NCP2892 Series

1.3 Watt Audio Power Amplifier with Fast Turn On Time

The NCP2892 is an audio power amplifier designed for portable communication device applications such as mobile phone applications. The NCP2892 is capable of delivering 1.3 W of continuous average power to an 8.0 Ω BTL load from a 5.0 V power supply, and 1.0 W to a 4.0 Ω BTL load from a 3.6 V power supply.

The NCP2892 provides high quality audio while requiring few external components and minimal power consumption. It features a low-power consumption shutdown mode, which is achieved by driving the SHUTDOWN pin with logic low.

The NCP2892 contains circuitry to prevent from “pop and click” noise that would otherwise occur during turn−on and turn−off transitions.

For maximum flexibility, the NCP2892 provides an externally controlled gain (with resistors), as well as an externally controlled turn−on time (with the bypass capacitor). When using a 1 μF bypass capacitor, it offers 100 ms wake up time.

Due to its excellent PSRR, it can be directly connected to the battery, saving the use of an LDO.

This device is available in a 9−Pin Flip−Chip CSP (Lead−Free).

Features
- 1.3 W to an 8.0 Ω BTL Load from a 5.0 V Power Supply
- Excellent PSRR: Direct Connection to the Battery
- “Pop and Click” Noise Protection Circuit
- Ultra Low Current Shutdown Mode: 10 nA
- 2.2 V−5.5 V Operation
- External Gain Configuration Capability
- External Turn−on Time Configuration Capability: 100 ms (1 μF Bypass Capacitor)
- Up to 1.0 nF Capacitive Load Driving Capability
- Thermal Overload Protection Circuity
- This is a Pb−Free Device*

Typical Applications
- Portable Electronic Devices
- PDAs
- Wireless Phones

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.
Figure 1. Typical Audio Amplifier Application Circuit with Single Ended Input

Figure 2. Typical Audio Amplifier Application Circuit with a Differential Input

This device contains 671 active transistors and 1899 MOS gates.
PIN DESCRIPTION

<table>
<thead>
<tr>
<th>Pin</th>
<th>Type</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>I</td>
<td>INM</td>
<td>Negative input of the first amplifier, receives the audio input signal. Connected to the feedback resistor Rf and to the input resistor Rin.</td>
</tr>
<tr>
<td>A2</td>
<td>O</td>
<td>OUTA</td>
<td>Negative output of the NCP2892. Connected to the load and to the feedback resistor Rf.</td>
</tr>
<tr>
<td>A3</td>
<td>I</td>
<td>INP</td>
<td>Positive input of the first amplifier, receives the common mode voltage.</td>
</tr>
<tr>
<td>B1</td>
<td>I</td>
<td>VM_P</td>
<td>Power Analog Ground.</td>
</tr>
<tr>
<td>B2</td>
<td>I</td>
<td>VM</td>
<td>Core Analog Ground.</td>
</tr>
<tr>
<td>B3</td>
<td>I</td>
<td>Vp</td>
<td>Positive analog supply of the cell. Range: 2.2 V−5.5 V.</td>
</tr>
<tr>
<td>C1</td>
<td>I</td>
<td>BYPASS</td>
<td>Bypass capacitor pin which provides the common mode voltage (Vp/2).</td>
</tr>
<tr>
<td>C2</td>
<td>O</td>
<td>OUTB</td>
<td>Positive output of the NCP2892. Connected to the load.</td>
</tr>
<tr>
<td>C3</td>
<td>I</td>
<td>SHUTDOWN</td>
<td>The device enters in shutdown mode when a low level is applied on this pin.</td>
</tr>
</tbody>
</table>

MAXIMUM RATINGS (Note 1)

