

# EVAL\_AUDAMP25

## MA5332 evaluation board



### About this document

#### Scope and purpose

The EVAL\_AUDAMP25 MA5332 evaluation board is a two-channel, 200 W/ch (4  $\Omega$  at  $\pm 36.5$  V; with heatsink) half-bridge class D audio power amplifier for Hi-Fi audio systems. This evaluation board demonstrates how to use MA5332 IC, implement protection circuits, and design an optimum PCB layout using 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 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:
  - 200 W x 2 channels (10 percent THD+N, 4  $\Omega$  at  $\pm 36.5$  V)
- 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

## Table of contents

|  |           |
|--|-----------|
| About this document.....                             | 1         |
| Table of contents.....                               | 2         |
| <b>1 Specifications .....</b>                        | <b>3</b>  |
| <b>2 EVAL_AUDAMP25 overview.....</b>                 | <b>4</b>  |
| <b>3 Set-up guide .....</b>                          | <b>5</b>  |
| 3.1 Typical connections .....                        | 5         |
| <b>4 Audio analyzer set-up .....</b>                 | <b>6</b>  |
| <b>5 Operating the evaluation board .....</b>        | <b>7</b>  |
| 5.1 Test set-up .....                                | 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         |
| <b>6 Audio performance.....</b>                      | <b>9</b>  |
| 6.1 Power vs. THD+N .....                            | 9         |
| 6.2 Frequency response .....                         | 9         |
| 6.3 Noise floor.....                                 | 10        |
| 6.4 Noise floor with 1 V <sub>RMS</sub> output ..... | 10        |
| <b>7 Efficiency .....</b>                            | <b>11</b> |
| <b>8 Thermal information .....</b>                   | <b>12</b> |
| 8.1.1 Peak power duration thermal information.....   | 12        |
| 8.1.2 Heatsink installation .....                    | 16        |
| <b>9 Schematic .....</b>                             | <b>17</b> |
| <b>10 PCB.....</b>                                   | <b>21</b> |
| 10.1 PCB specification.....                          | 21        |
| 10.2 PCB layout .....                                | 22        |
| <b>11 Bill of Materials (BOM) .....</b>              | <b>25</b> |
| Revision history.....                                | 31        |

# 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 to 6 $\Omega$                        | Resistive load                 |
| Self-oscillating frequency | 400 kHz                                | No input signal, adjustable    |
| Voltage gain               | 28 dB                                  | 1Vrms input yields rated power |

**Table 2 Electrical data**

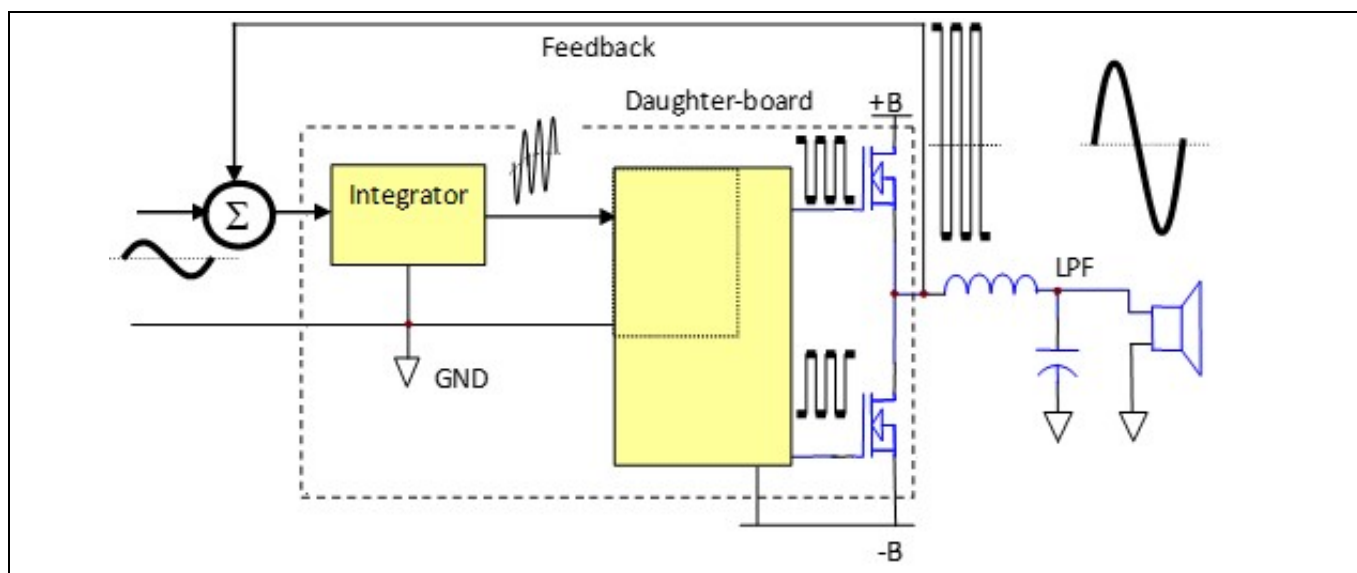
| Data                                      | Typical   | Notes/conditions   |
|---|---|--|
| Infineon devices                          | MA5332 integrated class D IC  |  |
| Modulator                                 | Self-oscillating, second-order sigma-delta modulation, analog input |  |
| Output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

## 2 EVAL\_AUDAMP25 overview

The EVAL\_AUDAMP25 features a two-channel self-oscillating type PWM modulator 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:

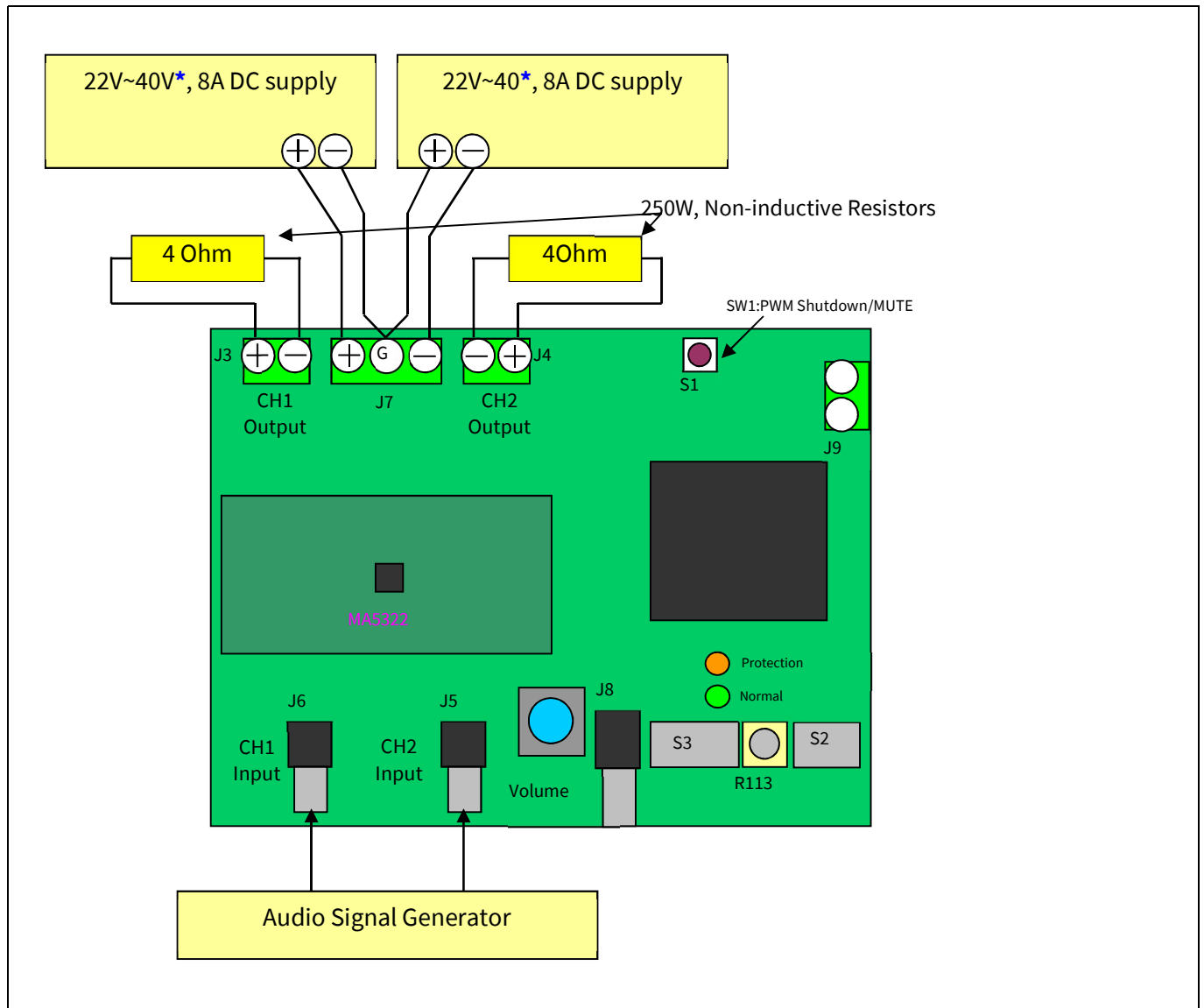
- Front-end integrator
- PWM comparator
- Level shifters
- Integrated gate drivers and MOSFETs
- Output LPF



