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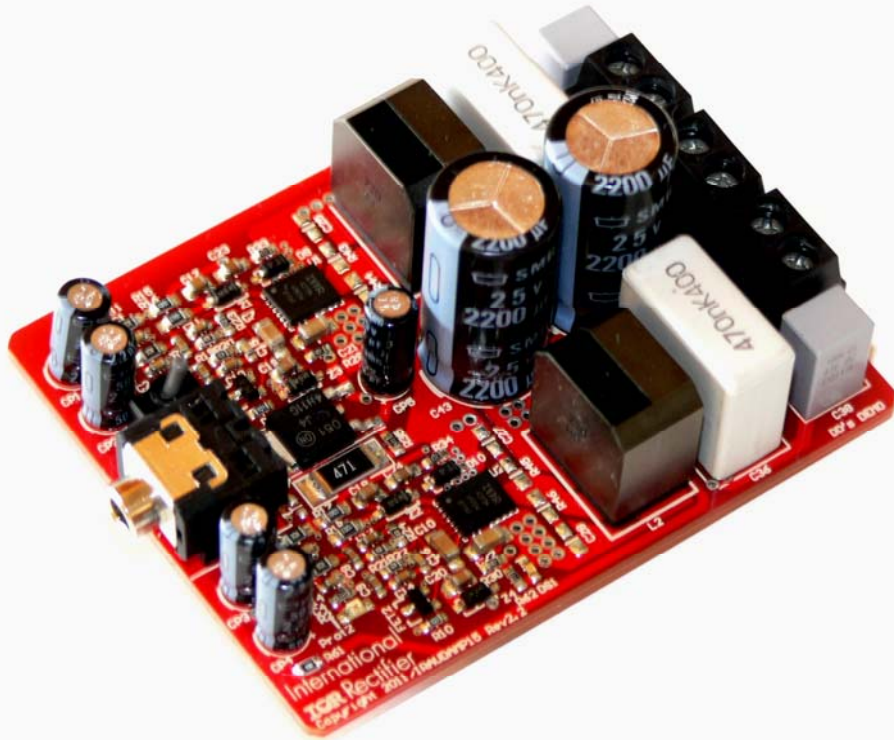
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# IRAUDAMP15

## 35W/4Ω x 2 Channel Class D Audio Power Amplifier Using the IR4311

By  
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### CAUTION:

International Rectifier suggests the following guidelines for safe operation and handling of IRAUDAMP15 Demo board;

- Always wear safety glasses whenever operating Demo Board
- Avoid physical contact with exposed metal surfaces when operating Demo Board
- Turn off Demo Board when placing or removing measurement probes

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## Introduction

The IRAUDAMP15 reference design is a two-channel, 35W/ch half-bridge Class D audio power amplifier with single power supply. This reference design demonstrates how to use the IR4311 IC with single power supply, implement protection circuits, and design an optimum PCB layout using PowIRaudio integrated Class D IC. This reference design does not require additional heatsink or fan cooling for normal operation (one-eighth of continuous rated power). The reference design provides all the required housekeeping power supplies for ease of use. The two-channel design is scalable for power and the number of channels.

## Applications

- Docking station audio systems
- PC audio systems
- Musical instruments
- Karaoke amplifiers
- Game consoles
- Powered speaker systems
- Car audio amplifiers

## Features

Output Power: 35W x 2 channels (4Ω load)  
 Multiple Protection Features: Over-current protection (OCP), high side and low side  
 Over-voltage protection (OVP),  
 Under-voltage protection (UVP), high side and low side  
 Over-temperature protection (OTP)  
 PWM Modulator: Self-oscillating half-bridge topology

## Specifications

General Test Conditions (unless otherwise noted)		Notes / Conditions
Supply Voltages	18-31V*	
Load Impedance	2-4Ω	Resistive load
Self-Oscillating Frequency	400kHz	No input signal, Adjustable
Gain Setting	21.4dB	1Vrms input yields rated power

Electrical Data		Typical	Notes / Conditions
IR Devices Used	IR4311 PowIRaudio integrated Class D IC		
Modulator	Self-oscillating, second order sigma-delta modulation, analog input		
Power Supply Range	18-31V*	Single power supply;	
Output Power CH1-2: (1% THD+N)	26W	1kHz	
Output Power CH1-2: (10% THD+N)	35W	1kHz	
Rated Load Impedance	2-4Ω	Resistive load	
Idling Supply Current	90mA	No input signal	
Total Idle Power Consumption	2.8W	No input signal	
Distortion	0.02%	THD+N @ 5W, 4Ω	
Residual Noise	230μV	IHF-A weighted, AES-17 filter	
Channel Efficiency	96%	Single-channel driven, 35W, Class D stage	

