SLVS055F – APRIL 1981 – REVISED DECEMBER 1999

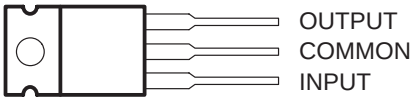
- **±1% Output Tolerance at 25°C**
- **±2% Output Tolerance Over Full Operating Range**
- **Thermal Shutdown**
- **Internal Short-Circuit Current Limiting**
- **Pinout Identical to μA7800 Series**
- **Improved Version of μA7800 Series**

## description

Each fixed-voltage precision regulator in the TL780 series is capable of supplying 1.5 A of load current. A unique temperature-compensation technique, coupled with an internally trimmed band-gap reference, has resulted in improved accuracy when compared to other three-terminal regulators. Advanced layout techniques provide excellent line, load, and thermal regulation. The internal current-limiting and thermal-shutdown features make the devices essentially immune to overload.

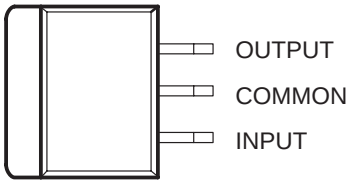
The TL780-xxC series regulators are characterized for operation over the virtual junction temperature range of 0°C to 125°C.

**KC PACKAGE**
**(TOP VIEW)**



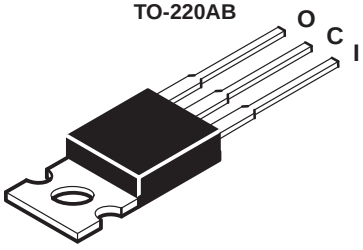

The COMMON terminal is in electrical contact with the mounting base.

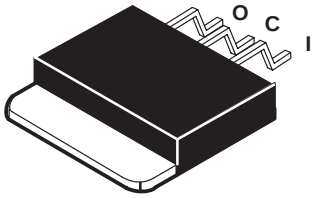
**KTE PACKAGE**
**(TOP VIEW)**




The COMMON terminal is in electrical contact with the mounting base.

