LOW DROPOUT VOLTAGE REGULATOR

■ GENERAL DESCRIPTION

The NJM2845/46 is low dropout voltage regulator. Advanced Bipolar technology achieves low noise, high ripple rejection and low quiescent current.

NJM2845 is 3 terminal type and NJM2846 is ON/OFF control built in type. These product can be selected according to the applications.

■ FEATURES

- High Ripple Rejection 75dB typ. (f=1kHz,3V Version)
- Output Noise Voltage Vno=45µVrms typ. (Vo=3V Version)
- Output capacitor with 2.2µF ceramic capacitor (Vo≥2.6V)
- Output Current Io(max.)=800mA
- High Precision Output Vo ±1.0%
- Low Dropout Voltage 0.18V typ. (Io=500mA)
- ON/OFF Control (NJM2846)
- Internal Short Circuit Current Limit
- Internal Thermal Overload Protection
- Bipolar Technology
- Package Outline TO-252-3 (NJM2845DL1), TO-252-5 (NJM2846DL3)

■ PIN CONFIGURATION

NJM2845DL1
1. VIN
2. GND
3. VOUT

NJM2846DL3
1. CONTROL
2. VIN
3. GND
4. Vo
5. NC

■ EQUIVALENT CIRCUIT
NJM2845/46

■ OUTPUT VOLTAGE

<table>
<thead>
<tr>
<th>Device Name</th>
<th>V\text{OUT}</th>
</tr>
</thead>
<tbody>
<tr>
<td>NJM284<em>DL</em>-15</td>
<td>1.5V</td>
</tr>
<tr>
<td>NJM284<em>DL</em>-18</td>
<td>1.8V</td>
</tr>
<tr>
<td>NJM284<em>DL</em>-02</td>
<td>2.0V</td>
</tr>
<tr>
<td>NJM284<em>DL</em>-22</td>
<td>2.2V</td>
</tr>
<tr>
<td>NJM284<em>DL</em>-23</td>
<td>2.3V</td>
</tr>
<tr>
<td>NJM284<em>DL</em>-25</td>
<td>2.5V</td>
</tr>
<tr>
<td>NJM284<em>DL</em>-03</td>
<td>3.0V</td>
</tr>
<tr>
<td>NJM284<em>DL</em>-33</td>
<td>3.3V</td>
</tr>
<tr>
<td>NJM284<em>DL</em>-04</td>
<td>4.0V</td>
</tr>
<tr>
<td>NJM284<em>DL</em>-05</td>
<td>5.0V</td>
</tr>
</tbody>
</table>

Output voltage options available: 1.5 ~ 5.0V (0.1V step)

■ ABSOLUTE MAXIMUM RATINGS (Ta=25°C)

<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\text{IN}</td>
<td>+14</td>
<td>V</td>
</tr>
<tr>
<td>Control Voltage</td>
<td>V\text{CONT}</td>
<td>+14(^1)</td>
<td>V</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>P\text{D}</td>
<td>10(Tc≤25°C) 1.0(Ta≤25°C)</td>
<td>W</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>Topr</td>
<td>-40 ~ +85</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>T\text{STG}</td>
<td>-40 ~ +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

(\^1): When input voltage is less than +14V, the absolute maximum control voltage is equal to the input voltage.

■ Operating voltage

V\text{IN}=+2.5V (in case of Vo<2.3V) \sim +(Vo+9V)

■ NJM2845

■ ELECTRICAL CHARACTERISTICS

(V\text{IN}=Vo+1V, C\text{IN}=0.33\mu\text{F}, C\text{O}=2.2\mu\text{F}(1.7V<Vo≤2.6V; C\text{O}=4.7\mu\text{F}, Vo≤1.7V; C\text{O}=10\mu\text{F}), Ta=25°C)

