

DRV593 and DRV594 PWM Power Driver Evaluation Module

User's Guide

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

EVM IMPORTANT NOTICE

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation kit being sold by TI is intended for use for **ENGINEERING DEVELOPMENT OR EVALUATION PURPOSES ONLY** and is not considered by TI to be fit for commercial use. As such, the goods being provided may not be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety measures typically found in the end product incorporating the goods. As a prototype, this product does not fall within the scope of the European Union directive on electromagnetic compatibility and therefore may not meet the technical requirements of the directive.

Should this evaluation kit not meet the specifications indicated in the EVM User's Guide, the kit may be returned within 30 days from the date of delivery for a full refund. **THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.**

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Please be aware that the products received may not be regulatory compliant or agency certified (FCC, UL, CE, etc.). Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive**.

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein**.

Please read the EVM User's Guide and, specifically, the EVM Warnings and Restrictions notice in the EVM User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact the TI application engineer.

Persons handling the product must have electronics training and observe good laboratory practice standards.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the supply voltage range of 2.8 V to 5.5 V.

Exceeding the specified supply range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the supply range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's 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, some circuit components may have case temperatures greater than 125°C. The EVM is designed to operate properly with certain components above 125°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

Preface

How to Use This Manual

This document contains the following chapters:

- Chapter 1—Introduction
- Chapter 2—Operating Instructions

Related Documentation From Texas Instruments

- DRV593, DRV594*** data sheet (SLOS401).

FCC Warning

This equipment is for use in a laboratory test environment only. It generates and uses radio frequency energy. It may also radiate such energy. The equipment has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the EVM in other environments may cause interference with radio communications, in which case users at their own expense must take whatever measures are required to correct this interference.

Contents

1	Introduction	1-1
1.1	Feature Highlights	1-2
1.2	Description	1-2
1.3	EVM Specifications	1-2
2	Operating Instructions	2-1
2.1	Precautions	2-2
2.2	Operating Instructions List	2-2
2.2.1	DRV593/594 EVM Schematic	2-4
2.2.2	DRV593/594 EVM Bill of Materials	2-5
2.2.3	DRV593/594 EVM PCB Layers	2-6

Figures

2-1	DRV593/594 EVM Schematic Diagram	2-4
2-2	DRV593 Top Layer	2-6
2-3	DRV594 Top Layer	2-6
2-4	DRV593 and DRV594 Bottom Layer	2-7
2-5	DRV593 and DRV594 Thermal Plane Layer	2-7

Tables

2-1	Typical Jumper Settings	2-2
2-2	Fault Indicators	2-3
2-3	DRV593/594 EVM Bill of Materials	2-5

Introduction

This chapter provides an overview of the Texas Instruments (TI) DRV593/594 high-efficiency power driver evaluation module. It includes a list of EVM features, a brief illustrated description of the module, and a list of EVM specifications.

Topic	Page
1.1 Feature Highlights	1-2
1.2 Description	1-2
1.3 EVM Specifications	1-2

1.1 Feature Highlights

The DRV593/594 evaluation module includes the following features:

- PWM operation with only one output filter required
- High efficiency
- Small solution size
- Low supply current in active and shutdown modes
- LEDs and test points for fault monitoring
- Jumpers for selecting device options
- Easy connections for inputs, outputs, and power supply

1.2 Description

The DRV593/594 PWM power driver evaluation module is a complete power stage solution. It consists of the TI DRV593/594 PWM power driver IC, along with a few discrete passive components required for operation. It also includes jumpers for configuring the features of the device, LEDs and test points for fault monitoring, and an output filter that is easily modified. The 5-way jacks for the inputs, outputs, and power supply provide ease of connection to any system, from an existing design to a bread-boarded prototype.

1.3 EVM Specifications

Supply voltage range, V_{DD}	2.8 V to 5.5 V
Supply current, I_{DD}	3.1 A max

Operating Instructions

Follow the steps in this chapter to quickly prepare the DRV593/594 EVM for use.

