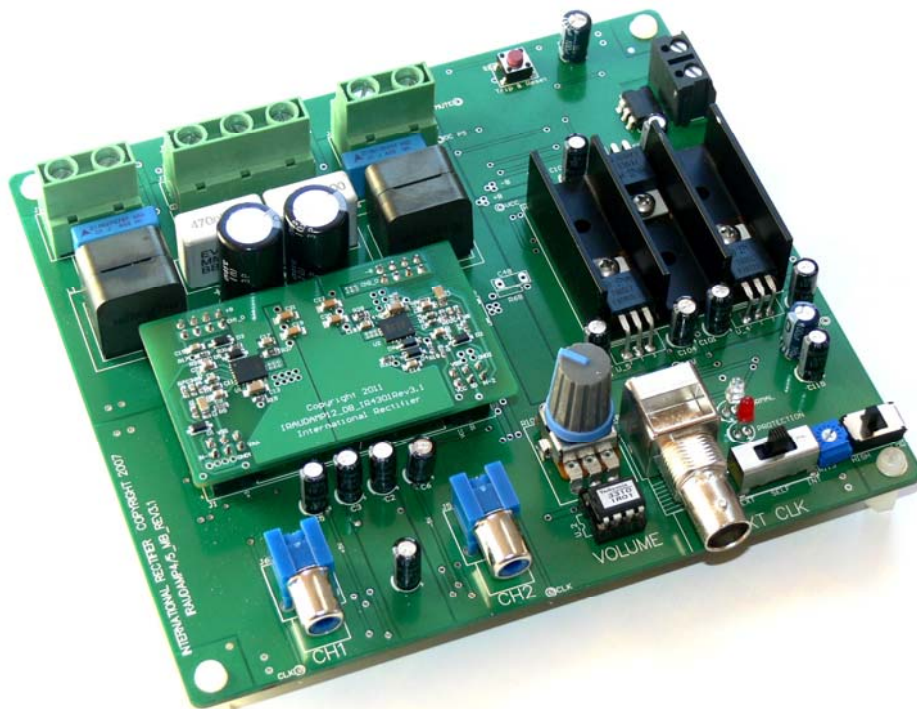


# IRAUDAMP21

## 90W/2 $\Omega$ x 2 Channel Class D Audio Power Amplifier Using the IR4321

By

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### CAUTION:

International Rectifier suggests the following guidelines for safe operation and handling of IRAUDAMP21 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 IRAUDAMP21 reference design is a two-channel, 90W/ch ( $2\Omega/\pm 18V$ ; no heatsink)/ 135W/ch ( $2\Omega/\pm 22V$ ; \*with heatsink) half-bridge Class D audio power amplifier. This reference design demonstrates how to use the IR4321 IC, implement protection circuits, and design an optimum PCB layout using PowIRaudio integrated Class D IC. This reference design does not require 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

- AV receivers
- Home theater systems
- Mini component stereos
- Powered speakers
- Sub-woofers
- Musical Instrument amplifiers
- Car audio amplifiers

## Features

|                               |                                                                                                                                                                                                                |
|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Output Power:                 | 90W x 2 channels (10%THD+N $2\Omega$ load; no heatsink),<br>135W x 2 channels (10%THD+N $2\Omega$ load; *with heatsink),                                                                                       |
| Multiple Protection Features: | Over-current protection (OCP), high side and low side<br>Over-voltage protection (OVP),<br>Under-voltage protection (UVP), high side and low side<br>DC-protection (DCP),<br>Over-temperature protection (OTP) |
| PWM Modulator:                | Self-oscillating half-bridge topology with optional clock<br>synchronization                                                                                                                                   |

## Specifications

| General Test Conditions (unless otherwise noted) |                        | Notes / Conditions                     |
|--------------------------------------------------|------------------------|----------------------------------------|
| Supply Voltages                                  | $\pm 12V \sim \pm 18V$ | Bipolar power supply; without heatsink |
|                                                  | $\pm 12V \sim \pm 22V$ | Bipolar power supply; *with heatsink   |
| Load Impedance                                   | 4- $2\Omega$           | Resistive load                         |
| Self-Oscillating Frequency                       | 400kHz                 | No input signal, Adjustable            |
| Gain Setting                                     | 26dB                   | 1Vrms input yields rated power         |

| Electrical Data                |                                                                     | Typical                         | Notes / Conditions |
|--------------------------------|---------------------------------------------------------------------|---------------------------------|--------------------|
| IR Devices Used                | IR4321 PowIRaudio integrated Class D IC                             |                                 |                    |
| Modulator                      | Self-oscillating, second order sigma-delta modulation, analog input |                                 |                    |
| Output Power CH1-2: (1% THD+N) | 70W                                                                 | 1kHz, 4Ω load, without heatsink |                    |
|                                | 70W                                                                 | 1kHz, 4Ω load, *with heatsink   |                    |
|                                | 90W                                                                 | 1kHz, 3Ω load, without heatsink |                    |
|                                | 90W                                                                 | 1kHz, 3Ω load, *with heatsink   |                    |
|                                | 70W                                                                 | 1kHz, 2Ω load, without heatsink |                    |
|                                | 100W                                                                | 1kHz, 2Ω load, *with heatsink   |                    |

|                                 |        |                                                              |
|---------------------------------|--------|--------------------------------------------------------------|
| Output Power CH1-2: (10% THD+N) | 90W    | 1kHz, 4Ω load, without heatsink                              |
|                                 | 90W    | 1kHz, 4Ω load, *with heatsink                                |
|                                 | 120W   | 1kHz, 3Ω load, without heatsink                              |
|                                 | 120W   | 1kHz, 3Ω load, *with heatsink                                |
|                                 | 90W    | 1kHz, 2Ω load, without heatsink                              |
|                                 | 135W   | 1kHz, 2Ω load, *with heatsink                                |
| Rated Load Impedance            | 4-2Ω   | Resistive load                                               |
| Idling Supply Current           | ±70mA  | No input signal                                              |
| Total Idle Power Consumption    | 2.4W   | No input signal                                              |
| Distortion                      | 0.016% | THD+N @ 40W, 2Ω                                              |
| Residual Noise                  | 250μV  | IHF-A weighted, AES-17 filter                                |
| Channel Efficiency              | 88%    | Single-channel driven, 90W (With No heatsink), Class D stage |

