# AT78M00

0.5 A Positive Voltage Regulator

Immense Advance Tech.

## FEATURES

- Output current up to 0.5A
- 3-Terminal Regulators
- Internal Thermal Overload Protection
- Internal Short-Circuit Current Limiting
- Output Transistor Safe-Area Protection
- TO-220 and TO-252 Packages
- High Power Dissipation Capability
- Direct replacements for LM78M00

## APPLICATION

- Post-Regulator Switching DC/DC Converters
- Bias Supply for Analog Circuits
- Instrumentation and Audio Systems
- Logic Systems
- Others too numerous to mention

## DESCRIPTION

The AT78M00 is classic regulator useful in a wide range of applications. For example, you can use them for local on-card regulation to eliminate the distribution problems associated with single point regulation.

Although designed as fixed voltage regulators, you can add a few external components to make adjustable voltages and currents.

Current limiting prevents the peak output current to a safe value. Safe-area protection for the output transistor limits internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit activates to prevent the regulator from overheating. These versatile workhorses are easy to use. You do not need to bypass the output, although this does improve transient response. Input bypassing is needed only if you place the regulator far from the filter capacitor of the power supply.

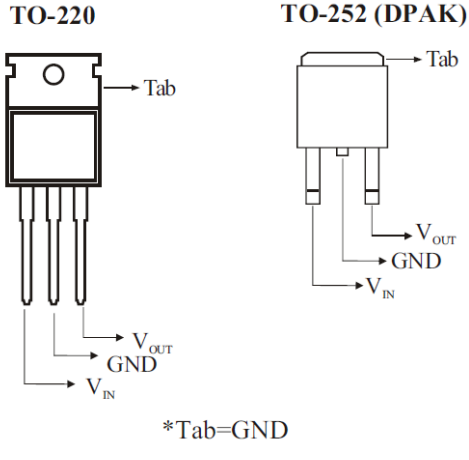
The AT78M00 is available in TO-220 and TO-252 Packages.

## ORDER INFORMATION

**AT 78M- 00 TJ R**

- IAT
- Circuit Type
- Output Voltage:
  - 05 : 5.0V,06 : 6.0V
  - 08：8.0V, 09：9.0V
  - 12 : 12.0V, 15 : 15.0V
  - 18 : 18.0V, 24 : 24.0V
- TJ:TO-220-3
  TE: TO-252-3
- Shipping:
  - R: Tape & Reel
  - T: Tube

