EVM User's Guide: PCM1809EVM

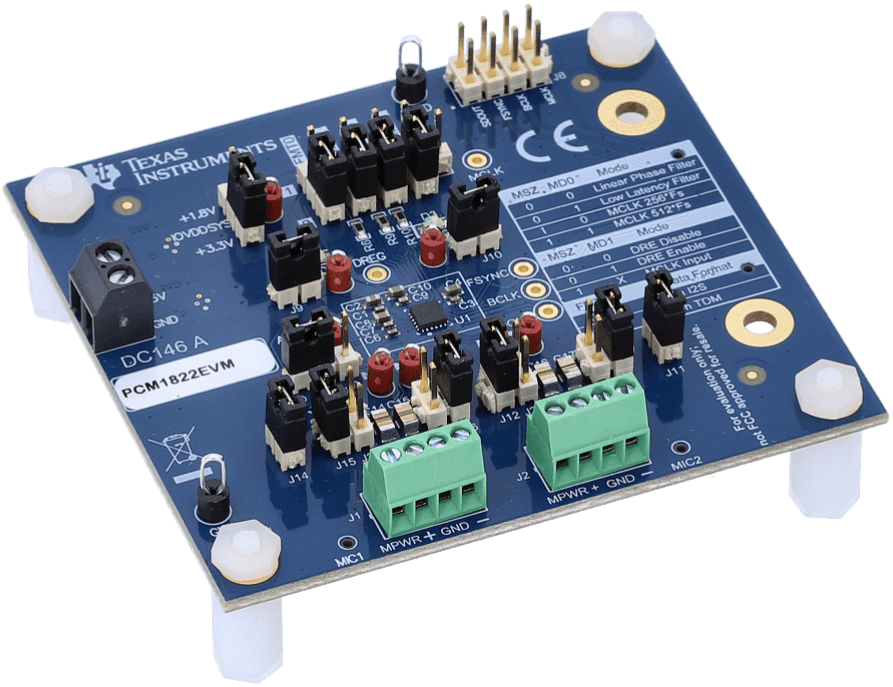
PCM1809 Evaluation Module

Description

The PCM1809EVM evaluation module (EVM) allows the user to test the capabilities of the PCM1809 device, which is a hardware-controlled, high-performance audio analog-to-digital converter (ADC) intended for applications in voice-activated systems, professional microphones, audio conferencing, portable computing, communication and entertainment applications. The EVM provides convenient connections to the input, output and hardware control pins.

Features

- Onboard microphones provided for voice recording testing
- Pin-controlled for simple and fast operation
- Direct access to digital audio signals and control interface for simple end-system integration



PCM1809EVM

1 Evaluation Module Overview

1.1 Introduction

The PCM1809EVM is an evaluation module (EVM) designed to demonstrate the performance and functionality of the PCM1809 device. The PCM1809 is a high-performance audio analog-to-digital converter (ADC) that is configured through logic-level mode selection pins and does not require a digital interface such as I2C or SPI to configure registers. As such, no software is necessary to interface with the EVM. The EVM is powered with a single 5V supply. Access to the converter output is provided on the audio serial interface in I2S or TDM format.

This user's guide describes the function and use of the PCM1809EVM evaluation module. This document includes the hardware configuration instructions, a quick-start guide, jumper and connector descriptions, schematics, and printed-circuit board (PCB) layout that demonstrate TI's recommended practices for these devices.

