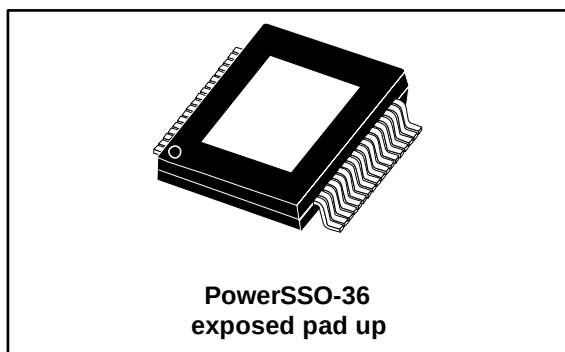


## 100 W mono BTL class-D audio amplifier

Datasheet - production data



### Features

- 100 W output power at THD = 10% with  $R_L = 6\ \Omega$  and  $V_{CC} = 36\text{ V}$
- 80 W output power at THD = 10% with  $R_L = 8\ \Omega$  and  $V_{CC} = 34\text{ V}$
- Wide-range single-supply operation (14 - 39 V)
- High efficiency ( $\eta = 90\%$ )
- Four selectable, fixed gain settings of nominally 25.6 dB, 31.6 dB, 35.1 dB and 37.6 dB

- Differential inputs minimize common-mode noise
- Standby and mute features
- Short-circuit protection
- Thermal overload protection
- Externally synchronizable

### Description

The TDA7498MV is a mono BTL class-D audio amplifier with single power supply designed for home systems and active speaker applications.

It comes in a 36-pin PowerSSO package with exposed pad up (EPU) to facilitate mounting a separate heatsink.

**Table 1: Device summary**

| Order code  | Operating temp. range | Package          | Packaging     |
|-------------|-----------------------|------------------|---------------|
| TDA7498MVTR | -40 to 85 °C          | PowerSSO36 (EPU) | Tape and reel |

---

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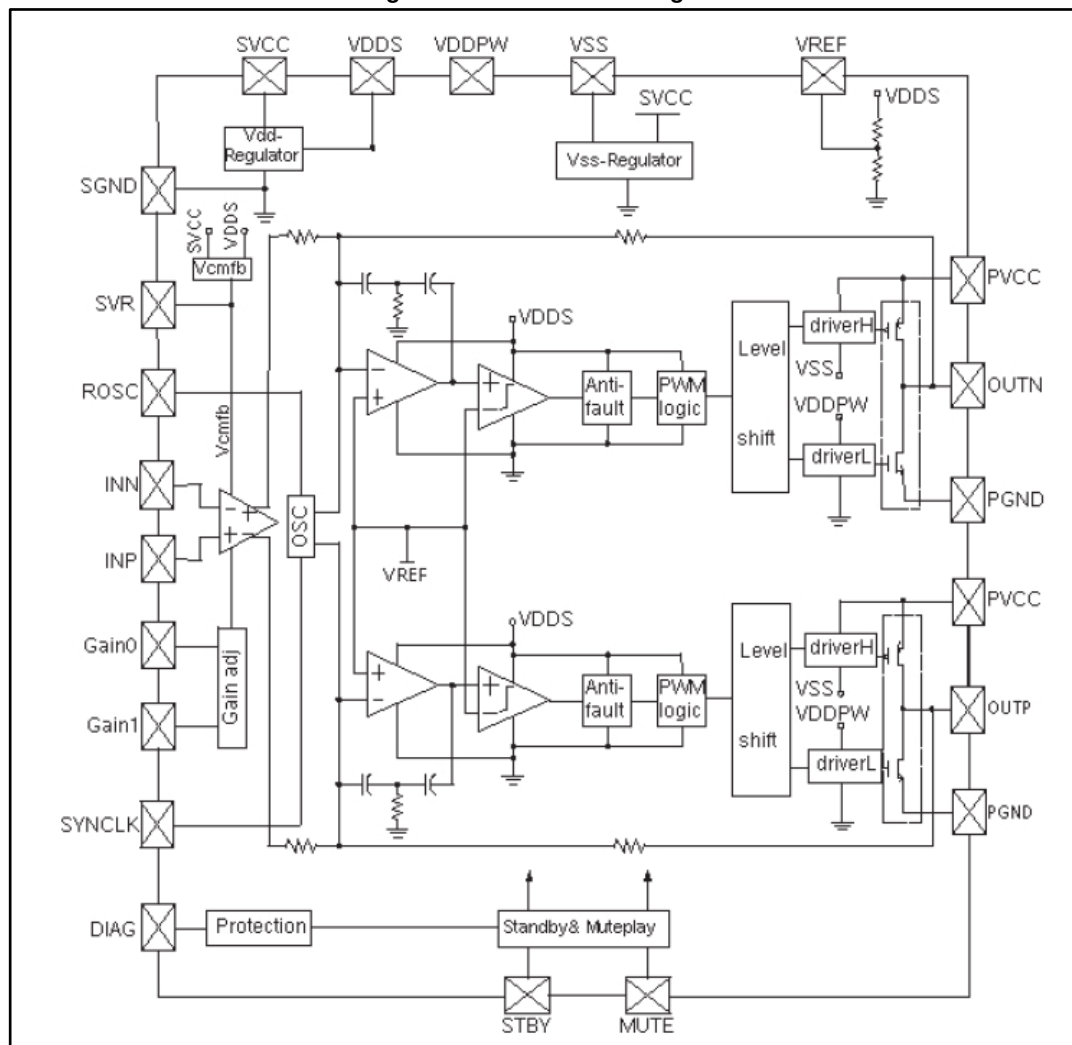
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# 1 Device block diagram

Figure 1: "Internal block diagram" shows the block diagram of the TDA7498MV.

