International
IOR Rectifier

REFERENCE DESIGN

IRAUDAMP12

130W/4Ω x 2 Channel Class D Audio Power Amplifier Using the IR4301

By

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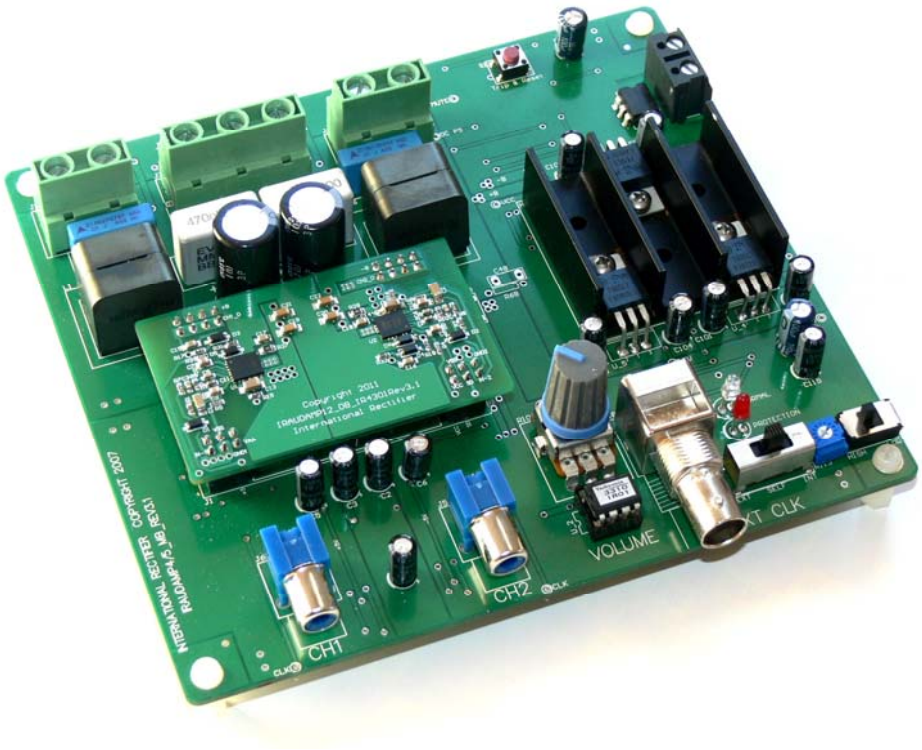

CAUTION:

International Rectifier suggests the following guidelines for safe operation and handling of IRAUDAMP12 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 IRAUDAMP12 reference design is a two-channel, 130W/ch (4Ω/±31V; no heatsink)/ 160W/ch (4Ω/±34V; *with heatsink) half-bridge Class D audio power amplifier. This reference design demonstrates how to use the IR4301 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:	130W x 2 channels (10%THD+N 4Ω load; no heatsink), 160W x 2 channels (10%THD+N 4Ω 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	±15V~±31V	Bipolar power supply; without heatsink
	±15V~±34V	Bipolar power supply; *with heatsink
Load Impedance	4-2Ω	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	IR4301 PowIRaudio integrated Class D IC	
Modulator	Self-oscillating, second order sigma-delta modulation, analog input	
Output Power CH1-2: (1% THD+N)	100W	1kHz, 4Ω load, without heatsink
	130W	1kHz, 4Ω load, *with heatsink
	80W	1kHz, 3Ω load, without heatsink
	95W	1kHz, 3Ω load, *with heatsink
	55W	1kHz, 2Ω load, without heatsink
	70W	1kHz, 2Ω load, *with heatsink

Output Power CH1-2: (10% THD+N)	130W	1kHz, 4Ω load, without heatsink
	160W	1kHz, 4Ω load, *with heatsink
	100W	1kHz, 3Ω load, without heatsink
	120W	1kHz, 3Ω load, *with heatsink
	70W	1kHz, 2Ω load, without heatsink
	90W	1kHz, 2Ω load, *with heatsink
Rated Load Impedance	4-2Ω	Resistive load
Idling Supply Current	±80mA	No input signal
Total Idle Power Consumption	4W	No input signal
Distortion	0.02%	THD+N @ 50W, 4Ω
Residual Noise	250μV	IHF-A weighted, AES-17 filter
Channel Efficiency	96%	Single-channel driven, 130W/*160W(* with heatsink), Class D stage

