# LM78XX Series Voltage Regulators

**Check for Samples: LM7805C, LM7812C, LM7815C**

## 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**

## 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.

### Voltage Range

| | |
|---|---|
| LM7805C | 5V |
| LM7812C | 12V |
| LM7815C | 15V |

### Connection Diagrams

**Metal Can Package**
**TO-3 (K)**
**Aluminum**

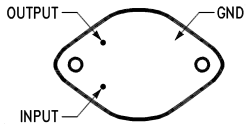



**Figure 1. Bottom View**

PRODUCT PREVIEW

**Plastic Package**
**TO-220 (T)**

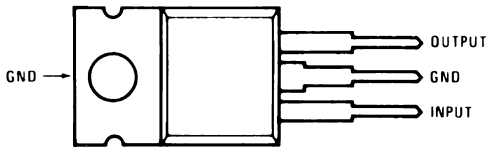
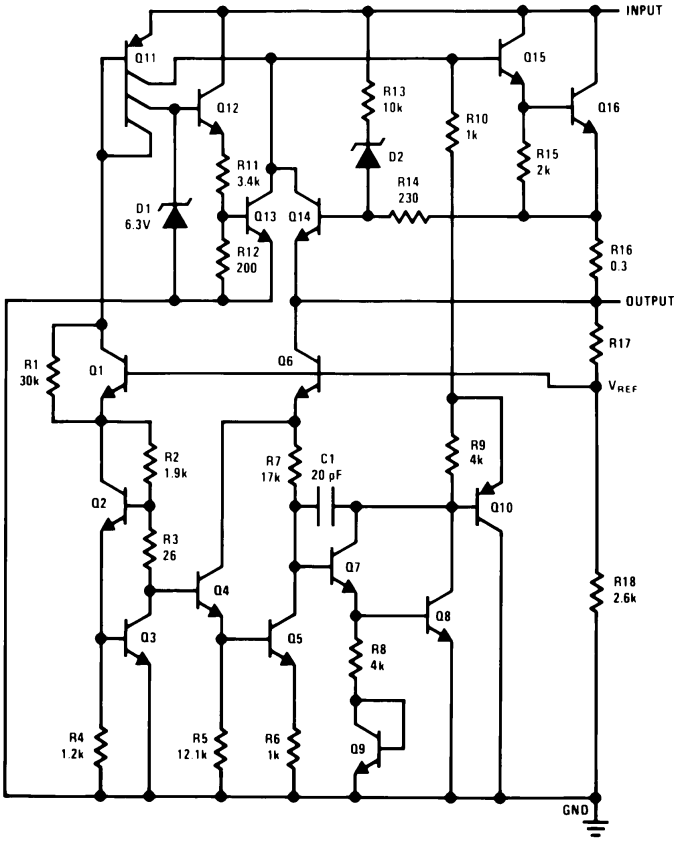



**Figure 2. Top View**

## Schematic Diagram




These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

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## Absolute Maximum Ratings (1)

| | |
|---|---|
| Input Voltage | |
| ($V_O$ = 5V, 12V and 15V) | 35V |
| Internal Power Dissipation (2) | 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 |

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. For guaranteed specifications and the test conditions, see Electrical Characteristics.

(2) 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.

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## Electrical Characteristics LM78XXC (1)

