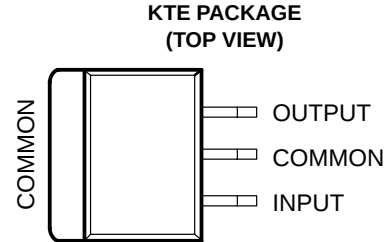
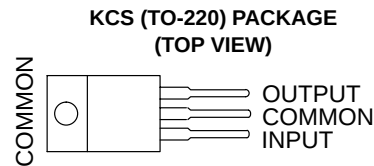
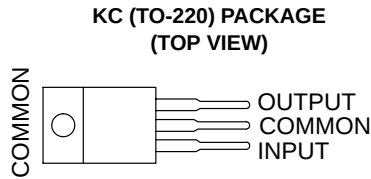


# TL780 SERIES POSITIVE-VOLTAGE REGULATORS

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- $\pm 1\%$  Output Tolerance at  $25^{\circ}\text{C}$
- $\pm 2\%$  Output Tolerance Over Full Operating Range
- Thermal Shutdown
- Internal Short-Circuit Current Limiting
- Pinout Identical to  $\mu\text{A}7800$  Series
- Improved Version of  $\mu\text{A}7800$  Series



## description/ordering information

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 essentially make the devices immune to overload.

## ORDERING INFORMATION

| $T_J$                                        | $V_O$ TYP (V) | PACKAGE <sup>†</sup>         |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------------------------------------|---------------|------------------------------|--------------|-----------------------|------------------|
| $0^{\circ}\text{C}$ to $125^{\circ}\text{C}$ | 5             | Power Flex (KTE)             | Reel of 2000 | TL780-05CKTER         | TL780-05C        |
|                                              |               | TO-220 (KC)                  | Tube of 50   | TL780-05CKC           | TL780-05C        |
|                                              |               | TO-220, short shoulder (KCS) | Tube of 20   | TL780-05KCS           | TL780-05         |
|                                              | 12            | TO-220 (KC)                  | Tube of 50   | TL780-12CKC           | TL780-12C        |
|                                              |               | TO-220, short shoulder (KCS) | Tube of 20   | TL780-12KCS           | TL780-12         |
|                                              | 15            | TO-220 (KC)                  | Tube of 50   | TL780-15CKC           | TL780-15C        |
|                                              |               | TO-220, short shoulder (KCS) | Tube of 20   | TL780-15KCS           | TL780-15         |