<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>Output Voltage</td>
<td>\text{Vo}</td>
<td>Io=30mA</td>
<td>-1.0%</td>
<td>-</td>
<td>+1.0%</td>
<td>V</td>
</tr>
<tr>
<td>Quiescent Current</td>
<td>\text{Io}</td>
<td>Io=0mA</td>
<td>-</td>
<td>400</td>
<td>600</td>
<td>\mu\text{A}</td>
</tr>
<tr>
<td>Output Current</td>
<td>\text{Io}</td>
<td>Vo - 0.3V</td>
<td>800</td>
<td>1050</td>
<td>-</td>
<td>mA</td>
</tr>
<tr>
<td>Line Regulation</td>
<td>\Delta\text{Vo}/\Delta\text{VIN}</td>
<td>V\text{IN}=Vo+1V \sim Vo+6V, Io=30mA</td>
<td>-</td>
<td>-</td>
<td>0.10</td>
<td>%/V</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>\Delta\text{Vo}/\Delta\text{Io}</td>
<td>Io=0 ~ 800mA</td>
<td>-</td>
<td>-</td>
<td>0.004</td>
<td>%/mA</td>
</tr>
<tr>
<td>Dropout Voltage(^2)</td>
<td>\Delta\text{V}_{\text{O}}</td>
<td>Io=500mA</td>
<td>-</td>
<td>0.18</td>
<td>0.28</td>
<td>V</td>
</tr>
<tr>
<td>Ripple Rejection</td>
<td>RR</td>
<td>ein=200mVrms, f=1kHz, Io=10mA, Vo=3V Version</td>
<td>-</td>
<td>75</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Average Temperature Coefficient of Output Voltage</td>
<td>\Delta\text{Vo}/\Delta\text{Ta}</td>
<td>Ta=0 ~ 85°C, Io=10mA</td>
<td>-</td>
<td>±50</td>
<td>-</td>
<td>ppm/°C</td>
</tr>
<tr>
<td>Output Noise Voltage</td>
<td>\text{V}_{\text{NO}}</td>
<td>f=10Hz \sim 80kHz, Io=10mA, Vo=3V Version</td>
<td>-</td>
<td>45</td>
<td>-</td>
<td>\mu\text{Vrms}</td>
</tr>
</tbody>
</table>

(\^2): The output voltage excludes under 2.3V.
The above specification is a common specification for all output voltages.
Therefore, it may be different from the individual specification for a specific output voltage.
**POWER DISSIPATION vs. AMBIENT TEMPERATURE**

![Power Dissipation vs. Ambient Temperature Graph](image)

**TEST CIRCUIT**

![Test Circuit Diagram](image)

*3 1.7V<Vo≤2.6V version: Co=4.7μF, Vo≤1.7V: Co=10μF (ceramic)

**TYPICAL APPLICATION**

![Typical Application Diagram](image)

*4 1.7V<Vo≤2.6V version: Co=4.7μF, Vo≤1.7V: Co=10μF (ceramic)
NJM2846

ELECTRICAL CHARACTERISTICS
(V<sub>IN</sub>=Vo+1V, C<sub>C</sub>=0.33µF, C<sub>o</sub>=2.2µF (1.7V<Vo≤2.6V version: C<sub>o</sub>=4.7µF, Vo≤1.7V: C<sub>o</sub>=10µF), Ta=25°C)

<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>Output Voltage</td>
<td>Vo</td>
<td>Io=30mA</td>
<td>-1.0%</td>
<td>-</td>
<td>+1.0%</td>
<td>V</td>
</tr>
<tr>
<td>Quiescent Current</td>
<td>I&lt;sub&gt;Q&lt;/sub&gt;</td>
<td>Io=0mA</td>
<td>-</td>
<td>400</td>
<td>600</td>
<td>µA</td>
</tr>
<tr>
<td>Quiescent Current at Control OFF</td>
<td>I&lt;sub&gt;Q(OFF)&lt;/sub&gt;</td>
<td>V&lt;sub&gt;CONT&lt;/sub&gt;=0V</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>Line Regulation</td>
<td>Io</td>
<td>V&lt;sub&gt;o&lt;/sub&gt; - 0.3V</td>
<td>800</td>
<td>1050</td>
<td>-</td>
<td>mA</td>
</tr>
<tr>
<td>Load Regulation</td>
<td>∆Vo/∆Io</td>
<td>Io=0 ~ 800mA</td>
<td>-</td>
<td>-</td>
<td>0.004</td>
<td>%/mA</td>
</tr>
<tr>
<td>Dropout Voltage(*5)</td>
<td>∆V&lt;sub&gt;I-O&lt;/sub&gt;</td>
<td>Io=500mA</td>
<td>-</td>
<td>0.18</td>
<td>0.28</td>
<td>V</td>
</tr>
<tr>
<td>Ripple Rejection</td>
<td>RR</td>
<td>ein=200mVrms, f=1kHz, Io=10mA, V&lt;sub&gt;o&lt;/sub&gt;=3V Version</td>
<td>-</td>
<td>75</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Average Temperature</td>
<td>∆Vo/∆Ta</td>
<td>Ta=0 ~ 85°C, Io=10mA</td>
<td>-</td>
<td>±50</td>
<td>-</td>
<td>ppm/°C</td>
</tr>
<tr>
<td>Coefficient of Output Voltage</td>
<td>∆Vo/∆Io</td>
<td>Io=0 ~ 800mA</td>
<td>-</td>
<td>45</td>
<td>-</td>
<td>µVrms</td>
</tr>
<tr>
<td>Control Current</td>
<td>I&lt;sub&gt;CONT&lt;/sub&gt;</td>
<td>V&lt;sub&gt;CONT&lt;/sub&gt;=1.6V, Io=0mA</td>
<td>-</td>
<td>3</td>
<td>12</td>
<td>µA</td>
</tr>
<tr>
<td>Control Voltage for ON-state</td>
<td>V&lt;sub&gt;CONT(ON)&lt;/sub&gt;</td>
<td>1.6</td>
<td>-</td>
<td>-</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Control Voltage for OFF-state</td>
<td>V&lt;sub&gt;CONT(OFF)&lt;/sub&gt;</td>
<td>-</td>
<td>-</td>
<td>0.6</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