*Power Supply Voltage Range	18~27V	27~37V
*R25~R28	220Ω	470Ω

## Connection Setup

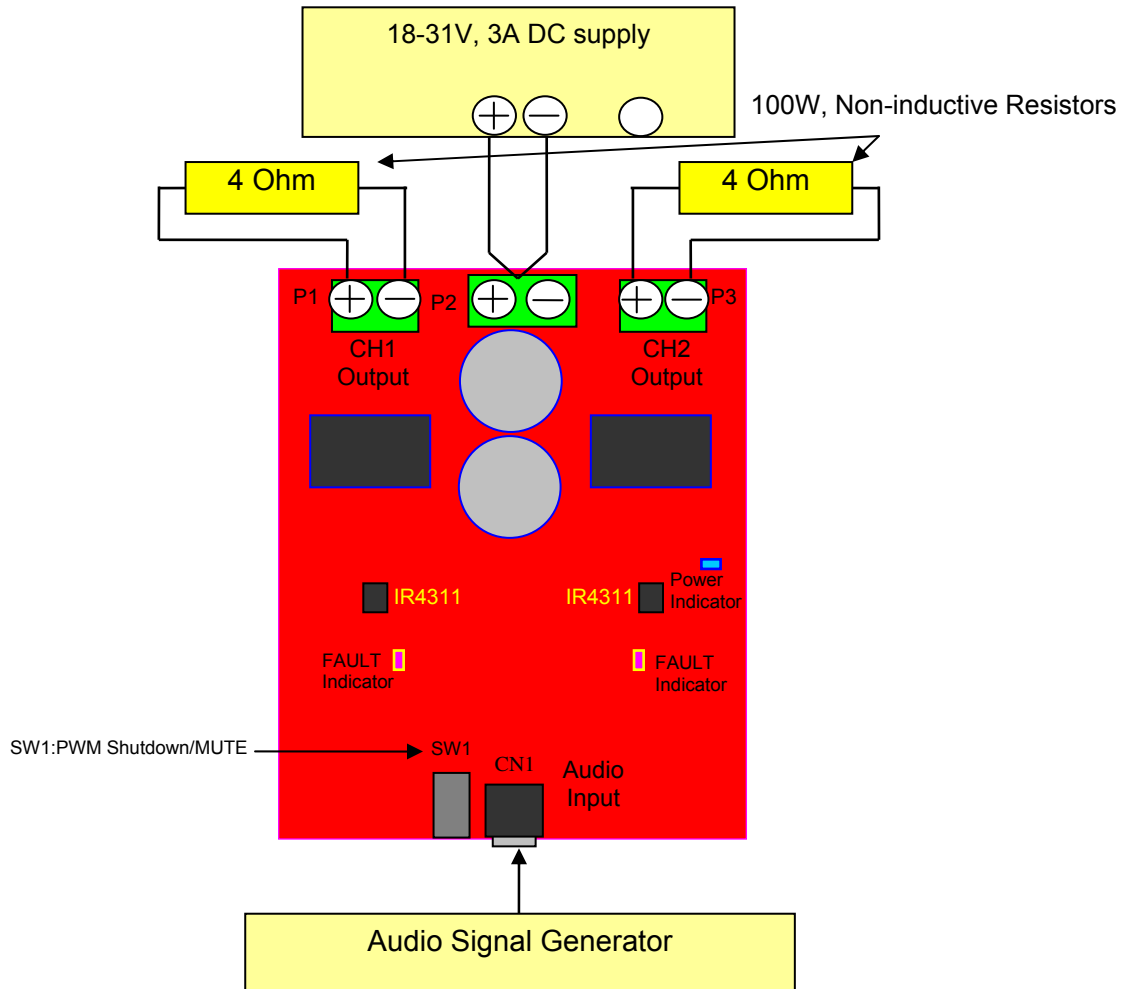


Fig 1 Typical Test Setup

## Connector Description

Audio IN	CN1	Analog input for CH1 and CH2
POWER	P2	Single supply
CH1 OUT	P1	Output for CH1
CH2 OUT	P3	Output for CH2

## Test Procedures

### Test Setup:

1. Connect 4Ω, 100W load to both output connectors, P1 and P3 and audio analyzer (Ap).
2. Connect Audio Signal Generator to CN1 for CH1 and CH2 respectively (Ap).
3. Connect a single power supply to P2 pre-adjusted to 18-31V as shown on Figure above
4. Turn on the power supply.
5. Turn on SW1 (right side).
6. Blue LED (Normal) stays turning on after RED LED extinguished.
7. With an Oscilloscope, monitor switching waveform at VS of CH1 and CH2.
8. Quiescent current for the power supply should be 70mA ±10mA at 31V.

