User's Guide
SLOU233−March 2009

TPA6140A2EVM

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1   Introduction

1.1   Description

The TPA6140A2 is a DirectPath™ Class-G stereo headphone amplifier with a built-in I2C 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.

DirectPath is a trademark of Texas Instruments.
Windows is a trademark of Microsoft Corporation.

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 Ω, Vdd = 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 Ω

2   Operation

The TPA6140A2EVM can be evaluated in a stand-alone mode or when connected to existing circuits with I²C controls.

2.1   Quick Start List for Stand-Alone Operation

A desktop or laptop computer with Windows™ 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.

Note: **It is unnecessary to repeat the steps in Section 2.1.1, once the software is installed.**

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 I²C inputs from the EVM itself.
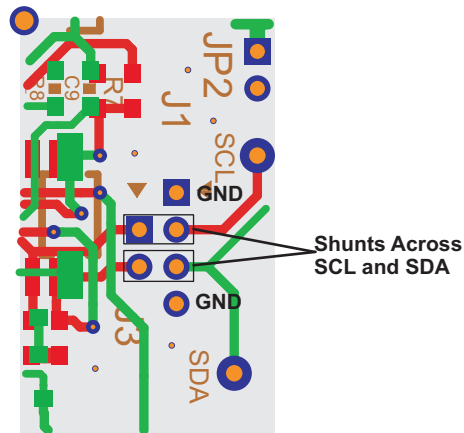
Figure 1. YFF EVM—Place Shunts Horizontally Across SCL and SDA

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.
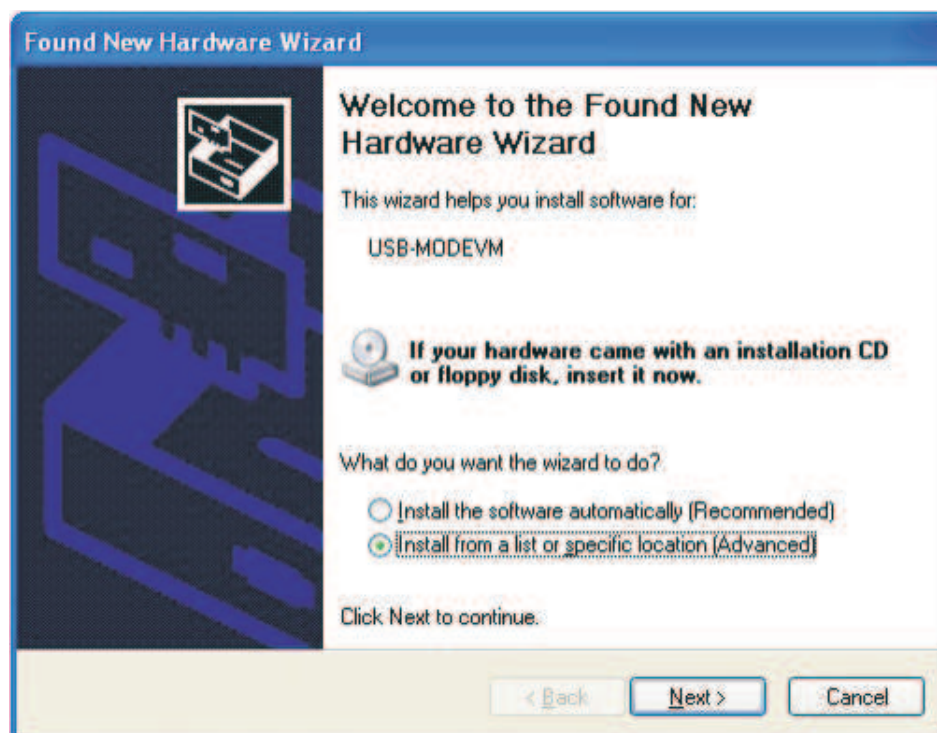   c. Windows will automatically install the driver.

