TPA0102
Audio Power Amplifier Evaluation Module

APPLICATION REPORT: SLOU005

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TEXAS INSTRUMENTS

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Abstract

The Purpose of this document is to serve as a reference manual for the TPA0102PWP Stereo 1.5-W Audio Power Amplifier Evaluation Module (SLOP101). This document provides information on the optimal setup and operation of this product.

How to Use this Manual

This document contains the following chapters:

Chapter 1 Overview

A general description of the TPA0102, its key features, operating specifications, and design notes.

Chapter 2 User's Guide

A description of the TPA0102, hardware including board schematic, connections, layout and bill of materials.

I. Quick Start

Included below is a quick checklist of setup steps to get the TPA0102 up and running fast.

1. Set S1 to the “off” position.
2. Align the TPA0102 in socket U2, such that its pins line up exactly with the socket, and firmly connect it to the P-n-P board.
3. Check the power supply jumper setting on the P-n-P board. To use battery power select JP3, to select wall mount AC/DC power select JP2, or to use a bench type DC power supply select JP1 **Note: be sure only one of these three jumpers is connected by a shorting block.**
4. Check the mode/mute jumper circuitry (JP6, JP7, JP8). To begin with, set JP7 to Lo, JP8 to Hi and JP6 to Mode. This arrangement causes theTPA0102 to be in BTL mode when no headphones are present and SE mode when HP are plugged in. In the future refer to Table 1 in the P-n-P board Application Report (SLOU001) to adjust these settings.
5. Check the Audio Input Path Selection Circuitry, if there is no EVM present in U1, then set S2 to the “off” position
6. Set S3 to the “U2” position.
7. Connect a mono audio source to either J3 or J5 (or both), or connect a stereo audio source to J4.
8. Connect a 4Ω or 8Ω speaker(s) to either (or both of) the RCA jacks at J7 and J9 or to the wire clips at J8.
9. Connect your power supply to the P-n-P board.
10. Push S1 to the “on” position. Activate the audio source.

Step 10 will activate the EVMs present on the P-n-P. If you do not hear sound, please consult the troubleshooting section of the P-n-P Board application report (SLOU001).

To use power from J1, J2, B1 a DC/DC converter must be used at U6. If no converter is present, use DC power at J6.

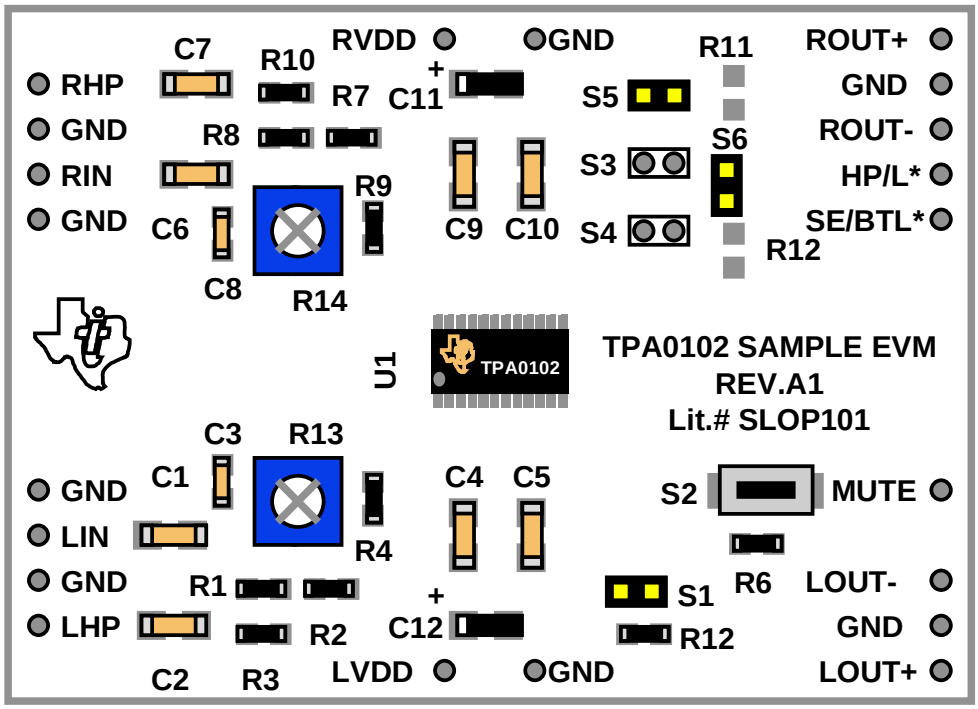
1. Overview

1.1 Introduction

The TPA0102 Sample EVM is designed to provide the basic circuitry required to evaluate the TPA0102 performance without having to invest in a PCB layout and assembly. Refer to the TPA0102 data sheet for a description of the basic circuit configuration.

