ADJUSTABLE LOW DROPOUT VOLTAGE REGULATOR

- GENERAL DESCRIPTION
  The NJM2387/89 are adjustable low dropout voltage regulators. The output current is up to 1.0A and dropout voltage is 0.2V typ. at Io=0.5A. NJM2387 has ON/OFF control circuit and enable to reduce quiescent current. The NJM2387/89 are suitable for power module, TV, Display, car stereo and low power applications.

- FEATURES
  - Low Dropout Voltage \( \Delta V_{CL}=0.2V \) typ. at Io=0.5A
  - Output Current Io(max.)=1.0A
  - Reference Voltage Vref=1.26V ± 2%
  - ON/OFF Control (Active High : Only NJM2387)
  - Internal Short Circuit Current Limit
  - Internal Overvoltage Protection
  - Internal Thermal Overload Protection
  - Bipolar Technology
  - Package Outline TO-252-5(NJM2387), TO-220F-4(NJM2389)

- PIN CONFIGURATION

- BLOCK DIAGRAM
**NJM2387/89**

### ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>RATINGS</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>$V_{IN}$</td>
<td>+35</td>
<td>V</td>
</tr>
<tr>
<td>Control Voltage</td>
<td>$V_{\text{CONT}}$</td>
<td>+35(*1)</td>
<td>V</td>
</tr>
<tr>
<td>Adjust Terminal Voltage</td>
<td>$V_{\text{ADJ}}$</td>
<td>+6</td>
<td>V</td>
</tr>
<tr>
<td>Power Dissipation (NJM2387)</td>
<td>$P_D$</td>
<td>NJM2387</td>
<td>1190(*2) / 3125(*3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NJM2389</td>
<td>18(Tc&lt;50°C)</td>
</tr>
<tr>
<td>Operating Junction Temperature Range</td>
<td>$T_j$</td>
<td>-40 ~ +150</td>
<td>°C</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>$T_{\text{opr}}$</td>
<td>-40 ~ +85</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>$T_{\text{stg}}$</td>
<td>-50 ~ +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

(*1): This applies for NJM2387. When input voltage is less than +35V, the absolute maximum control voltage is equal to the input voltage.

(*2): Mounted on glass epoxy board. (76.2 x 114.3 x 1.6mm:based on EIA/JDEC standard, 2Layers, Cu area 100mm²)

(*3): Mounted on glass epoxy board. (76.2 x 114.3 x 1.6mm:based on EIA/JDEC standard, 4Layers)

(For 4Layers: Applying 74.2 x 74.2mm inner Cu area and a thermal via hole to a board based on JEDEC standard JESD51-5)

### NJM2387

#### ELECTRICAL CHARACTERISTICS ($V_{IN}=15V, V_{O}=10V, I_o=0.5A, R_1=1k\Omega, C_N=0.33\mu F, C_o=22\mu F, T_a=25°C$)

Measurement is to be conducted is pulse testing.

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>$V_{IN}$</td>
<td>-</td>
<td>3.8</td>
<td>-</td>
<td>35</td>
<td>V</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>$V_{OUT}$</td>
<td>-</td>
<td>1.5</td>
<td>-</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>Reference Voltage</td>
<td>$V_{\text{ref}}$</td>
<td>-</td>
<td>1.235</td>
<td>1.26</td>
<td>1.285</td>
<td>V</td>
</tr>
<tr>
<td>Line Regulation</td>
<td>$\Delta V_{O}/\Delta V_{IN}$</td>
<td>$V_R=V_{IN}+1V \sim V_{O}+17V$</td>
<td>-</td>
<td>0.04</td>
<td>0.16</td>
<td>%/V</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>$\Delta V_{O}/\Delta I_{O}$</td>
<td>$V_{IN}=V_{O}+2V, I_{O}=0A \sim 1.0A$</td>
<td>-</td>
<td>0.2</td>
<td>1.4</td>
<td>%/A</td>
</tr>
<tr>
<td>Average Temperature Coefficient of Output Voltage</td>
<td>$\Delta V_{O}/\Delta T$</td>
<td>$T_{j}=0 \sim +125^\circ C$</td>
<td>-</td>
<td>±0.02</td>
<td>-</td>
<td>%/°C</td>
</tr>
<tr>
<td>Quiescent Current</td>
<td>$I_{Q}$</td>
<td>$I_{O}=0A$</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>mA</td>
</tr>
<tr>
<td>Dropout Voltage</td>
<td>$\Delta V_{O}/\Delta I_{O}$</td>
<td>$I_{O}=0.5A$</td>
<td>-</td>
<td>0.2</td>
<td>0.5</td>
<td>V</td>
</tr>
<tr>
<td>Ripple Rejection</td>
<td>$RR$</td>
<td>$V_{IN}=V_{O}+2V, \text{ein}=0.5Vrms, f=120Hz$</td>
<td>52</td>
<td>65</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>ON Control Voltage</td>
<td>$V_{\text{CONT(ON)}}$</td>
<td>-</td>
<td>2.0(*4)</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>OFF Control Voltage</td>
<td>$V_{\text{CONT(OFF)}}$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.4</td>
<td>V</td>
</tr>
<tr>
<td>ON Control Current</td>
<td>$I_{\text{CONT(ON)}}$</td>
<td>$V_{C}=2.7V$</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>µA</td>
</tr>
<tr>
<td>OFF Control Current</td>
<td>$I_{\text{CONT(OFF)}}$</td>
<td>$V_{C}=0.4V$</td>
<td>-</td>
<td>-</td>
<td>-20</td>
<td>µA</td>
</tr>
</tbody>
</table>

