

LMH3404EVM Evaluation Module (EVM)

The LMH3404EVM is an evaluation module for the single LMH3404 amplifier in a 16-lead high-performance RF package. This evaluation module is designed to quickly and easily demonstrate the functionality and versatility of the amplifier. The EVM is ready to connect to power, output common mode voltage, signal source, and test instruments through the use of onboard connectors. The EVM comes configured for easy connection with common 50- Ω laboratory equipment on its inputs and outputs. The amplifier is configured for single-ended input with gain of 20 dB (10 V/V). The board has differential outputs, one for each of the amplifier outputs. It can be easily configured for differential inputs, and single- or split-supply operation.

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1 Features

This EVM supports the following features:

- Uses single, 5-V supply
- Fully differential
- Onboard baluns for use with 50-Ω single-ended test equipment
- Can be reconfigured for differential input signals
- Output common mode control
- Disable with jumpers.
- Inputs and outputs include SMA connectors

2 EVM Specifications

The following table lists the EVM specifications:

V_S	Single-supply voltage range (V_- = ground)	3.3 V to 5.25 V
PD	Power down (PD) input voltage	GND to V_{CC}
$I_{S\pm}$	Supply current	123 mA
I_{IN}	Input voltage	$V_{S\pm}$, Max
I_{OUT}	Output drive	± 40 mA

Figure 1 illustrates the EVM board.

