

## ICEpower50ASX2 Designer's Manual

2x50W or 1x170W ICEpower Amplifiers with integrated ICEpower Supply

Version 1.1

### Contents

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Introduction.....	2
Important Notes.....	2
Typical Wiring Diagrams.....	3
Different Ways to Power-Up.....	5
Shielding and Grounding of Audio Signals.....	6
Capacitive Loading of the AUX Supply.....	6
Pulsed loading on the AUX supply.....	7
EMI Management.....	14
Mechanical Mounting.....	17
Safety.....	18
Safety Guidelines.....	18
Thermal Design.....	19
Notice.....	19
Appendix A - Recommended Wiring Diagram.....	20
Appendix B - Evaluation Kit Cables.....	21

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## Introduction

This document is intended as a design-in guide for users of the ICEpower50ASX2 module. This document is to be used in conjunction with the ICEpower50ASX2 Datasheet, which contains details on specifications, pin-configuration and measurements. Since no two applications are alike, the recommendations of this document can only serve as general guidelines for your specific designs.

A key point of this document is that when dealing with high-power switching technologies, you are facing a design challenge regarding proper wiring to ensure that the final product is in compliance with standards on electromagnetic compatibility (EMC). These challenges can be overcome by means of proper module mounting, simple shielding in very compact designs and, most importantly, proper cabling routing.

## Important Notes

### **±25V auxiliary supply**

Note that the auxiliary ±25V outputs are protected against over current with 400mA fuses. Even a brief short circuit on these outputs may result in a defective fuse!

Another very important thing is to be careful of the load capacitance on the AUX supply. Please read the section "Capacitive Loading of the AUX Supply" for more information.

### Typical Wiring Diagrams

#### Simple Stereo Operation (SE version)

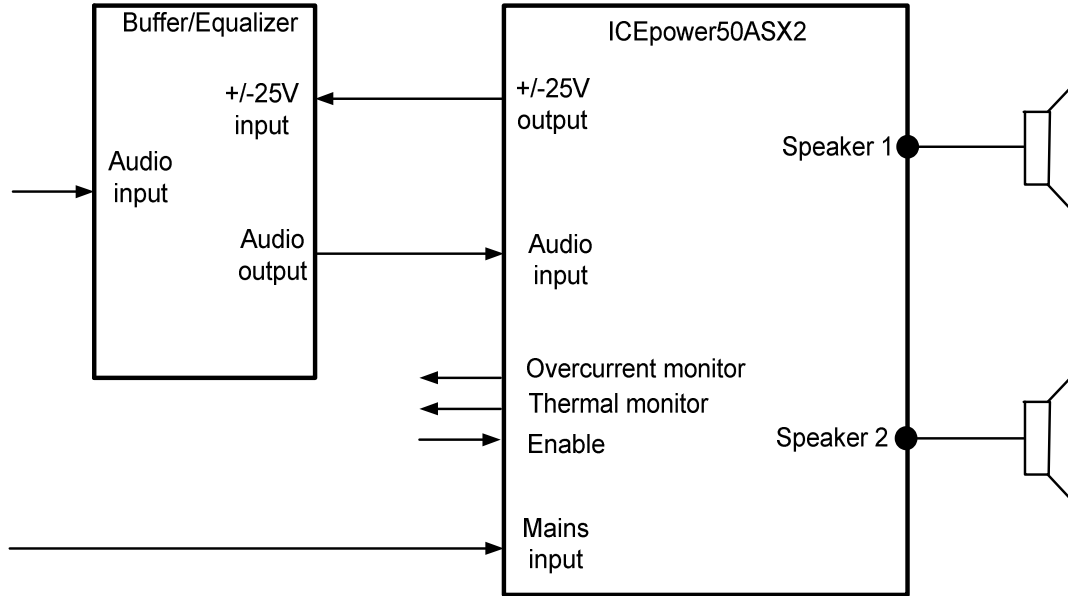


Figure 1: Stereo setup with external signal conditioning.

#### Mono Operation (BTL version)

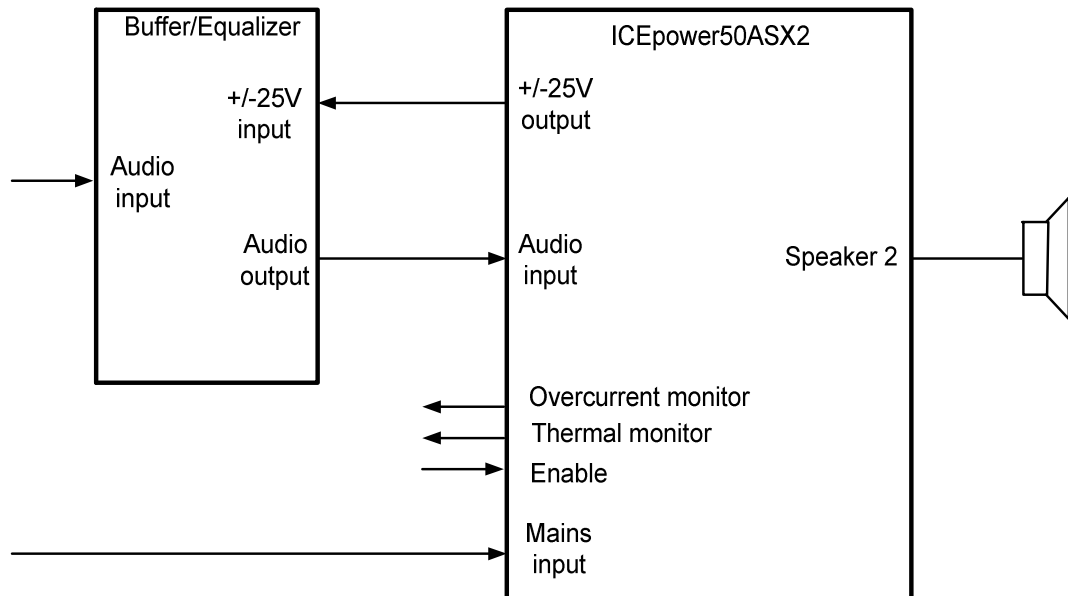


Figure 2: 1 way active loudspeaker (ex. subwoofer) with active crossover.

### 2-Way Speaker with Active Crossover (SE version)

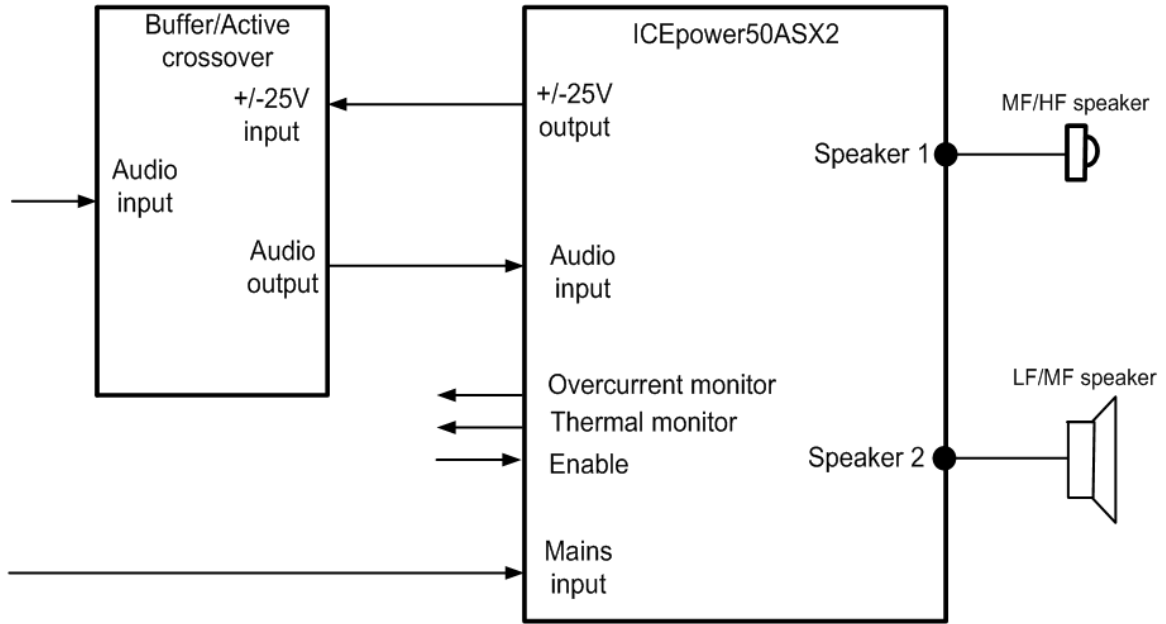


Figure 3: 2-way active loudspeaker with active crossover.

