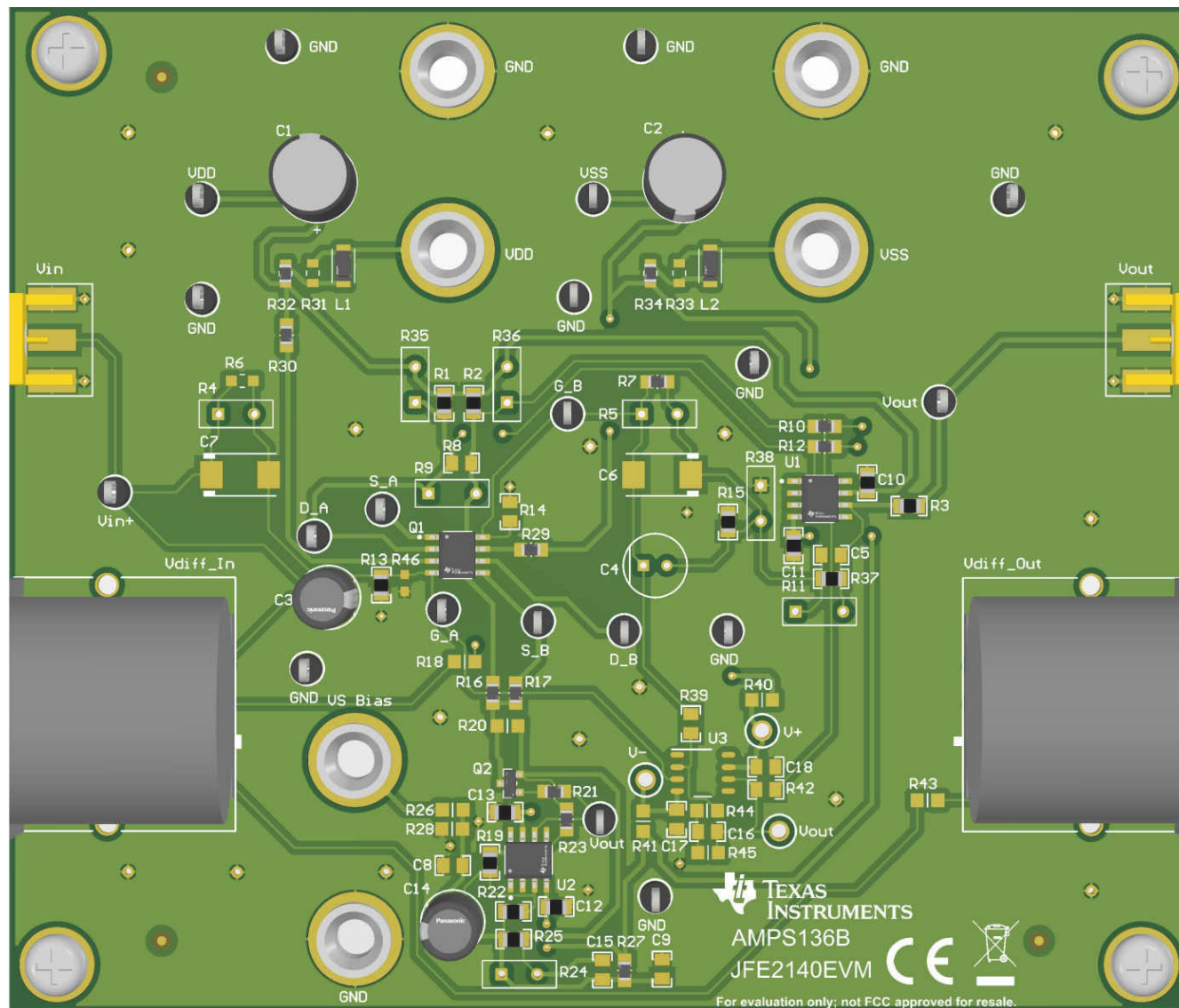


User's Guide

JFE2140 Evaluation Module



ABSTRACT



This user's guide contains information and support documentation for the [JFE2140](#) evaluation module (EVM). Included are the circuit description, schematic, and bill of materials of the JFE2140EVM. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the JFE2140EVM.

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1 Overview

This section provides a basic description of the devices used, kit contents, EVM limitations, and related documentation.

1.1 JFE2140 Overview

The [JFE2140](#) is a Burr-Brown™ matched-pair, discrete JFET built using Texas Instruments' modern, high performance, analog bipolar process. The JFE2140 features performance not previously available in older discrete JFET technologies. The JFE2140 offers excellent noise performance across all current ranges, where the quiescent current is adjustable from 50 μ A to 20 mA. When biased at 5 mA, the device yields 0.9 nV/ $\sqrt{\text{Hz}}$ of input-referred noise.

1.2 JFE2140EVM Overview

The JFE2140EVM provides a basic functional evaluation of the [JFE2140](#) device. Key EVM features include:

- SMA and XLR connections for input and output
- Convenient test points to all pertinent nodes
- Resistor and capacitor through-hole and surface-mount pad options for critical signal paths
- Banana plug connections for power supplies and bias nodes

1.2.1 Kit Contents

[Table 1-1](#) details the contents of the EVM kit. Contact the nearest TI Product Information Center if any component is missing JFE2140EVM.

Table 1-1. Contents of JFE2140EVM Kit

Item	Quantity
JFE2140EVM evaluation board PCB	1

1.3 Related Documentation

[Table 1-2](#) lists the documents that provide information about TI's integrated circuits and support tools for the JFE2140EVM.

Table 1-2. Related Documentation

Document	Literature Number
JFE2140 product data sheet	SLPS730
OPA202 product data sheet	SBOS812

1.4 Evaluation Module Limitations

The default JFE2140EVM configuration operates within the specified voltage and current regions of the [JFE2140](#) N-channel JFET and the [OPA202](#) op amp. User modifications can be made to the JFE2140EVM. Reference the respective product data sheets to maintain the specified operating conditions for each device. In addition to observing the specified current and voltage levels, use proper electrostatic discharge precautions when handling and applying the EVM.

