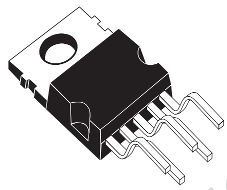
# 32 W hi-fi audio power amplifier

## Features

- High output power (50 W music power IEC 268.3 rules)
- High operating supply voltage (50 V)
- Single or split supply operations
- Very low distortion
- Short-circuit protection (OUT to GND)
- Thermal shutdown



Pentawatt V

## Description

The TDA 2050 is a monolithic integrated circuit in a Pentawatt package, intended for use as an audio class-AB audio amplifier.

Thanks to its high power capability the TDA2050 is able to provide up to 35 W true RMS power into a 4 ohm load at THD = 0%, $V_S$ = ±18 V, f = 1 kHz and up to 32 W into an 8 ohm load at THD = 10%, $V_S$ = ±22 V, f = 1 kHz.

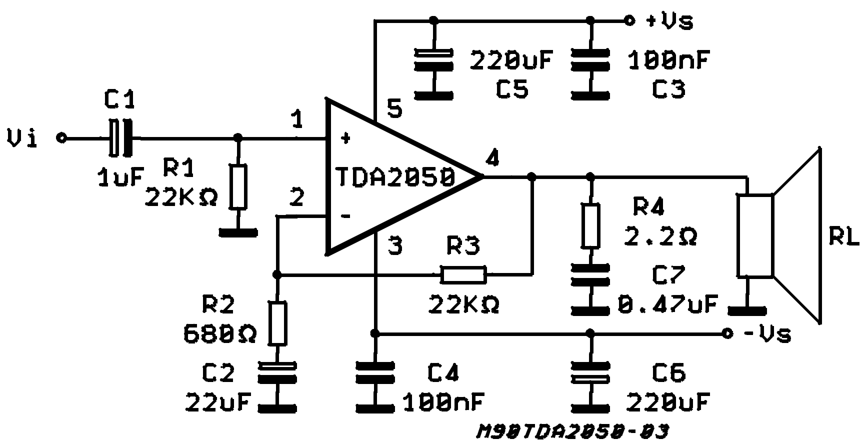
Moreover, the TDA2050 delivers typically 50 W music power into a 4 ohm load over 1 sec at $V_S$ = 22.5 V, f = 1 kHz.

The high power and very low harmonic and crossover distortion (THD = 0.05% typ, at $V_S$ = ±22 V, $P_O$ = 0.1 to 15 W, $R_L$ = 8 ohm, f = 100 Hz to 15 kHz) make the device most suitable for both hi-fi and high-end TV sets.

**Table 1. Device summary**

| Order code | Package |
| --- | --- |
| TDA2050V | Pentawatt vertical |

**Figure 1. Test and application circuit**



# 1 Device overview

Table 2. **Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_s$ | Supply voltage | ±25 | V |
| $V_i$ | Input voltage | $V_s$ | |
| $V_i$ | Differential input voltage | ±15 | V |
| $I_o$ | Output peak current (internally limited) | 5 | A |
| $P_{tot}$ | Power dissipation at $T_{CASE}$ = 75 °C | 25 | W |
| $T_{stg}$, $T_j$ | Storage and junction temperature | -40 to 150 | °C |

Table 3. **Thermal data**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $R_{th\ j\text{-}case}$ | Thermal resistance junction-case | 3 (max) | °C |

Figure 2. **Pin connections (top view)**

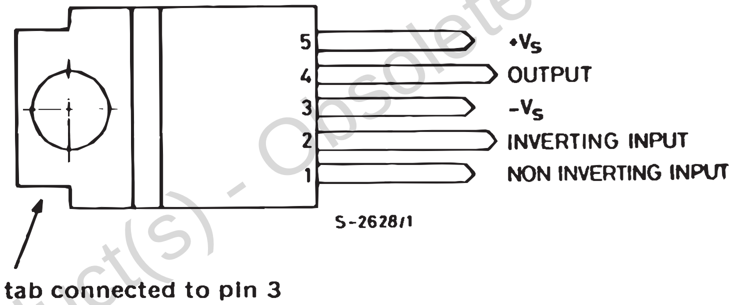
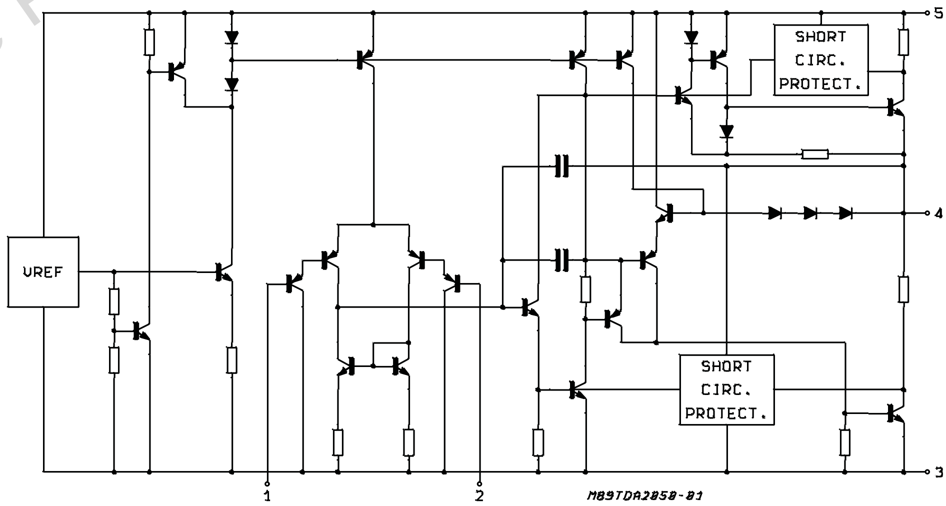



Figure 3. **Schematic diagram**



The values given in the following table refer to the test circuit $V_S$ = ±18 V, $T_{amb}$ = 25 °C, f = 1 kHz, unless otherwise specified.

