SINGLE-SUPPLY DUAL OPERATIONAL AMPLIFIER

■ GENERAL DESCRIPTION

The NJM2904 consists of two independent, high gain, internally frequency compensated operation amplifiers, which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, DC gain blocks, and all the conventional op amp circuits, which now can be more easily implemented in single power supply systems. For example, the NJM2904 can be directly operated off of the standard +5V power supply voltage, which is used in digital systems and will easily provide the required interface electronics without requiring the additional ±15V power supplies.

■ FEATURES

- Single Supply
- Operating Voltage  +3V~+32V
- Low Operating Current  0.7mA typ.
- Slew Rate  0.5V/μs typ.
- Bipolar Technology
- Package Outline  DIP8, DMP8, SSOP8, SIP8, SOP8 JEDEC 150mil

■ PIN CONFIGURATION

1. A OUTPUT
2. A –INPUT
3. A +INPUT
4. V –
5. B +INPUT
6. B –INPUT
7. B OUTPUT
8. V +

■ EQUIVALENT CIRCUIT  (1/2 Shown)
### ABSOLUTE MAXIMUM RATINGS

(\(Ta=25^\circ C\))

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>RATINGS</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage (V^+(\text{V}^-))</td>
<td>(V)</td>
<td>32 (or (\pm 16))</td>
<td>V</td>
</tr>
<tr>
<td>Differential Input Voltage (V_{ID})</td>
<td></td>
<td>32</td>
<td>V</td>
</tr>
<tr>
<td>Input Voltage (V_{IC})</td>
<td></td>
<td>(-0.3)~+32 (note 2)</td>
<td>V</td>
</tr>
</tbody>
</table>

Power Dissipation

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>RATINGS</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(P_D)</td>
<td></td>
<td>DIP8: 500</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DMP8: 300</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>EMP8: 300</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SSOP8: 250</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>MSOP8(VSP8/TVSP8): 320</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SIP8: 800</td>
<td></td>
</tr>
</tbody>
</table>

Operating Temperature Range

\(T_{opr}\) \(-40\)~+85 \(^\circ C\)

Storage Temperature Range

\(T_{stg}\) \(-50\)~+125 \(^\circ C\)

(note 1) Continuous short-circuits from output to GND is guaranteed only when \(V^+\leq 15\) V.

(note 2) For supply voltage less than 32V, the absolute maximum input voltage is equal to the supply voltage.

### ELECTRICAL CHARACTERISTICS

(\(Ta=25^\circ C, V^+=5V\))

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>TEST CONDITION</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Offset Voltage (V_{IO})</td>
<td>(R_S=0)Ω</td>
<td>-</td>
<td>2</td>
<td>7</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>Input Offset Current (I_{IO})</td>
<td></td>
<td>-</td>
<td>5</td>
<td>50</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Input Bias Current (I_B)</td>
<td></td>
<td>-</td>
<td>25</td>
<td>250</td>
<td>nA</td>
<td></td>
</tr>
<tr>
<td>Large Signal Voltage Gain (A_V)</td>
<td>(R_L \geq 2k)Ω</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Maximum Output Voltage Swing (V_{OPP})</td>
<td>(R_L \geq 2k)Ω</td>
<td>3.5</td>
<td>-</td>
<td>-</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Input Common Mode Voltage Range (V_{ICM})</td>
<td></td>
<td>0~3.5</td>
<td>-</td>
<td>-</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Common Mode Rejection Ratio (CMR)</td>
<td></td>
<td>-</td>
<td>85</td>
<td>-</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Supply Voltage Rejection Ratio (SVR)</td>
<td></td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Output Source Current (I_{SOURCE})</td>
<td>(V_W'=1V, V_N'=0V)</td>
<td>20</td>
<td>30</td>
<td>-</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Output Sink Current (I_{SINK})</td>
<td>(V_W'=0V, V_N'=1V)</td>
<td>8</td>
<td>20</td>
<td>-</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Channel Separation (CS)</td>
<td>(f=1k\sim20kHz, \text{Input Referred})</td>
<td>-</td>
<td>120</td>
<td>-</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Operating Current (I_{CC})</td>
<td>(R_L=\infty)</td>
<td>-</td>
<td>0.7</td>
<td>1.2</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Slew Rate (SR)</td>
<td>(V^+/V^-=\pm 15V)</td>
<td>-</td>
<td>0.5</td>
<td>-</td>
<td>V/\mu s</td>
<td></td>
</tr>
<tr>
<td>Unity Gain Bandwidth (f_T)</td>
<td>(V^+/V^-=\pm 15V)</td>
<td>-</td>
<td>0.6</td>
<td>-</td>
<td>MHz</td>
<td></td>
</tr>
</tbody>
</table>
TYPICAL CHARACTERISTICS

Operating Current vs. Operating Voltage

Input Bias Current vs. Operating Voltage

Channel Separation vs. Frequency

Voltage Gain vs. Operating Voltage

Maximum Output Voltage Swing vs. Frequency

Open Loop Voltage Gain vs. Frequency
TYPICAL CHARACTERISTICS

- Maximum Output Voltage Swing vs. Temperature
  \( (V^+=30V, R_L=2k\Omega) \)

- Input Offset Voltage vs. Temperature
  \( (V^+=5V) \)

- Operating Current vs. Temperature
  \( (V^+=5V) \)

- Input Bias Current vs. Temperature
  \( (V^+=5V) \)

- Maximum Output Voltage vs. Load Resistance
  \( (V^+=5V, Ta=25^\circ C) \)
■ TYPICAL CHARACTERISTICS

Maximum Output Voltage vs. Operating Voltage
($R_L=2k\Omega, Ta=25^\circ C$)

Output Voltage vs. Sink Current
($V^+=5V, Ta=25^\circ C$)

Source Current
($V^+=15V, Ta=25^\circ C$)
NJM2904, in its static state (No input and output condition) when designing, $Q_U$ being biased by constant current (break down beam), yet, $Q_L$ stays OFF.

While using with both power source modes, the cross-over distortion might occur instantly when $Q_L$ ON.

There might be cases when application for amplifier of audio signals, not only distortion but also the apparent frequency bandwidth being narrowed remarkably.

It is adjustable especially when using both power source modes, constantly to use with higher current on $Q_U$ than the load current (including feedback current), and then connect the pull-down resistor $R_P$ at the part between output and $V^-$ pins.

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**APPLICATION**

Improvement of Cross-over Distortion

Equivalent circuit at the output stage

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**[CAUTION]**

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