<table>
<thead>
<tr>
<th>Rating</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>Vp</td>
<td>6.0</td>
<td>V</td>
</tr>
<tr>
<td>Operating Supply Voltage</td>
<td>Op Vp</td>
<td>2.2 to 5.5 V</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.0 V = Functional Only</td>
<td></td>
</tr>
<tr>
<td>Input Voltage</td>
<td>Vin</td>
<td>−0.3 to Vcc +0.3</td>
<td>V</td>
</tr>
<tr>
<td>Max Output Current</td>
<td>Iout</td>
<td>500</td>
<td>mA</td>
</tr>
<tr>
<td>Power Dissipation (Note 2)</td>
<td>Pd</td>
<td>Internally Limited</td>
<td>–</td>
</tr>
<tr>
<td>Operating Ambient Temperature</td>
<td>T_A</td>
<td>−40 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>Max Junction Temperature</td>
<td>T_J</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>T_stg</td>
<td>−65 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>Thermal Resistance Junction−to−Air</td>
<td>R_ThJA</td>
<td>(Note 3)</td>
<td>°C/W</td>
</tr>
<tr>
<td>ESD Protection Human Body Model (HBM) (Note 4)</td>
<td>–</td>
<td>8000</td>
<td>V</td>
</tr>
<tr>
<td>NCP2892A</td>
<td></td>
<td>6000</td>
<td></td>
</tr>
<tr>
<td>Machine Model (MM) (Note 5)</td>
<td></td>
<td>&gt;250</td>
<td></td>
</tr>
<tr>
<td>Latchup Current at T_A = 85°C (Note 6)</td>
<td>–</td>
<td>±100</td>
<td>mA</td>
</tr>
</tbody>
</table>

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Maximum electrical ratings are defined as those values beyond which damage to the device may occur at T_A = +25°C.
2. The thermal shutdown set to 160°C (typical) avoids irreversible damage on the device due to power dissipation. For further information see page 10.
3. The R_ThJA is highly dependent of the PCB Heatsink area. For example, R_ThJA can equal 195°C/W with 50 mm² total area and also 135°C/W with 500 mm². For further information see page 10. The bumps have the same thermal resistance and all need to be connected to optimize the power dissipation.
4. Human Body Model, 100 pF discharge through a 1.5 kΩ resistor following specification JESD22/A114.
5. Machine Model, 200 pF discharged through all pins following specification JESD22/A115.
6. Maximum ratings per JEDEC standard JESD78.
ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min (Note 7)</th>
<th>Typ</th>
<th>Max (Note 7)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Quiescent Current</td>
<td>(I_{dd})</td>
<td>(V_{p} = 2.6 , \text{V}, \text{No Load})</td>
<td>–</td>
<td>1.5</td>
<td>–</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{p} = 5.0 , \text{V}, \text{No Load})</td>
<td>–</td>
<td>1.7</td>
<td>–</td>
<td>mA</td>
</tr>
<tr>
<td>Common Mode Voltage</td>
<td>(V_{cm})</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>(V_{p}/2)</td>
<td>V</td>
</tr>
<tr>
<td>Shutdown Current</td>
<td>(I_{SD})</td>
<td>(T_{A} = +25^\circ \text{C})</td>
<td>–</td>
<td>0.01</td>
<td>–</td>
<td>(\mu\text{A})</td>
</tr>
<tr>
<td>Shutdown Voltage High</td>
<td>(V_{SDIH})</td>
<td>–</td>
<td>1.2</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Shutdown Voltage Low</td>
<td>(V_{SDIL})</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.4</td>
<td>V</td>
</tr>
<tr>
<td>Turning On Time (Note 9)</td>
<td>(T_{WU})</td>
<td>(C_{by} = 1 , \mu\text{F})</td>
<td>–</td>
<td>90</td>
<td>–</td>
<td>ms</td>
</tr>
<tr>
<td>Turning Off Time</td>
<td>(T_{OFF})</td>
<td>–</td>
<td>–</td>
<td>1.0</td>
<td>–</td>
<td>(\mu\text{s})</td>
</tr>
<tr>
<td>Output Impedance in Shutdown Mode</td>
<td>(Z_{SD})</td>
<td>NCP2892A</td>
<td>–</td>
<td>100</td>
<td>–</td>
<td>(\Omega)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NCP2892B</td>
<td>–</td>