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

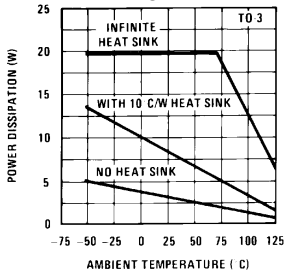
| Output Voltage | | | | 5V | | | 12V | | | 15V | | | Units |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Input Voltage (unless otherwise noted) | | | | 10V | | | 19V | | | 23V | | | |
| Symbol | Parameter | Conditions | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| $V_O$ | Output Voltage | Tj = 25°C, 5 mA ≤ $I_O$ ≤ 1A | | 4.8 | 5 | 5.2 | 11.5 | 12 | 12.5 | 14.4 | 15 | 15.6 | V |
| | | $P_D$ ≤ 15W, 5 mA ≤ $I_O$ ≤ 1A | | 4.75 | | 5.25 | 11.4 | | 12.6 | 14.25 | | 15.75 | V |
| | | $V_{MIN}$ ≤ $V_{IN}$ ≤ $V_{MAX}$ | | (7.5 ≤ $V_{IN}$ ≤ 20) | | | (14.5 ≤ $V_{IN}$ ≤ 27) | | | (17.5 ≤ $V_{IN}$ ≤ 30) | | | V |
| $\Delta V_O$ | Line Regulation | $I_O$ = 500 mA | Tj = 25°C | | 3 | 50 | | 4 | 120 | | 4 | 150 | mV |
| | | | $\Delta V_{IN}$ | (7 ≤ $V_{IN}$ ≤ 25) | | | 14.5 ≤ $V_{IN}$ ≤ 30) | | | (17.5 ≤ $V_{IN}$ ≤ 30) | | | V |
| | | | 0°C ≤ Tj ≤ +125°C | | | 50 | | | 120 | | | 150 | mV |
| | | | $\Delta V_{IN}$ | (8 ≤ $V_{IN}$ ≤ 20) | | | (15 ≤ $V_{IN}$ ≤ 27) | | | (18.5 ≤ $V_{IN}$ ≤ 30) | | | V |
| | | $I_O$ ≤ 1A | Tj = 25°C | | | 50 | | | 120 | | | 150 | mV |
| | | | $\Delta V_{IN}$ | (7.5 ≤ $V_{IN}$ ≤ 20) | | | (14.6 ≤ $V_{IN}$ ≤ 27) | | | (17.7 ≤ $V_{IN}$ ≤ 30) | | | V |
| | | | 0°C ≤ Tj ≤ +125°C | | | 25 | | | 60 | | | 75 | mV |
| | | | $\Delta V_{IN}$ | (8 ≤ $V_{IN}$ ≤ 12) | | | (16 ≤ $V_{IN}$ ≤ 22) | | | (20 ≤ $V_{IN}$ ≤ 26) | | | V |
| $\Delta V_O$ | Load Regulation | Tj = 25°C | 5 mA ≤ $I_O$ ≤ 1.5A | | 10 | 50 | | 12 | 120 | | 12 | 150 | mV |
| | | | 250 mA ≤ $I_O$ ≤ 750 mA | | | 25 | | | 60 | | | 75 | mV |
| | | 5 mA ≤ $I_O$ ≤ 1A, 0°C ≤ Tj ≤ +125°C | | | | 50 | | | 120 | | | 150 | mV |