Topic	Page
2.1 Precautions	2-2
2.2 Operating Instructions List	2-2

2.1 Precautions

Power Supply Input Polarity and Maximum Voltage

Always ensure that the polarity and voltage of the external power connected V_{DD} power input connector J8 is correct. Overvoltage or reverse-polarity power applied to this terminal can damage the evaluation module.

2.2 Operating Instructions List (See Figures 2–2 and 2–3.)

Table 2–1. Typical Jumper Settings

J1(FREQ)	J2 (INT/EXT)	J3 (SHUTDOWN)
ON	ON	ON

Power supply

- 1) Ensure that all external power sources are set to OFF.
- 2) Connect a 2.8-V to 5.5-V power supply to J8 (V_{DD}) and J9 (GND), taking care to observe proper polarity.

Inputs and outputs

- 3) Connect a dc control voltage to J4 (IN+), ranging from ground to V_{DD} . The terminal J5 (IN–) is held to $V_{DD}/2$ with a resistor voltage divider, as shown in the schematic. Therefore, a dc control voltage of $V_{DD}/2$ provides 0-V output from PWM to H/C.

If a different bias or offset is required, replace the voltage divider resistors R7 and R8. To minimize gain error due to imbalance in the impedance of the differential input stage, the value of R7 and R8 in parallel should not exceed 1 k Ω . Alternatively, the resistor divider may be removed and a different common voltage output (such as from an op-amp buffer or a power supply) may be connected to J5 (IN–).

Note:

The common mode input range of the DRV593 and DRV594 are 1.2 V to 3.8 V when using a 5-V supply, and 1.2 V to 2.1 V when using a 3.3-V supply. Refer to the DRV593/594 data sheet, SLOS401.

- 4) Connect a load across J6 (PWM) and J7 (H/C). The polarity of the connection depends on the operation of the dc control voltage. As the voltage at IN+ becomes greater than the voltage at IN–, the voltage at PWM increases and the H/C voltage remains at ground. The differential voltage created causes current to flow from PWM to H/C. Similarly, as the voltage at IN+ decreases lower than IN–, the voltage at H/C goes to V_{DD} and the PWM voltage decreases. The differential voltage increases in the opposite direction, causing current to flow from H/C to PWM.

For example, consider the load to be a TEC element and the dc control voltage to be the output of a temperature control circuit. In this example, as temperature increases the output of the temperature control circuit increases. The TEC element should therefore be connected with the anode at PWM and the cathode at H/C to ensure that the TEC element cools when the temperature increases.

Evaluation module jumpers, LEDs, and test points

- 5) Jumper J1 (FREQ) should be ON for normal operation.

When J1 is ON, the device is configured for 500-kHz operation.

When J1 is OFF, the device is configured for 100-kHz operation. However, capacitor C9 must be removed and replaced with a 1-nF capacitor for proper operation.

- 6) Jumper J2 (INT/ $\overline{\text{EXT}}$) should be ON for normal operation.

When J2 is ON, the internal oscillator is used to generate the switching outputs. When J2 is OFF, an external TTL-compatible clock signal can be driven into the COSC pins of DRV593 and DRV594. In that case, the capacitor C9 is removed and a wire is soldered to the pad closest to the IC for connecting the external clock.

- 7) Jumper J3 ($\overline{\text{SHUTDOWN}}$) should be ON for normal operation. (Remove J3 to place the DRV593 and DRV594 in shutdown mode.)

If an external shutdown control signal is to be used, it should be connected to the right-hand pin of J3 (which is connected to resistor R5). The control signal must be TTL-compatible; a logic high provides normal operation, a logic low places the DRV593 and DRV594 in shutdown.

- 8) The LED D1 lights if FAULT1 is active, and LED D2 lights if FAULT0 is active. If external fault monitoring is to be used, test point TP1 is connected to FAULT1 and test point TP2 is connected to FAULT0. The pins and test points go low when a fault is present, lighting the LEDs. The faults are shown in the table below. Refer to the DRV593/594 data sheet (SLOS401) for additional information on the fault indicators.