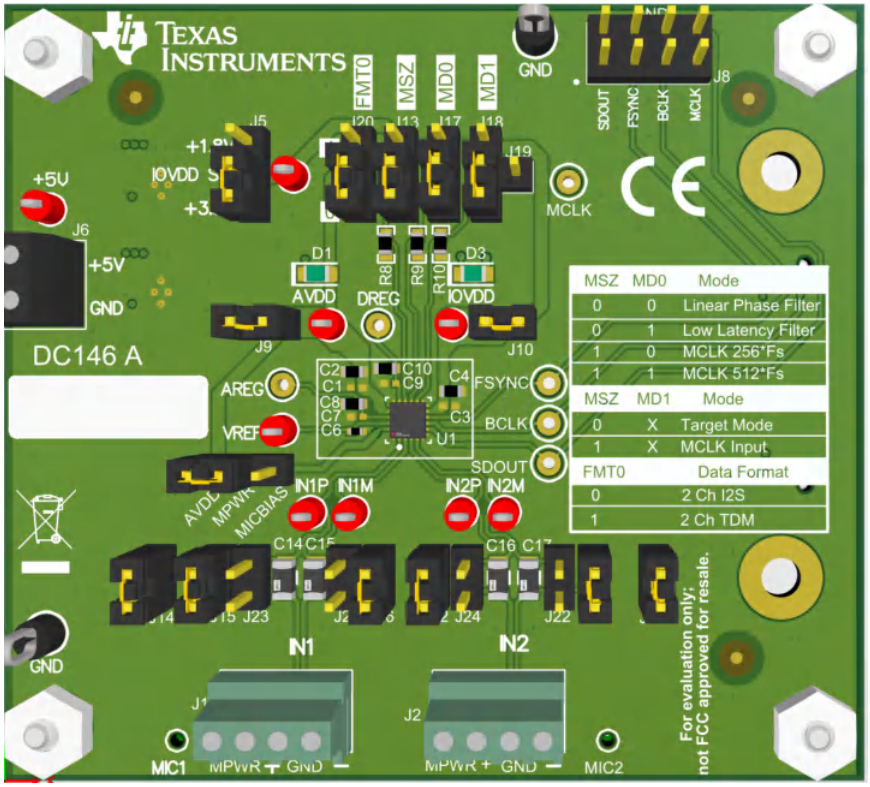


Figure 1-1. EVM Board

1.2 Kit Contents

The PCM1809EVM kit includes a PCM1809EVM evaluation board.

1.3 Specification

PCM1809 is tailored to operate in space-constrained audio recording applications such as smart speakers, video-conferencing systems, and IP network cameras. The device features stereo recording, integrated decimation filters, and pin control to verify audio quality with ease of implementation.

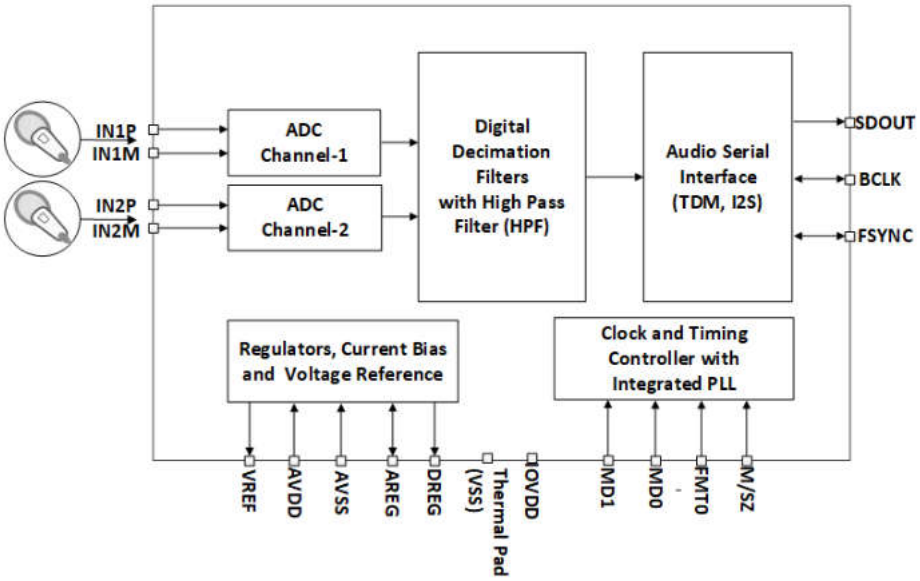


Figure 1-2. PCM1809 Functional Block Diagram

1.4 Device Information

The PCM1809 is an audio analog-to-digital converter (ADC) that supports single-ended and differential line and microphone inputs with a 2VRMS full-scale differential signal. The device integrates a phase-locked loop (PLL), a DC removal high-pass filter (HPF), and supports sample rates up to 192kHz. The device supports time-division multiplexing (TDM) or I2S audio formats, selectable with the hardware pin level. Additionally, the PCM1809 supports controller and target mode selection for the audio bus interface operation.

2 Hardware

2.1 Power Supply

The PCM1809EVM can be powered with a single 5V power supply connected to J6. Onboard low dropout regulators convert the 5V supply to the 3.3V and 1.8V rails used by the ADC. The analog supply, AVDD, is fixed at 3.3V. The digital supply, IOVDD, can be set to either 1.8V or 3.3V with J5. To power the ADC directly, remove J9 and J5 and apply a voltage directly to the AVDD and IOVDD test points. Note that if this is done, then keep J10 populated (or make sure there is a path between the pins if the supply current is being monitored) as this jumper connects the applied IOVDD to the mode selection pins and other circuitry that relies on IOVDD.