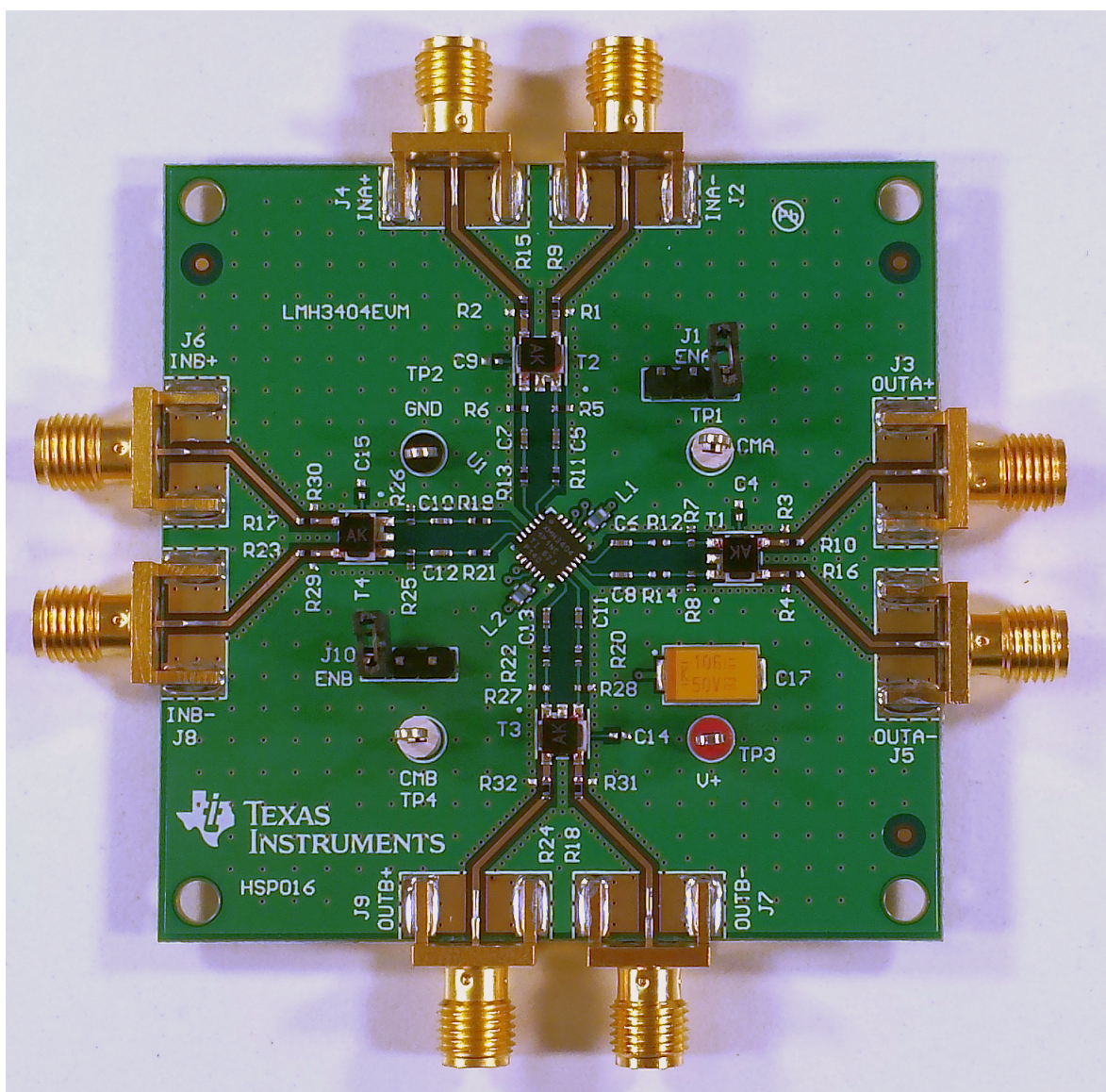


Figure 1. LMH3404 EVM

3 Power Connections

The LMH3404EVM is equipped with test loops for easy power connection. The positive supply input is red and is labeled V+. The ground is black and is labeled GND. The ground connection sets the voltage reference level for the ENA and ENB enable pins. The LMH3404 output common-mode voltage is set by the yellow CMA and CMB test loops. The CM pins have no onboard reference so they must be set by an external supply. The suggested output common-mode voltage is one-half of the supply voltage (V+).

To power the LMH3404 EVM, one 5-V bench supply capable of sourcing 200 mA as well as one 2.5-V power supply is needed. The 2.5-V supply needs to source only 10 mA. A power cable with mini grabbers is also required.

3.1 Split-Supply Operation

The LMH3404EVM board is not configured to support split-supply operation.

4 Input and Output Connections

4.1 Single-Ended 50-Ω

The LMH3404EVM is equipped with SMA connectors for easy connection of signal generators and analysis equipment. As shipped, the EVM is configured for a gain of 20 dB, split supply, differential input, and differential outputs – each with 50-Ω termination. While the amplifier is configured for 20 dB of gain, the EVM net gain will be 3 dB, due to onboard resistor losses and balun losses.

Single-ended to differential conversion is accomplished by the onboard transformers (ETC1-1-13). For best results, signals must be routed to and from the EVM with cables having 50-Ω characteristic impedance. To use single-ended, 50-Ω test signals, it is necessary to place an SMA shorting block on the unused input. For example: If using IN+ and OUT+, put shorting blocks on IN– and OUT–. If an SMA shorting block is not available, the unused input can be shorted to ground by soldering a 0-Ω resistor into resistor position R1 or R2 for the A channel and R20 or R30 for the B channel. Only one input should be shorted to ground. The board is symmetrical, so either input or either output can be chosen.

The LMH3404 EVM outputs are also configured for single-ended 50-Ω signals. As with the inputs, select one output SMA connector to be the active connector and place an SMA shorting block on the unused output. If an SMA shorting block is not available, the unused output can be shorted to ground by soldering a 0-Ω resistor into resistor position R3 or R4 for the A channel and R31 or R32 for the B channel. Only one output should be shorted to ground.

