

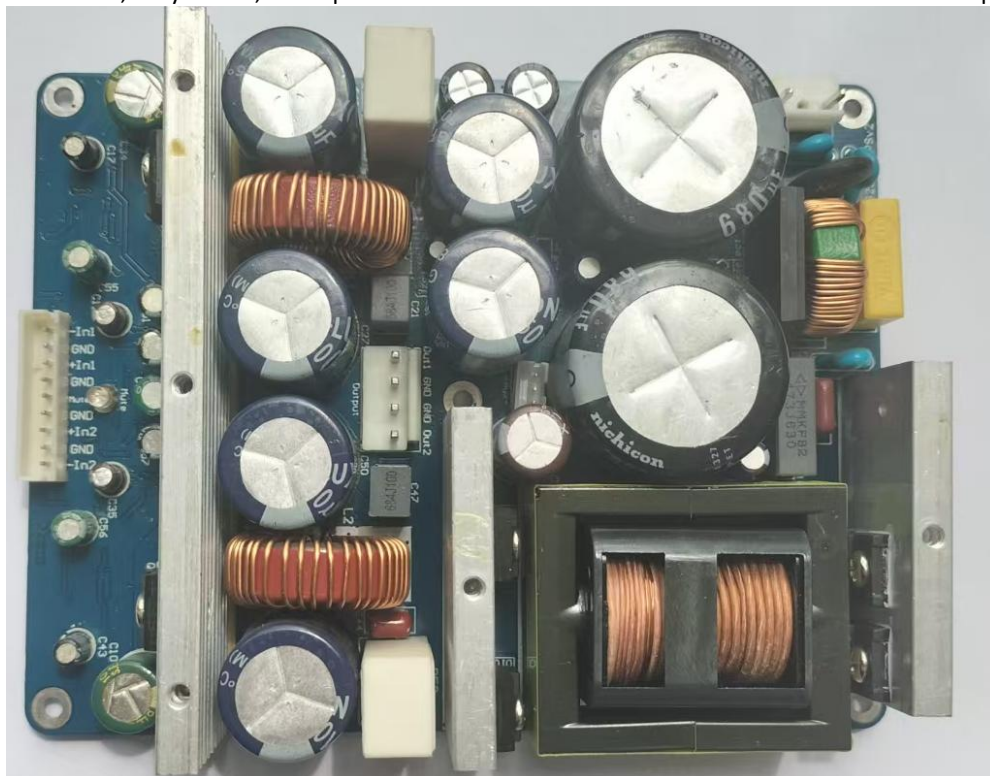
# IRS2200SMPS Audio Amplifier Module

IRS2200SMPS Audio Amplifier Module is a Powered Stereo Class D Audio Amplifier plug&play solution based on the IRS2092S dedicated audio power amplifier driver made by Infineon (formerly IR). The amplifier is optimized for 4Ω speakers and is capable to deliver 200W on each channel with less than 0.1% THD at rated power and as low as 0.02% THD at 10-80W power range. All the supply voltages and control signals required for proper operation are supplied by the on-board integrated Power Supply, No other external Power Supply is required.

IRS2200SMPS Audio Amplifier Module is a very compact Audio Amplifier module, just 130mm long, 100mm wide and 32mm tall, a very compact class D power amplifier can be built. IRS2200SMPS offers a complete solution for a compact, medium power audio amplifier system used for DIY built amplifiers or even OEM production amplifiers.

## Amplifier Features:

- Output Power: 200W at 4Ω, with max. 0.1% THD+N, @ 120V/230V mains supply voltage.
- 400W on 8Ω impedance in BTL mode @ 120V/230V mains supply voltage.
- Audiophile sound Quality: 0.02% THD+N at 80W on 4Ω impedance on all audio frequency range.
- High efficiency: Up to 90.4% at 2x100W, 8Ω with max. 0.1% THD @ 230V mains supply voltage.
- Full Protection set included: Short-circuit, over-current, over-temperature, over-voltage, under-voltage, active DC speaker protection with instant SMPS latched shut-down, click/pop free turn ON/Off.
- Quick and easy BTL operation without any additional signal phase shifter interface. Recommended BTL load impedance is 8Ω.
- Mute control and DC fast disconnect pins interface the amplifier with the dedicated RxE series SMPS.
- Compact size 100x130mm, 32mm tall, including PCB board thickness and SMD components underneath.
- Multi-channel setup possible, each IRS2200SMPS Amplifier Module can provide two channels of amplification with 200W into 4Ω or a single BTL channel with 400W into 8Ω
- Fully balanced input with 1.5V RMS input sensitivity for rated output power allows easy and straight-forward interconnection with standardized commercial audio sources.
- User accessible, easy to use, Mute pin and Mute On-board LED to indicate the status of the amplifier.



**Figure 1: IRS2200SMPS Amplifier Module appearance**

## Amplifier Description:

The cores of the IRS2200SMPS Audio Amplifier are two IRS2092S IC's, dedicated Class D Audio Power Amplifier driver, one for each channel as well as several other components to allow system integration.

The main blocks of this amplifier are:

- Input stage, which contains one low-noise, high performance Operational Amplifier for impedance matching and to allow both balanced and unbalanced input connections;
- Amplifier Power Stage, built around IRS2092S dedicated Class D amplifier controller, one for each channel plus the Class D dedicated dual-transistor MOS-FET;
- House-keeping power supply, control and protections circuits and dedicated SMPS interface circuits.

