- **3-Terminal Regulators**
- **Output Current up to 1.5 A**
- **Internal Thermal-Overload Protection**
- **High Power-Dissipation Capability**
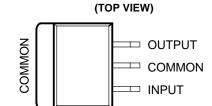- **Internal Short-Circuit Current Limiting**
- **Output Transistor Safe-Area Compensation**

**KC (TO-220) PACKAGE**
**(TOP VIEW)**

**KCS (TO-220) PACKAGE**
**(TOP VIEW)**

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

## description/ordering information

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 1.5 A of output current. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload. In addition to use as fixed-voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents, and also can be used as the power-pass element in precision regulators.

### ORDERING INFORMATION

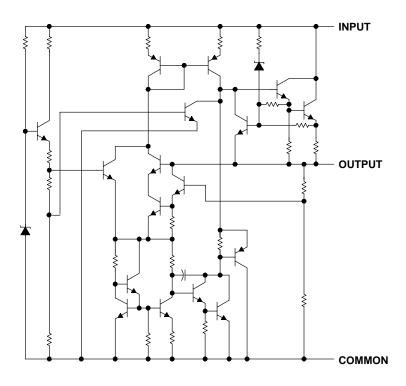| $T_J$ | $V_{O(NOM)}$ (V) | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|---|
| 0°C to 125°C | 5 | POWER-FLEX (KTE) | Reel of 2000 | µA7805CKTER | µA7805C |
| | | TO-220 (KC) | Tube of 50 | µA7805CKC | µA7805C |
| | | TO-220, short shoulder (KCS) | Tube of 20 | µA7805CKCS | |
| | 8 | POWER-FLEX (KTE) | Reel of 2000 | µA7808CKTER | µA7808C |
| | | TO-220 (KC) | Tube of 50 | µA7808CKC | µA7808C |
| | | TO-220, short shoulder (KCS) | Tube of 20 | µA7808CKCS | |
| | 10 | POWER-FLEX (KTE) | Reel of 2000 | µA7810CKTER | µA7810C |
| | | TO-220 (KC) | Tube of 50 | µA7810CKC | µA7810C |
| | 12 | POWER-FLEX (KTE) | Reel of 2000 | µA7812CKTER | µA7812C |
| | | TO-220 (KC) | Tube of 50 | µA7812CKC | µA7812C |
| | | TO-220, short shoulder (KCS) | Tube of 20 | µA7812CKCS | |
| | 15 | POWER-FLEX (KTE) | Reel of 2000 | µA7815CKTER | µA7815C |
| | | TO-220 (KC) | Tube of 50 | µA7815CKC | µA7815C |
| | | TO-220, short shoulder (KCS) | Tube of 20 | µA7815CKCS | |
| | 24 | POWER-FLEX (KTE) | Reel of 2000 | µA7824CKTER | µA7824C |
| | | TO-220 (KC) | Tube of 50 | µA7824CKC | µA7824C |

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

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**TEXAS INSTRUMENTS**

## schematic



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

Input voltage, $V_I$: μA7824C ............................................................... 40 V
                   All others ............................................................... 35 V
Package thermal impedance, $\theta_{JA}$ (see Notes 1 and 2): KC/KCS package ...................... 25°C/W
                                                KTE package ........................ 23°C/W
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

† 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 $P_D = (T_J(max) - T_A)/\theta_{JA}$. Selecting the maximum of 150°C can affect reliability.
           2. The package thermal impedance is calculated in accordance with JESD 51-5.

## recommended operating conditions

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_I$ | Input voltage | μA7805C | 7 | 25 | V |
| | | μA7808C | 10.5 | 25 | |
| | | μA7810C | 12.5 | 28 | |
| | | μA7812C | 14.5 | 30 | |
| | | μA7815C | 17.5 | 30 | |
| | | μA7824C | 27 | 38 | |
| $I_O$ | Output current | | | 1.5 | A |
| $T_J$ | Operating virtual junction temperature | μA7800C series | 0 | 125 | °C |

