# STEREO DIGITAL AMPLIFIER POWER STAGE

TM

## FEATURES

- 2×125 W at 10% THD+N Into 4-Ω BTL
- 2×98 W at 10% THD+N Into 6-Ω BTL
- 2×76 W at 10% THD+N Into 8-Ω BTL
- 4×45 W at 10% THD+N Into 3-Ω SE
- 4×35 W at 10% THD+N Into 4-Ω SE
- 1×192 W at 10% THD+N Into 3-Ω PBTL
- 1×240 W at 10% THD+N Into 2-Ω PBTL
- >100-dB SNR (A-Weighted)
- <0.1% THD+N at 1 W
- Thermally Enhanced Package Option:
  - DKD (36-Pin PSOP3)
- High-Efficiency Power Stage (>90%) With 140-mΩ Output MOSFETs
- Power-On Reset for Protection on Power Up Without Any Power-Supply Sequencing
- Integrated Self-Protection Circuits Including:
  - Undervoltage
  - Overtemperature
  - Overload
  - Short Circuit
- Error Reporting
- EMI Compliant When Used With Recommended System Design
- Intelligent Gate Drive

## APPLICATIONS

- Mini/Micro Audio System
- DVD Receiver
- Home Theater

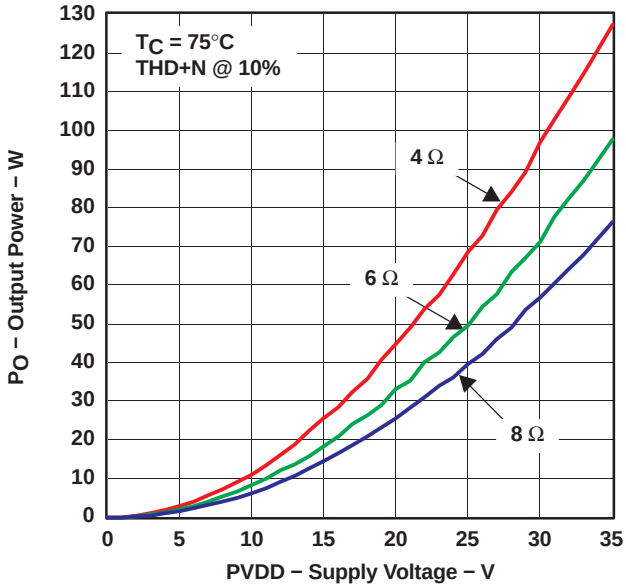
## DESCRIPTION

The TAS5152 is a third-generation, high-performance, integrated stereo digital amplifier power stage with improved protection system. The TAS5152 is capable of driving a 4-Ω bridge-tied load (BTL) at up to 125 W per channel with low integrated noise at the output, low THD+N performance, and low idle power dissipation.

A low-cost, high-fidelity audio system can be built using a TI chipset, comprised of a modulator (e.g., TAS5508) and the TAS5152. This system only requires a simple passive LC demodulation filter to deliver high-quality, high-efficiency audio amplification with proven EMI compliance. This device requires two power supplies, 12 V for GVDD and VDD, and 35 V for PVDD. The TAS5152 does not require power-up sequencing due to internal power-on reset. The efficiency of this digital amplifier is greater than 90% into 6 Ω, which enables the use of smaller power supplies and heatsinks.

The TAS5152 has an innovative protection system integrated on-chip, safeguarding the device against a wide range of fault conditions that could damage the system. These safeguards are short-circuit protection, overcurrent protection, undervoltage protection, and overtemperature protection. The TAS5152 has a new proprietary current-limiting circuit that reduces the possibility of device shutdown during high-level music transients. A new programmable overcurrent detector allows the use of lower-cost inductors in the demodulation output filter.

**BTL OUTPUT POWER vs SUPPLY VOLTAGE**

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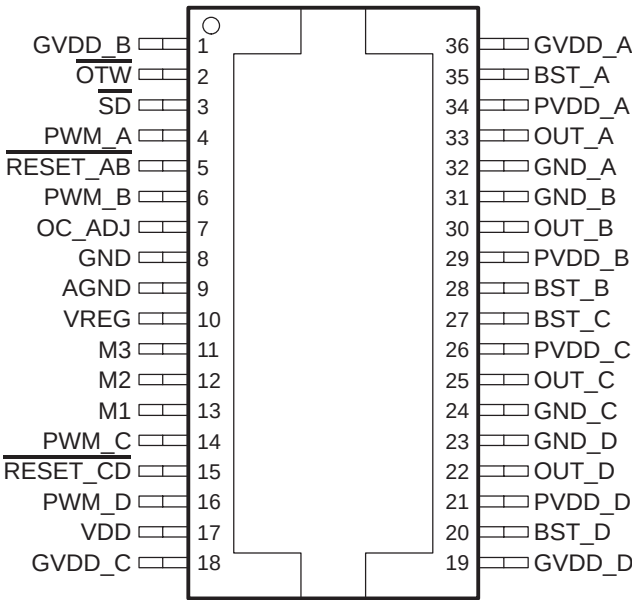
These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## GENERAL INFORMATION

The TAS5152 is available in a 36-pin PSOP3 (DKD) thermally enhanced package. The package contains a heat slug that is located on the top side of the device for convenient thermal coupling to the heatsink.

**DKD PACKAGE**
**(TOP VIEW)**




### MODE Selection Pins

| MODE PINS | | | PWM INPUT | OUTPUT CONFIGU-RATION | PROTECTION SCHEME |
|---|---|---|---|---|---|
| M3 | M2 | M1 | | | |
| 0 | 0 | 0 | 2N (1) AD/BD modulation | 2 channels BTL output | BTL mode (2) |
| 0 | 0 | 1 | Reserved | | |
| 0 | 1 | 0 | 1N (1) AD modulation | 2 channels BTL output | BTL mode (2) |
| 0 | 1 | 1 | 1N (1) AD modulation | 1 channel PBTL output | PBTL mode. Only PWM_A input is used. |
| 1 | 0 | 0 | 1N (1) AD modulation | 4 channels SE output | Protection works similarly to BTL mode (2). Only difference in SE mode is that OUT_x is Hi-Z instead of a pulldown through internal pulldown resistor. |
| 1 | 0 | 1 | Reserved | | |
| 1 | 1 | 0 | | | |
| 1 | 1 | 1 | | | |

(1) The 1N and 2N naming convention is used to indicate the required number of PWM lines to the power stage per channel in a specific mode.

(2) An overload protection (OLP) occurring on A or B causes both channels to shut down. An OLP on C or D works similarly. Global errors like overtemperature error (OTE), undervoltage protection (UVP) and power-on reset (POR) affect all channels.

### Package Heat Dissipation Ratings (1)

| PARAMETER | TAS5152DKD |
|---|---|
| $R_{\theta JC}$ (°C/W)—2 BTL or 4 SE channels (8 transistors) | 1.28 |
| $R_{\theta JC}$ 〈°C/W)—1 BTL or 2 SE channel(s) (4 transistors) | 2.56 |
| $R_{\theta JC}$ (°C/W)—(1 transistor) | 8.6 |
| Pad area (2) | 80 $mm^2$ |

(1) JC is junction-to-case, CH is case-to-heatsink.

(2) $R_{\theta CH}$ is an important consideration. Assume a 2-mil thickness of typical thermal grease between the pad area and the heatsink. The $R_{\theta CH}$ with this condition is 0.8°C/W for the DKD package and 1.8°C/W for the DDV package.

## Absolute Maximum Ratings

over operating free-air temperature range unless otherwise noted(1)

| TAS5152 | |
|---|---|
| VDD to AGND | –0.3 V to 13.2 V |
| GVDD_X to AGND | –0.3 V to 13.2 V |
| PVDD_X to GND_X (2) | –0.3 V to 50 V |
| OUT_X to GND_X (2) | –0.3 V to 50 V |
| BST_X to GND_X (2) | –0.3 V to 63.2 V |
| VREG to AGND | –0.3 V to 4.2 V |
| GND_X to GND | –0.3 V to 0.3 V |
| GND_X to AGND | –0.3 V to 0.3 V |
| GND to AGND | –0.3 V to 0.3 V |
| PWM_X, OC_ADJ, M1, M2, M3 to AGND | –0.3 V to 4.2 V |
| $\overline{\text{RESET\_X}}$, $\overline{\text{SD}}$, $\overline{\text{OTW}}$ to AGND | –0.3 V to 7 V |
| Maximum continuous sink current ($\overline{\text{SD}}$, $\overline{\text{OTW}}$) | 9 mA |
| Maximum operating junction temperature range, $T_J$ | 0°C to 125°C |
| Storage temperature | –40°C to 125°C |
| Lead temperature, 1,6 mm (1/16 inch) from case for 10 seconds | 260°C |
| Minimum pulse width low | 50 ns |

(1) 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 conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) These voltages represent the dc voltage + peak ac waveform measured at the terminal of the device in all conditions.

## Ordering Information

| $T_A$ | PACKAGE | DESCRIPTION |
|---|---|---|
| 0°C to 70°C | TAS5152DKD | 36-pin PSOP3 |

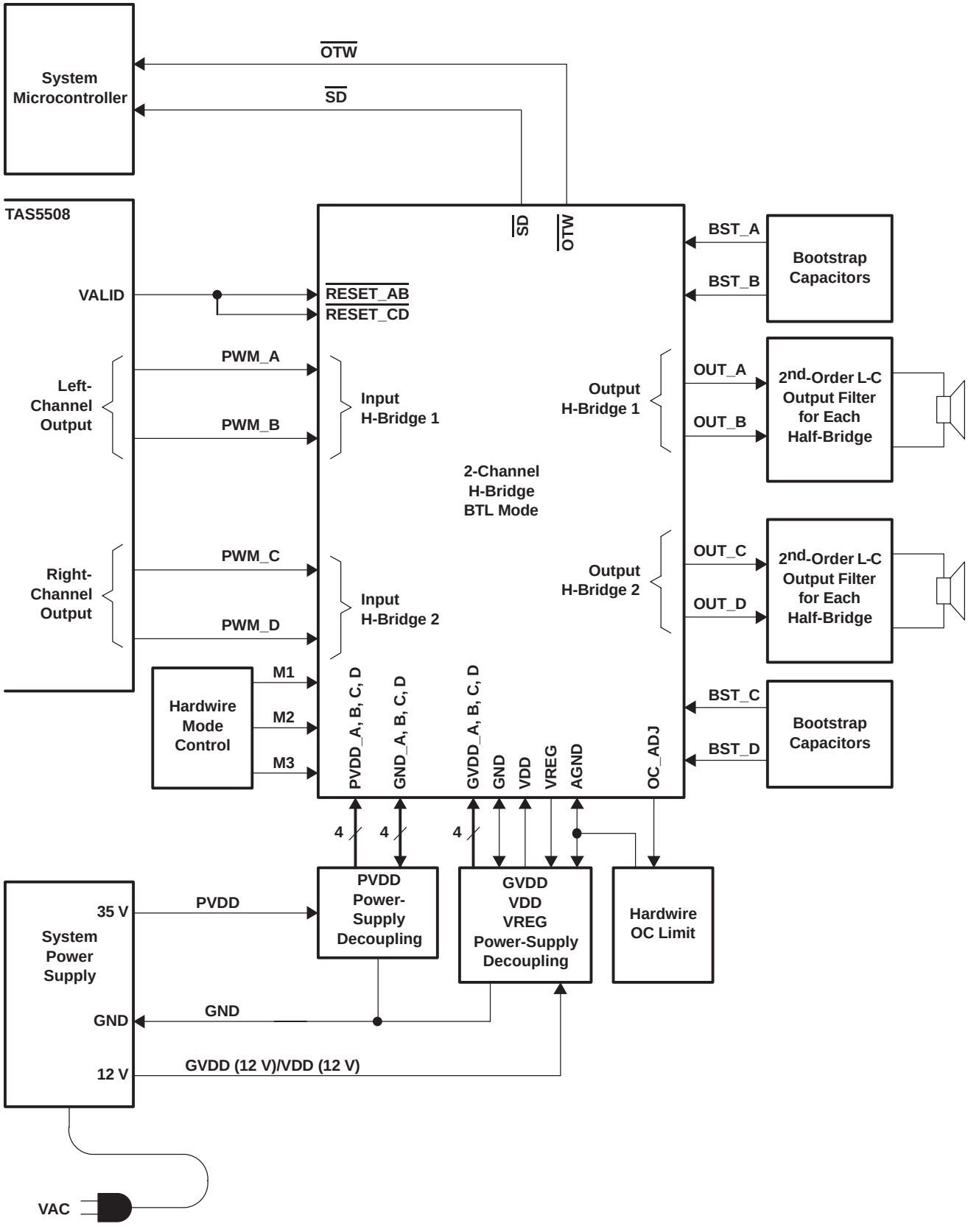
For the most current specification and package information, see the TI Web site at www.ti.com.

