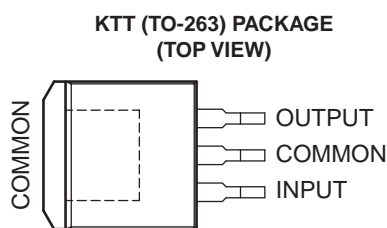
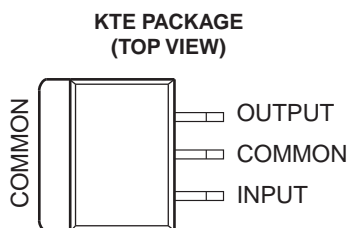
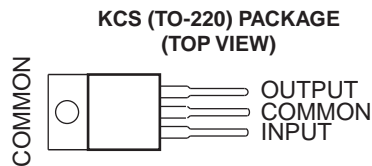
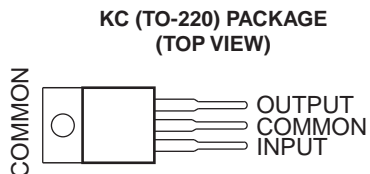


## FEATURES

- $\pm 1\%$  Output Tolerance at 25°C
- $\pm 2\%$  Output Tolerance Over Full Operating Range
- Thermal Shutdown
- Internal Short-Circuit Current Limiting
- Pinout Identical to  $\mu A7800$  Series
- Improved Version of  $\mu A7800$  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>(1)</sup>       |              | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|--------------|---------------|------------------------------|--------------|-----------------------|------------------|
| 0°C to 125°C | 5             | PowerFLEX™ – 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         |
|              |               | TO-263 – KTT                 | Reel of 500  | TL780-05CKTTR         | TL780-05C        |
|              | 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         |

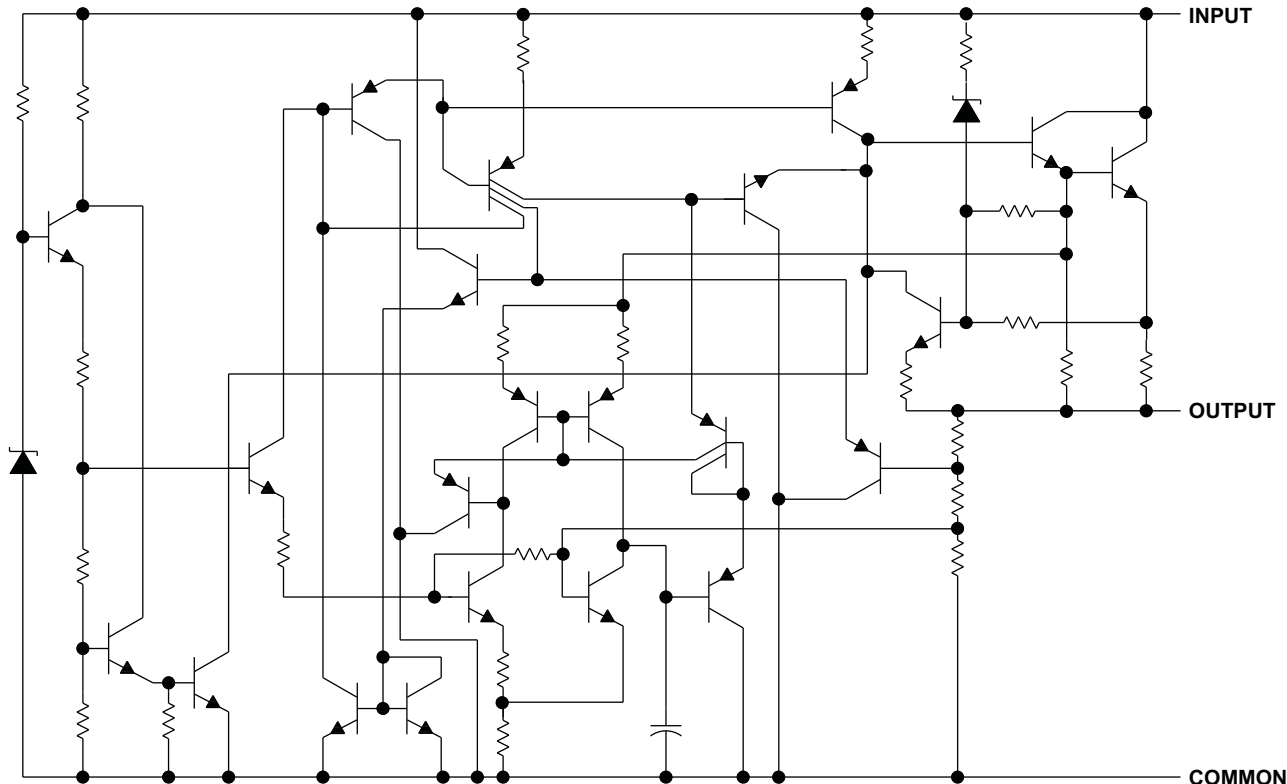
(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PowerFLEX, PowerPAD are trademarks of Texas Instruments.