<sup>†</sup> Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

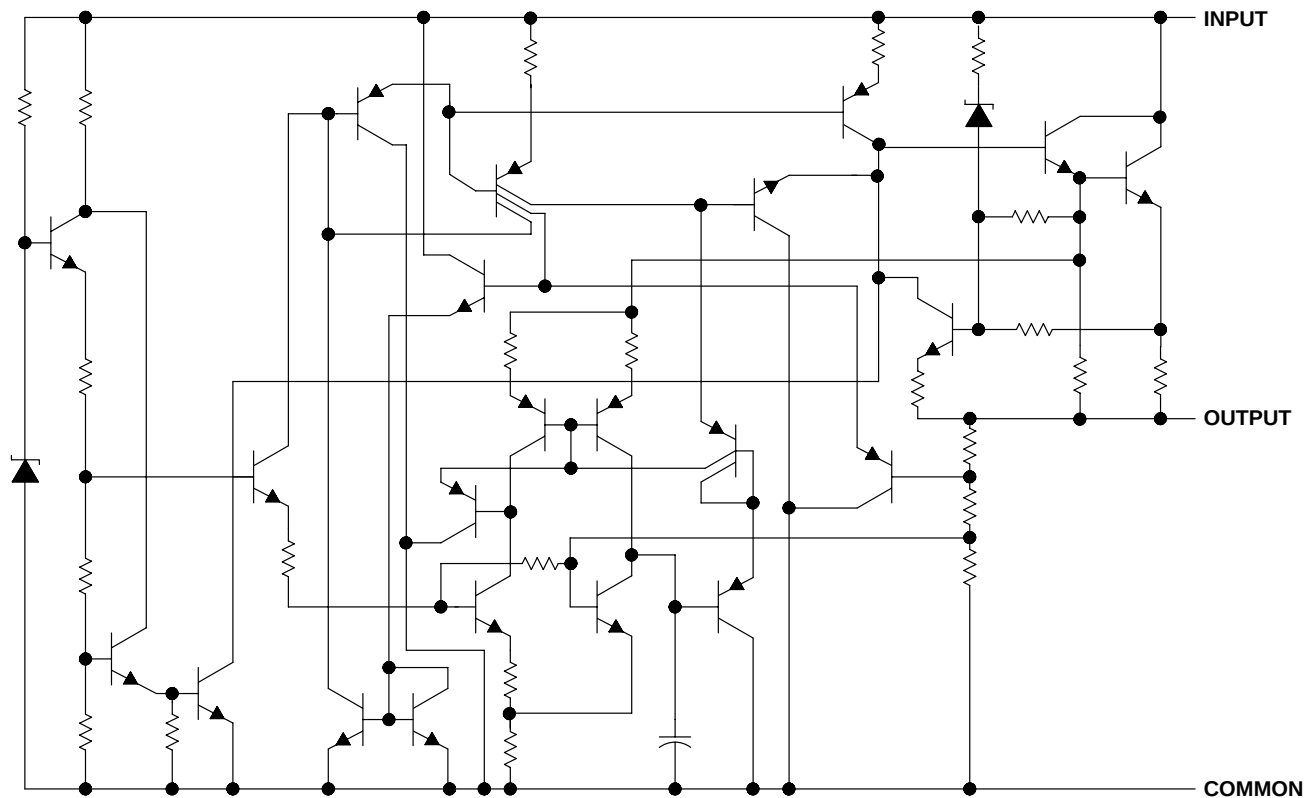
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TL780 SERIES  
POSITIVE-VOLTAGE REGULATORS

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schematic



absolute maximum ratings over operating temperature range (unless otherwise noted)<sup>†</sup>

|                                                              |                |
|--------------------------------------------------------------|----------------|
| Input voltage, $V_I$                                         | 35 V           |
| Operating virtual junction temperature, $T_J$                | 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 |

<sup>†</sup> 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.

package thermal data (see Note 1)

| PACKAGE          | BOARD             | $\theta_{JC}$ | $\theta_{JA}$ |
|------------------|-------------------|---------------|---------------|
| Power Flex (KTE) | High K, JESD 51-5 | 3°C/W         | 23°C/W        |
| TO-220 (KC/KCS)  | High K, JESD 51-5 | 3°C/W         | 19°C/W        |

NOTE 1: Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect 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.

# TL780 SERIES POSITIVE-VOLTAGE REGULATORS

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## recommended operating conditions

|                                              |           | MIN  | MAX | UNIT |
|----------------------------------------------|-----------|------|-----|------|
| $V_I$ Input voltage                          | TL780-05C | 7    | 25  | V    |
|                                              | TL780-12C | 14.5 | 30  |      |
|                                              | TL780-15C | 17.5 | 30  |      |
| $I_O$ Output current                         |           |      | 1.5 | A    |
| $T_J$ Operating virtual junction temperature |           | 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, $P \leq 15$ W,<br>$V_I = 7$ 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 |      | $\Omega$ |
| 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     |      | $\mu$ V  |
| 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- $\mu$ F capacitor across the input and a 0.22- $\mu$ F capacitor across the output.

# TL780 SERIES

## POSITIVE-VOLTAGE REGULATORS

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**electrical characteristics at specified virtual junction temperature,  $V_I = 19\text{ V}$ ,  $I_O = 500\text{ mA}$  (unless otherwise noted)**

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

<sup>†</sup> 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- $\mu\text{F}$  capacitor across the input and a 0.22- $\mu\text{F}$  capacitor across the output.

