

# TPS71401DCKEVM-425

This user's guide describes the characteristics, operation, and use of the TPS71401DCKEVM-425 evaluation module. This document includes setup instructions, a schematic diagram, thermal guidelines, a bill of materials (BOM), and printed circuit board (PCB) layout drawings.

## Contents

1	Overview .....	1
2	Setup .....	2
3	Operation .....	3
4	Thermal Guidelines .....	3
5	Board Layout, Schematic, and Parts List .....	4

## List of Figures

1	Assembly Layer .....	5
2	Top Layer Routing .....	6
3	Bottom Layer Assembly .....	7
4	Bottom Layer Routing .....	8
5	TPS71401DCKEVM-425 Schematic .....	9

## 1 Overview

This document describes the characteristics, operation, and use of the TPS71401DCKEVM-425 evaluation module (EVM). This EVM demonstrates the capabilities and features of Texas Instruments' [TPS71401](#), a low-dropout (LDO) linear regulator, an 80-mA, low quiescent current linear regulator in an SC70-5 package. The TPS71401DCKEVM-425 EVM helps designers evaluate the operation and performance of the TPS71401 LDO in a variety of configurations.

### 1.1 Related Documentation from Texas Instruments

The following related documents are available through the Texas Instruments web site at <http://www.ti.com>.

**Table 1. Related Documentation**

Part Number	Literature Number
<a href="#">TPS71401</a>	<a href="#">SBVS116</a>

## 2 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up, and use the TPS71401EVM.

### 2.1 Electrostatic Discharge Notice

#### CAUTION

Many of the components on the TPS71401EVM are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

Failure to observe proper ESD handling procedures may result in damage to EVM components.

### 2.2 Input/Output Connector Descriptions

#### 2.2.1 J1: VIN

This connector is the positive input supply voltage. The leads to the input supply should be twisted and kept as short as possible to minimize electromagnetic interference (EMI) transmission. Additional bulk capacitance should be added between J1 and J2 if the supply leads are longer than 6 in (15,24 cm). An additional 47  $\mu$ F or greater capacitor improves the transient response of the TPS71401 and helps to reduce ringing on the input when long supply wires are used.

#### 2.2.2 J2: VOUT

This point is the positive connection from the output. Connect this pin to the positive input of the load.

#### 2.2.3 J3: GND

This is the return connection for the input power supply of the regulator.

#### 2.2.4 J4: GND

This point is the return connection for the output.

#### 2.2.5 J5: Output Voltage Selection

This jumper is used to select the output voltage of the TPS71401. The jumper selects different feedback resistors to change the output voltage setting. The output voltage is set by inserting a shorting jumper across two pins of J5. The pre-programmed output voltages are configured as shown in [Table 2](#).

**Table 2. Output Voltage Setting**

Output Voltage (V)	Jumper Between Pins
5.0	1 and 2
3.3	3 and 4
2.7	5 and 6
2.5	7 and 8

Other output voltages can be configured by changing the feedback resistors on the board. The pins of J5 connect directly to the feedback network of the TPS71401. The feedback network is high impedance and sensitive to noise or resistance value changes. The pins of J5 should not be touched while the device is powered on because the impedance of a human is enough to alter the output voltage set point. The output voltage may increase or decrease if J5 is touched, which may damage any load connected to the EVM.

### 3 Operation

This section discusses the operation of the TPS71401EVM.

#### 3.1 Power On

Connect the positive input power supply to J1. Connect the input power return (ground) to J3. The TPS71401EVM has an absolute maximum input voltage of 11.0 V. The recommended maximum operating voltage is 10 V. The actual highest input voltage may be less than 10 V as a result of thermal conditions. See the [Thermal Considerations](#) section of this manual to determine the highest input voltage.

Connect the desired load between J2 (positive lead) and J4 (negative or return lead). Configure jumper J5 for the desired output voltage. The function of J5 is described in [Section 2.2.5](#) of this manual.

#### 3.2 Fixed Output TPS714xx Device Configuration

The TPS71401 EVM can also be used to evaluate fixed-output voltage versions of the TPS714 LDO. The board layout and device footprints are the same for both the adjustable and the fixed-output voltage versions of the TPS714. To evaluate a fixed-output voltage version, the IC on the board must be changed to the desired fixed output voltage (TPS714xx). Note that R<sub>1</sub> must be removed from the EVM board if a fixed output voltage version is mounted to the EVM board.