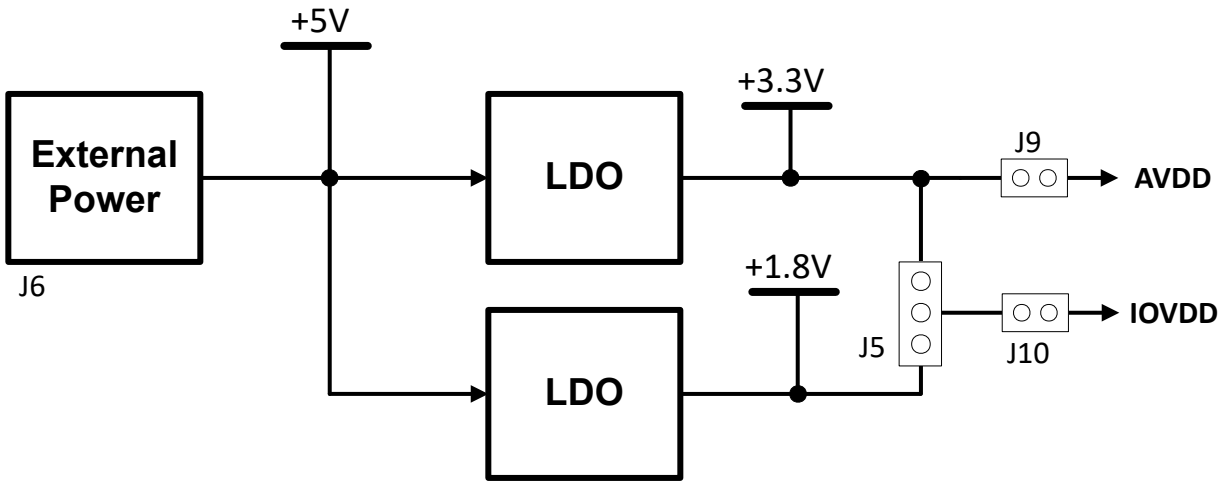


Figure 2-1. PCM1809 Power Supply

2.2 Hardware Configuration

The format of the audio data and the operating mode of the ADC are controlled by the following pins: MD0,MD1, MSZ, and FMT0. These signals are referenced to IOVDD and can be set to high (1) or low (0). If no shunt is installed, then a 47kΩ pulldown resistor sets the pin low so that the ADC remains in a defined state. Table 2-1 shows the header numbers and the pin functions and Table 2-2, Table 2-2 and , Table 2-2 show the possible modes and output formats. The MSZ pin selects whether the device is a controller or a target on the audio bus. When MSZ is pulled high, the device is in controller mode and MD1 becomes an input for MCLK. A shunt connecting J19 to the center pin of J18 routes the MCLK signal provided on J8 to the MD1 pin on the ADC to allow for easy interfacing with audio measurement equipment.

Table 2-1. PCM1809EVM Headers and Jumpers

Designator	Function
J1	Differential line/mic input 1
J2	Differential line/mic input 2
J4	MICBIAS Selection
J5	IOVDD-SYS voltage Selection (1.8V or 3.3V)
J6	+5V input
J7	AC-MB Connector
J8	Audio Serial Interface header
J9	Connect AVDD to onboard 3.3V regulator
J10	Connect IOVDD to onboard regulator
J11	Connect MICBIAS to onboard MIC2
J12	Connect MIC2 OUT+ to ADC IN2P
J13	MSZ select
J14	Connect MICBIAS to onboard MIC1
J15	Connect MIC1 OUT+ to ADC IN1P

Table 2-1. PCM1809EVM Headers and Jumpers (continued)

Designator	Function
J16	Connect MIC1 OUT- to ADC IN1M
J17	MD0 select
J18	MD1 select
J19	MCLK to MD1
J20	FMT0 select
J21	Connect MIC2 OUT- to ADC IN2M
J22	IN2M capacitor bypass
J23	IN1P capacitor bypass
J24	IN2P capacitor bypass
J25	IN1M capacitor bypass

Table 2-2. PCM1809EVM Modes

MD0 Modes		
MD0	*MSZ (0 = Target, 1 = Controller)*	*MD0 Functional Mode*
0	0	Linear phase filters are used for the decimation in target mode. For controller mode, the device always use linear phase filters for the decimation.
0	1	System clock with frequency 256 × fS connected to the MD1 pin as MCLK.
1	0	System clock with frequency 512 × fS connected to the MD1 pin as MCLK.
1	1	Low latency filters are used for the decimation in target mode. For controller mode, the device always use linear phase filters for the decimation.

Table 2-3. PCM1809EVM MD1 Modes

MD1 Modes		
MD1	*MSZ (0 = Target, 1 = Controller)*	*Functional mode*
X	0	Target mode
MCLK	1	MCLK input in controller mode

Table 2-4. PCM1809EVM Audio Output Format

Audio Output Data Format	
FMT0	*Audio Serial Interface Format*
0	2-channel output with inter IC sound (I2S) mode
1	2-channel output with time division multiplexing (TDM) mode

All hardware pins are tied low by default, placing the device in target mode with a linear phase filter and 2-channel I2S audio output. For more information on the operating modes of the PCM1809 device, see the *PCM1809 Stereo Channel, 102dB Dynamic Range Audio ADC* data sheet.