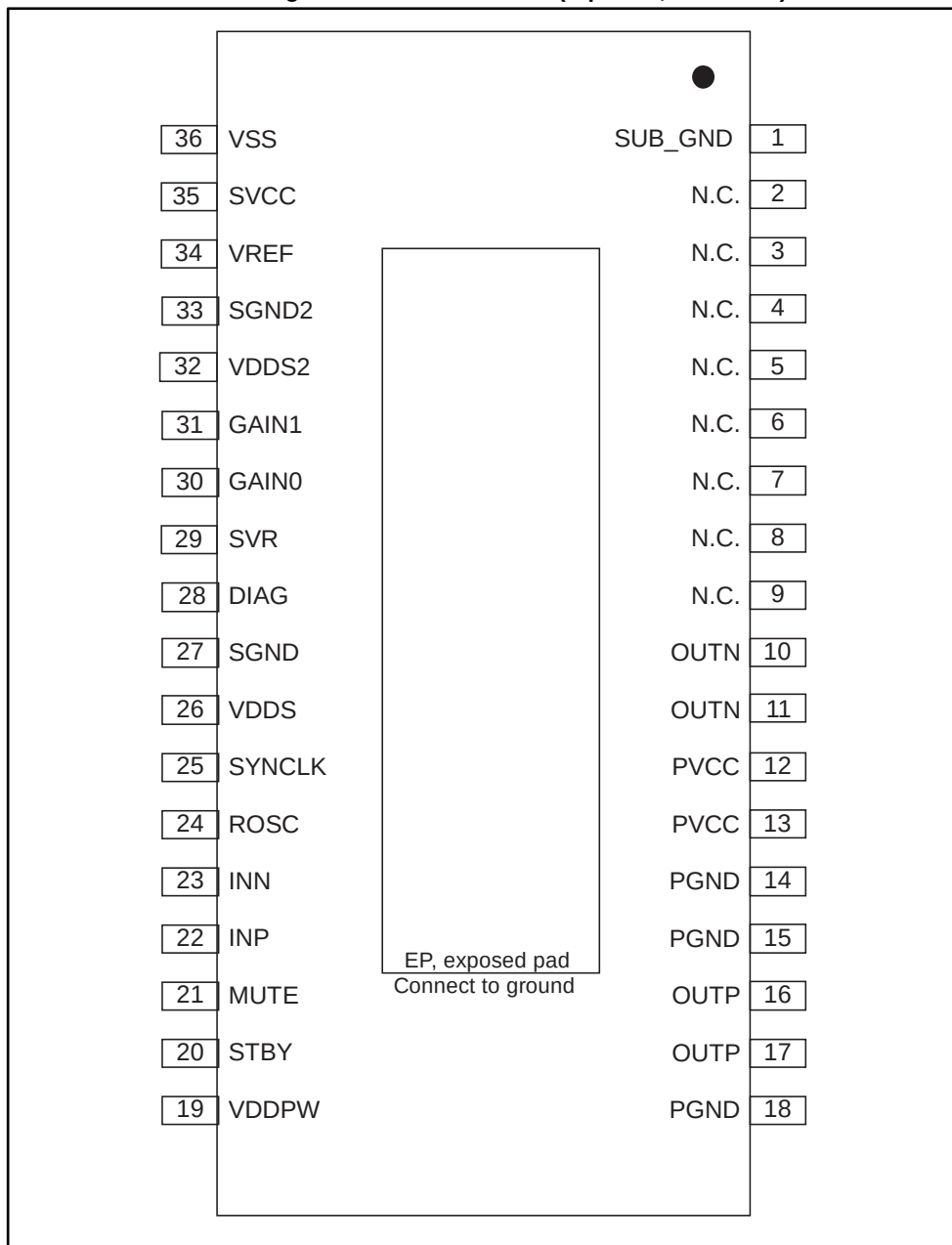
Figure 1: Internal block diagram



## 2 Pin description

### 2.1 Pinout

Figure 2: Pin connections (top view, PCB view)



## 2.2 Pin list

Table 2: Pin description list

| Number | Name    | Type | Description                                                           |
|--------|---------|------|-----------------------------------------------------------------------|
| 1      | SUB_GND | PWR  | Connect to the frame                                                  |
| 2, 3   | NC      | -    | No internal connection                                                |
| 4, 5   | NC      | -    | No internal connection                                                |
| 6, 7   | NC      | -    | No internal connection                                                |
| 8, 9   | NC      | -    | No internal connection                                                |
| 10, 11 | OUTN    | O    | Negative PWM output for audio channel                                 |
| 12, 13 | PVCC    | PWR  | Power supply for audio channel                                        |
| 14, 15 | PGND    | PWR  | Power stage ground                                                    |
| 16, 17 | OUTP    | O    | Positive PWM output for audio channel                                 |
| 18     | PGND    | PWR  | Power stage ground                                                    |
| 19     | VDDPW   | O    | 3.3-V (nominal) regulator output referred to ground for power stage   |
| 20     | STBY    | I    | Standby mode control                                                  |
| 21     | MUTE    | I    | Mute mode control                                                     |
| 22     | INP     | I    | Positive differential input                                           |
| 23     | INN     | I    | Negative differential input                                           |
| 24     | ROSC    | O    | Master oscillator frequency-setting pin                               |
| 25     | SYNCLK  | I/O  | Clock in/out for external oscillator                                  |
| 26     | VDDS    | O    | 3.3-V (nominal) regulator output referred to ground for signal blocks |
| 27     | SGND    | PWR  | Signal ground                                                         |
| 28     | DIAG    | O    | Open-drain diagnostic output                                          |
| 29     | SVR     | O    | Supply voltage rejection                                              |
| 30     | GAIN0   | I    | Gain setting input 1                                                  |
| 31     | GAIN1   | I    | Gain setting input 2                                                  |
| 32     | VDDS2   | O    | Connect to VDDS (pin 26)                                              |
| 33     | SGND2   | PWR  | Connect to SGND (pin 27)                                              |
| 34     | VREF    | O    | Half VDDS (nominal) referred to ground                                |
| 35     | SVCC    | PWR  | Signal power supply decoupling                                        |
| 36     | VSS     | O    | 3.3-V (nominal) regulator output referred to power supply             |
| -      | EP      | -    | Exposed pad for heatsink, to be connected to ground                   |

## 3 Electrical specifications

### 3.1 Absolute maximum ratings

Table 3: Absolute maximum ratings

| Symbol        | Parameter                                                                      | Value       | Unit |
|---------------|--------------------------------------------------------------------------------|-------------|------|
| $V_{CC\_MAX}$ | DC supply voltage for pins PVCCA, PVCCB, SVCC                                  | 45          | V    |
| $V_{L\_MAX}$  | Voltage limits for input pins STBY, MUTE, INNA, INPA, INNB, INPB, GAIN0, GAIN1 | -0.3 to 3.6 | V    |
| $T_{j\_MAX}$  | Operating junction temperature                                                 | 0 to 150    | °C   |
| $T_{op\_MAX}$ | Operating temperature                                                          | -40 to 85   | °C   |
| $T_{stg}$     | Storage temperature                                                            | -40 to 150  | °C   |



**Warning:** Stresses beyond those listed under “Absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “Recommended operating condition” are not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability. In the real application, the power supply with nominal value rated inside recommended operating conditions may rise beyond the maximum operating condition for a short time when no or very low current is sunk (amplifier in mute state). In this case the reliability of the device is guaranteed, provided that the absolute maximum rating is not exceeded.

### 3.2 Thermal data

Table 4: Thermal data

| Symbol           | Parameter                            | Min | Typ | Max | Unit |
|------------------|--------------------------------------|-----|-----|-----|------|
| $R_{th\ j-case}$ | Thermal resistance, junction to case | -   | 2   | 3   | °C/W |

### 3.3 Recommended operating conditions

Table 5: Recommended operating conditions

| Symbol    | Parameter                            | Min | Typ | Max | Unit |
|-----------|--------------------------------------|-----|-----|-----|------|
| $V_{CC}$  | Supply voltage for pins PVCCA, PVCCB | 14  | -   | 39  | V    |
| $T_{amb}$ | Ambient operating temperature        | -20 | -   | 85  | °C   |



### 3.4 Electrical specifications

Unless otherwise stated, the values in the table below are specified for the conditions:  
 $V_{CC} = 36\text{ V}$ ,  $R_L = 6\ \Omega$ ,  $R_{OSC} = R3 = 39\text{ k}\Omega$ ,  $C8 = 100\text{ nF}$ ,  $f = 1\text{ kHz}$ ,  $G_V = 25.6\text{ dB}$  and  
 $T_{amb} = 25\text{ }^\circ\text{C}$ .

