TLC5946EVM-274

This user's guide describes the characteristics, setup, and use of the TLC5946EVM-274 Evaluation Module (EVM). This EVM helps the user evaluate the features of the Texas Instruments TLC5946, which is a 16-channel, constant-current LED driver. This user's guide includes setup instructions, a schematic diagram, a bill of materials, printed-circuit board layout drawings, and software instructions.

Contents

List of Figures

List of Tables

1 Introduction

The Texas Instruments TLC5946 is a 16-channel, constant-current LED driver that is capable of driving up to 40 mA per channel. The TLC5944 has several features including 6-bit dot correction, 12-bit grayscale PWM dimming, LED failure, and overtemperature detection. For more information on PWM dimming, see the TLC5946 data sheet (SLVS824), a dot correction technical paper (SLYT225), and a PWM dimming technical paper (SLYT238) on the TI Web site. This EVM contains three TLC5946 integrated circuits (IC) connected in series. The three ICs drive 16 light-emitting diodes (LED), each having a red, green, and blue LED in the same package.

1.1 Requirements

In order to operate this EVM, the following components must be connected and properly configured. All components, software, and connectors are supplied in the EVM except for the host computer and the dc power supply

1.1.1 Software

Texas Instruments provides a compact disk (CD) in the EVM kit that contains the software necessary to evaluate the TLC5946EVM. Check the TLC5946 product folder on the TI Web site (www.ti.com) for updates to the software.

1.1.2 Host Computer

A computer with a USB port is required to operate this EVM. The TLC5946 software runs on the personal computer (PC) and communicates with the EVM via the PC's USB port.

PC Requirements:

- Windows™ 2000 or Windows XP operating system
- USB port
- Minimum of 30 MB of free hard disk space (100 MB recommended)
- Minimum of 256 MB of RAM

1.1.3 Power Supply Requirements

A dc power supply capable of delivering 5 V at 1 A is required to power the EVM.

1.1.4 Printed-Circuit Board Assemblies

The TLC5946EVM-274 EVM kit contains three printed-circuit boards: HPA274 (Driver board), HPA249 (LED board), and TMDSCNCD2808 (DSP board). The Driver board contains the TLC5946 ICs and their required external components. This board contains several jumpers and connectors that enable you to customize the board for specific operating conditions. The LED board contains 16 LEDs, each with three individual LEDs in the same package: a red, a green, and a blue LED. The orderable Texas Instruments part number for this PCB is RGBLEDEVM-249. The EVM is designed to directly drive the LED board. The customer may also remove the LED board to drive a custom LED board. The DSP board contains a TMS320F2808 microcontroller that programs and controls the three TLC5946 ICs on the Driver board. The DSP board's orderable part number is TMDSCNCD2808. Figure 1 shows how these boards are connected.

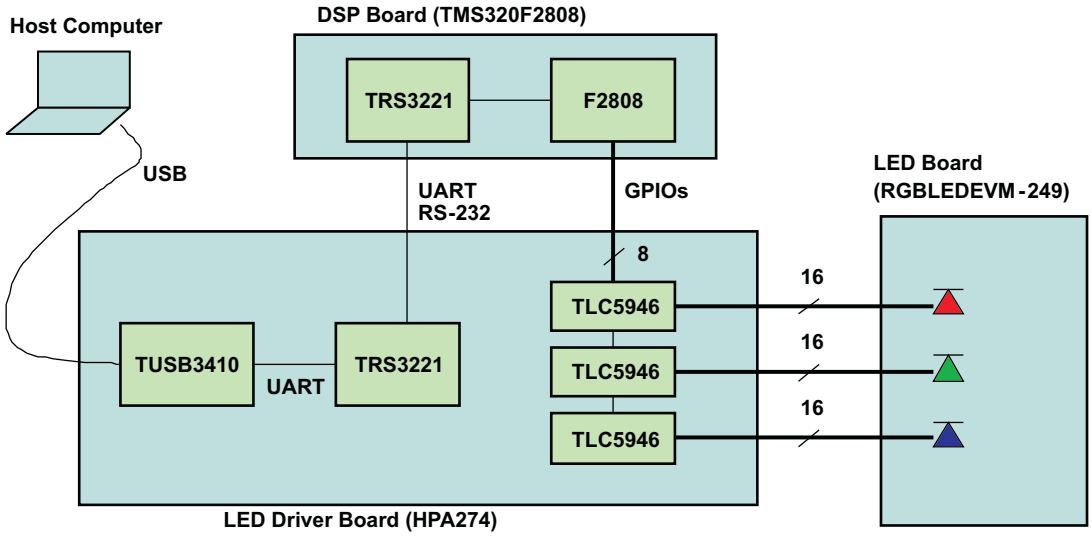


Figure 1. Board Connections

The user's computer connects to the LED Driver board with a USB cable and communicates with a TUSB3410 using a TI proprietary protocol. The LED Driver board requires a Texas Instruments TRS3221 to communicate with the DSP board because the DSP board is an existing plug-in DSP module with an RS-232 interface bus. The 'F2808 DSP decodes the information from the LED Driver board and converts it into a form required by the TLC5946 ICs. The TLC5946s drive the LEDs, which are located on the LED board.

1.2 Related Documentation From Texas Instruments

1. *TLC5946, 16-Channel, 12-Bit PWM LED Driver With 6-Bit Dot Correction* data sheet (SLVS824)
2. TLC594x software (SLVC186)
3. TMDSCNCD2808 DSP controlCARD™ documents (SPRR101)

2 Setup

This section describes the jumpers and connectors on the EVM as well as how to properly connect, set up, and use the TLC5946EVM-274.

2.1 Input/Output Connector Descriptions

2.1.1 J1 – USB Input Connector

This mini-USB connector connects the EVM directly to the host PC's USB port.

2.1.2 J2 – ZigBee™ Input Connector

This connector mates to the HPA249 LED board. The customer also can connect a custom board to this connector with a 30-pin ribbon cable. To minimize stray inductance and ringing on the output traces, make connections to this connector as short as possible. This connector allows the user to connect ZigBee devices such as the eZ430-RF2500. The user can write customized code to control the TLC5946EVM with a wireless ZigBee connection. J2 is not populated or used with the supplied EVM software.

2.1.3 J3 – RS-232 Input Connector

This connector allows the user to connect an RS-232 device. The user can write customized code to control the TLC5946EVM or to modify the DSP board's firmware. J3 is not populated or used with the supplied EVM software.

2.1.4 J4 – DSP Board Connector

The DSP board plugs into the J4 connector on the Driver board.

2.1.5 J5 – JTAG Input Connector

This connector can be used for JTAG communications to help debug user-generated software. J5 is not populated or used with the supplied EVM software.

2.1.6 J6 – VIN

This is the positive input supply to the EVM. The input voltage must be between 5 V and 17 V. To minimize power dissipation, the input voltage must be as low as possible. The leads to the input supply must be twisted and kept as short as possible to minimize EMI transmission.

2.1.7 J7 – Input Power Connector

This is a right-angle miniature power jack with a 3,5-mm diameter connection. The user can use this connector to supply input power to the EVM from an ac-to-dc plug-in adapter. The inner pin on the connector is connected directly to J6 (Vin). The outer pin on the connector is connected directly to J8 (GND). When using an ac-to-dc plug-in adapter, ensure that the plug-in adapter's output voltage is stable and does not drop below 5 V when loaded.

2.1.8 J8 – GND Connector

This connector is the return for the input supply to the EVM. The leads to the input supply must be twisted and kept as short as possible to minimize EMI transmission.

2.1.9 J9 – Communications Connector

This connector contains shorting shunts that connect the 'F2808 DSP to the TLC5946 LED drivers. The shunts are preconfigured to properly connect the DSP's GPIO control signals to the LED driver ICs. The GND pins on this connector do not need shorting shunts because these pins are connected to the ground plane of the PCB. The user can remove all shorting shunts to disconnect the 'F2808 from the TLC5946 ICs. This allows the user to connect control signals from a separate microprocessor to this connector to program the LED drivers. The XERR signal does not need a shorting jumper because the graphical user interface (GUI) software does not use this signal.

CAUTION

Do not drive the outputs of the TMS320F2808 on the DSP board with external control signals.

2.1.10 J10 – LED Connector

This connector mates to the HPA249 LED board. The user also can connect a custom board to this connector with a standard 30-pin ribbon cable with 0.1-inch, pin-to-pin spacing. In order to minimize stray inductance and ringing on the output traces, connections to this connector must be as short as possible.

2.1.11 J11 – LED Connector

This connector mates to the HPA249 LED board. The user also can connect a custom board to this connector with a standard 30-pin ribbon cable with 0.1-inch, pin-to-pin spacing. In order to minimize stray inductance and ringing on the output traces, connections to this connector must be as short as possible.

2.1.12 JP1 – Default 'F2808 Boot Location

When a short is connected between pins 1-2, the 'F2808 boots up from the USB port connector, J1. When a short is connected between pins 2-3, the 'F2808 boots up from its internal flash EEPROM. The default boot location is the 'F2808 internal EEPROM. Firmware updates to the EEPROM require changes to the JP1 settings. The GUI software provides detailed instructions on how to update the firmware. If the user configures the EVM to communicate through the RS-232 or Zigbee connector, short JP1 pins 1 and 2 together so that the DSP boots from the RS-232 or Zigbee connector.

