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## 1 Introduction

### 1.1 Description

The TPA6140A2 is a DirectPath™ Class-G stereo headphone amplifier with a built-in I<sup>2</sup>C volume control. Class-G technology maximizes battery life by adjusting the voltage supplies of the headphone amplifier based on audio signal level. DirectPath eliminates external DC-blocking capacitors. Availability in a 0.4 mm pitch WCSP package makes TPA6140A2 an ideal choice for both cellular handsets and PDAs.

The TPA6140A2 evaluation module (EVM) is a complete, stand-alone audio board. It contains the TPA6140A2 WCSP (YFF) Class-G stereo headphone amplifier.

All components and the EVM are Pb free.

## 1.2 TPA6140A2EVM Specifications

|          |  |                           |
|----------|--|---------------------------|
| $V_{DD}$ | Supply voltage range   | -0.3 V to 6 V             |
| $I_{DD}$ | Supply current   | 2 A Maximum               |
| $P_o$    | Continuous output power per channel, $16 \Omega$ , $V_{DD} = 5.0$ V, THD + N = 10% | 25 mW                     |
| $V_I$    | Audio Input Voltage  | 0.5 V to $V_{DD}$ - 0.5 V |
| RL       | Minimum load impedance   | 16 $\Omega$               |

## 2 Operation

The TPA6140A2EVM can be evaluated in a stand-alone mode or when connected to existing circuits with I<sup>2</sup>C controls.

### 2.1 Quick Start List for Stand-Alone Operation

A desktop or laptop computer with Windows<sup>TM</sup> XP installed is required for the stand-alone operation. Install the software before connecting the EVM to a computer with a USB cable. The inputs accept standard RCA plugs and the outputs accept banana connectors.

#### 2.1.1 Software Installation Sequence

1. Insert the CD provided.
2. Unzip the files to a temporary folder.
3. Install TPA6140A2 software by executing setup.exe located in *TPA6140A2 Interface\Volume*.

Accept license agreement and defaults, and complete the installation. Note: you can uninstall later with Add/Remove Programs.

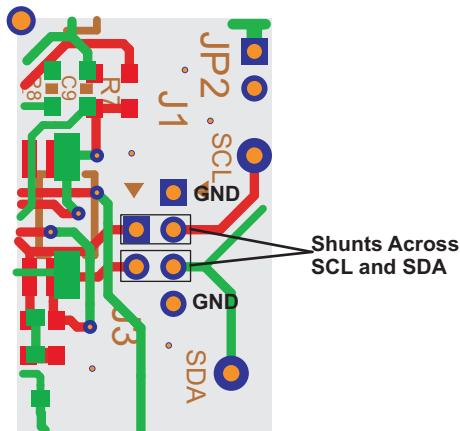
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**Note:** It is unnecessary to repeat the steps in [Section 2.1.1](#), once the software is installed.

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#### 2.1.2 Evaluation Module Preparations

1. Ensure that all external power sources are set to OFF.
2. Install shunt in jumper JP4
3. Install shunts in jumpers JP1 and JP2 when single-ended audio inputs are used; this ties INL+ and INR+ to ground.
4. Install shunts to connect J1-SCL to J3-SCL, and J1-SDA to J3-SDA as shown in [Figure 1](#). This sets the TPA6140A2 to accept I<sup>2</sup>C inputs from the EVM itself.



**Figure 1. YFF EVM—Place Shunts Horizontally Across SCL and SDA**

1. Powering the EVM:
  - The EVM can be powered via USB connection or by external power supply:
    - a. Via USB power: Install shunt for jumper USB+ if USB power is used.
    - b. External power supply: connect an external regulated power supply adjusted for 2.5 V–5.5 V to the module VDD and GND banana jacks, taking care to observe marked polarity. Make sure jumper USB+ is removed in this case.
  - Note:
    - i. USB interface may not be able to provide enough current. For best audio performance, use external power supply.
    - ii. Make sure only one power source is used. Connecting two power sources will cause damage to the device and the supply.
6. Connect audio source to RCA jacks INL and INR.
7. Connect headphone to the output headphone jack.
8. Plug in USB.
9. Turn on the power supply.
10. If this is the first time a TPA6140A2EVM is plugged in after installing the software, follow the Windows dialog (Figure 2), questions, and selections:
  - a. Select "Install from a list or specific location (Advanced)", then click next.
  - b. Browse to the folder where the TPA6140A2 interface is installed then click ok.
  - c. Windows will automatically install the driver.



