Evaluation Module for LM74704-Q1 and LM74703-Q1 Ideal Diode Controllers

TEXAS INSTRUMENTS

Description

The LM74704Q1EVM assists designers to evaluate the operation and performance of the LM74704-Q1 and LM74703-Q1 ideal diode controllers (8-pin DDF package). This evaluation module demonstrates how an N-channel power MOSFET driven by LM74704-Q1 can emulate a very-low forward voltage diode with low I_Q and low-leakage current flowing through the IC.

Features

- Reverse current blocking feature required for ORing application
- Input reverse battery protection
- FET_GOOD output to indicate external MOSFET health status
- On-board voltage regulator to provide pull-up voltage for open-drain FET_GOOD variant, LM74704-Q1
- Meets 12-V battery automotive ISO7637 and ISO16750-2 transient requirements

Applications

- Automotive ADAS systems - camera
- Automotive infotainment systems - digital cluster, head unit
- Body electronics and lighting
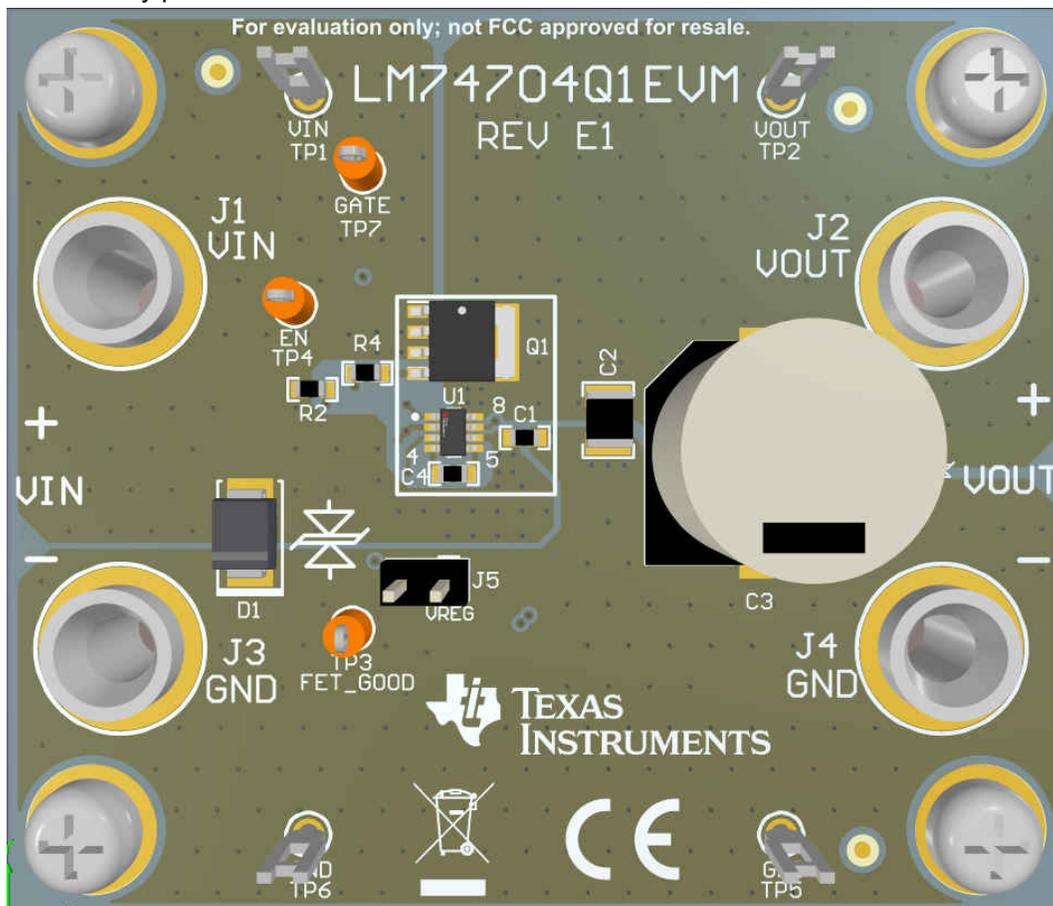
LM74704Q1EVM

1 Evaluation Module Overview

This user's guide describes the LM74704Q1EVM evaluation modules (EVM). The default mounted device is LM74704-Q1, and the EVM is also for LM74703-Q1 device as well. This guide provides configuration information, test setup details and contains the EVM schematics, bill of materials, assembly drawings, and top and bottom board layouts.