## Terminal Functions

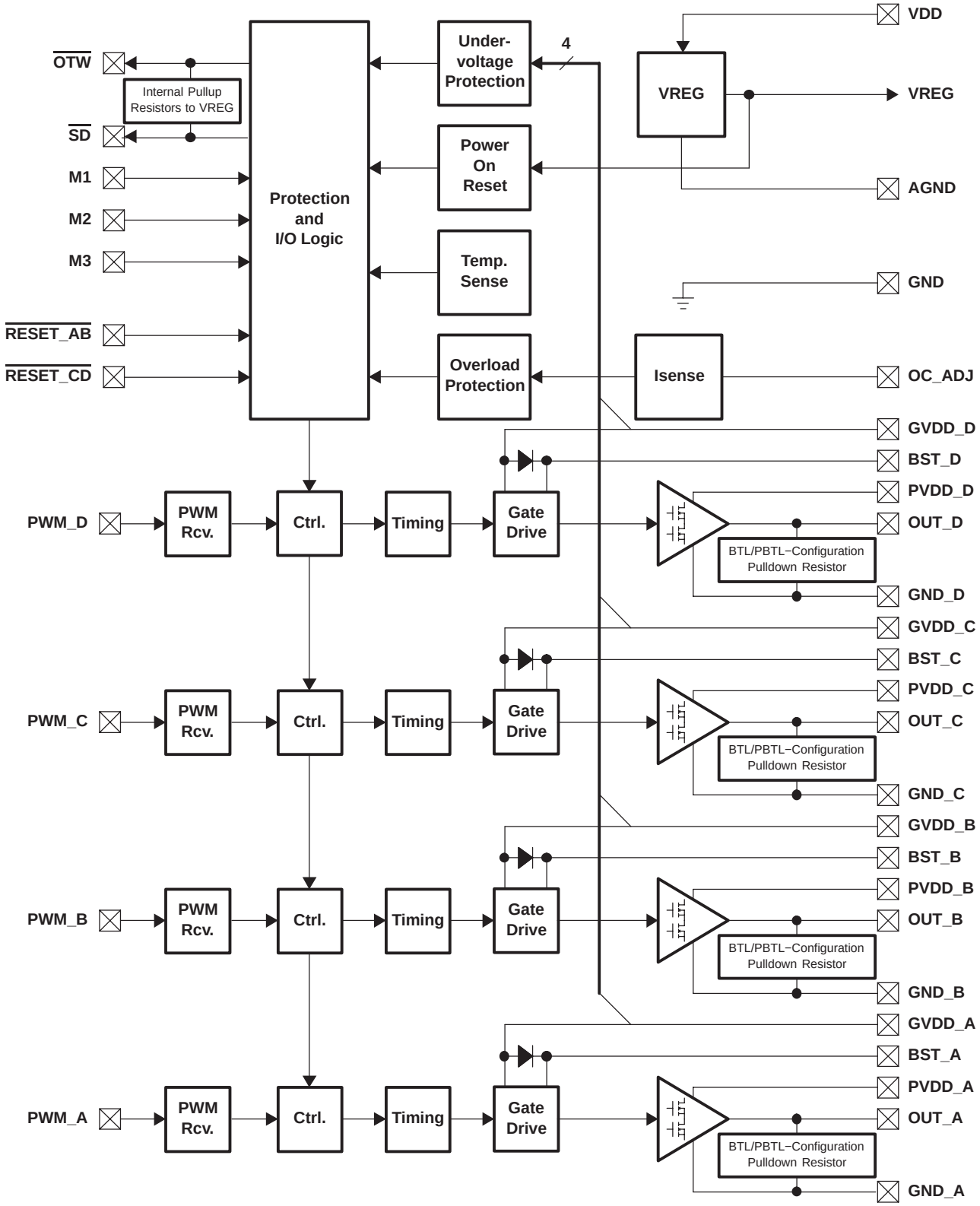
| TERMINAL | | FUNCTION (1) | DESCRIPTION |
|---|---|---|---|
| NAME | NO. | | |
| AGND | 9 | P | Analog ground |
| BST_A | 35 | P | HS bootstrap supply (BST), external capacitor to OUT_A required |
| BST_B | 28 | P | HS bootstrap supply (BST), external capacitor to OUT_B required |
| BST_C | 27 | P | HS bootstrap supply (BST), external capacitor to OUT_C required |
| BST_D | 20 | P | HS bootstrap supply (BST), external capacitor to OUT_D required |
| GND | 8 | P | Ground |
| GND_A | 32 | P | Power ground for half-bridge A |
| GND_B | 31 | P | Power ground for half-bridge B |
| GND_C | 24 | P | Power ground for half-bridge C |
| GND_D | 23 | P | Power ground for half-bridge D |
| GVDD_A | 36 | P | Gate-drive voltage supply requires 0.1-μF capacitor to AGND |
| GVDD_B | 1 | P | Gate-drive voltage supply requires 0.1-μF capacitor to AGND |
| GVDD_C | 18 | P | Gate-drive voltage supply requires 0.1-μF capacitor to AGND |
| GVDD_D | 19 | P | Gate-drive voltage supply requires 0.1-μF capacitor to AGND |
| M1 | 13 | I | Mode selection pin |
| M2 | 12 | I | Mode selection pin |
| M3 | 11 | I | Mode selection pin |
| OC_ADJ | 7 | O | Analog overcurrent programming pin requires resistor to ground |
| $\overline{\text{OTW}}$ | 2 | O | Overtemperature warning signal, open drain, active-low |
| OUT_A | 33 | O | Output, half-bridge A |
| OUT_B | 30 | O | Output, half-bridge B |
| OUT_C | 25 | O | Output, half-bridge C |
| OUT_D | 22 | O | Output, half-bridge D |
| PVDD_A | 34 | P | Power-supply input for half-bridge A requires close decoupling of 0.1-μF capacitor to GND_A |
| PVDD_B | 29 | P | Power-supply input for half-bridge B requires close decoupling of 0.1-μF capacitor to GND_B |
| PVDD_C | 26 | P | Power-supply input for half-bridge C requires close decoupling of 0.1-μF capacitor to GND_C |
| PVDD_D | 21 | P | Power-supply input for half-bridge D requires close decoupling of 0.1-μF capacitor to GND_D |
| PWM_A | 4 | I | Input signal for half-bridge A |
| PWM_B | 6 | I | Input signal for half-bridge B |
| PWM_C | 14 | I | Input signal for half-bridge C |
| PWM_D | 16 | I | Input signal for half-bridge D |
| $\overline{\text{RESET\_AB}}$ | 5 | I | Reset signal for half-bridge A and half-bridge B, active-low |
| $\overline{\text{RESET\_CD}}$ | 15 | I | Reset signal for half-bridge C and half-bridge D, active-low |
| $\overline{\text{SD}}$ | 3 | O | Shutdown signal, open drain, active-low |
| VDD | 17 | P | Power supply for digital voltage regulator requires 0.1-μF capacitor to GND. |
| VREG | 10 | P | Digital regulator supply filter pin requires 0.1-μF capacitor to AGND |

(1) I = input, O = Output, P = Power

## SYSTEM BLOCK DIAGRAM



## FUNCTIONAL BLOCK DIAGRAM



## RECOMMENDED OPERATING CONDITIONS

| | | CONDITIONS | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|---|
| PVDD_x | Half-bridge supply | DC supply voltage | 0 | 35 | 37 | V |
| GVDD_x | Supply for logic regulators and gate-drive circuitry | DC supply voltage | 10.8 | 12 | 13.2 | V |
| VDD | Digital regulator input | DC supply voltage | 10.8 | 12 | 13.2 | V |
| $R_L$ (BTL) | Load impedance | Output filter: L = 10 µH, C = 470 nF Output AD modulation, switching frequency > 350 kHz | 3 | 4 | | Ω |
| $R_L$ (SE) | | | 2 | 3 | | |
| $R_L$ (PBTL) | | | 1.5 | 2 | | |
| $L_{Output}$ (BTL) | Output-filter inductance | Minimum output inductance under short-circuit condition | | 10 | | µH |
| $L_{Output}$ (SE) | | | | 10 | | |
| $L_{Output}$ (PBTL) | | | | 10 | | |
| $F_{PWM}$ | PWM frame rate | | 192 | 384 | 432 | kHz |
| $T_J$ | Junction temperature | | 0 | | 125 | °C |

## AUDIO SPECIFICATIONS (BTL)

PVDD_X = 35 V, GVDD = VDD = 12 V, BTL mode, $R_L$ = 4 Ω, audio frequency = 1 kHz, AES17 filter, $F_{PWM}$ = 384 kHz, case temperature = 75°C, unless otherwise noted. Audio performance is recorded as a chipset, using TAS5508 PWM processor with an effective modulation index limit of 96.1%. All performance is in accordance with recommended operating conditions unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | TAS5152 | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| $P_o$ | Power output per channel | $R_L$ = 4 Ω,10% THD, clipped input signal | | 125 | | W |
| | | $R_L$ = 6 Ω,10% THD, clipped input signal | | 98 | | |
| | | $R_L$ = 8 Ω,10% THD, clipped input signal | | 76 | | |
| | | $R_L$ = 4 Ω, 0 dBFS, unclipped input signal | | 96 | | |
| | | $R_L$ = 6 Ω, 0 dBFS, unclipped input signal | | 72 | | |
| | | $R_L$ = 8 Ω, 0 dBFS, unclipped input signal | | 57 | | |
| THD+N | Total harmonic distortion + noise | 0 dBFS | | 0.1 | | % |
| | | 1 W | | 0.02 | | |
| $V_n$ | Output integrated noise | A-weighted | | 145 | | µV |
| SNR | Signal-to-noise ratio (1) | A-weighted | | 102 | | dB |
| DNR | Dynamic range | A-weighted, input level = –60 dBFS using TAS5508 modulator | | 102 | | dB |
| | | A-weighted, input level = –60 dBFS using TAS5518 modulator | | 110 | | dB |
| $P_{idle}$ | Power dissipation due to idle losses (IPVDDx) | $P_O$ = 0 W, 2 channels switching (2) | | 2 | | W |

(1) SNR is calculated relative to 0-dBFS input level.
(2) Actual system idle losses are affected by core losses of output inductors.