4.2 Differential 100-Ω

Option 1. To use the LMH3404 in a fully-differential manner, it is necessary to remove the baluns and also to remove the 0-Ω resistors that are shorting the balun primary coils to ground (if they have been installed). For 100-Ω differential input impedance operation, also remove the following resistors: R5, R6, R25, and R26. For 100-Ω output impedance operation, also remove the following resistors: R7, R8, R27, and R28. Resistors R12, R14, R20, and R22, must be removed and replaced with 40-Ω resistors. On both the inputs and the outputs short the TC1-1-13 balun pads.

Option 2. To use the LMH3404 in a fully-differential manner without removing the baluns, remove the following resistors: R5, R6, R25, and R26. This will give a 100-Ω differential, input resistance.

4.3 CM (Output Common-Mode Voltage) Input

The LMH3404 has an output common-mode control pin that is used to set the output common-mode voltage. The test-point loop can be used to connect an external voltage source to the amplifier. The valid voltage range for the CM pin is approximately (V+ –2 V) to (V– +2 V) (2.0 V to 3.0 V when using a 5-V supply). See the LMH3404 datasheet ([SBOS739](#)) for performance curves that show how performance is impacted by the output common-mode voltage. The ideal output common-mode voltage is exactly one-half of the supply voltage.

4.4 PD (Power Down) Input

The LMH3404 has a power down input pin that allows the amplifier to be put into a low power state when it does not need to be active. The LMH3404 PD pins are referenced to the GND pin. The threshold voltage is 1.1 V. Any voltage over 1.2 V above the ground reference disables the amplifier, any input below 1.0 V enables the amplifier. On chip, the PD pin is not referenced to either of the supply pins; however, the LMH3404EVM is configured with the PD pins referenced to ground. The LMH3404EVM has a jumper (JPD) that allows the amplifier to be manually disabled. With no jumper installed, the LMH3404 defaults to the enabled state.

4.5 Single-Ended Inputs

The LMH3404EVM is designed for use with 50-Ω, single-ended inputs. Even though the board is designed for single-ended inputs, the board is fully symmetrical. Connect a 50-Ω signal source to either of the inputs. The A and B channels of the LMH3404 are identical.

In order to use single-ended, 50- Ω test signals, it is necessary to place an SMA shorting block on the unused input. If an SMA shorting block is not available, the unused input can be shorted to ground by soldering a 0- Ω resistor into resistor position R1 or R2 for the A channel and R20 or R30 for the B channel. Only one input should be shorted to ground.

4.6 Differential Inputs

It is possible to use the LMH3404 for differential inputs. The LMH3404 has an internal resistance of 100 Ω (differential). In order to impedance-match a 100- Ω differential source, it is not necessary to use any external resistors; however, the board must be modified as described in [Section 4.2](#).

4.7 Single-Ended Outputs

As shipped, the LMH3404 EVM has onboard baluns to facilitate connection to conventional test equipment. As with the inputs, select one output SMA connector to be the active connector and place an SMA shorting block on the unused output. If an SMA shorting block is not available, the unused output can be shorted to ground by soldering a 0- Ω resistor into resistor position R3 or R4 for the A channel and R31 or R32 for the B channel. Only one output should be shorted to ground.

