

SMPS800RE

The SMPS800RE Switched Mode Power Supply (SMPS) it has a differential output voltage and two separate regulated auxiliary voltages. It is specially designed to be used with both Single-Ended and BTL output class AB, H, D or T Audio Amplifiers. SMPS800RE use state of the art, High efficiency LLC Series Resonant Converter Topology. Due to the soft-switched topology used, the SMPS800RE has very low EMI noise, lower losses and is more compact than a similar power rating classic hard-switched SMPS. Four output voltage ranges are available for SMPS800RE $\pm 40V$, $\pm 50V$, $\pm 60V$ and $\pm 72V$, plus other voltages on request, in range of $\pm 32V$ to $\pm 90V$. The output voltage is regulated, making the SMPS800RS suitable to be used with most of the Audio Amplifiers from the market.

SMPS800RE Features:

- LLC Series Resonant Converter Topology for high efficiency, up to 95.2% and lowest EMI.
- 230V AC (200-250V) and 120V (100-130V) AC compatible.
- 800W Continuous Output Power with cooling, 1000W Peak Output Power, 1150W Short-Time Peak Power.
- Four output voltages versions available from stock: SMPS800RE: $\pm 40V$, $\pm 50V$, $\pm 60V$ and $\pm 72V$.
- Two independent Auxiliary Voltages available, with voltage value of 2x5V, 2x12V or 2x15V at 200-500mA.
- Complete protection set, Under-voltage, Over-voltage, Over-current, and Over-temperature Protection.
- Burst-Mode operation at low load or no-load for high efficiency with under 3W consumption.
- On-board Soft Start for smooth turns ON without current peaks or breaker tripping.
- Compact size, 100x150x38mm, can fit inside a 1RU case, lightweight, ~ 550 grams.
- On-board variable speed fan controller and optional cooling fan, over-temperature shut-down.
- IEC type Connector for Mains Input voltage and terminal block for Voltage Output, LED light for power ON.



Fig.1 SMPS800RE picture

SMPS800RE Description: The current for the audio amplifiers producers, both in HI-FI or Pro-Audio field, is to use an old fashion mains transformer, Rectifier Bridge and capacitors. The main reason why the obsolete, heavy and low efficient mains transformers are still being used is the lack of knowledge on the R&D side of such “innovative” companies, corroborated with the lack of trust of most of the customers in this new “alien” technology called SMPS. Although we are using in our homes at least a dozen of SMPS without even notice. Almost all the electronic appliances are using SMPS nowadays. Imagine a flat screen LCD or LED TV without SMPS. If the SMPS is being used in commercial audio amplifiers, or even PA amplifiers, most of the companies are using hard-switching unregulated SMPS or at most a Quasi-Resonant unregulated SMPS to save the cost, both production cost and development cost which is higher for a regulated SMPS. Another reason for using unregulated SMPS for those amplifiers is that most of the class AB or H amplifiers have high power supply rejection ratio which allows using an unregulated power supply without degrading their performances. But for the class D and class T amplifiers, this might be not enough, especially if Audiophile Sound Quality is required. Unlike many other amplifiers which are using SMPS, this Power Supply has regulated output voltage, providing a constant output voltage, from zero load to full load which translates in cleaner sound, without peaks and drops, without hard clipping and distortions and true, real deep bass, transparent and clean medium and high frequencies without the need to add any extra large electrolytic capacitors, or even special made, with electrolyte made of snake oil, miracle capacitors which each cost 2-3 times more than the current SMPS and strongly relying on Placebo effect to justify the investment.

The topology used for the SMPS800RE is Series Resonant Converter or LLC Converter. It was chosen due to its many advantages compared with all other topologies. Among the advantages, we consider that the most important are superior efficiency, up to 95.2% lower EMI and noise, compact size and reasonable complexity. The operation principle of this converter was described in many papers, application notes, and reference designs. Although is not a relatively new technology, being discovered more than 30 years ago, until recently, the lack of knowledge, documentation and availability of good characteristic electronic components such as high-speed MOS-FET's or IGBT's prohibited this topology to spread like other hard switched topologies. Only after the LCD, Plasma and especially LED TV's came-up and initiatives to increase efficiency of the consumer products such as 80+, 90+ were imposed, engineers had to look towards other solution than the current, mature hard-switched topologies, which can't break the 90% efficiency barrier without significant cost increase and size. For an LLC resonant converter, efficiencies greater than 92% are common and even 95-96% can be achieved if the DC-DC converter is supplied from the output of an PFC pre-regulator capable to supply a constant 400V DC. In our case, the PFC stage is not required, due to the purpose of the application and because similar efficiencies can be achieved without using a complicated PFC circuitry which would increase the size of the SMPS board, EMI, and decrease the performance due to the fact that the available space is limited in the final amplifier enclosure and the PFC inductor might interfere with other circuits operation. In addition, all the home-users are not billed for reactive power.

