

TDA89x0SMPS Audio Amplifier Module - preliminary

The TDA89x0SMPS Audio Amplifier Module is a Class D Stereo Audio Amplifier with integrated SMPS, based on TDA8920/8950 Class D Audio Power Amplifier IC made by NXP (Philips) Company, together with a universal input, resonant mode SMPS. This amplifier is a complete solution for middle and above middle power level, it only requires signal and loudspeakers. The board can be used both in new designs, in which the user will adopt the preferred housing, input stages and potentiometer, connectors, etc., and can be used also as a drop-in replacement for existing audio amplifiers. The TDA89x0 Audio Amplifier can be supplied with balanced input signal or with unbalanced input signal. Also, the input stage is configured to be bridged easily without any other extra adapter.

Amplifier Features:

- TDA8920 version: Output Power: 2x65W at 4Ω, or 35W at 8Ω, each channel with max. 0.1% THD+N.
- TDA8950 version: Output Power: 2x105W at 4Ω, or 55W at 8Ω, each channel with max. 0.1% THD+N.
- Output Power in Bridge mode TDA8920 version: 150W at 4Ω, or 130W at 8Ω with max. 0.1% THD+N.
- Output Power in Bridge mode TDA8950 version: 130W at 4Ω, or 210W at 8Ω with max. 0.1% THD+N.
- Audiophile sound Quality: 0.02% THD+N at 35W for TDA8920 version and 65W for TDA8950 version.
- Very good global efficiency: 87% at 2x40W at 8Ω for TDA8920 and 88% at 2x60W at 8Ω for TDA8950.
- Very low stand-by quiescent current, total power drawn from mains below 1W, green compatible.
- Universal mains AC supply voltage: 90V-250V AC at minimum 1A at 110V, 0.5A at 230V for TDA8920 version and 2A at 110V, 1A at 230V for TDA8950 version.
- Output over-current and short-circuit to GND or Powers supply rails protected, thermal protection.
- Zero dead time switching and very low quiescent current.
- 30 dB gain with thermal fold-back gain feature for the TDA8950 version.
- Can be used in both in stereo or BTL mode, balanced or unbalanced input signal without modifications.
- Compact size, 100x50x40mm for TDA8920 version and 100x50x50mm for TDA8950 version.
- Mute control for easy integration into system, Status LED indicator
- Screw type terminals for output and Power Supply.

