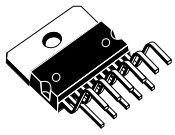
# TDA7391LV

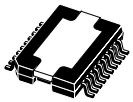
## 40 W bridge car radio amplifier with low voltage operation

**Datasheet - production data**



**Multiwatt 11 (vertical)**

**PowerSO-20 (slug-down)**



**PowerSO-20 (slug-up)**

GAPGPS03423

## Features

- High power capability:
  - 40 W/ 4 Ω max
  - 45 W/ 3.2 Ω max
  - 32 W/ 3.2 Ω @ $V_S$ = 14.4 V, f = 1 kHz, THD = 10 %
  - 26 W/ 4 Ω @ $V_S$ = 14.4 V, f = 1 kHz, THD = 10%
- Differential inputs (either single ended or differential input signal is accepted)
- Minimum external component count
- Standby function (CMOS compatible)
- Capable to operate to 6 V - ‘start-stop’ and ‘e-call’ compatibility
- Protections:
  - Short circuit (to GND, to $V_S$, across the load)
  - Very inductive loads
  - Chip over temperature
  - Load dump
  - Open GND
  - ESD

## Description

The TDA7391LV is a bridge class AB audio power amplifier for car radio applications.

The high power capability together with the possibility to operate either in differential input mode or single ended input mode makes it suitable for high end car radio equipment. The exclusive fully complementary output stage and the internal fixed gain configuration drop the external component count.

The on board clipping detector allows easy implementation of gain compression systems.

It is moreover compliant to the most recent OEM specifications for low voltage operation ('start-stop' battery profile during engine stop), and e-call functions.

**Table 1. Device summary**

| Order code | Package | Packing |
|---|---|---|
| TDA7391LV | Multiwatt 11 | Tube |
| TDA7391LVPD | PowerSO-20 (slug-down) | Tube |
| TDA7391LVPDTR | | Tape and reel |
| TDA7391LVPDU | PowerSO-20 (slug-up) | Tube |
| TDA7391LVPDUTR | | Tape and reel |



This is information on a product in full production. www.st.com

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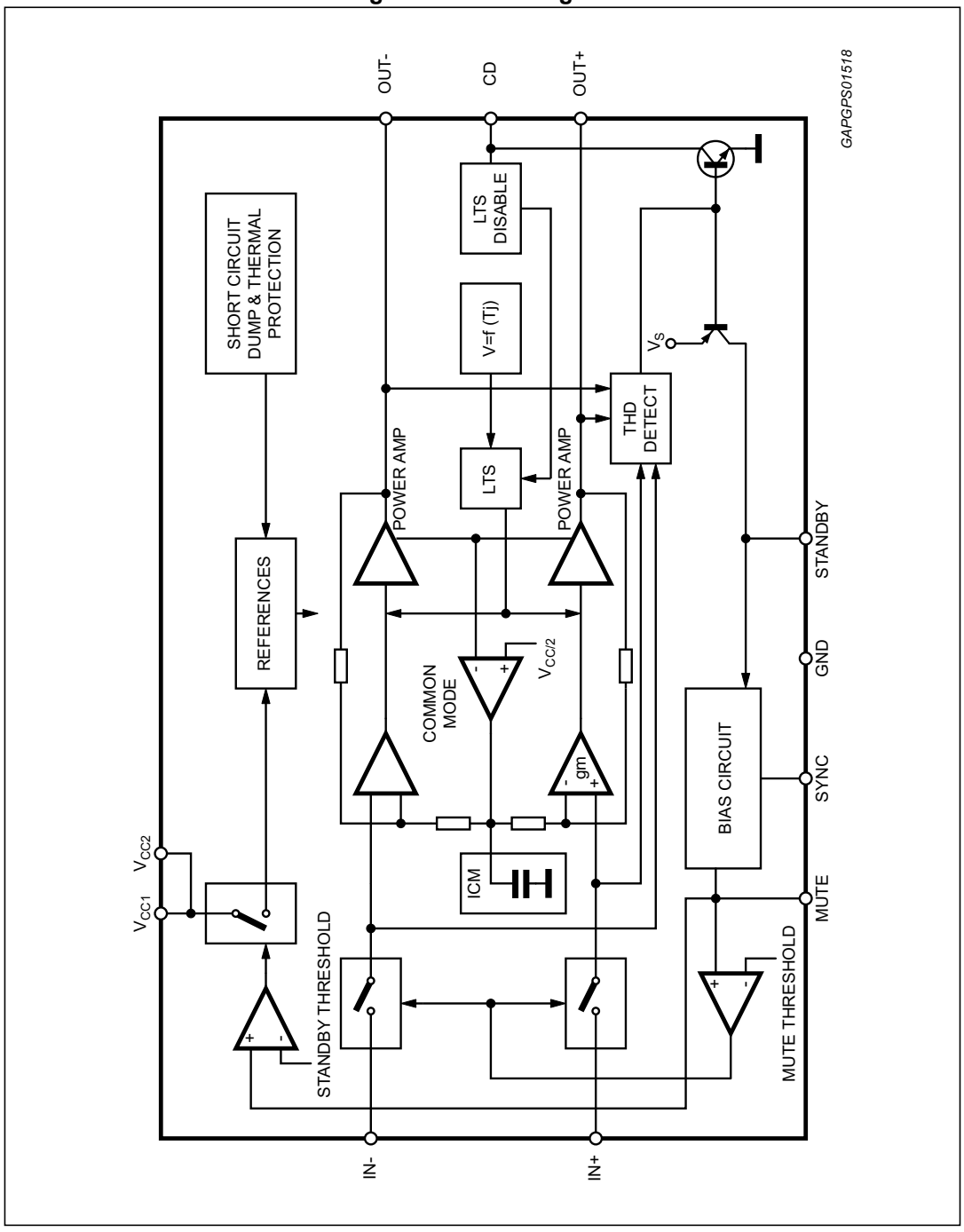
# 1 Block diagram, test and application circuit