**Table 4. Electrical characteristics**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_S$ | Supply voltage range | | ± 4.5 | | ± 25 | V |
| $I_d$ | Quiescent drain current | $V_s$ = ± 4.5<br>$V_s$ = ± 25 | | 30<br>55 | 50<br>90 | mA<br>mA |
| $I_b$ | Input bias current | $V_s$ = ± 22 | | 0.1 | 0.5 | µA |
| $V_{OS}$ | Input offset voltage | $V_s$ = ± 22 | | | ± 15 | mV |
| $I_{OS}$ | Input offset current | | | | ± 200 | nA |
| $P_O$ | Output power | d = 0.5%,<br>$R_L$ = 4 Ω<br>$R_L$ = 8 Ω<br>$V_s$ = ± 22 V, $R_L$ = 8 Ω | <br>24<br><br>22 | <br>28<br>18<br>25 | | <br>W<br>W<br>W |
| | | d = 10%,<br>$R_L$ = 4 Ω<br>$R_L$ = 8 Ω<br>$V_s$ = ± 22 V, $R_L$ = 8 Ω | | <br>35<br>22<br>32 | | <br>W<br>W<br>W |
| | Music power IEC268.3 rules | d = 10%, T = 1s<br>$R_L$ = 4 Ω; Vs = ± 22.5 V | | 50 | | W |
| d | Distortion | $P_o$ = 0.1 to 24W, $R_L$ = 4 Ω, f = 1 kHz<br>f = 100 to 10 kHz, Po = 0.1 to 18 W | | 0.03 | 0.5<br>0.5 | %<br>% |
| | | Vs = ± 22 V, $R_L$ = 8 Ω,<br>f = 1 kHz, Po = 0.1 to 20 W,<br>f = 100 Hz to 10 kHz;<br>$P_o$ = 0.1 to 15 W | | 0.02 | 0.5 | %<br>% |
| SR | Slew rate | | 5 | 8 | | V/µs |
| $G_V$ | Voltage gain (open loop) | f = 1 kHz | | 80 | | dB |
| $G_V$ | Voltage gain (closed loop) | f = 1 kHz | 30 | 30.5 | 31 | dB |
| BW | Power bandwidth (-3dB) | $V_i$ = 200 mW, $R_L$ = 4 Ω; | | 20 to 80.000 | | Hz |
| $e_N$ | Input noise voltage | B = Curve A<br>B = 22 Hz to 22 kHz | | 4<br>5 | <br>10 | µV<br>µV |
| $R_i$ | Input resistance (pin 1) | | 500 | | | kΩ |
| SVR | Supply voltage rejection | $R_g$ = 22 kΩ, f = 100 Hz;<br>$V_{ripple}$ = 0.5 $V_{RMS}$ | | 45 | | dB |
| h | Efficiency | $P_o$ = 28 W, $R_L$ = 4 Ω | | 65 | | % |
| | | $P_o$ = 25 W, $R_L$ = 8 Ω,$V_s$ = ± 22 V, | | 67 | | % |
| $T_{sd-j}$ | Thermal shutdown junction temperature | | | 150 | | °C |

**Figure 4. Split-supply typical application circuit**

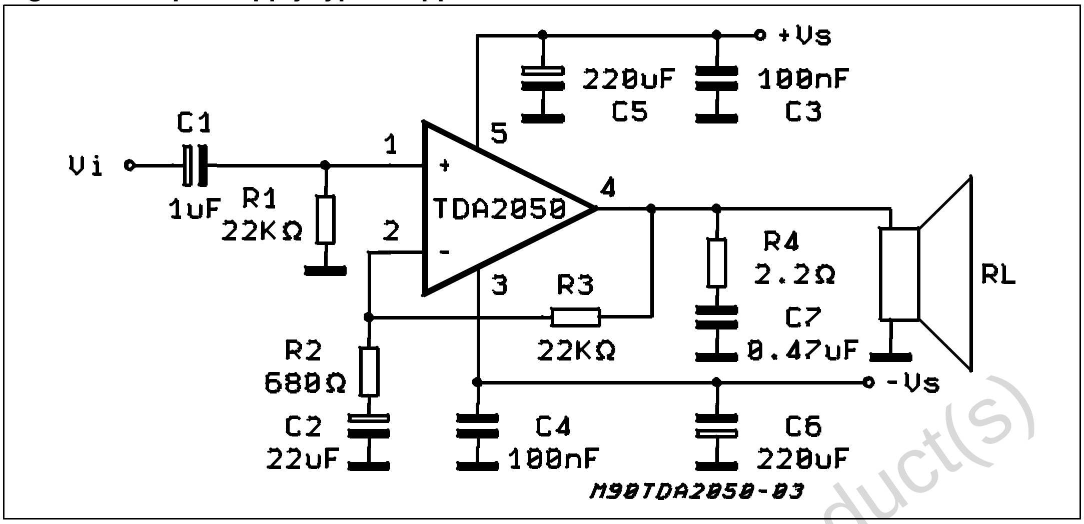
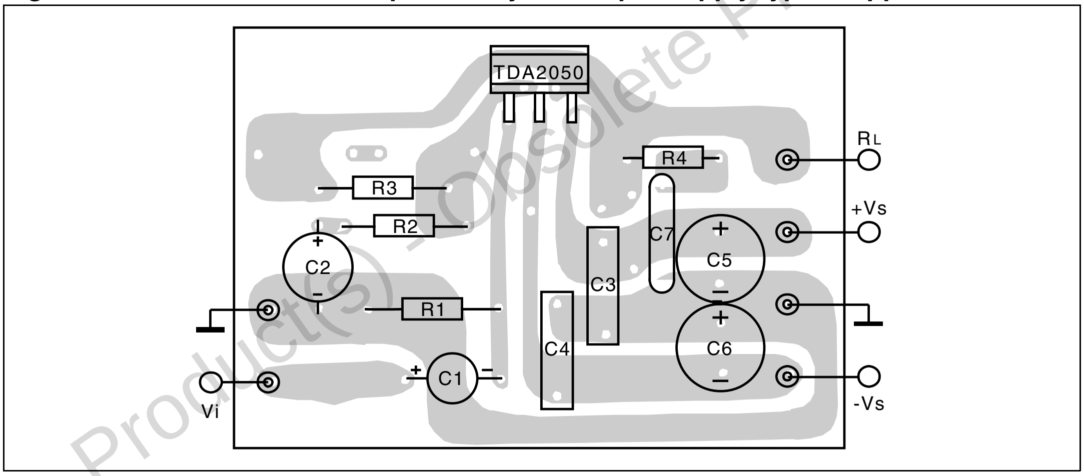



