EVM User's Guide: LDC5072Q1EVM

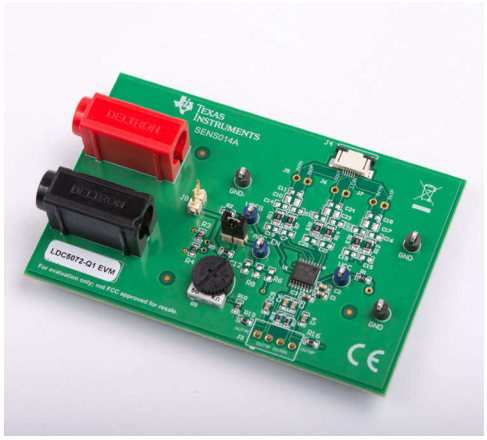
LDC5072-Q1 评估模块

说明

德州仪器 (TI) LDC5072-Q1 评估模块 (EVM) 套件可帮助设计人员评估 LDC5072-Q1 电感式位置传感器的运行情况和性能。

特性

- 集成 AFE，无需旋转变压器即可进行非接触式电感角度检测
- 快速集成到现有系统
- 可下载并支持电感式传感器设计工具：LDC5072-Q1-SENSOR-DESIGN-TOOL



LDC5072Q1EVM

English Document: SNOU162

1 评估模块概述

1.1 简介

LDC5072-Q1 评估模块 (EVM) 可帮助设计人员评估 LDC5072-Q1 电感位置传感器的运行情况和性能。该 EVM 也支持 LDC5071-Q1 器件，如器件兼容性表中所示。该 EVM 包含 LDC5072-Q1 所需的所有无源器件，可在系统中快速进行评估。LDC5072-Q1 的传感器印刷电路板 (PCB) 可通过 LDC5072-Q1 传感器设计器工具创建。

1.2 套件内容

该 EVM 包含一个焊接到 EVM PCB 上的 LDC5072-Q1。还包含 50kΩ 修整电位器，可帮助设计人员更改自动增益控制设置并在各种用例中评估 LDC5072-Q1。该套件还包含两块未组装的 PC 板，一块用于电感式传感器，另一个用于靠近传感器 PC 板旋转的目标。此套件中包含这些板，有助于您轻松开始使用 EVM。

如果附带的传感器和目标 PC 板不符合您的要求，则可以使用 LDC507X-SENSOR-DESIGN-TOOL（可从 TI.com 免费下载）设计您自己的传感器和板。有关该工具的更多信息,请参阅 LDC5072-Q1 传感器设计工具入门指南。包含的传感器和目标 PC 板是使用 LDC507X-SENSOR-DESIGN-TOOL 的默认设置进行设计的。

1.3 器件信息

LDC5072-Q1 IC 是一款模拟前端，适用于面向绝对旋转位置检测的非接触式电感式位置传感器。LDC5072-Q1 用于激励通常印刷在印刷电路板 (PCB) 上的线圈。该激励会通过靠近 PCB 的导电目标耦合回同一 PCB 上的两组接收器线圈。导电目标也可以是印刷在另一个 PCB 上的图案。线圈 PCB 保持静止，目标随电机、执行器或阀门移动。激励线圈会根据目标相对于接收器线圈的位置，在接收器线圈上产生次级电压。通过从接收器线圈中读取电压、对电压进行处理并给出表示目标位置的正弦和余弦分量的模拟输出，可以获得位置的信号表示。

下表显示了与 LDC5072-Q1 EVM 兼容的器件。

表 1-1. 器件兼容性

器件型号	封装	封装 尺寸
LDC5072-Q1	PW（TSSOP，16）	5.00mm × 6.40mm
LDC5071-Q1		

2 硬件

2.1 EVM 连接

2.1.1 工作原理

LDC05072-Q1 是一款面向电感位置传感器的前端，主要应用于汽车和工业领域的绝对旋转位置测量。电感式位置传感器的工作原理是涡流生成和磁耦合。LDC5072-Q1 连接到通常位于印刷电路板上的三个电感式感应线圈。其中一个线圈连接到 LDC5072-Q1 的激励电路并充当发送器，其他两个次级线圈用作接收器。发送器线圈在初级或次级线圈中感应出电压，这是传感器线圈上方导电目标的函数。LDC5072-Q1 解调次级线圈接收到的信号，并输出表示传感器线圈上方导电目标位置的正弦和余弦波形。