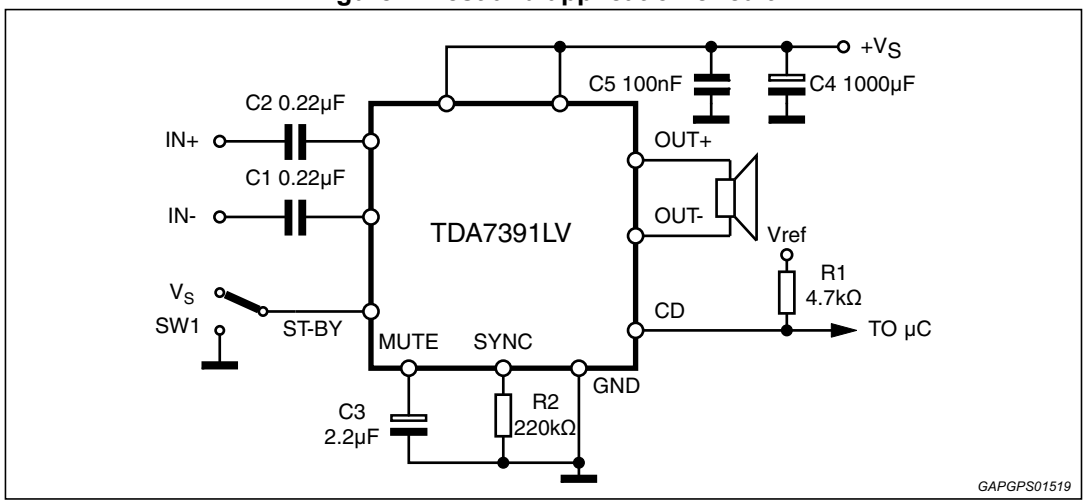
## 1.1 Block diagram

**Figure 1. Block diagram**



## 1.2 Test and application circuit

**Figure 2. Test and application circuit**



# 2 Pins description

**Figure 3. Multiwatt 11 pins connection (top view)**

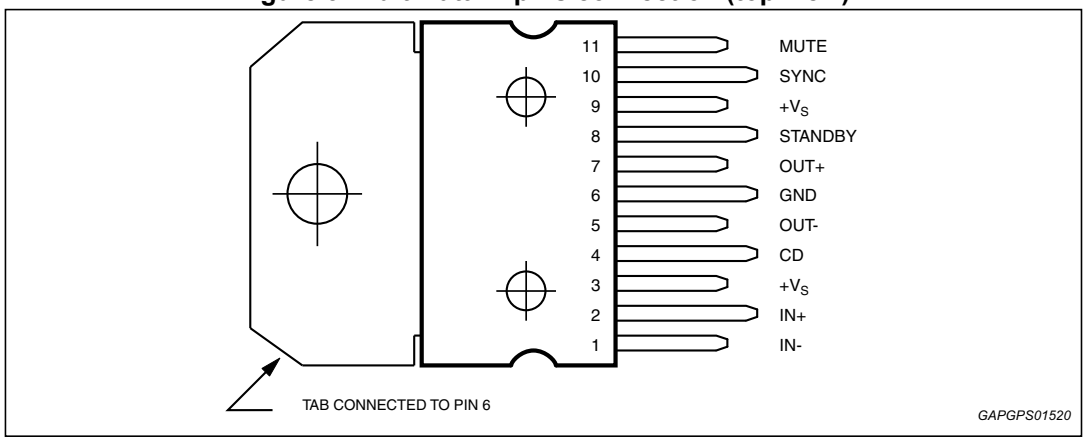



**Figure 4. PowerSO-20 pins connection**

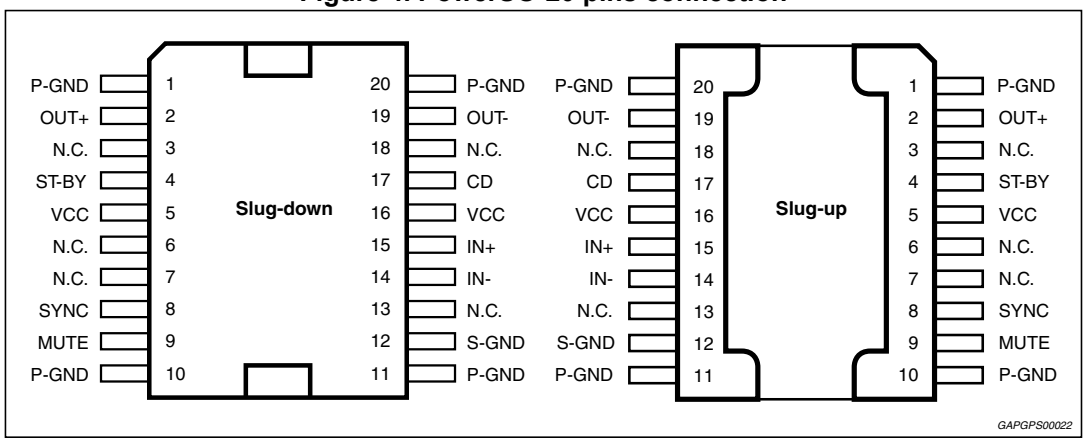



**Table 2. Pins function**

| Multiwatt 11 Pin # | PowerSO-20 Pin # | Name | Description |
|---|---|---|---|
| 1, 2 | 14, 15 | INPUTS | The input stage is a high impedance type also capable of operation in single ended mode with one input capacitively coupled to the signal GND. The impedance seen by the inverting and non inverting input pins must be matched. |
| 3, 9 | 5, 16 | $^{+}V_S$ | Supply voltage. |
| 4 | 17 | CD | The TDA7391LV is equipped with a diagnostic circuitry able to detect the clipping in the Output Signal (distortion = 10%).<br>The CD pin (open collector) gives out low level signal during clipping. |

**Table 2. Pins function (continued)**

| Multiwatt 11 Pin # | PowerSO-20 Pin # | Name | Description |
|---|---|---|---|
| 5, 7 | 2, 19 | OUTPUTS | The output stage is a bridge type able to drive loads as low as 3.2 Ω. It consists of two class AB fully complementary PNP/NPN stages fully protected.<br>A rail to rail output voltage swing is achieved without need of bootstrap capacitors.<br>No external compensation is necessary. |
| 6 | 1, 10, 11, 20 | GND | Power ground. |
| | 12 | S-GND | Signal ground. |
| 8 | 4 | STANDBY | The device features a standby function which shuts down all the internal bias supplies when the standby pin is low. In standby mode the amplifier sinks a small current (in the range of few µA). When the standby pin is high the IC becomes fully operational. |
| 10 | 8 | SYNC | A resistor ($R_2$) between pin 8 and GND set the charging current of capacitor $C_3$ (pin 9). The suggested values of $C_3$ and $R_2$ define the correct timing in order to switch on/off the amplifier without any pop noise. |
| 11 | 9 | MUTE | The pin is connected to a capacitor ($C_3$) tied to GND to set the mute/standby time.<br>An automatic mute during turn on/off is provided to prevent noisy transients. |

# 3 Electrical specifications

## 3.1 Absolute maximum ratings

**Table 3. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_S$ | DC supply voltage | 28 | V |
| $V_{OP}$ | Operating supply voltage | 18 | V |
| $V_{PEAK}$ | Peak supply voltage (t = 50 ms) | 50 | V |
| $I_O$ | Output peak current repetitive (f > 10 Hz) | 4.5 | A |
| | Output peak current non repetitive | 6 | A |
| $P_{tot}$ | Power dissipation ($T_{case}$ = 85 °C) | 43 | W |
| $T_{stg}$, $T_j$ | Storage and junction temperature | -40 to 150 | °C |

## 3.2 Thermal data

**Table 4. Thermal data**

| Symbol | Parameter | | Multiwatt | PowerSO | Unit |
|---|---|---|---|---|---|
| $R_{th\ j\text{-}case}$ | Thermal resistance junction-to-case | Max. | 1.8 | 2 | °C/W |

## 3.3 Electrical characteristics

$V_S$ = 14.4 V; $R_L$ = 4 Ω, f = 1 kHz, $T_{amb}$ = 25 °C, unless otherwise specified.