### 2-Way Speaker with Passive Crossover (SE version)

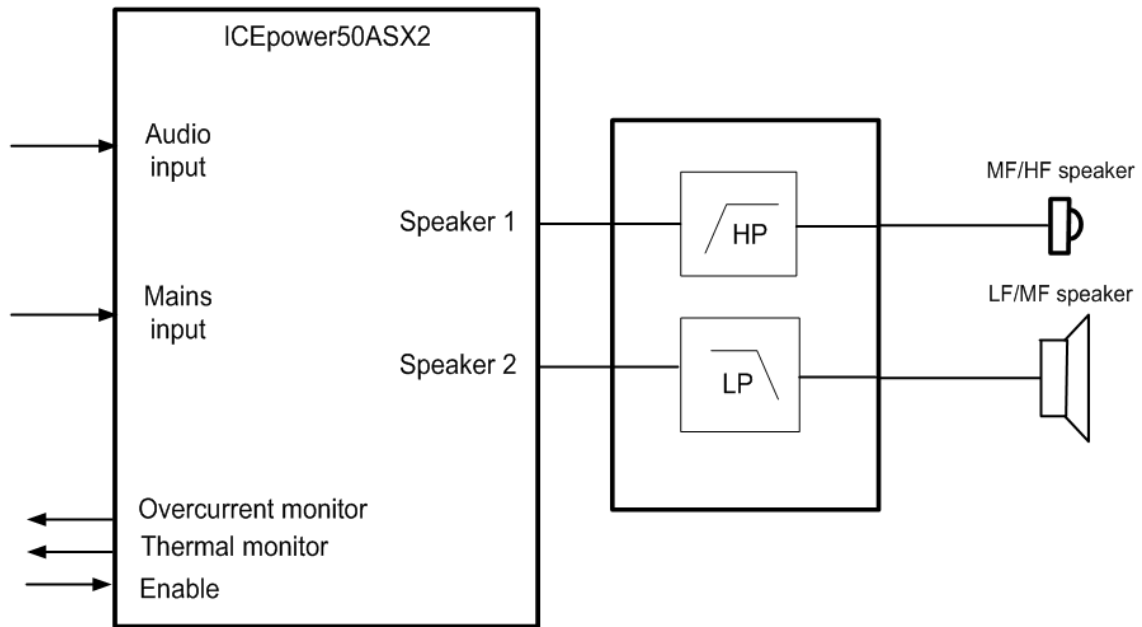


Figure 4: 2-way active loudspeaker with passive crossover.

## Different Ways to Power-Up

For further information regarding power-up, please refer to the datasheet under the section *Features -Enable pin*.

### Mains Switch

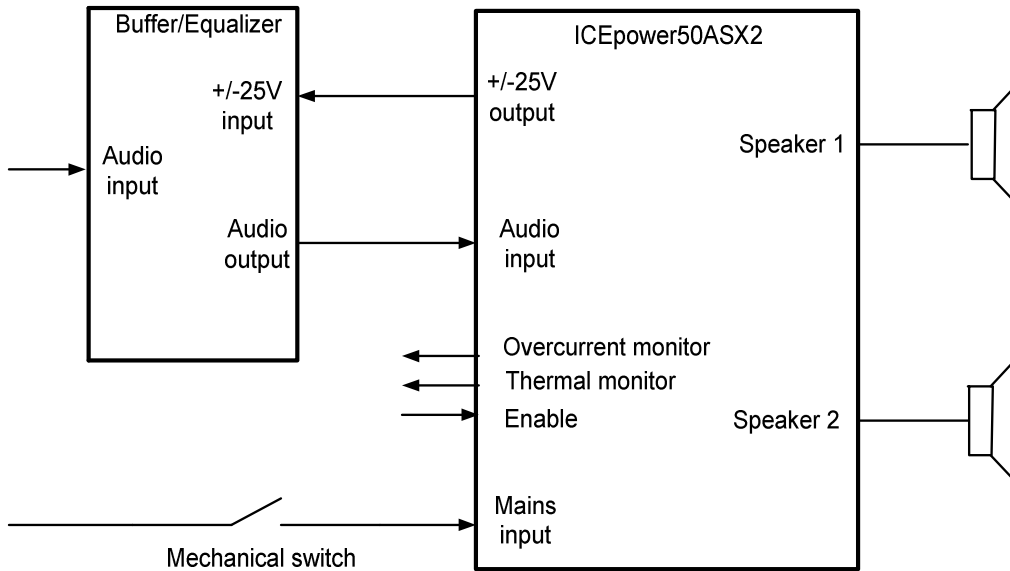


Figure 5: Power-up using mains switch.

### Remote Receiver

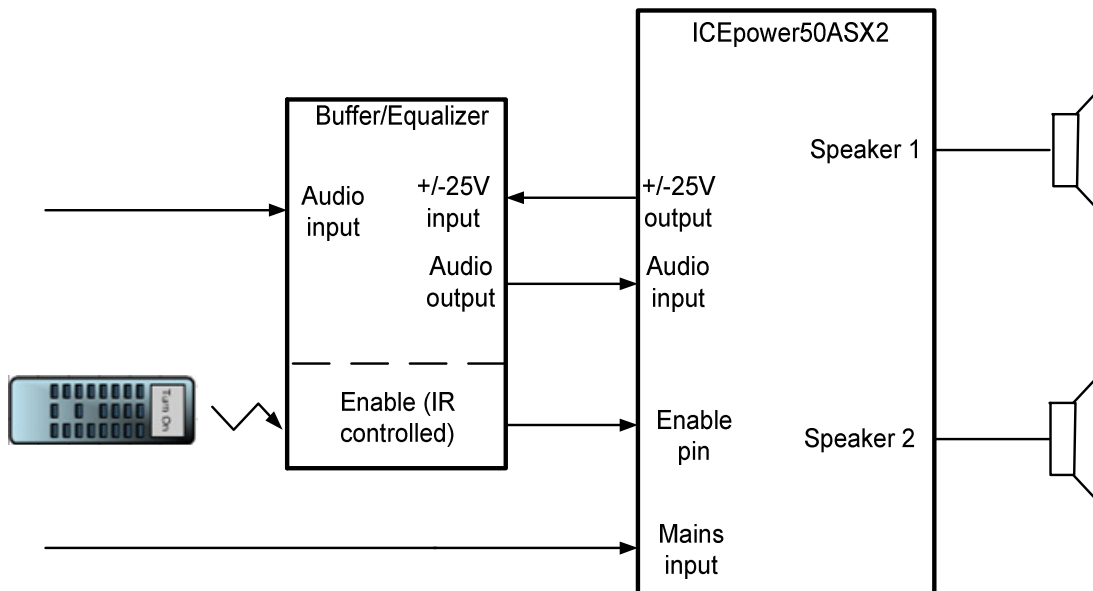


Figure 6: Power-up by remote control (Standby power consumption = 4W when disabled)

### Shielding and Grounding of Audio Signals

The analogue audio signal input interface of the ICEpower50ASX2 is intended for single ended signal routing. To eliminate hum and noise due to ground loops and induced noise, proper grounding and cable routing are very important design aspects.

Another issue when dealing with switching amplifiers is that unwanted frequency components may be present at the output of the amplifier. These signals (called spurious output) must be kept to a minimum to avoid audible effects. Avoiding spurious output requires attention to cabling and grounding. Schematics showing the recommended grounding and shielding philosophy can be found in Appendix A.

### Capacitive Loading of the AUX Supply

When connecting capacitors to the AUX supply (+/-25V), be sure to have at least 3 ohms resistance in series with the AUX supply (max. 1000uF). Capacitors with a value larger than 1000uF require a larger resistor in series as shown in Figure 7. This is to prevent the auxiliary supply fuse breaking during power up.