### Functionality Audio Tests:

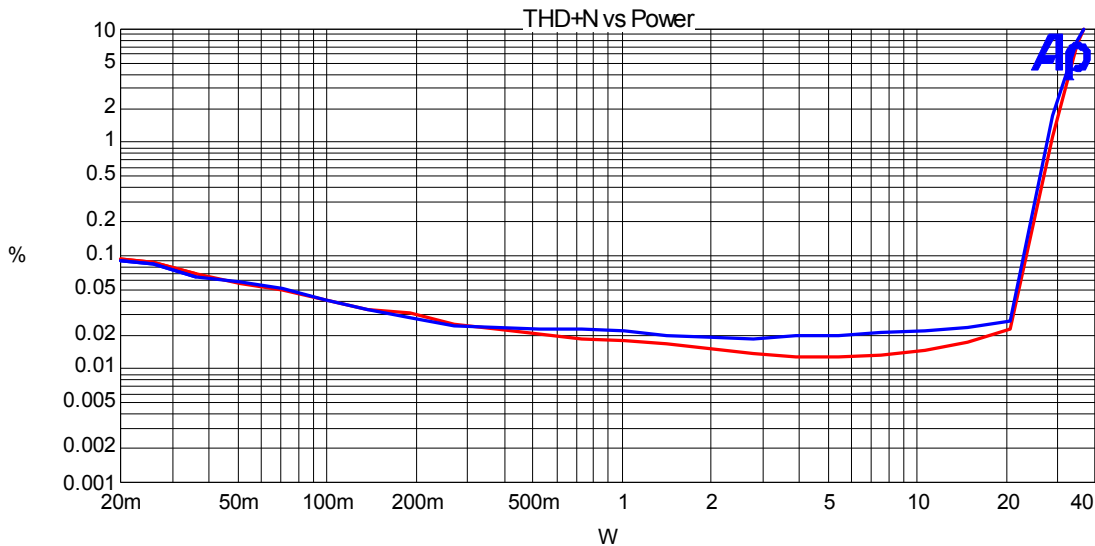
9. Sweep the audio signal voltage from 15 mV<sub>RMS</sub> to 1.5 V<sub>RMS</sub>.
10. Monitor the output signals at P1/P3 with an oscilloscope. The waveform must be a non distorted sinusoidal signal with input sinusoidal signal below 1Vrms.

## Performance and Test Graphs

### Power vs THD+N (without heatsink)

#### Test Conditions:

VBus = 31V  
Input Signal=1 kHz  
Load Impedance = 4 ohms



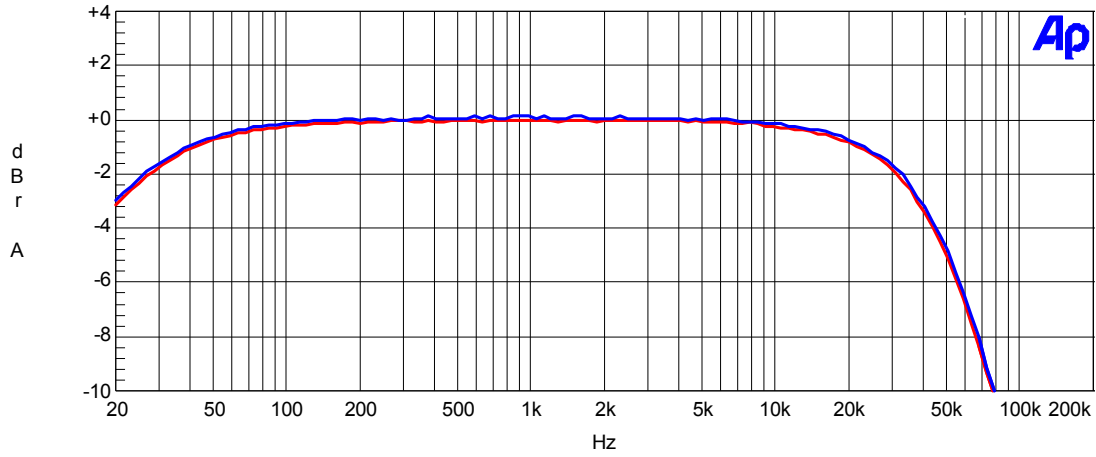
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Anlr.THd+N Ratio	Left	Ch1 4ohms 31V
1	3	Blue	Solid	2	Anlr.THd+N Ratio	Left	Ch2 4ohms 31V

Fig 2

**Frequency Response**

Test Conditions:

VBus = 31V  
Set Output = 1V  
Load Impedance = 4 ohms



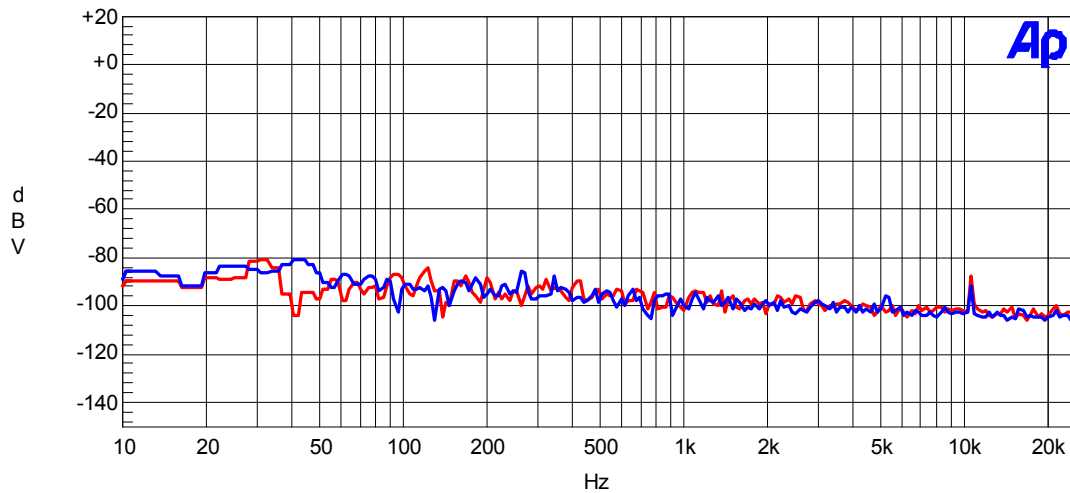
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Anlr.Level A	Left	Ch1 4ohm SP 25V
1	2	Blue	Solid	2	Anlr.Level B	Left	Ch2 4ohm SP 25V

Fig 3

**Noise Floor**

Test Conditions:

VBus = 31V  
Load Impedance = 4 ohms  
No Input Signal



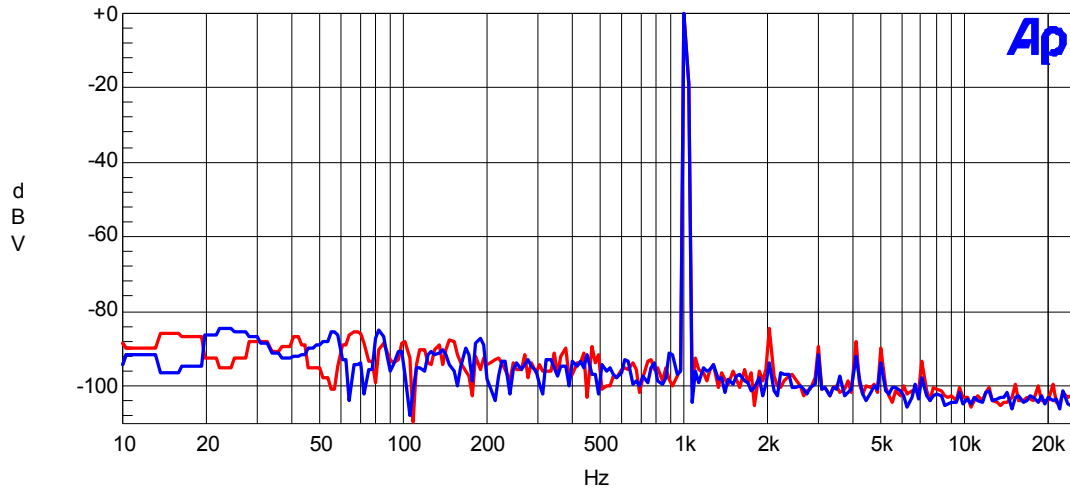
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Fft.Ch.1 Ampl	Left	Ch1
1	2	Blue	Solid	2	Fft.Ch.2 Ampl	Left	Ch2

Fig 4

**Noise Floor with 1Vrms Output**

Test Conditions:

VBus = 31V  
Output = 1Vrms @ 1 KHz  
Load Impedance = 4 ohms



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	Ft.Ch.1 Ampl	Left	Ch1 4ohm
1	2	Blue	Solid	2	Ft.Ch.2 Ampl	Left	Ch1 4ohm

