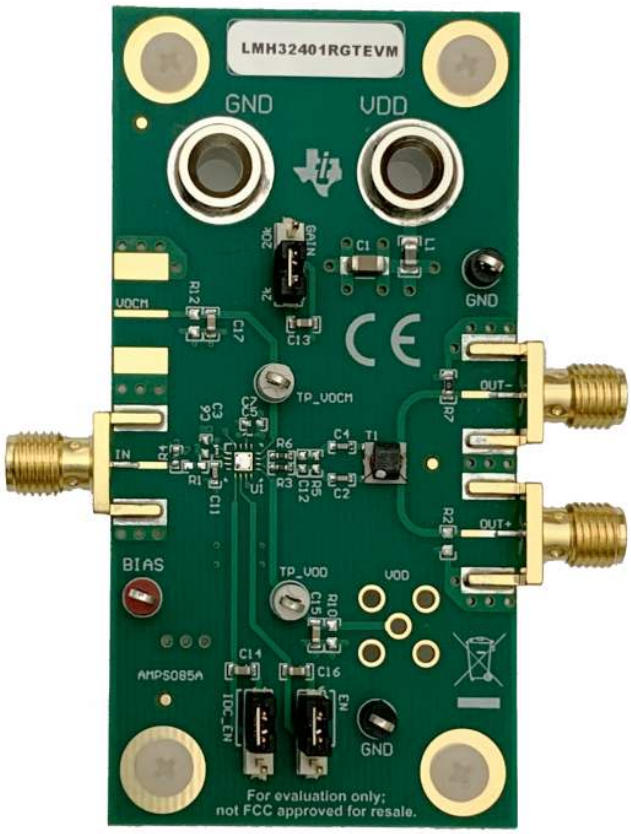
User's Guide
SBOU233–October 2019

LMH32401RGTEVM Evaluation Module



This user's guide describes the characteristics, operation, and use of the LMH32401RGTEVM. This evaluation module (EVM) is an evaluation and development kit for evaluating the LMH32401IRGT device, a programmable-gain, single-ended input to differential output transimpedance amplifier for light detection and ranging (LIDAR) applications and laser distance measurement systems. A complete circuit description as well as schematic diagram and bill of materials are included in this document.

Throughout this document, the abbreviation *EVM* and the term *evaluation module* are synonymous with the LMH32401RGTEVM.

The following related documentation is available through the Texas Instruments web site at www.ti.com.

Related Documentation

Device	Literature Number
LMH32401 data sheet	SBOS965

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Trademarks

1 Introduction

The LMH32401RGTEVM is an evaluation module (EVM) for the LMH32401IRGT differential output transimpedance amplifier. The EVM features a transformer to convert the output to a 50-Ω single-ended connection for easy measurement with standard test equipment, and the option to convert to fully-differential DC-coupled signals. The input is 50-Ω matched and configured by default to receive a voltage input that is converted to a current through a 2-kΩ resistor, but can be reconfigured to receive a true current input with optional photodiode bias connections on the back of the board. The EVM also includes easy-to-use jumpers to control the device gain, input bias current cancellation, and shutdown functions.

1.1 Features

- Configured for single-ended voltage input and output with 50-Ω matched SMA connections
- Includes options to connect a current input source with bias connections for edge mounting photodiodes
- Optional DC-coupled differential output configuration
- Jumpers included for easy control of gain, bias current cancellation, and power-down
- Designed for single 3.3-V supply operation

1.2 EVM Specifications

Table 1 lists the typical performance specifications for the LMH32401RGTEVM.

Table 1. LMH32401RGTEVM Specifications

Specification	Typical Value Range
Single-supply voltage range (VEE = ground)	3 V to 3.45 V
Quiescent current	29 mA
Output voltage swing (VCC = 3.3 V, 100-Ω load)	5 V_{PP}
Linear output current (VCC = 3.3 V, 25-Ω load)	26.6 mA

2 Power Connections

The LMH32401RGTEVM is equipped with a wire socket to easily connect power. The positive supply input is labeled VDD and ground is labeled GND.