1.5 Electrostatic Discharge Caution

CAUTION

Many of the components on the JFE2140EVM are susceptible to damage by electrostatic discharge (ESD). Use proper ESD handling precautions when unpacking and handling the EVM. Failure to observe ESD handling procedures can result in damage to the EVM components.

2 Getting Started

This section explains the connectors and test points, and details the basic EVM functionality.

2.1 Power Supplies

By default, the JFE2140EVM operates from a split supply voltage of $V_{DD} = 5\text{ V}$ and $V_{SS} = -5\text{ V}$.

2.2 Input

The input to the JFE2140EVM interfaces high-impedance sources to the gate of the JFET. The input is ac-coupled with capacitor C3, and the dc gate bias voltage is set with resistor R13. A single SMA connector and V_{in} test point are available at the input to allow for an easy interface with signal generators or other equipment. [Figure 3-2](#) shows that the midband gain of the circuit is approximately 1000 V/V or 60 dB. For example, a 1-mVpp, 1-kHz input signal produces an approximately 1-Vpp, 1-kHz signal measured on the output. The [Design tools and simulation](#) tab on the [JFE2140](#) web folder assists with other configurations.

2.3 Output

Monitor the EVM output by using the SMA connector labeled V_{out} or the test point labeled V_{out} . Resistor R3 is used as an isolation resistor on the OPA202 output to improve circuit stability while driving high capacitive loads greater than 1 nF. Resistor R3 can be removed if no capacitive load drive is required.

2.4 Capacitors

When altering the JFE2140EVM default configuration, consider the polarity of tantalum and electrolytic capacitors. The JFE2140EVM is populated with bipolar electrolytic capacitors for capacitors C3 and C14.

3 Application Circuit

The JFE2140EVM can be configured in standard JFET circuits for evaluation. For typical applications, see the [JFE2140 data sheet](#).

3.1 Ultra-Low-Noise Preamplifier

Figure 3-1 shows a simplified schematic of the EVM for the purpose of this application circuit. Figure 4-1 shows the full default configuration of the JFE2140EVM. The EVM operates on a split supply of $V_{DD} = 5\text{ V}$ and $V_{SS} = -5\text{ V}$. The output voltage, V_{out} , settles to approximately midsupply $\pm 2\text{ V}$.

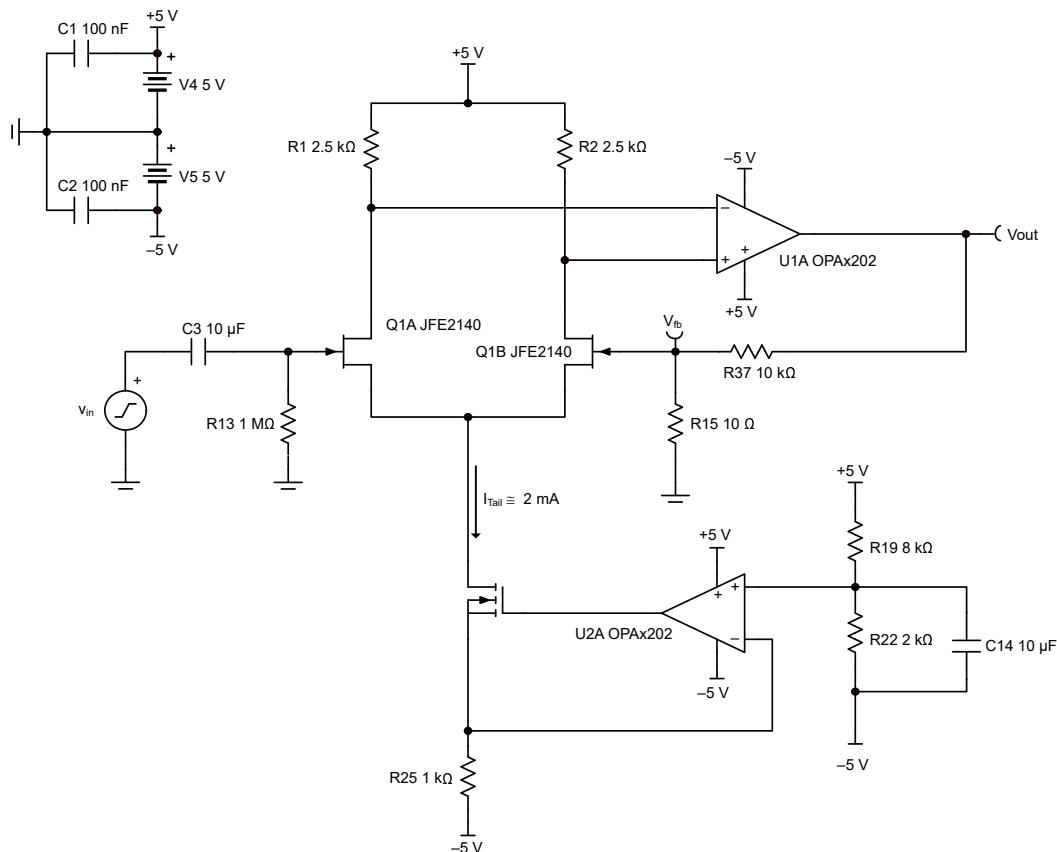


Figure 3-1. Preamp With JFE2140 Front End in a Closed-Loop Circuit

Figure 3-1 shows that tail current $I_{Tail} \approx 2\text{ mA}$. This figure also shows that resistors R37 and R15 form the beta feedback network that provides a closed-loop gain of 1001 V/V, or approximately 60 dB. Figure 3-2 shows the result. The high gain provided by the EVM is designed for small-signal amplification, but can also be used to measure the low V_{GS} mismatch of the JFE2140. A V_{GS} mismatch of 1 mV results in a dc output voltage of 1 V.