Fig 5

**Efficiency**

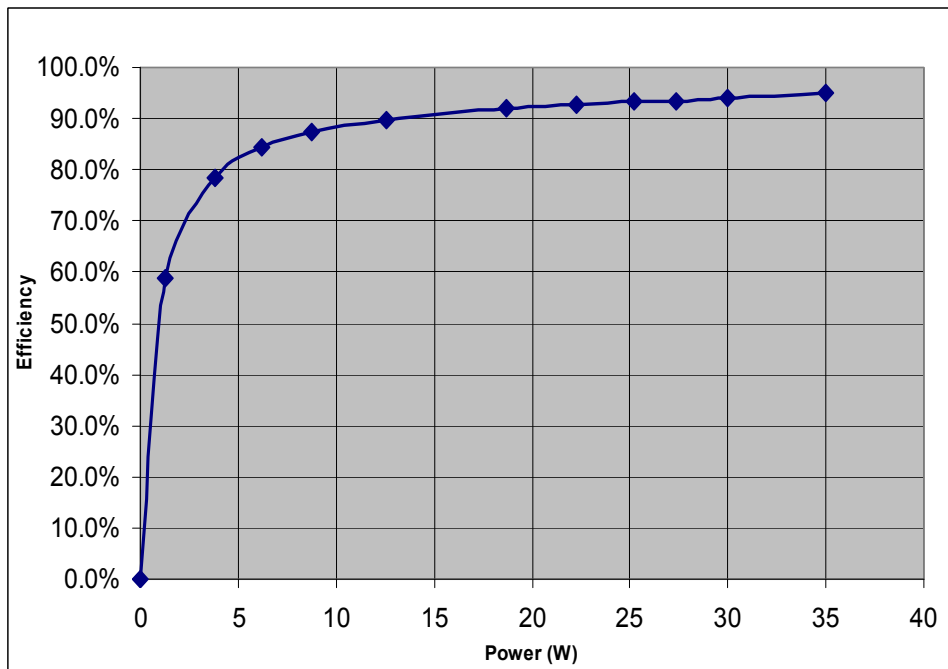


Fig 6



## Thermal Information:

### 1/8 Po Thermal Test

#### Conditions:

- Tamb=25°C natural convection cooling
- Both Channel Driven 1/8Po continuous 30mins
- Temperature measured by infrared camera

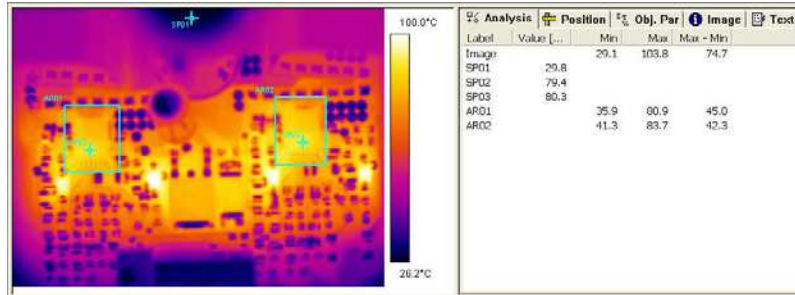


Fig 7 IRAUDAMP15 (Vbus=31V)