### 4 Thermal Guidelines

This section presents guidelines for the thermal management of the TPS71401DCKEVM-425 PCB.

#### 4.1 Thermal Considerations

Thermal management is a key design component of any power converter application and is especially important when the power dissipation in the LDO is high. To better help users design the TPS71401 family into an application, the following formula should be used to approximate the maximum power dissipation at a particular ambient temperature:

$$T_J = T_A + P_D \times \theta_{JA} \quad (1)$$

Where:

- T<sub>J</sub> is the junction temperature
- T<sub>A</sub> is the ambient temperature
- P<sub>D</sub> is the power dissipation in the IC
- θ<sub>JA</sub> is the thermal resistance from junction to ambient

All temperatures are in degrees Celsius.

The thermal resistance from junction to ambient for the TPS71401EVM has a typical value of 315°C/W. The recommended maximum operating junction temperature specified in the data sheet for the TPS71401 family is +125°C. With these two pieces of information, the maximum power dissipation can be found by using [Equation 1](#).

### Example 1. Maximum Power Dissipation Calculation

What is the maximum input voltage that can be applied to a TPS71401 with the output voltage configured to 3.3 V if the ambient temperature is +85°C and the full 80 mA of load current is required?

Given:

$$T_J = +125^\circ\text{C}, T_A = +85^\circ\text{C}, \theta_{JA} = 315^\circ\text{C/W}$$

Using Equation 1, we substitute in the given values above and find that the maximum power dissipation for the part is  $P_D = 0.615 \text{ W}$ .

$$+125^\circ\text{C} = +85^\circ\text{C} + P_D(315^\circ\text{C/W}) \quad (2)$$

This result means that the total power dissipation of the TPS71401 must be less than 0.126 W. Now the input voltage can be calculated:

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} = (V_{IN} - 3.3 \text{ V}) \times 0.08 \text{ A} = 0.126 \text{ W} \quad (3)$$

Therefore, the maximum input voltage should be 4.88 V or less in order to maintain a safe junction temperature.

Similar analyses can be performed to determine the maximum input voltage at room temperature (+25°C) to provide full output current while maintaining the junction temperature at or below +125°C. The maximum input voltage depends on the output voltage. Table 3 lists the maximum input voltage allowed for the pre-programmed output voltages.

**Table 3. Maximum Input Voltage (V)**

Output Voltage (V)	Maximum Input Voltage (V)
5.0	8.96
3.3	7.26
2.7	6.67
2.5	6.46

## 5 Board Layout, Schematic, and Parts List

This section provides the TPS71401DCKEVM-425 board layout and illustrations. It also includes the schematic and bill of materials for the EVM.

### 5.1 PCB Layouts

Figure 1 through Figure 3 show the layout for the TPS71401DCKEVM-425 PCB.

---

**Note:** Board layouts are not to scale. These figures are intended to show how the board is laid out; they are not intended to be used for manufacturing TPS71401DCKEVM-425 PCBs.