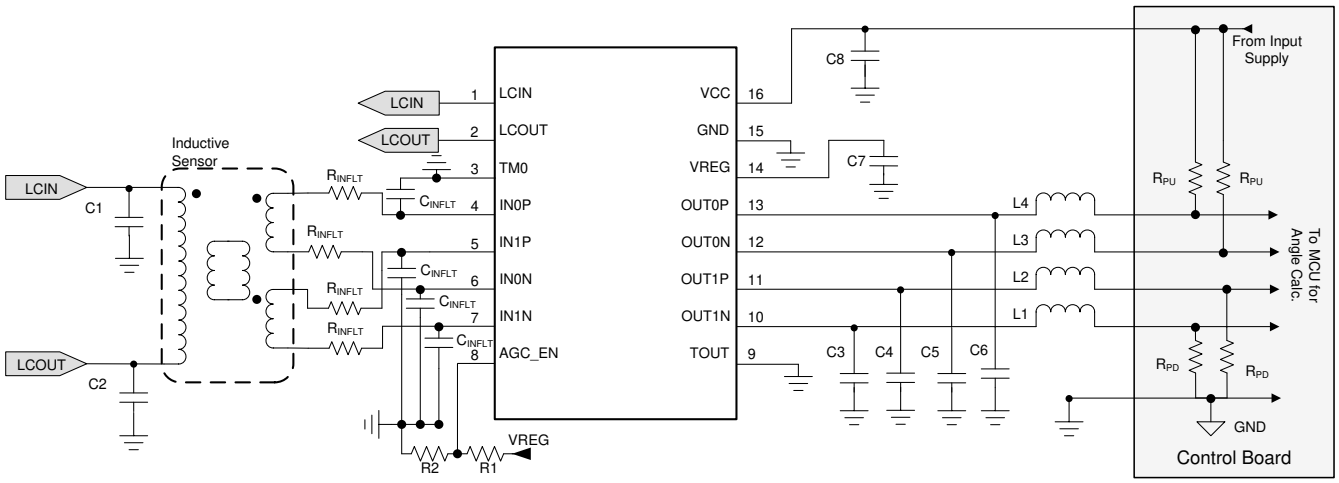


图 2-1. 典型应用图

2.1.2 EVM 连接

本节对 LDC5072Q1EVM 上的连接器进行了说明，并介绍了如何正确地连接、设置和使用 LDC5072-Q1。

表 2-1. 连接器说明

连接器	类型	功能
J1	香蕉插孔端子	VCC 电源
J2	香蕉插孔端子	接地
J3	4 引脚 100mil 端子块	为 OUT1N、OUT1P、OUT0N 和 OUT0P 提供与 ADC 的连接。
J4	6 位置 FPC 母连接器	为 LCIN、LCOUT、IN0P、IN1P、IN0N 和 IN1N 提供与传感器的连接。
J5	2 引脚 100mil 接头	提供与 IN0P 和 IN0N 的连接。
J6	2 引脚 100mil 接头	提供与 LCIN 和 LCOUT 的连接。
J7	2 引脚 100mil 接头	提供与 IN1P 和 IN1N 的连接。
J8	2 引脚 100mil 接头	用于将 VCC 连接到 VREG 的跳线。仅当使用 3.3V VCC 工作模式时，才能安装此插件。
J9	2 引脚 100mil 接头	跳线，用于将 AGC_EN 引脚连接到电位器电路。
R9 - AGC 调节	50kΩ 修整电位器	提供可调电阻，用于在 AGC 引脚上创建一个介于 0V 和 VREG 之间的分压器。