**Figure 1** Simplified block diagram of class D amplifier

### 3 Set-up guide

#### 3.1 Typical connections

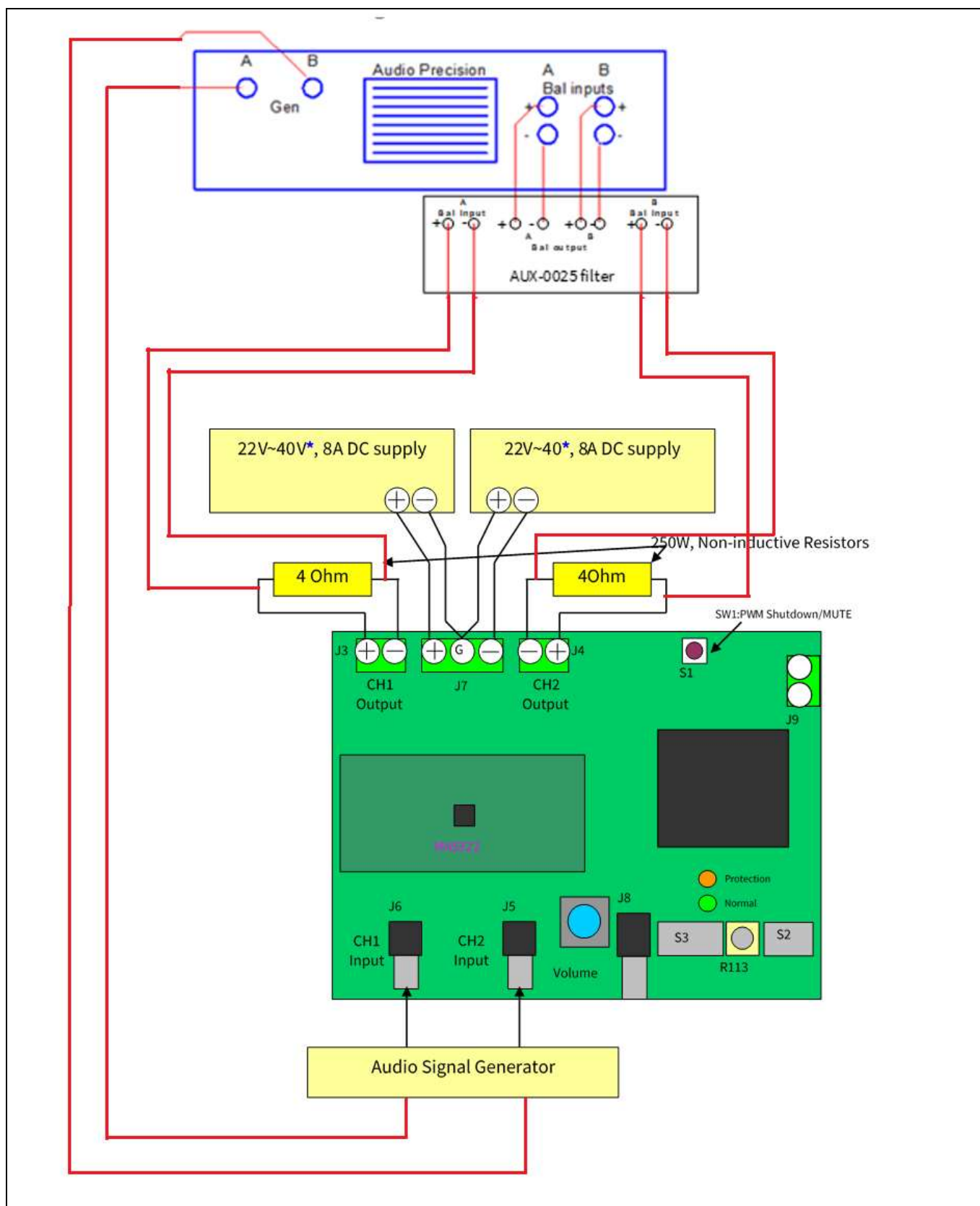


**Figure 2** Typical connection connector description

**Table 3** 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           |

## 4 Audio analyzer set-up



**Figure 3** Audio analyzer connection

## **5 Operating the evaluation board**

### **5.1 Test set-up**

1. Connect 4  $\Omega$  250 W dummy loads to output connectors (J3 and J4 as shown in Figure 2) 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  $\pm 36.5$  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 2 or Figure 3

### **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  $\pm 36.5$  V.
12. Quiescent current for the negative supply should be 80 mA  $\pm$  10 mA at  $\pm 36.5$  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<sub>RMS</sub> at 1 kHz sinusoidal signal from the ASG.
6. Turn control volume up (R108 clockwise) to obtain an output reading of 150 W (4  $\Omega$  load).
7. Sweep the audio signal voltage from 15 mV<sub>RMS</sub> to 1.5 V<sub>RMS</sub>.
8. Run the AP test as shown in Figures 4 to 11, 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<sub>RMS</sub> to 1.5 V<sub>RMS</sub>.

### **5.5 Power-down sequence**

14. Turn off  $\pm$  power supply at the same time.

15. All LEDs turn off when housekeeping power supplies are off.



## 6 Audio performance

### 6.1 Power vs. THD+N

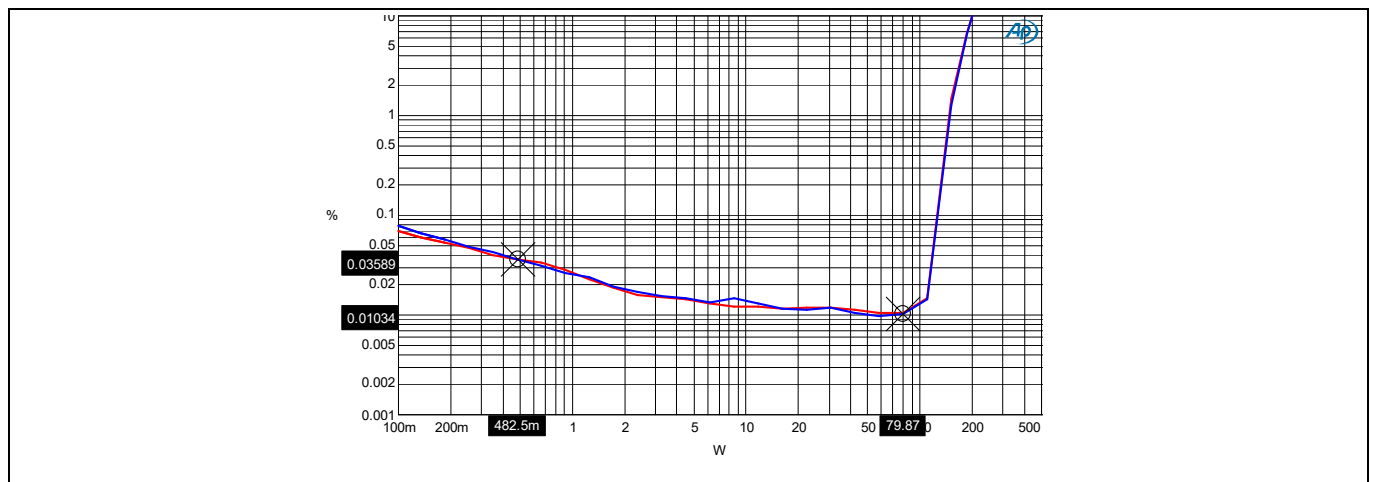
Test conditions:

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

Input signal = 1 kHz

Load impedance =  $4 \Omega$

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



**Figure 4** Power vs. THD+N  $4 \Omega$  load

### 6.2 Frequency response

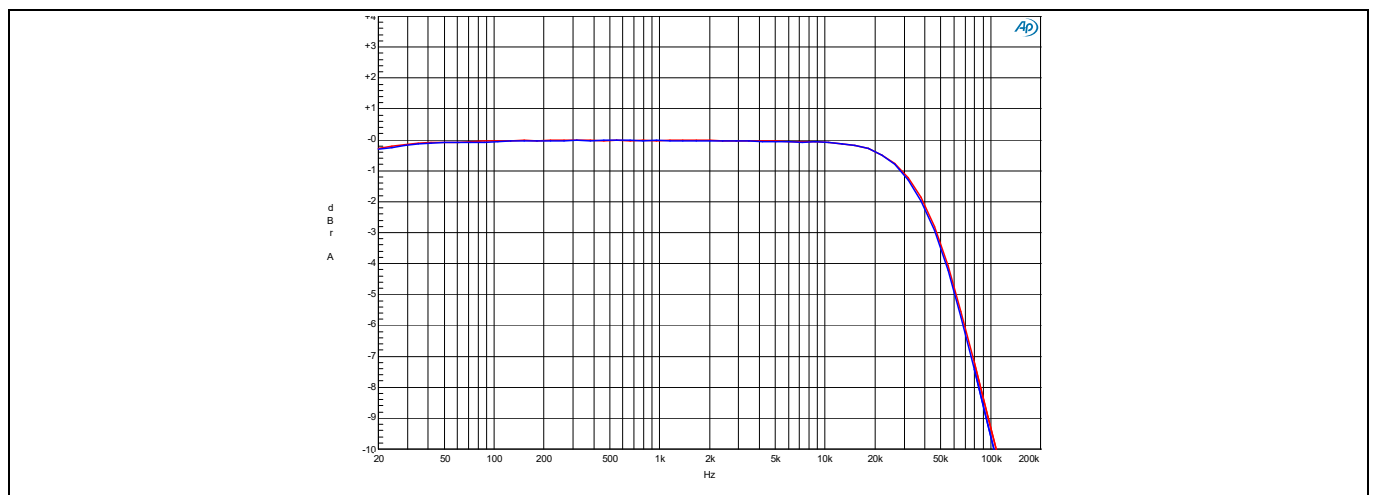
Test conditions:

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

Output power = 1 W

Load impedance =  $4 \Omega$

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



**Figure 5** Frequency response  $4 \Omega$  load

## EVAL\_AUDAMP25

### MA5332 evaluation board

#### 200 W+200 W class D amplifier

### 6.3 Noise floor

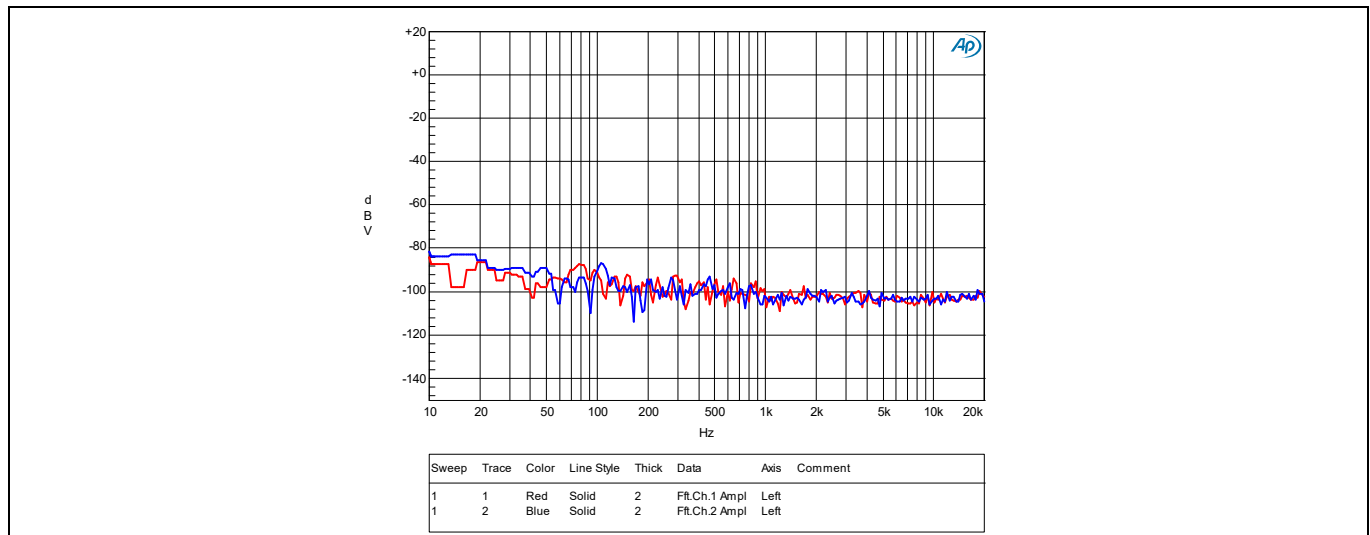
Test conditions:

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

No input signal

Load impedance =  $4 \Omega$

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



**Figure 6** Noise floor  $4 \Omega$  load

### 6.4 Noise floor with $1 V_{\text{RMS}}$ output

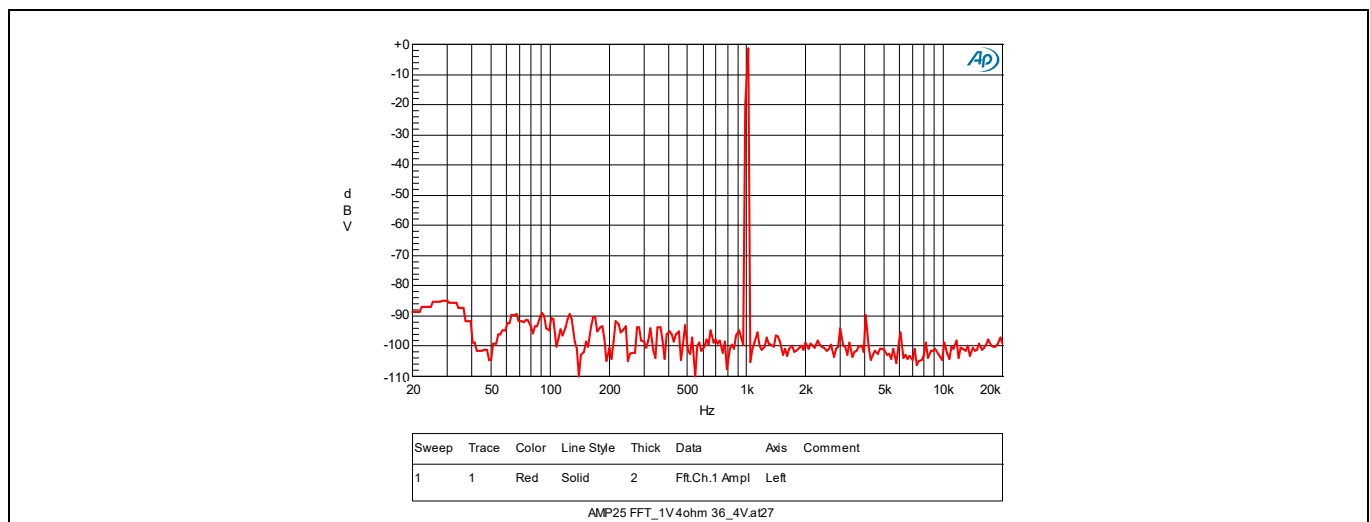
Test conditions:

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

Output =  $1 V_{\text{RMS}}$  at 1 kHz

Load impedance =  $4 \Omega$

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



**Figure 7** Noise floor with  $1 V_{\text{RMS}}$  output  $4 \Omega$  load

## 7 Efficiency

Test conditions:

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

Output =  $1 \text{ V}_{RMS}$  at 1 kHz

Load impedance =  $4 \Omega$

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

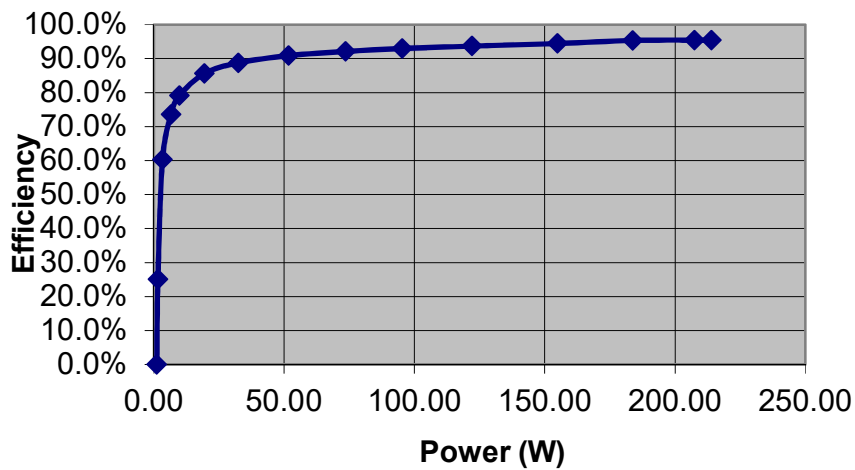


Figure 8 EVAL\_AUDAMP25  $4 \Omega$  load stereo,  $\pm B$  supply =  $\pm 36.5 \text{ V}$

## 8 Thermal information

### 8.1 Peak power duration thermal information

Test conditions:

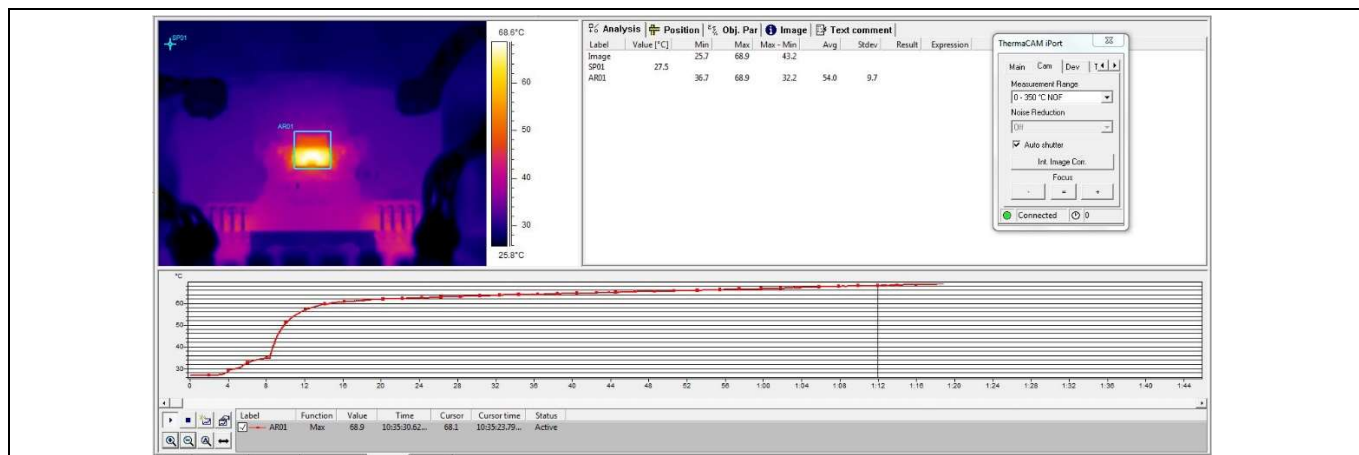
Input signal = 1 kHz

Both channels driven

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

**Table 4 Peak power with heatsink**

| Load ( $\Omega$ ) | $\pm V_{bus}$ (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                        |  |



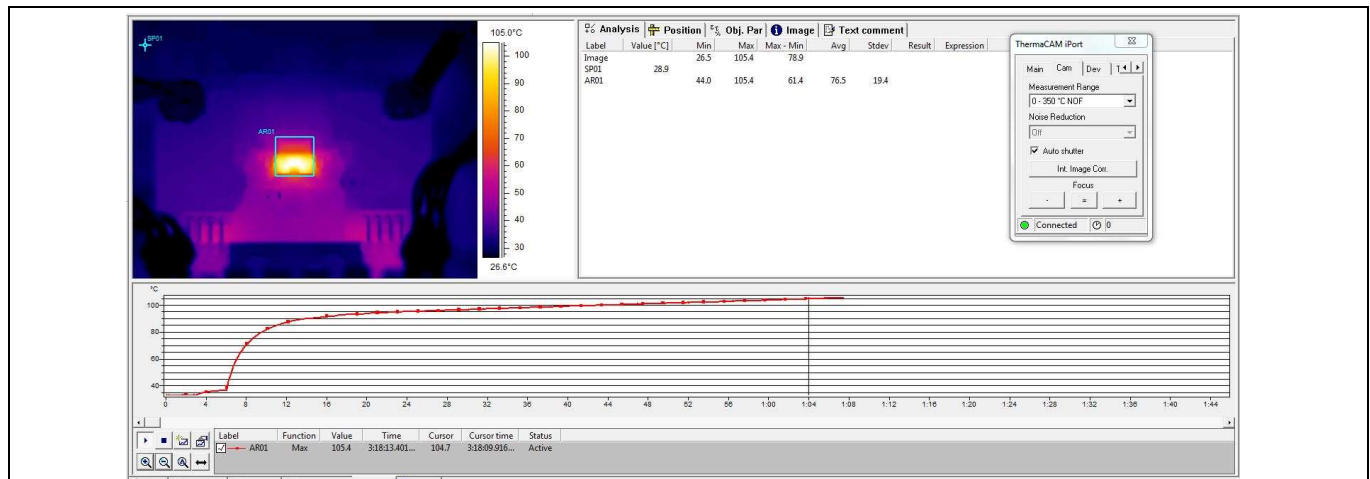
**Figure 9 Peak power  $P_{out} = 164 \text{ W}$  with  $6 \Omega$  load  $\pm 40 \text{ V}$**