**Table 5. Electrical characteristics**

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_S$ | Supply voltage range | - | 6 | - | 18 | V |
| $I_q$ | Total quiescent current | - | - | 60 | 150 | mA |
| $V_{OS}$ | Output offset voltage | - | - | - | 120 | mV |
| $I_{SB}$ | Standby current | $V_{ST\text{-}BY}$ = 1.5 V | - | - | 50 | µA |
| $I_{SBin}$ | Standby input bias current | $V_{ST\text{-}BY}$ = 5 V | - | - | 10 | µA |
| $V_{SBon}$ | Standby on threshold voltage | - | - | - | 1.5 | V |
| $V_{SBoff}$ | Standby off threshold voltage | - | 3.5 | - | - | V |
| $ATT_{ST\text{-}BY}$ | Standby attenuation | - | - | 90 | - | dB |
| $I_{M\ in}$ | Mute input bias current | ($V_{MUTE}$ = 5 V) | - | - | 10 | µA |
| $A_M$ | Mute attenuation | - | - | 90 | - | dB |

**Table 5. Electrical characteristics (continued)**

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $P_O$ | Output power | THD = 10 % | 20 | 26 | - | W |
| | | THD = 1 % | - | 21 | - | W |
| | | THD = 10 %; $R_L$ = 3.2 Ω | - | 32 | - | W |
| | | $V_S$ = 6 V; THD = 10 % | - | 4.2 | - | W |
| $P_{O\ MAX}$ | Max. output power (1) | $V_S$ = 14.4 V; $R_L$ = 3.2 Ω | - | 45 | - | W |
| | | $V_S$ = 6 V; THD = 10 % | - | 6 | - | W |
| THD | Total harmonic distortion | - | - | 0.06 | - | % |
| | | $P_O$ = 0.1 to 15 W | - | 0.03 | - | % |
| | | $V_S$ = 6 V; $P_O$ = 1 W | | 0.05 | | % |
| | | $V_S$ = 6 V; $P_O$ = 3.5 W | | 1.5 | | % |
| $G_V$ | Voltage gain | - | 29.5 | 30 | 30.5 | dB |
| $f_H$ | High frequency roll-off | $P_O$ = 1 W; -3 dB | 75 | - | - | kHz |
| $R_{IN}$ | Input Impedance | Differential | 36 | 60 | - | kΩ |
| | | Single ended | 30 | 55 | - | kΩ |
| $E_{IN}$ | Input noise voltage | $R_g$ = 0 Ω; f = 22 Hz to 22 kHz | - | 4 | - | mV |
| CMRR | Input common mode rejection | f = 1 kHz; $V_{IN}$ = 1 $V_{rms}$ | - | 65 | - | dB |
| SVR | Supply voltage rejection | $R_g$ = 0 Ω; $V_r$ = 1 Vrms | - | 60 | - | dB |
| CDL | Clipping detection level | - | 5 | 10 | 15 | % |
| $T_{sd}$ | Absolute thermal shutdown junction temperature | - | - | 160 | - | °C |

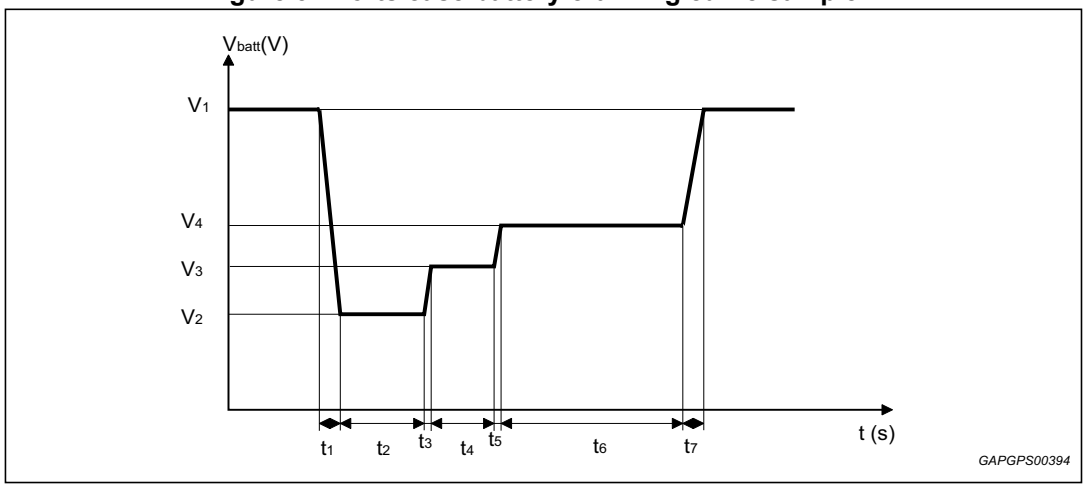
1. Saturated square wave output.

## 3.4 Low voltage operation ('start stop')

The most recent OEM specification are requiring automatic stop of car engine at traffic light, in order to reduce emissions of polluting substances. The TDA7391LV allows a continuous operation when battery falls down to 6/7 V during such conditions. The maximum system power will be reduced accordingly.

Worst case battery cranking curves are shown below, indicating the shape and durations of allowed battery transitions.

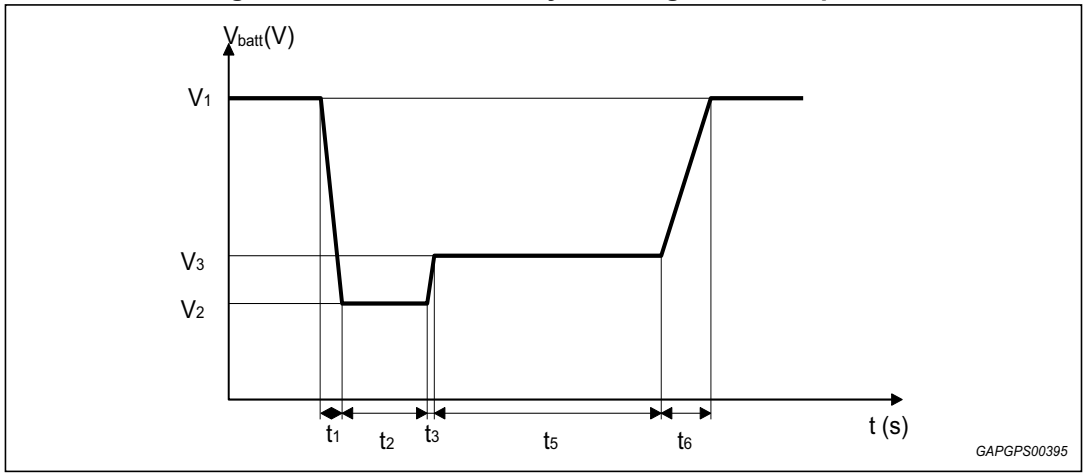
**Figure 5. Worts case battery cranking curve sample 1**




