LM74610-DQEVM

User's Guide

Literature Number: SNVU488
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1 Introduction

The Texas Instruments LM74610-DQ Evaluation Module helps designers evaluate the operation and performance of the LM74610-Q1 Reverse Polarity Protection Smart Diode Controller in an OR-ing configuration. In this design scheme two LM74610-Q1 ICs are combined with MOSFETs and used with redundant N+1 power supplies arrangements as replacement for schottky diodes in an OR-ing device as shown in Figure 1 . This EVM demonstrates how an N-channel power MOSFET can emulate a very low forward voltage diode with zero Iq and low reverse leakage current. For more information on the LM74610-Q1 functional and electrical characteristics, see the LM74610-Q1 Reverse Polarity Protection Smart Diode Controller Data Sheet (LM74610-Q1).

The EVM contains two LM74610-Q1 Smart Diode Controllers devices(See Table 1). For single channel LM74610-Q1 performance evaluation, use LM74610-SQEVM (LM74610-SQEVM).

Table 1. Device and Package Configurations

CONVERTER	IC	PACKAGE
U1	LM74610-Q1	VSSOP-8
U2	LM74610-Q1	VSSOP-8

2 Setup

This section describes the jumpers and connectors on the EVM as well and how to properly connect, set up and use the LM74610EVM. Ensure the power supply is turned off while making connections on the board.

2.1 Input/Output Connector Description

- **VBAT_1** is the power input connector to the positive rail of the input power supply.
- **VBAT_2** is the second power input connector to the positive rail of the input power supply.
- **GND** is the ground connector.
- **VOUT** is the power output connector to the positive side of the load.
- **TEST POINTS** are also available at **VBAT_1**, **VBAT_2**, **GND**, **VOUT**, **DRV_1**/ **DRV_2** (MOSFET Gate Voltage), and **VCAP_1**/ **VCAP_2** (charge pump capacitors).

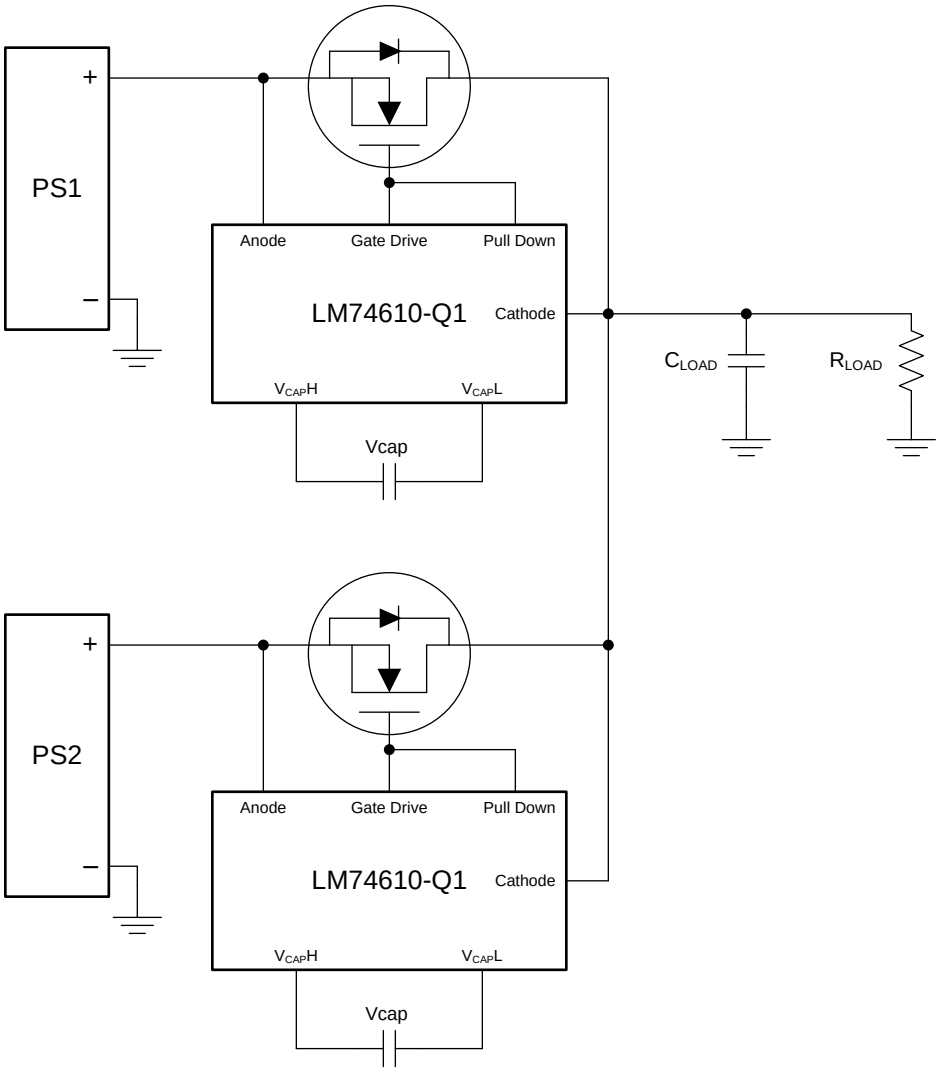

Figure 1. LM74610-Q1 Typical OR-ing Application Circuit

2.2 Board Setup

Before applying power to the LM74610-DQ EVM, all external connections should be verified. External power supplies should be turned off and connected with proper polarity to the VBAT_1 and GND connectors. **An electronic or resistive load must be connected at the output**. The LM74610-Q1 will not initiate the charge pump operation if a closed loop system is in standby mode or the drain current is smaller than 1mA (typical). The tests outlined in this document has 3A constant load current and 12V input supply voltage at (VBAT_1). VBAT_2 can be used as a secondary input when using LM74610-DQEVM as an OR-ing device. 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.

Once all connections to the LM74610EVM are verified, power can be applied to VBAT_1. The EVM will then begin to operate.

