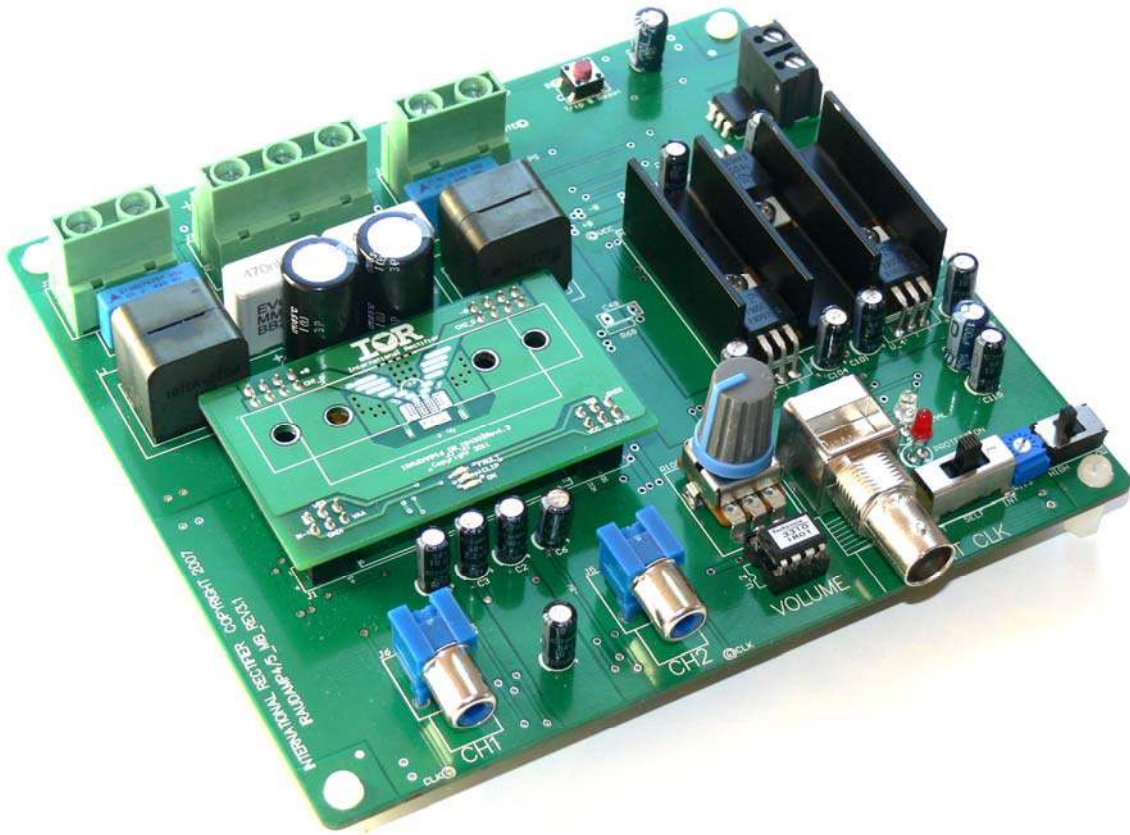


# IRAUDAMP22

## 50W/2Ω x 2 Channel Class D Audio Power Amplifier Using the IR4322

By  
Jun Honda, Alvin Rojas



### CAUTION:

International Rectifier suggests the following guidelines for safe operation and handling of IRAUDAMP22 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 IRAUDAMP22 reference design is a two-channel, 50W/ch (2Ω±13.5V; no heatsink)/ 100W/ch (2Ω±19V; \*with heatsink) half-bridge Class D audio power amplifier. This reference design demonstrates how to use the IR4322 IC, 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

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

## Features

Output Power:	50W x 2 channels (10%THD+N 2Ω load; no heatsink), 100W x 2 channels (10%THD+N 2Ω load; *with heatsink),
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 DC-protection (DCP), Over-temperature protection (OTP)
PWM Modulator:	Self-oscillating half-bridge topology with optional clock synchronization

## Specifications

General Test Conditions (unless otherwise noted)	Notes / Conditions	
Supply Voltages	±12V~±13.5V	Bipolar power supply; without heatsink
	±12V~±19V	Bipolar power supply; *with heatsink
Load Impedance	4-2Ω	Resistive load
Self-Oscillating Frequency	400kHz	No input signal, Adjustable
Gain Setting	23.5dB	1Vrms input yields rated power

Electrical Data	Typical	Notes / Conditions
IR Devices Used	IR4322 PowIRaudio integrated Class D IC	
Modulator	Self-oscillating, second order sigma-delta modulation, analog input	
Output Power CH1-2: (1% THD+N)	59W	1kHz, 4Ω load, without heatsink
	70W	1kHz, 4Ω load, *with heatsink
	50W	1kHz, 3Ω load, without heatsink
	92W	1kHz, 3Ω load, *with heatsink
	37W	1kHz, 2Ω load, without heatsink
	75W	1kHz, 2Ω load, *with heatsink

Output Power CH1-2: (10% THD+N)	80W	1kHz, 4Ω load, without heatsink
	95W	1kHz, 4Ω load, *with heatsink
	69W	1kHz, 3Ω load, without heatsink
	120W	1kHz, 3Ω load, *with heatsink
	50W	1kHz, 2Ω load, without heatsink
	100W	1kHz, 2Ω load, *with heatsink
Rated Load Impedance	4-2Ω	Resistive load
Idling Supply Current	±65mA	No input signal
Total Idle Power Consumption	1.5W	No input signal
Distortion	0.016%	THD+N @ 20W, 2Ω
Residual Noise	240μV	IHF-A weighted, AES-17 filter
Channel Efficiency	88%	Single-channel driven, 50W (With No heatsink), Class D stage

