

EVAL_AUDAMP25

MA5332 evaluation board



About this document

Scope and purpose

The EVAL_AUDAMP25 MA5332 evaluation board is a dual-channel, 200 W/ch (4 Ω at ± 36.5 V; with heatsink) half-bridge class D audio power amplifier for Hi-Fi audio systems. This evaluation board demonstrates how to use the MA5332 IC, implement protection circuits, and design an optimum PCB layout using an Infineon 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 dual-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:
 - 200 W x 2 channels (10 percent THD+N, 4 Ω at ± 36.5 V)
- Multiple protection features:
 - Overcurrent protection (OCP), high-side and low-side
 - Overvoltage protection (OVP)
 - Undervoltage protection (UVP), high-side and low-side
 - DC protection (DCP)
 - Overtemperature protection (OTP)
- Pulse width modulator (PWM):
 - Self-oscillating half-bridge topology with optional clock synchronization

Table of contents

About this document.....	1
Table of contents.....	2
1 Specifications	3
2 EVAL_AUDAMP25 overview	4
3 Setup guide	5
3.1 Typical connections	5
4 Audio analyzer setup	6
5 Operating the evaluation board	7
5.1 Test setup	7
5.2 Power-up sequence.....	7
5.3 Audio functionality tests	7
5.4 External clock function	7
5.5 Power-down sequence	7
6 Audio performance.....	8
6.1 Power vs. THD+N	8
6.2 Frequency response	8
6.3 Noise floor.....	9
6.4 Noise floor with 1 V _{RMS} output	9
7 Efficiency	10
8 Thermal information	11
8.1 Peak power duration thermal information	11
8.2 Heatsink installation	14
9 Schematic	15
10 PCB.....	19
10.1 PCB specifications.....	19
10.2 PCB layout	20
11 Bill of materials (BOM)	23
Revision history.....	29

Specifications

1 Specifications

Table 1 General test conditions

Condition		Notes/conditions
Supply voltages	$\pm 22\text{ V} \sim \pm 40\text{ V}$	Bipolar power supply
Rated load impedance	$2\ \Omega$ to $6\ \Omega$	Resistive load
Self-oscillating frequency	400 kHz	No input signal, adjustable
Voltage gain	28 dB	1 V _{RMS} input yields rated power

Table 2 Electrical data

Data	Typical	Notes/conditions
Infineon devices	MA5332 integrated class D IC	
Modulator	Self-oscillating, second-order sigma-delta modulation, analog input	
Output power CH1 to 2: (1 percent THD+N)	150 W	1 kHz, RL = 4 Ω
Output power CH1 to 2: (10 percent THD+N)	200 W	1 kHz, RL = 4 Ω
Rated load impedance	$2\ \Omega$ to $6\ \Omega$	Resistive load
Idling supply current	+55 mA	No input signal $\pm 36.5\text{ V}$
	-80 mA	
Residual noise	170 μV	Filter: A-weighting (12017), 20 kHz SPCL Gain setting: 28 dB
Channel efficiency	96 percent	Single-channel driven, 200 W, class D stage

2 EVAL_AUDAMP25 overview



Figure 1 EVAL_AUDAMP25 board

The EVAL_AUDAMP25 features a dual-channel self-oscillating type PWM for the lowest component count, highest performance and robust design. This topology represents an analog version of a second-order sigma-delta modulation, having a class D switching stage inside the loop. The benefit of the sigma-delta modulation, in comparison to the carrier-signal based modulation, is that all the error in the audible frequency range is shifted to the inaudible upper-frequency range by nature of its operation. Also, sigma-delta modulation enables the designer to apply sufficient error correction.

The EVAL_AUDAMP25 self-oscillating topology consists of the following essential functional blocks:

- Front-end integrator
- PWM comparator
- Level shifters
- Integrated gate drivers and MOSFETs
- Output LPF