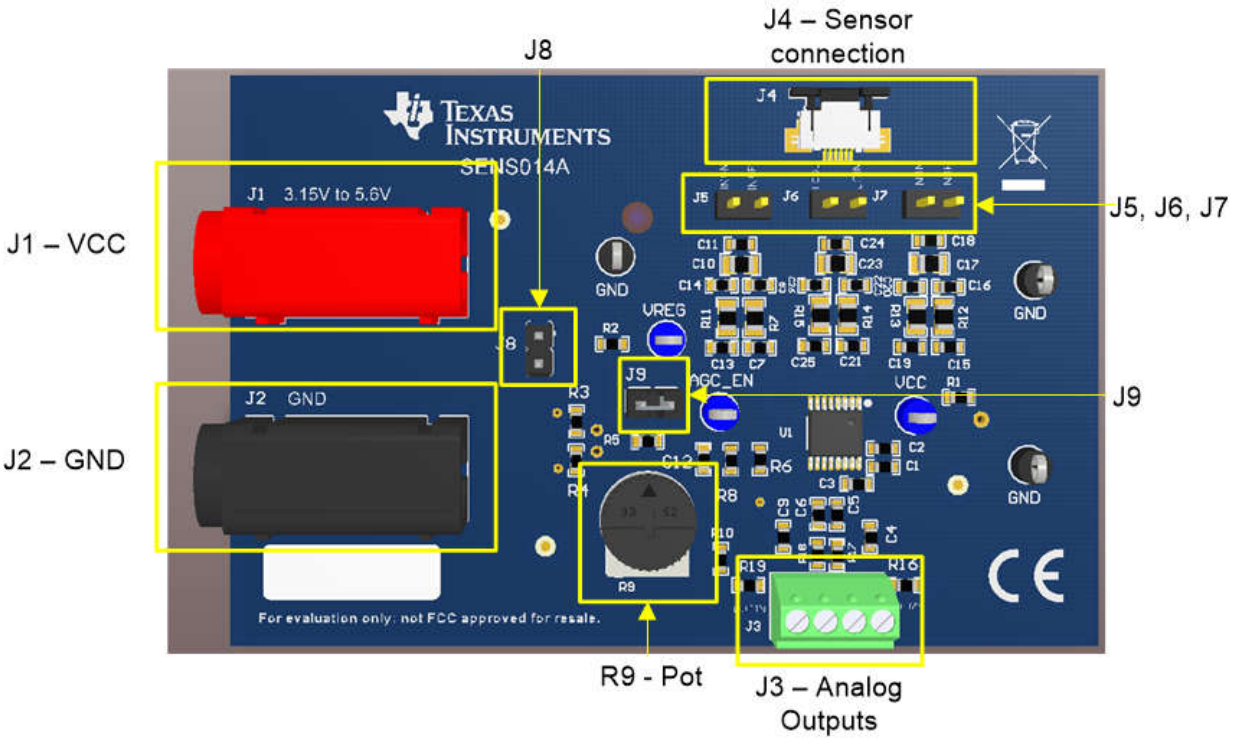


图 2-2. 连接器和功能位置

2.1.3 EVM 接口

LDC5072Q1EVM 可以通过放置在 EVM 左侧的 J1 (VCC) 和 J2 (GND) 使用 5V 电压供电。使用 5V 电压运行时，使跳线 J8 保持未安装状态。要选择 3.3V 工作电压，请向 J1 (VCC) 提供 3.3V 电压并安装跳线 J8。

LDC5072-Q1 启动时 AGC 引脚上的电压决定了自动增益控制设置。通过 50kΩ 修整电位器 (R96) 可轻松控制电压。

2.2 快速入门指南

2.2.1 为 LDC5072EVM 供电

电源可以通过香蕉插孔连接器（J1 – VCC 和 J2 – GND）提供。

5V 工作电压：

1. 移除跳线 J8。
2. 将 J1 连接到 5V 电源，将 J2 连接到 GND。

3.3V 工作电压：

1. 安装跳线 J8。
2. 将 J1 连接到 3.3V 电源，将 J2 连接到 GND。

2.2.2 调整 AGC

该 EVM 具有一个电位器 (R9)，可用于控制 AGC 引脚上的电压电平。请注意，在启动期间对 AGC_EN 引脚上的电压进行采样。将引脚调整为所需的电压后，重新启动电源以开始使用所选的 AGC_EN 设置。

图 2-3. EVM 上提供电位器

要在 AGC_EN 引脚上选择精确的电压，请执行以下步骤：

1. 卸载跳线 J9
2. 选择以下步骤之一：
   a. 使用 AGC_EN 测试点提供精确的电压
   b. 安装 R6 和 R8。这会在 VREG 电源上形成一个电阻分压器。