**Figure 5. PC board and component layout of split-supply typical application circuit**



# 2 Split-supply application suggestions

The recommended values of the external components are those shown on the application circuit of *Figure 5*. Different values can be used. The following table can help the designer.

**Table 5. Recommended values of external components**

| Component | Recommended value | Purpose | Larger than recommended value | Smaller than recommended value |
|---|---|---|---|---|
| R1 | 22 kΩ | Input impedance | Increase of input impedance | Decrease of Input Impedance |
| R2 | 680 Ω | Feedback resistor | Decrease of gain(1) | Increase of gain |
| R3 | 22 kΩ | | Increase of gain | Decrease of gain(1) |
| R4 | 2.2 Ω | Frequency stability | Danger of oscillations | |
| C1 | 1 µF | Input decoupling DC | | Higher low-frequency cutoff |
| C2 | 22 µF | Inverting input DC decoupling | Increase of switch ON/OFF noise | Higher low-frequency cutoff |
| C3, C4 | 100 nF | Supply voltage bypass | | Danger of oscillation |
| C5, C6 | 220 µF | Supply voltage bypass | | Danger of oscillation |
| C7 | 0.47 µF | Frequency stability | | Danger of oscillation |

1. The gain must be higher than 24 dB

## 2.1 Printed circuit board

The layout shown in *Figure 5* should be adopted by the designers. If different layouts are used, the ground points of input 1 and input 2 must be well decoupled from the ground return of the output in which a high current flows.

**Figure 6. Single-supply typical application circuit**

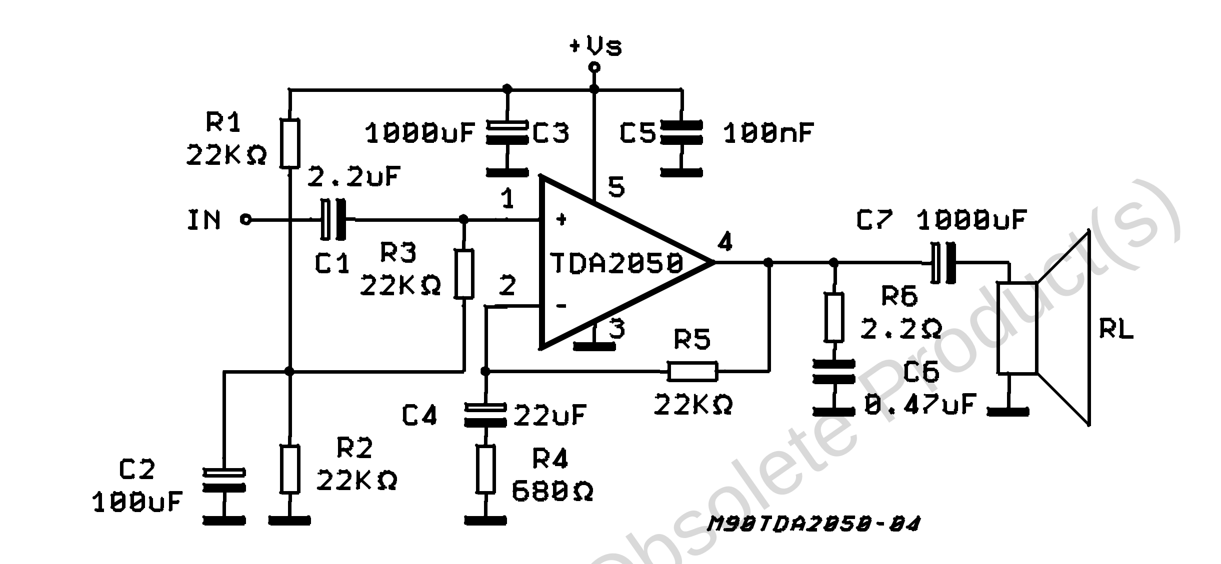
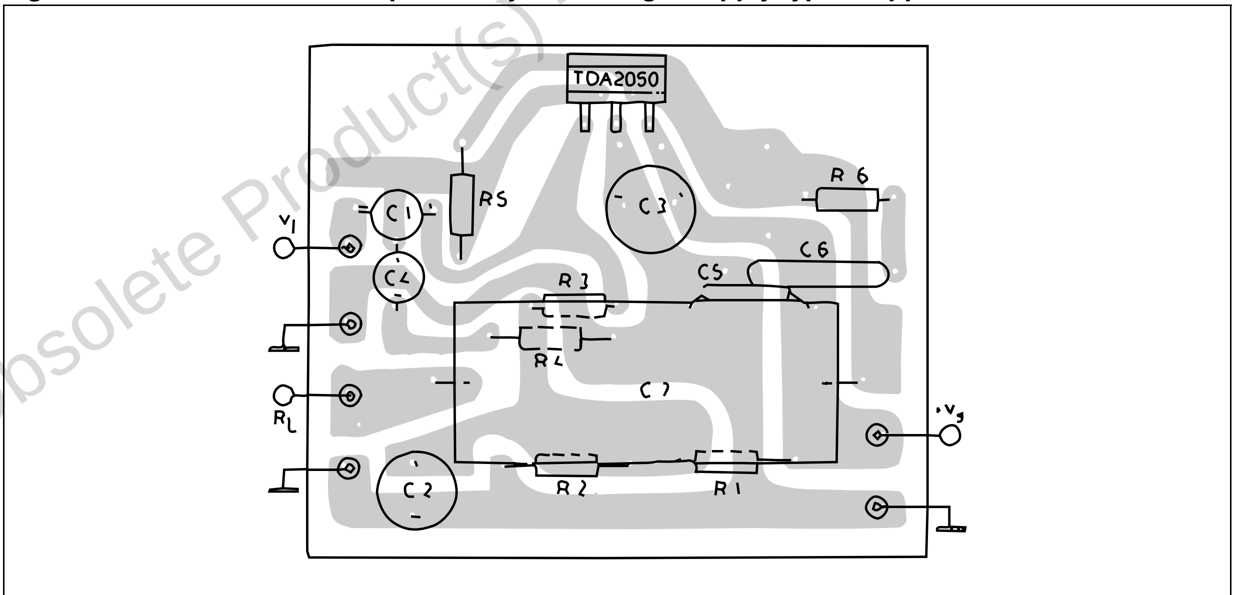