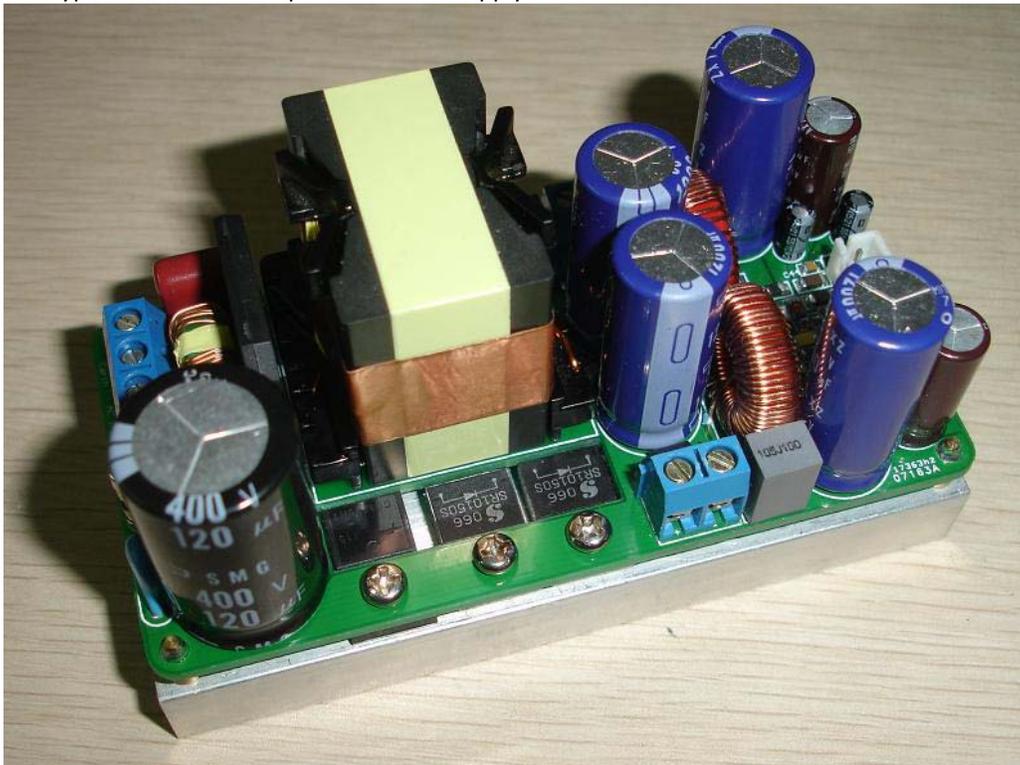


Figure 1: TDA89x0SMPS Audio Amplifier Module

Amplifier Description:

TDA89x0SMPS Audio Amplifier Module is built using TDA8920 or TDA8950, dedicated Audio Power amplifier Integrated Circuit and a Integrated Resonant Power Supply Controller and Switch. The TDA89x0 circuit has the role to convert the audio input signal into a digital Pulse Width Modulator (PWM) signal using an analog input stage and the PWM modulator. To enable the output power transistors to be driven, this digital PWM signal is applied to a control and handshake block and driver circuits for both the high side and low side. In this way a level shift is performed from the low power digital PWM signal (at logic levels) to a high power PWM signal which switches between the main supply lines. A 2nd-order low-pass filter converts the PWM signal to an analog audio signal across the loudspeakers. The TDA89x0 one-chip class-D amplifier contains high power D-MOS switches, drivers, timing and handshaking between the power switches and some control logic. For protection a temperature sensor and a maximum current detector are built-in. The two audio channels of the TDA89x0 contain two PWM modulators, two analog feedback loops and two differential input stages. It also contains circuits common to both channels such as the oscillator, all reference sources, the mode functionality and a digital timing manager. The TDA8920B contains two independent amplifier channels with high output power, high efficiency, low distortion and a low quiescent current.

The pinout of the input connector is as follows:

- Pin 1 Left Channel Positive Input
- Pin 2 Left Channel Negative Input
- Pin 3 GND
- Pin 4 Mute
- Pin 5 GND
- Pin 6 Right Channel Positive Input
- Pin 7 Right Channel Negative Input

The amplifier can be connected in the following configurations:

- Stereo Single-Ended amplifier with balanced input signal, pin 1 +Left, pin 2 –Left, pin 6 +Right, pin 7 –Right.
- Stereo Single-Ended amplifier with unbalanced input signal, pin 1 GND, pin –Left, pin 6 +Right, pin 7 GND.
- Mono Bridge-Tied Load (BTL) amplifier, with balanced input signal, pin 1 and 7 +Signal, pin 2 and 6 –Signal.
- Mono Bridge-Tied Load (BTL) amplifier, with unbalanced input signal, pin 1 and 7 +Signal, pin 2 and 6 GND.