2.3 PCM1809EVM Inputs

The PCM1809 device is intended to be driven with differential line or microphone inputs. Each of the inputs has a 1µF AC coupling film capacitor. Coupled with the 10kΩ input impedance of PCM1809, this sets the high pass filter cutoff frequency at approximately 16Hz. This can be adjusted by replacing the input AC coupling capacitors on the EVM if necessary. PCM1809 is optimized to support AC/DC coupling in both single-ended or differential input configurations. Figure 2-2 shows the architecture of the inputs to the evaluation module. The EVM supports a differential full scale input range of 2 VRMS with an AVDD of 3.3V.

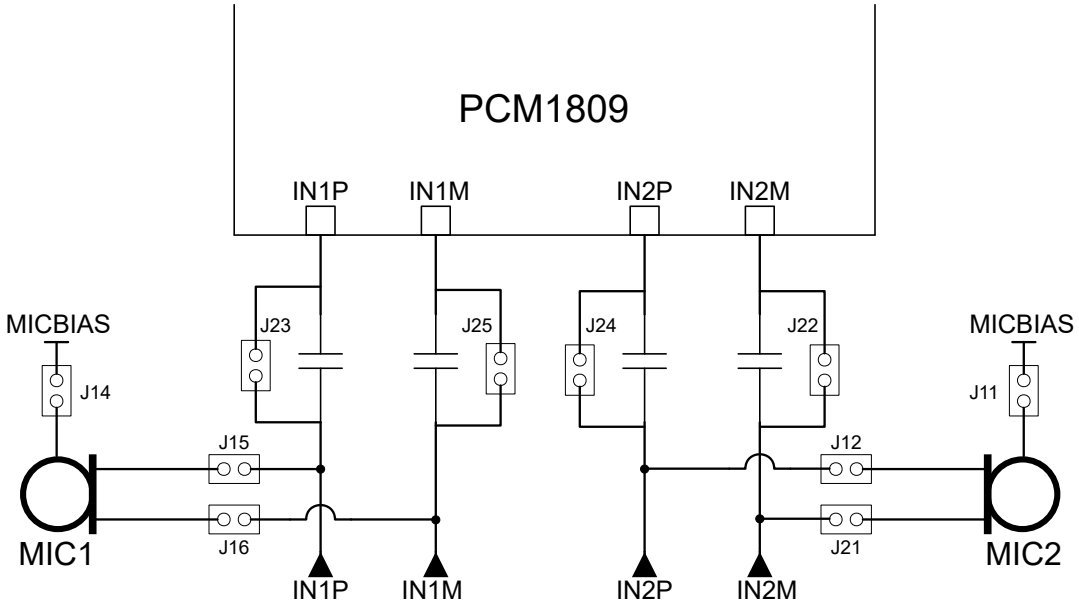


Figure 2-2. PCM1809 Input Architecture

2.3.1 Onboard Microphone Inputs

PCM1809EVM has two onboard differential microphones that can be routed to the inputs with jumpers. The microphones require a bias be applied to MPWR. MPWR can be tied to AVDD on J4, or to MICBIAS if using a device that supports this feature. Note that PCM1809 does not have an integrated MICBIAS and this option is provided for future devices that can incorporate this feature. The following jumpers need to be installed to use the onboard mics: J4, J11,J12, J14, J15, J16, and J21.

If the onboard mics are used, then leave the J1 and J2 headers unconnected to preserve the microphone performance.

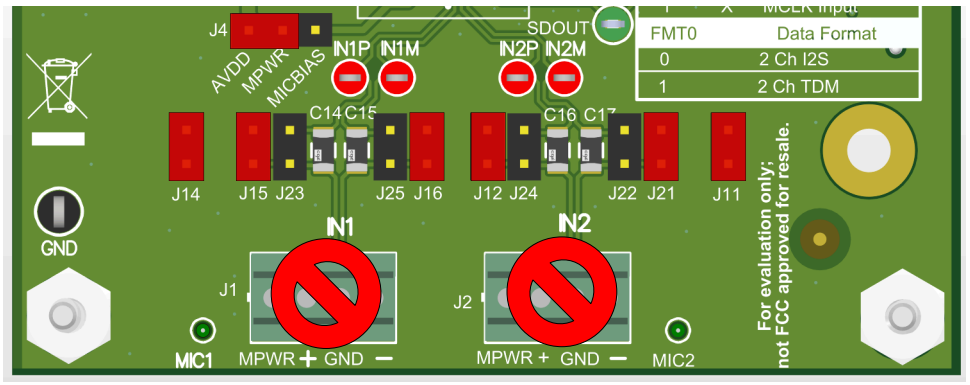


Figure 2-3. PCM1809 Onboard Microphones

2.3.2 Line Inputs

For the line input configuration, shown in Figure 2-4, the PCM1809 captures the audio signal provided through terminals J1 (IN1) and J2 (IN2). The input accepted in this mode is a differential, 2 VRMS, full-scale audio signal.

PCM1809 accepts , 1 VRMS, single ended full-scale audio signal.