## AUDIO SPECIFICATIONS (Single-Ended Output)

PVDD_X = 35 V, GVDD = VDD = 12 V, SE mode, $R_L$ = 4 Ω, audio frequency = 1 kHz, AES17 filter, $F_{PWM}$ = 384 kHz, case temperature = 75°C, unless otherwise noted. Audio performance is recorded as a chipset, using TAS5086 PWM processor with an effective modulation index limit of 96.1%. All performance is in accordance with recommended operating conditions unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | TAS5152 | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| $P_o$ | Power output per channel | $R_L$ = 3 Ω,10% THD, clipped input signal | | 45 | | W |
| | | $R_L$ = 4 Ω,10% THD, clipped input signal | | 35 | | |
| | | $R_L$ = 3 Ω, 0 dBFS, unclipped input signal | | 35 | | |
| | | $R_L$ = 4 Ω, 0 dBFS, unclipped input signal | | 25 | | |
| THD+N | Total harmonic distortion + noise | 0 dBFS | | 0.2 | | % |
| | | 1 W | | 0.03 | | |
| $V_n$ | Output integrated noise | A-weighted | | 90 | | μV |
| SNR | Signal-to-noise ratio (1) | A-weighted | | 100 | | dB |
| DNR | Dynamic range | A-weighted, input level = –60 dBFS using TAS5508 modulator | | 100 | | dB |
| $P_{idle}$ | Power dissipation due to idle losses (IPVDDx) | $P_O$ = 0 W, 4 channels switching (2) | | 2 | | W |

(1) SNR is calculated relative to 0-dBFS input level.
(2) Actual system idle losses are affected by core losses of output inductors.

## AUDIO SPECIFICATIONS (PBTL)

PVDD_X = 35 V, GVDD = VDD = 12 V, PBTL mode, $R_L$ = 3 Ω, audio frequency = 1 kHz, AES17 filter, $F_{PWM}$ = 384 kHz, case temperature = 75°C, unless otherwise noted. Audio performance is recorded as a chipset, using TAS5508 PWM processor with an effective modulation index limit of 96.1%. All performance is in accordance with recommended operating conditions unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | TAS5152 | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| $P_o$ | Power output per channel | $R_L$ = 3 Ω,10% THD, clipped input signal | | 192 | | W |
| | | $R_L$ = 2 Ω,10% THD, clipped input signal | | 240 | | |
| | | $R_L$ = 3 Ω, 0 dBFS, unclipped input signal | | 145 | | |
| | | $R_L$ = 2 Ω, 0 dBFS, unclipped input signal | | 190 | | |
| THD+N | Total harmonic distortion + noise | 0 dBFS | | 0.2 | | % |
| | | 1 W | | 0.02 | | |
| $V_n$ | Output integrated noise | A-weighted | | 160 | | μV |
| SNR | Signal-to-noise ratio (1) | A-weighted | | 102 | | dB |
| DNR | Dynamic range | A-weighted, input level = –60 dBFS using TAS5508 modulator | | 102 | | dB |
| | | A-weighted, input level = –60 dBFS using TAS5518 modulator | | 110 | | dB |
| $P_{idle}$ | Power dissipation due to idle losses (IPVDDx) | $P_O$ = 0 W, 1 channel switching (2) | | 2 | | W |

(1) SNR is calculated relative to 0-dBFS input level.
(2) Actual system idle losses are affected by core losses of output inductors.

## ELECTRICAL CHARACTERISTICS

$R_L$= 4 Ω. $F_{PWM}$ = 384 kHz, unless otherwise noted. All performance is in accordance with recommended operating conditions unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | TAS5152 | | | |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | UNITS |
| **Internal Voltage Regulator and Current Consumption** | | | | | | |
| VREG | Voltage regulator, only used as a reference node | VDD = 12 V | 3 | 3.3 | 3.6 | V |
| IVDD | VDD supply current | Operating, 50% duty cycle | | 7 | 17 | mA |
| | | Idle, reset mode | | 6 | 11 | |
| IGVDD_x | Gate supply current per half-bridge | 50% duty cycle | | 5 | 16 | mA |
| | | Reset mode | | 0.3 | 1 | |
| IPVDD_x | Half-bridge idle current | 50% duty cycle, without output filter or load | | 15 | 25 | mA |
| | | Reset mode, no switching | | 7 | 25 | μA |
| **Output Stage MOSFETs** | | | | | | |
| $R_{DSon,LS}$ | Drain-to-source resistance, LS | $T_J$= 25°C, includes metallization resistance, GVDD = 12 V | | 140 | 155 | mΩ |
| $R_{DSon,HS}$ | Drain-to-source resistance, HS | $T_J$= 25°C, includes metallization resistance, GVDD = 12 V | | 140 | 155 | mΩ |

## ELECTRICAL CHARACTERISTICS (continued)

$R_L$= 4 Ω. $F_{PWM}$ = 384 kHz, unless otherwise noted. All performance is in accordance with recommended operating conditions unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | TAS5152 | | | |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | UNITS |
| **I/O Protection** | | | | | | |
| $V_{uvp,G}$ | Undervoltage protection limit, GVDD_x | | | 9.8 | | V |
| $V_{uvp,hyst}$(1) | Undervoltage protection hysteresis | | | 250 | | mV |
| OTW(1) | Overtemperature warning | | 115 | 125 | 135 | °C |
| $OTW_{HYST}$(1) | Temperature drop needed below OTW temp. for $\overline{OTW}$ to be inactive after the $\overline{OTW}$ event | | | 25 | | °C |
| OTE(1) | Overtemperature error | | 145 | 155 | 165 | °C |
| OTE-OTW differential(1) | OTE-OTW differential | | | 30 | | °C |
| $OTE_{HYST}$(1) | Temperature drop needed below OTE temp. for $\overline{SD}$ to be released following an $\overline{OTE}$ event | | | 25 | | °C |
| OLPC | Overload protection counter | $F_{pwm}$ = 384 kHz | | 1.25 | | ms |
| $I_{OC}$ | Overcurrent limit protection | Resistor-programmable, high end, $R_{OCP}$ = 15 kΩ | 8.5 | 10.8 | 11.8 | A |
| $I_{OCT}$ | Overcurrent response time | | | 210 | | ns |
| $R_{OCP}$ | OC programming resistor range | Resistor tolerance = 5% | 15 | | 69 | kΩ |
| $R_{PD}$ | Internal pulldown resistor at the output of each half-bridge | Connected when $\overline{RESET}$ is active to provide bootstrap capacitor charge. Not used in SE mode | | 2.5 | | kΩ |
| **Static Digital Specifications** | | | | | | |
| $V_{IH}$ | High-level input voltage | PWM_A, PWM_B, PWM_C, PWM_D, M1, M2, M3, RESET_AB, RESET_CD | 2 | | | V |
| $V_{IL}$ | Low-level input voltage | | | | 0.8 | V |
| Leakage | Input leakage current | | –10 | | 10 | µA |
| **OTW/SHUTDOWN (SD)** | | | | | | |
| $R_{INT\_PU}$ | Internal pullup resistance, $\overline{OTW}$ to VREG, $\overline{SD}$ to VREG | | 20 | 26 | 32 | kΩ |
| $V_{OH}$ | High-level output voltage | Internal pullup resistor | 3 | 3.3 | 3.6 | V |
| | | External pullup of 4.7 kΩ to 5 V | 4.5 | | 5 | |
| $V_{OL}$ | Low-level output voltage | $I_O$ = 4 mA | | 0.2 | 0.4 | V |
| FANOUT | Device fanout $\overline{OTW}$ , $\overline{SD}$ | No external pullup | | 30 | | Devices |