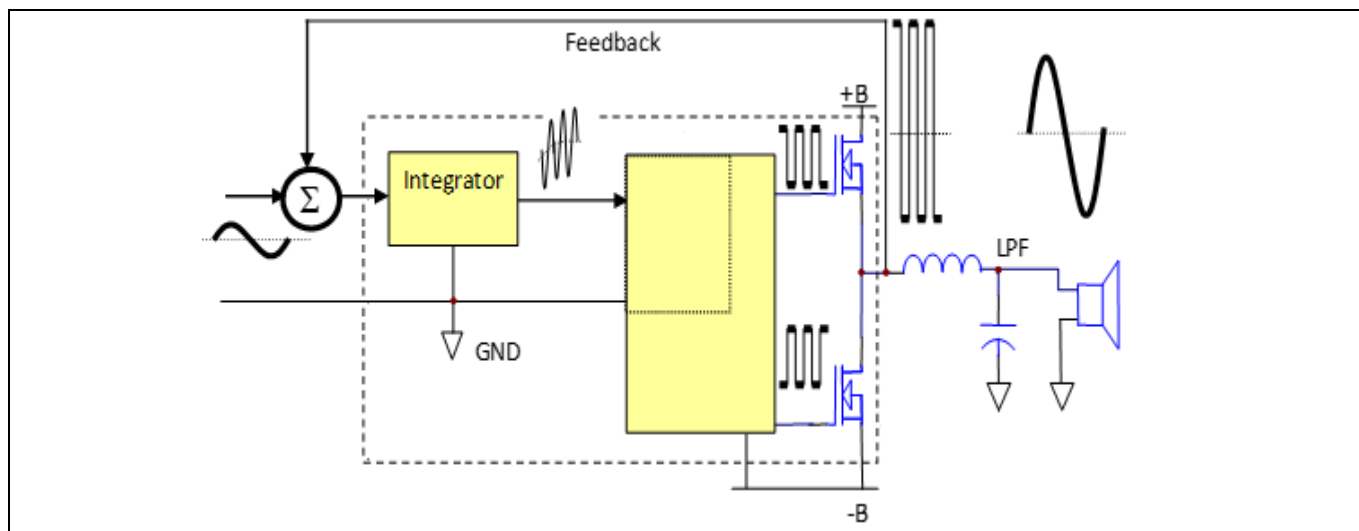


Figure 2 Simplified block diagram of class D amplifier

3 Setup guide

3.1 Typical connections

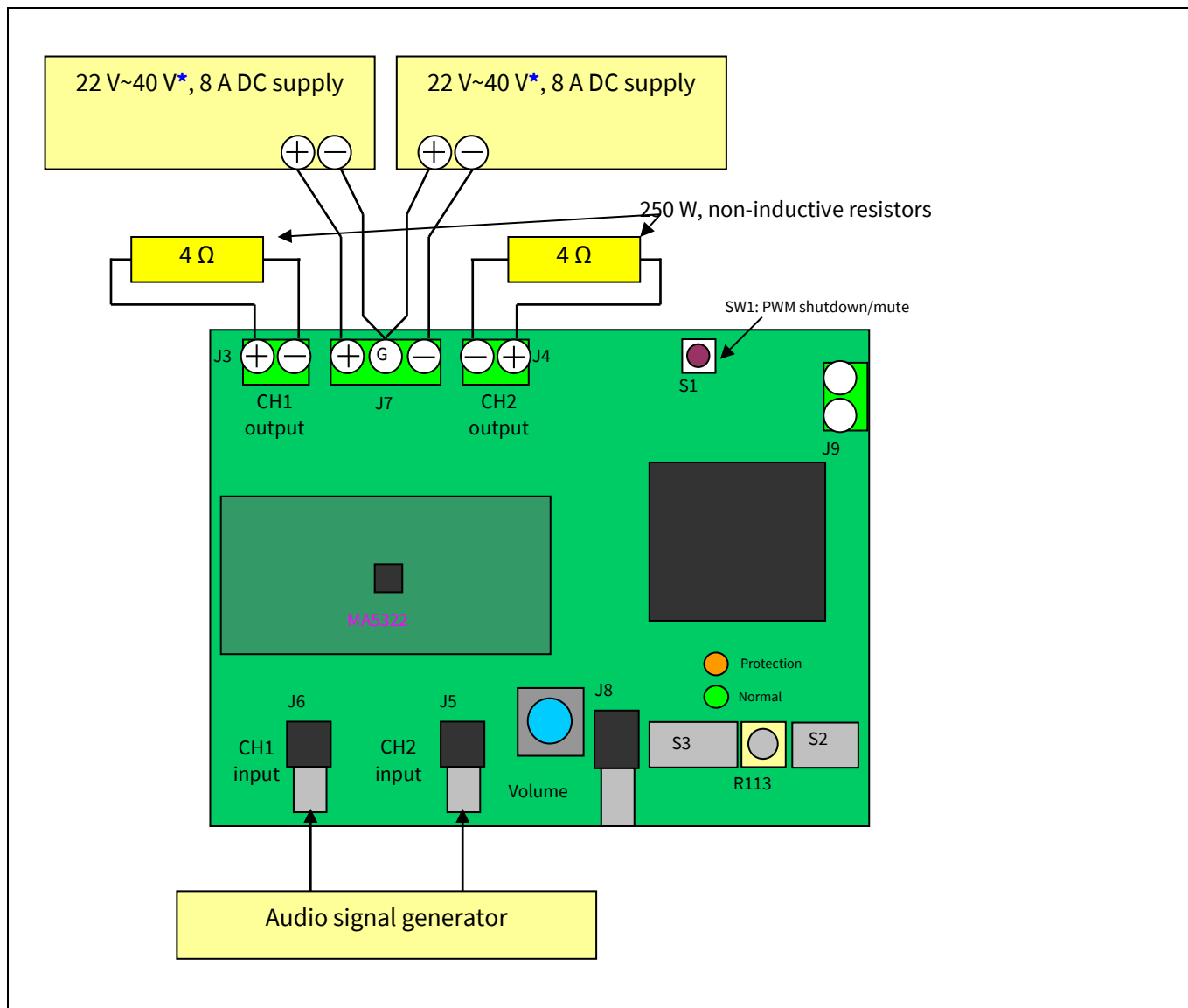


Figure 3 Typical connectors

Table 3 Connector descriptions

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

4 Audio analyzer setup

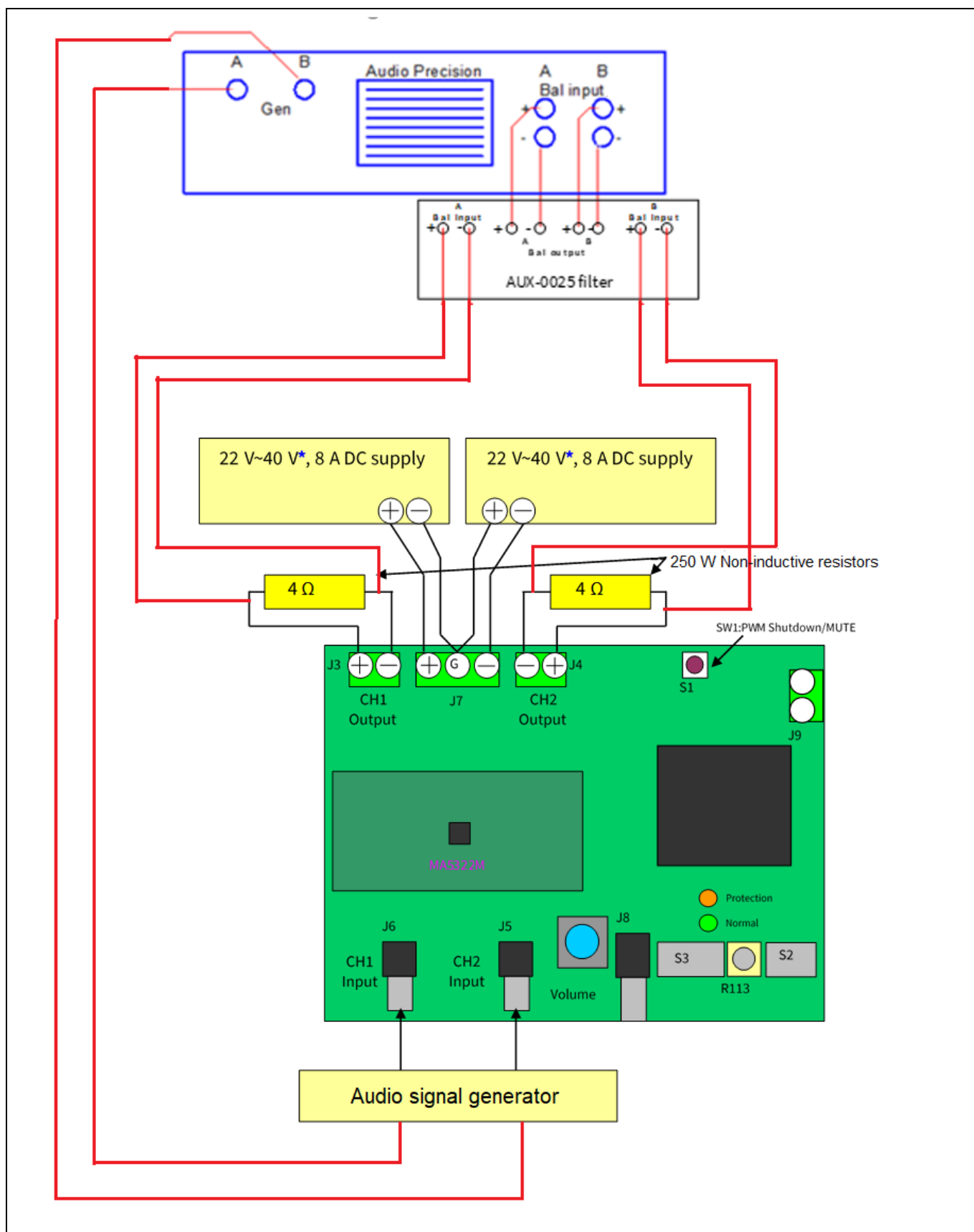


Figure 4 Audio analyzer connections

5 Operating the evaluation board

5.1 Test setup

1. Connect 4 Ω 250 W dummy loads to output connectors (J3 and J4, as shown in [Figure 3](#)) and parallel it with the input of the audio precision (AP) analyzer.
2. Connect the audio signal generator (ASG) to J6 and J5 for CH1 and CH2 respectively (AP).
3. Set up the dual power supply with voltages of ± 36.5 V; set current limit to 8 A.
4. Turn off the dual power supply before connecting to “on” of the unit under test (UUT).
5. Set switch S1 to the middle position (self-oscillating).
6. Set volume level knob R108 fully counter-clockwise (minimum volume).
7. Connect the dual power supply to J7, as shown in [Figure 3](#) or [Figure 4](#).

5.2 Power-up sequence

8. Turn on the dual power supply. The $\pm B$ supplies must be applied and removed at the same time.
9. Red LED (protection) should turn on almost immediately and turn off after about 3 s.
10. Green LED (normal) then turns on after the red LED is extinguished and should stay on.
11. Quiescent current for the positive supply should be 55 mA $\pm$ 10 mA at ± 36.5 V.
12. Quiescent current for the negative supply should be 80 mA $\pm$ 10 mA at ± 36.5 V.
13. Push S3 switch (trip and reset push-button) to restart the sequence of LED indicators, which should be the same as noted above in steps 9 to 10.

5.3 Audio functionality tests

1. With AP no filter (more than 500 kHz), monitor the channel's switching frequency on the AP's analog analyzer.
2. Set S1 to “self” (self-oscillating) position.
3. Set the AP's analog analyzer to 20 kHz AES17 filter.
4. Connect the audio signal from the AP to J6 and J5.
5. Apply 1 V_{RMS} at 1 kHz sinusoidal signal from the ASG.
6. Turn control volume up (R108 clockwise) to obtain an output reading of 150 W (4 Ω load).
7. Sweep the audio signal voltage from 15 mV_{RMS} to 1.5 V_{RMS}.
8. Run the AP test as shown in Figures 5 to 12, below.

5.4 External clock function

1. With AP no filter (more than 500 kHz), monitor the channel's switching frequency on the AP's analog analyzer.
2. Set S1 to “self” (self-oscillating) position.
3. Set S1 to “ext” (external clock) position to enable the onboard clock oscillator.
4. Connect the external clock signal generator output to J8.
5. Set the AP's analog analyzer to 20 kHz AES17 filter.
6. Connect the audio signal from the AP to J6 and J5.
7. Sweep the audio signal voltage from 15 mV_{RMS} to 1.5 V_{RMS}.

5.5 Power-down sequence

14. Turn off $\pm$ power supply at the same time.
15. All LEDs turn off when the housekeeping power supplies are off.

Audio performance

6 Audio performance

6.1 Power vs. THD+N

Test conditions:

$V_{bus} = \pm 36.5 \text{ V}$

Input signal = 1 kHz

Load impedance = 4Ω

$F_{PWM} = 400 \text{ kHz}$

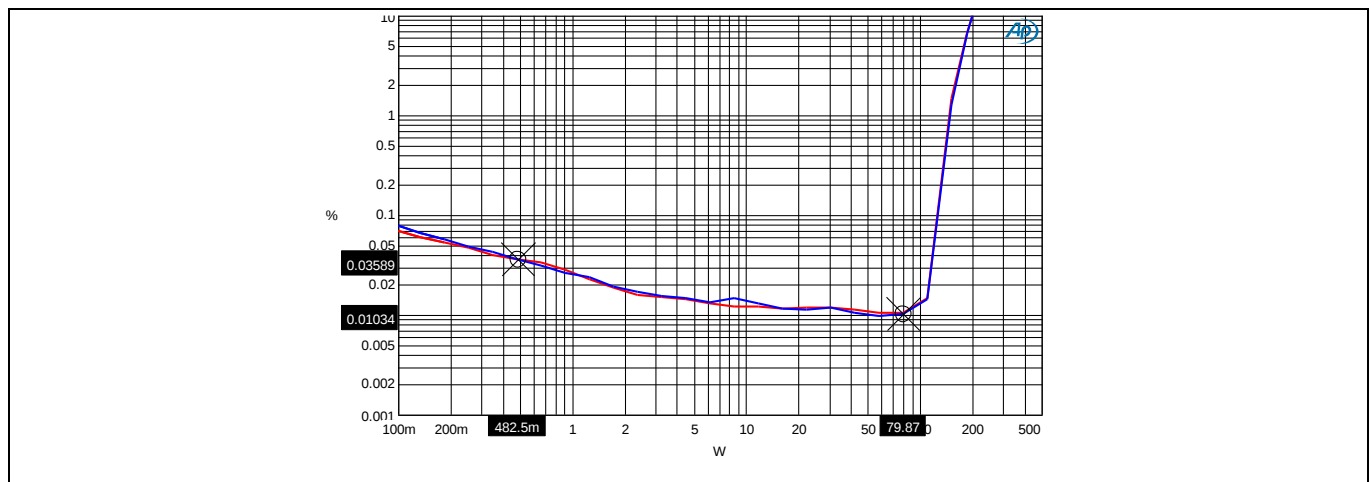


Figure 5 Power vs. THD+N 4Ω load

6.2 Frequency response

Test conditions:

$V_{bus} = \pm 36.5 \text{ V}$

Output power = 1 W

Load impedance = 4Ω

$F_{PWM} = 400 \text{ kHz}$

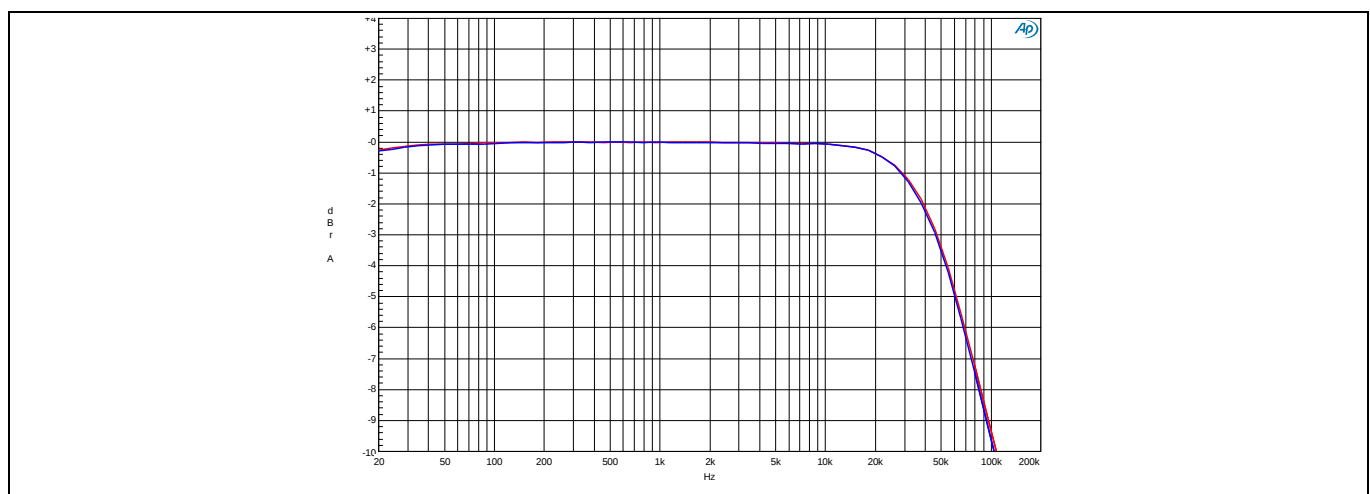


Figure 6 Frequency response 4Ω load

EVAL_AUDAMP25

MA5332 evaluation board

Audio performance

6.3 Noise floor

Test conditions:

$$V_{\text{bus}} = \pm 36.5 \text{ V}$$

No input signal

Load impedance = 4Ω

$$F_{\text{PWM}} = 400 \text{ kHz}$$

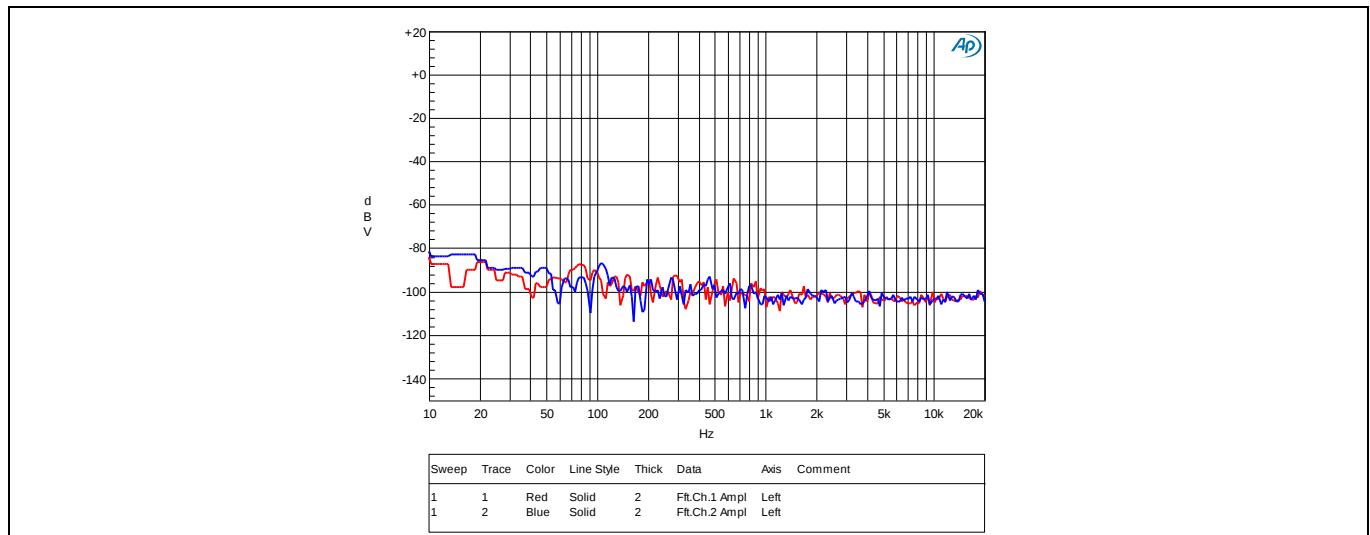


Figure 7 Noise floor 4Ω load

6.4 Noise floor with 1 V_{RMS} output

Test conditions:

$$V_{\text{bus}} = \pm 36.5 \text{ V}$$

Output = 1 V_{RMS} at 1 kHz

Load impedance = 4Ω

$$F_{\text{PWM}} = 400 \text{ kHz}$$

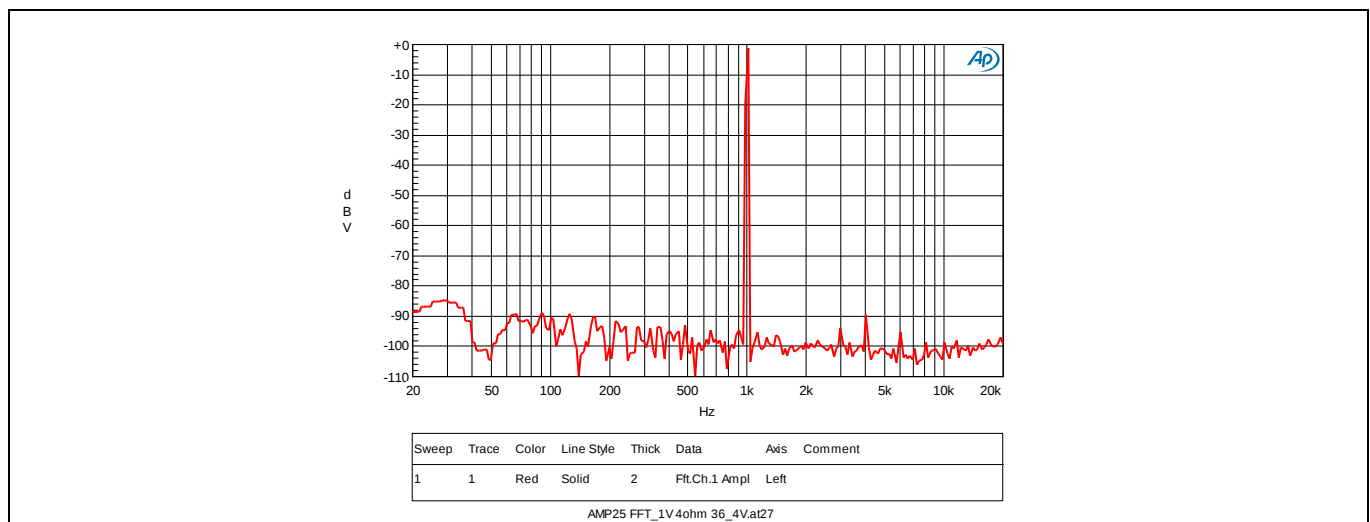


Figure 8 Noise floor with 1 V_{RMS} output 4Ω load

Efficiency

7 Efficiency

Test conditions:

$V_{bus} = \pm 36.5 \text{ V}$

Output = 1 V_{RMS} at 1 kHz

Load impedance = 4Ω

$F_{PWM} = 400 \text{ kHz}$

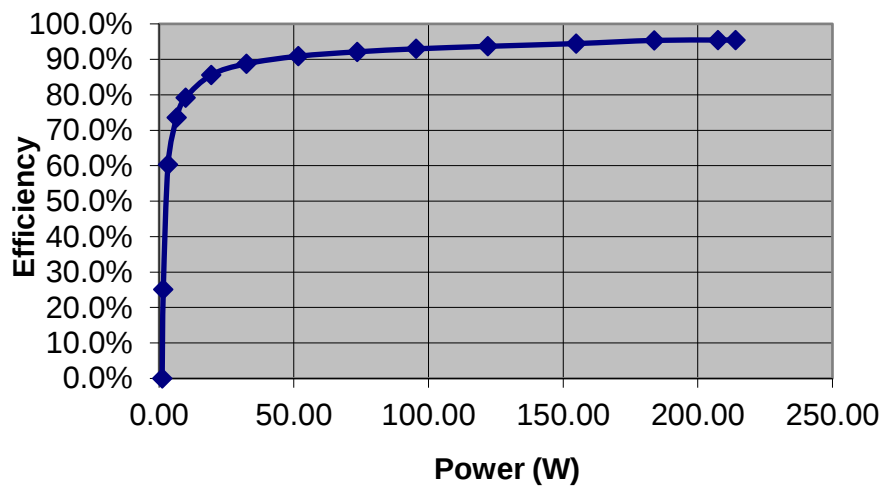


Figure 9 EVAL_AUDAMP25 4Ω load stereo, $\pm B$ supply = $\pm 36.5 \text{ V}$

Thermal information

8 Thermal information

8.1 Peak power duration thermal information

Test conditions:

Input signal = 1 kHz

Both channels driven

$F_{PWM} = 400$ kHz

Table 4 Peak power with heatsink

Load (Ω)	$\pm V_{bus}$ (V)	10 percent THD+N power (W)	Duration
6	40	160	More than 1 minute no thermal shutdown
4	36.5	200	
3	31.5	190	
2	23	150	

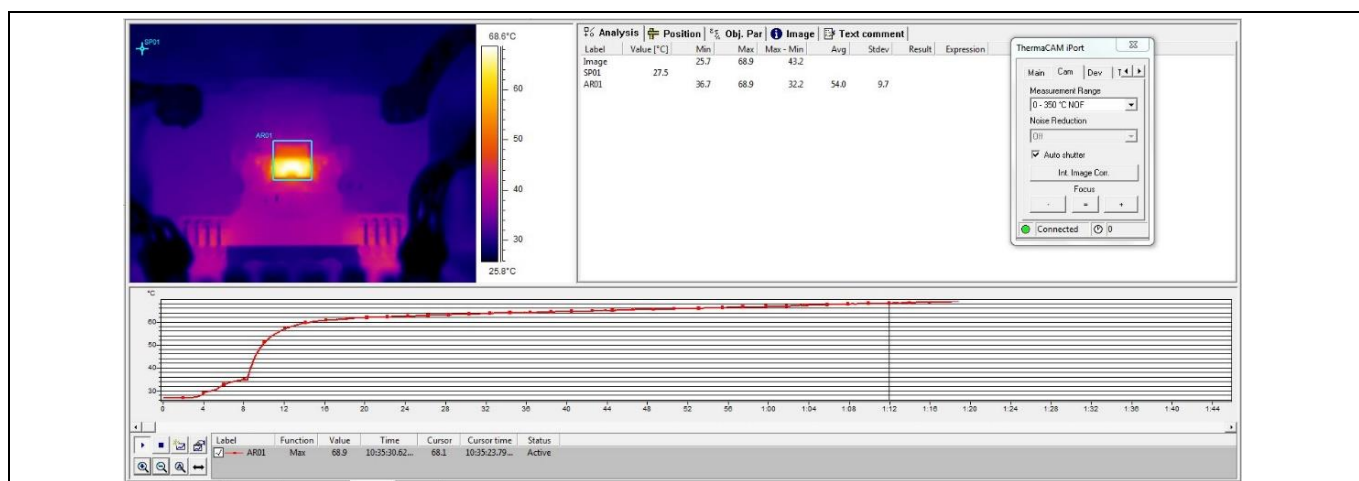


Figure 10 Peak power $P_{out} = 164$ W with 6 Ω load ± 40 V

Note: Maximum temperature 68.9°C at 1 minute.

