

## LOG114EVM User Guide

This user's guide describes the characteristics, operation, and use of the LOG114EVM evaluation board. It discusses how to set up and configure the board hardware, and reviews various methods of using the evaluation module (EVM). Throughout this document, the terms *evaluation board*, *evaluation module*, and *EVM* are synonymous with the LOG114EVM. This document also includes an electrical schematic, printed circuit board (PCB) layout drawings, and a parts list for the EVM.

### Contents

1	Overview .....	2
2	LOG114EVM .....	3
3	Connecting to the LOG114EVM .....	7
4	Using the LOG114EVM .....	11
5	Verifying Results .....	12
6	LOG114EVM Documentation .....	13

### List of Figures

1	LOG114EVM .....	2
2	LOG114EVM Level Shifter.....	3
3	LOG114EVM Signal Path.....	4
4	High-Current Linearity Correction Circuit .....	5
5	LOG114EVM Complete Circuit.....	6
6	Connecting the 5V Power Supply.....	7
7	Using a Photodiode with the High-Current Linearity Correction Circuitry .....	7
8	Using a Photodiode Without the High-Current Linearity Correction Circuitry .....	8
9	Applying a 0.5-V Reverse Bias to the Photodiode.....	8
10	Using a Resistor to Create an Input Current .....	9
11	Using a Resistor and the High Current Linearity Correction Circuitry .....	10
12	LOG114EVM Components.....	11
13	LOG114EVM Measured Results .....	12
14	LOG114EVM Board Schematic.....	13
15	LOG114EVM: Top Side Composite Drawing .....	14
16	LOG114EVM: Top Copper Layer .....	14
17	LOG114EVM: Bottom Copper Layer.....	14

## 1 Overview

The [LOG114](#) is a single-supply, high-speed, precision logarithmic amplifier. This device computes the logarithm or log-ratio of an input current or voltage relative to a reference current or voltage. The LOG114EVM (shown in [Figure 1](#)) is a ready-to-use platform for evaluating the performance of the LOG114 in various configurations. This document gives a general overview of the LOG114EVM, and provides a general description of the features and functions to be considered while using this evaluation module.

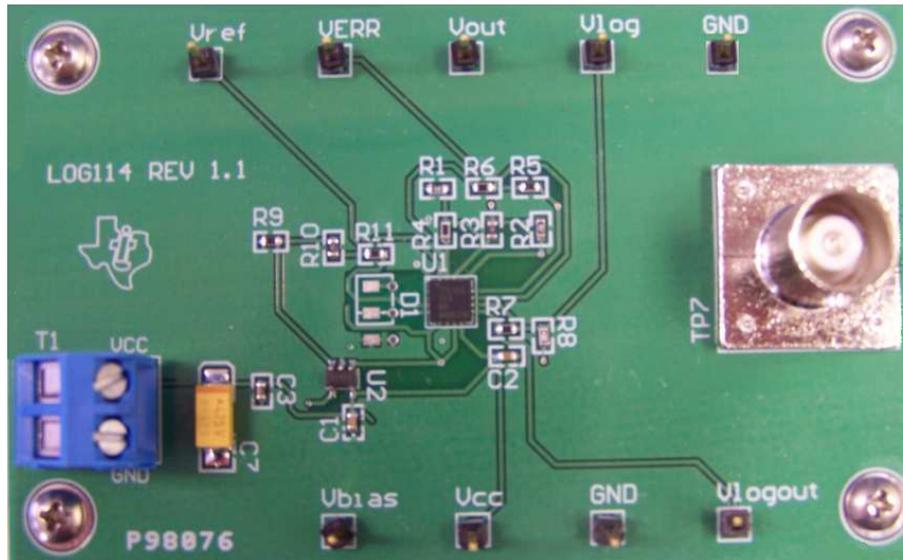


Figure 1. LOG114EVM

### 1.1 Getting Started

Tested at the factory over a wide range of input currents, the LOG114EVM comes ready to use and includes this Quick Start User's Guide. Use of the LOG114EVM requires a 5-V power source, an input source such as a photodiode or resistor, and a digital voltmeter or oscilloscope.

### 1.2 Related Documentation from Texas Instruments

The following documents provide information regarding Texas Instruments' integrated circuits and support tools for the LOG114EVM. This user's guide is available from the TI web site under literature number **SBOU110**. Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions may be available from the [TI web site](#), or call the Texas Instruments' Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

#### Related Documentation

Document	Literature Number
LOG114 Product Data Sheet	<a href="#">SBOS301</a>
LOG114 TINA-TI Reference Design	<a href="#">SBOM384B</a>
LOG114 TINA-TI Spice Model	<a href="#">SBOM385B</a>

## 2 LOG114EVM

The LOG114EVM comes completely assembled and constructed to operate on a single 5-V power supply. The circuit used in the LOG114EVM is designed to operate over a wide range of input currents (10 nA to 10 mA) and scales the output voltage from 1.15 V to 2.75 V. There are three distinct sections to the LOG114EVM circuit: a precision level shifter, the signal path, and the high-current linearity correction section. Each section is described below to familiarize you with the circuit functionality and operation.

### 2.1 Level Shifter

A precision level shifter is required to operate the LOG114 on a single power supply. On the LOG114EVM, the level shifter circuit is constructed by deriving a bias voltage of 2 V from the 2.5-V voltage reference internal to the LOG114. This level shift of 2 V is required to keep the nodes internal to the LOG114 properly biased when operating from a single power supply. Resistors R9 and R10 form a voltage divider that is then buffered by the OPA365 amplifier. The output of the OPA365 is a fixed voltage of 2 V, independent of the power-supply voltage or input signal. C2 is used to bypass the power supply for the OPA365. The level shifter circuit is shown in Figure 2.