IR4311's temperature saturated around 85°C within 30minutes

Schematic

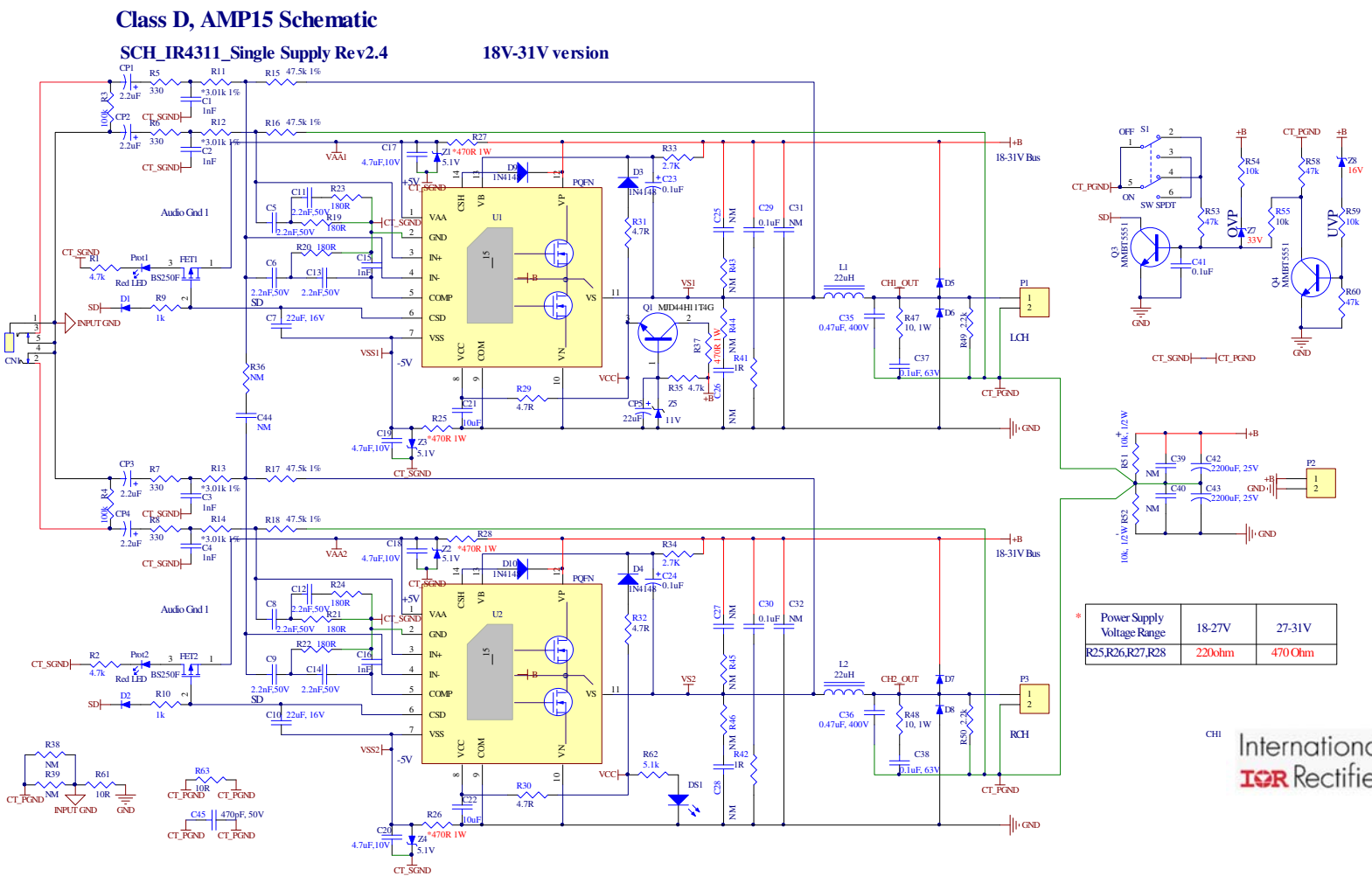


Fig8

Bill of Materials

No	Part Number	Designator	Description	Quantity	Vender
1	490-1494-1-ND	C1, C2, C3, C4, C15, C16	CAP CER 1000PF 50V 10% X7R 0603	6	Digikey
2	445-1309-1-ND	C5, C6, C8, C9, C11, C12, C13, C14	CAP CER 2200PF 50V X7R 10% 0603	8	Digikey
3	587-1433-1-ND	C7, C10	CAP CER 22UF 16V X5R 1206	2	Digikey
4	478-1429-1-ND	C17, C18, C19, C20	CAP CER 4.7UF 10V Y5V 0805	4	Digikey
5	399-3525-1-ND	C21, C22	CAP CERAMIC 10UF 16V X7R 1206	2	Digikey
6	311-1140-1-ND	C23, C24, C41	CAP CER 0.1UF 50V 10% X7R 0805	3	Digikey
7	445-1418-1-ND	C29, C30	CAP CER .10UF 100V X7R 10% 0805	2	Digikey
8	495-1315-ND	C35, C36	CAP FILM 0.47UF 400VDC RADIAL	2	Digikey
9	BC2054-ND	C37, C38	CAP FILM 0.1UF 63VDC RADIAL	2	Digikey
10	565-1064-ND	C42, C43	CAP ALUM 2200UF 25V 20% RADIAL	2	Digikey
11	311-1124-1-ND	C45	CAP 470PF 50V CERAMIC X7R 0805	1	Digikey
12	CP1-3545N-ND	CN1	CONN JACK STEREO R/A 5PIN 3.5MM	1	Digikey
13	565-1103-ND	CP1, CP2, CP3, CP4	CAP ALUM 2.2UF 50V 20% RADIAL	4	Digikey
14	565-1056-ND	CP5	CAP 22UF 25V ELECT VR RADIAL	1	Digikey
15	1N4148WS-FDICT-ND	D1, D2	DIODE SWITCH 75V 200MW SOD323	2	Digikey
16	1N4148WDICT-ND	D3, D4, D9, D10	DIODE SWITCH 100V 400MW SOD-123	4	Digikey
17	160-1647-1-ND	DS1	LED BLUE CLEAR THIN 0603 SMD	1	Digikey
18	BS250FCT-ND	FET1, FET2	MOSFET P-CH 45V 90MA SOT23-3	2	Digikey
19	Sagami 7G13A-220M-R	L1, L2	Class D Inductor, 22UH 13A	2	Inductors, Inc
20	281-1414-ND	P1, P2, P3	CONN TERM BLOCK PCB 5.0MM 2POS	3	Digikey
21	160-1182-1-ND	Prot1, Prot2	LED RED ORANGE CLEAR 0603 SMD	2	Digikey
22	MJD44H11T4GOSCT-ND	Q1	TRANS PWR NPN 8A 80V DPAK	1	Digikey
23	MMBT5551FSCT-ND	Q3, Q4	TRANSISTOR NPN 160V SOT-23	2	Digikey
24	RMCF0603JT4K70CT-ND	R1, R2	RES 4.7K OHM 1/10W 5% 0603 SMD	2	Digikey
25	RMCF0603JT100KCT-ND	R3, R4	RES 100K OHM 1/10W 5% 0603 SMD	2	Digikey
26	RMCF0603JT330RCT-ND	R5, R6, R7, R8	RES 330 OHM 1/10W 5% 0603 SMD	4	Digikey
27	RMCF0603JT1K00CT-ND	R9, R10	RES 1K OHM 1/10W 5% 0603 SMD	2	Digikey