1.1 Introduction

In this design scheme, the LM74704-Q1 is combined with a MOSFET and used in series with a battery as a replacement for a Schottky diode and PFET, in reverse-polarity protection circuitry as shown in Figure 2-1. For more information on the LM74704-Q1 functional and electrical characteristics, see *LM74703-Q1, LM74704-Q1 Ideal Diode Controller with External FET Health Indication*.

1.2 Kit Contents

LM74704Q1EVM Kit Contents

Item	Description	Quantity
LM74704Q1EVM	PCB	1

1.3 Specification

The LM74704Q1EVM has the following features:

*   3.9-V to 60-V input range
    *   While testing for input voltage greater than 35 V, remove input 33 V TVS or use an appropriate TVS
*   5 A max current
*   Meets 12-V battery automotive ISO7637 and ISO16750-2 transient requirements
*   LM74704-Q1 device populated by default and can be replaced with LM74703-Q1 IC for evaluation

1.4 Device Information

The LM74703-Q1, LM74704-Q1 is an auto-midotive AEC Q100 qualified diode controller which operates in conjunction with an external N-channel MOSFET as an excellent diode rectifier for low loss reverse polarity protection with a 20-mV forward voltage drop. The wide supply input range of 3.2 V to 65 V allows control of many popular DC bus voltages such as 12-V, 24-V and 48-V automotive battery systems. The 3.2-V input voltage support is particularly an excellent choice for severe cold crank requirements in automotive systems. The device can withstand and protect the loads from negative supply voltages down to –65 V.

2 Hardware

2.1 Setup

This section describes the jumpers and connectors on the EVM, and how to properly connect, setup, and use the LM74704Q1EVM. Verify the power supply is turned off while making connections on the board.

2.1.1 I/O Connectors, Jumper and Test Points Description

I/O Connector	Description
J1	VIN: Power input connector to the positive rail of the input power supply
J3	GND: Ground connection for the power supply
J2	VOUT: Power output connector to the positive side of the load
J4	GND: Ground connection for the load

Test Point	Description
TP1	VIN: Test point for positive of input power supply
TP2	VOUT: Test point for positive side of the load
TP3	FET_GOOD: Test point for FET_GOOD pin
TP4	EN: Test point for EN pin
TP5, TP6	GND: Test point for GND

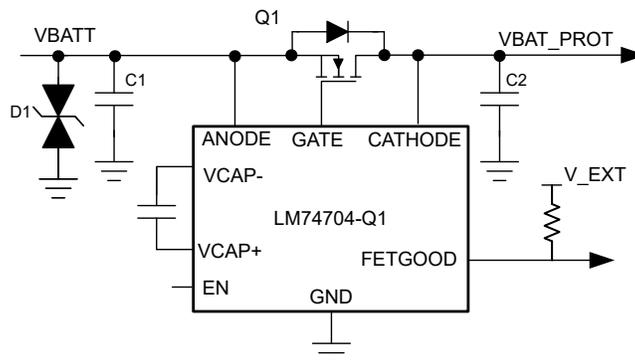| Jumper	Description
J5	Populate for on board pull-up while testing LM74704-Q1 which has open-drain FET_GOOD (Default Setting) Do not populate while testing LM74703-Q1 as the device has push-pull FET_GOOD output

Figure 2-1. LM74704Q1EVM Typical Application Circuit

2.1.2 Board Setup

Before applying power to the LM74704Q1EVM, verify all external connections. Turn off external power supplies and connect them with the proper polarity to the VIN and GND connectors. An electronic or resistive load must be connected at the output VOUT and GND connectors. The tests outlined in this document are conducted with 3-A constant current as the load and 12 V at the input. Make sure that the external power-supply source for the input voltage is capable of providing enough current to the output load so that the output voltage can be obtained.