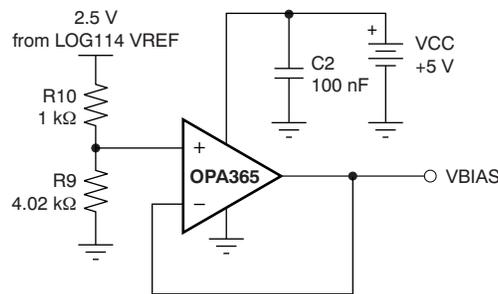


Figure 2. LOG114EVM Level Shifter

### 2.2 Signal Path

The LOG114 has two inputs,  $I_1$  and  $I_2$ . Input  $I_1$  is used for the input signal (usually from a photodiode) and  $I_2$  is a fixed-current reference signal. This fixed-current reference signal is derived from the 2.5-V voltage reference internal to the LOG114 and the 2-V output from the level shifter. The reference current into  $I_2$  is given by Equation 1.

$$I_{\text{REF}} = \frac{(2.5 \text{ V} - 2 \text{ V})}{1 \text{ M}\Omega} = 500 \text{ nA} \quad (1)$$

The input current must flow into  $I_1$  and comes directly from the anode of a photodiode. In non-optical applications, the input current could also be derived from a resistor, or a variety of other sources (see Section 3.4). For proper operation, each input to the LOG114 ( $I_1$  and  $I_2$ ) requires the current to flow into the LOG114.

The output from the LOG114 amplifier A3 is called  $V_{\text{LOGOUT}}$ . The relationship between  $V_{\text{LOGOUT}}$ ,  $I_1$  and  $I_2$ , and the bias voltage generated by the level shifter is described by Equation 2.

$$V_{\text{LOGOUT}} = 0.375 \cdot \text{LOG}_{10} \left( \frac{I_2}{I_1} \right) + 2 \text{ V} \quad (2)$$

The  $V_{\text{LOGOUT}}$  output is then scaled by resistors R7 and R8. These resistors divide the signal before combining with the high-current linearity correction section. Combining the input signal and linearity correction signal is accomplished with amplifier A4 and resistors R5 and R6. Capacitor C1 is used to bypass the power supply for the LOG114. The signal path circuit is shown in Figure 3.