*

Connection Setup

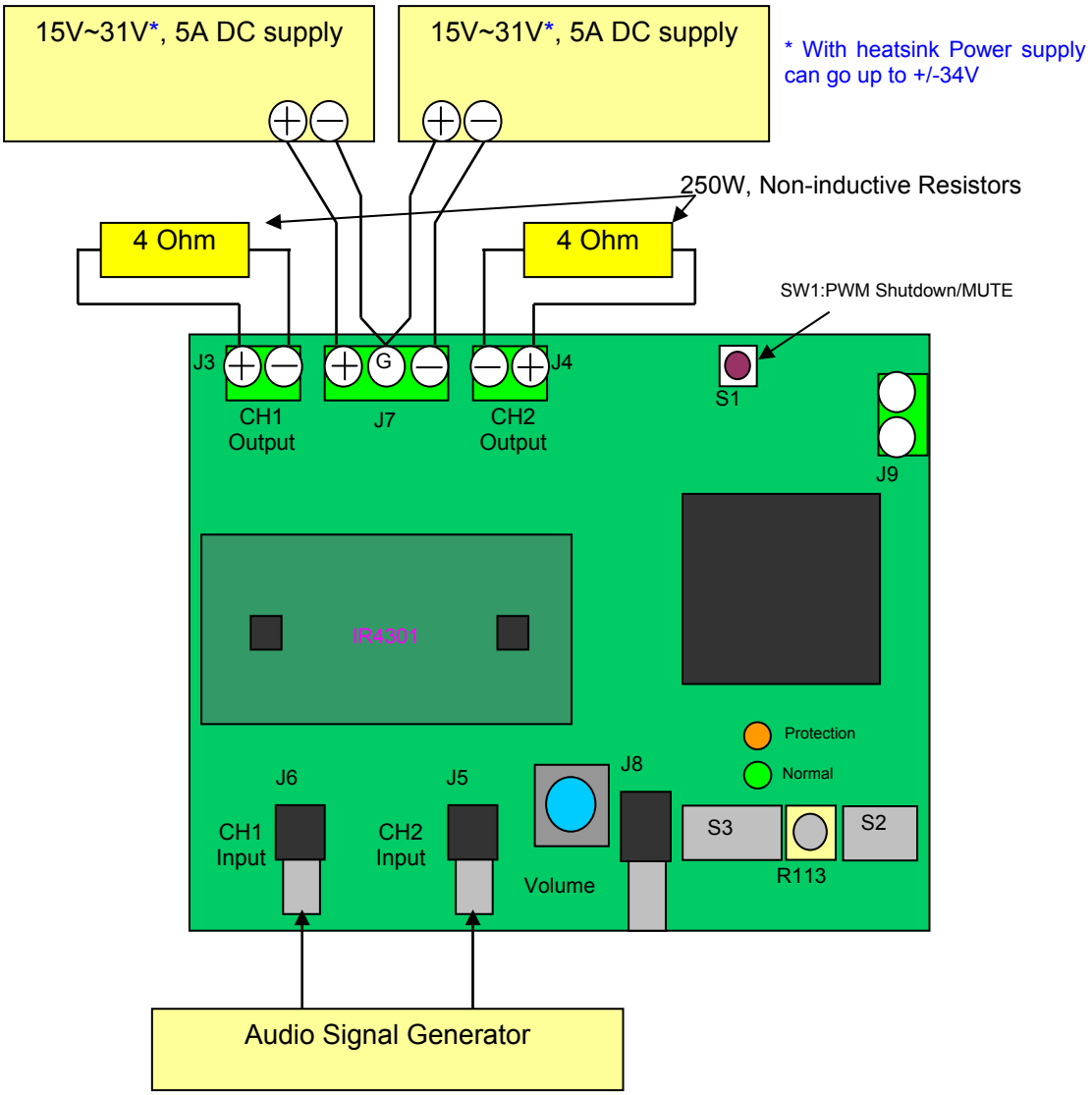


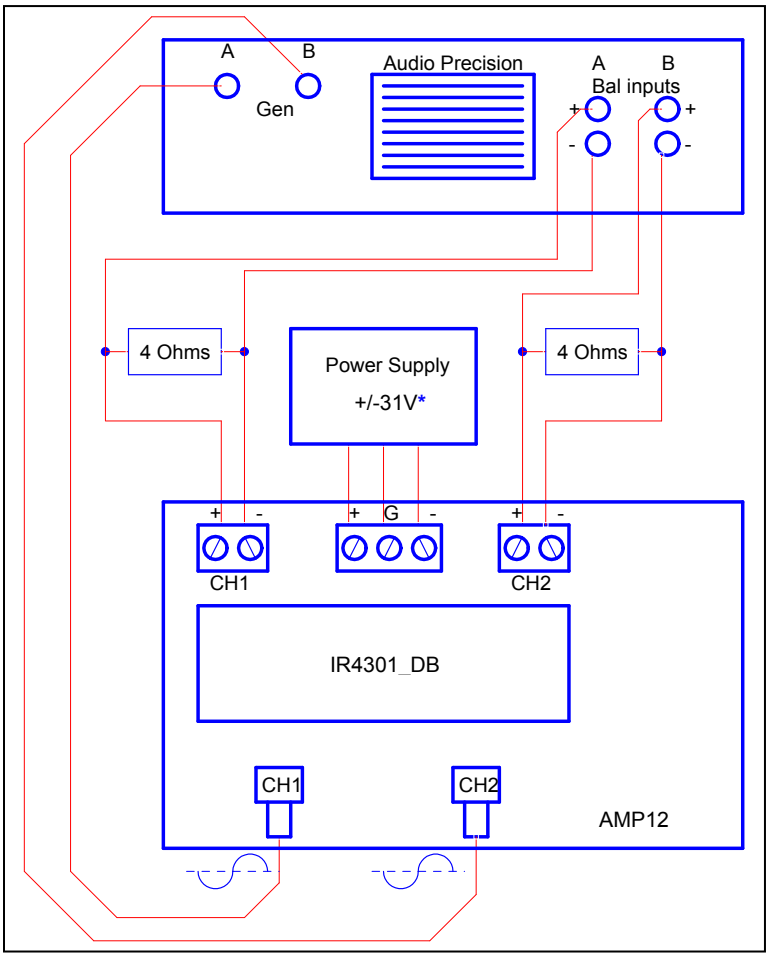
Figure 1 Typical Test Setup

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

IRAUDAMP12 and Audio Precision shall be connected according to the Figureure below:



* With heatsink Power supply can go up to +/-34V

Figure 2

Test Procedures

Test Setup:

1. Connect 4Ω-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 ±15V~±31V (up to ±34V 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 ±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 ±10mA at +31V.
11. Quiescent current for the negative supply should be 80mA ±10mA at –31V.
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:

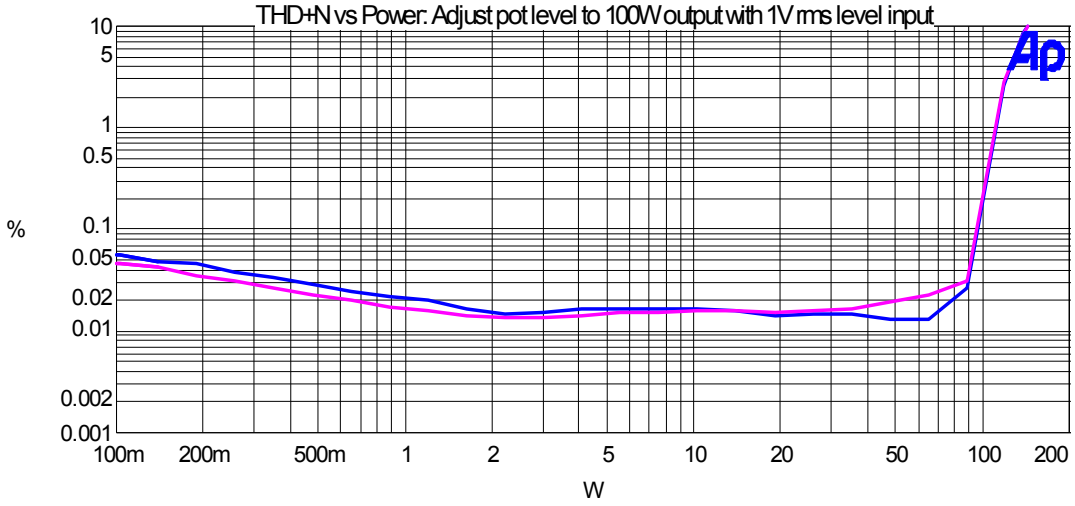
13. Apply 1V RMS at 1kHz sinusoidal signal from the Audio Signal Generator.
14. Turn control volume up (R130 clock-wise) to obtain an output reading of 250Watts.
15. For all subsequent tests as shown on the Audio Precision graphs below (Figure 3-Figure7), the measurements are taken across J3 and J4 with 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_{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

Test Conditions:

VBus = ± 31V
Input Signal = 1 KHz
Load Impedance = 4 ohms
Set Gain = 1% clipping 100W

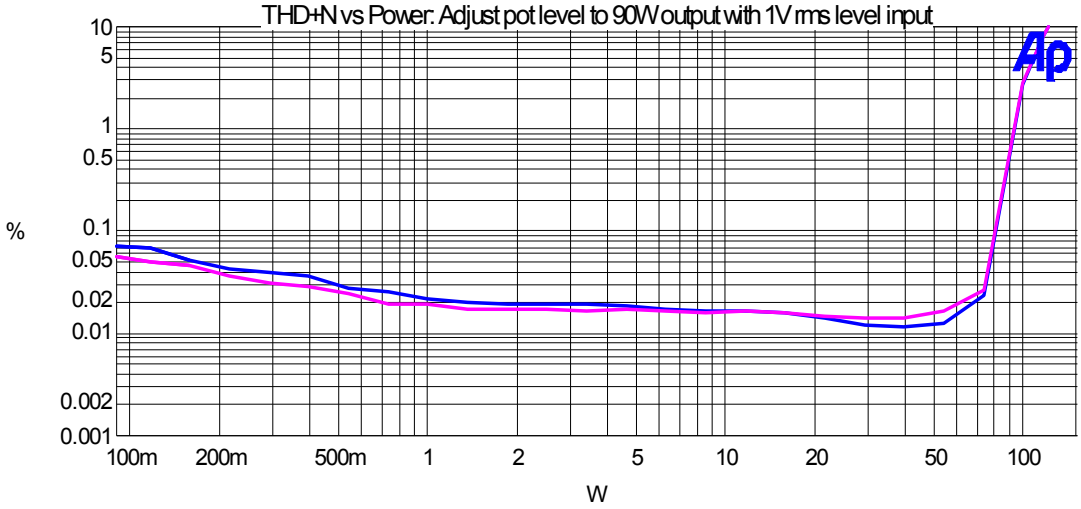


Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Blue	Solid	2	Anlr.THD+N Ratio	Left	CH1 - 4 Ohms
1	3	Magenta	Solid	2	Anlr.THD+N Ratio	Left	CH2 - 4 Ohms

Figure 3

Test Conditions:

VBus = ± 25V
Input Signal = 1 KHz
Load Impedance = 3 ohms
Set Gain = 1% clipping 90W

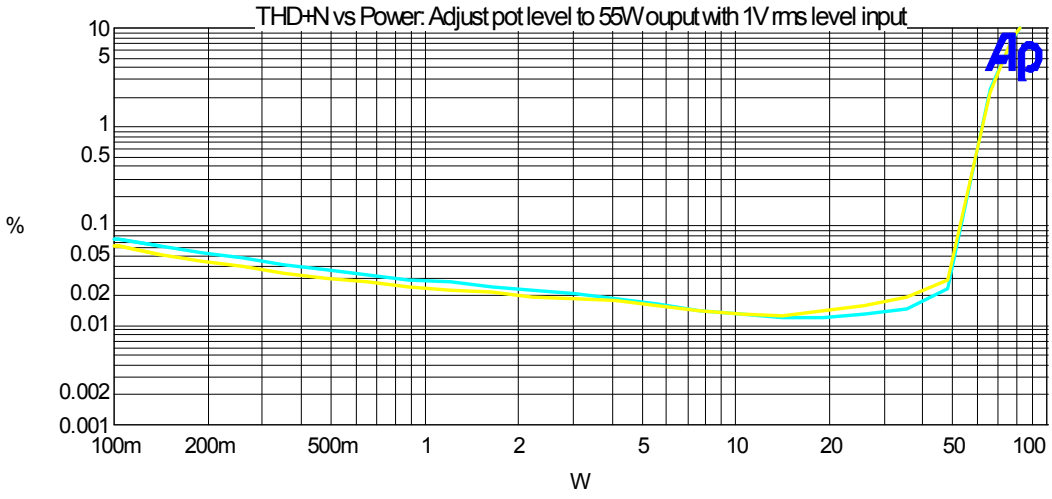


Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Blue	Solid	2	Anlr.THD+N Ratio	Left	CH1 - 3 Ohms
1	3	Magenta	Solid	2	Anlr.THD+N Ratio	Left	CH1 - 3 Ohms

Figure 4

Test Conditions:

VBus = ± 17V
Input Signal = 1 KHz
Load Impedance = 2 ohms
Set Gain = 1% clipping 55W