**Input Stage:** The audio input signal is provided to IRS2200SMPS through the Signal connector passes through a preamplifier stage which has the role of impedance adapter and balanced/unbalanced input adapter. The IRS2200SMPS Amplifier gain is a product of input stage gain and power stage gain. The default gain of the input stage is 2.3. The gain of Left Channel is:  $R4/(R2+R3)$  and for Right Channel:  $R34/(R31+R32)$ .

The input low-pass filter removes some of the very high, above the audio frequency range components, and allow only signals below 24KHz to pass to prevent beating or other class-D amplifiers associated issues. Having both the inverted and non-inverted inputs routed to the Signal Input connector, a quick and easy installation is possible. **One inherent advantage of fully balanced input is that the amplifier can be used with one channel 180° out of phase and the corresponding speaker output also inverted to avoid bus pumping phenomenon.** Changing the modes from balanced to unbalanced as well as Stereo to BTL is very easy and does not require any additional preamplifier or adapter just proper wiring.

The **Signal** input connector pinout is as follows:

- Pin 1: **-In1**: Inverting Input for Left Channel
- Pin 2: **GND**: GND Signal
- Pin 3: **+In1**: Non-Inverting Input for Left Channel
- Pin 4: **GND**: GND Signal
- Pin 5: **Mut**: Mute Control
- Pin 6: **GND**: GND Signal
- Pin 7: **+In2**: Non-Inverting Input for Right Channel
- Pin 8: **GND**: GND Signal
- Pin 9: **-In2**: Inverting Input for Right Channel

**Amplifier Power Stage:** The amplifier power stage comprises of one IRS2092S dedicated driver IC plus two dedicated dual MOS-FET transistors for Class D Audio amplifier applications. The topology used represents an analog version of a second-order sigma-delta modulation having a Class D switching stage inside the loop. The benefit of the sigma-delta modulation, in comparison to the carrier-signal based modulation, is that all the error in the audible frequency range is shifted to the inaudible upper-frequency range by nature of its operation. Also, sigma-delta modulation allows a designer to apply a sufficient amount of error correction. This self-oscillating topology consists of the following functional blocks: Integrator, Comparator, Level-shifter, Gate drivers, Power MOS-FET's and Output Low-pass Filter. More details are available on the IC manufacturer website.

Since the IRS2092S dedicated driver contains all the necessary blocks for a high performance class D amplifier, the implementation is simple and reliable. However, some parameters must be defined to allow operation in a wide range of conditions. These parameters are: amplifier gain, switching frequency, dead-time and several other parameters related to protection, such as Over-Current threshold, Over-temperature, and supply voltage limits, Under-voltage and over-voltage. Since all these parameters are optimally configured and tested during manufacturing for each board and each batch separately, there is no reason for end-user to change any of these parameters because it can worsen the operation conditions or even lead to malfunctions. In this manual, only a brief explanation regarding gain choice will be written.

The gain of the Power stage is 15.6, The gain of Left Channel is:  $(R1+R5)/R10$  and for Right Channel:  $(R30+R35)/R40$ . **The amplifier overall gain is 2.3 Input stage \* 15.6 Power stage = 36.** This requires 0.775V at the Input to achieve the rated 200W on 4Ω at the output of each channel.

Each amplifier batch and version is configured for optimal performance in terms of sound quality, electrical efficiency, and EMI radiation. We continuously try to improve the performance and parameters of the IRS2200SMPS amplifiers, by continuously testing and listening from minor to major changes of the Schematic and PCB layout. Due to the continuous improvement, some components might have different values from one version to another. We succeeded to improve the sound quality, efficiency and reliability as well as reducing the noise floor and EMI from the first batch released in 2014 till today by more than two fold, rising the IRS2200SMPS Amplifier sound quality and performance above most of the competitors.

The output filter of IRS2200SMPS is optimized for 6Ω loads to allow operation with both 4Ω and 8Ω loads without sacrificing the performances. It uses Micrometals®-2 material high-quality power inductors, made of special selected powder cores for high power and high frequency applications. Notable characteristics are high resistivity, low hysteresis and low eddy current losses and excellent inductance stability under both DC and AC conditions, no thermal aging, making them the most suitable choice for Output power inductor of a class D amplifier. Among these, Magnetics® Kool-Mu, MPP and HF can used, if carefully selected with excellent RF properties for some higher power versions. Although the current tendency on the market for similar IRS2092 amplifiers is to use a smaller and cheaper ferrite core inductor (more or less genuine) usually Sagami® replicas, easy to identify by the lack or genuine marking, and several other no-name brands, these are only suitable for a narrow power range applications, often up to 100-150W or even less due to their sharp saturation characteristics. Once the saturation current is reached, inductance sharply drops leading to high distortion and possible amplifier failure if the over-current protection isn't properly designed.

The amplifier has built-in Mute circuit, which allows silent turn ON/OFF without any click/pop noise and it can be operated without an additional speaker protection circuit because of its Active DC speaker protection with instant latched turn-off in case that DC component is detected at the output of any channels of the IRS2200SMPS Amplifier. Once the Fast-disconnect signal is pulled low, for at least 200uS to prevent false triggering, the power supply will shut-down immediately to prevent any possible damage to the speakers or the rest of the components from the amplifier. Because this error is unlikely to happen during normal operation, to resume operation, the Power must be disconnected from mains for at least 5 min allowing all the electrolytic capacitors to discharge and then can try again to restart. If the cause of DC component on output was not eliminated, the SMPS will shut down again immediately after power-on avoiding damage to the speaker. Note that this kind of fault is an abnormal situation never encountered in normal operation and should be avoided as much as possible because in some extreme cases can damage the amplifier due to bus-pumping. Possible causes are: excessive DC bias on the signal input, due to a damaged signal source or wrongly configured DC servo preamplifier which puts out DC voltage, which forces the amplifier power stage to deliver a biased output voltage proportional with input DC bias and sign.