<td>10</td>
<td>–</td>
<td>(\text{k}\Omega)</td>
</tr>
<tr>
<td>Output Swing</td>
<td>(V_{loadpeak})</td>
<td>NCP2892A</td>
<td>1.6</td>
<td>2.12</td>
<td>–</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NCP2892B</td>
<td>4.0</td>
<td>4.15</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>–</td>
<td>3.85</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Rms Output Power</td>
<td>(P_{O})</td>
<td>NCP2892A</td>
<td>–</td>
<td>0.36</td>
<td>–</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NCP2892B</td>
<td>–</td>
<td>0.28</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>–</td>
<td>1.08</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Maximum Power Dissipation (Note 9)</td>
<td>(P_{D\text{max}})</td>
<td>–</td>
<td>–</td>
<td>0.65</td>
<td>W</td>
<td>–</td>
</tr>
<tr>
<td>Output Offset Voltage</td>
<td>(V_{OS})</td>
<td>–</td>
<td>–30</td>
<td>30</td>
<td>30</td>
<td>mV</td>
</tr>
<tr>
<td>Signal–to–Noise Ratio</td>
<td>SNR</td>
<td>(V_{p} = 2.6 , \text{V}, G = 2.0)</td>
<td>–</td>
<td>84</td>
<td>–</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 Hz &lt; (F &lt; 20 , \text{kHz})</td>
<td>–</td>
<td>77</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Positive Supply Rejection Ratio</td>
<td>PSRR V+</td>
<td>(G = 2.0, R_{L} = 8.0 , \Omega)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>dB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{\text{Pripple}_{pp}} = 200 , \text{mV})</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(C_{by} = 1 , \mu\text{F})</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(F = 217 , \text{Hz})</td>
<td>(V_{p} = 5.0 , \text{V})</td>
<td>–</td>
<td>–64</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{p} = 3.0 , \text{V})</td>
<td>–</td>
<td>–</td>
<td>–72</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{p} = 2.6 , \text{V})</td>
<td>–</td>
<td>–</td>
<td>–73</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(F = 1.0 , \text{kHz})</td>
<td>(V_{p} = 5.0 , \text{V})</td>
<td>–</td>
<td>–64</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{p} = 3.0 , \text{V})</td>
<td>–</td>
<td>–</td>
<td>–74</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{p} = 2.6 , \text{V})</td>
<td>–</td>
<td>–</td>
<td>–75</td>
<td>–</td>
</tr>
<tr>
<td>Efficiency</td>
<td>(\eta)</td>
<td>(V_{p} = 2.6 , \text{V}, P_{\text{rms}} = 320 , \text{mW})</td>
<td>–</td>
<td>48</td>
<td>–</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{p} = 5.0 , \text{V}, P_{\text{rms}} = 1.0 , \text{W})</td>
<td>–</td>
<td>63</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>
**ELECTRICAL CHARACTERISTICS** Limits apply for $T_A$ between $-40^\circ$C to $+85^\circ$C (Unless otherwise noted).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min (Note 7)</th>
<th>Typ</th>
<th>Max (Note 7)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Shutdown Temperature (Note 10)</td>
<td>$T_{sd}$</td>
<td></td>
<td>140</td>
<td>160</td>
<td>180</td>
<td>°C</td>
</tr>
<tr>
<td>Total Harmonic Distortion</td>
<td>THD</td>
<td>$V_p = 2.6$, $F = 1.0$ kHz</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$R_L = 4.0\ \Omega$, $A_V = 2.0$</td>
<td>–</td>
<td>0.04</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$P_O = 0.32$ W</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_p = 5.0$ V, $F = 1.0$ kHz</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$R_L = 8.0\ \Omega$, $A_V = 2.0$</td>
<td>–</td>
<td>0.02</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$P_O = 1.0$ W</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
</tbody>
</table>