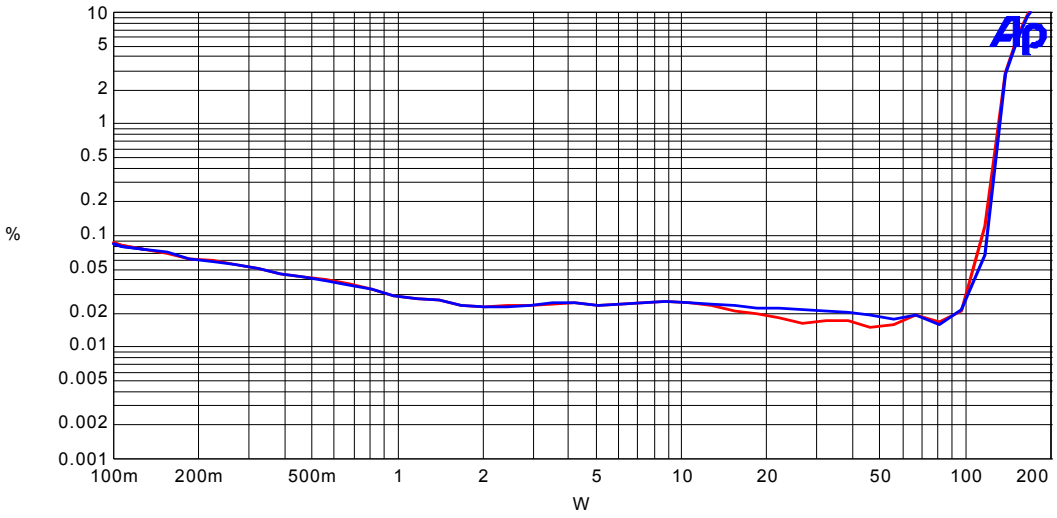
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Cyan	Solid	2	Anlr.THD+N Ratio	Left	CH1 - 2 Ohms
1	3	Yellow	Solid	2	Anlr.THD+N Ratio	Left	CH2 - 2 Ohms

Figure 5

Power vs THD+N (with heatsink)

Test Conditions:

VBus = ± 34V
Input Signal = 1 KHz
Load Impedance = 4 ohms
Set Gain = 1% clipping 130W

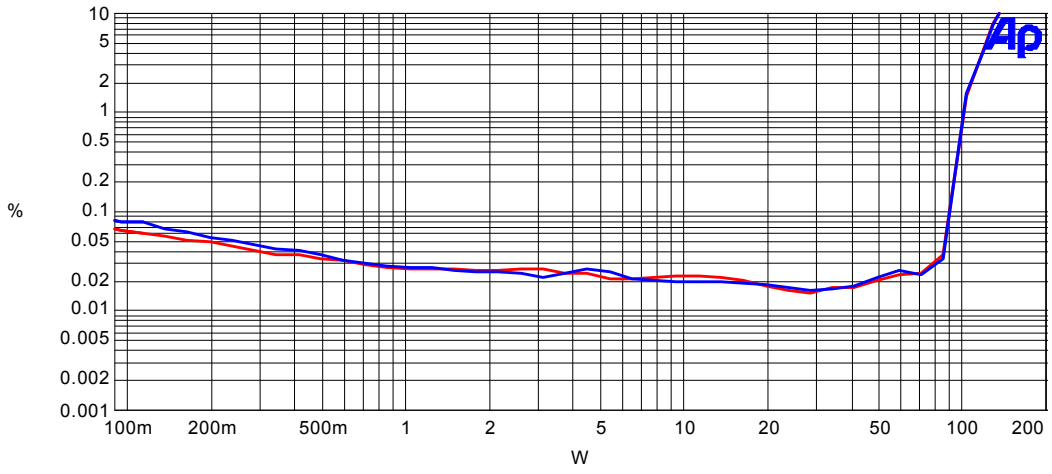


Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	S2.Anlr.THD+N Ratio	Left	CH1 4ohm 34V
1	3	Blue	Solid	2	S2.Anlr.THD+N Ratio	Left	CH2 4ohm 34V

Figure 6

Test Conditions:

VBus = ± 27V
Input Signal = 1 KHz
Load Impedance = 3 ohms
Set Gain = 1% clipping 95W

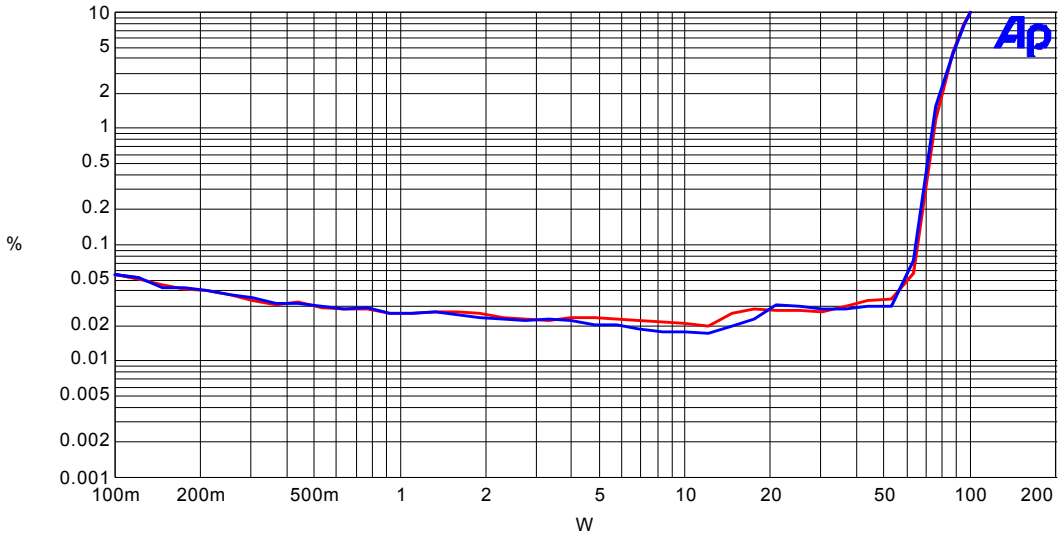


Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
5	1	Red	Solid	2	S2.Anlr.THD+N Ratio	Left	CH1 3ohm 27V
5	3	Blue	Solid	2	S2.Anlr.THD+N Ratio	Left	CH2 3ohm 27V

Figure 7

Test Conditions:

VBus = ± 19V
Input Signal = 1 KHz
Load Impedance = 2 ohms
Set Gain = 1% clipping 70W



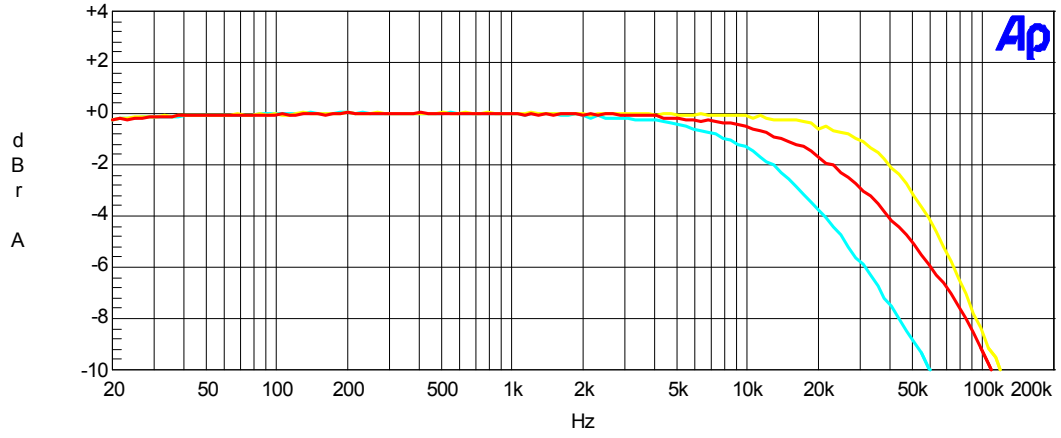
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	2	S2.Anlr.THD+N Ratio	Left	CH1 2ohm 19V
1	3	Blue	Solid	2	S2.Anlr.THD+N Ratio	Left	CH2 2ohm 19V

Figure 8

Frequency Response

Test Conditions:

VBus = ± 31V, 25V, 17V
Set Output = 1V
Load Impedance = 4, 3, 2 ohms



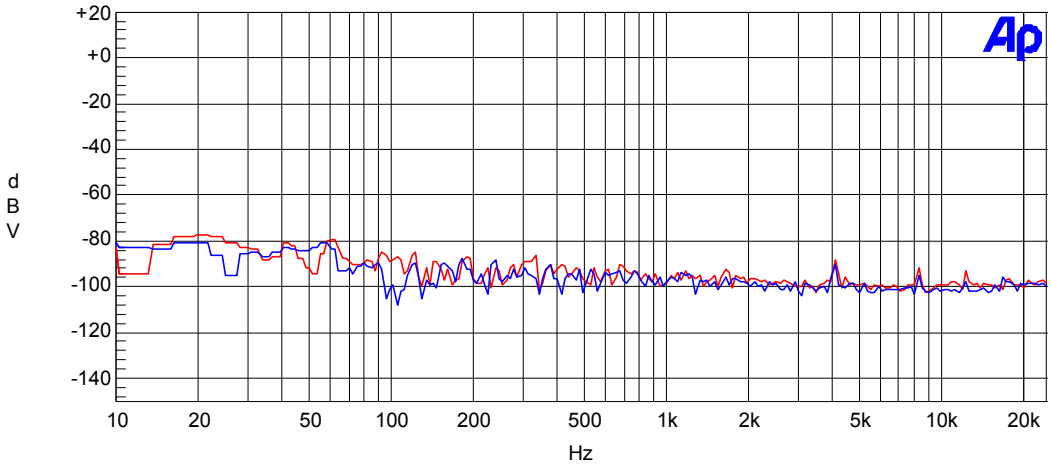
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Cyan	Solid	2	Anlr.Level A	Left	Ch2 2ohm +-17V
3	1	Yellow	Solid	2	Anlr.Level A	Left	Ch2 4ohm +-31V
4	1	Red	Solid	2	Anlr.Level A	Left	Ch2 3ohm +-25V

Figure 9

Noise Floor

Test Conditions:

VBus = ± 31V
Load Impedance = 4 ohms
Set Gain = 1% clipping
No Input Signal



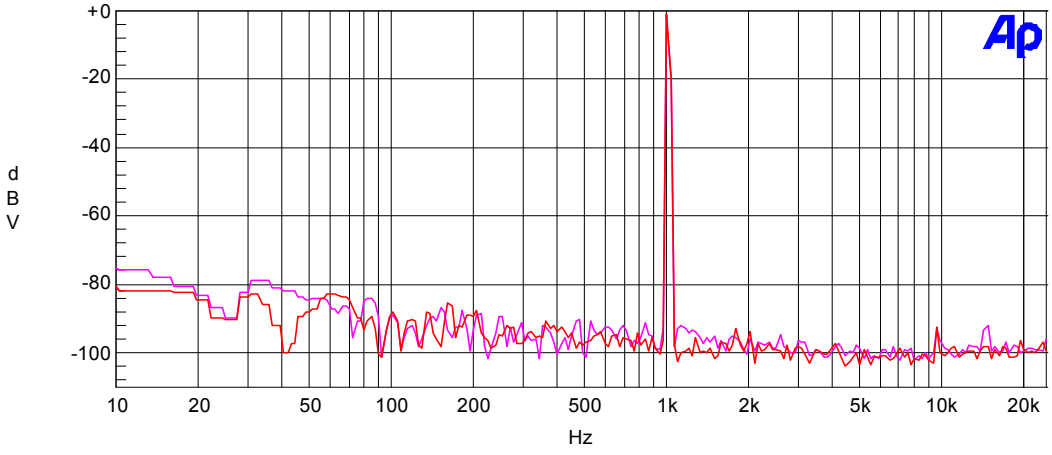
Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Red	Solid	1	Fft.Ch.1 Ampl	Left	Ch1
1	2	Blue	Solid	1	Fft.Ch.2 Ampl	Left	Ch2

Figure 10

Noise Floor with 1Vrms Output

Test Conditions:

VBus = ± 31V
Output = 1Vrms @ 1 KHz
Load Impedance = 4 ohms
Set Gain = 1% clipping



Sweep	Trace	Color	Line Style	Thick	Data	Axis	Comment
1	1	Magenta	Solid	1	Fft.Ch.1 Ampl	Left	Ch1 4ohm
1	2	Red	Solid	1	Fft.Ch.2 Ampl	Left	Ch2 4ohm

Figure 11

Efficiency

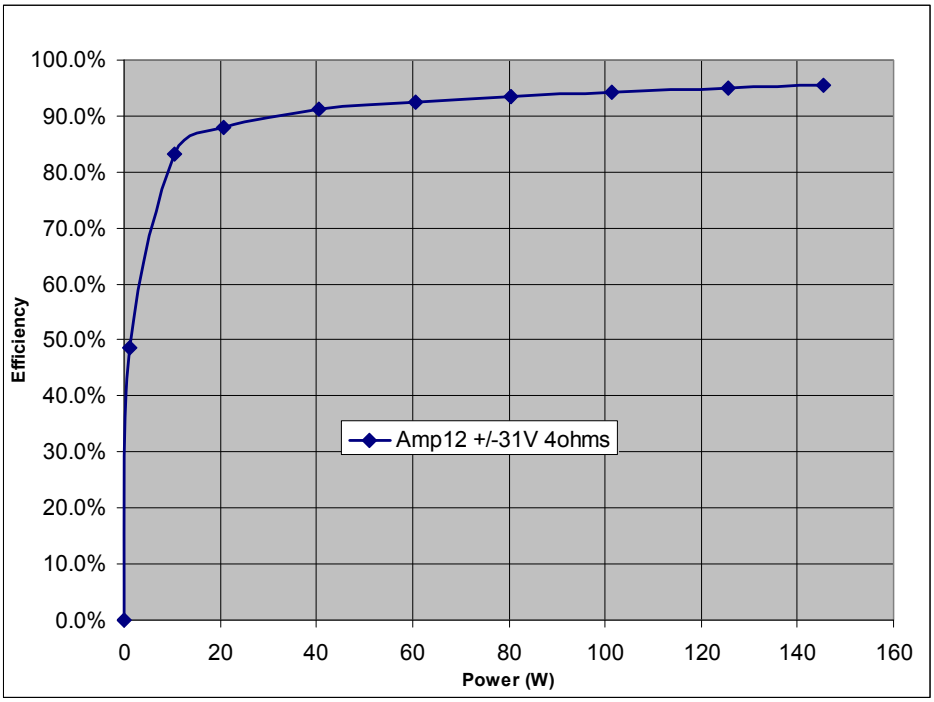


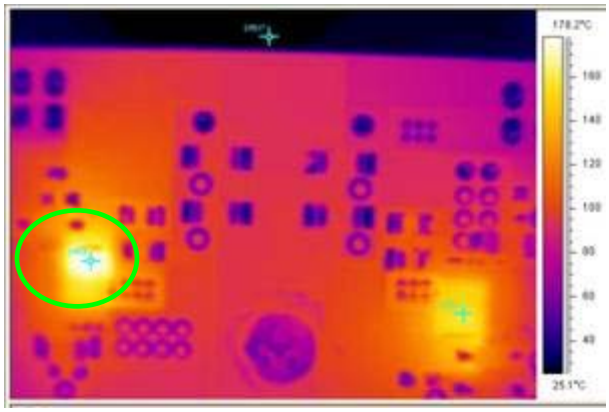
Figure 12

Thermal Information

1) 1/8 Po Thermal information for IRAUDAMP12

Conditions:

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



IR4301's temperature saturated ≤85°C within 30minutes

Figure 13

load impedance	1/8 Power(W)	THD=1% power(W)	THD=10% power(W)
4Ω load	12.5	100	130
	*16.25	*130	*160
3Ω load	10	80	100
	*11.875	*95	*120
2Ω load	6.375	55	70
	*11.125	*70	*90

*With heatsink (Digikey part#:294-1085-ND)

2) Peak Power duration (no heatsink)

Test conditions:

- Vbus=+/-31V for 4 ohms, 25V for 3 ohms, 17.0V for 2 ohms
- 1kHz sine wave signal input ; Both channels driven
- Fsw=400kHz

Test results:

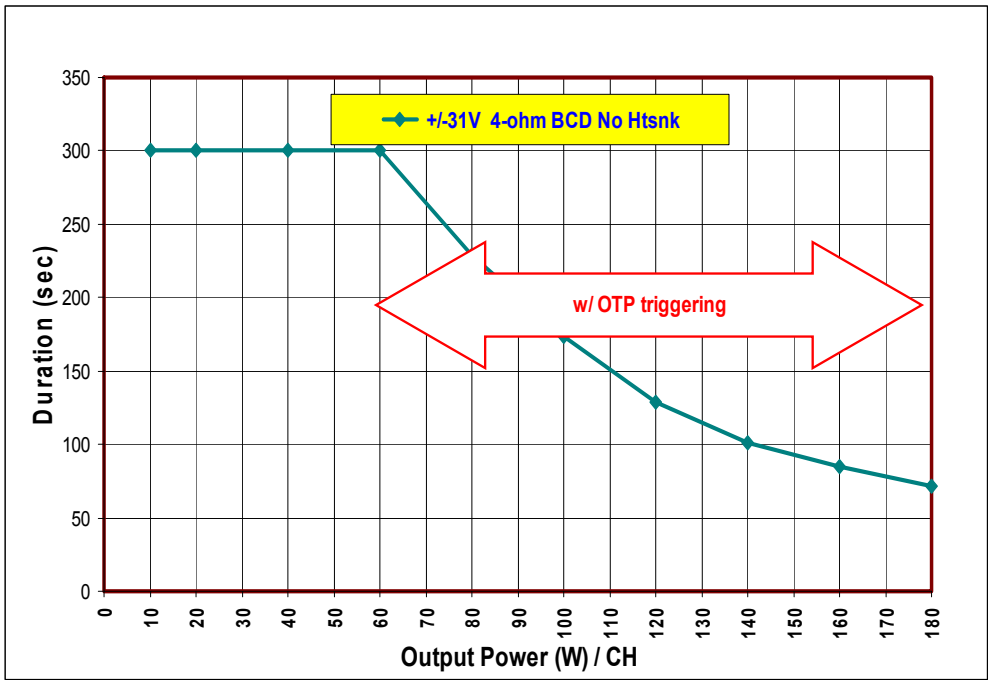


Figure 14

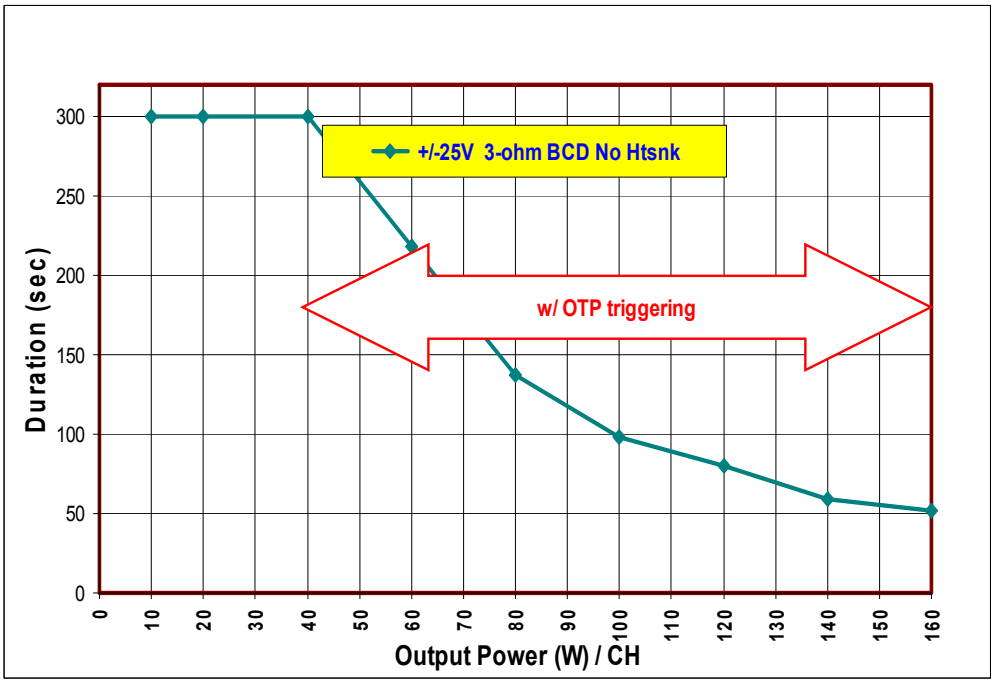


Figure15

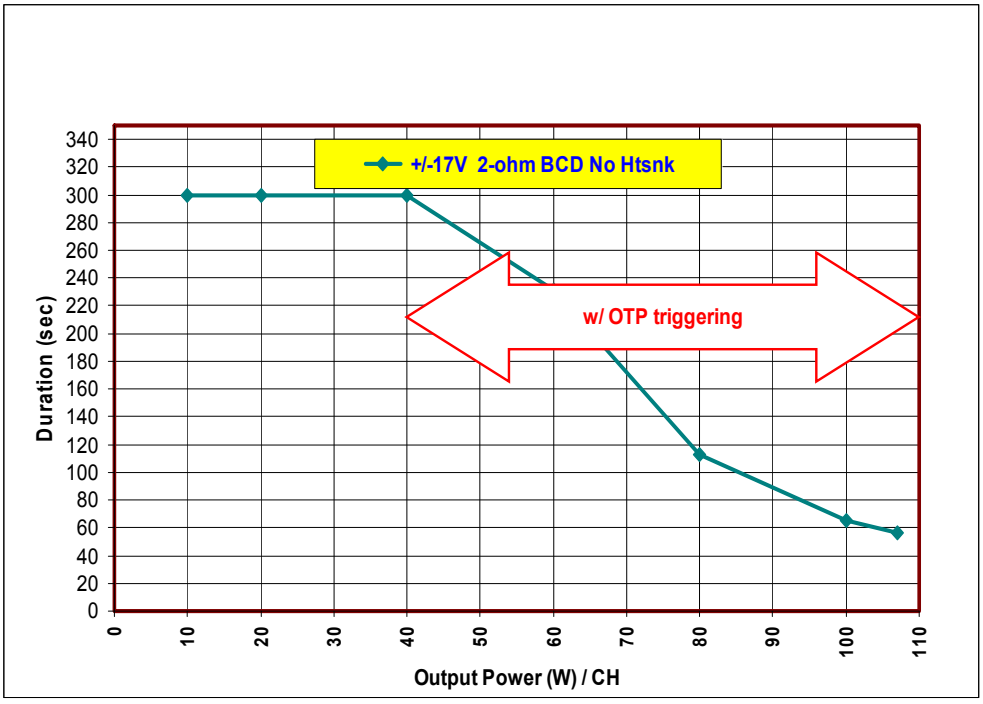


Figure 16

3) Peak Power duration (with heatsink)

Test conditions:

- Vbus=+/-34V for 4 ohms, 27V for 3 ohms, 19V for 2 ohms
- 1kHz sine wave signal input ; Both channels driven

Test results:

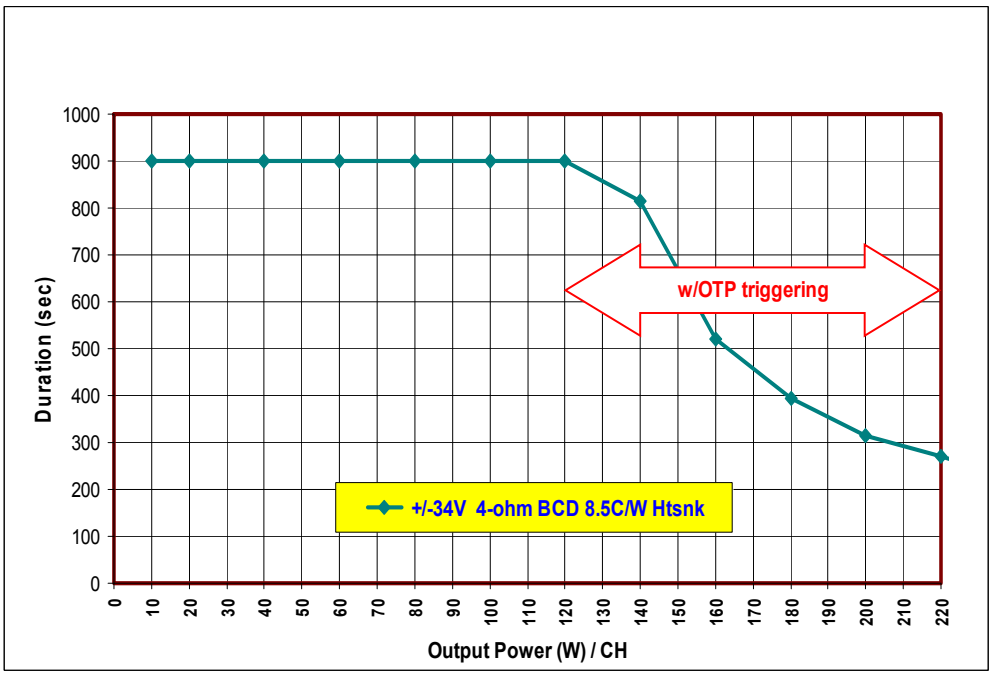


Figure 17

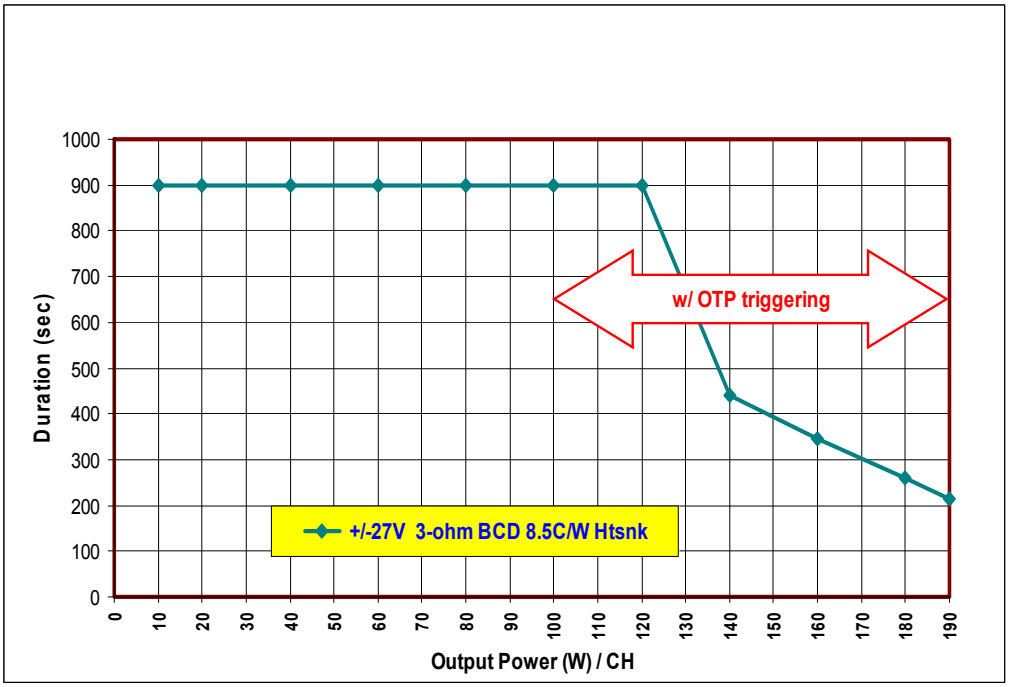


Figure 18

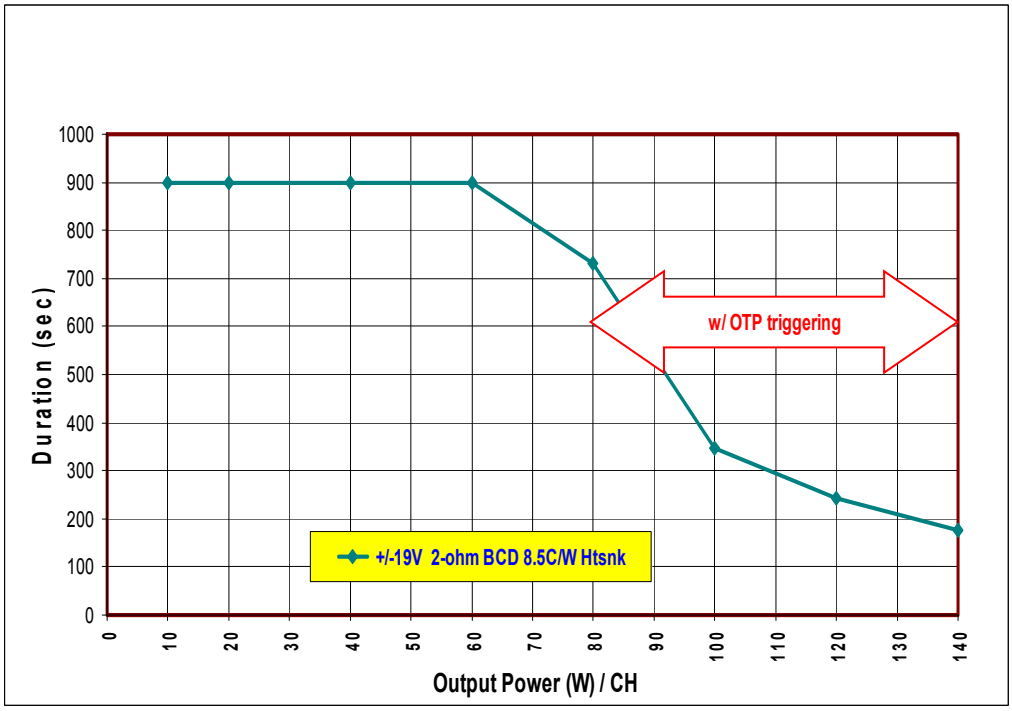


Figure 19

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.