(*5): The output voltage excludes under 2.3V.
The above specification is a common specification for all output voltages.
Therefore, it may be different from the individual specification for a specific output voltage.

POWER DISSIPATION vs. AMBIENT TEMPERATURE

NJM2846DL3
(Topr=40~+85°C, Tj=+150°C, P<sub>D</sub>=10W(T<sub>C</sub>≤25°C), P<sub>D</sub>=1W(Ta=25°C))
TEST CIRCUIT

*6 1.7V＜Vo≤2.6V version: Co=4.7μF, Vo＞1.7V: Co=10μF
**TYPICAL APPLICATIONS**

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

   ![Diagram of NJM2846 circuit](image)

   - **VIN**
   - **0.33 µF**
   - **R (0~300 kΩ)**
   - **NJM2846**
   - **VOUT**
   - **2.2 µF**
   - **GND**

   *7  1.7 V < Vo ≤ 2.6 V version: Cc=4.7 µF, Vo ≤ 1.7 V: Cc=10 µF

    Connect control terminal to VIN terminal

2. In use of ON/OFF CONTROL:

   ![Diagram of NJM2846 circuit with pull-up resistor](image)

   - **VIN**
   - **0.33 µF**
   - **R**
   - **NJM2846**
   - **VOUT**
   - **2.2 µF**

   *7  1.7 V < Vo ≤ 2.6 V version: Cc=4.7 µF, Vo ≤ 1.7 V: Cc=10 µF

   State of control terminal:
   - "H" → output is enabled.
   - "L" or "open" → output is disabled.

   *In the case of using a resistance "R" between VIN and control.
   The current flow into the control terminal while the IC is ON state (ICONT) can be reduced when a pull up resistance "R" is inserted between VIN and the control terminal.
   The minimum control voltage for ON state (VCONT(ON)) is increased due to the voltage drop caused by ICONT and the resistance "R". The ICONT is temperature dependence as shown in the "Control Current vs. Temperature" characteristics. Therefore, the resistance "R" should be carefully selected to ensure the control voltage exceeds the VCONT(ON) over the required temperature range.
**Input Capacitance \( C_{IN} \)**

Input capacitance \( C_{IN} \) is required to prevent oscillation and reduce power supply ripple for applications with high power supply impedance or a long power supply line.

Use the \( C_{IN} \) value of 0.33 \( \mu \)F greater to avoid the problem.

\( C_{IN} \) should connect between GND and \( V_{IN} \) as short as possible.

**Output Capacitance \( C_{O} \)**

Output capacitor (\( C_{O} \)) is required for a phase compensation of the internal error amplifier. The capacitance and the equivalent series resistance (ESR) influences stability of the regulator.

This product is designed to work with a low ESR capacitor for the \( C_{O} \); however, use of recommended capacitance or greater value is essential for stable operation.

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

Therefore, use \( C_{O} \) with the recommended capacitance or greater value and connect between \( V_{O} \) terminal and GND terminal with minimal wiring. The recommended capacitance depends on the output voltage. Low voltage regulator requires greater value of the \( C_{O} \). Thus, check the recommended capacitance for each output voltage.