28	RHM3.01KCRCT-ND	R11, R12, R13, R14	RES 3.01K OHM 1/8W 1% 0805 SMD	4	Digikey
29	311-47.5KCRCT-ND	R15, R16, R17, R18	RES 47.5K OHM 1/8W 1% 0805 SMD	4	Digikey
30	RHM180GCT-ND	R19, R20, R21, R22, R23, R24	RES 180 OHM 1/10W 5% 0603 SMD	6	Digikey
31	RMCF2512JT470RCT-ND	R25, R26, R27, R28	RES 470 OHM 1W 5% 2512 SMD	4	Digikey
32	P4.7ACT-ND	R29, R30, R31, R32	RESISTOR 4.7 OHM 1/8W 5% 0805	4	Digikey
33	RHM2.7KGCT-ND	R33, R34	RES 2.7K OHM 1/10W 5% 0603 SMD	2	Digikey
34	RHM4.7KGCT-ND	R35	RES 4.7K OHM 1/10W 5% 0603 SMD	1	Digikey
35	PT470XCT-ND	R37	RES 470 OHM 1W 5% 2512 SMD	1	Digikey
36	P1.0ACT-ND	R41, R42	RESISTOR 1.0 OHM 1/8W 5% 0805	2	Digikey
37	541-10.0AFCT-ND	R47, R48	RES 10.0 OHM 1W 1% 2512 SMD	2	Digikey
38	RMCF0805JT2K20CT-ND	R49, R50	RES 2.2K OHM 1/8W 5% 0805 SMD	2	Digikey
39	541-10KVCT-ND	R51, R52	RES 10K OHM 1/2W 5% 1210 SMD	2	Digikey
40	RHM47KARCT-ND	R53, R58, R60	RES 47K OHM 1/8W 5% 0805 SMD	3	Digikey
41	RHM10KARCT-ND	R54, R55, R59	RES 10K OHM 1/8W 5% 0805 SMD	3	Digikey
42	311-10ARCT-ND	R61, R63	RES 10 OHM 1/8W 5% 0805 SMD	1	Digikey
43	RMCF0603JT5K10CT-ND	R62	RES 5.1K OHM 1/10W 5% 0603 SMD	1	Digikey
44	360-1758-ND	S1	SWITCH TOGGLE SPDT .4VA SEAL PCB	1	Digikey
45	IR4311	U1, U2	2 CH PowIRaudio integrated Class D IC	2	IR

46	DDZ5V1BDICT-ND	Z1, Z2, Z3, Z4	DIODE ZENER 5.1V 500MW SOD-123	4	Digikey
47	BZT52C11-FDICT-ND	Z5	DIODE ZENER 11V 500MW SOD123	1	Digikey
48	568-3766-1-ND	Z7	DIODE ZENER 33V 375MW SOD123F	1	Digikey
49	BZT52C16-FDICT-ND	Z8	DIODE ZENER 16V 500MW SOD-123	1	Digikey

## PCB Specifications

PCB:

1. Two Layers SMT PCB with through holes
2. 1/16 thickness
3. 2/0 OZ Cu
4. FR4 material
5. 10 mil lines and spaces
6. Solder Mask to be Green enamel EMP110 DBG (CARAPACE) or Enthone Endplate DSR-3241 or equivalent.
7. Silk Screen to be white epoxy non conductive per IPC-RB 276 Standard.
8. All exposed copper must finished with TIN-LEAD Sn 60 or 63 for 100u inches thick.
9. Tolerance of PCB size shall be 0.010 –0.000 inches
10. Tolerance of all Holes is  $-.000 + 0.003$ "
11. PCB acceptance criteria as defined for class II PCB'S standards.