\*Tested with custom heat sink with thermal pad BER161-ND

## Connection Setup

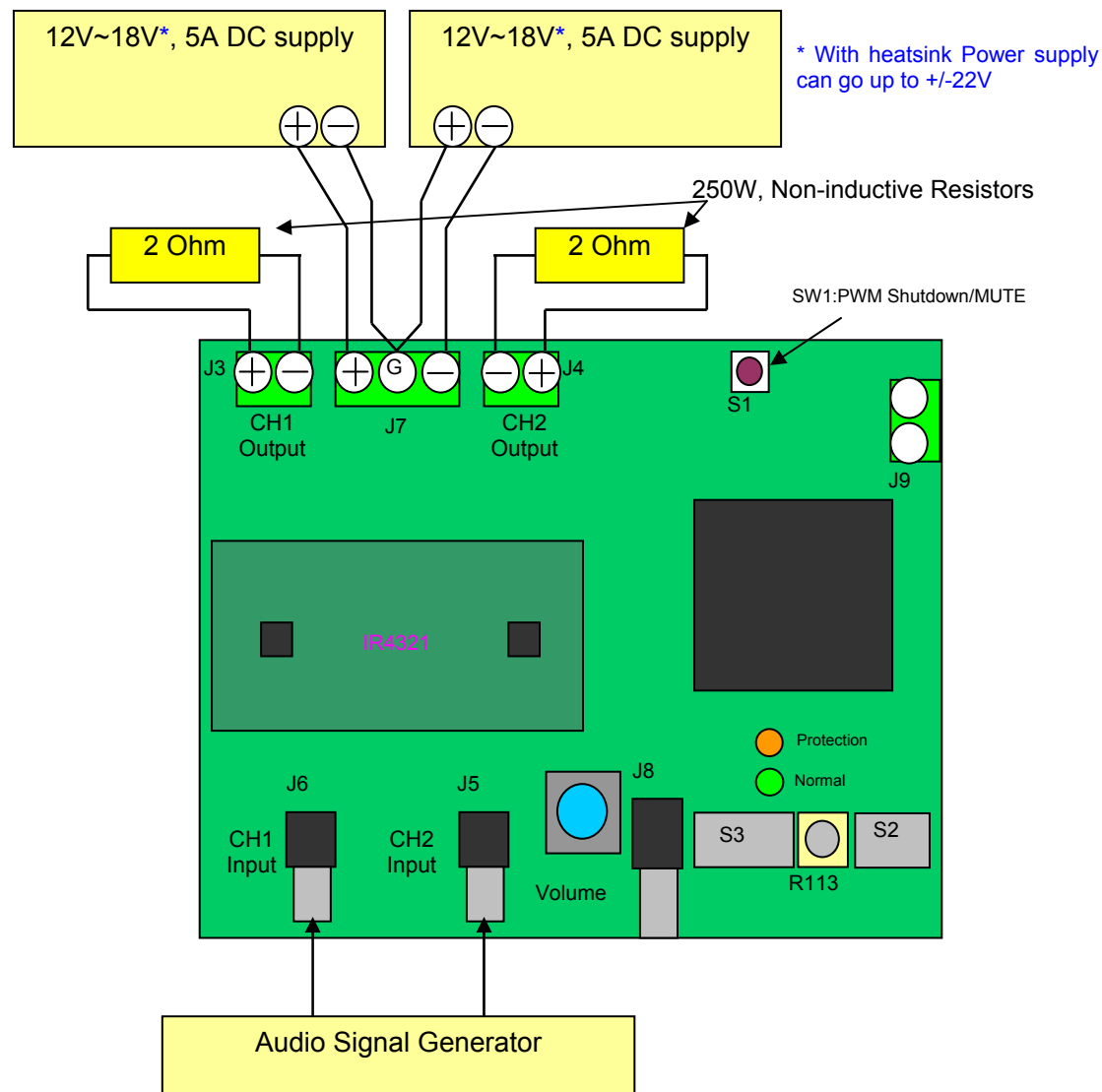


Figure 1 Typical Test Setup

## Connector Description

|         |    |                                        |
|---------|----|----------------------------------------|
| CH1 IN  | J6 | Analog input for CH1                   |
| CH2 IN  | J5 | Analog input for CH2                   |
| POWER   | J7 | Positive and negative supply (+B / -B) |
| CH1 OUT | J3 | Output for CH1                         |
| CH2 OUT | J4 | Output for CH2                         |
| EXT CLK | J8 | External clock sync                    |
| DCP OUT | J9 | DC protection relay output             |

## Audio Precision-Setup

IRAUDAMP21 and Audio Precision shall be connected according to the Figure below:

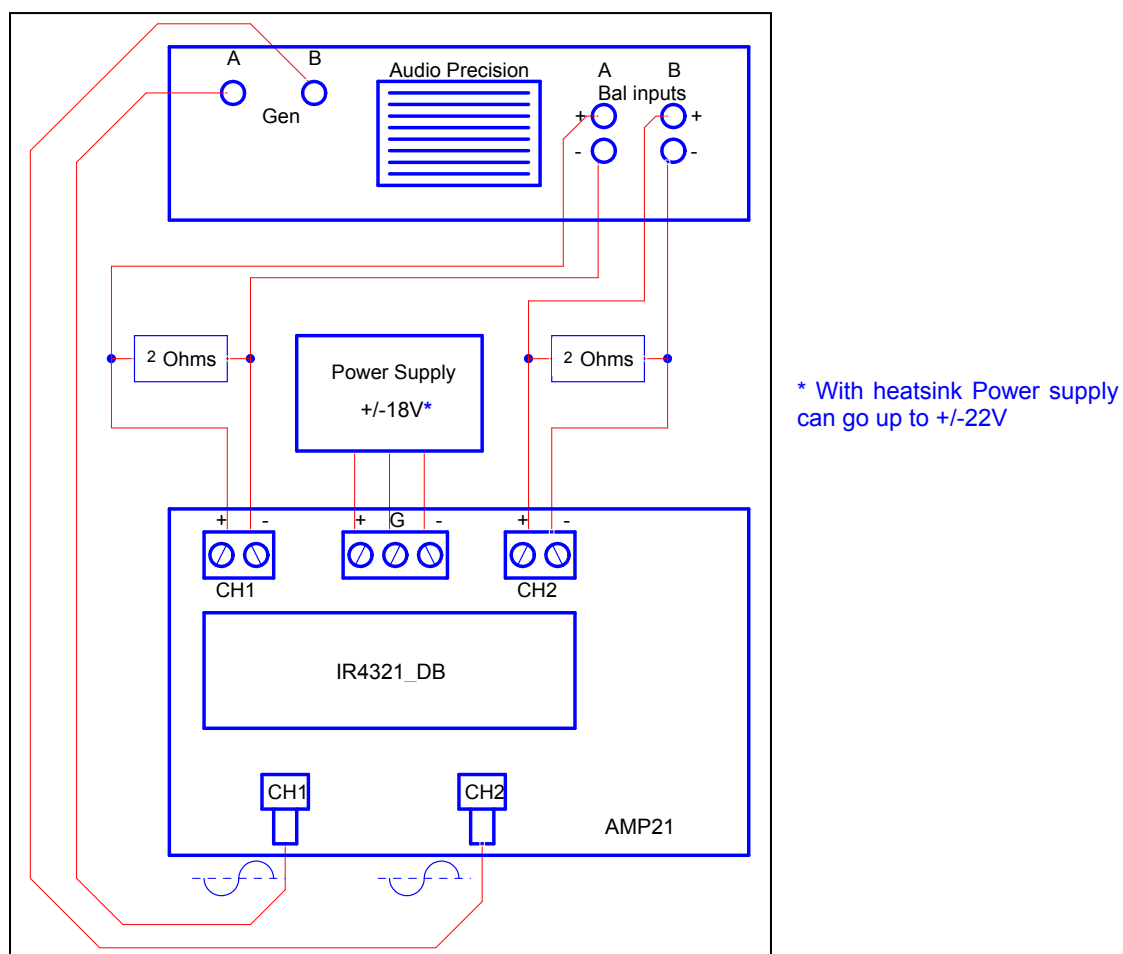


Figure 2

## Test Procedures

### Test Setup:

1. Connect 2 $\Omega$ -250 W dummy loads to output connectors (J3 and J4 as shown on Figure 1) and parallel it with input of Audio Precision analyzer (AP).
2. Connect Audio Signal Generator to J6 and J5 for CH1 and CH2 respectively (Ap).
3. Set up the dual power supply with voltages of  $\pm 12V \sim \pm 18V$  (up to  $\pm 22V$  with heatsink); set current limit to 5A.
4. Set switch S1 to middle position (self oscillating).
5. Set volume level knob R130 fully counter-clockwise (minimum volume).
6. Connect the dual power supply to J7. as shown on Figure 1

### Power up:

7. Turn ON the dual power supply. The  $\pm B$  supplies must be applied and removed at the same time.
8. Red LED (Protection) should turn on almost immediately and turn off after about 3s.
9. Green LED (Normal) then turns on after red LED is extinguished and should stay on.
10. Quiescent current for the positive supply should be 60mA  $\pm$  10mA at +18V.
11. Quiescent current for the negative supply should be 75mA  $\pm$  10mA at -18V.
12. Push S3 switch (Trip and Reset push-button) to restart the sequence of LEDs indicators, which should be the same as noted above in steps 9-10.

### Functionality Audio Tests:

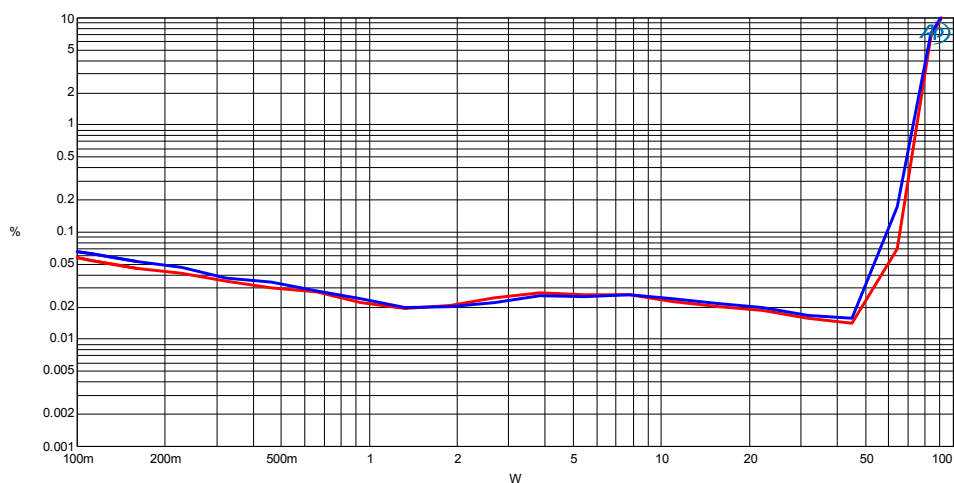
13. Apply 1V RMS at 1kHz sinusoidal signal from the Audio Signal Generator.
14. Turn control volume up (R130 clock-wise) to obtain an output reading of 70Watts.
15. For all subsequent tests as shown on the Audio Precision graphs below (Figure 3- Figure7), the measurements are taken across J3 and J4 with an AES-17 Filter. Observe that a 1  $V_{RMS}$  input generates an output around THD+N=1% power level.
16. Sweep the audio signal voltage from 15 mV<sub>RMS</sub> to 1 V<sub>RMS</sub>.
17. Monitor the output signals at J3/J4 with an oscilloscope. The waveform must be a non distorted sinusoidal signal with input signal below 1Vrms.