2.1.13 JP2 – Red LED

This jumper must be shorted to connect the red LED driver's OUT15 pin to the red LED. This jumper can be opened to measure the current flowing into the OUT15 pin from the red LED.

2.1.14 JP3 – Green LED

This jumper must be shorted to connect the green LED driver's OUT15 pin to the green LED. This jumper can be opened to measure the current flowing into the OUT15 pin from the green LED.

2.1.15 JP4 – Blue LED

This jumper must be shorted to connect the blue LED driver's OUT15 pin to the blue LED. This jumper can be opened to measure the current flowing into the OUT15 pin from the blue LED.

2.1.16 S1 – Power Switch

This switch connects and disconnects input power from the EVM.

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 TI Web site, go to the following URL 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; your PC gives you a security warning and asks if you want 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 automatically runs.

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

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

Ensure that S1 is in the OFF position.

Ensure that the shorting shunt is installed on JP1. The default for normal EVM operation is to short pins 2 and 3 together.

Ensure that the shorting shunts are installed on JP2, JP3, and JP4.

Connect the LED board (HPA249) to the LED Driver board (HPA274).

Connect the DSP board (TMDSCNCD2808) to the LED Driver board (HPA274). Ensure that the DSP board is fully seated in J4 with the tabs positioned to lock the DSP board in place.

Connect the LED Driver board to the host computer using the supplied USB cable.

Using either the J6 and J8 input power connectors or the J7 power jack connector, connect an input voltage supply to the TLC5946EVM board. The TLC5946 requires an input voltage between 5 V and 17 V. The input supply must be capable of supplying at least 1.5 A. Note that some ac-to-dc plug-in adapters do not provide clean power. Ensure that the input voltage is well regulated to avoid intermittent communication problems.

CAUTION

Hot plugging the input supply with long leads can generate transients on the input supply bus that exceed the maximum ratings of the EVM. The input supply must be connected before it is turned on.

Turn on the input supply voltage.

Move S1 from OFF to ON.

The 16 LEDs now are displaying a default pattern.

3 Operation

This section provides instructions on how to turn on the TLC5946EVM and operate the software.

The user now can run the host computer software and change the LED programming with the easy-to-use graphical interface.

3.1 Running the Software

Click on the TLC594xEVM GUI icon on the host computer to start the software. If no icon appears on the host computer, then use the start button in the lower left corner of the screen to browse the program folders to find the software. The default directory for software installation is Program Files\Texas Instruments\TLC594xEVM GUI Application. The executable file name is TLC594x.exe. Once started, the software checks the firmware in the DSP board to ensure it is compatible with the software. If the firmware is not compatible, the software gives the user instructions on how to reprogram it. Once the software is started and communication is established between the GUI and the EVM, the user can use the graphical interface to program the LEDs. If the EVM is properly connected, the software screen looks like Figure 2 when first opened.

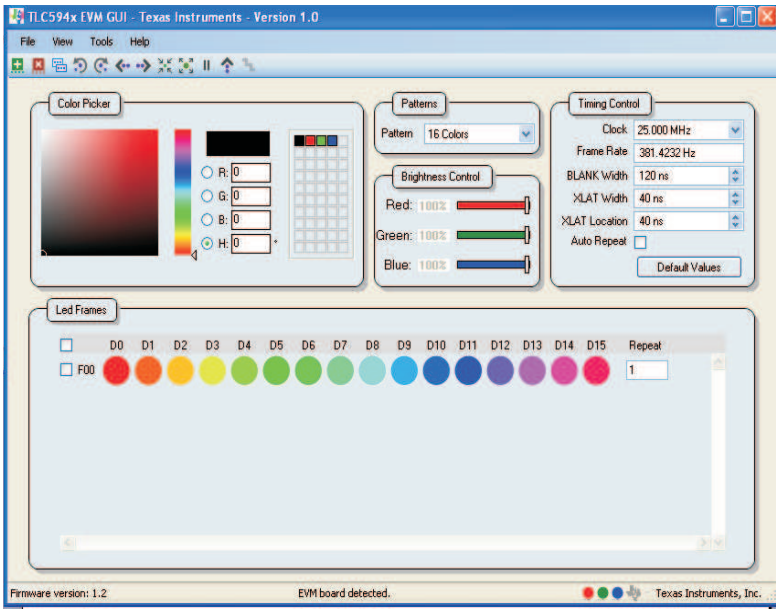


Figure 2. TLC5946EVM Software Start-Up Screen

3.2 Software Features

3.2.1 Color Picker

This window allows the user to choose the red, green, and blue PWM value for each LED. The software provides three options for choosing an LED's color. The user can manually enter the PWM values into the three text boxes, use the mouse to pick colors from the color bars, or use the mouse to click on a color from the custom color pallet. The color chosen in the Color Picker window is immediately displayed in the LEDs that are highlighted in the LED Frames window. The user can add custom colors to the pallet by dragging the current color to the custom color pallet. Custom colors can be deleted by right-clicking on the color to be removed. The TLC5946 is capable of displaying the full 2^{12}, or 4096 brightness levels per LED.

3.2.2 Patterns

This window provides the user with several preprogrammed LED frame patterns. Choosing a pattern immediately programs the LED Frames window with the pattern and then displays the pattern with the LEDs.

3.2.3 Global Brightness Control

This window allows the user to individually control the EVM's red, green, and blue global brightness values. Global Brightness data is only written to the EVM when one of the three values change.

3.2.4 Timing Control

The options in this window allow the user to modify the timing parameters of the signals written to the TLC5946 ICs. Note that all times and frequencies are approximate.

Clock: This drop-down menu allows the user to select the EVM's serial clock (SCLK) and grayscale (GSCLK) frequencies. The available clock frequencies are integral divisions of the 'F2808 clock frequency and cannot be modified.

Frame Rate: This shows the refresh rate for a single frame update. The Frame Rate is approximately 1/period, where period is the time to display all 2^{12} grayscale pulses at the chosen clock frequency plus the time the BLANK signal is high.

BLANK Width: This adjusts the width of the BLANK pulse.

XLAT Width: This adjusts the width of the XLAT pulse.

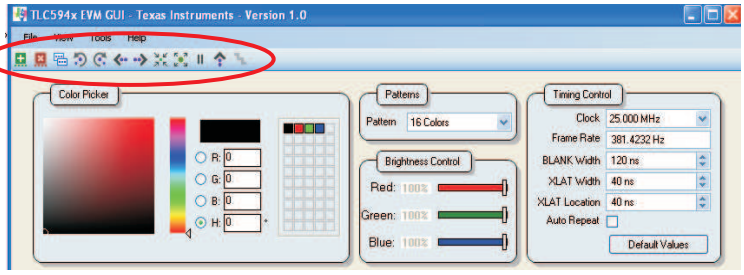
XLAT Location: This adjusts the rising edge of the XLAT pulse location. It is relative to the rising edge of the BLANK signal. A negative XLAT Location is shown when the XLAT signal rises before the BLANK signal.

Auto Repeat: This check box enables and disables the TLC5946's Auto Repeat function. Checking this box instructs the software to stop sending the BLANK signal. BLANK is held low during this time. Unchecking the box re-enables the BLANK signal. Note that the Auto Repeat function cannot be tested by removing the J9 jumper unless the BLANK line to the TLC5946 ICs is actively pulled low. If not pulled low, the BLANK signal may float high enough to be detected as a logic high, which turns all LEDs off.

Default Values: This box resets all Timing Controls to their default values.

3.2.5 LED Frames

The LED tool bar provides many easy-to-use functions to facilitate the EVM's evaluation. Each button has a pop-up description, which makes each function self-explanatory.



3.2.6 File – Save and Load

This tab allows the user to save and load custom frames. The file also saves all user-selectable settings such as operating frequency and Global Brightness settings.

3.2.7 View – Editing Radix

Changes the input format for the PWM Grayscale values in the Color Picker and Brightness Control Values between Hex, Percentage, and Absolute.

3.2.8 View – LED Display Mode

When Solid display mode is chosen, the pixel in the LED Frames window shows the LED pixels and their approximate color on the EVM. This color is generated by the mixing of the three individual LED colors. When RGB display mode is chosen, the pixel shows the relative intensity of each individual LED that makes up each pixel.

3.2.9 Tools – Update DSP Firmware

Clicking on this function provides step-by-step directions on how to update the EVM's DSP firmware.

3.2.10 Information Bar – EVM Status

The information bar displays whether or not the GUI detects the EVM hardware.

3.2.11 Information Bar – Firmware Version

This shows the user the DSP's firmware version.

3.2.12 Information Bar – Thermal Error Flag

The right side of the information bar displays three LED colors representing the thermal error flag for each TLC5946 on the EVM. In normal operation, the error flag is a solid color. When an IC detects an overtemperature condition, the colored circle turns into a burning IC. The EVM firmware latches the TLC5946 overtemperature signals to ensure that the GUI is able to read and display the error signals. The GUI can show an error condition for 2 seconds longer than the condition actually exists on the hardware.

3.3 Hardware Features

3.3.1 EVM Binary Identification Code

Resistors R16-R27 set a binary code that is read by the DSP at start-up. The DSP communicates this code to the GUI so that it knows what version of the EVM is connected and can load the proper software version.

