

## **TPS62351EVM**

This User's Guide describes the characteristics, operation, and use of the TPS62351EVM-122 Evaluation Module (EVM). This EVM demonstrates the Texas Instruments TPS62351 800 mA, 3 MHz, synchronous, step down converter with I<sup>2</sup>C™ interface. This User's Guide includes setup instructions, a schematic diagram, a bill of materials (BOM), and PCB layout drawings for the evaluation module.

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## 1 Introduction

### 1.1 Requirements

To operate this EVM properly, the user must connect and properly configure the following components.

A computer with a USB port is required to operate this EVM. The TPS62351 interface software runs on the PC and communicates with the EVM via the PC's USB port. The user can send commands to the internal registers of the TPS62351 through the USB port.

#### 1.1.1 Personal Computer Requirements

- Windows2000™ or WindowsXP™ operating System
- USB port
- Minimum of 30 MB of free hard disk space (100 MB recommended)
- Minimum of 256 MB of RAM

#### 1.1.2 Printed circuit board assembly

The TPS62351EVM-122 PCB contains the TPS62351 IC and its required external components. This board contains several jumpers and connectors that enable the user to customize the board for specific operating conditions.

#### 1.1.3 USB Interface Adapter

The USB Interface Adapter is the link that allows the PC and the EVM to communicate. One end of the USB Interface Adapter connects to the PC with the supplied USB cable; the other side of the USB Interface Adapter connects to the EVM with the supplied ribbon cable.

When writing a command to the EVM, the interface program running on the PC sends the commands to the PC USB port. The USB Interface Adapter receives the USB command, converts the signal to an I<sup>2</sup>C™ protocol, and sends the I<sup>2</sup>C™ signal to the TPS62351 EVM board.

#### 1.1.4 Software

Texas Instruments has provided software to assist the user in evaluating this EVM. The software can be installed from the supplied CD or downloaded from the web at [www.ti.com](http://www.ti.com).

## 2 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, setup, and use the TPS62351EVM-122.

### 2.1 Input/Output Connector Descriptions

#### 2.1.1 J1 –VIN Converter 1

This is the positive input supply voltage to converter 1. The leads to the input supply should be twisted and kept as short as possible to minimize EMI transmission.

#### 2.1.2 J2 – GND Converter 1

This is the return connection for the input power supply of converter 1.

#### 2.1.3 J3 – I<sup>2</sup>C™ Input Converter 1

This connector is the I<sup>2</sup>C™ input for converter 1.

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#### 2.1.4 J4 –VIN Converter 2

This is the positive input supply voltage to converter 2. The leads to the input supply should be twisted, and kept as short as possible to minimize EMI transmission.

#### 2.1.5 J5 – GND Converter 2

This is the return connection for the input power supply of converter 2.

#### 2.1.6 J6 – I<sup>2</sup>C™ Input Converter 2

This connector is the I<sup>2</sup>C™ input for converter 2.

#### 2.1.7 J7 – VOUT Converter 1

This is the positive connection for the output of converter 1. Connect this pin to the positive input of the load.

#### 2.1.8 J8 – GND Converter 1

This is the return connection for the output of converter 1.

#### 2.1.9 J9 –VOUT Converter 2

This is the positive connection for the output of converter 2. Connect this pin to the positive input of the load.

#### 2.1.10 J10 – GND Converter 2

This is the return connection for the output of converter 2.

#### 2.1.11 J11 – SYNC INPUT Converter 2

This connector is used to synchronize the switching of the TPS62351 to an external clock source. Pin 1 of J4 connects to the SYNC pin of the TPS62351 on converter 2. Pin 2 of J4 is connected to the ground of the TPS62351 on converter 2. The SYNC input has a 1-mΩ pull-down resistor installed on the EVM board.

#### 2.1.12 JP1 –SDA Converter 1

This jumper is used to tie the I<sup>2</sup>C™ SDA pin of the TPS62351 to either a 10-kΩ pull-up resistor to the input voltage or to short the SDA pin to ground. The shunt can be removed if the I<sup>2</sup>C™ master has its own pull up or operates from a voltage that is different than the input voltage of the TPS62351. The Texas Instruments USB Interface Adapter provides an active pull up so no jumper should be installed when using the adapter supplied with the EVM.

#### 2.1.13 JP2 – SDA Converter 2

This jumper is used to tie the I<sup>2</sup>C™ SDA pin of the TPS62351 to either a 10-kΩ pull-up resistor to the input voltage or to short the SDA pin to ground. The shunt can be removed if the I<sup>2</sup>C™ master has its own pull up or operates from a voltage that is different than the input voltage of the TPS62351. The Texas Instruments USB Interface Adapter provides an active pull up so no jumper should be installed when using the adapter supplied with the EVM.

**2.1.14 JP3 – SCL Converter 1**

This jumper is used to tie the I<sup>2</sup>C™ SCL pin of the TPS62351 to either a 10-kΩ pull-up resistor to the input voltage or to short SCL to ground. The shunt can be removed if the I<sup>2</sup>C™ master has its own pull up or operates from a voltage that is different than the input voltage of the TPS62351. The Texas Instruments USB Interface Adapter provides an active pull up so no jumper should be installed when using the adapter supplied with the EVM.

**2.1.15 JP4 – SCL Converter 2**

This jumper is used to tie the I<sup>2</sup>C™ SCL pin of the TPS62351 to either a 10-kΩ pull-up resistor to the input voltage or to short SCL to ground. The shunt can be removed if the I<sup>2</sup>C™ master has its own pull up or operates from a voltage that is different than the input voltage of the TPS62351. The Texas Instruments USB Interface Adapter provides an active pull up so no jumper should be installed when using the adapter supplied with the EVM.

**2.1.16 JP5 –ENABLE Converter 1**

This jumper enables or disables the converter. Connect the shorting jumper from the center ENABLE pin to either the ON or OFF position. This pin should never be left floating.

**2.1.17 JP6 –VSEL Converter 2**

This jumper is used to select the output voltage of the converter. Placing a shunt between pins 1 and 2 (HIGH and VSEL) sets the output voltage of the converter to the voltage defined by the internal VSEL1 register. Placing a shunt between pins 2 and 3 (VSEL and LOW) sets the output voltage of the converter to the voltage defined by the internal VSEL0 register.

**2.1.18 JP7 –VSEL Converter 1**

This jumper is used to select the output voltage of the converter. Placing a shunt between pins 1 and 2 (HIGH and VSEL) sets the output voltage of the converter to the voltage defined by the internal VSEL1 register. Placing a shunt between pins 2 and 3 (VSEL and LOW) sets the output voltage of the converter to the voltage defined by the internal VSEL0 register.

**2.1.19 JP8 – ENABLE Converter 2**

This jumper enables or disables the converter. Connect the shorting jumper from the center ENABLE pin to either the ON or OFF position. This pin should never be left floating.

**2.2 Software Setup**

If installing from a CD, insert the CD and run Setup.exe, follow all the prompts to allow the software to be installed.

If installing from the web, go to the following URL [www.ti.com](http://www.ti.com).

Note: this installation page is best viewed with Microsoft Internet Explorer browser (It may not work correctly with other browsers).

Click on the install button, the pc should give a security warning to the user, and ask if the user wants to install this application, select Install to proceed.

With both types of installation, the software attempts to install the Microsoft Dot Net Framework 2.0 (if it is not already installed) This framework is required for the software to run.

After installation the software should automatically run.

During future use of the software, it may prompt the user to install a new version if it becomes available on the web.

