EVM User's Guide: LOG200EVM LOG200

LOG200 Evaluation Module

Description

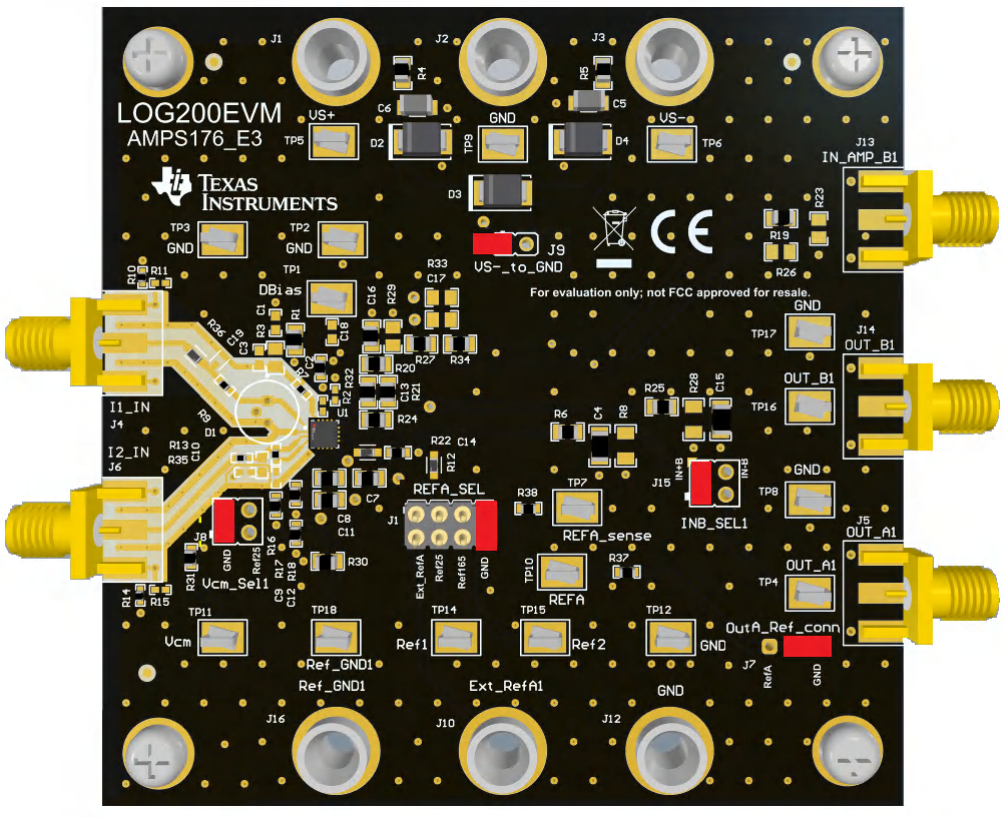
The LOG200 evaluation module (EVM) is a development platform for evaluating the LOG200, which is a precision, high-speed logarithmic amplifier with integrated photodiode bias and dark current correction. The LOG200 is optimized for current measurements across 160 dB wide dynamic range, over several decades with unparalleled speed and accuracy.

Features

- High-accuracy logarithmic transfer function
- Logarithmic ratio internally set to 250 mV/decade of current-to-voltage conversion
- Footprint for photosensor connection
- Integrated photodiode bias and dark current correction adaptive biasing circuit
- Integrated precision 1 µA current reference
- Integrated precision 1.65 V and 2.5 V voltage references
- Single supply (+5 V) or dual supply (±5 V) operation
- Sub-miniature version A (SMA) connectors and test points allow for quick tests

Applications

- Optical modules
- Inter_DC interconnect
- Optical network terminal unit
- Chemistry/gas analyzer



LOG200EVM Hardware Board

1 Evaluation Module Overview

1.1 Introduction

The LOG200EVM is the evaluation module (EVM) for the LOG200 precision, high-speed logarithmic amplifier. The device features two logarithmic amplifiers followed by a high-accuracy differential amplifier to convert current signals into a single-ended voltage that represents the log-compressed ratio of the two currents. The log amplifier ratio is internally set to 250 mV/decade of current-to-voltage conversion.

The LOG200 device integrates an uncommitted high-speed amplifier to allow the output to be configured for differential or filtered responses.

The LOG200EVM operates over a 4.5 V to 12 V range unipolar supply or dual supply of ±2.25V to ±6 V supply. See Table 2-2 for details. SMA and Test points provide convenient access to all critical functions of the LOG200.

Revision A / Revision E3 of LOG200EVM add a low-pass RC filter (R18, C12) between the VCM and REF25 connection through Jumper J8, and additional passive component footprints for flexibility. For a full schematic of the LOG200EVM and revision details, see Figure 3-1.

1.2 Kit Contents

Table 1-1. LOG200EVM Kit Contents

Item	Description	Quantity
LOG200EVM	PCB	1

1.3 Specification

The LOG200EVM offers the following features:

- The evaluation board enables users to connect the LOG200 to current sources through SMA connections via series resistors.
- The PCB includes a footprint to mount an optional photodiode to the INUM input for optical power measurement applications. The photosensor can be biased externally through a test point, or through the use of the LOG200 IBIAS adaptive biasing current output function by modifying the EVM.
- Allows access to the integrated precision 1 µA current reference
- Allows the use of the Integrated precision 1.65 V and 2.5 V voltage references in different circuit configurations
- The LOG200EVM provides access to the inputs and output of the secondary op-amp. The PCB provides optional passive component footprints to support different op-amp or filter configurations.