**TO-220AB**



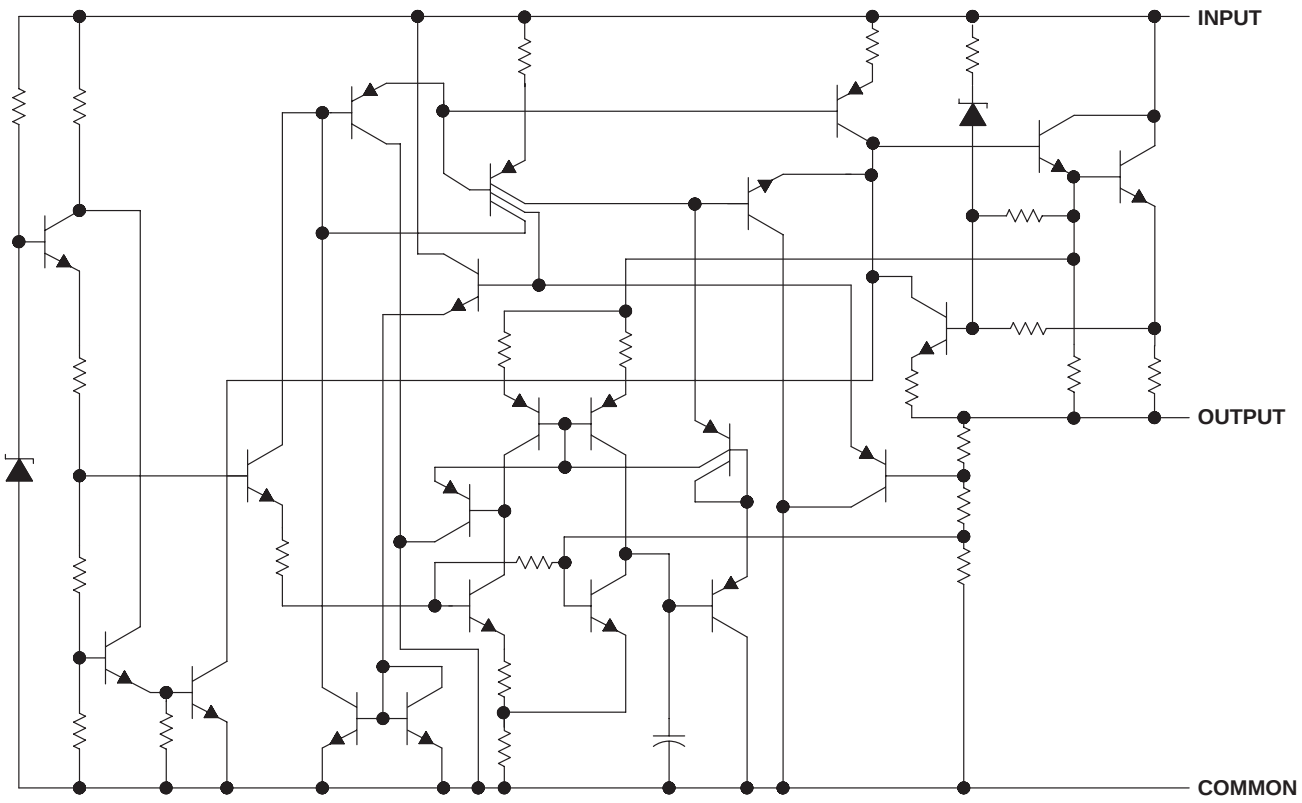




**AVAILABLE OPTIONS**

| $T_J$ | $V_O$ TYP (V) | PACKAGED DEVICES | | CHIP FORM (Y) |
|---|---|---|---|---|
| | | HEAT-SINK MOUNTED (KC) | PLASTIC FLANGE MOUNTED (KTE) | |
| 0°C to 125°C | 5 | TL780-05CKC | TL780-05CKTE | TL780-05Y |
| | 12 | TL780-12CKC | TL780-12CKTE | TL780-12Y |
| | 15 | TL780-15CKC | TL780-15CKTE | TL780-15Y |

The KTE package is available taped and reeled. Add the suffix R to the device type (e.g., TL780-05CKTER). Chip forms are tested at 25°C.

## schematic



## absolute maximum ratings over operating temperature range (unless otherwise noted)†

Input voltage, $V_I$ . . . . . 35 V
Package thermal impedance, $\theta_{JA}$ (see Notes 1 and 2): KC package . . . . . 22°C/W
KTE package . . . . . 23°C/W
Operating free-air, $T_A$; case, $T_C$; or virtual junction, $T_J$, temperature range . . . . . 0°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 260°C
Storage temperature range, $T_{stg}$ . . . . . –65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. Maximum power dissipation is a function of $T_J(max)$, $\theta_{JA}$, and $T_A$. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum $T_J$ of 150°C can impact reliability. Due to variations in individual device electrical characteristics and thermal resistance, the built-in thermal overload protection may be activated at power levels slightly above or below the rated dissipation.
2. The package thermal impedance is calculated in accordance with JESD 51.

## recommended operating conditions

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| Input voltage, $V_I$ | TL780-05C | 7 | 25 | V |
| | TL780-12C | 14.5 | 30 | |
| | TL780-15C | 17.5 | 30 | |
| Output current, $I_O$ | | | 1.5 | A |
| Operating virtual junction temperature, $T_J$ | | 0 | 125 | °C |