## PIN CONFIGURATIONS (TOP VIEW)

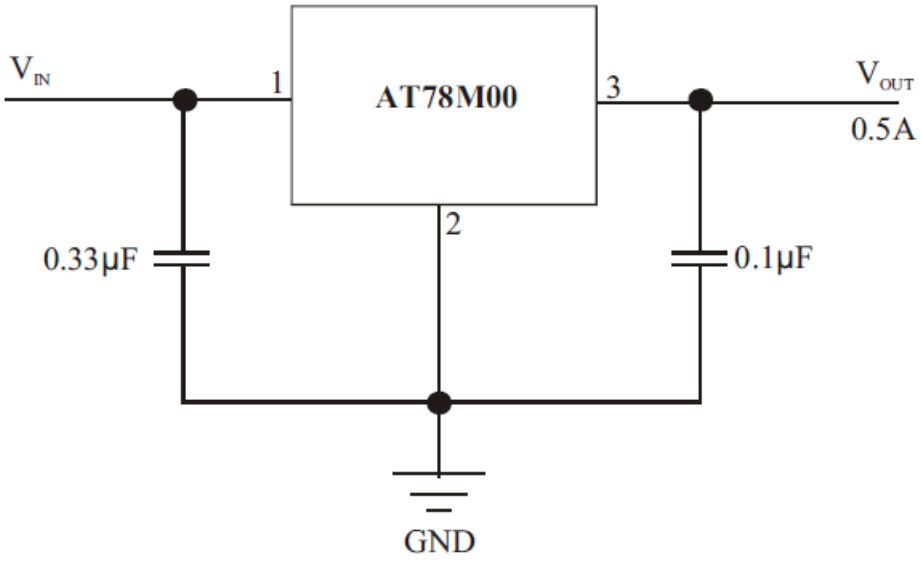



*Tab=GND

## PIN DESCRIPTIONS

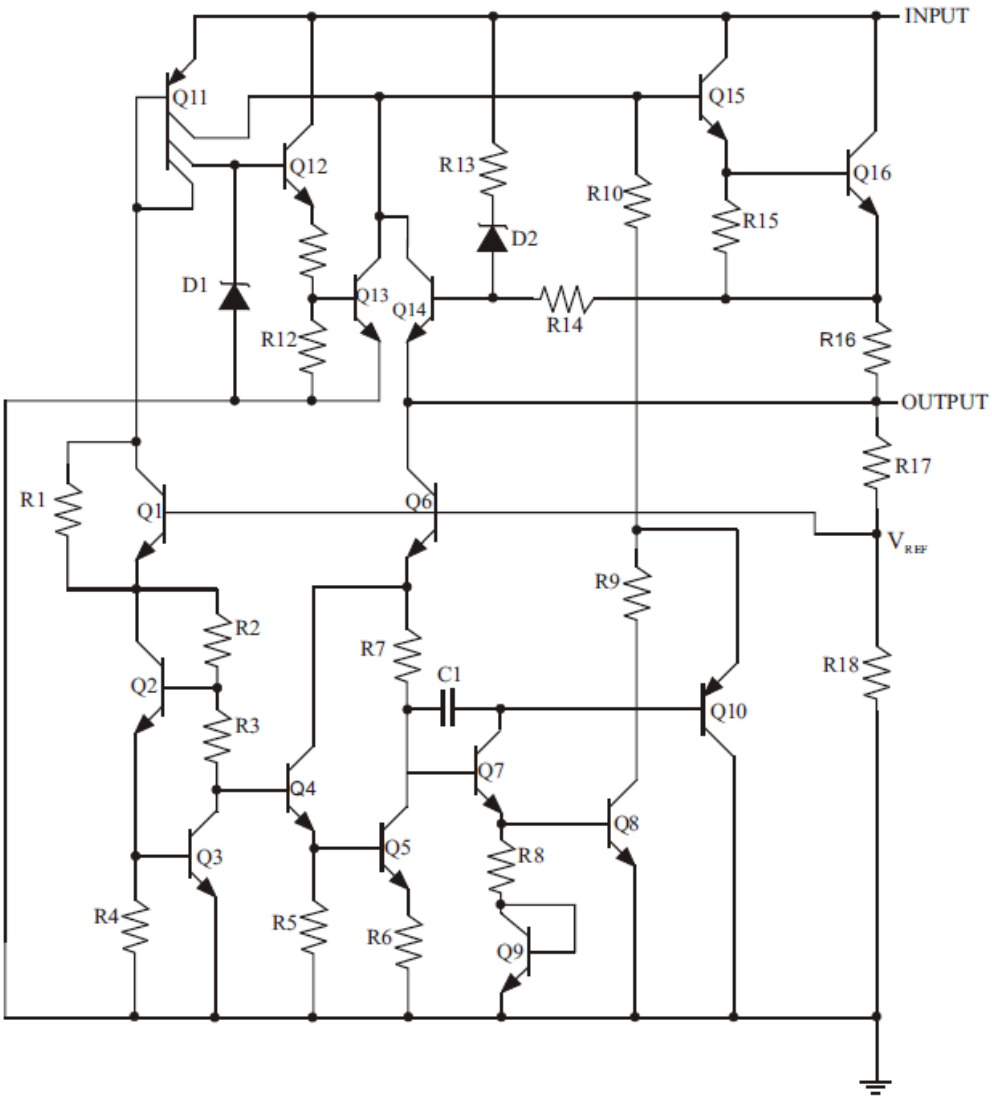
| Pin Name | Pin Description |
|---|---|
| GND | Reference ground. |
| $V_{OUT}$ | The pin is the power output of the device. |
| $V_{IN}$ | Input voltage. |

## TYPICAL APPLICATION CIRCUITS




For a positive regulator, a 0.33μF bypass capacitor should be used on the input terminals. While not necessary for stability, an output capacitor of 0.1μF may be used to improve the transient response of the regulator. These capacitors should be on or as near as possible to the regulator terminals .

## BLOCK DIAGRAM




## ABSOLUTE MAXIMUM RATING

| Parameter | | Symbol | Range | Unit |
|---|---|---|---|---|
| Input Voltage | | $V_{IN}$ | 35 | V |
| Operating junctions Temperature Range | | $T_J$ | 0 to +125 | ℃ |
| Output Current | | $I_{OUT}$ | 500 | mA |
| Storage Temperature Range | | $T_{STG}$ | -65 to +150 | ℃ |
| Lead Temperature (Soldering, 10 sec) | | $T_{LEAD}$ | 260 | ℃ |
| Thermal Resistance Junction to Case | TO-220 | $R_{\theta JC}$ | 5 | ℃/W |
| | TO-252 | | 8 | |

## ELECTRICAL CHARACTERISTICS

AT78M05

ELECTRICAL CHARACTERISTICS at specified Junction Temperature : $V_I$= 10V, $I_{OUT}$= 350mA, $T_A$= 25℃ (unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage (Note1) | $V_{OUT}$ | $I_{OUT}$=350mA<br>7.5V≤$V_{IN}$≤20V,5mA≤$I_{OUT}$≤350mA | 4.80<br>4.75 | 5.0<br>— | 5.20<br>5.25 | V |
| Line Regulation | $REG_{LINE}$ | 7V≤$V_{IN}$≤25V, $I_{OUT}$=200mA<br>8V≤$V_{IN}$≤12V, $I_{OUT}$=200mA | — | 3<br>1 | 100<br>50 | mV |
| Line Regulation (Note 1) | $REG_{LOAD}$ | 5mA≤$I_{OUT}$≤500mA<br>5mA≤$I_{OUT}$≤200mA | — | 30<br>12 | 100<br>50 | mV |
| Ground Current | $I_Q$ | $I_{OUT}$= 0mA | — | 3.0 | 6.0 | mA |
| Ground Current Change | $\triangle I_Q$ | 5mA≤$I_{OUT}$≤350mA<br>8V≤$V_{IN}$≤25V, $I_{OUT}$≤200mA | — | — | 0.5<br>0.8 | mA |
| Output Noise Voltage | $V_n$ | 10Hz≤f≤100KHz | — | 40 | — | μV |
| Ripple Rejection | RR | 8V≤$V_{IN}$≤18V, f=120Hz,<br>$I_{OUT}$ =100mA, $e_{IN}$=1Vrms | 62 | — | — | dB |
| Dropout Voltage (Note1) | $V_D$ | $I_{OUT}$= 500mA | — | 2.0 | — | V |
| Peak Output Current | $I_{PK}$ | $T_J$=25℃ | — | 700 | — | mA |
| Temperature Coefficient Output Voltage | $\triangle V_{OUT}/\triangle T_J$ | $I_{OUT}$= 5mA, 0℃ ≤$T_J$≤125℃ | — | -1.0 | — | mV/℃ |