When all connections to the LM74704Q1EVM are verified, apply power to VIN.

Figure 1-1 captures EVM board image.

2.2 Operation

2.2.1 Startup

Use the following instructions to capture the start-up profile of LM74704-Q1:

1. Set the input supply voltage VIN to 12 V and current limit of 5 A.
2. The default EVM configuration has EN tied to ANODE via R2. So, the device is enabled when input voltage goes above $V_{(EN\_IH)}$ threshold. This configuration allows us to capture startup with input voltage behavior of the IC.
   a. For startup with EN test, de-populate R2 and connect external control signal voltage to TP4 (EN).
3. Verify the jumper J5 is populated which connects the on board generated pull-up voltage to FET_GOOD signal.
4. Turn ON the power supply.
5. Observe the start-up profile of VIN, VOUT, GATE and input current.

Figure 2-2 shows the startup wavefom of LM74704-Q1 while input voltage is ramped up from 0 V to 12 V.
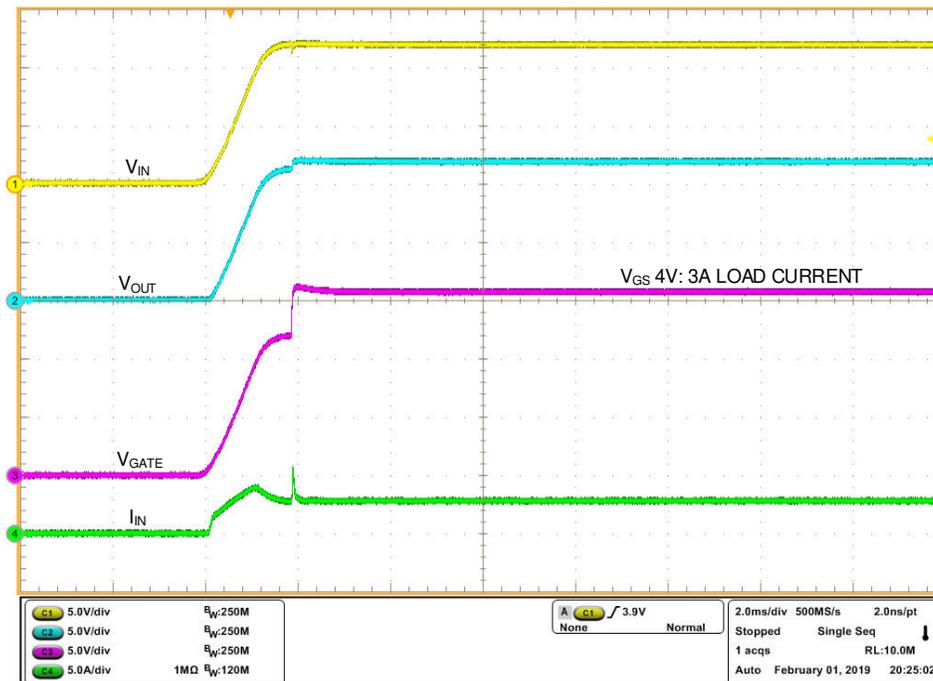

Figure 2-2. Startup with VIN Ramp Up - LM74704-Q1

Use the following instructions to capture the start-up profile of LM74703-Q1:

1. Replace U1 (default LM74704-Q1) on board with LM74703-Q1.
2. Set the input supply voltage, VIN to 12 V and current limit of 5 A.
3. The default EVM configuration has EN tied to ANODE via R2. So, the device is enabled when input voltage $V_{(EN\_IH)}$ threshold.
4. Verify the jumper J5 is de-populated as the LM74703-Q1 has push-pull output of FET_GOOD and does not require an external pull-up voltage.
5. Turn ON the power supply.
6. Observe the start-up profile of VIN, VOUT, GATE and FET_GOOD.