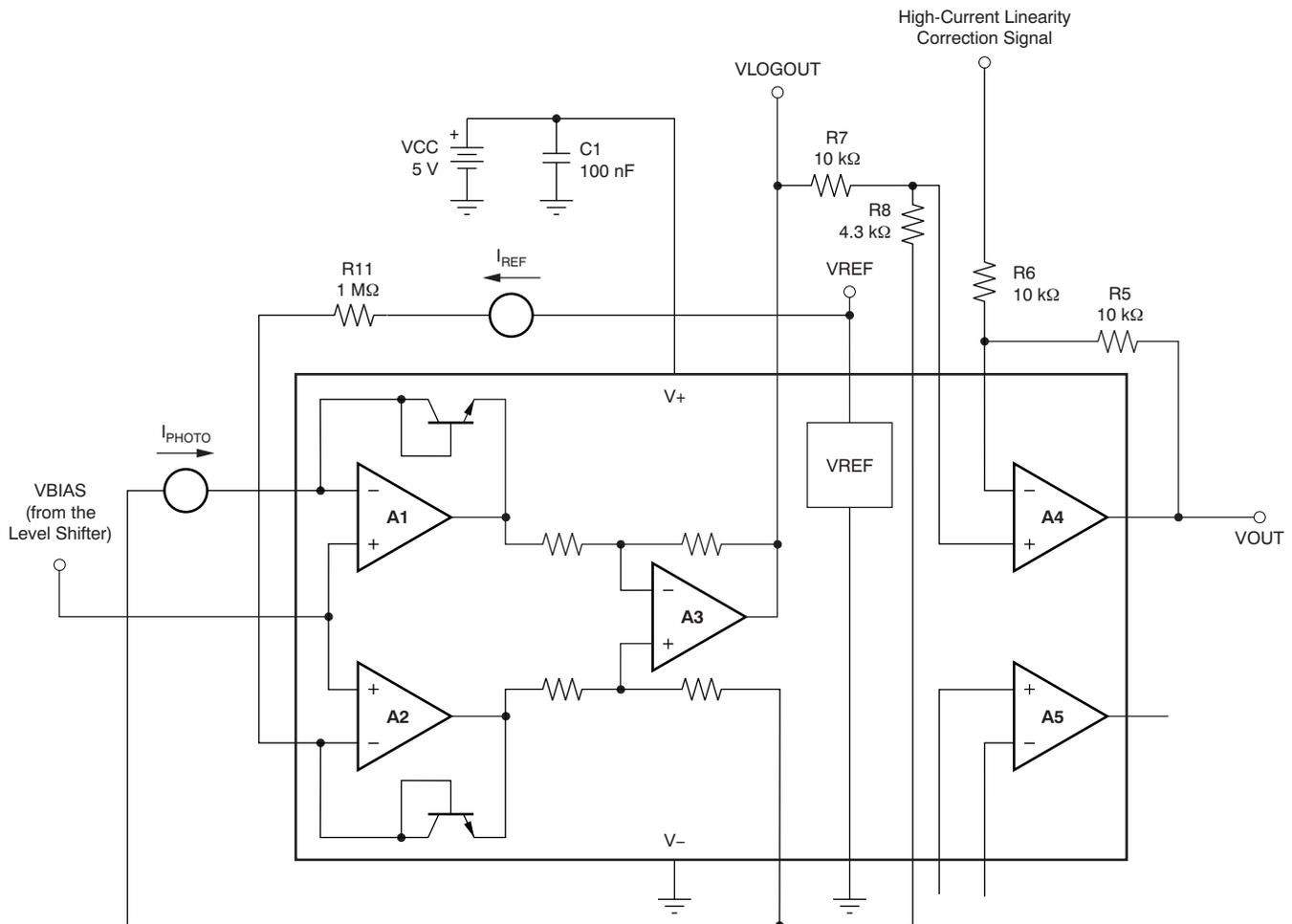


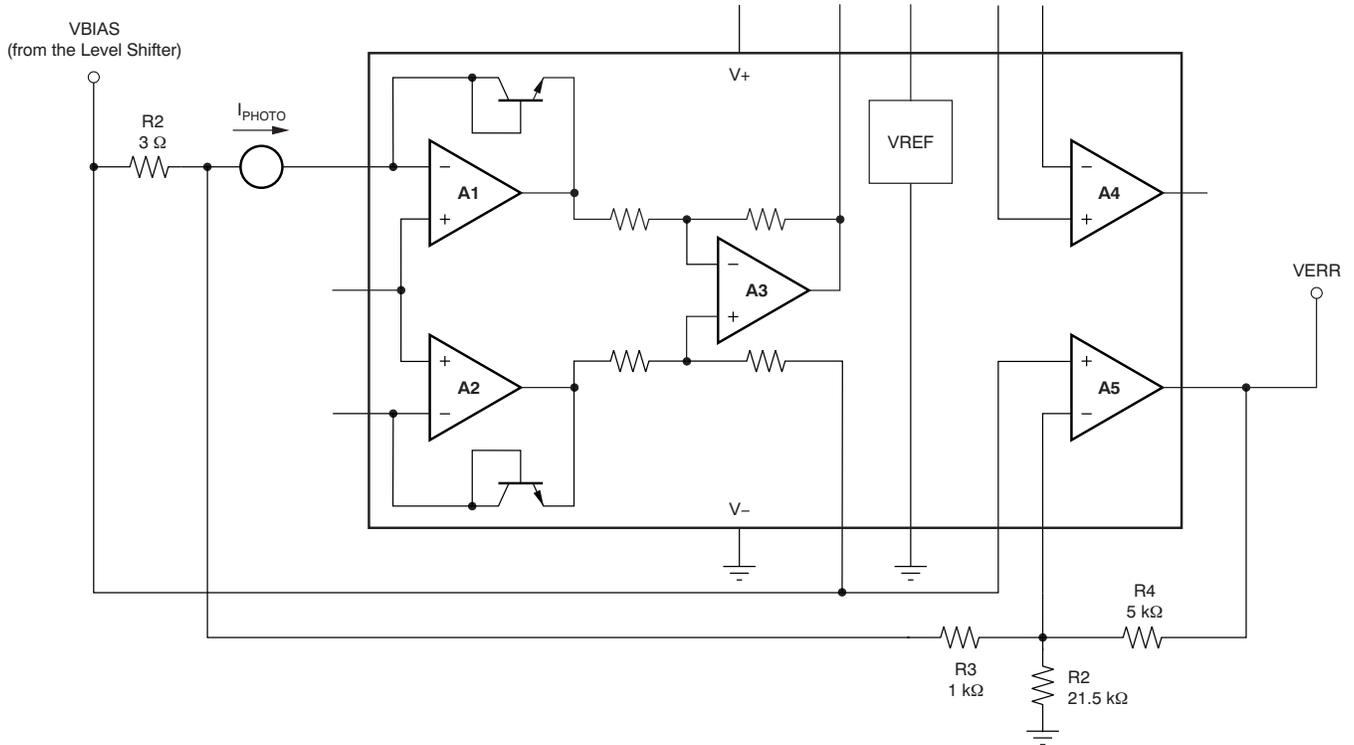
Figure 3. LOG114EVM Signal Path

### 2.3 High-Current Linearity Correction

The LOG114 is capable of handling a wide dynamic range of currents, from less than 100 pA in a carefully designed PCB to 10 mA in high-current applications. Because the LOG114 was designed for high speeds, the transistors that provide feedback around amplifiers A1 and A2 within the LOG114 have a small series resistance,  $R_S$ . This small series resistance causes a deviation from the ideal LOG114 transfer function at input currents that exceed approximately 1 mA. The modified equation for  $V_{\text{LOGOUT}}$  that shows this deviation from the ideal is given in Equation 3.

$$V_{\text{LOGOUT}} = 0.375 \cdot \text{LOG}_{10} \left( \frac{I_2}{I_1} \right) + 2 \text{ V} + I_1 \cdot R_S \quad (3)$$

The high-current linearity correction circuit (refer to Figure 4) creates an error signal that is proportional to input current  $I_1$  by using R2, R3 and R4, and amplifier A5. Resistor R1 is used to properly level-shift the resulting output signal. The signal at the output from amplifier A5 is then coupled to the input of amplifier A4 in a manner that subtracts the error signal from the output of the EVM,  $V_{OUT}$ .



**Figure 4. High-Current Linearity Correction Circuit**

Figure 5 shows the entire circuit layout of the LOG114EVM.