3 Input and Output Connections

The LMH32401RGTEVM is equipped with SMA connectors for easy connection of signal generators and analysis equipment. As shipped, the EVM is configured for a single-ended input and output, both with 50-Ω termination. The differential output of the amplifier is converted to a single-ended output through transformer T1 on the board. OUT+ is the output connector for single-ended output signals, and is terminated to 50-Ω single-ended. To use the EVM with a DC-coupled differential output, remove resistor R7 and transformer T1, and short the connections across the removed transformer input and outputs. When converting to differential, the output resistors may need to be modified to achieve a desired impedance match. For more details and instructions on how to reconfigure the EVM, see the applications section, schematics, and layouts in the *LMH32401 500-MHz, Programmable Gain, Differential Output Transimpedance Amplifier* data sheet.

3.1 Gain Control

The amplifier gain can be adjusted using the GAIN jumper on the board to switch between the 2-kΩ and 20-kΩ gain settings. By default, the EVM has R1 populated with a 2-kΩ resistor, which creates an effective voltage gain of 1 V/V and 10 V/V, respectively, for the two different gain settings.

3.2 Input DC Current Cancellation

The LMH32401 device features an input DC current cancellation circuit that is designed to remove any DC current that is present from a typical current input device such as a photodiode. This feature can be enabled or disabled using the IDC_EN jumper on the board. By default, the DC current cancellation circuit is enabled.

3.3 Enable Function

The LMH32401 device includes an optional disable function to put the device in a low-power mode when it is not being used. The EVM ships with jumper EN that can be used to easily enable and disable the device. By default, the board ships with the device enabled.

3.4 Optional VOCM Pin Connection

The common-mode voltage of the differential outputs of the amplifier can be controlled using the VOCM test point or optional SMA connector. If left unconnected, the amplifier output common mode will default to 1.1 V. By default, the transformer on the EVM will AC couple the output of the device and remove the effect of the output common-mode voltage. To match the board to a device that requires DC outputs with a specified common mode (such as an analog to digital converter) the transformer must be removed.

3.5 Option VOD Connection

The LMH32401 device also features a differential output offset pin that controls the DC differential offset of the two outputs. The EVM features a test point VOD as well as an optional through-hole SMA connector footprint to drive this pin. If left floating, the DC output differential voltage defaults to 510 mV. This feature is designed to compensate for unipolar input signals to achieve the maximum dynamic range of the differential outputs. For more information see the *LMH32401 500-MHz, Programmable Gain, Differential Output Transimpedance Amplifier* data sheet.

4 Optional EVM Configuration for Photodiode Input

The LMH32401RGTEVM features an optional configuration to accept a photodiode input in a typical TO style package. By removing the IN SMA connector, R4, and C11, and shorting C10 and R1, the trace from IN is shorted to the input of the device. Along with traces A, B, and C on the bottom of the board, the input trace can be used to connect a common three-terminal photodiode in a TO package. The photodiode can be mounted over the edge of the board where the cathode can be connected to the input of the amplifier and the case and anode connections can be soldered to any of the three traces on the bottom of the board. The A, B, and C traces can then be configured to connect to either ground or the BIAS test point where an external bias voltage can be applied. Table 2 shows a list of the resistor connections that can be shorted to connect the traces to bias or ground. By default, the EVM has trace A connected to the bias test point and trace B connected to ground.

Table 2. EVM Bottom-Side Diode Trace Connections(1)

Trace	Short to Connect to Bias	Short to Connect to Ground
A	R9	R8
B	R13	R11
C	R15	R14

(1) Each trace should only be shorted to either bias or ground. Do not short the traces to both bias and ground simultaneously or a power-supply short could occur.

5 Board Layout

Figure 1 to Figure 4 illustrate the board layers in top-to-bottom order.