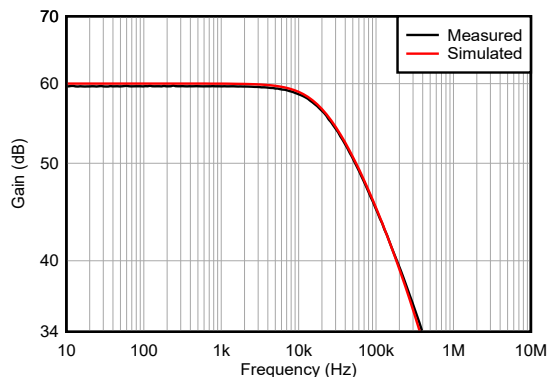


Figure 3-2. Gain vs Frequency

Figure 4-1 shows an optional integrator circuit using the OPA145 that helps reduce V_{GS} mismatch. The integrator circuit monitors both gates of the JFE2140 and feeds back a current to one drain. The integrator circuit path uses components U3A, R39-R42, R44, R45, and C16–C18. Make sure that resistor R42 is large enough to maintain the dc bias voltage of the drain on JFET Q1B. The EVM default configuration uses SMA connector J8 for single-in and single-out signal amplification. XLR connectors Vdiff_In and Vdiff_Out are provided as an option for differential-signal amplification. When using the EVM for differential-signal amplification, remove composite amplifier U1A and resistors R37 and R15. Component footprints R18, R14, and C4 are provided for the second input. A path for earth ground is provided through resistor R43.