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

| PARAMETER | TEST CONDITIONS | $T_J$† | μA7805C MIN | μA7805C TYP | μA7805C MAX | UNIT |
|---|---|---|---|---|---|---|
| Output voltage | $I_O$ = 5 mA to 1 A,   $V_I$ = 7 V to 20 V, $P_D$ ≤ 15 W | 25°C | 4.8 | 5 | 5.2 | V |
| | | 0°C to 125°C | 4.75 | | 5.25 | |
| Input voltage regulation | $V_I$ = 7 V to 25 V | 25°C | | 3 | 100 | mV |
| | $V_I$ = 8 V to 12 V | | | 1 | 50 | |
| Ripple rejection | $V_I$ = 8 V to 18 V,   f = 120 Hz | 0°C to 125°C | 62 | 78 | | dB |
| Output voltage regulation | $I_O$ = 5 mA to 1.5 A | 25°C | | 15 | 100 | mV |
| | $I_O$ = 250 mA to 750 mA | | | 5 | 50 | |
| Output resistance | f = 1 kHz | 0°C to 125°C | | 0.017 | | Ω |
| Temperature coefficient of output voltage | $I_O$ = 5 mA | 0°C to 125°C | | −1.1 | | mV/°C |
| Output noise voltage | f = 10 Hz to 100 kHz | 25°C | | 40 | | μV |
| Dropout voltage | $I_O$ = 1 A | 25°C | | 2 | | V |
| Bias current | | 25°C | | 4.2 | 8 | mA |
| Bias current change | $V_I$ = 7 V to 25 V | 0°C to 125°C | | | 1.3 | mA |
| | $I_O$ = 5 mA to 1 A | | | | 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 0.1-μF capacitor across the output.

## electrical characteristics at specified virtual junction temperature, $V_I$ = 14 V, $I_O$ = 500 mA (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | $T_J$† | μA7808C MIN | μA7808C TYP | μA7808C MAX | UNIT |
|---|---|---|---|---|---|---|
| Output voltage | $I_O$ = 5 mA to 1 A,   $V_I$ = 10.5 V to 23 V, $P_D$ ≤ 15 W | 25°C | 7.7 | 8 | 8.3 | V |
| | | 0°C to 125°C | 7.6 | | 8.4 | |
| Input voltage regulation | $V_I$ = 10.5 V to 25 V | 25°C | | 6 | 160 | mV |
| | $V_I$ = 11 V to 17 V | | | 2 | 80 | |
| Ripple rejection | $V_I$ = 11.5 V to 21.5 V,   f = 120 Hz | 0°C to 125°C | 55 | 72 | | dB |
| Output voltage regulation | $I_O$ = 5 mA to 1.5 A | 25°C | | 12 | 160 | mV |
| | $I_O$ = 250 mA to 750 mA | | | 4 | 80 | |
| Output resistance | f = 1 kHz | 0°C to 125°C | | 0.016 | | Ω |
| Temperature coefficient of output voltage | $I_O$ = 5 mA | 0°C to 125°C | | −0.8 | | mV/°C |
| Output noise voltage | f = 10 Hz to 100 kHz | 25°C | | 52 | | μV |
| Dropout voltage | $I_O$ = 1 A | 25°C | | 2 | | V |
| Bias current | | 25°C | | 4.3 | 8 | mA |
| Bias current change | $V_I$ = 10.5 V to 25 V | 0°C to 125°C | | | 1 | mA |
| | $I_O$ = 5 mA to 1 A | | | | 0.5 | |
| Short-circuit output current | | 25°C | | 450 | | 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 0.1-μF capacitor across the output.