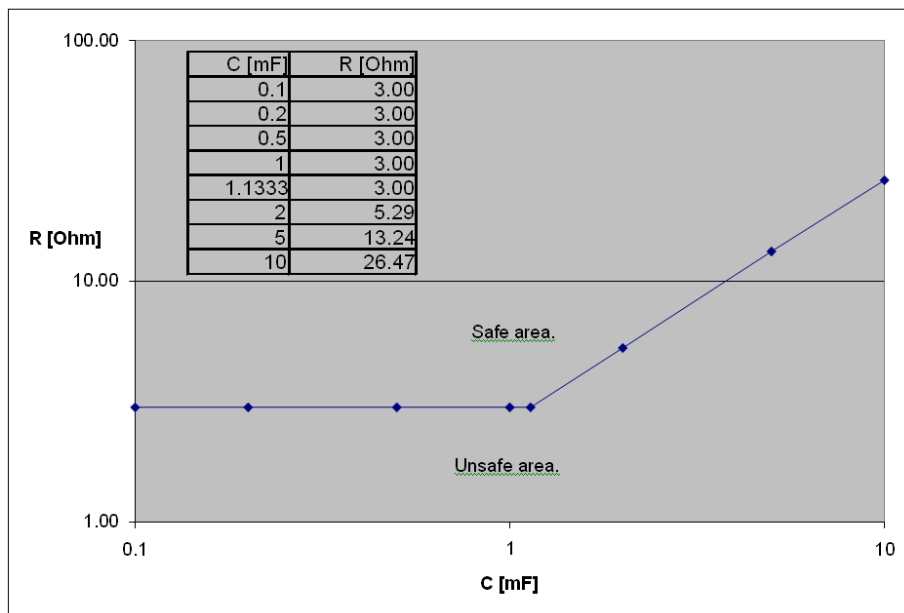


Figure 7: Capacitive loading of the AUX supply

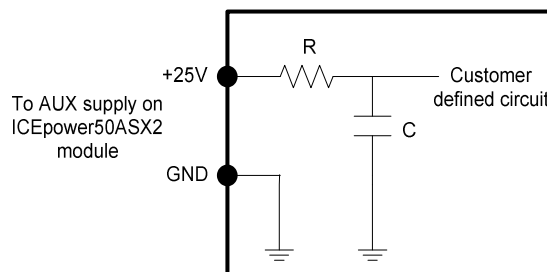


Figure 8: Diagram showing the resistor in series with the capacitor

### Pulsed loading on the AUX supply

If the application requires drawing pulsating currents with a frequency of less than 20kHz from the AUX supply special care should be taken to avoid unwanted tones being audible on the output.

Due to the impedance in the ground wire (signal ground and aux ground), which will always be a few milliohms, the current draw through will run in both ground wires (signal ground and aux ground) will create a voltage across the ground wire. This pulsing voltage over the signal ground wire will be modulated over the audio signal and may reach audible levels. Regulating the AUX supply as illustrated below will reduce audibility.

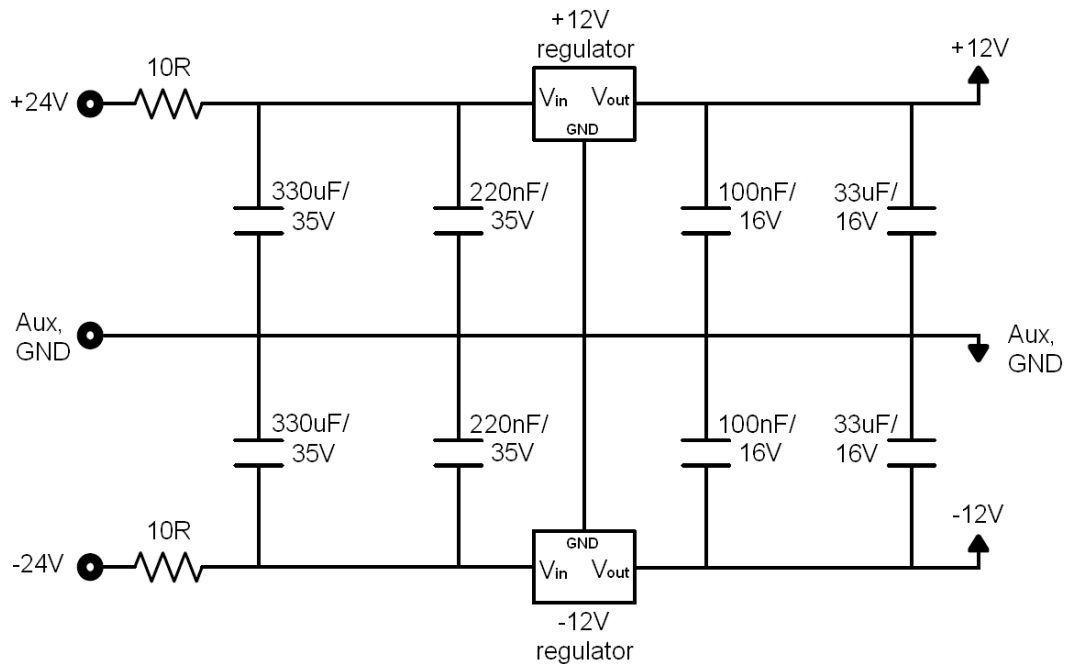


Figure 9a: 12V regulated power stage for external circuitry

**DO NOT draw currents larger than 100mA through the signal ground.** If higher currents are needed (up to 200mA) use the AUX ground instead. Do not draw high pulsed currents from this supply (+/-12V) as this will also be modulated with the input audio signal. The 10 ohm resistor and 330uF capacitor have a cutoff frequency (-3dB) of 48Hz. The resistor can be set to 1 ohm, which makes the cutoff frequency 480Hz, but allows higher current to be drawn from the AUX supply and reduce the power handling requirements of the resistor. The 33uF capacitors after the linear regulators stiffens the +/-12V supply and dampens the noise. The 220nF and 100nF capacitors should be connected as close as possible to the linear regulators I/O terminals. The required components needed to build the +/-12V supply and a rough component price are shown in the table below:

Components for the +12V and -12V regulator circuit				
Suggested components	Pieces	Roughly price [USD]	total Price [USD]	Comments
Resistor 10R, 2W film, 5%	2	0,04	0,08	min power rating: 1W
L7812 (TO-220 package), 12 V 1.5 A	1	0,19	0,19	
L7912 (TO-220 package), -12 V 1.5 A	1	0,195	0,195	
Capacitor 330uF, 35V, alu, low ESR	2	0,19	0,38	having a low ESR
Capacitor 220nF, 50V, 0805, X7R	2	0,023	0,046	

Capacitor 100nF, 50V, 0603, X7R	2	0,0071	0,0142	
Conn housing PH 3POS 2.0mm - PHR-3	1	0,0427	0,0427	
Capacitor 33UF, 25V, Electrolytic, 20%	2	0,04	0,08	
Heat Sink 12°c/w	2	0,45	0,9	
<b>Total component price</b>			<b>1,93</b>	

Components and prices can be found at: [www.octopart.com](http://www.octopart.com) and are only suggested components. The prices shown in the table above are 11<sup>th</sup> of June 2012 prices. At 25°C ambient and 200mA current draw, each case of the ±12V regulators reach up to 75°C. At ambient temperature above 25°C at 200mA, a larger heat sink is required and if the current draw of each 12V regulator is below 40mA, heat sinks for this can be left out resulting in a lower component cost.