2.2.3 连接电感式传感器

端子 J4 或接头 J5、J6 和 J7 可用于将 EVM 板连接到电感式位置传感器。

备注

如果没有传感器，LDC5072 默认进入故障状态，在 LCIN 上不会观察到任何输出，LCOUT 和 OUTx 引脚为高阻态。

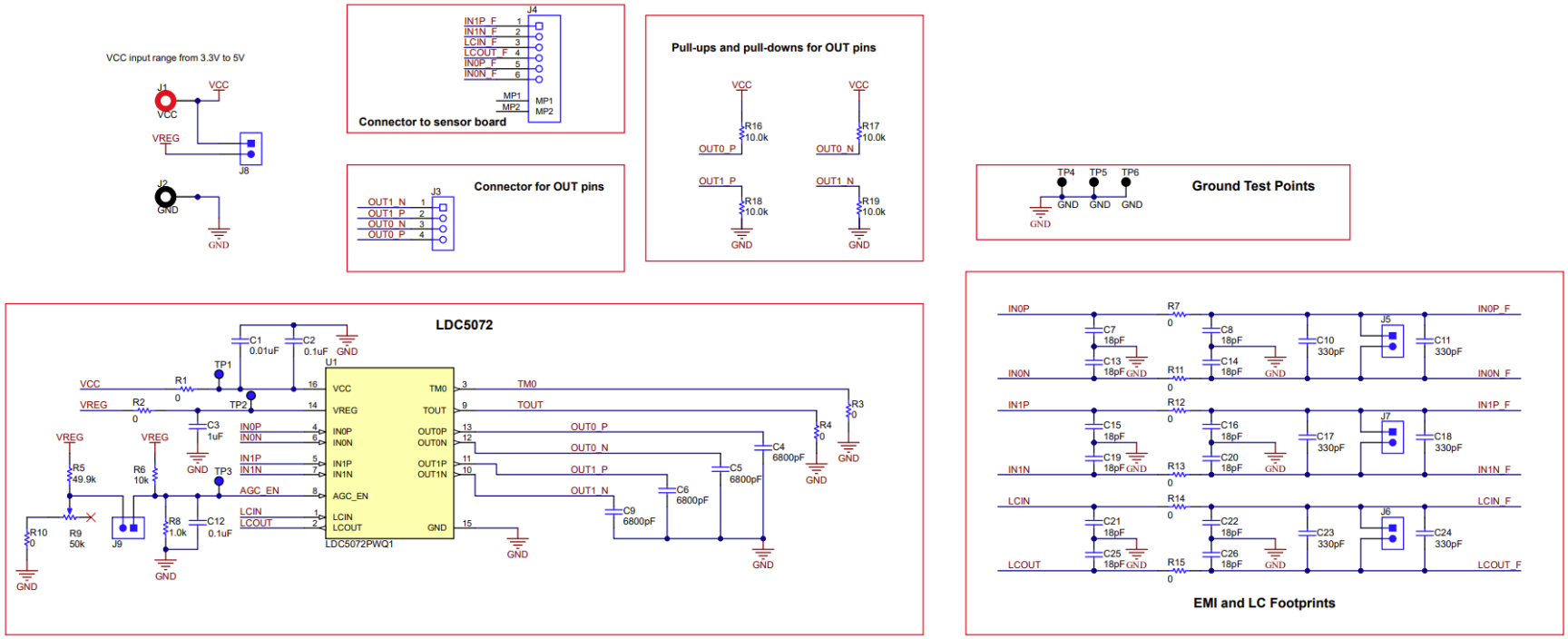
2.2.4 测量模拟输出