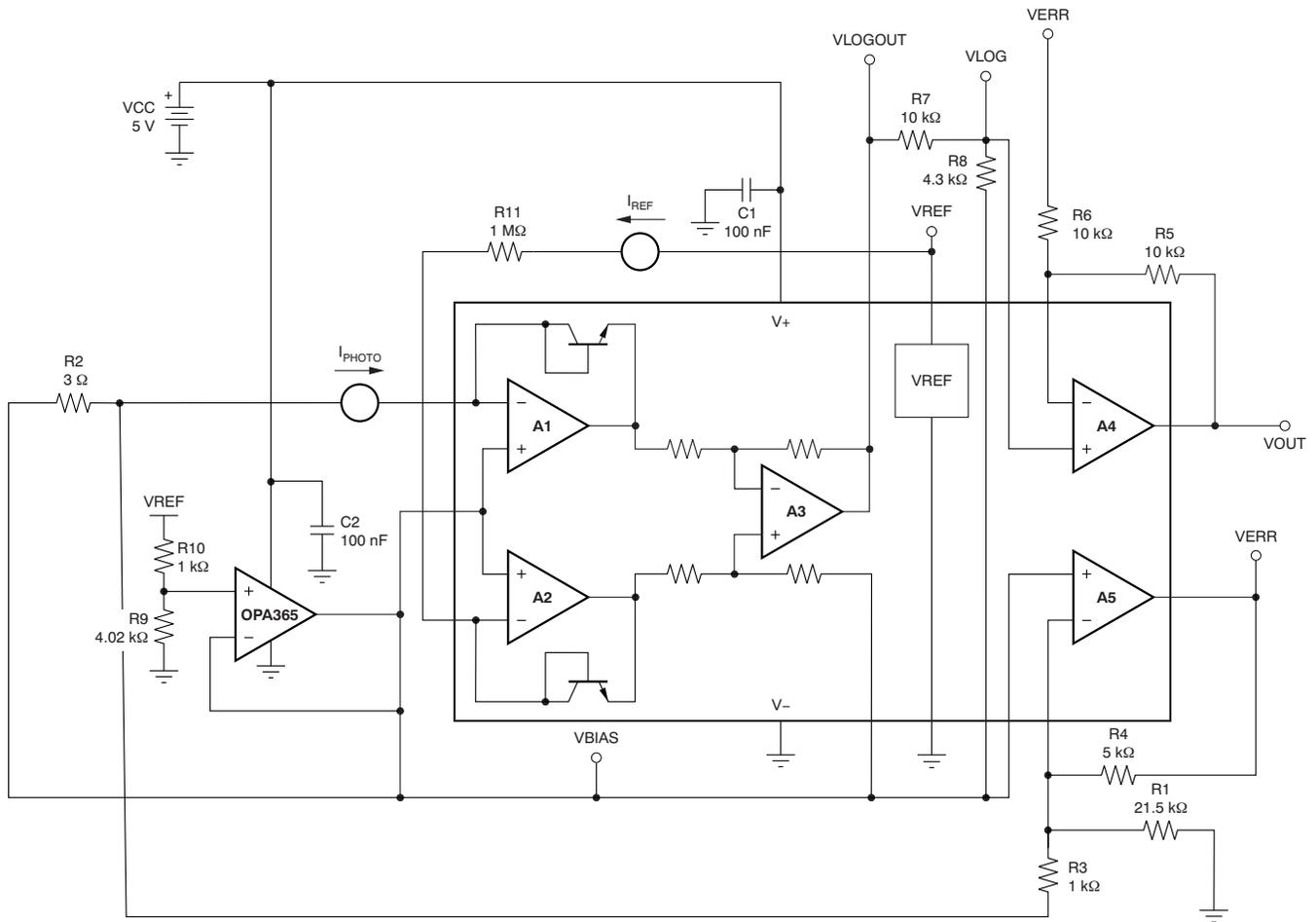


Figure 5. LOG114EVM Complete Circuit

### 3 Connecting to the LOG114EVM

The LOG114 requires only a few connections to operate: a 5-V power supply, an input source such as a photodiode or resistor, and a digital voltmeter or oscilloscope.

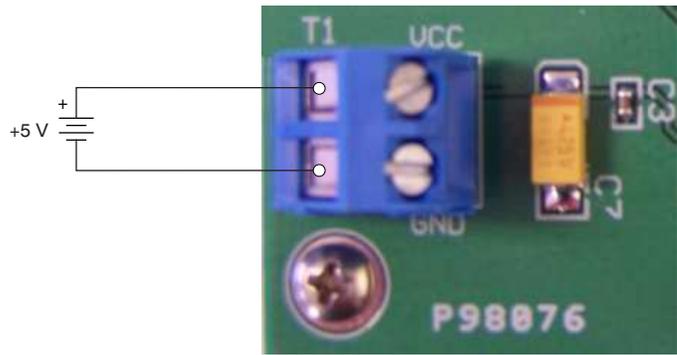
#### 3.1 Electrostatic Discharge Warning

**CAUTION**

Many of the components on the LOG114EVM are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

#### 3.2 Basic Connections

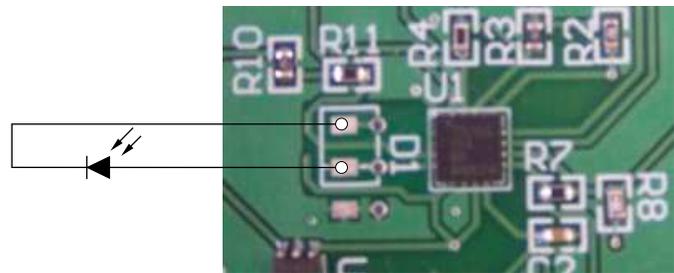
The connections for 5 V and ground are clearly marked on the LOG114EVM PCB. [Figure 6](#) shows how to properly connect the power supply to the connector.



**Figure 6. Connecting the 5V Power Supply**

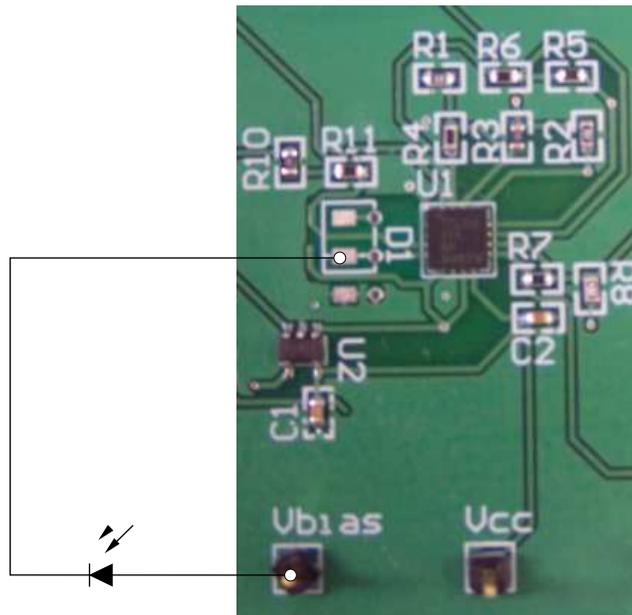
#### 3.3 Using a Photodiode

An anode of a photodiode can be connected to the LOG114 by either using the pads or pin sockets on the LOG114EVM. To use the high-current linearity correction circuitry, connect the photodiode as illustrated in [Figure 7](#).