**Over-current Protection:** The IRS2092 Stereo Audio Amplifier Module has built-in over-current protection circuitry to protect itself and the output transistors from over-current and short-circuit conditions. The over-current protection will Mute the corresponding amplifier channel when the current exceeds 22A and resume operation after approx. two seconds if the over-current condition was removed. The low-side current sensing feature protects the low side MOSFET from an overload condition in negative load current by measuring drain-to-source voltage across  $R_{DS(ON)}$  during its on state. OCP shuts down the switching operation if the drain-to-source voltage exceeds a preset trip level. The voltage setting on the OCSET pin programs the threshold for low-side over-current sensing. When the VS voltage during low-side conduction gets higher than the OCSET voltage, the IRS2092 turns off outputs and pulls CSD down to -VSS. At this values, the over-current threshold is set at 36 A. The high-side current sensing protects the high side MOSFET from an overload condition in positive load current by measuring drain-to-source voltage across  $R_{DS(ON)}$  during its on state. OCP shuts down the switching operation if the drain-to-source voltage exceeds a preset trip level. High-side over-current sensing monitors drain-to-source voltage of the high-side MOSFET while it is in the on state through the CSH and VS pins. The CSH pin detects the drain voltage with reference to the VS pin, which is the source of the high-side MOSFET. In contrast to the low-side current sensing, the threshold of CSH pin to trigger OC protection is internally fixed at 1.2V. An external resistive divider is used to program a threshold an external reverse blocking diode is required to block high voltage feeding into the CSH pin during low-side conduction.

**Under-voltage and Overvoltage Protection:** IRS2200SMPS Module senses the power rails through a dedicated detection circuit. The under-voltage and over-voltage thresholds are determined by the values of the resistors in the networks, and are power version dependent. If the supply voltage falls outside the upper and lower limits determined by the detection circuit, IRS2200SMPS module shuts enters in Mute condition. The removal of the over-voltage or under-voltage condition returns IRS2200SMPS module to normal operation. Please note that trip points specified in the Electrical Characteristics table are at 25°C and may change over temperature. The nominal operating voltage will typically be chosen as the supply “center point.” This allows the supply voltage to fluctuate, both above and below, the nominal supply voltage. Once the supply comes back into the supply voltage operating range (as defined by the supply sense resistors), IRS2200SMPS module will automatically be unmuted and will begin to amplify. There is a small hysteresis range on both the under-voltage and over-voltage thresholds. If the amplifier is powered up in the hysteresis band IRS2200SMPS module might misbehave and this supply voltage values must be avoided. Thus, the usable supply range is the difference between the over-voltage turn-off and under-voltage turn-off for both the V+ and V- supplies. It should be noted that there is a timer of approximately 300mS with respect to the over and under voltage sensing circuit. Thus, the supply voltage must be outside of the user defined supply range for greater than 200-300mS for IRS2200SMPS module to be muted.

**Bus Pumping:** An unwanted and potentially troublesome phenomenon present in all single-ended Class D amplifiers is the power supply pumping effect. It is caused by the flowing of the current from the output filter inductor into the power supply filter capacitors in opposite direction as the DC load sink current. The phenomenon is more evident at low-frequency and high amplitude signals, and if is not prevented it will trip the Over-voltage protection circuit, causing the amplifier to enter in Mute state until the supply voltage drop below the lower over-voltage protection threshold. Another cause of the Bus pumping is the DC offset which, if is larger than 100-200mV, opposite voltage rail will start increasing the voltage until the Over-voltage protection circuit will trip, and Mute the amplifier. IRS2200SMPS module does not need any kind of DC offset adjustment it has a very low DC offset, below 10mV. However, if the user is tempted to play with the input capacitor, and change it with some kind of potato size audiophile capacitor, or use no capacitor at all, relying on some sort of DC servo circuits, or not even such circuits, the smallest DC component present at the input of the amplifier will lead to DC offset at output and consequently lead to bus-pumping. For this reason we strongly suggest to NOT change the input capacitor or at most, if there's no way to convince of uselessness of this action, use a similar value and size. There is one single electrolytic capacitor in the entire signal chain for each channel, C11 for Left Channel and C35 for Right Channel, and in is strongly recommended to be kept as it is and NOT be changed with any so called audiophile capacitor because the performances won't change in better, but for sure in worse including the risk of damaging the amplifier by shorting or breaking PCB tracks. The currently used capacitors were selected for best parameters and all the amplifier tests and measurements were made using these capacitors.

There are few solutions to reduce the Bus-pumping. If the pumping effect is too high, this will lead to amplifier oscillations between ON/OFF states, since the under-voltage and over-voltage protection is not latched shutdown. The first solution is to use large Electrolytic capacitors on each power supply voltage rail to absorb the pumped supply current and to use-it in the next switching cycle. This method is less efficient when the output amplitude increase and the frequency decrease, being ineffective with DC signal Also, adding external electrolytic capacitors is impractical, will increase the size and is unreliable. **The best solution to avoid Bus-Pumping is to drive one amplifier channel 180° out of phase with respect to the other.** This setup will reduce the Bus-pumping in stereo and BTL amplification because each channel is pumping out of phase with the other, and the net effect is a cancellation of pumping currents in the power supply. The phase of the audio signals needs to be corrected by connecting one of the speakers in the opposite polarity as the other channel. To achieve the phase shift, the input signal must be connected as shown in Figure 4-7, and taking advantage of using the amplifier with differential audio signal input when is available.