Table 6: Electrical specifications

| Symbol       | Parameter                                | Condition                                                                       | Min  | Typ  | Max  | Unit             |
|--------------|------------------------------------------|---------------------------------------------------------------------------------|------|------|------|------------------|
| $I_q$        | Total quiescent current                  | No LC filter, no load                                                           | -    | 40   | 60   | mA               |
| $I_{qSTBY}$  | Quiescent current in standby             | -                                                                               | -    | 1    | 10   | $\mu\text{A}$    |
| $V_{OS}$     | Output offset voltage                    | Play mode                                                                       | -100 | -    | 100  | mV               |
|              |                                          | Mute mode                                                                       | -60  | -    | 60   |                  |
| $I_{OCP}$    | Overcurrent protection threshold         | $R_L = 0\ \Omega$                                                               | 5.5  | 7    | -    | A                |
| $T_{JS}$     | Junction temperature at thermal shutdown | -                                                                               | -    | 150  | -    | $^\circ\text{C}$ |
| $R_i$        | Input resistance                         | Differential input                                                              | 48   | 60   | -    | k $\Omega$       |
| $V_{OVP}$    | Overvoltage protection threshold         | -                                                                               | 42   | 43   | -    | V                |
| $V_{UVP}$    | Undervoltage protection threshold        | -                                                                               | -    | -    | 8    | V                |
| $R_{dsON}$   | Power transistor on-resistance           | High side                                                                       | -    | 0.2  | -    | $\Omega$         |
|              |                                          | Low side                                                                        | -    | 0.2  | -    |                  |
| $P_o$        | Output power                             | THD = 10%                                                                       | -    | 100  | -    | W                |
|              |                                          | THD = 1%                                                                        | -    | 78   | -    |                  |
| $P_o$        | Output power                             | $R_L = 8\ \Omega$ , THD = 10%,<br>$V_{CC} = 36\text{ V}$                        | -    | 80   | -    | W                |
| $P_D$        | Dissipated power                         | $P_o = 100\text{ W}$ ,<br>THD = 10%                                             | -    | 10   | -    | W                |
| $\eta$       | Efficiency                               | $P_o = 100\text{ W}$                                                            | -    | 90   | -    | %                |
| THD          | Total harmonic distortion                | $P_o = 1\text{ W}$                                                              | -    | 0.1  | -    | %                |
| $G_V$        | Closed-loop gain                         | GAIN0 = L, GAIN1 = L                                                            | 24.6 | 25.6 | 26.6 | dB               |
|              |                                          | GAIN0 = L, GAIN1 = H                                                            | 30.6 | 31.6 | 32.6 |                  |
|              |                                          | GAIN0 = H, GAIN1 = L                                                            | 34.1 | 35.1 | 36.1 |                  |
|              |                                          | GAIN0 = H, GAIN1 = H                                                            | 36.6 | 37.6 | 38.6 |                  |
| $\Delta G_V$ | Gain matching                            | -                                                                               | -1   | -    | 1    | dB               |
| eN           | Total input noise                        | A Curve, $G_V = 20\text{ dB}$                                                   | -    | 15   | -    | $\mu\text{V}$    |
|              |                                          | $f = 22\text{ Hz to } 22\text{ kHz}$                                            | -    | 25   | 50   |                  |
| SVRR         | Supply voltage rejection ratio           | $f_r = 100\text{ Hz}$ , $V_r = 0.5\text{ Vpp}$ ,<br>$C_{SVR} = 10\ \mu\text{F}$ | -    | 70   | -    | dB               |
| $T_r, T_f$   | Rise and fall times                      | -                                                                               | -    | 50   | -    | ns               |
| $f_{SW}$     | Switching frequency                      | Internal oscillator                                                             | 290  | 310  | 330  | kHz              |
| $f_{SWR}$    | Output switching frequency range         | With internal oscillator <sup>(1)</sup>                                         | 250  | -    | 400  | kHz              |
|              |                                          | With external oscillator <sup>(2)</sup>                                         | 250  | -    | 400  |                  |
| $V_{inH}$    | Digital input high (H)                   | -                                                                               | 2.3  | -    | -    | V                |

| Symbol            | Parameter                 | Condition                 | Min | Typ | Max | Unit |
|-------------------|---------------------------|---------------------------|-----|-----|-----|------|
| V <sub>inL</sub>  | Digital input low (L)     |                           | -   | -   | 0.8 |      |
| V <sub>STBY</sub> | Pin STBY voltage high (H) | -                         | 2.9 | -   | -   | V    |
|                   | Pin STBY voltage low (L)  |                           | -   | -   | 0.5 |      |
| V <sub>MUTE</sub> | Pin MUTE voltage high (H) | -                         | 2.5 | -   | -   | V    |
|                   | Pin MUTE voltage low (L)  |                           | -   | -   | 0.8 |      |
| A <sub>MUTE</sub> | Mute attenuation          | V <sub>MUTE</sub> < 0.8 V | -   | 70  | -   | dB   |

**Notes:**

<sup>(1)</sup>f<sub>SW</sub> = 10<sup>6</sup> / ((16 \* R<sub>OSC</sub> + 182) \* 4) kHz, f<sub>SYNCLK</sub> = 2 \* f<sub>SW</sub> with R3 = 39 kΩ (see [Figure 18: "Application circuit"](#)).

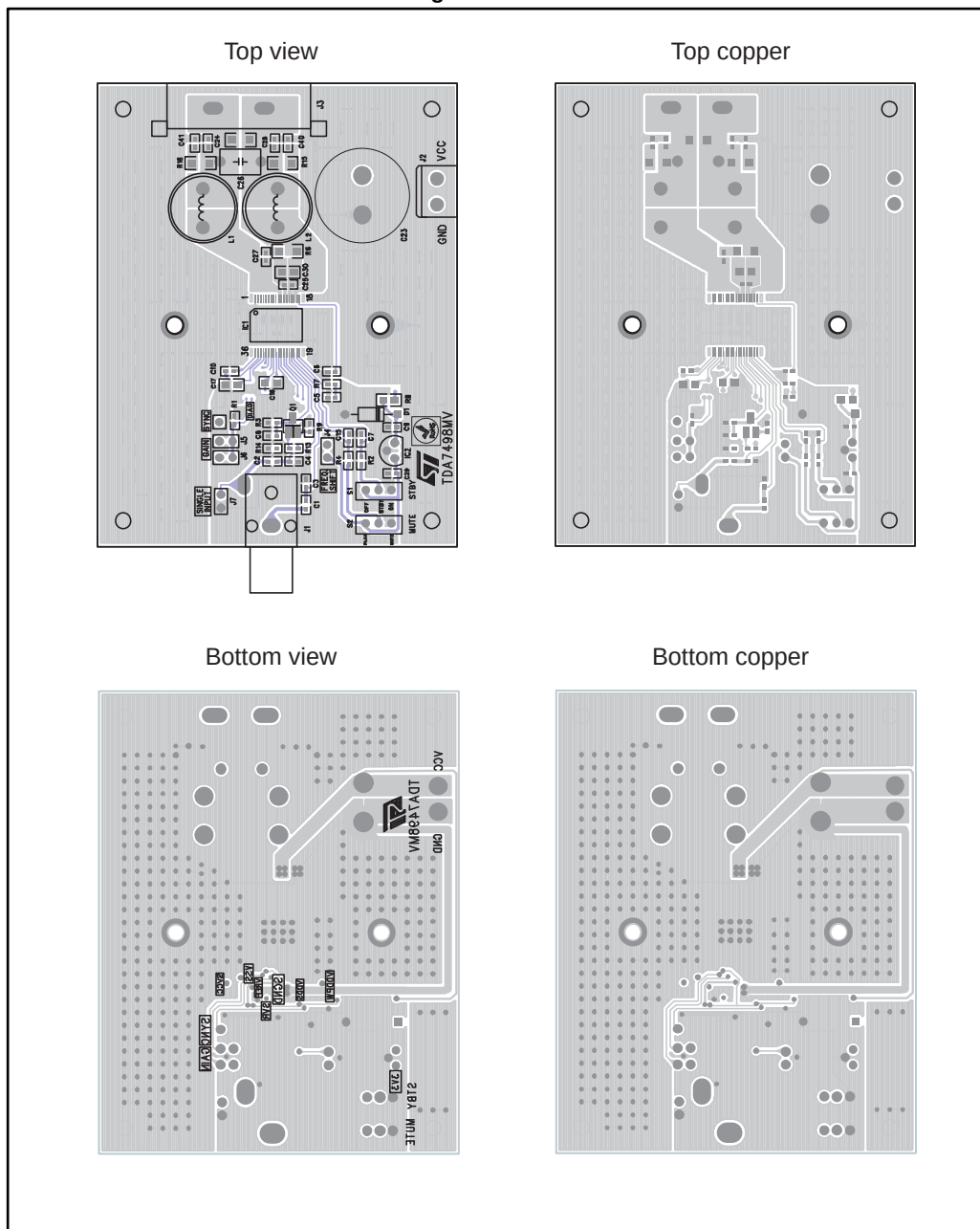
<sup>(2)</sup>f<sub>SW</sub> = f<sub>SYNCLK</sub> / 2 with the external oscillator.