7. Min/Max limits are guaranteed by design, test or statistical analysis.
8. This parameter is guaranteed but not tested in production in case of a 5.0 V power supply.
9. See page 12 for a theoretical approach of this parameter.
10. For this parameter, the Min/Max values are given for information.
TYPICAL PERFORMANCE CHARACTERISTICS

Figure 3. THD + N versus Power Out

Figure 4. THD + N versus Power Out

Figure 5. THD + N versus Power Out

Figure 6. THD + N versus Power Out

Figure 7. THD + N versus Power Out

Figure 8. THD + N versus Power Out

V_p = 2.5 V
R_L = 8 Ω
f = 1 kHz
A_V = 2

V_p = 3.2 V
R_L = 8 Ω
f = 1 kHz
A_V = 2

V_p = 3.6 V
R_L = 4 Ω
f = 1 kHz
A_V = 2

V_p = 2.5 V
R_L = 8 Ω
f = 1 kHz
A_V = 2

V_p = 3.6 V
R_L = 8 Ω
f = 1 kHz
A_V = 2

V_p = 3.6 V
R_L = 8 Ω
f = 1 kHz
A_V = 2

V_p = 5 V
R_L = 8 Ω
f = 1 kHz
A_V = 2

V_p = 3.6 V
R_L = 8 Ω
f = 1 kHz
A_V = 2

V_p = 3.6 V
R_L = 4 Ω
f = 1 kHz
A_V = 2

V_p = 3.6 V
R_L = 8 Ω
f = 1 kHz
A_V = 2
TYPICAL PERFORMANCE CHARACTERISTICS

Figure 9. Output Power versus Power Supply

Figure 10. THD + N versus Frequency

Figure 11. THD + N versus Frequency

Figure 12. THD + N versus Frequency

Figure 13. THD + N versus Frequency

Figure 14. THD + N versus Frequency
TYPICAL PERFORMANCE CHARACTERISTICS

Figure 15. PSRR @ $V_p = 3.6$ V
Single Ended Audio Input to Ground

Figure 16. PSRR @ $V_p = 5$ V
Single Ended Audio Input to Ground

Figure 17. PSRR @ $V_p = 3.6$ V
Differential Audio Input to Ground

Figure 18. PSRR @ $V_p = 5$ V
Differential Audio Input to Ground

Figure 19. PSRR @ $V_p = 3.6$ V
Single Ended Audio Input Floating

Figure 20. PSRR @ DC Output Voltage

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

$V_p = 3.6$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF

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$V_p = 5$ V
$V_{\text{ripple}} = 200$ mV_{pk-pk}
Input to Gnd
$C_{\text{bypass}} = 1$ μF
TYPICAL PERFORMANCE CHARACTERISTICS

Figure 21. $T_{\text{ON}}$ versus $C_{\text{bypass}}$ @ $V_{\text{bat}} = 3.6$ V, $T_A = +25^\circ\text{C}$

Figure 22. $T_{\text{ON}}$ versus Temperature @ $V_{\text{bat}} = 3.6$ V, $C_{\text{bypass}} = 1 \, \mu\text{F}$

Figure 23. $T_{\text{ON}}$ vs. $V_{\text{bat}}$ @ $C_{\text{bypass}} = 1 \, \mu\text{F}$, $T_A = +25^\circ\text{C}$

Figure 24. Power Dissipation versus Output Power

Figure 25. Power Dissipation versus Output Power

Figure 26. Power Dissipation versus Output Power
TYPICAL PERFORMANCE CHARACTERISTICS

Figure 27. Power Dissipation versus Output Power

- $P_D$, POWER DISSIPATION (W)
- $P_{out}$, OUTPUT POWER (W)
- $R_L = 4 \, \Omega$
- $V_p = 2.6 \, V$
- $F = 1 \, kHz$
- $THD + N < 0.1\%$

- $R_L = 8 \, \Omega$

Figure 28. Power Derating − 9−Pin Flip−Chip CSP

- $P_D_{max} = 633 \, mW$
- for $V_p = 5 \, V$, $R_L = 8 \, \Omega$

- $V_p = 2.6 \, V$
- $F = 1 \, kHz$
- $THD + N < 0.1\%$

- $RL = 8 \, \Omega$

Figure 29. Maximum Die Temperature versus PCB Heatsink Area

- Maximum Die Temperature 150°C
- $V_p = 5 \, V$
- $V_p = 4.2 \, V$
- $V_p = 3.3 \, V$
- $V_p = 2.6 \, V$

- $RL = 8 \, \Omega$

- $PCB$ Heatsink Area (mm²)
- 500 mm²
- 50 mm²
- 200 mm²
Figure 30. Zero Pop Noise Turn On Sequence with Differential Input to Ground; $C_{in} = 100 \, \text{nF}$, $R_{in} = 24 \, \Omega$, $R_f = 100 \, \text{k}\Omega$, $C_{byp} = 1 \, \mu\text{F}$, $R_L = 8 \, \Omega$

Figure 31. Zero Pop Noise Turn On Sequence with Differential Audio Source; $C_{in} = 100 \, \text{nF}$, $R_{in} = 24 \, \Omega$, $R_f = 100 \, \text{k}\Omega$, $C_{byp} = 1 \, \mu\text{F}$, $R_L = 8 \, \Omega$

Figure 32. Zero Pop Noise Turn Off Sequence with Differential Input to Ground; $C_{in} = 100 \, \text{nF}$, $R_{in} = 24 \, \Omega$, $R_f = 100 \, \text{k}\Omega$, $C_{byp} = 1 \, \mu\text{F}$, $R_L = 8 \, \Omega$

