

# CxD500 Audio Amplifier Module

The CxD500 Audio Amplifier Module is a complete assembled Class D Stereo Audio Amplifier containing all the necessary circuits for a complete modular power stage used as single or multi-channel amplifier. It is based on IRS2092S audio power amplifier driver made by International Rectifier. The amplifier output power exceeds 500W on 4Ω load impedance supplied at  $\pm 75V$  with THD+N below 0.1% and can reach 632W on 4Ω load impedance supplied at  $\pm 84V$  and 0.2% THD+N. The CxD500 Audio Amplifier Module along with a suitable Switched Mode Power Supply offers a complete solution for a compact, medium to high power audio amplifier system, especially for multichannel amplifiers or for OEM amplifiers.

## Amplifier Features:

- Output Power: 516W at 4Ω, or 264W at 8Ω, with max. 0.1% THD+N, supplied at  $\pm 75V$ .
- Output Power: 632W at 4Ω, or 320W at 8Ω, with max. 0.1% THD+N, supplied at  $\pm 84V$ .
- Output Power on 2R load: 920W with max. 0.1% THD+N, supplied at  $\pm 75V$  or 1135W supplied at  $\pm 84V$ .
- Output Power in Bridge mode for two identical modules supplied from same power source: 1810W at 4Ω or 1020W at 8Ω with max. 0.1% THD+N supplied at  $\pm 75V$  or 2110W at 4Ω or 1220W at 8Ω with max. 0.1% THD+N supplied at  $\pm 84V$ .
- Audiophile sound Quality: 0.01% THD+N at 470W at 4Ω or 280W at 8Ω supplied at  $\pm 78V$ .
- High efficiency: Up to 97.4% at 335W at 8Ω supplied at  $\pm 84V$  and 1% THD.
- Full Protection set included: Short-circuit, over-current, over-temperature, over-voltage, under-voltage.
- Mute control, status and DC fast disconnect pins for controlling the amplifier status within the system.
- Highest Power Density among all available class D amplifier modules: up to 5W per cm<sup>3</sup> or 80W per in<sup>3</sup>.
- Compact size 40x100mm, and 38mm tall including PCB board thickness and clearance under. Heatslug height 32mm, with M3 threaded holes on both sides and top side for easier Heatsink installation.