\*With Heatsink with thermal pad BER161-ND

## Connection Setup

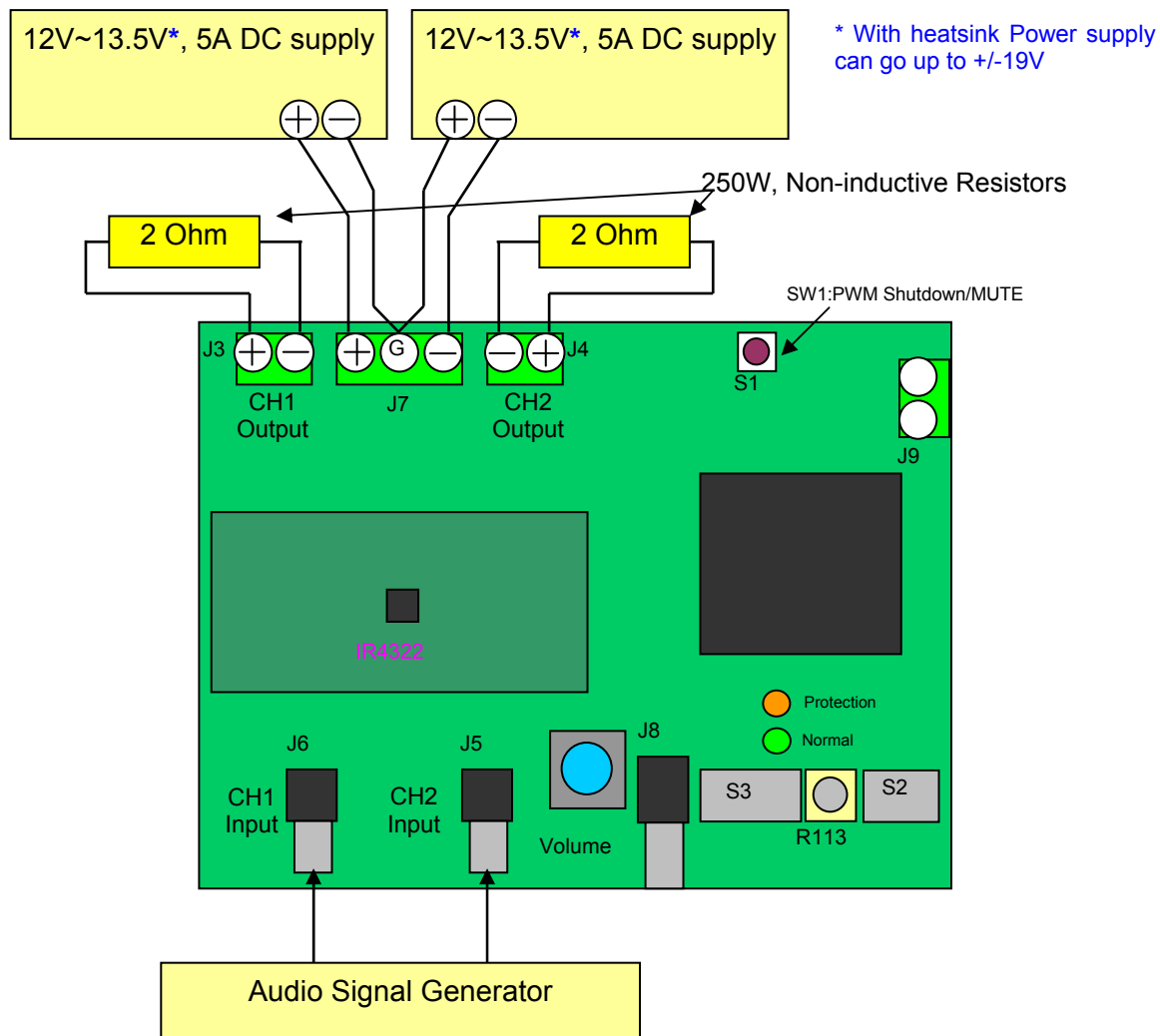


Figure 1 Typical Test Setup

### 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:

IRAUDAMP22 and Audio Precision shall be connected according to the Figure below:

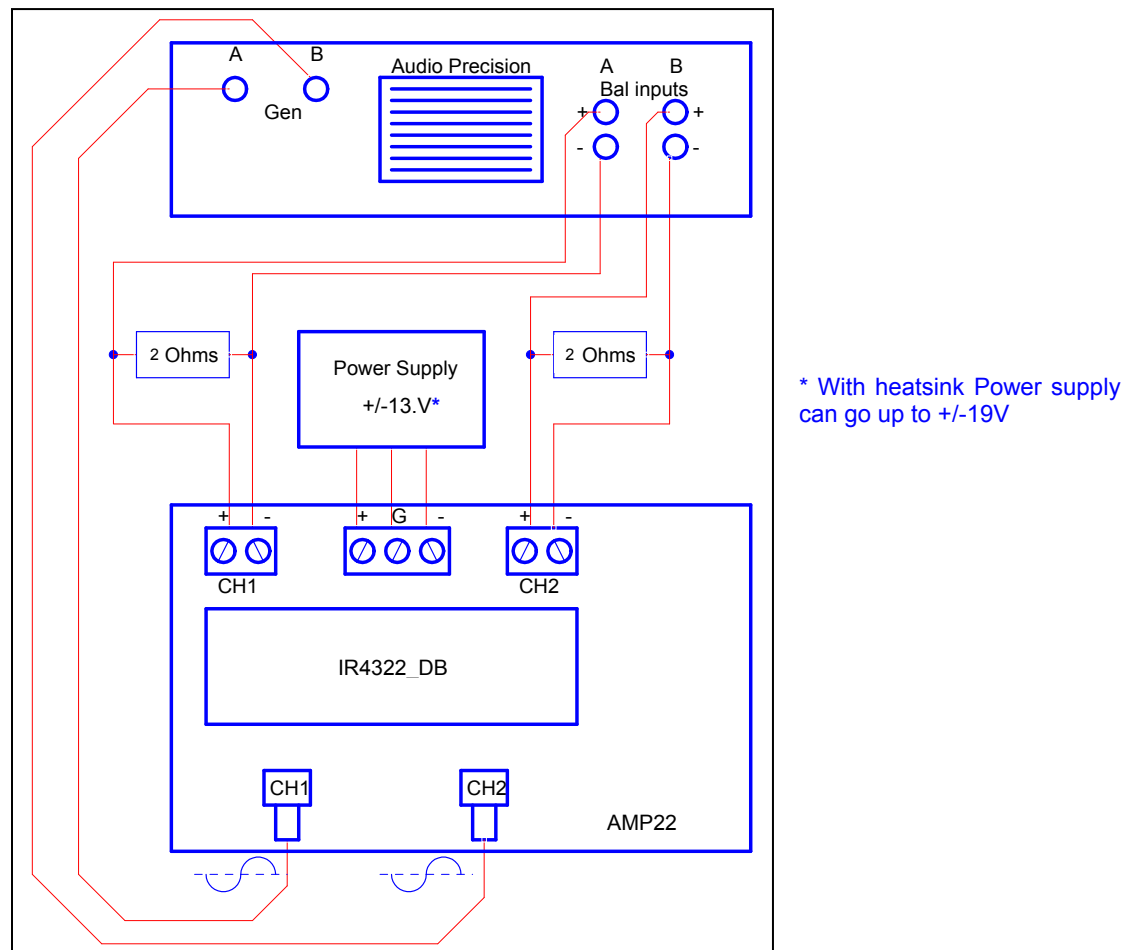


Figure 2

## 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  $\pm 12V \sim \pm 13.5V$  (up to  $\pm 19V$  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 55mA  $\pm$ 10mA at +13.5V.
11. Quiescent current for the negative supply should be 65mA  $\pm$ 10mA at -13.5V.
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 1 kHz sinusoidal signal from the Audio Signal Generator.
14. Turn control volume up (R130 clock-wise) to obtain an output reading of 37Watts.
15. For all subsequent tests as shown on the Audio Precision graphs below (Figure 3- Figure12), 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 m $V_{RMS}$  to 1  $V_{RMS}$ .
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 (without heatsink)

Test Conditions:

VBus = ± 13.5V  
 Input Signal = 1 KHz  
 Load Impedance = 2 ohms  
 Set Gain = 1% clipping 37W