---

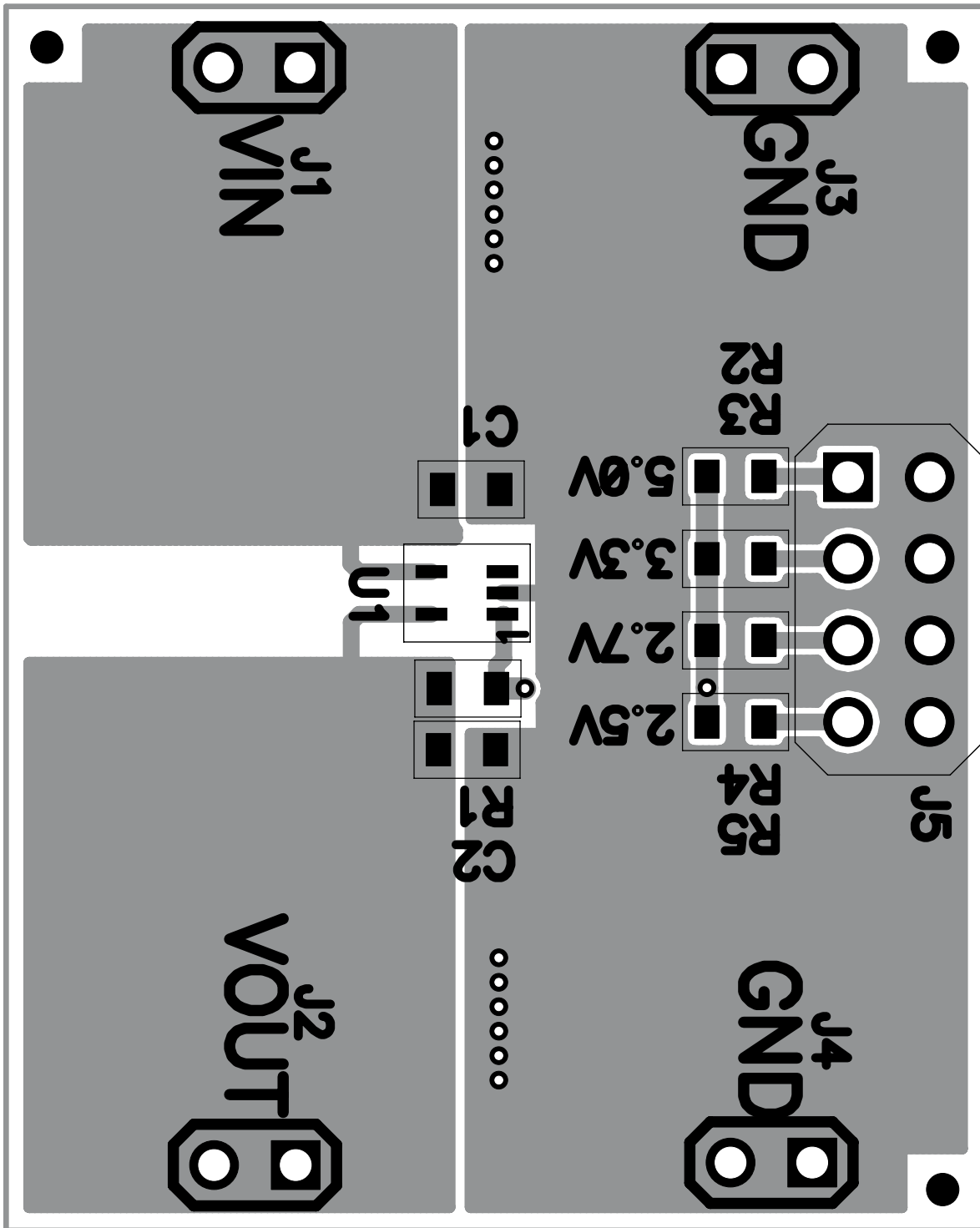


Figure 1. Assembly Layer

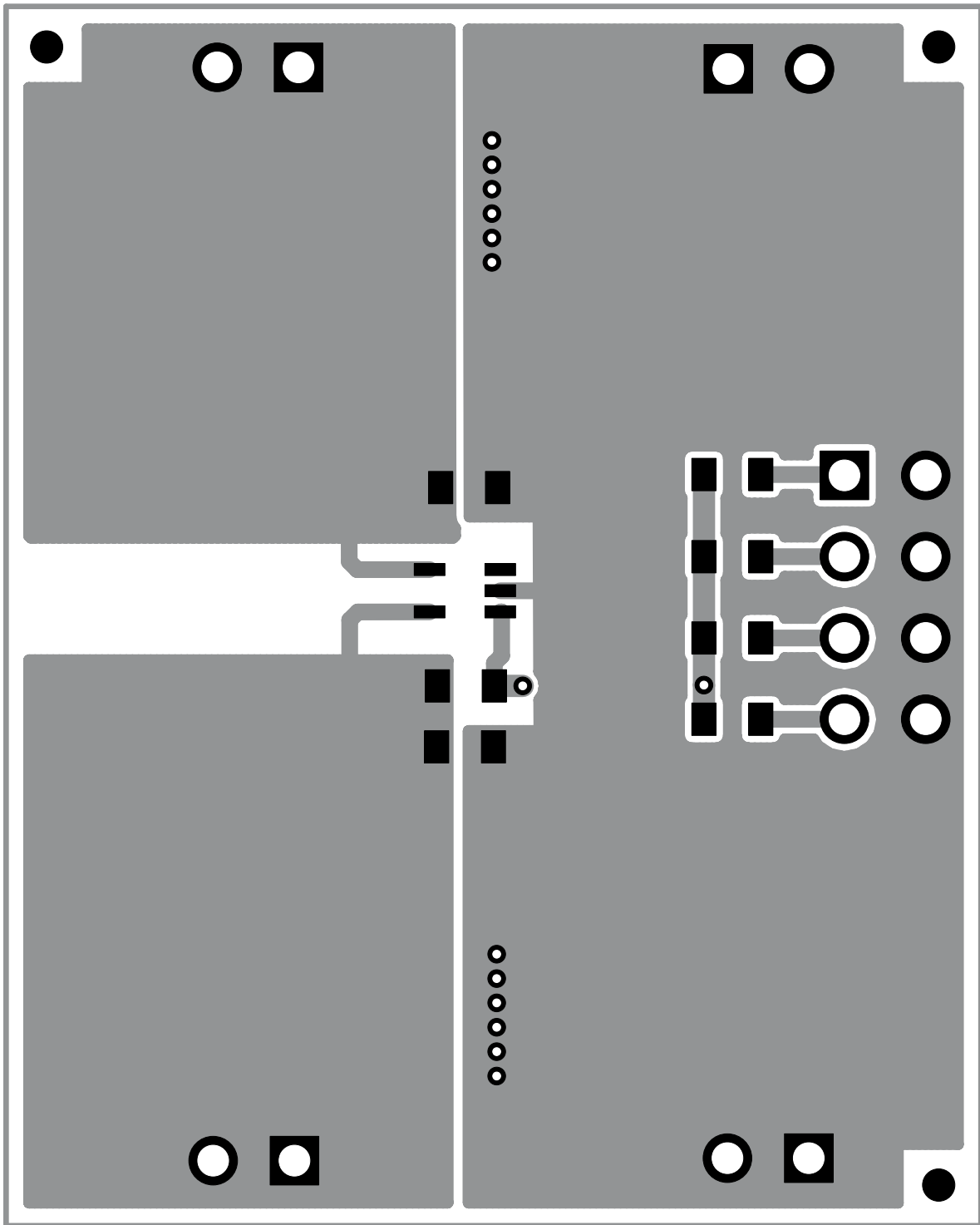


Figure 2. Top Layer Routing