*Note: Maximum temperature 68.9°C at 1 minute.*

# EVAL\_AUDAMP25

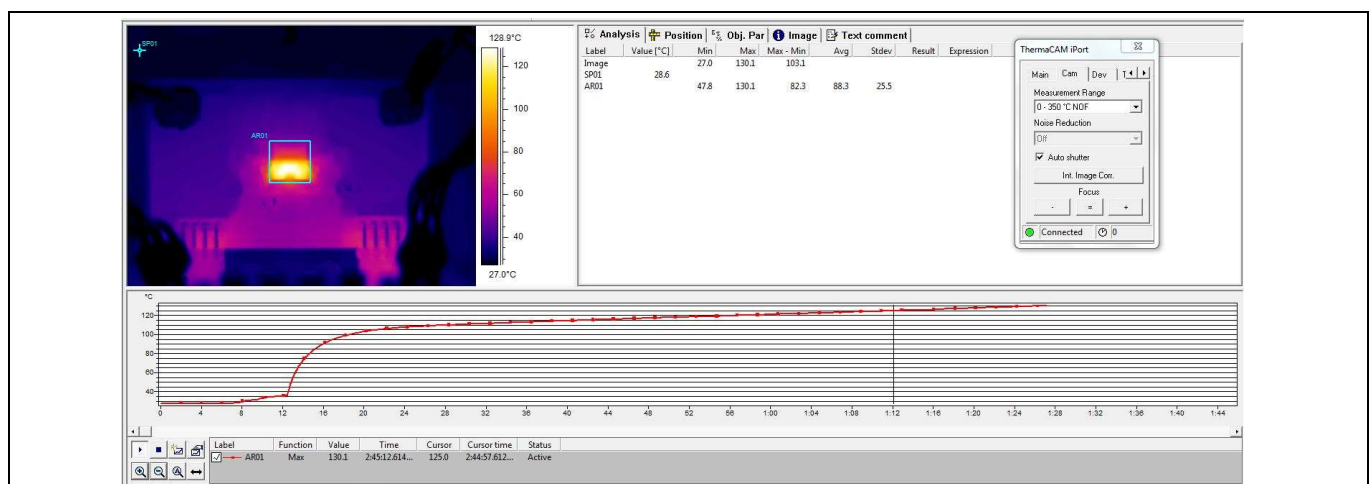
## MA5332 evaluation board

### 200 W+200 W class D amplifier



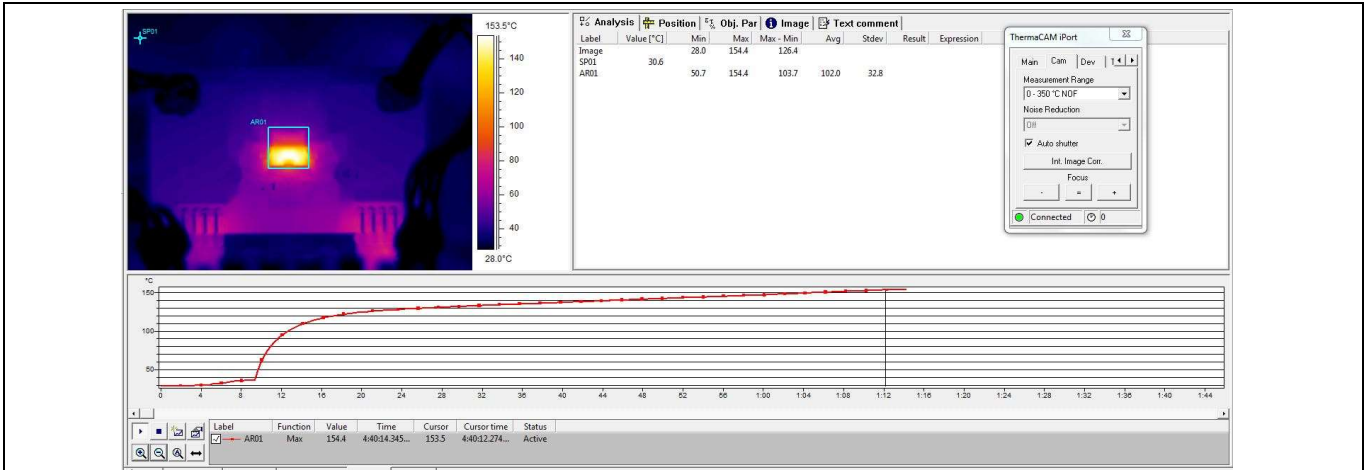
**Figure 10** Peak power  $P_{out} = 200\text{ W}$  with  $4\ \Omega$  load  $\pm 36.5\text{ V}$

Note: Maximum temperature  $105^{\circ}\text{C}$  at 1 minute.



**Figure 11** Peak power  $P_{out} = 194\text{ W}$  with  $3\ \Omega$  load  $\pm 31.5\text{ V}$

Note: Maximum temperature  $130^{\circ}\text{C}$  at 1 minute.

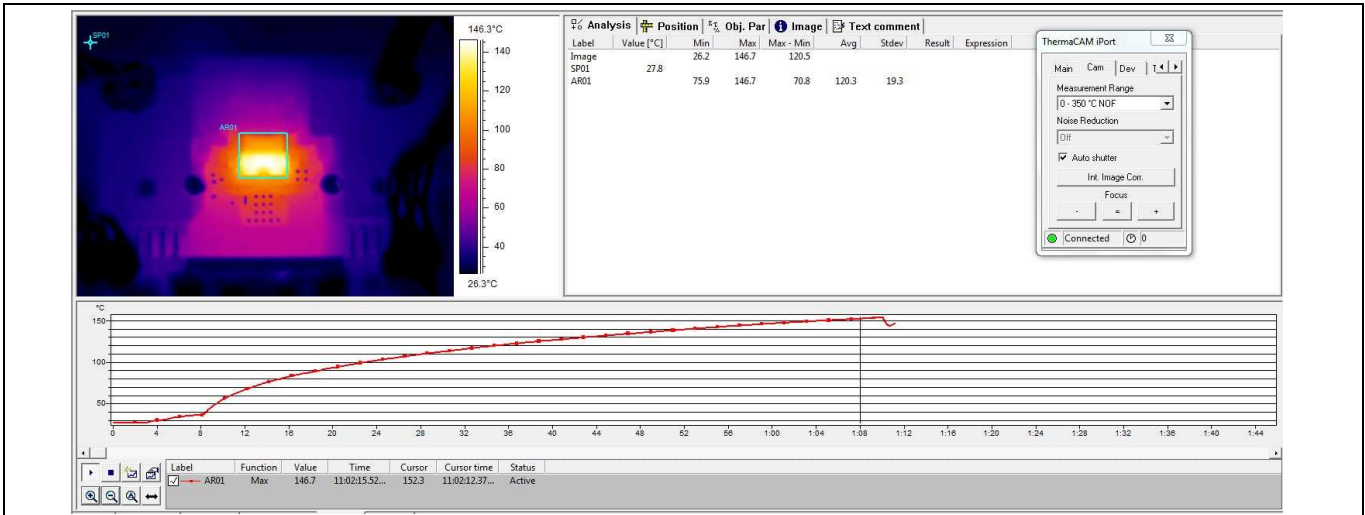


**Figure 12** Peak power  $P_{out} = 150\text{ W}$  with  $2\ \Omega$  load  $\pm 23\text{ V}$

*Note:* Maximum temperature  $154^{\circ}\text{C}$  at 1 minute.

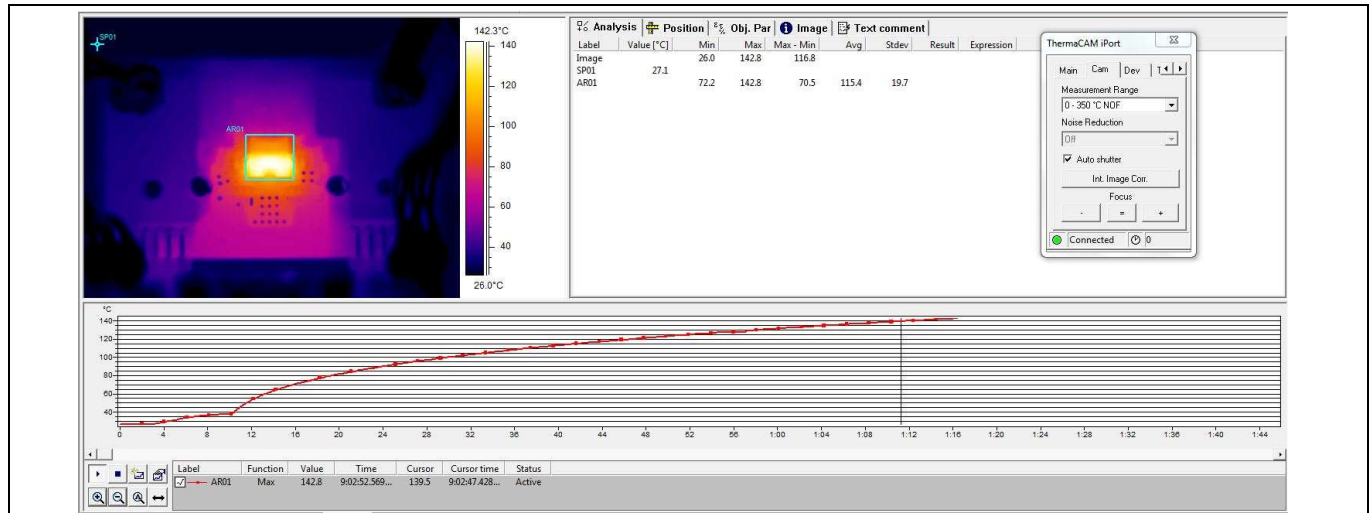
**Table 5** Peak power without heatsink

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



**Figure 13** Peak power  $P_{out} = 102\text{ W}$  with  $4\ \Omega$  load  $\pm 26.5\text{ V}$

*Note:* Maximum temperature  $146.7^{\circ}\text{C}$  at 1 minute.



**Figure 14** Peak power  $P_{out} = 55\text{ W}$  with  $2\ \Omega$  load  $\pm 13.7\text{ V}$

*Note:* Maximum temperature  $142.8^\circ\text{C}$  at 1 minute.

**Table 6** 1/8 power test with heatsink

| Load ( $\Omega$ ) | $\pm V_{bus}$ (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 ( $\Omega$ ) | $\pm V_{bus}$ (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                 |