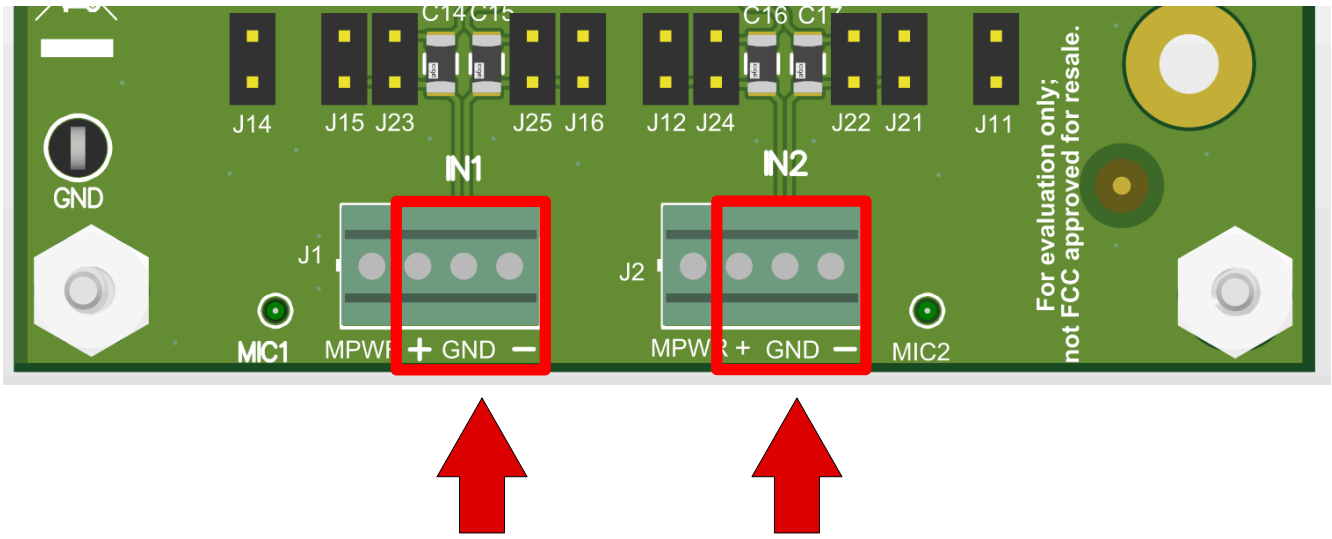


Figure 2-4. PCM1809 Line Inputs

3 Hardware Design Files

3.1 Schematics

Figure 3-1 illustrates the EVM schematic.

