LM78XX Series Voltage Regulators

General Description
The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents.

The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating.

Considerable effort was expanded to make the LM78XX series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

Features
- Output current in excess of 1A
- Internal thermal overload protection
- No external components required
- Output transistor safe area protection
- Internal short circuit current limit
- Available in the aluminum TO-3 package

Voltage Range
- LM7805C 5V
- LM7812C 12V
- LM7815C 15V

Connection Diagrams

Metal Can Package TO-3 (K)
Aluminum

Bottom View
Order Number LM7805CK,
LM7812CK or LM7815CK
See NS Package Number KC02A

Plastic Package TO-220 (T)

Top View
Order Number LM7805CT,
LM7812CT or LM7815CT
See NS Package Number T03B
**Absolute Maximum Ratings** (Note 3)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

- Input Voltage: \(V_O = 5\text{V}, 12\text{V} \text{ and } 15\text{V}\)
- Internal Power Dissipation (Note 1) Internally Limited
- Operating Temperature Range \(T_A\): 0˚C to +70˚C
- Maximum Junction Temperature (K Package): 150˚C
- (T Package): 150˚C
- Storage Temperature Range: −65˚C to +150˚C
- Lead Temperature (Soldering, 10 sec.): TO-3 Package K 300˚C
- TO-220 Package T 230˚C

**Electrical Characteristics LM78XXC** (Note 2)

### Output Voltage

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>5V</th>
<th>12V</th>
<th>15V</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_O)</td>
<td>Output Voltage</td>
<td>(T_j = 25^\circ\text{C}), 5 mA ≤ (I_O) ≤ 1 A</td>
<td>4.8</td>
<td>5</td>
<td>5.2</td>
</tr>
<tr>
<td>(P_D) ≤ 15W, 5 mA ≤ (I_O) ≤ 1 A</td>
<td>4.75</td>
<td>5.25</td>
<td>11.4</td>
<td>12.6</td>
<td>4.25</td>
</tr>
<tr>
<td>(V_{MIN}) ≤ (V_{IN}) ≤ (V_{MAX})</td>
<td>((7 \leq V_{IN} \leq 20))</td>
<td>((14.5 \leq V_{IN} \leq 27))</td>
<td>((17.5 \leq V_{IN} \leq 30))</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### \(\Delta V_O\)

- Line Regulation
  - \(I_O = 500\) mA, \(\Delta V_{IN}\)
    - \(\Delta V_O\) \(\leq 125^\circ\text{C}\)
    - \(\Delta V_{IN}\) \(\leq 25^\circ\text{C}\)
    - \(14.5 \leq V_{IN} \leq 30\)
    - \(17.5 \leq V_{IN} \leq 30\)
  - \(0^\circ\text{C} \leq T_j \leq \pm 125^\circ\text{C}\)
    - \(\Delta V_{IN}\) \(\leq 20^\circ\text{C}\)
    - \(14.6 \leq V_{IN} \leq 27\)
    - \(17.7 \leq V_{IN} \leq 30\)
  - \(I_O \leq 1\) A
    - \(\Delta V_{IN}\) \(\leq 20^\circ\text{C}\)
    - \(14.6 \leq V_{IN} \leq 27\)
    - \(17.7 \leq V_{IN} \leq 30\)

### \(\Delta V_O\)

- Load Regulation
  - \(\Delta V_O\) \(\leq 125^\circ\text{C}\)
    - \(\Delta V_{IN}\) \(\leq 12^\circ\text{C}\)
    - \(16 \leq V_{IN} \leq 22\)
    - \(20 \leq V_{IN} \leq 26\)

### \(I_O\)

- Quiescent Current
  - \(I_O \leq 1\) A
    - \(T_j = 25^\circ\text{C}\)
    - \(8 \leq I_O \leq 25\)
    - \(8 \leq V_{IN} \leq 8.5\)
    - \(8 \leq V_{IN} \leq 8.5\)
  - \(0^\circ\text{C} \leq T_j \leq +125^\circ\text{C}\)
    - \(8 \leq I_O \leq 25\)
    - \(8 \leq V_{IN} \leq 8.5\)
    - \(8 \leq V_{IN} \leq 8.5\)

### \(\Delta I_O\)

- Quiescent Current Change
  - \(I_O \leq 1\) A
    - \(T_j = 25^\circ\text{C}\)
    - \(V_{MIN}\) \(\leq V_{IN}\) \(\leq V_{MAX}\)
      - \(1.0 \leq I_O \leq 1.0\)
      - \(1.0 \leq V_{IN} \leq 1.0\)
    - \(0^\circ\text{C} \leq T_j \leq +125^\circ\text{C}\)
      - \(V_{MIN}\) \(\leq V_{IN}\) \(\leq V_{MAX}\)
      - \(1.0 \leq I_O \leq 1.0\)
      - \(1.0 \leq V_{IN} \leq 1.0\)