Figure 33. Zero Pop Noise Turn Off Sequence with Differential Audio Source; $C_{in} = 100 \, \text{nF}$, $R_{in} = 24 \, \Omega$, $R_f = 100 \, \text{k}\Omega$, $C_{byp} = 1 \, \mu\text{F}$, $R_L = 8 \, \Omega$
Detailed Description

The NCP2892 audio amplifier can operate under 2.6 V until 5.5 V power supply. With less than 1% THD+N, B version can deliver up to 1.2 W rms output power to an 8.0 Ω load ($V_p = 5.0$ V). If application allows to reach 10% THD+N, then 1.6 W can be provided using a 5.0 V power supply.

The structure of the NCP2892 is basically composed of two identical internal power amplifiers; the first one is externally configurable with gain–setting resistors $R_a$ and $R_f$ (the closed–loop gain is fixed by the ratios of these resistors) and the second is internally fixed in an inverting unity–gain configuration by two resistors of 20 kΩ. So the load is driven differentially through OUTA and OUTB outputs. This configuration eliminates the need for an output coupling capacitor. The NCP2892A has around 100 Ω and the NCP2892B has around 10 kΩ output impedance in the shutdown mode.

Internal Power Amplifier

The output PMOS and NMOS transistors of the amplifier were designed to deliver the output power of the specifications without clipping. The channel resistance ($R_{on}$) of the NMOS and PMOS transistors does not exceed 0.6 Ω when they drive current.

The structure of the internal power amplifier is composed of three symmetrical gain stages, first and medium gain stages are transconductance gain stages to obtain maximum bandwidth and DC gain.

Turn–On and Turn–Off Transitions

A cycle with a turn–on and turn–off transition is illustrated with plots that show both single ended signals on the previous page.

In order to eliminate “pop and click” noises during transitions, output power in the load must be slowly established or cut. When logic high is applied to the shutdown pin, the bypass voltage begins to rise exponentially and once the output DC level is around the common mode voltage, the gain is established instantaneously. This way to turn–on the device is optimized in terms of rejection of “pop and click” noises.

The device has the same behavior when it is turned–off by a logic low on the shutdown pin. During the shutdown mode, amplifier outputs are connected to the ground.

When a shutdown low level is applied, with 1 μF bypass capacitor, it takes 65 ms before the DC output level is tied to Ground on each output. However, no audio signal will be provided to the BTL load only 1 μs after the falling edge on the shutdown pin.

With 1 μF bypass capacitor, turn on time is set to 90 ms. This fast turn on time added to a very low shutdown current saves battery life and brings flexibility when designing the audio section of the final application.

NCP2892 is a zero pop noise device when using a differential audio input. In case of a single ended one, there is no audible pop click noise, especially when the input cut off frequency is higher than 100 Hz.

Shutdown Function

The device enters shutdown mode when shutdown signal is low. During the shutdown mode, the DC quiescent current of the circuit does not exceed 100 nA. In this configuration, the output impedance is 10 kΩ on each output.

Current Limit Circuit

The maximum output power of the circuit (Porms = 1.0 W, $V_p = 5.0$ V, $R_L = 8.0$ Ω) requires a peak current in the load of 500 mA.

In order to limit the excessive power dissipation in the load when a short–circuit occurs, the current limit in the load is fixed to 800 mA. The current in the four output MOS transistors are real–time controlled, and when one current exceeds 800 mA, the gate voltage of the MOS transistor is clipped and no more current can be delivered.

Thermal Overload Protection

Internal amplifiers are switched off when the temperature exceeds 160°C, and will be switched on again only when the temperature decreases fewer than 140°C.

The NCP2892 is unity–gain stable and requires no external components besides gain–setting resistors, an input coupling capacitor and a proper bypassing capacitor in the typical application.

The first amplifier is externally configurable ($R_f$ and $R_d$), while the second is fixed in an inverting unity gain configuration.

The differential–ended amplifier presents two major advantages:

- The possible output power is four times larger (the output swing is doubled) as compared to a single–ended amplifier under the same conditions.
- Output pins (OUTA and OUTB) are biased at the same potential $V_p/2$, this eliminates the need for an output coupling capacitor required with a single–ended amplifier configuration.

The differential closed loop–gain of the amplifier is given by $A_{vd} = 2 \cdot \frac{R_f}{R_{in}} = \frac{V_{rms}}{V_{inrms}}$.

