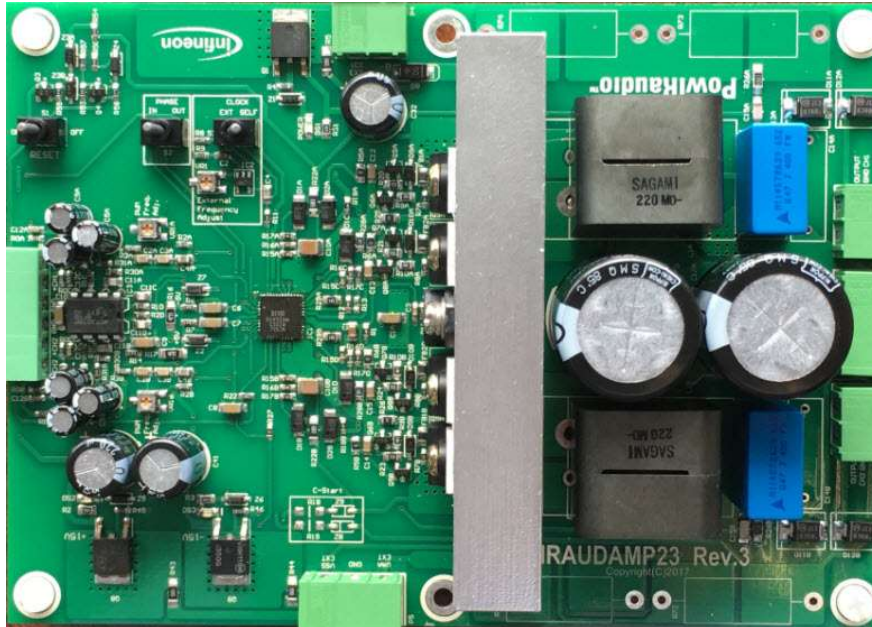


IRAUDAMP23

500 W x 2 channel constant voltage Class D audio amplifier using the IRS2452AM



About this document

Scope and purpose

The IRAUDAMP23 evaluation board is a two-channel, 500 W/ch (100 Vrms, 20 Ω at ± 148.3 V) half-bridge Class D audio power amplifier for high impedance distribution system. This evaluation board demonstrates how to use the IRS2452AM controller IC, implement protection circuits, and design an optimum PCB layout.

Applications

- Constant voltage distribution system
- Installation system
- Paging system

Features

- Output power:
- 500 W x 2 channel (1% THD+N, 100 Vrms or 70 Vrms)
- Multiple protection features:
 - Over-current protection (OCP), high side and low side FETs
 - Over-voltage protection (OVP)
 - Under-voltage protection (UVP), high side and low side FETs
 - Over-temperature protection (OTP)
- PWM modulator:
 - Self-oscillating half bridge topology with optional clock synchronization

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1 Specifications

Table 1 General test conditions

Conditions		Notes/conditions
Supply voltages	$\pm 80\text{ V} \sim \pm 180\text{ V}$	Bipolar power supply
	$\pm 148.3\text{ V}$	Nominal bipolar power supply for 100 Vrms
	$\pm 101\text{ V}$	Nominal bipolar power supply for 70 Vrms
Rated load impedance	$20\ \Omega$	Resistive load
Self-oscillating frequency	325 kHz	No input signal, Adjustable
Voltage gain	37.5 dB	

Table 2 Electrical data

Data	Typical	Notes/conditions
Infineon devices used	IRS2452AM integrated Class D IC	
Modulator	Self-oscillating, second order sigma-delta modulation, analog input	
Output power CH1-2: (1% THD+N)	500 W	1 kHz, 100 Vrms, $R_L=20\ \Omega$
	250 W*	1 kHz, 70 Vrms, $R_L=19.5\ \Omega$
Output power CH1-2: (10% THD+N)	600 W	1 kHz, 100 Vrms, $R_L=20\ \Omega$
	350 W*	1 kHz, 70 Vrms, $R_L=19.5\ \Omega$
Rated load impedance	$20\ \Omega$	100 Vrms output
	$19.5\ \Omega$	70 Vrms output
Idling supply current	$\pm 80\text{ mA}$	No input signal, $\pm 148.3\text{ V}$
THD+N	0.01%	@ 1 kHz, 100 W, $20\ \Omega$
Residual noise	280 μVrms	IHF-A weighted, AES-17 filter
Signal to noise ratio	110 dB	