4.8 Differential Outputs

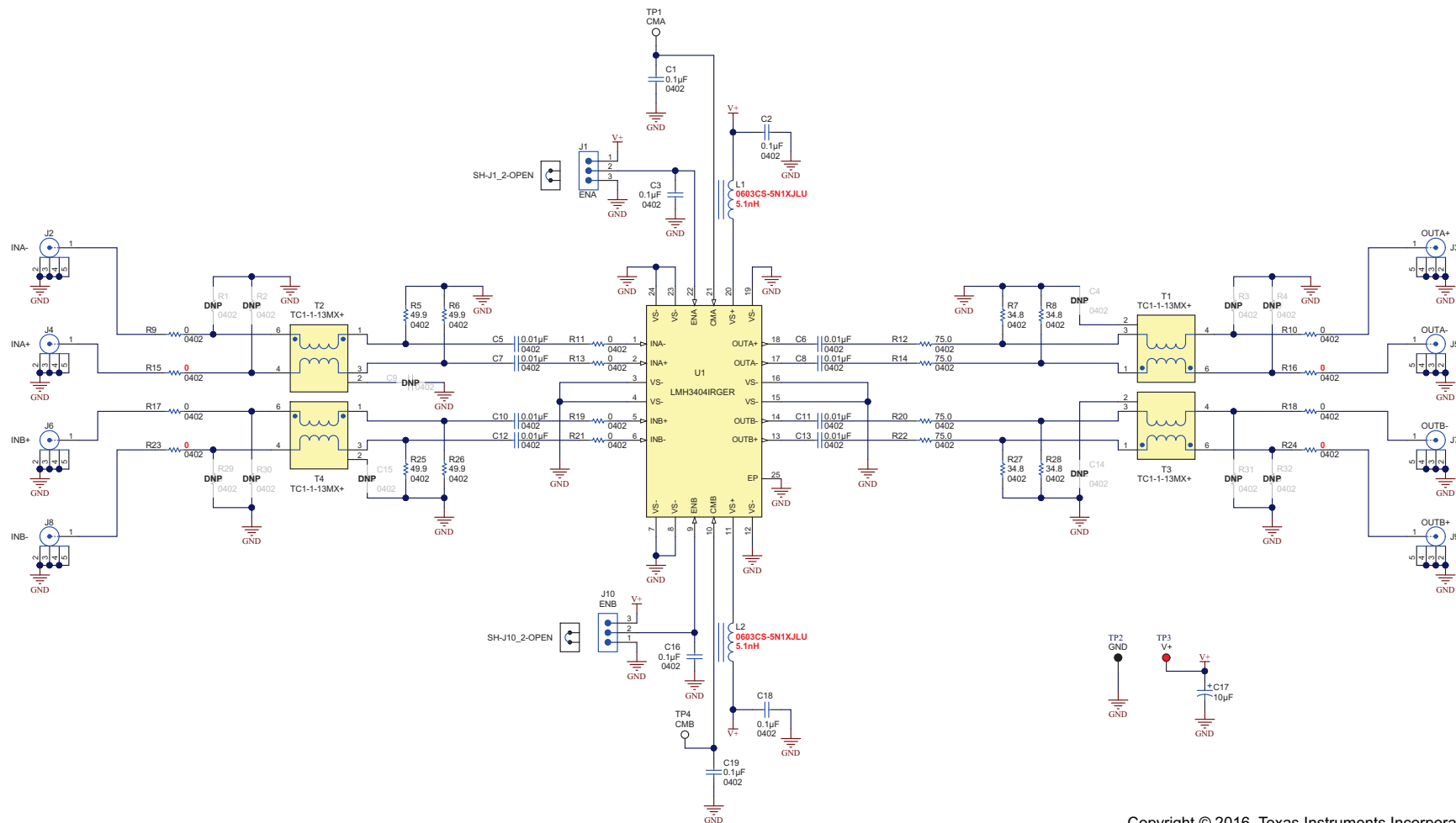
The LMH3404EVM has two output SMA connectors that are designed to mate to 50- Ω test equipment. To use the board with fully-differential outputs requires board modification as described in [Section 4.2](#).

5 LMH3404EVM Schematic, Layout, and Bill of Materials

This section contains the EVM schematic, PCB layouts, and the bill of materials (BOM).

5.1 Schematic

Figure 2 illustrates the LMH3404EVM schematic.



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Figure 2. LMH3404EVM Schematic

5.2 LMH3404EVM Layers

Figure 3 through Figure 6 show the LMH3404EVM layers.