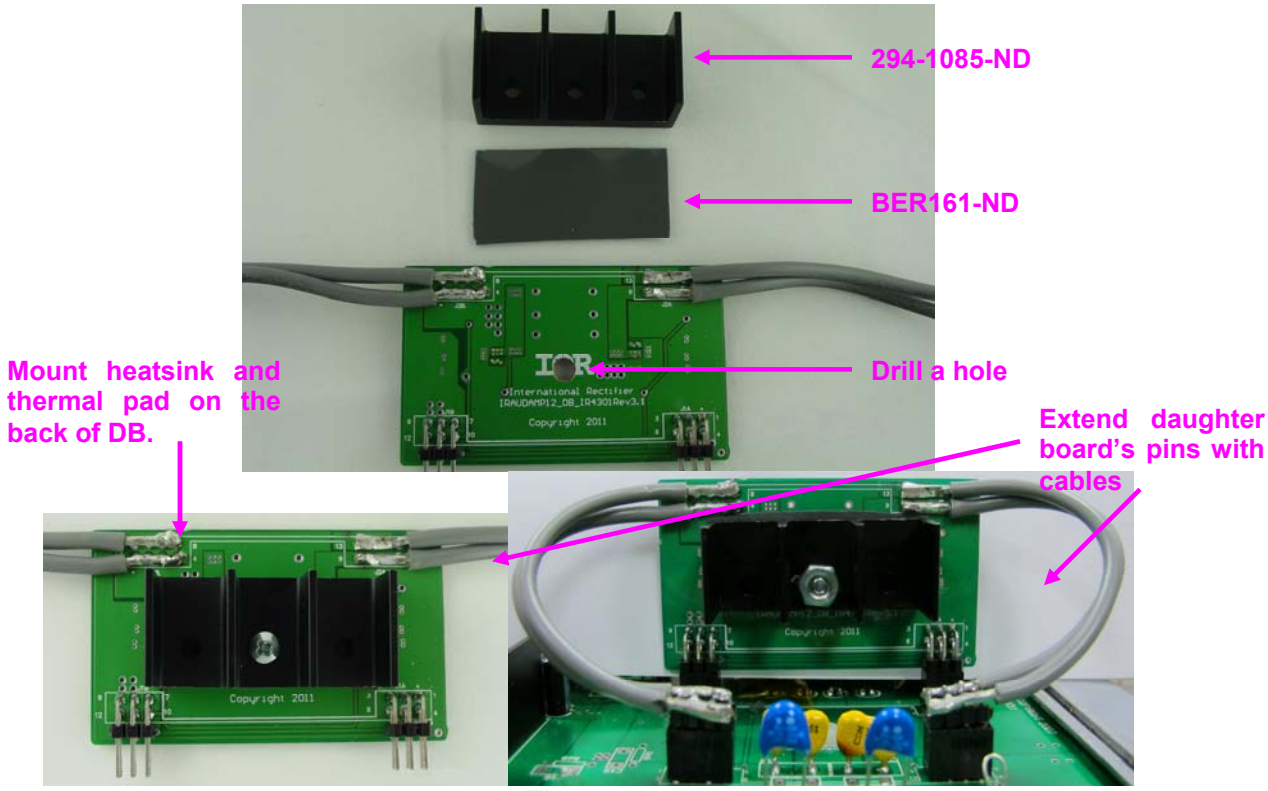


Figure 20

Schematic

Class D, Daughter Board IR4301 Module Schematic

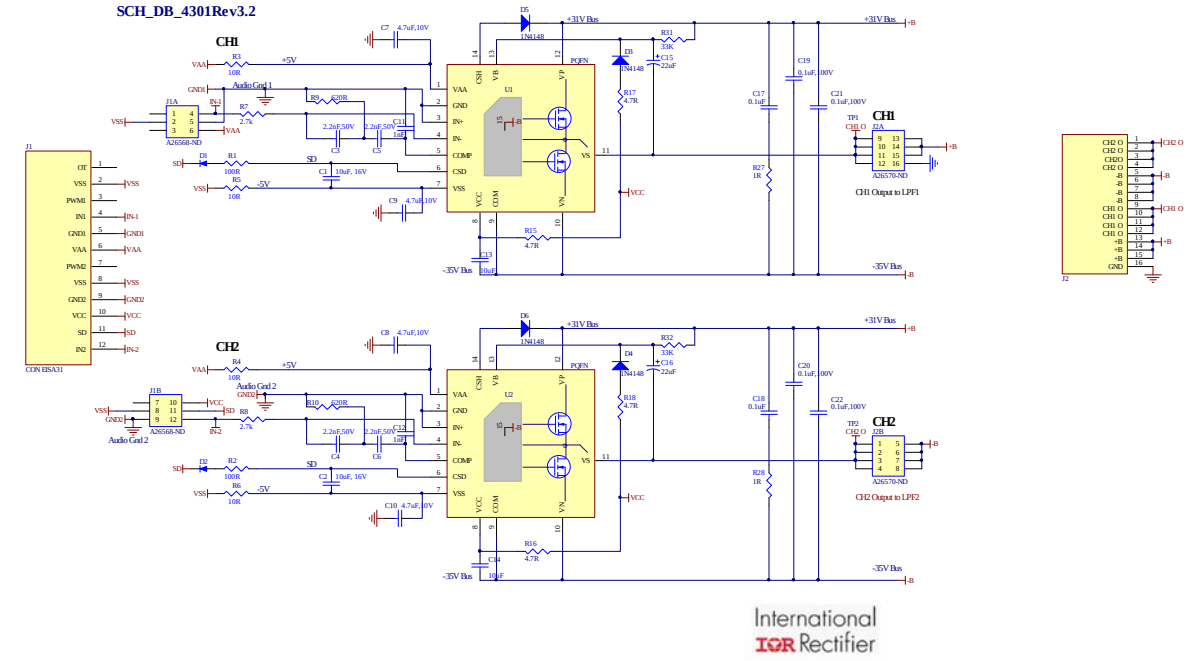


Figure 21

Class D, Mother Board Control Volume and Power Supplies Schematic

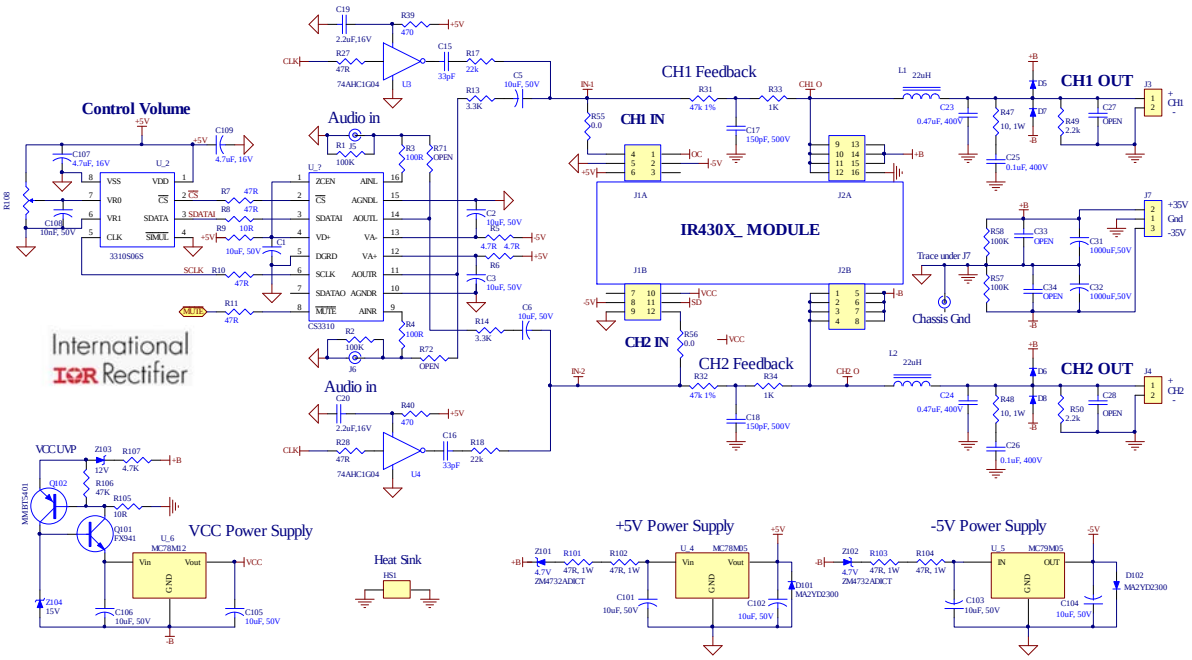


Figure 22

Class D, Mother Board Clock and House Keeping Schematic

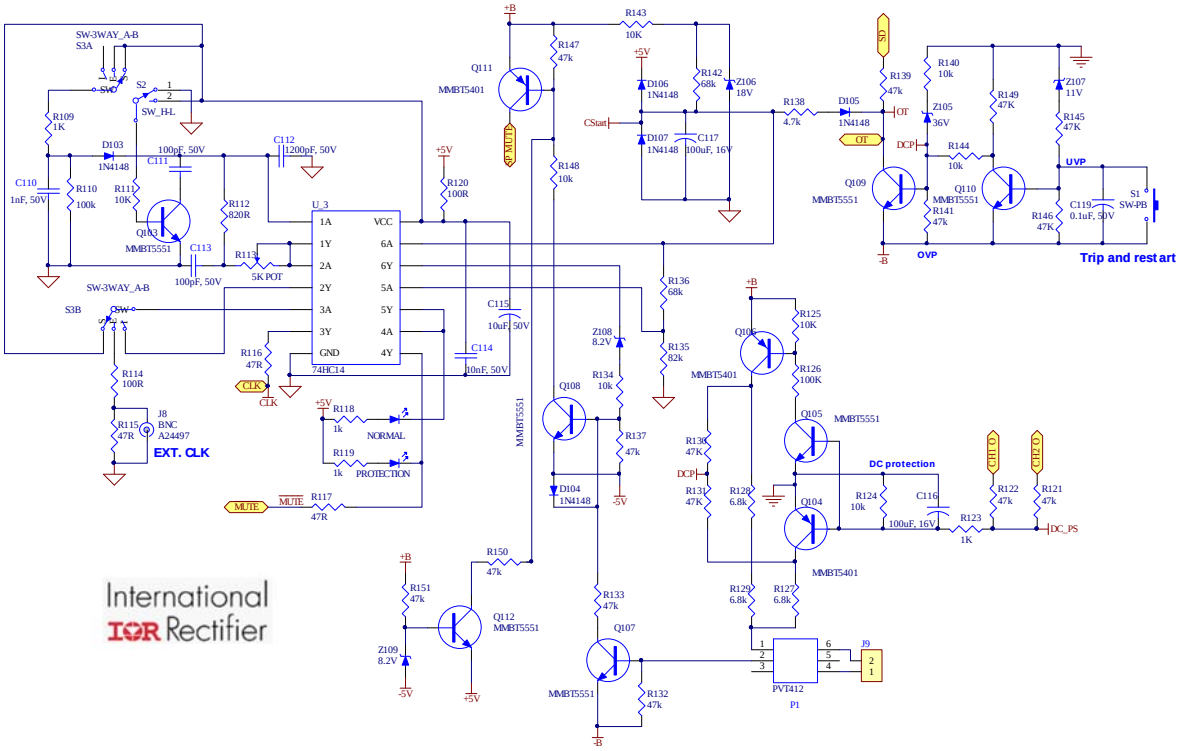


Figure 23

Bill of Materials

IRAUDAMP12 Daughter Board BOM

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-3241or 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