V1 = 12 V; V2 = 6 V; V3 = 7 V; V4 = 8 V

t1 = 2 ms; t2 = 50 ms; t3 = 5 ms; t4 = 300 ms; t5 =10 ms; t6 = 1 s; t7 = 2 ms

**Figure 6. Worst case battery cranking curve sample 2**




V1 = 12 V; V2 = 6 V; V3 = 7 V

t1 = 2 ms; t2 = 5 ms; t3 = 15 ms; t5 = 1 s; t6 = 50 ms

## 3.5 Electrical characteristics curves

**Figure 7. Quiescent current vs. supply voltage**

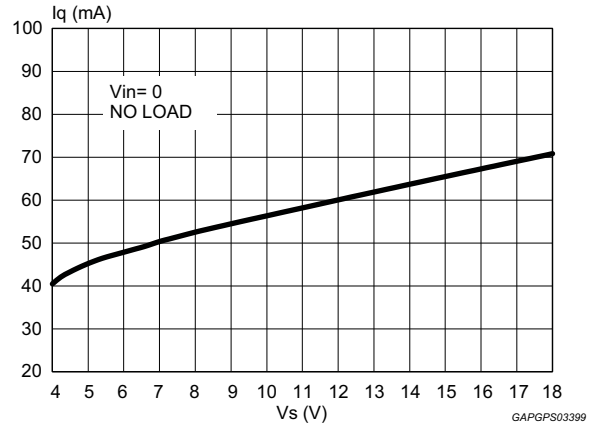



**Figure 8. Output power vs. supply voltage ($R_L$ = 3.2 Ω)**

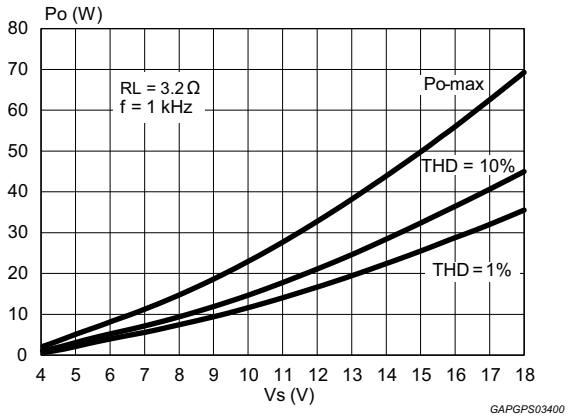



**Figure 9. Output power vs. supply voltage ($R_L$ = 4 Ω)**

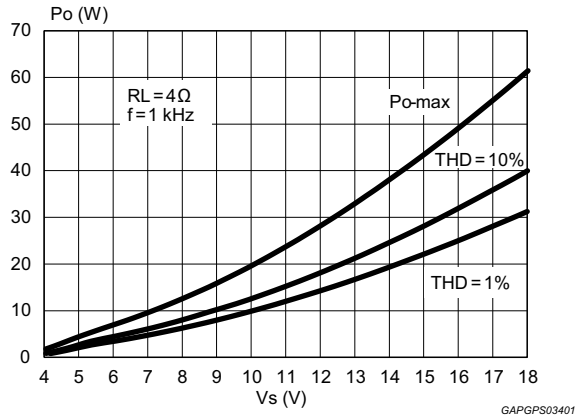



**Figure 10. Output power vs. supply voltage ($R_L$ = 8 Ω)**

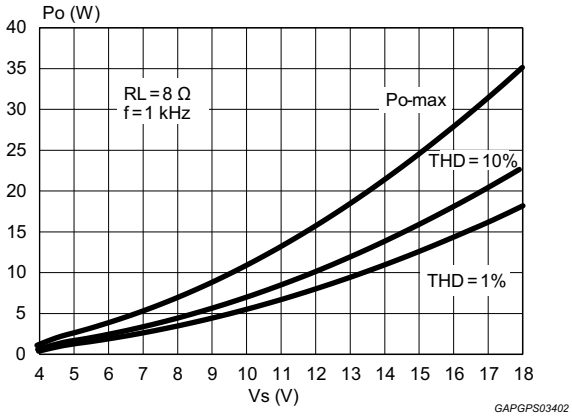



**Figure 11. Distortion vs. output power ($R_L$ = 3.2 Ω)**

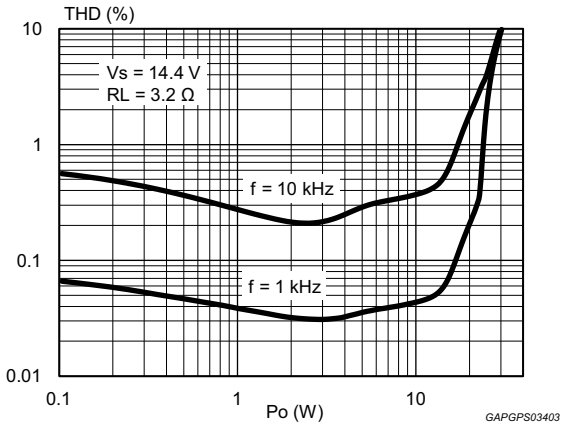



**Figure 12. Distortion vs. frequency ($R_L$= 3.2 Ω)**

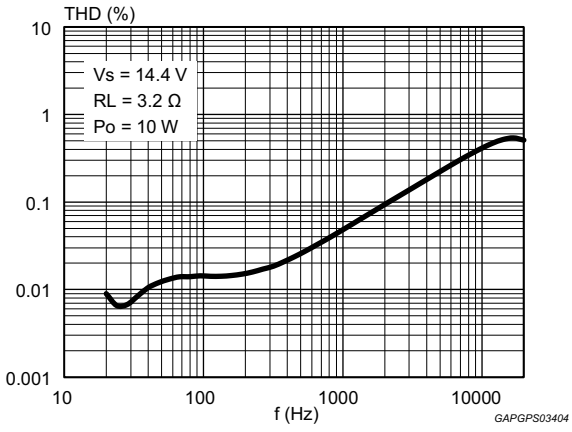


**Figure 13. Distortion vs. output power ($R_L$ = 4 Ω)**

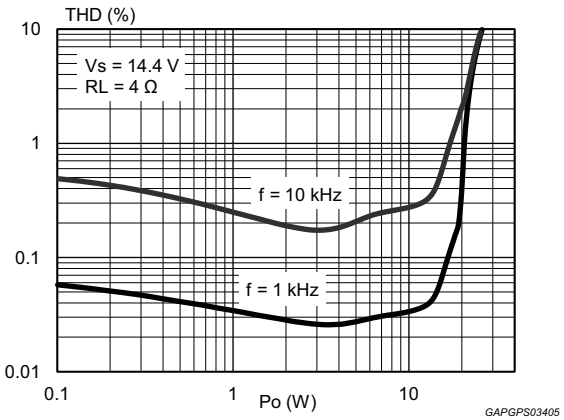