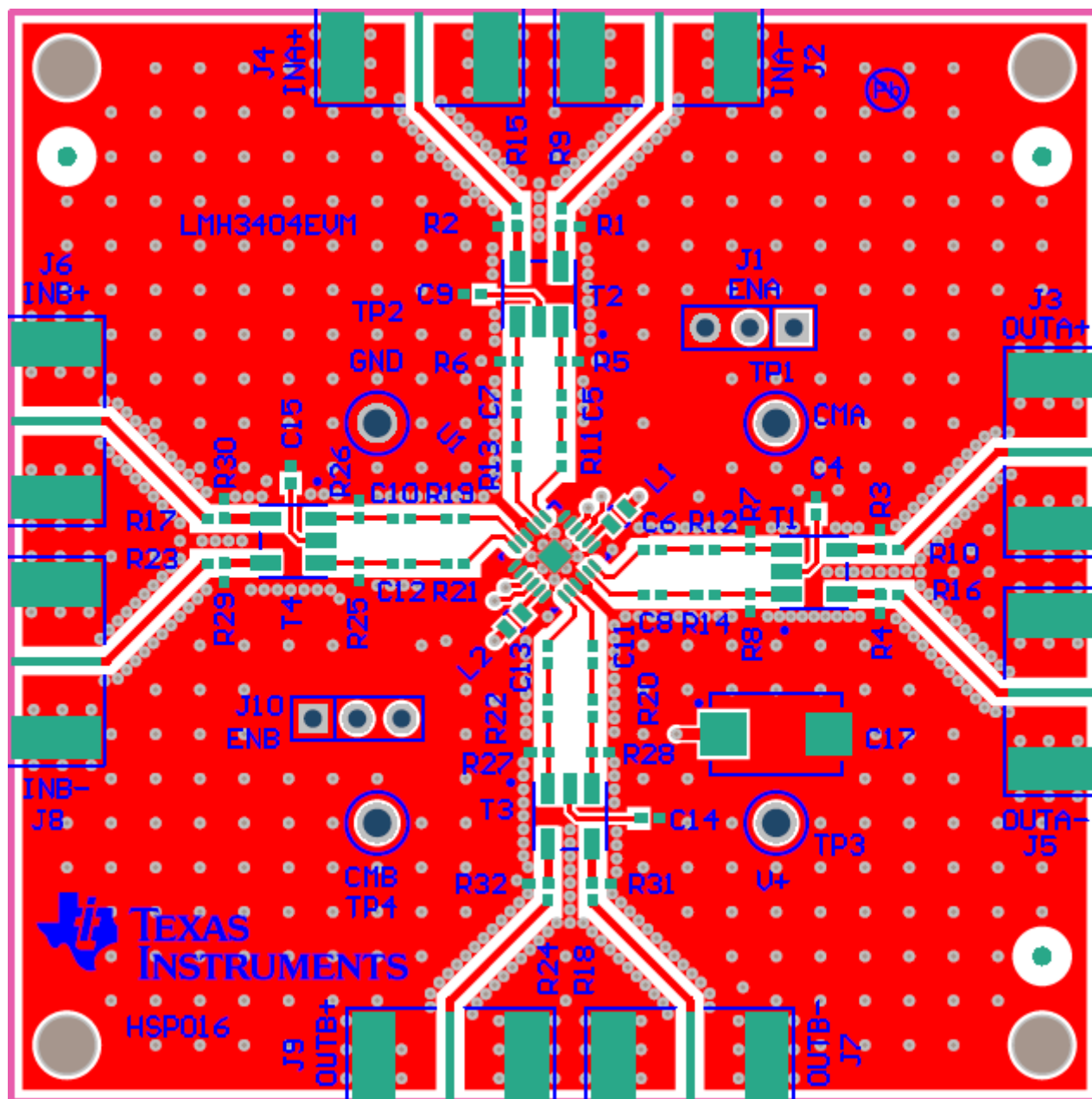


Figure 3. LMH3404EVM Top Layer