**Figure 2. Found New Hardware Wizard Advisory Screen**

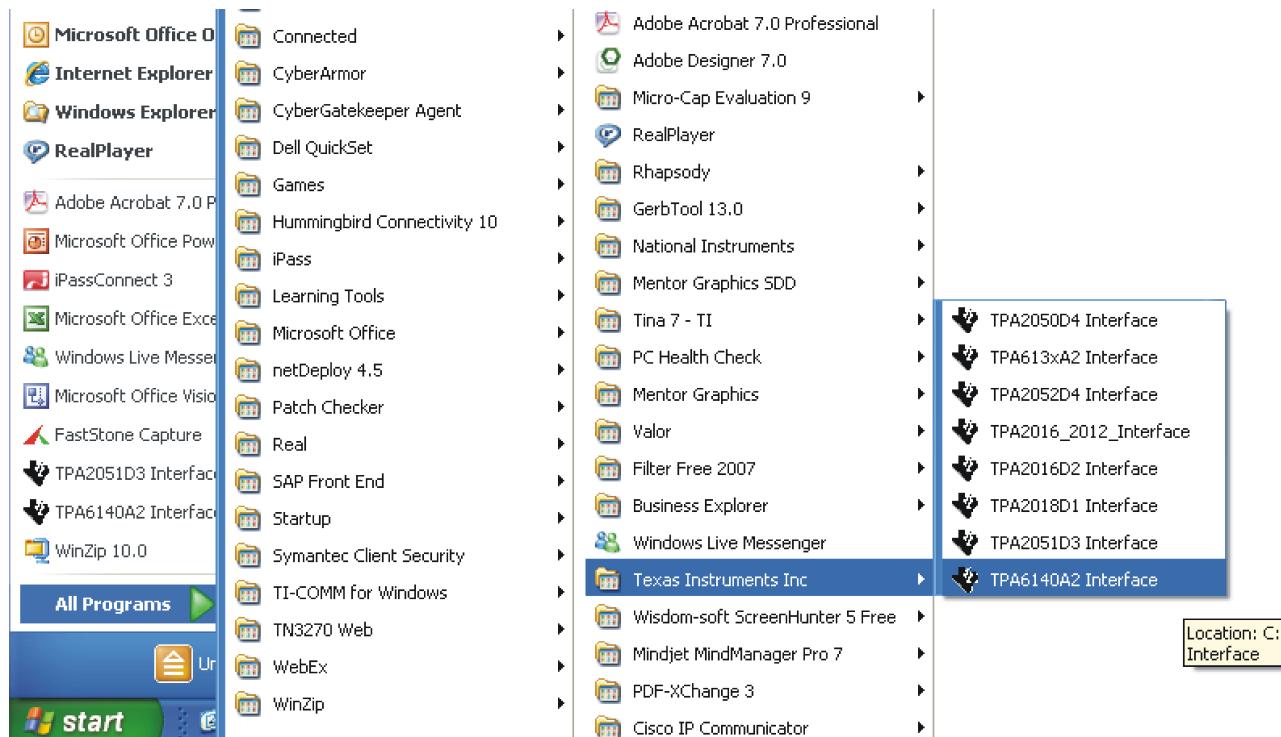
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**Note:** It is not necessary to repeat steps 10. a. to c., once the driver is installed.