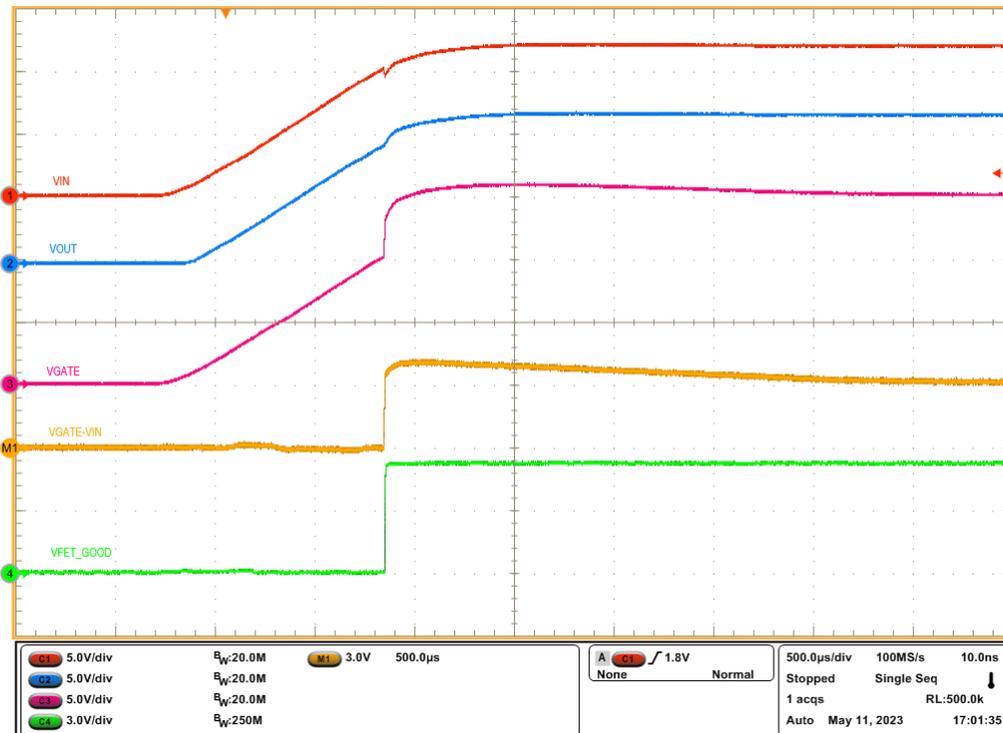Figure 2-3 shows the startup wavefom of LM74703-Q1 while input voltage is ramped up from 0 V to 12 V.

Figure 2-3. Startup with VIN Ramp Up - LM74703-Q1

2.2.2 FET Status Detection Test

To capture the device FET_GOOD pin behavior while starting up with the external FET short:

1. Connect a wire between TP1 and TP2 to emaulate the FET short behavior.
2. Set the input supply voltage VIN to 12 V and current limit of 5 A.
3. While testing with LM74704-Q1, verify the jumper J5 is populated which connects the on board generated pull-up voltage to FET_GOOD signal.
   a. For testing with external pull-up voltage, de-populate J5 jumper and apply external pull-up voltage to TP3 (FET_GOOD).
4. While testing with LM74703-Q1, verify the jumper J5 is de-populated as the LM74703-Q1 has push-pull output of FET_GOOD and does not require an external pull-up voltage.
5. Turn ON the power supply.
6. Observe the start-up profile of VIN, VOUT, GATE and FET_GOOD.

shows startup with FET short behavior of LM74704-Q1.