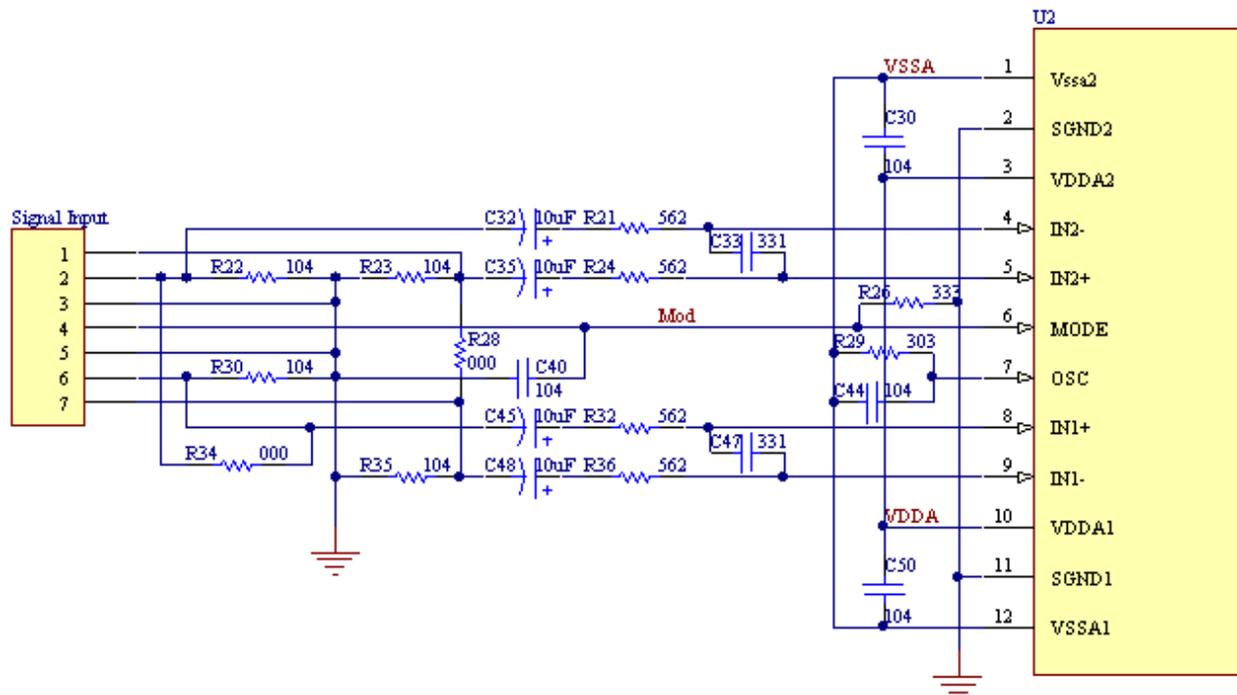


Figure 2: TDA89x0SMPS Audio Amplifier Module Input stage Schematic Diagram

Notice that channels left and right are driven with 180° shifted audio signal, and output is also shifted with 180°, so the left loudspeaker should be connected with – pin to output and + pin to GND. In this way, using the amplifier in BTL mode is easy, by simply connecting the both inputs together and the load between the outputs, without GND connection. In this case the system operates as a mono BTL amplifier and with the same loudspeaker impedance an approximately four times higher output power can be obtained. Another important advantage is that the pumping effect is attenuated due to the opposite signal phase from the Left and Right Channels, and the current handling of the power supply at low frequencies audio signal is improved. The amplifier Closed Loop Voltage Gain has the value of 30dB in stereo mode, and 36dB in BTL mode. The gain is fixed and cannot be changed, unless is used an input attenuator for reducing the gain, or an input preamplifier for increasing the gain. For most application, this gain values are optimal and does not require changes.

For pop noise-free start-up an RC time-constant is applied on the MODE pin. The bias-current setting of the VI-converter input is directly related to the voltage on the MODE pin. In turn the bias-current setting of the VI converters is directly related to the DC output offset voltage. In Mute mode the bias current setting of the VI converters is zero (VI converters disabled) and in Operating mode the bias current is at maximum. The time constant required to apply the DC output offset voltage gradually between Mute and Operating mode levels can be generated via an RC-network on the MODE pin. Thus a slow dV/dt on the MODE pin results in a slow dV/dt for the DC output offset voltage, resulting in pop noise-free start-up. A time-constant of 500 ms is sufficient to guarantee pop-free start-up. The amplifier system can be switched to one of three operating modes by pin MODE:

- **Standby mode**, with a very low supply current when on Mode Pin is applied a voltage less than 0.8V DC.
- **Mute mode**, the amplifiers are operational; but the audio signal at the output is suppressed by disabling the VI-converter input stages, when on Mode Pin is applied a voltage between 2.2V and 3V DC.
- **Operating mode**, the amplifiers are fully operational with output signal, when on Mode Pin is applied a voltage between 4.2V and 5.5V DC.