## 4 Characterization curves

*Figure 18: "Application circuit"* shows the test circuit with which the characterization curves, shown in the next sections, were measured. *Figure 3: "Test board"* shows the PCB layout.

### 4.1 Test board

Figure 3: Test board



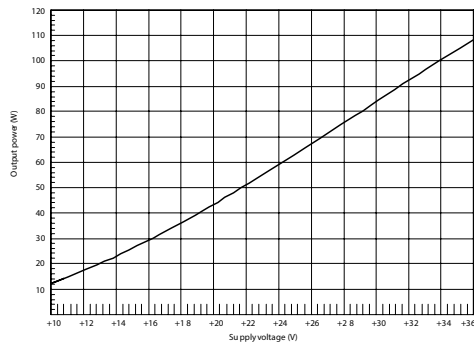
## 4.2 Characterization curves

Unless otherwise stated the measurements were made under the following conditions:

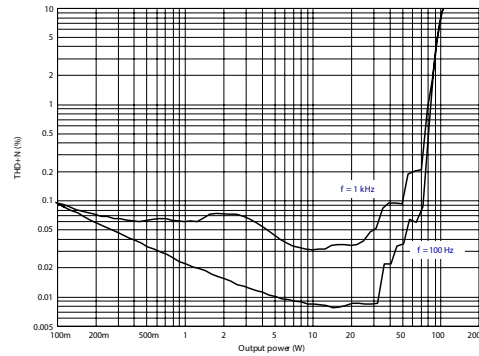
$V_{CC} = 36\text{ V}$ ,  $f = 1\text{ kHz}$ ,  $G_V = 25.6\text{ dB}$ ,  $R_{OSC} = 39\text{ k}\Omega$ ,  $C_{OSC} = 100\text{ nF}$ ,  $T_{amb} = 25\text{ }^\circ\text{C}$

### 4.2.1 For $R_L = 6\text{ }\Omega$

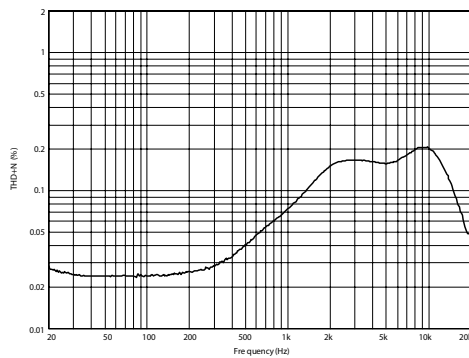
**Figure 4: Output power (THD = 10%) vs. supply voltage**



**Figure 5: THD vs. output power**



**Figure 6: THD vs. frequency (1 W)**



**Figure 7: THD vs. frequency (100 mW)**

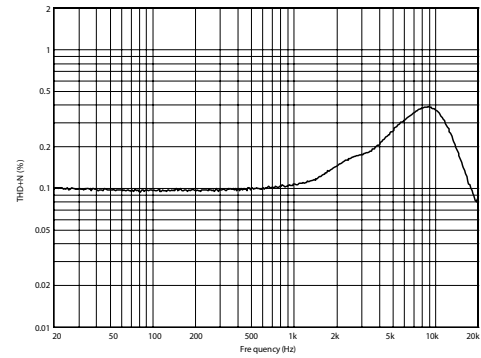


Figure 8: Frequency response

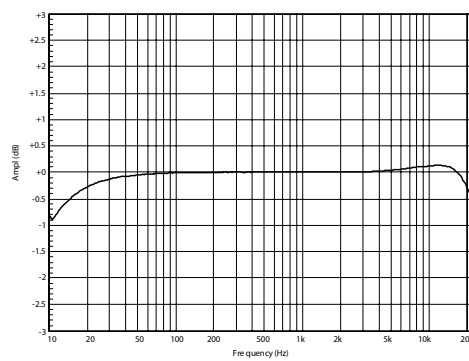


Figure 9: FFT performance (0 dBFS)

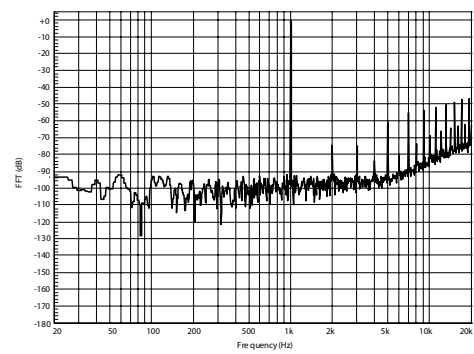
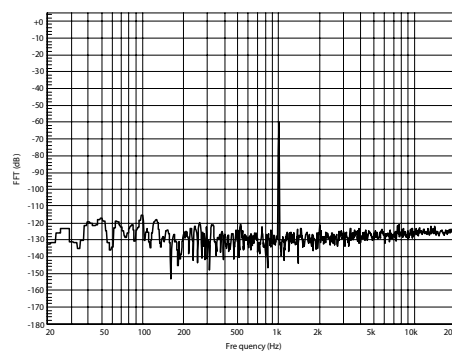


Figure 10: FFT performance (-60 dBFS)



4.2.2 For  $R_L = 8\ \Omega$ 

Figure 11: Output power (THD = 10%) vs. supply voltage

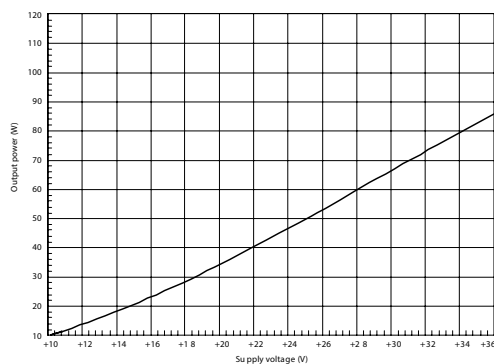


Figure 12: THD vs. output power

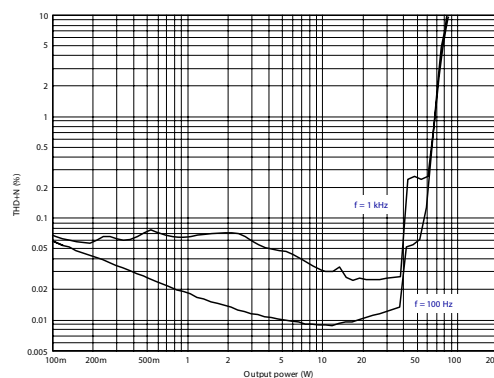


Figure 13: THD vs. frequency (1 W)