(*4): When ON/OFF CONTROL pin is open, Output Voltage is ON.
POWER DISSIPATION vs. AMBIENT TEMPERATURE

NJM2387DL3 PowerDissipation (Topr=-40→+85°C, Tj=150°C)

TEST CIRCUIT

Vo = Vref × (1 + R2/R1)
TYPICAL APPLICATION

1. In the case where ON/OFF Control is not required:

   ![Circuit Diagram](image)

   Connect control pin to \( V_{IN} \) pin or open.

2. In use of ON/OFF CONTROL:

   ![Circuit Diagram](image)

   State of control pin:
   - “H” or “open” → output is enabled.
   - “L” → output is disabled.

Recommended \( R_1 \) 100Ω-20kΩ
NJM2389

ELECTRICAL CHARACTERISTICS (V_IN=15V, V_O=10V, I_O=0.5A, R1=1kΩ, C_IN=0.33µF, C_O=22µF, T_a=25°C)

Measurement is to be conducted in pulse testing.

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<td>V_IN</td>
<td></td>
<td>3.8</td>
<td>-</td>
<td>35</td>
<td>V</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>V_OUT</td>
<td></td>
<td>1.5</td>
<td>-</td>
<td>20</td>
<td>V</td>
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<td>V_ref</td>
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<td>1.26</td>
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<td>Line Regulation</td>
<td>∆V_o/∆V_IN</td>
<td>V_IN=V_O+1V ~ V_O+17V</td>
<td>-</td>
<td>0.04</td>
<td>0.16</td>
<td>%/V</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>∆V_o/I_o</td>
<td>V_IN=V_O+2V, I_o=0A ~ 1.0A</td>
<td>-</td>
<td>0.2</td>
<td>1.4</td>
<td>%/A</td>
</tr>
<tr>
<td>Average Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient of Output Voltage</td>
<td>∆V_o/∆T</td>
<td>T_j=0 ~ +125°C</td>
<td>-</td>
<td>±0.02</td>
<td>-</td>
<td>%/°C</td>
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<tr>
<td>Quiescent Current</td>
<td>I_O</td>
<td>I_o=0A</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>mA</td>
</tr>
<tr>
<td>Dropout Voltage</td>
<td>∆V_o/I_O</td>
<td>I_o=0.5A</td>
<td>-</td>
<td>0.2</td>
<td>0.5</td>
<td>V</td>
</tr>
<tr>
<td>Ripple Rejection</td>
<td>RR</td>
<td>V_IN=V_o+2V, ein=0.5Vrms, ein=0.5Vrms f=120Hz</td>
<td>52</td>
<td>65</td>
<td>-</td>
<td>dB</td>
</tr>
</tbody>
</table>

POWER DISSIPATION vs. AMBIENT TEMPERATURE

POWER DISSIPATION vs. AMBIENT TEMPERATURE

<table>
<thead>
<tr>
<th>Ambient Temperature Ta(°C)</th>
<th>Power Dissipation PD(W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-50</td>
<td>20</td>
</tr>
<tr>
<td>-25</td>
<td>18</td>
</tr>
<tr>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>25</td>
<td>14</td>
</tr>
<tr>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>75</td>
<td>10</td>
</tr>
<tr>
<td>100</td>
<td>8</td>
</tr>
</tbody>
</table>

TEST CIRCUIT

\[ V_o = V_{ref} \times (1 + R_2/R_1) \]
*Feed back Resistance R1

The output voltage may rise against the set point by the leak current from the V\text{OUT} pin at high temperature when this resistance is set too big.

Conversely, the current flowing to R1 grows big when R1 is set too small, and make the consumption current increase.

From the above, recommend 100Ω to 20kΩ as a set range of R1.

*Input Capacitor C\text{IN}

Input Capacitor C\text{IN} is required to prevent oscillation and reduce power supply ripple for applications when high power supply impedance or a long power supply line.

Therefore, use the recommended C\text{IN} value (refer to conditions of ELECTRIC CHARACTERISTIC) or larger and should connect between GND and V\text{IN} as shortest path as possible to avoid the problem.

*Output Capacitor C\text{O}

Output capacitor (C\text{O}) will be required for a phase compensation of the internal error amplifier.

The capacitance and the equivalent series resistance (ESR) influence to stable operation of the regulator.

Use of a smaller C\text{O} may cause excess output noise or oscillation of the regulator due to lack of the phase compensation.

On the other hand, Use of a larger C\text{O} reduces output noise and ripple output, and also improves output transient response when rapid load change.

Therefore, use the recommended C\text{O} value (refer to conditions of ELECTRIC CHARACTERISTIC) or larger and should connect between GND and V\text{OUT} as shortest path as possible for stable operation.