**SCHEMATIC**



**Absolute Maximum Ratings<sup>(1)</sup>**

over operating temperature ranges (unless otherwise noted)

|           |  | MIN | MAX | UNIT |
|-----------|--|-----|-----|------|
| $V_I$     | Input voltage  |     | 35  | V    |
| $T_J$     | Operating virtual junction temperature               |     | 150 | °C   |
|           | Lead temperature 1,6 mm (1/16 in) from case for 10 s |     | 260 | °C   |
| $T_{stg}$ | Storage temperature range                            | -65 | 150 | °C   |

(1) 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<sup>(1)</sup>**

| PACKAGE         | BOARD             | $\theta_{JP}$ <sup>(2)</sup> | $\theta_{JC}$ | $\theta_{JA}$ |
|-----------------|-------------------|------------------------------|---------------|---------------|
| PowerFLEX (KTE) | High K, JESD 51-5 | 2.7°C/W                      | 11.6°C/W      | 23.3°C/W      |
| TO-220 (KC/KCS) | High K, JESD 51-5 | 3°C/W                        | 17°C/W        | 19°C/W        |
| TO-263 (KTT)    | High K, JESD 51-5 | 1.91°C/W                     | 18°C/W        | 25.3°C/W      |

(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 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.

(2) For packages with exposed thermal pads, such as QFN, PowerPAD™, or PowerFLEX,  $\theta_{JP}$  is defined as the thermal resistance between the die junction and the bottom of the exposed pad.

**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,  $V_I = 10\text{ V}$ ,  $I_O = 500\text{ mA}$  (unless otherwise noted)

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

(1) 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.

# TL780 SERIES POSITIVE-VOLTAGE REGULATORS

SLVS055M – APRIL 1981 – REVISED OCTOBER 2006

## Electrical Characteristics

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

| PARAMETER                                 | TEST CONDITIONS  | $T_J^{(1)}$  | 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             |

(1) 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.

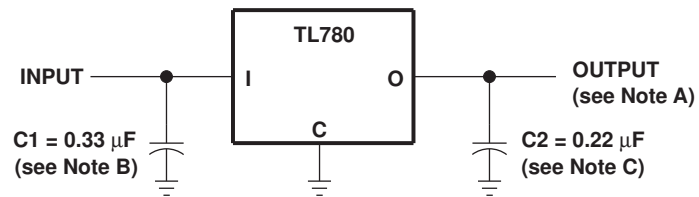
## Electrical Characteristics

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

| PARAMETER                                 | TEST CONDITIONS  | $T_J^{(1)}$  | 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             |

(1) 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.

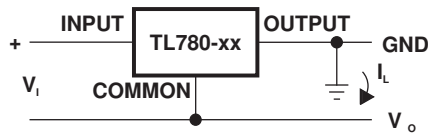
### PARAMETER MEASUREMENT INFORMATION



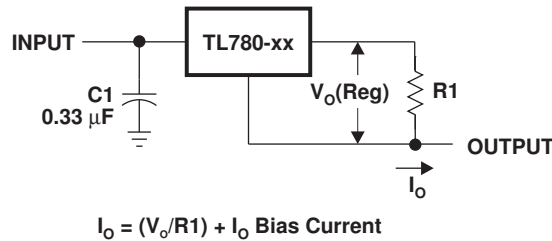
- A. Permanent damage can occur when OUTPUT is pulled below ground.
- B. C1 is required when the regulator is far from the power-supply filter.
- C. C2 is not required for stability; however, transient response is improved.