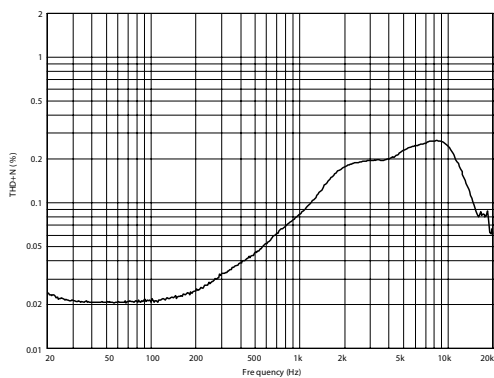


Figure 14: THD vs. frequency (100 mW)

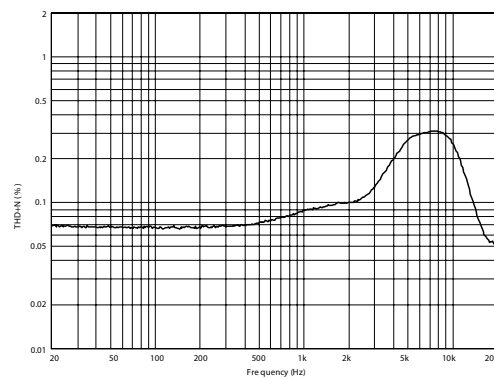


Figure 15: Frequency response

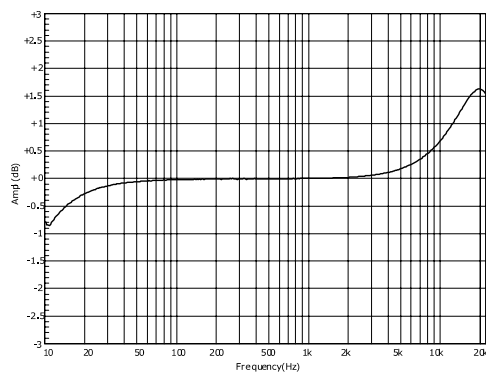


Figure 16: FFT performance (0 dB)

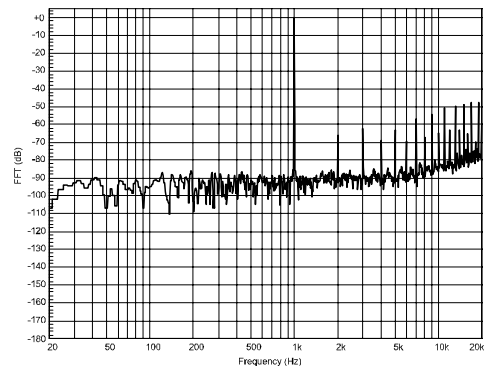
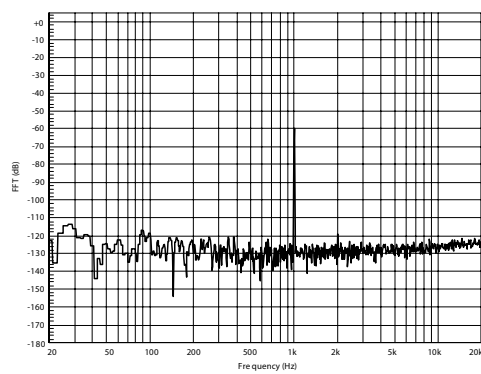


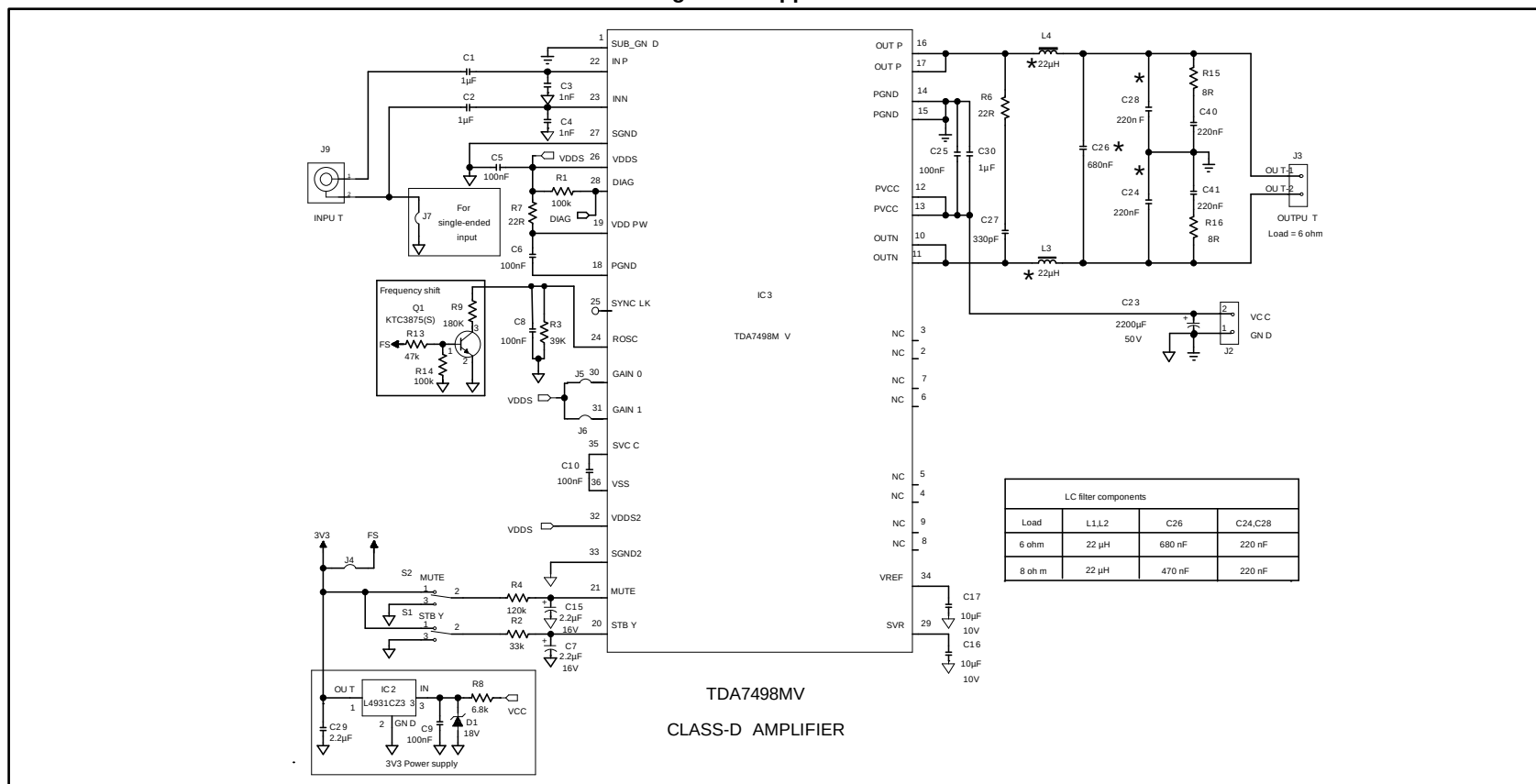
Figure 17: FFT performance (-60 dB)



## 5 Application information

### 5.1 Application circuit

Figure 18: Application circuit





## 5.2 Mode selection

The three operating modes of the TDA7498MV are set by the two inputs, STBY (pin 20) and MUTE (pin 21).

- Standby mode: all circuits are turned off, very low current consumption.
- Mute mode: inputs are connected to ground and the positive and negative PWM outputs are at 50% duty cycle.
- Play mode: the amplifiers are active.

The protection functions of the TDA7498MV are enabled by pulling down the voltages of the STBY and MUTE inputs shown in [Figure 19: "Standby and mute circuits"](#). The input current of the corresponding pins must be limited to 200  $\mu$ A.