可以通过监测 J3 上提供的 OUTx 信号来手动测量模拟输出。请注意，如果未连接传感器，器件会进入故障状态，这些引脚将处于高阻态。

这些模拟输出可以连接到差分 ADC 以模拟实际系统。

3 硬件设计文件

3.1 原理图



3.2 PCB 布局

表 3-1. 层使用情况

层	功能
顶层	信号和元件
中间层 1	接地平面
中间层 2	VCC 电源平面
底层	信号

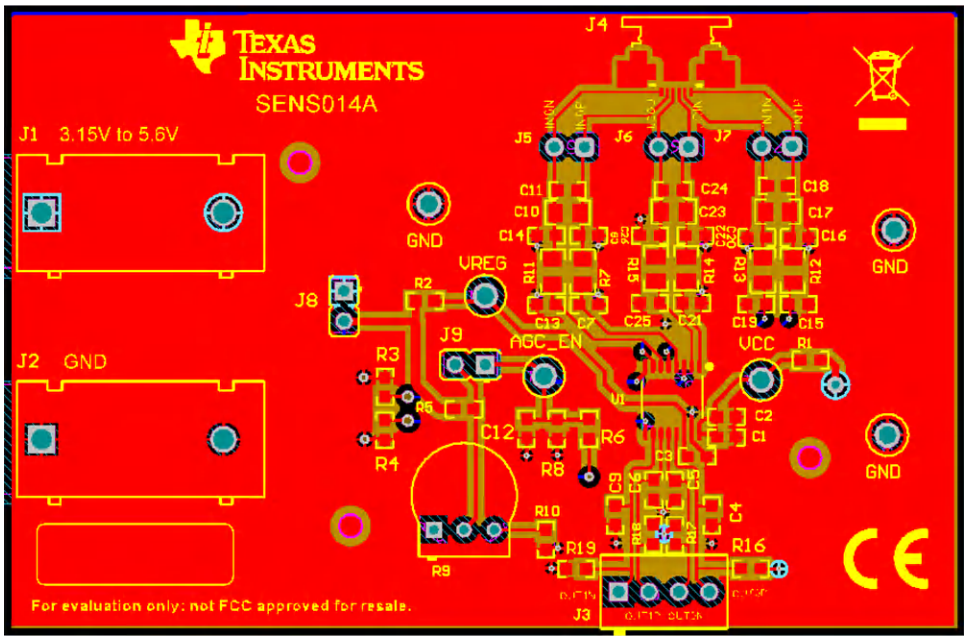