## electrical characteristics at specified virtual junction temperature, $V_I$ = 10 V, $I_O$ = 500 mA (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | $T_J$‡ | TL780-05C | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| Output voltage | $I_O$ = 5 mA to 1 A, P ≤ 15 W, $V_I$ = 7 V to 20 V | 25°C | 4.95 | 5 | 5.05 | V |
| | | 0°C to 125°C | 4.9 | | 5.1 | |
| Input voltage regulation | $V_I$ = 7 V to 25 V | 25°C | | 0.5 | 5 | mV |
| | $V_I$ = 8 V to 12 V | | | 0.5 | 5 | |
| Ripple rejection | $V_I$ = 8 V to 18 V, f = 120 Hz | 0°C to 125°C | 70 | 85 | | dB |
| Output voltage regulation | $I_O$ = 5 mA to 1.5 A | 25°C | | 4 | 25 | mV |
| | $I_O$ = 250 mA to 750 mA | | | 1.5 | 15 | |
| Output resistance | f = 1 kHz | 0°C to 125°C | | 0.0035 | | W |
| Temperature coefficient of output voltage | $I_O$ = 5 mA | 0°C to 125°C | | 0.25 | | mV/°C |
| Output noise voltage | f = 10 Hz to 100 kHz | 25°C | | 75 | | μV |
| Dropout voltage | $I_O$ = 1 A | 25°C | | 2 | | V |
| Input bias current | | 25°C | | 5 | 8 | mA |
| Input bias-current change | $V_I$ = 7 V to 25 V | 0°C to 125°C | | 0.7 | 1.3 | mA |
| | $I_O$ = 5 mA to 1 A | | | 0.003 | 0.5 | |
| Short-circuit output current | | 25°C | | 750 | | mA |
| Peak output current | | 25°C | | 2.2 | | A |

‡ Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-μF capacitor across the input and a 0.22-μF capacitor across the output.

## electrical characteristics at specified virtual junction temperature, $V_I$ = 19 V, $I_O$ = 500 mA (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | $T_J$† | TL780-12C | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| Output voltage | $I_O$ = 5 mA to 1 A, P ≤ 15 W, $V_I$ = 14.5 V to 27 V | 25°C | 11.88 | 12 | 12.12 | V |
| | | 0°C to 125°C | 11.76 | | 12.24 | |
| Input voltage regulation | $V_I$ = 14.5 V to 30 V | 25°C | | 1.2 | 12 | mV |
| | $V_I$ = 16 V to 22 V | | | 1.2 | 12 | |
| Ripple rejection | $V_I$ = 15 V to 25 V, f = 120 Hz | 0°C to 125°C | 65 | 80 | | dB |
| Output voltage regulation | $I_O$ = 5 mA to 1.5 A | 25°C | | 6.5 | 60 | mV |
| | $I_O$ = 250 mA to 750 mA | | | 2.5 | 36 | |
| Output resistance | f = 1 kHz | 0°C to 125°C | | 0.0035 | | W |
| Temperature coefficient of output voltage | $I_O$ = 5 mA | 0°C to 125°C | | 0.6 | | mV/°C |
| Output noise voltage | f = 10 Hz to 100 kHz | 25°C | | 180 | | μV |
| Dropout voltage | $I_O$ = 1 A | 25°C | | 2 | | V |
| Input bias current | | 25°C | | 5.5 | 8 | mA |
| Input bias-current change | $V_I$ = 14.5 V to 30 V | 0°C to 125°C | | 0.4 | 1.3 | mA |
| | $I_O$ = 5 mA to 1 A | | | 0.03 | 0.5 | |
| Short-circuit output current | | 25°C | | 350 | | mA |
| Peak output current | | 25°C | | 2.2 | | A |

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-μF capacitor across the input and a 0.22-μF capacitor across the output.