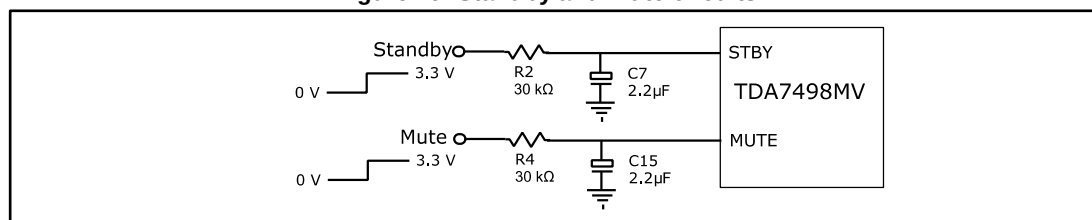
**Table 7: Mode settings**

| Mode    | STBY             | MUTE           |
|---------|------------------|----------------|
| Standby | L <sup>(1)</sup> | X (don't care) |
| Mute    | H <sup>(1)</sup> | L              |
| Play    | H                | H              |

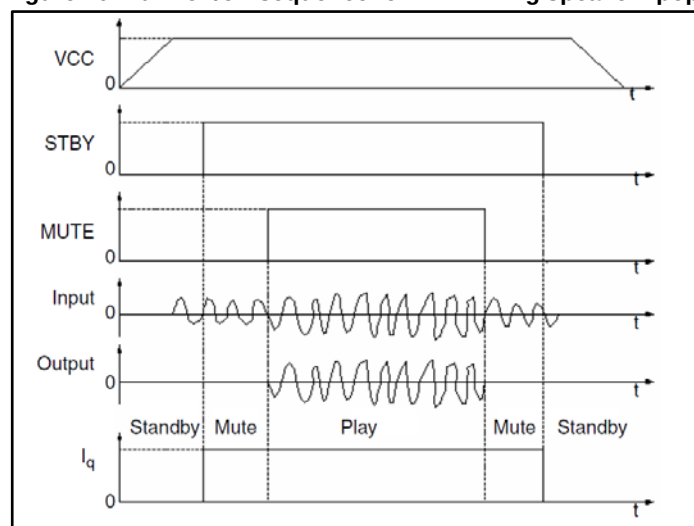
**Notes:**

<sup>(1)</sup>Drive levels defined in

**Figure 19: Standby and mute circuits**



**Figure 20: Turn on/off sequence for minimizing speaker "pop"**



### 5.3 Gain setting

The gain of the TDA7498MV is set by the two inputs, GAIN0 (pin 30) and GAIN1 (pin31). Internally, the gain is set by changing the feedback resistors of the amplifier.

Table 8: Gain settings

| GAIN0 | GAIN1 | Nominal gain, $G_v$ (dB) |
|-------|-------|--------------------------|
| L     | L     | 25.6                     |
| L     | H     | 31.6                     |
| H     | L     | 35.6                     |
| H     | H     | 37.6                     |

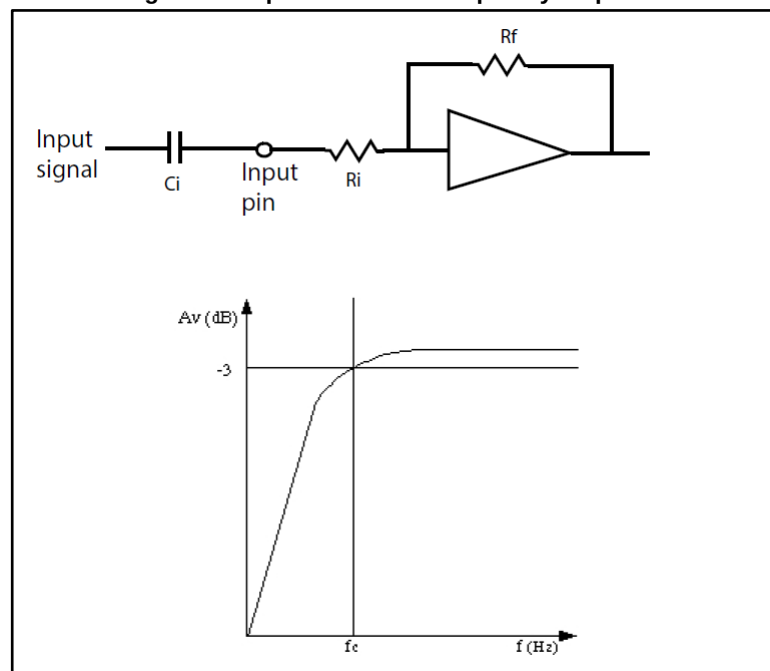
### 5.4 Input resistance and capacitance

The input impedance is set by an internal resistor  $R_i = 60 \text{ k}\Omega$  (typical). An input capacitor ( $C_i$ ) is required to couple the AC input signal.

The equivalent circuit and frequency response of the input components are shown in [Figure 21: "Input circuit and frequency response"](#). For  $C_i = 470 \text{ nF}$  the high-pass filter cutoff frequency is below 20 Hz:

$$f_c = 1 / (2 * \pi * R_i * C_i)$$

Figure 21: Input circuit and frequency response



## 5.5 Internal and external clocks

The clock of the class-D amplifier can be generated internally or can be driven by an external source.

If two or more class-D amplifiers are used in the same system, it is recommended that all devices operate at the same clock frequency. This can be implemented by using one TDA7498MV as master clock, while the other devices are in slave mode, that is, externally clocked. The clock interconnect is via pin SYNCLK of each device. As explained below, SYNCLK is an output in master mode and an input in slave mode.

### 5.5.1 Master mode (internal clock)

Using the internal oscillator, the output switching frequency,  $f_{SW}$ , is controlled by the resistor,  $R_{OSC}$ , connected to pin ROSC:

$$f_{SW} = 10^6 / [(R_{OSC} * 16 + 182) * 4] \text{ kHz}$$

where  $R_{OSC}$  is in k $\Omega$ .

In master mode, pin SYNCLK is used as a clock output pin whose frequency is:

$$f_{SYNCLK} = 2 * f_{SW}$$

For master mode to operate correctly then resistor  $R_{OSC}$  must be less than 60 k $\Omega$  as given below in [Table 9: "How to set up SYNCLK"](#).

### 5.5.2 Slave mode (external clock)

In order to accept an external clock input the pin ROSC must be left open, that is, floating. This forces pin SYNCLK to be internally configured as an input as given in [Table 9: "How to set up SYNCLK"](#).

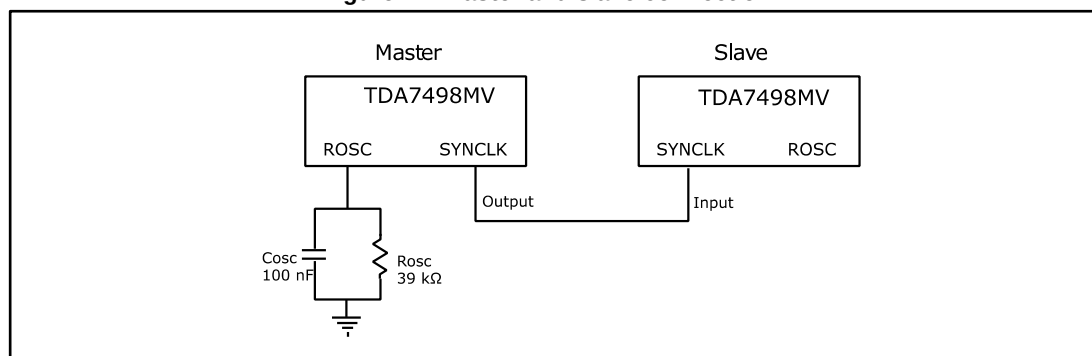
The output switching frequency of the slave devices is:

$$f_{SW} = f_{SYNCLK} / 2$$

**Table 9: How to set up SYNCLK**

| Mode   | ROSC                           | SYNCLK |
|--------|--------------------------------|--------|
| Master | $R_{OSC} < 60 \text{ k}\Omega$ | Output |
| Slave  | Floating (not connected)       | Input  |

**Figure 22: Master and slave connection**



## 5.6 Output low-pass filter

To avoid EMI problems, it may be necessary to use a low-pass filter before the speaker. The cutoff frequency should be larger than 22 kHz and much lower than the output switching frequency. It is necessary to choose the L and C component values depending on the loudspeaker impedance. Some typical values, which give a cutoff frequency of 27 kHz, are shown in [Figure 23: "Typical LC filter for an 8 Ω speaker"](#) and [Figure 24: "Typical LC filter for a 6 Ω speaker"](#) below.