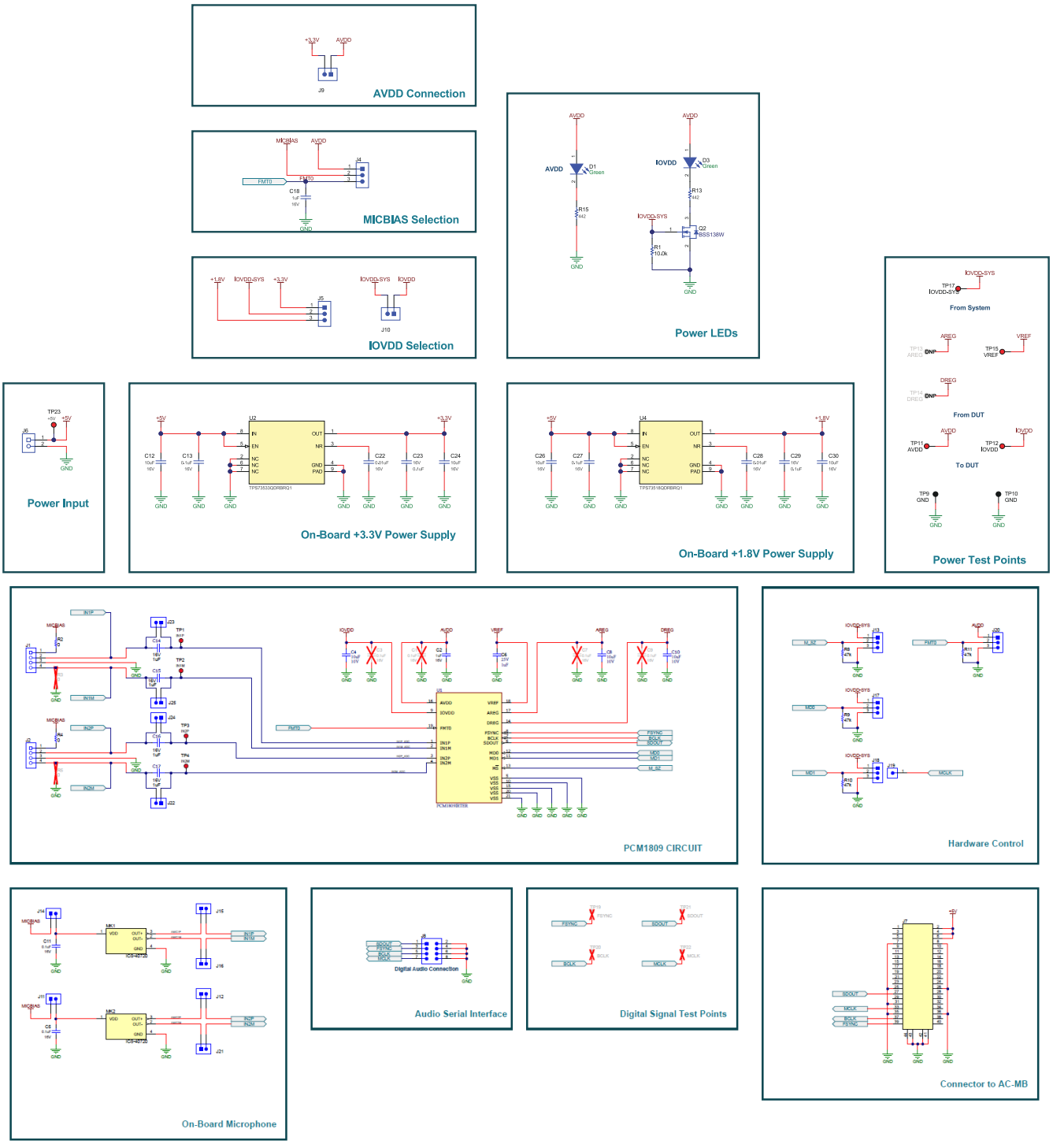


Figure 3-1. Schematic

3.2 Layer Plots

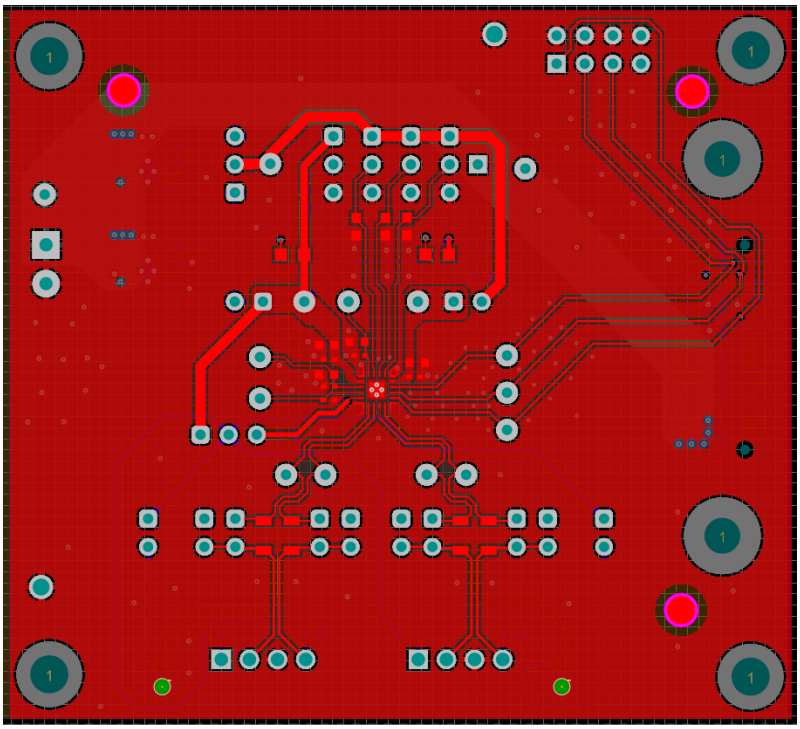


Figure 3-2. Top Layer

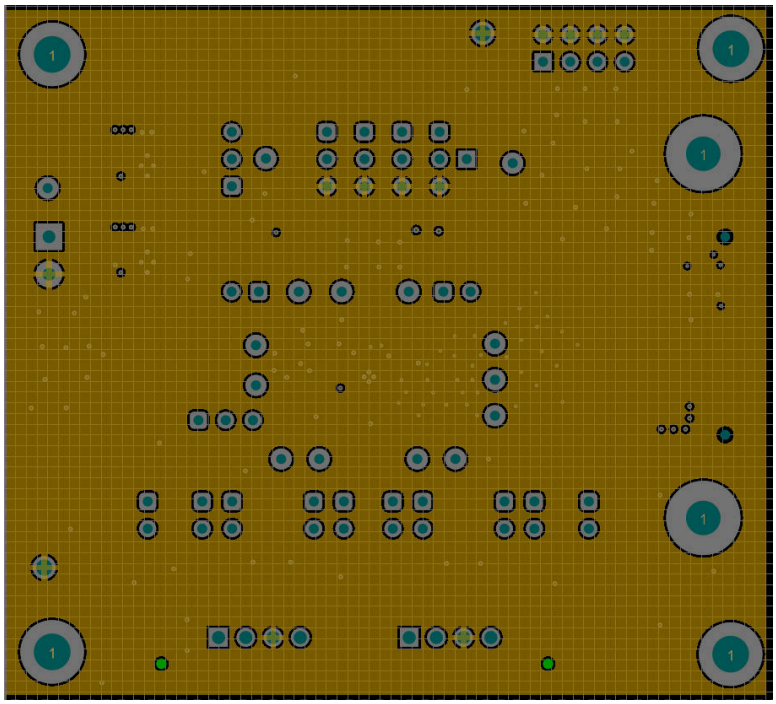


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Figure 3-3. Power Plane 1

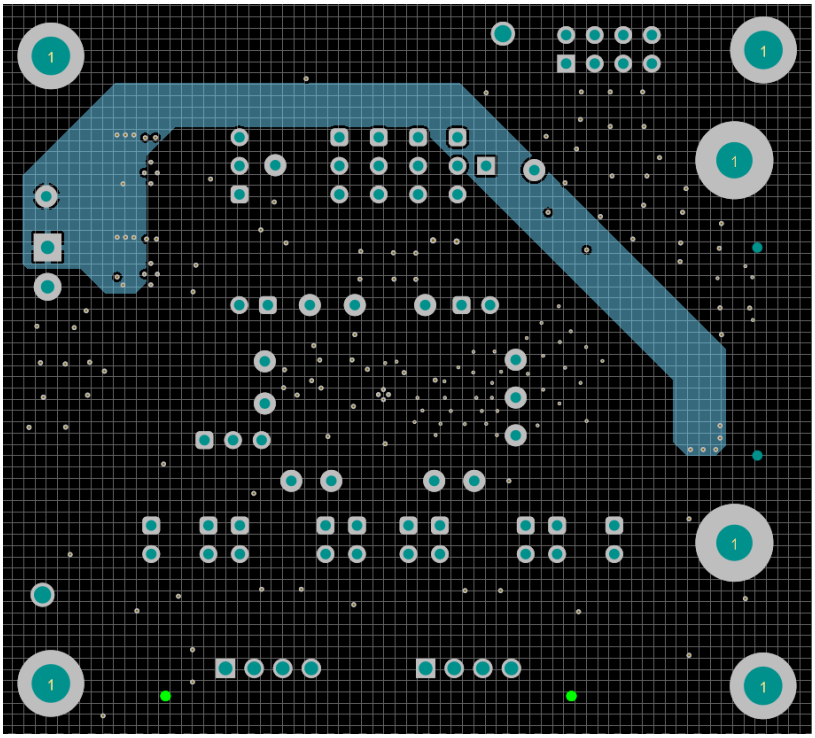

Figure 3-4. Power Plane 2

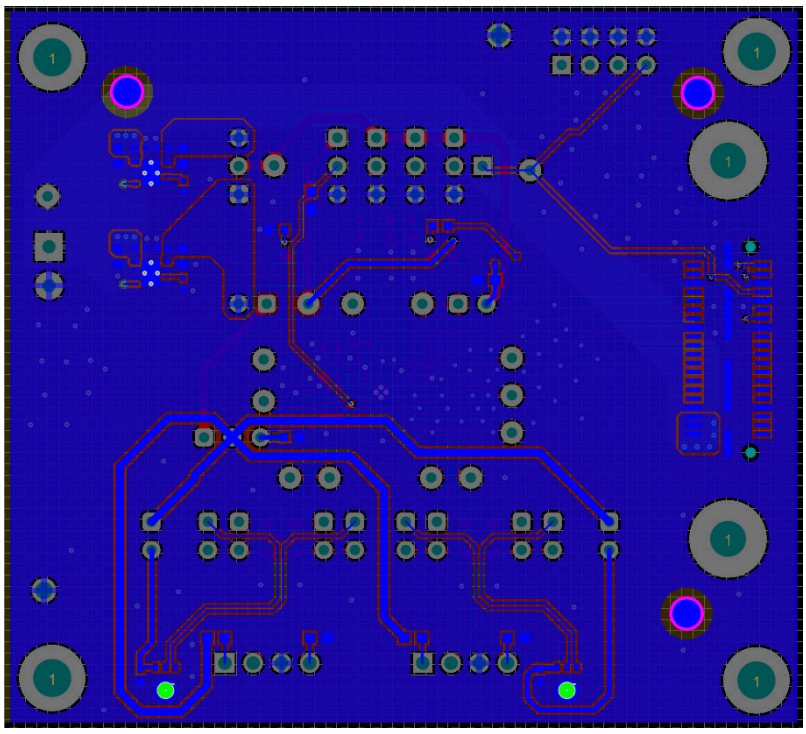

Figure 3-5. Bottom Layer

3.3 Bill of Materials

Table 3-1. Bill of Materials (BOM)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C1, C3, C5, C7, C9, C11, C13, C23, C27, C29	10	0.1uF	CAP, CERM, 0.1uF, 16V, +/- 10%, X7R, 0402	0402	885012205037	Wurth Elektronik
C2	1	1uF	CAP, CERM, 1uF, 16V, +/- 10%, X7R, 0603	0603	885012206052	Wurth Elektronik
C4, C8, C10	3	10uF	CAP, CERM, 10uF, 10V, +/- 20%, X5R, 0603	0603	C1608X5R1A106M080AC	TDK
C6	1	1uF	CAP, CERM, 1uF, 16V, +/- 10%, X5R, 0402	0402	EMK105BJ105KVHF	Taiyo Yuden
C12, C24, C26, C30	4	10uF	CAP, CERM, 10uF, 16V, +/- 20%, X5R, 0603	0603	EMK107BBJ106MA-T	Taiyo Yuden
C14, C15, C16, C17	4	4.7uF	CAP, CERM, 4.7uF, 50V, +/- 10%, X7R, 1206	1206	GRM31CR71H475KA12L	MuRata
C18	1	1uF	CAP, CERM, 1uF, 16V, +/- 10%, X7R, 0603	0603	EMK107B7105KA-T	Taiyo Yuden
C22, C28	2	0.01uF	CAP, CERM, 0.01uF, 16V, +/- 10%, X7R, 0402	0402	520L103KT16T	AT Ceramics
D1, D3	2	Green	LED, Green, SMD	LED_0805	LTST-C170KGKT	Lite-On