## electrical characteristics at specified virtual junction temperature, $V_I$ = 23 V, $I_O$ = 500 mA (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | $T_J$† | TL780-15C | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| Output voltage | $I_O$ = 5 mA to 1 A, P ≤ 15 W, $V_I$ = 17.5 V to 30 V | 25°C | 14.85 | 15 | 15.15 | V |
| | | 0°C to 125°C | 14.7 | | 15.3 | |
| Input voltage regulation | $V_I$ = 17.5 V to 30 V | 25°C | | 1.5 | 15 | mV |
| | $V_I$ = 20 V to 26 V | | | 1.5 | 15 | |
| Ripple rejection | $V_I$ = 18.5 V to 28.5 V, f = 120 Hz | 0°C to 125°C | 60 | 75 | | dB |
| Output voltage regulation | $I_O$ = 5 mA to 1.5 A | 25°C | | 7 | 75 | mV |
| | $I_O$ = 250 mA to 750 mA | | | 2.5 | 45 | |
| Output resistance | f = 1 kHz | 0°C to 125°C | | 0.0035 | | W |
| Temperature coefficient of output voltage | $I_O$ = 5 mA | 0°C to 125°C | | 0.62 | | mV/°C |
| Output noise voltage | f = 10 Hz to 100 kHz | 25°C | | 225 | | μV |
| Dropout voltage | $I_O$ = 1 A | 25°C | | 2 | | V |
| Input bias current | | 25°C | | 5.5 | 8 | mA |
| Input bias-current change | $V_I$ = 17.5 V to 30 V | 0°C to 125°C | | 0.4 | 1.3 | mA |
| | $I_O$ = 5 mA to 1 A | | | 0.02 | 0.5 | |
| Short-circuit output current | | 25°C | | 230 | | mA |
| Peak output current | | 25°C | | 2.2 | | A |

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-μF capacitor across the input and a 0.22-μF capacitor across the output.

## electrical characteristics, $V_I$ = 10 V, $I_O$ = 500 mA, $T_J$ = 25°C (unless otherwise noted)

| PARAMETER | TEST CONDITIONS† | TL780-05Y | | | UNIT |
|---|---|---|---|---|---|
| | | MIN | TYP | MAX | |
| Output voltage | $I_O$ = 5 mA to 1 A, P ≤ 15 W | | 5 | | V |
| Input voltage regulation | $V_I$ = 7 V to 25 V | | 0.5 | | mV |
| | $V_I$ = 8 V to 12 V | | 0.5 | | |
| Output voltage regulation | $I_O$ = 5 mA to 1.5 A | | 4 | | mV |
| | $I_O$ = 250 mA to 750 mA | | 1.5 | | |
| Output noise voltage | f = 10 Hz to 100 kHz | | 75 | | μV |
| Dropout voltage | $I_O$ = 1 A | | 2 | | V |
| Input bias current | | | 5 | | mA |
| Short-circuit output current | | | 750 | | mA |
| Peak output current | | | 2.2 | | A |

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-μF capacitor across the input and a 0.22-μF capacitor across the output.

## electrical characteristics, $V_I$ = 19 V, $I_O$ = 500 mA, $T_J$ = 25°C (unless otherwise noted)

| PARAMETER | TEST CONDITIONS† | TL780-12Y | | | UNIT |
|---|---|---|---|---|---|
| | | MIN | TYP | MAX | |
| Output voltage | $I_O$ = 5 mA to 1 A, P ≤ 15 W | | 12 | | V |
| Input voltage regulation | $V_I$ = 14.5 V to 30 V | | 1.2 | | mV |
| | $V_I$ = 16 V to 22 V | | 1.2 | | |
| Output voltage regulation | $I_O$ = 5 mA to 1.5 A | | 6.5 | | mV |
| | $I_O$ = 250 mA to 750 mA | | 2.5 | | |
| Output noise voltage | f = 10 Hz to 100 kHz | | 180 | | μV |
| Dropout voltage | $I_O$ = 1 A | | 2 | | V |
| Input bias current | | | 5.5 | | mA |
| Short-circuit output current | | | 350 | | mA |
| Peak output current | | | 2.2 | | A |

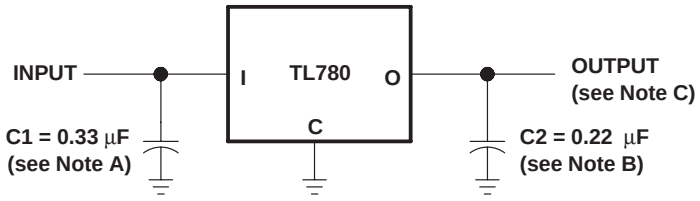
† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-μF capacitor across the input and a 0.22-μF capacitor across the output.