**EMI Reduction:** Each power MOS-FET has a fast recovery diode connected in parallel for reduction of ringing on the outputs of the MOS-FET's. They shunt the inductive energy generated in the parasitic inductance of the components leads and PCB tracks. The fast-recovery type SMD diodes are connected close to MOS-FET transistors to minimize the ringing. For some amplifier version, the diodes are redundant since the MOS-FET's body diodes are hyper-fast type and external diodes are not absolutely required.

Furthermore, for reducing the ringing, few bypass capacitors are placed close to output power MOS-FET's. There are 2 types of capacitors: one type is X7R material, ceramic capacitors, SMD1206 footprint placed on the bottom side of the PCB, very close to the output MOS-FET's and the other type are electrolytic capacitors, for energy storage during peaks. The ceramic capacitors are connected between V+ and GND, V- and GND and V+ to V-. They provide extremely low stray inductance and ESR, which is helpful for reducing ringing. The electrolytic capacitors acts as energy storage tank during peak power consumption, as well as minimizing the pumping effect which switching amplifiers experience at high power outputs and low frequencies.

**Thermal Management:** The IRS2200SMPS Amplifier Module, has 3 small heatsinks to keep the temperature within normal operation limits. On the larger heatsink the Amplifier Power stage MOSFETs are mounted, and on the other two smaller heatsinks the power supply transistors and diodes are mounted. All the heatsinks have the same height, 28mm and M3 holes allowing the IRS2200SMPS Amplifier Module to be installed onto a larger Aluminium cooling plate which will thermally connect all the heatsinks, allowing better temperature transfer to a larger heatsink or to the Amplifier enclosure. The optimal installation require using 4 28mm long M3 stand-offs and install the IRS2200SMPS Amplifier Module top side down with the on-board heatsink in thermal contact with enclosure bottom or side area, whichever offers lowest thermal resistance. In some cases, if the system size is limited or is difficult to provide an additional cooling area, the existing on-board heatsink can be used if a small cooling fan is used, at least 40mm type with 3-4 cf/m airflow blowing the air through the heatsink fins outside of the enclosure. The recommended internal height of the amplifier enclosure is 35mm, which will allow a tight fit of the IRS2200SMPS Amplifier Module and direct contact between on-board heatsinks and enclosure top cover, which will be used as extended cooling area for both the IRS2200SMPS Amplifier Module. With such implementation, if the enclosure is made of aluminum, and has a total thermal resistance below 2.4°C/W the cooling fan can be omitted. The temperature increase is only caused by the Power MOS-FET's, the linear regulators for +12V and housekeeping supply dissipate a negligible amount of power and they are SMD type installed on the backside of the PCB board. The IRS2200SMPS Amplifier Module has an over-temperature sensor which will Mute the amplifier if the heatsink temperature rise above 85-90°C to protect the power stage from failure and will resume operation once the temperature dropped to about 75-80°C. If the amplifier is overloaded or poorly ventilated, leading to overheating, it will toggle between Mute and Operation around the over-temperature tripping point.

**Mute control:** When the Mute pin 5 of the **Signal** connector is connected to GND the both amplifier channels are muted (both high and low-side transistors are turned off). There is a delay of approximately 800 milliseconds between the de-assertion of MUTE and the un-muting of IRS2200SMPS Amplifier Module which prevents false activation due to possible noise induced in the Mute wires from nearby noise sources. When the IRS2200SMPS Amplifier Module is Muted, either from an external Mute control signal, or due to an over-current, over-voltage or under-voltage condition, Mute LED's will lit. During Power-On sequence, the Mute will be automatically controlled by the SMPS, the amplifier will be kept in Mute state for about two seconds till all the supply voltages reach the nominal value and the amplifier reach a stable operation state. This will lead to a noiseless Turn-ON without click or pop noises which is extremely important especially when the amplifier is used at very low initial sound volume. At Power-Off, the IRS2200SMPS Amplifier Module will be Muted as soon as the mains voltage drops for at least 50-60ms, while the SMPS still operates and the output voltages are still stable, for the same reason, to prevent any click or pop noise which might occur if any of the supply voltage falls earlier than the other ones.

Although the IRS2200SMPS Amplifier Module has noiseless Turn-ON and Turn-Off, in some cases click and pop noise can be perceived if the signal source is powered On after the IRS2200SMPS Amplifier Module reach the operating mode, or the signal source is powered off before the IRS2200SMPS Amplifier Module is powered Off due to the fact that the signal source transients will be amplified by the IRS2200SMPS Amplifier Module if the correct power sequencing was not set. If this issue is encountered is strongly recommended to configure the setup in such way that the IRS2200SMPS Amplifier Module will last Turn-On and first Turn-Off to avoid the transients being amplified. The user can implement a simple and easy Mute control for the IRS2200SMPS Amplifier Module using a toggle switch mounted on the front panel of the enclosure. The switch will connect together the Mute pin and any of the adjacent GND pins from the signal connector. No other component is required. Once the Mute switch is activated the amplifier will enter in Mute state and will resume operation less than a second after Mute button is released.