**Figure 14. Distortion vs. frequency ($R_L$ = 4 Ω)**

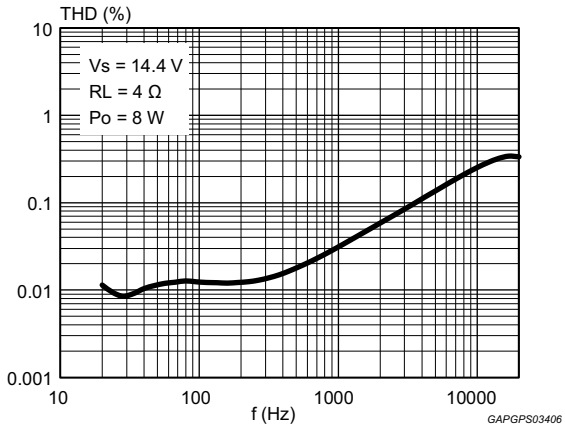



**Figure 15. Distortion vs. output power ($R_L$ = 8 Ω)**

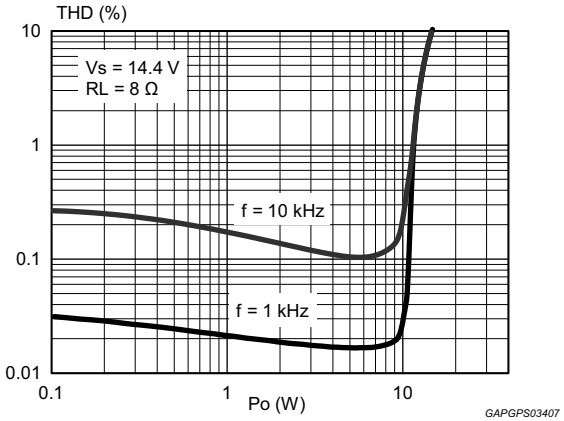



**Figure 16. Distortion vs. frequency ($R_L$ = 8 Ω)**

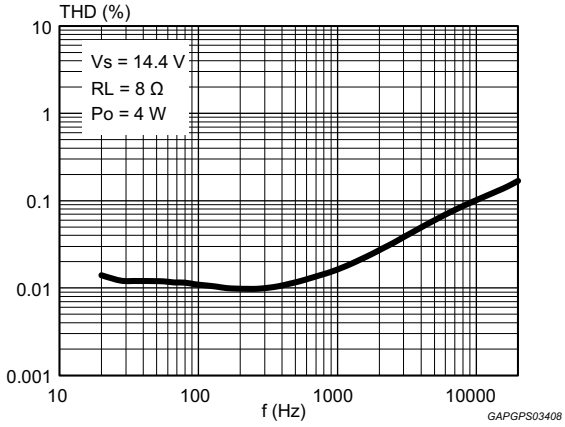



**Figure 17. Distortion vs. output power ($R_L$ = 4 Ω, $V_S$ = 6 V)**

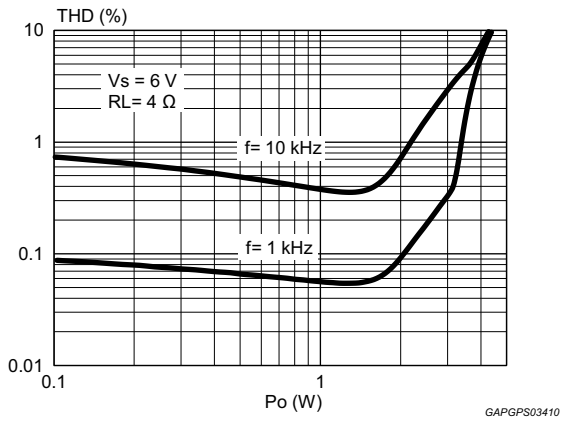



**Figure 18. Distortion vs. frequency ($R_L$ = 4 Ω, $V_S$ = 6 V)**

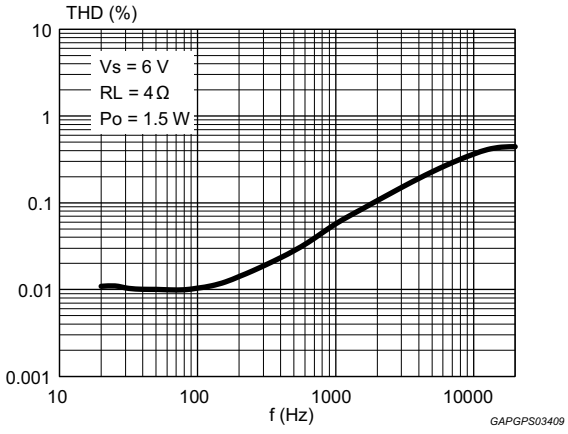


**Figure 19. Distortion vs. output power ($R_L$ = 8 Ω, $V_S$ = 6 V)**

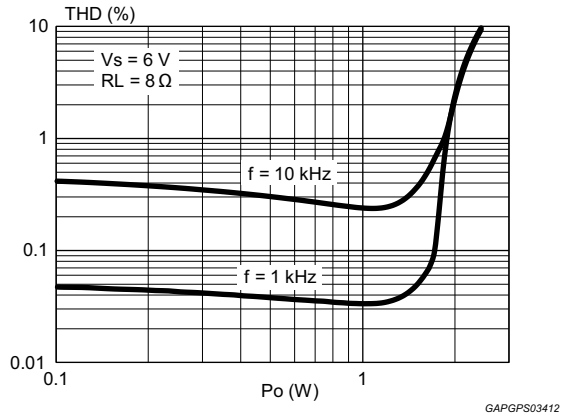



**Figure 20. Distortion vs. frequency ($R_L$ = 8 Ω, $V_S$ = 6 V)**

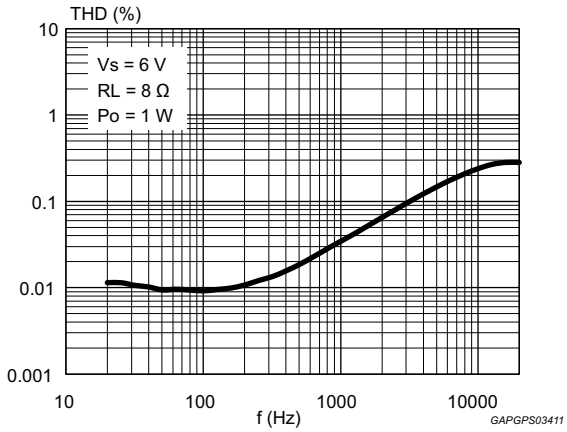



**Figure 21. Supply voltage rejection vs. frequency**

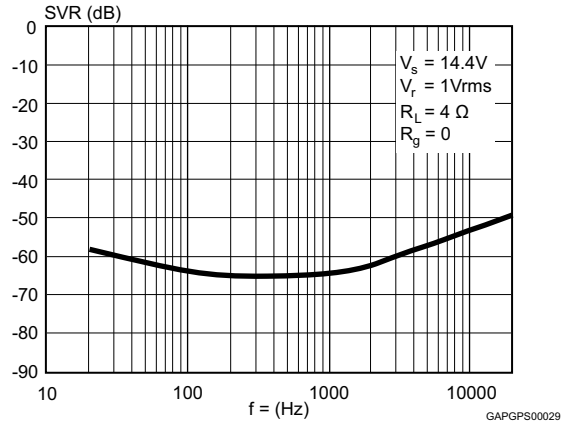



**Figure 22. Common mode rejection vs. frequency**

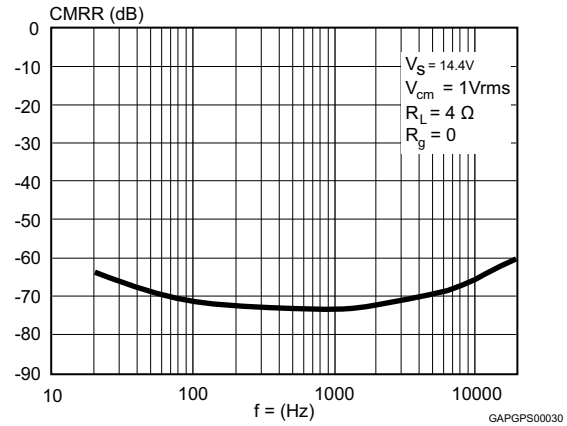