(1) Specified by design

## TYPICAL CHARACTERISTICS, BTL CONFIGURATION

TOTAL HARMONIC DISTORTION + NOISE
vs
OUTPUT POWER

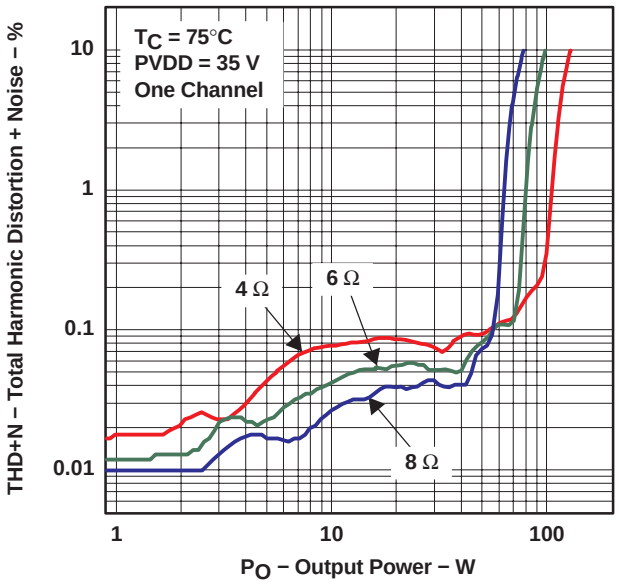



Figure 1

OUTPUT POWER
vs
SUPPLY VOLTAGE

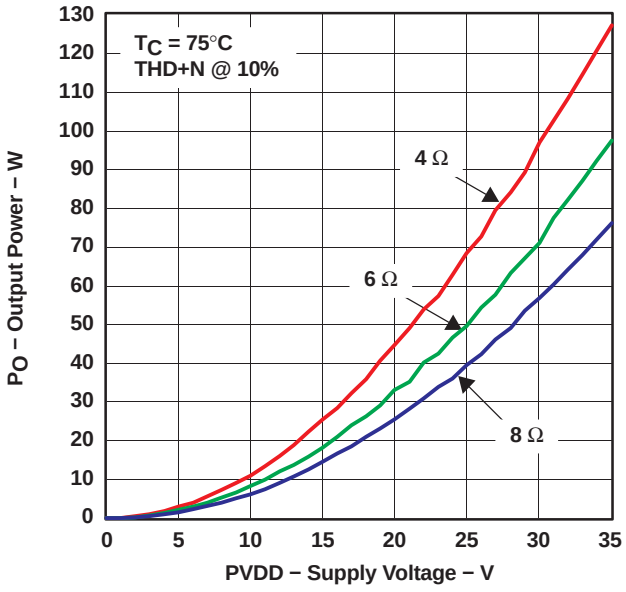



Figure 2

UNCLIPPED OUTPUT POWER
vs
SUPPLY VOLTAGE

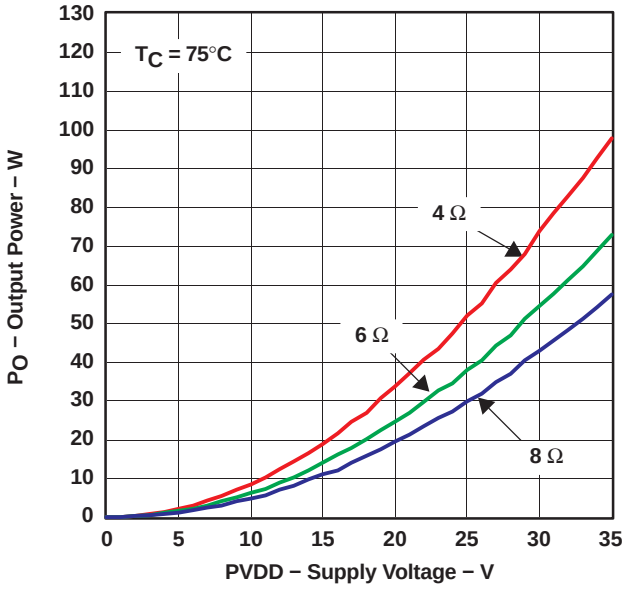



Figure 3

SYSTEM EFFICIENCY
vs
OUTPUT POWER

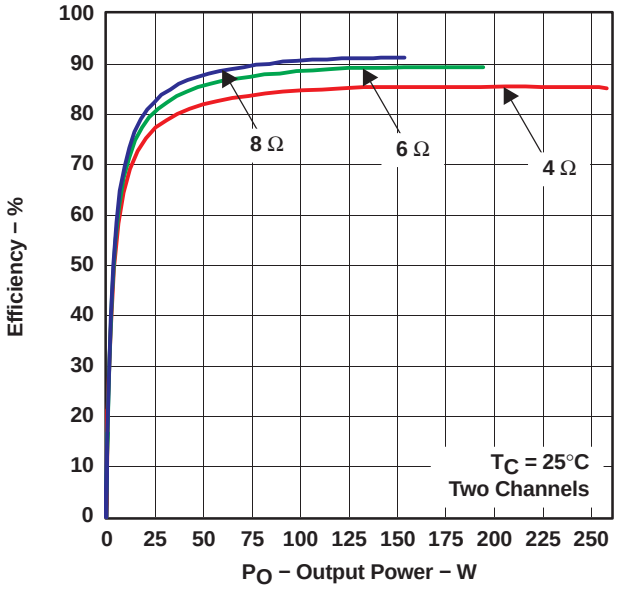



Figure 4

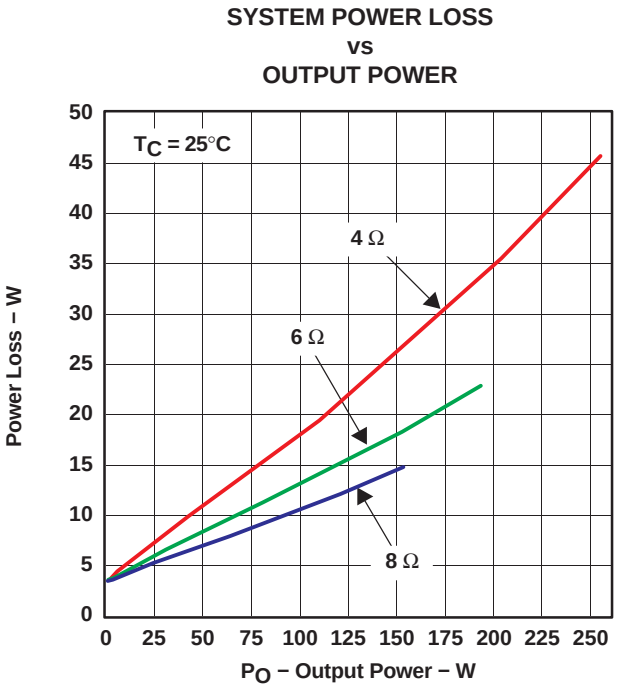



Figure 5

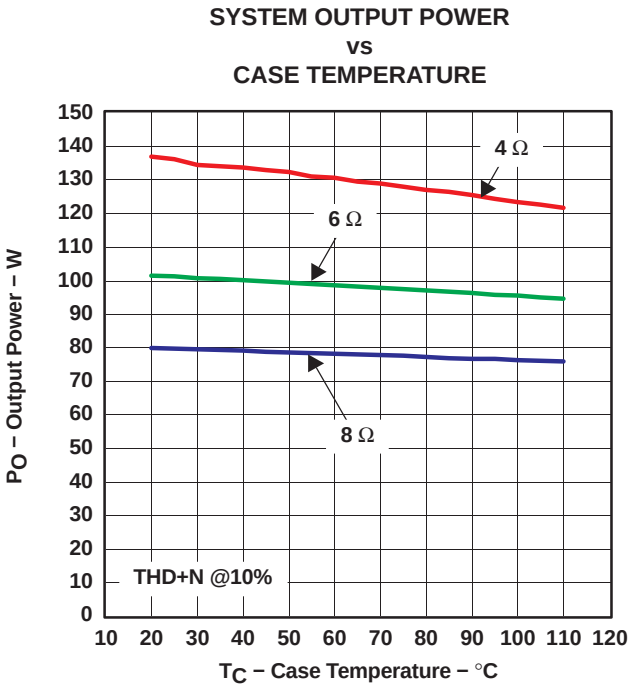



Figure 6

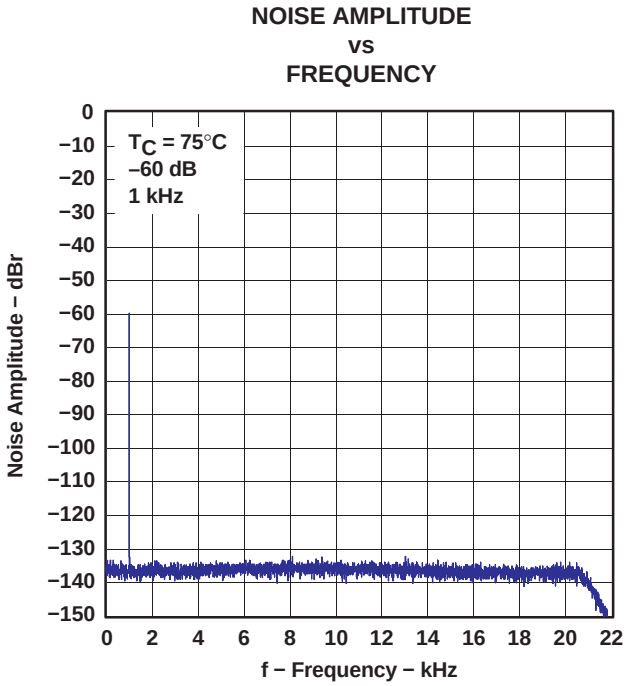



Figure 7

## TYPICAL CHARACTERISTICS, SE CONFIGURATION

TOTAL HARMONIC DISTORTION + NOISE
vs
OUTPUT POWER

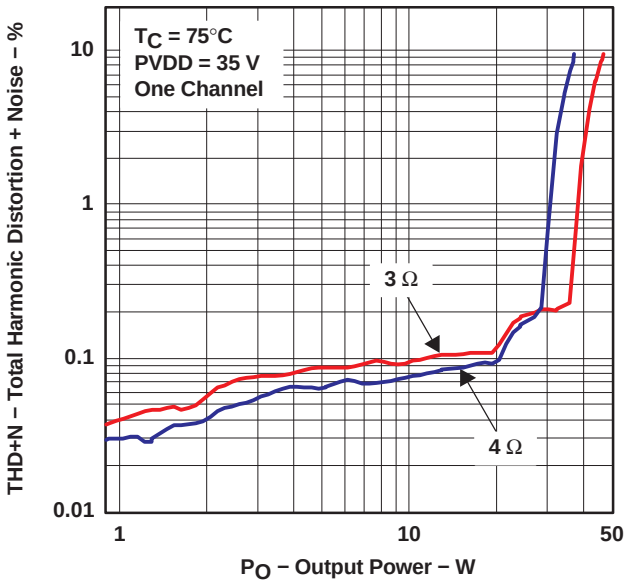



Figure 8

OUTPUT POWER
vs
SUPPLY VOLTAGE

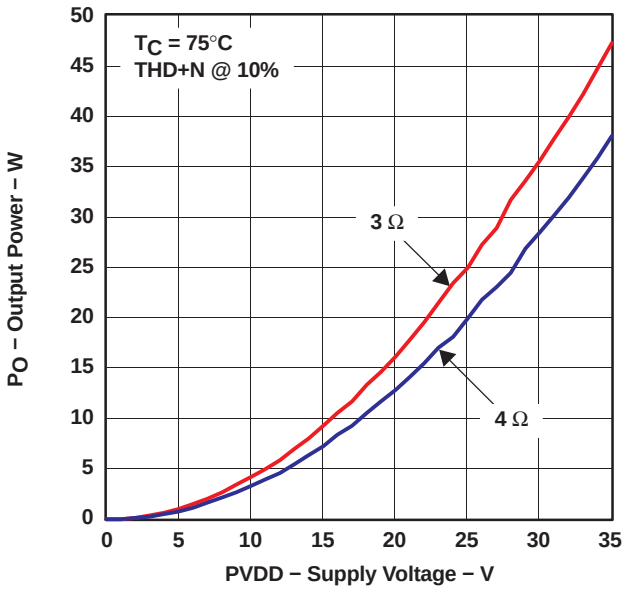



Figure 9

OUTPUT POWER
vs
CASE TEMPERATURE

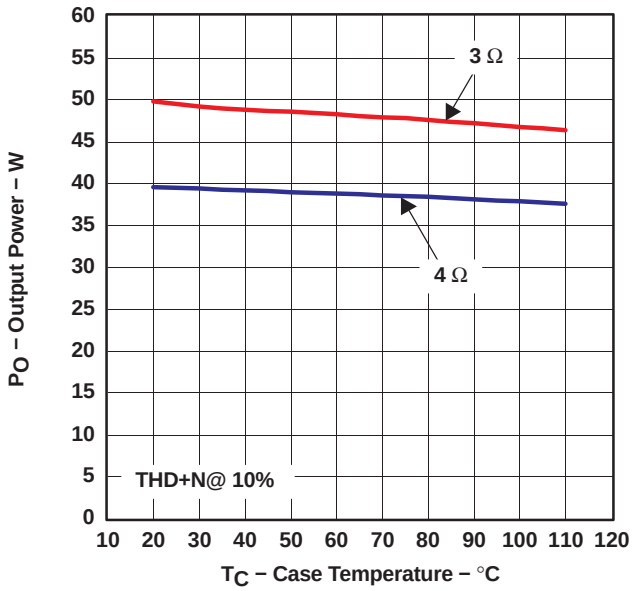



Figure 10

## TYPICAL CHARACTERISTICS, PBTL CONFIGURATION

### TOTAL HARMONIC DISTORTION + NOISE vs OUTPUT POWER

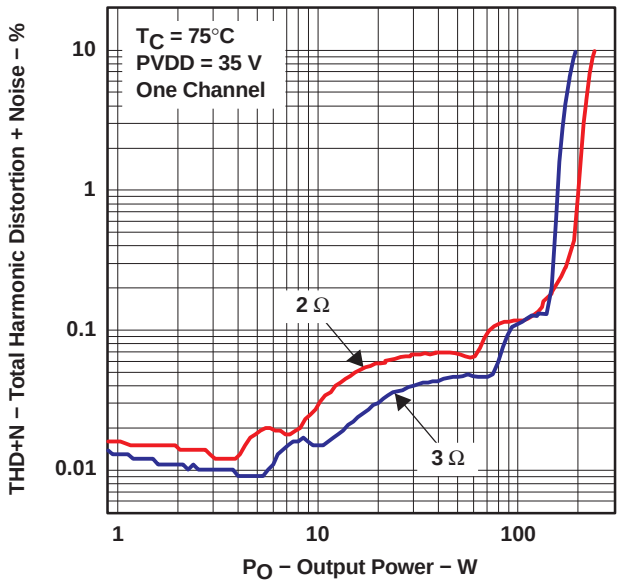



Figure 11

### OUTPUT POWER vs SUPPLY VOLTAGE

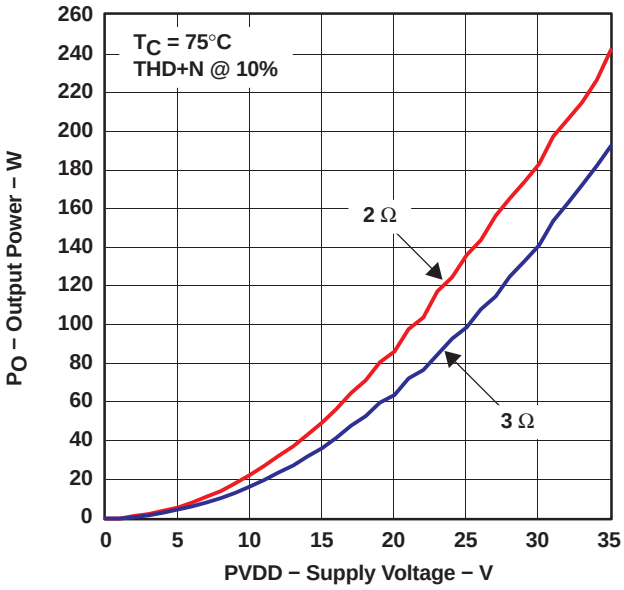



Figure 12

### SYSTEM OUTPUT POWER vs CASE TEMPERATURE

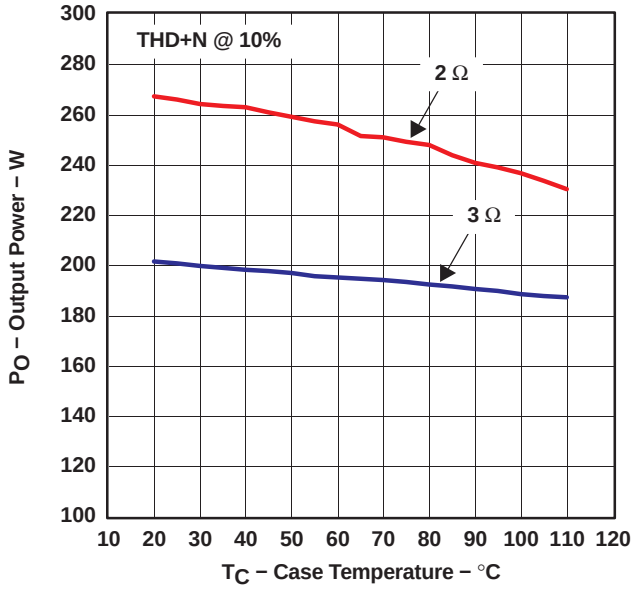



Figure 13

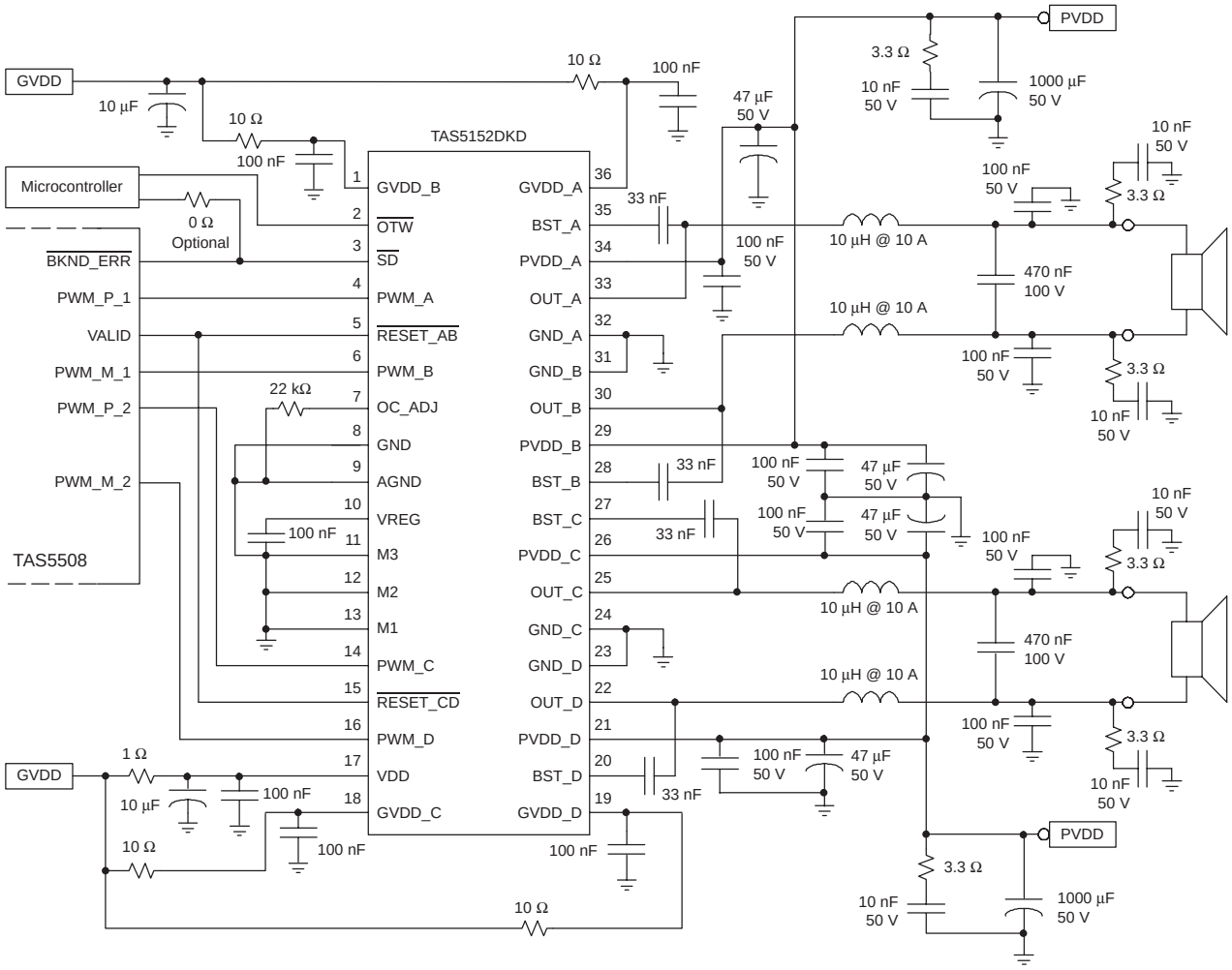



**Figure 14. Typical Differential (2N) BTL Application With AD Modulation Filters**

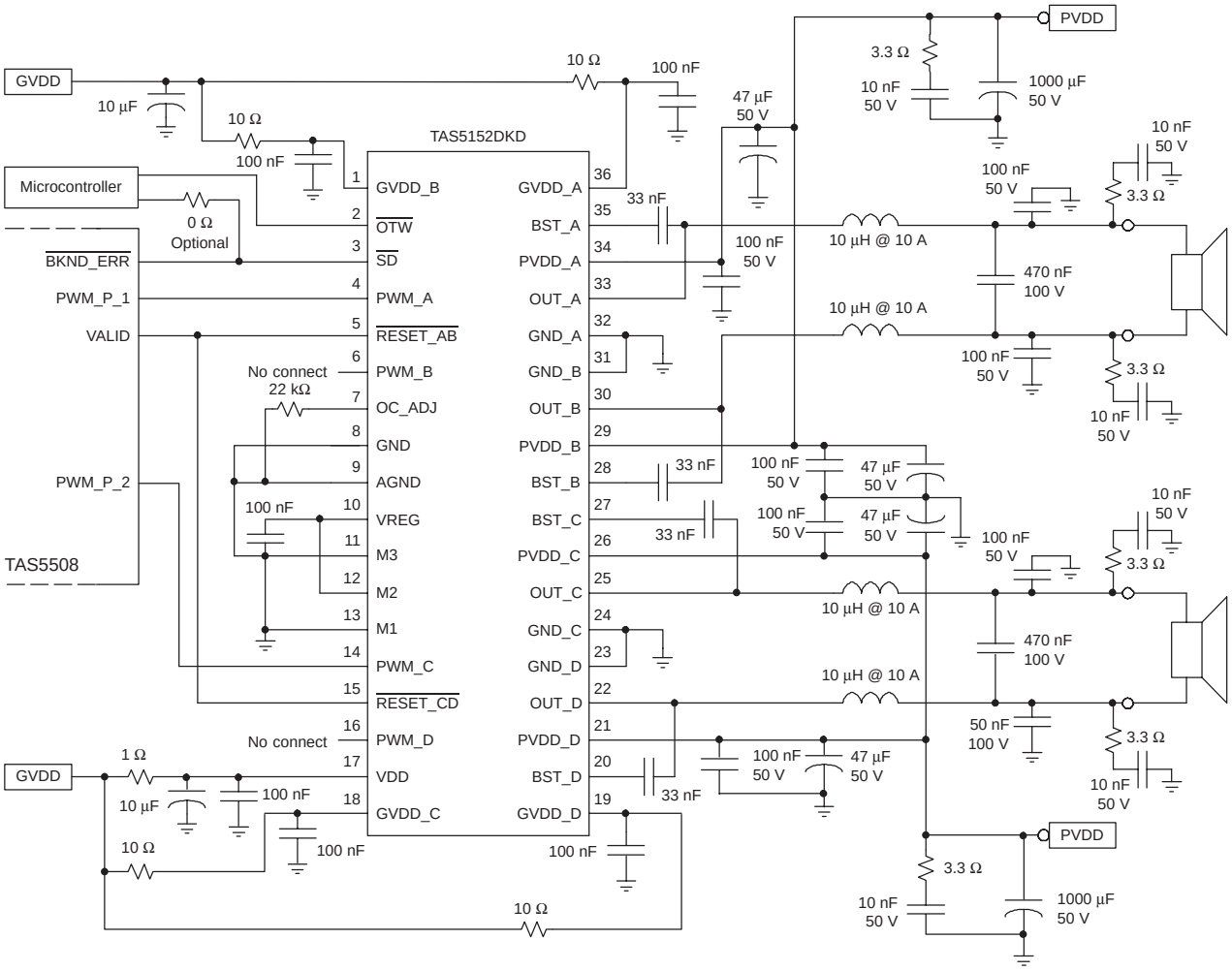



**Figure 15. Typical Non-Differential (1N) BTL Application With AD Modulation Filters**

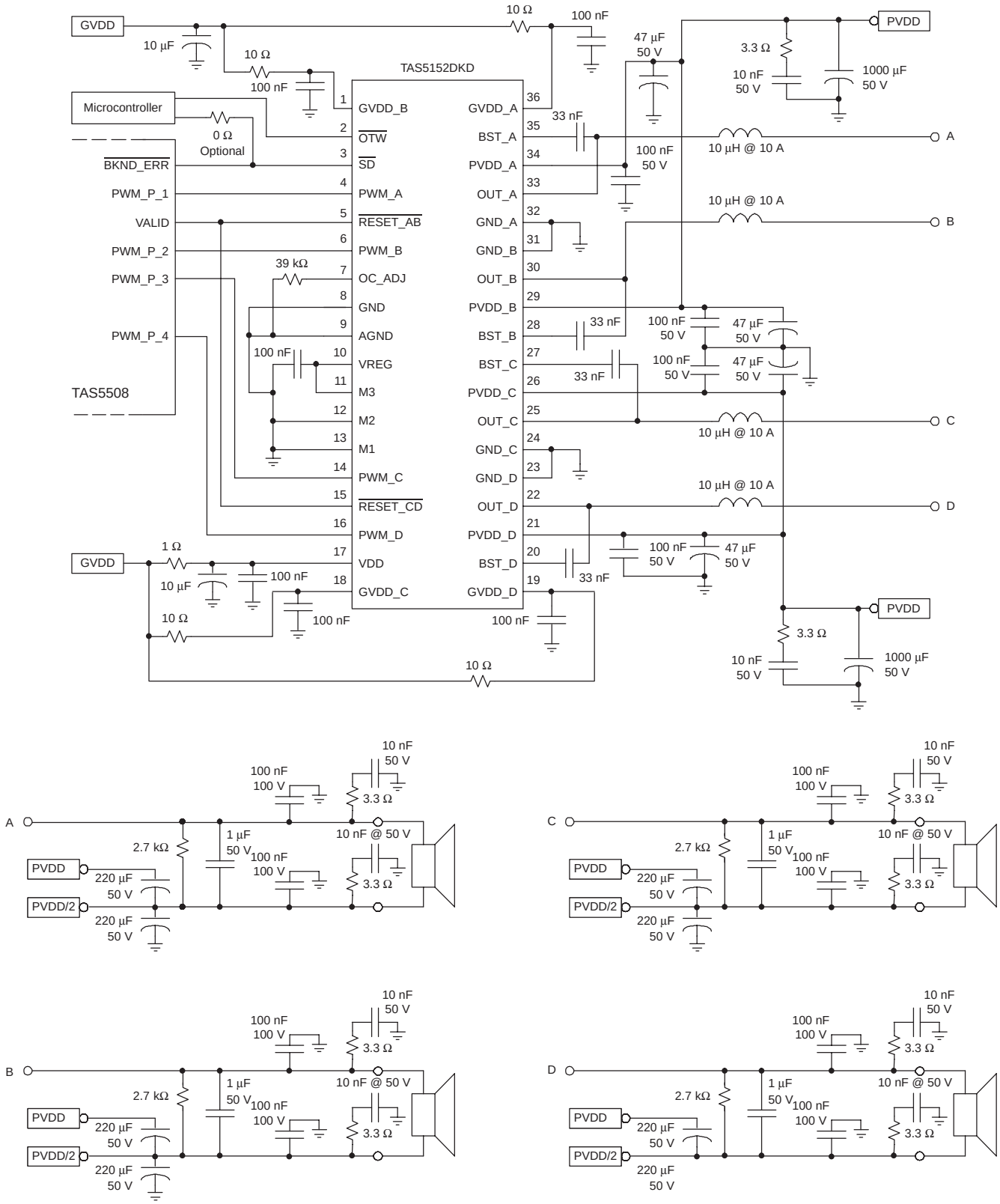



**Figure 16. Typical SE Application**

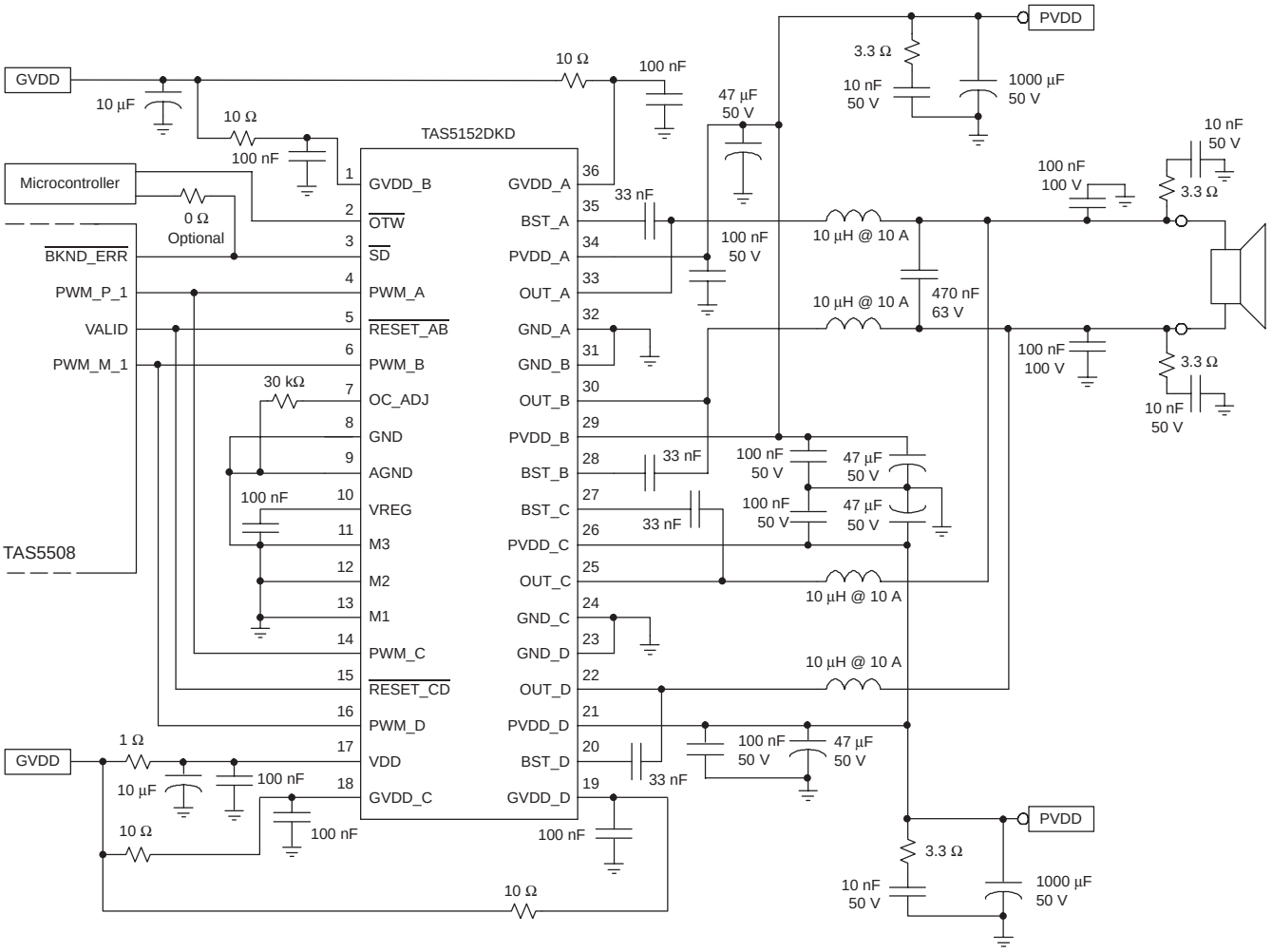



**Figure 17. Typical Differential (2N) PBTL Application With AD Modulation Filters**

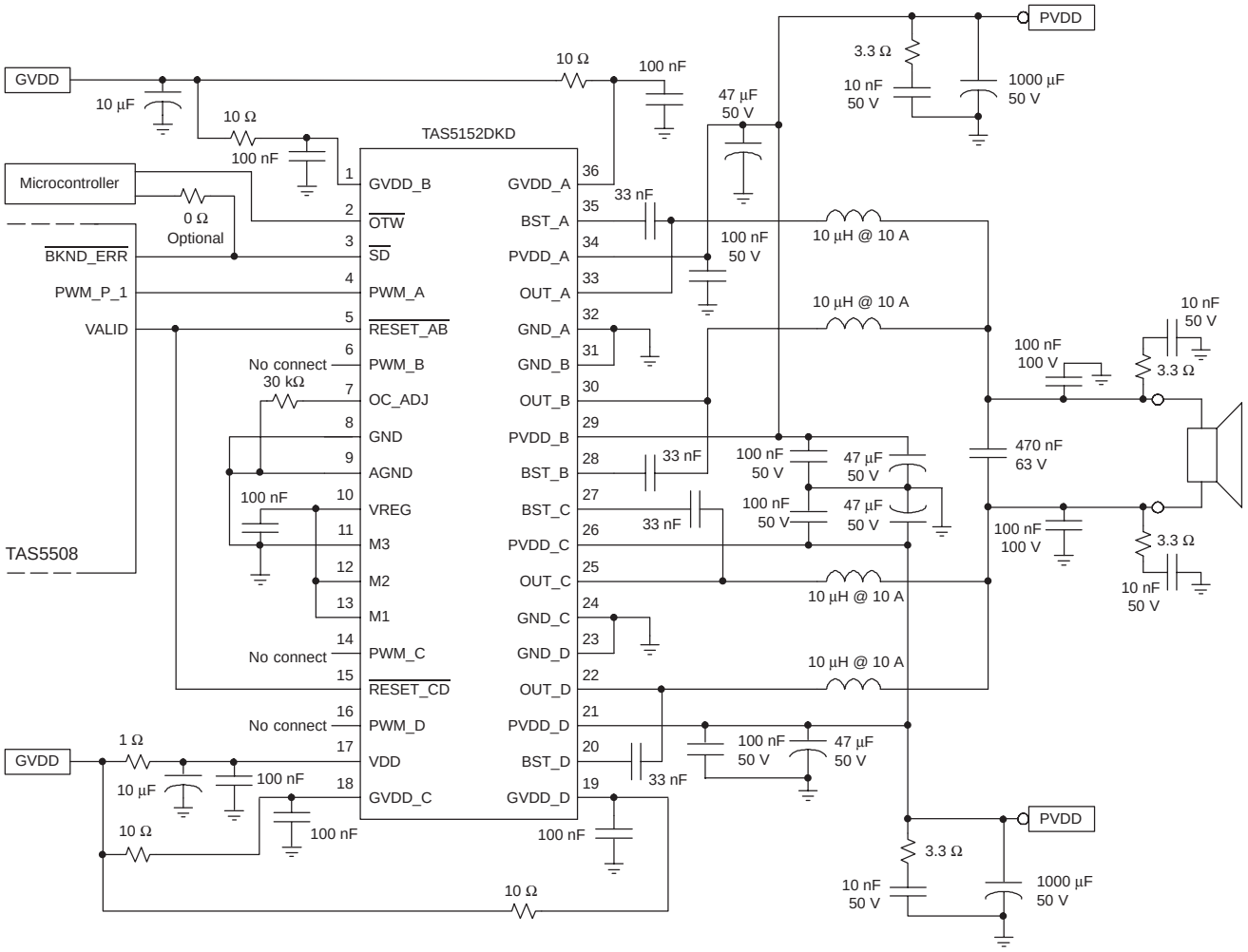