4 Schematic, PCB Layout, and Bill of Materials

4.1 Schematic

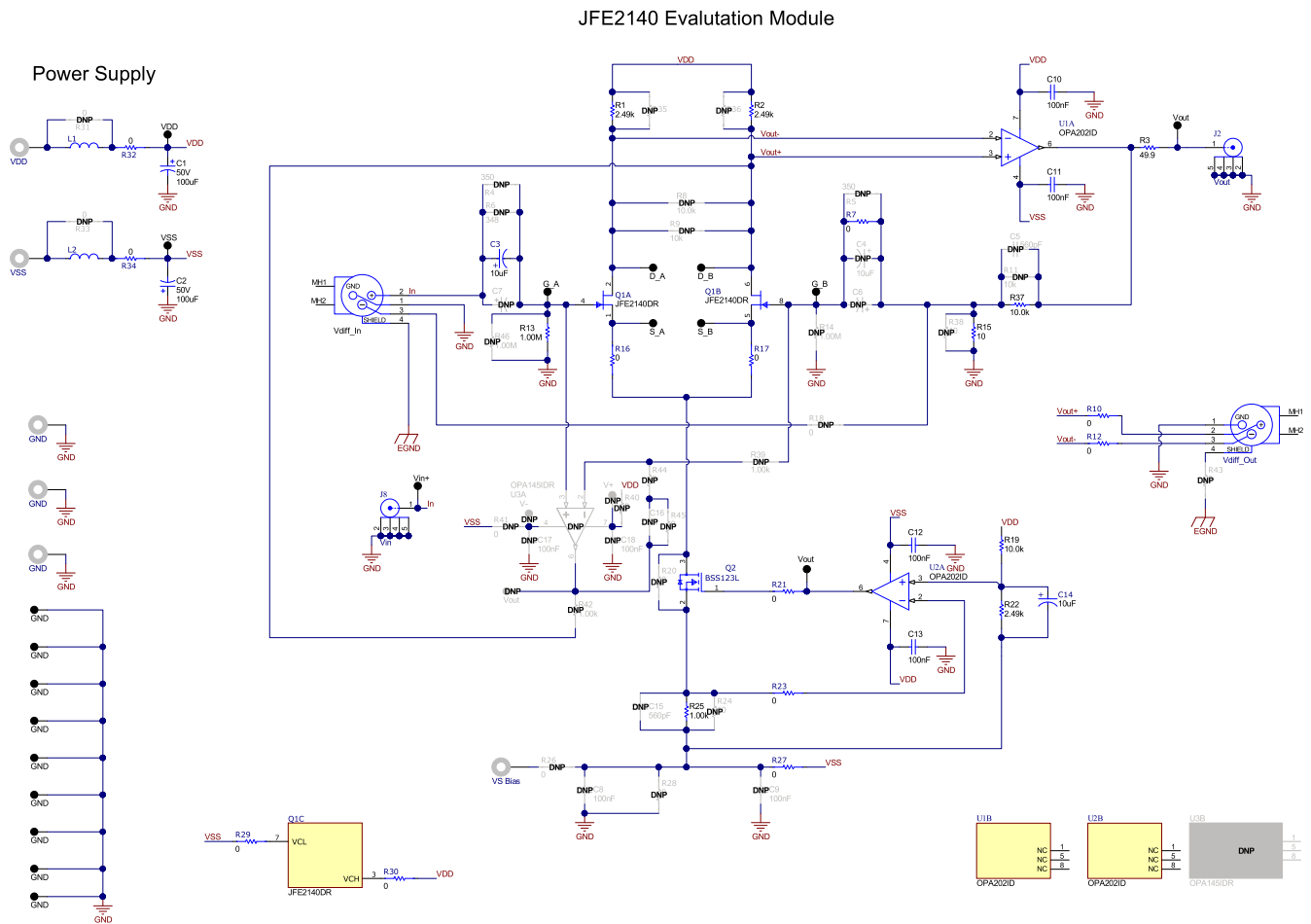


Figure 4-1. JFE2140EVM Default Configuration Schematic

4.2 PCB Layout

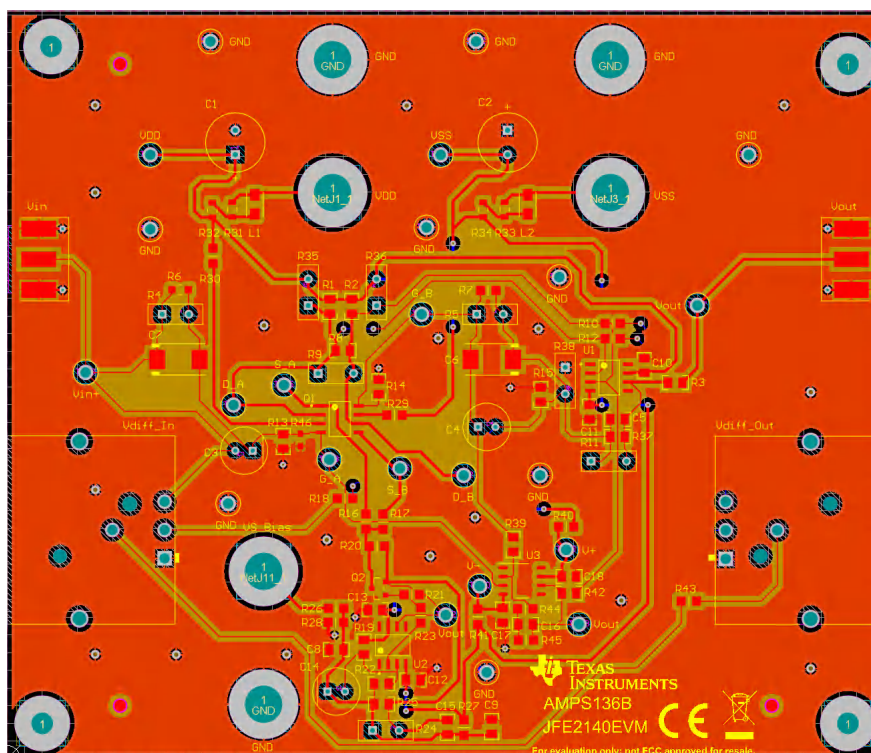


Figure 4-2. JFE2140EVM PCB Layout

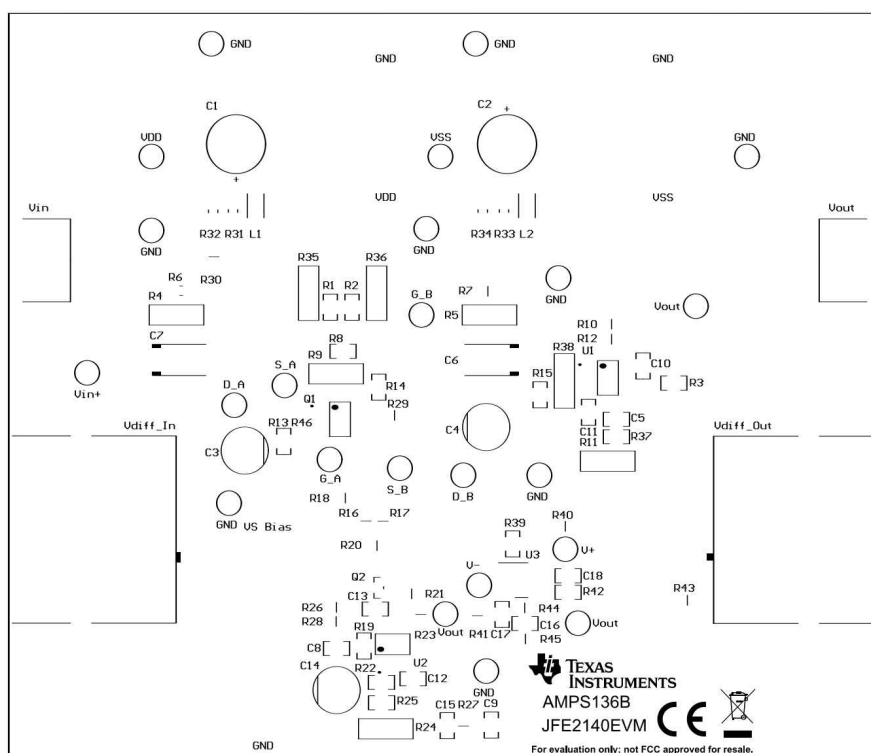