## Performance and Test Graphs

### Power vs THD+N

#### Test Conditions:

VBus =  $\pm 18V$   
Input Signal = 1 KHz  
Load Impedance = 2 ohms  
Set Gain = 1% clipping 70W



| Sweep | Trace | Color | Line Style | Thick | Data             | Axis | Comment |
|-------|-------|-------|------------|-------|------------------|------|---------|
| 1     | 1     | Red   | Solid      | 3     | Anlr.THd+N Ratio | Left | CH1     |
| 1     | 3     | Blue  | Solid      | 3     | Anlr.THd+N Ratio | Left | CH2     |

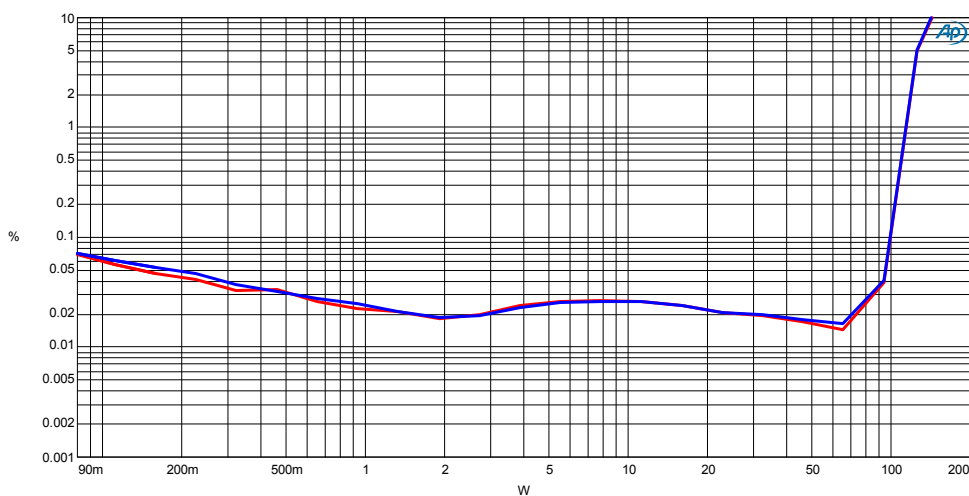
Amp21\_22 PWR vs THD.at27

Figure 3

### Power vs THD+N (with heatsink)

#### Test Conditions:

VBus =  $\pm 22V$   
Input Signal = 1 KHz  
Load Impedance = 2 ohms  
Set Gain = 1% clipping 100W



| Sweep | Trace | Color | Line Style | Thick | Data             | Axis | Comment |
|-------|-------|-------|------------|-------|------------------|------|---------|
| 1     | 1     | Red   | Solid      | 3     | Anlr.THd+N Ratio | Left | CH1     |
| 1     | 3     | Blue  | Solid      | 3     | Anlr.THd+N Ratio | Left | CH2     |

Amp21\_22 PWR vs THD.at27

Figure 4

## Frequency Response

### Test Conditions:

VBus =  $\pm 18V$

Set Output = 1V

Load Impedance = 2 ohms

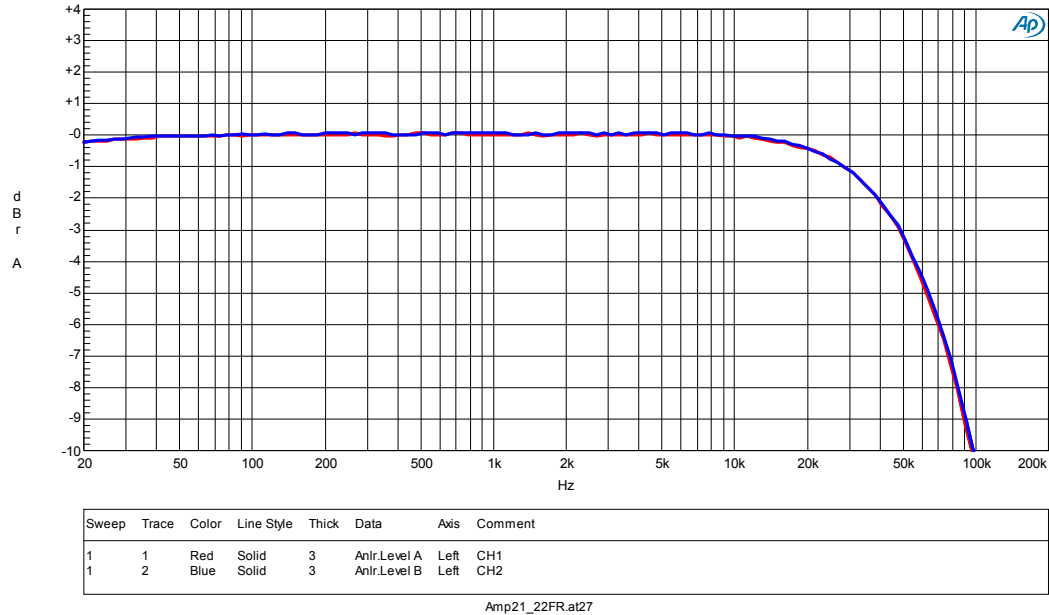


Figure 5

## Noise Floor

### Test Conditions:

VBus =  $\pm 18V$

Load Impedance = 2 ohms

Set Gain = 1% clipping

No Input Signal

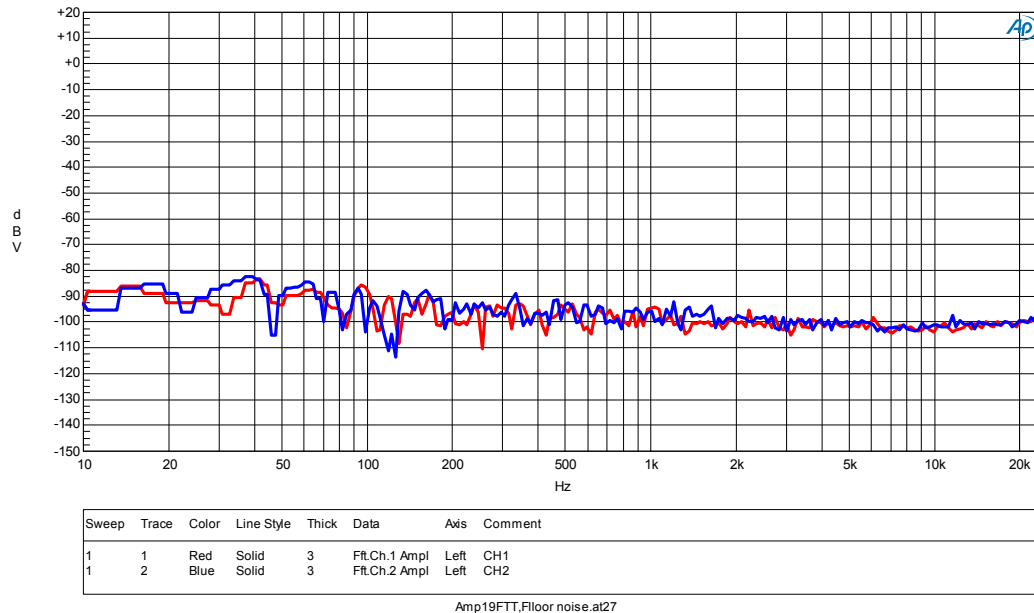


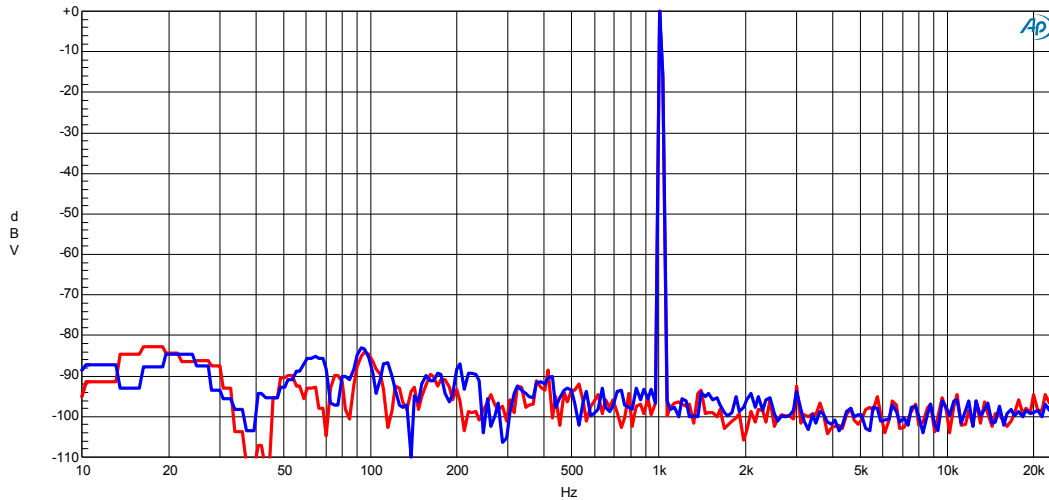
Figure 6



## Noise Floor with 1Vrms Output

### Test Conditions:

VBus =  $\pm 18V$   
Output = 1Vrms @ 1 KHz  
Load Impedance = 2 ohms  
Set Gain = 1% clipping