1.4 Device Information

The EVM is built with the LOG200IRGT device in the 16-pin QFN package with the thermal pad.

2 Hardware

2.1 Read this first: EVM Cleaning Guidelines

Logarithmic amplifier applications requiring picoampere range performance are very sensitive to PCB board contamination. Contaminants in the form of solder flux, oils and other impurities can form conductive paths over the sensitive PCB traces that allow small currents to leak from the input traces or other sensitive nodes, degrading performance. For best performance, make sure to keep the LOG200EVM as clean as possible. The following list shows best practices to clean the evaluation board and to help prevent the EVM from becoming contaminated:

- Leakage currents from solder flux contamination can disturb the logarithmic amplifier's operation, specially at lower current levels. The LOG200EVM undergoes a standard cleaning protocol after the fabrication, soldering and assembly process prior shipping to customers, providing picoampere level performance. The EVM must be re-cleaned anytime devices are soldered into the PCB or modified near the logarithmic amplifier sensitive nodes, if the LOG200 U1 device is replaced, or if these input sensitive connections become contaminated by other means.
- The recommended cleaning procedure requires access to an ultrasonic deionized (DI) water bath:
  - Place the EVM in the ultrasonic cleaner and fill with fresh deionized (DI) water.
  - Run the ultrasonic cleaner for 20 minutes at 45°C.
  - Remove all moisture from PCB.
- If an ultrasonic bath is not available, then a manual cleaning procedure is possible:
  - Scrub contaminants from the top layer I1 and I2 inputs at top layer.
  - Use a toothbrush to gently scrub for 60 seconds. Focus on areas surrounding U1 I1, I2, VCM, and IREF inputs, R9, R13, R16, R17, R35, D1, input SMA connectors J4 and J6 and guard traces.
  - Scrub contaminants from the bottom layer around the diode D1 photosensor footprint and input SMA connectors J4 and J6.
  - Flush the scrubbed areas with fresh DI water, tilting the board to allow runoff to flow away from the input areas.
  - Remove all moisture from PCB.
- When handling the EVM, always hold the board by the edges.
- When not in use, place the EVM in ESD bag or other enclosure to prevent dust and other contaminants from settling on the board.

2.2 Input and Output Connections

The current input signals for the logarithmic numerator, I1, and logarithmic denominator, I2, are provided through SMA connectors J4 and J6. These inputs are located at the left of the EVM. The input connections of the log amplifier have a series 10 kΩ resistors, R9 and R10. The logarithmic output connection is provided through SMA J5 and test point TP4 at the right side of the EVM.

The secondary op-amp inputs are accessible through SMA J14 and the output amplifier connection is provided through SMA connector J14, and test point TP16, located at the right side of the EVM. For a full schematic of the LOG200EVM, see Figure 3-1 and Figure 3-2.

Table 2-1 summarizes the input and output connectors and corresponding test points.

Table 2-1. LOG200EVM Input and Output Connections

Designator	Signal	Connector Type	Description
J4	I1_IN	SMA	Current input for logarithm numerator
J6	I1_IN	SMA	Current input for logarithm denominator
J5	OUT_A	SMA	Logarithm function voltage output
J13	IN_AMP_B	SMA	Secondary op-amp voltage non-inverting and inverting input
J14	OUT_B	SMA	Secondary op-amp voltage output
J16	REF_GND	Banana plug	Optional ext voltage reference negative
J10	Ext_RefA	Banana plug	Optional ext Logarithm function voltage output reference
J12	GND	Banana plug	EVM PCB ground
TP1	DBIAS	Test point	Optional ext Photodiode Vbias Cathode
TP4	OUT_A	Test point	Logarithm function voltage output
TP10	REFA	Test point	REFA: Log diff amp reference connection
TP7	REFA_sense	Test point	REFA: Log diff amp reference connection through 100kΩ isolation resistor
TP16	OUT_B	Test point	Secondary op-amp voltage output
TP11	VCM	Test point	Input common-mode voltage
TP14	REF1	Test point	REF25: 2.5V reference output
TP15	REF2	Test point	REF165: 1.65V reference output
TP18	REF_GND	Test point	Voltage reference negative
TP2, TP3, TP8, TP12, TP17	GND	Test point	EVM PCB ground

2.3 Power Requirements

The power-supply connections for the LOG200EVM are provided through standard banana jack connectors J1, J2, and J3 at the top of the EVM. The LOG200EVM can be set up with a single unipolar supply or with dual bipolar supplies by setting jumper J9. Table 2-2 summarizes the pin definition for supply connector J1, J2, and J3 and the allowed voltage range for each supply connection when configured with either unipolar or bipolar supplies.

Table 2-2. LOG200EVM Supply-Range Specifications

Connector Number	Supply Connection	Voltage Range
J1	(V+) supply	Unipolar: +4.5 V to +12 V Bipolar: +2.25 V to +6 V
J2	Ground	0 V
J3	(V-) Supply	Unipolar: Do not Connect Bipolar: –2.25 V to –6 V

The EVM is configured by default using bipolar supply by opening jumper J9. To configure the device with unipolar supply, set jumper J9 to shunt pin 1–2.

Figure 2-1 shows the J1, J2, and J3 standard banana supply connectors, and jumper J9 configuration.