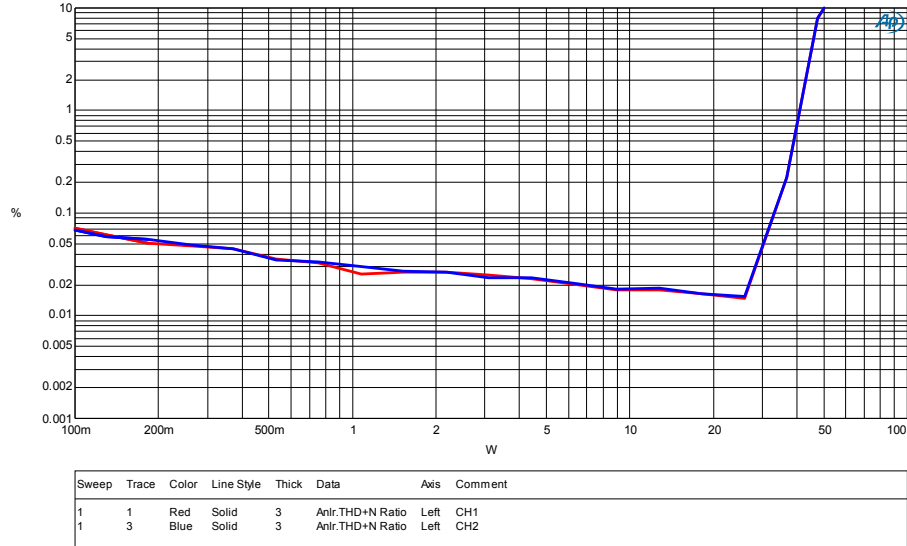


Figure 3

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

Test Conditions:

VBus = ± 19V  
 Input Signal = 1 KHz  
 Load Impedance = 2 ohms  
 Set Gain = 1% clipping 75W

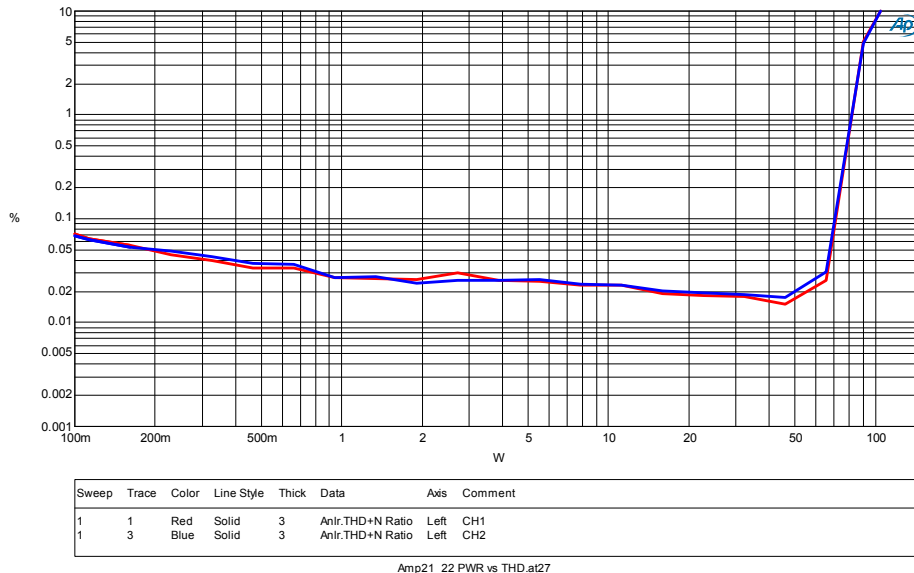


Figure 4

### Frequency Response

Test Conditions:

VBus = 13.5V  
Set Output = 1V  
Load Impedance = 2 ohms

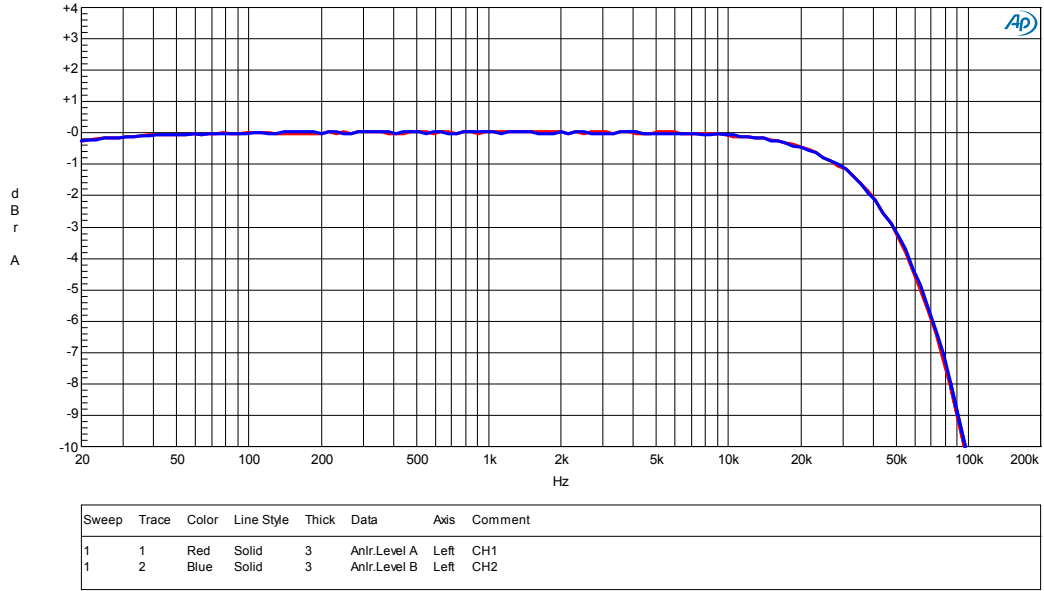


Figure 5

### Noise Floor

Test Conditions:

VBus = ± 13.5V  
Load Impedance = 2 ohms  
Set Gain = 1% clipping  
No Input Signal

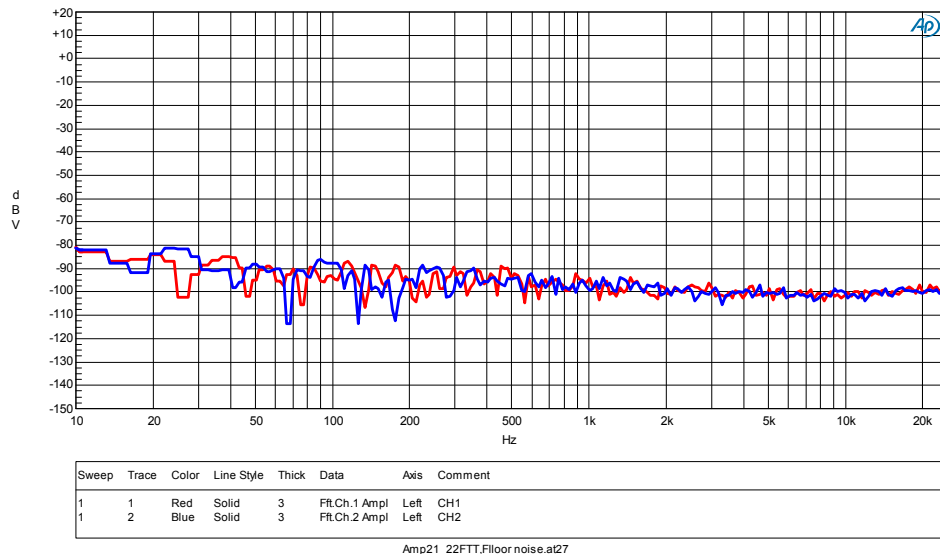


Figure 6



**Noise Floor with 1Vrms Output**

Test Conditions:

VBus = ± 13.5V  
 Output = 1Vrms @ 1 KHz  
 Load Impedance = 2 ohms  
 Set Gain = 1% clipping

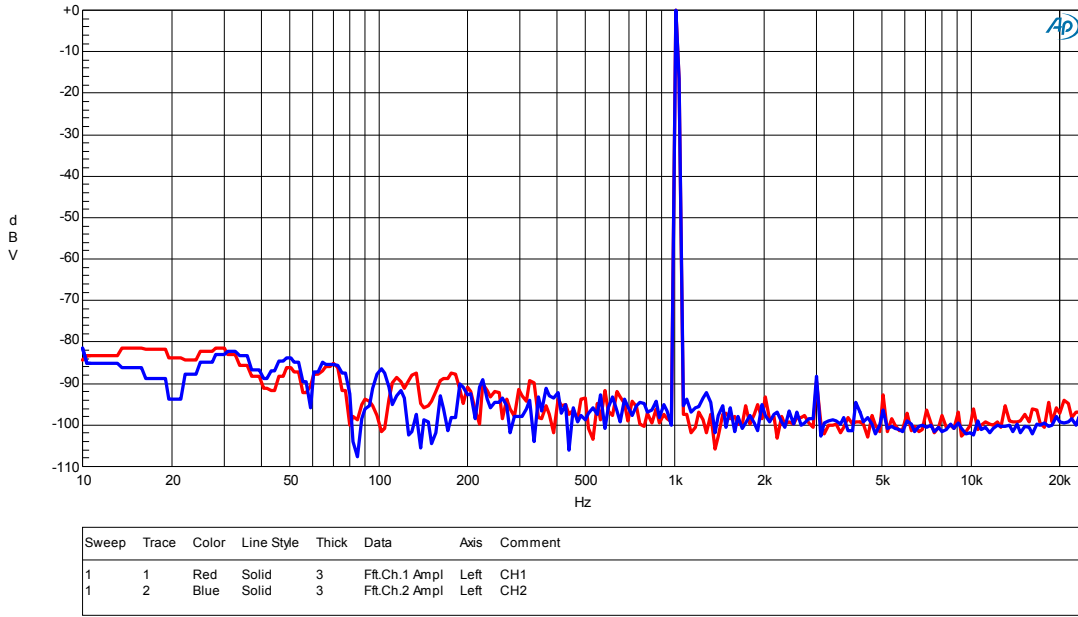
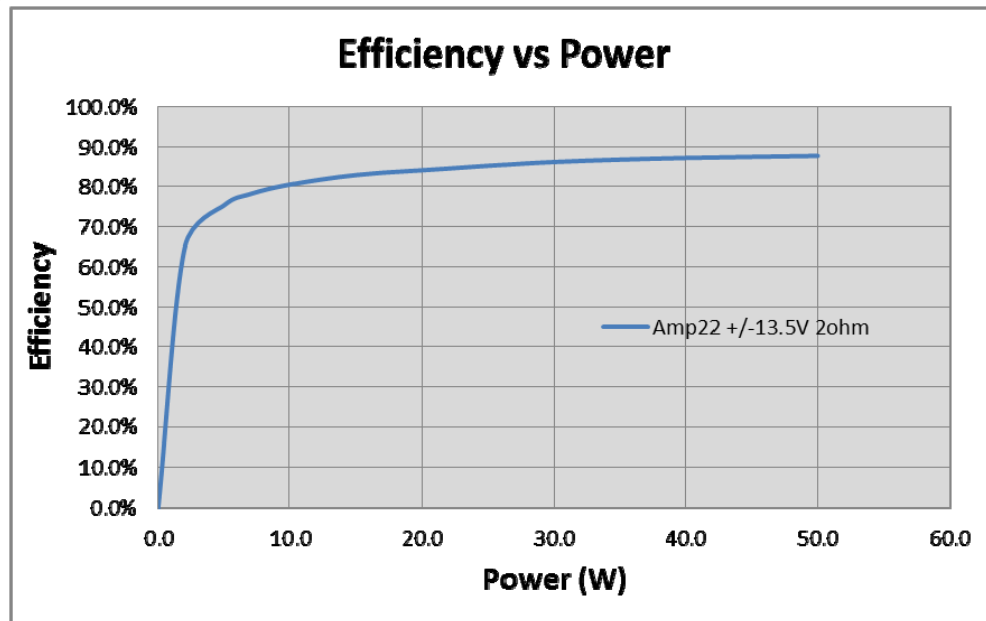


Figure7

**Efficiency**



Tested with no heat sink

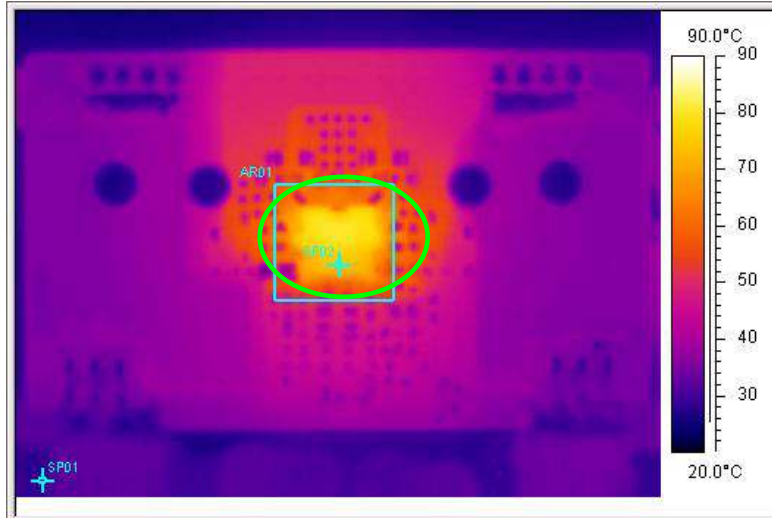
Figure8

## Thermal Information

### 1) 1/8 Po Thermal information for IRAUDAMP22

Conditions:

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



IR4322's temperature saturated  $\leq 85^{\circ}\text{C}$  within 30minutes

Figure9

load impedance	1/8 Power(W)	THD=1% power(W)	THD=10% power(W)
4 $\Omega$ load	7.44	59	80
	*9.28	*70	*95
3 $\Omega$ load	6.57	50	69
	*11.96	*92	*120
2 $\Omega$ load	4.65	37	50
	*9.4	*75	*100