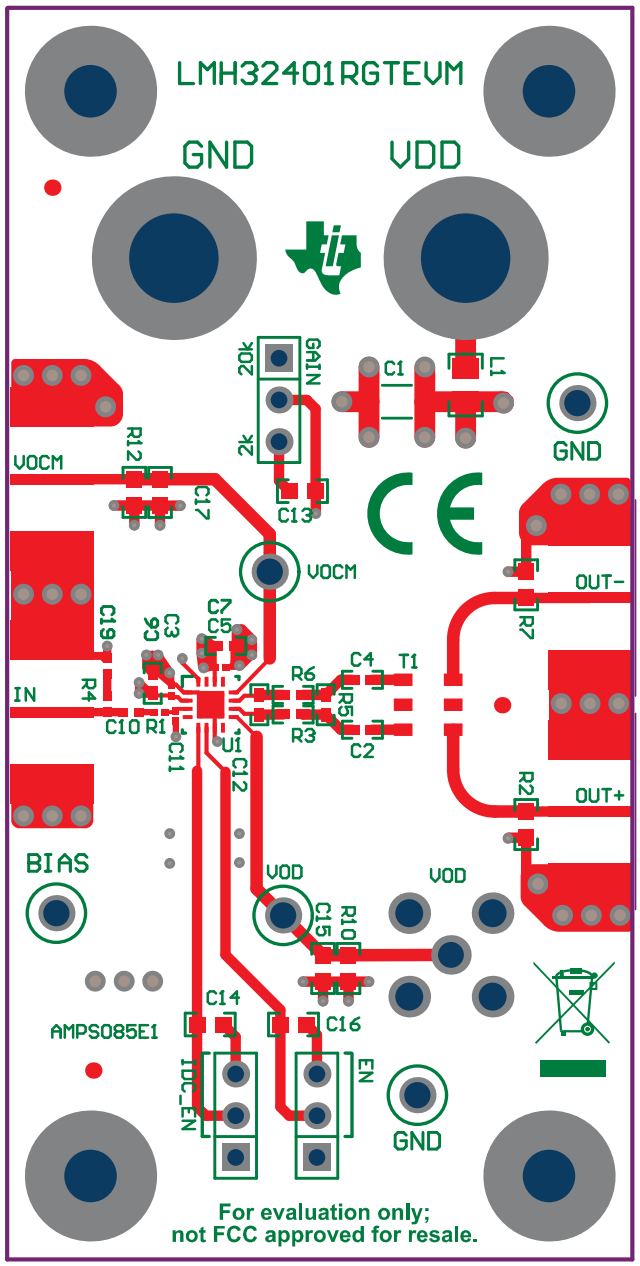

Figure 1. Top Layer

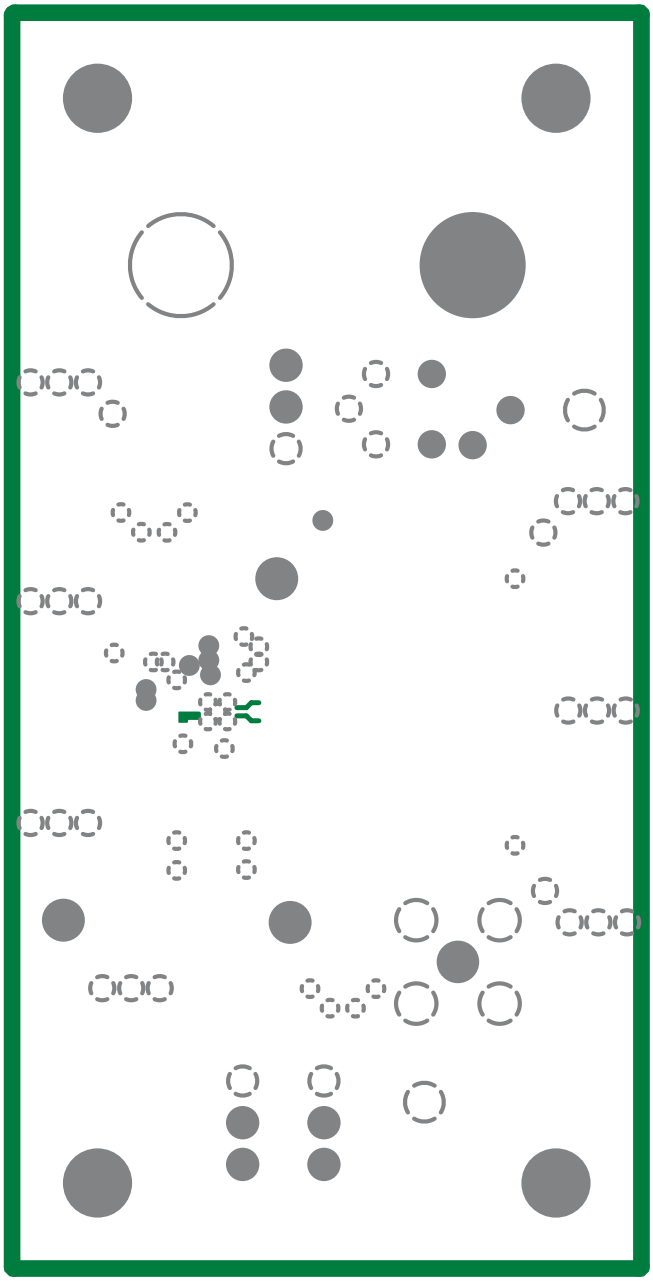

Figure 2. Ground Layer