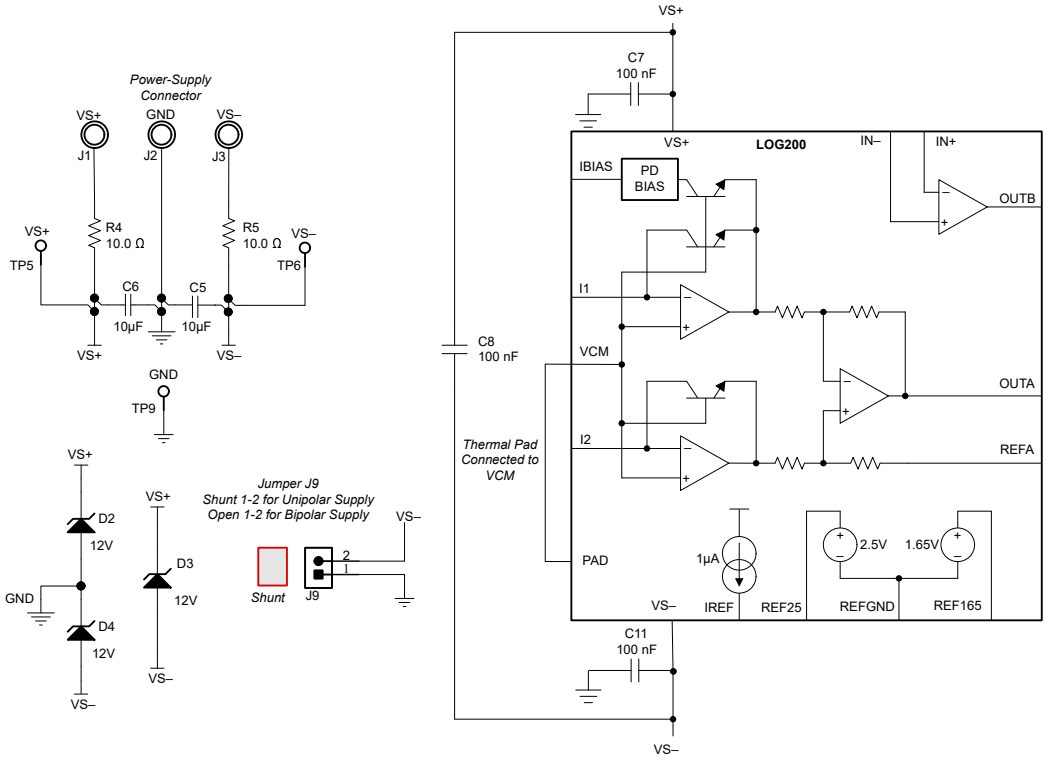


Figure 2-1. LOG200EVM Voltage Supply Connections

2.4 Jumper Information

Figure 2-2 details the default jumper settings of the LOG200EVM. Table 2-3 explains the configuration for these jumpers.

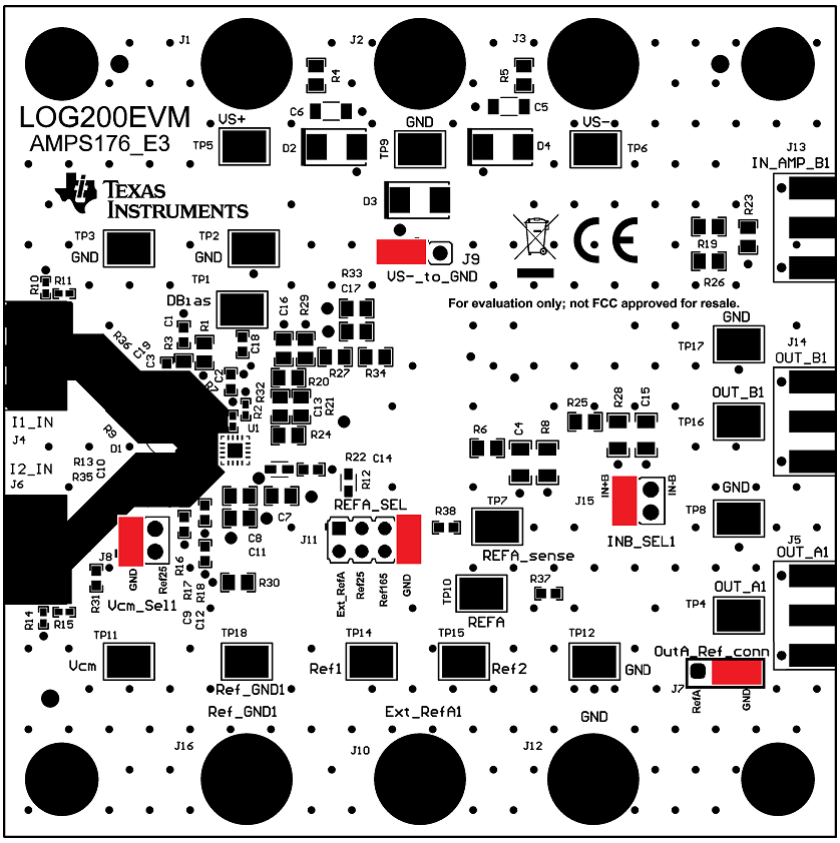


Figure 2-2. LOG200EVM Default Jumper Settings

Table 2-3. Default Jumper Configuration

Jumper	Function	Default Position	Description
J7	Out_A SMA J5 reference	Shunt 2-3	Shunt 2-3: SMA connector J3 referred to GND Shunt 1-2: SMA connector J3 referred to REFA
J8	VCM Select	Shunt 1-2	Shunt 1-2: VCM input connected to GND Shunt 3-4: Connects VCM input to 2.5V reference
J9	VS– connection	Open	Open: Bipolar supply configuration Shunt 1-2: Connects VS– to GND for unipolar supply configuration
J11	REF A Select	Shunt 7-8	Shunt 1-2: Sets log voltage REFA to external voltage through J10 Shunt 3-4: Sets REFA to REF25 Shunt 5-6: Sets REFA to REF165 Shunt 7-8: Sets REFA to GND
J15	Secondary op-amp input	Shunt 1-2	Shunt 1-2: Connects Aux AMP+IN to OUTA Shunt 3-4: Connects Aux AMP -IN to OUTA

2.5 Optional Photodiode Connections

The LOG200EVM PCB board layout includes a photosensor footprint (D1) to install a radial photodiode on current input I1 for the logarithmic numerator. See Figure 2-3 for the photosensor input and photosensor biasing connections.