AT78M06

ELECTRICAL CHARACTERISTICS at specified Junction Temperature : $V_I$= 11V, $I_{OUT}$= 350mA, $T_A$= 25℃ (unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage (Note1) | $V_{OUT}$ | $I_{OUT}$=350mA<br>8.5V≤$V_{IN}$≤21V,5mA≤$I_{OUT}$≤350mA | 5.76<br>5.70 | 6.0<br>— | 6.24<br>6.30 | V |
| Line Regulation | $REG_{LINE}$ | 8V≤$V_{IN}$≤25V, $I_{OUT}$=200mA<br>9V≤$V_{IN}$≤25V, $I_{OUT}$=200mA | — | 3<br>1 | 100<br>50 | mV |
| Line Regulation(Note 1) | $REG_{LOAD}$ | 5mA≤$I_{OUT}$≤500mA<br>5mA≤$I_{OUT}$≤200mA | — | 30<br>15 | 120<br>60 | mV |
| Ground Current | $I_Q$ | $I_{OUT}$= 0mA | — | 3.0 | 6.0 | mA |
| Ground Current Change | $\triangle I_Q$ | 5mA≤$I_{OUT}$≤350mA<br>9V≤$V_{IN}$≤25V, $I_{OUT}$≤200mA | — | — | 0.5<br>0.8 | mA |
| Output Noise Voltage | $V_n$ | 10Hz≤f≤100KHz | — | 60 | — | μV |
| Ripple Rejection | RR | 11.5V≤$V_{IN}$≤21.5V, f=120Hz,<br>$I_{OUT}$ =100mA, $e_{IN}$=1Vrms | 60 | — | — | dB |
| Dropout Voltage (Note1) | $V_D$ | $I_{OUT}$= 500mA | — | 2.0 | — | V |
| Peak Output Current | $I_{PK}$ | $T_J$=25℃ | — | 700 | — | mA |
| Temperature Coefficient Output Voltage | $\triangle V_{OUT}/\triangle T_J$ | $I_{OUT}$= 5mA, 0℃ ≤$T_J$≤125℃ | — | -0.5 | — | mV/℃ |

## ELECTRICAL CHARACTERISTICS(CONTINUED)

AT78M08

ELECTRICAL CHARACTERISTICS at specified Junction Temperature : $V_I$= 14V, $I_{OUT}$= 350mA, $T_A$= 25℃ (unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage (Note1) | $V_{OUT}$ | $I_{OUT}$=350mA<br>10.5V≤$V_{IN}$≤23V,5mA≤$I_{OUT}$≤350mA | 7.68<br>7.60 | 8.0<br>— | 8.32<br>8.40 | V |
| Line Regulation | $REG_{LINE}$ | 10.5V≤$V_{IN}$≤25V, $I_{OUT}$=200mA<br>11V≤$V_{IN}$≤12V, $I_{OUT}$=200mA | — | 4<br>1 | 100<br>50 | mV |
| Line Regulation(Note 1) | $REG_{LOAD}$ | 5mA≤$I_{OUT}$≤500mA<br>5mA≤$I_{OUT}$≤200mA | — | 30<br>15 | 160<br>80 | mV |
| Ground Current | $I_Q$ | $I_{OUT}$= 0mA | — | 3.0 | 6.0 | mA |
| Ground Current Change | △$I_Q$ | 5mA≤$I_{OUT}$≤350mA<br>10.5V≤$V_{IN}$≤25V, $I_{OUT}$≤200mA | — | — | 0.5<br>0.8 | mA |
| Output Noise Voltage | $V_n$ | 10Hz≤f≤100KHz | — | 80 | — | μV |
| Ripple Rejection | RR | 11.5V≤$V_{IN}$≤21.5V, f=120Hz,<br>$I_{OUT}$ =100mA, $e_{IN}$=1Vrms | 56 | — | — | dB |
| Dropout Voltage (Note1) | $V_D$ | $I_{OUT}$= 500mA | — | 2.0 | — | V |
| Peak Output Current | $I_{PK}$ | $T_J$=25℃ | — | 700 | — | mA |
| Temperature Coefficient Output Voltage | △$V_{OUT}$/△$T_J$ | $I_{OUT}$= 5mA, 0℃ ≤$T_J$≤125℃ | — | -0.5 | — | mV/℃ |