Figure 23: Typical LC filter for an 8 Ω speaker

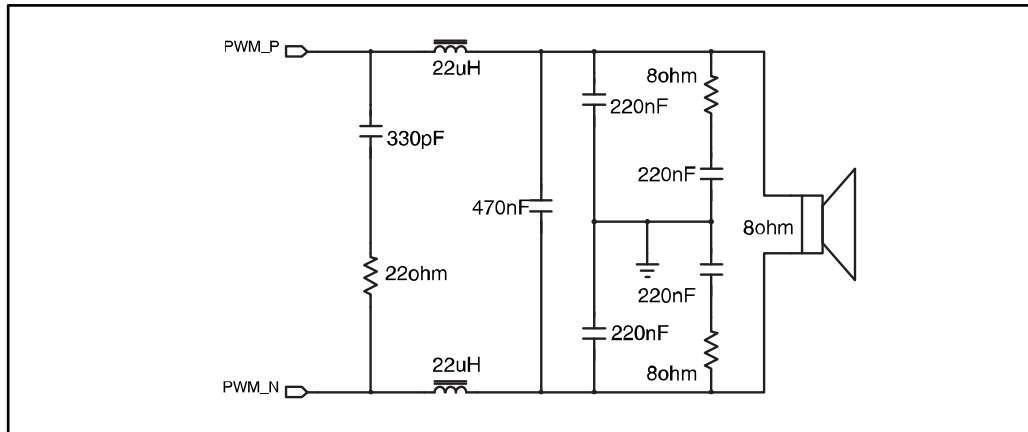
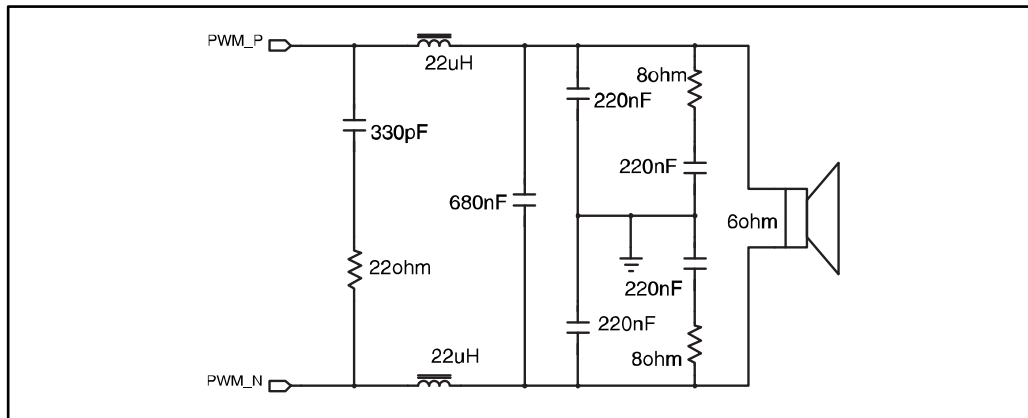


Figure 24: Typical LC filter for a 6 Ω speaker



## 5.7 Protection functions

The TDA7498MV is fully protected against overvoltages, undervoltages, overcurrents and thermal overloads as explained here.

### Overvoltage protection (OVP)

If the supply voltage exceeds the value for  $V_{OVP}$  given in [Table 6: "Electrical specifications"](#), the overvoltage protection is activated which forces the outputs to the high impedance state. When the supply voltage falls back to within the operating range, the device restarts.

### Undervoltage protection (UVP)

If the supply voltage drops below the value for  $V_{UVP}$  given in [Table 6: "Electrical specifications"](#), the undervoltage protection is activated which forces the outputs to the high impedance state. When the supply voltage recovers to within the operating range, the device restarts.

### Overcurrent protection (OCP)

If the output current exceeds the value for  $I_{OCP}$  given in [Table 6: "Electrical specifications"](#), the overcurrent protection is activated which forces the outputs to the high impedance state. Periodically, the device attempts to restart. If the overcurrent condition is still present, then the OCP remains active. The restart time,  $T_{OC}$ , is determined by the RC components connected to pin STBY.

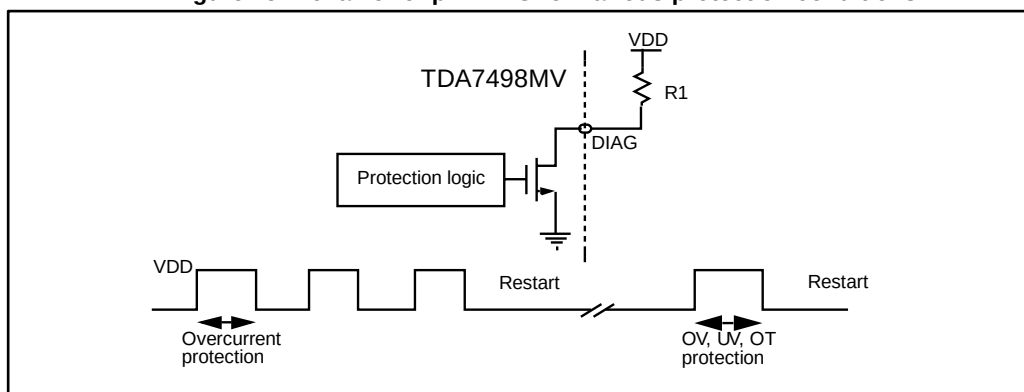
### Thermal protection (OTP)

If the junction temperature,  $T_j$ , reaches 145 °C (nominally), the device goes to mute mode and the positive and negative PWM outputs are forced to 50% duty cycle. If the junction temperature reaches the value for  $T_j$  given in [Table 6: "Electrical specifications"](#), the device shuts down and the output is forced to the high-impedance state. When the device cools sufficiently, the device restarts.

## 5.8 Diagnostic output

The output pin DIAG is an open drain transistor. When any protection is activated, it switches to the high impedance state. The pin can be connected to a power supply (< 39 V) by a pull-up resistor whose value is limited by the maximum sinking current (200  $\mu$ A) of the pin.