*Replace output FETs with IPP60R120C7 for 70 Vrms output

2 Connection setup

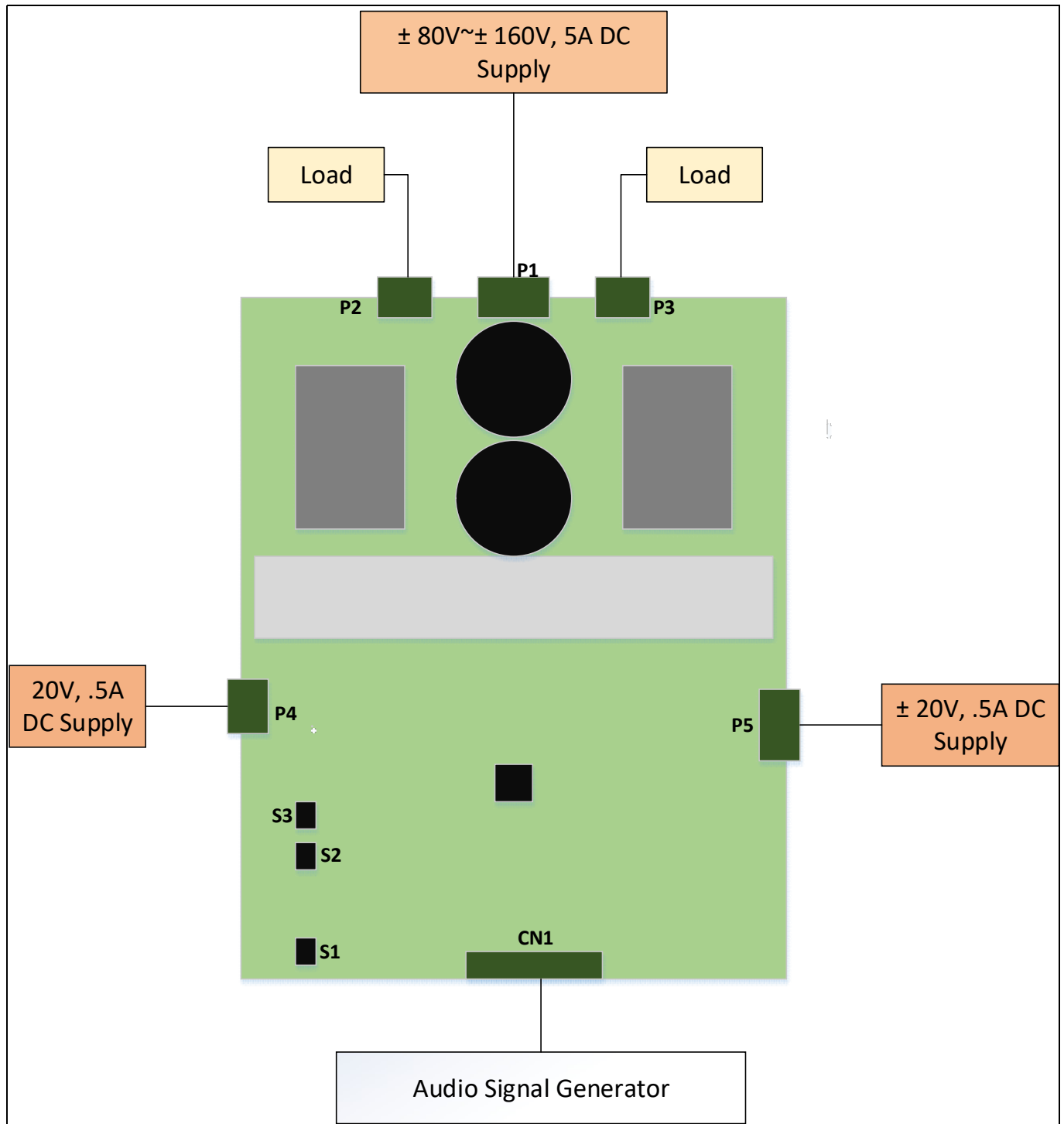


Figure 1 Typical test set-up

3 Connector description

Table 3 Connector description

CH1 IN	CN1	Analog input for CH1
CH2 IN	CN1	Analog input for CH2
POWER	P1	Positive and negative supply (+B / -B)
POWER	P4	Housekeeping supply (VCC)
POWER	P5	Housekeeping supply (VAA,VSS)
CH1 OUT	P2	Output for CH1
CH2 OUT	P3	Output for CH2
RESET	S1	On/off switch
PHASE	S2	Channel in/out phase switch
EXT CLK	S3	External clock sync

Audio precision-setup:

IRAUDAMP23 and Audio Precision shall be connected according to the figure below:

IRAUDAMP23

500 W x 2 channel constant voltage Class D audio amplifier using the IRS2452AM

Connector description

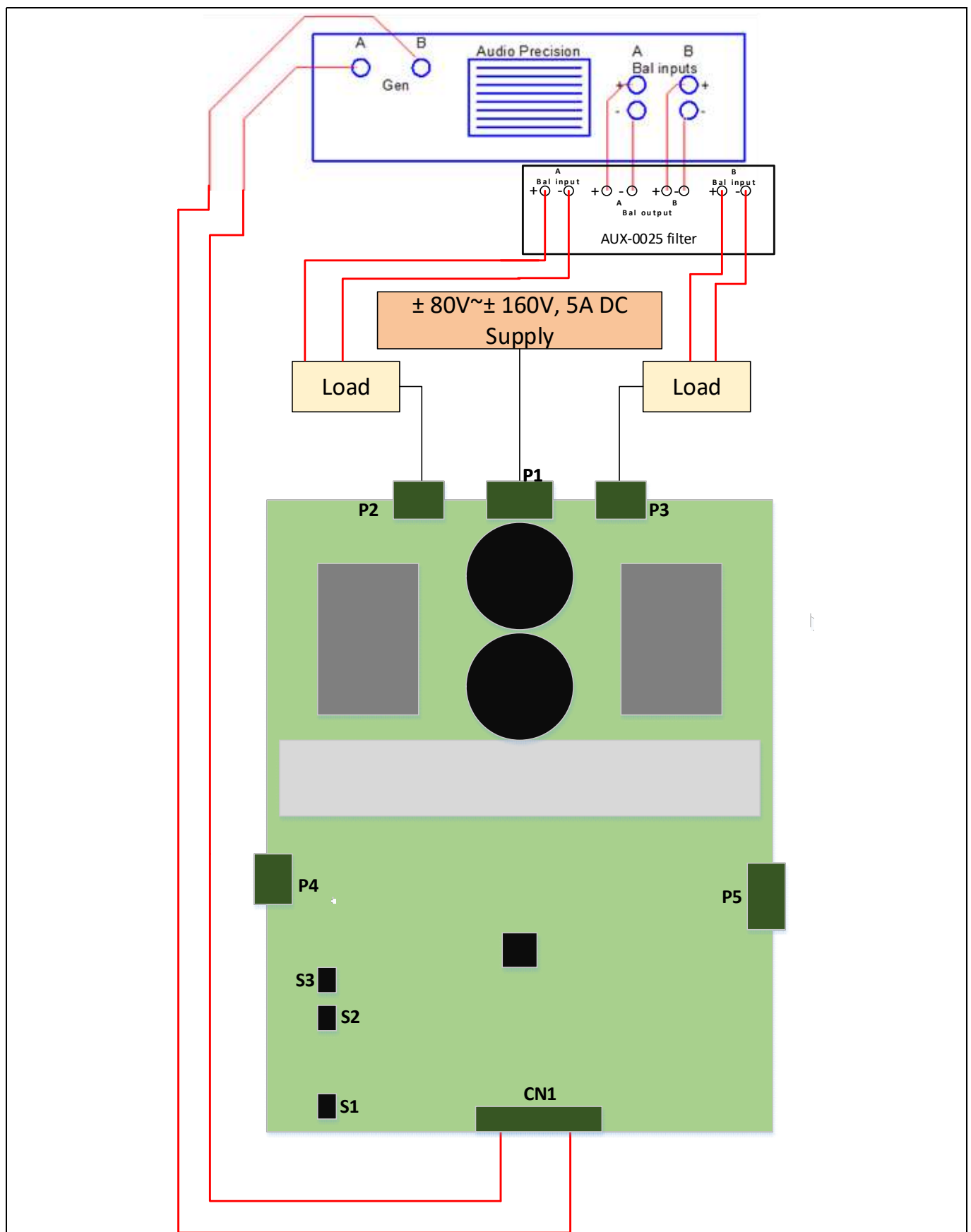


Figure 2 Example figure

Test procedures

4 Test procedures

Test setup:

1. Connect 20 Ω - 250 W dummy loads to the output connectors (P2, P3 as shown on figure 1).
2. Connect the Audio Precision analyzer (AP) signal generator output to CN1. Use Balanced connection with $Z_{out} \leq 20 \Omega$.
3. Initially set the voltages of the dual power supplies to ± 160 V with current limits (CL) to 0.3 A. Set the second external power supplies to 20 V w/ CL of 60 mA, and third dual power supply to ± 20 V w/ CL of 60 mA.
4. Connect the 20 V power supply to P4 = Vcc ext, -B, and ± 20 V dual power supply to P5 = Vaa, Gnd, Vss.
5. Connect the power to P1 = +B, Gnd, -B (± 160 V, current limit: 300 mA).
6. Make sure switch S1 is in the OFF position.

Power-up sequence:

1. Turn on the 20 V power supply, then turn on the ± 20 V power supply at the same time, lastly turn on the ± 160 V power supply at the same time.
2. Flip S1 switch to the ON position.
3. The power supply should read ± 160 V and +70 mA (± 5 mA), -70 mA (± 5 mA).
4. Blue LED's light up (normal) when all power supplies are on.

Functionality audio tests:

1. With AP no filter (> 500 kHz), monitor the channel's switching frequency on the AP's analog analyzer.
2. Set S3 to self (self-oscillating) position.
3. Adjust VR1A and VR1B on the board to self-oscillating frequency of $325 \text{ kHz} \pm 15 \text{ kHz}$.
4. Set AP's analog analyzer to 20 kHz AES17 filter.
5. Connect audio signal from AP to CN1.
6. Sweep the audio signal voltage from 15 mV_{RMS} to 2 V_{RMS}.
7. Use the balanced-floating signal from the generator outputs (AP).
8. Use the balanced inputs taken across output terminals, P2 and P3.
9. Connect AP frame ground to GND at terminal P1.
10. Run AP test as shown in Fig 3 below.