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Note: Verisign code signing is used to prevent any malicious code from changing this application. If at any time in the future the binaries are modified the code will no longer attempt to run.

### **2.3 Hardware Setup Converter 1 (upper board)**

Configure JP1, JP3, JP5 and JP7 using a shorting block. Jumpers JP1 and JP3 are used to connect the SDA and SCL lines of the I<sup>2</sup>C™ interface to a pull-up resistor to the input voltage. The USB Interface Adapter supplied with the EVM has its own internal pull-up resistors. Jumpers JP1 and JP3 should be left open with no jumper installed when using the USB Interface Adapter supplied with the EVM.

Configure the jumper on JP7 to the desired setting. Shorting between VSEL and HIGH (pin 1 and 2) makes the TPS62351 power up with the output voltage set by the VSEL1 register. Shorting between VSEL and LOW (pin 2 and 3) makes the TPS62351 power up with the output voltage set by the VSEL0 register.

Configure JP5 as desired. Shorting between EN and ON (pin 1 and 2) enables the TPS62351. Shorting between EN and OFF (pin 2 and 3) disables the TPS62351. The EN pin must be tied high (enabled) in order to establish communications with the IC via the I<sup>2</sup>C™ interface. The TPS62351 powers up with the device disabled no matter how JP5 is set. The software must enable the TPS62350 in order to produce a voltage at the output.

### **2.4 Hardware Setup Converter 2 (lower board)**

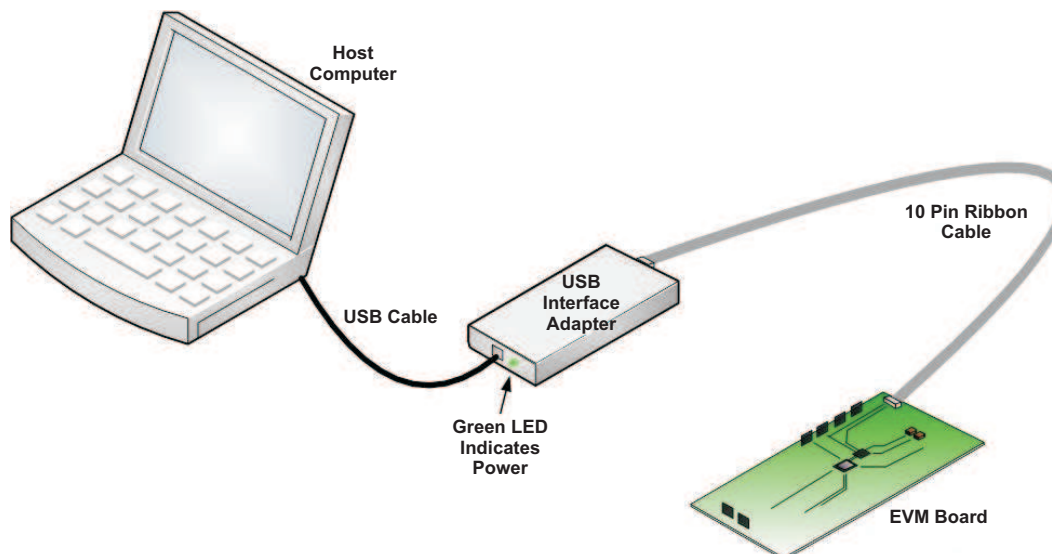
Configure JP2, JP4, JP6 and JP8 using a shorting block. These jumpers are used to connect the SDA and SCL lines of the I<sup>2</sup>C™ interface to a pull-up resistor to the input voltage. The USB Interface Adapter supplied with the EVM has its own internal pull-up resistors so no additional pull-up is required. No jumper is necessary if the Texas Instruments USB Interface Adapter is used to communicate with the TPS62351EVM board and JP2 and JP4 should be left open.

Configure the jumper on JP6 to the desired setting. Shorting between VSEL and HIGH (pin 1 and 2) makes the TPS62351 power up with the output voltage set by the VSEL1 register. Shorting between VSEL and LOW (pin 2 and 3) makes the TPS62351 power up with the output voltage set by the VSEL0 register.

Configure JP8 as desired. Shorting between EN and ON (pin 1 and 2) enables the TPS62351. Shorting between EN and OFF (pin 2 and 3) disables the TPS62351. The EN pin must be tied high (enabled) in order to establish communications with the IC via the I<sup>2</sup>C™ interface. The TPS62351 powers up with the device disabled no matter how JP8 is set. The software must enable the TPS62350 in order to produce a voltage at the output.

### **2.5 Hardware Setup Connection to Host Computer (upper or lower board)**

Connect the USB Interface Adapter to the host computer using the supplied USB cable. Connect the desired converter on the TPS62351EVM board to the USB Interface Adapter using the supplied 10 pin ribbon cable. The connectors on the ribbon cable are keyed to prevent incorrect installation.



**Figure 1. Quick Connection Diagram USB Interface Adapter**

Connect an input voltage supply to the TPS62351EVM board. The TPS62351 uses an input voltage between 2.7 V and 5.5 V. Connect the positive input voltage to J1 for converter 1 or J4 for converter 2. Connect the input voltage return (ground) connection to J2 for converter 1 or J5 for converter 2.

### 3 Operation

This section provides descriptions of the EVM Software.