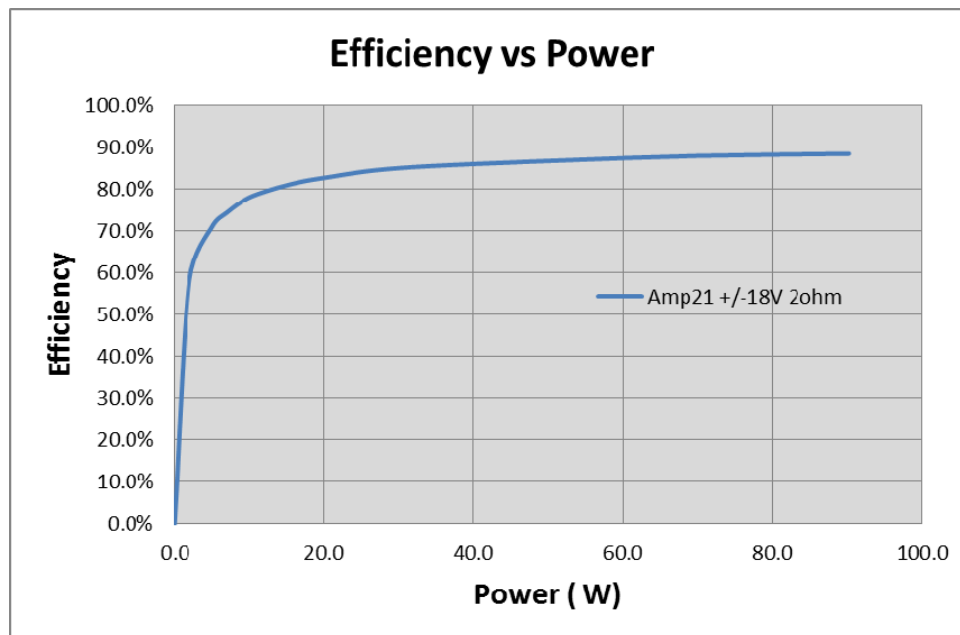


| Sweep | Trace | Color | Line Style | Thick | Data          | Axis | Comment |
|-------|-------|-------|------------|-------|---------------|------|---------|
| 1     | 1     | Red   | Solid      | 3     | Fft.Ch.1 Ampl | Left | CH1     |
| 1     | 2     | Blue  | Solid      | 3     | Fft.Ch.2 Ampl | Left | CH2     |

Amp21\_22\_FFT\_1V.at27

Figure 7

## Efficiency



Tested with no heat sink

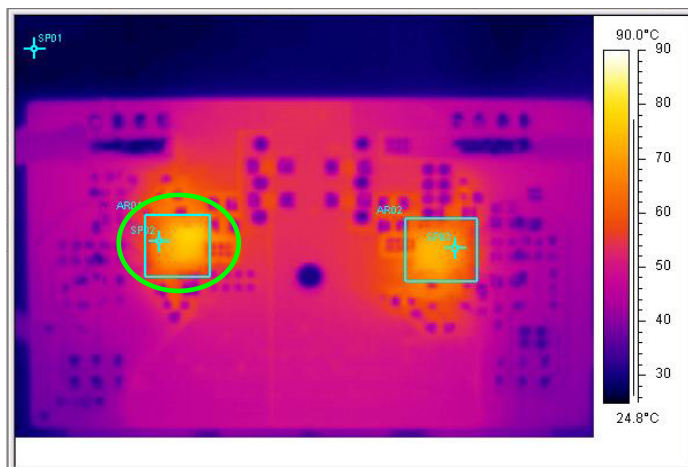
Figure 8

## Thermal Information

### 1) 1/8 Po Thermal information for IRAUDAMP21

Conditions:

- Tamb=25°C natural convection cooling
- Both Channel Driven 1/8Po continuous 30min
- Temperature measured by INFRARED Camera
- Measuring temperature point:



IR4321's temperature saturated  $\leq 85^{\circ}\text{C}$  within 30minutes

Figure 9

| load impedance  | 1/8 Power(W) | THD=1% power(W) | THD=10% power(W) |
|-----------------|--------------|-----------------|------------------|
| 4 $\Omega$ load | 9.28         | 70              | 90               |
|                 | *9.28        | *70             | *90              |
| 3 $\Omega$ load | 9.88         | 75              | 100              |
|                 | *12.29       | *95             | *120             |
| 2 $\Omega$ load | 8.92         | 70              | 90               |
|                 | *12.68       | *100            | *135             |

\*With heatsink

## 2) Peak Power duration (no heatsink)

Test conditions:

- 1kHz sine wave signal input ; Both channels driven
- Fsw=400kHz

| Load Z | 10%THD<br>Po W | Duration              |
|--------|----------------|-----------------------|
| 2Ω     | 90             | Till Thermal Shutdown |
| 3Ω     | 120            | Till Thermal Shutdown |
| 4Ω     | 90             | No Thermal Shutdown   |

## 3) Peak Power duration (With heatsink)

Test conditions:

- 1kHz sine wave signal input ; Both channels driven
- Fsw=400kHz

| Load Z | 10%THD<br>Po W | Duration            |
|--------|----------------|---------------------|
| 2Ω     | 135            | No Thermal Shutdown |
| 3Ω     | 120            | No Thermal Shutdown |
| 4Ω     | 90             | No Thermal Shutdown |

#### 4) Heatsink installation

Heatsink Installation:

- 1, Drill a hole in the center of daughter board.
- 2, Mount heatsink and thermal pad on the back of daughter board.
- 3, Extend daughter board's pins with cables as Figure20.