Table 2–2. Fault Indicators

FAULT1	FAULT0	
0	0	Overcurrent
1	0	Undervoltage
0	1	Overtemperature
1	1	Normal operation

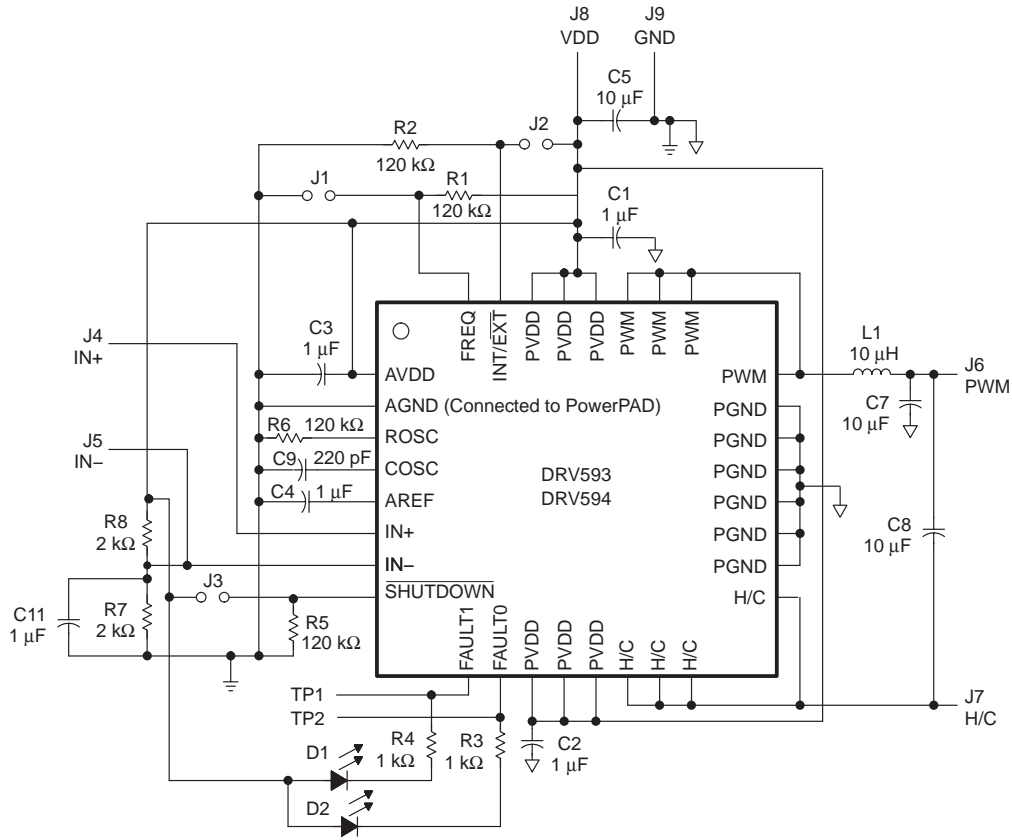
Note: 0 = LED ON (Fault) 1 = LED OFF (Normal)

Power up

- 9) Verify correct voltage, verify input polarity, and set the external power supply to ON. The EVM begins operation.