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### 2.1.3 Using the Software

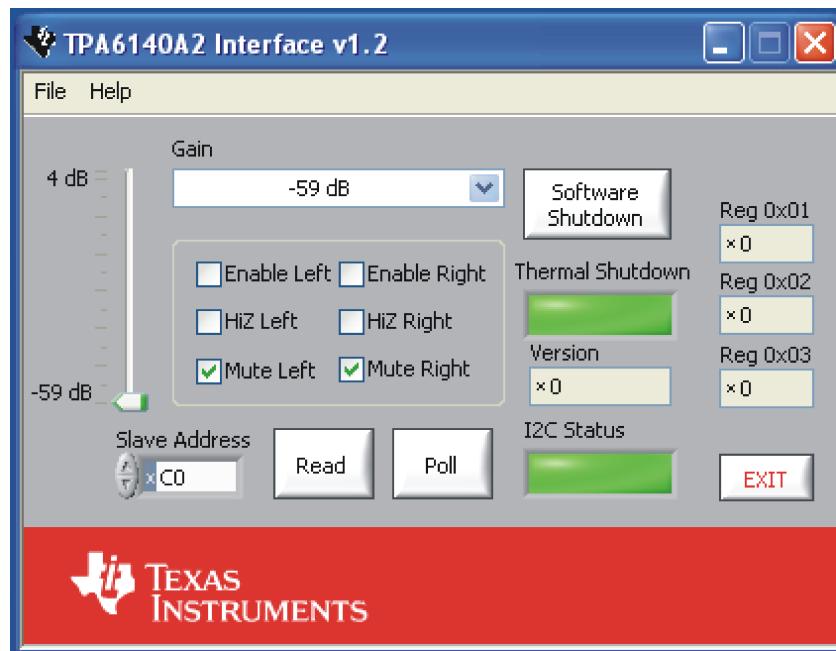
1. Start the TPA6140A2 Interface by clicking the *Start* menu and clicking on the *TPA6140A2 Interface* icon. <sup>(1)</sup>



**Figure 3. Starting the Software**

(1) Computer screen images showing Windows XP interface are courtesy of Microsoft Corporation

2. The TPA6140A2 software interface is as shown in [Figure 4](#).



**Figure 4. Software Interface**

**Note:** The TPA6140A2 powers up with the amplifier in software shutdown. To hear an output, uncheck shutdown.

3. Uncheck and check *Enable Left* or *Enable Right* to place the corresponding channels in and out of SHUTDOWN.
4. Uncheck and check *Mute Left* or *Mute Right* to mute the corresponding channels.
5. Click *Software Shutdown* to place the TPA6140A2 in and out of SOFTWARE SHUTDOWN.
6. *I2C Status* box reports the status of I<sup>2</sup>C communications. An error or failure has occurred if it turns red.
7. To read the I<sup>2</sup>C status, click *Read*.
8. *Thermal Shutdown* box reports the status of thermal failure. A thermal fault has occurred if it turns red.
9. The GUI has a built-in I<sup>2</sup>C programming interface. Follow the steps below to use the I<sup>2</sup>C programming function.
  - At the top left corner of the GUI, click *File* to access the I<sup>2</sup>C programming interface.
  - *Save Script* can record the current register values. Select *Save Script* >> Click the folder icon to browse to the place where you want to save the script >> name the file in text format, then select *OK* to save.
  - *Load Script* can load the previously saved script to program the entire register file. Select *Load Script* >> Click the folder icon to browse to the place where the script is located >> Select the file then click *OK* >> Click *Load*.
  - *I2C interface* can program individual register value of TPA6140A2. Select *I<sup>2</sup>C Interface* >> *I<sup>2</sup>C* address is *xCO*, which is the address of TPA6140A2. Device address is from 1 to 7, which is the register address of TPA6140A2.

#### 2.1.4 Shutdown Control

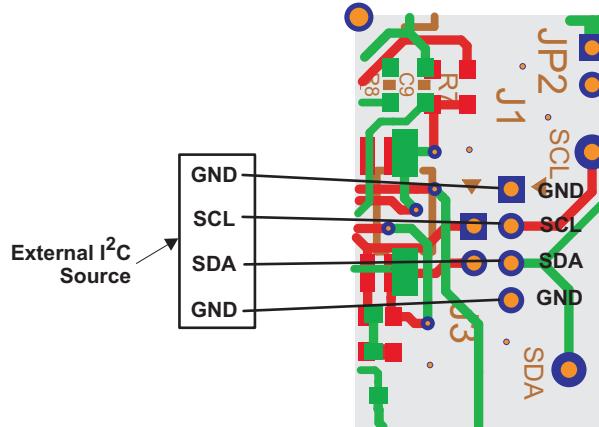
The TPA6140A2 EVM provides hardware shutdown control for the USB controller. Press and hold push button S1 to shutdown the USB controller. Release S1 to activate the USB controller.