The photodiode IBIAS adaptive biasing current output is accessible through optional jumper resistor R2. The adaptive current output biasing scheme creates a voltage to bias a photodiode with a current that is proportional to the photocurrent. This allows small bias voltages for low photodiode currents, reducing the dark current of the photodiode, and higher reverse-bias voltages as the photocurrent increases, reducing the capacitance of the photodiode.

The IBIAS function produces a current that is approximately 1.1x larger than the numerator current I1. Since the photosensor produces the input numerator current, the remaining 0.1*I1 current flows through the RBIAS resistor R3. The RBIAS resistor R3 needs to be scaled depending on the photosensor biasing requirements, the photosensor current range and the LOG200 supply voltage. The voltage at the IBIAS pin must not exceed (V+) - 1 V at the photosensor maximum current. If the IBIAS function is not used, then leave the IBIAS pin floating by removing resistor jumper R2.

Alternatively, the photosensor cathode can be reverse biased via test point TP1, DBIAS. Verify the resistor R2 is removed when biasing the photosensor through TP1.

Capacitors C1 and C3 can help providing dynamic currents during fast transients and help to improve stability. The value for best bias response depends on the photosensor and application requirements.

Figure 2-3 presents a simplified diagram of the photodiode connections. For a detailed schematic of the photosensor connections, see Figure 3-1.

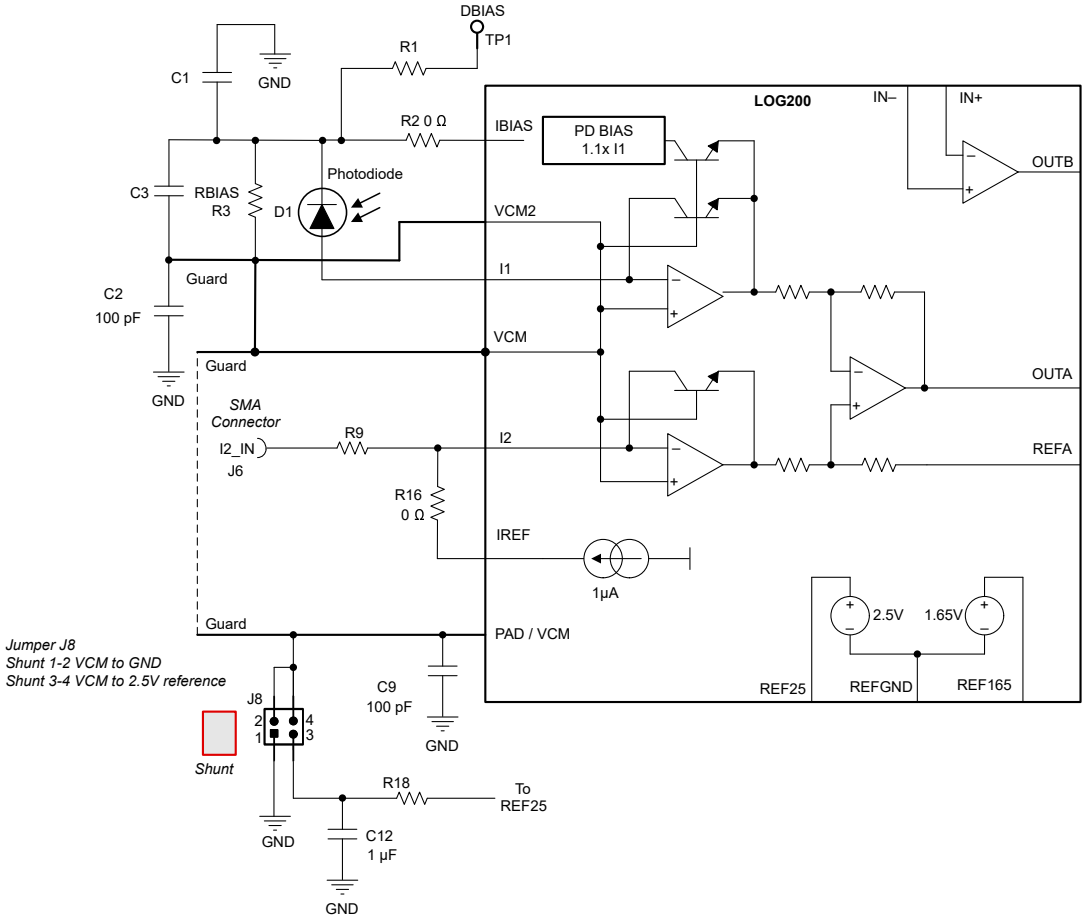
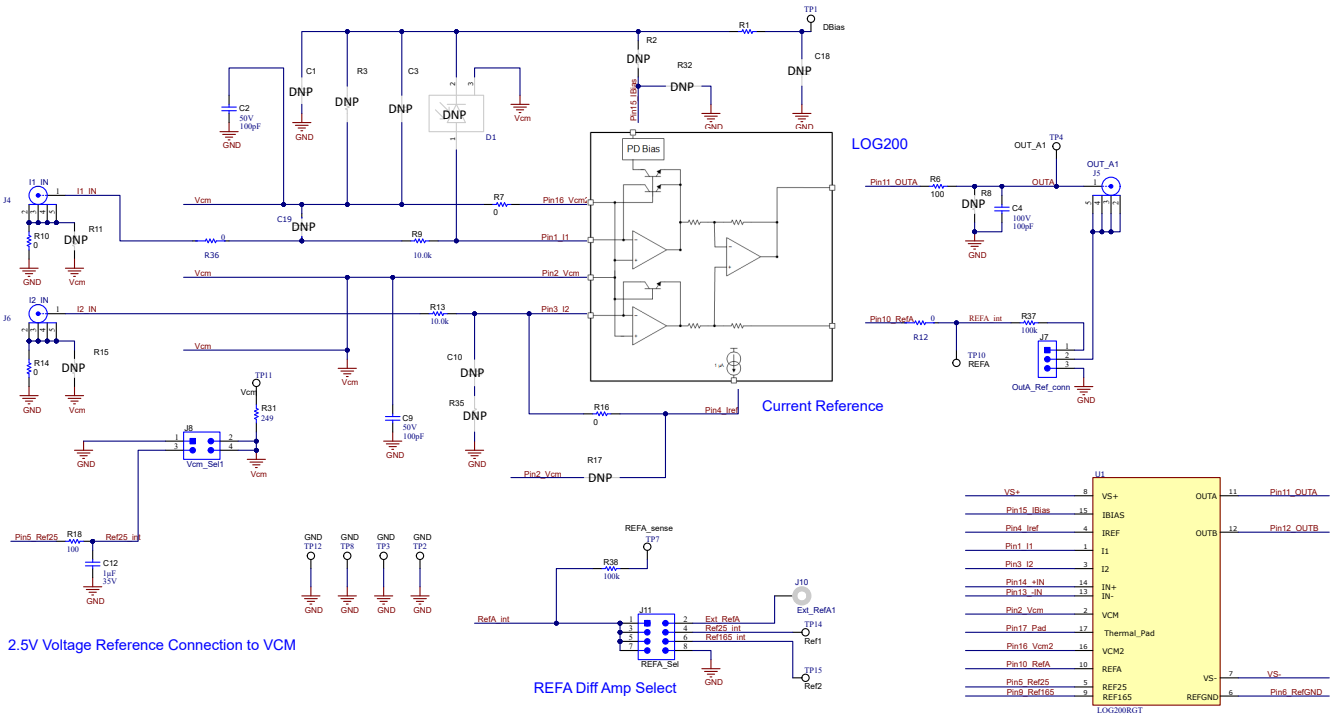