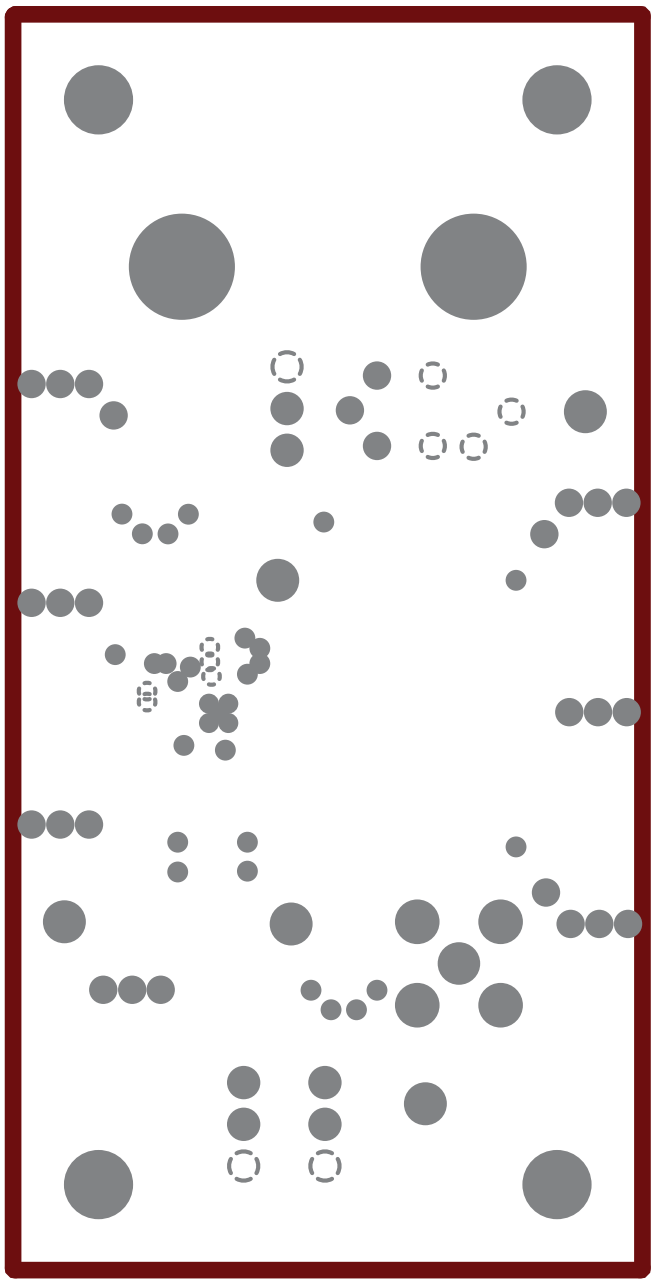

Figure 3. Power Layer

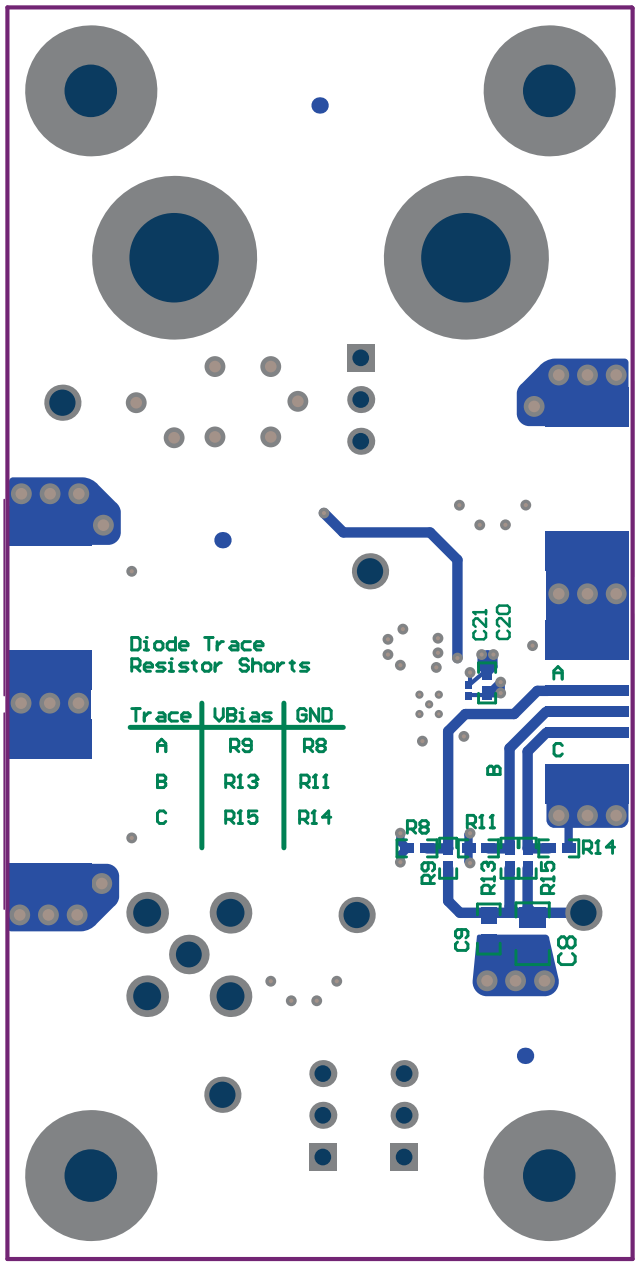

Figure 4. Bottom Layer

6 Schematic and Bill of Materials

This section provides the schematic and bill of materials (BOM) for the LMH32401RGTEVM.

6.1 Schematic

Figure 5 shows the EVM schematic.

