EVM User's Guide: LM74680

LM74680 Evaluation Module for Ideal Diode Bridge Controller

Description

The LM74680 Evaluation Module (LM74680EVM) helps designers evaluate the operation and performance of the LM74680 ideal diode bridge controller (12-pin DRR package). This evaluation module demonstrates how an N-channel power MOSFET driven by LM74680 can emulate a very-low forward voltage diode and increase the efficiency by a noticeable factor in bridge rectifiers.

Features

- Reverse current blocking feature required for AC rectification
- Input reverse battery protection
- Drives external N-Channel MOSFETs in bridge configuration
- Output LED for output high indication

Applications

- Video doorbells
- IP cameras
- Power distribution systems (24Vac)

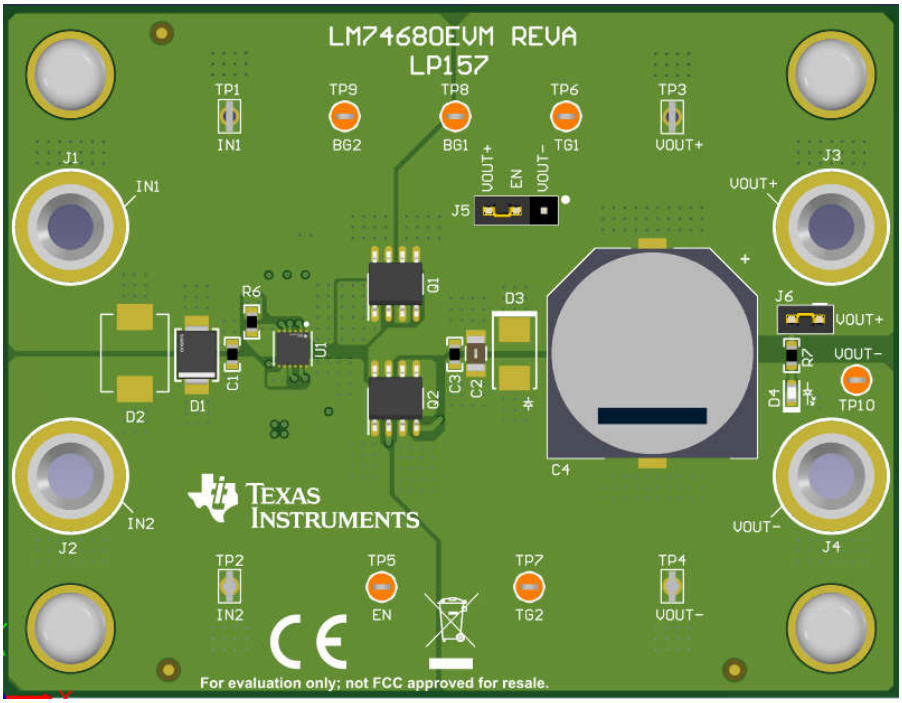

Figure 1-1. LM74680EVM

1 Evaluation Module Overview

1.1 Introduction

This user's guide describes the LM74680EVM evaluation module for evaluating the performance of the LM74680 ideal diode bridge controller devices. The LM74680 ideal diode bridge controller drives and controls four external back N-Channel MOSFETs in a bridge configuration to emulate an ideal diode bridge rectifier. This document provides EVM configuration information and test setup details for evaluating the LM74680 device. The EVM schematic, board layout, and bill of materials (BOM) are also included.

1.2 Kit Contents

Table 1-1. LM74680EVM Kit Contents

Item	Description	Quantity
LM74680EVM	PCB	1

1.3 Device Information

LM74680 is an ideal diode bridge controller that can drive four external N-channel MOSFETs to eliminate traditional diode bridges for superior thermals and efficiency. The top-gates are driven to emulate a very-low forward voltage (11.5mV typ.) diode with low IQ. The wide input supply of 4 V to 72 V allows protection and control of 24Vac systems.

2 Hardware

2.1 Test Points and Connectors

Table 2-1 lists the LM74680EVM evaluation board input and output connector functionality. Table 2-2 and Table 2-3 describe the test point availability and the jumper functionality.