2.2.1 DRV593/594 EVM Schematic

Figure 2-1. DRV593/594 EVM Schematic Diagram



2.2.2 DRV593/594 EVM Bill of Materials

Table 2–3. DRV593/594 EVM Bill of Materials

Reference	Description	Size	Qty.	MFG	Part #	Vendor/#
C1–4, C11	Capacitor, ceramic, 1 μ F, \pm 10%, X5R, 6.3 V	0603	5	Panasonic	ECJ1VB0J105K	Digi-Key/ PCC1915CT-ND
C5	Capacitor, ceramic, 22 μ F, \pm 10%, X5R, 16 V	1206	1	Panasonic	ECJ-4YB1C106K	Digi-Key/ PCC2169CT-ND
C6	Capacitor, ceramic (not assembled)	0603	1			
C7	Omitted					
C8	Capacitor, ceramic, 10 μ F, \pm 10%, X5R, 16 V	1210	1	Panasonic	ECJ-4YB1C106K	Digi-Key/ PCC2169CT-ND
C9	Capacitor, ceramic, 220 pF, \pm 10%, X7R	0603	1	Panasonic	ECUV1J221KBV	Digi-Key/ PCC221BVCT-ND
R1, R2, R5, R6	Resistor, chip, 120 k Ω , 1/16 W, 1%	0603	4	Phycomp	9C06031A1203F KHFT	Digi-Key/ 311-120KHCT-ND
R3, R4	Resistor, chip, 1 k Ω , 1/16 W, 1%	0603	2	Phycomp	9C06031A1001F KHFT	Digi-Key/ 311-1.00KHCT-ND
R7, R8	Resistor, chip, 2 k Ω , 1/16 W, 1%	0603	2	Phycomp	9C06031A2001F KHFT	Digi-Key/ 311-2.00KHCT-ND
D1, D2	LED, red, 2 V, 140° view angle	0805	2	Lumex	SML–LXT0805IW	Digi-Key/ 67–1552–2–ND
L1	Inductor, SMT, 10 μ H, 0.026 m Ω DCR (typical), 4.4 A max dc current		1	Sumida	CDRH104R-100	Harvey King/ CDRH104R–100
L2	Chip bead (not assembled)	1806	2			
J1, J2, J3	Header, 2 position	2 mm	3	Norcomp	2163-2-01-P2	Digi-Key/ 2163S-02-ND
	Shunts	2 mm	3	3M	953170-00	Digi-Key/ 953170-00
TP1, TP2	Test points		2			Farnell/240-333
IN–, IN+, V _{DD} , GND, OUT+, OUT– (J5–J9)	Uninsulated binding post with knurled thumb, nut-grounded type		6	Johnson Components	111-2223-001	Digi-Key/J587-ND
	Standoffs	4–40	4			Digi-Key/534-1804
U1	DRV593/DRV594, 32-pin Quad Flatpack		1	TI	DRV593/ DRV594VFP	TI/DRV593/ DRV594VFP