## electrical characteristics, $V_I$ = 23 V, $I_O$ = 500 mA, $T_J$ = 25°C (unless otherwise noted)

| PARAMETER | TEST CONDITIONS† | TL780-15Y | | | UNIT |
|---|---|---|---|---|---|
| | | MIN | TYP | MAX | |
| Output voltage | $I_O$ = 5 mA to 1 A, P ≤ 15 W | | 15 | | V |
| Input voltage regulation | $V_I$ = 17.5 V to 30 V | | 1.5 | | mV |
| | $V_I$ = 20 V to 26 V | | 1.5 | | |
| Output voltage regulation | $I_O$ = 5 mA to 1.5 A | | 7 | | mV |
| | $I_O$ = 250 mA to 750 mA | | 2.5 | | |
| Output resistance | f = 1 kHz | | 0.0035 | | W |
| Output noise voltage | f = 10 Hz to 100 kHz | | 225 | | μV |
| Dropout voltage | $I_O$ = 1 A | | 2 | | V |
| Input bias current | | | 5.5 | | mA |
| Short-circuit output current | | | 230 | | mA |
| Peak output current | | | 2.2 | | A |

† Pulse-testing techniques maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account separately. All characteristics are measured with a 0.33-μF capacitor across the input and a 0.22-μF capacitor across the output.

## PARAMETER MEASUREMENT INFORMATION




NOTES: A. C1 is required when the regulator is far from the power-supply filter.
B. C2 is not required for stability; however, transient response is improved.
C. Permanent damage can occur when OUTPUT is pulled below ground.

**Figure 1. Test Circuit**

## APPLICATION INFORMATION

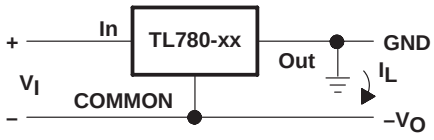



**Figure 2. Positive Regulator in Negative Configuration ($V_I$ Must Float)**

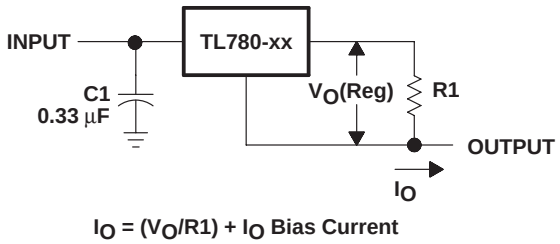



**Figure 3. Current Regulator**

### 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, instead, is connected to a voltage source of opposite polarity (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 4. This protects the regulator from output polarity reversals during startup and short-circuit operation.

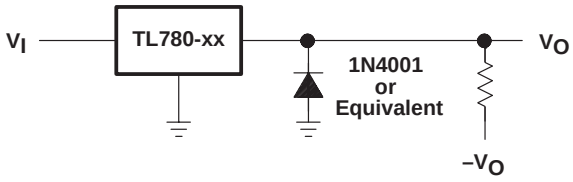



**Figure 4. Output Polarity-Reversal-Protection Circuit**

### reverse-bias protection

Occasionally, the input voltage to the regulator can collapse faster than the output voltage. This, for example, could occur when the input supply is crowbarred during an output overvoltage condition. If the output voltage is greater than approximately 7 V, 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 employed, as shown in Figure 5.