Thermal pad      **Digikey part#**  
BER161-ND

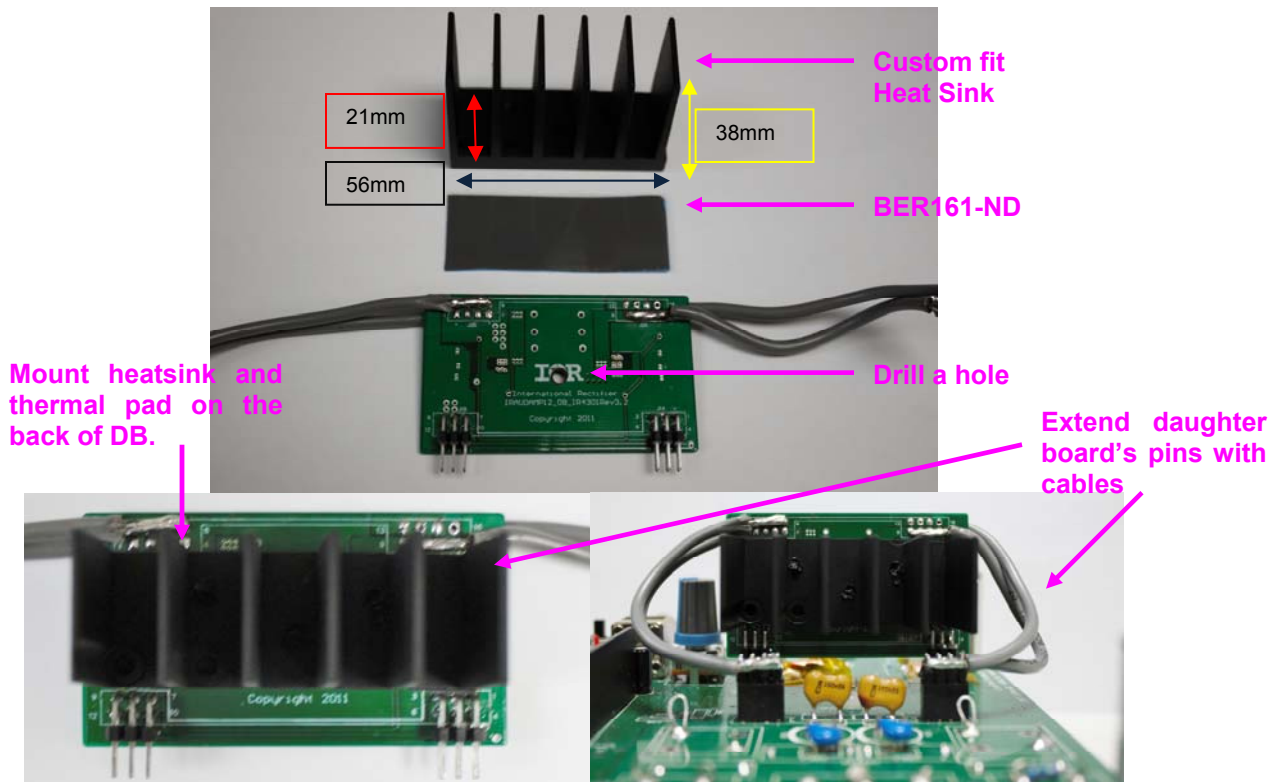


Figure 10

## Schematic

### Class D, Daughter Board IR4321 Module Schematic

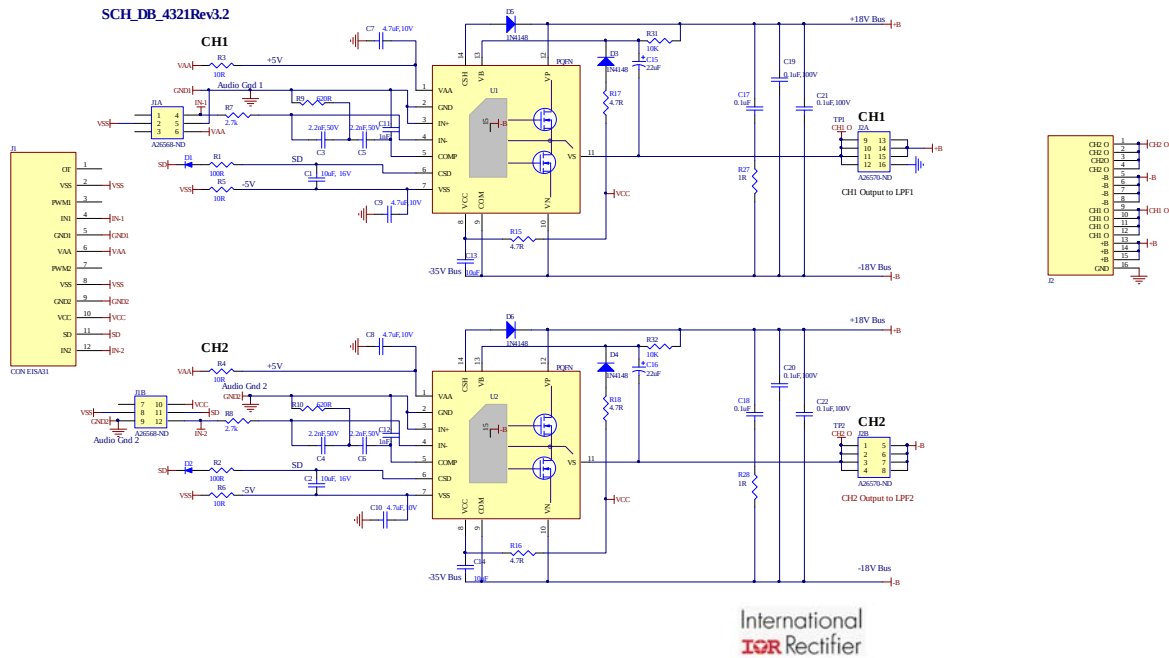


Figure 11

### Class D, Mother Board Control Volume and Power Supplies Schematic

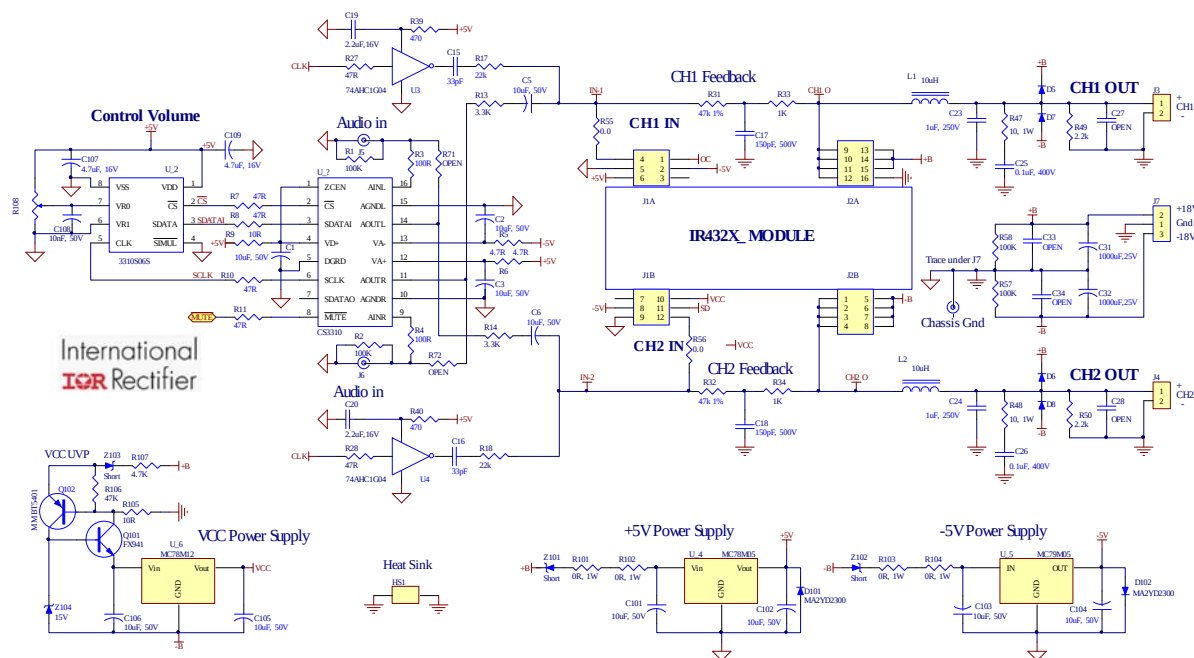


Figure 12

[www.irf.com](http://www.irf.com)

## Bill of Materials

### IRAUDAMP21 Daughter Board BOM

| No | Part Number         | Designator         | Description                      | Quantity | Vendor  |
|----|---------------------|--------------------|----------------------------------|----------|---------|
| 1  | 445-1601-1-ND       | C1, C2             | CAP CER 10UF 16V 20% X7R 1206    | 2        | Digikey |
| 2  | 445-1309-1-ND       | C3, C4, C5, C6     | CAP CER 2200PF 50V 10% X7R 0603  | 4        | Digikey |
| 3  | 587-1442-1-ND       | C7, C8, C9, C10    | CAP CER 4.7UF 10V 10% X7R 0805   | 4        | Digikey |
| 4  | 478-1215-1-ND       | C11, C12           | CAP CER 1000PF 50V 10% X7R 0603  | 2        | Digikey |
| 5  | 399-4939-1-ND       | C13, C14           | CAP CER 10UF 16V 20% X7R 1206    | 2        | Digikey |
| 6  | 445-6797-1-ND       | C15, C16           | CAP CER 22UF 16V 10% X5R 0805    | 2        | Digikey |
| 7  | 311-1140-1-ND       | C17, C18           | CAP CER 0.1UF 50V 10% X7R 0805   | 2        | Digikey |
| 8  | 478-1529-1-ND       | C19, C20, C21, C22 | CAP CER 0.1UF 100V 10% X7R 1206  | 4        | Digikey |
| 9  | 1N4148WS-FDICT-ND   | D1, D2             | DIODE SWITCH 75V 200MW SOD323    | 2        | Digikey |
| 10 | 1N4148W-FDICT-ND    | D3, D4, D5, D6     | DIODE SWITCH 100V 400MW SOD123   | 4        | Digikey |
| 11 | A26568-ND           | J1A, J1B           | CONN HEADER VERT 6POS .100 30AU  | 2        | Digikey |
| 12 | A26570-ND           | J2A, J2B           | CONN HEADER VERT .100 8POS 30AU  | 2        | Digikey |
| 13 | RMCF0603JT100RCT-ND | R1, R2             | RES 100 OHM 1/10W 5% 0603 SMD    | 2        | Digikey |
| 14 | RMCF0603JT10R0CT-ND | R3, R4, R5, R6     | RES 10 OHM 1/10W 5% 0603 SMD     | 4        | Digikey |
| 15 | RMCF0603FT2K70CT-ND | R7, R8             | RES 2.7K OHM 1/10W 1% 0603 SMD   | 1        | Digikey |
| 16 | 311-620GRCT-ND      | R9, R10            | RES 620 OHM 1/10W 5% 0603 SMD    | 2        | Digikey |
| 17 | 311-4.7GRCT-ND      | R15, R16, R17, R18 | RES 4.7 OHM 1/10W 5% 0603 SMD    | 4        | Digikey |
| 18 | 311-1.0GRCT-ND      | R27, R28           | RES 1.0 OHM 1/10W 5% 0603 SMD    | 2        | Digikey |
| 19 | RMCF0603JT10K0CT-ND | R31, R32           | RES 10K OHM 1/10W 5% 0603 SMD    | 2        | Digikey |
| 20 | IR4321              | U1, U2             | PowIRaudio integrated Class D IC | 2        | IR      |