AT78M09

ELECTRICAL CHARACTERISTICS at specified Junction Temperature : $V_I$= 15V, $I_{OUT}$= 350mA, $T_A$= 25℃ (unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage (Note1) | $V_{OUT}$ | $I_{OUT}$=350mA<br>11.5V≤VIN≤24V,5mA≤$I_{OUT}$≤350mA | 8.64<br>8.55 | 9.0<br>— | 9.36<br>9.45 | V |
| Line Regulation | $REG_{LINE}$ | 11.5V≤$V_{IN}$≤26V, $I_{OUT}$=200mA<br>12V≤$V_{IN}$≤25V, $I_{OUT}$=200mA | — | 4<br>1 | 100<br>50 | mV |
| Line Regulation(Note 1) | $REG_{LOAD}$ | 5mA≤$I_{OUT}$≤500mA<br>5mA≤$I_{OUT}$≤200mA | — | 30<br>15 | 180<br>90 | mV |
| Ground Current | $I_Q$ | $I_{OUT}$= 0mA | — | 3.5 | 6.0 | mA |
| Ground Current Change | △$I_Q$ | 5mA≤$I_{OUT}$≤350mA<br>12V≤$V_{IN}$≤25V, $I_{OUT}$≤200mA | — | — | 0.5<br>0.8 | mA |
| Output Noise Voltage | $V_n$ | 10Hz≤f≤100KHz | — | 90 | — | μV |
| Ripple Rejection | RR | 13V≤$V_{IN}$≤23V, f=120Hz,<br>$I_{OUT}$ =100mA, $e_{IN}$=1Vrms | 56 | — | — | dB |
| Dropout Voltage (Note1) | $V_D$ | $I_{OUT}$= 500mA | — | 2.0 | — | V |
| Peak Output Current | $I_{PK}$ | $T_J$=25℃ | — | 700 | — | mA |
| Temperature Coefficient Output Voltage | △$V_{OUT}$/△$T_J$ | $I_{OUT}$= 5mA, 0℃ ≤$T_J$≤125℃ | — | -0.5 | — | mV/℃ |

## ELECTRICAL CHARACTERISTICS(CONTINUED)

AT78M12

ELECTRICAL CHARACTERISTICS at specified Junction Temperature : $V_I$= 19V, $I_{OUT}$= 350mA, $T_A$= 25℃ (unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage (Note1) | $V_{OUT}$ | $I_{OUT}$=350mA<br>15V≤$V_{IN}$≤27V,5mA≤$I_{OUT}$≤350mA | 11.52<br>11.40 | 12.0<br>— | 12.48<br>12.60 | V |
| Line Regulation | $REG_{LINE}$ | 14.5V≤$V_{IN}$≤30V, $I_{OUT}$=200mA<br>16V≤$V_{IN}$≤30V, $I_{OUT}$=200mA | — | 5<br>3 | 100<br>50 | mV |
| Line Regulation(Note 1) | $REG_{LOAD}$ | 5mA≤$I_{OUT}$≤500mA<br>5mA≤$I_{OUT}$≤200mA | — | 30<br>15 | 240<br>120 | mV |
| Ground Current | $I_Q$ | $I_{OUT}$= 0mA | — | 3.5 | 6.0 | mA |
| Ground Current Change | △$I_Q$ | 5mA≤$I_{OUT}$≤350mA<br>14.5V≤$V_{IN}$≤30V, $I_{OUT}$≤200mA | — | — | 0.5<br>0.8 | mA |
| Output Noise Voltage | $V_n$ | 10Hz≤f≤100KHz | — | 110 | — | μV |
| Ripple Rejection | RR | 15V≤$V_{IN}$≤25V, f=120Hz,<br>$I_{OUT}$ =100mA, $e_{IN}$=1Vrms | 55 | — | — | dB |
| Dropout Voltage (Note1) | $V_D$ | $I_{OUT}$= 500mA | — | 2.0 | — | V |
| Peak Output Current | $I_{PK}$ | $T_J$=25℃ | — | 700 | — | mA |
| Temperature Coefficient Output Voltage | △$V_{OUT}$/△$T_J$ | $I_{OUT}$= 5mA, 0℃ ≤$T_J$≤125℃ | — | -0.5 | — | mV/℃ |