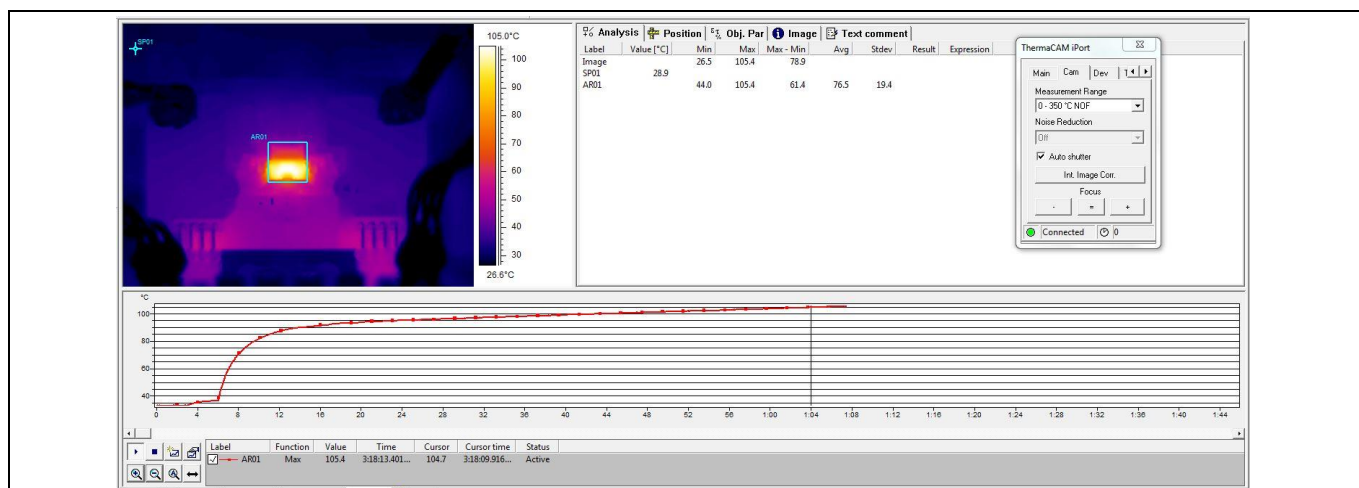


Figure 11 Peak power $P_{out} = 200$ W with 4 Ω load ± 36.5 V

Note: Maximum temperature 105°C at 1 minute.

Thermal information

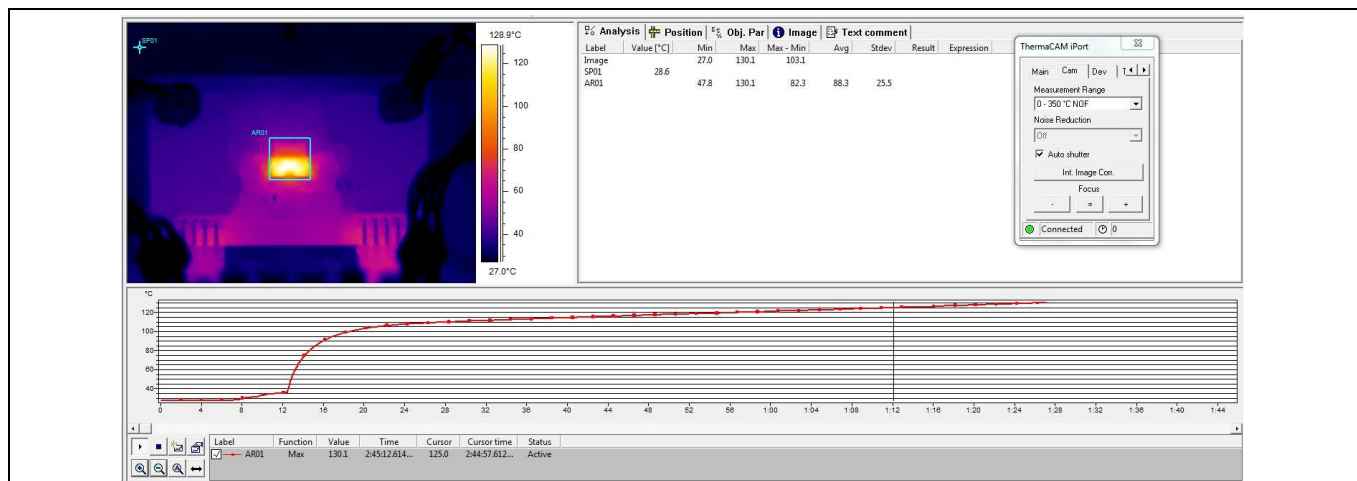


Figure 12 Peak power $P_{out} = 194\text{ W}$ with $3\ \Omega$ load $\pm 31.5\text{ V}$

Note: Maximum temperature 130°C at 1 minute.

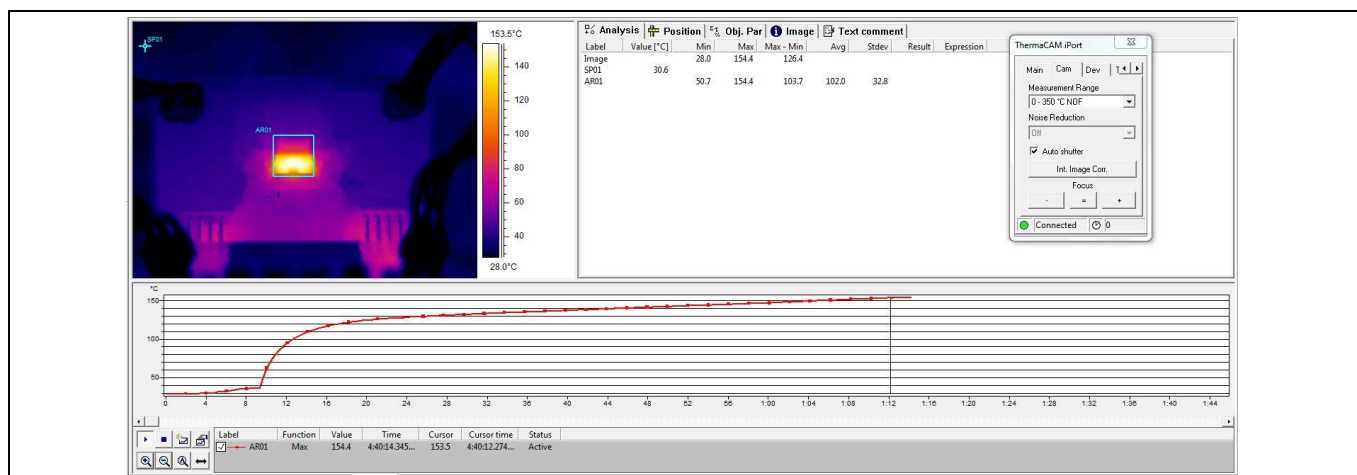


Figure 13 Peak power $P_{out} = 150\text{ W}$ with $2\ \Omega$ load $\pm 23\text{ V}$

Note: Maximum temperature 154°C at 1 minute.

Table 5 Peak power without heatsink

Load (Ω)	$\pm V_{bus}$ (V)	10 percent THD+N power (W)	Duration
4	26.5	100	More than 1 minute no thermal shutdown
2	13.7	50	

Thermal information

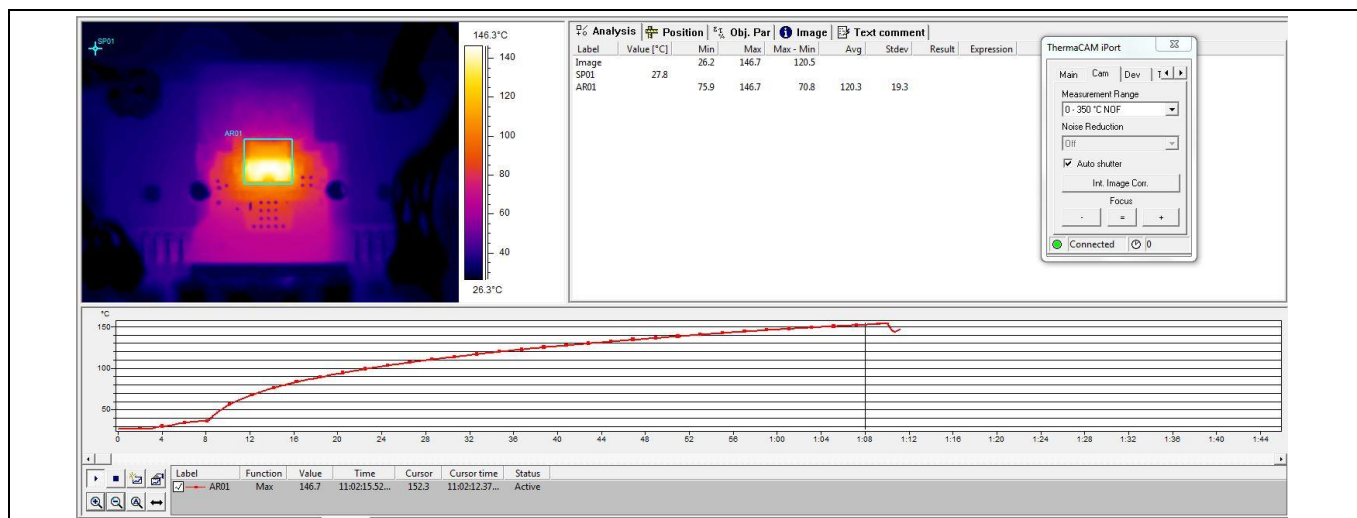


Figure 14 Peak power $P_{out} = 102\text{ W}$ with $4\ \Omega$ load $\pm 26.5\text{ V}$

Note: Maximum temperature 146.7°C at 1 minute.