\*Heatsink is an option for IRAUDAMP21 to deliver high power up to 135W/2Q

### IRAUDAMP21 Mother Board BOM

| NO | Part No       | Designator                                           | Description                    | #  | Vender  |
|----|---------------|------------------------------------------------------|--------------------------------|----|---------|
| 1  | 565-1106-ND   | C1, C5, C6, C101, C102, C103, C104, C105, C106, C115 | CAP ALUM 10UF 50V 20% RADIAL   | 10 | Digikey |
| 2  | 565-1103-ND   | C2, C3                                               | CAP ALUM 2.2UF 50V 20% RADIAL  | 2  | Digikey |
| 3  | 478-1281-1-ND | C15, C16                                             | CAP CER 33PF 100V 5% NP0 0805  | 2  | Digikey |
| 4  | 338-2598-ND   | C17, C18                                             | CAP MICA 150PF 500V 5% RADIAL  | 2  | Digikey |
| 5  | PCC1931CT-ND  | C19, C20                                             | CAP CER 2.2UF 16V 10% X7R 1206 | 2  | Digikey |
| 6  | PCC104BCT-ND  | C119                                                 | CAP CER 0.1UF 50V 10% X7R 1206 | 1  | Digikey |
| 7  | 399-5960-ND   | C23, C24                                             | CAP FILM 1UF 250VDC RADIAL     | 2  | Digikey |
| 8  | 495-1311-ND   | C25, C26                                             | CAP FILM 0.1UF 400VDC RADIAL   | 2  | Digikey |
| 9  | 565-1086-ND   | C31, C32                                             | CAP ALUM 1000UF 35V 20% RADIAL | 2  | Digikey |
| 10 | PCC2323CT-ND  | C107, C109                                           | CAP CER 4.7UF 16V 10% X5R 0805 | 2  | Digikey |

|    |                            |                                                                                                |                                  |    |                   |
|----|----------------------------|------------------------------------------------------------------------------------------------|----------------------------------|----|-------------------|
| 11 | PCC103BNCT-ND              | C108, C114                                                                                     | CAP CER 10000PF 50V 10% X7R 0805 | 2  | Digikey           |
| 12 | PCC102CGCT-ND              | C110                                                                                           | CAP CER 1000PF 50V 5% NP0 0805   | 1  | Digikey           |
| 13 | PCC101CGCT-ND              | C111, C113                                                                                     | CAP CER 100PF 50V 5% NP0 0805    | 2  | Digikey           |
| 14 | 478-1372-1-ND              | C112                                                                                           | CAP CER 1200PF 50V 10% X7R 0805  | 1  | Digikey           |
| 15 | 565-1037-ND                | C116, C117                                                                                     | CAP ALUM 100UF 16V 20% RADIAL    | 2  | Digikey           |
| 16 | 1N4148W-FDICT-ND           | D103, D104, D105, D106, D107                                                                   | DIODE SWITCH 100V 400MW SOD123   | 5  | Digikey           |
| 17 | MURA120T3GOSCT-ND          | D5, D6, D7, D8                                                                                 | DIODE ULTRA FAST 1A 200V SMA     | 4  | Digikey           |
| 18 | MA2YD2300LCT-ND            | D101, D102                                                                                     | DIODE SCHOTTKY 25V 1.0A MINI-2P  | 2  | Digikey           |
| 19 | 294-1086-ND                | HS1                                                                                            | HEATSINK HORZ SIX BLACK TO-220   | 1  | Digikey           |
| 20 | A32934-ND                  | J1A, J1B                                                                                       | CONN RECEPT 6POS .100 VERT DUAL  | 2  | Digikey           |
| 21 | A32935-ND                  | J2A, J2B                                                                                       | CONN RECEPT 8POS .100 VERT DUAL  | 2  | Digikey           |
| 22 | 277-1271-ND or 651-1714971 | J3, J4                                                                                         | CONN TERM BLOCK 2POS 9.52MM PCB  | 2  | Digikey or Mouser |
| 23 | CP-1422-ND                 | J5, J6                                                                                         | CONN RCA JACK R/A BLUE PCB       | 2  | Digikey           |
| 24 | 277-1272-ND or 651-1714984 | J7                                                                                             | CONN TERM BLOCK 3POS 9.52MM PCB  | 1  | Digikey or Mouser |
| 25 | A32248-ND                  | J8                                                                                             | CONN JACK BNC R/A 50 OHM PCB TIN | 1  | Digikey           |
| 26 | ED1567                     | J9                                                                                             | TERMINAL BLOCK 7.50MM VERT 2POS  | 1  | Digikey           |
| 27 | 7G17A-100M-R               | L1, L2                                                                                         | Class D inductor, 10uH           | 2  | Inductors, Inc    |
|    | 7G17A-100M-B               |                                                                                                |                                  |    | Inductors, Inc    |
|    | 911-1D17A-100M             |                                                                                                |                                  |    | Mouser            |
| 28 | 160-1143-ND                | NORMAL                                                                                         | LED 3MM GREEN TRANSPARENT        | 1  | Digikey           |
| 29 | PVT412PBF-ND               | P1                                                                                             | IC RELAY PHOTOVO 400V 140MA 6DIP | 1  | Digikey           |
| 30 | 160-1140-ND                | PROTECTION                                                                                     | LED 3MM HI-EFF RED TRANSPARENT   | 1  | Digikey           |
| 31 | FCX491CT-ND                | Q101                                                                                           | TRANSISTOR NPN 60V 1A SOT-89     | 1  | Digikey           |
| 32 | MMBT5401-FDICT-ND          | Q102, Q104, Q106, Q111                                                                         | TRANS PNP 150V 350MW SMD SOT23-3 | 4  | Digikey           |
| 33 | MMBT5551-FDICT-ND          | Q103, Q105, Q107, Q108, Q109, Q110, Q112                                                       | TRANS NPN 160V 350MW SMD SOT23-3 | 7  | Digikey           |
| 34 | P100KACT-ND                | R1, R2, R57, R58, R110, R126                                                                   | RES 100K OHM 1/8W 5% 0805 SMD    | 6  | Digikey           |
| 35 | P100ACT-ND                 | R3, R4, R114                                                                                   | RES 100 OHM 1/8W 5% 0805 SMD     | 3  | Digikey           |
| 36 | P4.7ECT-ND                 | R5, R6                                                                                         | RESISTOR 4.7 OHM 1/4W 5% 1206    | 2  | Digikey           |
| 37 | P47ACT-ND                  | R7, R8, R10, R11, R27, R28, R115, R116, R117                                                   | RES 47 OHM 1/8W 5% 0805 SMD      | 9  | Digikey           |
| 38 | P10ACT-ND                  | R9, R105                                                                                       | RES 10 OHM 1/8W 5% 0805 SMD      | 2  | Digikey           |
| 39 | P3.3KACT-ND                | R13, R14                                                                                       | RES 3.3K OHM 1/8W 5% 0805 SMD    | 2  | Digikey           |
| 40 | P22KACT-ND                 | R17, R18                                                                                       | RES 22K OHM 1/8W 5% 0805 SMD     | 2  | Digikey           |
| 41 | P47KACT-ND                 | R106, R121, R122, R130, R131, R132, R133, R137, R139, R141, R145, R146, R147, R149, R150, R151 | RES 47K OHM 1/8W 5% 0805 SMD     | 16 | Digikey           |
| 42 | P0.0ACT-ND                 | R55, R56                                                                                       | RES 0.0 OHM 1/8W 0805 SMD        | 2  | Digikey           |
| 43 | P470ACT-ND                 | R39, R40                                                                                       | RES 470 OHM 1/8W 5% 0805 SMD     | 2  | Digikey           |
| 44 | P100ECT-ND                 | R120                                                                                           | RES 100 OHM 1/4W 5% 1206 SMD     | 1  | Digikey           |
| 45 | PT47KAFCT-ND               | R31, R32                                                                                       | RES 47.0K OHM 1W 1% 2512 SMD     | 2  | Digikey           |
| 46 | P1.0KECT-ND                | R33, R34                                                                                       | RES 1.0K OHM 1/4W 5% 1206 SMD    | 2  | Digikey           |
| 47 | P1.0KACT-ND                | R109, R118, R119, R123                                                                         | RES 1.0K OHM 1/8W 5% 0805 SMD    | 4  | Digikey           |



