launch SMA, 50 Ω, SMT	142-0701-851	Cinch Connectivity
41	J_GND	1	Standard Banana Jack, Uninsulated, 5.5mm	575-4	Keystone
42	J_MODE_SEL	1	Header, 2.54mm, 3x1, Gold, TH	TSW-103-08-G-S	Samtec
43	J_PD	1	Connector, End launch SMA, 50 Ω, SMT	142-0701-851	Cinch Connectivity
44	J_PD_SEL	1	Header, 2.54mm, 3x1, Gold, TH	TSW-103-08-G-S	Samtec
45	J_RBIA_CTRL	1	Header, 2.54mm, 3x1, Gold, TH	TSW-103-08-G-S	Samtec
46	J_TIA-OUT	1	Connector, End launch SMA, 50 Ω, SMT	142-0701-851	Cinch Connectivity
47	J_VDD	1	Standard Banana Jack, Uninsulated, 5.5mm	575-4	Keystone
48	J_VLD	1	Standard Banana Jack, Uninsulated, 5.5mm	575-4	Keystone
49	J_VSET	1	Connector, End launch SMA, 50 Ω, SMT	142-0701-851	Cinch Connectivity
50	L1	1	Ferrite Bead, 31 Ω @ 100 MHz, 1.5 A, 1206	MI1206K310R-10	Laird-Signal Integrity Products
51	L2	1	Ferrite Bead, 31 Ω @ 100 MHz, 1.5 A, 1206	MI1206K310R-10	Laird-Signal Integrity Products
52	LBL1	1	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10	Brady
53	R1	1	RES 4.99 Ω 1% 1/20W 0201	RC0201FR-074R99L	Yageo America
54	R3	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
55	R5	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
56	R6	1	RES, 1.00 k, 1%, 0.1 W, 0603	ERJ-3EKF1001V	Panasonic
57	R7	1	RES, 50, 0.1%, 0.05 W, 0402	FC0402E50R0BST1	Vishay-Dale
58	R8	1	10kΩ, 0.25W, 1/4W PC Pins Through Hole Trimmer Potentiometer Cermet 12 Turn Top Adjustment	PV37W103C01B00	Bourns
59	R9	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
60	R10	1	RES, 50, 0.1%, 0.05 W, 0402	FC0402E50R0BST1	Vishay-Dale
61	R12	1	RES, 100 k, 0.1%, 0.1 W, 0603	RT0603BRD07100KL	Yageo America
62	R13	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
63	R14	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
64	R15	1	RES, 50, 0.1%, 0.05 W, 0402	FC0402E50R0BST1	Vishay-Dale

**Table 3-1. LMH13000RQEEVM BOM (continued)**

Item	Designator	Quantity	Description	Part Number	Manufacturer
65	R20	1	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	PMR03EZPJ000	RΩ
66	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
67	R22	1	RES, 0, 5%, 0.063 W, 0402	CRCW04020000Z0ED	Vishay-Dale
68	R24	1	RES, 50, 0.1%, 0.05 W, 0402	FC0402E50R0BST1	Vishay-Dale
69	R25	1	RES 4.99 Ω 1% 1/20W 0201	RC0201FR-074R99L	Yageo America
70	R28	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
71	R29	1	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
72	TIA_GND	1	Test Point, Multipurpose, Green, TH	5126	Keystone
73	TIA_REF	1	Test Point, Multipurpose, Black, TH	5011	Keystone Electronics
74	TIA_VCC	1	Test Point, Multipurpose, Red, TH	5010	Keystone Electronics
75	TIA_VEE	1	Test Point, Multipurpose, Black, TH	5011	Keystone Electronics
76	U1	1	LMH13000RNWR	LMH13000RNWR	Texas Instruments
77	U2	1	CMOS Amplifier 1 Circuit Rail-to-Rail SOT-23-5	TLV365DBVR	Texas Instruments
78	C1	0	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
79	C11	0	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	C1005NP01H102J050BA	TDK
80	C23	0	CAP, CERM, 5 pF, 50 V, +/- 5%, C0G/NP0, 0402	GRM1555C1H5R0CA01D	MuRata
81	C24	0	CAP, CERM, 5 pF, 50 V, +/- 5%, C0G/NP0, 0402	GRM1555C1H5R0CA01D	MuRata
82	C25	0	CAP, CERM, 5 pF, 50 V, +/- 5%, C0G/NP0, 0402	GRM1555C1H5R0CA01D	MuRata
83	D1	0	Laser Diode 940nm 3.2W 2.3V 4-SMD, No Lead	V105Q121A-940	Ams-OSRAM
84	D2	0	Diode, TVS, Uni, 24 V, 49 Vc, SOD-323	CDSOD323-T24S	Bourns
85	FID1	0	Fiducial mark. There is nothing to buy or mount.	N/A	N/A
86	FID2	0	Fiducial mark. There is nothing to buy or mount.	N/A	N/A
87	FID3	0	Fiducial mark. There is nothing to buy or mount.	N/A	N/A
88	J3	0	Laser Diode Socket for Ø9 mm Laser, 4 Pin	S8060-4	Thorlabs
89	R2	0	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
90	R4	0	RES, 20.0 k, .1%, .0625 W, 0402	RT0402BRD0720KL	Yageo America
91	R11	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	PMR03EZPJ000	RΩ
92	R16	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	PMR03EZPJ000	RΩ
93	R17	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	PMR03EZPJ000	RΩ
94	R18	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	PMR03EZPJ000	RΩ
95	R19	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	PMR03EZPJ000	RΩ
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.

<b>Changes from Revision * (February 2025) to Revision A (April 2025)</b>	<b>Page</b>
• Updated board image to revision B EVM.....	1
• Updated continuous current capability value in <i>Introduction</i> and <i>Device Information</i> sections.....	2
• Updated text regarding change in default configuration for EN and PD pins.....	3
• Updated text for J_PD_SEL and J_RBIAS_CTRL in <i>Jumper Information</i> .....	4
• Updated R21 connection change information for revision B EVM.....	4
• Updated installed snubber R and C values .....	4
• Updated Figure 3-1, <i>LMH13000RQEEVM Schematic</i> and added note for C2.....	5
• Updated Figure 3-2 to Figure 3-5.....	6
• Updated Table 3-1, <i>Bill of Materials</i> .....	10

## 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/llds/ti\\_ja/general/eStore/notice\\_01.page](http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_01.page) 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

<https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html>

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。技術適合証明を受けていないものご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。日本テキサス・イ

ンスツルメンツ株式会社

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/llds/ti\\_ja/general/eStore/notice\\_02.page](http://www.tij.co.jp/llds/ti_ja/general/eStore/notice_02.page)

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#### 3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.



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- 4 *EVM Use Restrictions and Warnings:*
    - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
    - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
    - 4.3 *Safety-Related Warnings and Restrictions:*
      - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
      - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
    - 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
  5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.
  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, INDEMNITY 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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