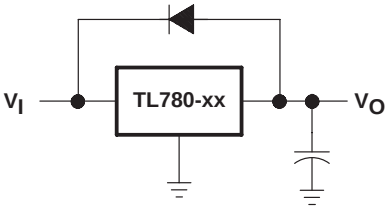
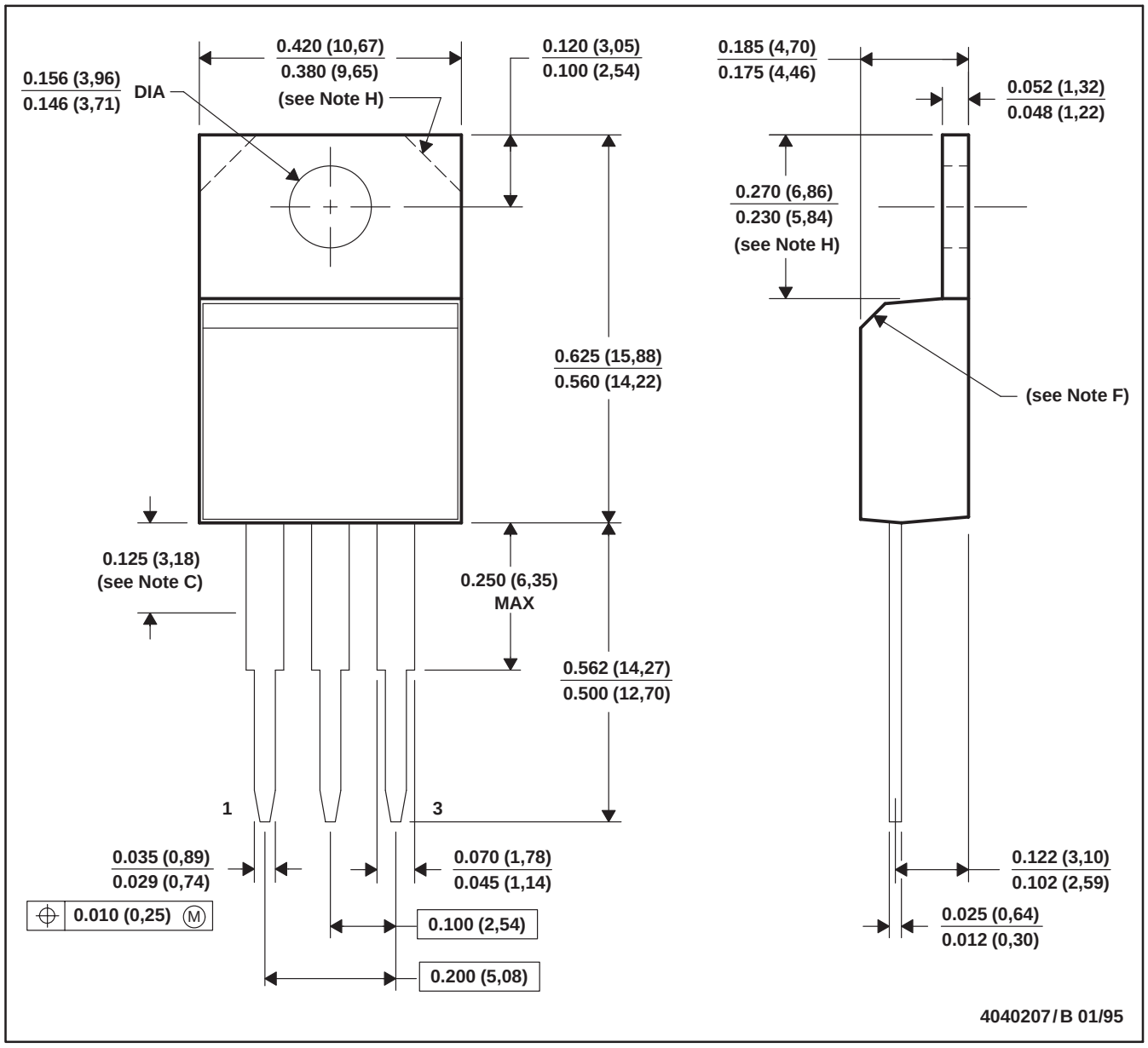



**Figure 5. Reverse-Bias-Protection Circuit**

MSOT007A – JANUARY 1995 – REVISED SEPTEMBER 1995

**KC (R-PSFM-T3)** **PLASTIC FLANGE-MOUNT PACKAGE**




NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Lead dimensions are not controlled within this area.
D. All lead dimensions apply before solder dip.
E. The center lead is in electrical contact with the mounting tab.
F. The chamfer is optional.
G. Falls within JEDEC TO-220AB
H. Tab contour optional within these dimensions