**Figure 7. PC board and component layout of single-supply typical application circuit**



# 3 Single-supply application suggestions

The recommended values of the external components are those shown in the application circuit of *Figure 6*. Different values can be used. The following table can help the designer.

**Table 6. Recommonded values**

| Component | Recommended value | Purpose | Larger than recommended value | Smaller than recommended value |
|---|---|---|---|---|
| R1, R2, R3 | 22 kΩ | Biasing resistor | | |
| R4 | 680 Ω | Feedback resistor | Increase of gain | Decrease of gain(1) |
| R5 | 22 kΩ | | Decrease of gain(1) | Increase of gain |
| R6 | 2.2 Ω | Frequency stability | Danger of oscillations | |
| C1 | 2.2 µF | Input decoupling DC | | Higher low-frequency cutoff |
| C2 | 100 µF | Supply voltage rejection | Worse turn-off transient<br>Worse turn-on delay | |
| C3 | 1000 µF | Supply voltage bypass | | Danger of oscillations<br>Worse turn-off transient |
| C4 | 22 µF | Inverting input DC decoupling | Increase of switching ON/OFF | Higher low-frequency cutoff |
| C5 | 100 nF | Supply voltage bypass | | Danger of oscillations |
| C6 | 0.47 µF | Frequency stability | | Danger of oscillations |
| C7 | 1000 µF | Output DC decoupling | | Higher low-frequency cutoff |

1. The gain must be higher than 24 dB

*Note: If the supply voltage is lower than 40 V and the load is 8 ohm (or more), a lower value of C2 can be used (i.e. 22 mF). C7 can be larger than 1000 µF only if the supply voltage does not exceed 40 V.*