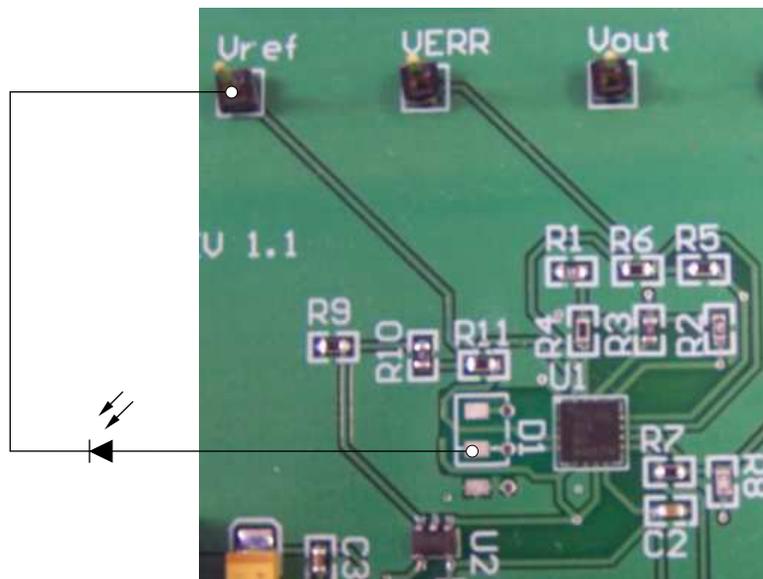
**Figure 7. Using a Photodiode with the High-Current Linearity Correction Circuitry**

Figure 8 shows the connections required to bypass the high-current linearity circuitry. This connection results in placing zero bias across the photodiode.



**Figure 8. Using a Photodiode Without the High-Current Linearity Correction Circuitry**

A 0.5-V reverse bias can be easily placed across the photodiode by connecting the photodiode as shown in Figure 9. When connecting the photodiode in this configuration, the high-current linearity correction circuitry is bypassed.



**Figure 9. Applying a 0.5-V Reverse Bias to the Photodiode**

### 3.4 Using a Resistor

Using a resistor instead of a photodiode to create an input current is quite simple. As Figure 10 shows, a 1-M $\Omega$  resistor is placed between V<sub>REF</sub> and the input I<sub>1</sub>. In this case, the input current I<sub>1</sub> is determined by Equation 4.

$$I_1 = \frac{(V_{REF} - V_{BIAS})}{R} \quad (4)$$

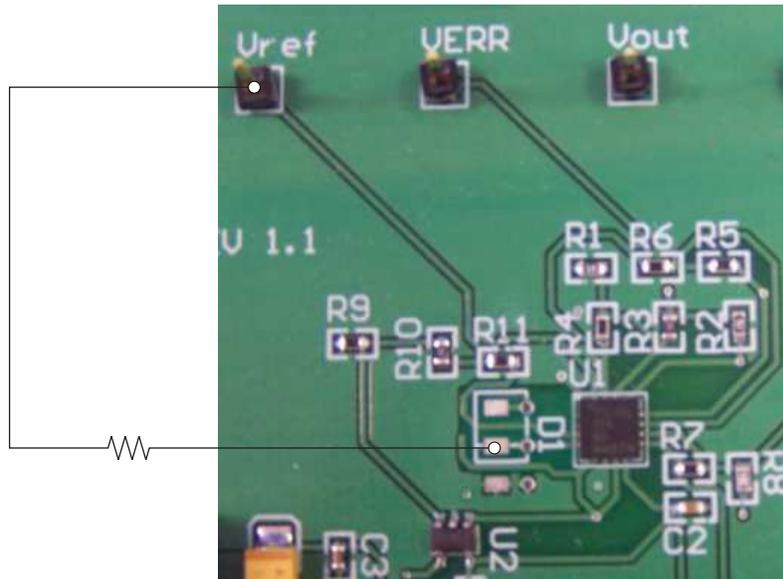
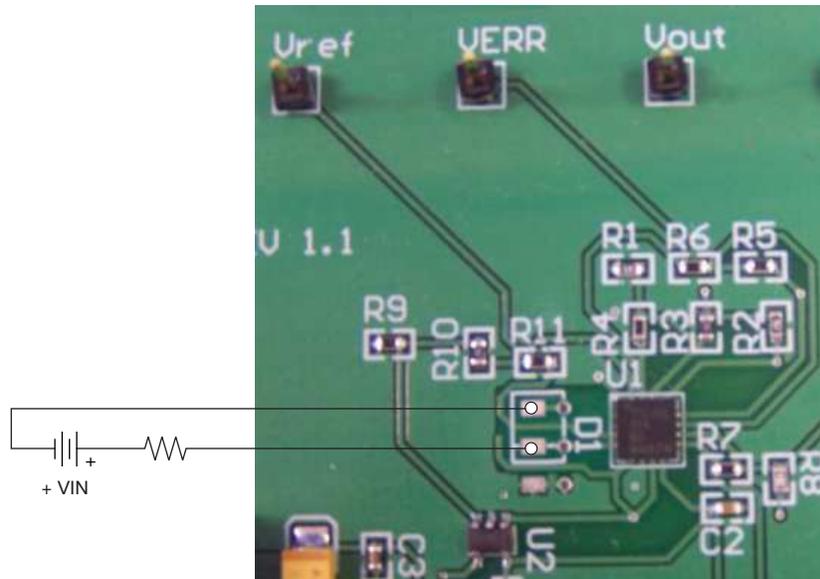


Figure 10. Using a Resistor to Create an Input Current

In the case where  $I_1 = 500 \text{ nA} = I_{\text{REF}}$ , the  $V_{\text{LOGOUT}}$  terminal is equal to the level shifting bias voltage of 2 V and the  $V_{\text{OUT}}$  terminal is equal to 1.5 V. The circuit in [Figure 10](#), while convenient for creating an input current, does not take advantage of the high-current linearity correction circuitry. To use this circuitry, a second power supply must be used and configured as shown in [Figure 11](#).