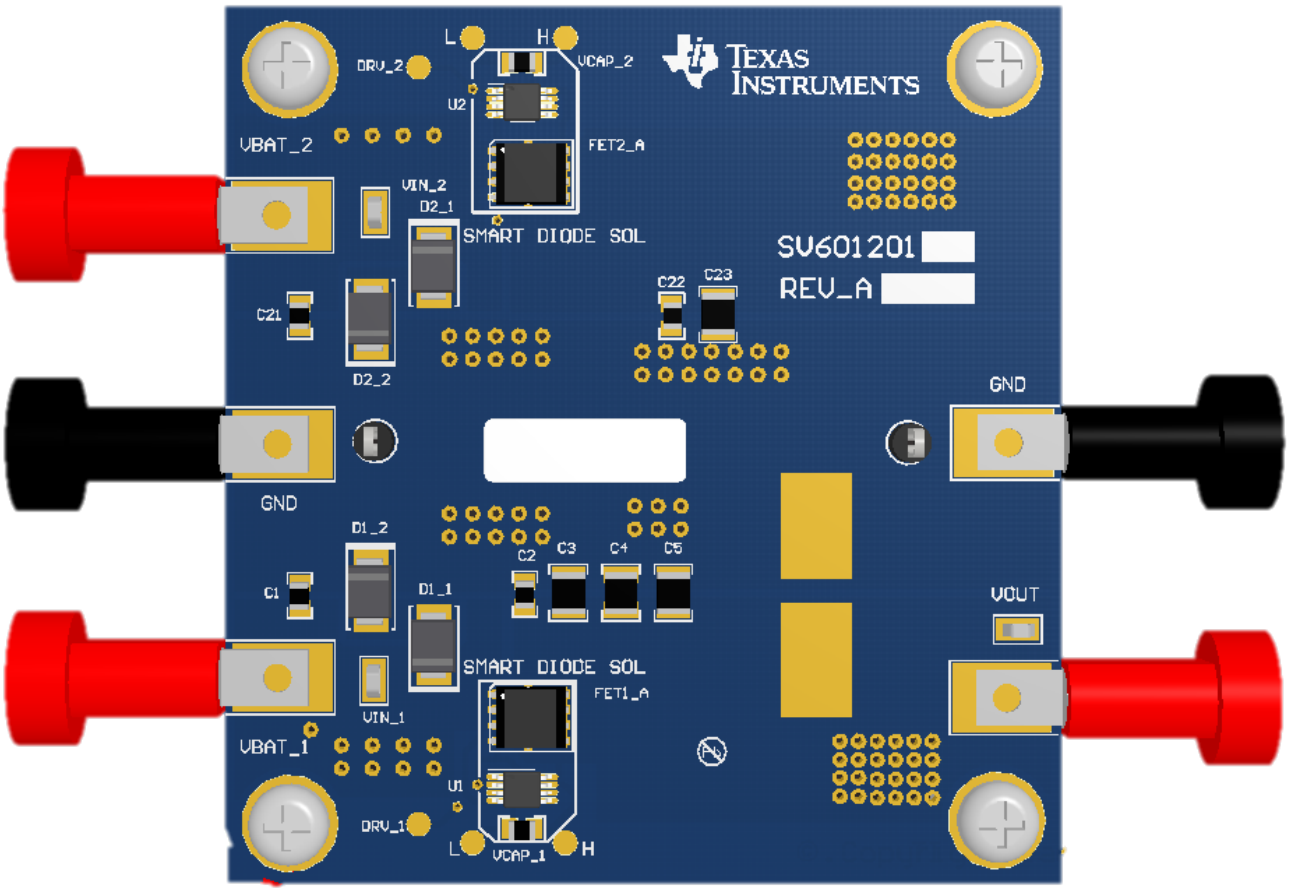

Figure 2. LM74610-DQ EVM

3 Operation

3.1 Reverse Polarity Protection

A dynamic voltage pulse from +12V to -20V is applied at the VBAT_1 input of the LM74610-DQEVM. Figure 3 shows when the input voltage (yellow) drops down to -20V, the output voltage (blue) does not go negative, and therefore, the load is protected from dynamic reverse pulses at the input. The LM74610-Q1 reacts the negative voltage surge within 2 µ sec and shuts down the MOSFET by pulling the gate voltage to zero (green). The output slowly decays due to the large output capacitors and increased time constant.