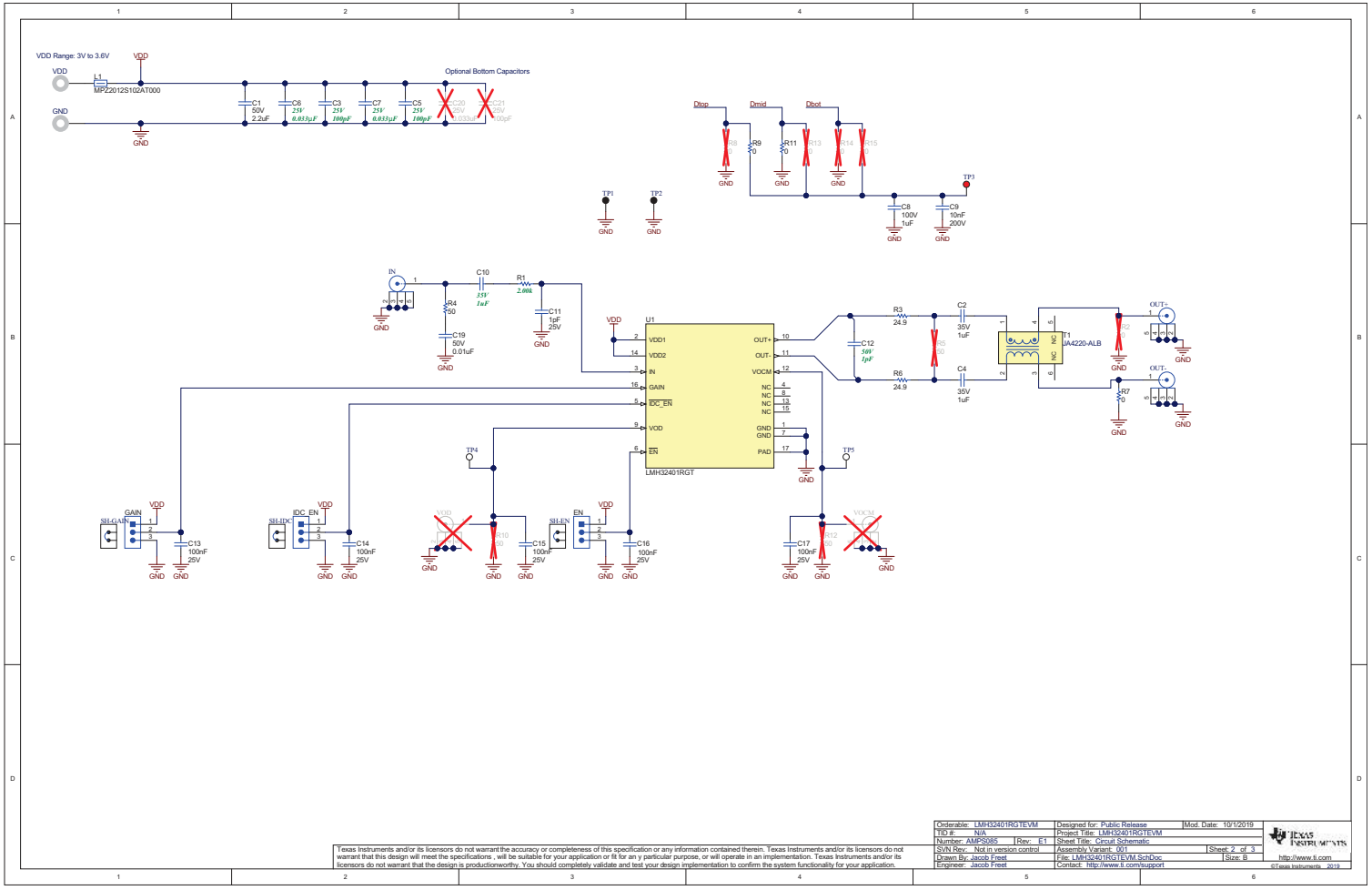

Figure 5. LMH32401RGTEVM Schematic

6.2 Bill of Materials

Table 3 lists the EVM BOM.