### \(V_N\)

- Output Noise Voltage
  - \(T_A = 25^\circ\text{C}\), 10 Hz \(\leq f \leq 100\) kHz
    - \(40 \leq V_N \leq 75\)
    - \(90 \leq V_N \leq 90\)
    - \(\mu V\)

### \(\frac{\Delta V_{IN}}{\Delta V_{OUT}}\)

- Ripple Rejection
  - \(f = 120\) Hz
    - \(I_O \leq 1\) A, \(T_j = 25^\circ\text{C}\)
      - \(62 \leq I_O \leq 55\)
      - \(72 \leq V_{IN} \leq 72\)
      - \(54 \leq V_{IN} \leq 70\)
      - \(\text{dB}\)
    - \(I_O \leq 500\) mA
      - \(62 \leq I_O \leq 55\)
      - \(54 \leq V_{IN} \leq 54\)
      - \(\text{dB}\)
  - \(0^\circ\text{C} \leq T_j \leq +125^\circ\text{C}\)
    - \(V_{MIN}\) \(\leq V_{IN}\) \(\leq V_{MAX}\)
      - \(8 \leq V_{IN} \leq 18\)
      - \(15 \leq V_{IN} \leq 25\)
      - \(18.5 \leq V_{IN} \leq 28.5\)
      - \(\text{dB}\)

### \(R_O\)

- Dropout Voltage
  - \(T_j = 25^\circ\text{C}\), \(I_{OUT} = 1\) A
    - \(2.0 \leq R_O \leq 2.0\)
    - \(2.0 \leq \text{m}\Omega\)
Electrical Characteristics LM78XXC (Note 2) (Continued)

0°C ≤ T_J ≤ 125°C unless otherwise noted.

<table>
<thead>
<tr>
<th>Output Voltage</th>
<th>5V</th>
<th>12V</th>
<th>15V</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Voltage (unless otherwise noted)</strong></td>
<td><strong>10V</strong></td>
<td><strong>19V</strong></td>
<td><strong>23V</strong></td>
<td></td>
</tr>
<tr>
<td>Symbol</td>
<td>Parameter</td>
<td>Conditions</td>
<td>Min</td>
<td>Typ</td>
</tr>
<tr>
<td>Short-Circuit Current</td>
<td>T_J = 25°C</td>
<td>2.1</td>
<td>1.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Peak Output Current</td>
<td>T_J = 25°C</td>
<td>2.4</td>
<td>2.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Average TC of V_OUT</td>
<td>0°C ≤ T_J ≤ +125°C, I_O = 5 mA</td>
<td>0.6</td>
<td>1.5</td>
<td>1.8</td>
</tr>
<tr>
<td>V_IN</td>
<td>Input Voltage Required to Maintain Line Regulation</td>
<td>T_J = 25°C, I_O ≤ 1A</td>
<td>7.5</td>
<td>14.6</td>
</tr>
</tbody>
</table>

**Note 1:** Thermal resistance of the TO-3 package (K, KC) is typically 4°C/W junction to case and 35°C/W case to ambient. Thermal resistance of the TO-220 package (T) is typically 4°C/W junction to case and 50°C/W case to ambient.

**Note 2:** All characteristics are measured with capacitor across the input of 0.22 µF, and a capacitor across the output of 0.1 µF. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques (t_w ≤ 10 ms, duty cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

**Note 3:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. For guaranteed specifications and the test conditions, see Electrical Characteristics.
Typical Performance Characteristics

Maximum Average Power Dissipation

- INFINITE HEAT SINK
- WITH 10 C/W HEAT SINK
- NO HEAT SINK

Peak Output Current

\[ \Delta V_{OUT} = 100 \text{ mV} \]

Output Voltage (Normalized to 1V at \( T_J = 25^\circ \text{C} \))

Ripple Rejection

\[ 1 = 120 \text{ Hz} \]

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Typical Performance Characteristics (Continued)

Output Impedance

![Output Impedance Graph](ds007746-11)

Dropout Voltage

![Dropout Voltage Graph](ds007746-12)

Dropout Characteristics

![Dropout Characteristics Graph](ds007746-13)

Quiescent Current

![Quiescent Current Graph](ds007746-14)

Quiescent Current

![Quiescent Current Graph](ds007746-15)
Physical Dimensions  inches (millimeters) unless otherwise noted

Aluminum Metal Can Package (KC)
Order Number LM7805CK, LM7812CK or LM7815CK
NS Package Number KC02A
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