Figure 4-3. JFE2140EVM Top Overlay

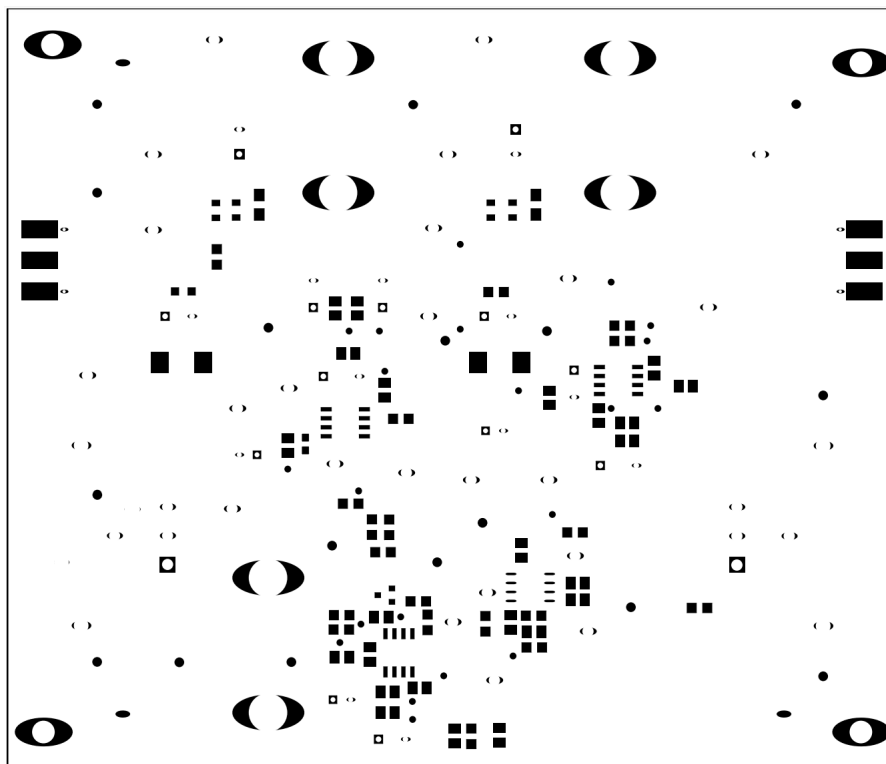


Figure 4-4. JFE2140EVM Top Solder Mask

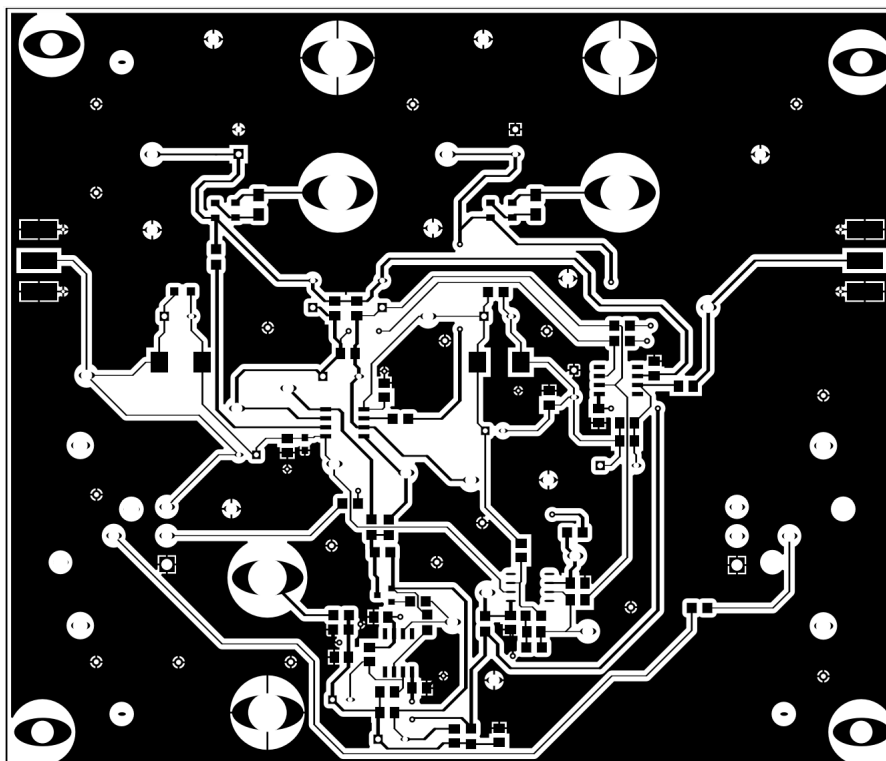


Figure 4-5. JFE2140EVM Top Layer

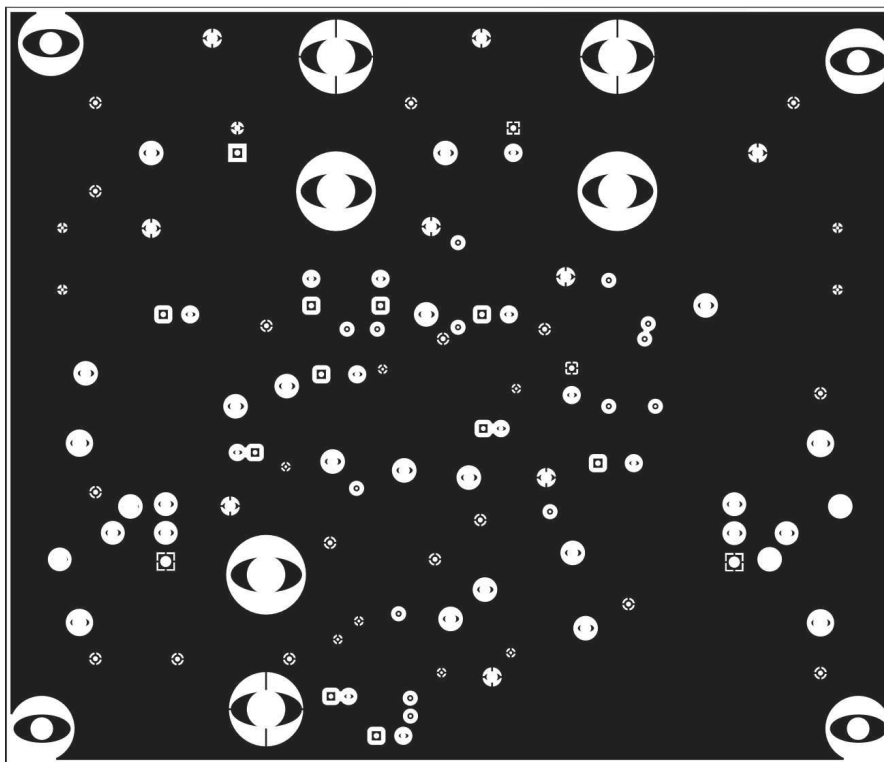


Figure 4-6. JFE2140EVM Signal Layer 1