Table 3. Bill of Materials

Item #	Designator	Qty	Value	Part Number	Manufacturer	Description	Package Reference
2	C1	1	2.2 µF	GCM31CR71H225KA55L	MuRata	CAP, CERM, 2.2 µF, 50 V, ±10%, X7R, AEC-Q200 Grade 1, 1206	1206
3	C2, C4, C10	3	1 µF	GRM155R6YA105KE11D	MuRata	CAP, CERM, 1 µF, 35 V, ±10%, X5R, 0402	402
4	C3, C5	2	100 pF	CC0201JRNPO8BN101	Yageo	CAP, CERM, 100 pF, 25 V, ±5%, C0G/NP0, 0201	201
5	C6, C7	2	0.033 µF	CC0402KRX7R8BB333	Yageo	CAP, CERM, 0.033 µF, 25 V, ±10%, X7R, 0402	402
6	C8	1	1 µF	C2012X7S2A105K125AB	TDK	CAP, CERM, 1 µF, 100 V, ±10%, X7S, 0805	805
7	C9	1	0.01 µF	C0603C103K2RACTU	Kemet	CAP, CERM, 0.01 µF, 200 V, ±10%, X7R, 0603	603
8	C11	1	1 pF	GJM0335C1E1R0WB01D	MuRata	CAP, CERM, 1 pF, 25 V, ±5%, C0G/NP0, 0201	201
9	C12	1	1 pF	GJM1555C1H1R0BB01D	MuRata	CAP, CERM, 1 pF, 50 V, ±10%, C0G/NP0, 0402	402
10	C13, C14, C15, C16, C17	5	0.1 µF	06033C104KAT2A	AVX	CAP, CERM, 0.1 µF, 25 V, ±10%, X7R, 0603	603
11	C19	1	0.01 µF	GCM155R71H103KA55D	MuRata	CAP, CERM, 0.01 µF, 50 V, ±10%, C0G/NP0, 0402	402
12	EN, GAIN, IDC_EN	3		PBC03SAAN	Sullins Connector Solutions	Header, 100 mil, 3 × 1, Gold, TH	PBC03SAAN
13	GND, VDD	2		575-4	Keystone	Standard Banana Jack, Uninsulated, 5.5 mm	Keystone_575-4
14	H1, H2, H3, H4	4		NY PMS 440 0025 PH	B&F Fastener Supply	Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw
15	H5, H6, H7, H8	4		1902C	Keystone	Standoff, Hex, 0.5"L #4-40 Nylon	Standoff
16	IN, OUT-, OUT+	3		142-0701-851	Cinch Connectivity	Connector, End launch SMA, 50 Ω, SMT	SMA End Launch
17	L1	1	1000 Ω	MPZ2012S102AT000	TDK	Ferrite Bead, 1000 Ω @ 100 MHz, 1.5 A, 0805	805
18	R1	1	2.00 kΩ	CRCW02012K00FKED	Vishay-Dale	RES, 2.00 k, 1%, 0.05 W, 0201	201
19	R3, R6	2	24.9	CRCW040224R9FKED	Vishay-Dale	RES, 24.9, 1%, 0.063 W, 0402	402
20	R4	1	50	FC0402E50R0BTBST1	Vishay Thin Film	RES, 50, 0.1%, 0.5 W, 0402	402
21	R7	1	0	CRCW06030000Z0EA	Vishay-Dale	RES, 0, 5%, 0.1 W, 0603	603
22	R9, R11	2	0	CRCW04020000Z0ED	Vishay-Dale	RES, 0, 5%, 0.063 W, 0402	402
23	SH-EN, SH-GAIN, SH-IDC	3	1 × 2	SNT-100-BK-G	Samtec	Shunt, 100mil, Gold plated, Black	Shunt
24	T1	1	15 µH	JA4220-ALB	Coilcraft CPS	Transformer, 15 µH, SMT	3.81x3.81mm
25	TP1, TP2	2		5006	Keystone	Test Point, Compact, Black, TH	Black Compact Testpoint
26	TP3	1		5005	Keystone	Test Point, Compact, Red, TH	Red Compact Testpoint
27	TP4, TP5	2		5007	Keystone	Test Point, Compact, White, TH	White Compact Testpoint
28	U1	1		LMH32401RGT	Texas Instruments	Programmable Gain, Differential Output Transimpedance Amplifier, RGT0016C (VQFN-16)	RGT0016C

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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*

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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.

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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.

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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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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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4.2 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.

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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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