|    |                    |                                                |                                     |   |            |
|----|--------------------|------------------------------------------------|-------------------------------------|---|------------|
| 48 | PT10XCT            | R47, R48                                       | RES 10 OHM 1W 5% 2512 SMD           | 2 | Digikey    |
| 49 | P2.2KECT-ND        | R49, R50                                       | RES 2.2K OHM 1/4W 5% 1206 SMD       | 2 | Digikey    |
| 50 | 541-0.0XCT-ND      | R101, R102, R103, R104                         | RES 0.0 OHM 1W Jump 2512 SMD        | 4 | Digikey    |
| 51 | P4.7KACT-ND        | R107, R138                                     | RES 4.7K OHM 1/8W 5% 0805 SMD       | 2 | Digikey    |
| 52 | CT2265-ND          | R108                                           | POT 10K OHM 1/8W CARB VERTICAL      | 1 | Digikey    |
| 53 | P10KACT-ND         | R111, R124, R125, R134, R140, R143, R144, R148 | RES 10K OHM 1/8W 5% 0805 SMD        | 8 | Digikey    |
| 54 | P820ACT-ND         | R112                                           | RES 820 OHM 1/8W 5% 0805 SMD        | 1 | Digikey    |
| 55 | 3362H-502LF-ND     | R113                                           | TRIMMER 5K OHM 0.5W TH              | 1 | Digikey    |
| 56 | P6.8KECT-ND        | R127, R128, R129                               | RES 6.8K OHM 1/4W 5% 1206 SMD       | 3 | Digikey    |
| 57 | P82KACT-ND         | R135                                           | RES 82K OHM 1/8W 5% 0805 SMD        | 1 | Digikey    |
| 58 | P68KACT-ND         | R136, R142                                     | RES 68K OHM 1/8W 5% 0805 SMD        | 2 | Digikey    |
| 59 | P8010S-ND          | S1                                             | SWITCH TACTILE SPST-NO 0.02A 15V    | 1 | Digikey    |
| 60 | EG1908-ND          | S2                                             | SWITCH SLIDE DPDT 12V .1A L=4       | 1 | Digikey    |
| 61 | EG1944-ND          | S3                                             | SWITCH SLIDE DP3T .2A L=6MM         | 1 | Digikey    |
| 62 | 296-1089-1-ND      | U3, U4                                         | IC SNGL INVERTER GATE SOT23-5       | 2 | Digikey    |
| 63 | 73C8016 or 72J5420 | U_1                                            | IC, DIGITAL VOLUME CONTROL, SOIC-16 | 1 | Newark     |
| 64 | 3310-IR01          | U_2                                            | CS3310 Stand-alone Controller       | 1 | *Tachyonix |
| 65 | 296-1194-1-ND      | U_3                                            | IC HEX SCHMITT-TRIG INV 14-SOIC     | 1 | Digikey    |
| 66 | MC78M05CTGOS-ND    | U_4                                            | IC REG VOLT POS 500MA 5V TO220AB    | 1 | Digikey    |
| 67 | LM79M05CT-ND       | U_5                                            | IC VOLT REG NEG 5V 500MA TO220-3    | 1 | Digikey    |
| 68 | LM78M12CT-ND       | U_6                                            | IC VOLT REG 12V 500MA TO220-3       | 1 | Digikey    |
| 69 | P0.0ECT-ND         | Z101, Z102                                     | RES 0.0 OHM 1/4W JUMP 1206 SMD      | 2 | Digikey    |
| 70 | P0.0ACT-ND         | Z103                                           | RES 0.0 OHM 1/8W JUMP 0805 SMD      | 1 | Digikey    |
| 71 | BZT52C15-FDICT-ND  | Z104                                           | DIODE ZENER 15V 500MW SOD-123       | 1 | Digikey    |
| 72 | 568-6362-1-ND      | Z105                                           | DIODE ZENER 27V 500MW SOD-123       | 1 | Digikey    |
| 73 | BZT52C18-FDICT-ND  | Z106                                           | DIODE ZENER 18V 500MW SOD-123       | 1 | Digikey    |
| 74 | BZT52C10-FDICT-ND  | Z107                                           | DIODE ZENER 10V 500MW SOD123        | 1 | Digikey    |
| 75 | BZT52C8V2-FDICT-ND | Z108, Z109                                     | DIODE ZENER 8.2V 500MW SOD-123      | 2 | Digikey    |
| 76 | 10M7578            | Volume Knob                                    | ROUND KNURLED KNOB, 6MM             | 1 | Newark     |
| 77 | 82K6096            | Thermally TO-220 mounting kit with screw       | THERMALLOY - 4880G - Mounting Kit   | 3 | Newark     |
| 78 | 8401K-ND           | 1/2" Standoffs 4-40                            | STDOFF HEX M/F 4-40 .500"L ALUM     | 5 | Digikey    |
| 79 | H724-ND            | 4-40 Nut                                       | NUT HEX 4-40 STAINLESS STEEL        | 5 | Digikey    |
| 80 | H729-ND            | No. 4 Lock Washer                              | WASHER LOCK INTERNAL #4 SS          | 5 | Digikey    |

\*Tachyonix Corporation, <http://www.tachyonix.co.jp>

## PCB Specifications

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 nonconductive per IPC–RB 276 Standard.
8. All exposed copper must be 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.