If a 5V supply output is needed from the 24V AUX supply then the following circuit can be made:

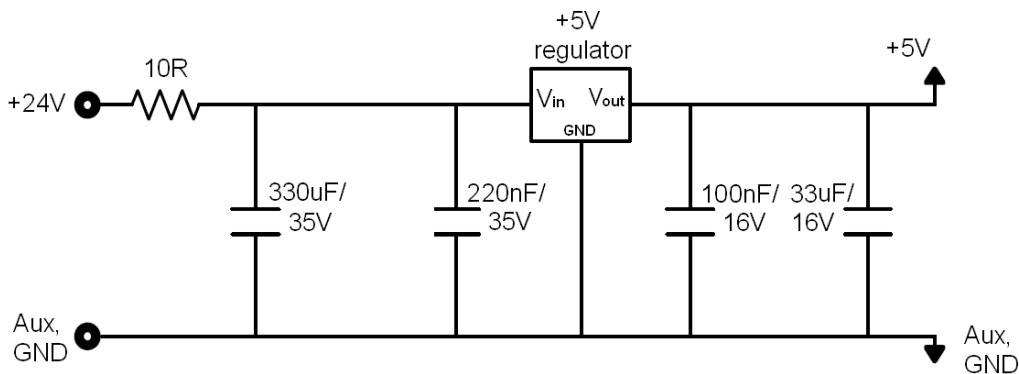


Figure 9b: 5V regulated power stage for external circuitry

The required components needed to build the +5V supply and a rough component price are shown in the following table:

Components for the +5V regulator circuit				
Suggested components	Pieces	Roughly price [USD]	total Price [USD]	Comments
Resistor 10R, 2W film, 5%	1	0,04	0,04	min power rating: 1W
L7805 (TO-220 package), 5 V 1.5 A	1	0,15	0,15	
Capacitor 330uF, 35V, alu, low ESR	1	0,19	0,19	having a low ESR
Capacitor 220nF, 50V, 0805, X7R	1	0,023	0,023	
Capacitor 100nF, 50V, 0603, X7R	1	0,007	0,007	
Conn housing PH 3POS 2.0mm - PHR-3	1	0,043	0,043	
Capacitor 33UF, 25V, Electrolytic, 20%	1	0,04	0,04	
Heat Sink 12°c/w	1	0,45	0,45	
<b>Total component price</b>			<b>0,943</b>	



At 25°C ambient and 120mA current draw, the case of the +5V regulator reaches up to 75°C. At ambient temperature above 25°C at 120mA or higher current draw, a larger heat sink is required. The +/-12V supply and 5V supply can also be made by step-down voltage regulators. Besides having a high efficiency these require no heat sinks and have output current limiter. The total component price will be a little higher and both the -12V, 5V and +12V will be made from the +24V AUX supply. Application notes on the step down regulators can be found at: <http://www.ti.com/lit/ds/symlink/lm2674.pdf> <http://www.ti.com/lit/an/slva317a/slva317a.pdf> <http://www.ti.com/lit/ds/symlink/tps5410.pdf>

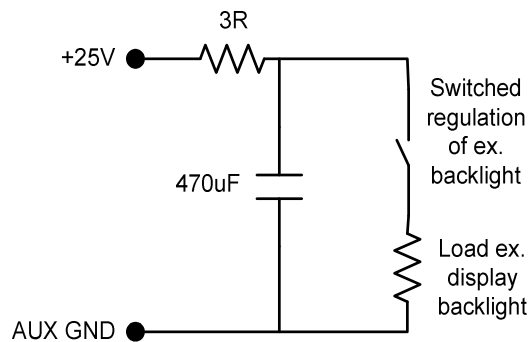


Figure 10: Local decoupling close to switching circuit

Local decoupling close to the switched load also has a good damping effect on the unwanted tone. Remember to place minimum 3 ohms resistance in series with the capacitor. The cut-off frequency here is 113Hz. The capacitor can be changed if another cut-off frequency is desired.

A good noise reduction can be achieved with the input circuit shown below, in combination with the circuits mentioned above. All 5k6 resistors should be with 1% or 0.1% tolerance for best performance.

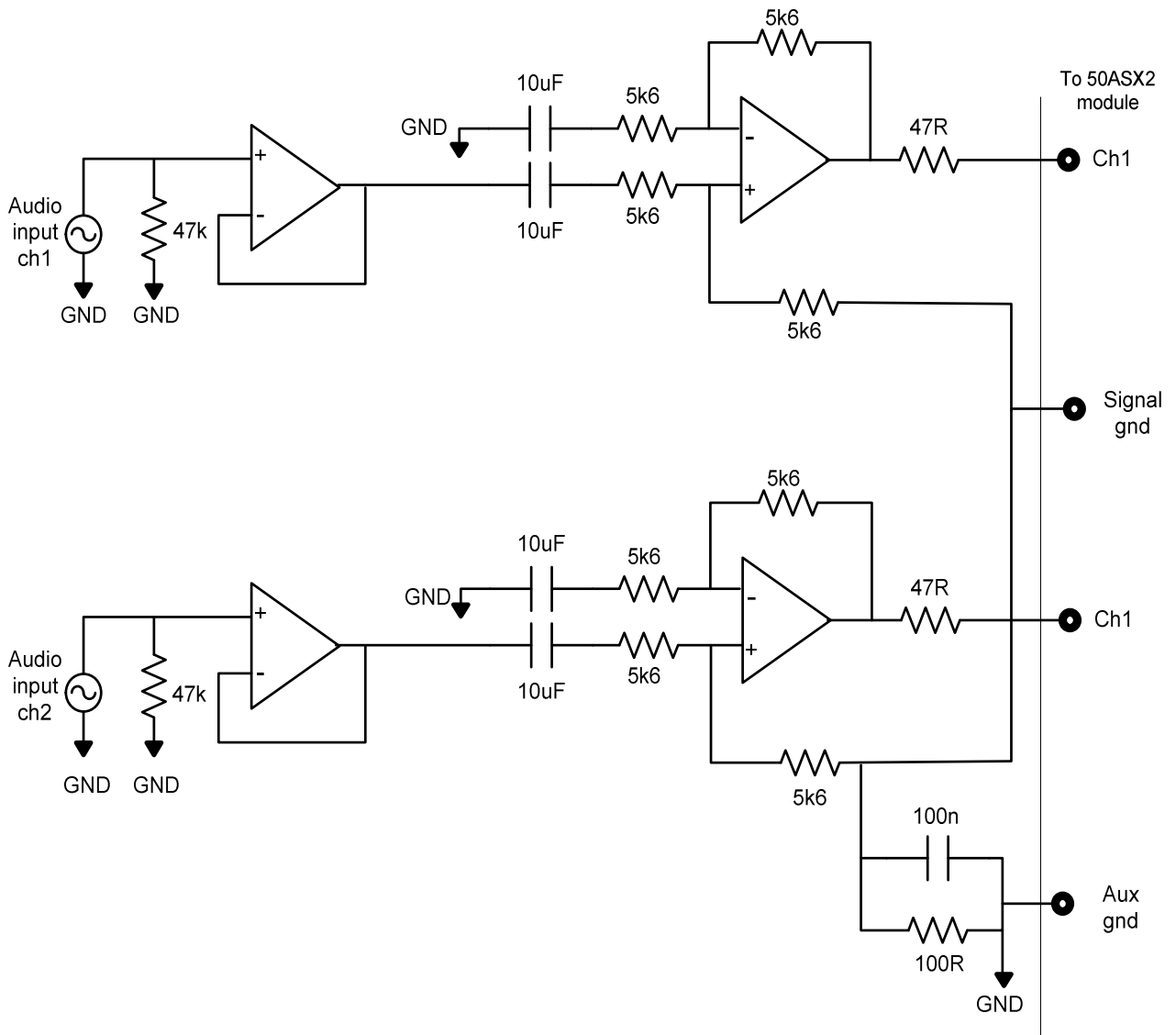


Figure 11 Noise reduction circuit for SE amplifier (conceptual schematic)

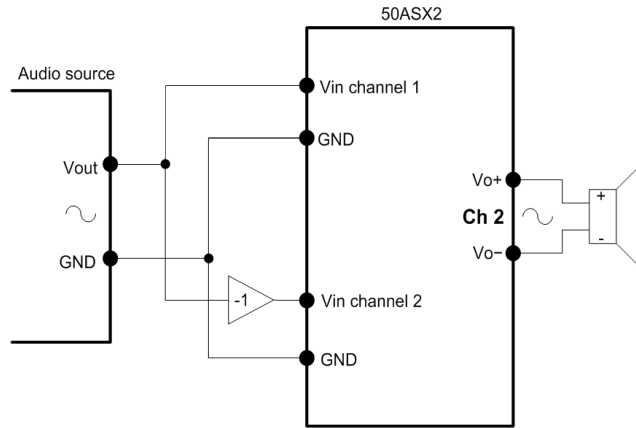


Figure 12: Input wiring diagram for the BTL module

If noise is not an issue, the following input buffer can be used in each channel instead.