## 2.2 Quick Start List When Connected to Existing Circuits With I<sup>2</sup>C Controls

The TPA6140A2EVM can be easily connected to existing circuits with I<sup>2</sup>C controls. Connections to the EVM module can be made using banana plugs for the power supply. The inputs accept standard RCA plugs and the outputs accept banana connectors.

### 2.2.1 Evaluation Module Preparations

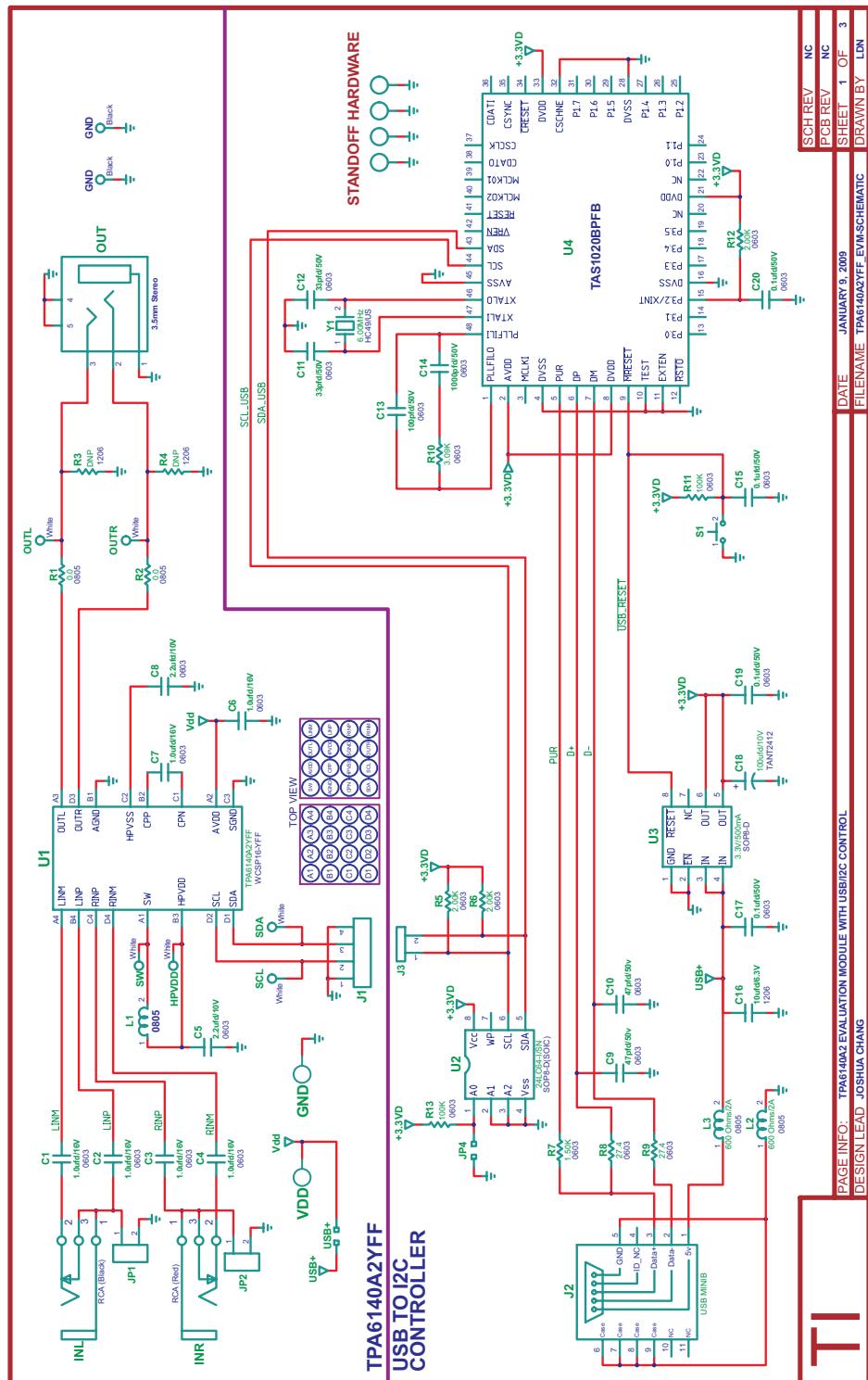
1. Ensure that all external power sources are set to OFF.
2. Install shunts in jumpers JP4.
3. Remove shunts between J1 and J3 and connect I<sup>2</sup>C controls to J1 as shown in [Figure 5](#) (YFF EVM shown).