PCB Layout  
Top side:

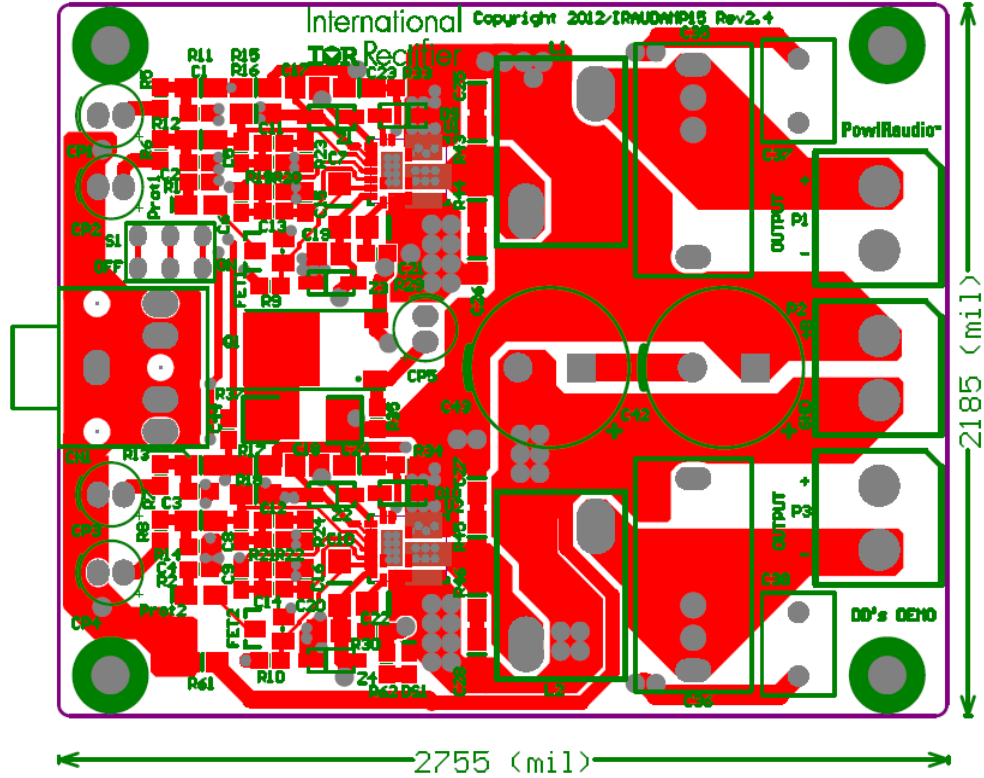


Fig 9

Bottom side:

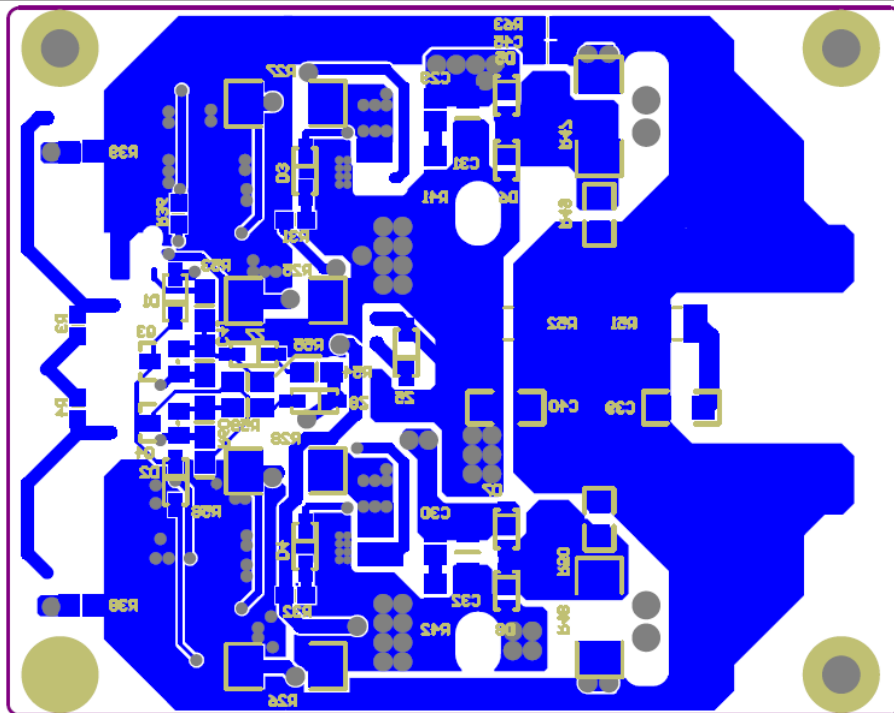


Fig 10

Note: Refer to AN1170 for footprint and board mounting details.

## Revision changes descriptions

Revision	Changes description	Date
Rev 1.0	Released	May, 11 2012