Figure 25: Behavior of pin DIAG for various protection conditions



## 6 Package information

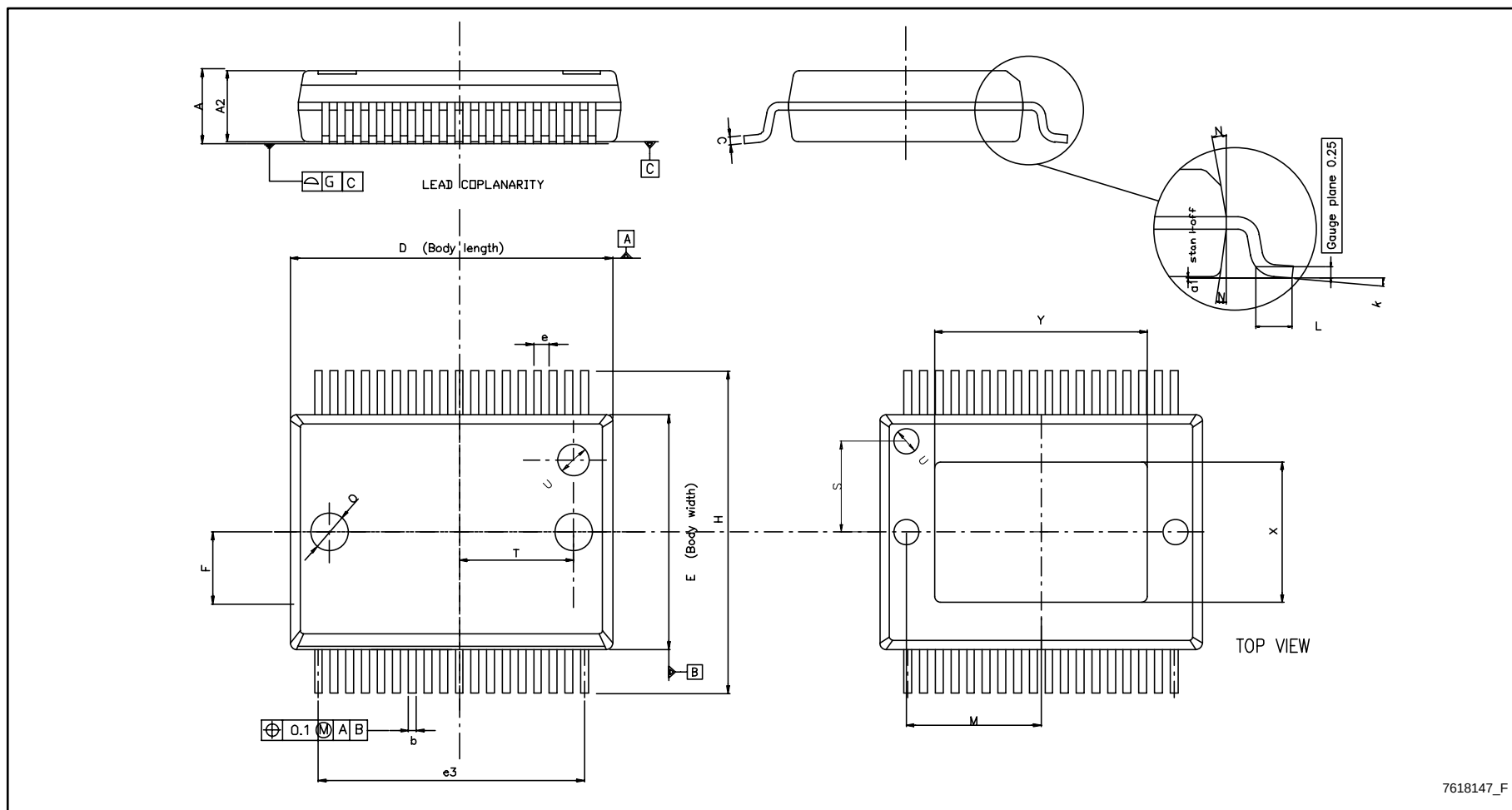
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

### 6.1 PowerSSO-36 EPU package information

The device comes in a 36-pin PowerSSO package with exposed pad up (EPU).

*Figure 26: "PowerSSO-36 EPU package outline"* shows the package outline and *Table 10: "PowerSSO-36 EPU package mechanical data"* gives the dimensions.

Figure 26: PowerSSO-36 EPU package outline



7618147\_F

Table 10: PowerSSO-36 EPU package mechanical data

| Symbol | Dimensions in mm |      |            | Dimensions in inches |       |            |
|--------|------------------|------|------------|----------------------|-------|------------|
|        | Min.             | Typ. | Max.       | Min.                 | Typ.  | Max.       |
| A      | 2.15             | -    | 2.45       | 0.085                | -     | 0.096      |
| A2     | 2.15             | -    | 2.35       | 0.085                | -     | 0.093      |
| a1     | 0                | -    | 0.10       | 0                    | -     | 0.004      |
| b      | 0.18             | -    | 0.36       | 0.007                | -     | 0.014      |
| c      | 0.23             | -    | 0.32       | 0.009                | -     | 0.013      |
| D      | 10.10            | -    | 10.50      | 0.398                | -     | 0.413      |
| E      | 7.40             | -    | 7.60       | 0.291                | -     | 0.299      |
| e      | -                | 0.5  | -          | -                    | 0.020 | -          |
| e3     | -                | 8.5  | -          | -                    | 0.335 | -          |
| F      | -                | 2.3  | -          | -                    | 0.091 | -          |
| G      | -                | -    | 0.10       | -                    | -     | 0.004      |
| H      | 10.10            | -    | 10.50      | 0.398                | -     | 0.413      |
| h      | -                | -    | 0.40       | -                    | -     | 0.016      |
| k      | 0                | -    | 8 degrees  | 0                    | -     | 8 degrees  |
| L      | 0.55             | -    | 0.85       | 0.022                | -     | 0.033      |
| M      | -                | 4.30 | -          | -                    | 0.169 | -          |
| N      | -                | -    | 10 degrees | -                    | -     | 10 degrees |
| O      | -                | 1.20 | -          | -                    | 0.047 | -          |
| Q      | -                | 0.80 | -          | -                    | 0.031 | -          |
| S      | -                | 2.90 | -          | -                    | 0.114 | -          |
| T      | -                | 3.65 | -          | -                    | 0.144 | -          |
| U      | -                | 1.00 | -          | -                    | 0.039 | -          |
| X      | 4.10             | -    | 4.70       | 0.161                | -     | 0.185      |
| Y      | 4.90             | -    | 7.10       | 0.193                | -     | 0.280      |



## 7 Revision history

**Table 11: Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30-Nov-2009 | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 28-Jul-2010 | 2        | Removed datasheet preliminary status, updated features list and updated <a href="#">Table 1: "Device summary"</a><br>Added operating temperature range to <a href="#">Table 3: "Absolute maximum ratings"</a> Updated minimum supply voltage and temperature range in <a href="#">Table 5: "Recommended operating conditions"</a> Updated voltage for logical 1 on pin STBY in <a href="#">Table 6: "Electrical specifications "</a> |
| 27-Jan-2011 | 3        | Updated application circuit in <a href="#">Figure 18: "Application circuit"</a> .                                                                                                                                                                                                                                                                                                                                                    |
| 24-Feb-2014 | 4        | Updated order code in <a href="#">Table 1: "Device summary"</a>                                                                                                                                                                                                                                                                                                                                                                      |
| 19-Sep-2014 | 5        | Updated <a href="#">Figure 2: "Pin connections (top view, PCB view)"</a> Updated package information (representation on page 1, <a href="#">Figure 26: "PowerSSO-36 EPU package outline"</a> , <a href="#">Table 10: "PowerSSO-36 EPU package mechanical data"</a> ).                                                                                                                                                                |
| 09-Sep-2015 | 6        | Updated $V_{CC\_MAX}$ in <a href="#">Table 3: "Absolute maximum ratings"</a><br>Updated dimension L in <a href="#">Table 10: "PowerSSO-36 EPU package mechanical data"</a> .                                                                                                                                                                                                                                                         |

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