# 4 Typical characteristics (split-supply test circuit unless otherwise specified)

Figure 8. Output power vs. supply voltage

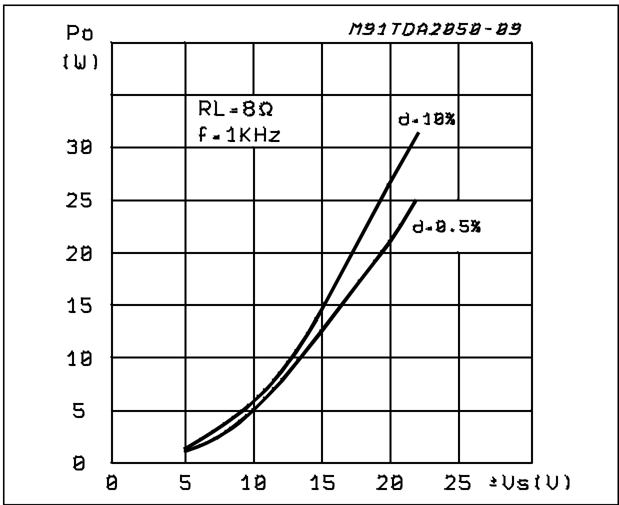



Figure 9. Distortion vs. output power

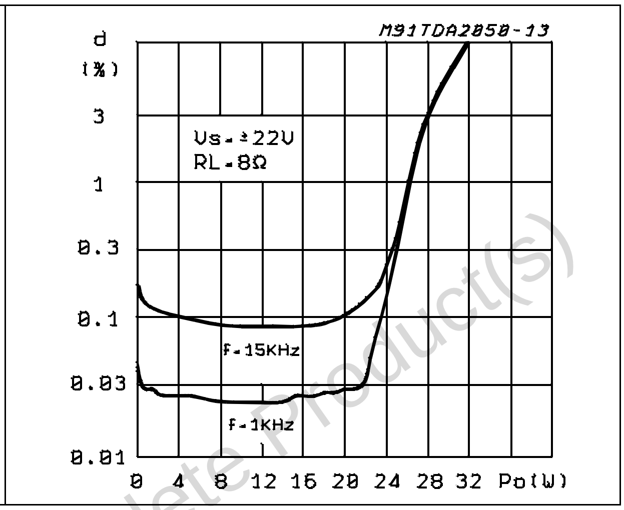



Figure 10. Output power vs. supply voltage

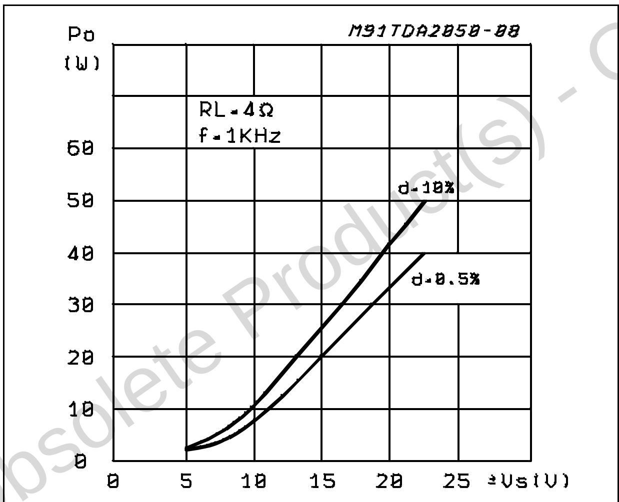



Figure 11. Distortion vs. output power

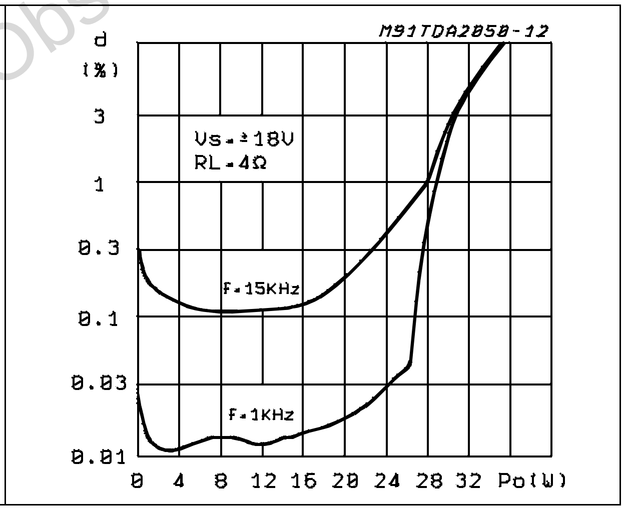


**Figure 12. Distortion vs. frequency**

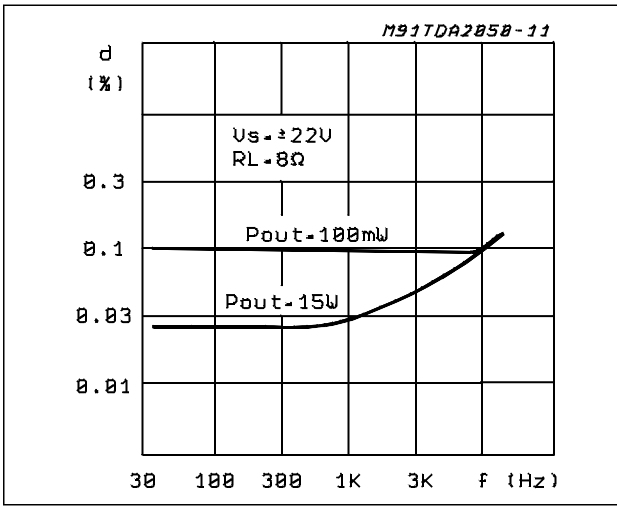



**Figure 13. Distortion vs. frequency**

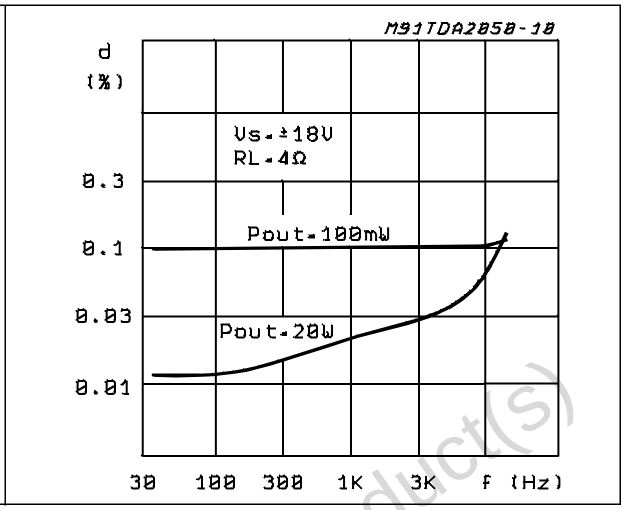



**Figure 14. Quiescent current vs. supply voltage**

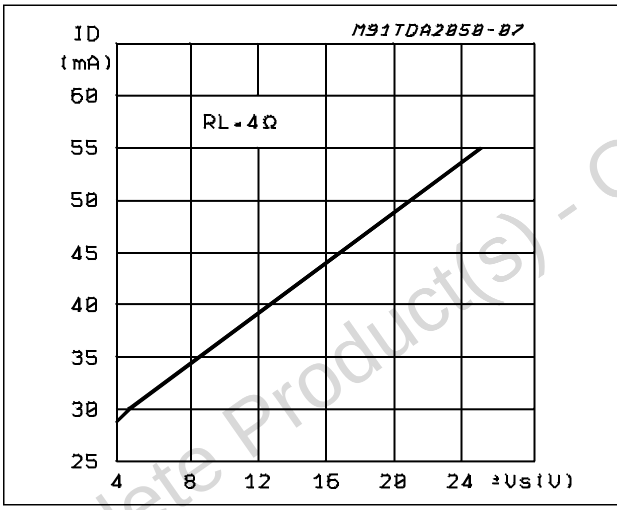



**Figure 15. Supply voltage rejection vs. frequency**

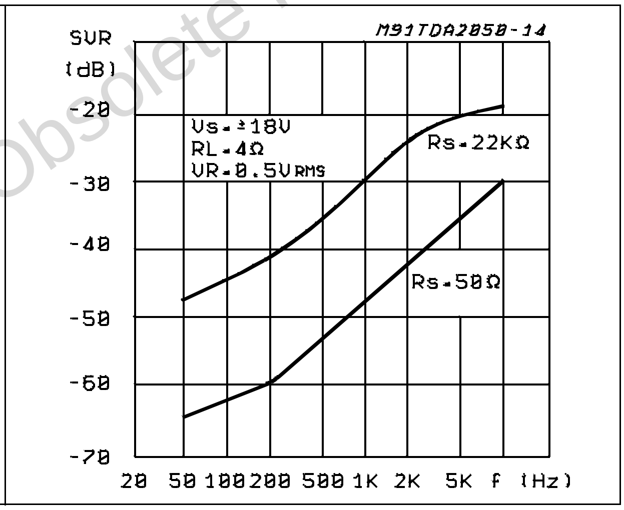


**Figure 16. Supply voltage rejection vs. frequency (single-supply) for different values of C2 (*Figure 6*)**

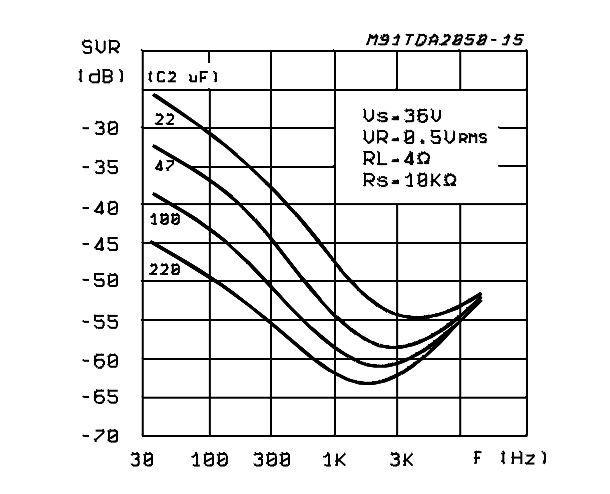



**Figure 17. Supply voltage rejection vs. frequency (single-supply) for different values of C2 (*Figure 6*)**

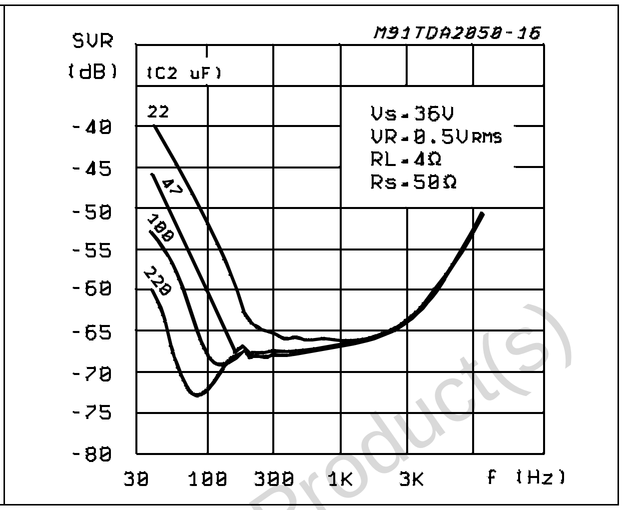



**Figure 18. Total power dissipation and efficiency vs. output power**

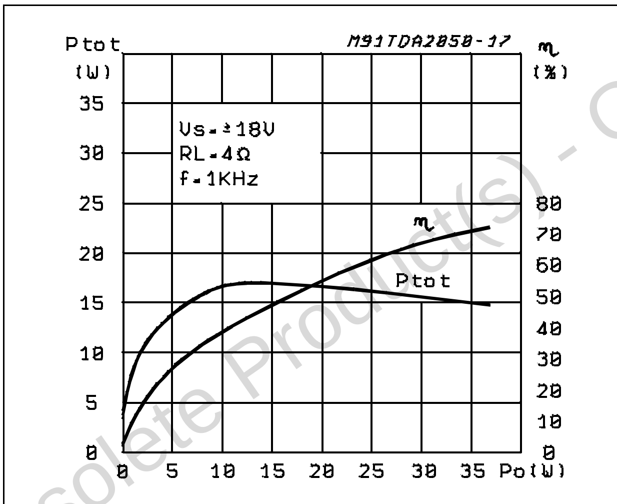