3.3.2 RS-232 Communication Frequency

Resistors R28-R30 set a binary code that sets the default RS-232 communication frequency. Table 1 shows the available settings. The default frequency is 115.2 kbps. The user can change this setting for custom software and communication protocol development.

Table 1. Available Settings

Default Frequency	GPIO 10	GPIO 9
9.6 kbps	0	0
57.6 kbps	0	1
115.2 kbps	1	0
Not used	1	1

3.3.3 Impedance Matching Termination Network

Each control line contains an RC impedance matching termination network. These are shown in the lower right corner on page 4 of the schematic. These networks are not installed and are not needed when using the DSP board to drive the LED drivers. If the user drives the LED drivers from an external source, these components may need to be installed to provide proper impedance matching of the PCB traces and the external drive circuitry. Excessive ringing caused by impedance mismatch can be interpreted as low-to-high logic level changes, causing erratic EVM behavior.

4 Schematics, Board Layouts, and Bill of Materials

4.1 Schematics

Figure 3 through Figure 7 provides the schematics for the TLC5946EVM-274 and the RGBLEDEVM-249.

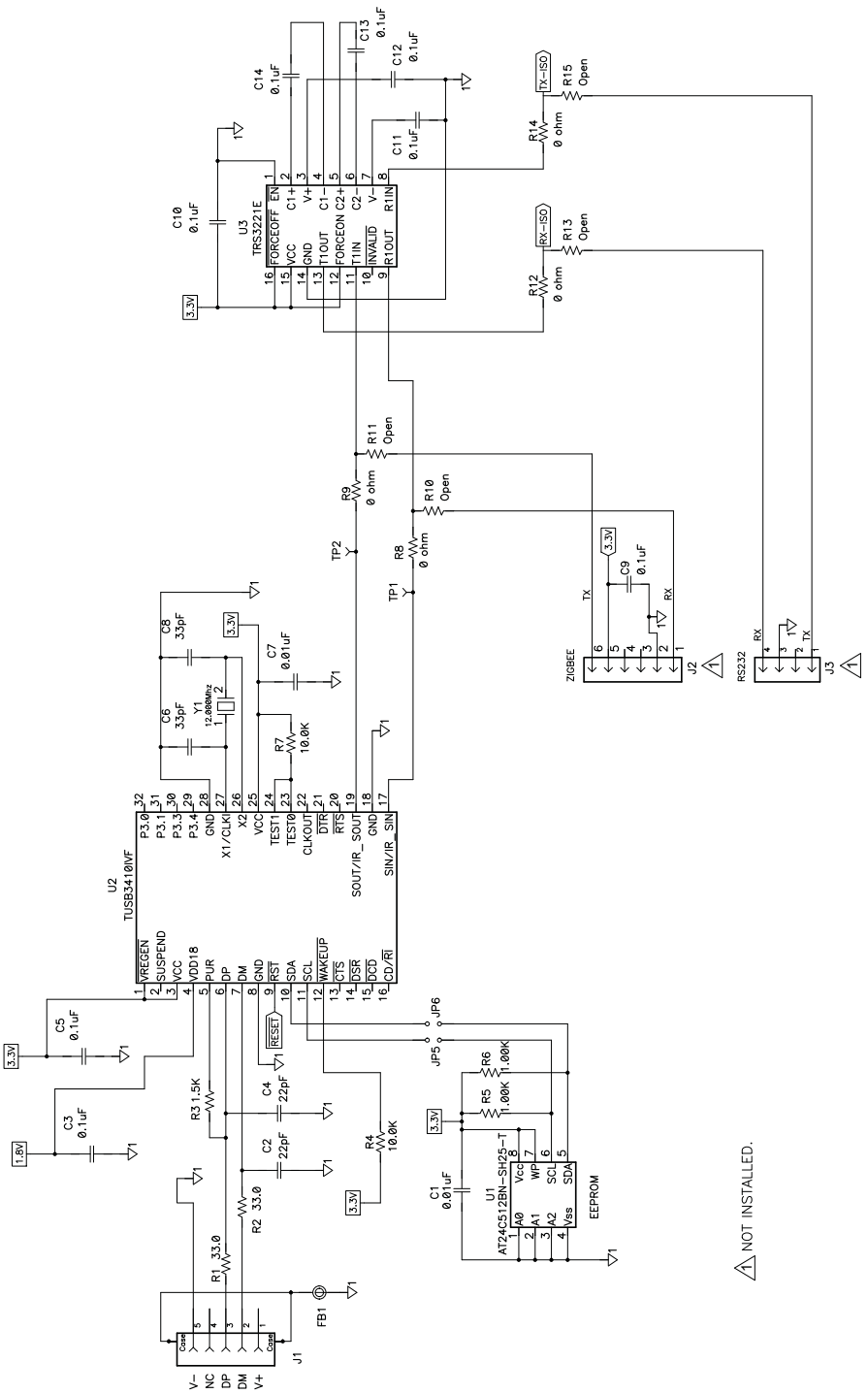


Figure 3. HPA274 - Schematic 1

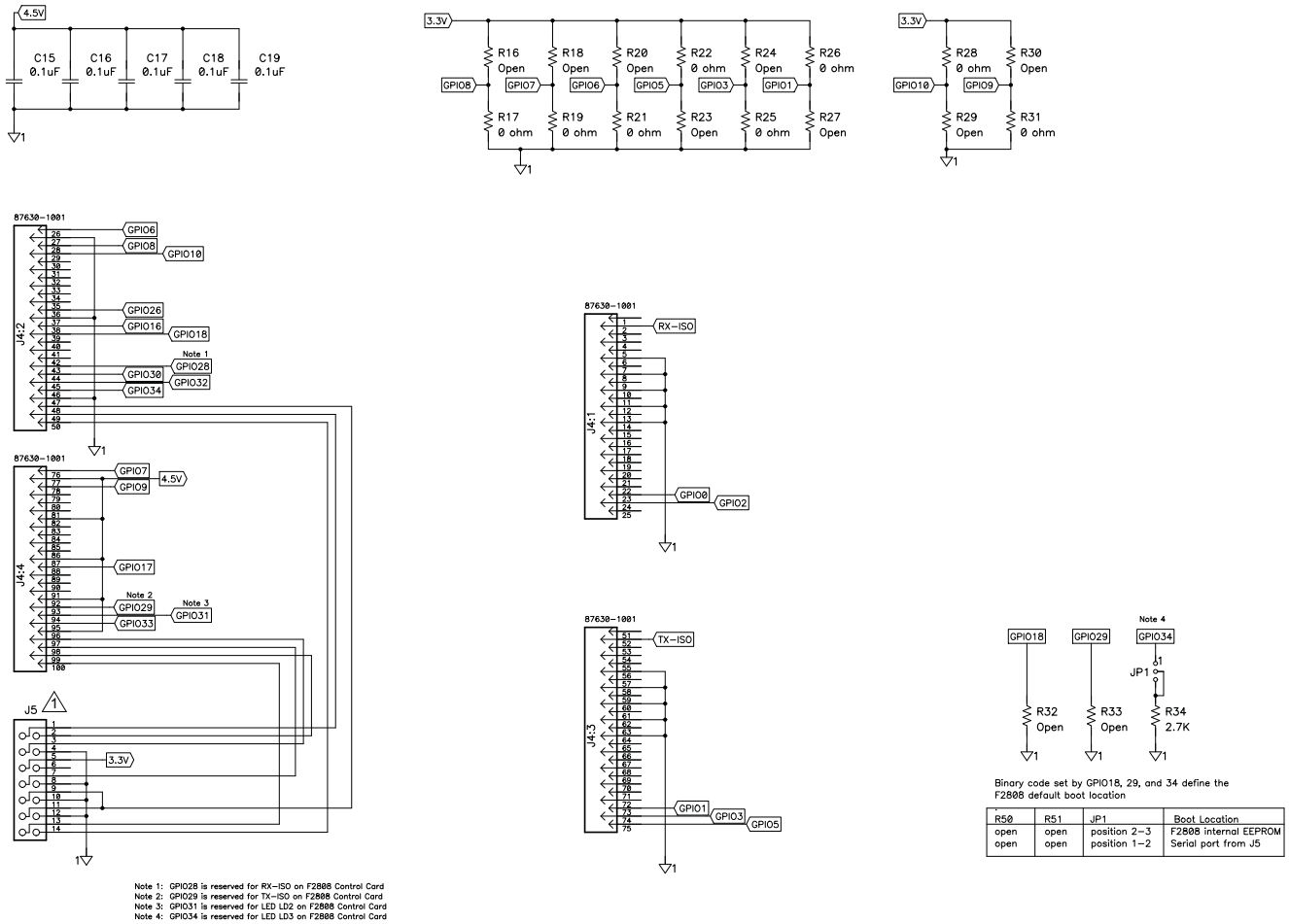


Figure 4. HPA274 - Schematic 2

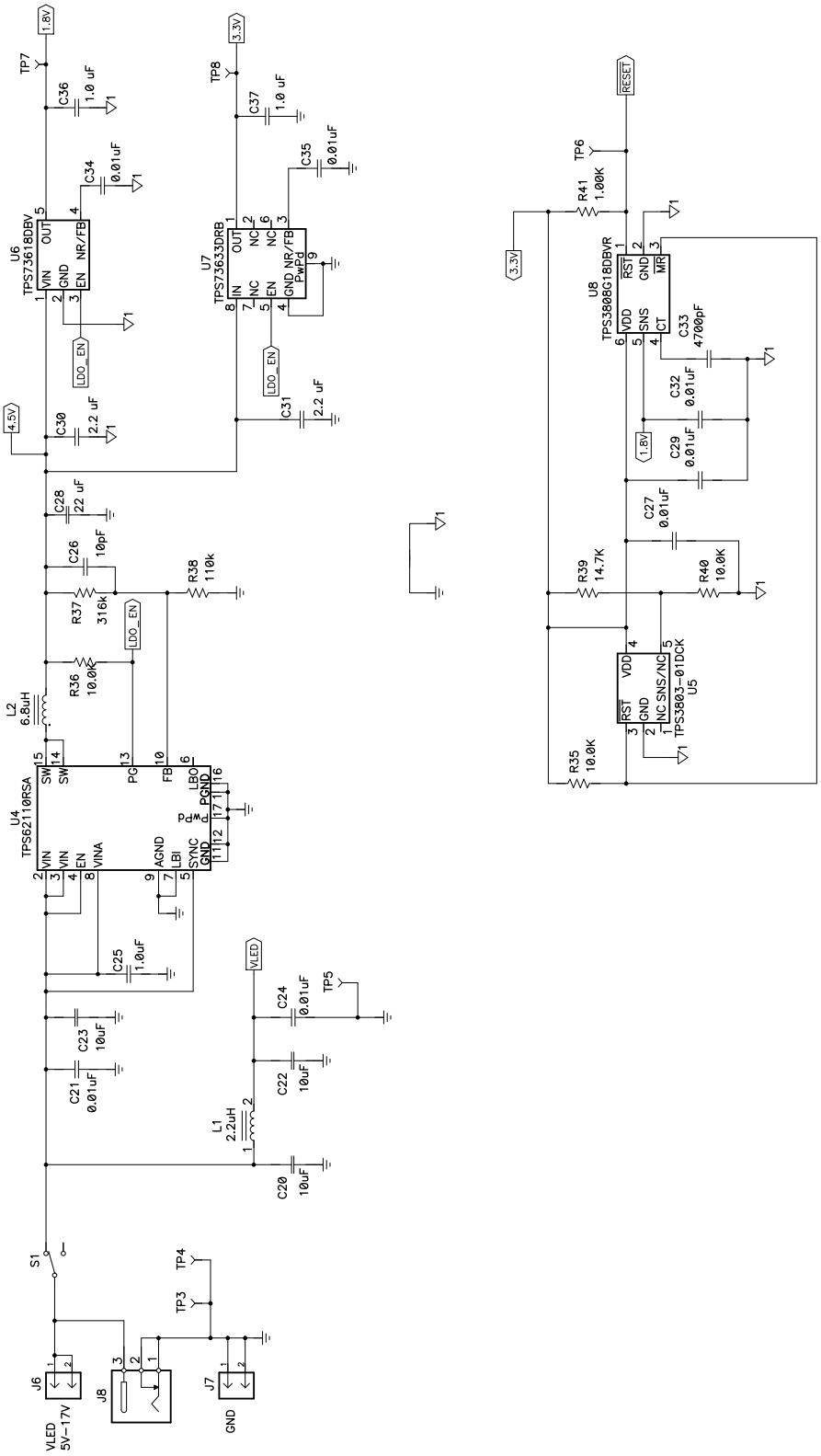


Figure 5. HPA274 - Schematic 3

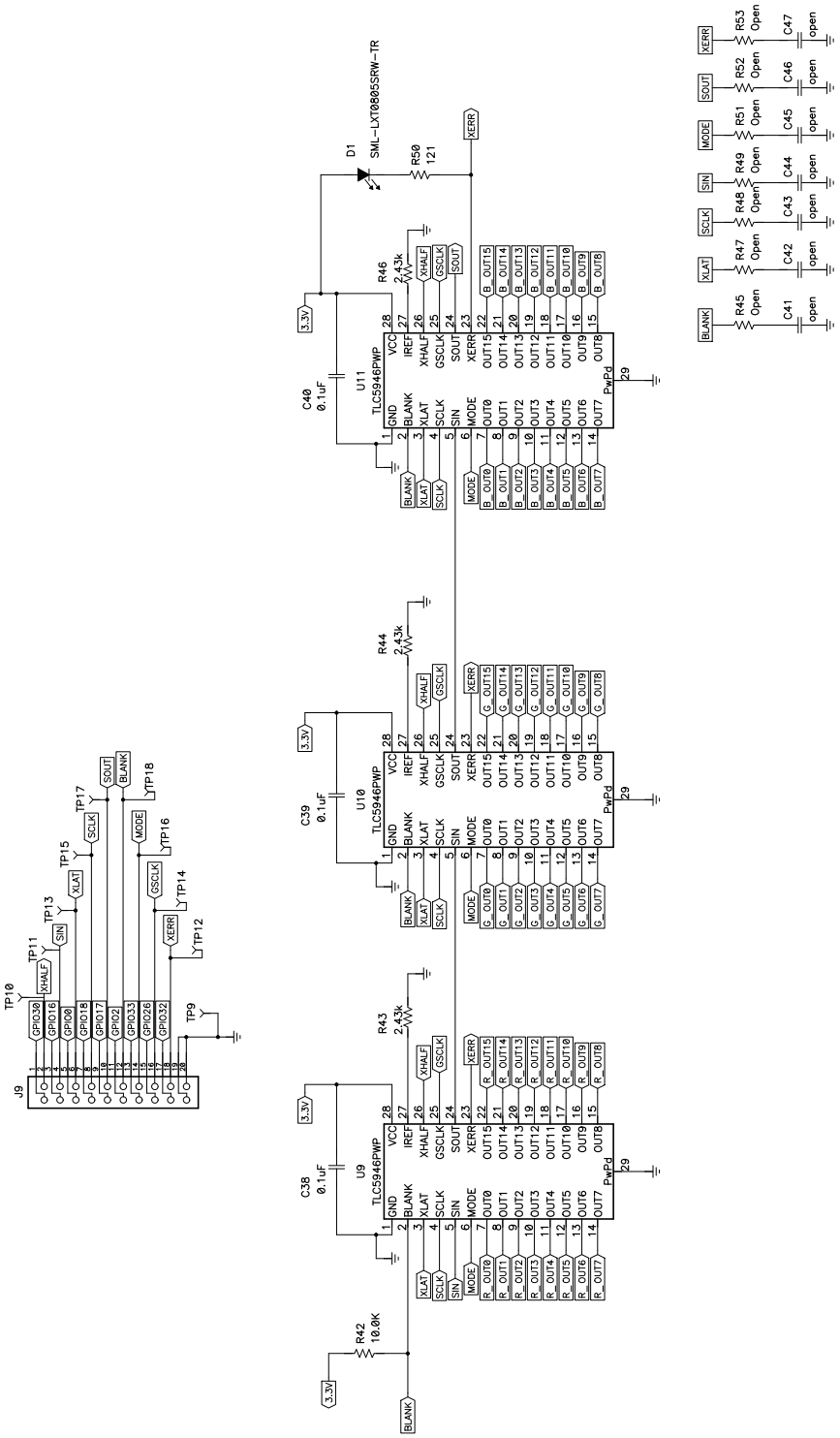


Figure 6. HPA274 - Schematic 4

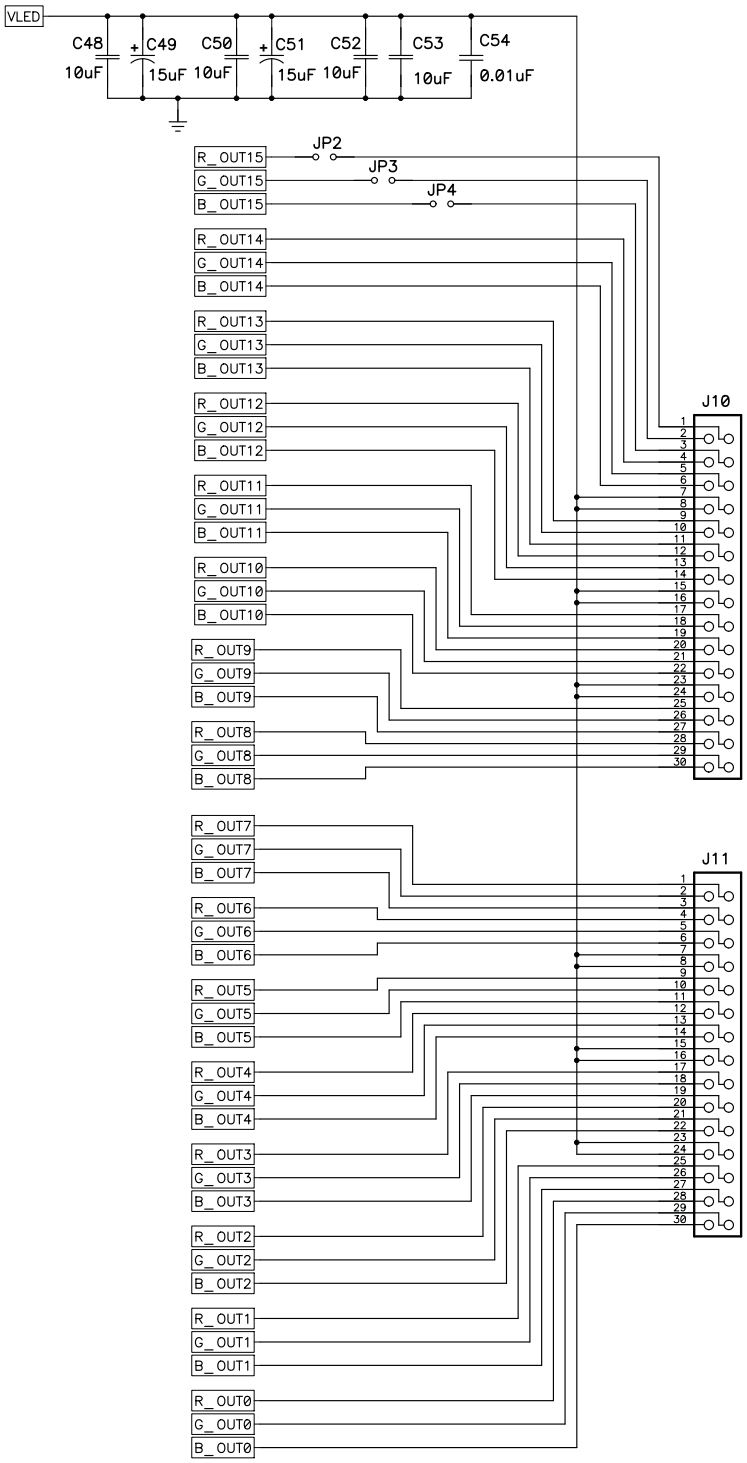


Figure 7. HPA274 - Schematic 5

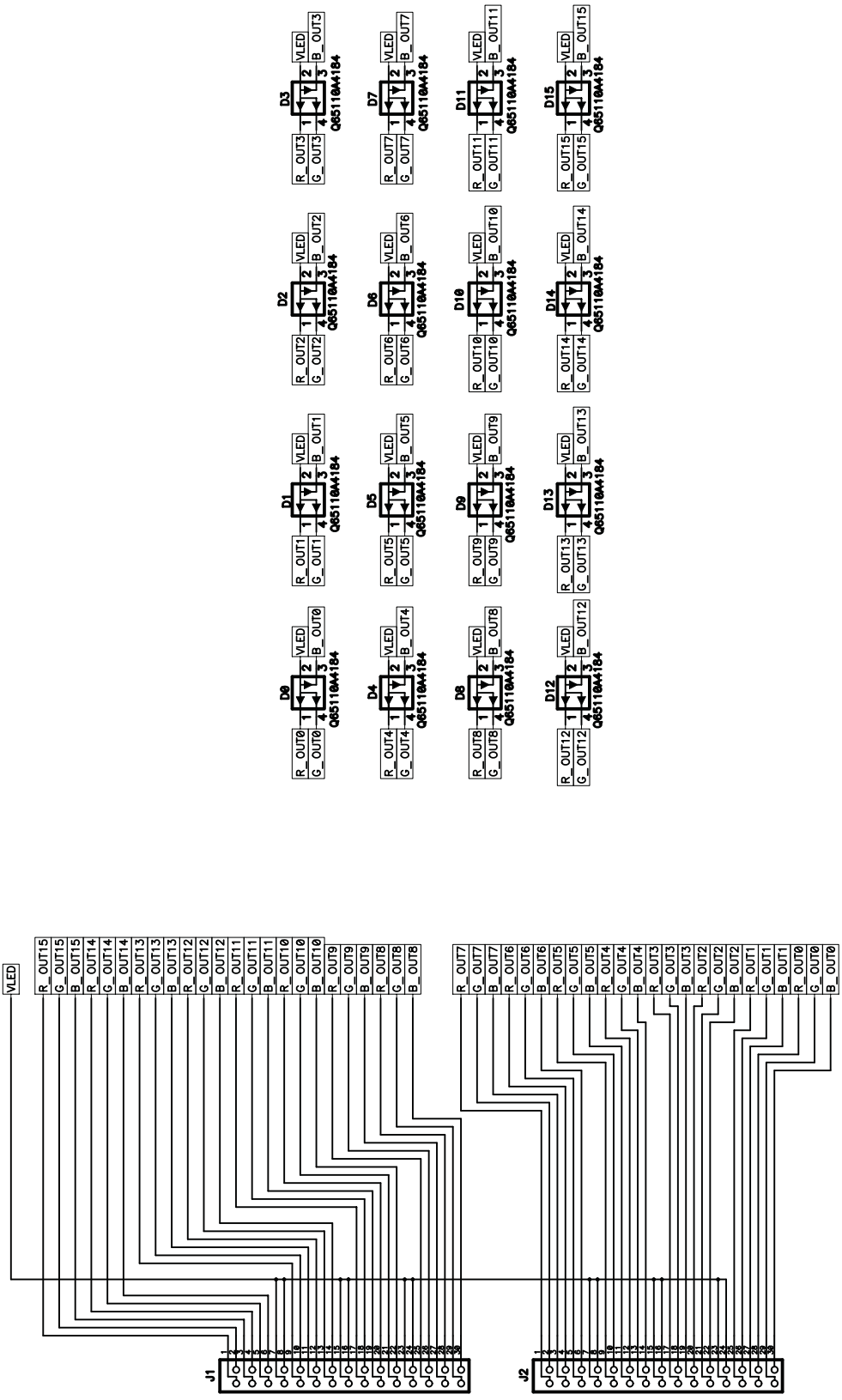


Figure 8. HPA249A Schematic

4.2 Board Layouts

This section provides the TLC5946EVM-274 and RGBLEDEVM-249 board layouts and illustrations.

Figure 9 through Figure 13 show the board layout for the LED driver board, HPA274.