An important aspect which must be considered when the SMPS800RE is powered ON, the initial current drawn from the mains is few times higher than the average operating current. The reason for this is that the filter capacitors are completely discharged, and act as a short circuit for a brief period. The current is higher as the capacitors capacity and voltage is higher, and is proportional with the capacitor stored energy ($CU^2/2$). To prevent harmful effects which this high value inrush current might have to the Power Supply components, a thermistor was used to limit the inrush current to a lower value than the mains fuse will trip or might damage any components from the Amplifier Power Supply. This thermistor has higher electrical resistance at low temperature, thus reducing the inrush current, and when the current which passes through, will heat-up the thermistor, the resistance will decrease, and the dissipated power will be reduced. As soon as the SMPS800RE starts and work normally, with a load of at least 2-3W a relay closes and shunt the thermistor to reduce the power dissipation and temperature increase even more. Due to use of on-board soft-start, there is no need to use any other external power soft-start circuit when the SMPS800RE is powered from standard mains supply voltage of 110 or 220V AC.

The SMPS800RE features a soft-start characteristic, which allows progressive charge of the output filter capacitors, with a controlled charging current, without tripping over-current protection. These capacitors have enough capacitance for most stringent applications, adding extra capacitors are not necessary or recommended, because if the capacitance is too high, the over-current protection might trip during power ON. Although the soft-switching characteristic allows the SMPS800RE to run cooler than similar power hard-switched SMPS's, a variable speed fan controller and over-temperature protection was added. This consists of a circuit which monitors the temperature of the primary MOS-FET's, start the fan when they reach 50°C and increase the speed till about 70°C when the maximum speed is reached, and disables the power supply when the operating temperature reach 90°C.