Application instructions:

The TDA89x0SMPS Audio Amplifier Module is fully assembled and tested and can be used as Power Audio Amplifier in custom designed or DIY amplifiers or can be used as drop-in replacement for existing audio amplifiers, which already have housing and input stage. The amplifier requires to be mounted onto an external heat sink which will be able to dissipate the heat generated by the TDA8920/8950 IC and the Power Supply. Limiting factor is the 150 °C maximum junction temperature $T_j(\max)$ which cannot be exceeded. Note that due to the finite thermal resistance between the chip junction and the heat sink, the heat sink maximum temperature will be much lower than the junction temperature, even when the junction has a temperature close to 150°C. To keep the chip temperature within the limits, a heat sink with maximum 3.5 K/W is required. Convection cooling is enough, no need forced air cooling unless the heat sink is very small and is fitted inside a tight and unventilated space, or in case of using few modules together in as small housing. The TDA8920/8950 IC heat sink must be installed with very good thermal conductor. Thermo conductive silicon can be used between the heat sink and Amplifier base-plate. The mounting screws should be M3 size, with maximum length of 3mm on the baseplate, and the tightening torque should be between 0.25 to 0.35 Nm. The size and position of the heat sink holes should be same as the board holes, which can be seen in the Figure 3. A tolerance of less than 0.3 mm is recommended.

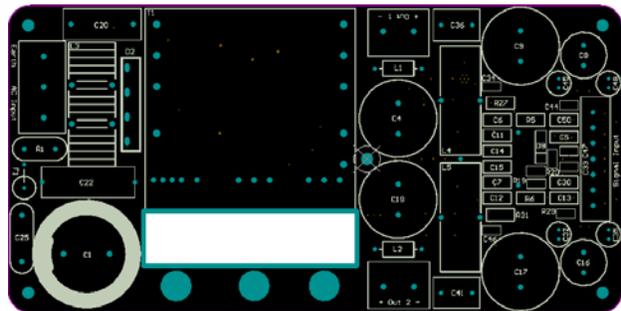


Figure 3. Board layout and mounting holes position.

The Mains power supply is connected to the screw type connector placed on the top left of the board. The pin-out is as follows: Pin 1: Earth, Pin 2: neutral, Pin 3: Live. Special care must be taken when wiring the amplifier mains supply, since potential lethal voltages are present. The amplifier should be connected to protective Earth on pin 1 of the mains power supply connector. This pin is connected to the amplifier base-plate and heat sink as well, and the amplifier GND. Ground loops must be avoided, otherwise the amplifier will be unstable, will have noise and the power stage can be damaged if the GND loops voltages are above the maximum voltage admitted.

The loudspeakers connectors are placed on the middle top and bottom of the board. The pin-out is as follows: - Left Speaker: bottom connector, Pin 1 positive output, Pin 2 Negative Output.

- Right Speaker: top connector, Pin 1 positive output, Pin 2 Negative Output.

For stereo applications, due to inverted input the left loudspeaker should be connected with – pin to output and + pin to GND. In this way, using the amplifier in BTL mode is easy, by simply connecting the both inputs together and the load between the outputs, without GND connection.

Disclaimer:

The TDA89x0SMPS Audio Amplifier Module shall be used according with the instructions provided in this document. The user should NOT attempt to modify or change any of the parameters of this product, which can lead to malfunction. The designer and manufacturer of the product, **PCBstuff**, and the official distributor, **Connexelectronic**, will not be liable for any kind of loss or damage, including but not limited to incidental or consequential damages. Due to the high level of voltages on this board, the user should take all the caution measures needed when working with high voltage levels, should not touch any unisolated part of the board or connectors, or short-circuit any part of the board or connectors. Any misuse will be made on user responsibility.

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