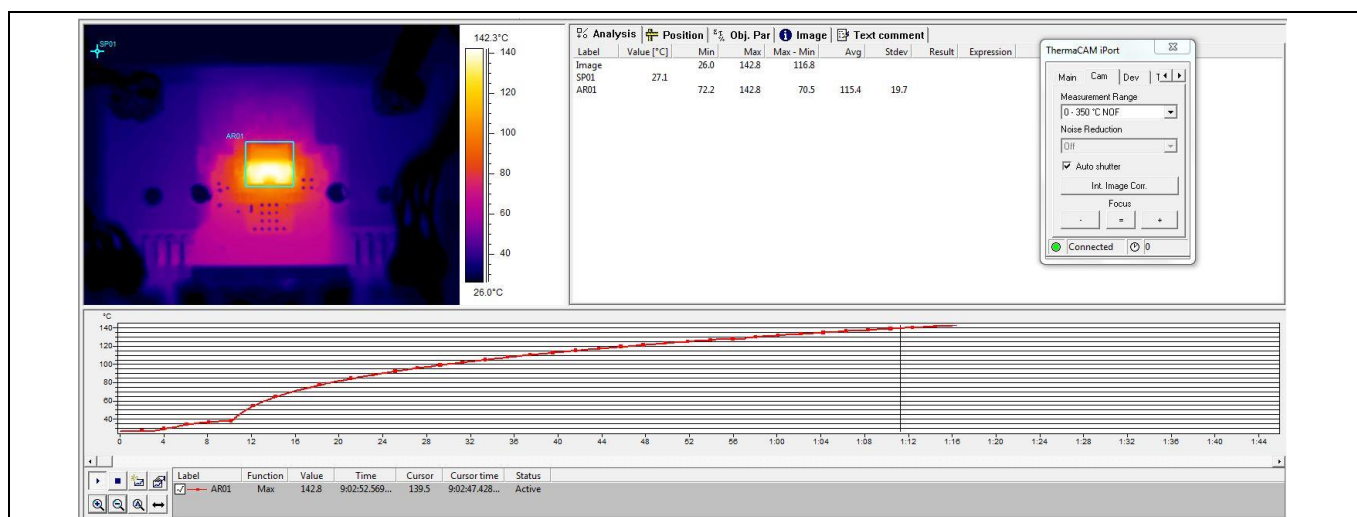


Figure 15 Peak power $P_{out} = 55\text{ W}$ with $2\ \Omega$ load $\pm 13.7\text{ V}$

Note: Maximum temperature 142.8°C at 1 minute.

Table 6 1/8 power test with heatsink

Load (Ω)	$\pm V_{bus}$ (V)	Max. T-case ($^\circ\text{C}$)	1/8 power (W)	Duration (minutes)
6	40	71.6	16.5	30
4	36.5	85.6	19.8	30
3	31.5	87.2	19.7	30
2	23	84.8	15	30

Table 7 1/8 power test without heatsink

Load (Ω)	$\pm V_{bus}$ (V)	Max. T-case ($^\circ\text{C}$)	1/8 power (W)	Duration (minutes)
4	22.7	84.6	7.12	30
2	13.7	76.1	4.88	30