**Figure 23. Total power dissipation and efficiency vs. output power ($R_L$ = 4 Ω)**

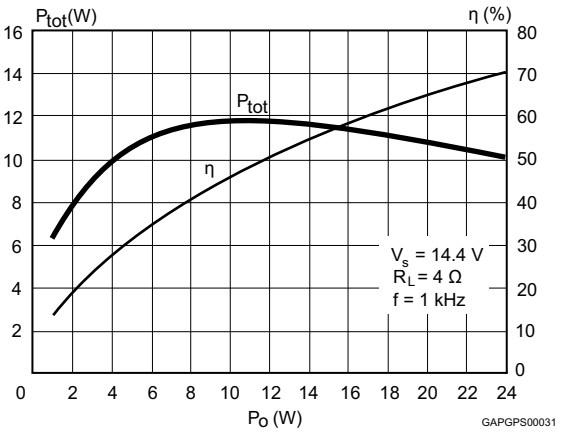



**Figure 24. Power dissipation vs. average output power (audio program simulation, $R_L$ = 4 Ω)**

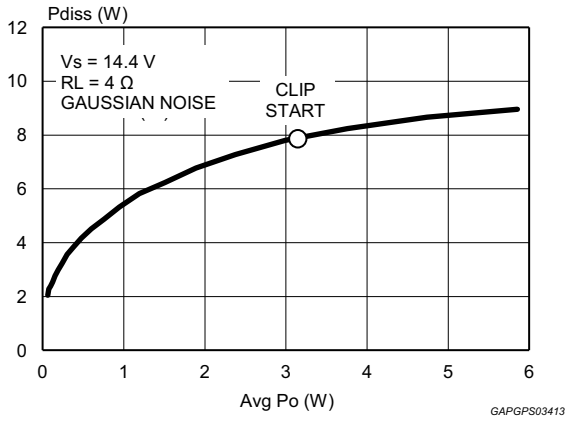


**Figure 25. Power dissipation vs. average output power (audio program simulation, $R_L$ = 4 Ω & 8 Ω, $V_s$ = 6 V)**

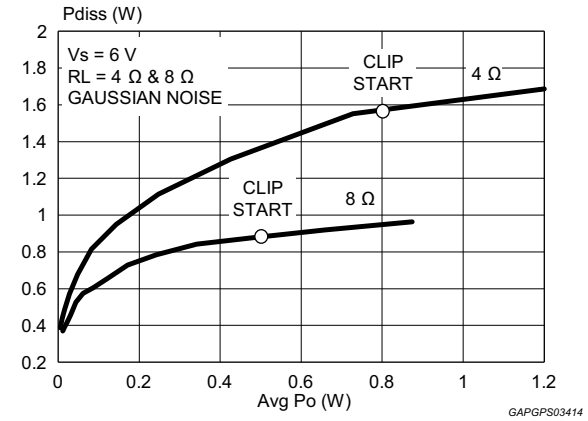
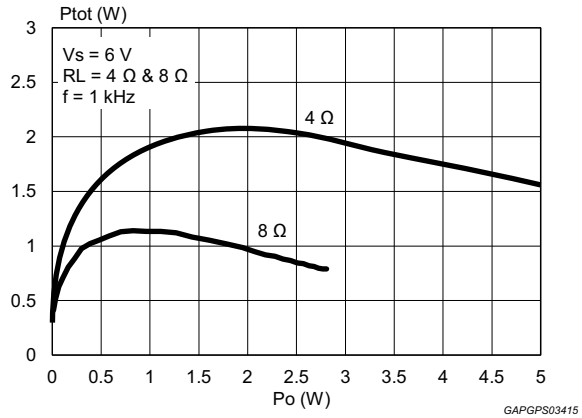



**Figure 26. Power dissipation vs. output power ($R_L$ = 4 Ω & 8 Ω, sine, $V_s$ = 6 V)**



# 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*.

ECOPACK® is an ST trademark.

## 4.1 Multiwatt 11 (vertical) package mechanical data

**Figure 27. Multiwatt 11 (vertical) package mechanical drawing**

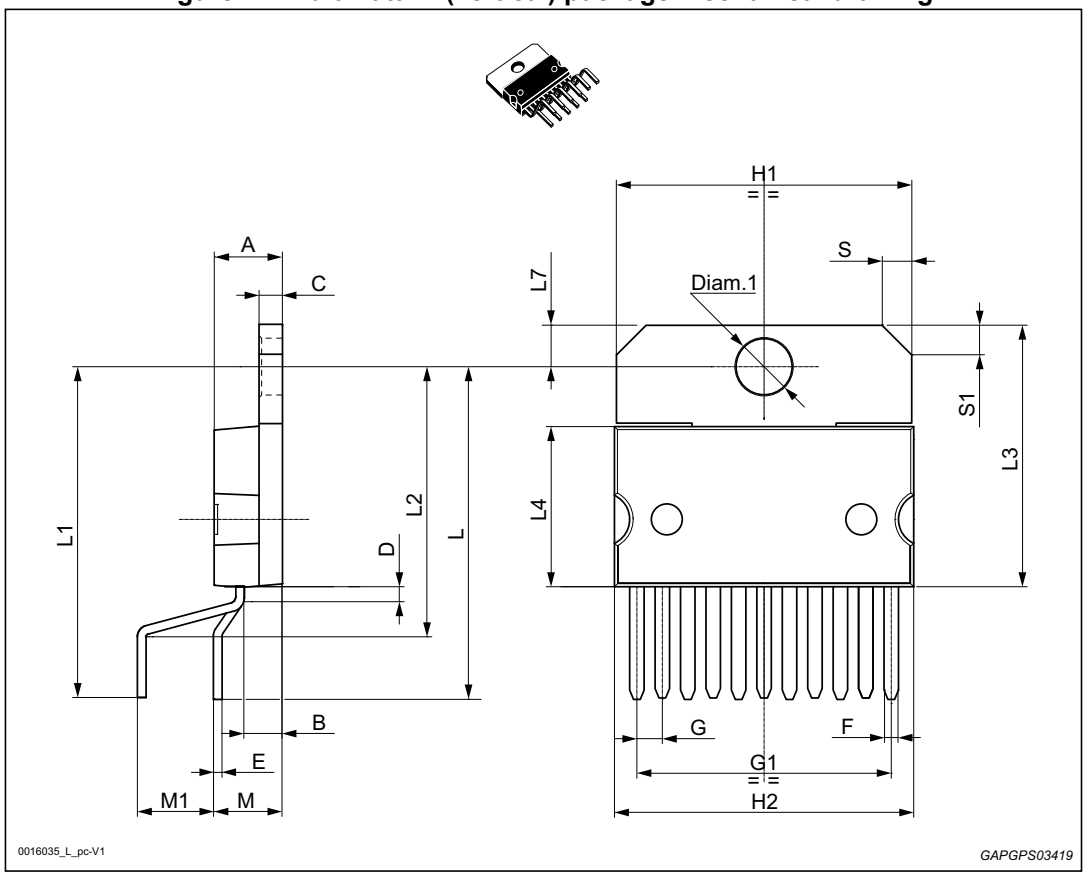



**Table 6. Multiwatt 11 (vertical) package mechanical data**

| Symbol | Millimeters | | | Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 5 | | | 0.1969 |
| B | | | 2.65 | | | 0.1043 |
| C | | | 1.6 | | | 0.063 |
| D | | 1 | | | 0.0394 | |