**Figure 18. Typical Non-Differential (1N) PBTL Application**

# THEORY OF OPERATION

## POWER SUPPLIES

To facilitate system design, the TAS5152 needs only a 12-V supply in addition to the (typically) 35-V power-stage supply. An internal voltage regulator provides suitable voltage levels for the digital and low-voltage analog circuitry. Additionally, all circuitry requiring a floating voltage supply, e.g., the high-side gate drive, is accommodated by built-in bootstrap circuitry requiring only a few external capacitors.

In order to provide outstanding electrical and acoustical characteristics, the PWM signal path including gate drive and output stage is designed as identical, independent half-bridges. For this reason, each half-bridge has separate gate drive supply (GVDD_X), bootstrap pins (BST_X), and power-stage supply pins (PVDD_X). Furthermore, an additional pin (VDD) is provided as supply for all common circuits. Although supplied from the same 12-V source, it is highly recommended to separate GVDD_A, GVDD_B, GVDD_C, GVDD_D, and VDD on the printed-circuit board (PCB) by RC filters (see application diagram for details). These RC filters provide the recommended high-frequency isolation. Special attention should be paid to placing all decoupling capacitors as close to their associated pins as possible. In general, inductance between the power-supply pins and decoupling capacitors must be avoided. (See reference board documentation for additional information.)

For a properly functioning bootstrap circuit, a small ceramic capacitor must be connected from each bootstrap pin (BST_X) to the power-stage output pin (OUT_X). When the power−stage output is low, the bootstrap capacitor is charged through an internal diode connected between the gate-drive power-supply pin (GVDD_X) and the bootstrap pin. When the power-stage output is high, the bootstrap capacitor potential is shifted above the output potential and thus provides a suitable voltage supply for the high-side gate driver. In an application with PWM switching frequencies in the range 352 kHz to 384 kHz, it is recommended to use 33-nF ceramic capacitors, size 0603 or 0805, for the bootstrap supply. These 33-nF capacitors ensure sufficient energy storage, even during minimal PWM duty cycles, to keep the high-side power-stage FET (LDMOS) fully turned on during the remaining part of the PWM cycle. In an application running at a reduced switching frequency, generally 192 kHz, the bootstrap capacitor might need to be increased in value.