Thermal information

8.2 Heatsink installation

Heatsink: V8818V

Thermal pad: BER161-ND



Figure 16 Heatsink installation

9 Schematic

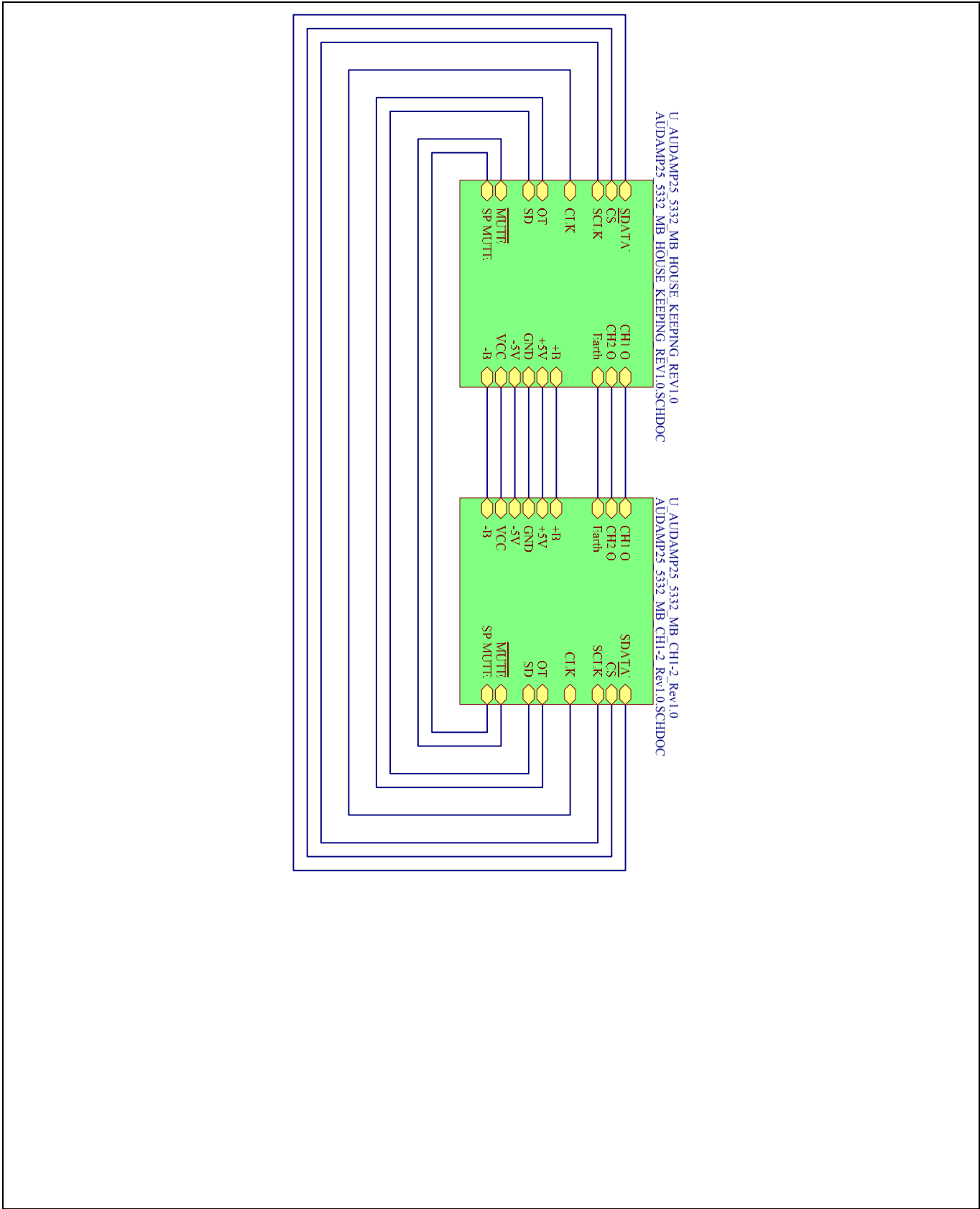


Figure 17 Motherboard schematic 1

Class D, Mother Board Clock and House Keeping Schematic

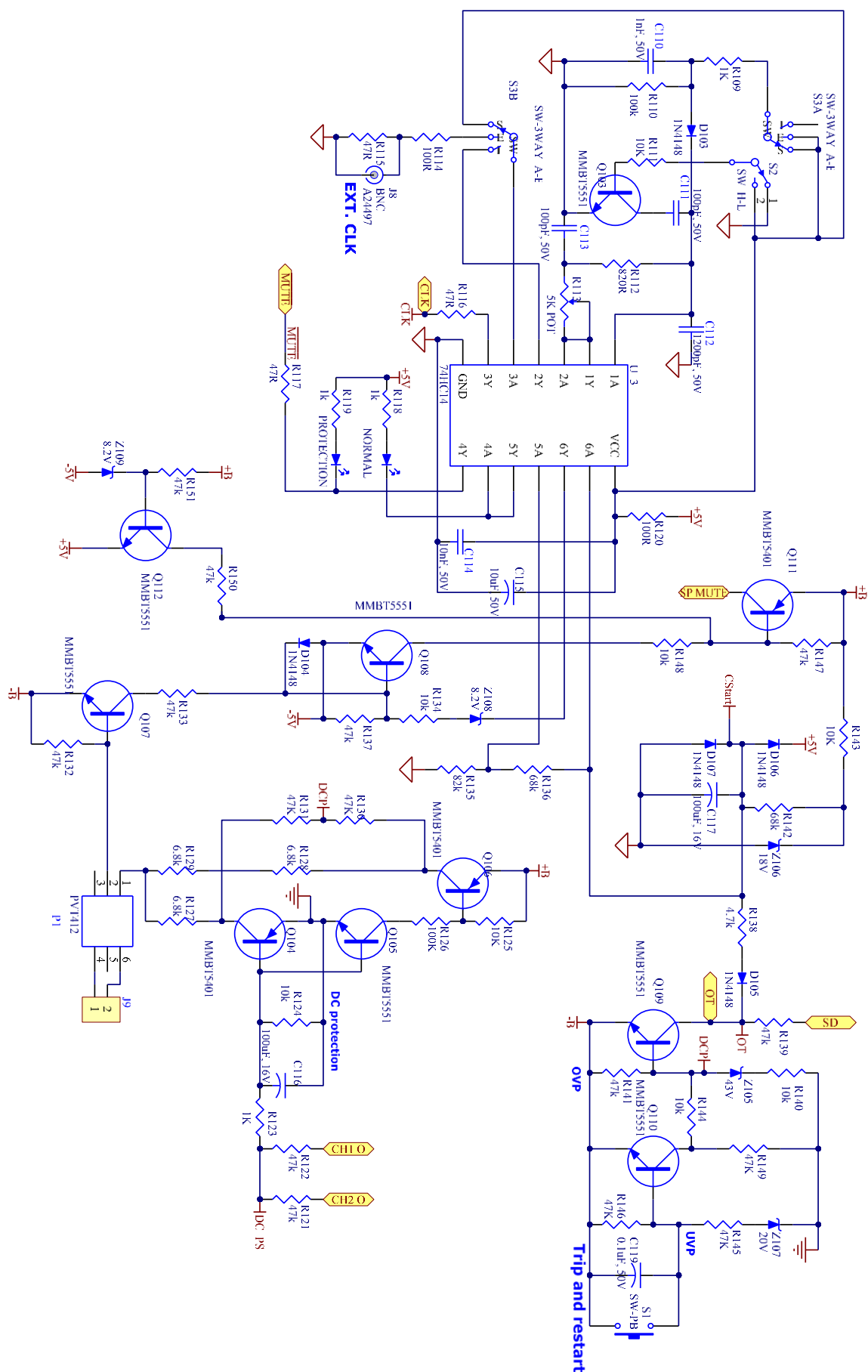


Figure 18 Motherboard schematic 2

Schematic

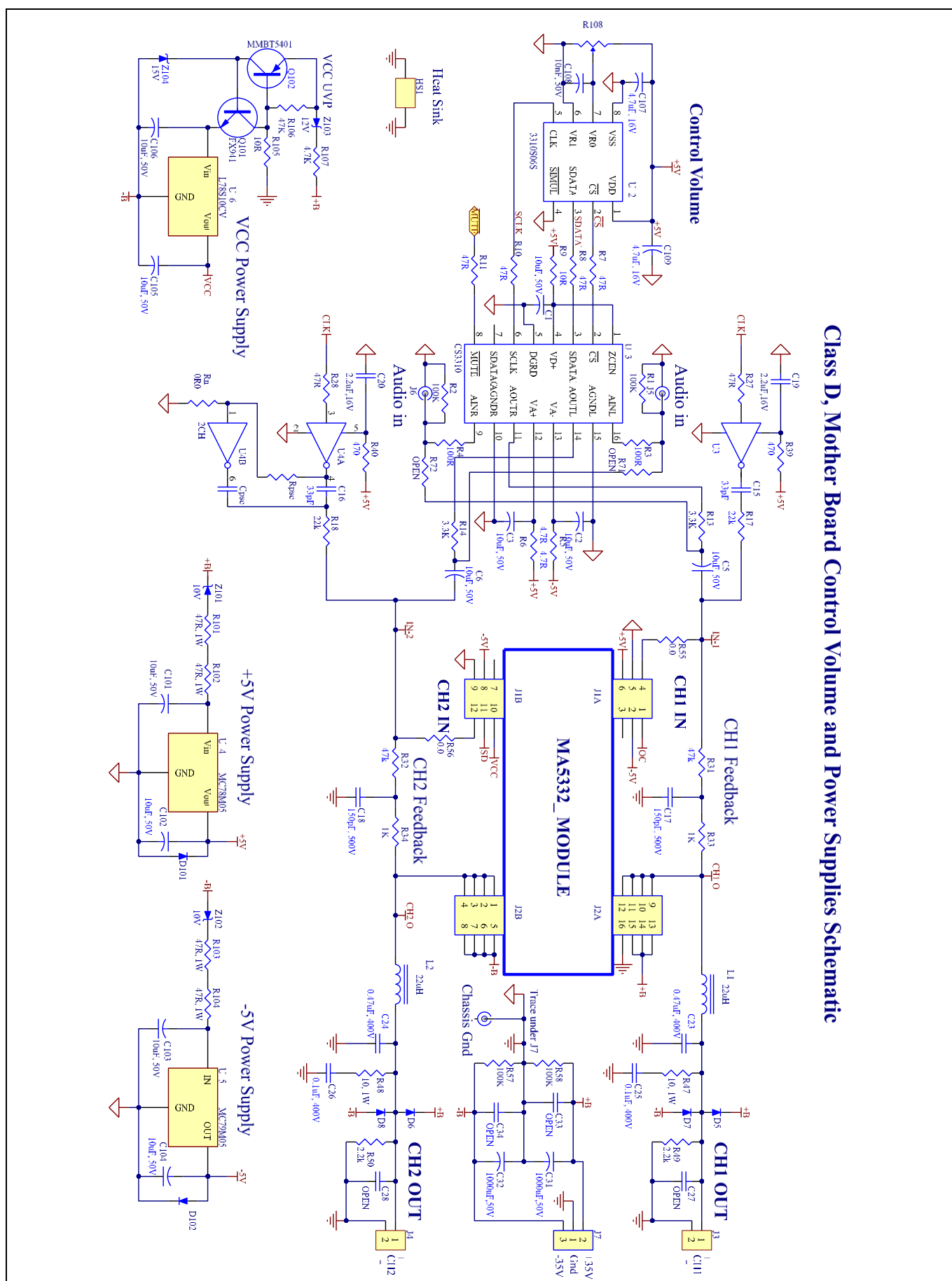
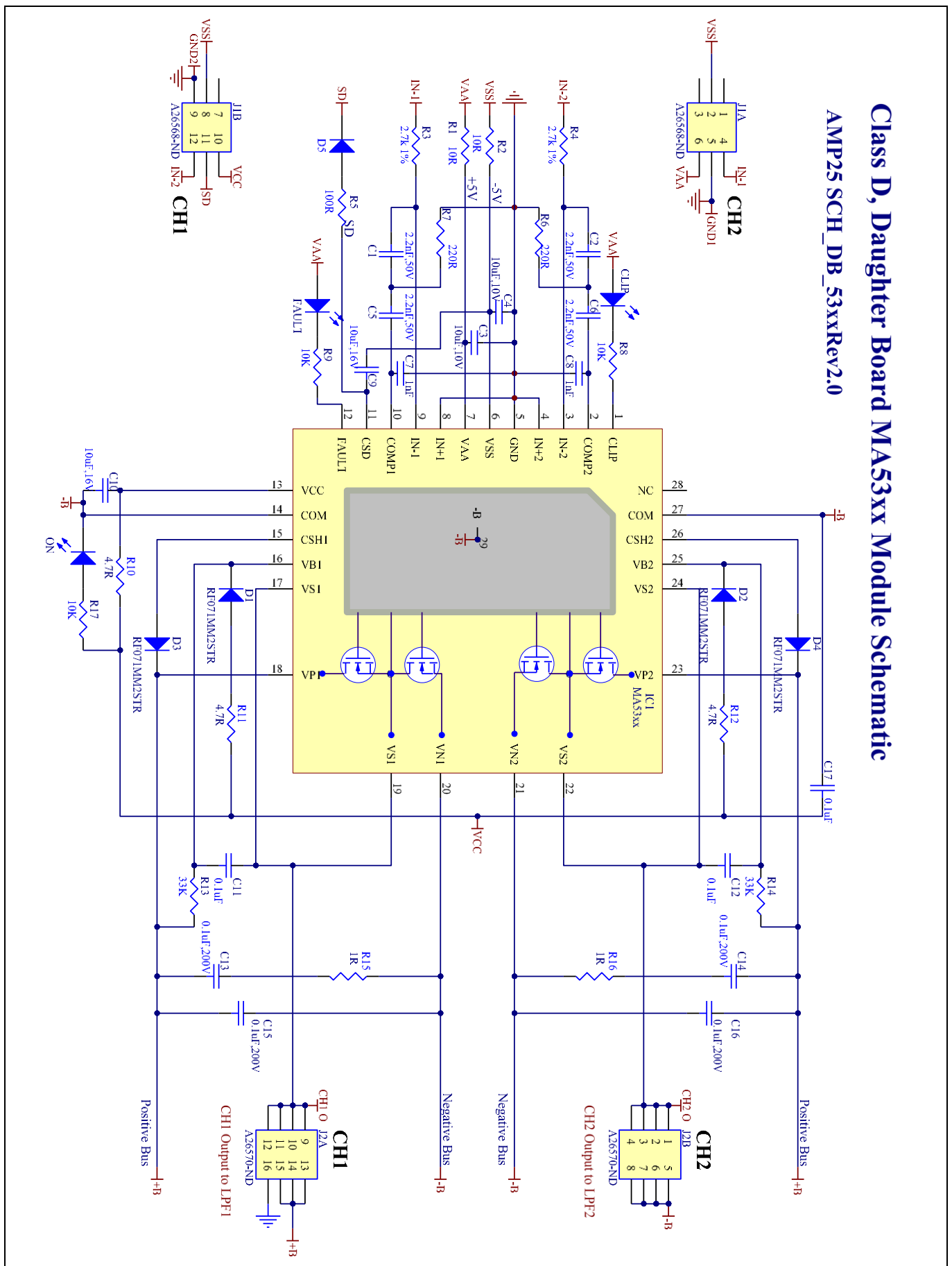