AT78M15

ELECTRICAL CHARACTERISTICS at specified Junction Temperature : $V_I$= 23V, $I_{OUT}$= 350mA, $T_A$= 25℃ (unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage (Note1) | $V_{OUT}$ | $I_{OUT}$=350mA<br>17.5V≤$V_{IN}$≤30V,5mA≤$I_{OUT}$≤350mA | 14.40<br>14.25 | 15.0<br>— | 15.60<br>15.75 | V |
| Line Regulation | $REG_{LINE}$ | 17.5V≤$V_{IN}$≤30V, $I_{OUT}$=200mA<br>20V≤$V_{IN}$≤30V, $I_{OUT}$=200mA | — | 6<br>3 | 100<br>50 | mV |
| Line Regulation(Note 1) | $REG_{LOAD}$ | 5mA≤$I_{OUT}$≤500mA<br>5mA≤$I_{OUT}$≤200mA | — | 30<br>15 | 300<br>150 | mV |
| Ground Current | $I_Q$ | $I_{OUT}$= 0mA | — | 4.5 | 6.0 | mA |
| Ground Current Change | △$I_Q$ | 5mA≤$I_{OUT}$≤350mA<br>17.5V≤$V_{IN}$≤30V, $I_{OUT}$≤200mA | — | — | 0.5<br>0.8 | mA |
| Output Noise Voltage | $V_n$ | 10Hz≤f≤100KHz | — | 130 | — | μV |
| Ripple Rejection | RR | 18.5V≤$V_{IN}$≤28.5V, f=120Hz,<br>$I_{OUT}$ =100mA, eIN=1Vrms | 54 | — | — | dB |
| Dropout Voltage (Note1) | $V_D$ | $I_{OUT}$= 500mA | — | 2.0 | — | V |
| Peak Output Current | $I_{PK}$ | $T_J$=25℃ | — | 700 | — | mA |
| Temperature Coefficient Output Voltage | △$V_{OUT}$/△$T_J$ | $I_{OUT}$= 5mA, 0℃ ≤$T_J$≤125℃ | — | -0.6 | — | mV/℃ |

## ELECTRICAL CHARACTERISTICS(CONTINUED)

AT78M18

ELECTRICAL CHARACTERISTICS at specified Junction Temperature : $V_I$= 27V, $I_{OUT}$= 350mA, $T_A$= 25℃ (unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage (Note1) | $V_{OUT}$ | $I_{OUT}$=350mA<br>21V≤$V_{IN}$≤33V,5mA≤$I_{OUT}$≤350mA | 17.28<br>17.10 | 18.0<br>— | 18.72<br>18.90 | V |
| Line Regulation | $REG_{LINE}$ | 21V≤$V_{IN}$≤33V, $I_{OUT}$=200mA<br>24V≤$V_{IN}$≤33V, $I_{OUT}$=200mA | — | 7<br>3 | 100<br>50 | mV |
| Line Regulation(Note 1) | $REG_{LOAD}$ | 5mA≤$I_{OUT}$≤500mA<br>5mA≤$I_{OUT}$≤200mA | — | 30<br>15 | 360<br>180 | mV |
| Ground Current | $I_Q$ | $I_{OUT}$= 0mA | — | 4.5 | 6.0 | mA |
| Ground Current Change | △$I_Q$ | 5mA≤$I_{OUT}$≤350mA<br>21V≤$V_{IN}$≤33V, IOUT≤200mA | — | — | 0.5<br>0.8 | mA |
| Output Noise Voltage | $V_n$ | 10Hz≤f≤100KHz | — | 140 | — | μV |
| Ripple Rejection | RR | 22V≤VIN≤32V, f=120Hz,<br>$I_{OUT}$ =100mA, eIN=1Vrms | 53 | — | — | dB |
| Dropout Voltage (Note1) | $V_D$ | $I_{OUT}$= 500mA | — | 2.0 | — | V |
| Peak Output Current | $I_{PK}$ | $T_J$=25℃ | — | 700 | — | mA |
| Temperature Coefficient Output Voltage | △$V_{OUT}$/△$T_J$ | $I_{OUT}$= 5mA, 0℃ ≤$T_J$≤125℃ | — | -0.6 | — | mV/℃ |

AT78M24

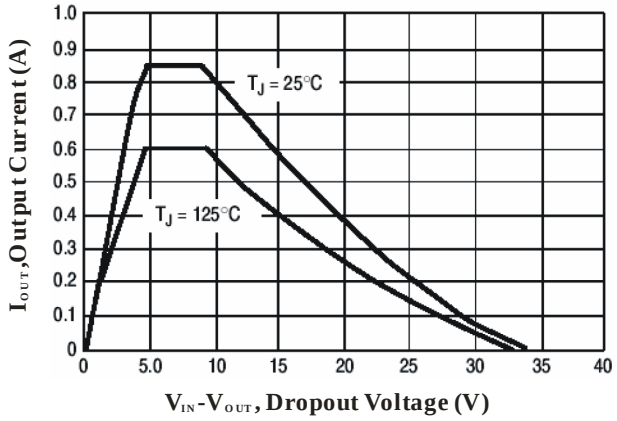
ELECTRICAL CHARACTERISTICS at specified Junction Temperature : $V_I$= 33V, $I_{OUT}$= 350mA, $T_A$= 25℃ (unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Output Voltage (Note1) | $V_{OUT}$ | $I_{OUT}$=350mA<br>27V≤$V_{IN}$≤33V,5mA≤$I_{OUT}$≤350mA | 23.04<br>22.80 | 24.0<br>— | 24.96<br>25.20 | V |
| Line Regulation | $REG_{LINE}$ | 27V≤$V_{IN}$≤33V, $I_{OUT}$=200mA<br>28V≤$V_{IN}$≤33V, $I_{OUT}$=200mA | — | 10<br>5 | 100<br>50 | mV |
| Line Regulation(Note 1) | $REG_{LOAD}$ | 5mA≤$I_{OUT}$≤500mA<br>5mA≤$I_{OUT}$≤200mA | — | 30<br>15 | 480<br>240 | mV |
| Ground Current | $I_Q$ | $I_{OUT}$= 0mA | — | 4.8 | 6.0 | mA |
| Ground Current Change | △IQ | 5mA≤$I_{OUT}$≤350mA<br>27V≤$V_{IN}$≤33V, IOUT≤200mA | — | — | 0.5<br>0.8 | mA |
| Output Noise Voltage | $V_n$ | 10Hz≤f≤100KHz | — | 170 | — | μV |
| Ripple Rejection | RR | 28V≤$V_{IN}$≤38V, f=120Hz,<br>$I_{OUT}$ =100mA, eIN=1Vrms | 50 | — | — | dB |
| Dropout Voltage (Note1) | $V_D$ | $I_{OUT}$= 500mA | — | 2.0 | — | V |
| Peak Output Current | $I_{PK}$ | $T_J$=25℃ | — | 700 | — | mA |
| Temperature Coefficient Output Voltage | △$V_{OUT}$/△$T_J$ | $I_{OUT}$= 5mA, 0℃ ≤$T_J$≤125℃ | — | -0.7 | — | mV/℃ |