## 8.2 Heatsink installation

Heatsink: V8818V

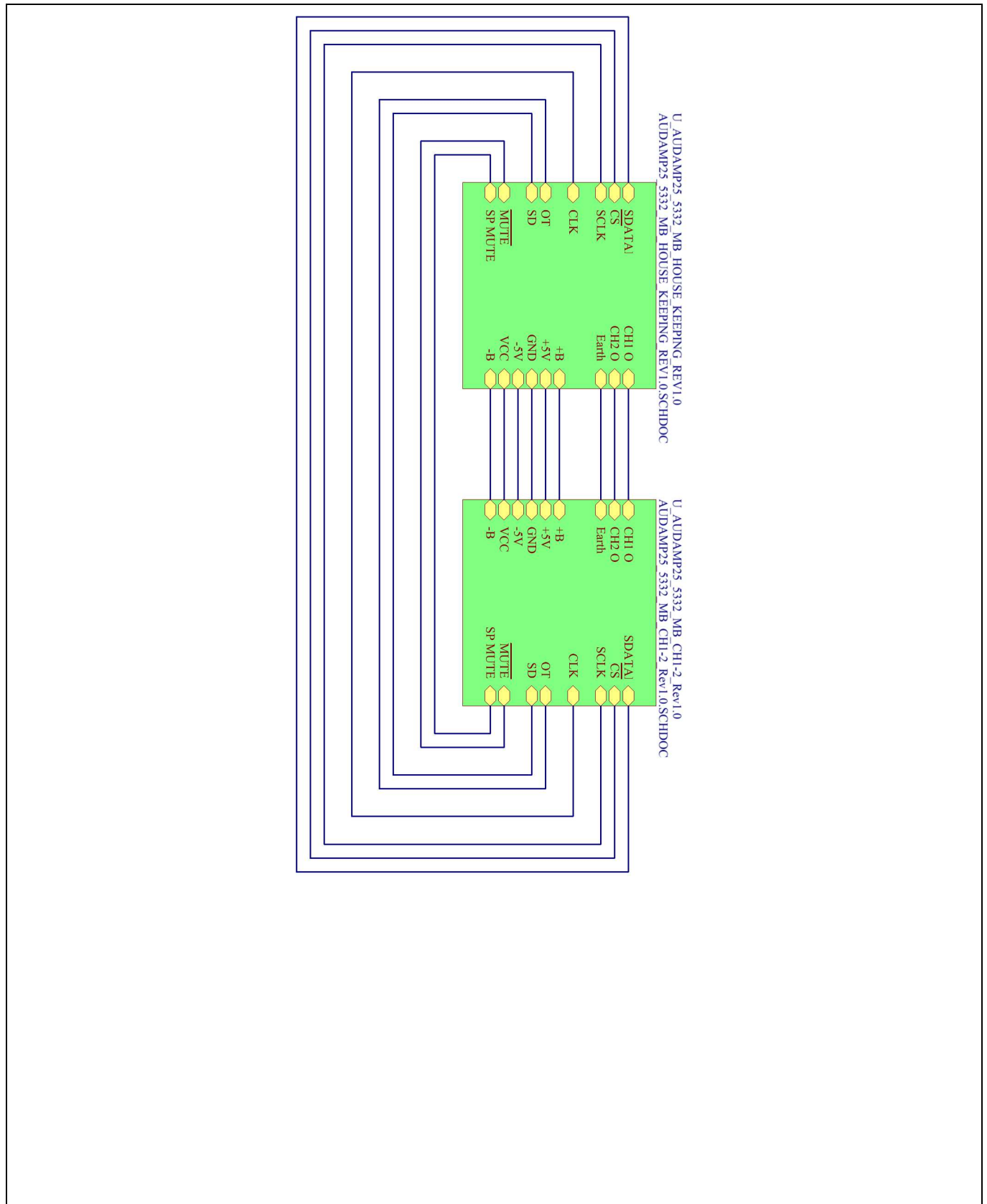
Thermal pad: BER161-ND



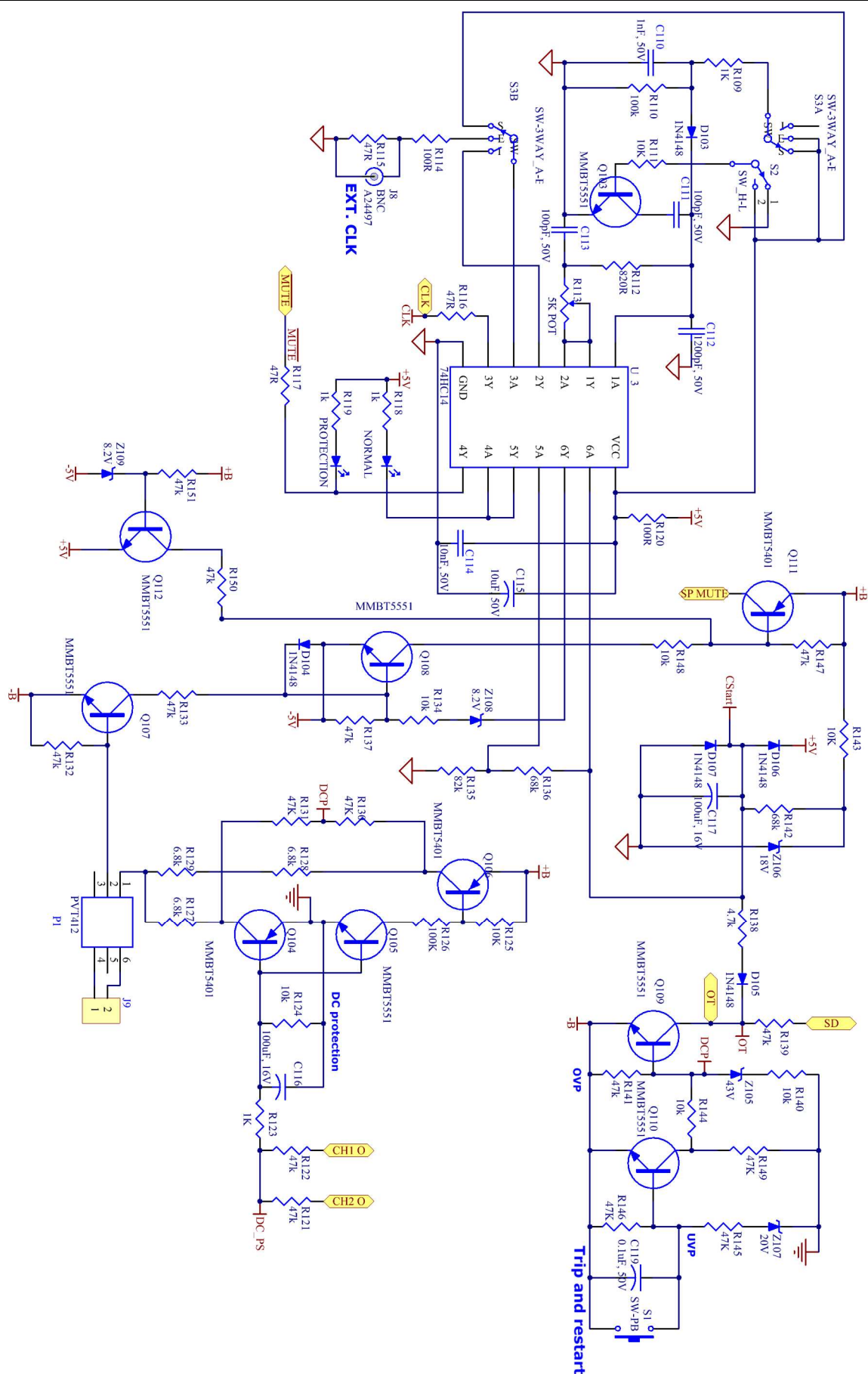
**Figure 15**      **Heatsink installation**