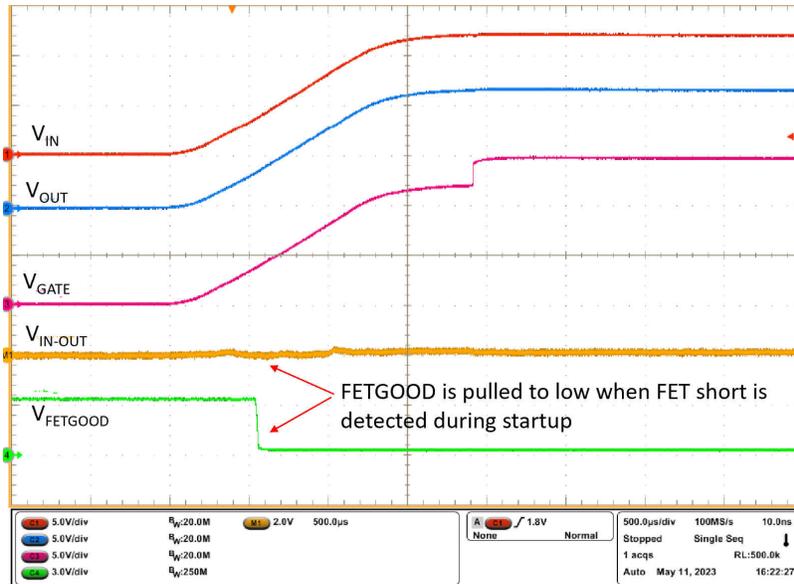**Figure 2-4. FET_GOOD During Startup with FET Short (LM74704-Q1) with External Pull-Up Voltage**
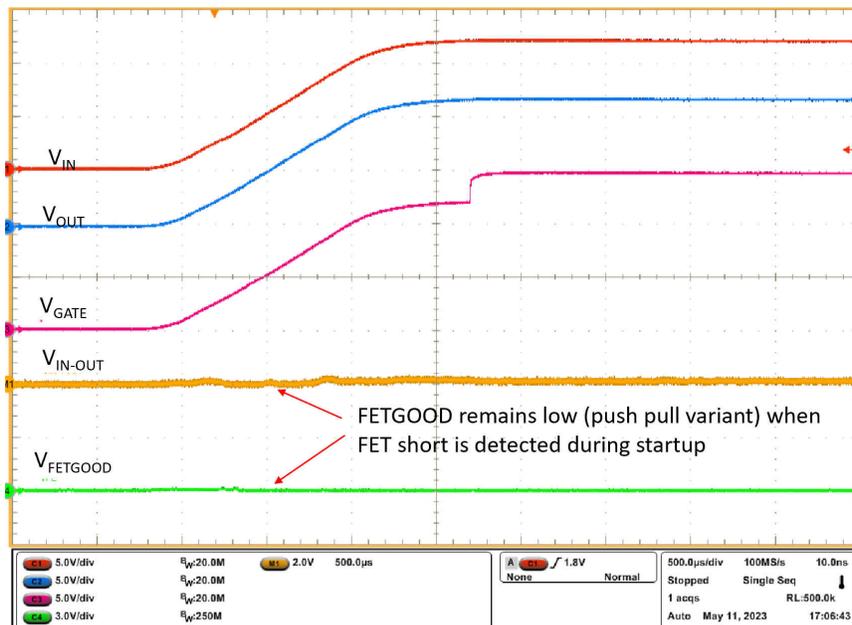
shows startup with FET short behavior of LM74703-Q1.

Figure 2-5. FETGOOD During Startup with FET Short (LM74703-Q1)

3 Hardware Design Files

Users can request the design files at https://www.ti.com.

3.1 Schematic

Figure 3-1 illustrates the EVM schematic.