External clock function:

1. With AP no filter (> 500 kHz), monitor the channel's switching frequency on the AP's analog analyzer.
2. Set S3 to self (self-oscillating) position.
3. Adjust VR1A and VR1B on the board to self-oscillating frequency to 20-30% higher than desired external clock.
4. Set S3 to Ext (external clock) position in order to enable the on board clock oscillator.
 - a. Adjust VR1 on the board to change the external clock frequency.
5. Set AP's analog analyzer to 20 kHz AES17 filter.
6. Connect audio signal from AP to CN1.
7. Sweep the audio signal voltage from 15 mV_{RMS} to 2 V_{RMS}.

Test procedures

Power-down sequence:

1. Flip S1 switch to the off position.
2. Turn off the ± 160 V power supply, then turn off the 20 V power supply, lastly turn off ± 20 V power supply at the same time.
3. Blue LED's turn off when housekeeping power supplies are off.

5 Performance and test graphs

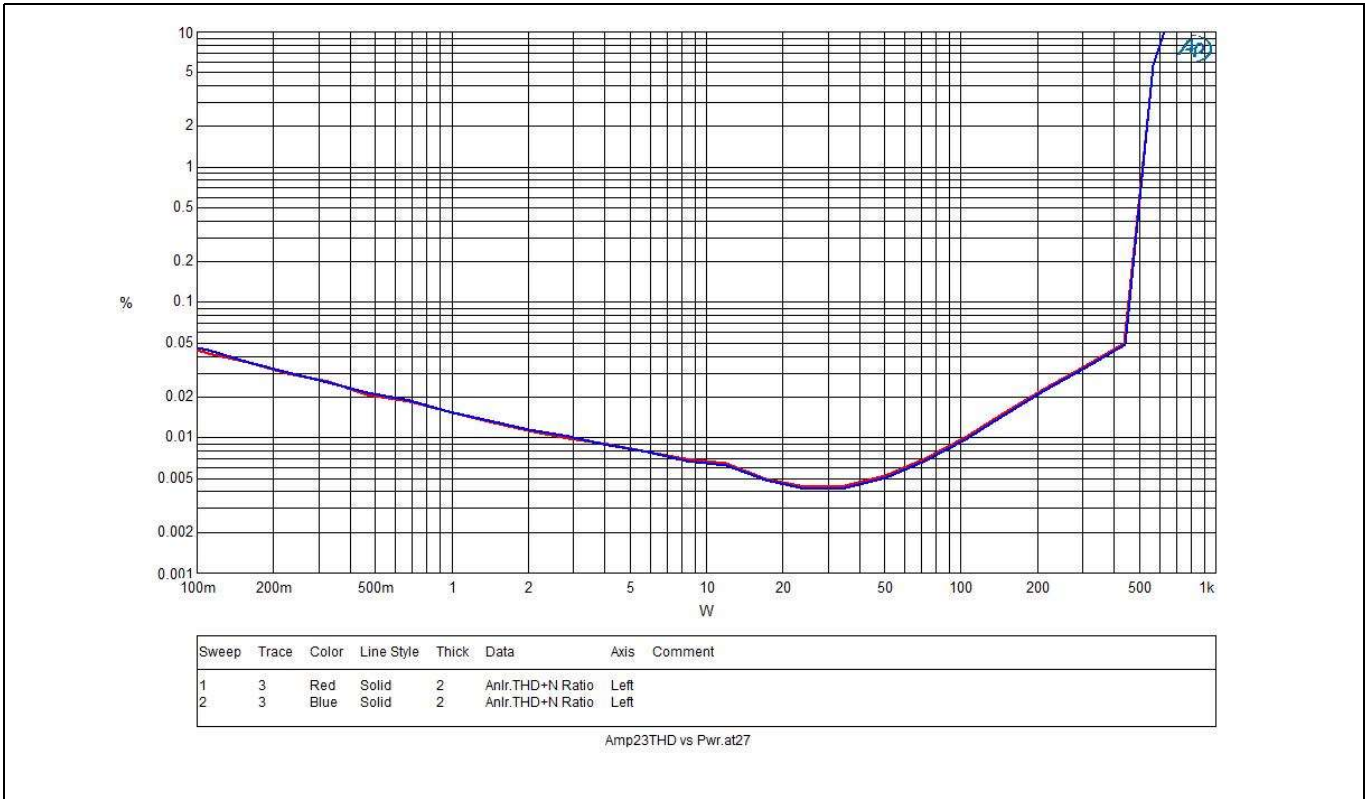


Figure 3 Power vs. THD+N

Test conditions:

$V_{Bus} = \pm 148.3 \text{ V}$, input signal = 1 kHz, load impedance = 20 ohms, $F_{PWM} = 325 \text{ kHz}$

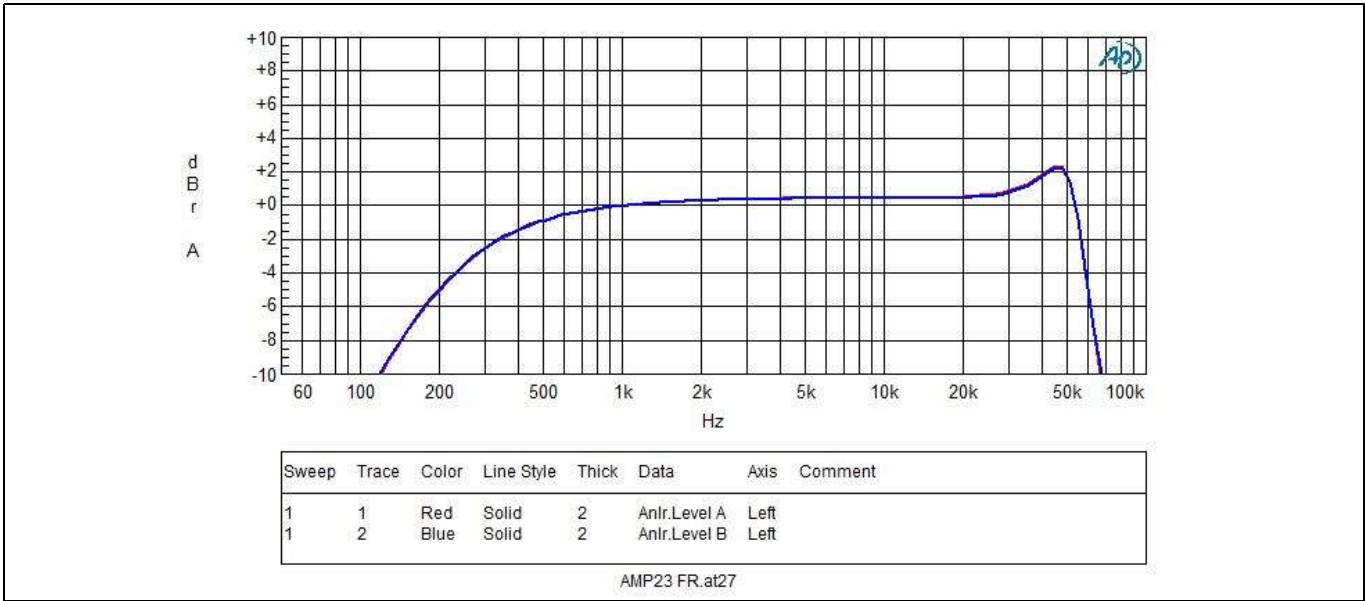


Figure 4 Frequency response

Test conditions:

$V_{Bus} = \pm 160$ V, set output = 1 W, load impedance = 23 ohms

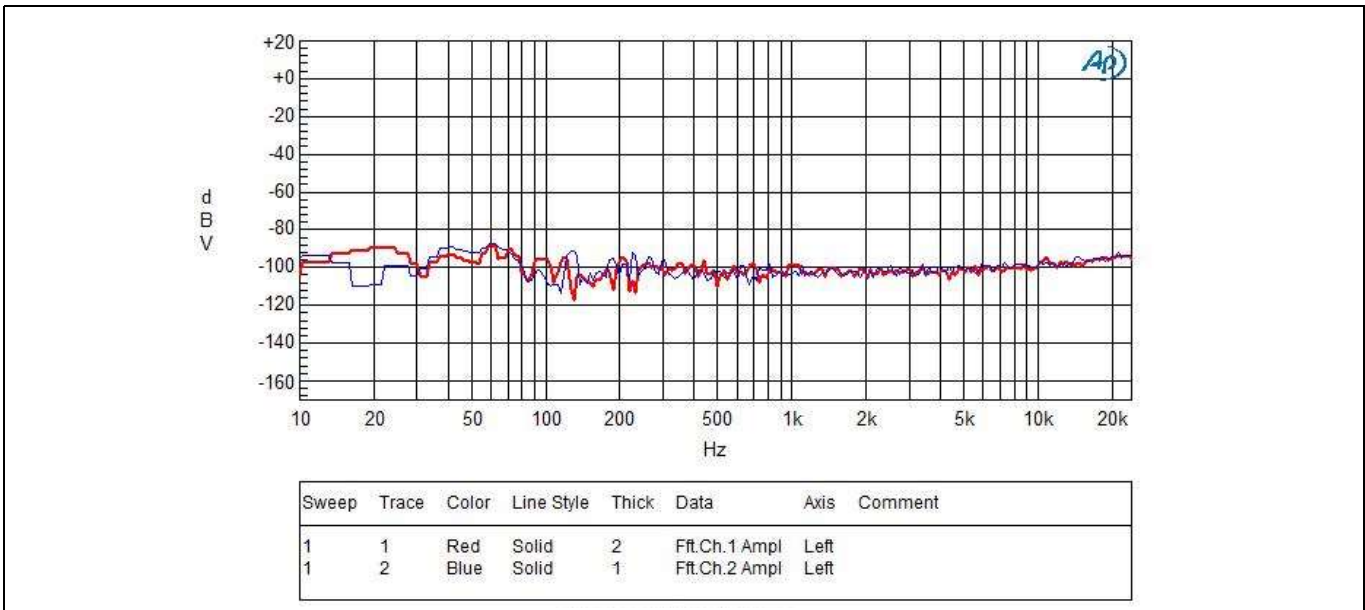


Figure 5 Noise floor

Test conditions:

$V_{Bus} = \pm 160$ V, load impedance = 23 ohms, no input signal

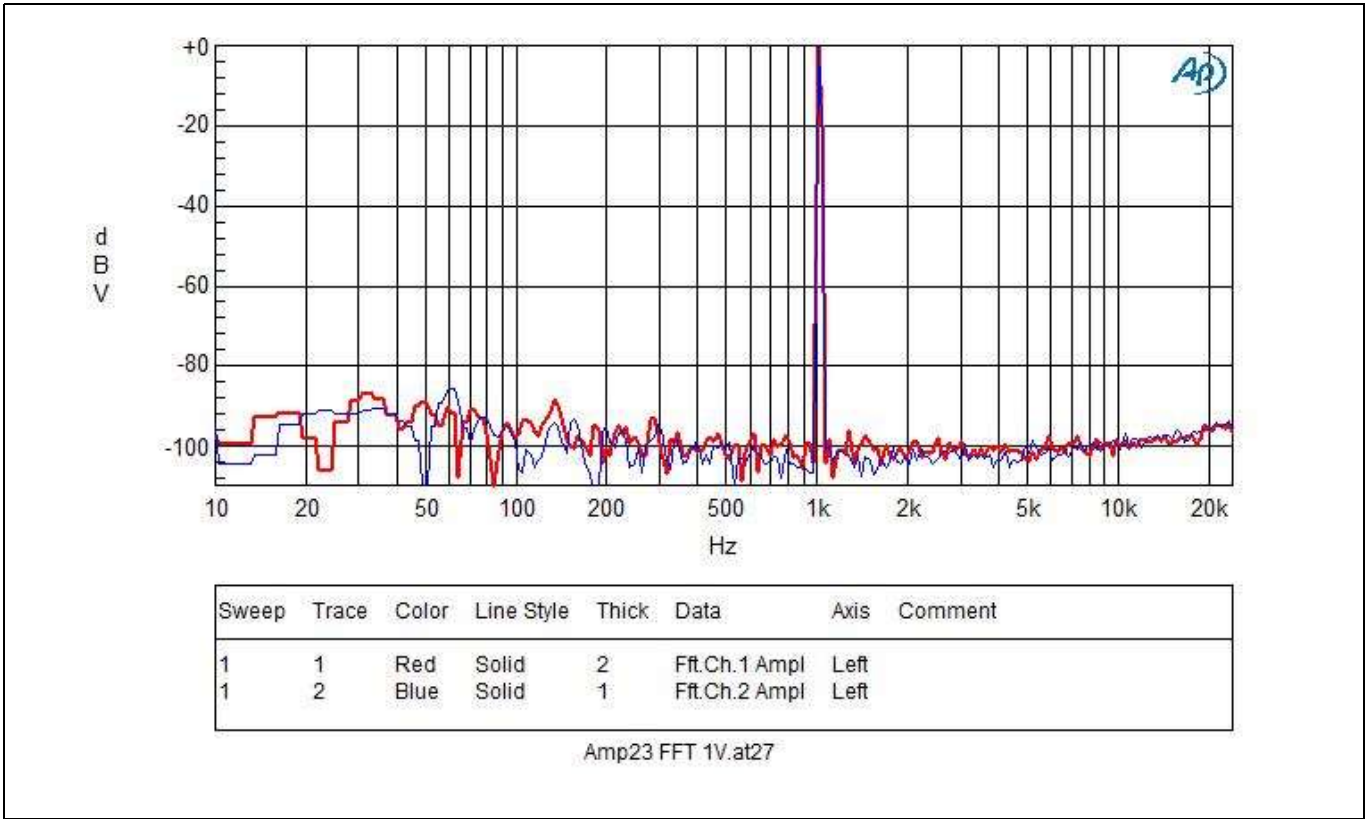


Figure 6 Noise floor with 1 V_{RMS} output

Test conditions:

$V_{Bus} = \pm 160 \text{ V}$, output = 1 V_{rms} @ 1 kHz, load impedance = 23 ohms

6 Thermal information

6.1 Peak power duration thermal information

Test conditions:

1 kHz sine wave signal input; both channels driven, $F_{sw}=325$ kHz

Table 4 Peak power

Load Z	1% THD P_o (W)	Duration
20 Ω	500	>1 min no thermal shutdown at $T_{HEATSINK}=100^{\circ}\text{C}$