Use of a greater \( C_{O} \) reduces output noise and ripple output, and also improves transient response of the output voltage against rapid load change.
TYPICAL CHARACTERISTICS (NJM2845)

**Output Voltage vs. Input Voltage**

![Graph](image1)

- Output Voltage: $V_o (V)$
- Input Voltage: $V_{IN} (V)$
- @ $Ta=25^\circ C$
- $Co=2.2 \mu F$ (Ceramic)
- $Io=0A$
- $Io=200mA$
- $Io=500mA$

**Output Voltage vs. Output Current**

![Graph](image2)

- Output Voltage: $V_o (V)$
- Output Current: $I_o (mA)$
- @ $Ta=25^\circ C$
- $VIN=4V$
- $Co=2.2 \mu F$ (Ceramic)

**Ground Pin Current vs. Output Current**

![Graph](image3)

- Ground Pin Current: $I_{GN}$ (mA)
- Output Current: $I_o (mA)$
- @ $Ta=25^\circ C$
- $VIN=4V$
- $Co=2.2 \mu F$ (Ceramic)

**Dropout Voltage vs. Output Current**

![Graph](image4)

- Dropout Voltage: $dV_{IO} (V)$
- Output Current: $I_o (mA)$
- @ $Ta=25^\circ C$
- $Co=2.2 \mu F$ (Ceramic)

**Load Regulation vs. Output Current**

![Graph](image5)

- Load Regulation: $\frac{dV_o}{dI_o} (mV)$
- Output Current: $I_o (mA)$
- @ $Ta=25^\circ C$
- $VIN=4V$
- $Co=2.2 \mu F$ (Ceramic)

**Peak Output Current vs. Input Voltage**

![Graph](image6)

- Peak Output Current: $I_{O\text{MAX}} (mA)$
- Input Voltage: $V_{IN} (V)$
- @ $Ta=25^\circ C$
- $Co=2.2 \mu F$ (Ceramic)
**TYPICAL CHARACTERISTICS (NJM2845)**

**NJM2845_3.0V Quiescent Current vs. Input Voltage**
- \( I_Q \) vs. \( V_{IN} \) at \( T_a=25^\circ C \)
- Input is open
- \( C_o=2.2 \mu F \) (Ceramic)

**Output Noise Voltage vs. Output Current**
- \( V_{NO} \) vs. \( I_o \) at \( T_a=25^\circ C \)
- \( V_{IN}=4.0V \)
- \( f=80kHz \)
- \( C_o=2.2 \mu F \) (Ceramic)

**Ripple Rejection Ratio vs. Frequency**
- \( RR \) vs. \( f \) at \( T_a=25^\circ C \)
- \( I_o=0mA, 10mA, 30mA \)
- \( V_{IN}=4V \)
- \( e_{in}=200mVrms \)
- \( C_o=2.2 \mu F \) (Ceramic)

**Equivalent Series Resistance vs. Output Current**
- \( ESR \) vs. \( I_o \) at \( T_a=25^\circ C \)
- \( V_{IN}=4.0V \)
- \( C_o=2.2 \mu F \) (Ceramic)

**STABLE REGION**
TYPICAL CHARACTERISTICS (NJM2845)

**Dropout Voltage vs. Temperature**

- Dropout Voltage: $dV_{O}$ (V)
- Temperature: $T_a$ (°C)

**Output Voltage vs. Temperature**

- Output Voltage: $V_o$ (V)
- Temperature: $T_a$ (°C)

**Quiescent Current vs. Input Voltage**

- Quiescent Current: $I_q$ (mA)
- Temperature: $T_a$ (°C)

**Short Circuit Current vs. Temperature**

- Short Circuit Current: $I_{sc}$ (mA)
- Temperature: $T_a$ (°C)

**Line Regulation vs. Temperature**

- Line Regulation: $\frac{dV_o}{dI_o}$ (%/V)
- Temperature: $T_a$ (°C)

**Load Regulation vs. Temperature**

- Load Regulation: $\frac{dV_o}{dI_o}$ (%/mA)
- Temperature: $T_a$ (°C)
TYPICAL CHARACTERISTICS (NJM2845)

NJM2845_3.0V
Peak Output Current vs. Input Voltage

@: Ta=25°C
Co=2.2µF (Ceramic)

Temperature : Ta (°C)

Peak Output Current : IoMAX (mA)

Output Voltage vs. Temperature

@: VIN=4.0V
Io=30mA
Co=2.2µF (Ceramic)

Output Voltage : Vo (V)

Line Transient Response

Output Voltage : Vo [V]
Input Voltage : VIN [V]

Time : t [µs]

Output Current

Load Transient Response

Output Voltage : Vo [V]
Output Current : Io [mA]

Time : t [µs]
TYPICAL CHARACTERISTICS (NJM2846)

**Output Voltage vs. Input Voltage**

@ Ta=25°C
Vin=4.0V
Co=2.2µF (Ceramic)

**Output Voltage vs. Output Current**

@ Ta=25°C
Vin=4.0V
Co=2.2µF (Ceramic)