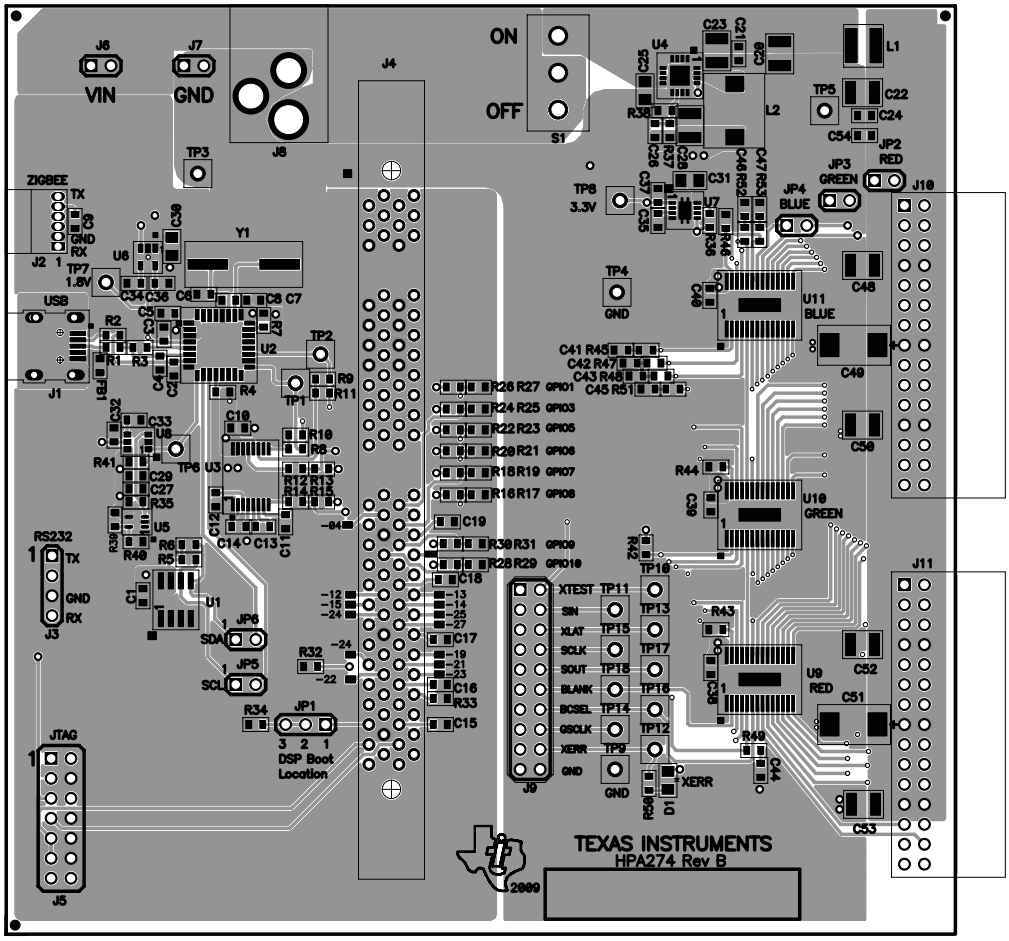


Figure 9. Assembly Layer Routing

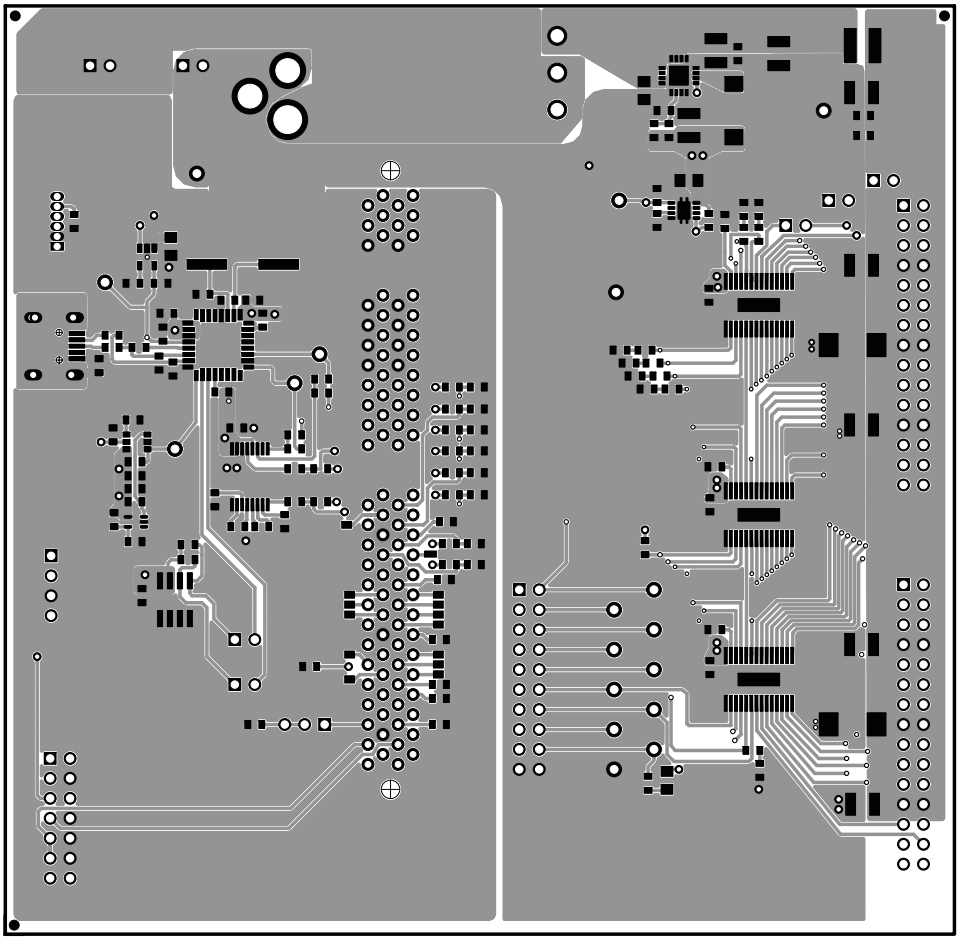


Figure 10. Top Layer Routing

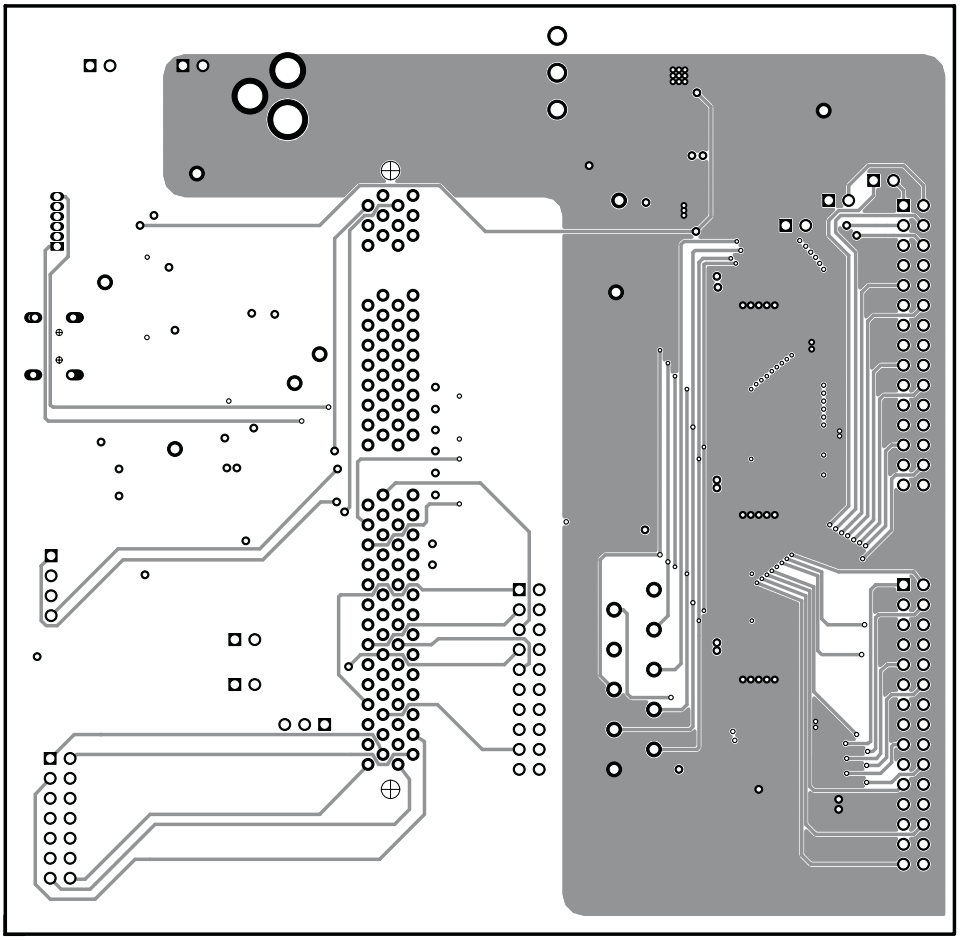


Figure 11. Layer 2 Routing