Figure 2-3. LOG200EVM Photodiode Connections

3 Hardware Design Files

3.1 Schematics

Figure 3-1 and Figure 3-2 show the EVM schematics.

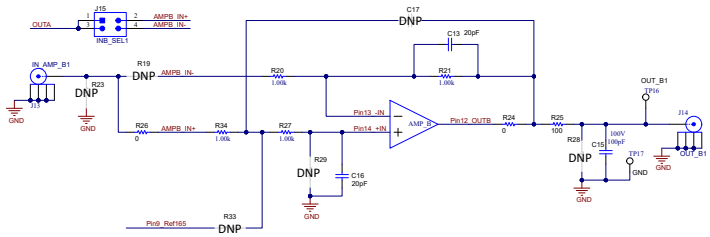


Rev E3: Modified REF25 connection to VCM, through REF25 filter: R18=100Ohm, C12=1uF. Modified Capacitors values C2, C9 from 1000pF to 100pF
Modified REF165 bypass capacitor C14 from 330pF to 100pF. Added C19, R36, R37, R38, TP7 for flexibility.

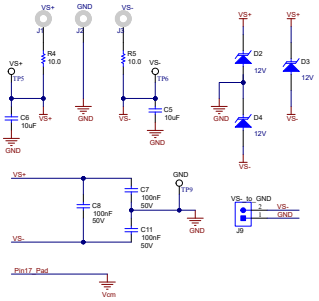
Note: DNP components are not populated.

Figure 3-1. LOG200EVM Schematic

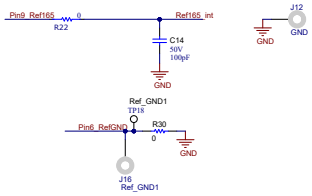
LOG200 Operational Amplifier B



Power Supplies



Voltage Reference Connections Bypass Cap



Rev E3: Modified REF165 bypass C14, from 330pF to 100pF

Note: DNP components are not populated.

Figure 3-2. LOG200EVM Schematic

3.2 PCB Layout

The LOG200EVM is a four-layer PCB design. Figure 3-3 to Figure 3-7 show the PCB layer illustrations.

The top layer routes the sensitive input current signal path traces. The logarithmic amplifier is optimized to perform current measurements across several decades. At the low current level ranges, leakage current can cause significant errors. To minimize leakage current paths, a complete guard ring is implemented with traces that encircle the complete signal path of each high-impedance current input of the log amplifier. The guard presents a low-impedance path for leakage currents of equal potential to the high-impedance traces that are being guarded. The guard traces are driven to the input common-mode voltage (VCM); therefore, the current flowing between the input current traces and the guard is negligible because both traces are similarly at the same potential.