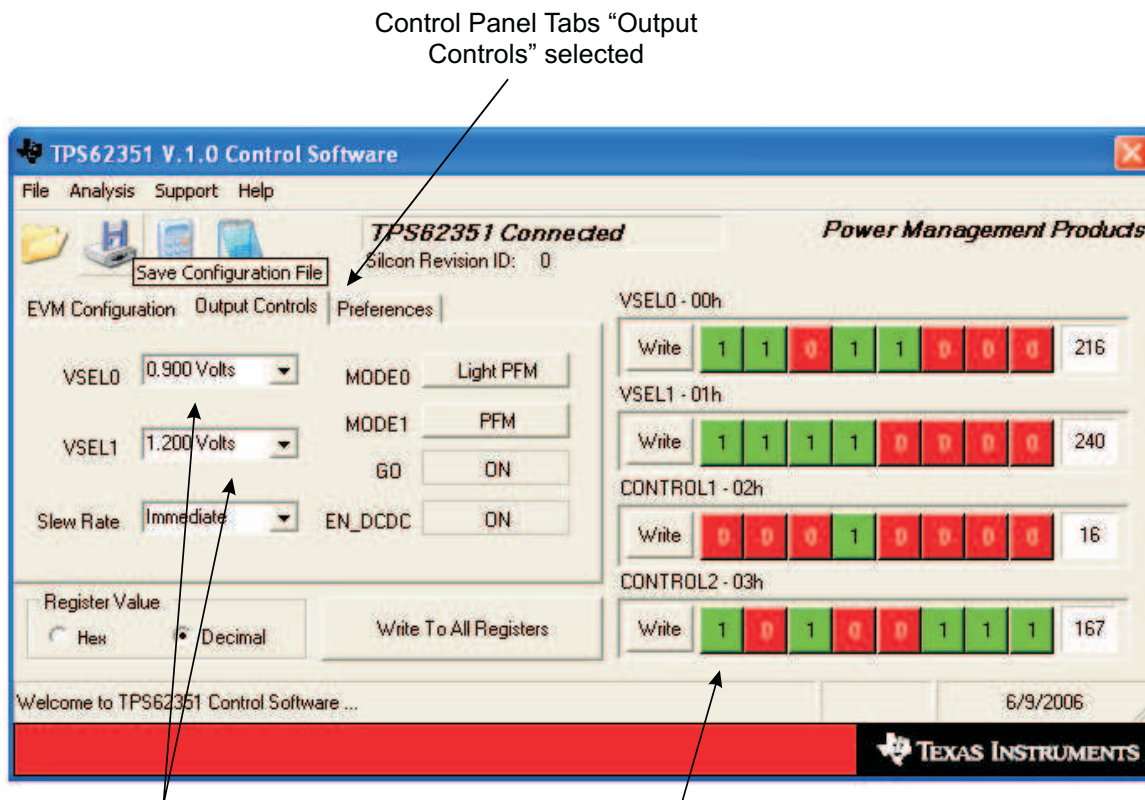
#### 3.1 Operation

The supplied software is used to communicate with the TPS62351 EVM. Click on the icon on the host computer to start the software. If there is no icon on the host computer then use the *start* button in the lower left hand corner of the screen to browse the program folders to find the software. Once started, the software will ask which version of the IC is on the board. Check the *TPS62351* box and click the *continue* box. The software displays the main control panel for the user interface. When initialized, the host computer software automatically searches the internet (if connected) for updates. If a new update is available, the software will notify the user of the update, and downloads the update.

The main control panel for the user interface has three main page tabs, *EVM Configuration*, *Output Controls* and *Preferences*. The software will initialize with the *EVM Configuration* tab selected. This page can be used to set register values that correspond to the hardware configuration of the EVM. The EVM can be operated with the default values.

[Figure 2](#) shows the user interface with the *Output Control* tab selected. The TPS62351 powers up with the output disabled no matter how ENABLE jumper is configured. The ENABLE jumper must be set to ENABLED in order for the TPS62351EVM software to communicate with the IC. Once the ENABLE jumper is set to ENABLE, the software can be used to turn on the output of the converter. Push the *EN\_DCDC* button on the *Output Control* tab to turn the output of the converter on.

The *Output Control* tab is used to change the output voltage of the TPS62351 via the register settings. The page has two pull down boxes, one for VSEL0 and one for VSEL1, with the available output voltage. The voltages listed in the boxes assume PWM mode of operation, so the actual output voltage of the EVM varies from the listed values at light loads.



Control Panel Tabs "Output Controls" selected

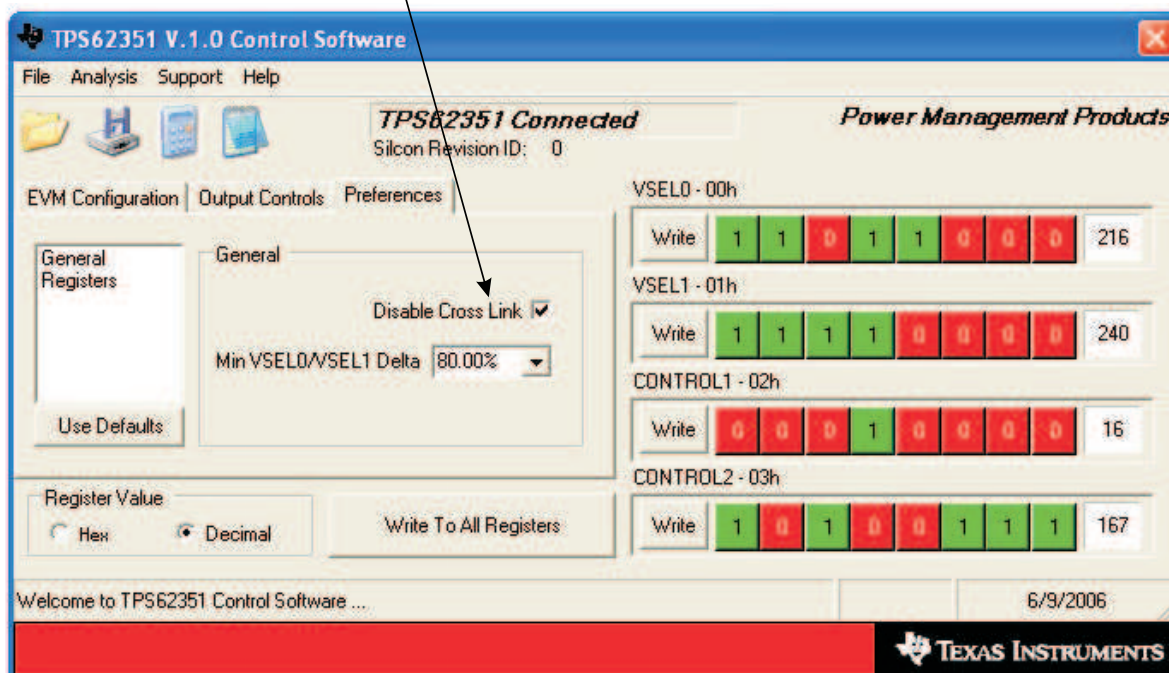
Output Voltage Selection Pull Down Boxes

TPS62350 Internal Register Values. Can be altered bit by bit if desired. Will update register when "Write" button is pushed.

**Figure 2. Output Controls Tab**

Figure 3 shows the page of the *Preference* tab. The *Preferences* page is used to change the look of the user interface such as the text color or the color of the boxes used to display a logic one or zero in the register displays. The preference page also provides an option for cross linking the values in the VSELO and VSEL1 registers within a selectable percentage. The default is no cross linking. If cross linking is enabled then the difference between VSELO and VSEL1 cannot exceed the selected percentage. This feature provides a method to limit the ratio of voltages that can be selected. This can be used to avoid inadvertently selecting output voltages, in the output voltage pull down boxes, that are too high for the application being tested.

Cross Link enable and delta selection



**Figure 3. Preferences Tab**

All three tabs show the bit representation of all four internal registers of the TPS62351. These bits can be individually altered by clicking on them. Clicking on a bit does not immediately change the register value of the IC. The *Write* button must be pushed to update the register with the newly selected bit values. Each register display has its own *Write* button that will only update the register that is displayed next to it. The *Write To All Registers* button will update all four registers with one push.



## 4 Test Results

This section provides typical performance waveforms for the TPS62351EVM-122 board.