Figure 3-1. LM74704Q1EVM Schematic

3.2 PCB Drawings

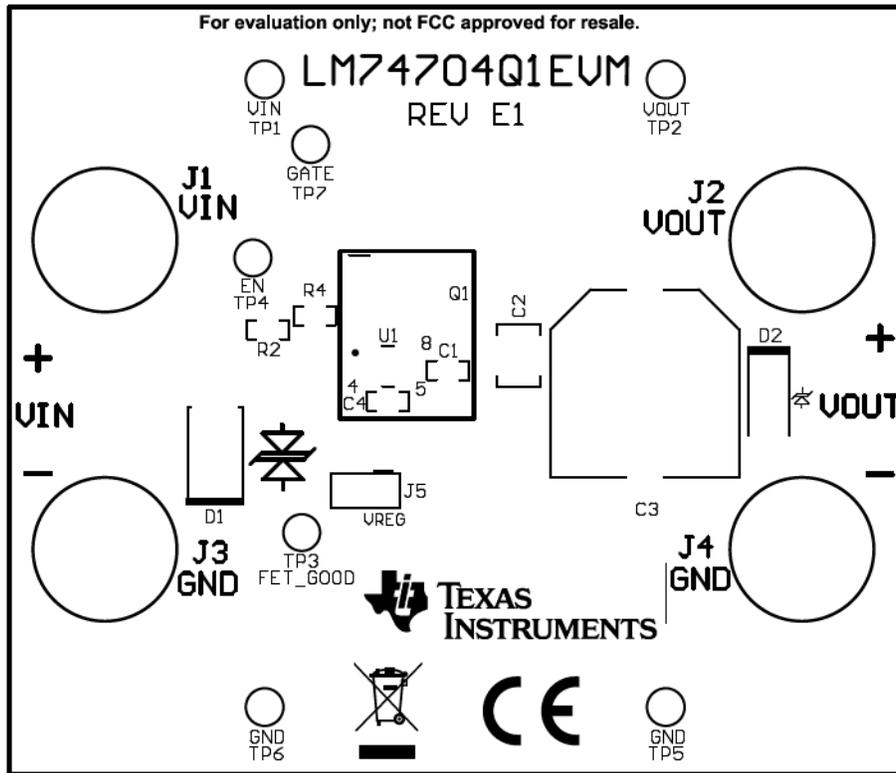through show component placement and layout of this EVM.

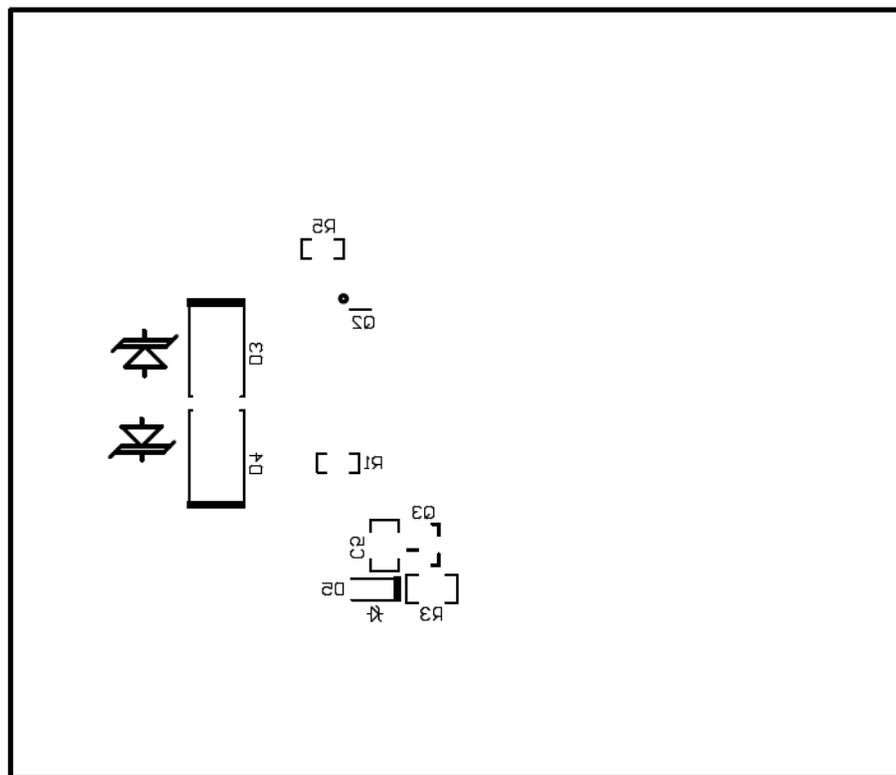**Figure 3-2. LM74704Q1EVM Top Side Placement**
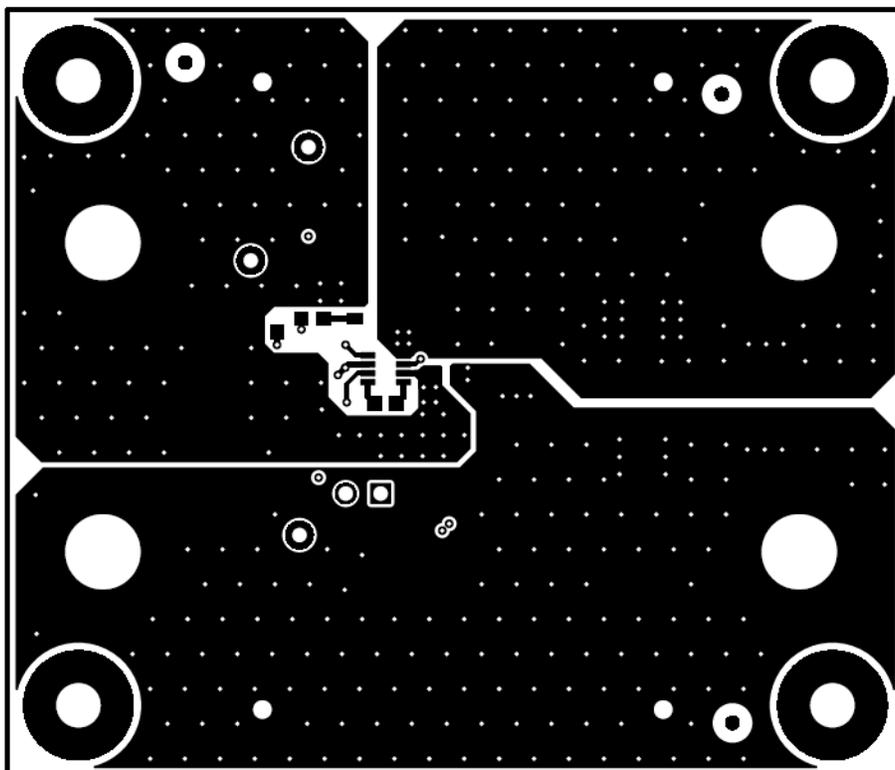