Table 6. Multiwatt 11 (vertical) package mechanical data (continued)

| Symbol | Millimeters | | | Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| E | 0.49 | | 0.55 | 0.0193 | | 0.0217 |
| F | 0.88 | | 0.95 | 0.0346 | | 0.0374 |
| G | 1.45 | 1.7 | 1.95 | 0.0571 | 0.0669 | 0.0768 |
| G1 | 16.75 | 17 | 17.25 | 0.6594 | 0.6693 | 0.6791 |
| H1 | 19.6 | | | 0.7717 | | |
| H2 | | | 20.2 | | | 0.7953 |
| L | 21.9 | 22.2 | 22.5 | 0.8622 | 0.874 | 0.8858 |
| L1 | 21.7 | 22.1 | 22.5 | 0.8543 | 0.8701 | 0.8858 |
| L2 | 17.4 | | 18.1 | 0.685 | | 0.7126 |
| L3 | 17.25 | 17.5 | 17.75 | 0.6791 | 0.689 | 0.6988 |
| L4 | 10.3 | 10.7 | 10.9 | 0.4055 | 0.4213 | 0.4291 |
| L7 | 2.65 | | 2.9 | 0.1043 | | 0.1142 |
| M | 4.25 | 4.55 | 4.85 | 0.1673 | 0.1791 | 0.1909 |
| M1 | 4.73 | 5.08 | 5.43 | 0.1862 | 0.2 | 0.2138 |
| S | 1.9 | | 2.6 | 0.0748 | | 0.1024 |
| S1 | 1.9 | | 2.6 | 0.0748 | | 0.1024 |
| Diam.1 | 3.65 | | 3.85 | 0.1437 | | 0.1516 |

## 4.2 PowerSO-20 (slug-down) package mechanical data

**Figure 28. PowerSO-20 (slug-down) package mechanical drawing**

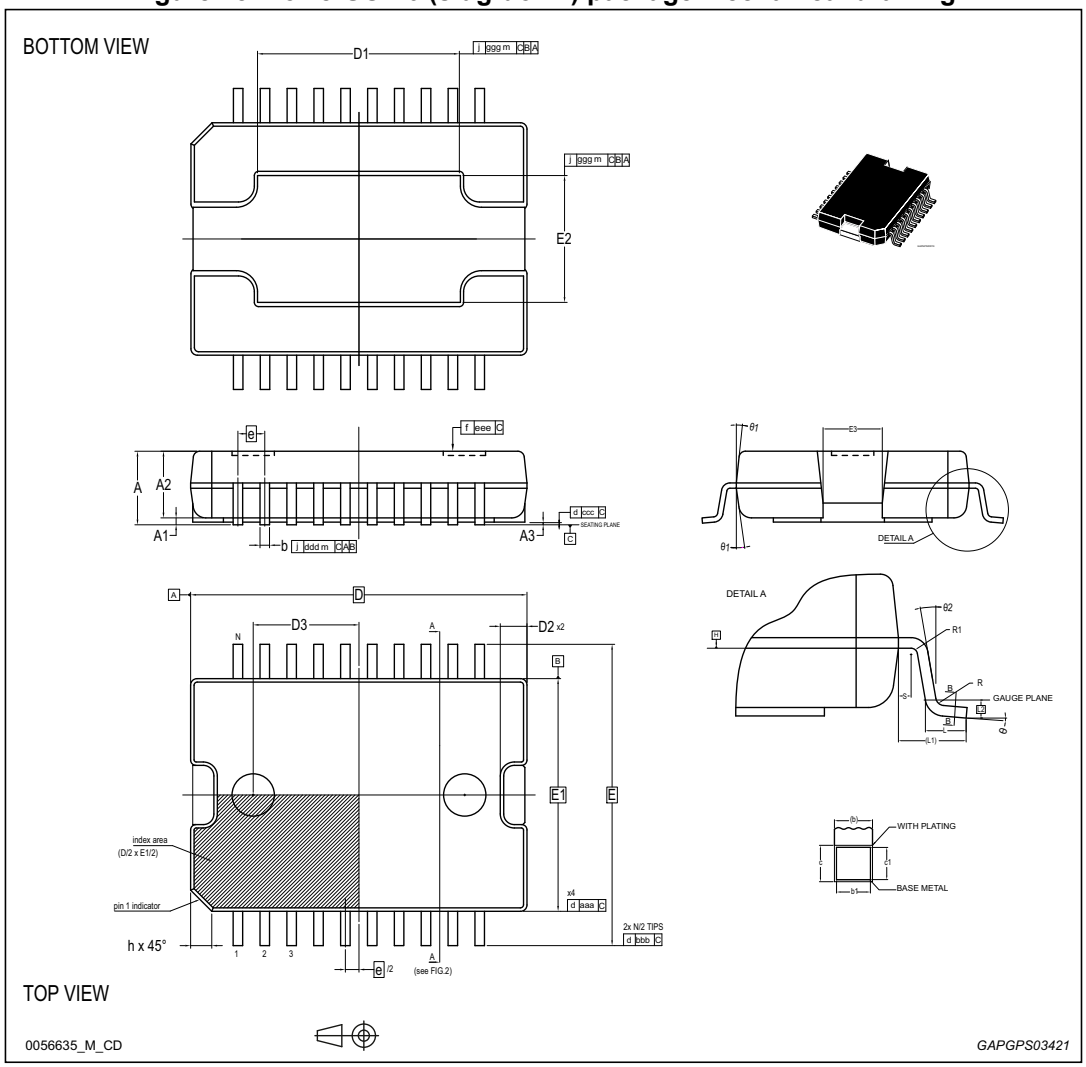



**Table 7. PowerSO-20 (slug-down) package mechanical data**

| Symbol | Millimeters | | | Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| Θ | 0° | | 8° | 0° | | 8° |
| Θ1 | 5° | | 10° | 5° | | 10° |
| Θ2 | 0° | | | 0° | | |
| A | | | 3.6 | | | 0.1417 |
| A1 | 0.1 | | | 0.0039 | | |
| A2 | 3 | 3.15 | 3.3 | 0.1181 | 0.124 | 0.1299 |
| A3 | | | 0.1 | | | 0.0039 |