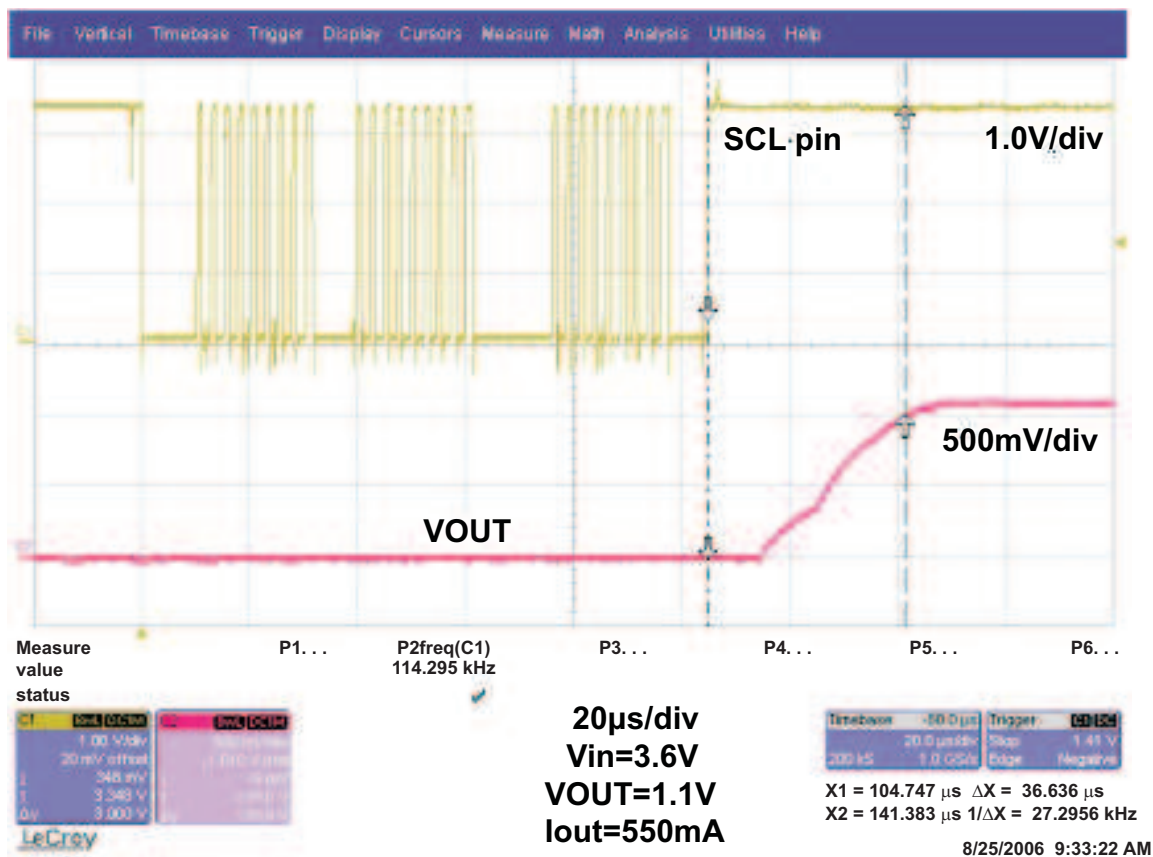


Figure 4. Start Up From Software Enable

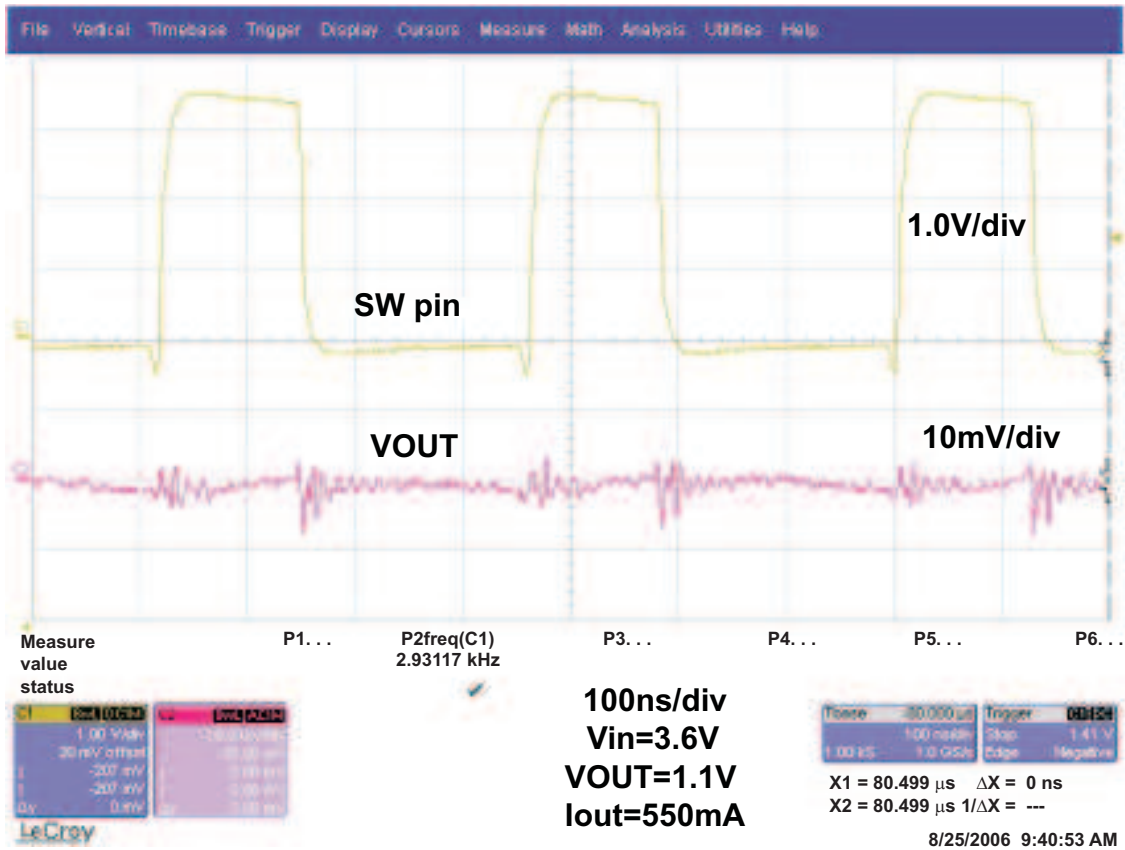


Figure 5. Output Ripple

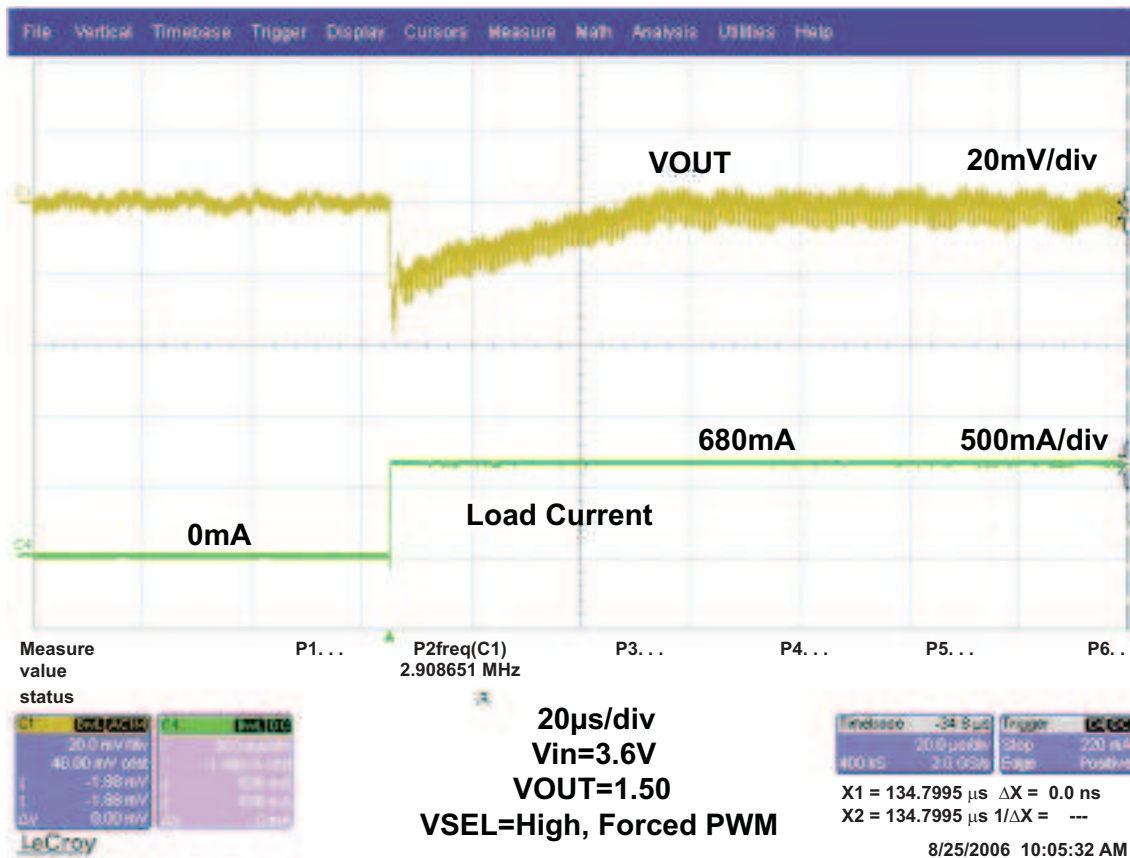


Figure 6. Load Transient, 0 mA to 680 mA Step

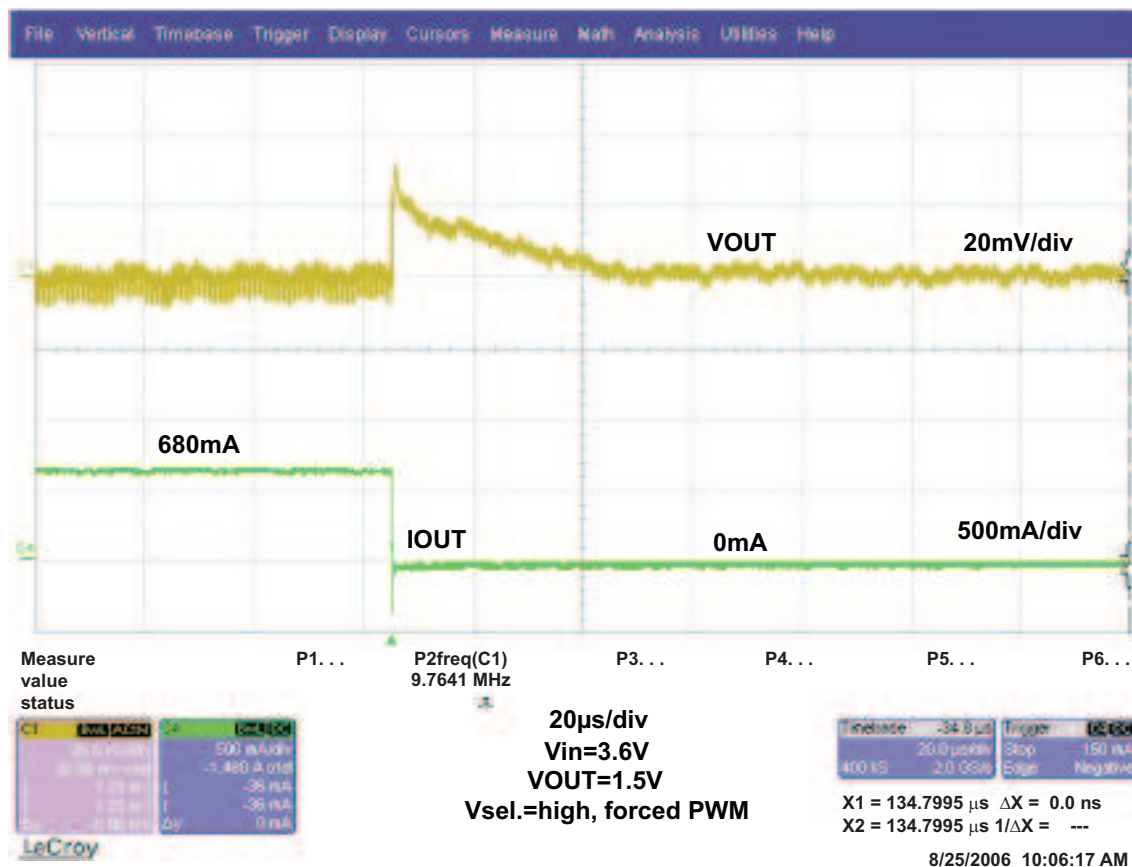


Figure 7. Load Transient, 680 mA to 0 mA Step

## 5 Board Layout

This section provides the TPS62351EVM-122 board layout and illustrations.

### 5.1 Layout

Board layout is critical for all high frequency switch mode power supplies. Figure 8 through Figure 11 show the board layout for the TPS62351EVM-122 PWB. The nodes with high switching frequencies and currents are kept as short as possible to minimize trace inductance. Careful attention has been given to the routing of high frequency current loops and a single point grounding scheme is used. See the data sheet for the specific layout guidelines.