| $I_Q$ | Quiescent Current | $I_O$ ≤ 1A | Tj = 25°C | | | 8 | | | 8 | | | 8 | mA |
| | | | 0°C ≤ Tj ≤ +125°C | | | 8.5 | | | 8.5 | | | 8.5 | mA |
| $\Delta I_Q$ | Quiescent Current | 5 mA ≤ $I_O$ ≤ 1A | | | | 0.5 | | | 0.5 | | | 0.5 | mA |
| | Change | Tj = 25°C, $I_O$ ≤ 1A | | | | 1.0 | | | 1.0 | | | 1.0 | mA |
| | | $V_{MIN}$ ≤ $V_{IN}$ ≤ $V_{MAX}$ | | (7.5 ≤ $V_{IN}$ ≤ 20) | | | (14.8 ≤ $V_{IN}$≤ 27) | | | (17.9 ≤ $V_{IN}$ ≤ 30) | | | V |
| | | $I_O$ ≤ 500 mA, 0°C ≤ Tj ≤ +125°C | | | | 1.0 | | | 1.0 | | | 1.0 | mA |
| | | $V_{MIN}$ ≤ $V_{IN}$ ≤ $V_{MAX}$ | | (7 ≤ $V_{IN}$ ≤ 25) | | | (14.5 ≤ $V_{IN}$≤ 30) | | | (17.5 ≤ $V_{IN}$ ≤ 30) | | | V |
| $V_N$ | Output Noise Voltage | $T_A$ =25°C, 10 Hz ≤ f ≤ 100 kHz | | | 40 | | | 75 | | | 90 | | µV |
| $\frac{\Delta V_{IN}}{\Delta V_{OUT}}$ | Ripple Rejection | | $I_O$ ≤ 1A, Tj = 25°C or | 62 | 80 | | 55 | 72 | | 54 | 70 | | dB |
| | | f = 120 Hz | $I_O$ ≤ 500 mA | 62 | | | 55 | | | 54 | | | dB |
| | | | 0°C ≤ Tj ≤ +125°C | | | | | | | | | | |
| | | $V_{MIN}$ ≤ $V_{IN}$ ≤ $V_{MAX}$ | | (8 ≤ $V_{IN}$ ≤ 18) | | | (15 ≤ $V_{IN}$ ≤ 25) | | | (18.5 ≤ $V_{IN}$ ≤ 28.5) | | | V |
| $R_O$ | Dropout Voltage | Tj = 25°C, $I_{OUT}$ = 1A | | | 2.0 | | | 2.0 | | | 2.0 | | V |
| | Output Resistance | f = 1 kHz | | | 8 | | | 18 | | | 19 | | mΩ |
| | Short-Circuit Current | Tj = 25°C | | | 2.1 | | | 1.5 | | | 1.2 | | A |
| | Peak Output Current | Tj = 25°C | | | 2.4 | | | 2.4 | | | 2.4 | | A |
| | Average TC of $V_{OUT}$ | 0°C ≤ Tj ≤ +125°C, $I_O$ = 5 mA | | | 0.6 | | | 1.5 | | | 1.8 | | mV/°C |
| $V_{IN}$ | Input Voltage | | | | | | | | | | | | |
| | Required to Maintain | Tj = 25°C, $I_O$ ≤ 1A | | | 7.5 | | 14.6 | | | 17.7 | | | V |
| | Line Regulation | | | | | | | | | | | | |