**Figure 5. Connect I<sup>2</sup>C Controls to J1 (YFF EVM shown)**

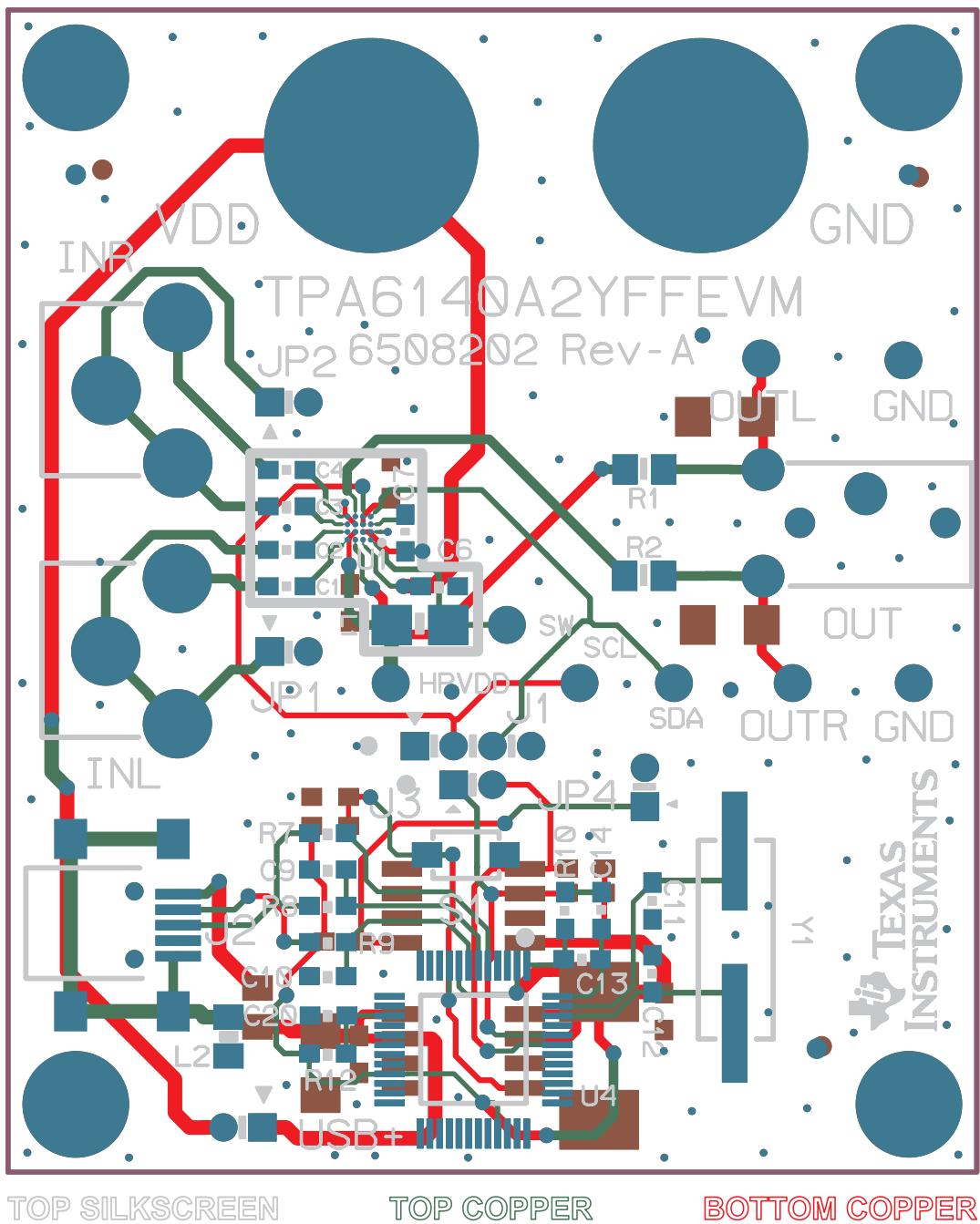
4. Install shunts in jumpers JP1 and JP2 when single-ended audio inputs are used; this ties INL– and INR– to ground.
5. Remove jumper USB+.
6. Connect an external regulated power supply adjusted for 2.5 V–5.5 V to the module VDD and GND banana jacks, taking care to observe marked polarity.
7. Connect audio source to RCA jack INL and INR.
8. Connect headphone to the output headphone jack.
9. Turn on power supply.