Table 2-1. Input and Output Connector Functionality

Connector	Label	Description
J1	IN1	Power input connector to the positive rail of the input power supply.
J2	IN2	Power input connector to the negative rail of the input power supply.
J3	VOUT+	Power output connector to the positive side of the load.
J4	VOUT-	Ground connection for the load.

Table 2-2. Test Points Description

Test Points	Label	Description
TP1	IN1	Input power supply to the EVM.
TP2	IN2	Input power supply to the EVM.
TP3	VOUT+	Output from the EVM.
TP4	PGND	Ground connection for the load.
TP5	EN	Enable control (active high) of the controller.
TP6	TG1	GATE of the external top side MOSFET 1.
TP7	TG2	GATE of the external top side MOSFET 2.
TP8	BG1	GATE of the external bottom side MOSFET 1.
TP9	BG2	GATE of the external bottom side MOSFET 2.
TP10	VOUT-	Connected to PGND.

Table 2-3. Jumper and LED Descriptions

Jumper	Connection	Description
J5	1-2	EN connected to GND. EN pulled low.
	2-3	EN connected to VOUT+. EN pulled high.
J6	1-2	D4 LED indication when output high.

2.2 Test Equipment and Setup

2.2.1 Power Supplies

One adjustable power supply with 0V to 24Vac output and 0A to 3A output current limit.

2.2.2 Meters

One DMM minimum needed.

2.2.3 Oscilloscope

An MSO58B or equivalent, 8 × 10 voltage probes, and a DC current probe.

2.2.4 Loads

One resistive load or equivalent that can tolerate up to 3A DC load at 24Vac.

2.3 Test Setup and Procedures

Make sure the evaluation board has default jumper settings as shown in Table 2-4.

Table 2-4. Default Jumper Setting for LM74680EVM Evaluation Board

Jumper	Default Setting	Functionality
J5	2-3	EN connected to VOUT+. EN pulled high.
J6	1-2	Output high D4 LED indication.