## 9 Schematic

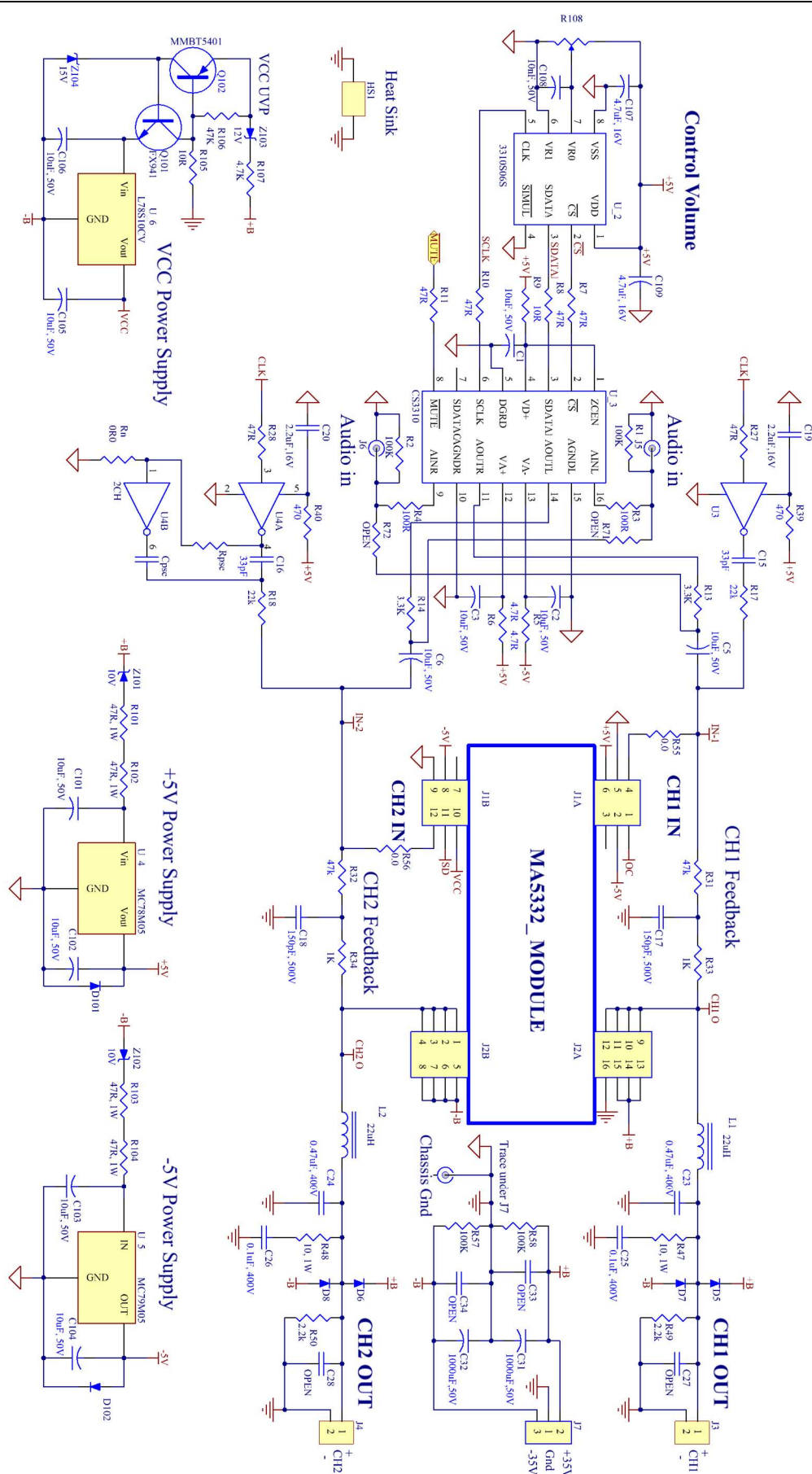


**Figure 16** Motherboard schematic 1

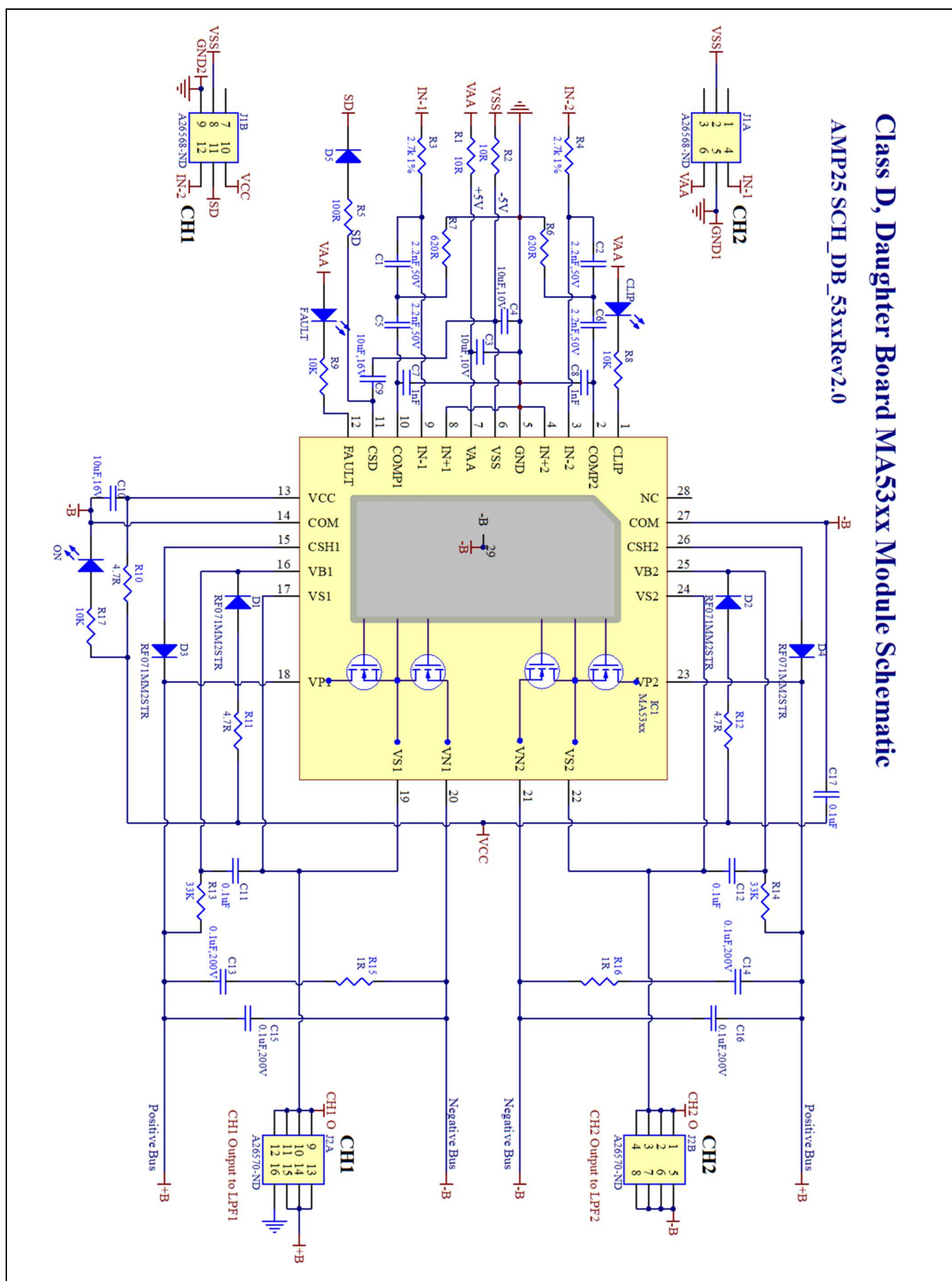


**Figure 17**      **Motherboard schematic 2**

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



**Figure 18** Motherboard schematic 3



**Figure 19**      **Daughterboard schematic**

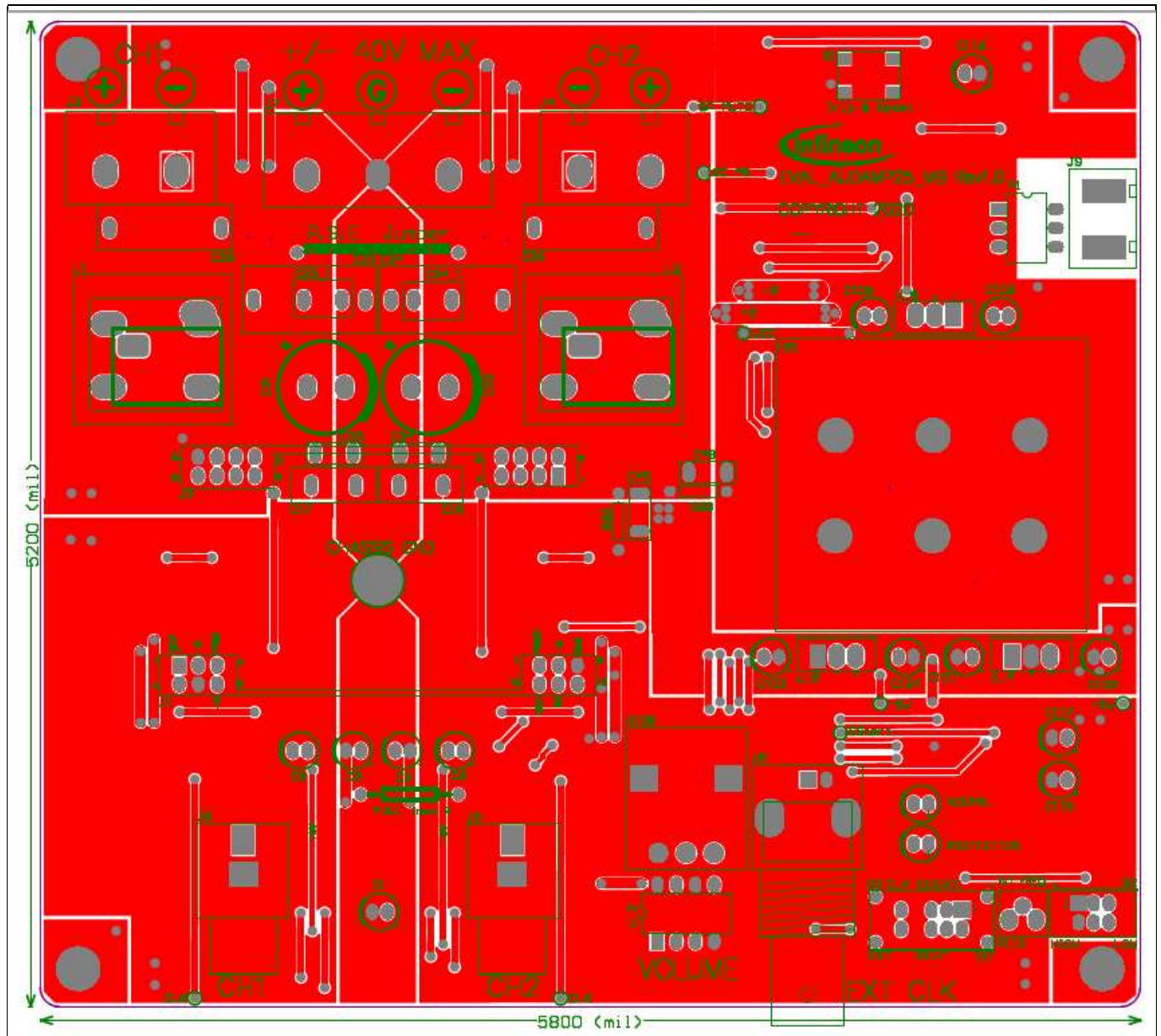
## **10 PCB**

### **10.1 PCB specification**

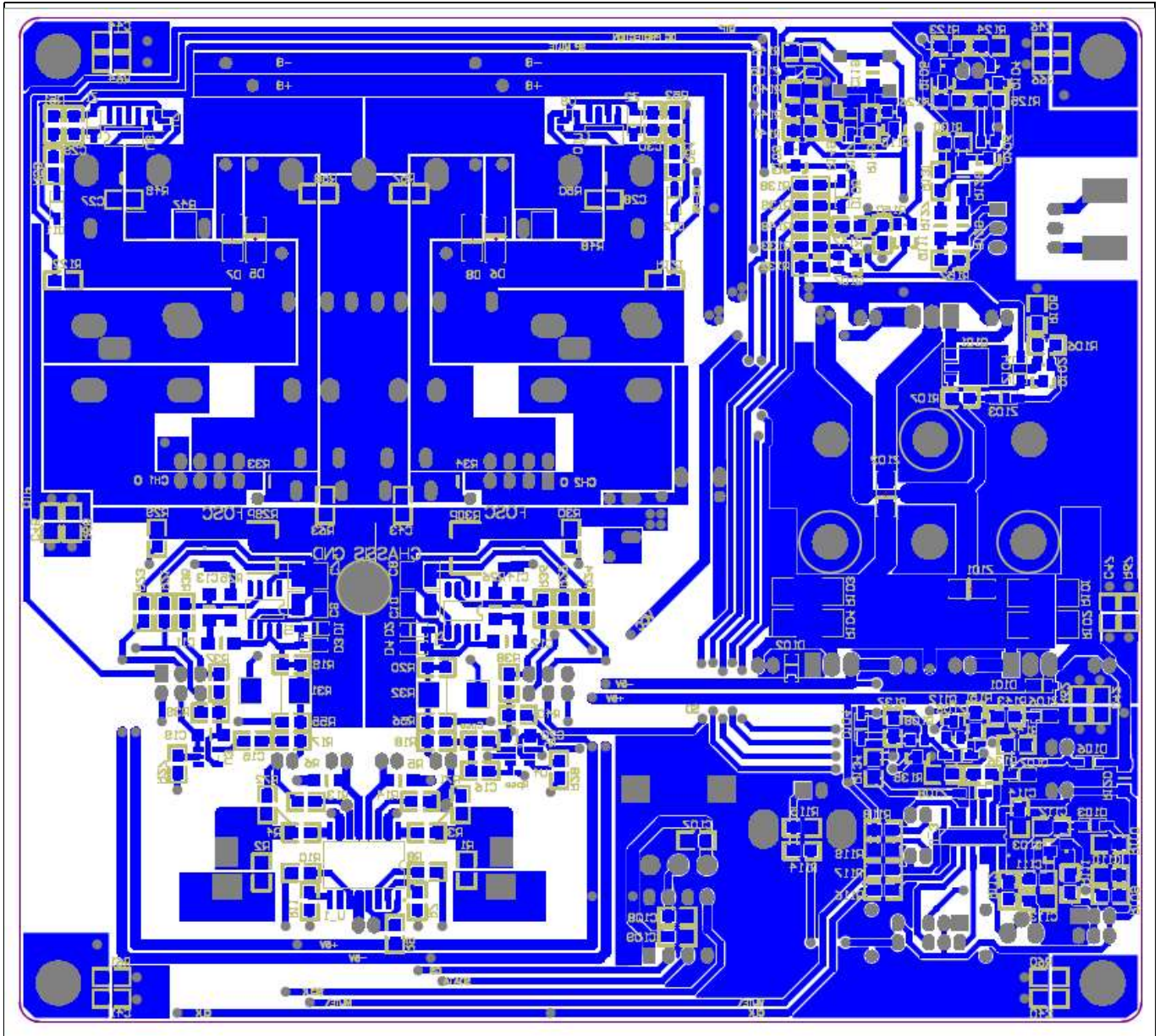
1. Two-layer SMT PCB with through-holes
2. 1/16 thickness
3. 2/0 oz. Cu
4. FR4 material
5. 20 mil lines and spaces
6. Solder mask to be green enamel EMP110 DBG (CARAPACE) or Enthone endplate DSR-3241 or equivalent
7. Silkscreen to be white epoxy non-conductive per IPC-RB 276 standard
8. All exposed copper must be finished with tin-lead Sn 60 or 63 for 100  $\mu$  inches thick
9. Tolerance of PCB size shall be 0.010 to 0.000 inches
10. Tolerance of all holes is/- 0.003 inches
11. PCB acceptance criteria as defined for class II PCB standards