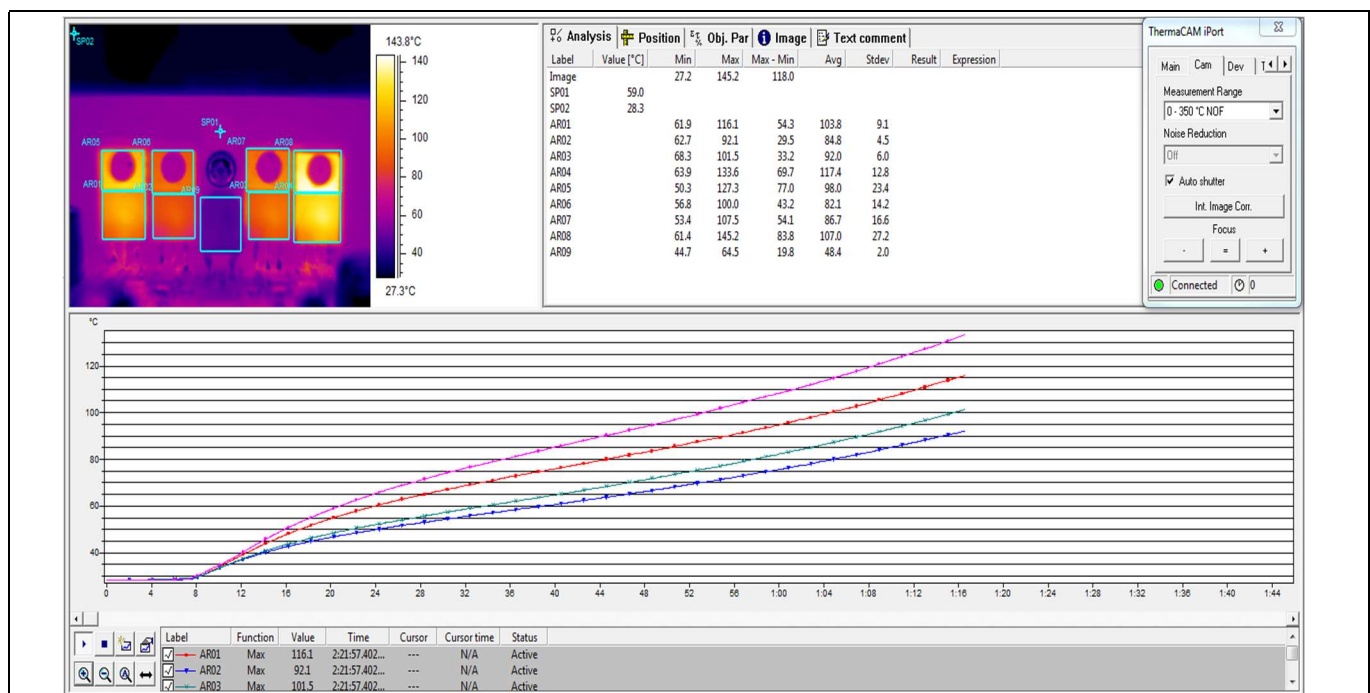


Figure 7 Max temp 145.2°C at 1 minute, room = 27°C (pink: ch2 highside FET, red: ch1 highside FET, green: ch2 lowside FET, blue: ch1 lowside FET)