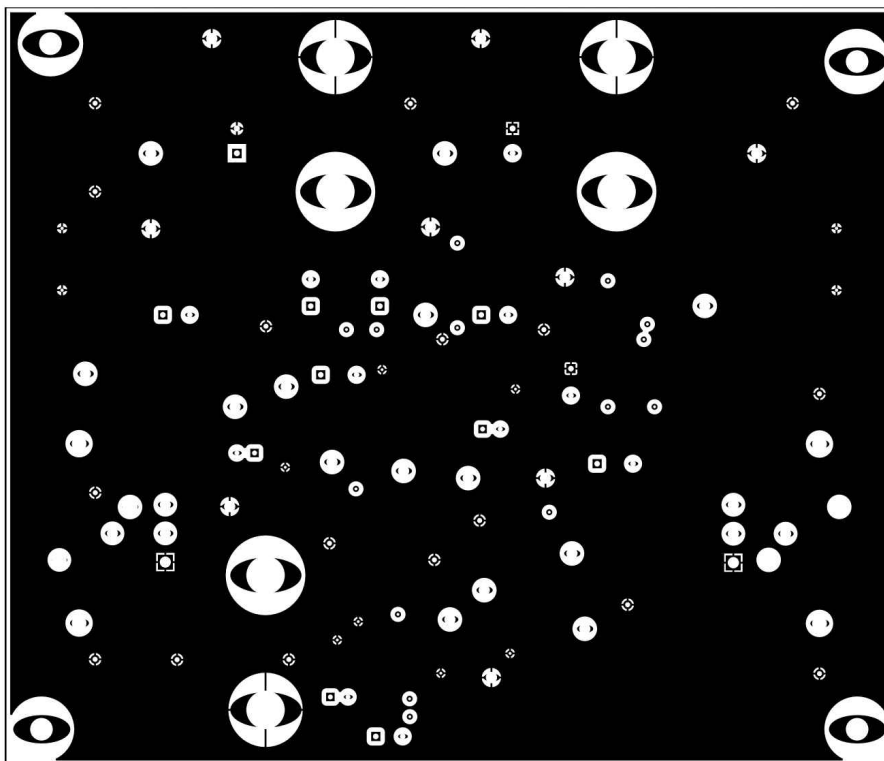


Figure 4-7. JFE2140EVM Signal Layer 2

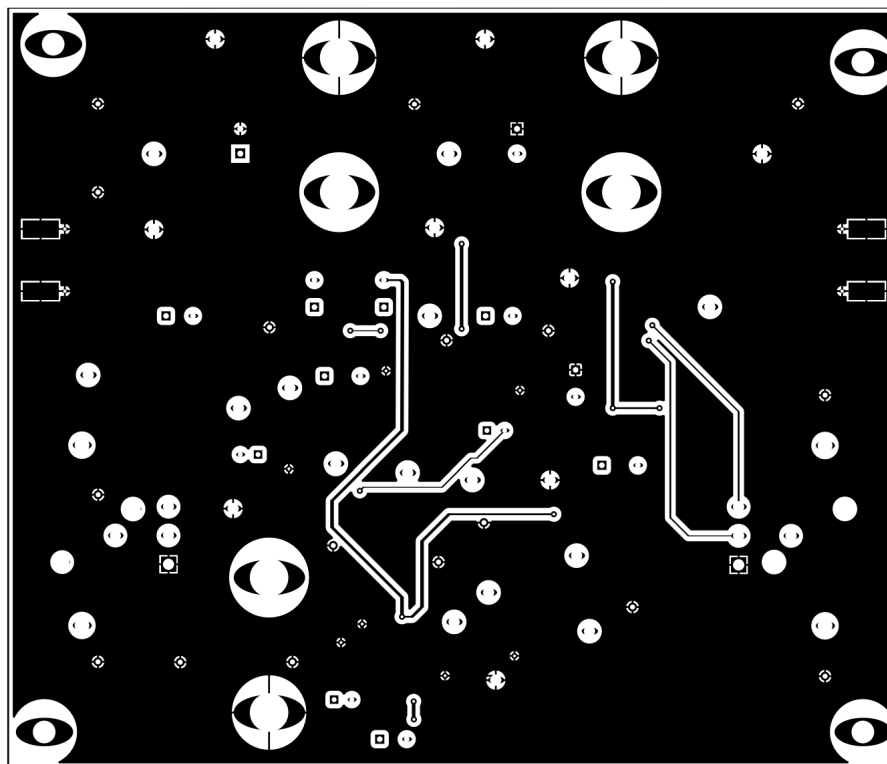


Figure 4-8. JFE2140EVM Bottom Layer

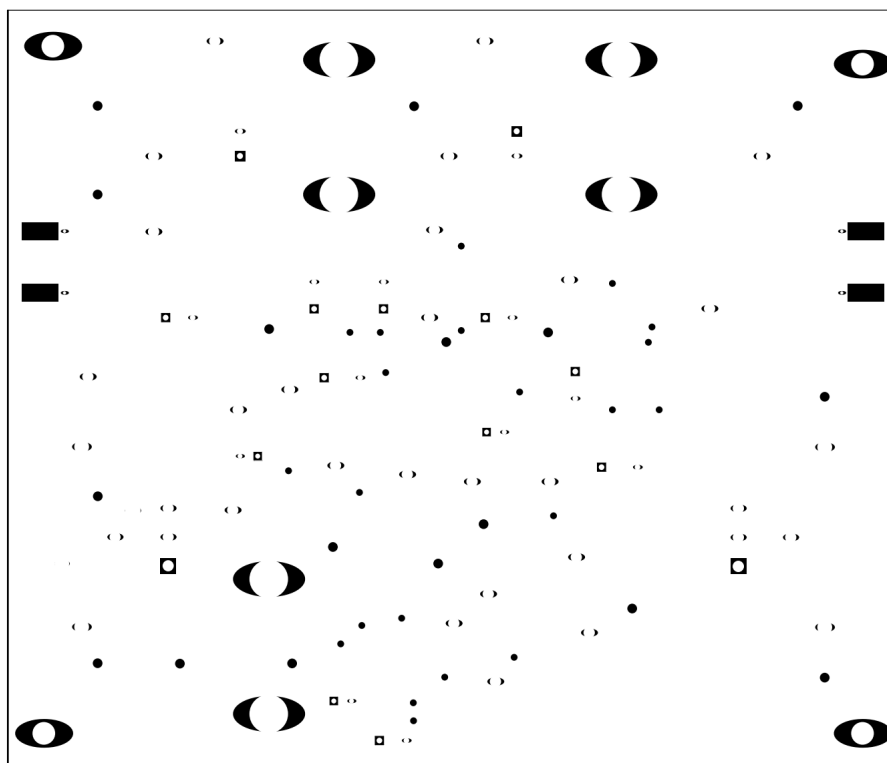


Figure 4-9. JFE2140EVM Bottom Solder Mask

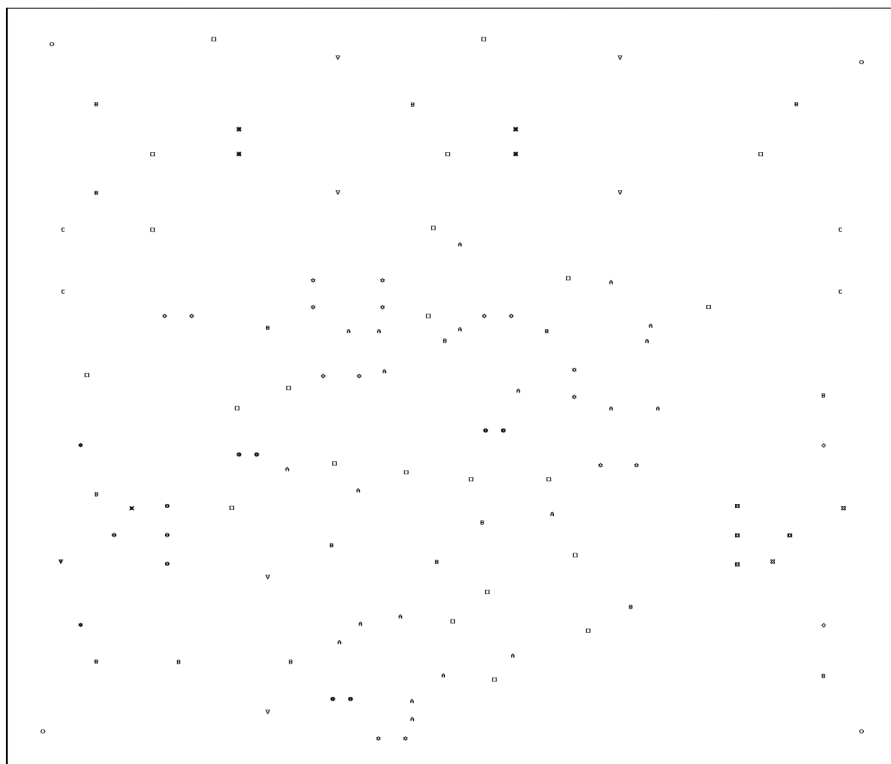