Figure 3-3. LM74704Q1EVM Bottom Side Placement

Figure 3-4. LM74704Q1EVM Top Layer Routing

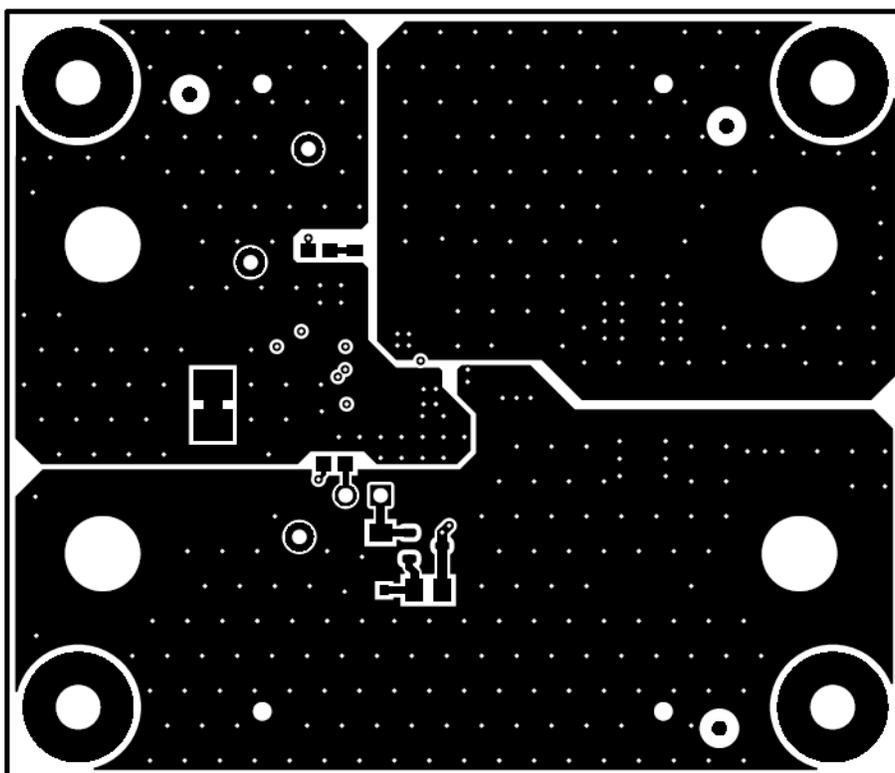**Figure 3-5. LM74704Q1EVM Bottom Layer Routing**