\*With heatsink

## 2) Peak Power duration (no heatsink)

Test conditions:

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

Load Z	10%THD Po W	Duration
2Ω	50	Till Thermal Shutdown
3Ω	69	Till Thermal Shutdown
4Ω	80	Till Thermal Shutdown

## 3) Peak Power duration (With heatsink)

Test conditions:

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

Load Z	10%THD Po W	Duration
2Ω	100	No Thermal Shutdown
3Ω	120	No Thermal Shutdown
4Ω	95	No Thermal Shutdown

4) Heatsink installation

Thermal pad

Digikey part#  
BER161-ND

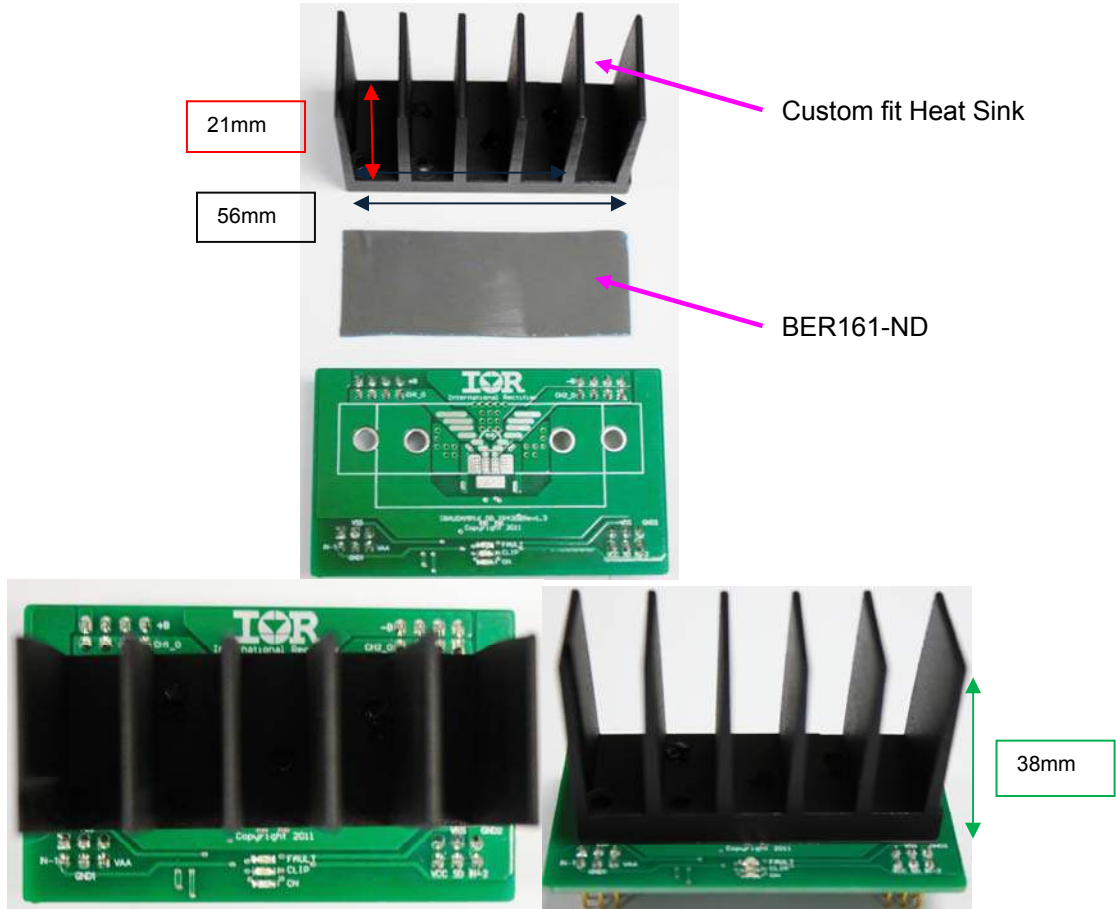


Figure10

Schematic

Class D, Daughter Board IR4322 Module Schematic

AMP22 SCH\_DB\_4322 Rev1.3

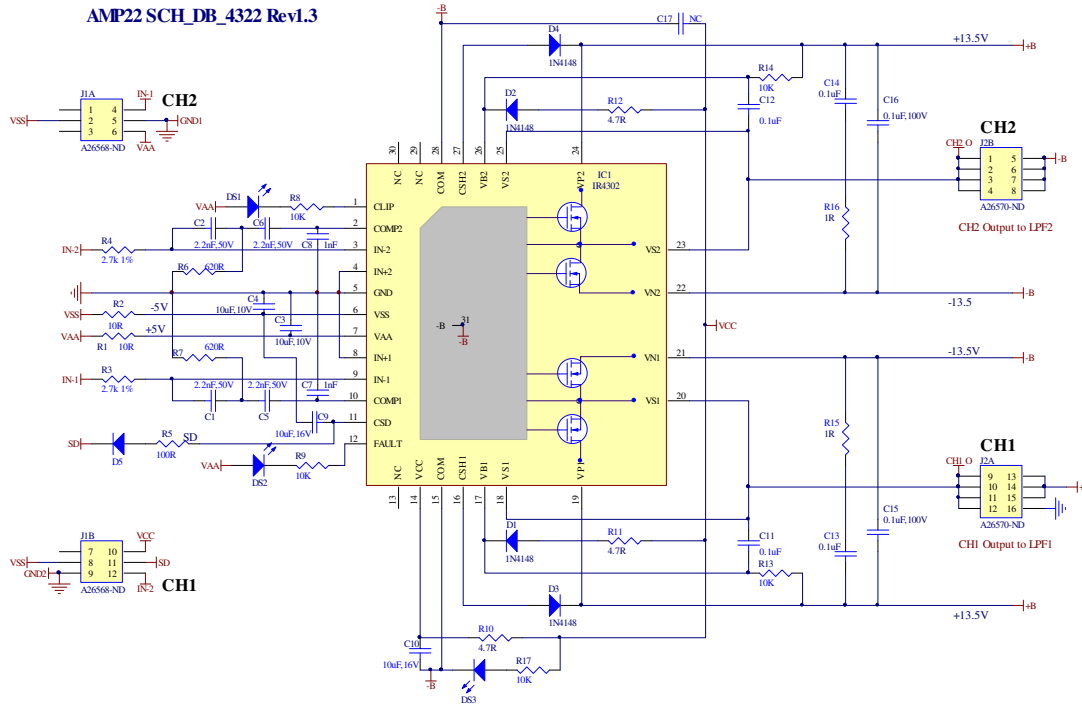


Figure11

Class D, Mother Board Control Volume and Power Supplies Schematic

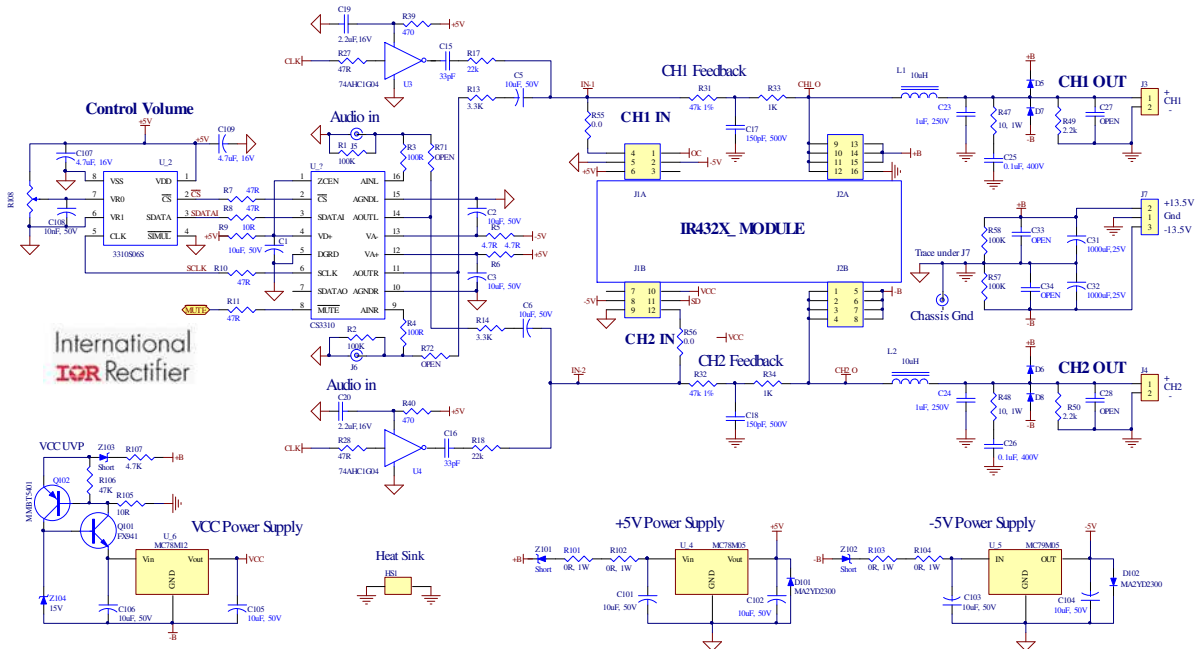


Figure12

**Class D, Mother Board Clock and House Keeping Schematic**

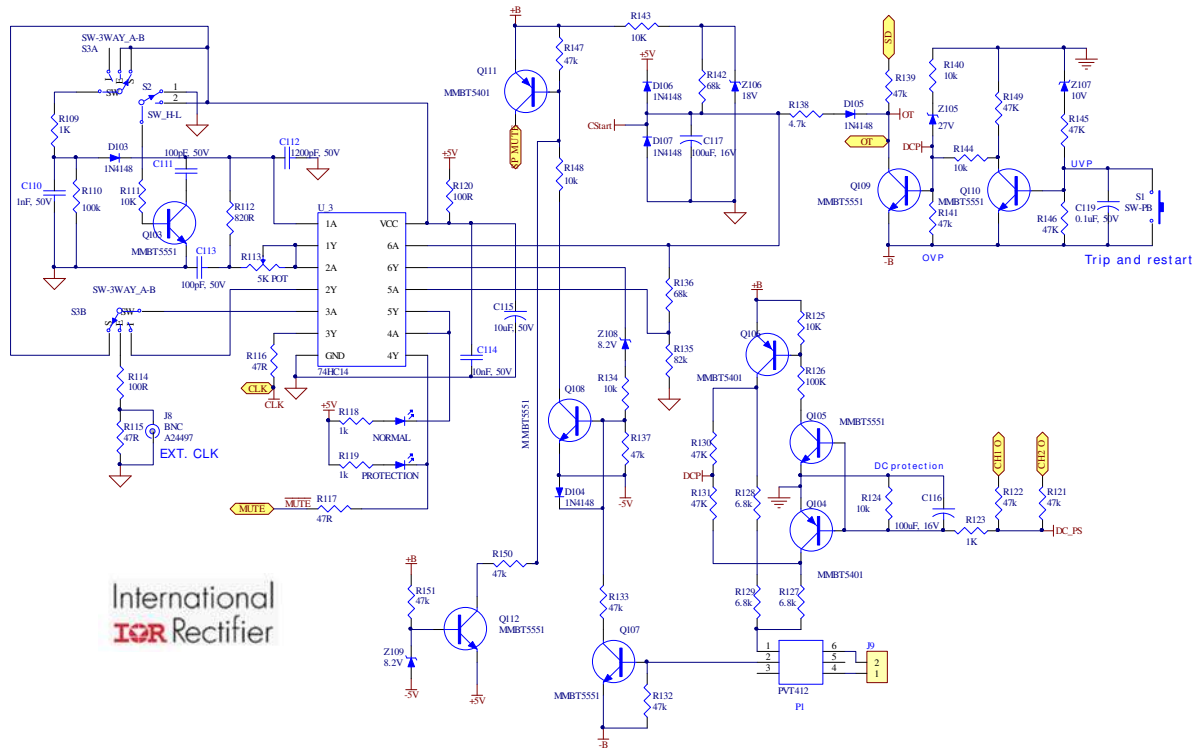


Figure13

## IRAUDAMP22 Bill of Materials

### IRAUDAMP22 Daughter Board BOM

No	Part Number	Designator	Description	Quantity	Vendor
1	490-1500-1-ND	C1, C2, C5, C6	CAP CER 2200PF 50V 10% X7R 0603	4	Digikey
2	587-2668-1-ND	C3, C4	CAP CER 10UF 10V X7R 10% 0805	2	Digikey