**Figure 1. Test Circuit**

**APPLICATION INFORMATION**



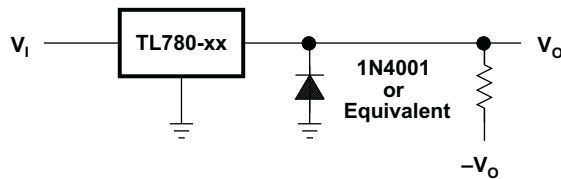
**Figure 2. Positive Regulator in Negative Configuration ( $V_i$  Must Float)**



**Figure 3. Current Regulator**

**Operation With a Load Common to a Voltage of Opposite Polarity**

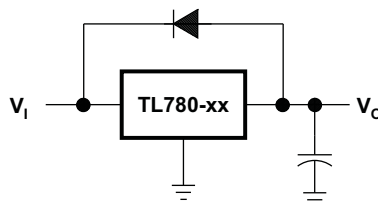
In many cases, a regulator powers a load that is not connected to ground, but instead, is connected to a voltage source of opposite polarity (e.g., operational amplifiers, level-shifting circuits, etc.). In these cases, a clamp diode should be connected to the regulator output as shown in [Figure 4](#). 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**

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type     | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup>    | Lead/<br>Ball Finish | MSL Peak Temp <sup>(3)</sup> | Samples<br>(Requires Login)               |
|------------------|-----------------------|------------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|---|
| TL780-05CKC      | OBSOLETE              | TO-220           | KC              | 3    |             | TBD                        | Call TI              | Call TI                      | Replaced by TL780-05KCS                   |
| TL780-05CKTER    | OBSOLETE              | PFM              | KTE             | 3    |             | TBD                        | Call TI              | Call TI                      | Samples Not Available                     |
| TL780-05CKTTR    | ACTIVE                | DDPAK/<br>TO-263 | KTT             | 3    | 500         | Green (RoHS<br>& no Sb/Br) | CU SN                | Level-3-245C-168 HR          | <a href="#">Request Free Samples</a>      |
| TL780-05CKTTRG3  | ACTIVE                | DDPAK/<br>TO-263 | KTT             | 3    | 500         | Green (RoHS<br>& no Sb/Br) | CU SN                | Level-3-245C-168 HR          | <a href="#">Request Free Samples</a>      |
| TL780-05KCS      | ACTIVE                | TO-220           | KCS             | 3    | 50          | Pb-Free (RoHS)             | CU SN                | N / A for Pkg Type           | Contact TI Distributor<br>or Sales Office |
| TL780-05KCSE3    | ACTIVE                | TO-220           | KCS             | 3    | 50          | Pb-Free (RoHS)             | CU SN                | N / A for Pkg Type           | Contact TI Distributor<br>or Sales Office |
| TL780-12CKC      | OBSOLETE              | TO-220           | KC              | 3    |             | TBD                        | Call TI              | Call TI                      | Replaced by TL780-12KCS                   |
| TL780-12CKCE3    | OBSOLETE              | TO-220           | KC              | 3    |             | TBD                        | Call TI              | Call TI                      | Samples Not Available                     |
| TL780-12CKTER    | OBSOLETE              | PFM              | KTE             | 3    |             | TBD                        | Call TI              | Call TI                      | Samples Not Available                     |
| TL780-12KCS      | ACTIVE                | TO-220           | KCS             | 3    | 50          | Pb-Free (RoHS)             | CU SN                | N / A for Pkg Type           | Contact TI Distributor<br>or Sales Office |
| TL780-12KCSE3    | ACTIVE                | TO-220           | KCS             | 3    | 50          | Pb-Free (RoHS)             | CU SN                | N / A for Pkg Type           | Contact TI Distributor<br>or Sales Office |
| TL780-15CKC      | OBSOLETE              | TO-220           | KC              | 3    |             | TBD                        | Call TI              | Call TI                      | Replaced by TL780-15KCS                   |
| TL780-15CKTER    | OBSOLETE              | PFM              | KTE             | 3    |             | TBD                        | Call TI              | Call TI                      | Samples Not Available                     |
| TL780-15KCS      | ACTIVE                | TO-220           | KCS             | 3    | 50          | Pb-Free (RoHS)             | CU SN                | N / A for Pkg Type           | Contact TI Distributor<br>or Sales Office |
| TL780-15KCSE3    | ACTIVE                | TO-220           | KCS             | 3    | 50          | Pb-Free (RoHS)             | CU SN                | N / A for Pkg Type           | Contact TI Distributor<br>or Sales Office |

<sup>(1)</sup> 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.