In addition, Please choose an appropriate capacitor in considering varied characteristics of capacitor (a frequency characteristic, a temperature characteristic, and so on) when selecting C\text{O}.
TYPICAL CHARACTERISTICS

**Output Voltage vs. Input Voltage**
- @ $T_a=25^\circ C$
- $C_o=22 \mu F$
- $I_o=0A$
- $I_o=0.5A$
- $I_o=1A$

**Output Voltage vs. Output Current**
- @ $T_a=25^\circ C$
- $C_o=22 \mu F$
- $V_{IN}=11V$
- $V_{IN}=22V$
- $V_{IN}=35V$

**Ground Pin Current vs. Output Current**
- @ $T_a=25^\circ C$
- $V_{IN}=11V$
- $C_o=22 \mu F$
- $R_1=1k\Omega$
- $R_2=6.94k\Omega$

**Dropout Voltage vs. Output Current**
- @ $T_a=25^\circ C$
- $C_o=22 \mu F$
- $R_1=1k\Omega$
- $R_2=6.94k\Omega$

**Control Current vs. Control Voltage**
- @ $T_a=25^\circ C$
- $V_{IN}=11V$
- $C_o=22 \mu F$ (Ceramic)
- $R_c=0\Omega$
- $R_c=50k\Omega$
- $R_c=100k\Omega$
TYPICAL CHARACTERISTICS

### Load Regulation vs. Output Current
![Load Regulation vs. Output Current](image1)

- **Graph Title**: Load Regulation vs. Output Current
- **Parameters**:
  - \( V_{IN} = 12V \)
  - \( C_o = 22\,\mu\text{F} \)
  - \( R_1 = 1\,\text{k}\Omega \)
  - \( R_2 = 6.94\,\text{k}\Omega \)

### Peak Output Current vs. Input Voltage
![Peak Output Current vs. Input Voltage](image2)

- **Graph Title**: Peak Output Current vs. Input Voltage
- **Parameters**:
  - \( V_{IN} = 15V \)
  - LPF: 80kHz
  - \( C_o = 22\,\mu\text{F} \)

### Quiescent Current vs. Input Voltage
![Quiescent Current vs. Input Voltage](image3)

- **Graph Title**: Quiescent Current vs. Input Voltage
- **Parameters**:
  - \( V_{IN} = 12V \)
  - \( R_1 = 1\,\text{k}\Omega \)
  - \( R_2 = 6.94\,\text{k}\Omega \)
  - \( C_o = 22\,\mu\text{F} \)
  - Output is open.

### Output Noise Voltage vs. Output Current
![Output Noise Voltage vs. Output Current](image4)

- **Graph Title**: Output Noise Voltage vs. Output Current
- **Parameters**:
  - \( V_{IN} = 12V \)
  - \( ein = 500\,\text{mVrms} \)
  - \( C_o = 22\,\mu\text{F} \)

### Ripple Rejection Ratio vs. Frequency
![Ripple Rejection Ratio vs. Frequency](image5)

- **Graph Title**: Ripple Rejection Ratio vs. Frequency
- **Parameters**:
  - \( V_{IN} = 12V \)
  - \( ein = 500\,\text{mVrms} \)
  - \( f = 120\,\text{Hz} \)
  - \( C_o = 22\,\mu\text{F} \)

### Ripple Rejection vs. Output Current
![Ripple Rejection vs. Output Current](image6)

- **Graph Title**: Ripple Rejection vs. Output Current
- **Parameters**:
  - \( V_{IN} = 12V \)
  - \( ein = 500\,\text{mVrms} \)
  - \( f = 120\,\text{Hz} \)
  - \( C_o = 22\,\mu\text{F} \) (Ceramic)
**TYPICAL CHARACTERISTICS**

**Output Noise Peak Value of Spectrum vs Output Current**

- @ $T_a=25^\circ C$
- $V_i=11V$
- $C_i=22\mu F$
- $E_R=0.1\Omega$
- $E_R=0.2\Omega$
- $E_R=0.5\Omega$
- $E_R=1\Omega$

**Dropout Voltage vs. Temperature**

- @ $I_o=0.5A$
- $V_i=11V$
- $C_i=22\mu F$

**Control Voltage vs. Temperature**

- @ $V_i=11V$
- $C_i=22\mu F$

**Output Voltage vs. Temperature**

- @ $V_i=11V$
- $C_i=22\mu F$

**Output Peak Current vs. Temperature**

- @ $V_i=11V$
- $C_i=22\mu F$

**Quiescent Current vs. Input Voltage**

- Output is open.
TYPICAL CHARACTERISTICS

Line Regulation vs. Temperature

Load Regulation vs. Temperature

Output Voltage vs. Temperature

Short Circuit Current vs. Temperature

ON/OFF Transient Response without Load

ON/OFF Transient Response
TYPICAL CHARACTERISTICS

![Input Transient Response](image1)

![Load Transient Response](image2)

CAUTION

The specifications on this databook are only given for information, without any guarantee as regards either mistakes or omissions. The application circuits in this databook are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial rights.