H1, H2, H3, H4	4		Small nylon hex nut, 0.10 thick with a 0.250 outside diameter and a 4-40 threading	Hex Nut,4-40 Thread, 250" Head Dia	9605	Keystone
H5, H6, H7, H8	4		Standoff, Hex, Male/Female, 4-40, Nylon, 1/2"	Standoff, Hex, Male/Female, 4-40, Nylon, 1/2"	4802	Keystone
J1, J2	2		Terminal Block, 2.54mm, 4x1, Brass, TH	Terminal Block, 2.54mm, 4-pole, TH	OSTVN04A150	On-Shore Technology
J4, J5, J13, J17, J18, J20	6		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
J6	1		Terminal Block, 3.5mm Pitch, 2x1, TH	7.0x8.2x6.5mm	ED555/2DS	On-Shore Technology
J7	1		Connector, Header, High Speed, 20 pairs, SMT	QTE-020-01-X-D-A	QTE-020-01-L-D-A	Samtec
J8	1		Header, 100mil, 4x2, Gold, TH	4x2 Header	TSW-104-07-G-D	Samtec
J9, J10, J11, J12, J14, J15, J16, J21, J22, J23, J24, J25	12		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
J19	1		Header, 100mil, 1pos, Gold, TH	Test point	TSW-101-07-G-S	Samtec
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady

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

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
MK1, MK2	2		Approx. 77Hz - 20kHz Analog Microphone MEMS (Silicon), approx. 1.5V - 3.63V Omnidirectional (-37.5dB ±1dB at 94dB SPL) Solder Pads	LGA4	ICS-40740	TDK
Q2	1	50V	MOSFET, N-CH, 50V, 0.21A, SOT-323	SOT-323	BSS138W	Fairchild Semiconductor
R1	1	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R2, R4	2	0	RES, 0, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