**BTL mode operation:** If the output power delivered by the amplifier in Single-Ended operation mode is not enough for a given application, IRS2200SMPS Amplifier Module can be used in BTL mode without any modification to the board, by just wiring the input signals accordingly, one channel 180° out of phase with respect to another. The theoretical output power in BTL mode is 4 times the power of a single channel on the same load, but practical output power which can be achieved with THD within low limits are between 3.2 to 3.8 times the output power of a single channel. However, when the amplifier operates with 8Ω load impedance, the output power is the sum of each channel driving a 4Ω impedance effectively doubling the output power on 8Ω in BTL mode. Operating the amplifier in BTL mode will cancel the Bus-Pumping phenomenon due to the fact that each channel is driven with 180° out of phase Audio Signal, and at any time power will be drawn from both supply rails, by each channel power stage alternatively. Although the amplifier is capable to drive loads with impedance as low as 6Ω, the minimum load impedance for BTL operation is 8Ω because in BTL mode both channels are operating simultaneously with the same amount of output power and the total dissipated power will be significant. The recommended BTL operation load impedance is 8Ω. When operating in BTL mode, the input signal amplitude for both channels must be identical, any difference in amplitude will lead to distortion and overloading. The easiest way to make sure the signal amplitude is identical for both channels is to wire the corresponding inputs in parallel and feed them from the same signal source.

**Layout:** The PCB Layout design has an important contribution to the overall performance of the IRS2200SMPS Amplifier Module. That's why double layer, FR-4 material with 1.6mm thickness was chosen. The tracks width, were calculated to withstand the currents which they have to carry, and also the distance between adjacent tracks which carries higher voltages than 50V is big enough to satisfy the clearance conditions imposed by the safety standards. The size of the PCB is 130 x 100 mm or approx 5.1 x 4 inch, and has 5 isolated mounting holes, on each corner of the PCB and one in the center. The mounting holes are 3.2mm diameter or 0.12 inch, copper plated and soldered, for better mechanical strength. The distance from the edge of the board to the mounting holes is 4mm for each hole, thus the mounting holes are arranged in a 122x92mm perimeter. The heat sink is mounted directly onto the PCB and does not require additional support. The heatsink height is 28mm and for easier installation, 4 brass standoffs with the same height can be installed from each mounting hole to the base plate or heatsink on which the on-board heatsink will stand as well. The standoffs are isolated from GND or any other potential, only the heatsink will be connected to Power GND, avoiding GND loops.

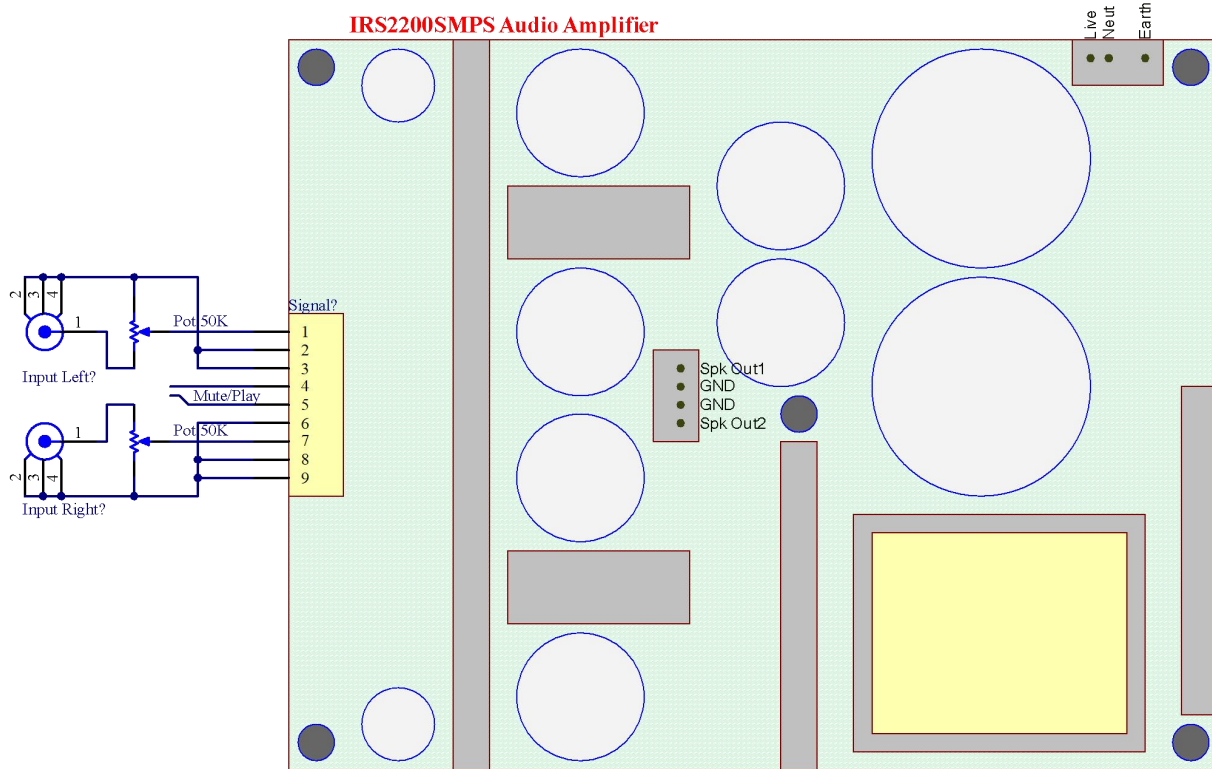
**Wiring:** the amplifier to the connectors, potentiometer, transformers, input boards, must be done with proper size wires and the cables must be laid carefully to avoid parasitic couplings, both capacitive and inductive, which will degrade the S/N ratio and amplifier performances. It is recommended to use heavy gauge wires for Power Supply and Loudspeaker Output and short shielded cables for Audio Input. The input cables can be wired with shielded cables as short as possible, far from the amplifier output section or **SMPS**. The power connections, to the loudspeakers and SMPS must be wired with wires which are able to carry currents in excess of 10A. **Attention** must be paid to insulation, especially for the mains powered wires, where double insulation wires must be used.