3	399-1082-1-ND	C7, C8	CAP 1000PF 50V CERAMICX7R 0603	2	Digikey
4	490-5519-1-ND	C9, C10	CAP CER 10UF 16V X6S 0805	2	Digikey
5	445-1418-1-ND	C13, C14, C11, C12	CAP CER .10UF 100V X7R 10% 0805	4	Digikey
6	445-1377-1-ND	C15, C16	CAP CER .1UF 100V X7R 10% 1206	2	Digikey
7	1N4148W-FDICT-ND	D1, D2, D3, D4, D5	DIODE SWITCH 100V 400MW SOD123	5	Digikey
8	160-1183-1-ND	DS1(CLIP)	LED GREEN CLEAR 0603 SMD	1	Digikey
9	160-1181-1-ND	DS2(Fault)	LED RED CLEAR 0603 SMD	1	Digikey
10	160-1646-1-ND	DS3(ON)	LED 468NM BLUE CLEAR 0603 SMD	1	Digikey
11	IR4322	IC1	2 CH PowIRaudio integrated Class D IC	1	IR
12	A26568-ND	J1A, J1B	CONN HEADER VERT 6POS .100 30AU	2	Digikey
13	A26570-ND	J2A, J2B	CONN HEADER VERT .100 8POS 30AU	2	Digikey
14	RMCF0603JT10R0CT-ND	R1, R2	RES 10 OHM 1/10W 5% 0603 SMD	2	Digikey
15	RMCF0603FT2K70CT-ND	R3, R4	RES 2.7K OHM 1/10W 1% 0603 SMD	2	Digikey
16	RMCF0603JT100RCT-ND	R5	RES 100 OHM 1/10W 5% 0603 SMD	1	Digikey
17	RHM620GCT-ND	R6, R7	RES 620 OHM 1/10W 5% 0603 SMD	2	Digikey
18	RHM10KGCT-ND	R8, R9, R17	RES 10K OHM 1/10W 5% 0603 SMD	3	Digikey
19	RMCF0603JT4R70CT-ND	R10, R11, R12	RES TF 1/10W 4.7 OHM 5% 0603	3	Digikey
20	P10KGCT-ND	R13, R14	RES 10K OHM 1/10W 5% 0603 SMD	2	Digikey
21	311-1.0ARCT-ND	R15, R16	RES 1.0 OHM 1/8W 5% 0805 SMD	2	Digikey