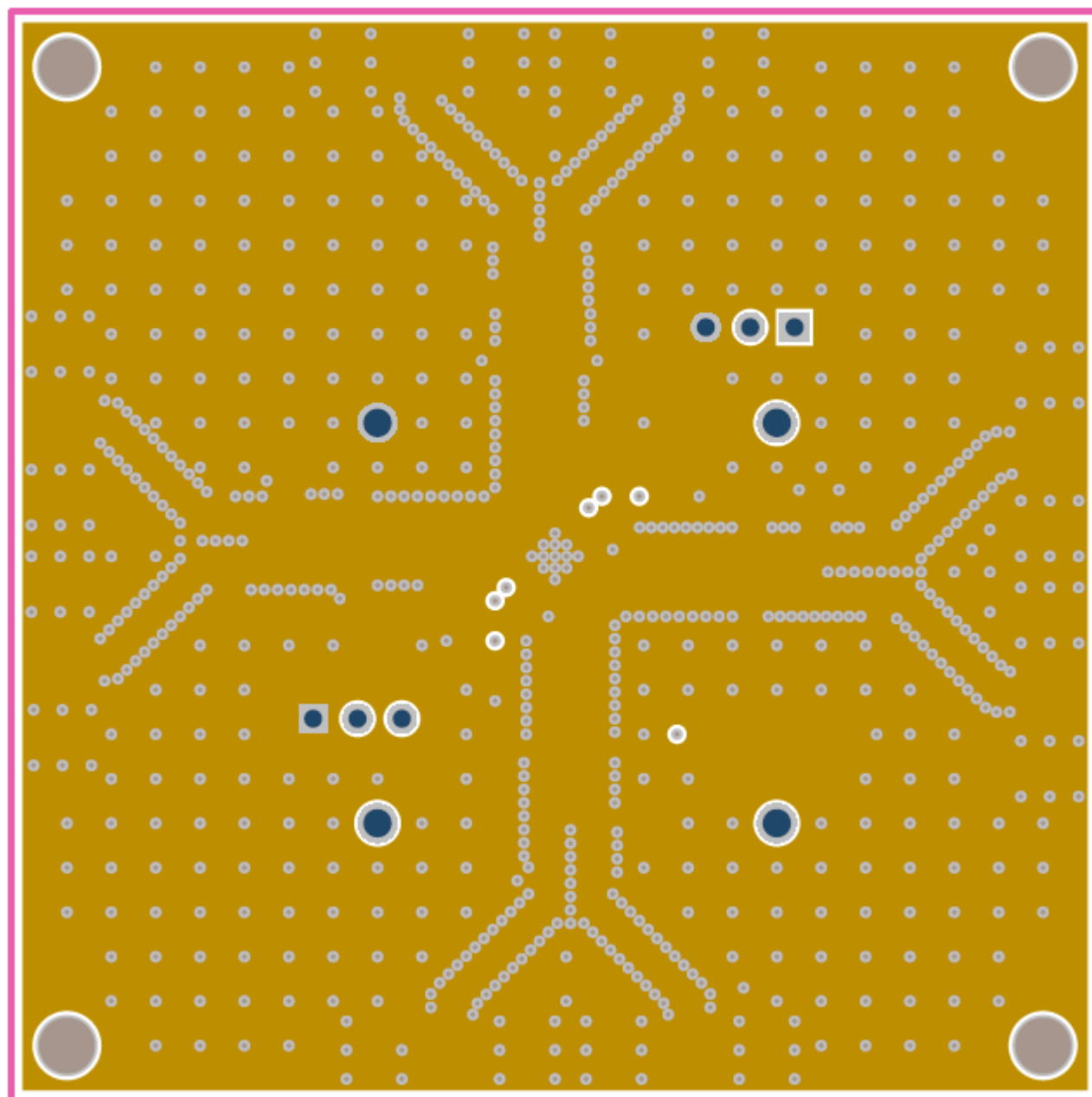


Figure 4. Layer 2 Ground

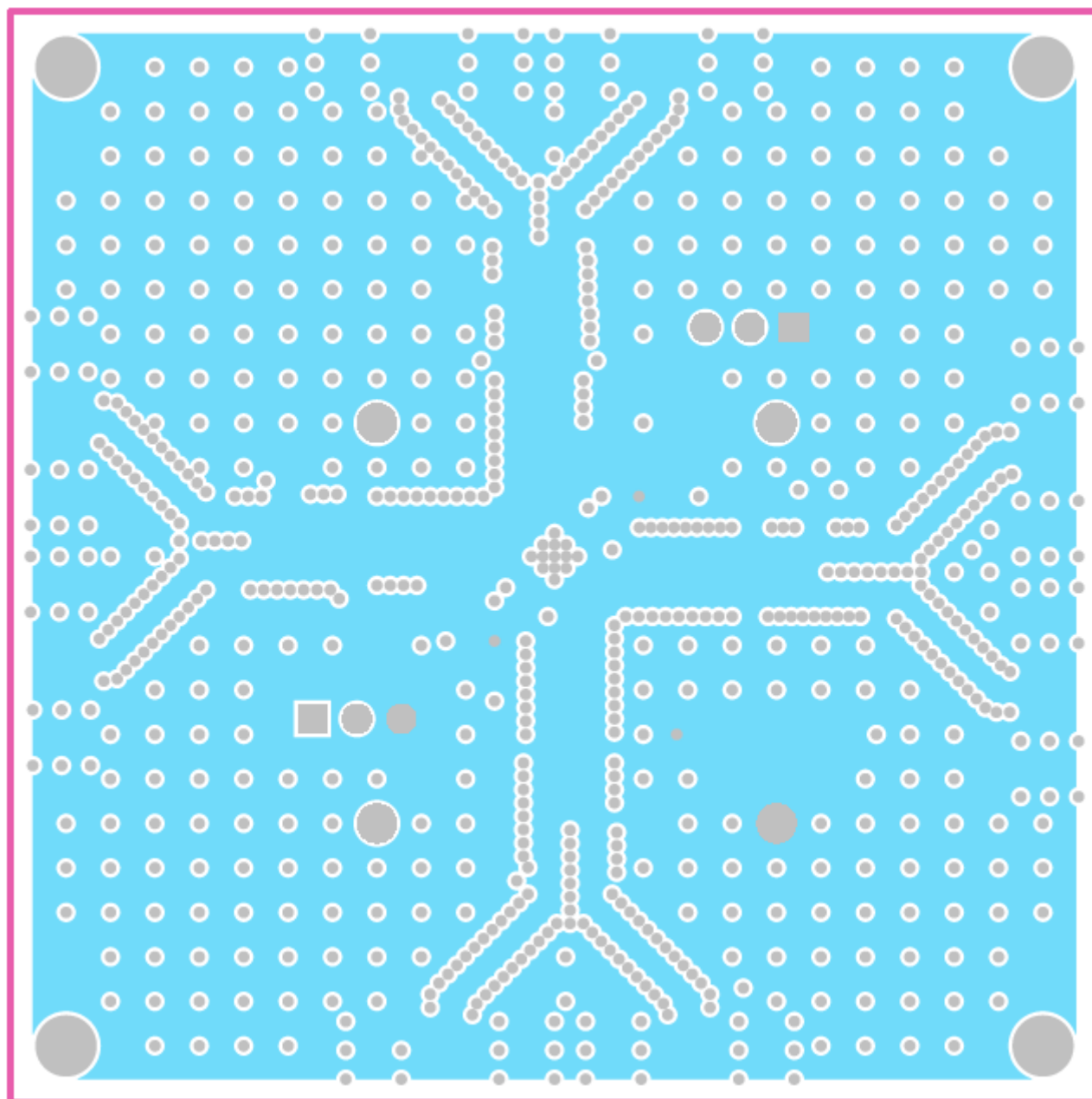


Figure 5. Layer 3 Power



5.3 Bill of Materials

Table 1 lists the EVM BOM.