The 9 way wire harness, 4 way speaker wire harness and the Mains 3 way wire harness are included.

## Amplifier Connection and Operation:

For proper operation, IRS2200SMPS Amplifier Module must be used according with the instructions provided in this manual. IRS2200SMPS Amplifier Module can be used in several configurations, depending on the system requirements. To build a complete amplifier based on the configuration described, two RCA type Signal Input connectors for unbalanced input signal or two XLR connectors for balanced input signal and two Speaker connectors are needed. They must be installed on the enclosure backside and wired according to the schematics below, for each shown configuration.

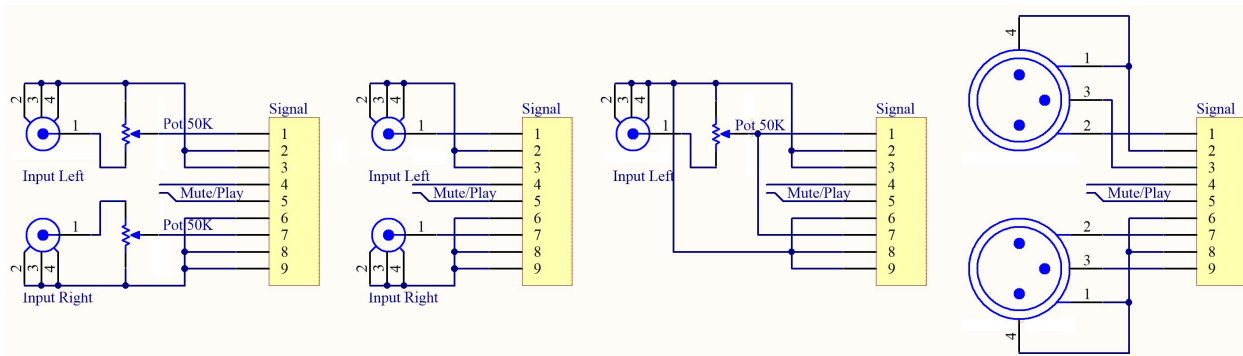
The most common and simple configuration use, unbalanced input signal and a dual potentiometer for adjusting the volume. IRS2200SMPS Amplifier Module can be supplied with either balanced or unbalanced audio signal with the maximum amplitude of 0.775V RMS. The audio signal must be applied at the input of the IRS2200SMPS Amplifier Module, on the Signal connector as can be seen in the following schematics. In the first schematic represented in **Figure2**, the signal phase is inverted for left channel input and the left speaker is also connected in anti phase to reduce bus pumping phenomenon. To be able to conveniently adjust the listening volume it is strongly recommended to use a potentiometer, logarithmic type with 50K $\Omega$  value or maximum 100K $\Omega$ .



**Figure2: IRS2200SMPS Amplifier Module Interconnection using unbalanced RCA connectors and potentiometer**

**Figure3** shows various interconnection schematics between IRS2200SMPS Amplifier Module and signal input sources and different input signal wiring configuration, using unbalanced input RCA Connectors and no potentiometer. The configuration without potentiometer must be used only when a preamplifier with volume control and free pop/click noise precede the amplifier in the signal chain. It is not recommended to use a mobile device, phone or tablet or even a desktop computer or a laptop with the configuration without potentiometer because all of these devices suffer from transients bursts which exceed the maximum limit for the IRS2200SMPS Amplifier Module amplitude of the input signal. It is very important to remember, to not connect or disconnect the Signal Input or the speaker output wiring or connectors while the amplifier is powered On. Any input or output wiring must be connected or disconnected only after the amplifier is powered off and the power cable is disconnected from mains wall plug. Failing to respect this simple rule might lead to damage of the amplifier or the signal source equipment.





**Figure3: Various Input Signal configuration for the IRS2200SMPS Amplifier**

Several input signal connection configurations are possible, four of them are shown in **Figure3** above. For simplification, only the input connector is shown with various input wiring configurations, from left to right:

1. Unbalanced input using RCA Connectors and potentiometer, explained in the description of **Figure2**.
2. Unbalanced input using RCA Connectors without potentiometer, explained in the description of **Figure3**.
3. Single channel BTL connection using one single RCA Connector and potentiometer. The speaker must be connected across + Out L which will be negative speaker terminal and + Out R which will be positive speaker terminal. No GND connection is required for speaker connection.
4. Fully balanced input using two XLR Connectors without potentiometer. The IRS2200SMPS Amplifier Module can be connected straightforward to a line level signal source.