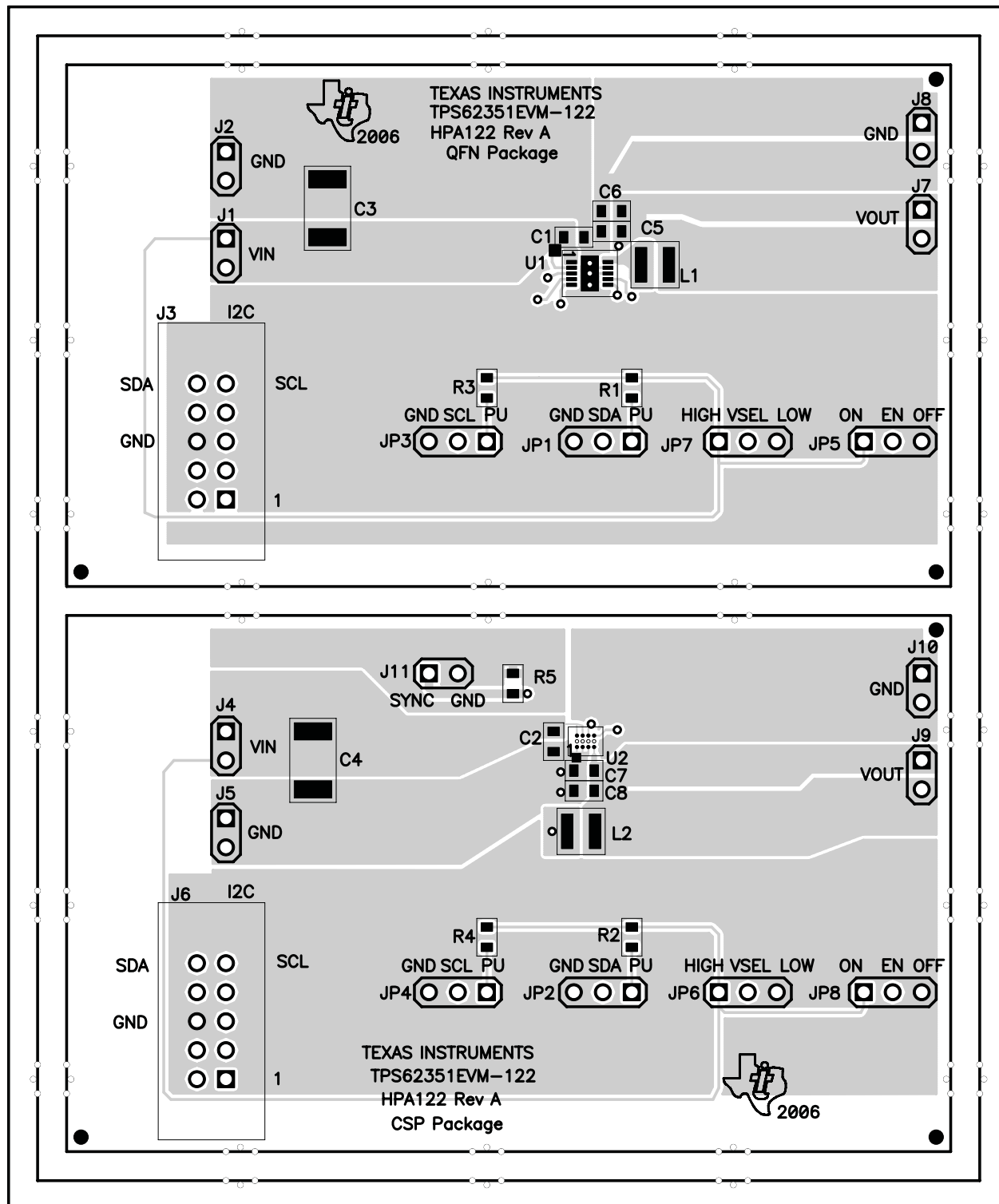


Figure 8. Assembly Layer

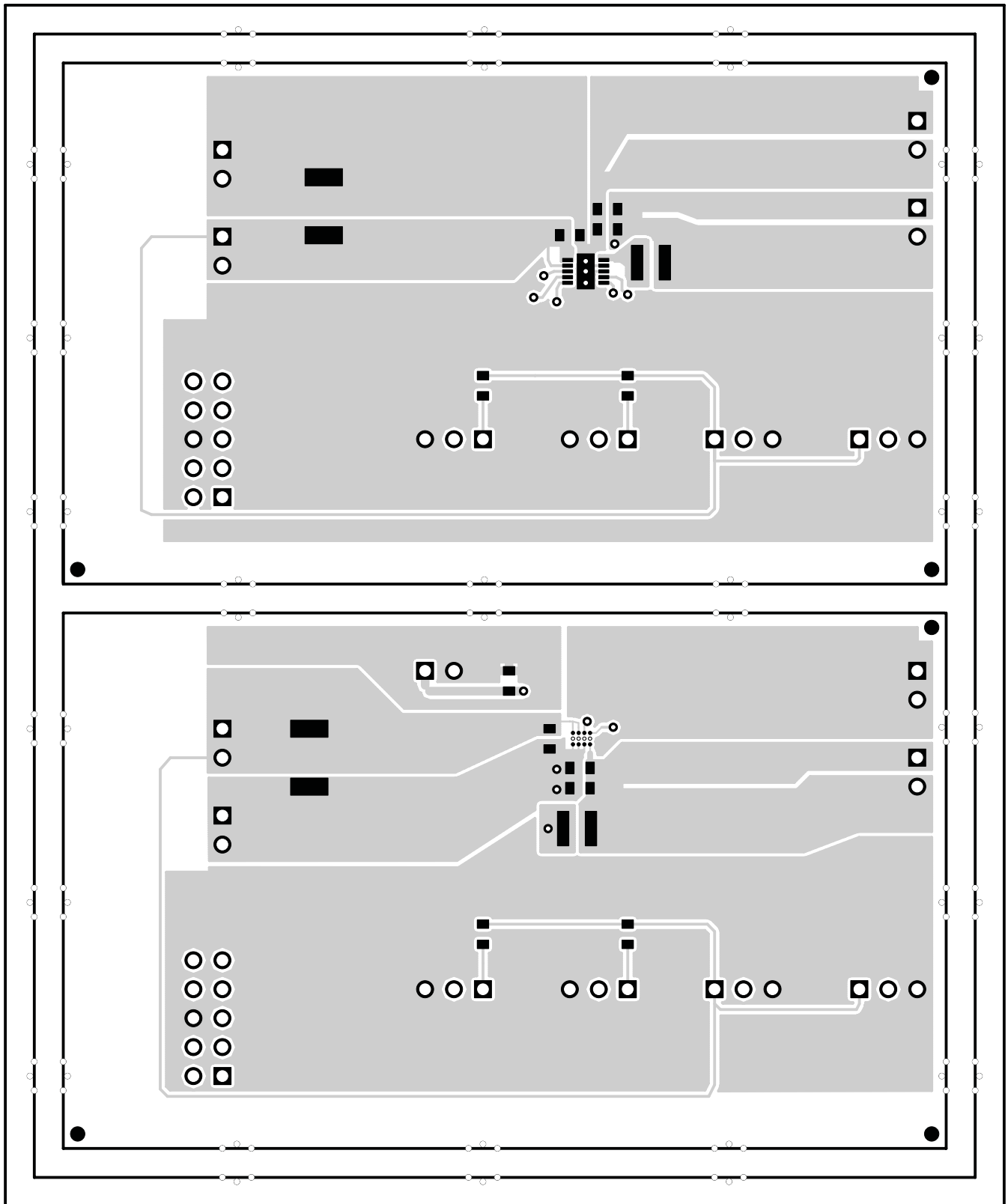


Figure 9. Top Layer Routing

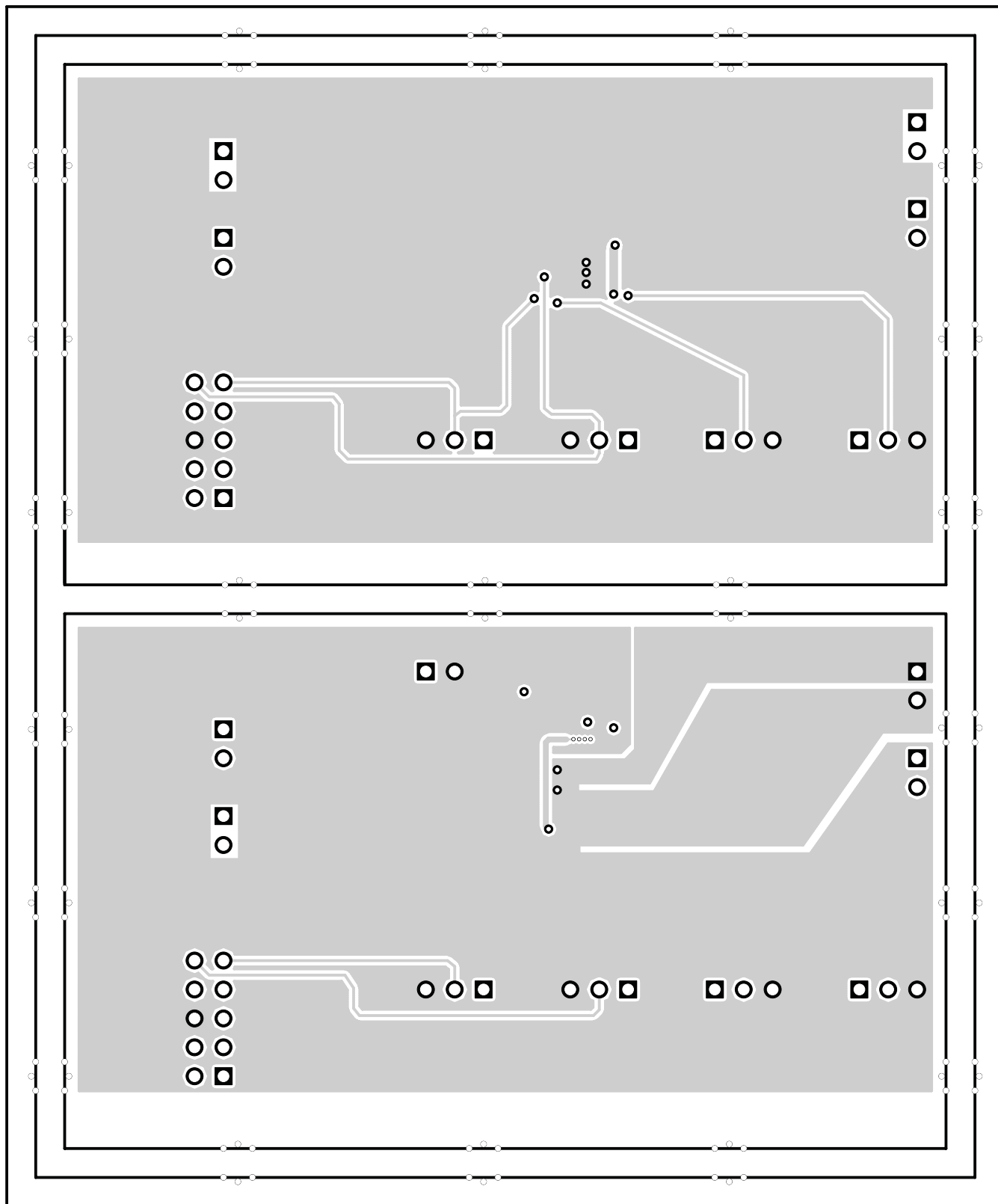


Figure 10. Bottom Layer Routing

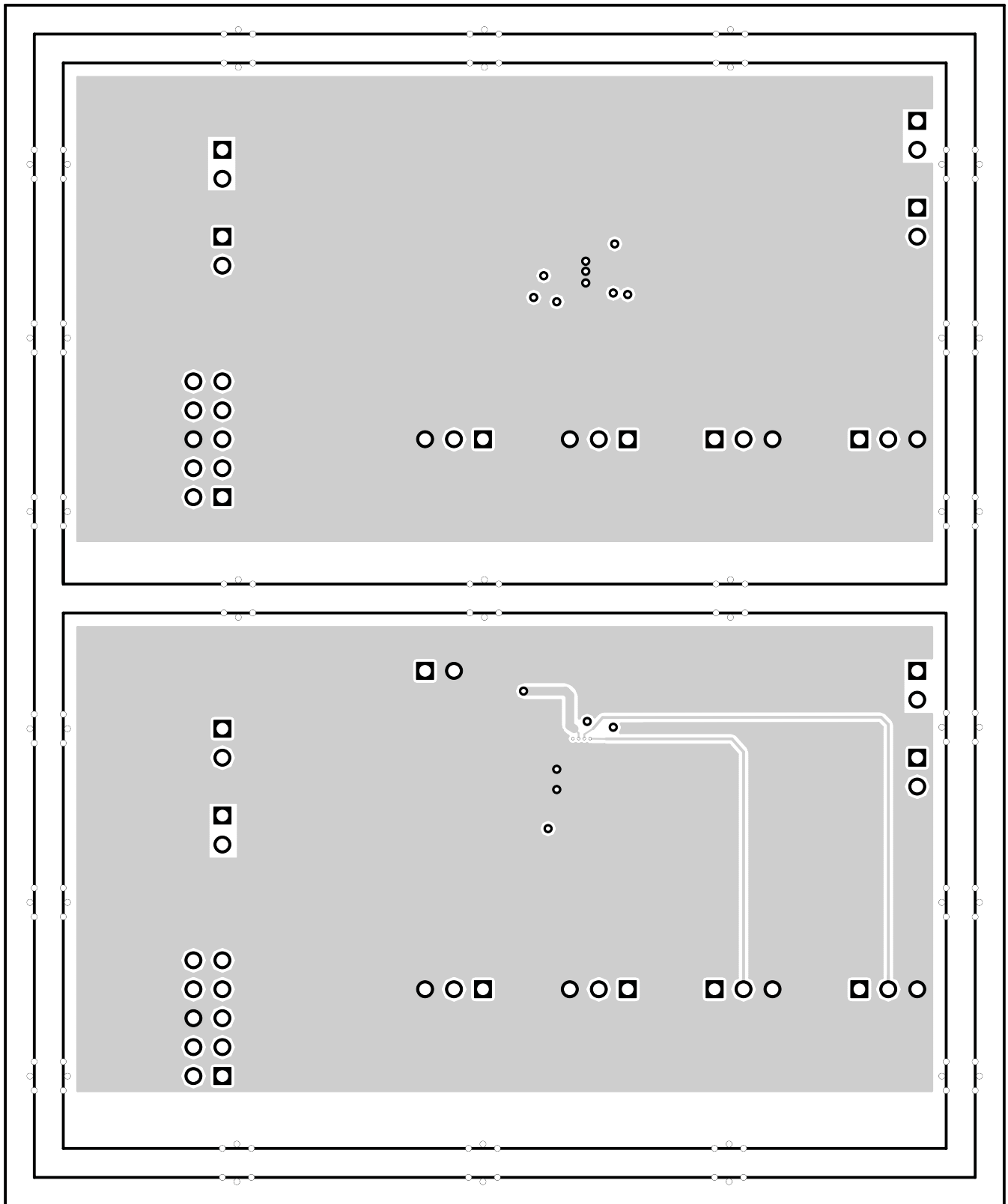


Figure 11. Layer 2 Routing



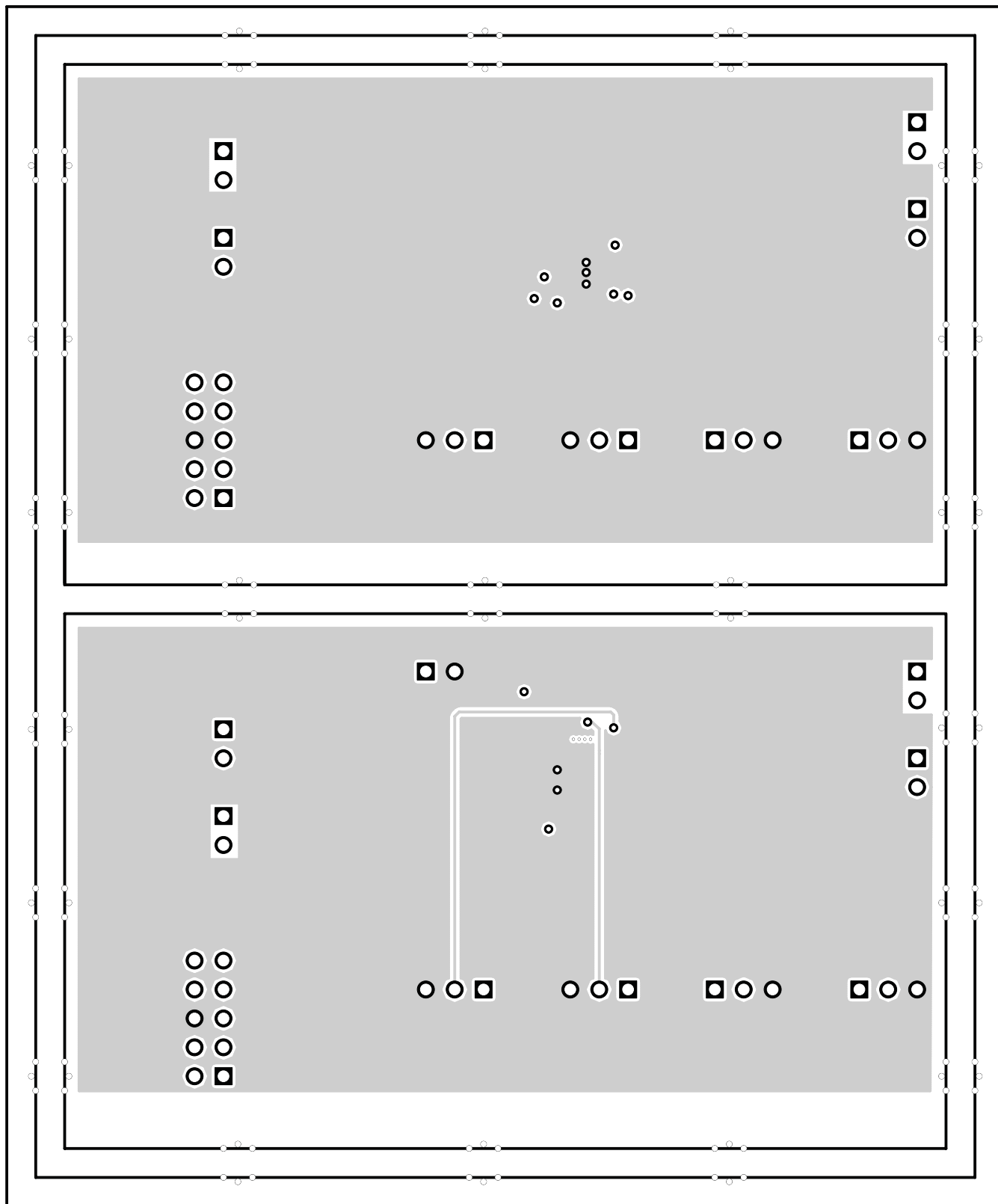


Figure 12. Layer 3 Routing

## 6 Schematic and Bill of Materials

This section provides the TPS62351EVM-122 schematic and bill of materials.

### 6.1 Schematic

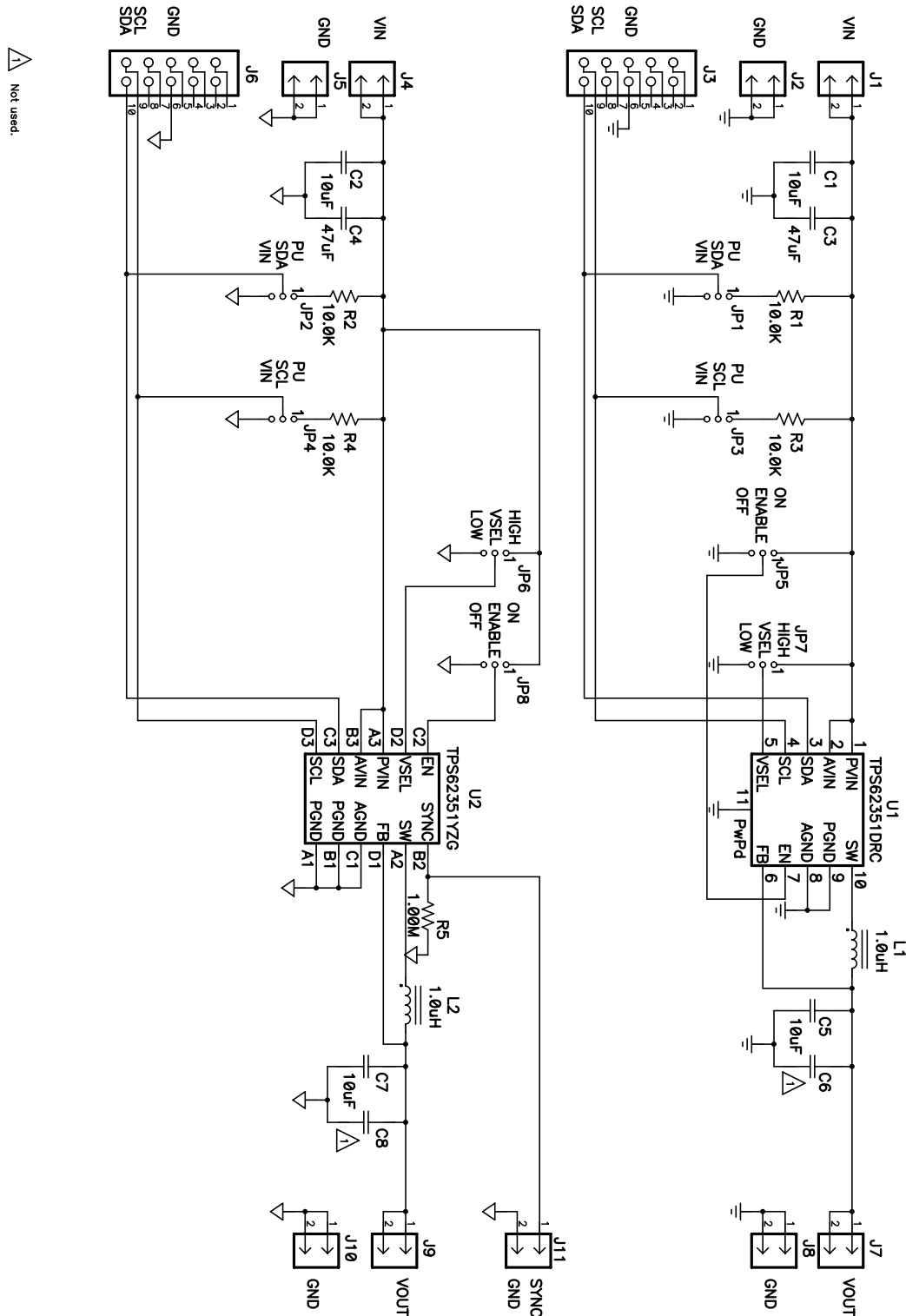


Figure 13. TPS62351EVM-122 Schematic

## 6.2 Bill of Materials

**Table 1. HPA122A BOM**

COUNT	RefDes	Value	Description	Size	Part Number	MFR