3.3 Bill of Materials

lists the LM74704Q1EVM BOM.

Table 3-1. Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate PartNumber
!PCB	1		Printed Circuit Board		LP108	Any	
C1	1	0.1uF	CAP, CERM, 0.1 µF, 100 V,+/-10%, X7R, AEC-Q200 Grade 1, 0603	0603	HMK107B7104KAHT	Taiyo Yuden	
C2	1	2.2uF	CAP, CERM, 2.2 µF, 100 V, +/-10%, X7R, 1210	1210	C1210C225K1RACTU	Kemet	
C3	1	220uF	CAP, AL, 220 µF, 63 V, +/-20%, 0.16 ohm, AEC-Q200 Grade 2, SMD	SMT Radial H13	EEV-FK1J221Q	Panasonic	
C4	1	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/-10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E2X7R1E104K080AA	TDK	
C5	1	2.2uF	CAP, CERM, 2.2 µF, 25 V,+/-10%, X7R, AEC-Q200 Grade 1, 0805	0805	GCM21BR71E225KA73L	MuRata	
D1	1	33 V	Diode, TVS, Bi, 33 V, SMB	SMB	SMBJ33CA-13-F	Diodes Inc.	
D5	1	4.7V	Diode, Zener, 4.7 V, 300 mW, SOD-323	SOD-323	MM3Z4V7ST1G	ON Semiconductor	
H1, H2, H3, H4	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply	
H5, H6, H7, H8	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone	
J1, J2, J3, J4	4		Standard Banana Jack, Uninsulated, 8.9mm	Keystone575-8	575-8	Keystone	
J5	1		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions	
Q1	1	60 V	MOSFET, N-CH, 60 V, 100 A, SOT669	SOT669	PSMN5R6-60YL	Nexperia	
Q3	1	160 V	Transistor, NPN, 160 V, 0.3 A, SOT-23	SOT-23	PMBT5551,215	Nexperia	
R1	1	10.0k	RES, 10.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	RMCF0603FT10K0	Stackpole Electronics Inc	
R2, R4, R5	3	0	RES, 0, 5%, 0.1 W, 0603	0603	CRCW06030000Z0EA	Vishay-Dale	
R3	1	10.0k	RES, 10.0 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	ERJ-6ENF1002V	Panasonic	
SH1	1	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec	969102-0000-DA
TP1, TP2, TP5, TP6	4		TEST POINT SLOTTED .118", TH	Test point, TH Slot Test point	1040	Keystone	
TP3, TP4, TP7	3		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone	
U1	1		Ideal Diode Controller with FET Good Output, SOT23-8	SOT23-8	LM74704DDF	Texas Instruments	
D2	0	58 V	Diode, TVS, Uni, 58 V, SMA	SMA	SMAJ58A	Diodes Inc.	
D3	0	58 V	Diode, TVS, Uni, 58 V, 93.6 Vc, SMB	SMB	SMBJ58A-13-F	Diodes Inc.	
D4	0	24 V	Diode, TVS, Uni, 24 V, 38.9 Vc, SMB	SMB	SMBJ24A-13-F	Diodes Inc.	

Table 3-1. Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer	Alternate PartNumber
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A	
Q2	0	60 V	MOSFET, N-CH, 60 V, 100 A, SOT669	SOT669	PSMN5R6-60YL	Nexperia	

4 Additional Information

Trademarks

All trademarks are the property of their respective owners.

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.

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<u>WARNING</u>

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.

</div>

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

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   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.

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