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.

For output voltage other than 5V, 12V and 15V the LM117 series provides an output voltage range from 1.2V to 57V.

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

Plastic Package
TO-220 (T)

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

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**
  - \( V_O = 5V, 12V \text{ and } 15V \)
  - 35V
- **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)

0˚C ≤ \( T_J \) ≤ 125˚C unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>5V</th>
<th>12V</th>
<th>15V</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_O )</td>
<td>Output Voltage</td>
<td>( T_J = 25˚C ), 5 mA ≤ ( I_O ) ≤ 1A</td>
<td>4.8</td>
<td>5</td>
<td>5.2</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( P_D ) ≤ 15W, 5 mA ≤ ( I_O ) ≤ 1A</td>
<td>4.75</td>
<td>5.25</td>
<td>11.4</td>
<td>(14.5 ≤ ( V_IN ) ≤ 27)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{MIN} ) ≤ ( V_IN ) ≤ ( V_{MAX} )</td>
<td>4.75</td>
<td>5.25</td>
<td>11.4</td>
<td>(14.5 ≤ ( V_IN ) ≤ 27)</td>
</tr>
<tr>
<td>( \Delta V_O )</td>
<td>Line Regulation</td>
<td>( I_O = 500 ) mA</td>
<td>( \Delta V_IN ) (7 ≤ ( V_IN ) ≤ 25</td>
<td>3</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( \Delta V_IN ) (7 ≤ ( V_IN ) ≤ 25</td>
<td>50</td>
<td>120</td>
<td>150</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0˚C ≤ ( T_J ) ≤ +125˚C</td>
<td>( \Delta V_IN ) (8 ≤ ( V_IN ) ≤ 20</td>
<td>50</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( \Delta V_IN ) (8 ≤ ( V_IN ) ≤ 20</td>
<td>15</td>
<td>25</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( \Delta V_IN ) (8 ≤ ( V_IN ) ≤ 20</td>
<td>15</td>
<td>25</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_O ) ≤ 1A</td>
<td>( \Delta V_IN ) (7.5 ≤ ( V_IN ) ≤ 20</td>
<td>50</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( \Delta V_IN ) (7.5 ≤ ( V_IN ) ≤ 20</td>
<td>15</td>
<td>25</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0˚C ≤ ( T_J ) ≤ +125˚C</td>
<td>( \Delta V_IN ) (8 ≤ ( V_IN ) ≤ 12</td>
<td>50</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( \Delta V_IN ) (8 ≤ ( V_IN ) ≤ 12</td>
<td>15</td>
<td>25</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>( \Delta V_O )</td>
<td>Load Regulation</td>
<td>( T_J = 25˚C )</td>
<td>5 mA ≤ ( I_O ) ≤ 1.5A</td>
<td>10</td>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>250 mA ≤ ( I_O ) ≤ 750 mA</td>
<td>25</td>
<td>60</td>
<td>75</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 mA ≤ ( I_O ) ≤ 1A, 0˚C ≤ ( T_J ) ≤ +125˚C</td>
<td>50</td>
<td>120</td>
<td>150</td>
<td>mV</td>
</tr>
<tr>
<td>( I_O )</td>
<td>Quiescent Current</td>
<td>( I_O = 1A )</td>
<td>( T_J = 25˚C )</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0˚C ≤ ( T_J ) ≤ +125˚C</td>
<td>8.5</td>
<td>8.5</td>
<td>8.5</td>
<td>mA</td>
</tr>
<tr>
<td>( \Delta I_O )</td>
<td>Quiescent Current Change</td>
<td>( I_O = 1A )</td>
<td>( T_J = 25˚C ), ( I_O = 1A )</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{MIN} ) ≤ ( V_IN ) ≤ ( V_{MAX} )</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( I_O = 500 ) mA, 0˚C ≤ ( T_J ) ≤ +125˚C</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( V_{MIN} ) ≤ ( V_IN ) ≤ ( V_{MAX} )</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>mA</td>
</tr>
<tr>
<td>( V_N )</td>
<td>Output Noise Voltage</td>
<td>( T_A = 25˚C ), 10 Hz ≤ ( f ) ≤ 100 kHz</td>
<td>40</td>
<td>75</td>
<td>90</td>
<td>µV</td>
</tr>
<tr>
<td>( \Delta V_{IN} )</td>
<td>Ripple Rejection</td>
<td>62</td>
<td>80</td>
<td>55</td>
<td>72</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>( f = 120 ) Hz</td>
<td>62</td>
<td>55</td>
<td>54</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( I_O = 500 ) mA</td>
<td>62</td>
<td>55</td>
<td>54</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0˚C ≤ ( T_J ) ≤ +125˚C</td>
<td>(8 ≤ ( V_IN ) ≤ 18</td>
<td>(15 ≤ ( V_IN ) ≤ 25</td>
<td>(18.5 ≤ ( V_IN ) ≤ 28.5)</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>( R_O )</td>
<td>Dropout Voltage</td>
<td>( T_J = 25˚C ), ( I_{OUT} = 1A )</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Output Resistance</td>
<td>( f = 1 ) kHz</td>
<td>8</td>
<td>18</td>
<td>19</td>
<td>mΩ</td>
</tr>
</tbody>
</table>
### Electrical Characteristics LM78XXC (Note 2) (Continued)

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>5V</th>
<th>12V</th>
<th>15V</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short-Circuit Current</td>
<td>T_J = 25°C</td>
<td>2.1</td>
<td>1.5</td>
<td>1.2</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Peak Output Current</td>
<td>T_J = 25°C</td>
<td>2.4</td>
<td>2.4</td>
<td>2.4</td>
<td>A</td>
</tr>
<tr>
<td></td>
<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>
<td>mV/°C</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>
<td>17.7</td>
<td>V</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

Output Voltage (Normalized to 1V at T_J = 25°C)

- ΔV_{OUT} = 100 mV

Ripple Rejection

- FOR 8 V_{DC} + 3.5 V_{rms}
- T_J = 1A
- T_J = 25°C
- F = 120 Hz

Peak Output Current

- Input to Output Differential (V)
- Output Current (A)

- T_J = 25°C
- T_J = 0°C
- T_J = 125°C

Ripple Rejection

- Output Voltage (V)
- Ripple Rejection (dB)
Typical Performance Characteristics (Continued)

**Output Impedance**

![Output Impedance Graph]

**Dropout Voltage**

![Dropout Voltage Graph]

**Dropout Characteristics**

![Dropout Characteristics Graph]

**Quiescent Current**

![Quiescent Current Graph]
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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)

[Diagram and measurements]

TO-220 Package (T)
Order Number LM7805CT, LM7812CT or LM7815CT
NS Package Number T03B

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