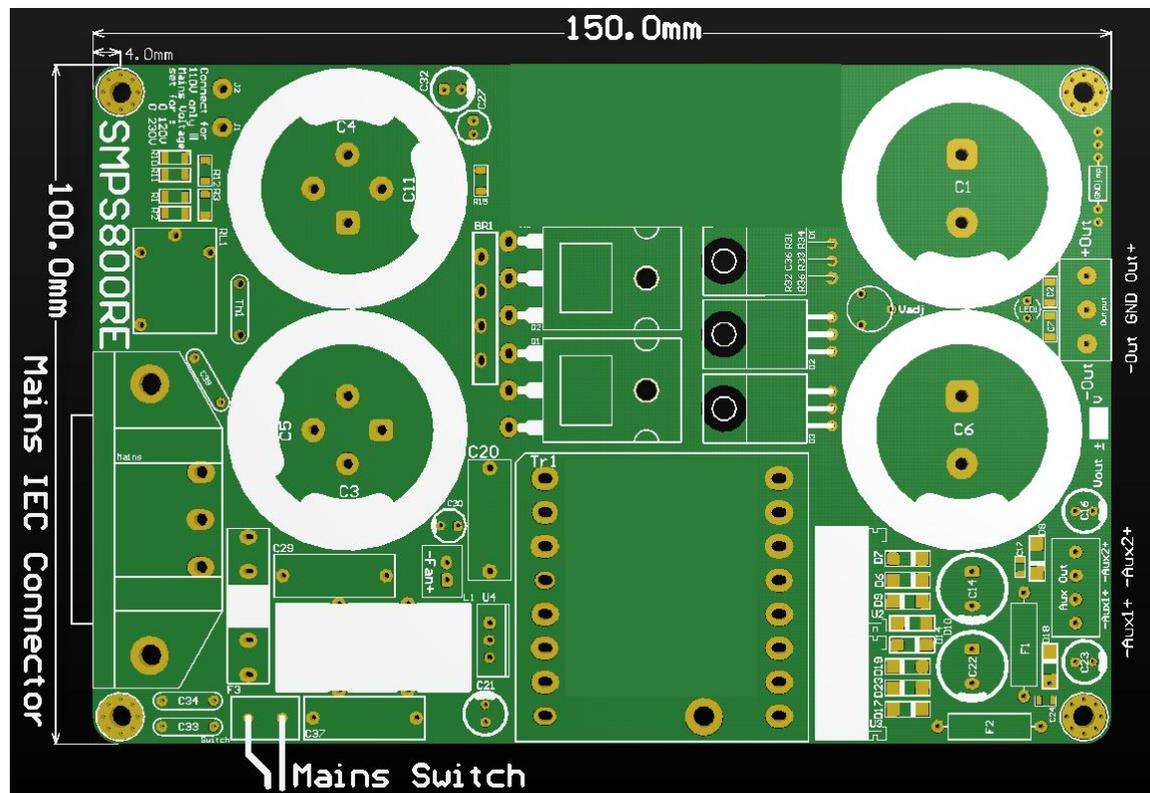


Fig.2 SMPS800RE board layout

The SMPS800RE has on-board Mains IEC connector, which allows safe and easy integration into the amplifier housing. Since the mains connector is present on the board, an ON/OFF switch must be added. For this purpose, the connector called Mains Switch was added on the bottom left side of the board, right next to the EMI filter. A 10A 250V AC rated switch must be used in order to connect or disconnect the mains voltage from the SMPS800RE. When the SMPS800RE will be switched ON, the power supply should start with a delay of about 500-800ms, due to the start-up circuit, and then the ON LED placed on the secondary side, near the output voltage connector will lit. Note that when the power supply is working in burst mode due to low load, or no-load, the LED light might dim as well as the mains soft start relay might click ON-Off due to insufficient load on the output, especially when minimum voltage was set at no load. The output load must be connected to the Output Connector, placed on the upper right side, terminal block connector. Proper wire gauge should be used, the largest which can safely fit into the Terminal Block conn, and NEVER use thin wires, unisolated or with poor or damaged isolation.

The auxiliary output voltage output is connected at the smaller terminal block connector, placed at the bottom right of the board. For reliable operation, never short-circuit the outputs, and never connect them to other power supply outputs, except the Aux. GND which can be referenced to any other polarity main output. Use this feature with extreme care, if the Aux. GND is referenced to negative main output or positive main output and a short-circuit between any auxiliary output and positive or negative main output will damage the power supply !!!

In some cases, the dissipated power will lead to temperature rise on the power supply parts. For moderate output power levels, as well as for most of audio amplifiers application, natural convection cooling is enough. When the SMPS800RE is installed into an enclosure where the ambient temperature might rise above 50°C, a cooling fan should be used to keep the power supply temperature at safe levels. For this, an on-board variable speed fan controller is used, and an optional fan can be provided on request, or a standard 12V 100-200mA fan can be used. This should be connected at red connector, with correct polarity. A suitable fan is 50x50x10mm which can be attached on top of the heatsink, blowing air from ambient, down, towards the heatsink fins and recirculating through the sides and bottom of the power transformer. The fan will start spinning when the temperature of the power transistors, where the sensor is installed will reach 50°C and increase the speed till about 70°C when the maximum speed is reached, and disables the power supply when the operating temperature reach 90°C, requiring shut-down and wait 2-5 min till the temperature drop to a safe value and the power supply can be restarted.

The SMPS800RE has two independent regulated Auxiliary outputs which can be used to supply power for other stages of the amplifier, such as preamplifier, speaker protection, cross-over, etc. The common values for aux. Output are 2x5V, 2x12V or 15V for standard available versions, and any combination of two voltages for custom ordered version. For example for TA3020 based amplifiers, two separate GND and regulated voltages are required, one 5V and one 10-12. In this case, a 5V for aux. 1 and 12V for aux. 2 can be ordered. The auxiliary output voltage is regulated, using LM78xx series voltage regulators, and the GND is isolated from the main output GND and each other, allowing flexible interconnection to any of the main output terminals. This should be done with extreme care and only if the working principle of the power supply is understood otherwise can lead to serious damage due to the high voltage difference between the main output voltage and auxiliary output voltage. It should be noted that the auxiliary outputs must be loaded only when the main output is loaded, and not at idle or when the SMPS800RS is running in burst mode, which can lead to unstable and low current auxiliary voltage. When the auxiliary output voltage is used to power noise sensitive stages, further filtering and regulation is recommended.



Warning:

Before you proceed with installation, make sure you have read this warning SMPS800RE: The SMPS800RS is powered from the mains voltage and the primary side of the SMPS has hazardous voltages up to 340V DC and up to 500V 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 SMPS 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 is 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 SMPS800RS. A safety clearance of at least 6mm must be kept between the board and the case, or any conductive part of the amplifier. The heat transfer between the heatsink and ambient must not be obstructed for proper operation. Use proper wire gauge wires for interconnection, with intact isolation, and as thick and short as possible. Use different colors for different polarities, respecting the standards and never touch the wires by hand or tools. Ignoring this recommendation can cause power supply failure, injuries or fire !!!