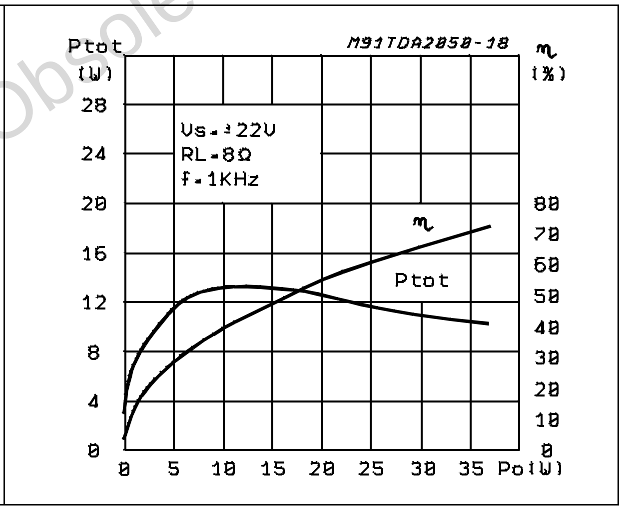



**Figure 19. Total power dissipation and efficiency vs. output power**



# 5 Short-circuit protection

The TDA2050 has an original circuit which limits the current of the output transistors. The maximum output current is a function of the collector emitter voltage, hence the output transistors work within their safe operating area. This function can therefore be considered as being peak power limiting rather than simple current limiting. It reduces the possibility that the device gets damaged during an accidental short-circuit from AC output to ground.

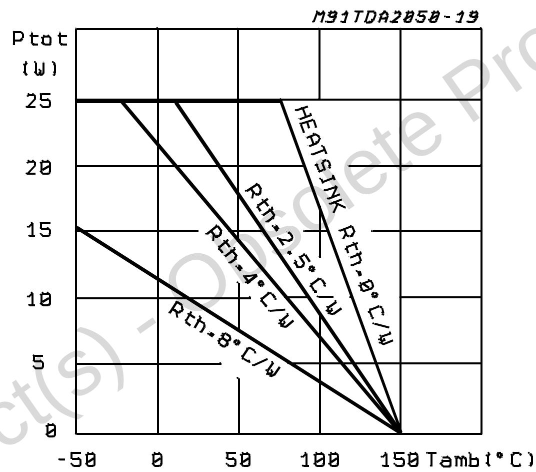
# 6 Thermal shutdown

The presence of a thermal limiting circuit offers the following advantages:

1. An overload on the output (even if it is permanent), or an above-limit ambient temperature can be easily tolerated since Tj cannot be higher than 150 °C.
2. The heatsink can have a smaller factor of safety compared with that of a conventional circuit. There is no possibility of device damage due to high junction temperature. If for any reason, the junction temperature increases up to 150 °C, the thermal shutdown simply reduces the power dissipation and the current consumption.

