

IRAUDAMP15

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

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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 PowlRaudio 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 PowlRaudio 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

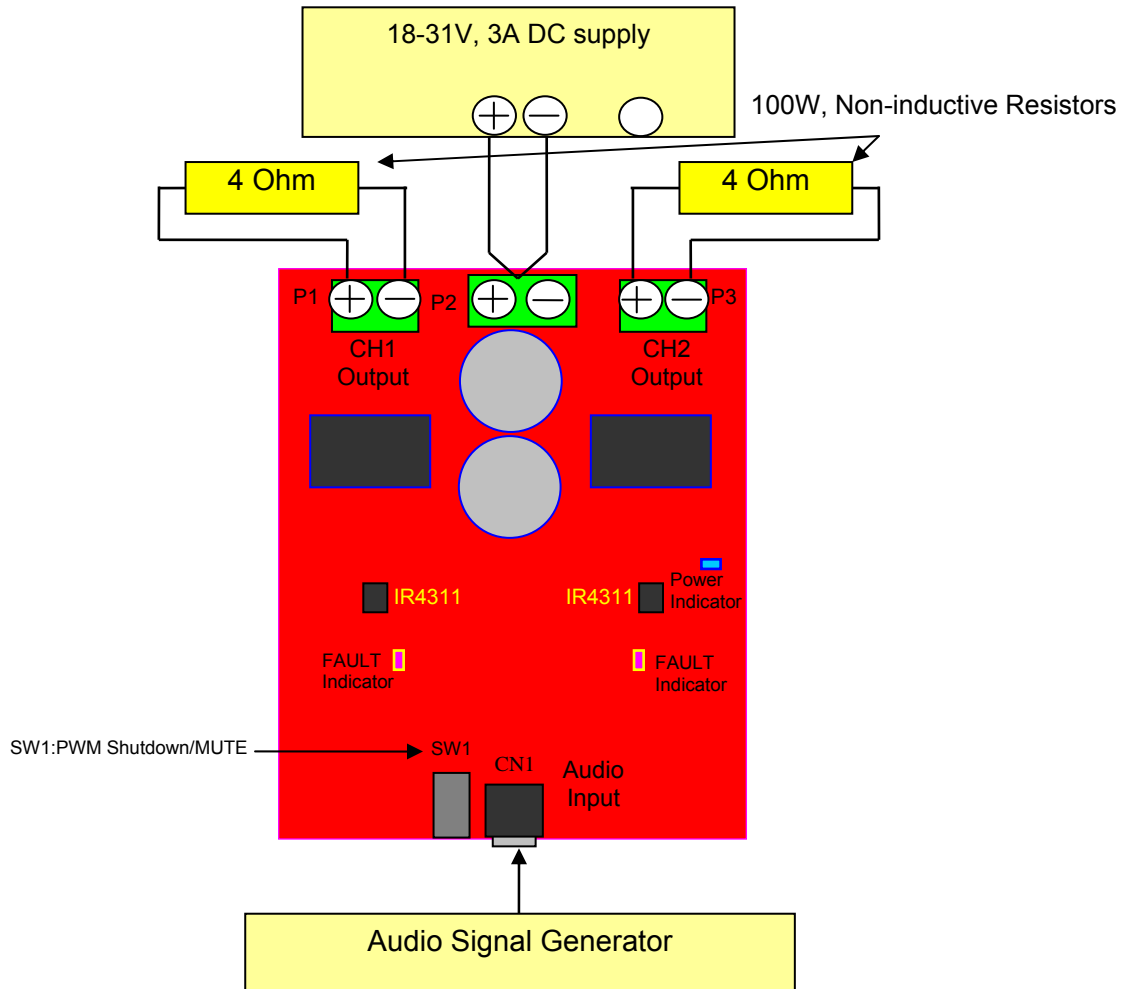


Fig 1 Typical Test Setup

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:

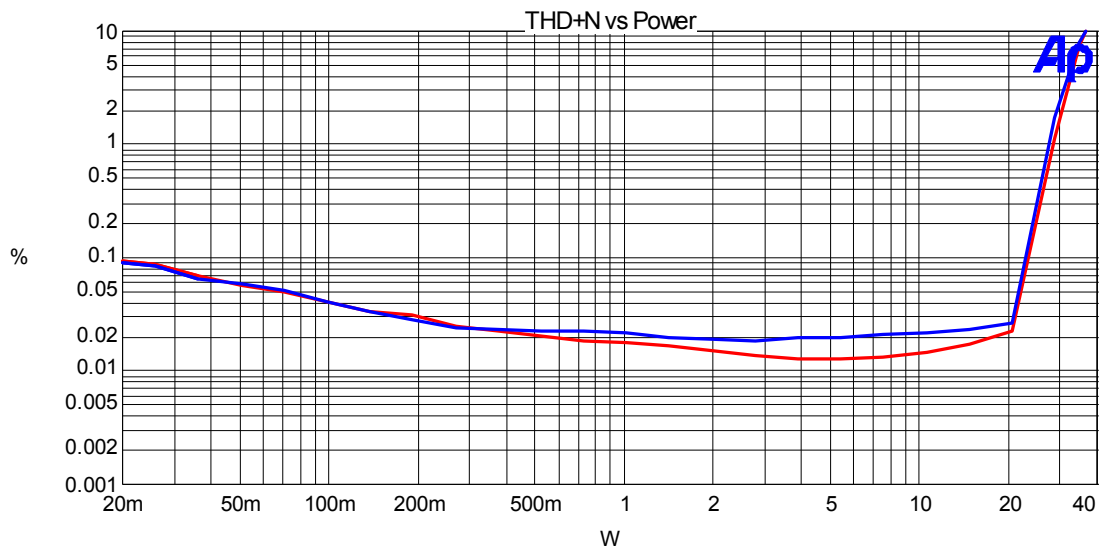
9. Sweep the audio signal voltage from 15 mV_{RMS} to 1.5 V_{RMS}.
10. Monitor the output signals at P1/P3 with an oscilloscope. The waveform must be a non distorted sinusoidal signal with input sinusoidal signal below 1Vrms.

Performance and Test Graphs

Power vs THD+N (without heatsink)

Test Conditions:

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



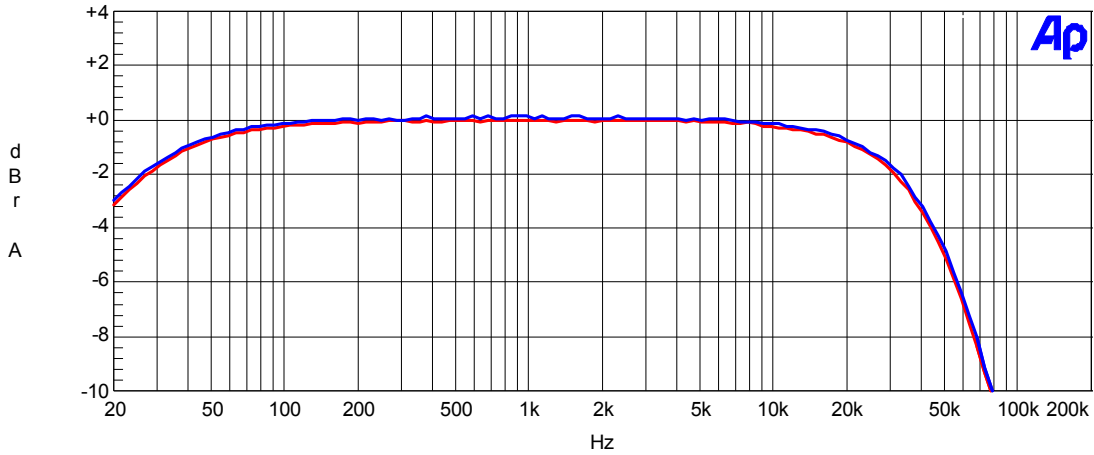
| Sweep | Trace | Color | Line Style | Thick | Data | Axis | Comment |
|-------|-------|-------|------------|-------|------------------|------|---------------|
| 1 | 1 | Red | Solid | 2 | Anlr.THd+N Ratio | Left | Ch1 4ohms 31V |
| 1 | 3 | Blue | Solid | 2 | Anlr.THd+N Ratio | Left | Ch2 4ohms 31V |