### 3 TPA6140A2EVM Schematic



**Figure 6. TPA6140A2EVM Schematic with YFF Device**

## 4 TPA6140A2EVM PCB Layouts for YFF Device



**Figure 7. TPA6140A2EVM –Top Layer for YFF Device**

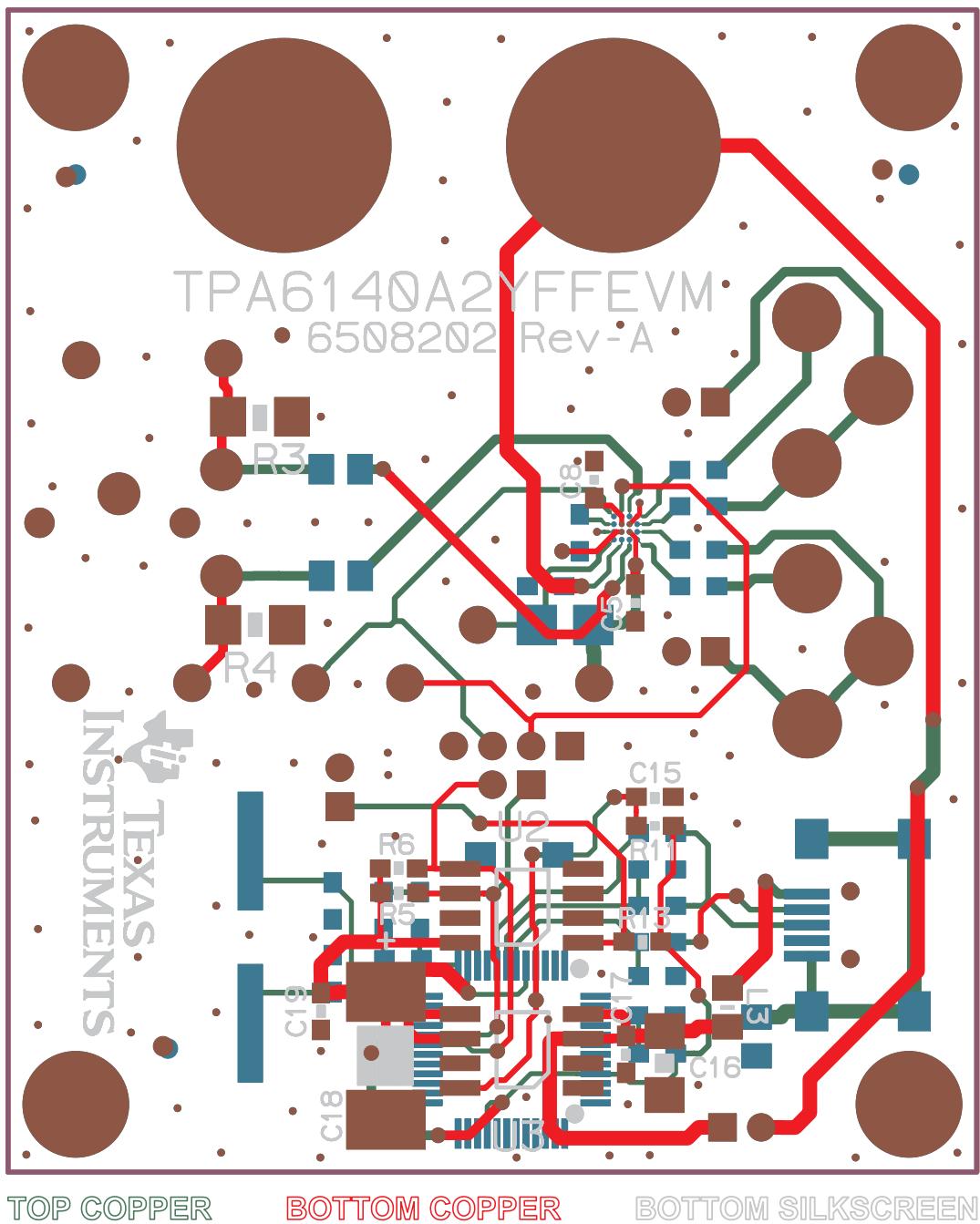


Figure 8. TPA6140A2EVM – Bottom Layer for YFF Device

## 5 TPA6140A2EVM Parts List

**Table 1. TPA6140A2EVM Parts List**

| DESCRIPTION                                     | REF                                   | QTY | MFR                  | MFR PART NUMBER    | VENDOR            |
|---|---------------------------------------|-----|----------------------|--------------------|-------------------|
| Stereo Class-G Amplifier                        | U1                                    | 1   | TEXAS INSTRUMENTS    | TPA6140A2YFF       | TEXAS INSTRUMENTS |
| USB Streaming Controller, TQFP48-PFB            | U2                                    | 1   | TEXA4S INSTRUMENTS   | TAS1020BPFB        | DIGI-KEY          |
| FAST TRANSIENT RESPONSE LDO, SOP8-D             | U3                                    | 1   | TEXAS INSTRUMENTS    | TPS77533D          | DIGI-KEY          |
| EEPROM, SERIAL 64K 2.5V SOIC-8                  | U4                                    | 1   | MICROCHIP TECHNOLOGY | 24LC64-I/SN        | DIGI-KEY          |
| CRYSTAL, 6.000MHz, HC49M ROHS                   | Y1                                    | 1   | ECS                  | ECS-60-32-5PXDН-TR | DIGI-KEY          |
| CAP 33 pF 50V 5% CERM 0603 NPO ROHS             | C11, C12                              | 2   | PANASONIC            | ECJ-1VC1H330J      | DIGI-KEY          |
| CAP 47 pF 50V 5% CERM 0603 NPO ROHS             | C9, C10                               | 2   | PANASONIC            | ECJ-1VC1H470J      | DIGI-KEY          |
| CAP 100 pF 50V 5% CERM 0603 NPO ROHS            | C13                                   | 1   | PANASONIC            | ECJ-1VC1H101J      | DIGI-KEY          |
| CAP 1000 pF50V CERM 0603 COG ROHS               | C14                                   | 1   | TDK CORP.            | C1608C0G1H102J     | DIGI-KEY          |
| CAP 0.1 UFD 50V CERM 0603 X7R ROHS              | C15, C17, C19, C20                    | 4   | TDK CORP.            | C1608X7R1H104K     | DIGI-KEY          |
| CAP 1.0 UFD 10V 10% CERM 0603 X5R ROHS          | C7                                    | 1   | PANASONIC            | ECJ-1VB1A105K      | DIGI-KEY          |