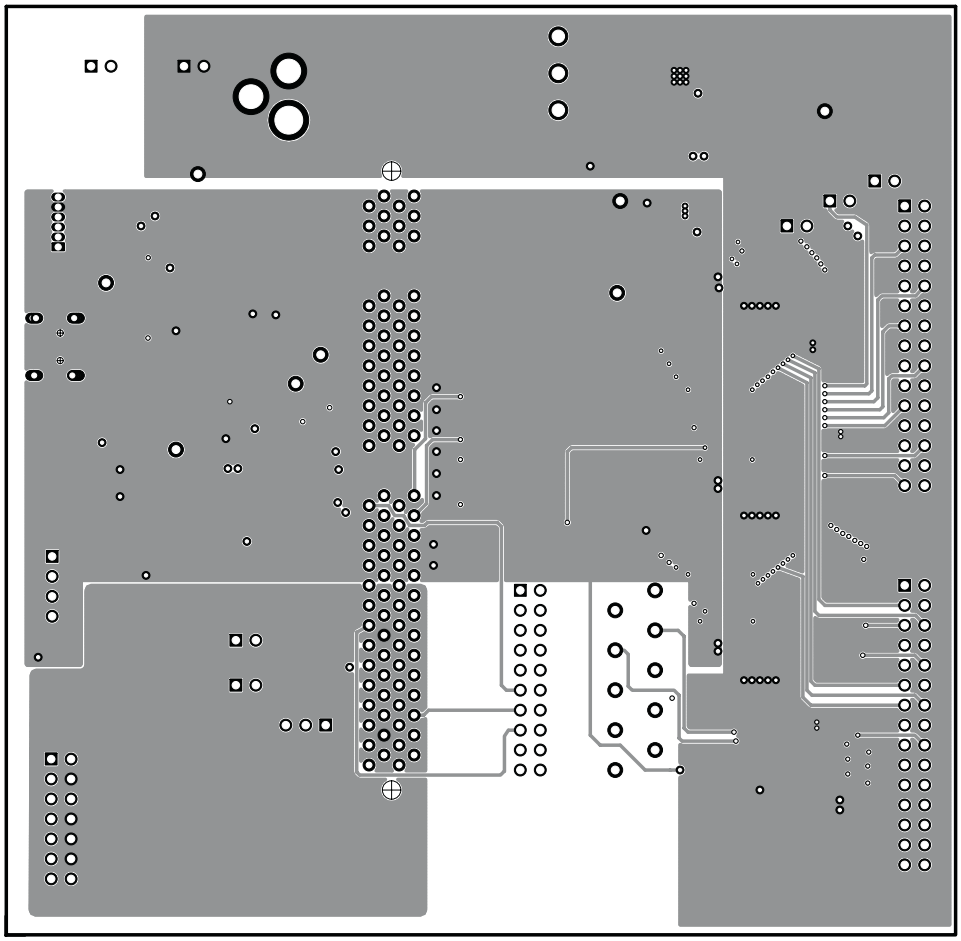


Figure 12. Layer 3 Routing

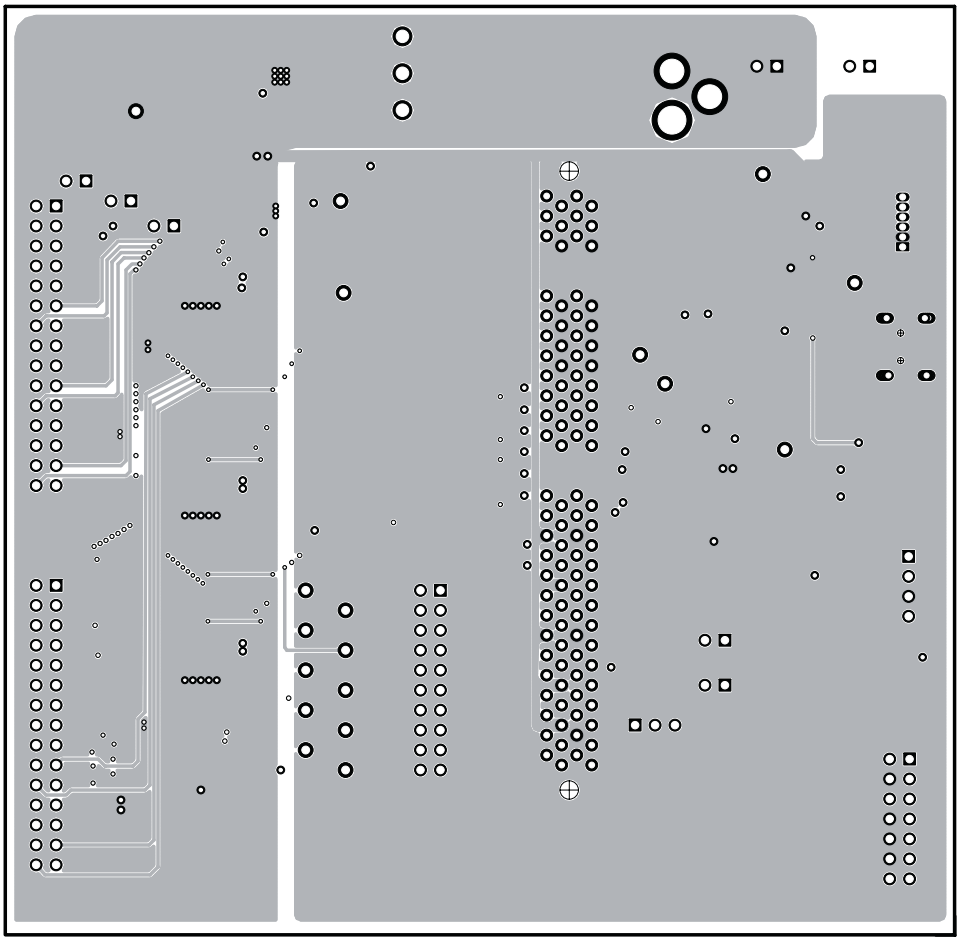


Figure 13. Bottom Layer Routing

Figure 14 through Figure 16 show the board layout for the LED board, HPA249.