<sup>(2)</sup> 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.

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**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)

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

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**TAPE AND REEL INFORMATION**



**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|---------------|--------------|-----------------|------|-----|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TL780-05CKTTR | DDPAK/TO-263 | KTT             | 3    | 500 | 330.0              | 24.4               | 10.6    | 15.8    | 4.9     | 16.0    | 24.0   | Q2            |

**TAPE AND REEL BOX DIMENSIONS**

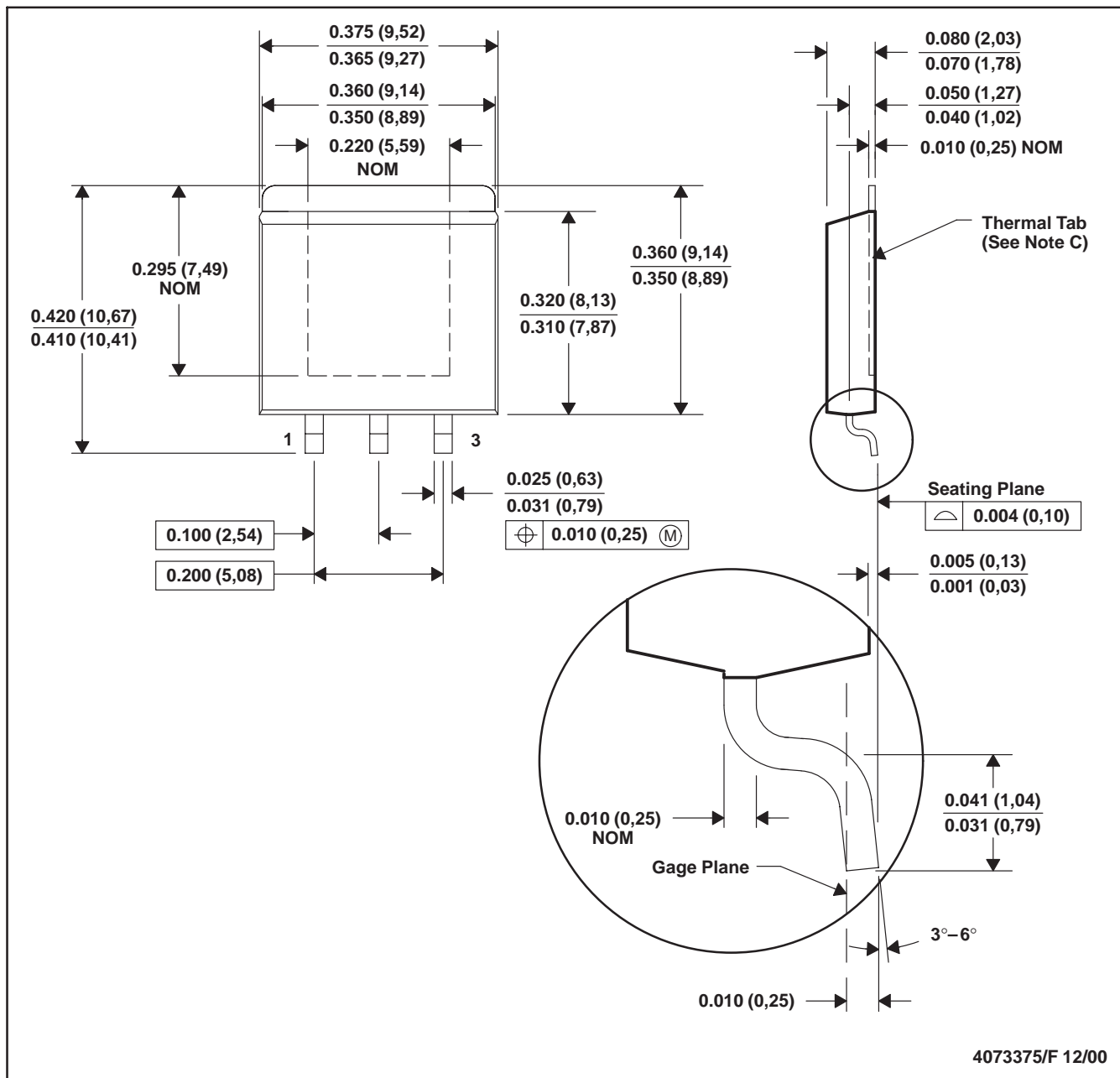


\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|-----|-------------|------------|-------------|
| TL780-05CKTTR | DDPAK/TO-263 | KTT             | 3    | 500 | 340.0       | 340.0      | 38.0        |