Fig 2

Frequency Response

Test Conditions:

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



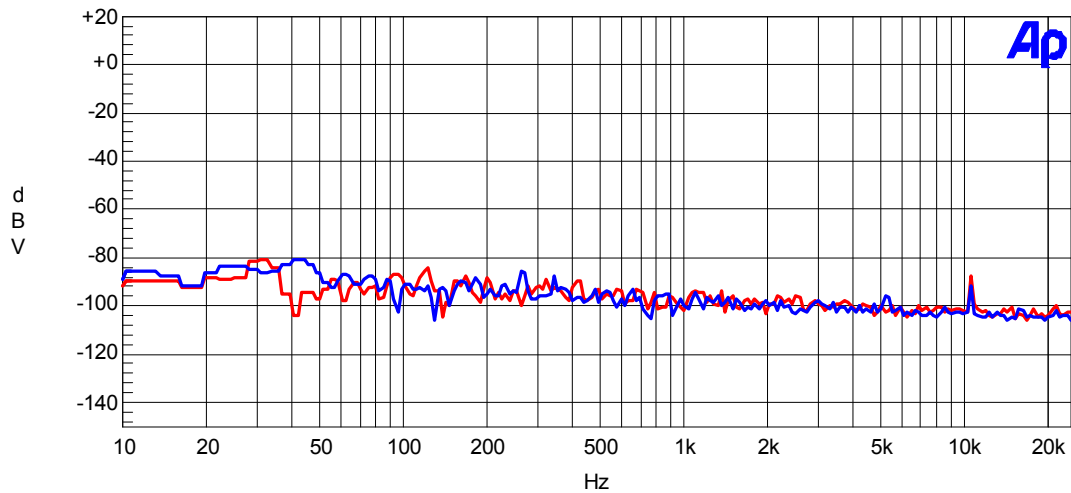
| Sweep | Trace | Color | Line Style | Thick | Data | Axis | Comment |
|-------|-------|-------|------------|-------|--------------|------|-----------------|
| 1 | 1 | Red | Solid | 2 | Anlr.Level A | Left | Ch1 4ohm SP 25V |
| 1 | 2 | Blue | Solid | 2 | Anlr.Level B | Left | Ch2 4ohm SP 25V |

Fig 3

Noise Floor

Test Conditions:

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



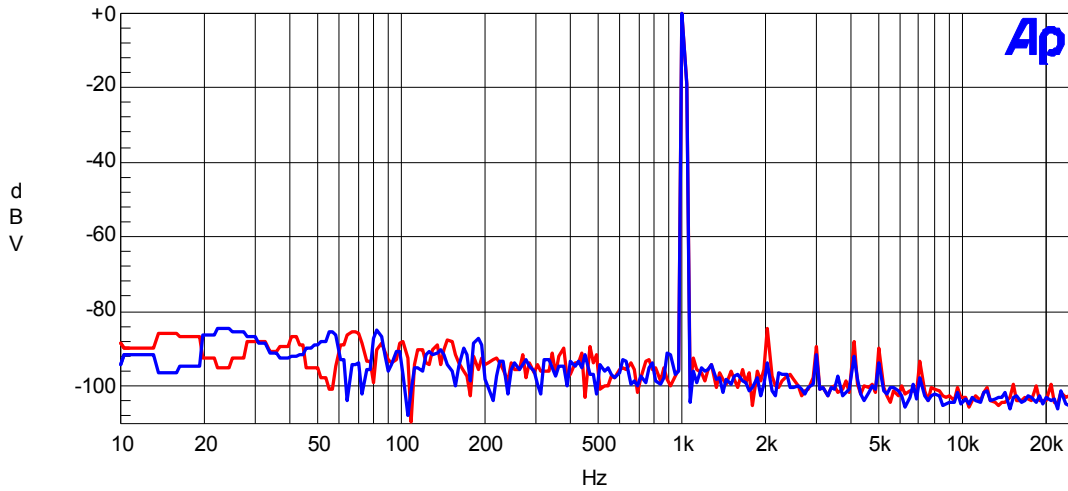
| Sweep | Trace | Color | Line Style | Thick | Data | Axis | Comment |
|-------|-------|-------|------------|-------|---------------|------|---------|
| 1 | 1 | Red | Solid | 2 | Fft.Ch.1 Ampl | Left | Ch1 |
| 1 | 2 | Blue | Solid | 2 | Fft.Ch.2 Ampl | Left | Ch2 |