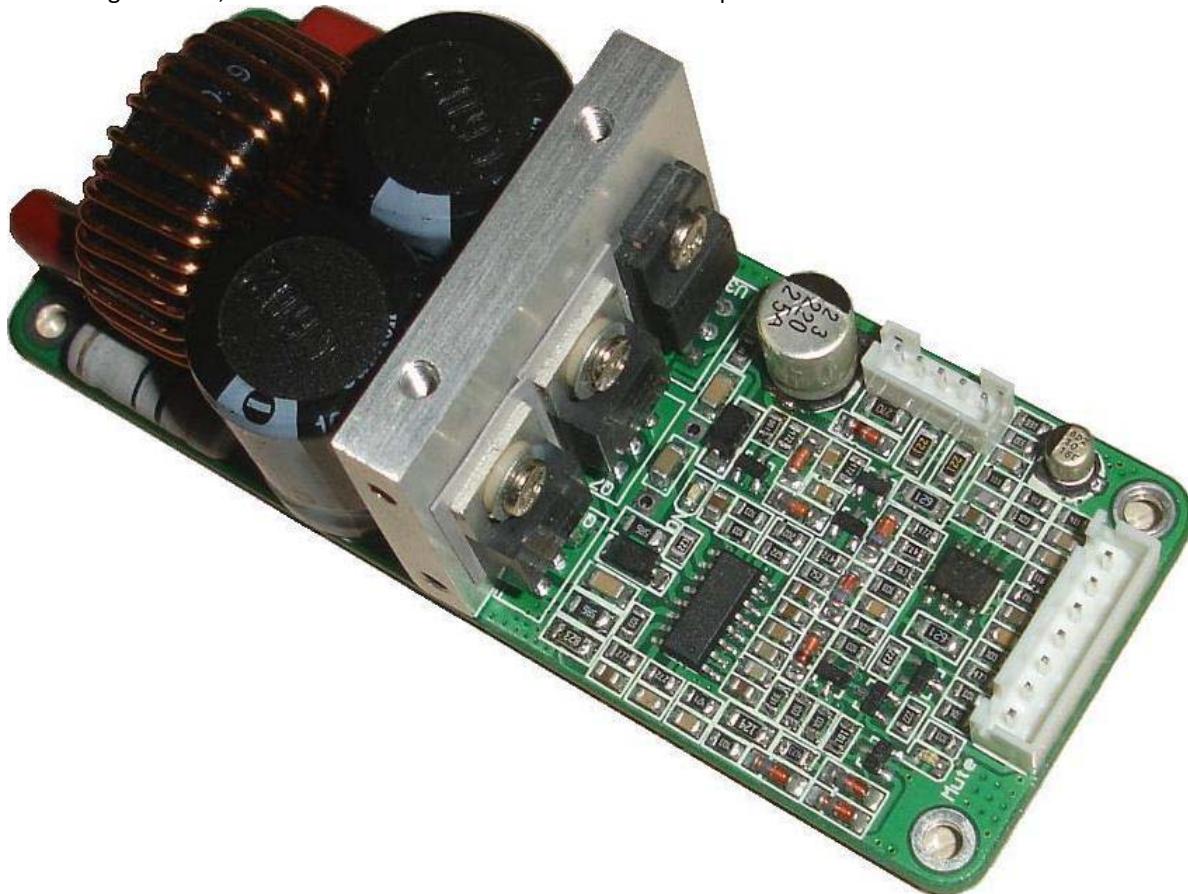


Figure 1: CxD500 Audio Amplifier Module

## Amplifier Description:

The CxD500 is built around IRS2092S, dedicated audio power amplifier driver, 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 match and to allow both balanced and unbalanced input connections;
- Amplifier Power Stage, built around IRS2092S dedicated Class D amplifier controller, one for each channel;
- Output Low-Pass Filter which re
- House-keeping power supply and protections circuits.

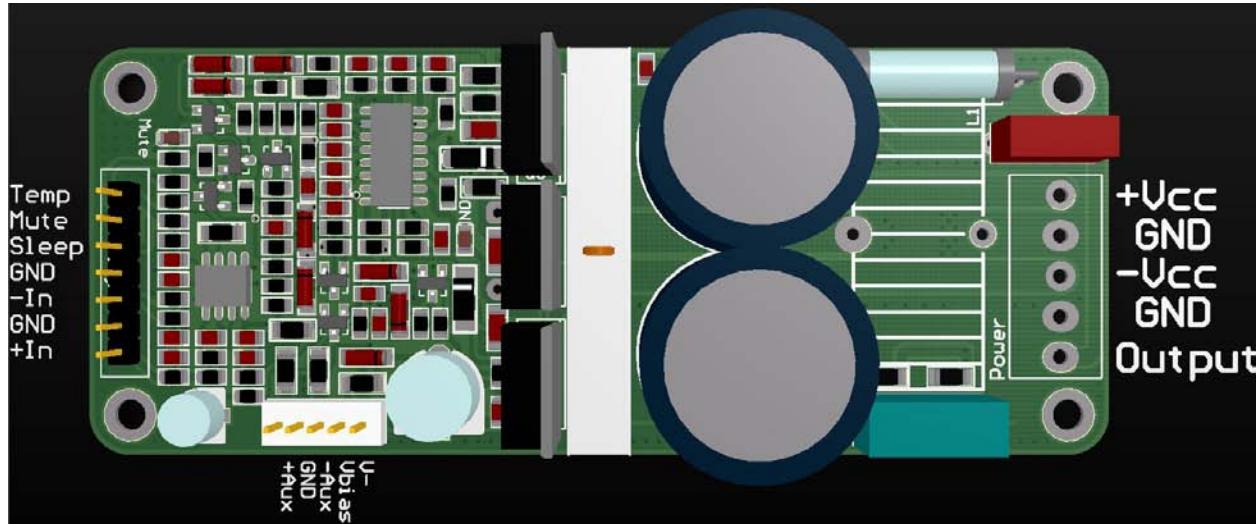


Figure 2: CxD500 Audio Amplifier Module Layout view and connectors description

**Input Stage:** The audio input signal is provided to the CxD500 through the Signal connector passes through a preamplifier stage which has the role of impedance adapter and balanced/unbalanced input adapter. The default gain of this input stage is 1. It also remove some of the very high, above the audio frequency range components, and allow only signals below 27KHz 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, 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 two identical CxD500 Amplifier Modules, the 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. There is only one electrolytic capacitor in the entire signal chain for each channel, and it is strongly recommended to be kept and NOT changed with any so called audiophile capacitor because the performances won't change in better but possible to be worse. Correct wiring of input signal and output is more important in this case.