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

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

2.1.3 Using the Software

1. Start the TPA6140A2 Interface by clicking the *Start* menu and clicking on the *TPA6140A2 Interface* icon. (1)
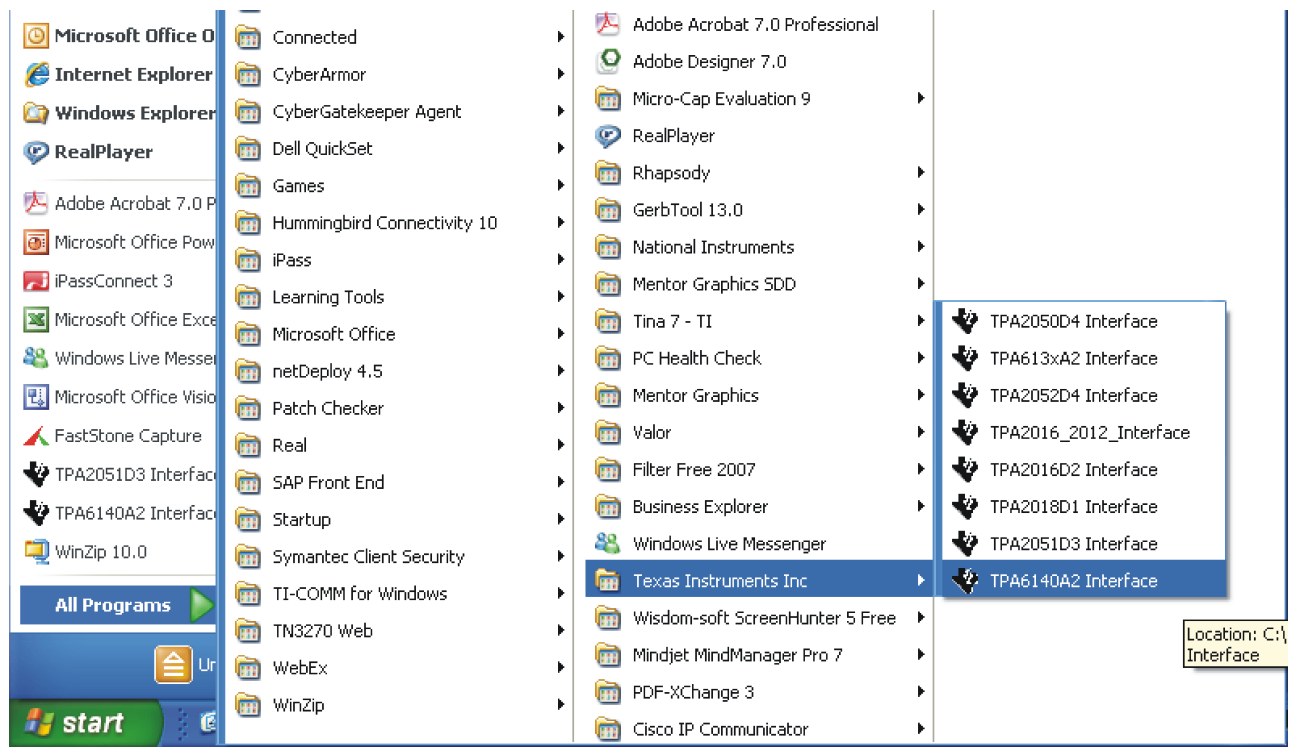

Figure 3. Starting the Software

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

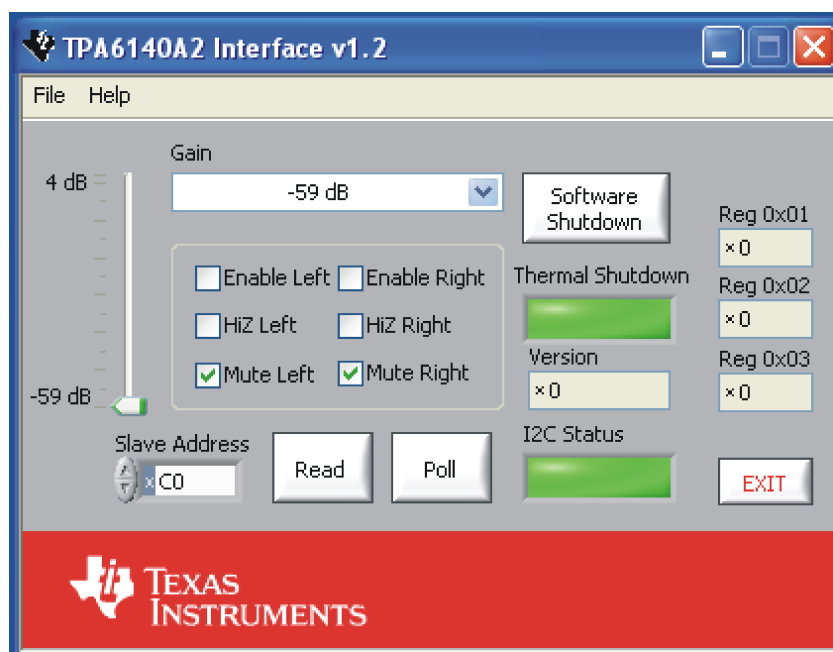2. The TPA6140A2 software interface is as shown in Figure 4.