(1) All characteristics are measured with capacitor across the input of 0.22 µF, and a capacitor across the output of 0.1µF. 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.

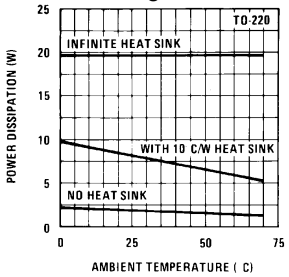
PRODUCT PREVIEW

## Typical Performance Characteristics

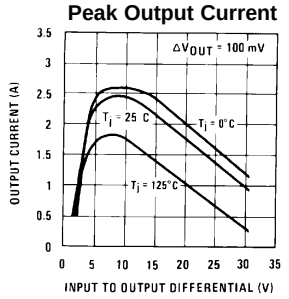
**Maximum Average Power Dissipation**



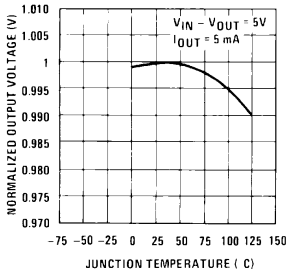

**Maximum Average Power Dissipation**



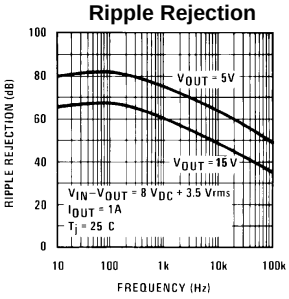

**Peak Output Current**



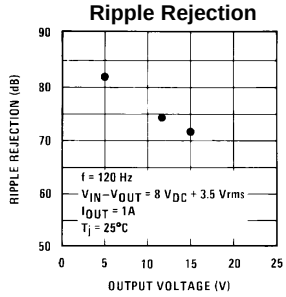

**Output Voltage (Normalized to 1V at $T_J$ = 25°C)**



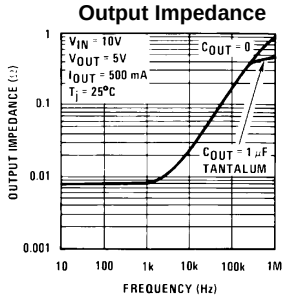

**Ripple Rejection**



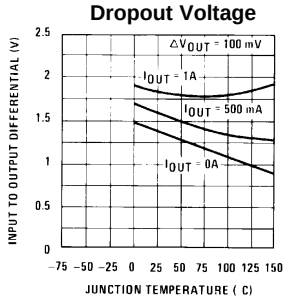

**Ripple Rejection**



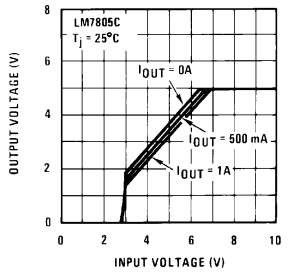

**Output Impedance**



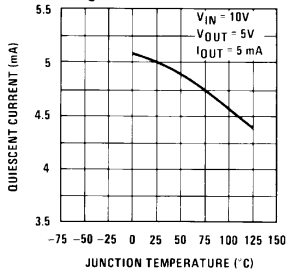

**Dropout Voltage**




**Dropout Characteristics**




**Quiescent Current**

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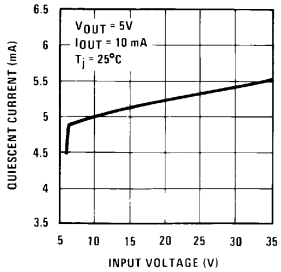
## Typical Performance Characteristics (continued)