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

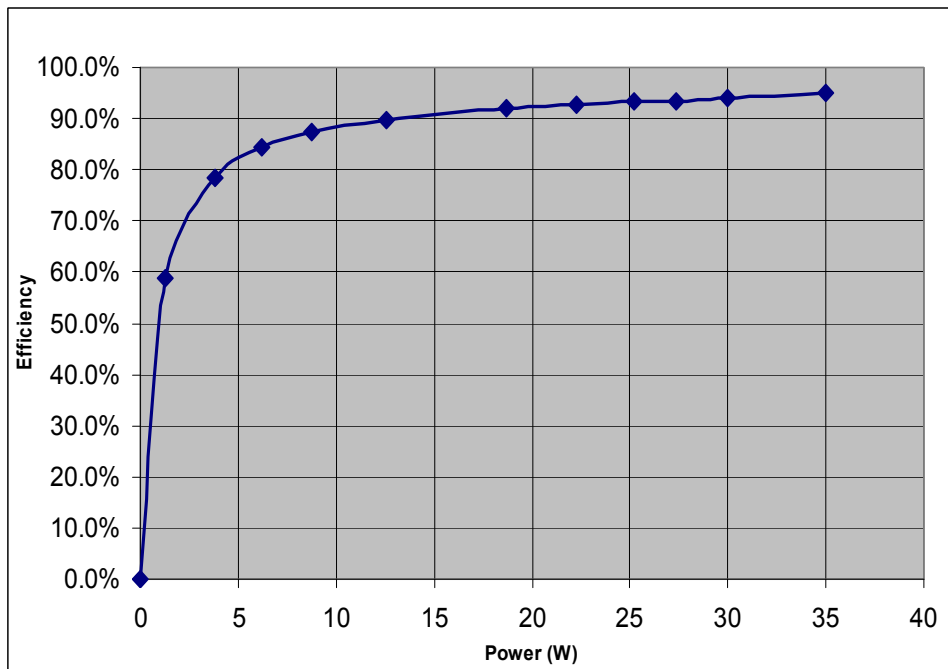


Fig 6

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

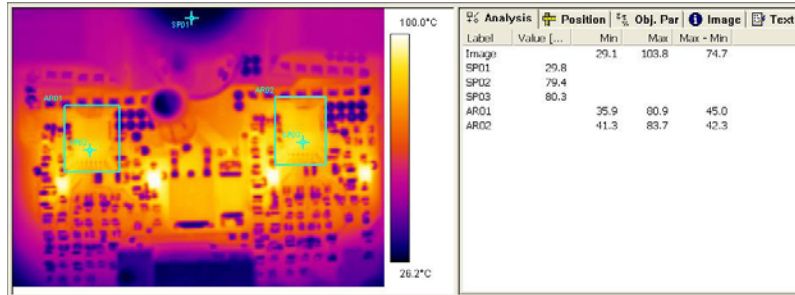


Fig 7 IRAUDAMP15 (Vbus=31V)