**Figure 11. Using a Resistor and the High Current Linearity Correction Circuitry**

Changing the input voltage or the resistor value changes the input current  $I_1$  ( $I_1 = V_{\text{IN}}/R$ ) and results in a change for the  $V_{\text{LOGOUT}}$  terminal voltage according to [Equation 5](#).

$$V_{\text{LOGOUT}} = 0.375 \cdot \text{LOG}_{10}\left(\frac{I_2}{I_1}\right) + 2 \text{ V} + I_1 \cdot 50 \Omega \quad (5)$$

For input currents less than 1 mA, this equation simplifies to [Equation 2](#).

The voltage at the  $V_{\text{LOG}}$  terminal is given by [Equation 6](#):

$$V_{\text{LOG}} = \left[0.375 \cdot \text{LOG}_{10}\left(\frac{I_2}{I_1}\right) + I_1 \cdot 50 \Omega\right] \cdot 0.3 \text{ V/V} + 2 \text{ V} \quad (6)$$

The voltage at the  $V_{\text{ERR}}$  terminal is given by [Equation 7](#):

$$V_{\text{ERR}} = 2 + \left[\frac{(I_1 \cdot 3)}{1 \text{ k}\Omega} + \frac{2}{21.5 \text{ k}\Omega}\right] \cdot 5 \text{ k}\Omega \quad (7)$$

The voltage at the  $V_{\text{OUT}}$  terminal is given by [Equation 8](#):

$$V_{\text{OUT}} = 2 \cdot V_{\text{LOG}} - V_{\text{ERR}} \quad (8)$$

#### 4 Using the LOG114EVM

Once the LOG114EVM has power applied and an input signal, easy access terminal pins allow for quickly evaluating the circuit performance. Connect a digital voltmeter or oscilloscope to any of the terminals to make the measurements. Figure 12 is a reference guide to the LOG114EVM and its related components.

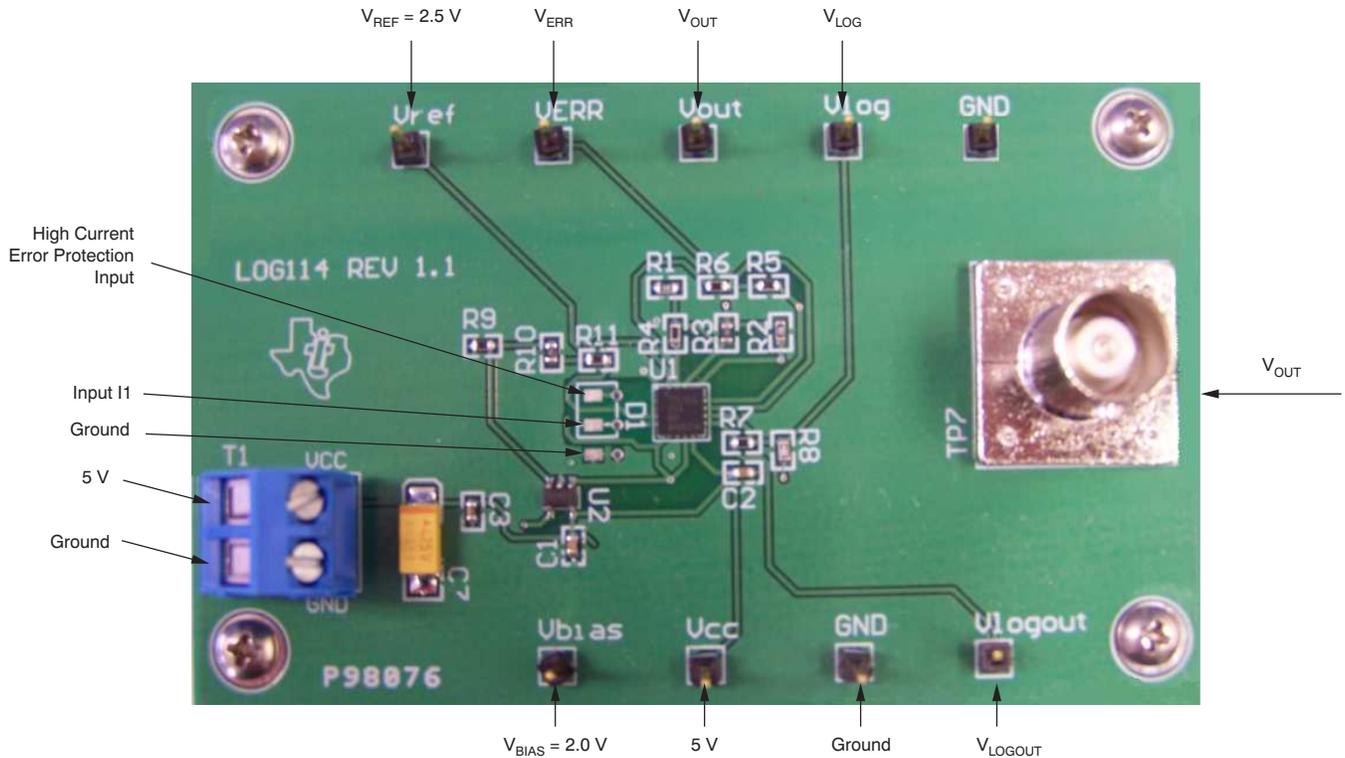
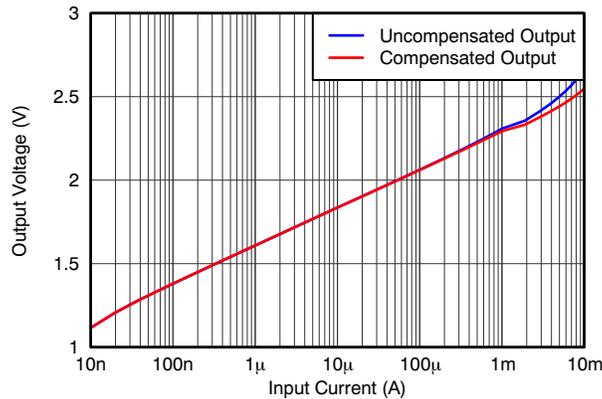