**electrical characteristics at specified virtual junction temperature,  $V_I = 23\text{ V}$ ,  $I_O = 500\text{ mA}$  (unless otherwise noted)**

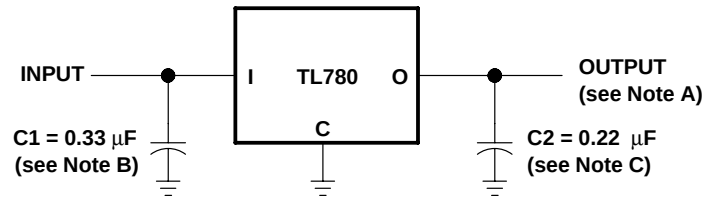
| PARAMETER                                 | TEST CONDITIONS                                                                                    | $T_J^\dagger$ | TL780-15C |        |       | UNIT          |
|-------------------------------------------|----------------------------------------------------------------------------------------------------|----------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

<sup>†</sup> 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- $\mu\text{F}$  capacitor across the input and a 0.22- $\mu\text{F}$  capacitor across the output.



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**PARAMETER MEASUREMENT INFORMATION**



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

**Figure 1. Test Circuit**

# TL780 SERIES POSITIVE-VOLTAGE REGULATORS

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## APPLICATION INFORMATION

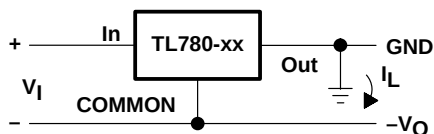
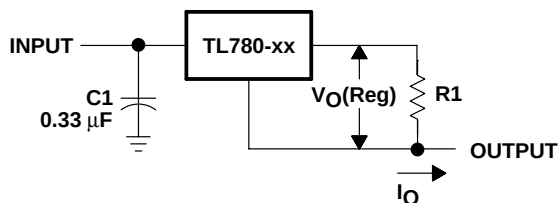


Figure 2. Positive Regulator in Negative Configuration ( $V_I$  Must Float)



$$I_O = (V_O/R1) + I_O \text{ Bias Current}$$

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.