KTE (R-PSFM-G3)

PowerFLEX™ PLASTIC FLANGE-MOUNT



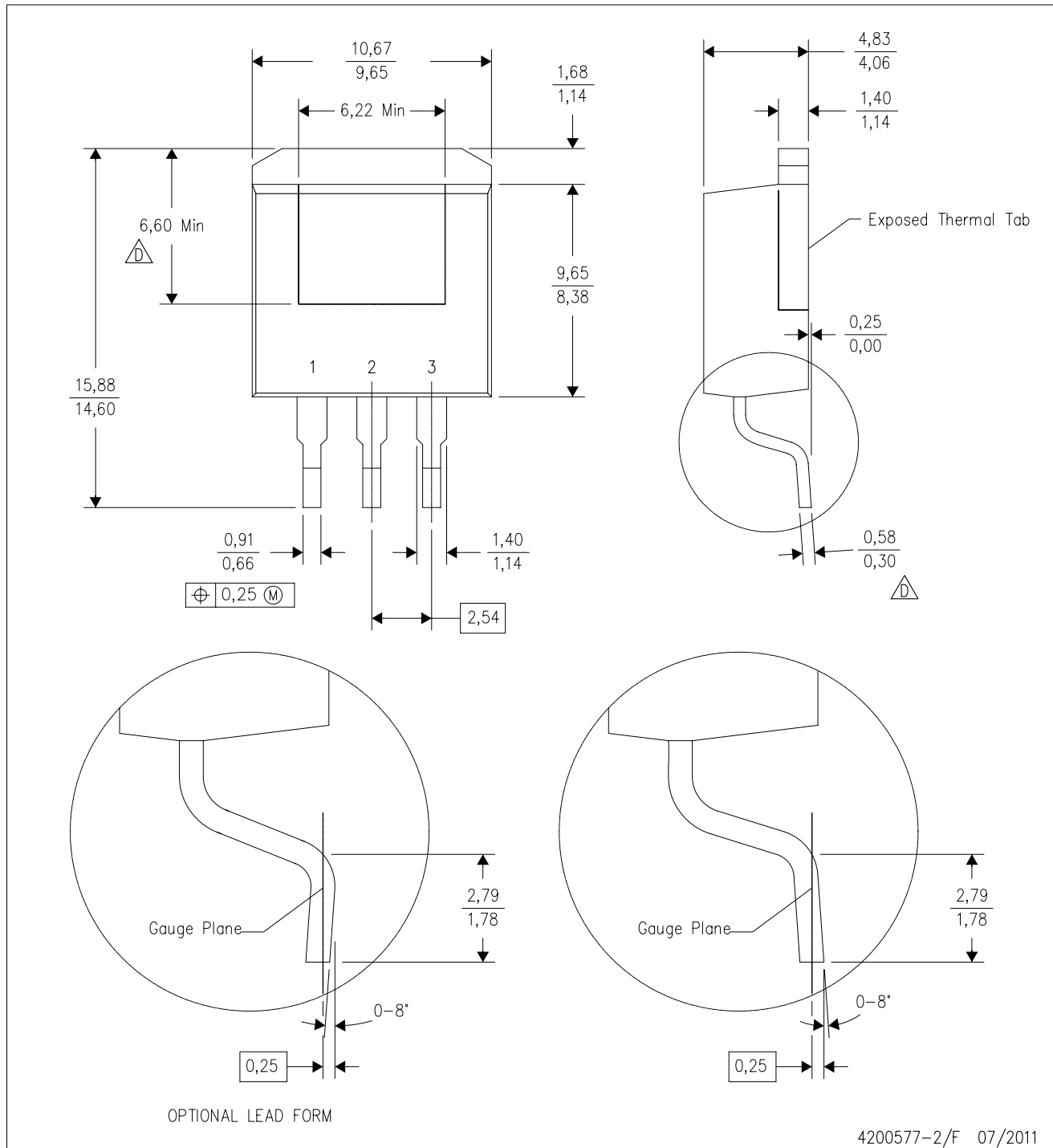
- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. The center lead is in electrical contact with the thermal tab.  
 D. Dimensions do not include mold protrusions, not to exceed 0.006 (0,15).  
 E. Falls within JEDEC MO-169

PowerFLEX is a trademark of Texas Instruments.