The maximum allowable power dissipation depends upon the thermal resistance junction-ambient. *Figure 20* shows this dissipable power as a function of ambient temperature for different thermal resistances.

**Figure 20. Maximum allowable power dissipation vs. ambient temperature**




## 6.1 Mounting instructions

The power dissipated in the circuit must be removed by adding an external heatsink. Thanks to the pentawatt package, the heatsink mounting operation is very simple, a screw or a compression spring (clip) being sufficient. Between the heatsink and the package it is better to insert a layer of silicon grease, to optimize the thermal contact; no electrical isolation is needed between the two surfaces. *Figure 21* shows an example of a heatsink.

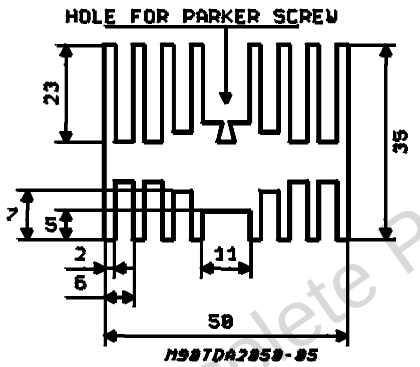
## 6.2 Dimension recommendations

The following table shows the length that the heatsink in *Figure 21* must have for several values of $P_{tot}$ and $R_{th}$.

**Table 7. Dimension recommendations**

| | | | |
|---|---|---|---|
| $P_{tot}$ (W) | 12 | 8 | 6 |
| Length of heatsink (mm) | 60 | 40 | 30 |
| $R_{th}$ of heatsink (°C/W) | 4.2 | 6.2 | 8.3 |

**Figure 21. Example of heatsink**



# Appendix A

## A.1 Music power concept

Music power is (according to the IEC clauses n.268-3 of Jan. 83) the maximum power which the amplifier is capable of producing across the rated load resistance (regardless of non-linearity) 1 sec after the application of a sinusoidal input signal of frequency 1 kHz.
According to this definition our method of measurement comprises the following steps:

- Set the voltage supply at the maximum operating value
- Apply a input signal in the form of a 1 kHz tone burst of 1 sec duration: the repetition period of the signal pulses is 60 sec
- The output voltage is measured 1 sec from the start of the pulse
- Increase the input voltage until the output signal shows a THD=10%
- The music power is then $V^2_{out}$ /$R_L$, where $V_{out}$ is the output voltage measured in the condition of point 4 and $R_L$ is the rated load impedance

The target of this method is to avoid excessive dissipation in the amplifier.

## A.2 Instantaneous power

Another power measurement (maximum instantaneous output power) was proposed by the IEC in 1988 (IEC publication 268-3 subclause 19.A). We give here only a brief extract of the concept, and a circuit useful for the measurement. The supply voltage is set at the maximum operating value.

The test signal consists of a sinusoidal signal whose frequency is 20 Hz, to which are added alternate positive and negative pulses of 50 µs duration and 500 Hz repetition rate. The amplitude of the 20 Hz signal is chosen to drive the amplifier to its voltage clipping limits, while the amplitude of the pulses takes the amplifier alternately into its current-overload limits. A circuit for generating the test signal is given in *Figure 22*.

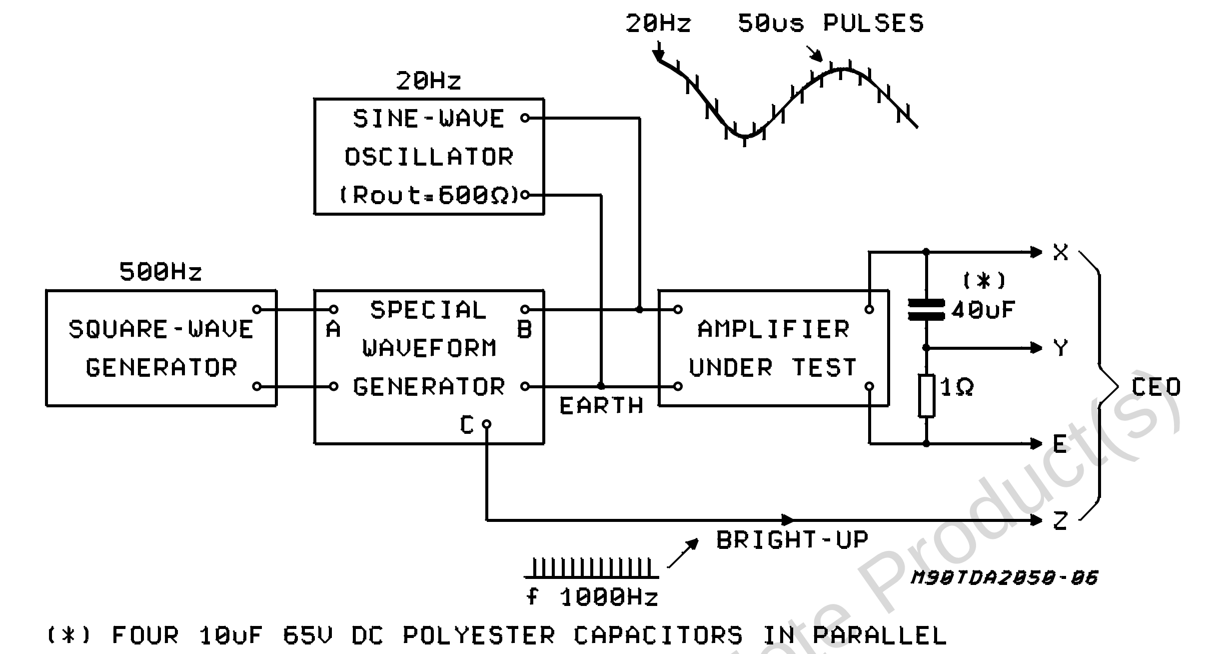
The load network consists of a 40 µF capacitor, in series with a 1 ohm resistor. The capacitor limits the current due to the 20 Hz signal to a low value, whereas for the short pulses the effective load impedance is of the order of 1 ohm, and a high output current is produced.