## Connectors Pinout:

The Signal input connector pinout is as follows:

- Pin 1: **-In1**: Inverting Input for Left Channel
- Pin 2: **GND**: GND Signal
- Pin 3: **+In1**: Non-Inverting Input for Left Channel
- Pin 4: **GND**: GND Signal
- Pin 5: **Mut**: Mute Control
- Pin 6: **GND**: GND Signal
- Pin 7: **+In2**: Non-Inverting Input for Right Channel
- Pin 8: **GND**: GND Signal
- Pin 9: **-In2**: Inverting Input for Right Channel

The power supply fast-on tabs polarity is marked on the backside of the PCB silkscreen. It is strongly recommended to observe the polarity marked on the PCB and match the polarity with the polarity of the power supply output tabs. Double check the correct connection before power ON first time. Working connection can lead to damage of the the IRS2200SMPS Amplifier Module and power supply.

The speaker output screw terminal polarity is marked on the backside of the PCB silkscreen. It is recommended to observe the polarity marked on the PCB and phase the speakers with correct polarity. If the speakers are connected with wrong polarity the sound quality will be severely affected.

**IRS2200SMPS Amplifier Module measurements and performance:** To characterize the IRS2200SMPS Amplifier Module performances, some relevant measurements were done and displayed below:



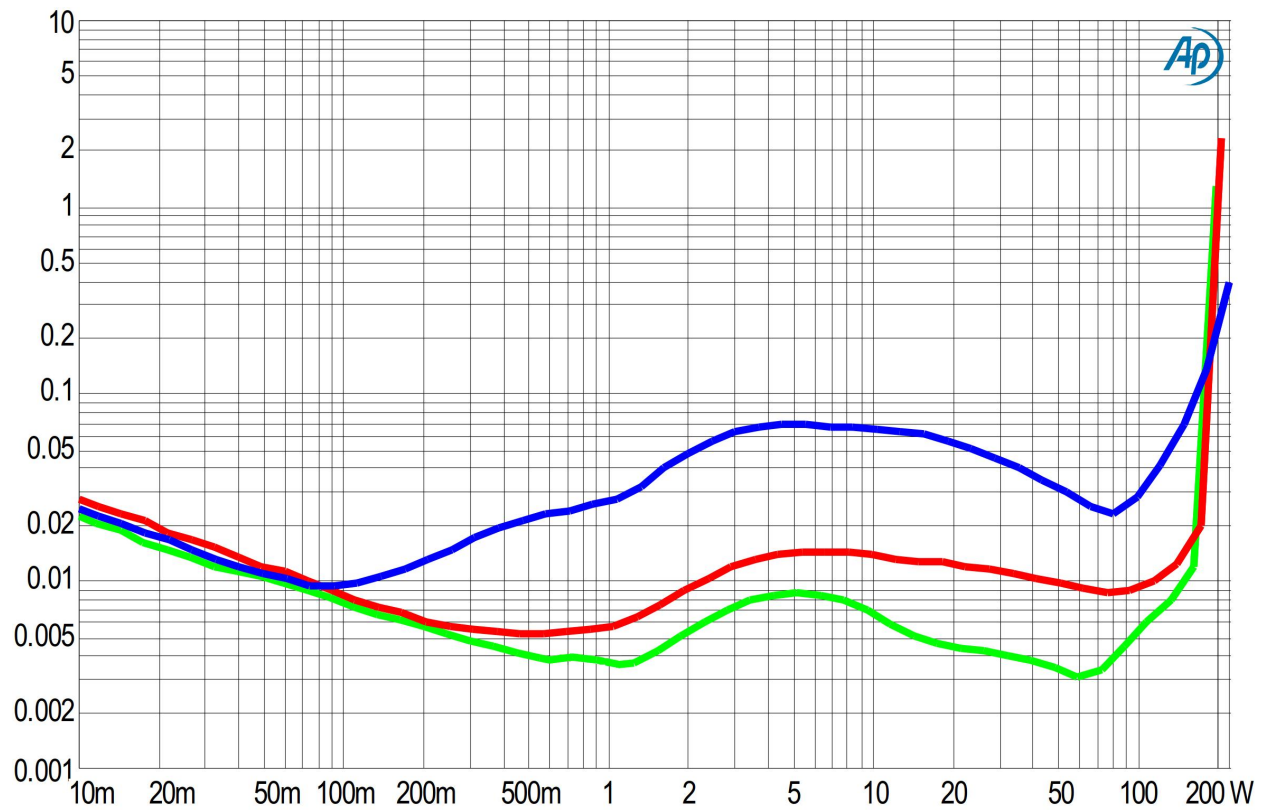


Figure5: THD vs Power on 6Ω for the IRS2200SMPS Amplifier at 100Hz green, 1kHz red and 6.7kHz blue trace.