KTT (R-PSFM-G3)

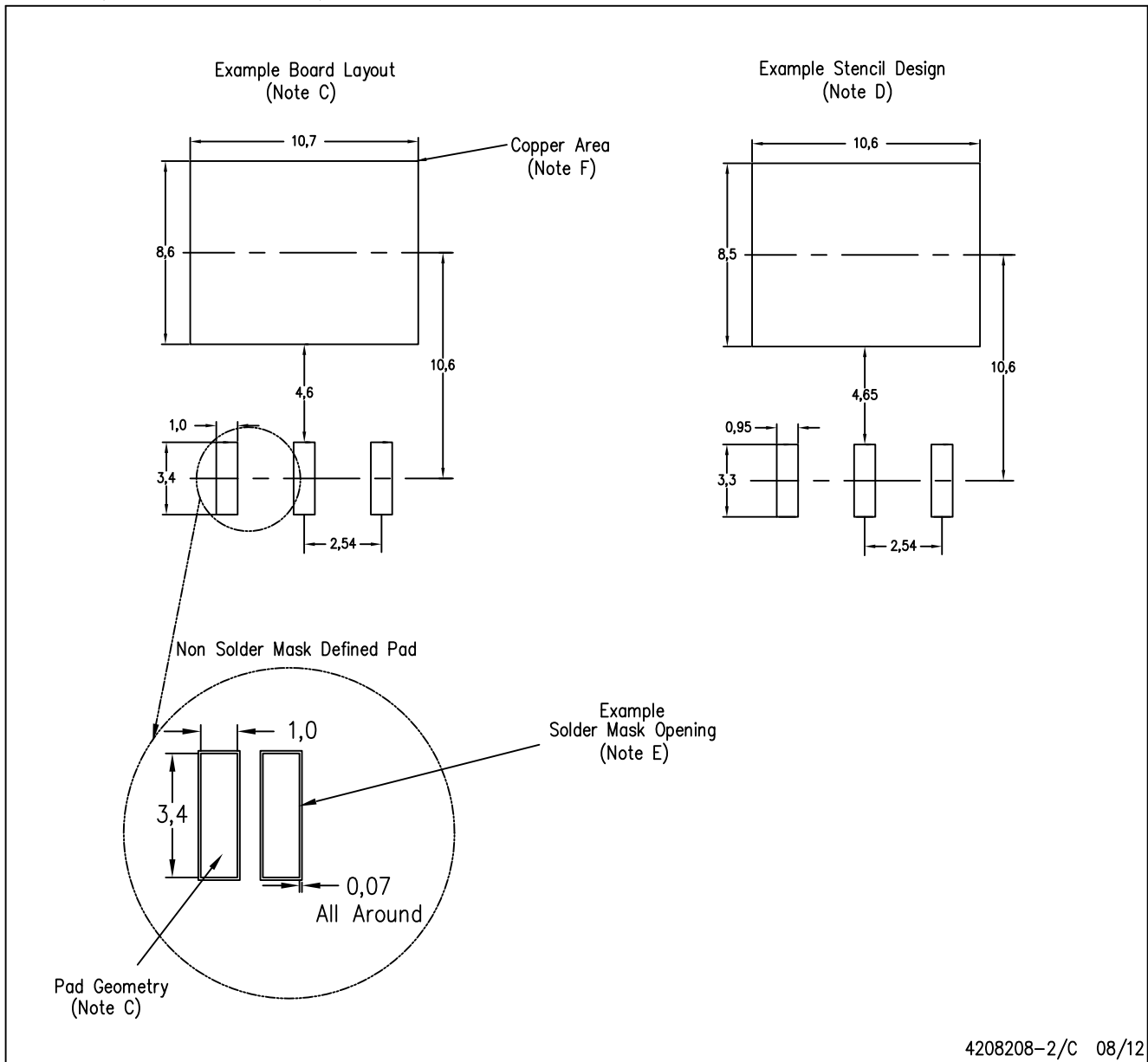
PLASTIC FLANGE-MOUNT PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion. Mold flash or protrusion not to exceed 0.005 (0,13) per side.
- △ Falls within JEDEC TO-263 variation AA, except minimum lead thickness and minimum exposed pad length.