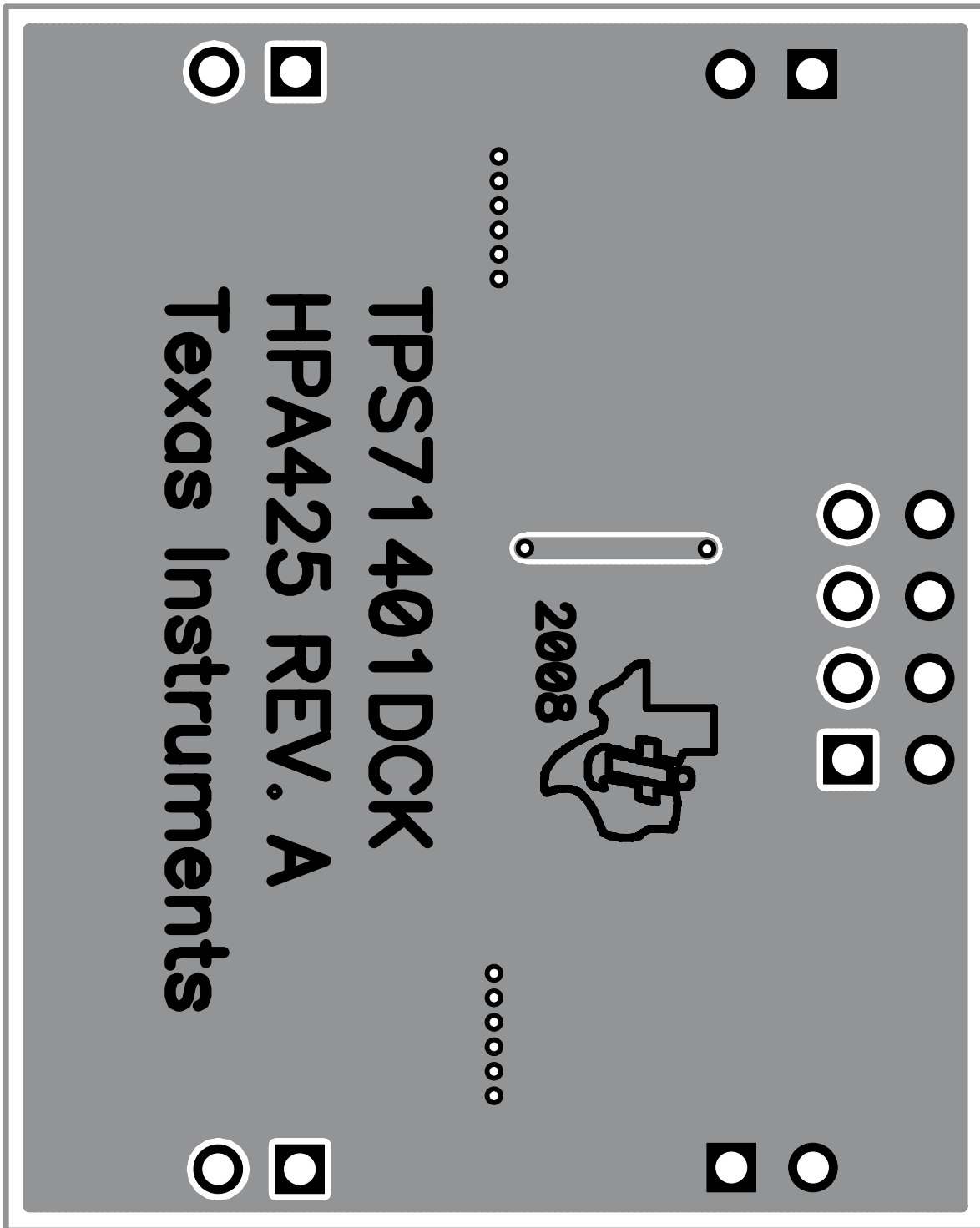


Figure 3. Bottom Layer Assembly

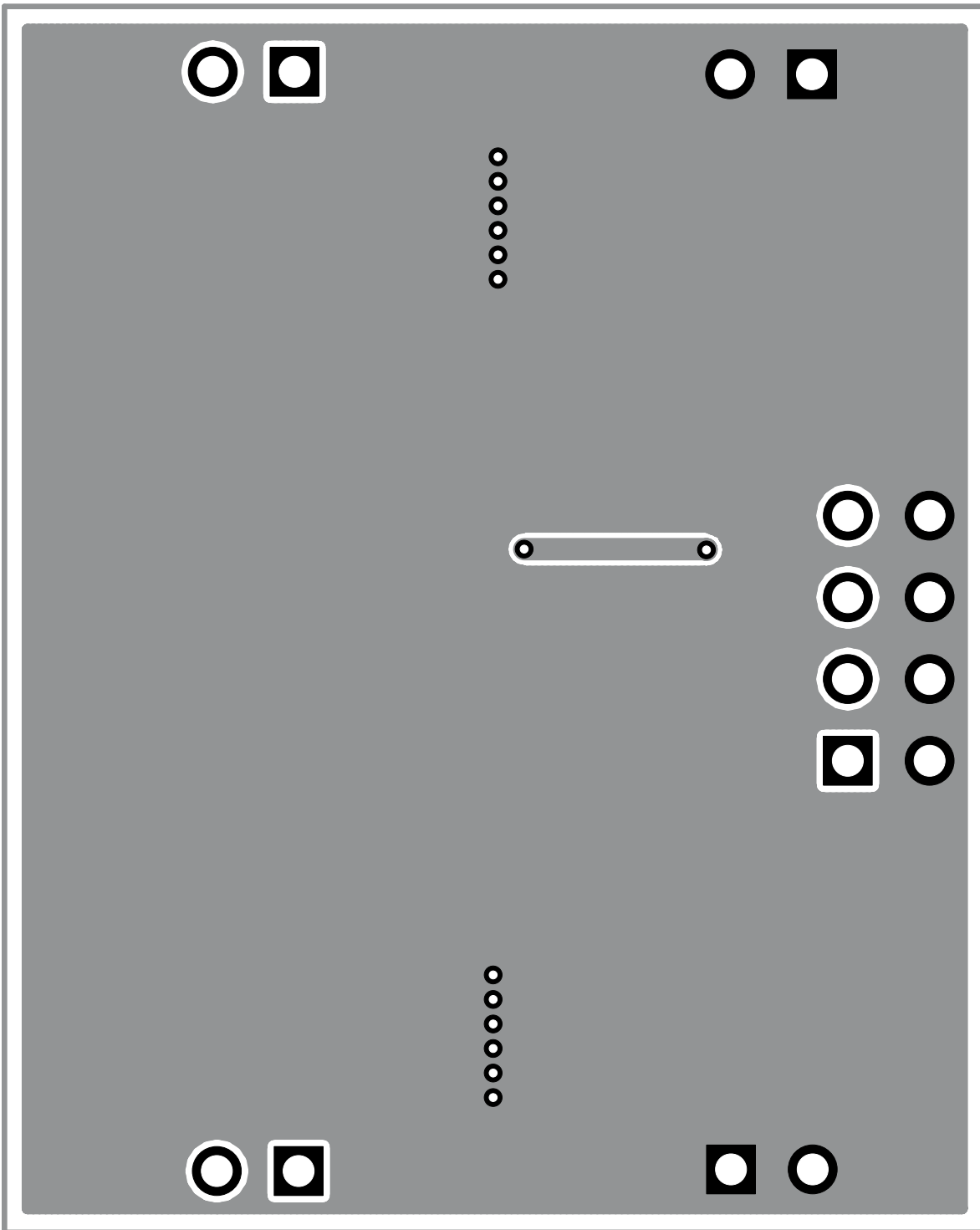


Figure 4. Bottom Layer Routing



## 5.2 Schematic and BOM

Figure 5 illustrates the TPS71401DCKEVM-425 schematic. Table 4 lists the bill of materials for this EVM.