图 3-1. 顶层

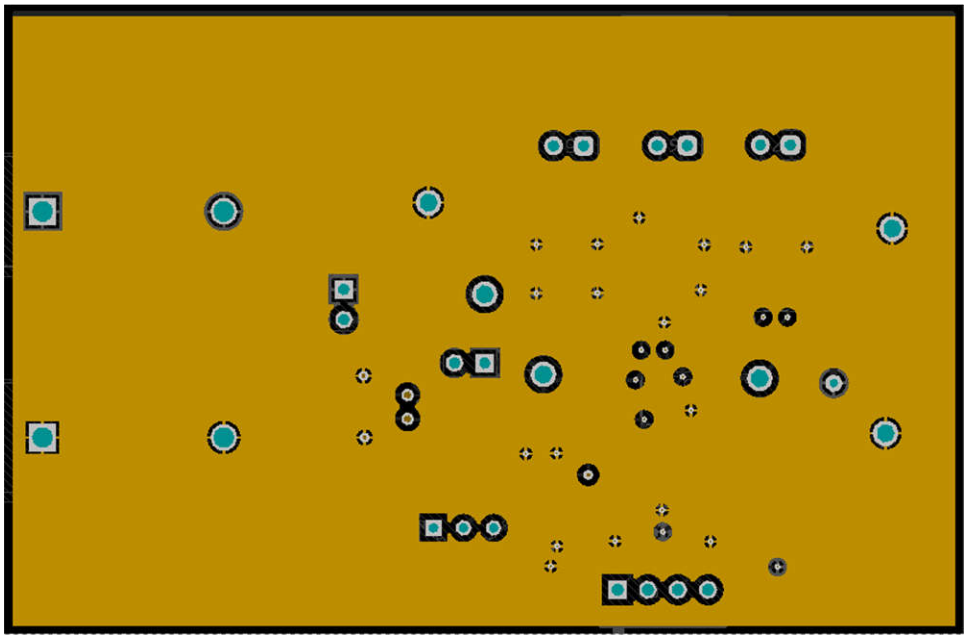


图 3-2. 中间层 1

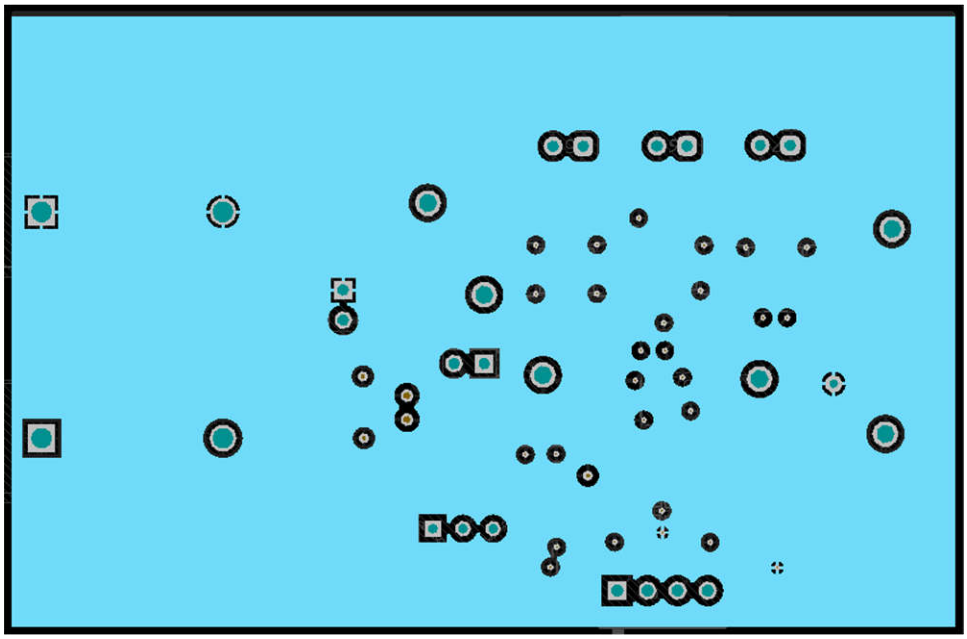


图 3-3. 中间层 2

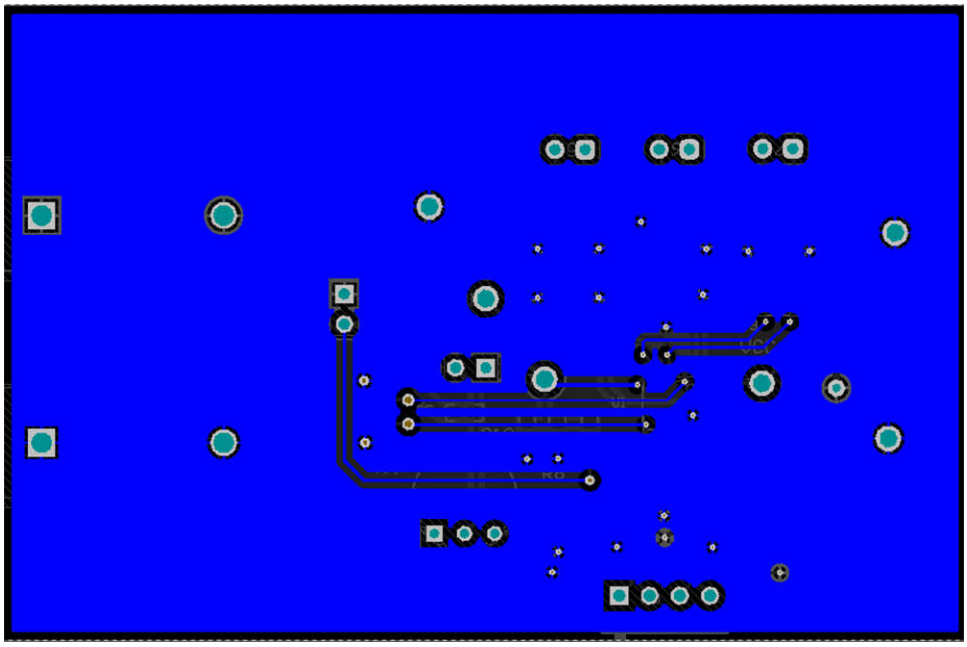


图 3-4. 底层

3.3 物料清单 (BOM)