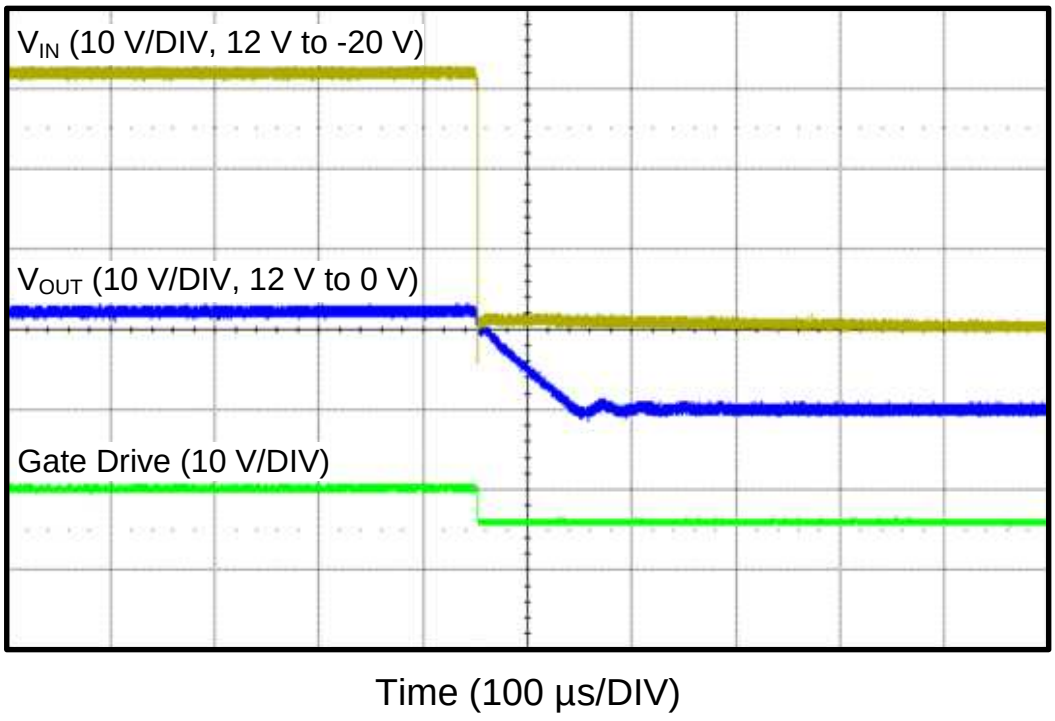

Figure 3. Response to Reverse Polarity 12V to -20V

A -12V source is connected to the VBAT_1 input of the LM74610-DQEVM. Figure 4 shows that the Output voltage will stay at a constant 0V in this situation. This test simulates the event of connecting a 12V battery in the reverse direction, and therefore, protects the load from negative voltages.

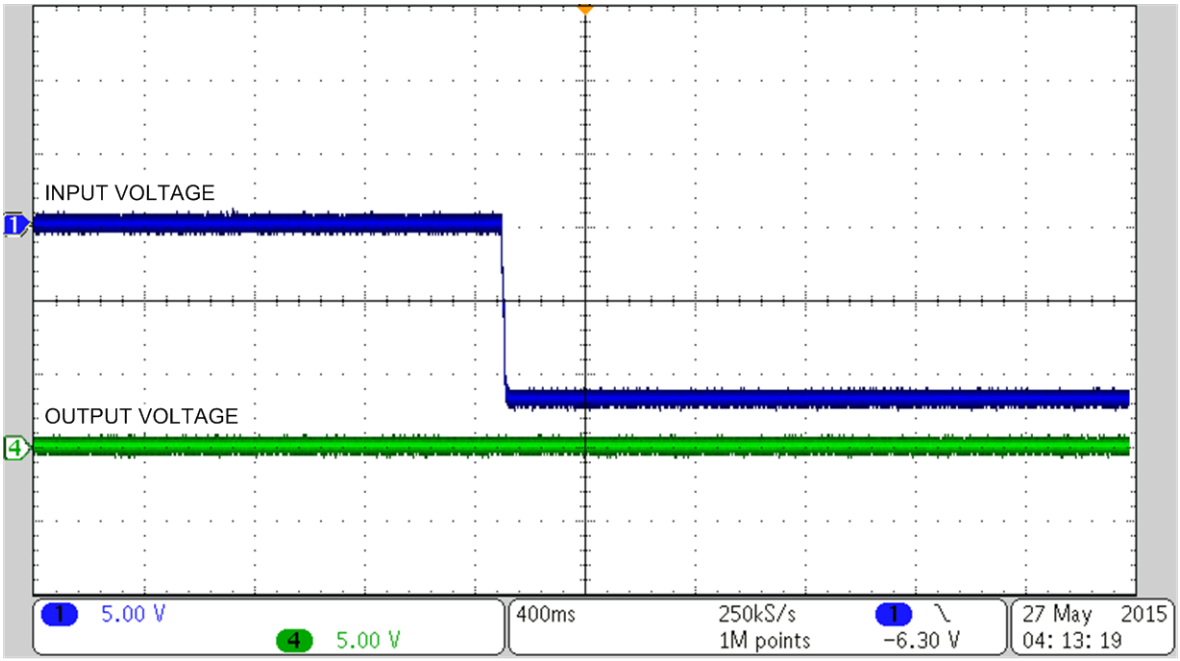

Figure 4. Response to Start Up Reverse Polarity

Note: the leakage current is 60uA (typ). This means that if you apply a voltage on the output you will see some voltage on input and this voltage will collapse if you draw more current than the leakage current. The same applies for a reverse voltage applied on the input.

3.2 Output Voltage

When power is initially applied, the load current (I_D) will flow through the body diode of the MOSFET. This current will produce a forward voltage drop (Vf) across the MOSFET body diode. This voltage is used to charge up the charge pump capacitor Vcap. This periodic voltage drop will be equal to the MOSFET body diode forward voltage drop and occurs for about 25.6msec as shown in Figure 5.