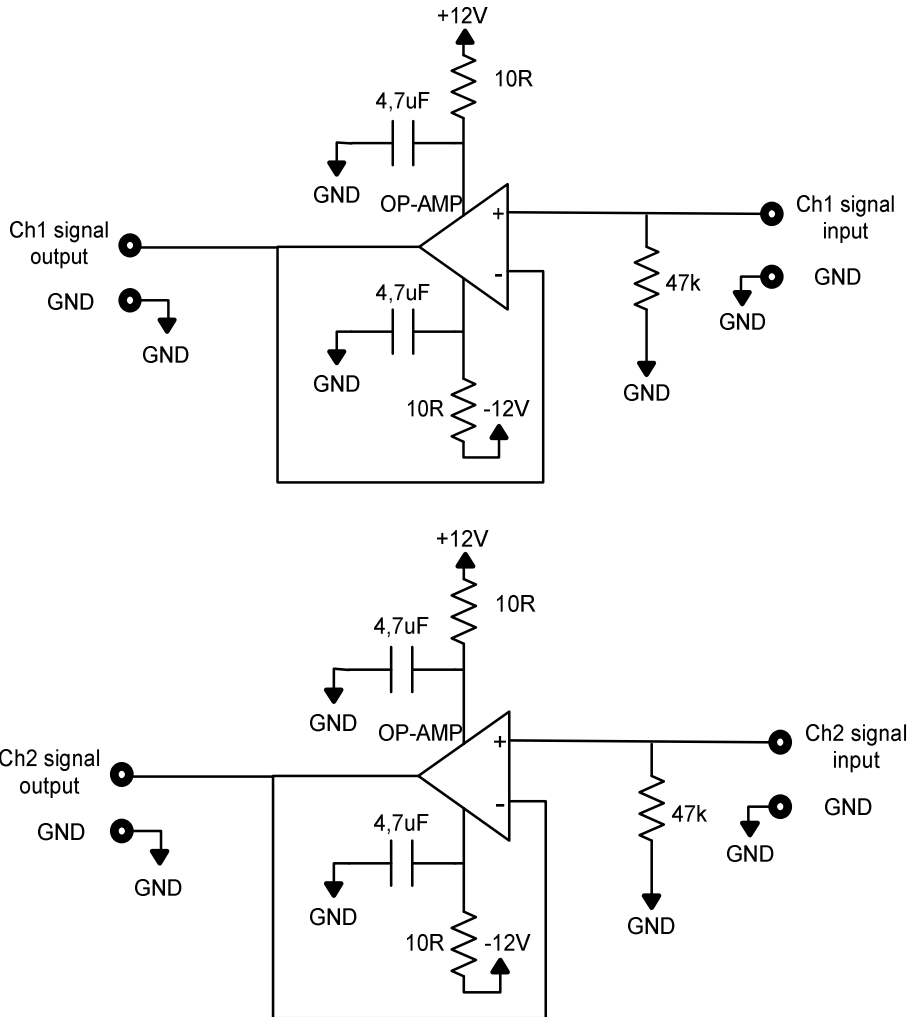


Figure 13: Simple input buffer with reduced noise reduction ability (conceptual schematic)

The input stereo buffer is shown above. Each channel (amplifier) is decoupled with  $10\Omega$  and  $4.7\mu\text{F}$ . This decouples unwanted noise and lowers crosstalk between the channels.

This circuit is helpful even in BTL mode if noise is an issue because the amplifier inputs are two SE inputs referenced to ground. All 5k6 resistors should be with 1% or 0.1% tolerance for best performance.

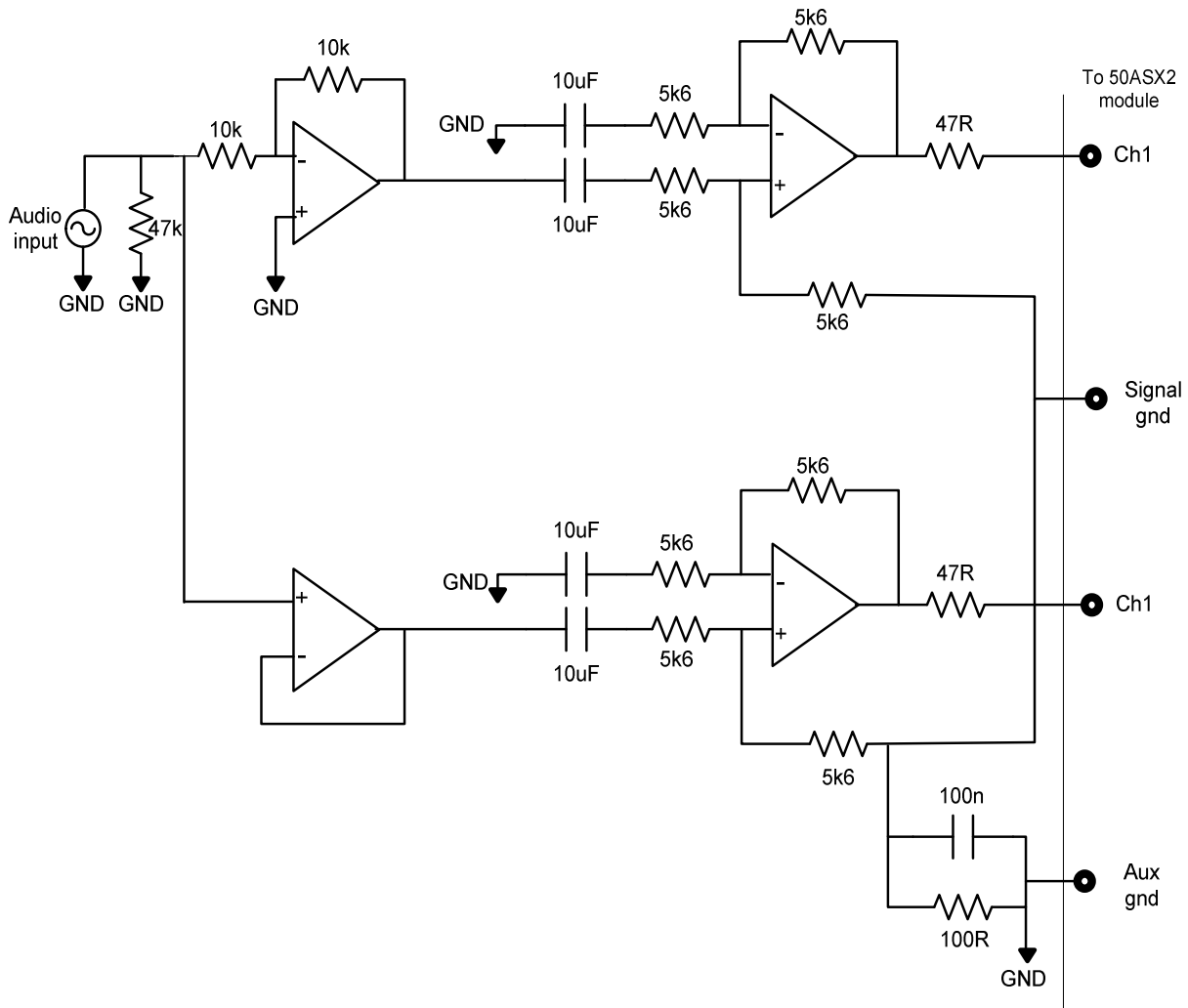


Figure 14 Noise reduction circuit for BTL amplifier (conceptual schematic)

## EMI Management

ICEpower amplifiers and power supplies utilize the latest switching technology to offer intelligent, compact and efficient audio power conversion systems. However, operating with fast switching signals generates unwanted high frequency noise. Unless the necessary high frequency design precautions are not taken this noise may exceed the standardized EMI limits.