表 3-2. LDC5072Q1EVM BOM

位号	数量	值	说明	封装	器件型号	制造商
C1	1	0.01uF	电容，陶瓷，0.01µF，25V，+/- 10%，X7R，0603	0603	GRM188R71E103KA01D	MuRata
C2	1	0.1uF	电容，陶瓷，0.1µF，25V，+/-10%，X7R，0603	0603	C1608X7R1E104K080AA	TDK
C3	1	1uF	电容，陶瓷，1µF，35V，+/-10%，X7R，AEC-Q200 1 级，0603	0603	CGA3E1X7R1V105K080AC	TDK
C4、C5、C6、C9	4	6800pF	电容，陶瓷，6800pF，25V，+/-10%，X7R，0603	0603	GRM188R71E682KA01D	MuRata
H9、H10、H11、H12	4		Bumpon，半球形，0.44 X 0.20，透明	透明 Bumpon	SJ-5303 (CLEAR)	3M
J1	1		标准香蕉插孔，绝缘，10A，红色	571-0500	571-0500	DEM Manufacturing
J2	1		标准香蕉插孔，绝缘，10A，黑色	571-0100	571-0100	DEM Manufacturing
J4	1		FFC/FPC 连接器，6 档，0.5mm，R/A，锡，SMT	FFC/FPC 连接器，6 档，0.5mm，R/A，SMT	52745-0633	Molex
J8、J9	2		接头，2.54mm，2x1，锡，TH	接头，2.54mm，2x1，TH	22284023	Molex
LBL1	1		热转印打印标签，0.650" (宽) x 0.200" (高) - 10,000/卷	PCB 标签，0.650 x 0.200 英寸	THT-14-423-10	Brady
R1、R2、R3、R4、R10	5	0	电阻，0，5%，0.1W，AEC-Q200 0 级，0603	0603	CRCW06030000Z0EA	Vishay-Dale
R5	1	49.9k	电阻，49.9k，1%，0.1W，AEC-Q200 0 级，0603	0603	ERJ-3EKF4992V	Panasonic
R7、R11、R12、R13、R14、R15	6	0	电阻，0，5%，0.125W，AEC-Q200 0 级，0805	0805	CRCW08050000Z0EA	Vishay-Dale
R9	1	50k	修整电位器，50K，0.5W，TH	9.53mm x 8.89mm	3352T-1-503LF	Bourns
R16、R17、R18、R19	4	10.0k	电阻，10.0k，1%，0.1W，AEC-Q200 0 级，0603	0603	CRCW060310K0FKEA	Vishay-Dale
SH-J1	1		分流器，2.54mm，金，黑色	分流器，2.54mm，黑色	60900213421	Wurth Elektronik

表 3-2. LDC5072Q1EVM BOM（续）

位号	数量	值	说明	封装	器件型号	制造商
TP1、TP2、TP3	3		测试点，紧凑型，蓝色，TH	蓝色紧凑型测试点	5122	Keystone
TP4、TP5、TP6	3		测试点，紧凑型，黑色，TH	黑色紧凑型测试点	5006	Keystone
U1	1		具有 Sin/Cos 接口的电感式位置传感器，PW0016A (TSSOP-16)	PW0016A	LDC5072PWQ1	德州仪器 (TI)
C7、C8、C13、C14、C15、C16、C19、C20、C21、C22、C25、C26	0	18pF	电容，陶瓷，18pF，100V，+/-5%，C0G/NP0，0603	0603	GRM1885C2A180JA01D	MuRata
C10、C17、C23	0	330pF	电容，陶瓷，330pF，50V，+/-5%，C0G/NP0，0805	0805	08055A331JAT2A	AVX
C11、C18、C24	0	330pF	电容，陶瓷，330pF，50V，+/-1%，C0G/NP0，0603	0603	C1608C0G1H331F080AA	TDK
C12	0	0.1uF	电容，陶瓷，0.1µF，25V，+/-10%，X7R，0603	0603	C1608X7R1E104K080AA	TDK
FID1、FID2、FID3	0		基准标记。没有需要购买或安装的元件。	不适用	不适用	不适用
J3	0		端子块，4x1，2.54mm，绿色，TH	端子块，4x1，2.54mm，TH	1725672	Phoenix Contact
J5、J6、J7	0		接头，100mil，2x1，金，TH	2x1 接头	TSW-102-07-G-S	Samtec
R6	0	10k	电阻，10k，5%，0.1W，0603	0603	RC0603JR-0710KL	Yageo
R8	0	1.0k	电阻，1.0k，5%，0.1W，AEC-Q200 0 级，0603	0603	CRCW06031K00JNEA	Vishay-Dale

4 其他信息

4.1 商标

所有商标均为其各自所有者的财产。

5 修订历史记录

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision * (November 2018) to Revision A (June 2026)	Page
• 将*摘要*中的内容移至*说明*和*套件内容*部分	1
• 添加了*特性*列表	1
• 添加了*评估模块概述*部分	2
• 添加了*简介*部分	2
• 添加了*“套件内容”*部分	2
• 添加了 LDC5072-Q1 数据表中的*器件信息*	2
• 添加了*硬件*部分	3
• 将不完整的原理图更新为完整的原理图	7

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。

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東京都新宿区西新宿 6 丁目 2 4 番 1 号

西新宿三井ビル

3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

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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.

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9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.

10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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