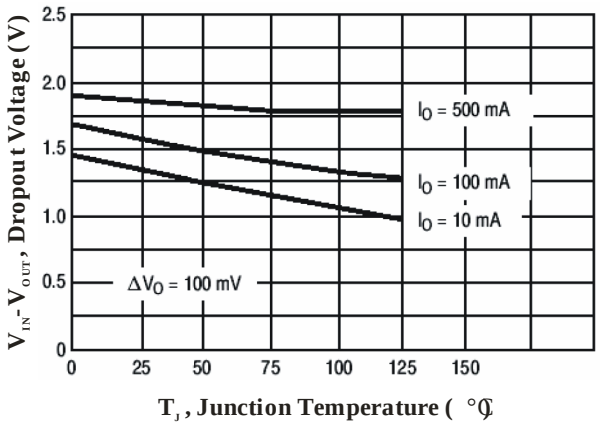
**Note 1:** Low duty pulse testing with kelvin connections required.

## TYPICAL OPERATING CHARACTERISTICS

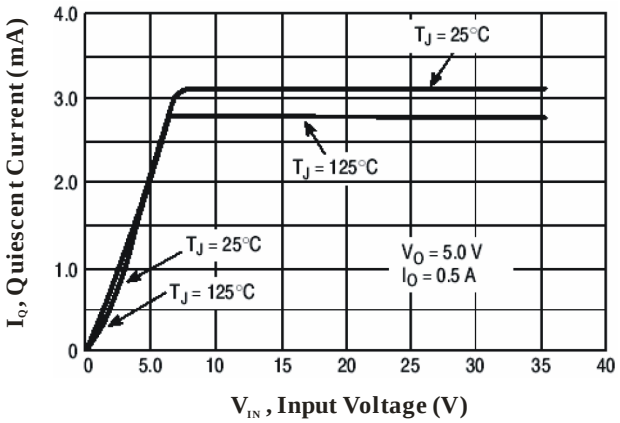
### Peak Output Current vs. Dropout Voltage