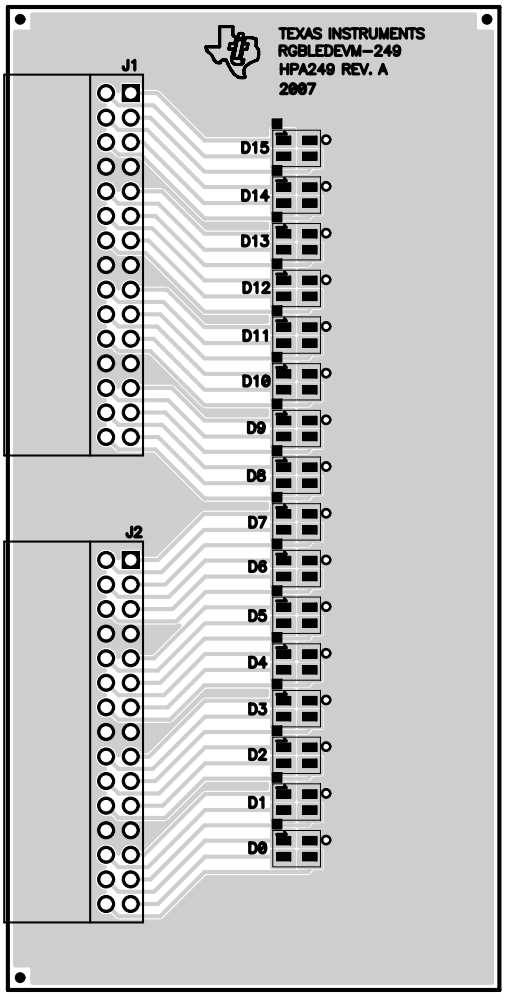


Figure 14. Assembly Layer

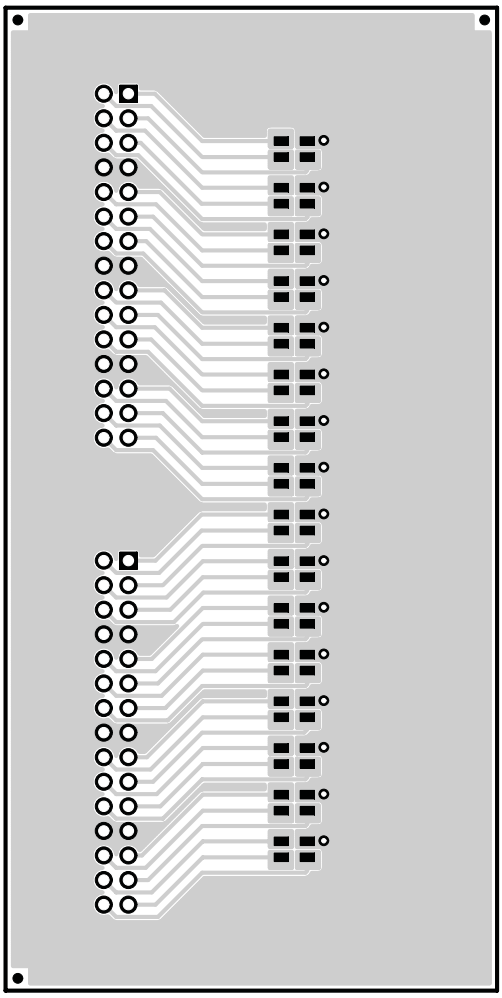


Figure 15. Top Layer

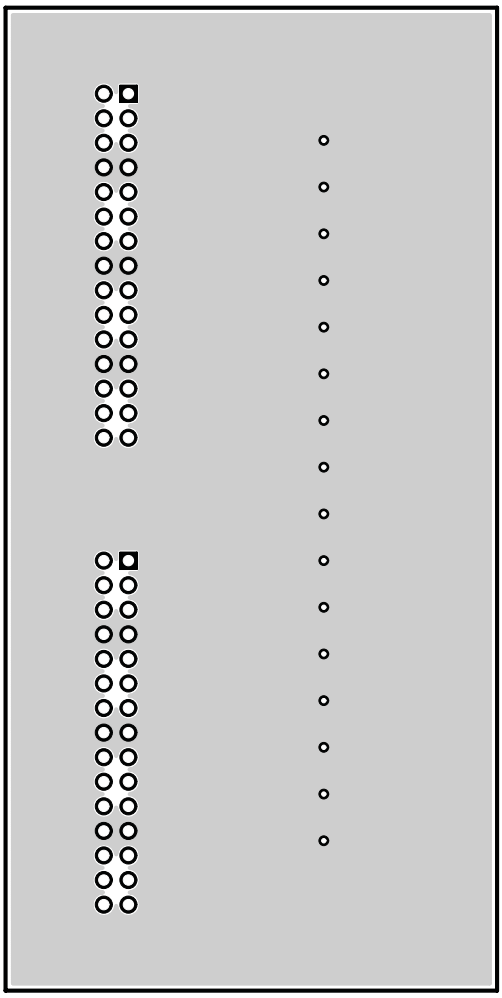


Figure 16. Bottom Layer

4.3 Bill of Materials

Table 2. HPA274B Bill of Materials

Count								
-001	-002	-003	RefDes	Value	Description	Size	Part Number	MFR
10	10	10	C1, C7, C21, C24, C27, C29, C32, C34, C35, C54	0.01µF	Capacitor, Ceramic, 50V, X7R, 20%	0603	GRM188R71H103MA	Murata
2	2	2	C2, C4	22pF	Capacitor, Ceramic, 50V, COG, 5%	0603	GRM1885C1H220JA	Murata
16	16	16	C3, C5, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C38, C39, C40	0.1µF	Capacitor, Ceramic, 6.3V, X7R, 10%	0603	GRM188R70J104KA	Murata
2	2	2	C6, C8	33pF	Capacitor, Ceramic, 6.3V, X7R, 10%	0603	Std	Std
7	7	7	C20, C22, C23, C48, C50, C52, C53	10µF	Capacitor, Ceramic, 25V, X5R, 10%	1210	GRM32DR71E106KA12L	Murata
1	1	1	C25	1.0µF	Capacitor, Ceramic, 25V, X5R, 20%	0805	GRM216R61E105KA	Murata
1	1	1	C26	10pF	Capacitor, Ceramic, 50V, C0G, 5%	0603	C1608C0G1H100DB	TDK
1	1	1	C28	22µF	Capacitor, Ceramic, 16V, X7R, 20%	1210	C3225X7R1C226M	TDK
2	2	2	C30, C31	2.2µF	Capacitor, Ceramic, 6.3V, X5R, 10%	0805	C2012X5R0J225KT	TDK
1	1	1	C33	4700pF	Capacitor, Ceramic, 16V, X7R, 10%	0603	GRM188R71C472KA	Murata
2	2	2	C36, C37	1.0µF	Capacitor, Ceramic, 6.3V, X5R, 10%	0603	C3216X5R0J105KT	TDK
2	2	2	C49, C51	15µF	Capacitor, POSCAP, 25V, 90milliohm, 20%	7343(D)	20TQC15M	Sanyo
0	0	0	C41, C42, C43, C44, C45, C46, C47	Open	Capacitor, Ceramic, 6.3V, X7R, 10%	0603	Std	Std
1	1	1	D1	SML-LXT0805SRW-TR	Diode, LED, Red, 100 mA	0805	SML-LXT0805SRW-TR	Lumex
1	1	1	FB1	74279266	Bead, SMD Ferrite, 100 MHz Max. 200mA , ±25%	0603	74279266	WE
1	1	1	J1	UX60-MB-5S8	Connector, Recpt, USB-B, Mini, 5-pins, SMT	0.354 × 0.303 Inches	UX60-MB-5S8	
2	2	2	J10, J11	PEC30DBAN	Header, Male 2x15-pin, 100mil spacing (36-pin strip), Right-Angle	0.100 inch × 15 x 2	PEC30DBAN	Sullins
0	0	0	J2	Open	Header, 1x6-pin, 50mil spacing	1.000 × 0.085 inch	850-106-10-S-RA	Millmax
0	0	0	J3	Open	Header, Male 4-pin, 100mil spacing, (36-pin strip)	0.100 inch × 4	PEC36SAAN	Sullins
1	1	1	J4	87630-1001	Connector, PCI Card, 100-pin 1.27 mm pitch	0.300 x 3.850 inch	87630-1001	Molex
0	0	0	J5	Open	Header, 2x7 pin, 100mil spacing (36 pin strip)	0.100 inch × 2X7	PEC36DAAN	Sullins
2	2	2	J6, J7	PEC36SAAN	Header, 2-pin, 100mil spacing, (36-pin strip)	0.100 inch × 2	PEC36SAAN	Sullins
1	1	1	J8	RAPC 712	Connector, Pin dia.2.5mm, DC Jack,	0.57 × 0.35 inch	RAPC 712	Switchcraft
1	1	1	J9	PEC36DAAN	Header, Male 2x10-pin, 100mil spacing (36-pin strip)	0.100 inch × 10 × 2	PEC36DAAN	Sullins
1	1	1	JP1	PEC36SAAN	Header, 3-pin, 100mil spacing, (36-pin strip)	0.100 inch × 3	PEC36SAAN	Sullins
3	3	3	JP2, JP3, JP4	PEC36SAAN	Header, 2-pin, 100mil spacing, (36-pin strip)	0.100 inch × 2	PEC36SAAN	Sullins
2	2	2	JP5, JP6	PEC36SAAN	Header, 2-pin, 100mil spacing, (36-pin strip)	0.100 inch x 2	PEC36SAAN	Sullins
1	1	1	L1	2.2µH	Inductor, SMT, 3.4A, 70milliohm	0.153 × 0.153 inch	LPS4018-222ML	Coilcraft
1	1	1	L2	6.8µH	Inductor, SMT, 1.6A, 49.2milliohm	0.276 sq	SLF7032T-6R8M1R6	TDK
2	2	2	R1, R2	33.0	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R3	1.5K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
6	6	6	R4, R7, R35, R36, R40, R42	10.0K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	3	3	R5, R6, R41	1.00K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
6	6	6	R8, R9, R12, R14, R28, R31	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	0	R10, R11, R13, R15, R29, R30, R32, R33, R45, R47, R48, R49, R51, R52, R53	Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
			R16	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	0		Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R17	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std
				Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
			R18	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std

Table 2. HPA274B Bill of Materials (continued)

Count								
-001	-002	-003	RefDes	Value	Description	Size	Part Number	MFR
0	0	0		Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R19	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std
				Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
			R20	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0	0		Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R21	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std
				Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
		1	R22	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0			Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1		R23	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std