\*Heatsink is an option for IRAUDAMP22 to deliver high power up to 100W/2Ω

### IRAUDAMP22 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	RES 0.0 OHM 1W Jump 2512 SMD	4	Digikey



		R104			
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 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.

**Daughter Board**

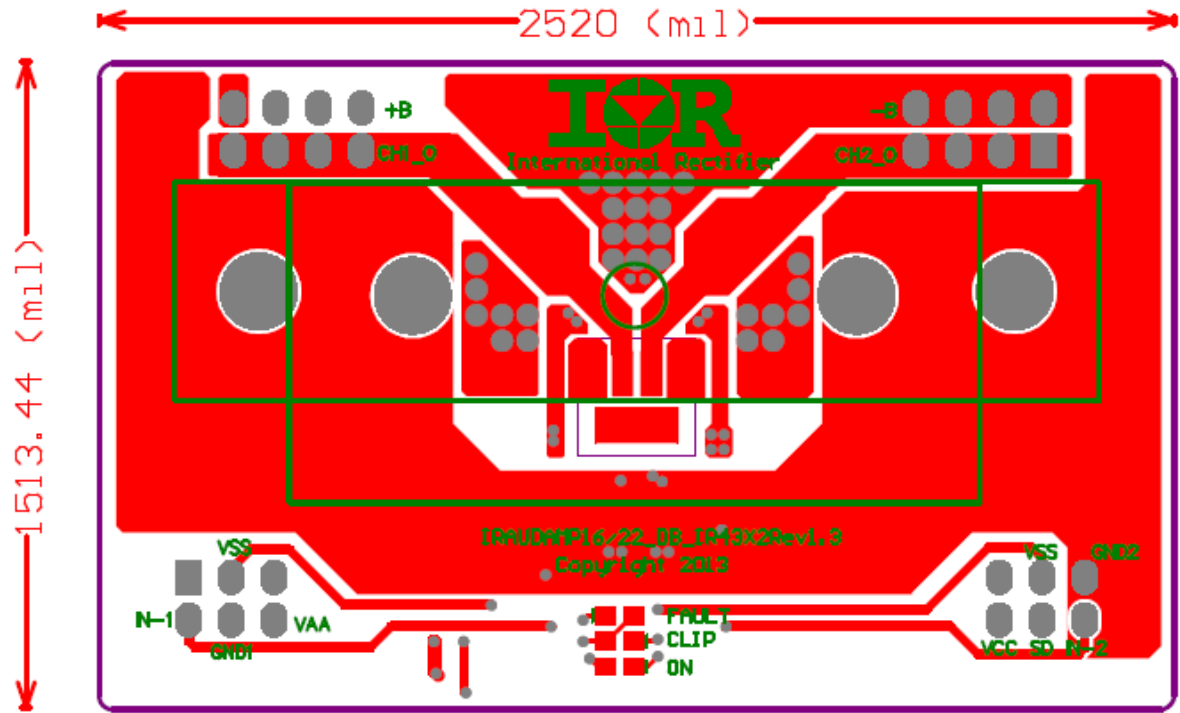