## 10.2 PCB layout

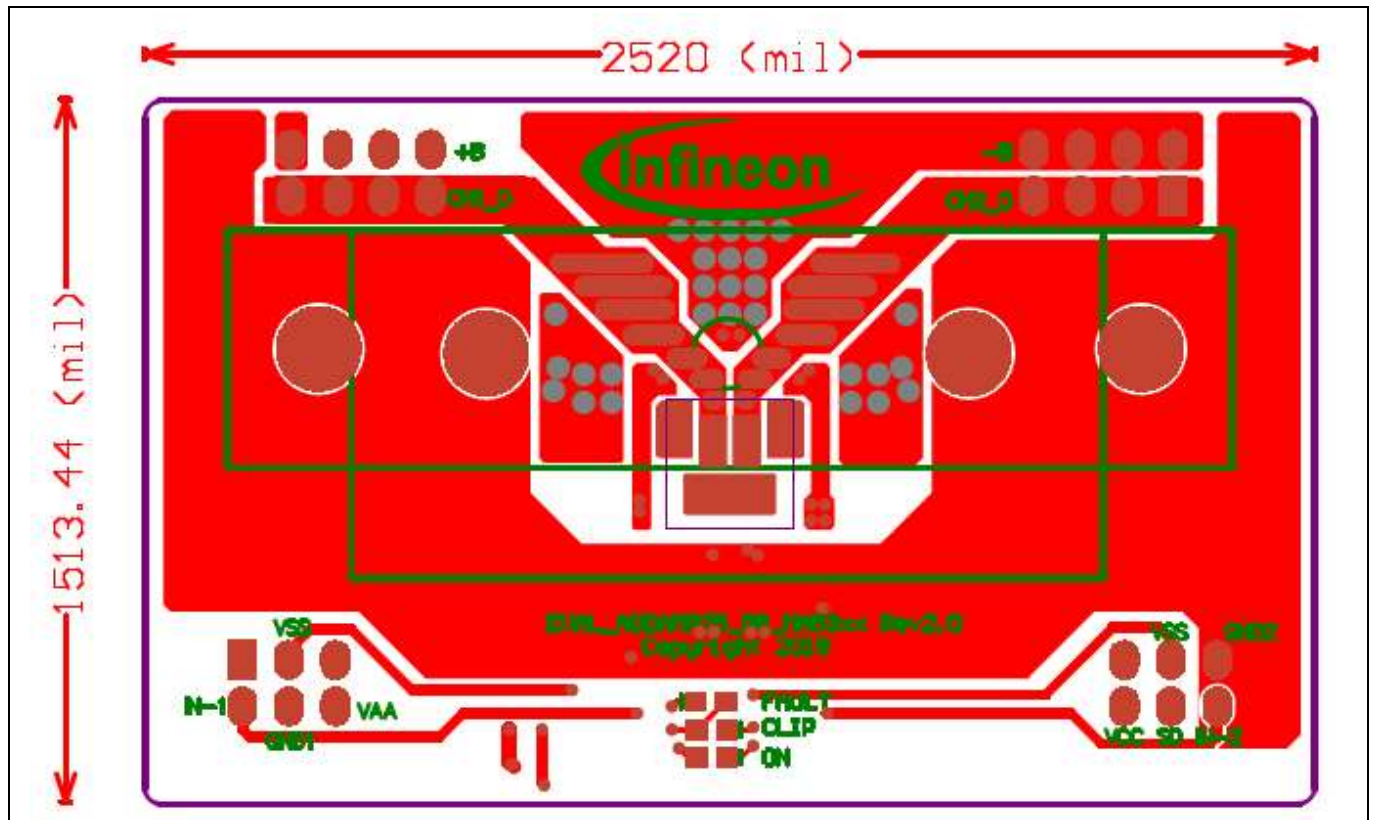


**Figure 20** Motherboard top view

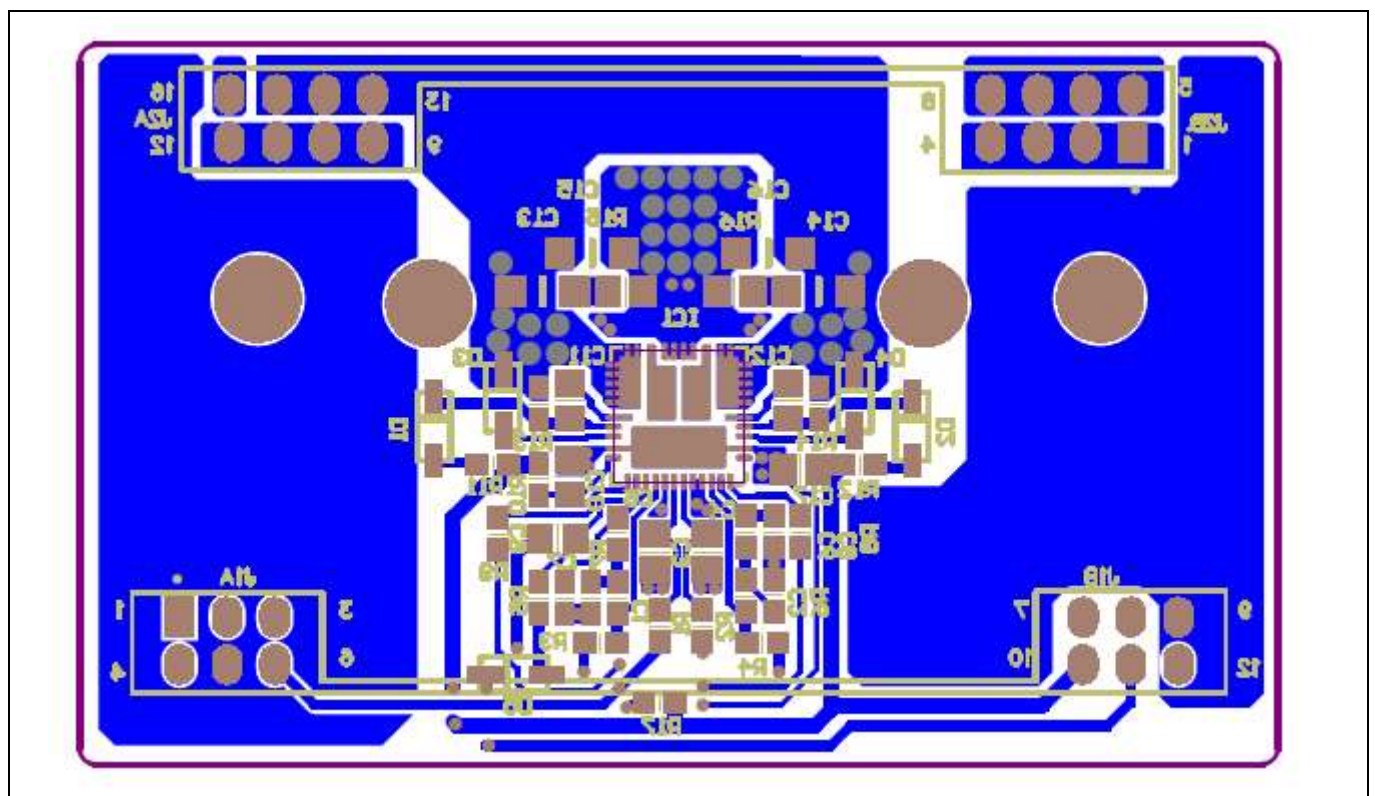


**Figure 21**      **Motherboard bottom view**





**Figure 22** Daughterboard top view



**Figure 23** Daughterboard 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 | CAP ALUM 10UF 20% 50V RADIAL     | 10       | Digikey |
| 2   | 565-1103-ND       | C2, C3   | CAP ALUM 2.2UF 20% 50V RADIAL    | 2        | Digikey |
| 3   | 478-1281-1-ND     | C15, C16   | CAP CER 33PF 100V C0G/NP0 0805   | 2        | Digikey |
| 4   | 338-2598-ND       | C17, C18   | CAP MICA 150PF 5% 500V RADIAL    | 2        | Digikey |
| 5   | 1276-3141-1-ND    | C19, C20   | CAP CER 2.2UF 16V X7R 1206       | 2        | Digikey |
| 6   | 732-8127-1-ND     | C119   | CAP CER 0.1UF 50V X7R 1206       | 1        | Digikey |
| 7   | 495-1315-ND       | C23, C24   | CAP FILM 0.47UF 5% 400VDC RADIAL | 2        | Digikey |
| 8   | 495-1311-ND       | C25, C26   | CAP FILM 0.1UF 5% 400VDC RADIAL  | 2        | Digikey |
| 9   | 565-1114-ND       | C31, C32   | CAP ALUM 1000UF 20% 50V RADIAL   | 2        | Digikey |
| 10  | 490-14466-1-ND    | C107, C109   | CAP CER 4.7UF 16V X7R 0805       | 2        | Digikey |
| 11  | 732-8074-1-ND     | C108, C114   | CAP CER 10000PF 50V X7R 0805     | 2        | Digikey |
| 12  | 732-7858-1-ND     | C110   | CAP CER 1000PF 50V C0G/NP0 0805  | 1        | Digikey |
| 13  | 732-7852-1-ND     | C111, C113   | CAP CER 100PF 50V C0G/NP0 0805   | 2        | Digikey |
| 14  | 478-1372-1-ND     | C112   | CAP CER 1200PF 50V X7R 0805      | 1        | Digikey |
| 15  | 565-1037-ND       | C116, C117   | CAP ALUM 100UF 20% 16V RADIAL    | 2        | Digikey |
| 16  | 1N4148W-FDICT-ND  | D103, D104, D105, D106, D107                         | DIODE GEN PURP 100V 300MA SOD123 | 5        | Digikey |
| 17  | MURA120T3GOSCT-ND | D5, D6, D7, D8                                       | DIODE GEN PURP 200V 2A SMA       | 4        | Digikey |
| 18  | RB161MM-20CT-ND   | D101, D102   | DIODE SCHOTTKY 25V 1A PMDU       | 2        | Digikey |
| 19  | 294-1086-ND       | HS1  | HEATSINK HORZ SIX BLACK TO-220   | 1        | Digikey |