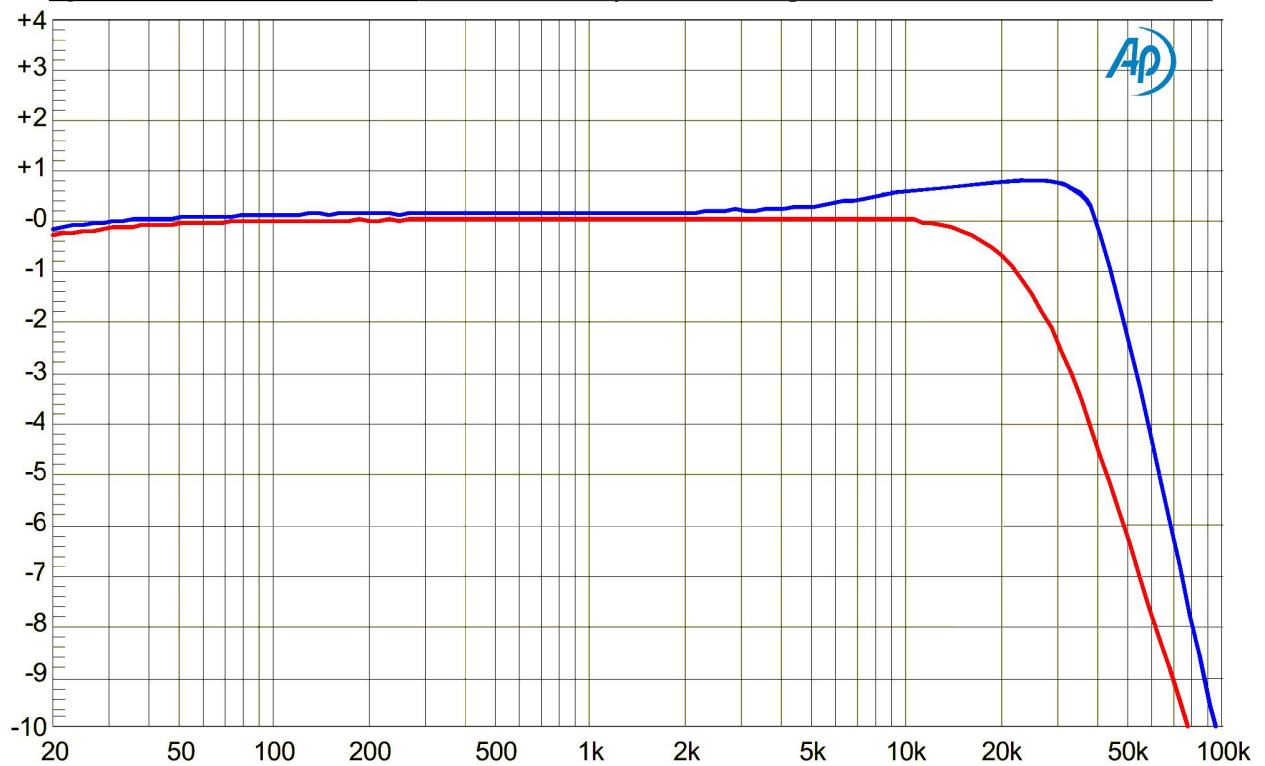
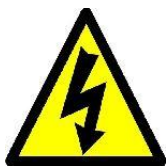


Figure6: Frequency response of the IRS2200SMPS Amplifier: red trace: 4Ω load impedance blue trace: 8Ω load impedance.



## Warning:

Before you proceed with installation, make sure you have read this warning:

The IRS2200SMPS Amplifier Module contains potentially hazardous voltages up to 320V DC or 230V AC. This voltage levels are present on the top and bottom of the board, and during installation and operation should never touch any part of the board while it is connected to the mains and at least 5 minutes after complete disconnect from mains. If any adjustment or re-connection needs to be done, disconnect the unit from the mains and allow all capacitors to discharge for at least 5 minutes before handling it. Any ignorance of this warning will be made on user's responsibility, and can lead to serious injuries and possible death by electrocution if is handled improperly. This product has no serviceable parts only the SMPS used together with the IRS2200SMPS Amplifier Module has an on-board mains fuse. In case of blown fuse, replace the fuse with the same type and rating only if no other visible damage occurred. Do not attempt to change any other component from the board, especially capacitors. A safety clearance of at least 6mm must be kept between the board and the case, or any conductive part of the amplifier.

## For best performances and long term reliable operation read before proceed!!!

Peaking phenomenon will occur when the amplifier input is connected or disconnected while the amplifier is powered ON or the input is touched by hand to "test" if the amplifier is working. This is a very stupid mistake for any kind of amplifier, as the body static voltage corroborated with the voltage induced by the near electromagnetic field, less than ideal mains to amplifier ground isolation, will lead to high voltages build-up usually tens of volts which have 90% chances to damage any kind of amplifier with input impedance bigger than 10KΩ. Although the mains hum is dominant when "testing" the amplifier using this rude method, there is a full, rich spectrum of frequencies up to tens or hundreds of KHz, something which any normal amplifier should never expect. To prevent the amplifier failure, and making it ~~idiot-proof~~, a more or less complex circuit can be employed but this will reduce its performances and sound quality, and due to this fact we strongly believe that the user know what he's doing and will avoid torturing the amplifier for its own good.

Although the amplifier comes with optimized components, yet some peoples still want to improve an optimized amplifier. The very common mistake found on Class D and T amplifier while tuning the amplifier, is to replace the input capacitors with bigger size, sometimes as big as a potato input capacitors. This is one of the biggest mistakes which can be possibly done on such amplifier. Not only that these placebo capacitors will not improve the sound, they will make it worse, and in some cases will damage the amplifier. Because as I wrote few rows above, the input should not be touched by hand or tools while is working, NEVER!!! (and this is often done during the tuning process) and these capacitors with their large volume and area will act like antennas which will pick-up the switching noise from the power stage, from the power supply, from environment, and also common mode noise from the amplifier housing if is made of metal and they are touching the case, even without electrical contact due to the stray capacitance between the capacitor and metal parts in close proximity.

## Disclaimer:

The IRS2200SMPS Amplifier Module Audio Amplifier 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, 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 mains voltages of this board, the user should take all the caution measures needed when working with mains voltages, should not touch any uninsulated 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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