| CAP 1.0 UFD 16V 10% CERM 0603 X5R ROHS          | C1-C4, C6, C7                         | 5   | TDK CORP             | C1608X5R1C105K     | DIGI-KEY          |
| CAP 2.2 UFD 10V CERM 0603 X7R                   | C5, C8                                | 2   | MURATA ELECTRONICS   | GRM188R71A225KE15D | DIGI-KEY          |
| CAP 10 UFD 6.3V 10% CERM 1206 X5R ROHS          | C16                                   | 1   | TDK CORP             | C3216X5R0J106K     | DIGI-KEY          |
| CAP 100 UFD 10V 10% TANT SMD1206 ROHS           | C18                                   | 1   | AVX CORP             | TPSB686K010R0600   | DIGI-KEY          |
| RES 27.4 Ω 1/16W 1% SMD 0603 ROHS               | R8, R9                                | 2   | PANASONIC            | ERJ-3EKF27R4V      | DIGI-KEY          |
| RES 1.50 kΩ 1/16W 1% SMD 0603 ROHS              | R7                                    | 1   | PANASONIC            | ERJ-3EKF1501V      | DIGI-KEY          |
| RES 2.00 kΩ 1/16W 1% SMD 0603 ROHS              | R5, R6, R12                           | 3   | PANASONIC            | ERJ-3EKF2001V      | DIGI-KEY          |
| RES 3.09 kΩ 1/16W 1% SMD 0603 ROHS              | R10                                   | 1   | PANASONIC            | ERJ-3EKF3091V      | DIGI-KEY          |
| RES 100K OHM 1/10W 5% SMD 0603 ROHS             | R11, R13                              | 2   | PANASONIC            | ERJ-3GEYJ104V      | DIGI-KEY          |
| RES 0.0 Ω 1/10W 5% SMD 0805                     | R1, R2                                | 2   | PANASONIC            | ERJ-GEY0R00V       | DIGI-KEY          |
| Do not populate                                 | R3, R4                                |     |                      |                    |                   |
| Inductor, 2.2μH, 800mA, SMD 0805                | L1                                    | 1   | TOKO                 | MDT2012-CH2RA      | TOKO              |
| FERRITE BEAD 600 Ω 2A SM0805 ROHS               | L2, L3                                | 2   | TDK CORP             | MPZ2012S601A       | DIGI-KEY          |
| HEADER 2 PIN, PCB 2.0 MM ROHS                   | J3, JP1-JP4                           | 5   | NORCOMP              | 26630201RP2        | DIGI-KEY          |
| HEADER 4 PIN, PCB 2.0MM ROHS                    | J1                                    | 1   | NORCOMP              | 26630401RP2        | DIGI-KEY          |