Figure 19 Motherboard schematic 3


Figure 20 Daughterboard schematic

PCB

10 PCB

10.1 PCB specifications

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

10.2 PCB layout

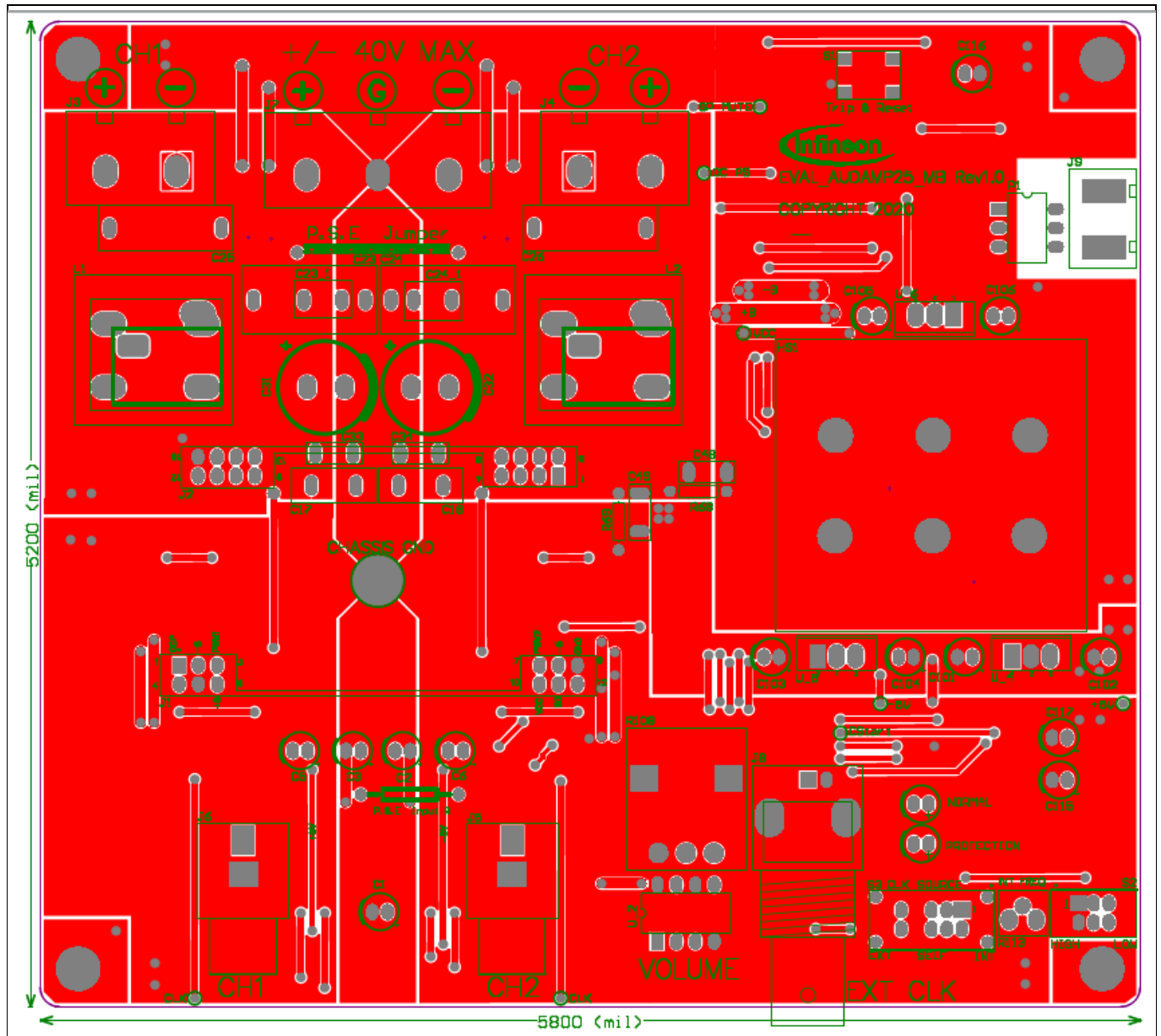


Figure 21 Motherboard top view

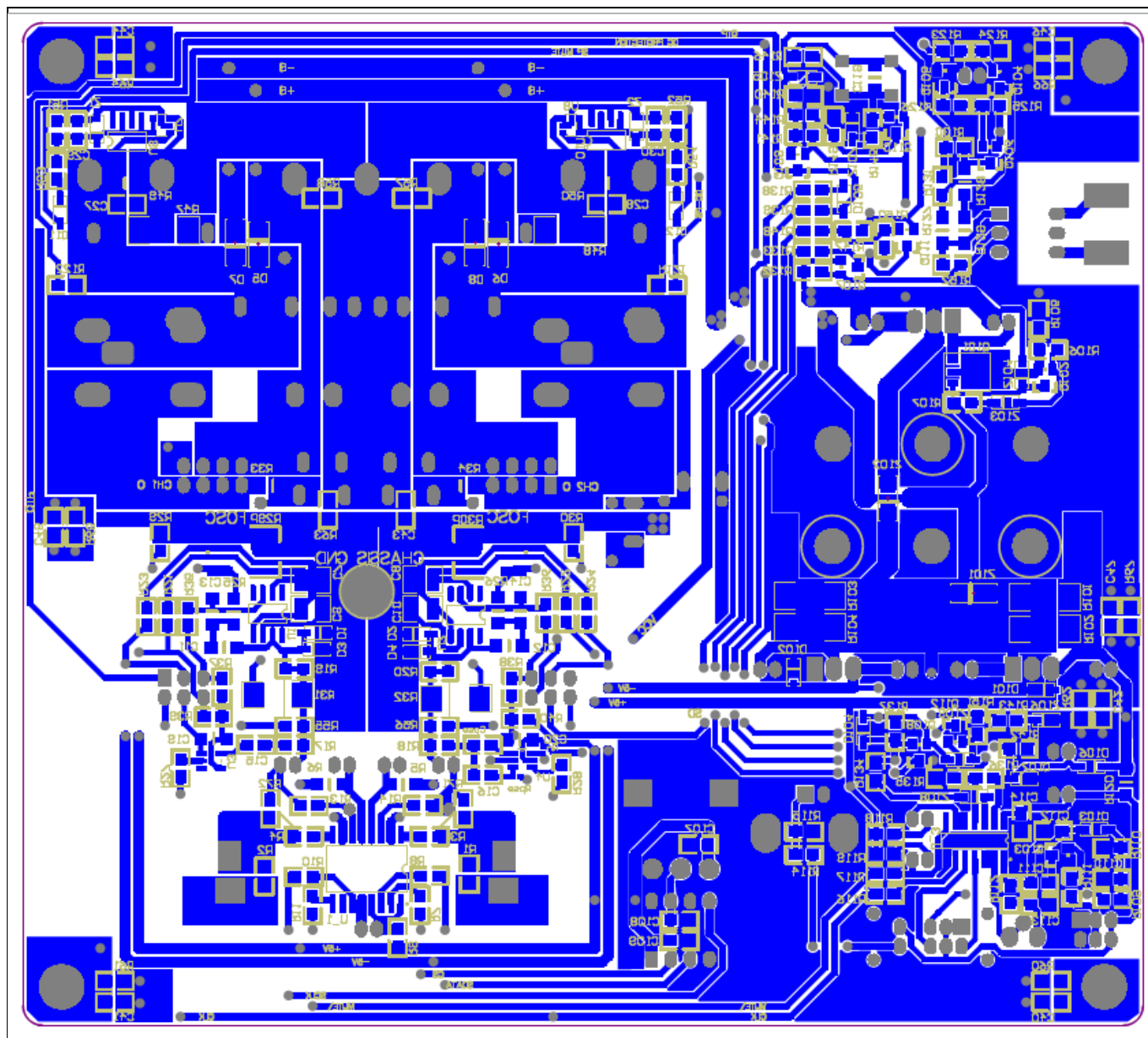


Figure 22 Motherboard bottom view

11 Bill of materials (BOM)

Table 8 Motherboard BOM

No.	Part number	Designator	Description	Quantity	Vendor
1	565-1106-ND	C1, C5, C6, C101, C102, C103, C104, C105, C106, C115	Aluminum capacitor 10 μ F 20% 50 V radial	10	Digikey
2	565-1103-ND	C2, C3	Aluminum capacitor 2.2 μ F 20% 50 V radial	2	Digikey
3	478-1281-1-ND	C15, C16	Ceramic capacitor 33 pF 100 V C0G/NP0 0805	2	Digikey
4	338-2598-ND	C17, C18	Mica capacitor 150 pF 5% 500 V radial	2	Digikey
5	1276-3141-1-ND	C19, C20	Ceramic capacitor 2.2 μ F 16 V X7R 1206	2	Digikey
6	732-8127-1-ND	C119	Ceramic capacitor 0.1 μ F 50 V X7R 1206	1	Digikey
7	495-1315-ND	C23, C24	Film capacitor 0.47 μ F 5% 400 V DC radial	2	Digikey
8	495-1311-ND	C25, C26	Film capacitor 0.1 μ F 5% 400 V DC radial	2	Digikey
9	565-1114-ND	C31, C32	Aluminum capacitor 1000 μ F 20% 50 V radial	2	Digikey
10	490-14466-1-ND	C107, C109	Ceramic capacitor 4.7 μ F 16 V X7R 0805	2	Digikey
11	732-8074-1-ND	C108, C114	Ceramic capacitor 10000 pF 50 V X7R 0805	2	Digikey
12	732-7858-1-ND	C110	Ceramic capacitor 1000 pF 50 V C0G/NP0 0805	1	Digikey
13	732-7852-1-ND	C111, C113	Ceramic capacitor 100 pF 50 V C0G/NP0 0805	2	Digikey
14	478-1372-1-ND	C112	Ceramic capacitor 1200 pF 50 V X7R 0805	1	Digikey

Bill of materials (BOM)

No.	Part number	Designator	Description	Quantity	Vendor
15	565-1037-ND	C116, C117	Aluminum capacitor 100 μ F 20% 16 V radial	2	Digikey
16	1N4148W-FDICT-ND	D103, D104, D105, D106, D107	General-purpose diode 100 V 300 MA SOD123	5	Digikey
17	MURA120T3GOSCT-ND	D5, D6, D7, D8	General-purpose diode 200 V 2 A SMA	4	Digikey
18	RB161MM-20CT-ND	D101, D102	Schottky diode 25 V 1 A PMDU	2	Digikey
19	294-1086-ND	HS1	Heatsink Horz six black TO-220	1	Digikey
20	A32934-ND	J1A, J1B	Connector receptor 6POS 0.1 gold PCB	2	Digikey
21	A32935-ND	J2A, J2B	Connector receptor 8POS 0.1 gold PCB	2	Digikey
22	277-1271-ND	J3, J4	Terminal block 2P side ent. 9.53 mm PCB	2	Digikey or Mouser
23	CP-1422-ND	J5, J6	Connector RCA jack mono 3.2 mm R/A	2	Digikey
24	277-1272-ND	J7	Terminal block 3P side ent. 9.53 mm PCB	1	Digikey or Mouser
25	A32248-ND	J8	Connector BNC jack R/A 50 Ω PCB	1	Digikey
26	ED1567	J9	Terminal block 2POS side ent. 7.5 mm PCB	1	Digikey
27	Sagami 7G17A-	L1, L2	class D inductor, 22 μ H	2	Inductors, Inc.
	1D17A-220M				ICE Components, Inc.
	CPD1715F-220				Codaca
28	160-1143-ND	Normal	LED green clear T-1 T/H	1	Digikey
29	PVT412PBF-ND	P1	SSR relay SPST-NO 140 MA 0 to 400 V	1	Digikey
30	160-1140-ND	Protection	LED red clear T-1 T/H	1	Digikey
31	FCX491CT-ND	Q101	Transistor NPN 60 V 1 A SOT-89	1	Digikey