The **Signal** input connector pinout (from bottom to top) is as follows:

- Pin 1: Non-Inverting Input
- Pin 2: GND Signal
- Pin 3: Inverting Input
- Pin 4: GND Signal
- Pin 5: Sleep (sleep mode=5V Run mode=-5V)
- Pin 6: Mute (pull-down = Mute, left open or >5V Run)
- Pin 7: Temperature feedback (Heatslug temperature monitor 3-10V DC)

## **Amplifier Power Stage:**

The amplifier power stage comprises of one IRS2092S dedicated driver IC plus two special selected MOS-FET transistors suitable for medium-high power 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 were defined to allow operation in a wide range of conditions, from low power, to highest power. 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 already 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 amplifier power stage is particularly configured for optimal performance in terms of sound quality, electrical efficiency, and EMI radiation. Some critical components such as Power MOS-FET's and output filter components (power inductor, low-pass filter capacitors, Zobel Network resistors and capacitors) as well as several smaller components which are supply voltage dependant, might have different values than the default ones. The supply voltage must be carefully chosen to prevent malfunction or damage of the CxD500 Amplifier Modules, if the supply voltage choice is wrong especially higher than the maximum limit. Note that although each board has Under-voltage and Over-voltage protections, these protections are intended to protect the amplifier from power supply voltage swing due to bus pumping if a poor power supply is used (low current capability, small electrolytic capacitors) with the CxD500 Module, and protecting the module in case of excessively higher voltages than was designed for is not guaranteed in any form. Again, end-user should never intervene and/or change any of these components in any situation. The power devices are installed onto a small, 40x32x6mm aluminum heatslug which serve as heat transfer interface from the CxD500 Amplifier Module power devices to an external heatsink which must have a thermal resistance of not more than  $0.8^{\circ}\text{C}/\text{W}$  for proper operation even with the lowest impedance loads. A thermal sensor installed inside the heatslug will monitor the temperature and Mute the power stage if the temperature reaches  $85\text{-}90^{\circ}\text{C}$  to protect the power transistors.

The output filter of the CxD500 uses high-quality power inductors, made of special selected powder cores for high power applications. Notable characteristics are high resistivity, low hysteresis and eddy current losses and excellent inductance stability under both DC and AC conditions and no thermal aging, make them most suitable choice for Output power inductor of a class D amplifier. Among these, Magnetics® Kool-Mu, MPP and HF are used, as well as Micrometals®-2 materials, with excellent RF properties for dedicated 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) made by Sagami® and several other no-name brands, these are only suitable for low-power and high load impedance versions, such as up to 200W at  $4\ \Omega$  or 300W at  $8\ \Omega$  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 can be operated with or without an external speaker protection circuit. However, if the amplifier is high power version, or is used with some expensive speakers, a speaker protection circuit can be considered as an extra level of protection. The latest amplifier versions include DC protection and quick-disconnect signals for SMPS in the unlikely event of DC signal present at the output of the amplifier. Matched power supply for amplifiers with this feature under development and will be available around April-May 2013. The Fast-disconnect signal is a logic signal, open collector, active on low, with 1k series resistor, so it must be biased and monitored for proper operation. Once the fault is asserted, the Fast-disconnect pin is pulled to GND and the power supply must shut-down immediately to prevent any possible damage to the speakers or the rest of the components from the amplifier. Note that this kind of fault is an abnormal situation never encountered in normal operation. The Fast-disconnect is available on pin 2 of AuxSupply connector.



## Warning:

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

The CxD500 Amplifier Module contains potentially hazardous voltages up to 190V DC or 140V AC. These 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 reconnection 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 handled improperly. This product has no serviceable parts other than the on-board mains fuse. In case of blown fuse, only replace the fuse with the same type and rating. Do not attempt to change any other component from the board. 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 "<sup>idiot-proof</sup>", 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 the improvements". 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 coke can 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 CxD500 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 unisolated part of the board or connectors, or short-circuit any part of the board or connectors. Any misusage will be made on user responsibility.

The designer and manufacturer reserve the right to make changes or modifications on both the product functions and performances without notice. The schematic and PCB design is Connexelectronic proprietary and shall not be distributed, copied or published without the Connexelectronic written agreement. Connexelectronic reserve the right to offer limited support for the boards purchased directly from Connexelectronic or Connexelectronic, and no support at all for the similar boards which aren't purchased directly from Connexelectronic and Connexelectronic, or future listed resellers, and from various reasons they look or pretend to be similar, exactly same, or improved version products. Purchasing the product means that you are aware and agree with all this conditions.

## Distribution network:

We are continuously striving to offer the best product quality and availability for our products and part of our policy, however, since the shipping and delivery time becomes more and more a burden, we have decided to provide our products through our distributors networks as well. The current distributors are shown below, and the list will be updated.

- Audiophonics, France, and near European Countries: <http://www.audiophonics.fr>
- Enigma, UK, and near European Countries: <http://www.enigma-shop.com>