| JACK, MINI-STEREO, PCB-RA, 3.5 mm ROHS          | OUT                                   | 1   | CUI STACK            | SJ1-3535N          | DIGI-KEY          |
| JACK, RCA, PCB-RA, BLACK                        | INL                                   | 1   | SWITCHCRAFT          | PJRAN1X1U01        | NEWARK            |
| JACK, RCA, PCB-RA, RED                          | INR                                   | 1   | SWITCHCRAFT          | PJRAN1X1U03        | NEWARK            |
| JACK USB MINIB SMT-RA 5PIN ROHS                 | J2                                    | 1   | HIROSE               | UX60-MB-5ST        | DIGI-KEY          |
| PC Testpoint, Black                             | GND, GND                              | 2   | KEYSTONE ELECTRONICS | 5001               | DIGI-KEY          |
| PC Testpoint, White                             | HPVDD, OUTL,<br>OUTR, SCL, SDA,<br>SW | 6   | KEYSTONE ELECTRONICS | 5002               | DIGI-KEY          |
| Switch, Momentary SMT-Short, Black Tab, 240g    | S1                                    | 1   | PANASONIC            | EVQ-PPDA25         | DIGI-KEY          |
| BINDING-POST, NONINS, THRU, ROHS                | GND, VDD                              | 2   | EMERSON NPCS         | J587               | DIGI-KEY          |
| SHUNT, BLACK AU FLASH 2 MM                      | JP1-JP4, J2-J4                        | 6   | NORCOMP INC.         | 800-002-SP2-001    | DIGI-KEY          |
| Hex Nut, 4-40, Zinc/Steel                       | HW1-HW4                               | 4   | BUILDING FASTENERS   | HNZ440             | DIGI-KEY          |
| Standoff 4-40 Threaded M/F 0.50 in.<br>ALUM-HEX | HW1-HW4                               | 4   | KEYSTONE ELECTRONICS | 8401               | DIGI-KEY          |

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### EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the supply voltage range of  $-0.3\text{ V}$  to  $6\text{ V}$  and the input voltage range of  $-0.3\text{ V}$  to  $\text{VDD} + 0.3\text{ V}$ .

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  $85^\circ\text{C}$ . The EVM is designed to operate properly with certain components above  $85^\circ\text{C}$  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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