The LOG200EVM provides a footprint to connect a photodiode to the I1 input pin. The photosensor is kept in close proximity to the I1 input to minimize parasitic capacitance. The evaluation board provides all the necessary photosensor and adaptive bias circuit connections through resistor R2, R3 and optional capacitors C1, C3. For a detailed explanation, refer to the photodiode connections section of the User Guide.

Decoupling capacitors C7, C8 and C11 are positioned on the top layer as close as possible to the power-supply pins of the device. Similarly, reference bypass capacitor C12 and C14 are located in close proximity to the reference pins.

The second internal layer is a dedicated to the power supplies connections and contains a common-mode (VCM) plane. The third internal layer and bottom layers contain a ground plane and route additional auxiliary amplifier/reference signals.

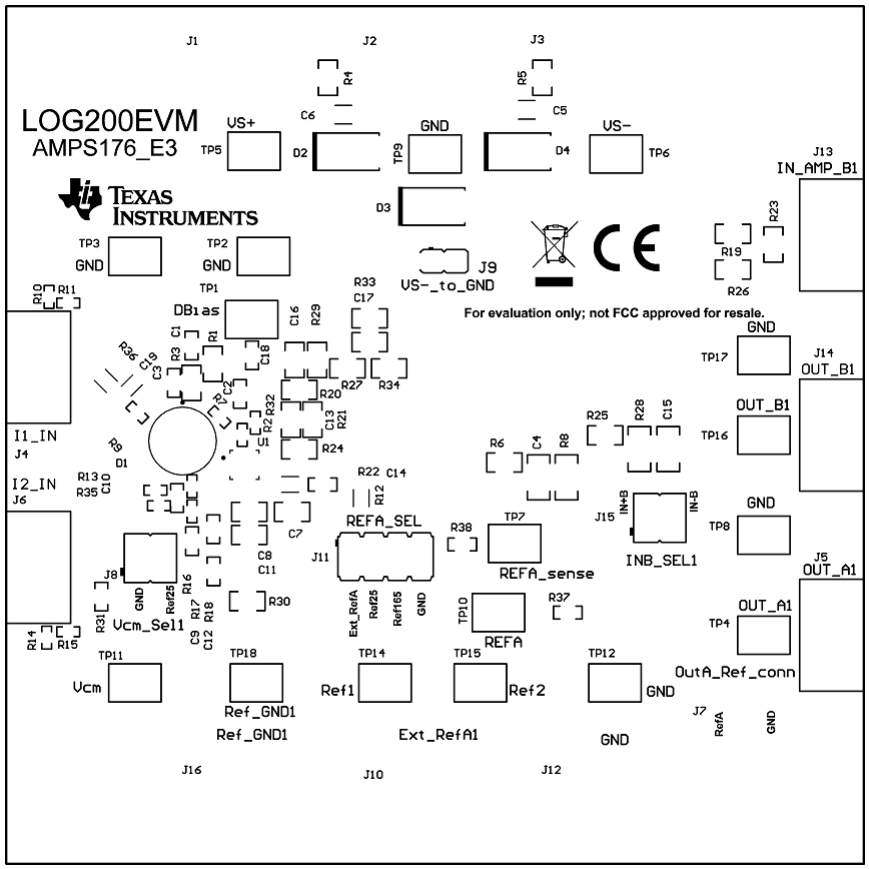


Figure 3-3. Top Overlay PCB Layout

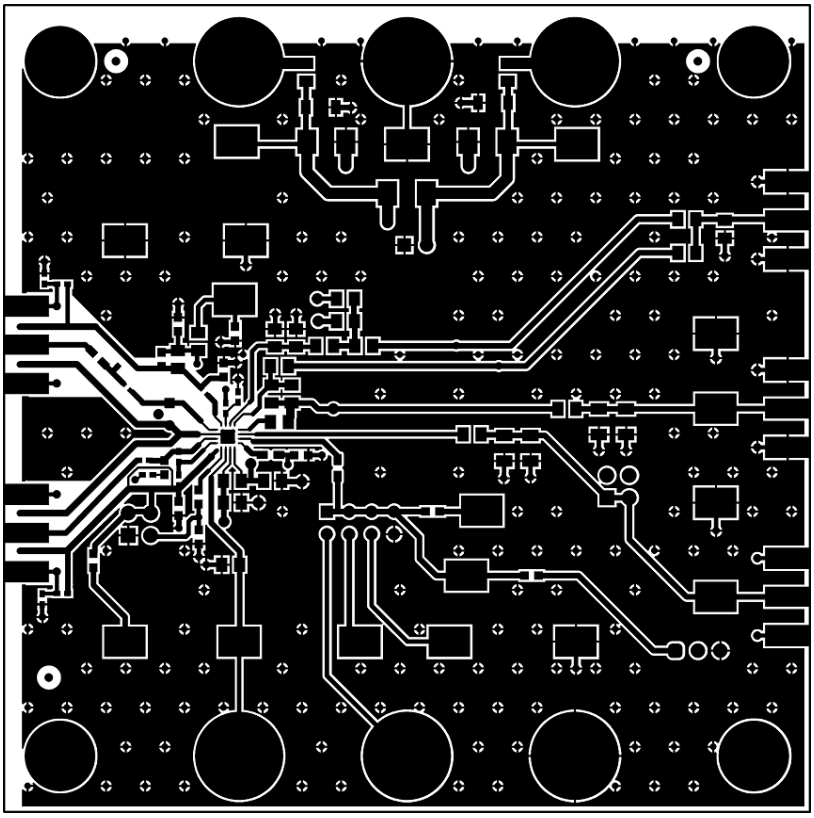


Figure 3-4. Top Layer PCB Layout

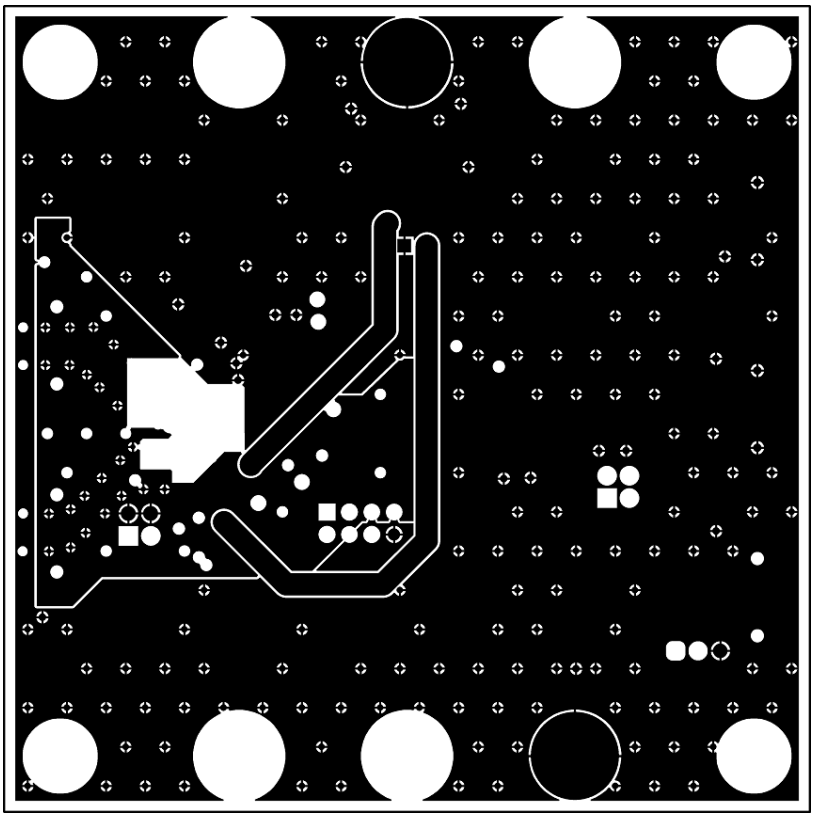


Figure 3-5. Mid Layer 1 PCB Layout

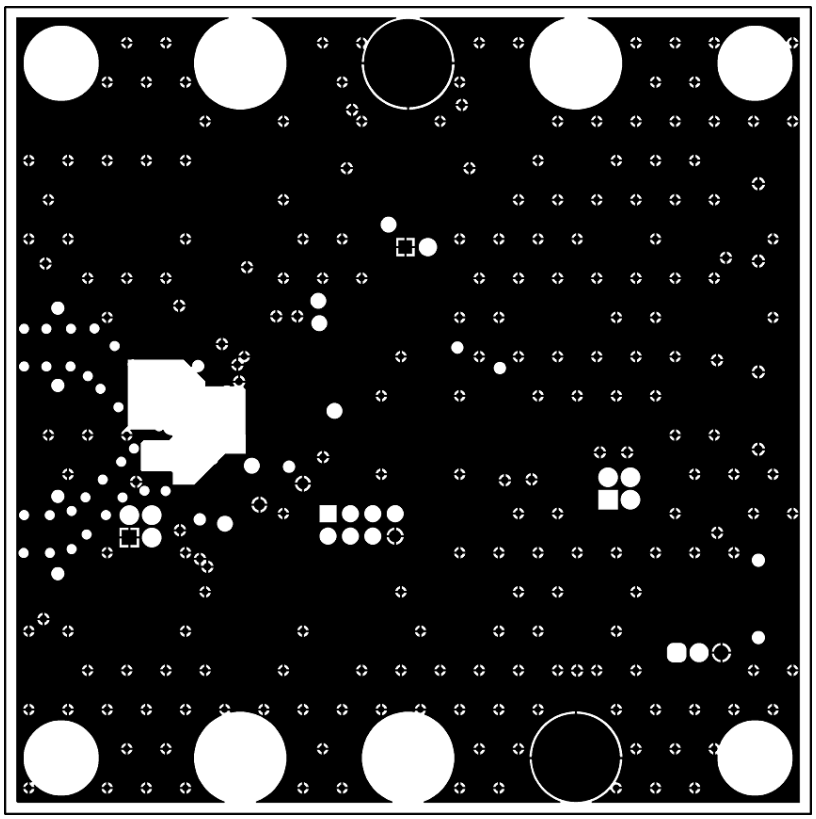


Figure 3-6. Mid Layer 2 PCB Layout

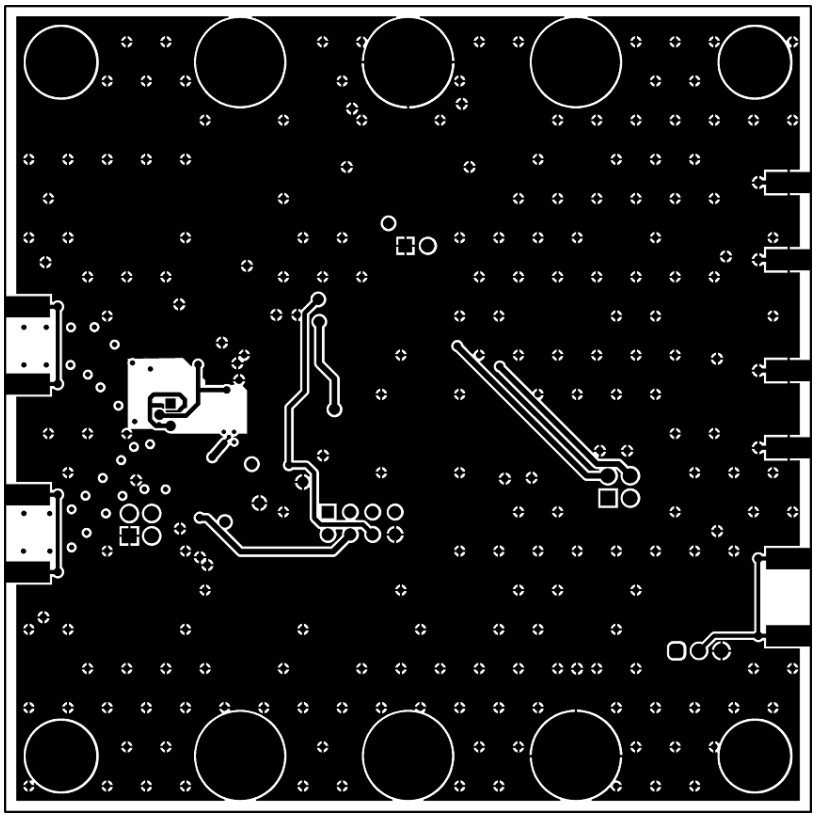


Figure 3-7. Bottom Layer PCB Layout

3.3 Bill of Materials (BOM)

Table 3-1 lists the LOG200EVM bill of materials (BOM).

Table 3-1. LOG200EVM Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		AMPS176	Any
C2, C9, C14		100 pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0603	0603	06035A101JAT2A	AVX