Figure14

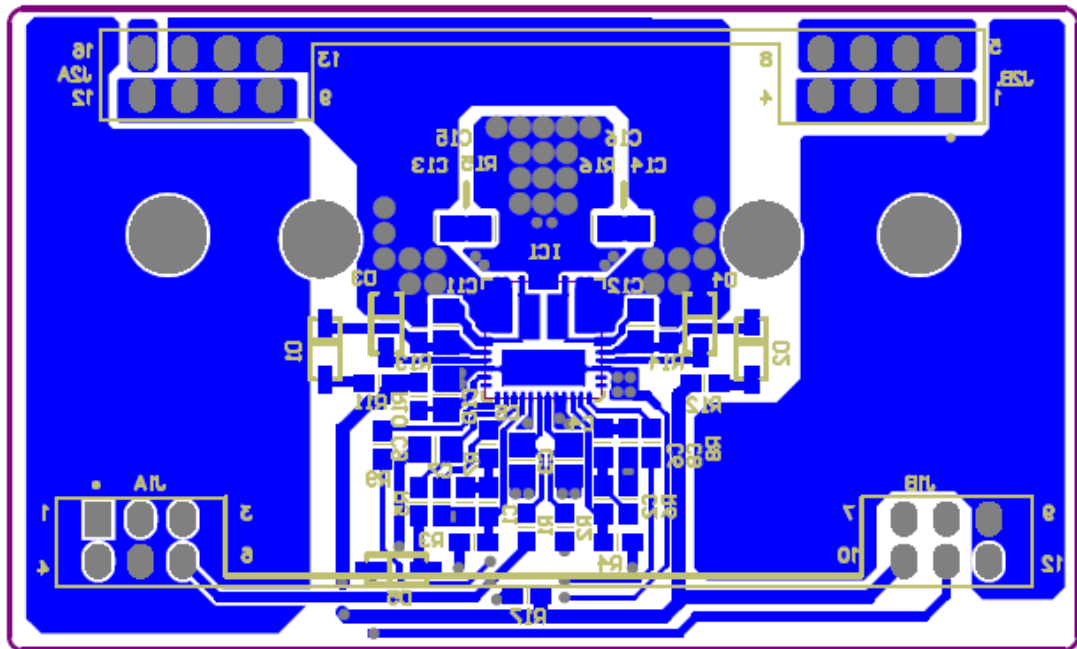


Figure15

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

**Mother Board**

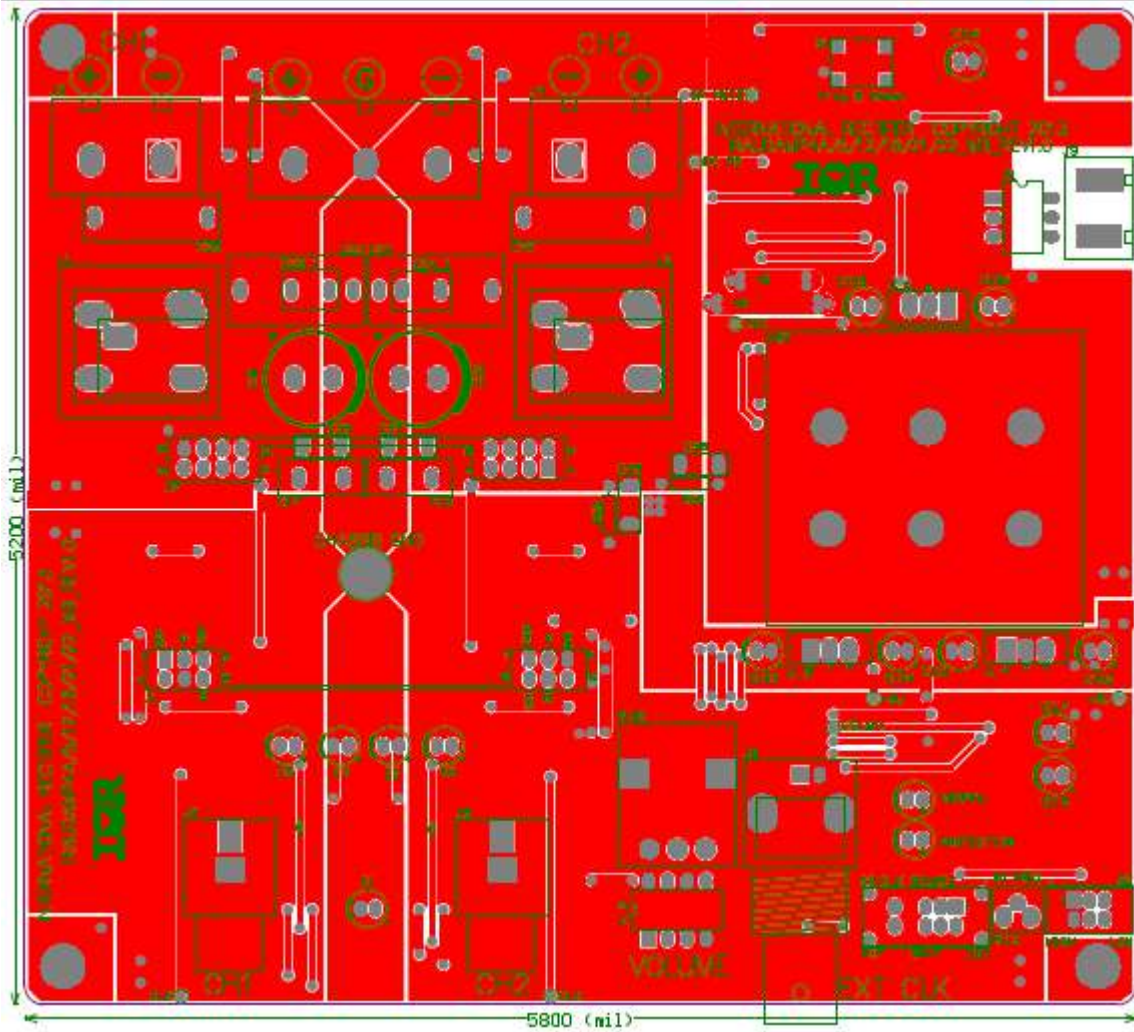


Figure16

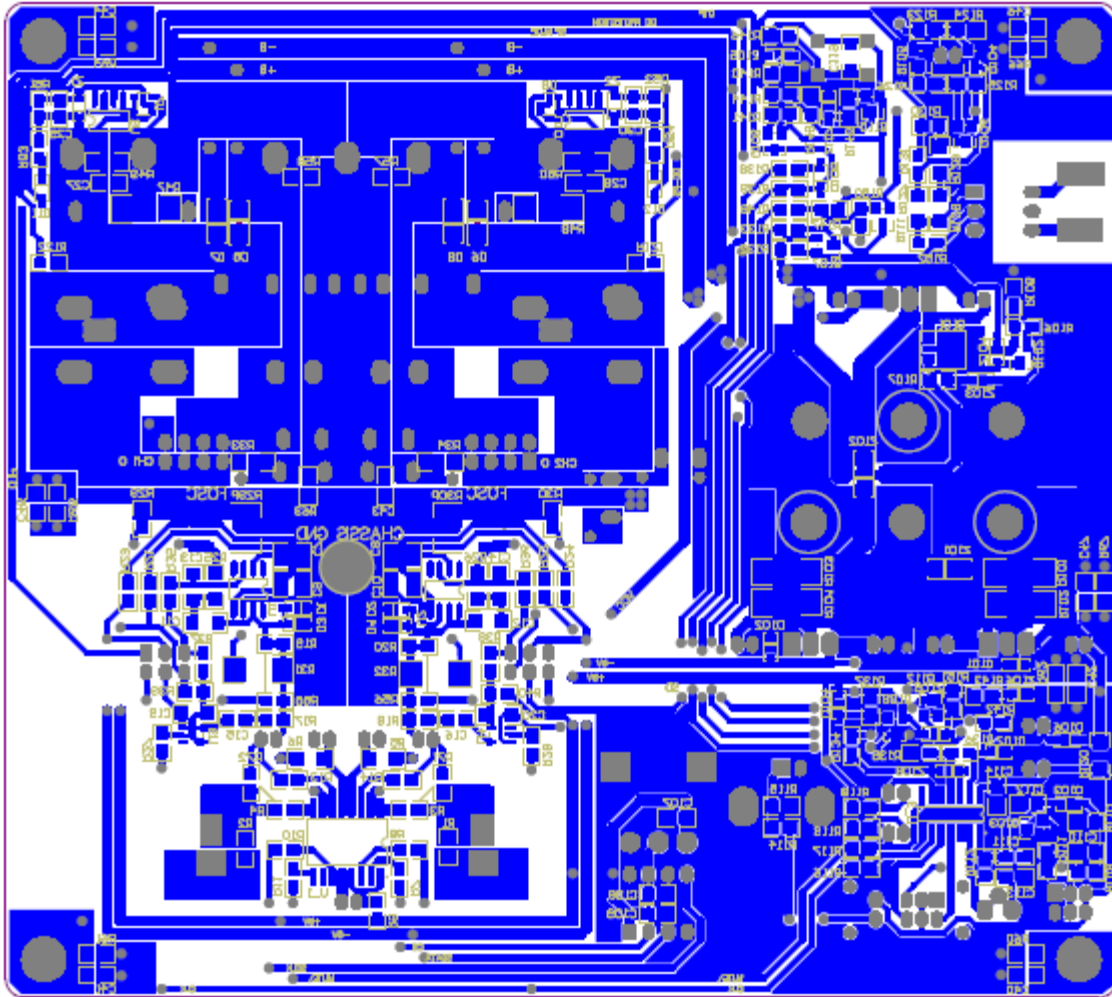


Figure17

## Revision changes descriptions

Revision	Changes description	Date
Rev 1.0	Released	April, 30 2013