4	C1, C2, C5, C7	10uF	Capacitor, Ceramic, 6.3V, XR5, 10%	0603	C1608X5R0J106KT	TDK
2	C3, C4	47uF	Capacitor, Ceramic, 10V, XR5, 20%	1812	C4532X5R1A476M	TDK
0	C6, C8	Open	Capacitor, Ceramic, vvV	0603		
9	J1, J2, J4, J5, J7 - J11		Header, 2 pin, 100mil spacing, (36-pin strip)	0.100 x 2	PTC36SAAN	Sullins
2	J3, J6		Connector, Male Straight 2x10 pin, 100mil spacing, 4 Wall	0.338 x 0.788	2510-6002UB	3M
8	JP1 - JP8		Header, 3 pin, 100mil spacing, (36-pin strip)	0.100 x 3	PTC36SAAN	Sullins
2	L1, L2	1.0uH	Inductor, SMT, 1.6A, ±30%	0.118 x 0.118	LPS3010-102NLC	Coilcraft
4	R1 - R4	10.0k	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	R5	1.00M	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	U1		IC, 3MHz Synchronous Step Down Converter with I <sup>2</sup> C 800mA	QFN-10	TPS62351DRC	TI
1	U2		IC, 3MHz Synchronous Step Down Converter with I <sup>2</sup> C 800mA	QFN-12	TPS62351YZG	TI
1	--		PCB, 4.15 In x 3.45 In x 0.062 In		HPA122	Any
8	--		Shunt, 100 mil, Black	0.100	929950-00	3M

## 6.3 Related Documentation From Texas Instruments

TPS62351 data sheet ([SLVS540](#))

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### EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 2.7 V to 5.5 V and the output voltage range of 0.9 V to 1.6875 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.

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