IRAUDAMP23

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Thermal information

6.2 Heatsink installation

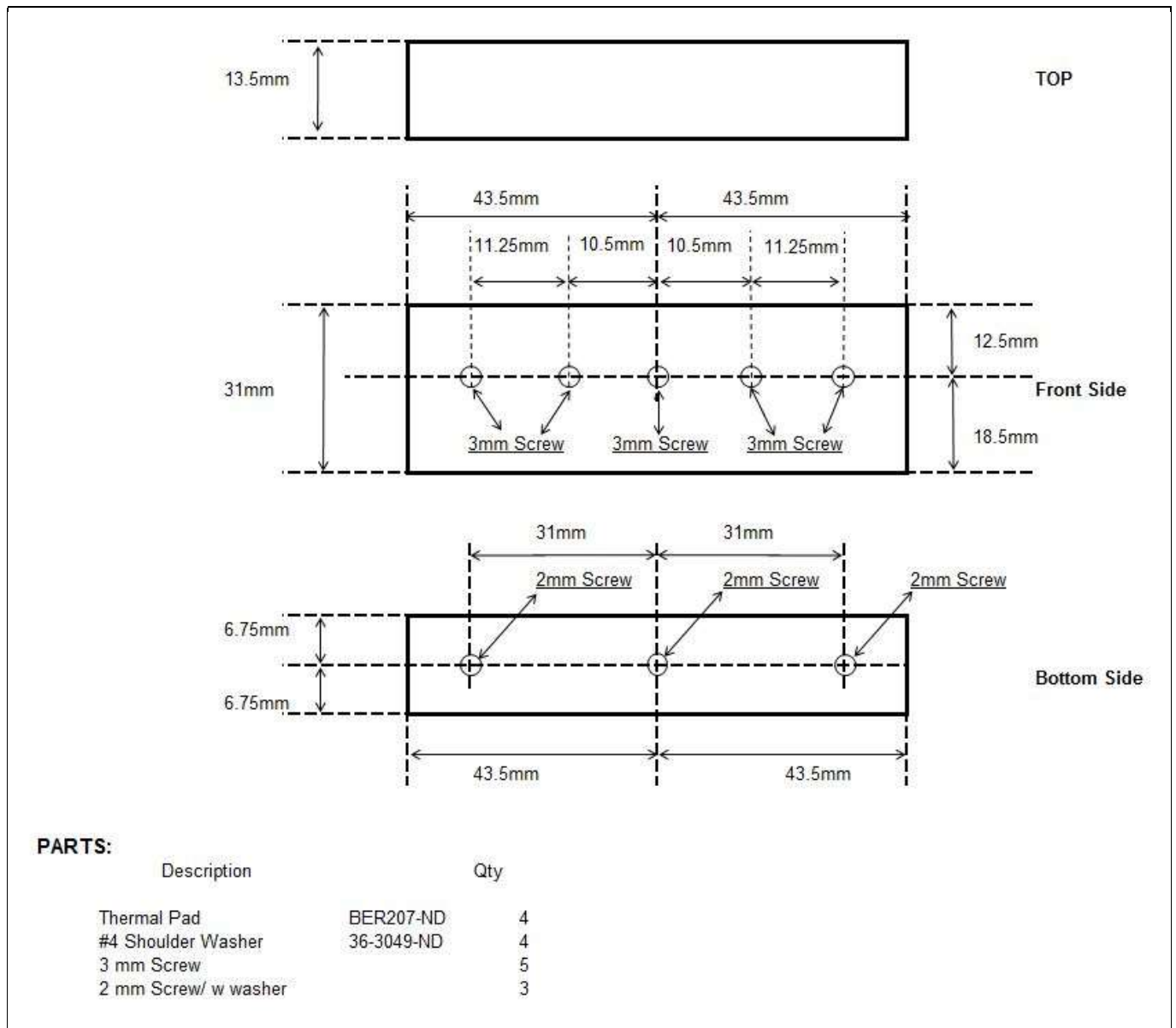


Figure 8 Heatsink installation

IRAUDAMP23

500 W x 2 channel constant voltage Class D audio amplifier using the IRS2452AM

Schematic

7 Schematic

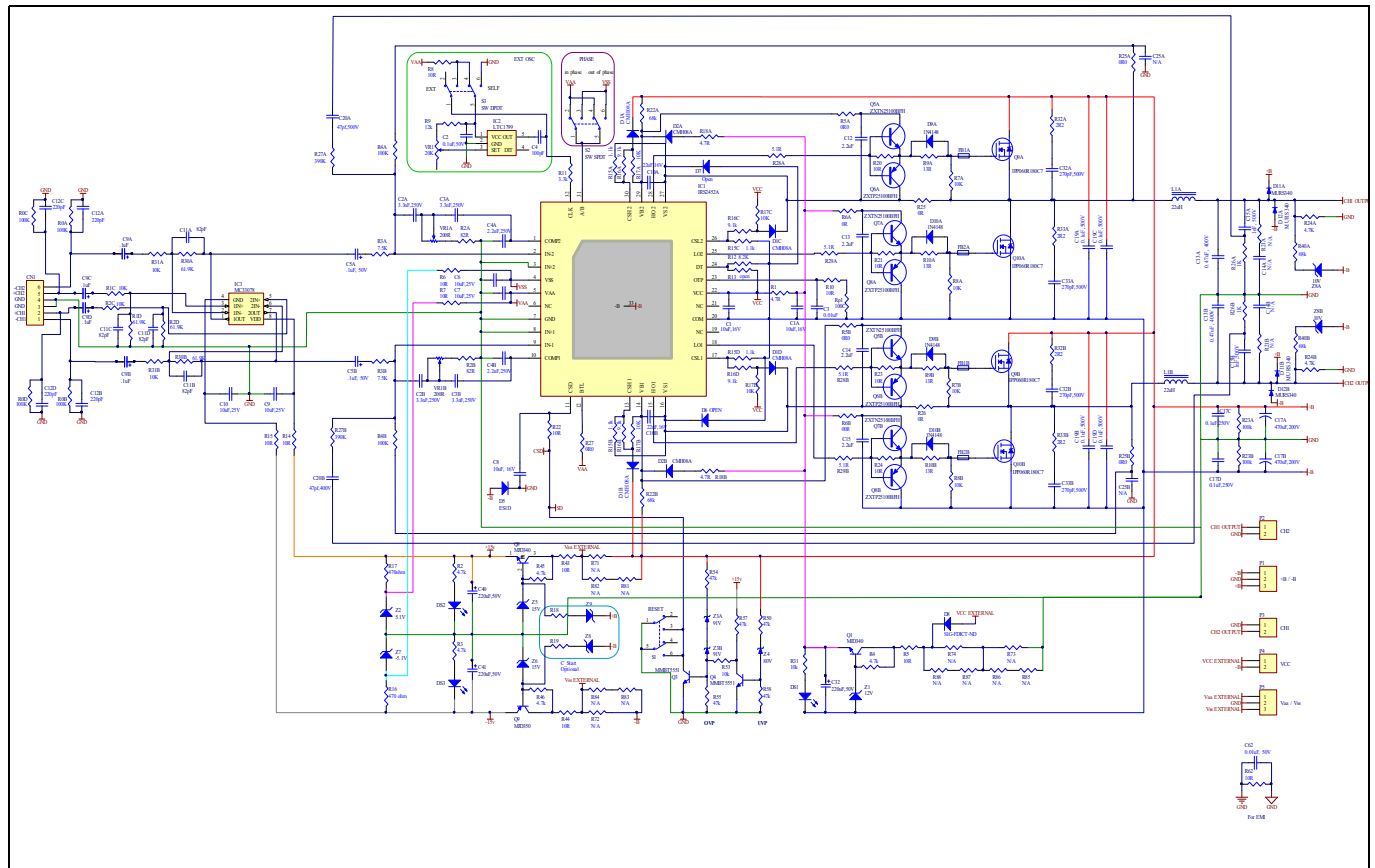


Figure 9 Schematic of IRAUDAMP23 Class D audio amplifier featuring IRS2452AM and IPP60R180C7

7.1 MOSFET selection guide

Table 5

MOSFET	70 V	100 V
IPP60R120C7	500 W	500 W
IPP60R180C7	250 W	500 W

8 IRAUDAMP23 Bill of Materials

Table 6

No	Part Number	Designator	Description	Quantity	Vendor
1	493-14485-ND	C5A, C5B, C9A, C9B, C9C, C9D	CAP ALUM 0.1 μ F 10% 50 V RADIAL	2	Digikey
2	445-7644-1-ND	C1	CAP CER 10 μ F 16 V X5R 0805	1	Digikey
3	445-7706-1-ND	C1A	CAP CER 10 μ F 25 V X7R 1206	1	Digikey
4	490-1519-1-ND	C2	CAP CER 0.1 μ F 50 V X7R 0603	1	Digikey
5	445-15549-1-ND	C2A, C2B, C3A, C3B	CAP CER 3300 pF 250 V C0G 0805	4	Digikey
6	445-2327-1-ND	C4A, C4B	CAP CER 2200 pF 250 V C0G 0805	2	Digikey
7	445-9274-1-ND	C15A, C15B	CAP CER 1000 pF 500 V C0G 1206	2	Digikey
8	490-1512-1-ND	C3	CAP CER 10000 pF 50 V X7R 0603	1	Digikey
9	399-7981-1-ND	C4	CAP CER 100 pF 50 V X7R 0805	1	Digikey
10	445-7706-1-ND	C6, C7, C9, C10, C1A	CAP CER 10 μ F 25 V X7R 1206	5	Digikey
11	490-3383-1-ND	C8	CAP CER 10 μ F 16 V Y5V 1206	1	Digikey
12	445-1382-1-ND	C12, C13, C14, C15	CAP CER 2.2 μ F 25 V X7R 1206	4	Digikey
13	445-3945-1-ND	C10A, C10B	CAP CER 22 μ F 16 V X7R 1210	2	Digikey
14	478-1315-1-ND	C11A, C11B, C11C, C11D	CAP CER 82 pF 50 V C0G/NP0 0805	4	Digikey
15	490-1483-1-ND	C12A, C12B, C12C, C12D	CAP CER 220 pF 50 V X7R 0603	4	Digikey
16	495-1315-ND	C13A, C13B	CAP FILM 0.47 μ F 5% 400 V _{DC} RADIAL	2	Digikey
18	565-2731-ND	C17A, C17B	CAP ALUM 470 μ F 20% 200 V SNAP	2	Digikey
19	1276-3084-1-ND	C17C, C17D	CAP CER 0.1 μ F 250 V X7R 1206	2	Digikey
20	445-2300-1-ND	C19A, C19B, C19C, C19D	CAP CER 0.1 μ F 630 V X7R 1812	4	Digikey
21	399-7203-1-ND	C20A, C20B	CAP CER 47 pF 500 V C0G/NP0 1206	2	Digikey
23	565-1111-ND	C32, C40, C41	CAP ALUM 220 μ F 20% 50 V RADIAL	3	Digikey
24	490-1511-1-ND	C62	CAP CER 10000 pF 50 V X7R 0603	1	Digikey
25	399-15036-1-ND	C32A, C32B, C33A, C33B	CAP CER 270 pF 500 V C0G/NP0 0805	4	Digikey