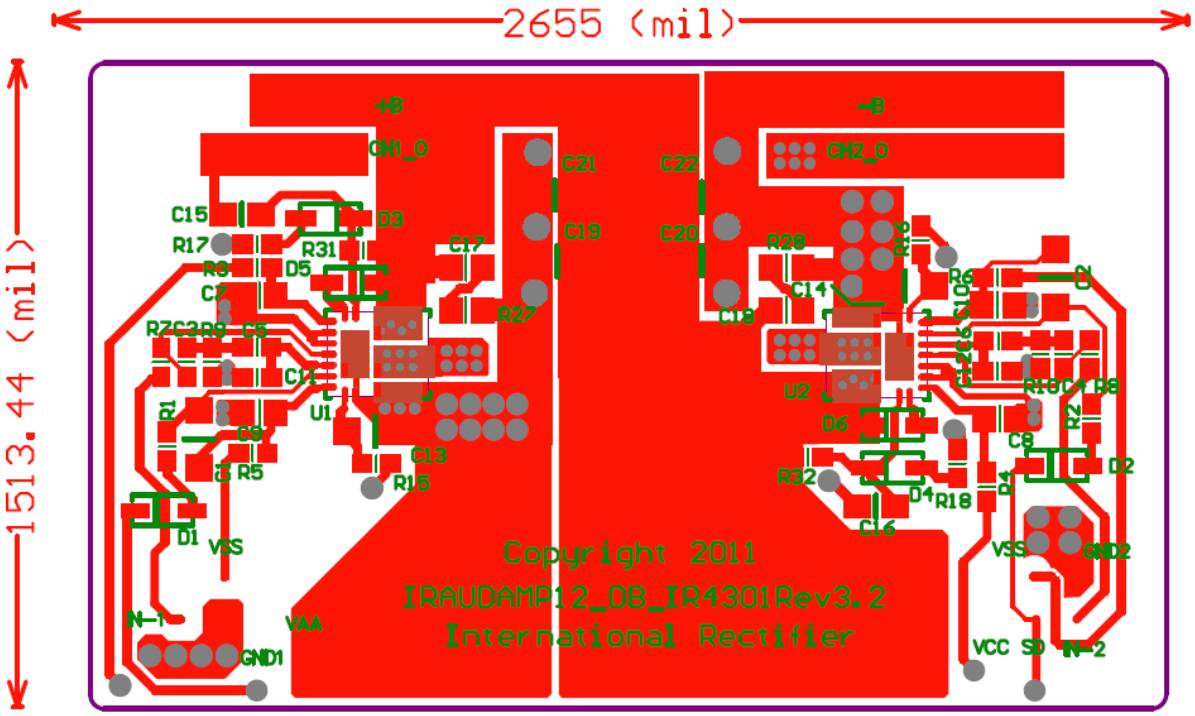


Figure 24

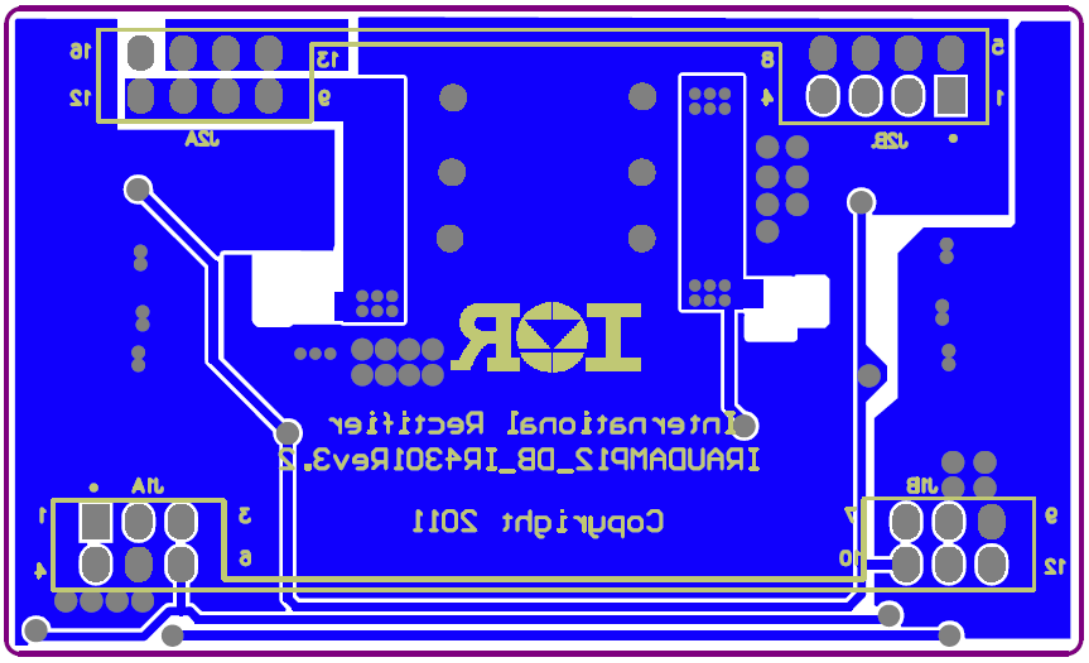


Figure 25

Mother Board

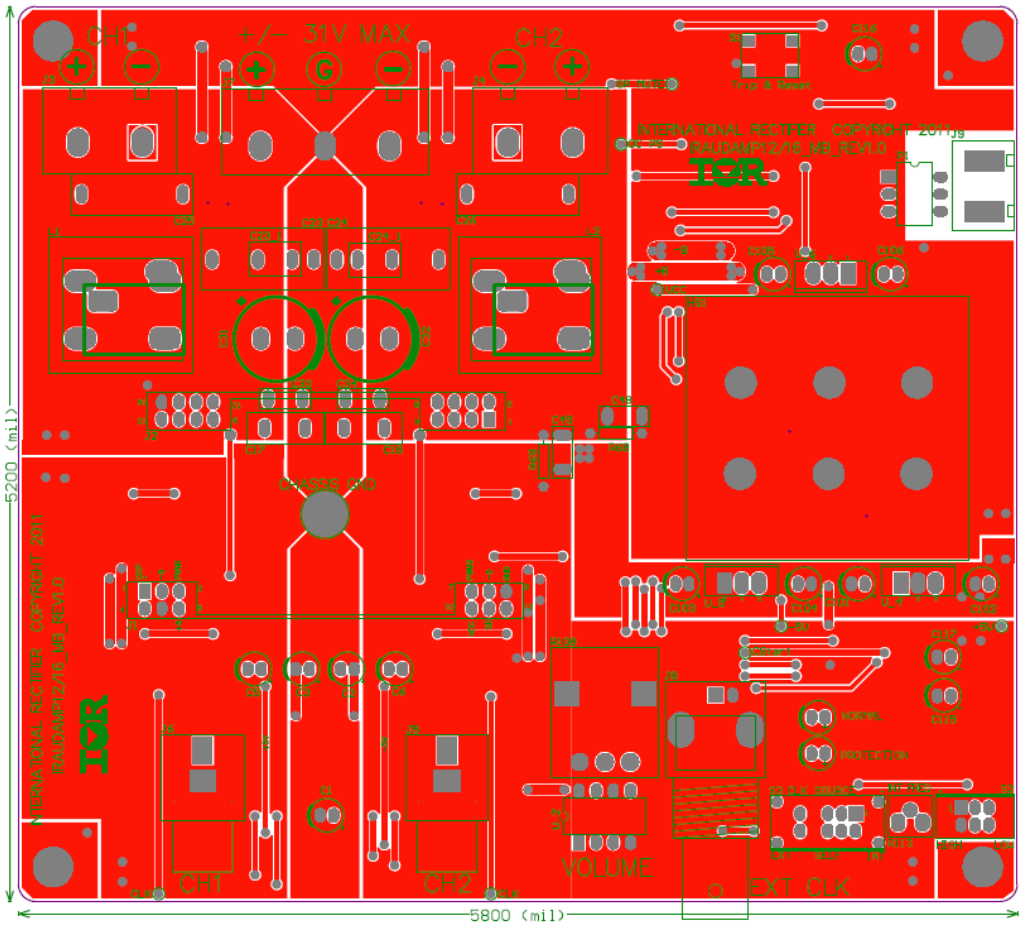


Figure 26

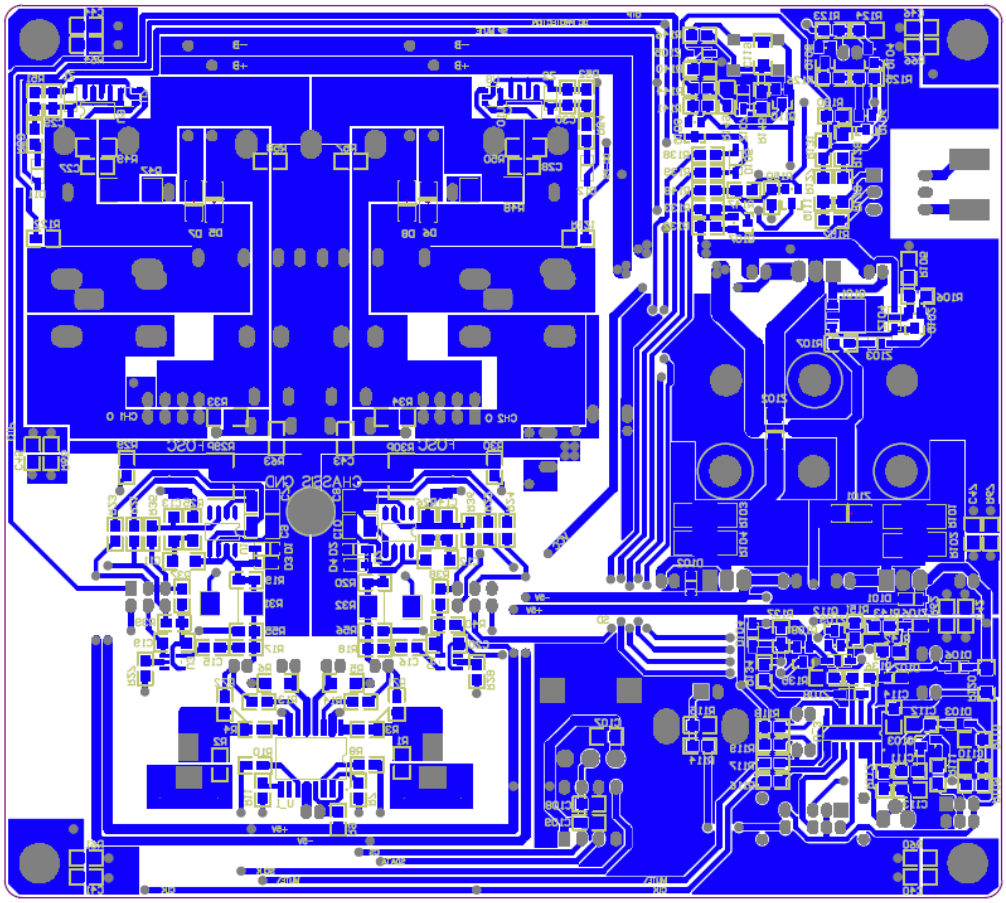


Figure 27

Revision changes descriptions

Revision	Changes description	Date
Rev 1.0	Released	Apr,30 2012

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