Bill of materials (BOM)

No.	Part number	Designator	Description	Quantity	Vendor
32	MMBT5401-FDICT-ND	Q102, Q104, Q106, Q111	Transistor PNP 150 V 0.6 A SMD SOT23-3	4	Digikey
33	MMBT5551-FDICT-ND	Q103, Q105, Q107, Q108, Q109, Q110, Q112	Transistor NPN 160 V 0.6 A SOT23-3	7	Digikey
34	P100KACT-ND	R1, R2, R57, R58, R110, R126	Resistor SMD 100K Ω 5% 1/8 W 0805	6	Digikey
35	P100ACT-ND	R3, R4, R114	Resistor SMD 100 Ω 5% 1/8 W 0805	3	Digikey
36	P4.7ECT-ND	R5, R6	Resistor SMD 4.7 Ω 5% 1/4 W 1206	2	Digikey
37	P47ACT-ND	R7, R8, R10, R11, R27, R28, R115, R116, R117	Resistor SMD 47 Ω 5% 1/8 W 0805	9	Digikey
38	P10ACT-ND	R9, R105	Resistor SMD 10 Ω 5% 1/8 W 0805	2	Digikey
39	P3.3KDACT-ND	R13, R14	Resistor 3.3K Ω 0.1% 1/8 W 0805	2	Digikey
40	P22KACT-ND	R17, R18	Resistor SMD 22K Ω 5% 1/8 W 0805	2	Digikey
41	P47KACT-ND	R106, R121, R122, R130, R131, R132, R133, R137, R139, R141, R145, R146, R147, R149, R150, R151	Resistor SMD 47K Ω 5% 1/8 W 0805	16	Digikey
42	P0.0ACT-ND	R55, R56	Resistor SMD 0 Ω JUMPER 1/8 W 0805	2	Digikey
43	P470ACT-ND	R39, R40	Resistor SMD 470 Ω 5% 1/8 W 0805	2	Digikey
44	P100ECT-ND	R120	Resistor SMD 100 Ω 5% 1/4 W 1206	1	Digikey
45	TNPW251247K0BEEG-ND	R31, R32	Resistor 47K Ω 0.1% 1/2 W 2512	2	Digikey
	CPD3119-220M	Substitute			Codaca
46	YAG2331CT-ND	R33, R34	Resistor SMD 1K Ω 0.1% 1/4 W 1206	2	Digikey
47	P1.0KACT-ND	R109, R118, R119, R123	Resistor SMD 1K Ω 5% 1/8 W 0805	4	Digikey
48	PT10XCT	R47, R48	Resistor SMD 10 Ω 5% 1 W 2512	2	Digikey
49	P2.2KECT-ND	R49, R50	Resistor SMD 2.2K Ω 5% 1/4 W 1206	2	Digikey
50	PT47XCT-ND	R101, R102, R103, R104	Resistor SMD 47 Ω 5% 1 W 2512	4	Digikey

Bill of materials (BOM)

No.	Part number	Designator	Description	Quantity	Vendor
51	P4.7KACT-ND	R107, R138	Resistor SMD 4.7K Ω 5% 1/8 W 0805	2	Digikey
52	PDB12-H4251-103BF	R108	Potentiometer 10K Ω 0.08 W carbon linear	1	Digikey
53	P10KACT-ND	R111, R124, R125, R134, R140, R143, R144, R148	Resistor SMD 10K Ω 5% 1/8 W 0805	8	Digikey
54	P820ACT-ND	R112	Resistor SMD 820 Ω 5% 1/8 W 0805	1	Digikey
55	3362H-502LF-ND	R113	Trimmer 5K Ω 0.5 W PC pin top	1	Digikey
56	P6.8KECT-ND	R127, R128, R129	Resistor SMD 6.8K Ω 5% 1/4 W 1206	3	Digikey
57	P82KACT-ND	R135	Resistor SMD 82K Ω 5% 1/8 W 0805	1	Digikey
58	P68KACT-ND	R136, R142	Resistor SMD 68K Ω 5% 1/8 W 0805	2	Digikey
59	RMCF0402ZT0R00CT- ND	Rn	Resistor 0 Ω jumper 1/16 W 0402	1	Digikey
60	P8010S-ND	S1	Tactile switch SPST-NO 0.02 A 15 V	1	Digikey
61	EG1908-ND	S2	Slide switch DPDT 100 MA 12 V	1	Digikey
62	EG1944-ND	S3	Slide switch DP3T 200 MA 30 V	1	Digikey
63	296-11599-1-ND	U3	SN74LVC1G04DBVR	1	Digikey
64	296-13261-1-ND	U4	SN74LVC2G04DBVR	1	Digikey
65	73C8016 or 72J5420	U_1	IC, digital volume control, SOIC-16	1	Newark
66	3310-IR01	U_2	CS3310 standalone controller	1	*Tachyonix
67	296-1194-1-ND	U_3	IC Schmitt inverter 6CH 14SOIC	1	Digikey
68	MC78M05CTGOS-ND	U_4	IC linear regulator 5 V 500 MA TO220AB	1	Digikey
69	LM79M05CT-ND	U_5	IC linear regulator - 5 V 500 MA TO220-3	1	Digikey
70	497-6039-5-ND	U_6	IC linear regulator 10 V 2 A TO220AB	1	Digikey
71	BZT52C15-FDICT-ND	Z103	Zener diode 15 V 500 MW SOD123	1	Digikey

Bill of materials (BOM)

No.	Part number	Designator	Description	Quantity	Vendor
72	1SMA5917BT3GOSCT-ND	Z101, Z102	Zener diode 4.7 V 1.5 W SMA	2	Digikey
73	BZT52C24-FDICT-ND	Z104	Zener diode 24 V 500 MW SOD123	1	Digikey
74	MMSZ5260BT1GOSCT-ND	Z105	Zener diode 43 V 500 MW SOD123	1	Digikey
75	BZT52C18-FDICT-ND	Z106	Zener diode 18 V 500 MW SOD123	1	Digikey
76	MMSZ20T1GOSCT-ND	Z107	ON Semiconductor Zener diode 20 V 500 MW SOD123	1	Digikey
77	BZT52C8V2-FDICT-ND	Z108, Z109	Zener diode 8.2 V 500 MW SOD123	2	Digikey
78	CR-BA-7C6-180D	Volume knob	Round knob with indicator line	1	Newark
79	82K6096	Thermalloy TO-220 mounting kit with screw	Mounting kit TO- 220	3	Newark
80	8401K-ND	1/2" standoffs 4-40	Hexagonal standoff #4-40 Aluminum 1/2"	5	Digikey
81	H724-ND	4-40 nut	Hexagonal nut 4-40 stainless steel	5	Digikey
82	H729-ND	No. 4 lock washer	Internal lock washer #4 SS	5	Digikey

Note: *: Tachyonix Corporation, 14 Gonaka Jimokuji Jimokuji-cho, Ama-gun Aichi, JAPAN 490-1111
<http://www.tachyonix.co.jp> email: info@tachyonix.co.jp

Table 9 Daughterboard bill of materials

No.	Part number	Designator	Description	Quantity	Vendor
1	490-1500-1-ND	C1, C2, C5, C6	Ceramic capacitor 2200 pF 50 V 10% X7R 0603	4	Digikey
2	587-2668-1-ND	C3, C4	Ceramic capacitor 10 μ F 10 V X7R 10% 0805	2	Digikey
3	399-1082-1-ND	C7, C8	Ceramic capacitor 1000 pF 50 V X7R 0603	2	Digikey
4	490-5519-1-ND	C9, C10	Ceramic capacitor 10 μ F 16 V X6S 0805	2	Digikey
5	445-1418-1-ND	C11, C12, C17	Ceramic capacitor 0.10 μ F 100 V X7R 10% 0805	3	Digikey

Bill of materials (BOM)

No.	Part number	Designator	Description	Quantity	Vendor
6	732-12081-1-ND	C13, C14, C15, C16	Ceramic capacitor 0.1 μ F 200 V X7R 1206	4	Digikey
7	RF071MM2SCT-ND	D1, D2, D3, D4, D5	General-purpose diode 200 V 700 MA PMDU	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 468 nm blue clear 0603 SMD	1	Digikey
11	MA5332	IC1	2-channel PowIRaudio integrated class D IC	1	Infineon
12	A26568-ND	J1A, J1B	Vertical header connector 6POS 0.100 30 AU	2	Digikey
13	A26570-ND	J2A, J2B	Vertical header connector 8POS 0.100 30 AU	2	Digikey
14	RMCF0603JT10R0CT- ND	R1, R2	Resistor 10 Ω 1/10 W 5% 0603 SMD	2	Digikey
15	RMCF0603FT2K70CT- ND	R3, R4	Resistor 2.7 k Ω 1/10 W 1% 0603 SMD	2	Digikey
16	RMCF0603JT100RCT- ND	R5	Resistor 100 Ω 1/10 W 5% 0603 SMD	1	Digikey
17	311-620GRCT-ND	R6, R7	Resistor 620 Ω 1/10 W 5% 0603 SMD	2	Digikey
18	RHM10KGCT-ND	R8, R9, R17	Resistor 10K Ω 1/10 W 5% 0603 SMD	3	Digikey
19	RMCF0603JT4R70CT- ND	R10, R11, R12	Resistor TF 1/10 W 4.7 Ω 5% 0603	3	Digikey
20	RHM33KGCT-ND	R13, R14	Resistor 33K Ω 1/10 W 5% 0603 SMD	2	Digikey
21	311-1.0ARCT-ND	R15, R16	Resistor 1.0 Ω 1/8 W 5% 0805 SMD	2	Digikey
22*	V8818V	Heatsink	Heatsink aluminum anode	1	Digikey
23	BER161-ND	Thermal pad	Thermal pad	1/8	Digikey
24	Screws		Depends on holes on the heatsink	2	

Note: Heatsink is an option for AMP25 to deliver higher power.

Revision history

Document version	Date of release	Description of changes
V 1.0	2021-10-11	First release

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