The ICEpower50ASX2 has been pre-approved according to the following EMC standards:

- EN55013
- EN55020
- EN61000-3-2
- EN61000-3-3
- EN61000-4-2
- EN61000-4-3
- EN61000-4-4
- FCC part 15-B

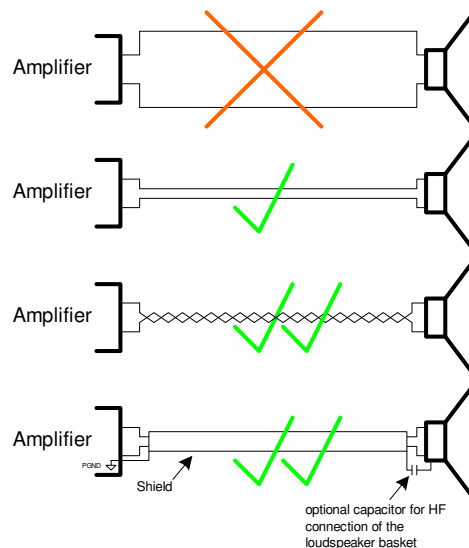
The device under test is mounted on a backplane and loaded with a resistive load (see test setup on page 16). The test signal is pink noise corresponding to 1/8<sup>th</sup> of the rated power dissipated in the load.

Even though the ICEpower50ASX2 module is pre-approved for EMC, it is always necessary to approve the final product according to the applicable standards on EMC.

### Do's and Don'ts

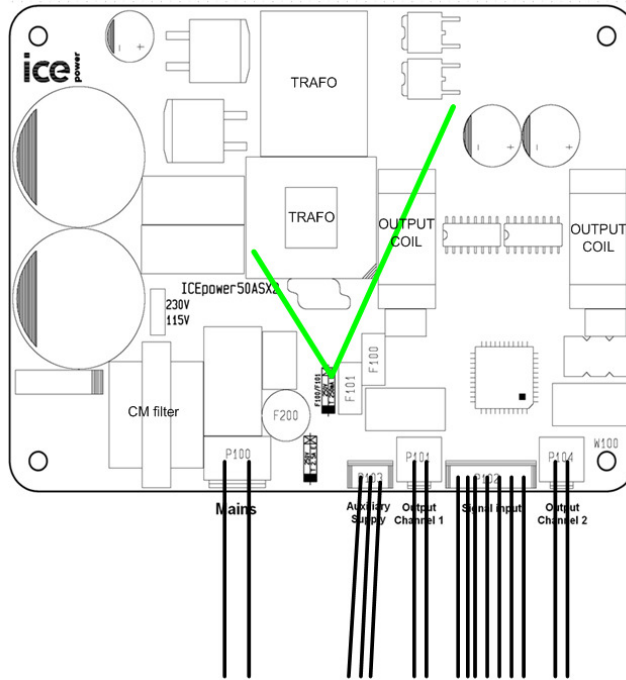
Electromagnetic Interference (EMI) is emitted from any cable carrying RF currents. This chapter describes some guidelines to help reduce EMI in an ICEpower system.

- Loops conducting RF currents emit EMI. It is important that speaker cables are twisted, shielded or at least run closely paralleled to reduce the loop area as much as possible. The same applies to mains and internal power supply cables as well as signal cables.

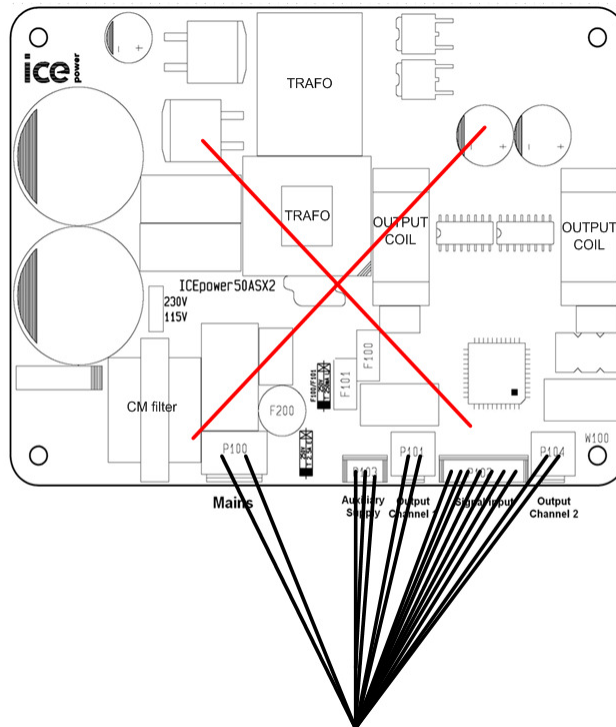


Note: When using shielded loudspeaker cable the shield should not be connected directly to the basket of the loudspeaker. Loudspeakers may short the voice coil to the basket during heavy load resulting in damage to the module due to the short to ground. This can be avoided by making the connection to the basket through a small capacitor.

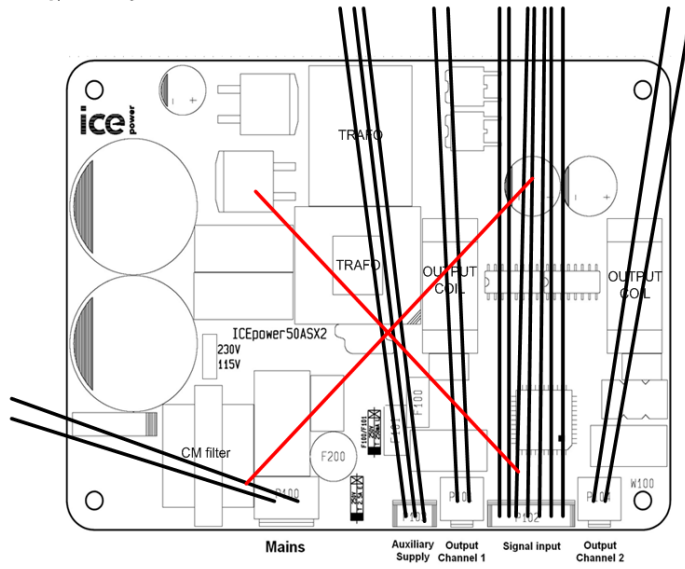
- Twist the speaker cables and keep them away from Signal input cables. The AUX supply cables should be kept separate from all other cables and the mains cable should be kept separate from all other cables as well.
- Keep all the wires as short as possible.



- Do not bundle input, output and mains cables to the modules!