Table 7. PowerSO-20 (slug-down) package mechanical data (continued)

| Symbol | Millimeters | | | Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| b | 0.4 | | 0.53 | 0.0157 | | 0.0209 |
| b1 | 0.4 | 0.45 | 0.5 | 0.0157 | 0.0177 | 0.0197 |
| c | 0.23 | | 0.32 | 0.0091 | | 0.0126 |
| c1 | 0.23 | 0.25 | 0.29 | 0.0091 | 0.0098 | 0.0114 |
| D | | 15.90 BSC | | | 0.626 BSC | |
| D1(1) | 9 | | 13 | 0.3543 | | 0.5118 |
| D2 | | | 1.1 | | | 0.0433 |
| D3 | | 5 | | | 0.1969 | |
| e | | 1.27 BSC | | | 0.050 BSC | |
| E | | 14.20 BSC | | | 0.5591 BSC | |
| E1(1) | | 11.00 BSC | | | 04331 BSC | |
| E2 | 5.6 | | 6.2 | 0.2205 | | 0.2441 |
| E3 | | | 2.9 | | | 0.1142 |
| h | | | 1.1 | | | 0.0433 |
| L | 0.8 | | 1.1 | 0.0315 | | 0.0433 |
| L1 | | 1.60 REF | | | 0.063 REF | |
| L2 | | 0.35 BSC | | | 0.0138 BSC | |
| N | | 20 | | | 0.7874 | |
| R | 0.2 | | | 0.0079 | | |
| R1 | 0.2 | | | 0.0079 | | |
| S | 0.25 | | | 0.0098 | | |
| aaa | | 0.1 | | | 0.0039 | |
| bbb | | 0.3 | | | 0.0118 | |
| ccc | | 0.1 | | | 0.0039 | |
| ddd | | 0.25 | | | 0.0098 | |
| eee | | 0.1 | | | 0.0039 | |
| ggg | | 0.25 | | | 0.0098 | |

1. Dimensions ‘D’ and ‘E1’ do not include mold flash or protrusions. Allowable mold flash or protrusions is “0.25 mm” per side D and “0.15 mm” per side E1. D and E1 are Maximum plastic body size dimensions including mold mismatch.

## 4.3 PowerSO-20 (slug-up) package mechanical data

**Figure 29. PowerSO-20 (slug-up) package mechanical drawing**

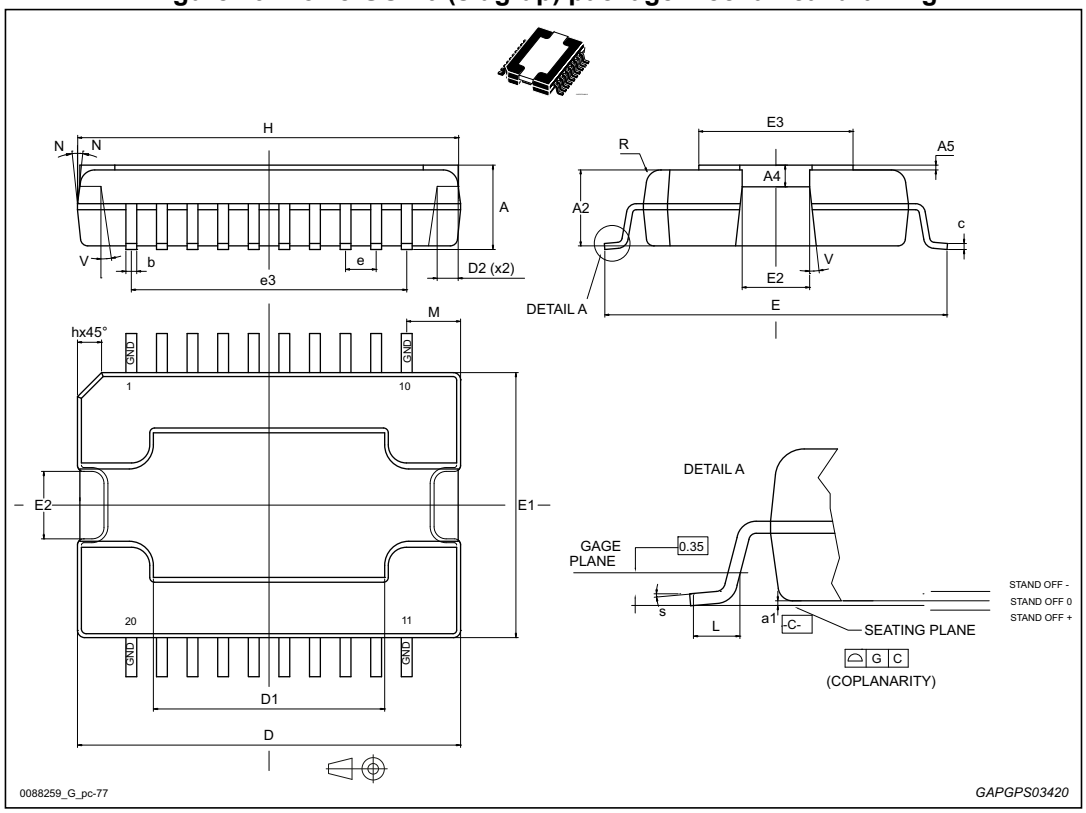



**Table 8. PowerSO-20 (slug-up) package mechanical data**

| Symbol | Millimeters | | | Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 3.25 | | 3.5 | 0.128 | | 0.1378 |
| A2 | 3 | 3.15 | 3.3 | 0.1181 | 0.124 | 0.1299 |
| a1 | 0.03 | | -0.04 | 0.0012 | | -0.0016 |
| A4 | 0.8 | | 1 | 0.0315 | | 0.0394 |
| A5 | 0.15 | 0.2 | 0.25 | 0.0059 | 0.0079 | 0.0098 |
| b | 0.4 | | 0.53 | 0.0157 | | 0.0209 |
| c | 0.23 | | 0.32 | 0.0091 | | 0.0126 |
| D | 15.8 | | 16 | 0.622 | | 0.6299 |
| D1 (1) | 9.4 | | 9.8 | 0.3701 | | 0.3858 |
| D2 | | 1 | | | 0.0394 | |
| E | 13.9 | | 14.5 | 0.5472 | | 0.5709 |
| e | 1.12 | 1.27 | 1.42 | 0.0441 | 0.05 | 0.0559 |
| e3 | | 11.43 | | | 0.45 | |

Table 8. PowerSO-20 (slug-up) package mechanical data (continued)

| Symbol | Millimeters | | | Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| E1 (1) | 10.9 | | 11.1 | 0.4291 | | 0.437 |
| E2 | | | 2.9 | | | 0.1142 |
| E3 | 5.8 | | 6.2 | 0.2283 | | 0.2441 |
| G | 0 | | 0.1 | 0 | | 0.0039 |
| h | | | 1.1 | | | 0.0433 |
| H | 15.5 | | 15.9 | 0.6102 | | 0.626 |
| L | 0.8 | | 1.1 | 0.0315 | | 0.0433 |
| N | | | 10d. | | | 10d. |
| R | | 0.6 | | | 0.0236 | |
| s | 0d. | | 8d. | 0d. | | 8d. |
| V | 5d. | | 7d. | 5d. | | 7d. |

1. ‘D’ and ‘E1’ do not include mold flash or protrusions.
Mold flash or protrusions shall not exceed 0.15 mm (0.006 inches) per side.

# 5 Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 29-Mar-2012 | 1 | Initial release. |
| 18-Sep-2013 | 2 | Updated:<br>*Features on page 1*;<br>*Figure 1: Block diagram on page 5*;<br>*Table 2: Pins function*.<br>Updated disclaimer. |
| 01-Dec-2014 | 3 | Updated:<br>*Features* and *Description on page 1*;<br>*Table 5: Electrical characteristics*<br>*Section 3.5: Electrical characteristics curves*;<br>*Section 4: Package information*. |

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