Figure 4. Software Interface

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

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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^{2}C communications. An error or failure has occurred if it turns red.
7. To read the I^{2}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^{2}C programming interface. Follow the steps below to use the I^{2}C programming function.

- At the top left corner of the GUI, click *File* to access the I^{2}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^{2}C Interface >> I^{2}C address is xC0, 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 I²C Controls

The TPA6140A2EVM can be easily connected to existing circuits with I²C 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 I²C controls to J1 as shown in Figure 5 (YFF EVM shown).
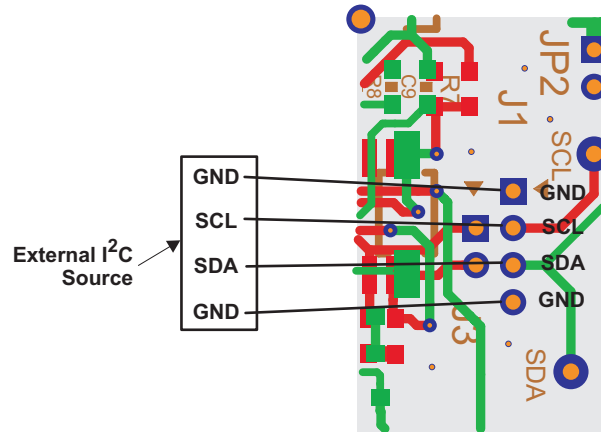
Figure 5. Connect I²C Controls to J1 (YFF EVM shown)

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.
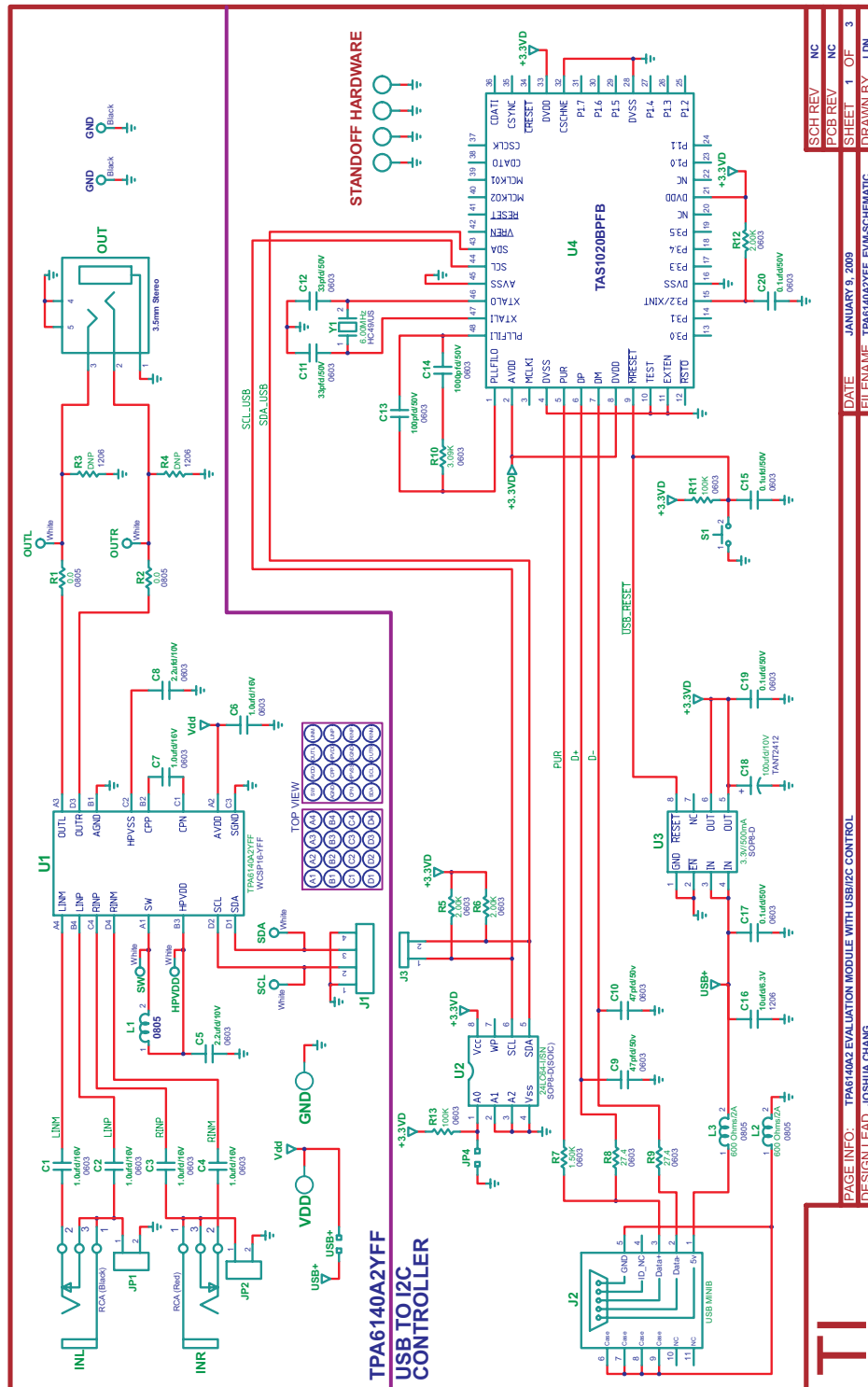9. Turn on power supply.