Special attention should be paid to the power-stage power supply; this includes component selection, PCB placement and routing. As indicated, each half-bridge has independent power-stage supply pins (PVDD_X). For optimal electrical performance, EMI compliance, and system reliability, it is important that each PVDD_X pin is decoupled with a 100-nF ceramic capacitor placed as close as possible to each supply pin. It is recommended to follow the PCB layout of the TAS5152 reference design. For additional information on recommended power supply and required components, see the application diagrams given previously in this data sheet.

The 12-V supply should be from a low-noise, low-output-impedance voltage regulator. Likewise, the 35-V power-stage supply is assumed to have low output impedance and low noise. The power-supply sequence is not critical as facilitated by the internal power-on-reset circuit. Moreover, the TAS5152 is fully protected against erroneous power-stage turnon due to parasitic gate charging. Thus, voltage-supply ramp rates (dV/dt) are non-critical within the specified range (see the *Recommended Operating Conditions* section of this data sheet).

## SYSTEM POWER-UP/POWER-DOWN SEQUENCE

### Powering Up

The TAS5152 does not require a power-up sequence. The outputs of the H−bridges remain in a high-impedance state until the gate-drive supply voltage (GVDD_X) and VDD voltage are above the undervoltage protection (UVP) voltage threshold (see the *Electrical Characteristics* section of this data sheet). Although not specifically required, it is recommended to hold $\overline{\text{RESET\_AB}}$ and $\overline{\text{RESET\_CD}}$ in a low state while powering up the device. This allows an internal circuit to charge the external bootstrap capacitors by enabling a weak pulldown of the half-bridge output.