Using this signal and load network the measurement may be made without causing excessive dissipation in the amplifier. The dissipation in the 1 ohm resistor is much lower than a rated output power of the amplifier, because the duty-cycle of the high output current is low. By feeding the amplifier output voltage to the Xplates of an oscilloscope, and the voltage across the 1 ohm resistor (representing the output current) to the Y=plates, it is possible to read on the display the value of the maximum instantaneous output power.

The result of this test applied on the TDA2050 is:

Peak power = 100 W typ

**Figure 22. Test circuit for peak power measurement**



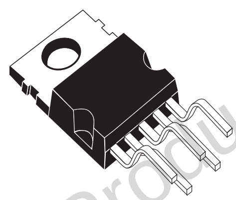
# 7 Package mechanical data

**Figure 23. Pentawatt V package**

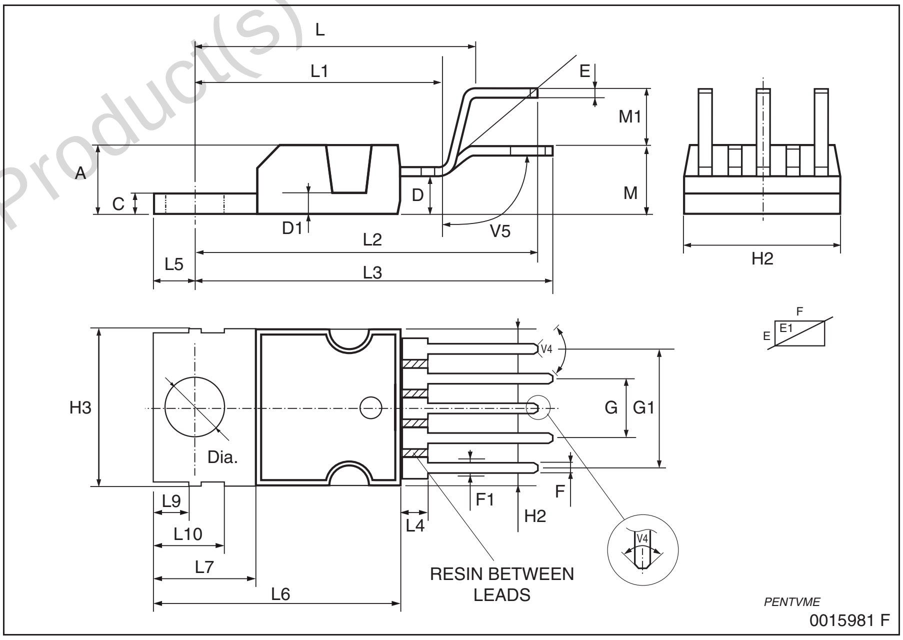
| DIM. | mm | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 4.80 | | | 0.188 |
| C | | | 1.37 | | | 0.054 |
| D | 2.40 | | 2.80 | 0.094 | | 0.11 |
| D1 | 1.20 | | 1.35 | 0.047 | | 0.053 |
| E | 0.35 | | 0.55 | 0.014 | | 0.022 |
| E1 | 0.76 | | 1.19 | 0.030 | | 0.047 |
| F | 0.80 | | 1.05 | 0.031 | | 0.041 |
| F1 | 1.00 | | 1.40 | 0.039 | | 0.055 |
| G | 3.20 | 3.40 | 3.60 | 0.126 | 0.134 | 0.142 |
| G1 | 6.60 | 6.80 | 7.00 | 0.260 | 0.267 | 0.275 |
| H2 | | | 10.40 | | | 0.41 |
| H3 | | | 10.40 | | | 0.409 |
| L | 17.55 | 17.85 | 18.15 | 0.691 | 0.703 | 0.715 |
| L1 | 15.55 | 15.75 | 15.95 | 0.612 | 0.620 | 0.628 |
| L2 | 21.2 | 21.4 | 21.6 | 0.831 | 0.843 | 0.850 |
| L3 | 22.3 | 22.5 | 22.7 | 0.878 | 0.886 | 0.894 |
| L4 | | | 1.29 | | | 0.051 |
| L5 | 2.60 | | 3.00 | 0.102 | | 0.118 |
| L6 | 15.10 | | 15.80 | 0.594 | | 0.622 |
| L7 | 6.00 | | 6.60 | 0.236 | | 0.260 |
| L9 | 2.10 | | 2.70 | 0.083 | | 0.106 |
| L10 | 4.30 | | 4.80 | 0.170 | | 0.189 |
| M | 4.23 | 4.5 | 4.75 | 0.167 | 0.178 | 0.187 |
| M1 | 3.75 | 4.0 | 4.25 | 0.148 | 0.157 | 0.187 |
| V4 | 40° (Typ.) | | | | | |
| V5 | 90° (Typ.) | | | | | |
| DIA | 3.65 | | 3.85 | 0.143 | | 0.151 |

**OUTLINE AND MECHANICAL DATA**

**Weight:** 2.00gr



**Pentawatt V**



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# 8 Revision history

**Table 8. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 31-Aug-2011 | 3 | Removed minimum value from Pentawatt (vertical) package dimension H3 in *Figure 23: Pentawatt V package*<br>Revised general presentation, minor textual updates |