1.2 Layout Definition

Figure 1 TPA0102 EVM Circuit Component Placement



U1 - TPA0102PWP
stereo 1.5 W Audio Amplifier


C1, C2 - Capacitor, 1.0 uF Ceramic

C3 - Capacitor, 5 pF Ceramic


C4, C5 - Capacitor, 2.2 uF Ceramic


C6, C7 - Capacitor, 1.0 uF Ceramic

C8 - Capacitor, 5 p uF Ceramic


C9, C10 - Capacitor, 2.2 uF Ceramic


C11, C12 - Capacitor, 10 uF Electrolytic

R1, R3, R4 - Resistor, 20 kΩ Carbon

R2, R5, R6 - Resistor, 100 kΩ Carbon

R7, R11 - Resistor, 100 kΩ Carbon

R8, R9, R10 - Resistor, 20 kΩ Carbon


S1, S3, S4 - 2 pin header


S2 - Switch, momentary, push botton

1.3 Operation Notes

The TPA0102 EVM (SLOP101) was designed to plug into TI's Plug-n-Play Audio Evaluation Platform (SLOP097). Slot U2 on the Plug-n-Play Audio Evaluation Platform is compatible with the TPA0102 EVM. No soldering is required for use in the Plug-n-Play Audio Evaluation Platform system. Standard speaker jacks, RCA jacks and 1/8" headphone jacks are provided on the Plug-n-Play Audio Evaluation Platform for quick and easy evaluation of all TI TPA series audio power amplifier EVMs. The TPA0102 is normally used as a single chip audio drive speaker and headphone/line outputs on notebook computers.

The connection pins of the TPA0102 EVM are on a 0.1" grid for easy interface to standard plugboard based prototype systems. The thermal layout of the EVM is important. Linear audio power amplifiers dissipated large amounts of heat during operation. The data sheet for the TPA0102 (SLOS166a) details heat dissipation for 5 and 3.3 volt applications. The PowerPAD should be connected to as much copper area as possible on the surface of the PCB. This copper area should then be connected with vias to ground plane layers inside the PCB. This becomes more important in high ambient temperature applications.

The 24-pin TSSOP PowerPAD package is designed to dissipate heat into the PCB. Proper layout can dissipate up to 4 Watts of heat in room temperature applications. Special consideration must be given to thermal layout due to the effect on maximum ambient temperature operation. It is recommended to place a copper area under the IC equal to the flat area of the IC body. This copper area should then be connected to the ground plane layer with vias. The vias should not use WEBed connections but should have a solid connection to the copper areas. The solid connections makes a much better thermal connection. Refer to the TPA0102 data sheet, Thermal Applications section, for detailed information on thermal layout and related thermal calculations.

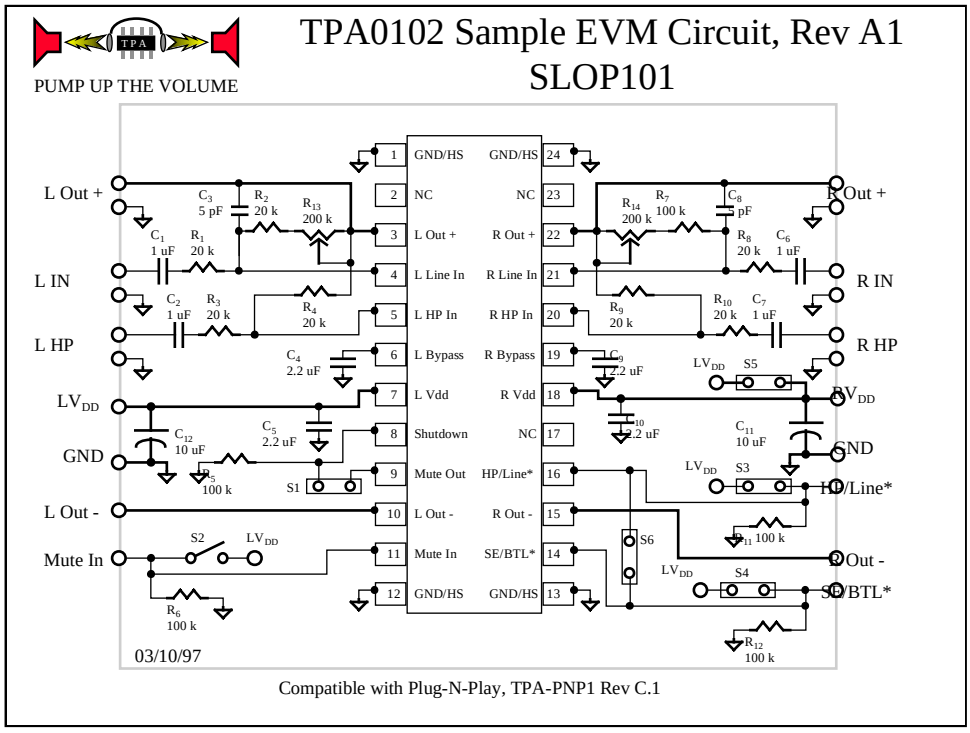
With 4 ohm speakers, 1.5 Watts rms power levels are possible at less than .05 % Total Harmonic Distortion (THD) with a steady-state sine wave input. Real music power will vary according to the type of music. Peak-to-average ratios vary greatly among different types of music. A 9 to 12 dB peak-to-average ratio is a good figure for rough calculations. In terms of power this means 1.5 Watts peaks would come from an average listening power of 94 mW for 12 dB and 188 mW for 9 dB.