IRAUDAMP23 Bill of Materials

No	Part Number	Designator	Description	Quantity	Vendor
26	277-2427-ND	CN1	TERM BLOCK HDR 6POS 90DEG 3.5 mm	1	Digikey
27	277-2414-ND	CN1	TERM BLOCK PLUG 6POS STR 3.5 mm	1	Digikey
29	CMH08A(TE12LQM)CT-ND	D1A, D1B, D1C, D1D, D2A, D2B, D5,	DIODE GEN PURP 400 V 2 A MFLAT	9	Digikey
30	160-1419-1-ND	DS1, DS2, DS3	LED BLUE CLEAR 0805 SMD	3	Digikey
31	1N4148WDICT-ND	D9A, D9B, D10A, D10B	DIODE GEN PURP 100 V 300 mA SOD123	4	Digikey
32	MURS360BT3GOSCT-ND	D11A, D11B, D12A, D12B	DIODE GEN PURP 600 V 3 A SMB	4	Digikey
33	S1G-FDICT-ND	D8	DIODE GEN PURP 400 V 1 A SMA	1	Digikey
34	490-1053-1-ND	FB1A, FB1B, FB2A, FB2B	FERRITE BEAD 60 OHM 0805 1LN	4	Digikey
35	IRS2452AM	IC1	IC CONTROLLER GAN 32 PQFN	1	Digikey
36	LTC1799CS5#TRMPBFCT- ND	IC2	IC OSC SILICON PROG TSOT23-5	1	Digikey
37	MC33078PGOS-ND	IC3	IC OPAMP GP 16 MHz 8DIP	1	Digikey
38	7G23A-220M-R	L1A, L1B	Class D inductor, 22 μ H	2	Inductors Inc.
39	A98249-ND	P1, P5	TERM BLOCK HDR 3POS 90DEG 5 mm	2	Digikey
40	282805-3-SI-ND	P1, P5	TERM BLOCK PLUG 3POS 90DEG 5 mm	2	Digikey
41	A98248-ND	P2, P3, P4	TERM BLOCK HDR 2POS 90DEG 5 mm	3	Digikey
42	A98241-ND	P2, P3, P4	TERM BLOCK PLUG 2POS STR 5 mm	3	Digikey
43	MJD340TFCT-ND	Q1, Q8	TRANS NPN 300 V 0.5 A DPAK	2	Digikey
44	MMBT5551LT1GOSCT-ND	Q3, Q4	TRANS NPN 160 V 0.6 A SOT23	2	Digikey
45	ZXTN25100BFHCT-ND	Q5A, Q5B, Q7A, Q7B	TRANS NPN 100 V 3 A SOT23- 3	4	Digikey
46	ZXTP25100BFHCT-ND	Q6A, Q6B, Q8A, Q8B	TRANS PNP 100 V 2 A SOT23- 3	4	Digikey
47	MJD350TFCT-ND	Q9	TRANS PNP 300 V 0.5 A DPAK	1	Digikey
48	IPP60R180C7	Q9A, Q9B, Q10A, Q10B	MOSFET N-CH 600 V 13 A TO220-3	4	Digikey
49	RHM100KGCT-ND	R0A, R0B, R0C, R0D	RES SMD 100 k Ω 5% 1/10 W 0603	4	Digikey

IRAUDAMP23 Bill of Materials

No	Part Number	Designator	Description	Quantity	Vendor
50	RHM4.7GCT-ND	R1, R18A, R18B	RES SMD 4.7 Ω 5% 1/10 W 0603	3	Digikey
51	RHM4.7KARCT-ND	R2, R3	RES SMD 4.7 k Ω 5% 1/8 W 0805	2	Digikey
52	P82.0HCT-ND	R2A, R2B	RES SMD 82 Ω 1% 1/10 W 0603	2	Digikey
53	P7.5KGTR-ND	R3A, R3B	RES SMD 7.5 k Ω 5% 1/10 W 0603	2	Digikey
54	RHM100KCRCT-ND	R4A, R4B, R23A, R23B	RES SMD 100 k Ω 1% 1/8 W 0805	4	Digikey
55	408-1869-1-ND	R5, R43, R44	RES SMD 10 Ω 0.5% 1 W 1206	3	Digikey
56	RHM10KGCT-ND	R1C, R2C, R7A, R7B, R8A, R8B, R17A, R17B, R17C, R17D, R31A, R31B, R53, R62	RES SMD 10 k Ω 5% 1/10 W 0603	14	Digikey
57	RMCF0805ZT0R00CT-ND	R27, R5A, R5B, R6A, R6B, R25, R26	RES SMD 0 Ω JUMPER 1/8 W 0805	7	Digikey
58	RMCF1206ZT0R00CT-ND	R25A, R25B	RES SMD 0 Ω JUMPER 1/4 W 1206	2	Digikey
59	RHM10GCT-ND	R6, R7, R8, R10, R14, R15, R22	RES SMD 10 Ω 5% 1/10 W 0603	7	Digikey
60	RMCF0603JT22K0CT-ND	R9	RES SMD 22 k Ω 5% 1/10 W 0603	1	Digikey
61	RMCF0805JT10R0DKR-ND	R20, R21, R23, R24	RES SMD 10 Ω 5% 1/8 W 0805	4	Digikey
62	P13ACT-ND	R9A, R9B, R10A, R10B	RES SMD 13 Ω 5% 1/8 W 0805	4	Digikey
63	RNCP1206FTD1K00CT-ND	R26A, R26B	RES SMD 1 k Ω 1% 1/2 W 1206	2	Digikey
64	RHM3.3KGCT-ND	R11,	RES SMD 3.3 k Ω 5% 1/10 W 0603	1	Digikey
65	RG16P2.21KBCT-ND	R15A, R15B, R15C, R15D	RES SMD 2.21 k Ω 5% 1/10 W 0603	4	Digikey
66	P7.5KGCT-ND	R16A, R16B, R16C, R16D	RES SMD 7.5 k Ω 5% 1/10 W 0603	4	Digikey
67	P470ECT-ND	R16,R17	RES SMD 470 Ω 5% 1/4 W 1206	2	Digikey
69	Open	R13		0	N/A
70	RHM8.2KCGCT-ND	R12	RES SMD 8.2 k Ω 5% 1/10 W 0603	1	Digikey
72	P5.1ACT-ND	R28A, R28B, R29A, R29B	RES SMD 5.1 Ω 5% 1/8 W 0805	4	Digikey
77	RMCF1206JT68K0CT-ND	R22A, R22B, R40A, R40B	RES SMD 68 k Ω 5% 1/4 W 1206	4	Digikey
78	RHC2512FT4K70CT-ND	R24A, R24B	RES SMD 4.7 k Ω 1% 2 W 2512	2	Digikey
79	RHM61.9KCLCT-ND	R1D, R2D, R30A, R30B	RES SMD 61.9 k Ω 1% 1/10 W 0603	4	Digikey

IRAUDAMP23 Bill of Materials

No	Part Number	Designator	Description	Quantity	Vendor
80	RMCF0805JT10K0CT-ND	R31	RES SMD 10 kΩ 5% 1/8 W 0805	1	Digikey
81	RHM4.7KGCT-ND	R4, R45, R46	RES SMD 4.7 kΩ 5% 1/10 W 0603	3	Digikey
82	RHM47KGCT-ND	R50, R54, R55, R57, R58	RES SMD 47 kΩ 5% 1/10 W 0603	5	Digikey
83	RPC2512JT2R20CT-ND	R32A,R32B, R33A, R33B	RES SMD 2.2 Ω 5% 1.5 W 2512	4	Digikey
84	P390KACT-ND	R27A, R27B	RES SMD 390 kΩ 5% 1/8 W 0805	2	Digikey
85	317-1318-ND	Rp1	THERMOSTAT 100 DEG C NC 2SIP	1	Digikey
86	360-1758-ND	S1, S2	SWITCH TOGGLE SPDT 0.4 VA 28 V	2	Digikey
87	360-2791-ND	S3	SWITCH TOGGLE DPDT 0.4 VA 28 V	1	Digikey
88	ST32ETA103CT-ND	VR1	TRIMMER 10 kΩ 0.125 W SMD	1	Digikey
89	ST32ETA201CT-ND	VR1A, VR1B	TRIMMER 200 Ω 0.125 W SMD	2	Digikey
90	BZT52C1213-FDICT-ND	Z1	DIODE ZENER 12 V 500 mW SOD123	1	Digikey
91	MMSZ5270BT1GOSCT-ND	Z3A, Z3B	DIODE ZENER 91 V 500 mW SOD123	2	Digikey
92	MMSZ5267BT1GOSCT-ND	Z4,	DIODE ZENER 75 V 500 mW SOD123	1	Digikey
94	MMSZ5245BT1GOSCT-ND	Z5, Z6	DIODE ZENER 15 V 500 mW SOD123	2	Digikey
95	MMSZ5231BT1GOSCT-ND	Z2, Z7	DIODE ZENER 5.1 V 500 mW SOD123	2	Digikey
96	MMSZ4697-E3-08CT-ND	Z8A, Z8B	DIODE ZENER 10 V 500 mW SOD123	2	Digikey