Table 1. LMH3404EVM Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
!PCB1	1		Printed Circuit Board		HSP016	Any	-	-
C1, C18, C19	3	0.1uF	CAP, CERM, 0.1 μ F, 10 V, +/- 10%, X5R, 0402	0402	C1005X5R1A104K	TDK		
C2, C3, C16	3	0.1uF	CAP, CERM, 0.1uF, 10V, +/-10%, X5R, 0402	0402	C1005X5R1A104K	TDK	-	-
C5, C6, C7, C8, C10, C11, C12, C13	8	0.01uF	CAP, CERM, 0.01uF, 25V, +/-10%, X7R, 0402	0402	C1005X7R1E103K	TDK		
C17	1	10uF	CAP, TA, 10 μ F, 50 V, +/- 10%, 0.3 ohm, SMD	7343-43	T495X106K050ATE300	Kemet		
FID1, FID2, FID3, FID4, FID5, FID6	6		Fiducial mark. There is nothing to buy or mount.	Fiducial	N/A	N/A		
J1, J10	2		Header, 100mil, 3x1, Gold, TH	PBC03SAAN	PBC03SAAN	Sullins Connector Solutions		
J2, J3, J4, J5, J6, J7, J8, J9	8		Connector, End launch SMA, 50 ohm, SMT	SMA End Launch	142-0701-851	Emerson Network Power		
L1, L2	2	5.1nH	Inductor, Wirewound, Ceramic, 5.1 nH, 0.7 A, 0.140 ohm, SMD	0603	0603CS-5N1XJLU	Coilcraft		
R5, R6, R25, R26	4	49.9	RES, 49.9, 1%, 0.063 W, 0402	0402	CRCW040249R9FKED	Vishay-Dale		
R7, R8, R27, R28	4	34.8	RES, 34.8, 1%, 0.063 W, 0402	0402	CRCW040234R8FKED	Vishay-Dale		
R9, R10, R11, R13, R15, R16, R17, R18, R19, R21, R23, R24	12	0	RES, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
R12, R14, R20, R22	4	75.0	RES, 75.0, 1%, 0.063 W, 0402	0402	CRCW040275R0FKED	Vishay-Dale		
SH-J1_2-OPEN, SH-J10_2-OPEN	2	1x2	Shunt, 100mil, Gold plated, Black		382811-6	AMP		
T1, T2, T3, T4	4		RF Transformer, 50 ohm, 4.5 to 3000 MHz, TH	3.81x3.81mm	TC1-1-13MX+	Minicircuits		
TP1, TP4	2		Test Point, Multipurpose, White, TH	White Multipurpose Testpoint	5012	Keystone		
TP2	1	Black	Test Point, TH, Multipurpose, Black		5011	Keystone Electronics		
TP3	1	Red	Test Point, TH, Multipurpose, Red		5010	Keystone Electronics		
U1	1		Dual, 7-GHz, Low-Noise, Low-Power, Fully-Differential Amplifier, LMH3404RGE	LMH3404RGE	LMH3404IRGER	Texas Instruments	LMH3404IRGET	Texas Instruments
C4, C9, C14, C15	0		CAP, CERM, xxxF, xxV, [TempCo], xx%, [PackageReference]	0402	Used in BOM report	Used in BOM report	-	-
R1, R3, R30, R31	0		RES, xxx ohm, x%, xW, [PackageReference]	0402	Used in BOM report	Used in BOM report	-	-
R2, R4, R29, R32	0	0	RES, 0, 5%, 0.063 W, 0402	0402	CRCW04020000Z0ED	Vishay-Dale		
	Notes:	Unless otherwise noted in the Alternate Part Number and/or Alternate Manufacturer columns, all parts may be substituted with equivalents.						

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- 3 *Regulatory Notices:*

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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.

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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.

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- *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

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). 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.

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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:

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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.

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If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

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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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.

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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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