2.2.3 DRV593/594 EVM PCB Layers

Figure 2–2. DRV593 Top Layer

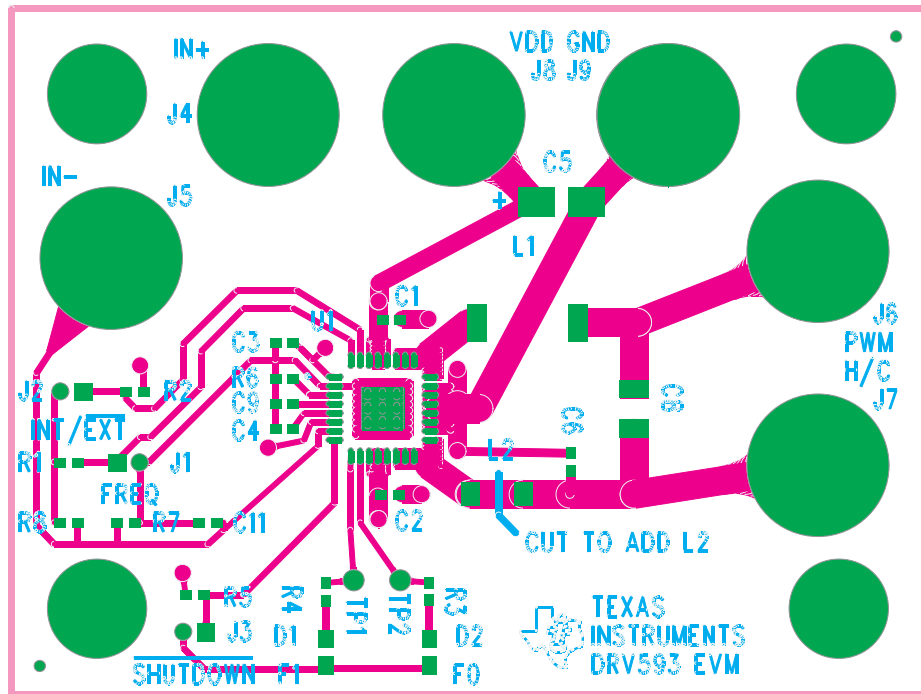


Figure 2–3. DRV594 Top Layer

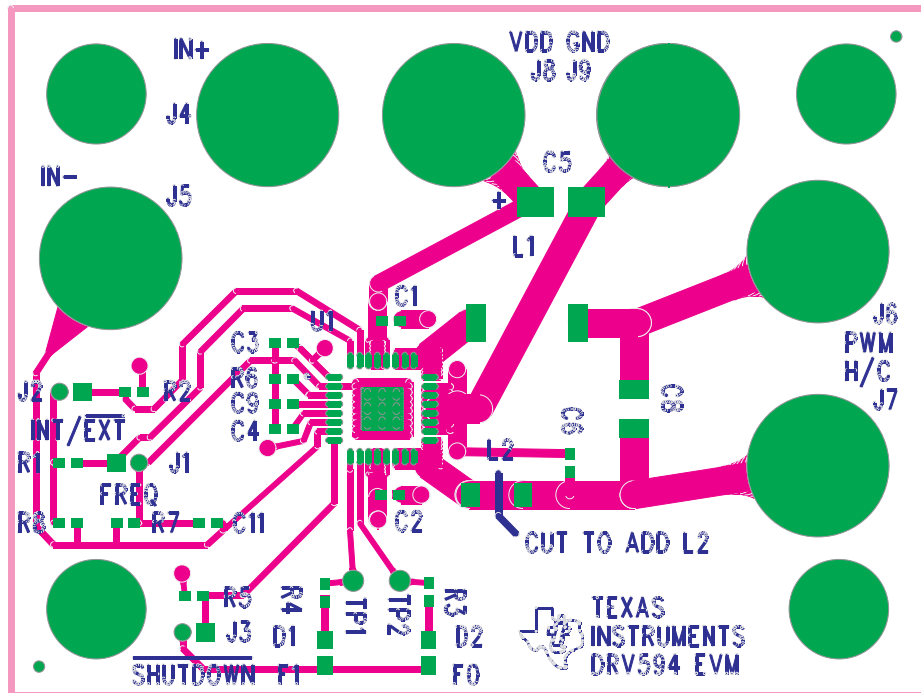


Figure 2-4. DRV593 and DRV594 Bottom Layer

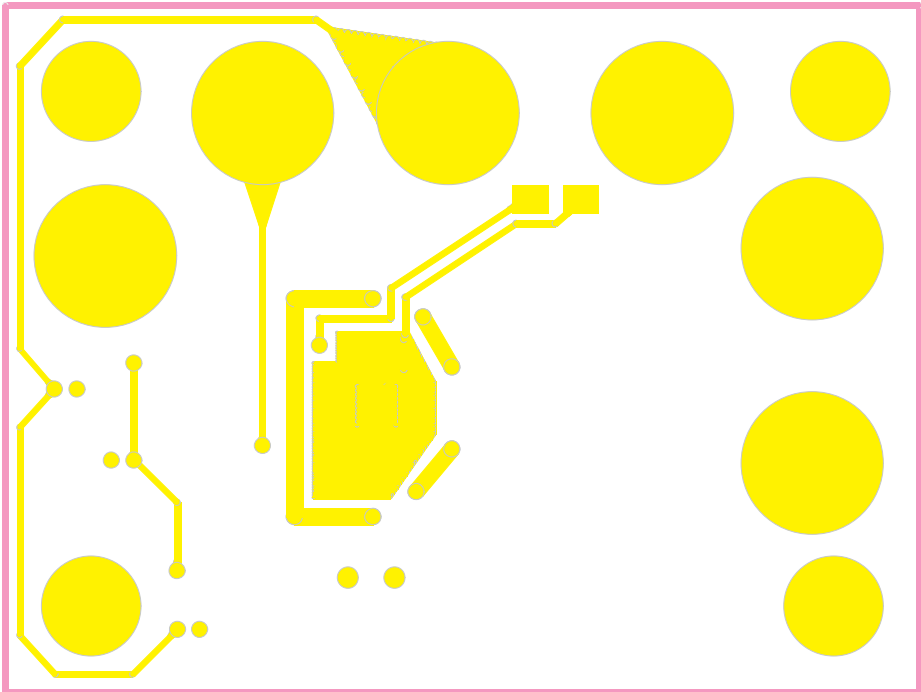


Figure 2-5. DRV593 and DRV594 Thermal Plane Layer