C4, C15	2	100 pF	CAP, CERM, 100 pF, 100 V, +/- 10%, C0G/NP0, 1206	1206	12061A101KAT2A	AVX
C5, C6	2	10uF	CAP, CERM, 10 uF, 25 V, +/- 20%, X7R, 1206_190	1206_190	C3216X7R1E106M160AE	TDK
C7, C8, C11	3	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0805	0805	GRM21BR71H104KA01L	MuRata
C12	1	1uF	CAP, CERM, 1 µF, 35 V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E1X7R1V105K080AE	TDK
C13, C16	2	20 pF	CAP, CERM, 20 pF, 100 V, +/- 5%, C0G/NP0, 0805	0805	08051A200JAT2A	AVX
D2, D3, D4	3	12 V	Diode, TVS, Uni, 12 V, 19.9 Vc, SMB	SMB	SMBJ12A-13-F	Diodes Inc.
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1, J2, J3, J10, J12, J16	6		Standard Banana Jack, Uninsulated, 5.5mm	Keystone_575-4	575-4	Keystone
J4, J5, J6, J13, J14	5		Connector, End launch SMA, 50 ohm, SMT	End Launch SMA	142-0701-801	Cinch Connectivity
J7	1		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
J8, J15	2		Header, 2.54mm, 2x2, Gold, TH	Header, 2.54mm, 2x2, TH	PBC02DAAN	Sullins Connector Solutions
J9	1		Header, 2.54mm, 2x1, Tin, THHeader, 2.54mm, 2x1, TH	Header, 2.54mm, 2x1, TH	22284023	Molex
J11	1		Header, 2.54 mm, 4x2, Gold, TH	Header, 2.54 mm, 4x2, TH	802-10-008-10-001000	Mill-Max
R1, R24, R26, R30	4	0	RES, 0, 5%, 0.125 W, 0805	0805	MCR10EZPJ000	Rohm
R4, R5	2	10	RES, 10.0, 1%, 0.25 W, 0805	0805	RNCP0805FTD10R0	Stackpole Electronics Inc
R6, R25	2	100	RES, 100, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	CRCW0805100RFKEA	Vishay-Dale
R7, R10, R14, R16	4	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R9, R13	2	10.0k	RES, 10.0 k, .1%, .0625 W, 0402	0402	RT0402BRD0710K	Yageo America