Figure 12. LOG114EVM Components

## 5 Verifying Results

Making measurements on the LOG114EVM is fast and easy. Connect a digital voltmeter or oscilloscope to the terminal of interest and record the results. Included with the graph of measured results is a table of results for common values of input currents. In [Figure 13](#), two curves are shown. Both curves use a resistor input and  $V_{OUT}$  is recorded as a function of input current. The compensated (red) curve connects the resistor as shown in [Figure 11](#) and uses the high-current linearity correction circuitry. The uncompensated curve (blue) uses the resistor connected to  $I_1$  and  $V_{REF}$  as shown in [Figure 10](#).



**Figure 13. LOG114EVM Measured Results**

[Table 1](#) lists several typical results obtained with various input voltages.

**Table 1. LOG114EVM Typical Results**

Input	Uncompensated		Compensated	
	$V_{LOGOUT}$ (V)	$V_{OUT}$ (V)	$V_{LOGOUT}$ (V)	$V_{OUT}$ (V)
10 nA	1.36	1.15	1.36	1.15
100 nA	1.74	1.38	1.74	1.38
1 $\mu$ A	2.11	1.60	2.11	1.60
10 $\mu$ A	2.49	1.83	2.49	1.83
100 $\mu$ A	2.87	2.06	2.87	2.06
1 mA	3.29	2.31	3.29	2.30
10 mA	4.11	2.82	4.11	2.67

## 6 LOG114EVM Documentation

This section contains the complete bill of materials and PCB layout for the LOG114EVM.

**NOTE:** These board layouts are not to scale. These image are intended to show how the board is laid out; they are not intended to be used for manufacturing LOG114EVM PCBs.

### 6.1 Schematic

Figure 14 shows the schematic for the LOG114EVM board

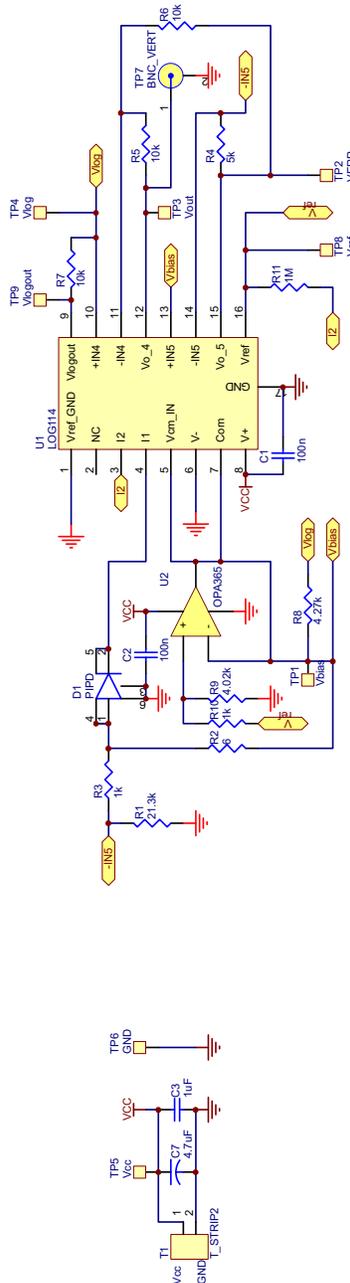


Figure 14. LOG114EVM Board Schematic

## 6.2 PCB Layout

Figure 15 through Figure 17 show the PCB layout of the LOG114EVM.