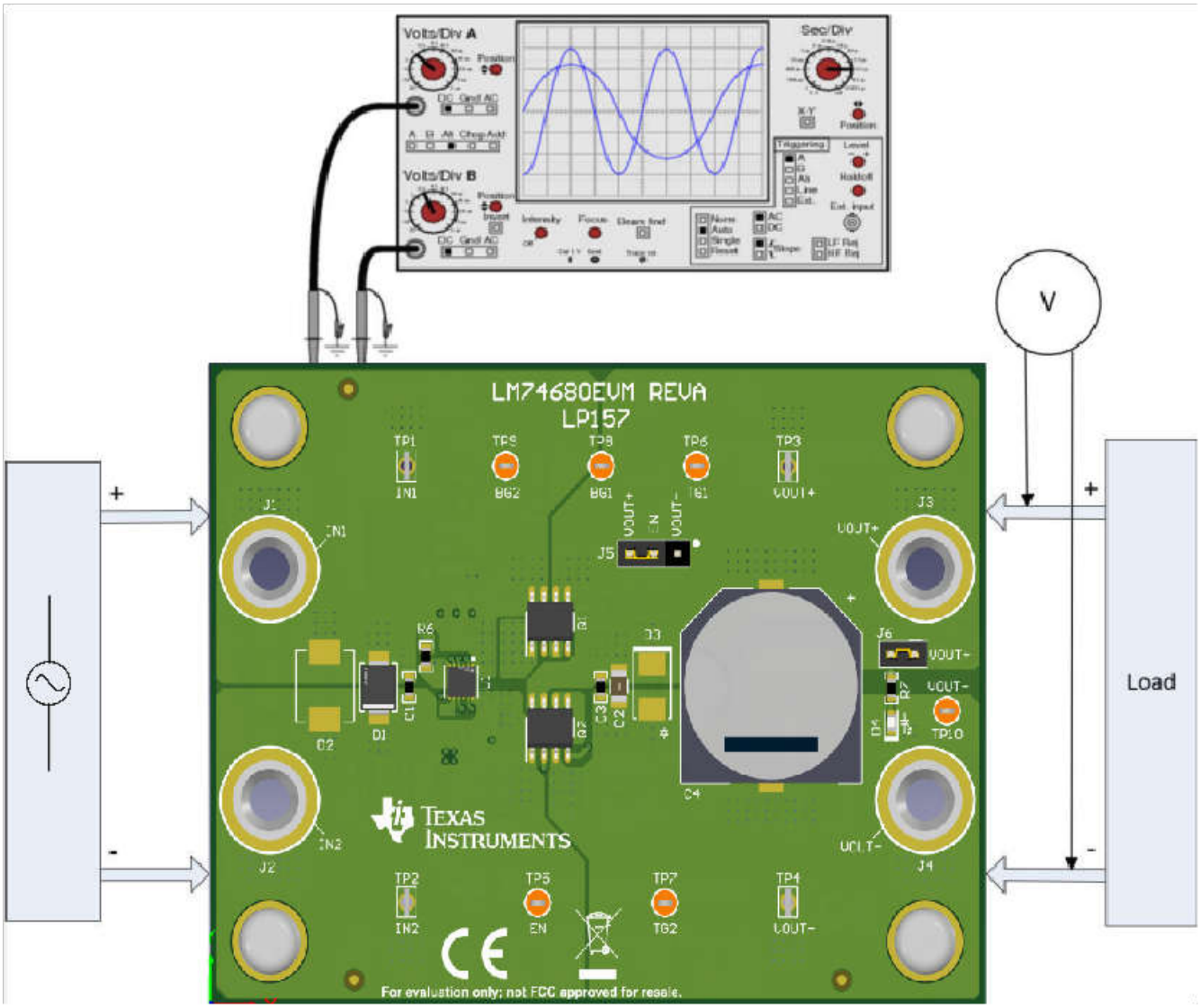

Figure 2-1. LM74680EVM Setup With Test Equipment

Use the following instructions before starting any test and repeat again before moving to next test.

1. Set the power supply output VIN to 0V.
2. Turn ON the power supply and set the power supply output VIN to 24Vac and current limit of 3A.
3. Turn OFF the power supply.
4. Set the jumper setting on EVM to default position as shown in Table 2-4.

2.3.1 Power-Up With Enable

Use the following instructions to capture the startup with EN profile.

1. Set the input supply voltage VIN to 24Vac and current limit of 3A.
2. Use a secondary supply for EN step and set it to 3V.
3. Open the jumper J5 and connect secondary supply to TP5.
4. Turn ON the AC supply.
5. Turn ON the secondary supply.
6. Observe the start-up profile of EN, BG1, BG2, TG1, TG2.

Figure 2-2 shows an example of power-up with EN profile captured on the LM74680EVM evaluation board.