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

Schematic

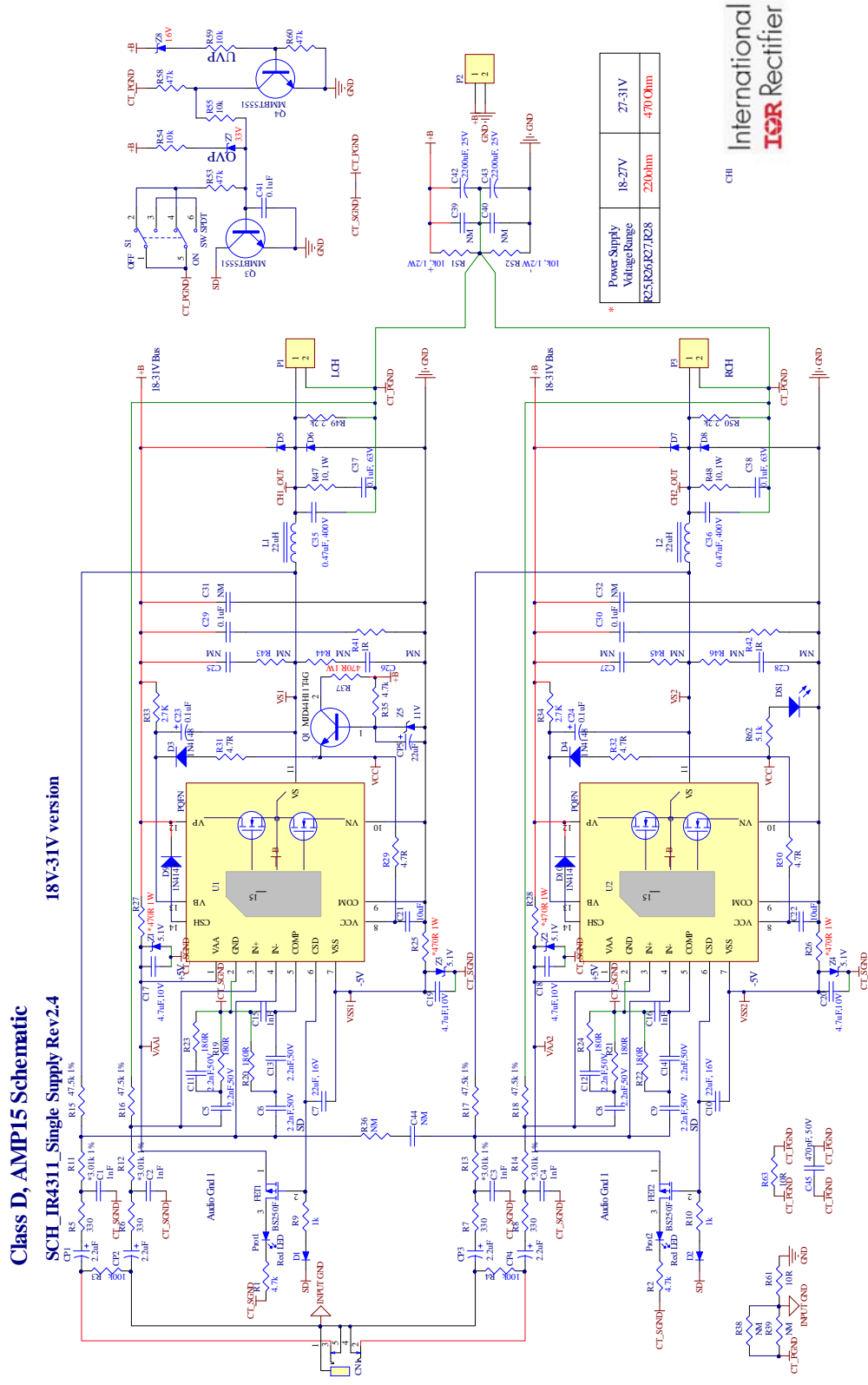


Fig8

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:

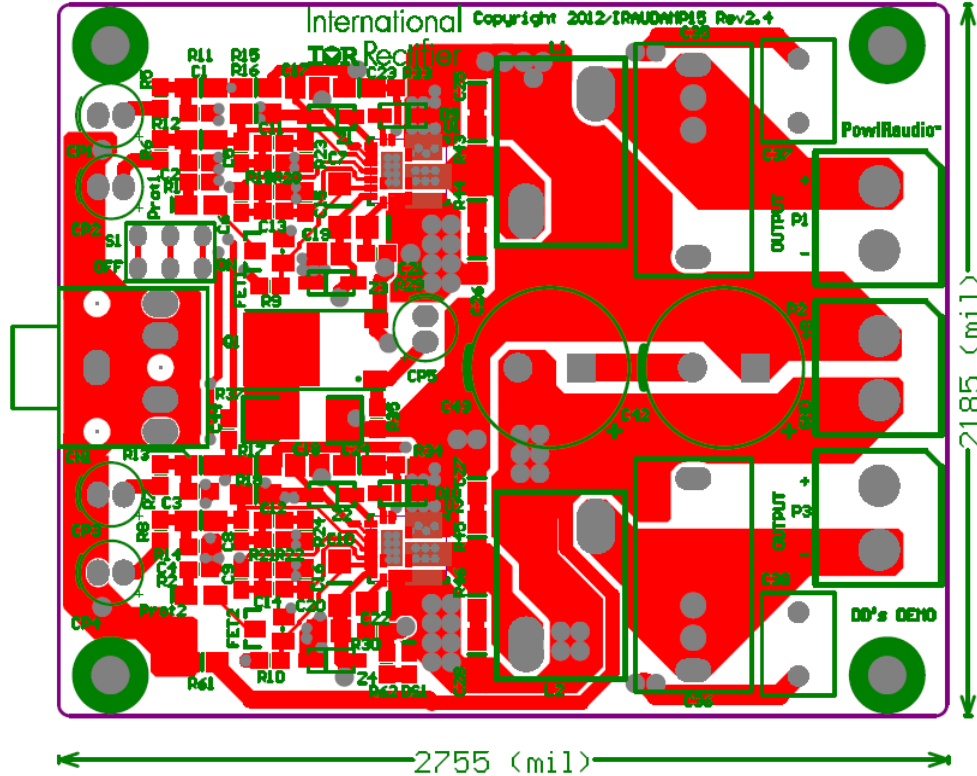


Fig 9

Bottom side:

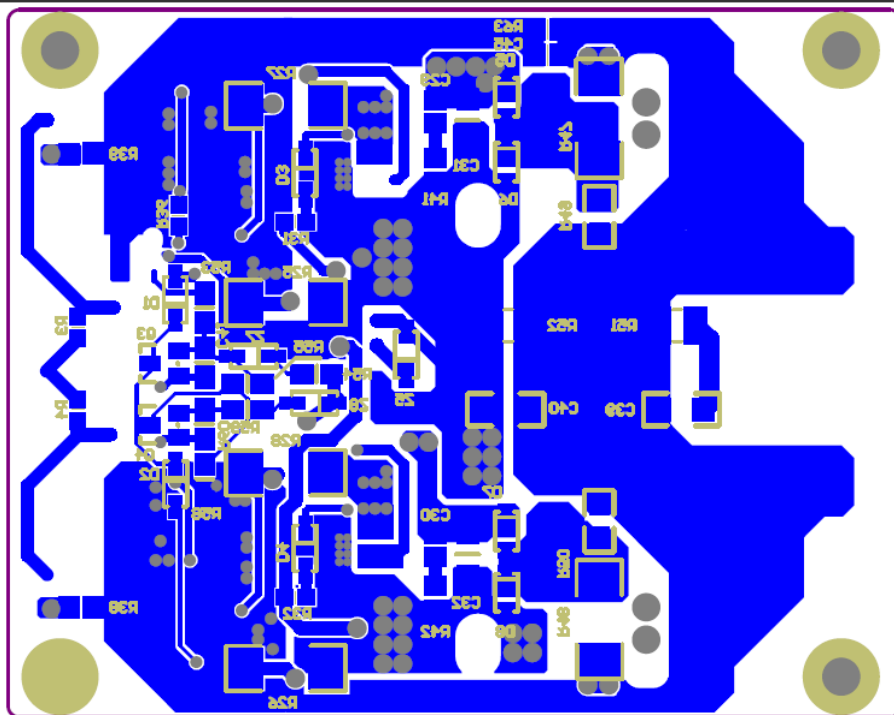


Fig 10

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

Revision changes descriptions

| Revision | Changes description | Date |
|----------|---------------------|--------------|
| Rev 1.0 | Released | May, 11 2012 |

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