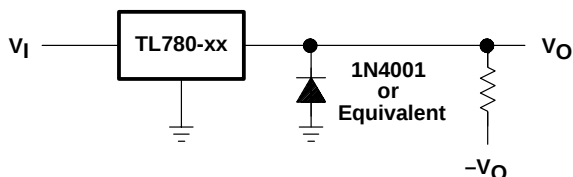


Figure 4. Output Polarity-Reversal-Protection Circuit

### 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.

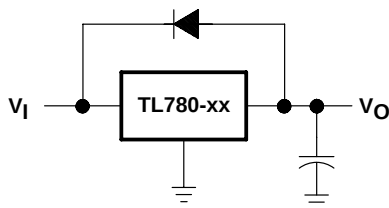
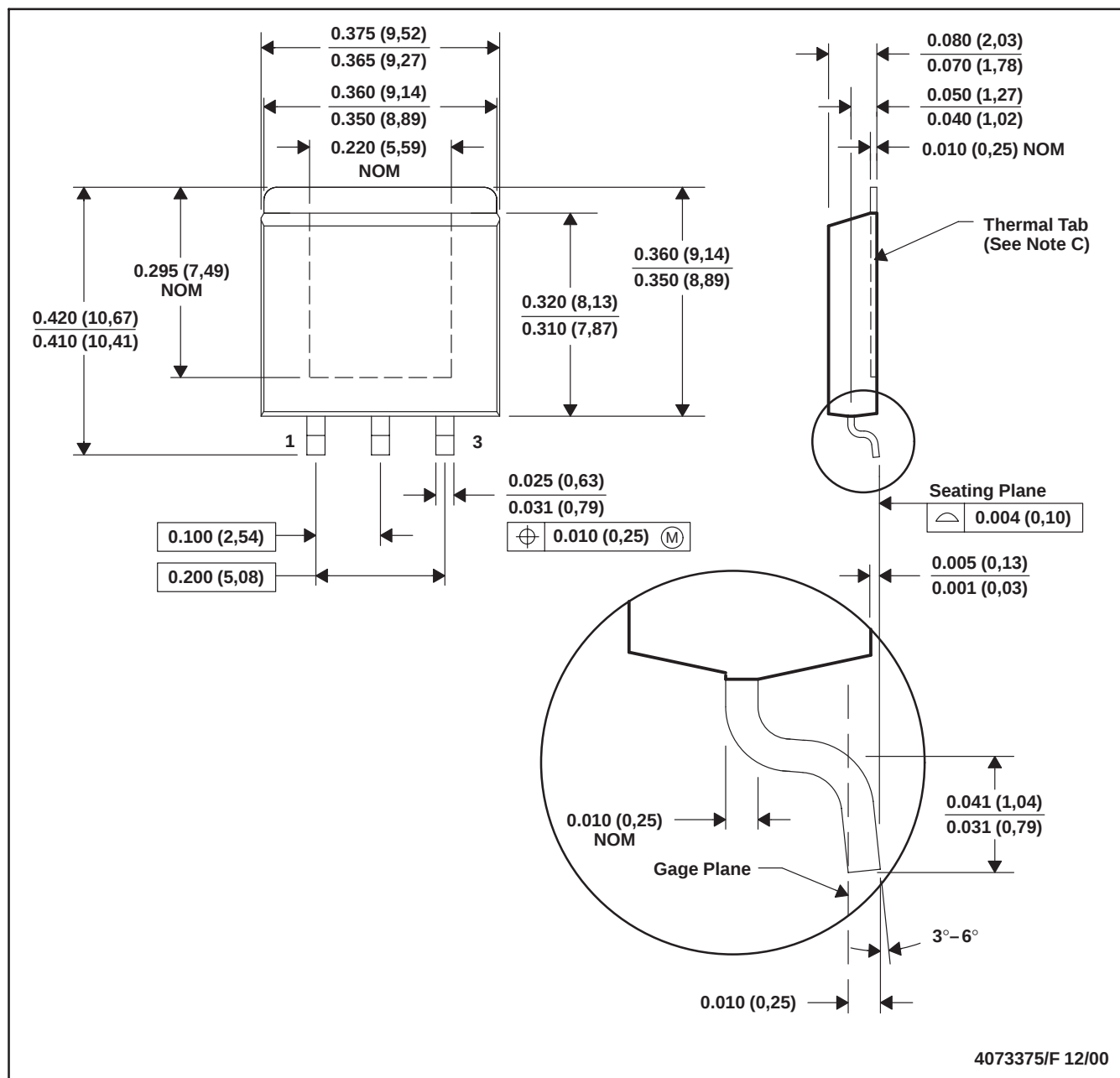


Figure 5. Reverse-Bias-Protection Circuit

KTE (R-PSFM-G3)

PowerFLEX™ PLASTIC FLANGE-MOUNT



- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - The center lead is in electrical contact with the thermal tab.
  - Dimensions do not include mold protrusions, not to exceed 0.006 (0,15).
  - Falls within JEDEC MO-169