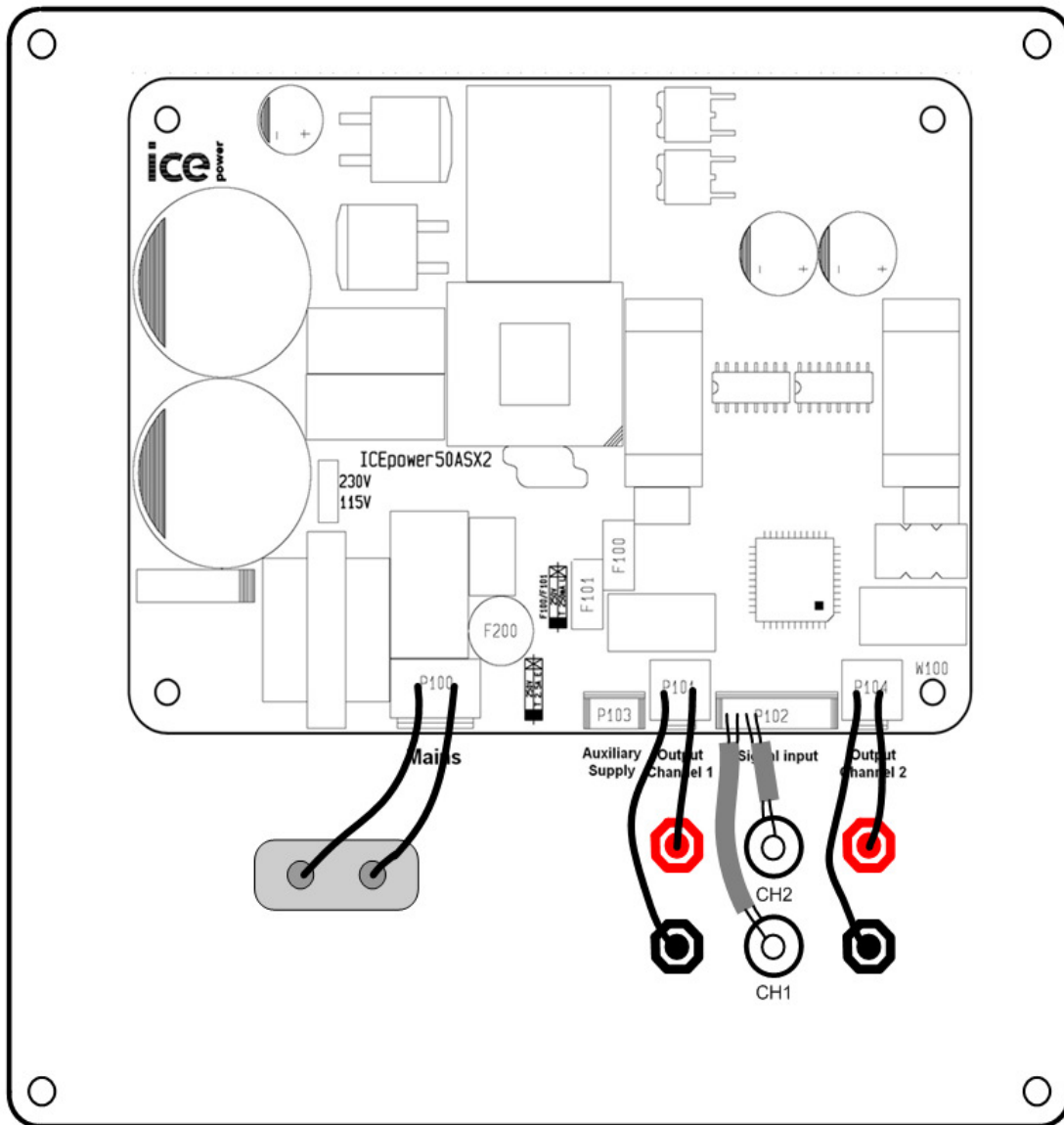


- Do not run the cables to the modules near the amplifier output coil or the power supply transformer.
- Keep the mains cable away from the CM filter.





During the ICEpower50ASX2 approvals phase the following internal wiring setup was used:



Note the proper routing of the cables. The speaker terminals were loaded with 4 ohms.

Note: Screw hole W100 was electrically connected to the metal backplate as this improves EMC performance.

### Mechanical Mounting

The ICEpower50ASX2 module is designed for mounting either inside or outside the acoustic volume of a speaker enclosure or inside a normal amplifier metal cabinet. The module is mounted by means of the four 3.5mm holes in the board. The holes are indicated on the illustration on this page.

Avoid loudspeaker cabinet damping material close to the module and ensure free airflow around the module to maximize thermal performance. Vertical mounting is preferred.

## Safety

To ease the design-in process the ICEpower50ASX2 module will be safety approved by UL according to the following standards:

Europe: IEC 60065 7<sup>th</sup> ed.

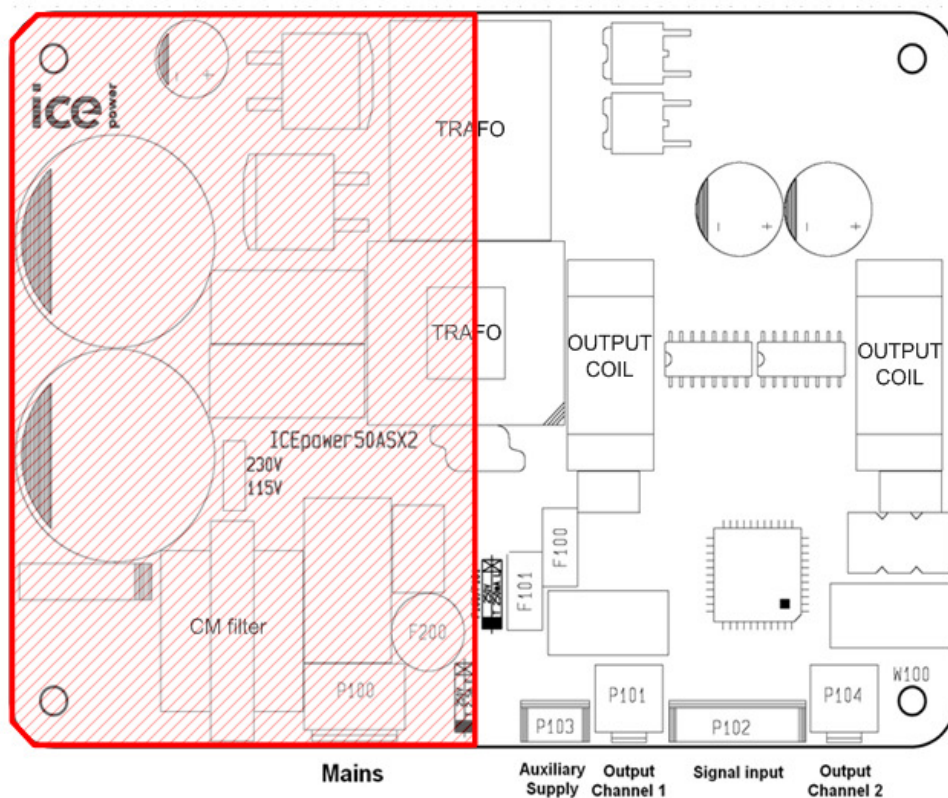
US: UL60065 7<sup>th</sup> ed.

### Safety class

Class 2 (without earth)

## Safety Guidelines

The ICEpower50ASX2 module is developed for class-2 equipment. Therefore all secondary parts must be kept at least 6mm away from the primary side. On the illustration below, the primary side is indicated by a red hatching. All components and PCB tracks within this area are connected to the primary side, including components on the back of the PCB.



## Thermal Design

### General

Even with the high efficiency of the ICEpower50ASX2 module, proper thermal design is very important

When doing the thermal design and tests, it is important to note that the amplifiers are to be used for music signal reproduction. Thorough investigations have shown that the RMS level of any music signal does not normally exceed  $1/8^{\text{th}}$  of the peak value. Consequently, pink noise with an RMS level corresponding to  $1/8^{\text{th}}$  of the rated maximum power should be used as the worst-case signal along with various music signals.

Avoid loudspeaker cabinet damping material close to the module and ensure free airflow around the module to maximize thermal performance. Vertical mounting is preferred.

The ICEpower50ASX2 module has full onboard thermal protection for both the power supply and amplifier section. This protection circuitry shuts down the module if the temperature reaches critical levels.