KTT (R-PSFM-G3)

PLASTIC FLANGE-MOUNT PACKAGE

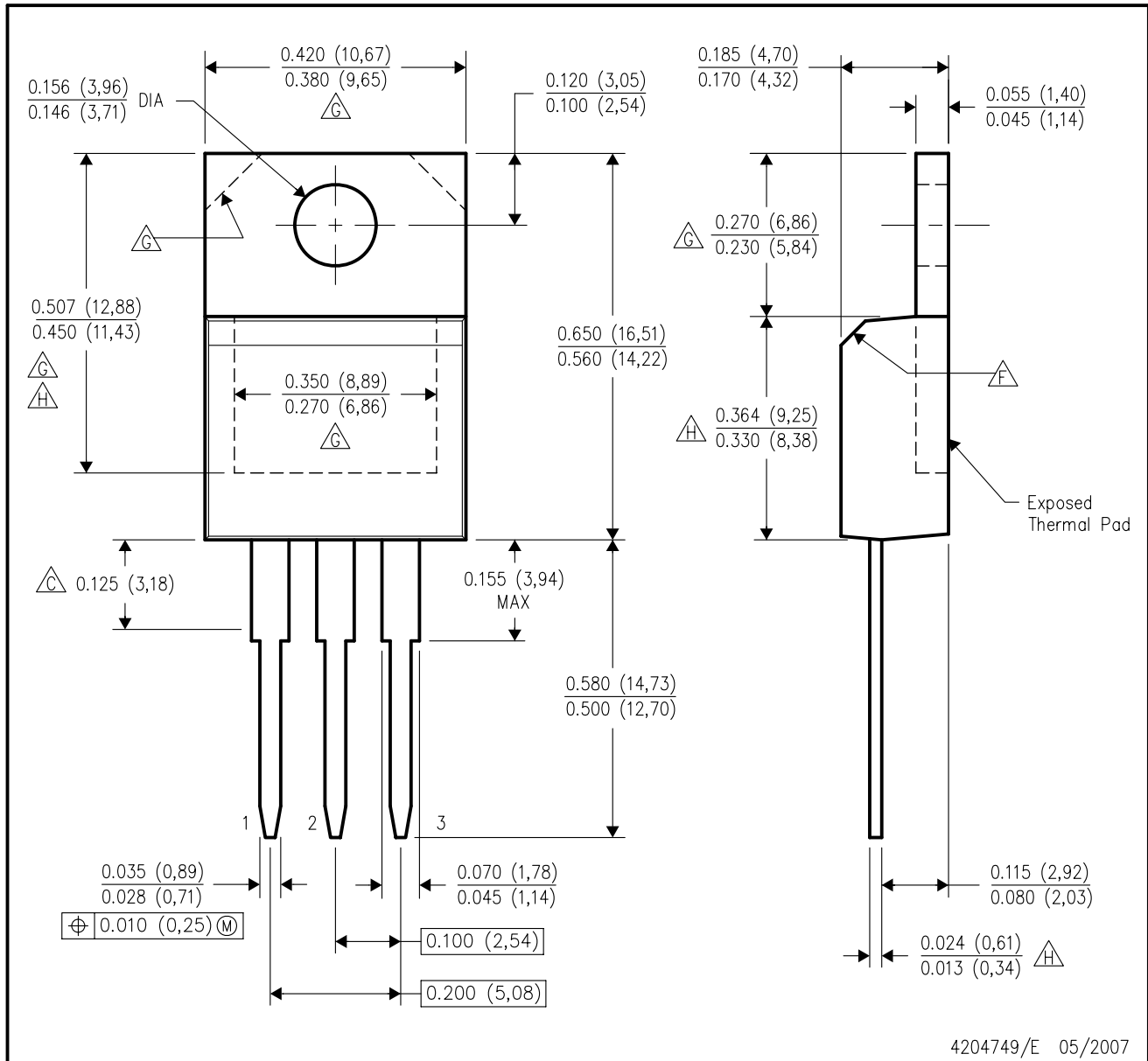


4208208-2/C 08/12

- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-SM-782 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.
  - This package is designed to be soldered to a thermal pad on the board. Refer to the Product Datasheet for specific thermal information, via requirements, and recommended thermal pad size. For thermal pad sizes larger than shown a solder mask defined pad is recommended in order to maintain the solderable pad geometry while increasing copper area.