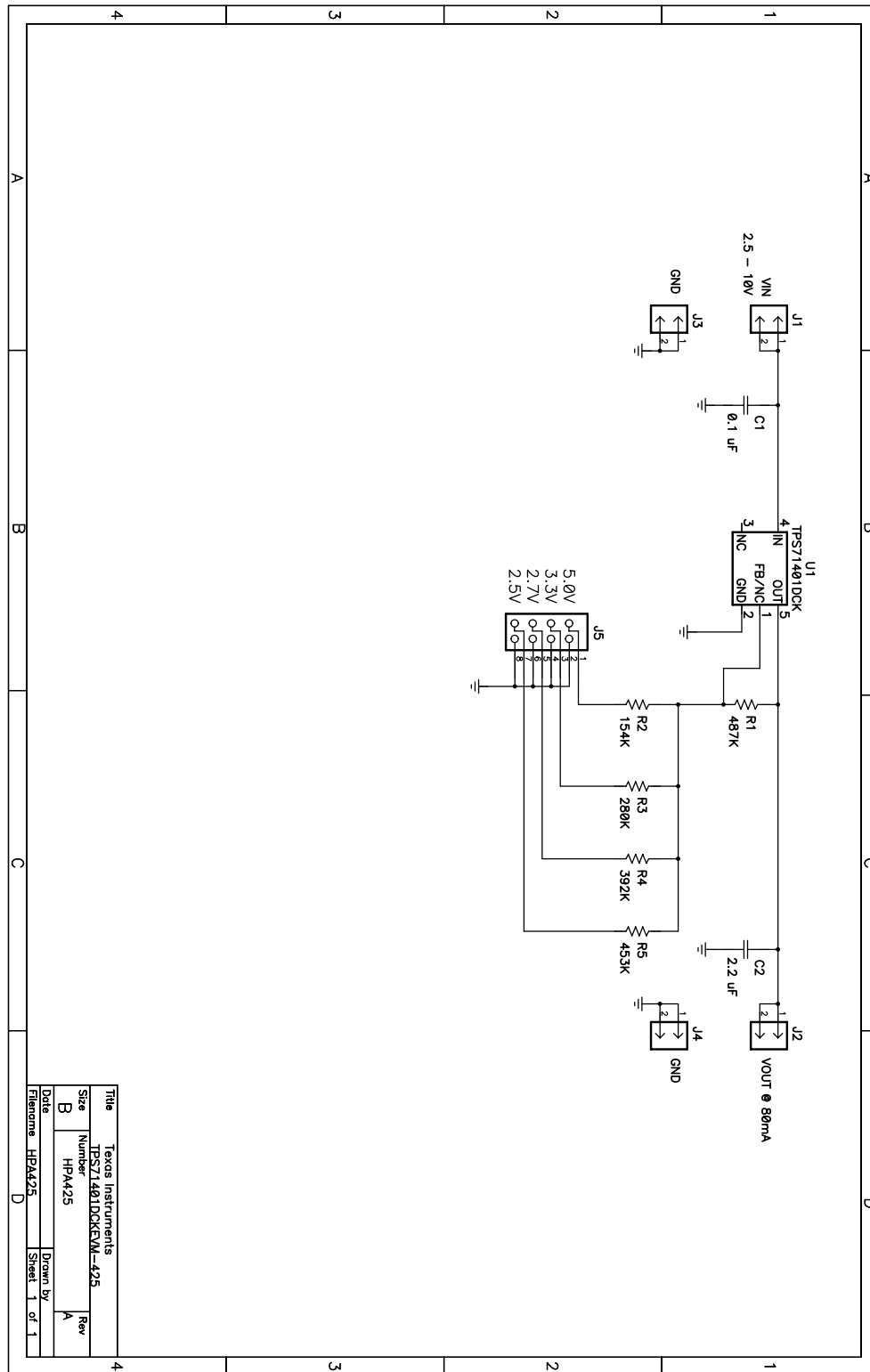


Figure 5. TPS71401DCKEVM-425 Schematic

**Table 4. TPS71401DCKEVM-425 Bill of Materials<sup>(1)(2)(3)</sup>**

Count	RefDes <sup>(4)</sup>	Value	Description	Size	Part Number	Mfr
1	C1	0.1 $\mu$ F	Capacitor, Ceramic, 0.1- $\mu$ F, 16-V, X7R, 10%	0603	STD	Any
1	C2	2.2 $\mu$ F	Capacitor, Ceramic, 2.2- $\mu$ F, 10-V, X7R, 10%	0603	STD	Any
4	J1, J2, J3, J4	PTC36SAAN	Header, 2-pin, 100-mil spacing	0.100 x 2	PTC36SAAN	Sullins
1	J5	PTC36DAAN	Header, Male 2x4-pin, 100-mil spacing	0.20 x 0.40 in	PTC36DAAN	Sullins
1	N/A	N/A	PCB, 1.5 In x 1.2 In x 0.062 In	—	HPA425	Any
1	R1	487k	Resistor, Chip, 1.00M $\Omega$ 1/16-W, 1%	0603	STD	Any
1	R2	154k	Resistor, Chip, 1/16W, 5%	0603	STD	Any
1	R3	280k	Resistor, Chip, 1/16W, 5%	0603	STD	Any
1	R4	392k	Resistor, Chip, 1/16W, 5%	0603	STD	Any
1	R5	453k	Resistor, Chip, 1/16W, 5%	0603	STD	Any
1	U1	TPS71401DCK	IC, 80mA, 10V, Quiescent Current 3.2 $\mu$ A LDO Linear Regulator	SC70	TPS71401DCK	TI
1	—	—	100 mil 2 Pin Shunt	0.100 x 2	929957-08	3M

- (1) These assemblies are ESD sensitive. ESD precautions shall be observed.
- (2) These assemblies must be clean and free from flux and all contaminants. Use of no-clean flux is not acceptable.
- (3) These assemblies must comply with workmanship standards IPC-A-610 Class 2.
- (4) Components can be substituted with equivalent manufacturer components.

## EVALUATION BOARD/KIT IMPORTANT NOTICE

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

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/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. 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 User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please contact the TI application engineer or visit [www.ti.com/esh](http://www.ti.com/esh).

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.

### FCC Warning

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

### EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 2.5 V to 10 V and the output voltage range of 1.2 V to 8.8 V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input 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 +85°C. The EVM is designed to operate properly with certain components above +85°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  
Copyright © 2009, Texas Instruments Incorporated

## 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 TI 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. Information of third parties may be subject to additional restrictions.

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.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

### Products

Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
RF/IF and ZigBee® Solutions	<a href="http://www.ti.com/lprf">www.ti.com/lprf</a>

### Applications

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Broadband	<a href="http://www.ti.com/broadband">www.ti.com/broadband</a>
Digital Control	<a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Military	<a href="http://www.ti.com/military">www.ti.com/military</a>
Optical Networking	<a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Telephony	<a href="http://www.ti.com/telephony">www.ti.com/telephony</a>
Video & Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>
Wireless	<a href="http://www.ti.com/wireless">www.ti.com/wireless</a>

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2009, Texas Instruments Incorporated