| No. | Part number       | Designator                                     | Description   | Quantity | Vendor                     |
|-----|-------------------|--|---|----------|----------------------------|
| 20  | A32934-ND         | J1A, J1B                                       | CONN RCPT 6POS 0.1<br>GOLD PCB                            | 2        | Digikey                    |
| 18  | 478-1281-1-ND     | C40, C58                                       | Ceramic capacitor 33 pF 5<br>percent 100 V NP0 0805       | 2        | Digikey                    |
| 19  | 445-1432-1-ND     | C41, C43, C59, C61                             | Ceramic capacitor 3.3 $\mu$ F<br>50 V X7R 20 percent 1210 | 4        | Digikey                    |
| 20  | 565-1161-ND       | C45, C46, C47, C48                             | Capacitor 1200 $\mu$ F 100 V<br>elect. SMG RAD            | 4        | Digikey                    |
| 21  | PCC1812CT-ND      | C62, C63, C68, C78                             | Capacitor .1 $\mu$ F 16 V<br>ceramic X7R 0805             | 4        | Digikey                    |
| 21  | A32935-ND         | J2A, J2B                                       | CONN RCPT 8POS 0.1<br>GOLD PCB                            | 2        | Digikey                    |
| 22  | 277-1271-ND       | J3, J4   | TERM BLK 2P SIDE ENT<br>9.53MM PCB                        | 2        | Digikey or<br>Mouser       |
| 23  | CP-1422-ND        | J5, J6   | CONN RCA JACK MONO<br>3.2MM R/A                           | 2        | Digikey                    |
| 24  | 277-1272-ND       | J7   | TERM BLK 3P SIDE ENT<br>9.53MM PCB                        | 1        | Digikey or<br>Mouser       |
| 25  | A32248-ND         | J8   | CONN BNC JACK R/A 50<br>OHM PCB                           | 1        | Digikey                    |
| 26  | ED1567            | J9   | TERM BLK 2POS SIDE ENT<br>7.5MM PCB                       | 1        | Digikey                    |
| 27  | Sagami 7G17A-     | L1, L2   | Class D inductor, 22uH                                    | 2        | Inductors, Inc             |
|     | 1D17A-220M        |  |   |          | ICE<br>Components,<br>Inc. |
|     | CPD1715F-220      |  |   |          | CODACA                     |
| 28  | 160-1143-ND       | NORMAL   | LED GREEN CLEAR T-1<br>T/H                                | 1        | Digikey                    |
| 29  | PVT412PBF-ND      | P1   | SSR RELAY SPST-NO<br>140MA 0-400V                         | 1        | Digikey                    |
| 30  | 160-1140-ND       | PROTECTION                                     | LED RED CLEAR T-1 T/H                                     | 1        | Digikey                    |
| 31  | FCX491CT-ND       | Q101   | TRANS NPN 60V 1A SOT-<br>89                               | 1        | Digikey                    |
| 32  | MMBT5401-FDICT-ND | Q102, Q104, Q106,<br>Q111                      | TRANS PNP 150V 0.6A<br>SMD SOT23-3                        | 4        | Digikey                    |
| 33  | MMBT5551-FDICT-ND | Q103, Q105, Q107,<br>Q108, Q109, Q110,<br>Q112 | TRANS NPN 160V 0.6A<br>SOT23-3                            | 7        | Digikey                    |
| 34  | P100KACT-ND       | R1, R2, R57, R58,<br>R110, R126                | RES SMD 100K OHM 5%<br>1/8W 0805                          | 6        | Digikey                    |
| 35  | P100ACT-ND        | R3, R4, R114                                   | RES SMD 100 OHM 5%<br>1/8W 0805                           | 3        | Digikey                    |

| No. | Part number             | Designator  | Description                        | Quantity | Vendor  |
|-----|-------------------------|---|------------------------------------|----------|---------|
| 36  | P4.7ECT-ND              | R5, R6  | RES SMD 4.7 OHM 5%<br>1/4W 1206    | 2        | Digikey |
| 37  | P47ACT-ND               | R7, R8, R10, R11,<br>R27, R28, R115,<br>R116, R117  | RES SMD 47 OHM 5%<br>1/8W 0805     | 9        | Digikey |
| 38  | P10ACT-ND               | R9, R105  | RES SMD 10 OHM 5%<br>1/8W 0805     | 2        | Digikey |
| 39  | P3.3KDACT-ND            | R13, R14  | RES 3.3K OHM 0.1% 1/8W<br>0805     | 2        | Digikey |
| 40  | P22KACT-ND              | R17, R18  | RES SMD 22K OHM 5%<br>1/8W 0805    | 2        | Digikey |
| 41  | P47KACT-ND              | R106, R121, R122,<br>R130, R131, R132,<br>R133, R137, R139,<br>R141, R145, R146,<br>R147, R149, R150,<br>R151 | RES SMD 47K OHM 5%<br>1/8W 0805    | 16       | Digikey |
| 42  | P0.0ACT-ND              | R55, R56  | RES SMD 0 OHM JUMPER<br>1/8W 0805  | 2        | Digikey |
| 43  | P470ACT-ND              | R39, R40  | RES SMD 470 OHM 5%<br>1/8W 0805    | 2        | Digikey |
| 44  | P100ECT-ND              | R120  | RES SMD 100 OHM 5%<br>1/4W 1206    | 1        | Digikey |
| 45  | TNPW251247K0BEEG-<br>ND | R31, R32  | RES 47K OHM 0.1% 1/2W<br>2512      | 2        | Digikey |
|     | CPD3119-220M            | Substitute  |                                    |          | CODACA  |
| 46  | YAG2331CT-ND            | R33, R34  | RES SMD 1K OHM 0.1%<br>1/4W 1206   | 2        | Digikey |
| 47  | P1.0KACT-ND             | R109, R118, R119,<br>R123   | RES SMD 1K OHM 5%<br>1/8W 0805     | 4        | Digikey |
| 48  | PT10XCT                 | R47, R48  | RES SMD 10 OHM 5% 1W<br>2512       | 2        | Digikey |
| 49  | P2.2KECT-ND             | R49, R50  | RES SMD 2.2K OHM 5%<br>1/4W 1206   | 2        | Digikey |
| 50  | PT47XCT-ND              | R101, R102, R103,<br>R104   | RES SMD 47 OHM 5% 1W<br>2512       | 4        | Digikey |
| 51  | P4.7KACT-ND             | R107, R138  | RES SMD 4.7K OHM 5%<br>1/8W 0805   | 2        | Digikey |
| 52  | PDB12-H4251-103BF       | R108  | POT 10K OHM 0.08W<br>CARBON LINEAR | 1        | Digikey |
| 53  | P10KACT-ND              | R111, R124, R125,<br>R134, R140, R143,<br>R144, R148  | RES SMD 10K OHM 5%<br>1/8W 0805    | 8        | Digikey |
| 54  | P820ACT-ND              | R112  | RES SMD 820 OHM 5%<br>1/8W 0805    | 1        | Digikey |

| No. | Part number         | Designator       | Description   | Quantity | Vendor     |
|-----|---------------------|------------------|---|----------|------------|
| 55  | 3362H-502LF-ND      | R113             | TRIMMER 5K OHM 0.5W<br>PC PIN TOP                   | 1        | Digikey    |
| 56  | P6.8KECT-ND         | R127, R128, R129 | RES SMD 6.8K OHM 5%<br>1/4W 1206                    | 3        | Digikey    |
| 57  | P82KACT-ND          | R135             | RES SMD 82K OHM 5%<br>1/8W 0805                     | 1        | Digikey    |
| 58  | P68KACT-ND          | R136, R142       | RES SMD 68K OHM 5%<br>1/8W 0805                     | 2        | Digikey    |
| 59  | RMCF0402ZT0R00CT-ND | Rn               | RES 0 OHM JUMPER<br>1/16W 0402                      | 1        | Digikey    |
| 60  | P8010S-ND           | S1               | SWITCH TACTILE SPST-<br>NO 0.02A 15V                | 1        | Digikey    |
| 61  | EG1908-ND           | S2               | SWITCH SLIDE DPDT<br>100MA 12V                      | 1        | Digikey    |
| 62  | EG1944-ND           | S3               | SWITCH SLIDE DP3T<br>200MA 30V                      | 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<br>CONTROL, SOIC-16              | 1        | Newark     |
| 66  | 3310-IR01           | U_2              | CS3310 Stand-alone<br>Controller                    | 1        | *Tachyonix |
| 67  | 296-1194-1-ND       | U_3              | IC INVERTER SCHMITT<br>6CH 14SOIC                   | 1        | Digikey    |
| 68  | MC78M05CTGOS-ND     | U_4              | IC REG LINEAR 5V 500MA<br>TO220AB                   | 1        | Digikey    |
| 69  | LM79M05CT-ND        | U_5              | IC REG LINEAR -5V 500MA<br>TO220-3                  | 1        | Digikey    |
| 70  | 497-6039-5-ND       | U_6              | IC REG LINEAR 10V 2A<br>TO220AB                     | 1        | Digikey    |
| 71  | BZT52C15-FDICT-ND   | Z103             | DIODE ZENER 15V 500MW<br>SOD123                     | 1        | Digikey    |
| 72  | 1SMA5917BT3GOSCT-ND | Z101, Z102       | DIODE ZENER 4.7V 1.5W<br>SMA                        | 2        | Digikey    |
| 73  | BZT52C24-FDICT-ND   | Z104             | DIODE ZENER 24V 500MW<br>SOD123                     | 1        | Digikey    |
| 74  | MMSZ5260BT1GOSCT-ND | Z105             | DIODE ZENER 43V 500MW<br>SOD123                     | 1        | Digikey    |
| 75  | BZT52C18-FDICT-ND   | Z106             | DIODE ZENER 18V 500MW<br>SOD123                     | 1        | Digikey    |
| 76  | MMSZ20T1GOSCT-ND    | Z107             | ON Semiconductor<br>DIODE ZENER 20V 500MW<br>SOD123 | 1        | Digikey    |
| 77  | BZT52C8V2-FDICT-ND  | Z108, Z109       | DIODE ZENER 8.2V<br>500MW SOD123                    | 2        | Digikey    |

| No. | Part number    | Designator                                | Description                      | Quantity | Vendor  |
|-----|----------------|---|----------------------------------|----------|---------|
| 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                       | HEX STANDOFF #4-40 ALUMINUM 1/2" | 5        | Digikey |
| 81  | H724-ND        | 4-40 Nut                                  | NUT HEX 4-40 STAINLESS STEEL     | 5        | Digikey |
| 82  | H729-ND        | No. 4 Lock Washer                         | WASHER LOCK INTERNAL #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](mailto: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     | 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  | C11, C12, C17      | CAP CER .10UF 100V X7R 10% 0805      | 3        | Digikey  |
| 6   | 732-12081-1-ND | C13, C14, C15, C16 | CAP CER 0.1UF 200V X7R 1206          | 4        | Digikey  |
| 7   | RF071MM2SCT-ND | D1, D2, D3, D4, D5 | DIODE GEN PURP 200V 700MA 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 468NM BLUE CLEAR 0603 SMD        | 1        | Digikey  |
| 11  | MA5332         | IC1                | 2 CH PowlRadio integrated Class D IC | 1        | Infineon |
| 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  |

| No. | Part number         | Designator    | Description                      | Quantity | Vendor  |
|-----|---------------------|---------------|----------------------------------|----------|---------|
| 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  | 311-620GRCT-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  | RHM33KGCT-ND        | R13, R14      | RES 33K 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 |
| 22* | V8818V              | Heatsink      | HEATSINK ALUM ANOD               | 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            | 2020-11-20      | Initial release   |
| V 1.1            | 2023-07-12      | Changed value of R6, R7 on daughter card schematic to match BOM |
|                  |                 |   |

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**Email: [erratum@infineon.com](mailto:erratum@infineon.com)**

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