$$Headroom_{dB} = 10 \text{ Log } (P_{max}/P_{avg})$$

2. User's Guide

2.1 Schematic

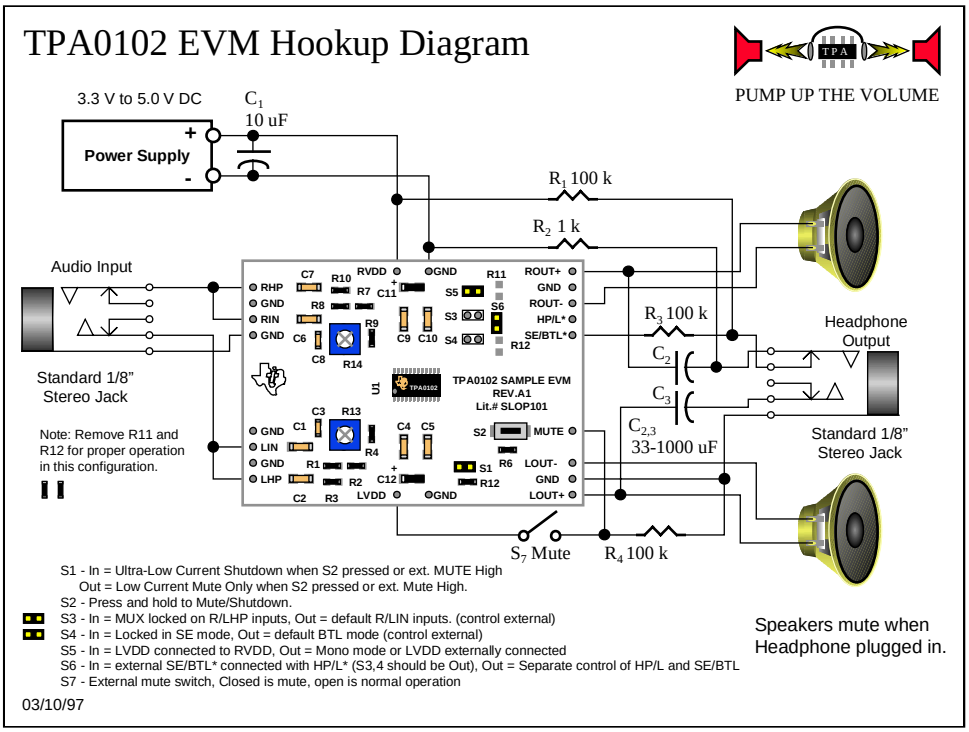
Figure 2



TPA0102 EVM Schematic

2.2 Input/Output Connections

Figure 3 TPA0102 EVM Hookup Diagram



The hookup diagram shows a complete stereo output drive system using the TPA0102 EVM (SLOP101) configured to drive stereo speakers and a headphone output jack. A standard 1/8” stereo input jack is shown providing a convenient connection to CD players and other commercial sources of audio signals.

2.2.1 Key Features

The key features of the system are:

- Stereo Bridge-Tied-Load (BTL) drive of 4 ohm speakers. BTL drive for internal speakers provides the optimum Audio-Power-to-Supply-Voltage ratio, eliminates output coupling capactorss and enhances power supply noise rejection.
- Stereo Single-Ended (SE) drive of 4 ohm and greater external speakers or headphones. SE drive is required for the standard 1/8” stereo jack due to the 3-wire connection to the loads. Output coupling capacitors are required for the SE outputs as shown.