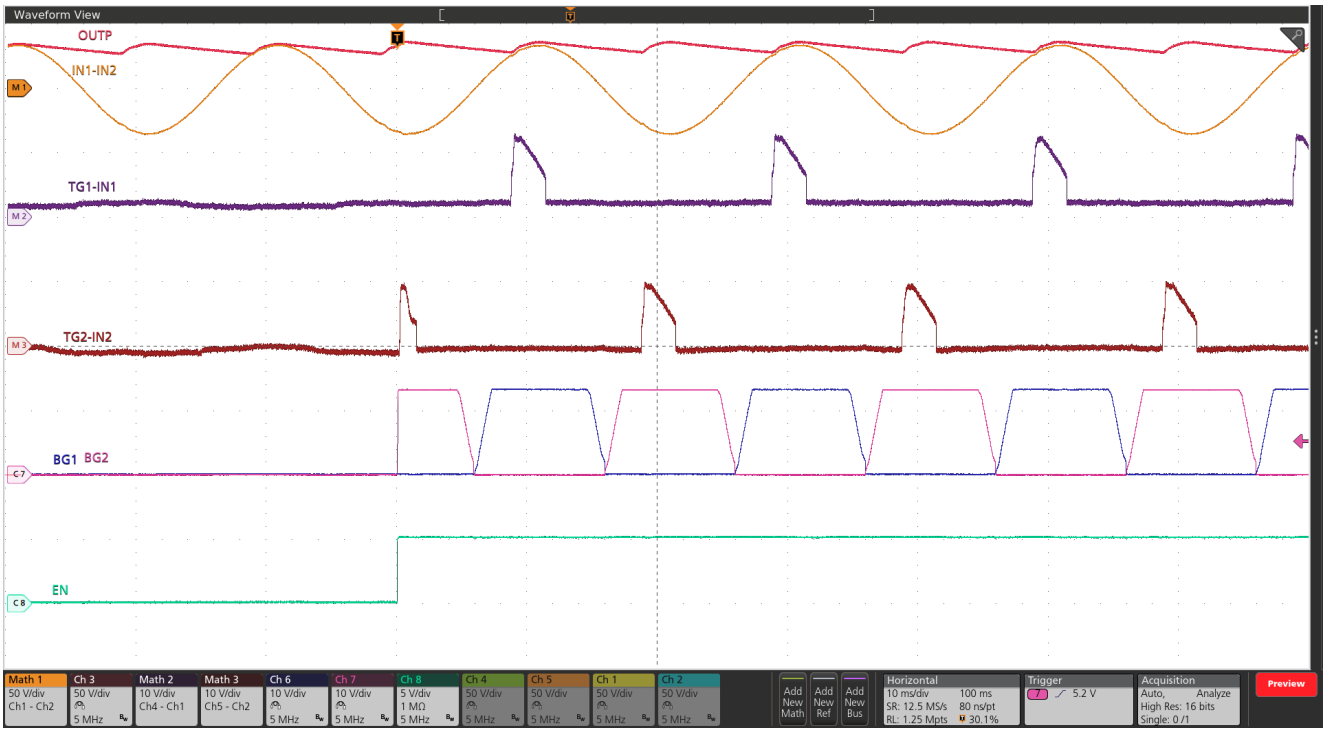

Figure 2-2. LM74680 Power-Up With EN

2.3.2 Load Step

Use the following instructions to perform the load step test.

1. Set the input supply voltage VIN to 24Vac and current limit of 3A.
2. Turn ON the power supply and observe the rectification of input voltage.
3. Once in steady-state, increase the load using a rheostat.
4. Observe the increase in TG1-IN1 and TG2-IN2 voltage levels.

Figure 2-3 shows an example of load step profile captured on the LM74680EVM evaluation board.