Daughter Board

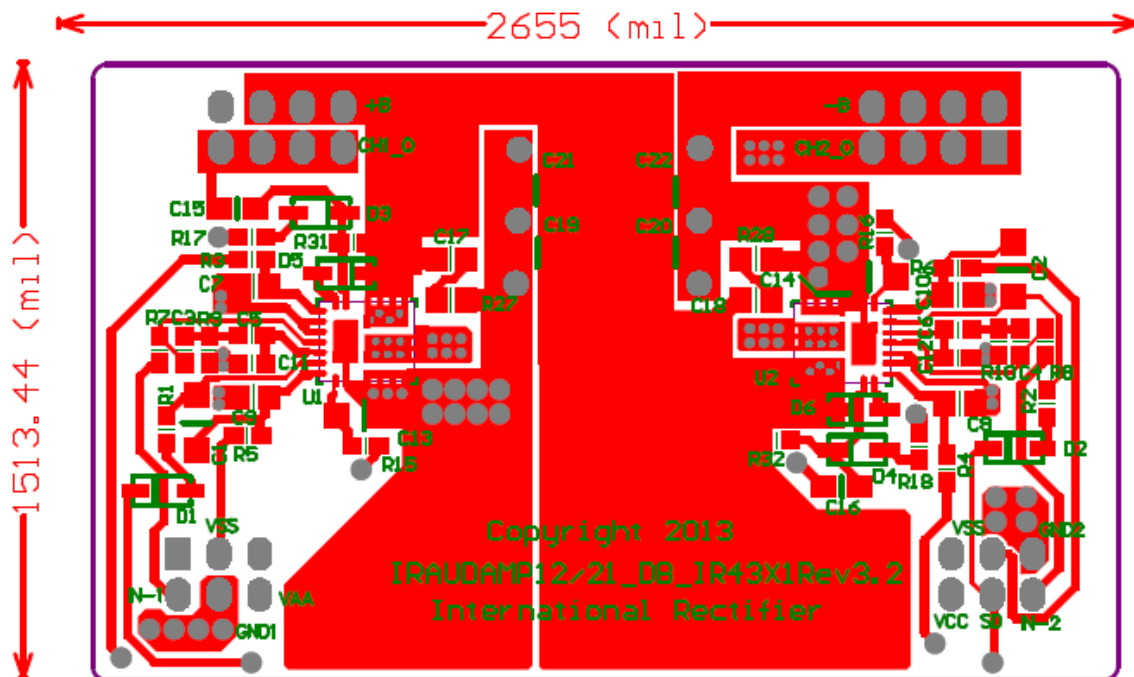


Figure 14

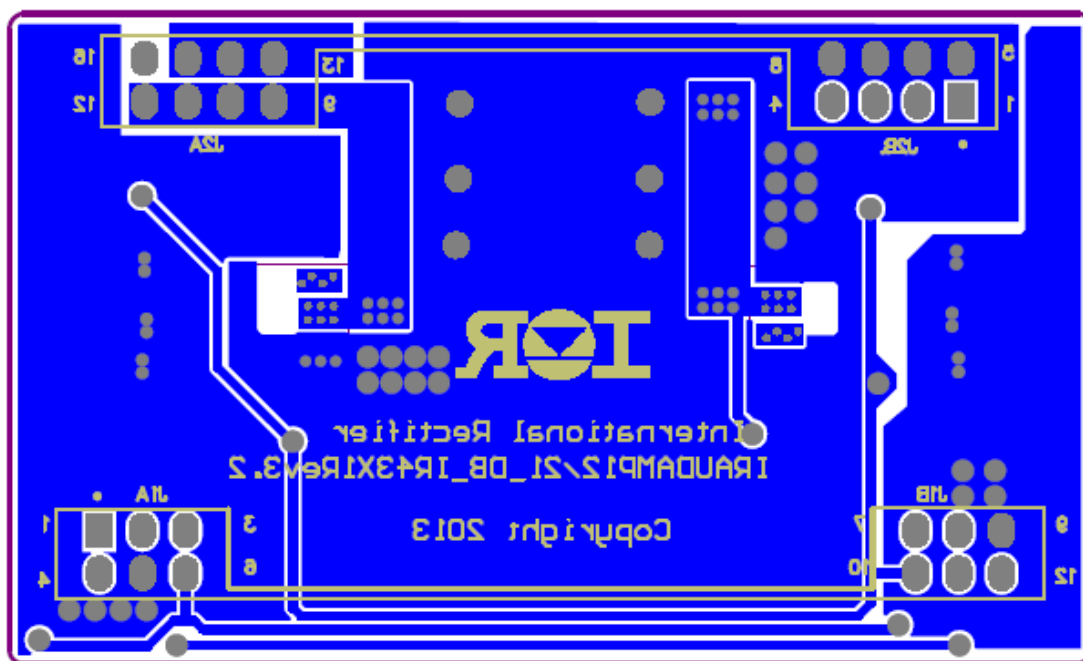


Figure 15

**Mother Board**

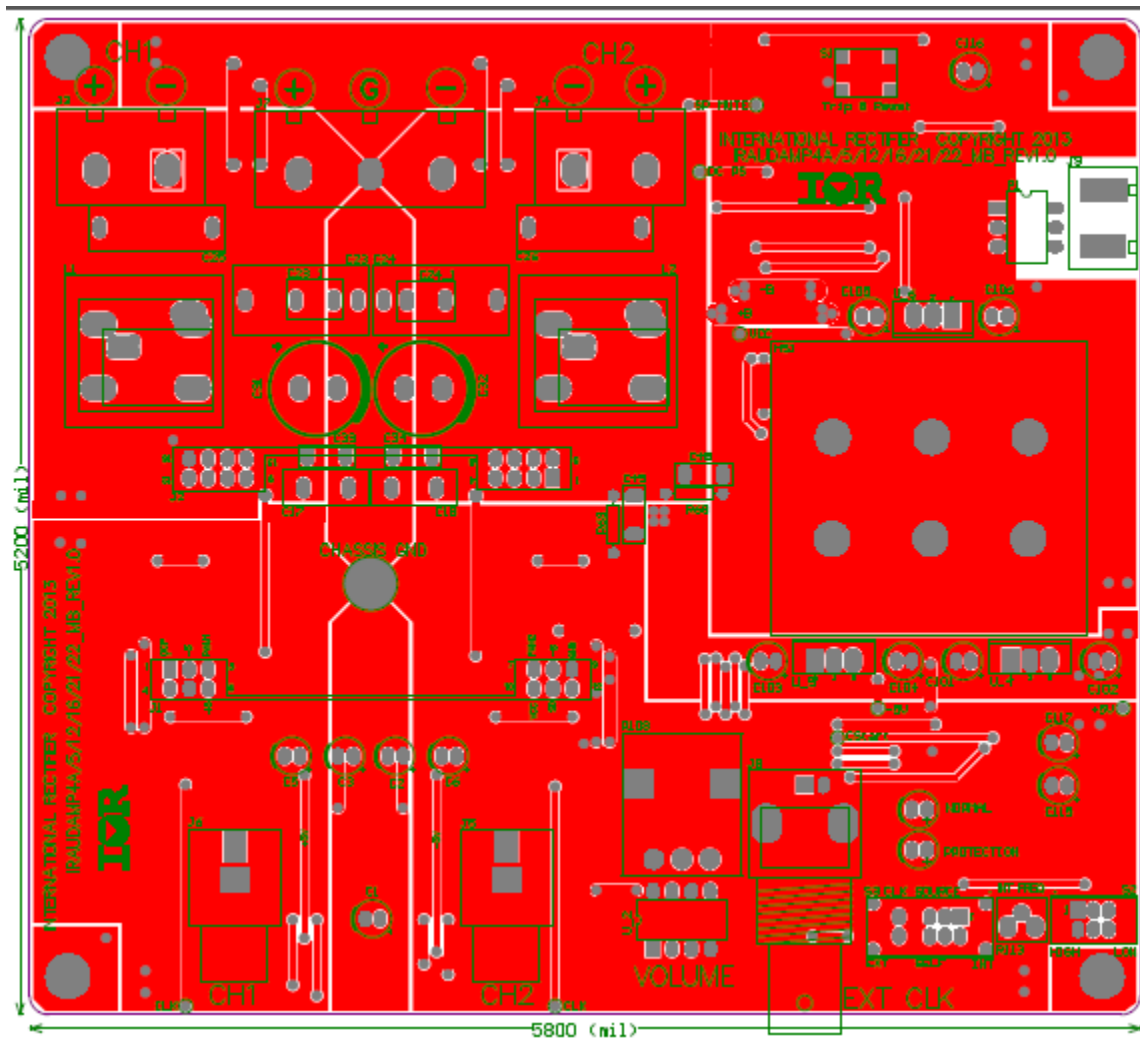


Figure 16

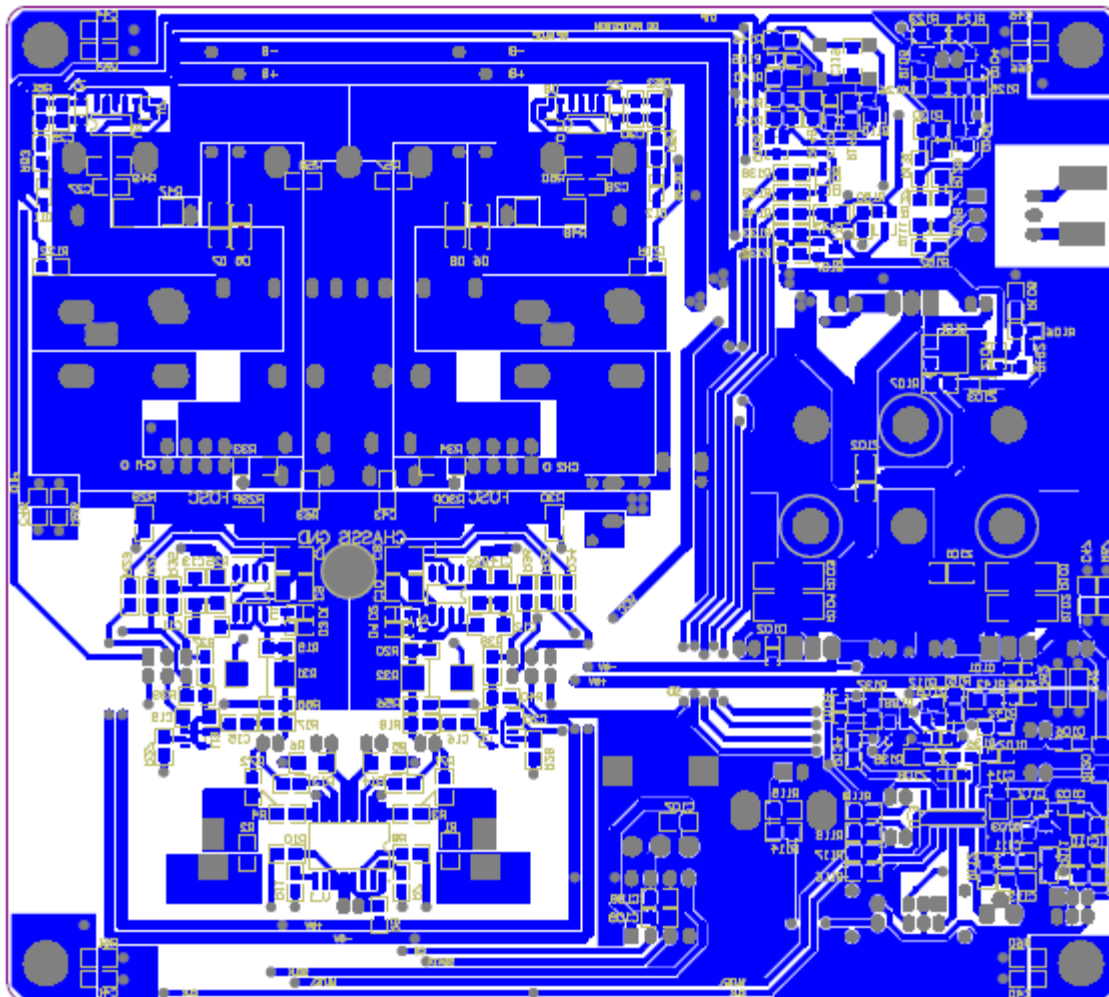


Figure 17

## Revision changes descriptions

| Revision | Changes description | Date        |
|----------|---------------------|-------------|
| Rev 1.0  | Released            | Apr,30 2013 |

International  
**IOR** Rectifier

**WORLD HEADQUARTERS:** 101 N. Sepulveda Blvd., El Segundo, California 90245 Tel: (310) 252-7105  
Data and specifications subject to change without notice. 05/08/2013

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