3 TPA6140A2EVM Schematic

Figure 6. TPA6140A2EVM Schematic with YFF Device
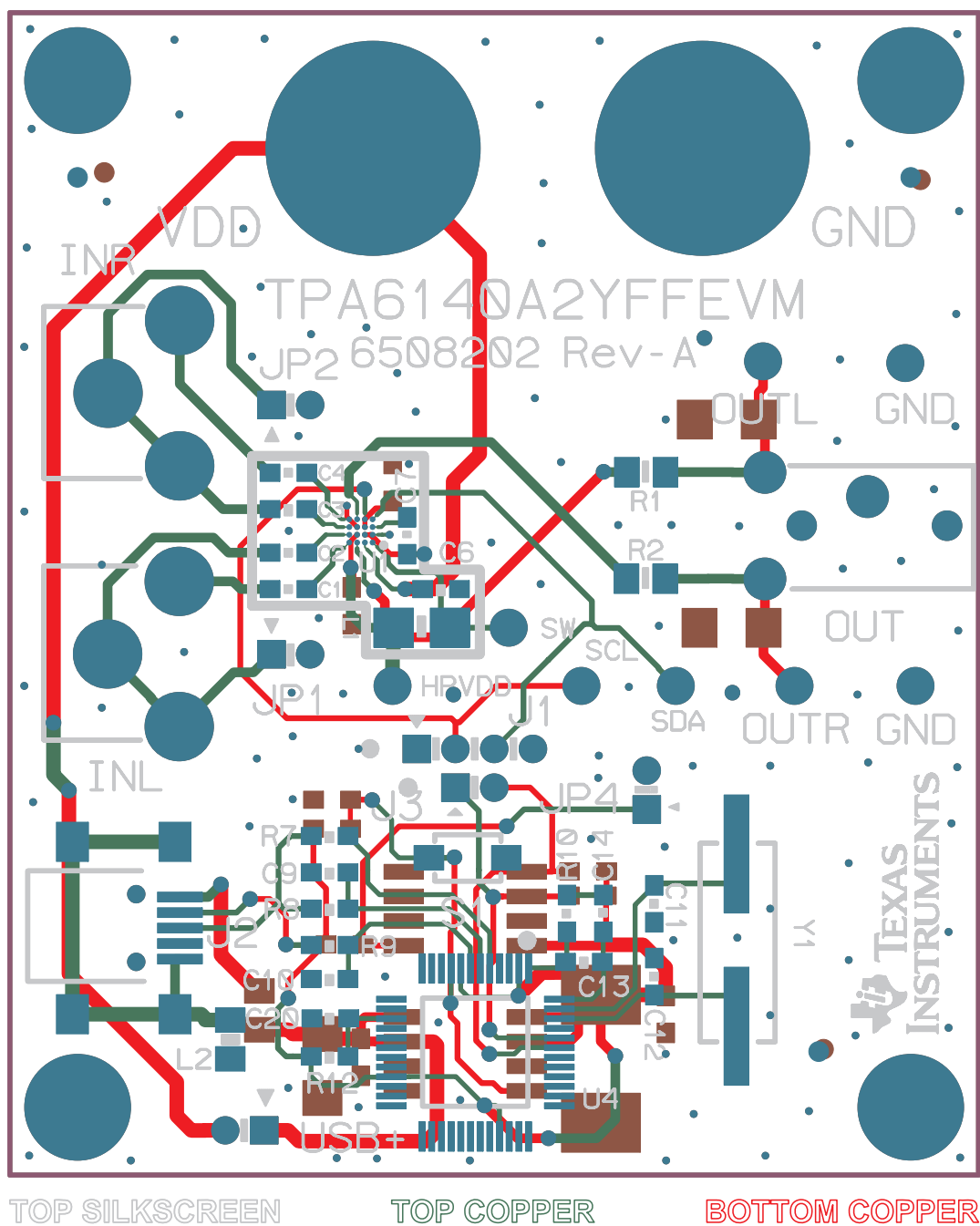
4 TPA6140A2EVM PCB Layouts for YFF Device
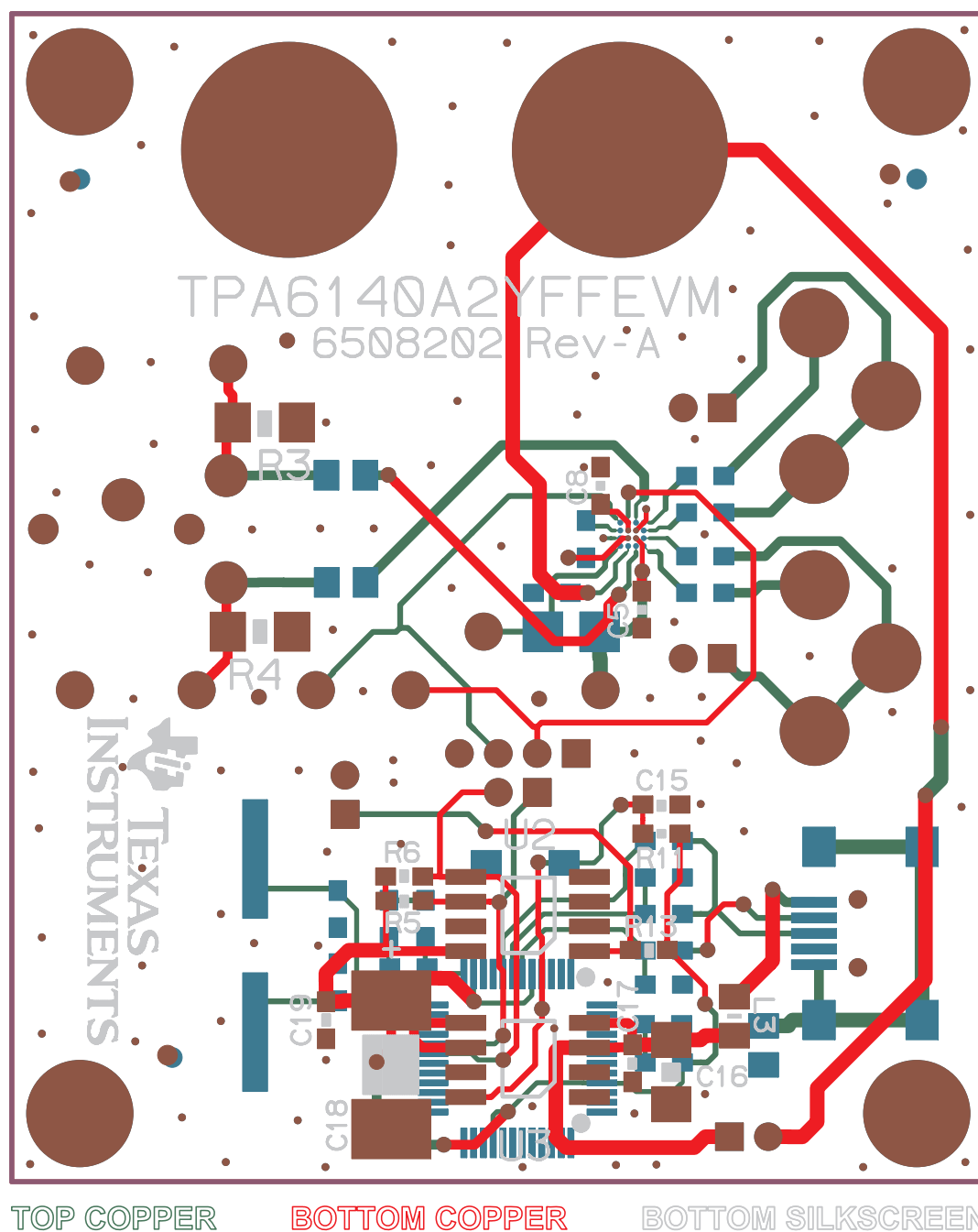

Figure 7. TPA6140A2EVM –Top Layer for YFF Device

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-60-32-5PXDN-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, OUTR, SCL, SDA, 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. ALUM-HEX	HW1–HW4	4	KEYSTONE ELECTRONICS	8401	DIGI-KEY

EVALUATION BOARD/KIT IMPORTANT NOTICE

FCC Warning

EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the supply voltage range of −0.3 V to 6 V and the input voltage range of −0.3 V to VDD +0.3 .

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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