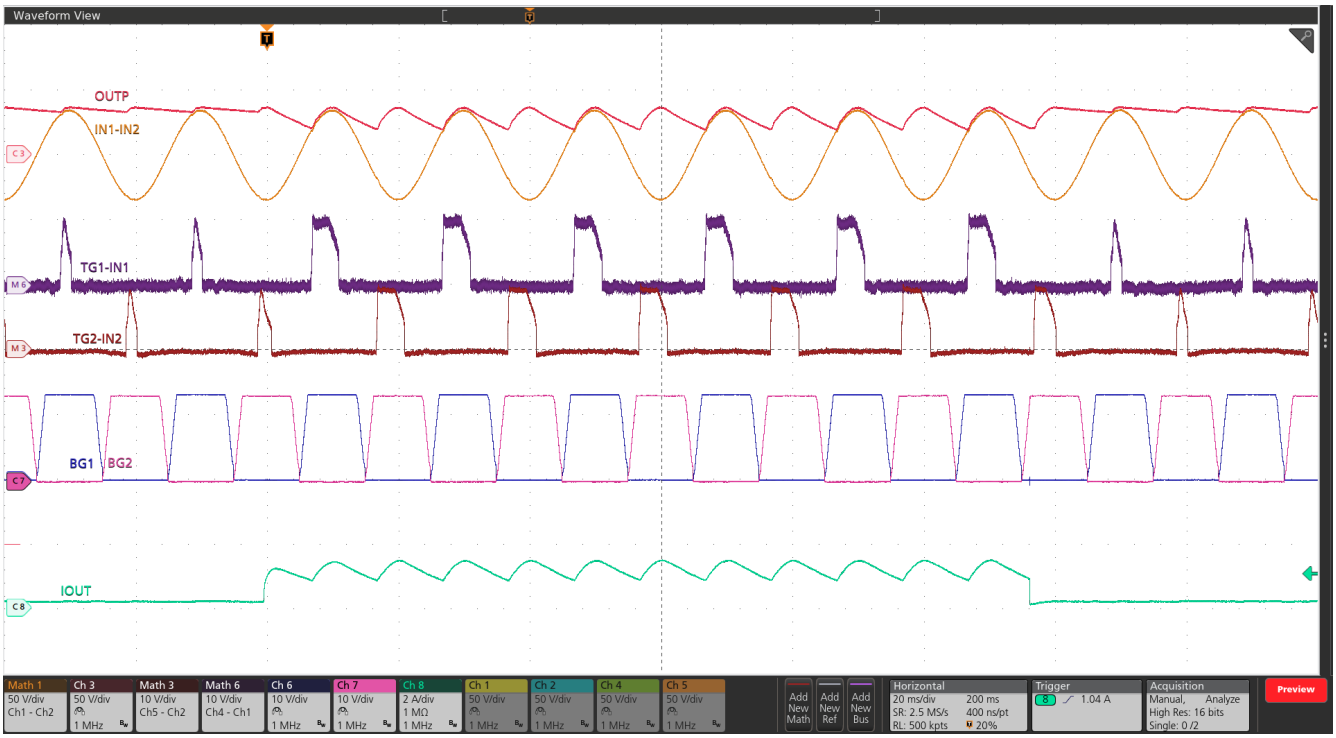

Figure 2-3. Load Step Response of LM74680 Device

3 Hardware Design Files

3.1 Schematic

Figure 3-1 illustrates the EVM schematic.