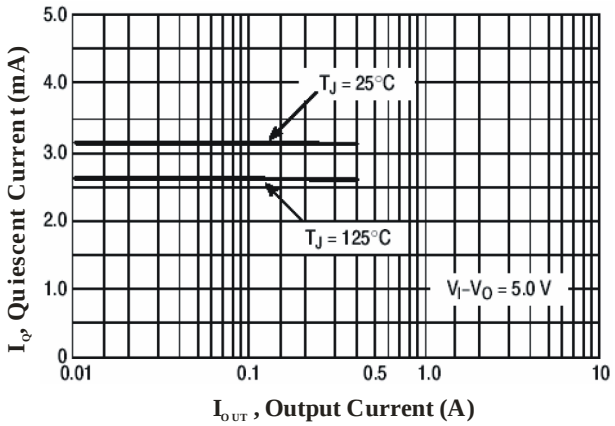

### Dropout Voltage vs. Junction Temperature



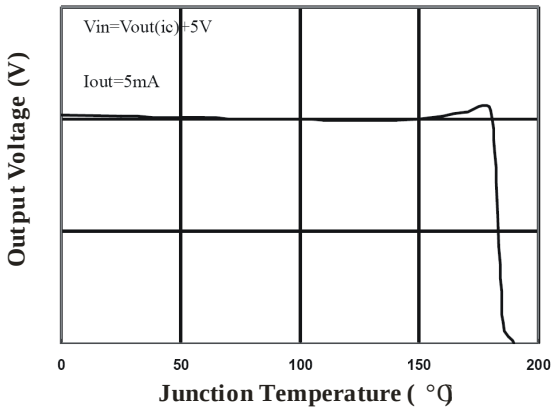

### Quiescent Current vs. Input Voltage




### Quiescent Current vs. Input Voltage




### Output Voltage as a Function of Junction



## APPLICATION INFORMATION

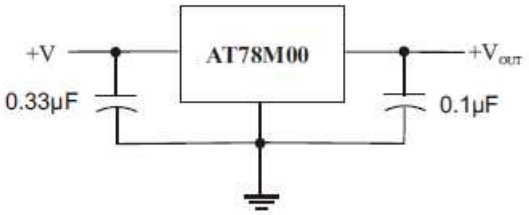



Figure 1. Fixed-Output Regulator

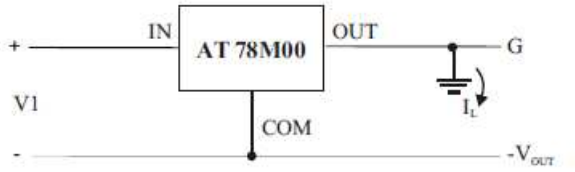
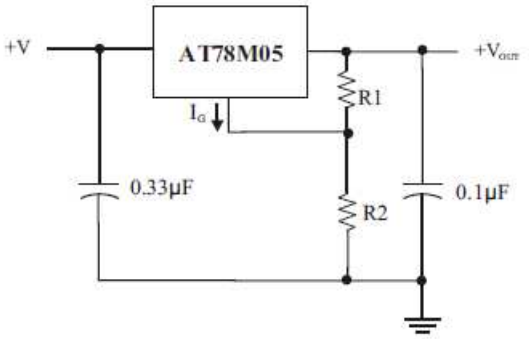
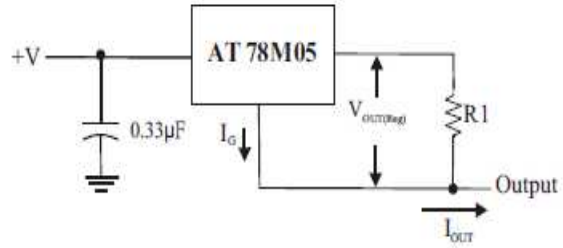



Figure 2. Positive Regulator in Negative Configuration(V, Must Float)




$$V_{OUT} = 5(1+\frac{R2}{R1}) + I_G R2$$

Figure 3. Circuit for Increasing Output Voltage




$$I_{OUT} = (5/R1) + I_G$$

Figure 4. Constant Current Source

**Operation with a load common to a voltage of opposite polarity**

In many cases, a regulator powers a load that is not connected to ground but, connected to a voltage source of opposite polarity instead (e.g.,operational amplifiers, level-shifting circuits, etc.). In these cases, a clamp diode should be connected to the regulator output as shown in Figure 5. This protects the regulator from output polarity reversals during startup and short-circuit operation.

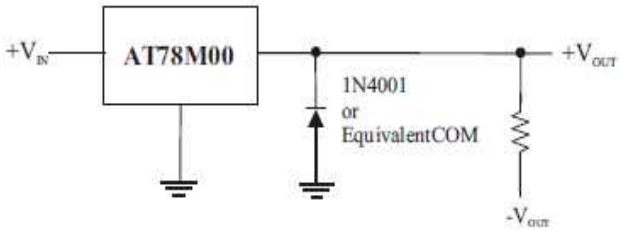



Figure 5. Output Polarity-Reversal-Protection Circuit

### Reverse-bias protection

Occasionally, the input voltage to the regulator can collapse faster than the output voltage. This can occur, for example, when the input supply is shorted, the output capacitor will discharge into the output of the regulator, the emitter-base junction of the series-pass element (internal or external) could break down and be damaged. To prevent this, a diode shunt can be used as shown in Figure 6.