When the TAS5152 is being used with TI PWM modulators such as the TAS5508, no special attention to the state of $\overline{\text{RESET\_AB}}$ and $\overline{\text{RESET\_CD}}$ is required, provided that the chipset is configured as recommended.

### Powering Down

The TAS5152 does not require a power-down sequence. The device remains fully operational as long as the gate-drive supply (GVDD_X) voltage and VDD voltage are above the undervoltage protection (UVP) voltage threshold (see the *Electrical Characteristics* section of this data sheet). Although not specifically required, it is a good practice to hold $\overline{\text{RESET\_AB}}$ and $\overline{\text{RESET\_CD}}$ low during power down, thus preventing audible artifacts including pops or clicks.

When the TAS5152 is being used with TI PWM modulators such as the TAS5508, no special attention to the state of $\overline{\text{RESET\_AB}}$ and $\overline{\text{RESET\_CD}}$ is required, provided that the chipset is configured as recommended.

## ERROR REPORTING

The $\overline{SD}$ and $\overline{OTW}$ pins are both active-low, open-drain outputs. Their function is for protection-mode signaling to a PWM controller or other system-control device.

Any fault resulting in device shutdown is signaled by the $\overline{SD}$ pin going low. Likewise, $\overline{OTW}$ goes low when the device junction temperature exceeds 125°C (see the following table).

| $\overline{SD}$ | $\overline{OTW}$ | DESCRIPTION |
|---|---|---|
| 0 | 0 | Overtemperature (OTE) or overload (OLP) or undervoltage (UVP) |
| 0 | 1 | Overload (OLP) or undervoltage (UVP) |
| 1 | 0 | Junction temperature higher than 125°C (overtemperature warning) |
| 1 | 1 | Junction temperature lower than 125°C and no OLP or UVP faults (normal operation) |

Note that asserting either $\overline{RESET\_AB}$ or $\overline{RESET\_CD}$ low forces the $\overline{SD}$ signal high, independent of faults being present. TI recommends monitoring the $\overline{OTW}$ signal using the system microcontroller and responding to an overtemperature warning signal by, e.g., turning down the volume to prevent further heating of the device resulting in device shutdown (OTE).

To reduce external component count, an internal pullup resistor to 3.3 V is provided on both $\overline{SD}$ and $\overline{OTW}$ outputs. Level compliance for 5-V logic can be obtained by adding external pullup resistors to 5 V (see the *Electrical Characteristics* section of this data sheet for further specifications).

## DEVICE PROTECTION SYSTEM

TAS5152 contains advanced protection circuitry carefully designed to facilitate system integration and ease of use, as well as to safeguard the device from permanent failure due to a wide range of fault conditions such as short circuits, overload, overtemperature, and undervoltage. The TAS5152 responds to a fault by immediately setting the power stage in a high-impedance state (Hi-Z) and asserting the $\overline{SD}$ pin low. In situations other than overload, the device automatically recovers when the fault condition has been removed, i.e., the junction temperature has dropped or the voltage supply has increased. For highest possible reliability, recovering from an overload fault requires external reset of the device (see the *Device Reset* section of this data sheet) no sooner than 1 second after the shutdown.

### Use of TAS5152 in High-Modulation-Index Capable Systems

This device requires at least 50 ns of low time on the output per 384-kHz PWM frame rate in order to keep the bootstrap capacitors charged. As an example, if the modulation index is set to 99.2% in the TAS5508, this setting allows PWM pulse durations down to 20 ns. This signal, which does not meet the 50-ns requirement, is sent to the PWM_x pin and this low-state pulse time does not allow the bootstrap capacitor to stay charged. In this situation, the low voltage across the bootstrap capacitor can cause a failure of the high-side MOSFET transistor, especially when driving a low-impedance load. The TAS5152 device requires limiting the TAS5508 modulation index to 96.1% to keep the bootstrap capacitor charged under all signals and loads.

Therefore, TI strongly recommends using a TI PWM processor, such as TAS5508 or TAS5086, with the modulation index set at 96.1% to interface with TAS5152.

### Overcurrent (OC) Protection With Current Limiting and Overload Detection

The device has independent, fast-reacting current detectors with programmable trip threshold (OC threshold) on all high-side and low-side power-stage FETs. See the following table for OC-adjust resistor values. The detector outputs are closely monitored by two protection systems. The first protection system controls the power stage in order to prevent the output current from further increasing, i.e., it performs a current-limiting function rather than prematurely shutting down during combinations of high-level music transients and extreme speaker load impedance drops. If the high-current situation persists, i.e., the power stage is being overloaded, a second protection system triggers a latching shutdown, resulting in the power stage being set in the high-impedance (Hi-Z) state. Current limiting and overload protection are independent for the half-bridges A and B and, respectively, C and D. That is, if the bridge-tied load between half-bridges A and B causes an overload fault, only half-bridges A and B are shut down.

- For the lowest-cost bill of materials in terms of component selection, the OC threshold measure should be limited, considering the power output requirement and minimum load impedance. Higher-impedance loads require a lower OC threshold.
- The demodulation-filter inductor must retain at least 3 µH of inductance at twice the OC threshold setting.

Unfortunately, most inductors have decreasing inductance with increasing temperature and increasing current (saturation). To some degree, an increase in temperature naturally occurs when operating at high output currents, due to core losses and the DC resistance of the inductor's copper winding. A thorough analysis of inductor saturation and thermal properties is strongly recommended.

Setting the OC threshold too low might cause issues such as lack of enough output power and/or unexpected shutdowns due to too-sensitive overload detection.

In general, it is recommended to follow closely the external component selection and PCB layout as given in the *Application* section.

For added flexibility, the OC threshold is programmable within a limited range using a single external resistor connected between the OC_ADJ pin and AGND. (See the *Electrical Characteristics* section of this data sheet for information on the correlation between programming-resistor value and the OC threshold.) It should be noted that a properly functioning overcurrent detector assumes the presence of a properly designed demodulation filter at the power-stage output. Short-circuit protection is not provided directly at the output pins of the power stage but only on the speaker terminals (after the demodulation filter). It is required to follow certain guidelines when selecting the OC threshold and an appropriate demodulation inductor:

| OC-Adjust Resistor Values (kΩ) | Max. Current Before OC Occurs (A) |
|---|---|
| 15 | 10.8 |
| 22 | 9.4 |
| 27 | 8.6 |
| 39 | 6.4 |
| 47 | 6 |
| 69 | 4.7 |

### Overtemperature Protection

The TAS5152 has a two-level temperature-protection system that asserts an active-low warning signal ($\overline{\text{OTW}}$) when the device junction temperature exceeds 125°C (nominal) and, if the device junction temperature exceeds 155°C (nominal), the device is put into thermal shutdown, resulting in all half-bridge outputs being set in the high-impedance state (Hi-Z) and $\overline{\text{SD}}$ being asserted low. OTE is latched in this case. To clear the OTE latch, both $\overline{\text{RESET\_AB}}$ and $\overline{\text{RESET\_CD}}$ must be asserted. Thereafter, the device resumes normal operation.

### Undervoltage Protection (UVP) and Power-On Reset (POR)

The UVP and POR circuits of the TAS5152 fully protect the device in any power-up/down and brownout situation. While powering up, the POR circuit resets the overload circuit (OLP) and ensures that all circuits are fully operational when the GVDD_X and VDD supply voltages reach 9.8 V (typical). Although GVDD_X and VDD are independently monitored, a supply voltage drop below the UVP threshold on any VDD or GVDD_X pin results in all half-bridge outputs immediately being set in the high-impedance state (Hi-Z) and $\overline{\text{SD}}$ being asserted low. The device automatically resumes operation when all supply voltages have increased above the UVP threshold.

## DEVICE RESET

Two reset pins are provided for independent control of half-bridges A/B and C/D. When $\overline{\text{RESET\_AB}}$ is asserted low, all four power-stage FETs in half-bridges A and B are forced into a high-impedance state (Hi-Z). Likewise, asserting $\overline{\text{RESET\_CD}}$ low forces all four power-stage FETs in half-bridges C and D into a high-impedance state. Thus, both reset pins are well suited for hard-muting the power stage if needed.

In BTL modes, to accommodate bootstrap charging prior to switching start, asserting the reset inputs low enables weak pulldown of the half-bridge outputs. In the SE mode, the weak pulldowns are not enabled, and it is therefore recommended to ensure bootstrap capacitor charging by providing a low pulse on the PWM inputs when reset is asserted high.

Asserting either reset input low removes any fault information to be signalled on the $\overline{\text{SD}}$ output, i.e., $\overline{\text{SD}}$ is forced high.

A rising-edge transition on either reset input allows the device to resume operation after an overload fault.

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TAS5152DKD | ACTIVE | HSSOP | DKD | 36 | 29 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-4-260C-72 HR | 0 to 70 | TAS5152 | Samples |
| TAS5152DKDG4 | ACTIVE | HSSOP | DKD | 36 | 29 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-4-260C-72 HR | 0 to 70 | TAS5152 | Samples |
| TAS5152DKDR | ACTIVE | HSSOP | DKD | 36 | 500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-4-260C-72 HR | 0 to 70 | TAS5152 | Samples |

(1) The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

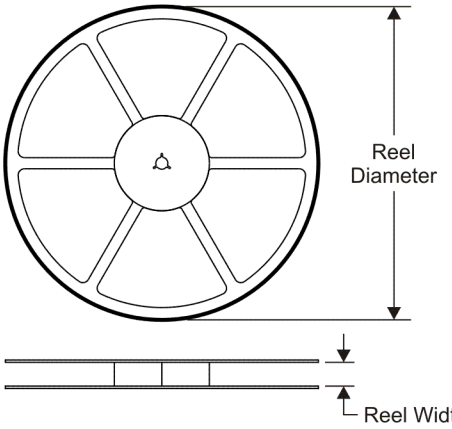
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

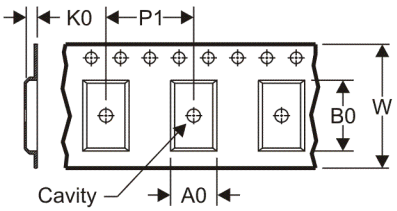
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

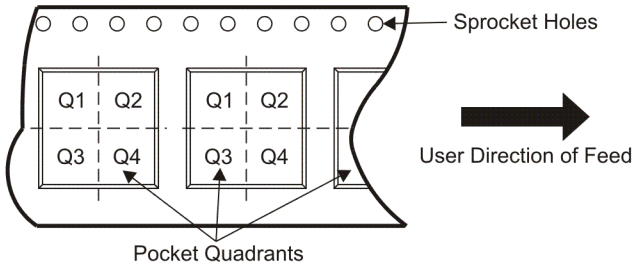



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

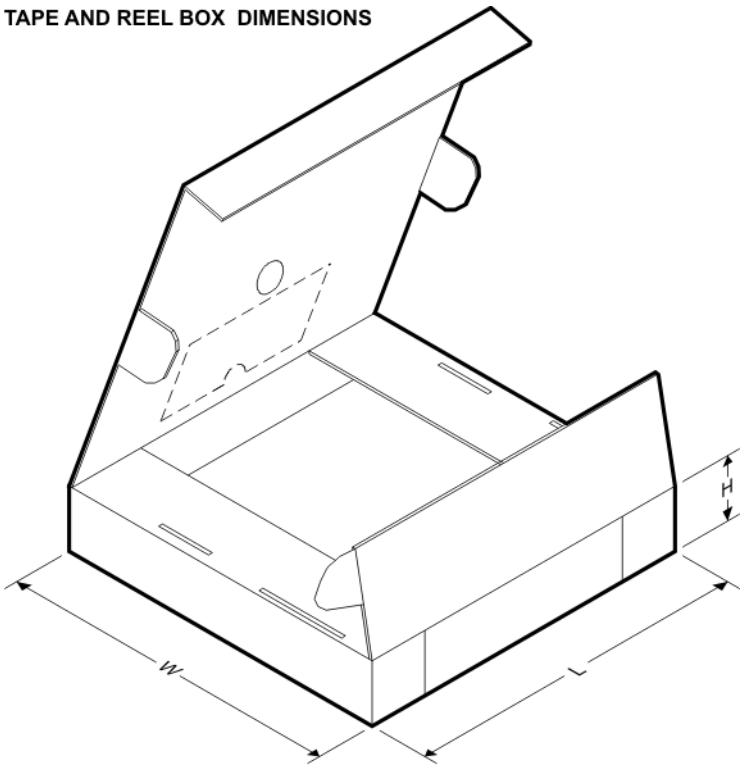
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TAS5152DKDR | HSSOP | DKD | 36 | 500 | 330.0 | 24.4 | 14.7 | 16.4 | 4.0 | 20.0 | 24.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