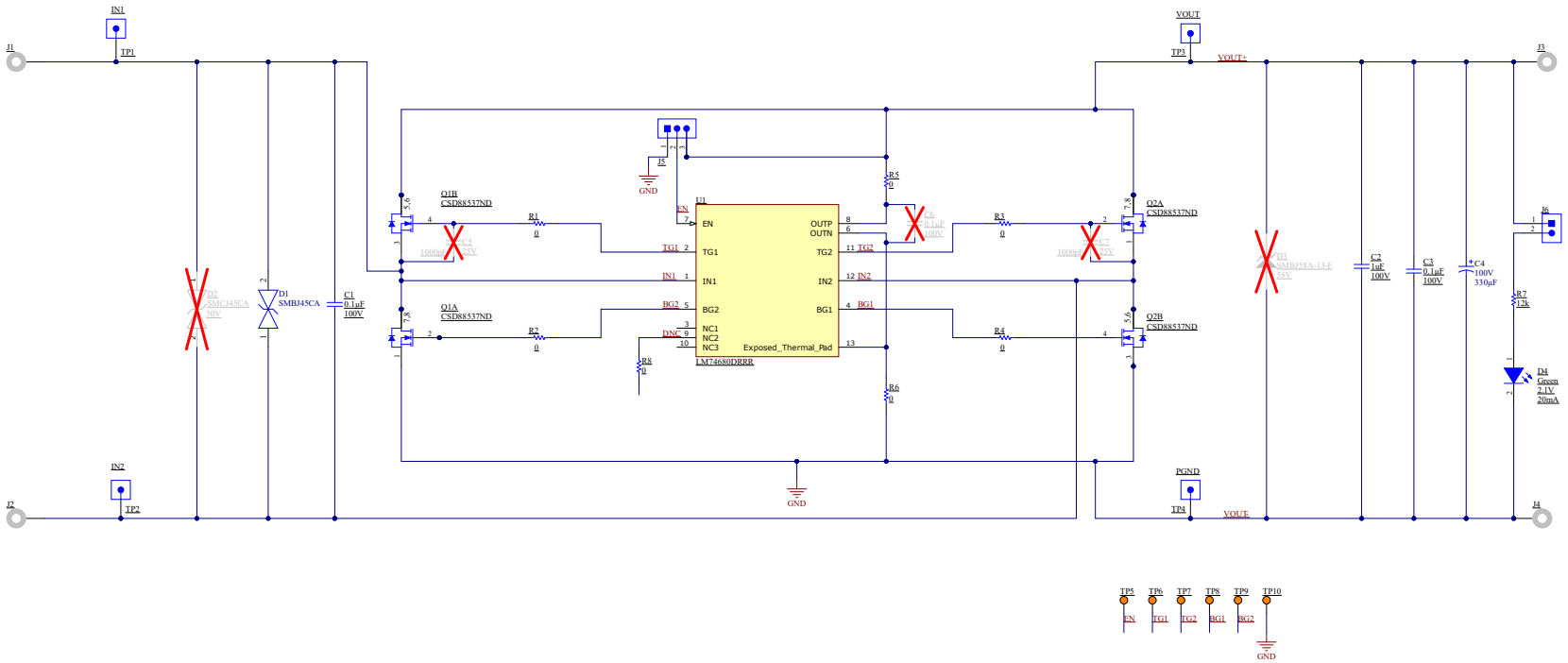

Figure 3-1. LM74680EVM: Evaluation Module Schematic

3.2 PCB Layouts

Figure 3-2 and Figure 3-3 show component placement of the EVAL board. Figure 3-4 and Figure 3-5 show PCB layout images.