Figure 4-10. JFE2140EVM Drill Drawing

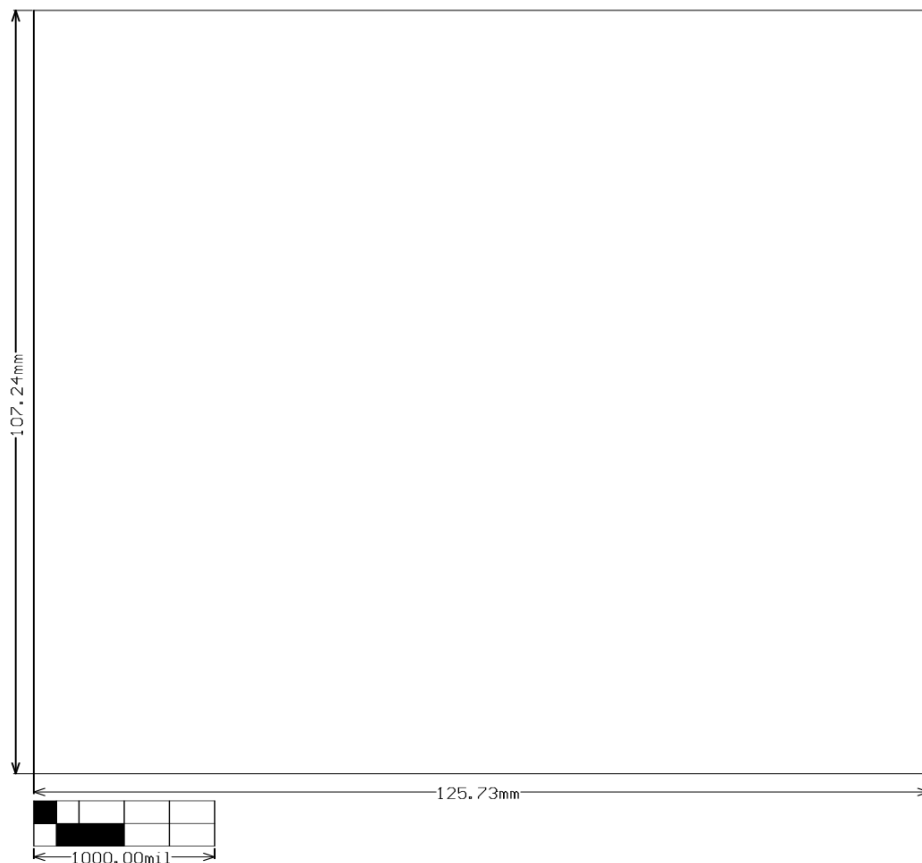


Figure 4-11. JFE2140EVM Board Dimensions

4.3 Bill of Materials

The [Table 4-1](#) lists the complete bill of materials for the JFE2140EVM. Data for each component are available from the corresponding manufacturer web site.