		0		Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1			R24	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	0	0		Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
	1	1	R25	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0				Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
		1	R26	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std
0	0			Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1		R27	0 Ohm	Resistor, Chip, 1/16W, 1%	0603	Std	Std
		0		Open	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R34	2.7K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R37	316K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R38	110K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R39	14.7K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
3	3	3	R43, R44, R46	2.43K	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	R50	121	Resistor, Chip, 1/16W, 1%	0603	Std	Std
1	1	1	S1	CS12ANW03	Switch, SPDT, Miniature Slide, 3A 125VAC	0.276 × 0.551 inch	CS12ANW03	NKK
14	14	14	TP1, TP2, TP6, TP7, TP8, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18	5000	Test Point, Red, Thru Hole Color Keyed	0.100 × 0.100 inch	5000	Keystone
4	4	4	TP3, TP4, TP5, TP9	5001	Test Point, Black, Thru Hole Color Keyed	0.100 × 0.100 inch	5001	Keystone
1	1	1	U1	AT24C512BN-SH25-T	IC, 512K, Serial EEPROM	SO-8	AT24C512BN-SH25-T	Atmel
1	1	1	U2	TUSB3410IVF	IC, USB to Serial Port Controller	PQFP32	TUSB3410IVF	TI
1	1	1	U3	TRS3221E	IC, RS-232 Transceivers with AutoShutdown	SSOP-16	TRS3221E	TI
1	1	1	U4	TPS62110RSA	IC, Synchronous Step-Down Converter, 17V, 1.2A	QFN-16	TPS62110RSA	TI
1	1	1	U5	TPS3803-01DCK	IC, Voltage Supervisor	SOP-5 (DCK)	TPS3803-01DCK	TI
1	1	1	U6	TPS73618DBV	IC, Cap-Free, NMOS, 400mA LDO Regulator with Reverse Current Protection.	SOT23-5	TPS73618DBV	TI
1	1	1	U7	TPS73633DRB	IC, Cap-Free, NMOS, 400mA LDO Regulator With Reverse Current Protection	QFN-8	TPS73633DRB	TI
1	1	1	U8	TPS3808G18DBVR	IC, SVS, Low Quiescent Current, Programmable 1.8-V, Delay Time: 1.25ms to10s	SOT23-6	TPS3808G18DBVR	TI
3			U9, U10, U11	TLC5943PWP	IC, 16 Chan LED Driver With 16 BIT PWM Dimming and 6 bit Global Brightness Control	TSSOP-28	TLC5943PWP	TI
	3			TLC5941PWP	IC, 16 Chan LED Driver With Dot Correction/Grayscale PWM Control	TSSOP-28	TLC5941PWP	TI
		3		TLC5946PWP	IC, 16 Chan LED Driver With Dot Correction/Grayscale PWM Control	TSSOP-28	TLC5946PWP	TI
1	1	1	Y1	ABLS-12.000Mhz-B2	Crystal, Controlled Oscillators	0.150 × 0.528 inch	ABLS-12.000Mhz-B2	ABRACON
14	14	14	—		Shunt, 100-mil, Black	0.100	929950-00	3M
1	1	1	—		PCB		HPA274	Any
1	1	1	—		Label	1.25 × 0.25 inch	THT-13-457-10	Brady
4	4	4	—	2566	Bumper, rubber		2566	SPC Tech
1	1	1	—		LED board		HPA249_Osram_LED_Board	TI
1	1	1	See Note 6		F2808 DSP Control Card		TMDSCNCD2808	TI

Table 2. HPA274B Bill of Materials (continued)

Count								
-001	-002	-003	RefDes	Value	Description	Size	Part Number	MFR

Notes: 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. Ref designators marked with an asterisk ('**') cannot be substituted. All other components can be substituted with equivalent MFG's compponents.

5. Install label after final wash. Text shall be 8 pt font. Text shall be per Table 1.

6. DSP Control card will be supplied by TI.

Table 1

Assembly Number	Text
HPA274-001	TLC5946EVM-274
HPA274-002	TLC5941EVM-274
HPA274-003	TLC5946EVM-274

Table 3. HPA249A Bill of Materials

Count	RefDes	Value	Description	Size	Part Number	MFR
16	D0–D15	Q65110A4184	Diode, LED, 20mA, Common Anode (LATBT66B)	0.118 × 0.134	Q65110A4184	Osram
2	J1, J2	PPTC152LJBN-RC	Header, female, 2×5-pin, .100 inch, RA	0.500 × 1.520 inch	PPTC152LJBN-RC	Sullins
1	—		PCB, 2 In × 4 In × 0.062 In		HPA248	Any

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.

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 5 V to 17 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 60°C. The EVM is designed to operate properly with certain components above 60° 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

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		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DLP® Products	www.dlp.com	Broadband	www.ti.com/broadband
DSP	dsp.ti.com	Digital Control	www.ti.com/digitalcontrol
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Military	www.ti.com/military
Logic	logic.ti.com	Optical Networking	www.ti.com/opticalnetwork
Power Mgmt	power.ti.com	Security	www.ti.com/security
Microcontrollers	microcontroller.ti.com	Telephony	www.ti.com/telephony
RFID	www.ti-rfid.com	Video & Imaging	www.ti.com/video
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Wireless	www.ti.com/wireless

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265