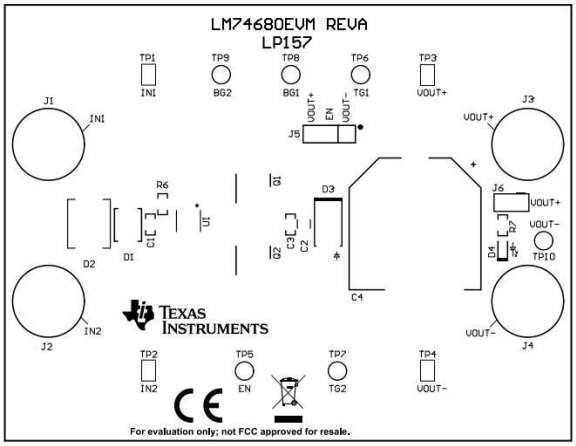

Figure 3-2. LM74680EVM Board Top Overlay

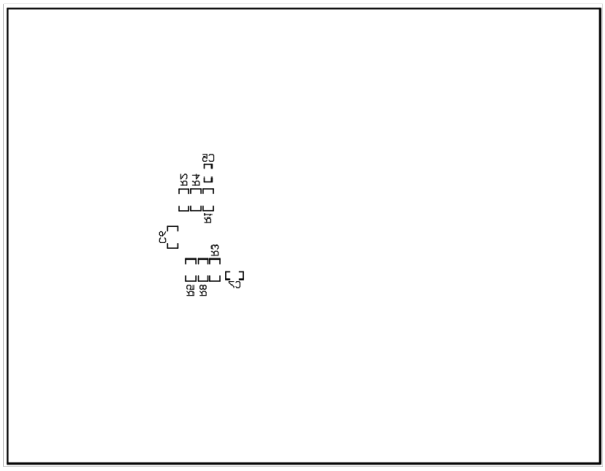

Figure 3-3. LM74680EVM Board Bottom Overlay

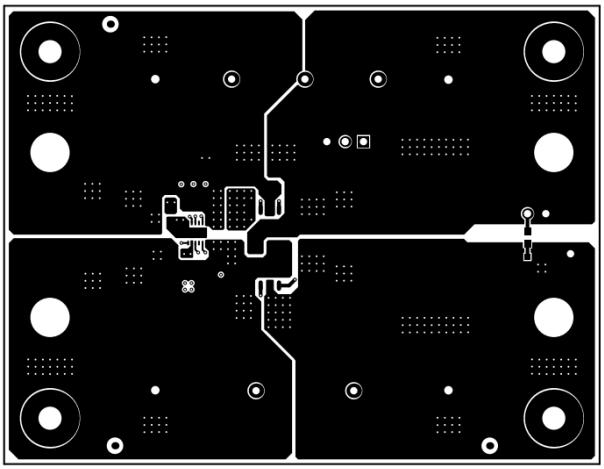

Figure 3-4. LM74680EVM Board Top Layer

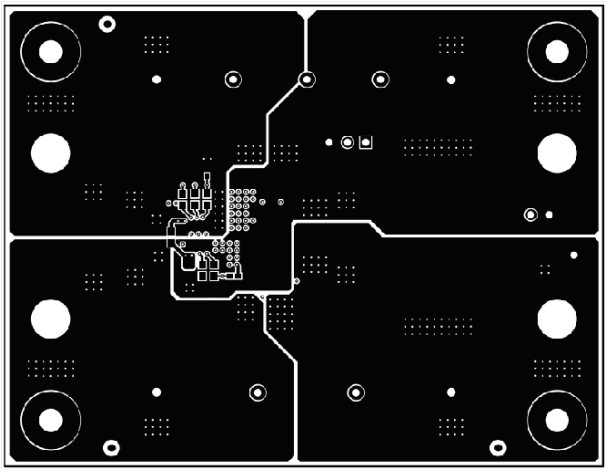

Figure 3-5. LM74680EVM Board Bottom Layer

3.3 Bill of Materials (BOM)

Section 3.3 lists the EVM BOM.

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
!PCB1	1		Printed Circuit Board		LM74680EVM	Any
C1, C3	2	0.1uF	CAP, CERM, 0.1 µF, 100 V,+/- 10%, X8L, AEC-Q200 Grade 0, 0603	0603	GCJ188L8EL104KA07D	MuRata
C2	1	1µF	1µF ±10% 100V Ceramic Capacitor X8L 1206 (3216 Metric)	1206	GCJ31CL8EL105KA07L	Murata
C4	1	330uF	CAP, AL, 330 µF, 100 V, +/- 20%, AEC-Q200 Grade 1, SMD	Cap, 1800x1650mm	EEVTG2A331M	Panasonic
D1	1	45V	SMBJ45CA SMBJ Series 55.3 V Bi-Directional Surface Mount TVS Diode - SMB	SMB	SMBJ45CA-13-F	Diodes Inc.
D4	1	Green	LED, Green, SMD	1.6x0.8x0.8mm	LTST-C190GKT	Lite-On
H1, H2, H3, H4	4		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
H5, H6, H7, H8	4		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
J1, J2, J3, J4	4		Standard Banana Jack, Uninsulated, 8.9mm	Keystone575-8	575-8	Keystone
J5	1		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
J6	1		Header, 100mil, 2x1, Tin, TH	Header, 2 PIN, 100mil, Tin	PEC02SAAN	Sullins Connector Solutions
Q1, Q2	2	60V	MOSFET, 2-CH, N-CH, 60 V, 15 A, D0008A (SOIC-8)	D0008A	CSD88537ND	Texas Instruments
R1, R2, R3, R4, R5, R6, R8	7	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	ERJ-3GEY0R00V	Panasonic

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
R7	1	12k	RES, 12 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060312K0JNEA	Vishay-Dale
SH1, SH2	2	1x2	Shunt, 100mil, Gold plated, Black	Shunt	SNT-100-BK-G	Samtec
TP1, TP2, TP3, TP4	4		TEST POINT SLOTTED .118", TH	Test point, TH Slot Test point	1040	Keystone
TP5, TP6, TP7, TP8, TP9, TP10	6		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone
U1	1		Ideal Diode Bridge Controller	WSON12	LM74680DRRR	Texas Instruments
C5, C7	0	1000pF	CAP, CERM, 1000 pF, 25 V, +/- 5%, X7R, 0402	0402	C0402C102J3RACTU	Kemet
C6	0	0.1uF	CAP, CERM, 0.1 µF, 100 V,+/- 10%, X8L, AEC-Q200 Grade 0, 0603	0603	GCJ188L8EL104KA07D	MuRata
D2	0	45V	Diode TVS Single Bi-Dir 45V 1.5KW 2-Pin DO-214AB	DO214AB	SMCJ45CA	Littelfuse Inc
D3	0	58V	Diode, TVS, Uni, 58 V, 93.6 Vc, SMB	SMB	SMBJ58A-13-F	Diodes Inc.

4 Additional Information

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NOTE:

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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.

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- *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*

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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.

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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

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https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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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.

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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.

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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.

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