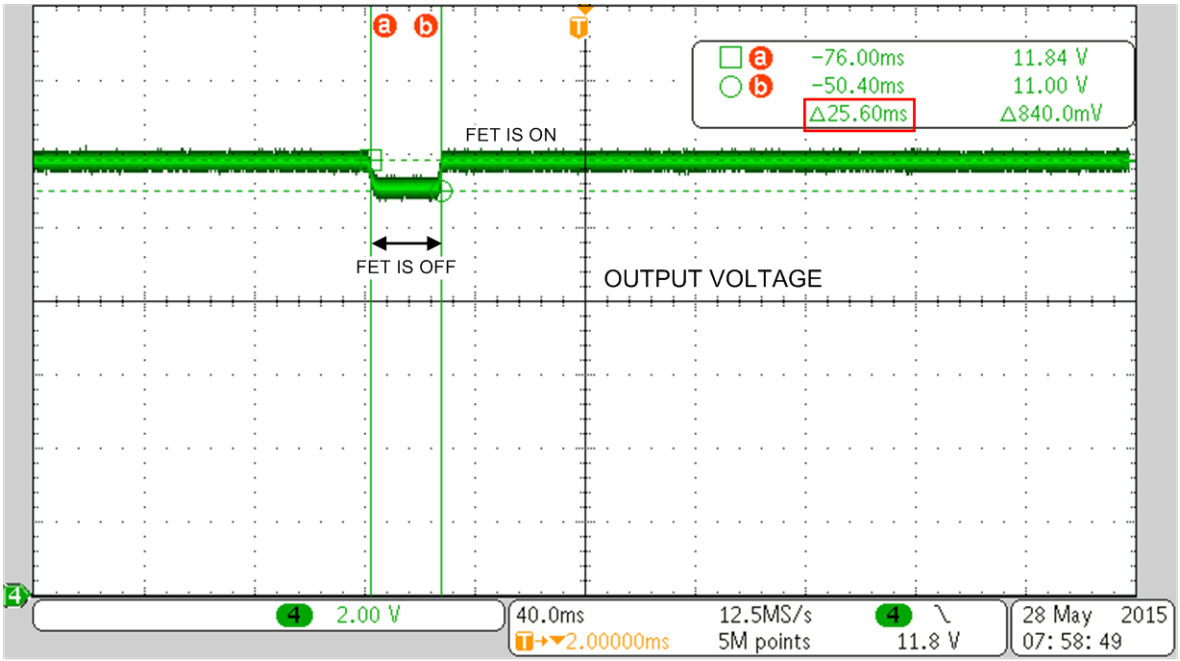

Figure 5. Periodic Body Diode Voltage Drop at the Output

During the rest of the period of conduction, the LM74610-Q1 will drive the gate of the MOSFET. When the MOSFET is ON, it provides a low resistive path for the drain current to flow and minimizes the power dissipation associated with forward conduction. The power losses during the MOSFET ON state depend primarily on the RDSON of the selected MOSFET and load current. The LM74610-Q1 operation keeps the MOSFET ON at approximately 98% as shown in Figure 6, leading to very little overall power dissipation when compared to a typical diode.

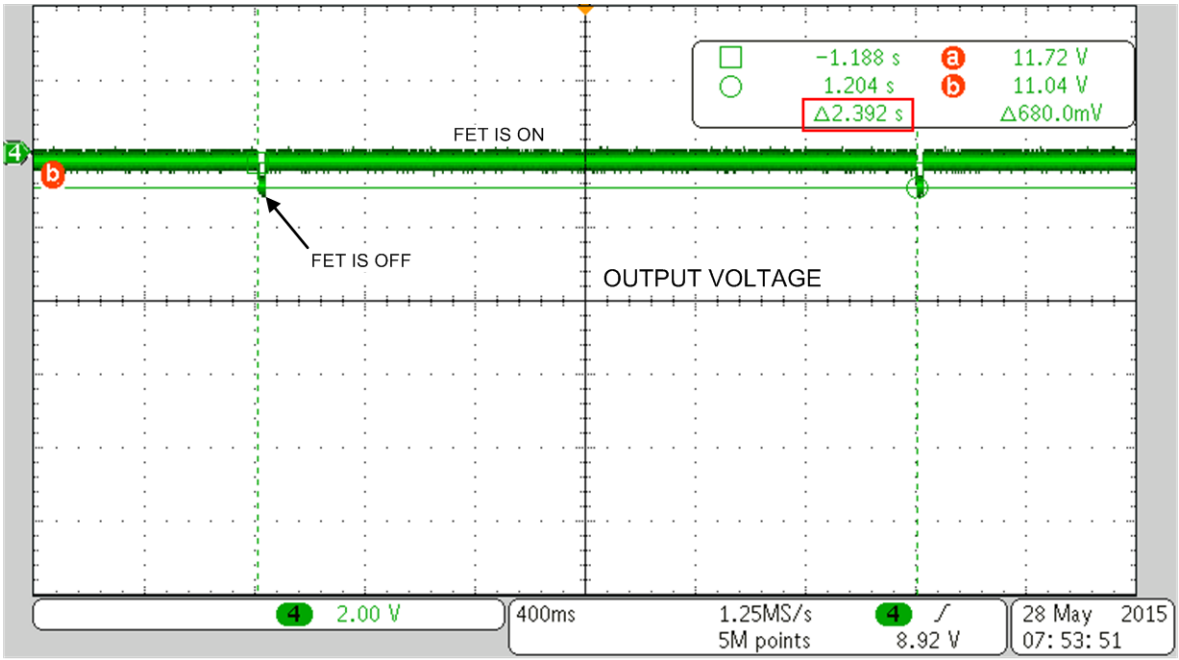

Figure 6. The LM74610-DQEVM Output Voltage Waveform

3.3 ORing Application Test

When using LM74610-DQEVM as an OR-ing device, if the input supplies operate at slightly different voltages, the voltage at the common load point should follow the higher voltage. The LM74610-Q1 prevents reverse current flow from the common load point to the lower voltage supply rail. This test uses 15V and 12V at the inputs (VBAT_1 and VBAT_2). As shown in Figure 7, the voltage source at Input 1 is turned off for a period of time and the output (VOUT) equals the voltage from Input 2. When the voltage source at Input 1 is turned on again, the output equals the voltage from Input 1 because of its larger voltage.