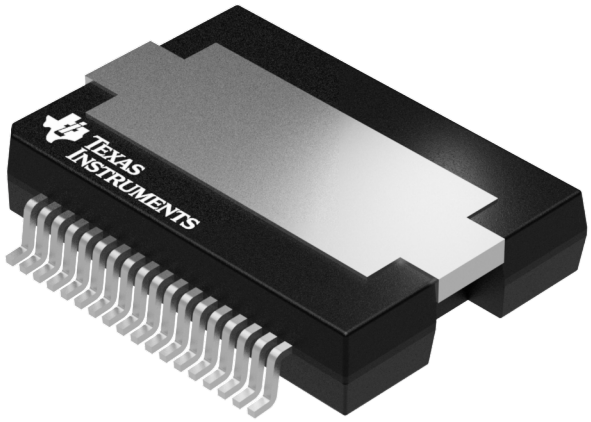

*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TAS5152DKDR | HSSOP | DKD | 36 | 500 | 337.0 | 343.0 | 41.0 |

# GENERIC PACKAGE VIEW

## DKD 36 PowerPAD™ SSOP - 3.6 mm max height

PLASTIC SMALL OUTLINE

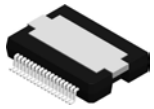



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4204421-2/N

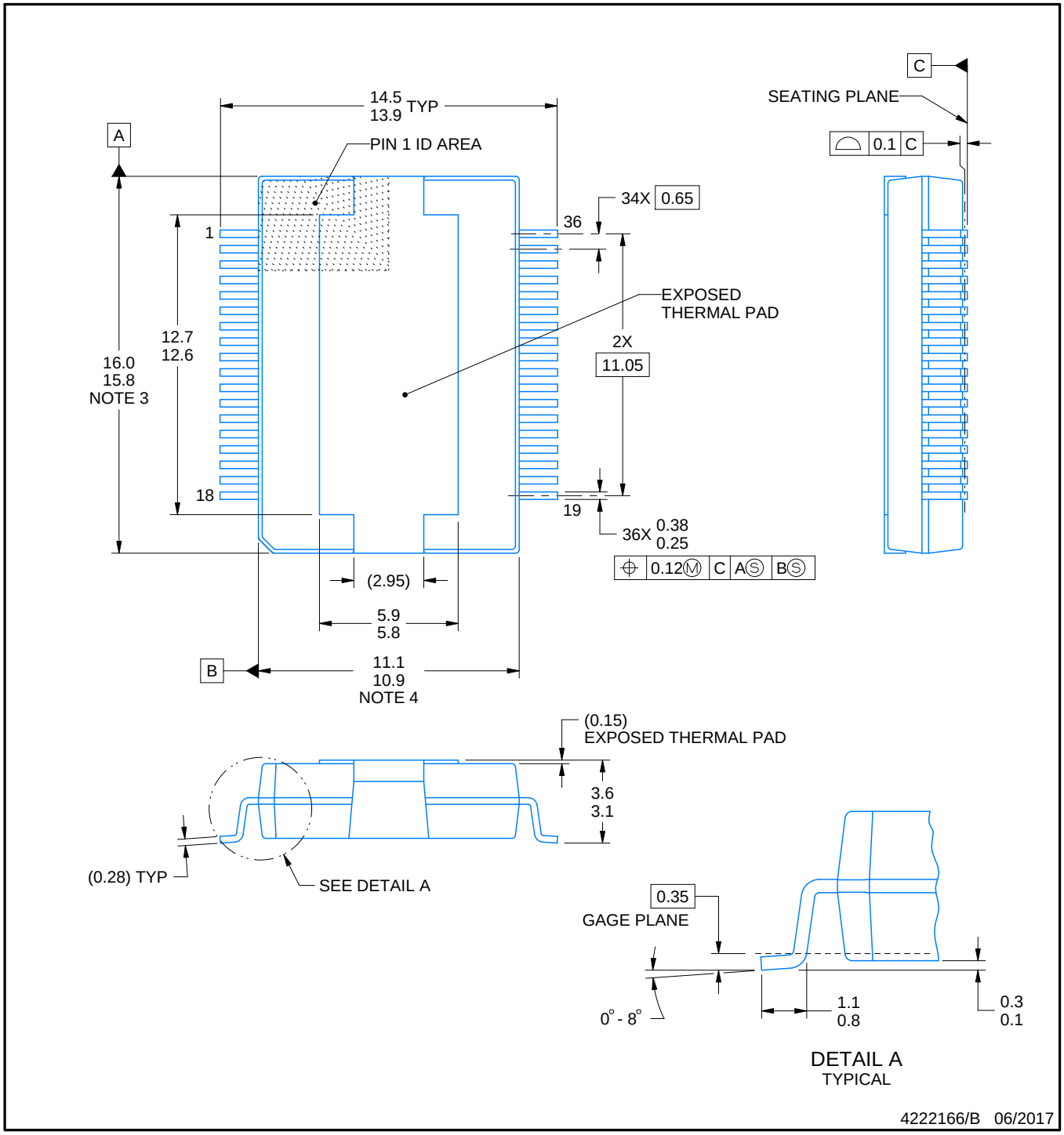
# PACKAGE OUTLINE

## DKD0036A



## PowerPAD™ SSOP - 3.6 mm max height

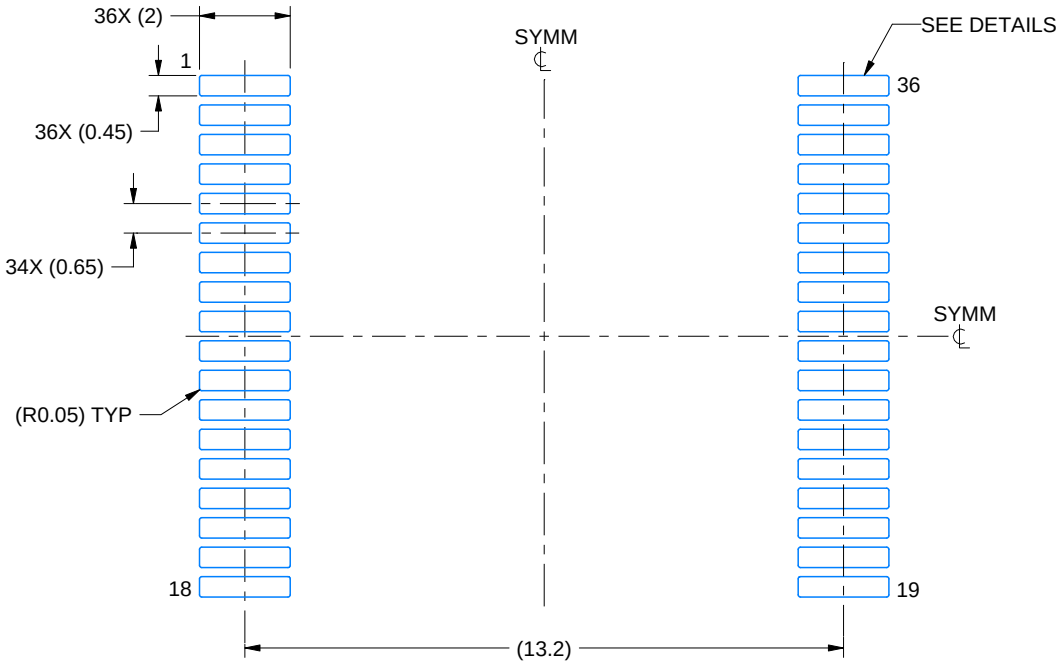
PLASTIC SMALL OUTLINE



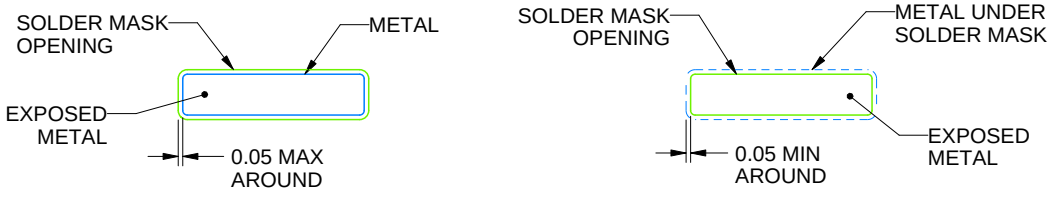

PowerPAD is a trademark of Texas Instruments.

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. The exposed thermal pad is designed to be attached to an external heatsink.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:6X

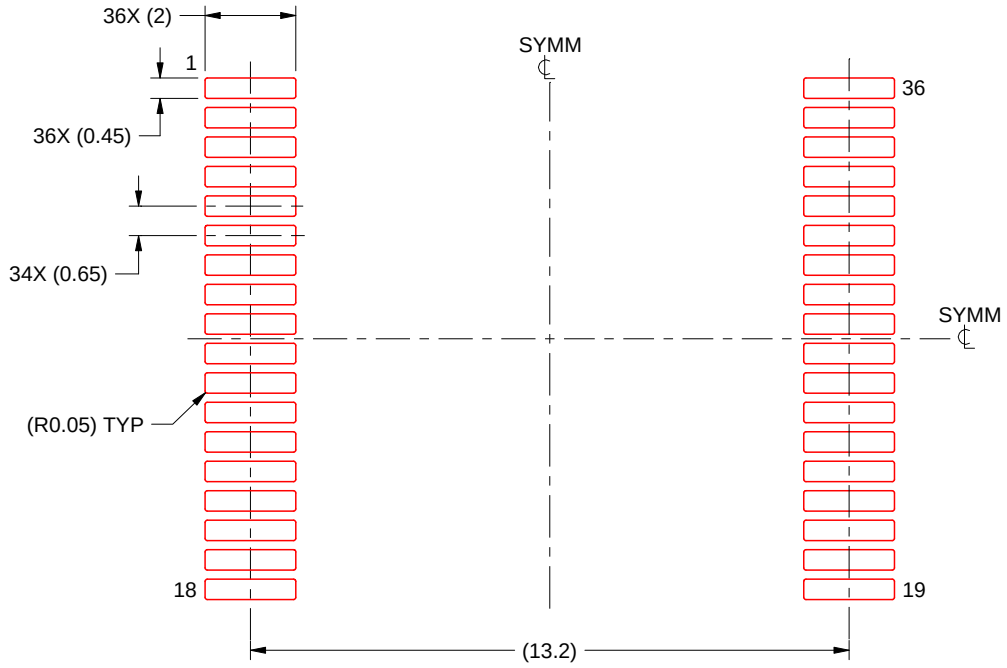



SOLDER MASK DETAILS
NOT TO SCALE

4222166/B 06/2017

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.




SOLDER PASTE EXAMPLE
BASED ON 0.125 MM THICK STENCIL
SCALE:6X

4222166/B 06/2017

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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