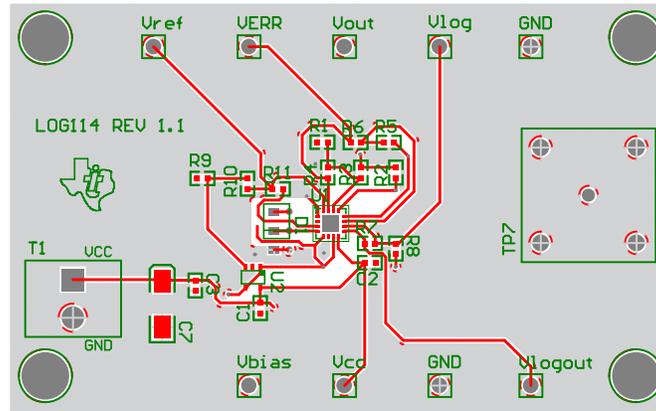


Figure 15. LOG114EVM: Top Side Composite Drawing

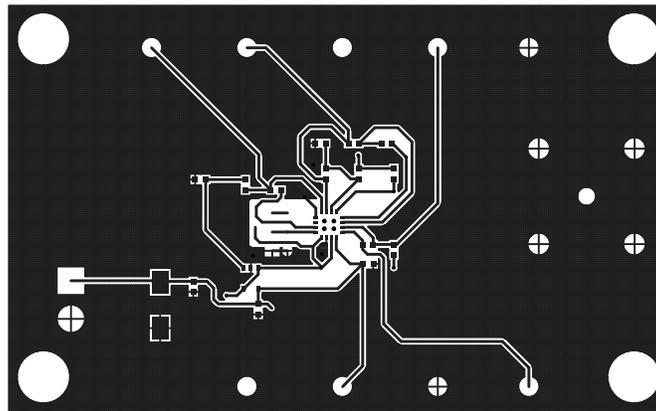


Figure 16. LOG114EVM: Top Copper Layer

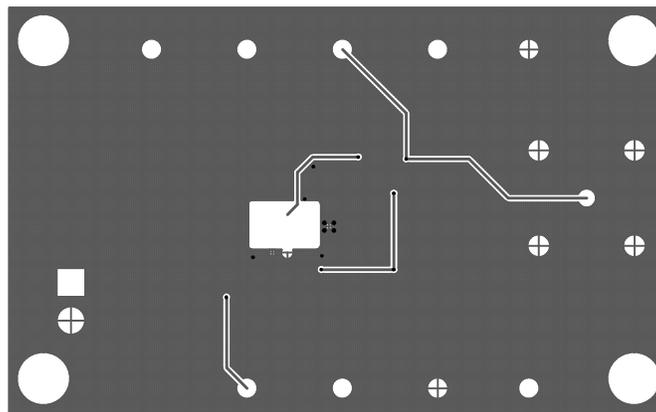


Figure 17. LOG114EVM: Bottom Copper Layer

### 6.3 Bill of Materials

Table 2 lists the bill of materials for the LOG114EVM

**Table 2. LOG114 Bill of Materials**

Item No	Count	Value	Ref Des	Description	MFR	Mfr Part Number
1	1	21.5 k $\Omega$	R1	Resistor, 21.5 k $\Omega$ 1/10W 1% 0603 SMD	Yageo	RC0603FR-0721K5L
2	1	3 $\Omega$	R2	Resistor, 3.0 $\Omega$ 1/10W 5% 0603	Panasonic - ECG	ERJ-3GEYJ3R0V
3	2	1 k $\Omega$	R3, R10	Resistor, 1.0 k $\Omega$ .25W 5% 0603 SMD	Vishay/Dale	CRCW06031K00JNEAHP
4	1	4.99 k $\Omega$	R4	Resistor, 4.99 k $\Omega$ 1/10W 1% 0603 SMD	Panasonic	ERJ-3EKF4991V
5	3	10 k $\Omega$	R5, R6, R7	Resistor, 10.0 k $\Omega$ 1/10W 1% 0603 SMD	Panasonic	ERJ-3EKF1002VRES
6	1	4.3 k $\Omega$	R8	Resistor, 4.3 k $\Omega$ 1/16W .5% 0603 SMD	Susumu	RR0816P-432-D
7	1	4.02 k $\Omega$	R9	Resistor, 4.02 k $\Omega$ 1/10W 1% 0603 SMD	Panasonic	ERJ-3EKF4021V
8	1	1 M $\Omega$	R11	Resistor, 1.00 M $\Omega$ 1/10W 1% 0603 SMD	Panasonic	ERJ-3EKF1004V
9	1	4.7 $\mu$ F	C7	Capacitor, Tantalum 4.7 $\mu$ F 35V 10% SM	AVX Corporation	TAJC475K035RNJ
10	1	0.1 $\mu$ F	C3	Capacitor, Ceramic .100 $\mu$ F 25V X7R 0603	Yageo	CC0603KRX7R8BB104
11	2	100 nF	C1, C2	Capacitor, Ceramic 1000 pF 25V Y5V 0603	Murata Electronics North America	GRM188F51E102ZA01D
12	1	—	U1	LOG114	Texas Instruments	LOG114AIRGVT
13	1	—	U2	OPA365	Texas Instruments	OPA365AIDBVR
14	1	BNC	TP7	Connector, Jack BNC Vert 50 $\Omega$	Tyco Electronics	5227699-1
15	1	—	T1	PCB Terminal Block 5 MM 2-Pos	On-Shore Technology Inc	ED300/2
16	9	N/A	Test Points, All	Connector, Header 1-Pos .100" Sgl Gold	Samtec	TSW-101-07-G-S
17	4	Standoff	—	Standoffs, Hex , 4-40 Threaded, 0.500-in. length, 0.250-in OD, Aluminum Iridite Finish	Keystone	2203
18	4	Screw	—	Screw, Machine, Phillips 4-40x1/4 SS	B & F Fastener Supply	PMSSS 440 0025 PH
19	1	N/A	D1	Do not install	—	—

## Evaluation Board/Kit Important Notice

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. **THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.**

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

**EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.**

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive**.

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.**

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please contact the TI application engineer or visit [www.ti.com/esh](http://www.ti.com/esh).

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

## FCC Warning

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

## EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of  $\pm 2.4\text{V}$  to  $\pm 5.5\text{V}$  and the output voltage range of  $\pm 1.8\text{V}$  to  $\pm 4.9\text{V}$ .

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than  $+25^{\circ}\text{C}$ . The EVM is designed to operate properly with certain components above  $+25^{\circ}\text{C}$  as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

## EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please visit [www.ti.com/esh](http://www.ti.com/esh) or contact TI.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used. TI currently deals with a variety of customers for products, and therefore our arrangement with the user is not exclusive. TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.

## REGULATORY COMPLIANCE INFORMATION

As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

### General Statement for EVMs including a radio

*User Power/Frequency Use Obligations:* This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

### 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

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**

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.

### **For EVMs annotated as IC – INDUSTRY CANADA Compliant**

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

### **Concerning EVMs including radio transmitters**

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

### **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.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

### **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.

### **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.

## **【Important Notice for Users of this Product in Japan】**

**This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan**

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product 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 this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

**Texas Instruments Japan Limited**  
**(address) 24-1, Nishi-Shinjuku 6 chome, Shinjuku-ku, Tokyo, Japan**

<http://www.tij.co.jp>

### **【ご使用にあたっての注】**

本開発キットは技術基準適合証明を受けておりません。

本製品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番4号  
西新宿三井ビル

<http://www.tij.co.jp>

## EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMERS

**For Feasibility Evaluation Only, in Laboratory/Development Environments.** Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure 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.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

**Certain Instructions.** It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

**Agreement to Defend, Indemnify and Hold Harmless.** You agree to 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 use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

**Safety-Critical or Life-Critical Applications.** If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2012, Texas Instruments Incorporated

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)