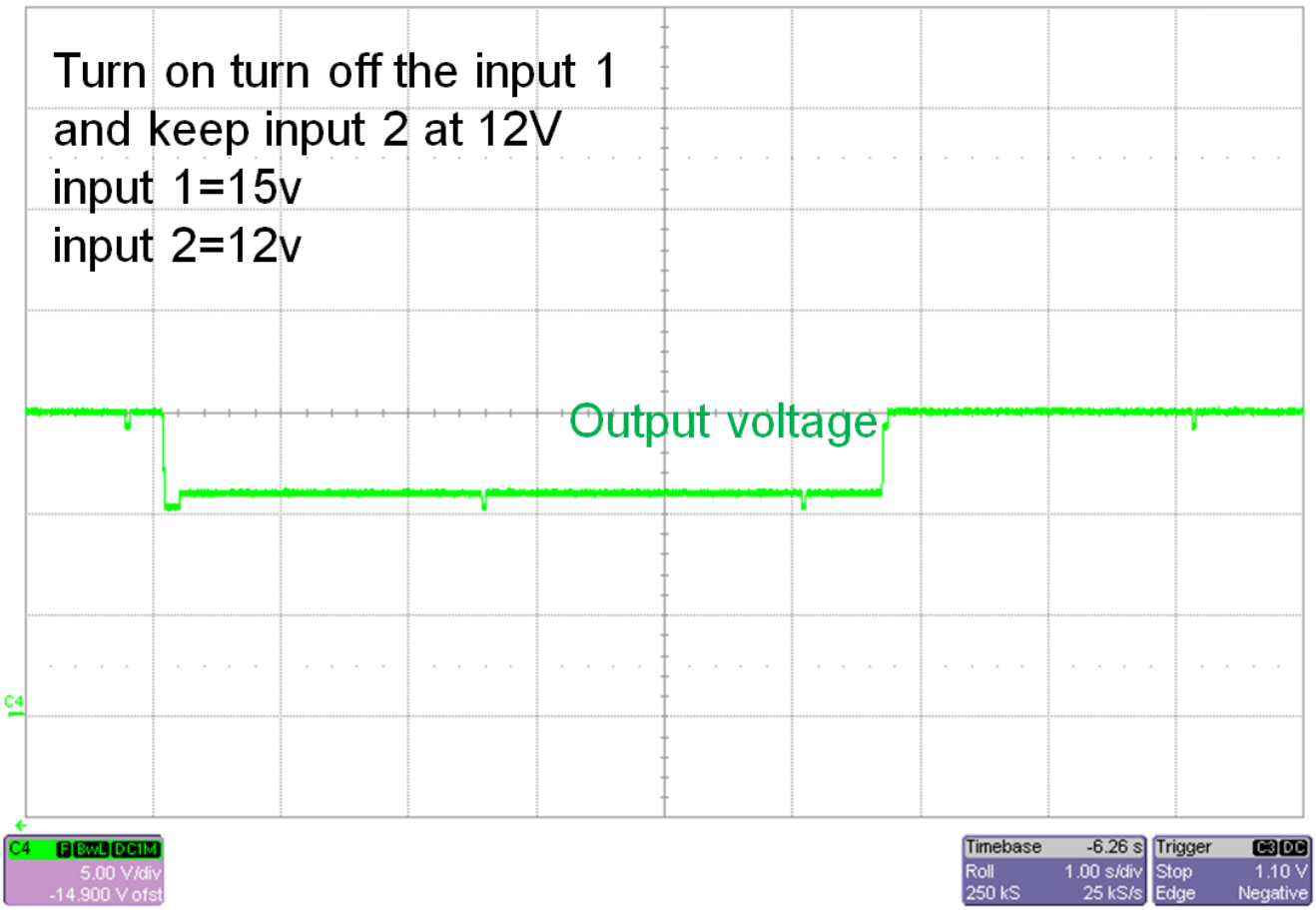

Figure 7. OR-ing Application Output Voltage Waveform

A dynamic voltage pulse from +14V to -37V is applied at the input (VBAT_1) of the EVM. A 10V source is connected to the second input (VBAT_2) of the EVM. Figure 8 shows that the VOUT voltage equals 10V when VBAT_1 equals -37V and does not go negative. Therefore, the load is protected from dynamic reverse pulses at the input.