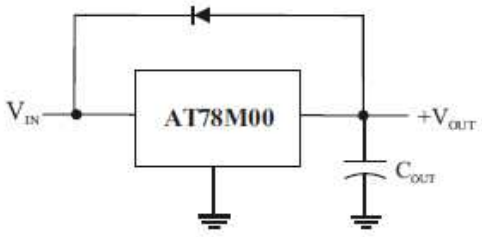
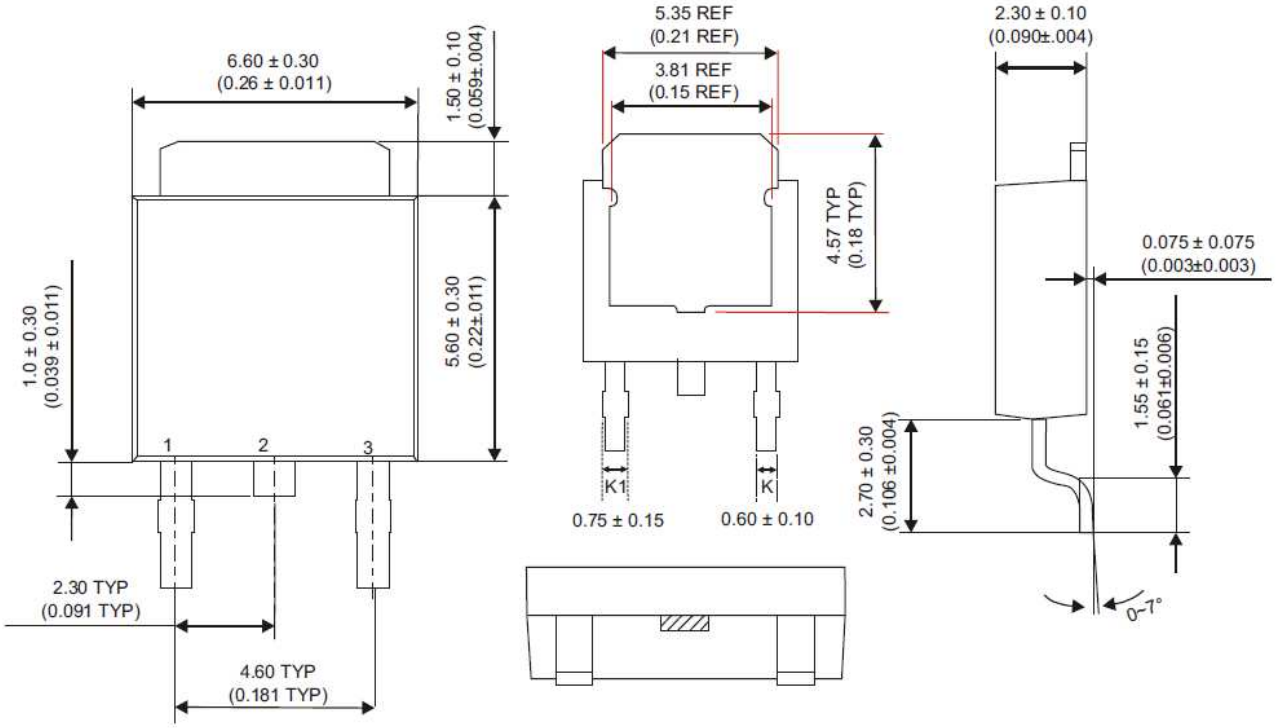


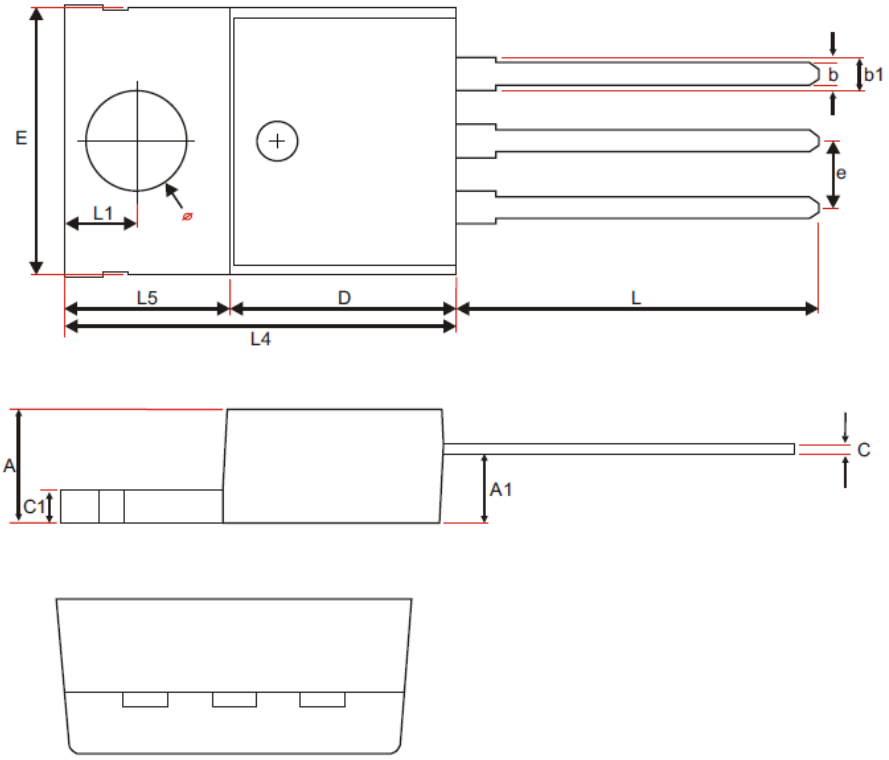

Figure 6. Reverse-Bias-Protection Circuit

## PACKAGE OUTLINE DIMENSIONS
### TO-252 PACKAGE OUTLINE DIMENSIONS




**Unit :mm(inch)**

## PACKAGE OUTLINE DIMENSIONS
### TO-220 PACKAGE OUTLINE DIMENSIONS




| REF. | DIMENSIONS Millimeter | |
|---|---|---|
| | Min. | Max. |
| A | 4.40 | 4.80 |
| b | 0.76 | 1.00 |
| D | 8.60 | 9.00 |
| c | 0.36 | 0.50 |
| E | 9.80 | 10.4 |
| L4 | 14.70 | 15.30 |
| L5 | 6.20 | 6.60 |
| c1 | 1.25 | 1.45 |
| b1 | 1.17 | 1.47 |
| L | 13.25 | 14.25 |
| e | 2.54 REF. | |
| L1 | 2.60 | 2.89 |
| ø | 3.71 | 3.96 |
| A1 | 2.60 | 2.80 |