R8, R9, R10, R11	4	47k	RES, 47 k, 5%, 0.1 W, 0603	0603	RC0603JR-0747KL	Yageo
R13, R15	2	442	RES, 442, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603442RFKEA	Vishay-Dale
SH1, SH2, SH3, SH4, SH5, SH6, SH7, SH8, SH9, SH10, SH11, SH12, SH13, SH14	14	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4, TP11, TP12, TP15, TP17, TP23	9		Test Point, Miniature, Red, TH	Red Miniature Test point	5000	Keystone
TP9, TP10	2		Test Point, Multipurpose, Black, TH	Black Multipurpose Test point	5011	Keystone
U1	1		PCM1821 - 106dB HW Stereo ADC	WQFN20	PCM1821IRTER	Texas Instruments
U2	1		500mA, Low Quiescent Current, Low-Noise, High PSRR, Low-Dropout Linear Regulator for Automotive, DRB0008B (VSON-8)	DRB0008B	TPS73533QDRBRQ1	Texas Instruments
U4	1		500mA, Low Quiescent Current, Low-Noise, High PSRR, Low-Dropout Linear Regulator for Automotive, DRB0008B (VSON-8)	DRB0008B	TPS73518QDRBRQ1	Texas Instruments
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
R3, R5	0	0	RES, 0, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale
TP13, TP14	0		Test Point, Miniature, Red, TH	Red Miniature Test point	5000	Keystone
TP19, TP20, TP21, TP22	0		Test Point, Miniature, Green, TH	Green Miniature Test point	5116	Keystone

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

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   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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