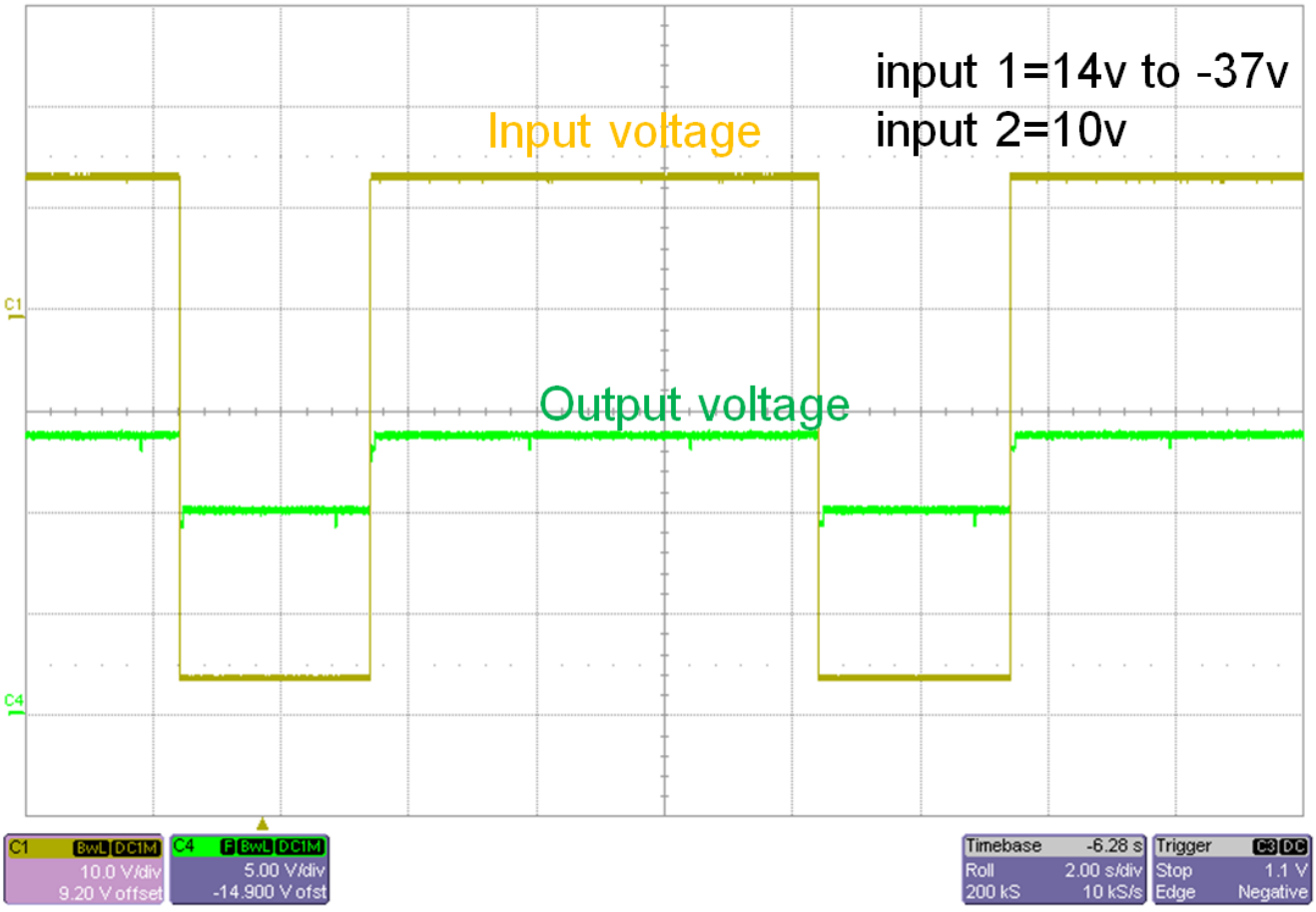

Figure 8. ORing Application for One DC Input and One Dynamic Pulse

If one of the power supplies fails in LM74610-Q1 OR-ing controller application, the output remains uninterrupted. This behavior is similar to diode OR-ing.Figure 9

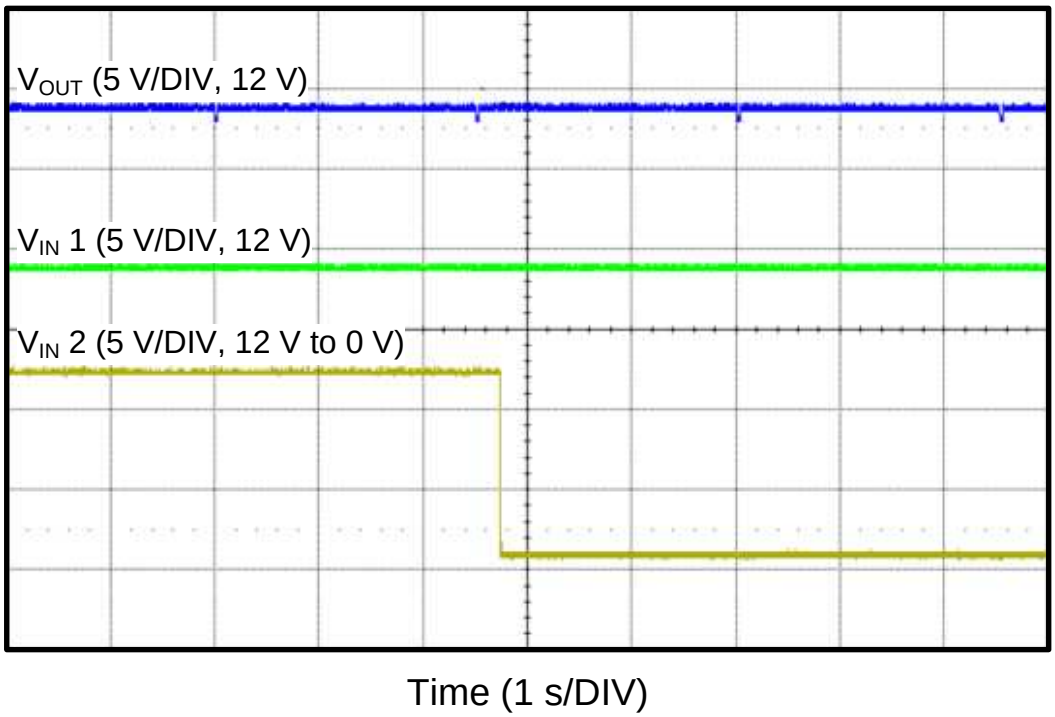

Figure 9. LM74610-Q1 OR-ing Waveform

3.4 Power Supply Consideration

While testing the LM74610-DQEVM OR-ing solution, it is important to use low impedance power supply which allows current sinking. If the power supply does not allow current sinking, it would prevent the current flow in the reverse direction in the event of reverse polarity. The MOSFET gate won't get pulled down immediately due to the absence of reverse current flow.