Table 4-1. JFE2140EVM BOM

Designator	Quantity	Value	Description	PartNumber	Manufacturer
C1, C2	2	100 μ F	CAP, AL, 100 uF, 50 V, +/- 20%, 0.17 ohm, TH	50YXJ100MT78X11.5	Rubycon
C3, C14	2	10 μ F	Cap Aluminum 10 uF 50 V 20 % (6.3 X 11.2 mm) Radial 2.5 mm 50 mA 2000 hr 85 C Bulk	ECE-A1HN100U	Panasonic
C10, C11, C12, C13	4	0.1 μ F	CAP, CERM, 0.1 uF, 50 V, +/- 10 %, X7R, AEC-Q200 Grade 0, 0805	C0805C104K5RACAUTO	Kemet
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	1902C	Keystone
J1, J3, J4, J7, J9, J11	6		Standard Banana Jack, Uninsulated, 5.5mm	575-4	Keystone
J2, J8	2		Connector, End launch SMA, 50 ohm, SMT	142-0701-801	Cinch Connectivity
J12	1		Receptacle, 160 mil, 3 Position, R/A, TH	PQG3FRA112	Switchcraft
J13	1		Receptacle, Male, 3 Position, R/A, TH	PQG3MRA112	Switchcraft
L1, L2	2	100 μ H	Wire Wound Ferrite Inductor for Power Lines 100 μ H \pm 10 % 15.6 Ohm 80 mA 1206	LQH31CN101K03L	Murata
Q1	1		Ultra-Low Noise, Matched, Dual, Low-Gate Current, Discrete, Audio, N-Channel JFET, SOIC8	JFE2140DR	Texas Instruments
Q2	1		N-Channel 100 V 170 mA (Ta) 360 mW (Ta) Surface Mount SOT-23-3	BSS123L	onsemi
R1, R2, R22	3	2.49 k Ω	RES, 2.49 k, 0.1%, 0.125 W, 0805	RT0805BRD072K49L	Yageo America
R3	1	49.9 Ω	RES, 49.9, 1%, 0.25 W, AEC-Q200 Grade 0, 0805	RNCP0805FTD49R9	Stackpole Electronics Inc
R7, R10, R12, R16, R17, R21, R23, R27, R29, R30	10	0 Ω	0 Ohms Jumper 0.5W, 1/2W Chip Resistor 0805 (2012 Metric) Automotive AEC-Q200 Metal Foil	HCJ0805ZT0R00	Stackpole
R13	1	1.00 M Ω	RES, 1.00 M, 0.1%, 0.125 W, AEC-Q200 Grade 0, 0805	ERA-6AEB105V	Panasonic
R15	1	10.0 Ω	RES, 10.0, 0.1%, 0.1 W, 0805	CRT0805-BY-10R0ELF	Bourns
R19	1	10.0 k Ω	RES, 10.0 k, 0.1%, 0.125 W, 0805	RT0805BRD0710KL	Yageo America
R25	1	1.00 k Ω	RES, 1.00 k, 0.1%, 0.25 W, 0805	RP73PF2A1K0BTDF	TE Connectivity
R32, R34	2	0 Ω	RES SMD 0 OHM JUMPER 1/8W 0805	RC0805FR-070RL	Yageo
R37	1	10.0 k Ω	RES, 10.0 k, 0.1%, 0.125 W, 0805	RG2012P-103-B-T5	Susumu Co Ltd
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP21, TP22	20		Test Point, Multipurpose, Black, TH	5011	Keystone Electronics
U1, U2	2		General Purpose Amplifier 1 Circuit Rail-to-Rail 8-SOIC	OPA202ID	Texas Instruments

Table 4-1. JFE2140EVM BOM (continued)

Designator	Quantity	Value	Description	PartNumber	Manufacturer
C4	0	10 μ F	Cap Aluminum 10 uF 50 V 20 % (6.3 X 11.2mm) Radial 2.5 mm 50 mA 2000 hr 85 C Bulk	ECE-A1HN100U	Panasonic
C5, C15, C16	0	560 pF	CAP, CERM, 560 pF, 50 V, +/- 10%, X7R, 0805	08055C561KAT2A	AVX
C6, C7	0	100 μ F	CAP, Tantalum Polymer, 100 uF, 20 V, +/- 20%, 0.055 ohm, 7.3x4.3mm SMD	20TQC100MYF	Panasonic
C8, C9, C17, C18	0	0.1 μ F	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 0, 0805	C0805C104K5RACAUTO	Kemet
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A
R4, R5	0	350 Ω	Res Metal Foil 350 Ohm 0.01% 3/5W \pm 2ppm/ $^{\circ}$ C Molded RDL Thru-Hole Bulk	Y0007350R000T9L	Vishay
R6	0	348 Ω	348 Ohms \pm 0.1% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric) Automotive AEC-Q200 Thin Film	ERA-6AEB3480V	Panasonic Electronic Components
R8	0	10.0 k Ω	RES, 10.0 k, 0.1%, 0.125 W, 0805	RT0805BRD0710KL	Yageo America
R9, R11	0	10 k Ω	Res Metal Foil 10K Ohm 0.01% 0.6W Molded RDL Bulk	Y078510K0000T9L	Vishay
R14	0	1.00 M Ω	RES, 1.00 M, 0.1%, 0.125 W, AEC-Q200 Grade 0, 0805	ERA-6AEB105V	Panasonic
R18, R20, R26, R28, R40, R41, R43, R44, R45	0	0 Ω	0 Ohms Jumper 0.5W, 1/2W Chip Resistor 0805 (2012 Metric) Automotive AEC-Q200 Metal Foil	HCJ0805ZT0R00	Stackpole
R24, R38	0	10 Ω	Res Metal Foil 10 Ohm 0.05% 3/5W \pm 2ppm/ $^{\circ}$ C Molded RDL Thru-Hole Bulk	Y000710R0000A9L	Vishay
R31, R33	0	0 Ω	RES SMD 0 OHM JUMPER 1/8W 0805	RC0805FR-070RL	Yageo
R35, R36	0	500 Ω	500 Ohms \pm 0.01% 0.6W Through Hole Resistor Radial Moisture Resistant, Non-Inductive Metal Foil	Y0785500R000T9L	Vishay
R39, R42	0	1.00 k Ω	RES, 1.00 k, 0.1%, 0.25 W, 0805	RP73PF2A1K0BTDF	TE Connectivity
R46	0	1.00 M Ω	RES, 1.00 M, 0.1%, 0.063 W, 0603	CPF0603B1M0E1	TE Connectivity
TP19, TP20, TP23	0		Test Point, Multipurpose, Black, TH	5011	Keystone Electronics
U3	0		5.5 MHz, High Slew Rate, Low-Noise, Low-power, RRO Precision JFET Operational Amplifier, D0008A (SOIC-8)	OPA145IDR	Texas Instruments

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.
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 - 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/lscs/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。
http://www.tij.co.jp/lscs/ti_ja/general/eStore/notice_01.page

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

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

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

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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。

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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/lscs/ti_ja/general/eStore/notice_02.page
電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。 http://www.tij.co.jp/lscs/ti_ja/general/eStore/notice_02.page

3.4 European Union

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

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

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

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.

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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.

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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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