KCS (R-PSFM-T3)

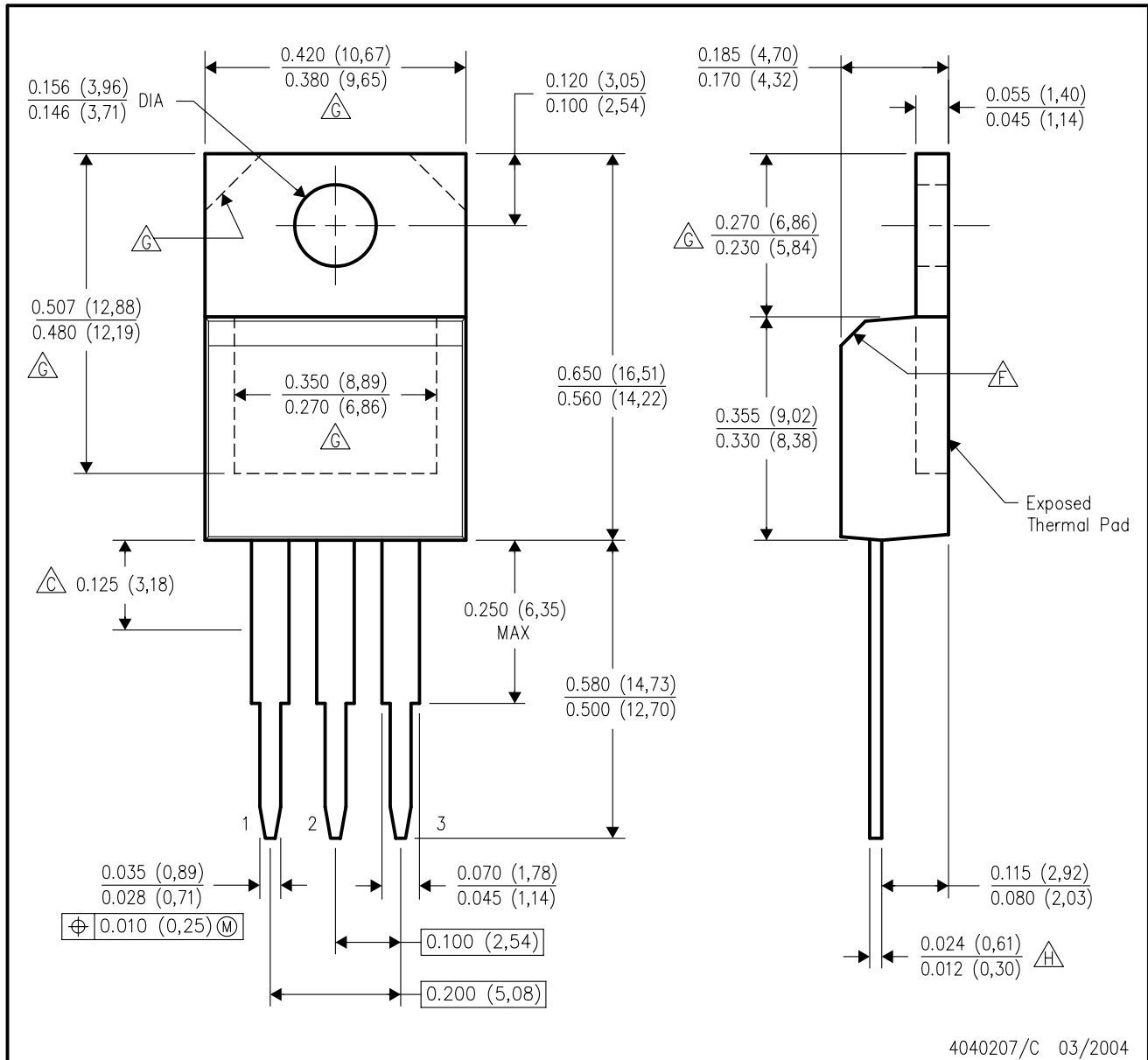
PLASTIC FLANGE-MOUNT PACKAGE



- 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, minimum exposed pad length, and maximum body length.

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.
  - $\triangle C$  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.
  - $\triangle F$  The chamfer is optional.
  - $\triangle G$  Thermal pad contour optional within these dimensions.
  - $\triangle H$  Falls within JEDEC TO-220 variation AB, except minimum lead thickness.

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