- Mute of the Speaker Drive - The BTL/SE control input on the EVM is used to control the mode of the amplifier. When the speakers are in use, the TPA0102 is in BTL mode. When a headphone plug is inserted into the output jack, the speakers mute and the TPA0102 is in SE mode.
- Independent Input MUX for headphone and speaker drive - Typically small speakers of the type found in computer systems require a higher gain than a headphone set. A ratio of about 10 is a good place to start. In the above configuration the gain of the speakers can be adjusted such that when the headphone is plugged in the listening level is essentially the same as the speakers. The gain of the headphone channel is fixed at -1. For a quick adjustment, set the gain pots to about mid scale. Using S6 to tie the BTL/SE control input to the HP/L control input will automatically switch the input channels when the headphone plug is inserted.

2.3 Controls Explanation

Power: 3.0 to 5.5 Vdc, 2 A peak, 1.25 A rms (Peak Tone), .5 A rms (12 dB Normal Music)

Audio Inputs: L/R IN1, Cap Coupled (1.0 uF), 0.75 Vpp Max,
G = 2 to 22 BTL Mode,
L/R HP2 , Cap Coupled (1.0 uF), 4 Vpp Max,
G = 1

Speaker Outputs: L/R Out+/Out-, BTL 4 ohm drive,
1.5 W rms continuous

L/R Out+, SE 4 ohm drive,
400 mW rms continuous

L/R Out+, SE 32 ohm drive,
70 mW rms continuous

BTL/SE* Input: High for SE Mode, Low for BTL Mode - S4 IN locks in SE mode.

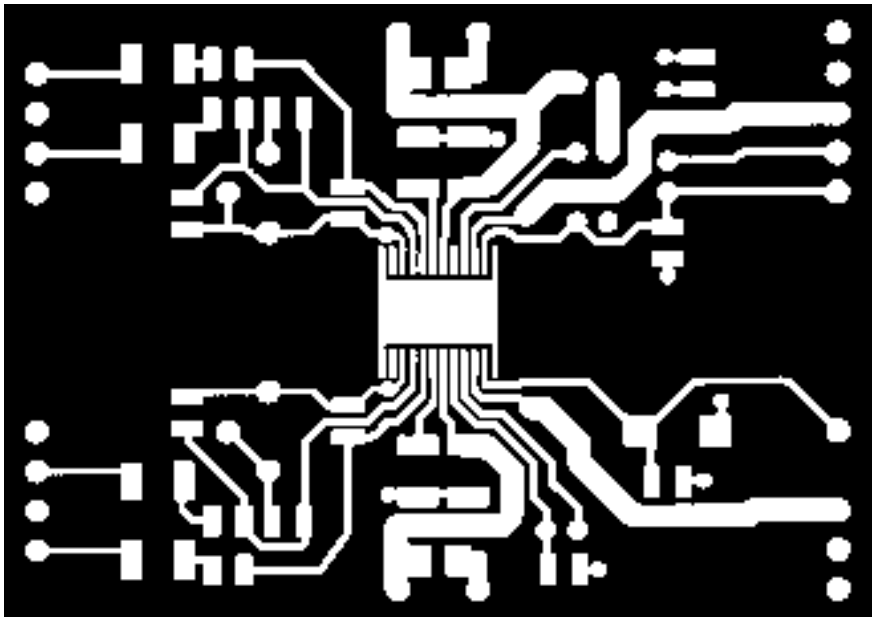
HP/LINE* Input: High for L/R HP2, Low for L/R Line - S3 locks in L/R HP2 select.

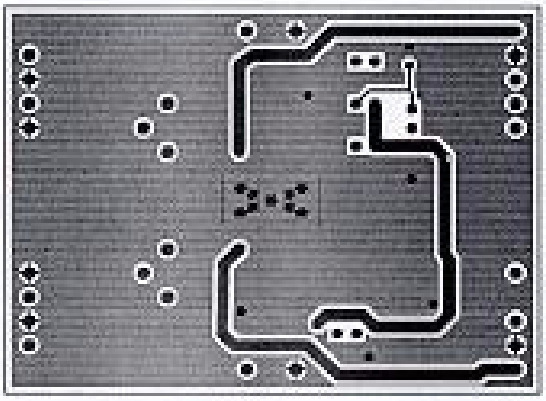
Mute In Input: High places amplifier in low current state (S1 IN follows mute to place device in ultra-low current mode), outputs are muted.