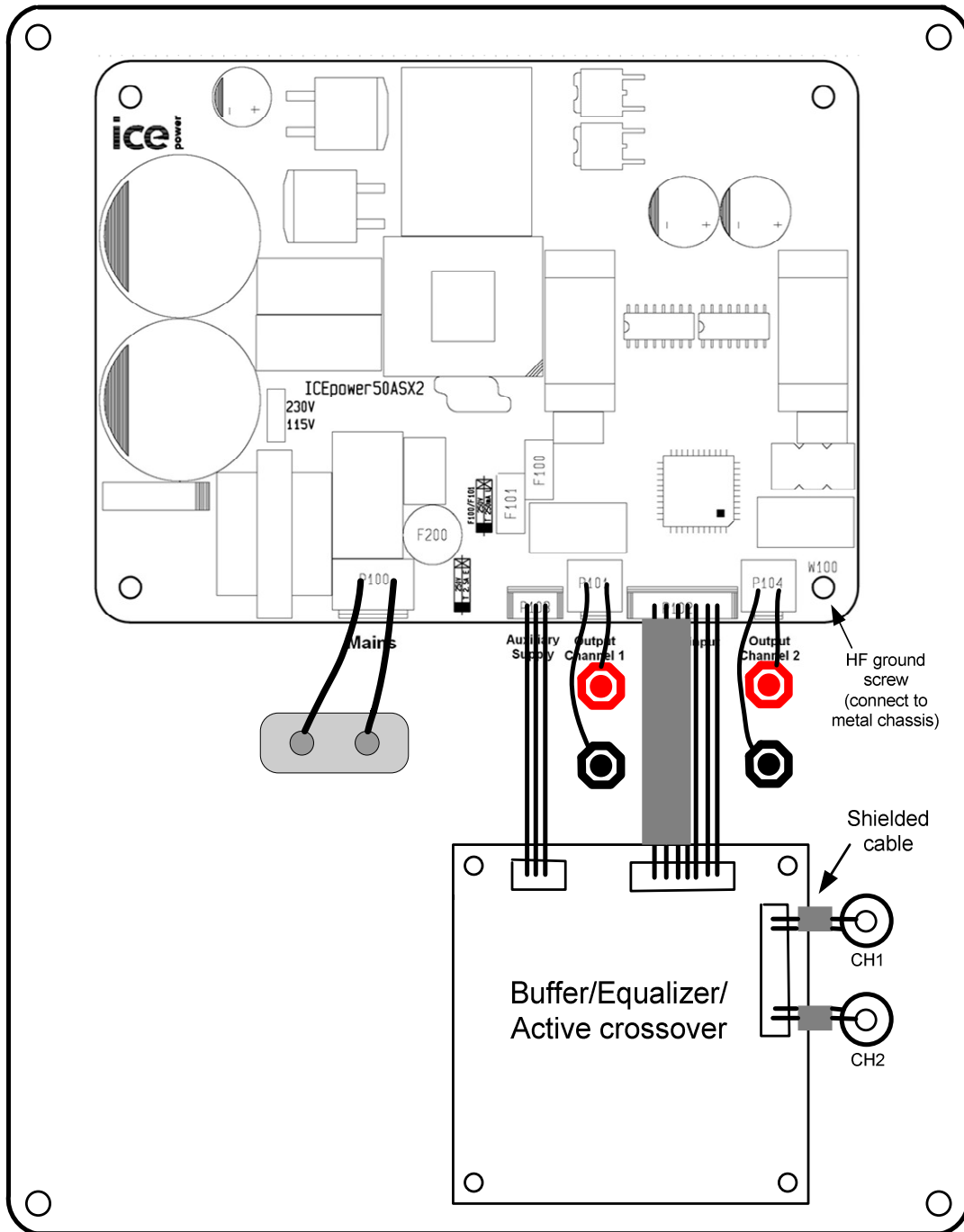
### Notice

The data sheet contains specifications that may be subject to change without prior notice. ICEpower® is a trademark of ICEpower a/s.

ICEpower a/s products are not authorized for use as critical components in life support devices or systems without the express written approval of the president and general counsel of ICEpower a/s. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labelling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

### Appendix A - Recommended Wiring Diagram



## Appendix B - Evaluation Kit Cables

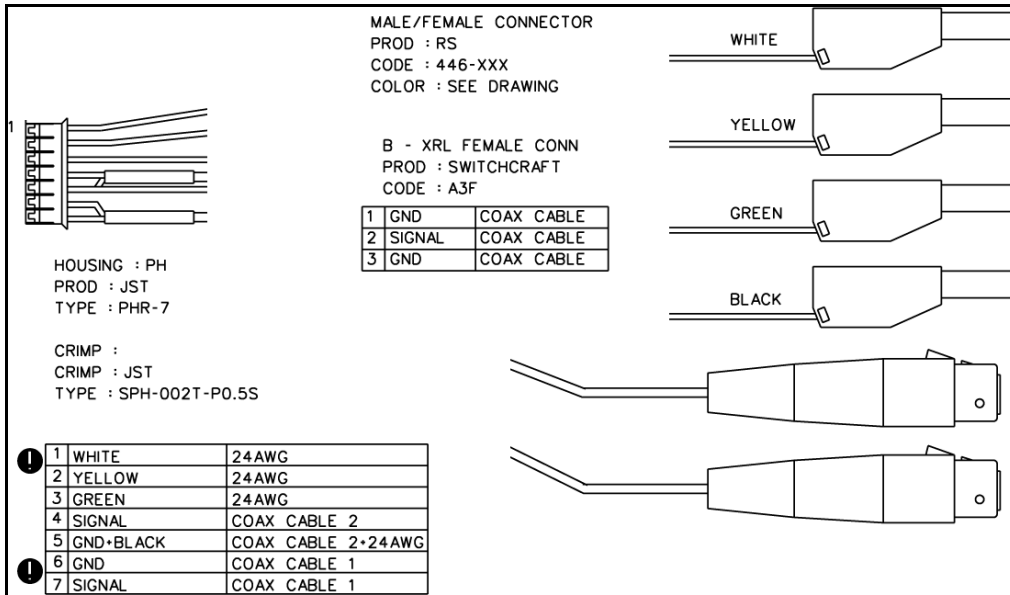


Fig. 1: Signal cable (ICEpower part number 6277141)

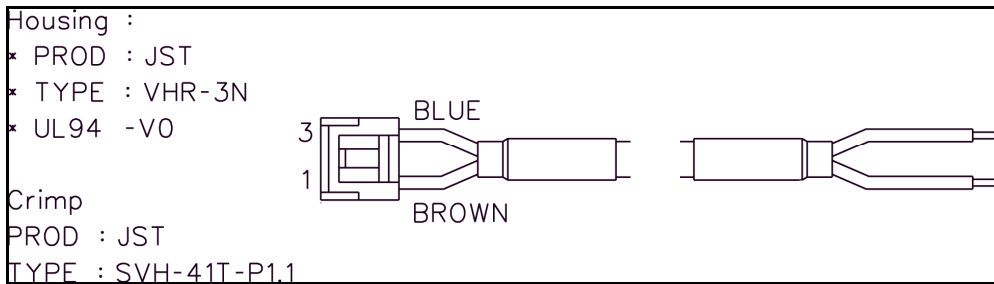


Fig. 2: Mains cable (ICEpower part number 6277847)

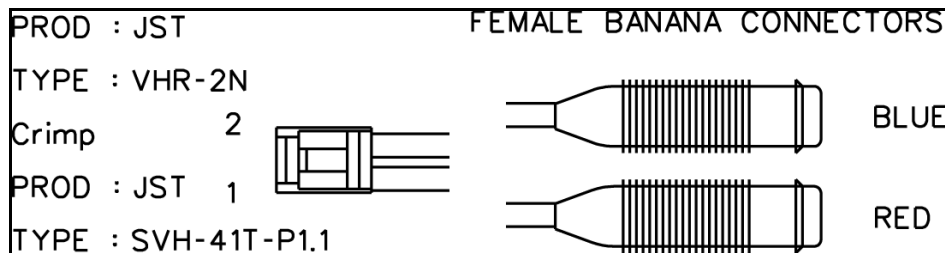


Fig. 3: Speaker Cable (ICEpower part number 6277692)  
 ICEpower50ASX(BTL) requires 1 pc, ICEpower50ASX(SE) requires 2 pcs.

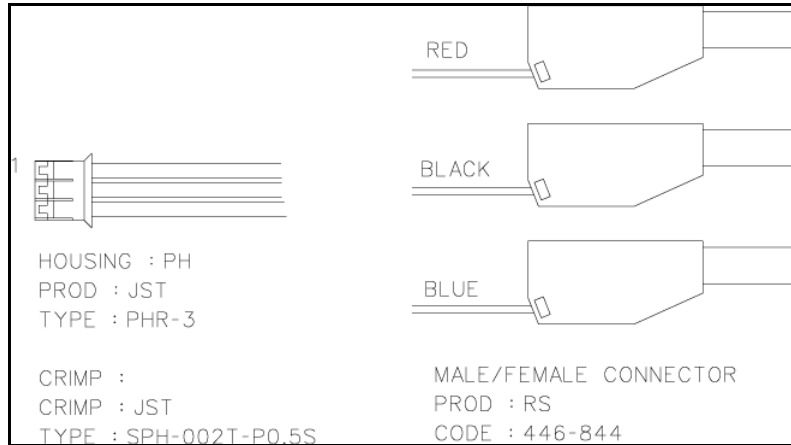


Fig. 4: Cable for AUX supply (ICEpower part number 6277140)