**Quiescent Current**




PRODUCT PREVIEW

## PACKAGING INFORMATION

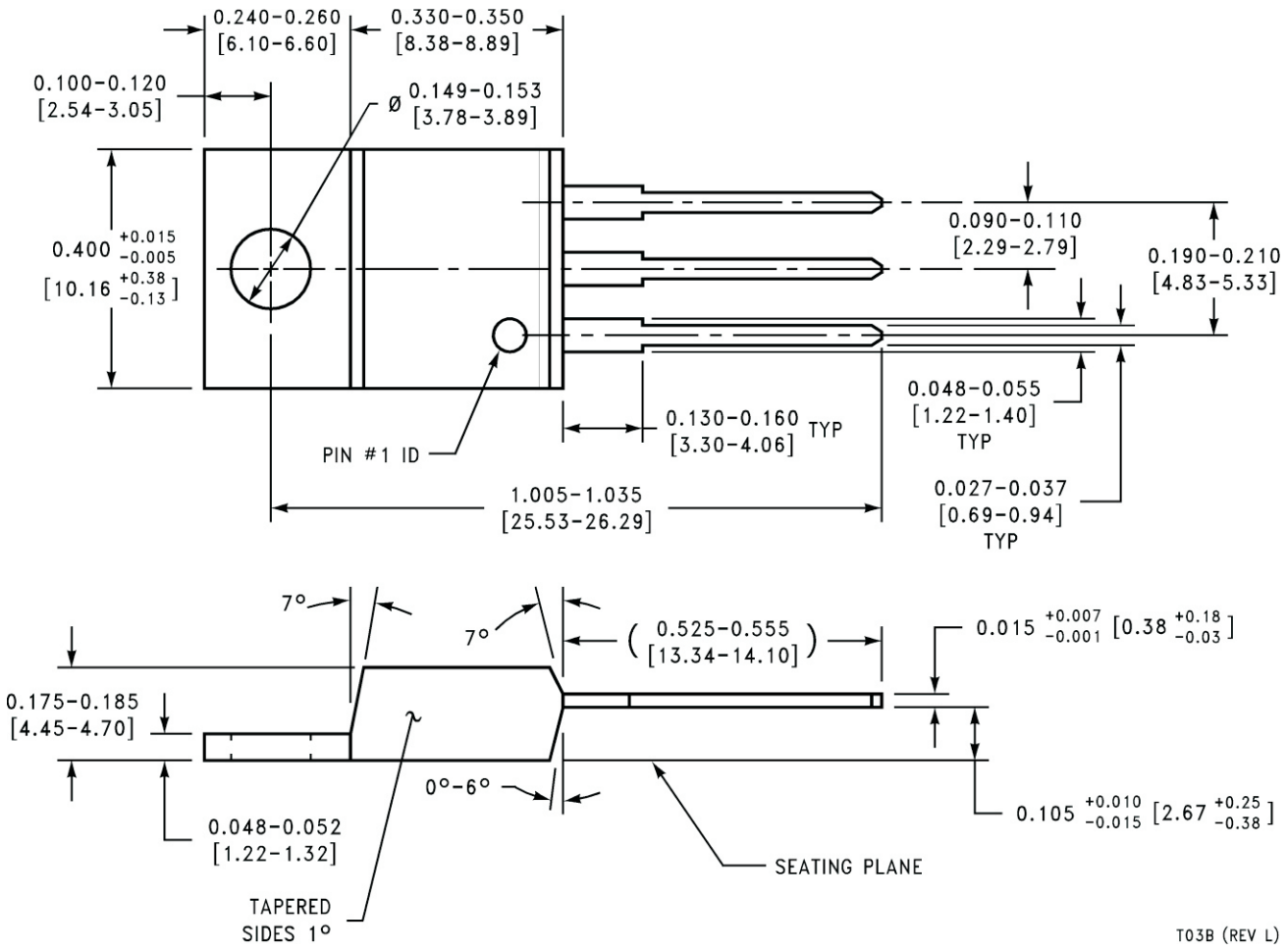
| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) | Samples (Requires Login) |
|---|---|---|---|---|---|---|---|---|---|
| LM7805CT | ACTIVE | TO-220 | NDE | 3 | 45 | TBD | CU SNPB | Level-1-NA-UNLIM | |
| LM7805CT/NOPB | ACTIVE | TO-220 | NDE | 3 | 45 | Pb-Free (RoHS Exempt) | CU SN | Level-1-NA-UNLIM | |
| LM7815CT | ACTIVE | TO-220 | NDE | 3 | 45 | TBD | CU SNPB | Level-1-NA-UNLIM | |
| LM7815CT/NOPB | ACTIVE | TO-220 | NDE | 3 | 45 | Green (RoHS & no Sb/Br) | CU SN | Level-1-NA-UNLIM | |

**(1)** The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.
**OBSOLETE:** TI has discontinued the production of the device.

**(2)** Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**TBD:** The Pb-Free/Green conversion plan has not been defined.
**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

**(3)** MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

NDE0003B


0.240-0.260
[6.10-6.60]
0.330-0.350
[8.38-8.89]
0.100-0.120
[2.54-3.05]
Ø 0.149-0.153
[3.78-3.89]
0.400 +0.015 -0.005
[10.16 +0.38 -0.13]
0.090-0.110
[2.29-2.79]
0.190-0.210
[4.83-5.33]
PIN #1 ID
0.130-0.160 TYP
[3.30-4.06]
0.048-0.055
[1.22-1.40]
TYP
1.005-1.035
[25.53-26.29]
0.027-0.037
[0.69-0.94]
TYP
7°
7°
( 0.525-0.555
[13.34-14.10] )
0.015 +0.007 -0.001 [0.38 +0.18 -0.03]
0.175-0.185
[4.45-4.70]
0°-6°
0.105 +0.010 -0.015 [2.67 +0.25 -0.38]
0.048-0.052
[1.22-1.32]
SEATING PLANE
TAPERED
SIDES 1°
T03B (REV L)

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