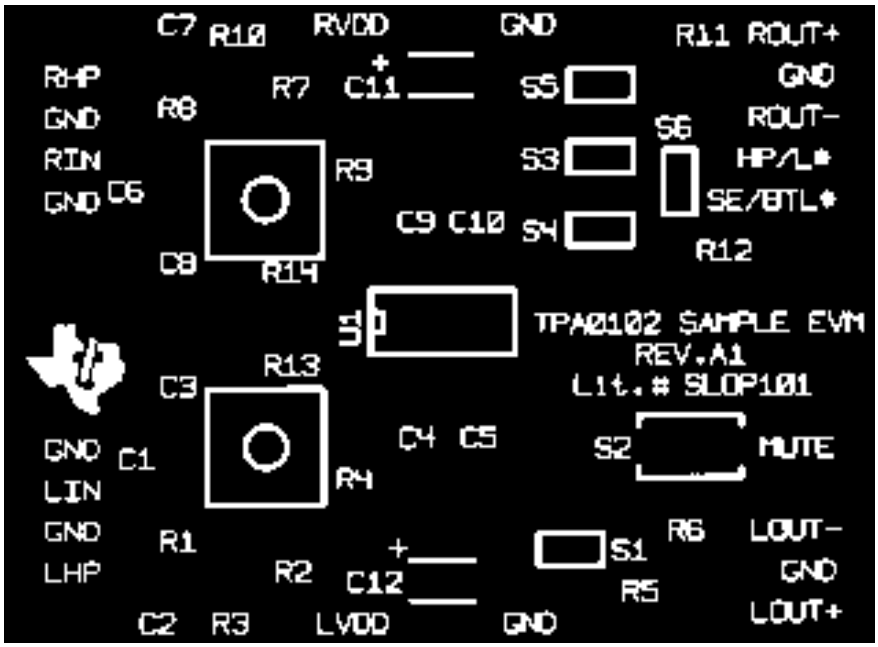
Mute Switch: Switch is a momentary action push button. Press S2 to pull mute high and mute amplifier.

2.4 Layout

NOTE: Layouts are not drawn to scale







Note: Layouts are not drawn to scale.

2.5 Bill of Materials

Table 1 - Bill of Materials

ITEM	DESCRIPTION	REFERENCE DESIGNATOR	PCBA QUANTITY	MANUFACTURER'S PART NUMBER	MANUFACTURERS PART NUMBER
1	CAP., 1.0UF, +80/-20%, NON POLARIZED, SMD SIZE 1206	C1,C2,C6,C7	4	(MURATA) GRM42-6Y5V105Z16BL	(NEWARK) 93F2254
2	CAP., 2.2UF,20%, NON POLARIZED, SMD SIZE 1206	C4,C5,C9,C10	4	(TDK) C3216X5R1A225	
3	CAP, 5.0 PF, SMD, SIZE 0805	C3,C8	2	(PANASONIC) ECU-V1H050CCN	(DIGI-KEY) PCC050CNCT-ND
4	CAP., 10UF/6.3V,SMD,SIZE "A"	C11,C12	2	(PANASONIC) ECS-TOJY106R	(DIGI-KEY) PCS1106CT-ND
5	RES., 20 K OHM, 1/8W, 5%, SMD, SIZE 0805	R1,R3,R4,R8,R9 ,R10	6	(PANASONIC) ERJ-6GEYJ203V	(DIGI-KEY) P20KABK-ND
6	RES., 100 K OHM, 1/8W, 5%, SMD, SIZE 0805	R2,R5,R6,R7,R1 1,R12	6	(PANASONIC) ERJ-6GEYJ104V	(DIGI-KEY) P100KABK-ND
7	POT., 200 K OHM, 1/8W, 20%, THRU HOLE	R13,R14	2	(BOURNS) 3323P-1-204	(DIGI-KEY) 3323P-204-ND
8	SWITCH, MOMENTARY, SMD	S2	1	(PANASONIC) P8048SCT-ND	(DIGI-KEY) P8048SCT-ND
9	HEADER, 2MM, 2 POSITION	S1,S3,S4	3	(NORCOMP)	(DIGI-KEY) 2163-02-ND
10	SHUNTS, 2MM	P1,P3,P4	3	(3M)	(DIGI-KEY) 953170-30-ND
11	IC., TPA0102, AUDIO AMPLIFIER, 1W, 2 CHANNEL,SMD, 24 PIN TSSOP	U1	1	(TI) TPA0102	
12	PCB, TPA0102 SAMPLE EVM (Rev. A1)	PCB1	1	(COMPUROUTE) TOOL # 008032	