R12, R22, R36	3	0	RES 0 OHM JUMPER 1/4W 0603	0603	HCJ0603ZT0R00	Stackpole Electronics
R18	1	100	RES, 100, 0.1%, 0.1 W, 0603	0603	RT0603BRD07100RL	Yageo America
R20, R21, R27, R34	4	1.00k	RES, 1.00 k, 0.1%, 0.125 W, 0805	0805	RT0805BRD071KL	Yageo America
R31	1	249	RES, 249, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603249RFKEA	Vishay-Dale
R37, R38	2	100k	RES, 100 k, 0.1%, 0.063 W, 0603	0603	CPF0603B100KE	TE Connectivity
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5	5		Shunt, 100mil, Gold plated, Black	Shunt 2 pos. 100 mil	881545-2	TE Connectivity

Table 3-1. LOG200EVM Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP14, TP15, TP16, TP17, TP18	17		Test Point, Compact, SMT	5016	Keystone	
U1	1		Precision, High-Speed Logarithmic Amplifier With Integrated Photodiode Bias and Dark Current Correction	VQFN16	LOG200RGT	Texas Instruments
D1	DNP		InGaAs PIN Photodiode. Pigtail type, 1.3/1.55 µm, 2 GHz	RADIAL	G8195	Hamamatsu

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

5 Revision History

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

Changes from Revision * (July 2023) to Revision A (January 2024) **Page**

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 DEGREDATION 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/lsds/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/lsds/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。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

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, INDEMITY 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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