9 PCB specifications

- Two layer SMT PCB with through holes
- 1/16 thickness
- 2/0 oz. Cu
- FR4 material
- 20 mil lines and spaces
- Solder mask to be green enamel EMP110 DBG (CARAPACE) or Enthone Endplate DSR-3241 or equivalent
- Silk screen to be white epoxy non conductive per IPC-RB 276 standard
- All exposed copper must finished with tin-lead Sn 60 or 63 for 100u inches thick
- Tolerance of PCB size shall be 0.010 -0.000 inches
- Tolerance of all holes is $-.000 + 0.003$ "
- PCB acceptance criteria as defined for class II PCB'S standards.

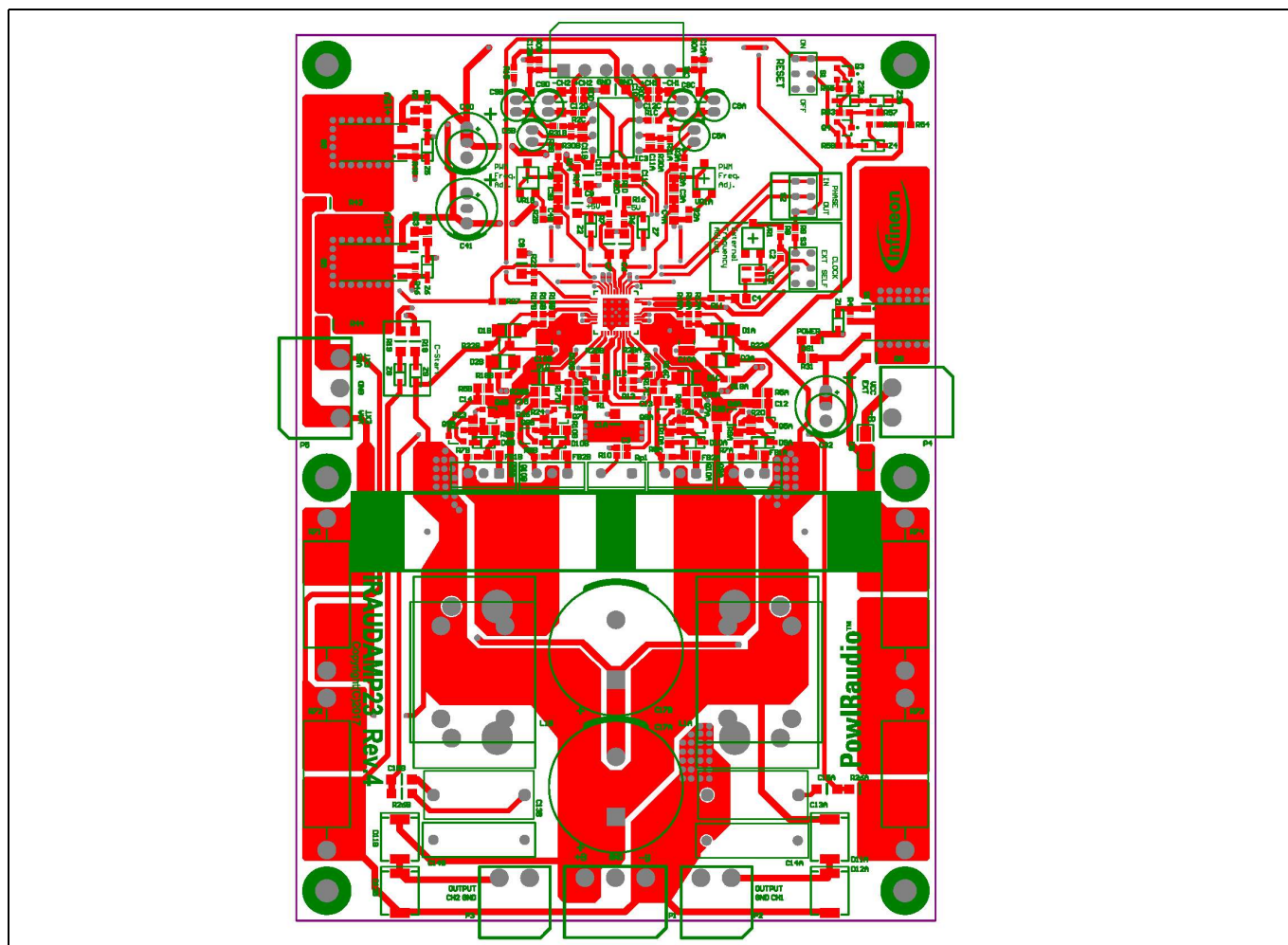


Figure 10 Top layer

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

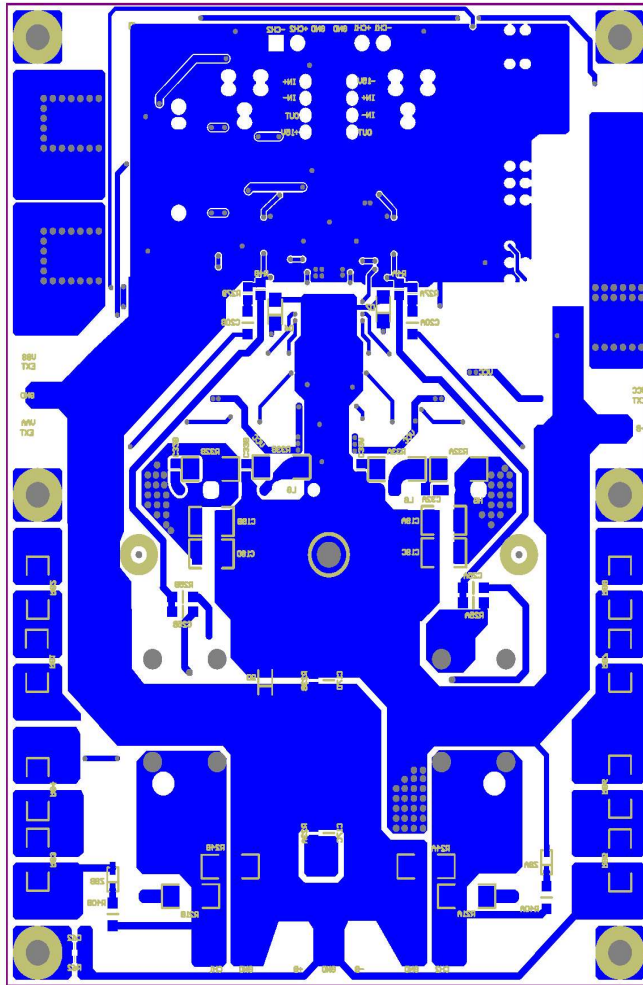


Figure 11 **Bottom layer**

Revision history

Document version	Date of release	Description of changes

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