SMPS800RE characteristics:

Model: Parameters:	SMPS800RE ±40V	SMPS800RE ±50V	SMPS800RE ±60V	SMPS800RE ±72V	SMPS800RE custom voltage
Main Output Voltage ¹ :	Minimum: ±37.1V Maximum: ±43.3V	Minimum: ±46.5V Maximum: ±53.3V	Minimum: ±56.8V Maximum: ±62.7V	Minimum: ±68.8V Maximum: ±74.8V	Min: ±32V Max: ±90V
Aux. Output Voltage ² :	Chose between 2x5V 2x12V 2x15V	Chose between 2x5V 2x12V 2x15V or any combination of two			
Mains input voltage ³ :	110V: 98-127V 230V: 196-254V				
Main Output Current ⁴ :	Nominal: 12.5A Peak: 18A	Nominal: 10A Peak: 14.5A	Nominal: 8A Peak: 15A	Nominal: 6.5A Peak: 13A	Nominal: -- Version Dependent Peak: -- Version Dependent
Aux. Output Current ⁵ :	Nominal: 0.2-0.5 A Peak: 0.75A				
No-Load power cons ⁶ :	Min: 1.2W Max: 1.9W	Min: 1.4W Max: 2.3W	Min: 1.6W Max: 2.4W	Min: 1.4W Max: 2.3W	Min: 1.2W Max: 1.9W
Efficiency at 50% load	110V: 92.3 % 230V: 92.9%	110V: 92.8 % 230V: 93.7%	110V: 93.3 % 230V: 94.5%	110V: 93.6 % 230V: 94.9%	110V: -- Version Dependent 230V: -- Version Dependent

- Notes: 1. The min. and max. voltages are relative and the values are +-0.5 to 1V of those listed.
 2. Default values, for any combination of two chose "custom voltage" option when order.
 3. Voltages below min values won't start the SMPS. Voltages above the max values can damage the SMPS.
 4. Peak current during power ON sequence, useful when sizing the wiring and mains fuses.
 5. Output current available is output voltage dependent and with main output loaded with at least 0.3A
 6. Measured values at 110V/230V mains, no load with output voltage set to default 36V, 48V, 60V or 72V.

An important aspect which can create issues in an amplifier is the correct wiring, especially the GND, to avoid forming of the GND loops. The GND loop occurs when there is more than one ground path between two items of equipment. Usually, one path is the screen of an audio cable connecting the two pieces of equipment and the other path is via their chassis safety earths in the mains plugs. Inside the equipment, the audio screen earth is often linked directly to the chassis earth, hence the possibility of a loop. If the two bits of equipment are plugged into the same mains socket, their chassis safety earths are effectively tied together at the same potential, and so there is unlikely to be any circulating ground current, despite the apparent ground loop. To prevent these issues, SMPS800RE has provision for a GND loop breaker, on the upper right side of Figure 2 there is a small footprint called GND Jmp where a GND Loop Breaker resistor can be installed. The optimum value of this resistor is in range of 100R to 1K depending on the topology of Grounding scheme used at SMPS800RE installation within the system.

The SMPS800RE board size is 100x150mm, and the height is about 38mm from the bottom of the PCB to the tallest component, the power transformer. Under the PCB, stand-offs must be used to keep proper clearance for safety reasons. With 5mm tall stand-offs, the SMPS800RE PCB can reach a total height of 42mm, which makes it suitable to be installed into a 1RU case. An insulated sheet should be installed under the PCB and the PCB should be mounted at the back side of the case, allowing the IEC connector to be accessible through a special cut window. The mains ON/OFF switch should be proper voltage and current rated, installed on the front panel and the power supply must be turned OFF whenever is not used, and should NEVER be left working without surveillance.

Due to countless requests from customers regarding all the products which use IEC Connectors for mains voltage, to not be soldered on the PCB because some of them are willing to install the board elsewhere in the enclosure where the access to the back wall is impeded, the SMPS800RS Mains IEC Connector is installed on the PCB board but it is NOT soldered leaving the choice for user to solder or remove it.

Mains voltage is set by default to 230V to prevent any possible faults if wrong voltage version is ordered, for example 110V version for countries where 230V is also available. In this case, the user must connect the 110V jumper IF and ONLY the mains voltage is within 100-120V interval otherwise damage might occur. A 230V configured power supply won't start at 110V and no damage can occur. But if is 110V configured and powered at 230V there are many chances to damage the power supply unit.

Disclaimer:

The SMPS800RE 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.

The designer and manufacturer **PCBstuff** reserve the right to make changes or modifications on both the product functions and performances without notice. The SMPS800RE schematic and PCB design is **PCBstuff** proprietary and shall not be distributed, copied or published without the **PCBstuff** written agreement. **PCBstuff** and **Connexelectronic** reserve the right to offer limited support for the boards purchased directly from **PCBstuff** or **Connexelectronic**, and no support at all for the similar boards which aren't purchased directly from **PCBstuff** and **Connexelectronic**, or future listed resellers, and from various reasons they look or pretend to be similar or exactly same products. Purchasing the product means that you are aware and agree with all this conditions.