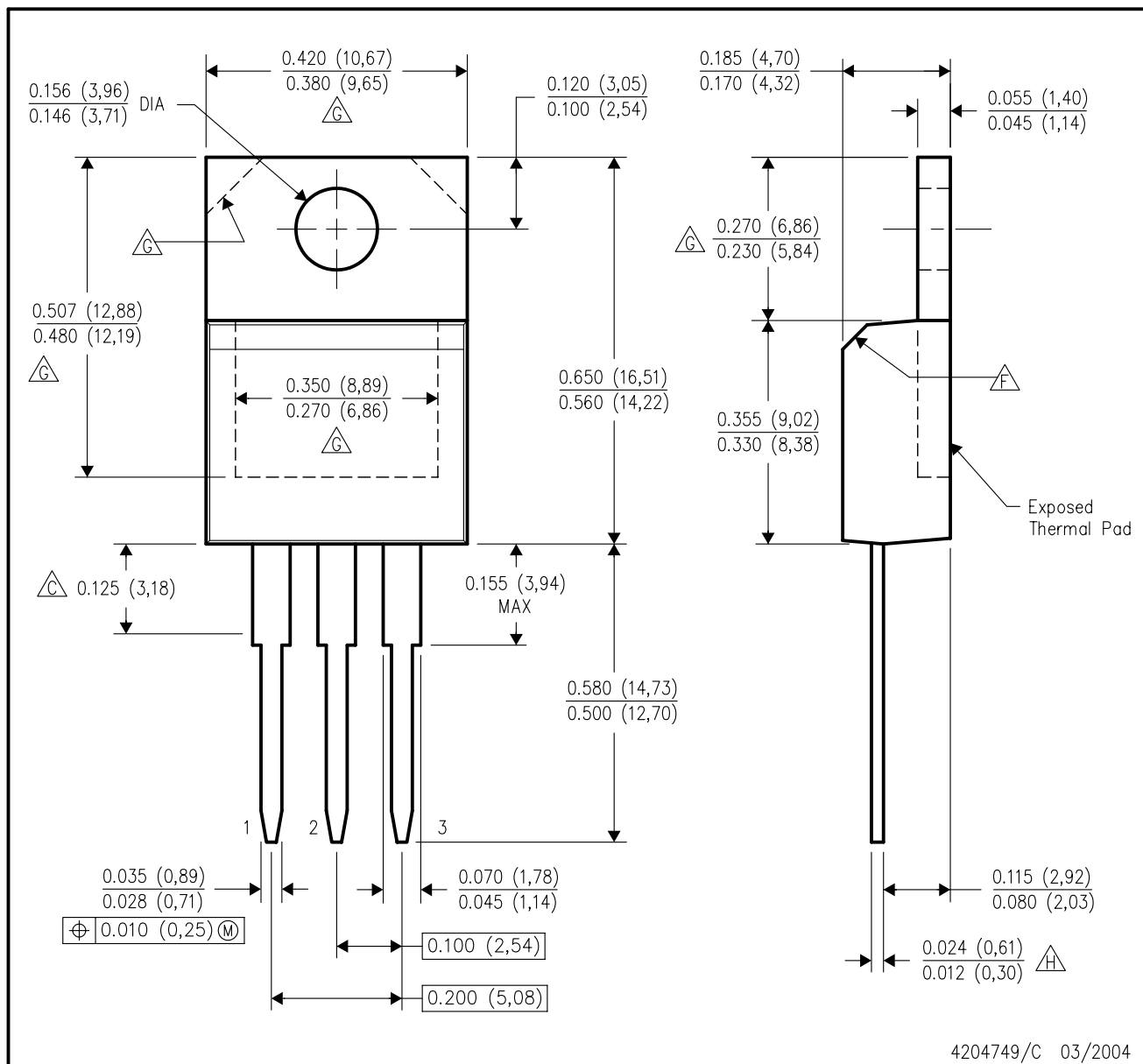
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## KCS (R-PSFM-T3)