Output power delivered to the load is given by $P_{rms} = \frac{(V_{peak})^2}{2 \cdot R_L}$ (Vpeak is the peak differential output voltage).

When choosing gain configuration to obtain the desired output power, check that the amplifier is not current limited or clipped.

The maximum current which can be delivered to the load is 500 mA $I_{peak} = \frac{V_{peak}}{R_L}$.
Gain-Setting Resistor Selection ($R_{in}$ and $R_f$)

$R_{in}$ and $R_f$ set the closed-loop gain of the amplifier. In order to optimize device and system performance, the NCP2892 should be used in low gain configurations. The low gain configuration minimizes THD + noise values and maximizes the signal to noise ratio, and the amplifier can still be used without running into the bandwidth limitations. A closed loop gain in the range from 2 to 5 is recommended to optimize overall system performance. An input resistor ($R_{in}$) value of 22 kΩ is realistic in most of applications, and doesn’t require the use of a too large capacitor $C_{in}$.

Input Capacitor Selection ($C_{in}$)

The input coupling capacitor blocks the DC voltage at the amplifier input terminal. This capacitor creates a high-pass filter with $R_{in}$, the cut-off frequency is given by $f_c = \frac{1}{2\pi R_{in} C_{in}}$. The size of the capacitor must be large enough to couple in low frequencies without severe attenuation. However a large input coupling capacitor requires more time to reach its quiescent DC voltage ($V_p/2$) and can increase the turn-on pops when a single ended audio input is used. An input capacitor value between 33 nF and 220 nF performs well in many applications (With $R_{in} = 22$ KΩ).

Bypass Capacitor Selection (Cby)

The bypass capacitor $C_{by}$ provides half-supply filtering and determines how fast the NCP2892 turns on (see Figure 21). With a differential audio input, the amplifier will be a zero pop noise device no matter the bypass capacitor. With a single ended audio input, this capacitor is a critical component to minimize the turn-on pop. A 1.0 µF bypass capacitor value ($C_{in} < 0.39$ µF) should produce clickless and popless shutdown transitions. The amplifier is still functional with a 0.1 µF capacitor value but is more susceptible to “pop and click” noises. Thus, a 1.0 µF bypassing capacitor is recommended.

Figure 34. Schematic of the Demonstration Board of the 9-Pin Flip-Chip CSP Device
Figure 35. Demonstration Board for 9−Pin Flip−Chip CSP Device − PCB Layers
# BILL OF MATERIAL

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<tr>
<th>Item</th>
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<th>Manufacturer</th>
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<tr>
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<td></td>
<td>–</td>
<td>ON Semiconductor</td>
<td>NCP2892</td>
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<td>Panasonic</td>
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<td>0805</td>
<td>Panasonic</td>
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<td>R3</td>
<td>0805</td>
<td>Panasonic</td>
<td>ERJ–6GEYJ154V</td>
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<tr>
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<td>0805</td>
<td>TDK</td>
<td>C2012X7R2A473K</td>
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<tr>
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<td>C3, C4</td>
<td>0805</td>
<td>TDK</td>
<td>C2012X7R1A105K</td>
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<tr>
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<td>100 mils</td>
<td>Tyco Electronics / AMP</td>
<td>5–826629–0</td>
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# ORDERING INFORMATION

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<th>Package</th>
<th>Shipping†</th>
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<td>MAX</td>
<td>9–Pin Flip−Chip CSP (Pb−Free)</td>
<td>3000/Tape and Reel</td>
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<td>NCP2892BFCT2G</td>
<td>MAZ</td>
<td>9–Pin Flip−Chip CSP (Pb−Free)</td>
<td>3000/Tape and Reel</td>
</tr>
</tbody>
</table>

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

NOTE: The NCP2892AFCT2G version requires a lead−free solder paste and should not be used with a SnPb solder paste.
9 PIN FLIP–CHIP
CASE 499E–01
ISSUE A

DATE 30 JUN 2004

SCALE 4:1

NOTES:
2. CONTROLLING DIMENSION: MILLIMETERS.
3. COPLANARITY APPLIES TO SPHERICAL CROWNS OF SOLDER BALLS.

**GENERIC MARKING DIAGRAM**

XXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
G or * = Pb–Free Package

*This information is generic. Please refer to device data sheet for actual part marking.
Pb–Free indicator, “G” or microdot “*”, may or may not be present.