**Ground Pin Current vs. Output Current**

@ Ta=25°C
Vin=4.0V
Co=2.2µF (Ceramic)

**Dropout Voltage vs. Output Current**

@ Ta=25°C
Vin=4.0V
Co=2.2µF (Ceramic)

**Control Current vs. Control Voltage**

@ Ta=25°C
Vin=4.0V
Co=2.2µF (Ceramic)

TYPICAL CHARACTERISTICS (NJM2846)

**Load Regulation vs. Output Current**
- @Ta=25°C
- VIN=4.0V
- Co=2.2µF (Ceramic)

**Output Current vs. Input Voltage**
- @Ta=25°C
- Co=2.2µF (Ceramic)

**Quiescent Current vs. Input Voltage**
- @Ta=25°C
- Output is open.
- Co=2.2µF (Ceramic) including Icont

**Output Noise Voltage vs. Output Current**
- @Ta=25°C
- VIN=4.0V
- LPF: 80kHz
- Co=2.2µF (Ceramic)

**Ripple Rejection vs. Frequency**
- @Ta=25°C
- VIN=4.0V
- ein=200mVrms
- Co=2.2µF (Ceramic)

**Ripple Rejection vs. Output Current**
- @Ta=25°C
- VIN=4.0V
- ein=200mVrms
- Co=2.2µF (Ceramic)
NJM2845/46

TYPICAL CHARACTERISTICS (NJM2846)

- Output Current: $I_o(mA)$
  - $T_a=25^\circ C$
  - $V_{IN}=4.0V$
  - $C_o=2.2\mu F$

- Equivalent Serial Resistance: $ESR(\Omega)$

- Dropout Voltage: $dV_{I-O}(V)$
  - $I_o=500mA$
  - $C_o=2.2\mu F$(Ceramic)

- Output Voltage: $V_o(V)$
  - $T_a=25^\circ C$
  - $V_{IN}=4.0V$
  - $I_o=30mA$
  - $C_o=2.2\mu F$(Ceramic)

- Control Voltage: $V_{cont-off}(V)$
  - $T_a=25^\circ C$
  - $V_{IN}=4.0V$
  - $I_o=30mA$
  - $C_o=2.2\mu F$(Ceramic)

- Control Current: $I_{CONT}(\mu A)$
  - $T_a=25^\circ C$
  - $V_{IN}=4V$
  - Output is open
  - $C_o=2.2\mu F$(Ceramic)
  - $V_{CONT}=1.6V$

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TYPICAL CHARACTERISTICS (NJM2846)

Quiescent Current vs. Input Voltage

@: VIN=4.0V
Output is open.
Co=2.2µF(Ceramic)

Short Circuit Current vs. Temperature

@: VIN=4.0V
Co=2.2µF(Ceramic)
Output is short to ground

Line Regulation vs. Temperature

@: VIN=4.0-9.0V
Io=30mA
Co=2.2µF(Ceramic)

Load Regulation vs. Temperature

@: VIN=4.0V
Io=0-800mA
Co=2.2µF(Ceramic)

Peak Output Current vs. Temperature

@: VIN=4.0V
Co=2.2µF(Ceramic)

Output Voltage vs. Temperature

@: VIN=4.0V
Io=30mA
Co=2.2µF(Ceramic)
**TYPICAL CHARACTERISTICS (NJM2846)**

- **ON/OFF Transient Response without Load**
  - **Output Voltage**: Vo [V]
  - **Control Voltage**: Vo [V]
  - **Time**: t [S]
  - Parameters:
    - Ta=25°C
    - Vin=4.0V
    - Co=2.2 µF (Ceramic)
    - Io=0mA

- **ON/OFF Transient Response with Load**
  - **Output Voltage**: Vo [V]
  - **Control Voltage**: Vo [V]
  - **Time**: t [mS]
  - Parameters:
    - Ta=25°C
    - Vin=4.0V
    - Co=2.2 µF (Ceramic)
    - Io=30mA

- **Line Transient Response**
  - **Output Voltage**: Vo [V]
  - **Input Voltage**: Vin [V]
  - **Time**: t [µs]
  - Parameters:
    - Ta=25°C
    - Vin=4V
    - Co=2.2 µF
    - Io=30mA

- **Load Transient Response**
  - **Output Voltage**: Vo [V]
  - **Output Current**: Io [mA]
  - **Time**: t [µs]
  - Parameters:
    - Ta=25°C
    - Vin=4V
    - Co=2.2 µF

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**[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.