4 Board Layout

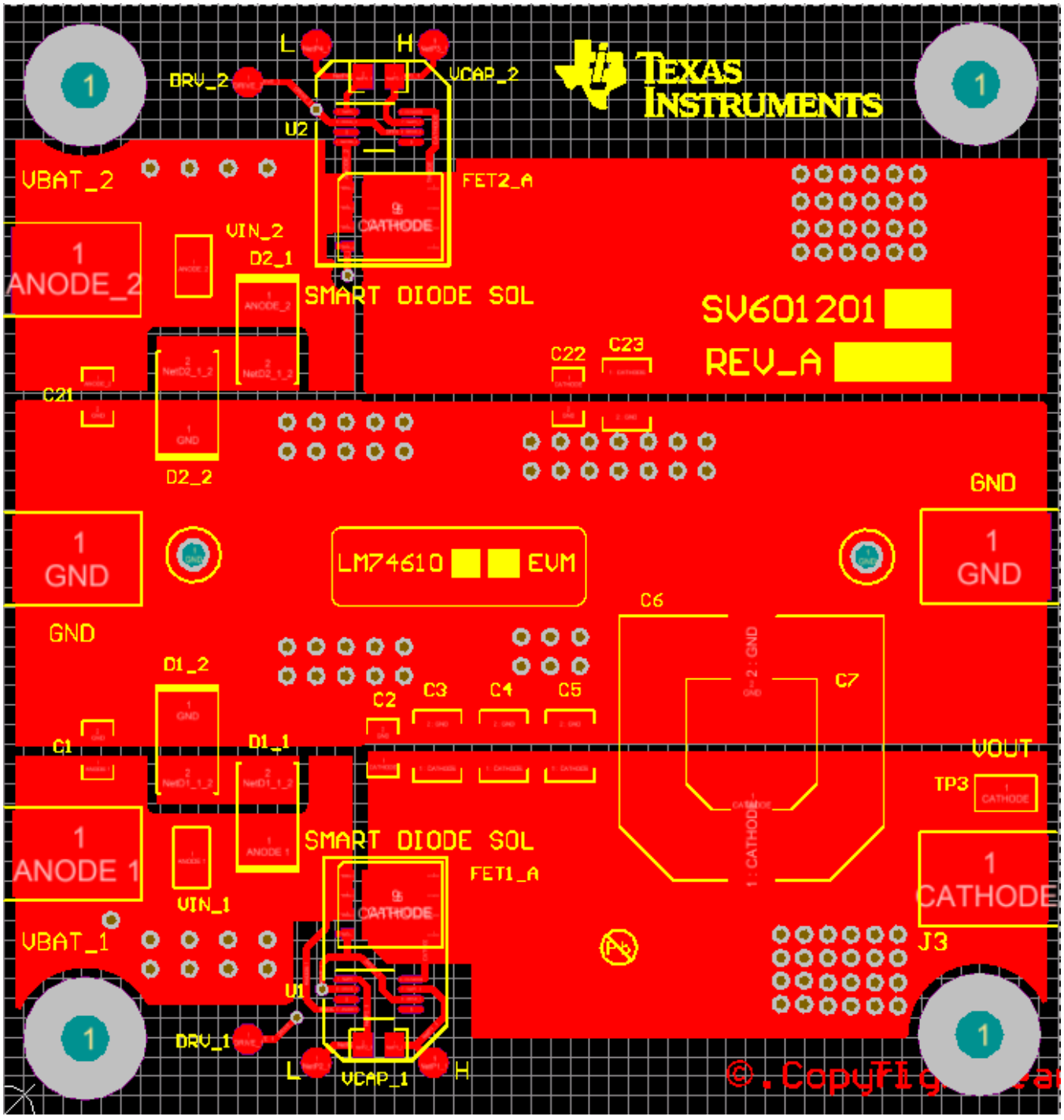

Figure 10. Top Assembly Layer

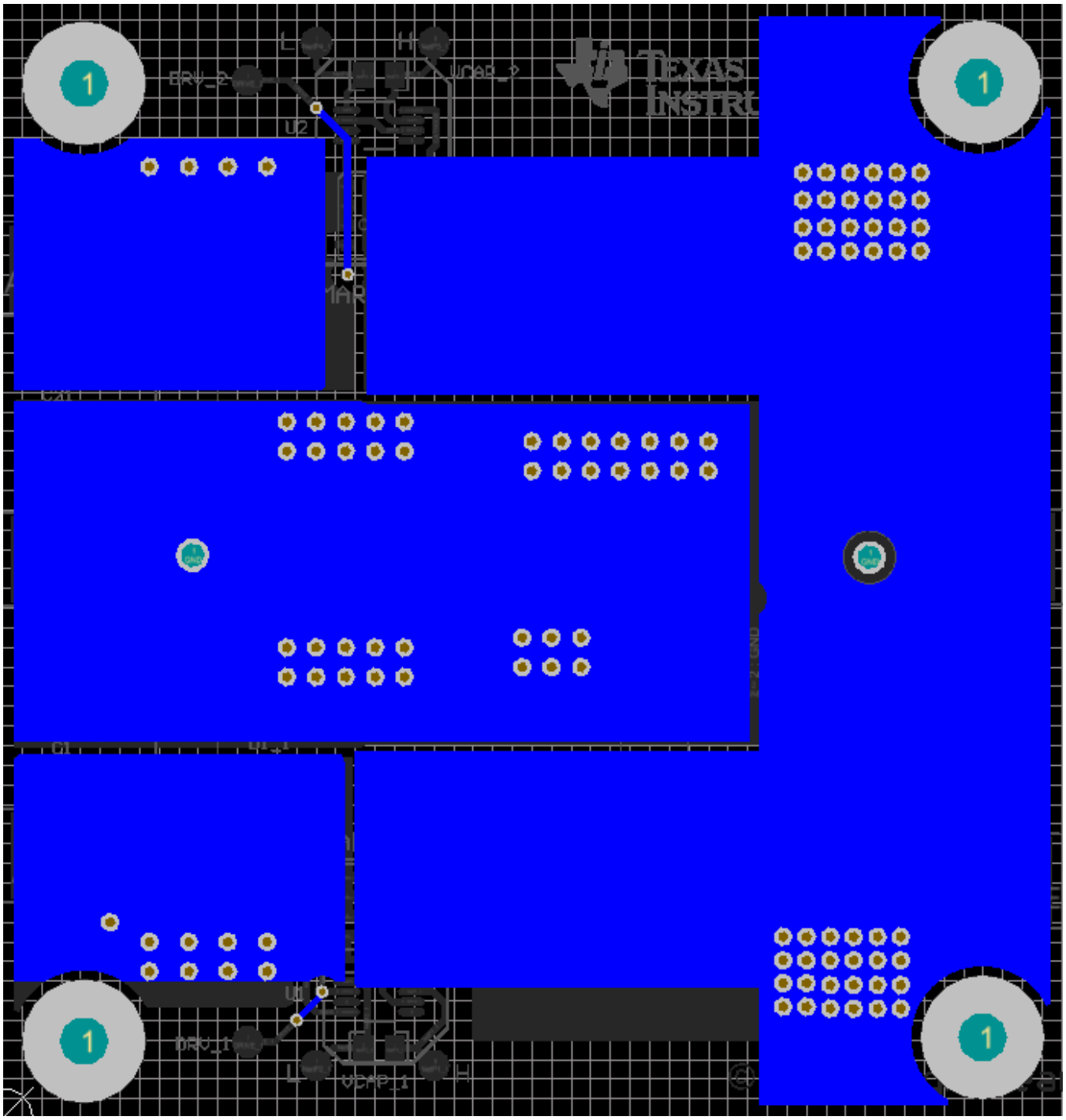

Figure 11. Bottom Layer

5 Schematic

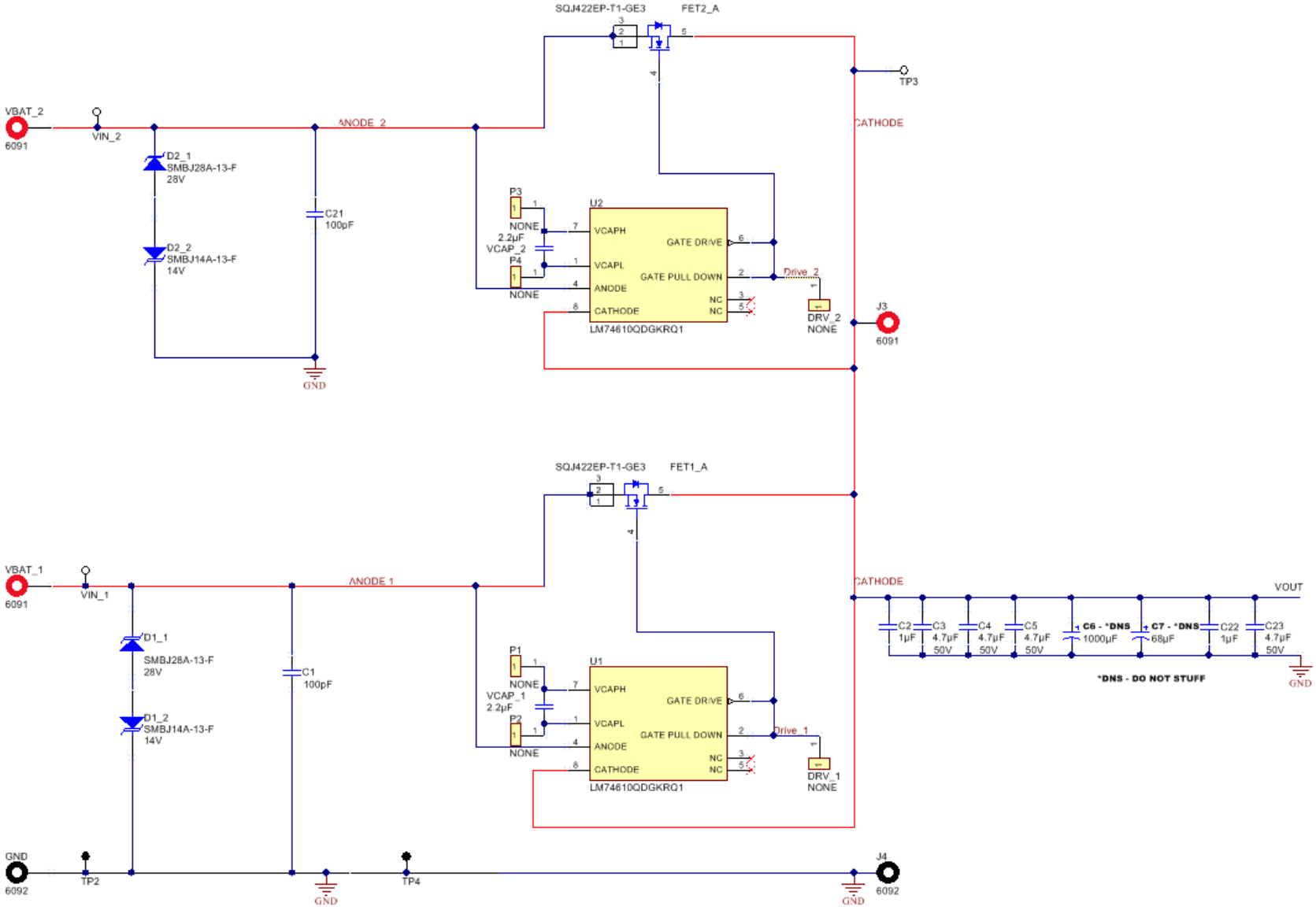

Figure 12. LM74610-DQ EVM Schematic

Note: The TVS+ and TVS- are not required for the LM74610-Q1. However, they are typically used to clamp the positive and negative voltage surges respectively. The output capacitors are recommended to protect the immediate output voltage collapse as a result of line disturbance.

6 Bill of Materials

Table 2. LM74610-DQ EVM Bill of Materials for Configuration

COUNT	REF DES	DESCRIPTION	MFR	PART NUMBER
6	DRV_1, DRV_2, P1, P2, P3, P4		NONE	NONE
3	TP3, VIN_1, VIN_2	Test Point, Miniature, SMT	Keystone	5015
DNS	C6	CAP, AL, 1000 µF, 50 V, +/- 20%, 0.073 ohm, SMD	Panasonic	EEV-FK1H102M
2	D1_1, D2_1	Diode, TVS, Uni, 28 V, 600 W, SMB	Diodes Inc.	SMBJ28A-13-F
2	D1_2, D2_2	Diode, TVS, Uni, 14 V, 600 W, SMB	Diodes Inc.	SMBJ14A-13-F
2	FET1_A, FET2_A	MOSFET, N-CH, 40 V, 75 A, PowerPAK_SO-8L	Vishay-Siliconix	SQJ422EP-T1-GE3
2	TP2, TP4	Test Point, Multipurpose, Black, TH	Keystone	5011
2	U1, U2	Smart Diode Controller, DGK0008A	Texas Instruments	LM74610QDGKRQ1
DNS	C7	CAP, AL, 68 µF, 50 V, +/- 20%, 0.6 ohm, SMD	Nippon Chemi-Con	EMVY500ADA680MHA0G
2	GND, J4	Standard Banana Jack, Insulated, Black	Keystone	6092
3	J3, VBAT_1, VBAT_2	Standard Banana Jack, Insulated, Red	Keystone	6091
4	C3, C4, C5, C23	CAP, CERM, 4.7 µF, 50 V, +/- 10%, X7R, 1210	MuRata	GRM32ER71H475KA88L
2	C1, C21	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0805	AVX	08055A101JAT2A
2	C2, C22	CAP, CERM, 1 µF, 50 V, +/- 10%, X7R, 0805	TDK	C2012X7R1H105K125AB
2	VCAP_1, VCAP_2	CAP, CERM, 2.2 µF, 50 V, +/- 10%, X5R, 0805	TDK	C2012X5R1H225K125AB

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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.*

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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

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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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