## PLASTIC FLANGE-MOUNT PACKAGE

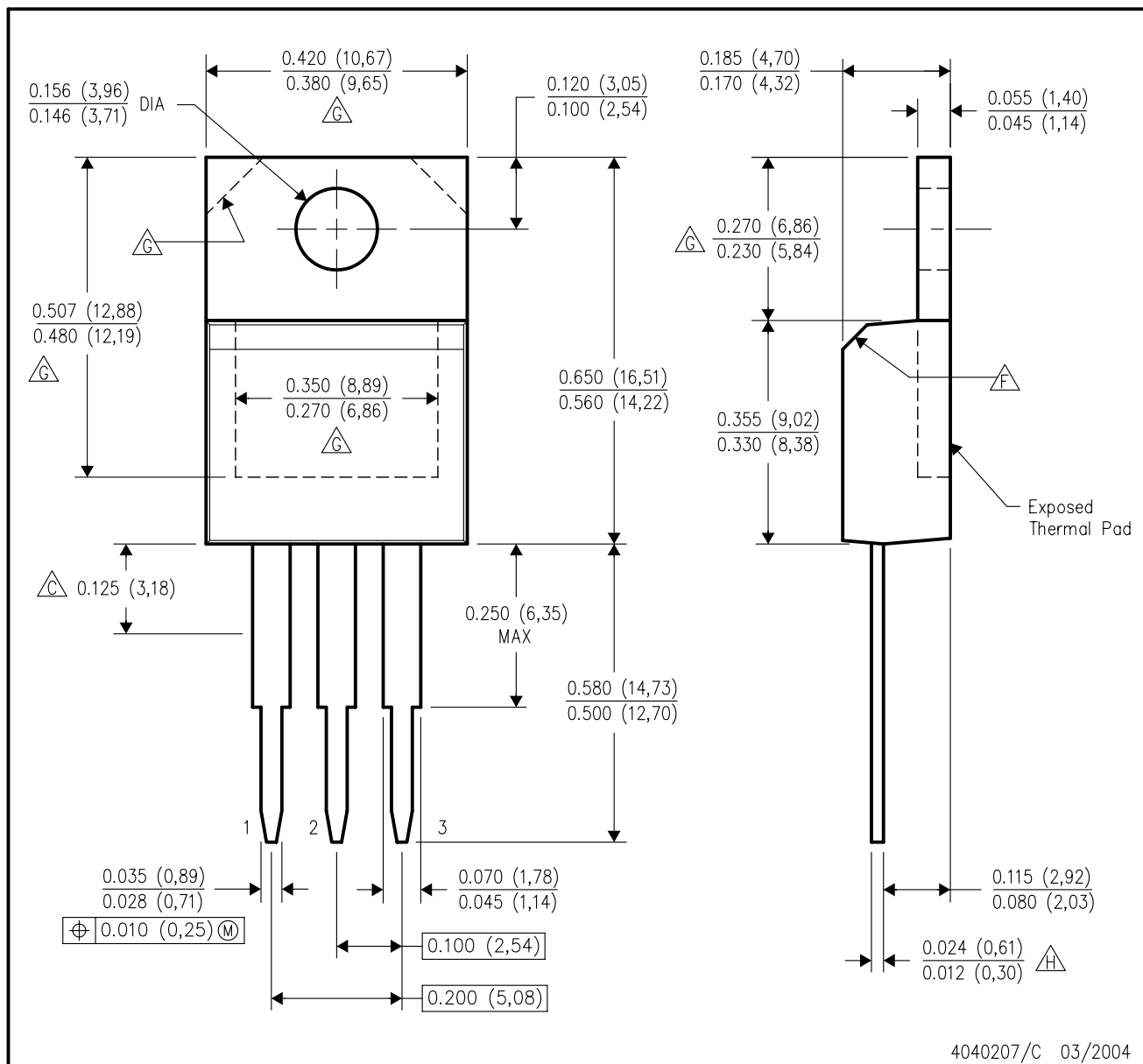


## NOTES:

- 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. Thermal pad contour optional within these dimensions.
- H. Falls within JEDEC TO-220 variation AB, except minimum lead thickness.

## 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. Thermal pad contour optional within these dimensions.
- H. Falls within JEDEC TO-220 variation AB, except minimum lead thickness.

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