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## electrical characteristics at specified virtual junction temperature, $V_I$ = 17 V, $I_O$ = 500 mA (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | $T_J$† | μA7810C MIN | μA7810C TYP | μA7810C MAX | UNIT |
|---|---|---|---|---|---|---|
| Output voltage | $I_O$ = 5 mA to 1 A,  $V_I$ = 12.5 V to 25 V, $P_D$ ≤ 15 W | 25°C | 9.6 | 10 | 10.4 | V |
| | | 0°C to 125°C | 9.5 | 10 | 10.5 | |
| Input voltage regulation | $V_I$ = 12.5 V to 28 V | 25°C | | 7 | 200 | mV |
| | $V_I$ = 14 V to 20 V | | | 2 | 100 | |
| Ripple rejection | $V_I$ = 13 V to 23 V,  f = 120 Hz | 0°C to 125°C | 55 | 71 | | dB |
| Output voltage regulation | $I_O$ = 5 mA to 1.5 A | 25°C | | 12 | 200 | mV |
| | $I_O$ = 250 mA to 750 mA | | | 4 | 100 | |
| Output resistance | f = 1 kHz | 0°C to 125°C | | 0.018 | | Ω |
| Temperature coefficient of output voltage | $I_O$ = 5 mA | 0°C to 125°C | | −1 | | mV/°C |
| Output noise voltage | f = 10 Hz to 100 kHz | 25°C | | 70 | | μV |
| Dropout voltage | $I_O$ = 1 A | 25°C | | 2 | | V |
| Bias current | | 25°C | | 4.3 | 8 | mA |
| Bias current change | $V_I$ = 12.5 V to 28 V | 0°C to 125°C | | | 1 | mA |
| | $I_O$ = 5 mA to 1 A | | | | 0.5 | |
| Short-circuit output current | | 25°C | | 400 | | 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 0.1-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 | $T_J$† | μA7812C MIN | μA7812C TYP | μA7812C MAX | UNIT |
|---|---|---|---|---|---|---|
| Output voltage | $I_O$ = 5 mA to 1 A,  $V_I$ = 14.5 V to 27 V, $P_D$ ≤ 15 W | 25°C | 11.5 | 12 | 12.5 | V |
| | | 0°C to 125°C | 11.4 | | 12.6 | |
| Input voltage regulation | $V_I$ = 14.5 V to 30 V | 25°C | | 10 | 240 | mV |
| | $V_I$ = 16 V to 22 V | | | 3 | 120 | |
| Ripple rejection | $V_I$ = 15 V to 25 V,  f = 120 Hz | 0°C to 125°C | 55 | 71 | | dB |
| Output voltage regulation | $I_O$ = 5 mA to 1.5 A | 25°C | | 12 | 240 | mV |
| | $I_O$ = 250 mA to 750 mA | | | 4 | 120 | |
| Output resistance | f = 1 kHz | 0°C to 125°C | | 0.018 | | Ω |
| Temperature coefficient of output voltage | $I_O$ = 5 mA | 0°C to 125°C | | −1 | | 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 |
| Bias current | | 25°C | | 4.3 | 8 | mA |
| Bias current change | $V_I$ = 14.5 V to 30 V | 0°C to 125°C | | | 1 | mA |
| | $I_O$ = 5 mA to 1 A | | | | 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 0.1-μF capacitor across the output.

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

| PARAMETER | TEST CONDITIONS | $T_J$† | μA7815C | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| Output voltage | $I_O$ = 5 mA to 1 A, $V_I$ = 17.5 V to 30 V, $P_D \leq$ 15 W | 25°C | 14.4 | 15 | 15.6 | V |
| | | 0°C to 125°C | 14.25 | | 15.75 | |
| Input voltage regulation | $V_I$ = 17.5 V to 30 V | 25°C | | 11 | 300 | mV |
| | $V_I$ = 20 V to 26 V | | | 3 | 150 | |
| Ripple rejection | $V_I$ = 18.5 V to 28.5 V,    f = 120 Hz | 0°C to 125°C | 54 | 70 | | dB |
| Output voltage regulation | $I_O$ = 5 mA to 1.5 A | 25°C | | 12 | 300 | mV |
| | $I_O$ = 250 mA to 750 mA | | | 4 | 150 | |
| Output resistance | f = 1 kHz | 0°C to 125°C | | 0.019 | | Ω |
| Temperature coefficient of output voltage | $I_O$ = 5 mA | 0°C to 125°C | | −1 | | mV/°C |
| Output noise voltage | f = 10 Hz to 100 kHz | 25°C | | 90 | | μV |
| Dropout voltage | $I_O$ = 1 A | 25°C | | 2 | | V |
| Bias current | | 25°C | | 4.4 | 8 | mA |
| Bias current change | $V_I$ = 17.5 V to 30 V | 0°C to 125°C | | | 1 | mA |
| | $I_O$ = 5 mA to 1 A | | | | 0.5 | |
| Short-circuit output current | | 25°C | | 230 | | mA |
| Peak output current | | 25°C | | 2.1 | | 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 0.1-μF capacitor across the output.

## electrical characteristics at specified virtual junction temperature, $V_I$ = 33 V, $I_O$ = 500 mA (unless otherwise noted)

| PARAMETER | TEST CONDITIONS | $T_J$† | μA7824C | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| Output voltage | $I_O$ = 5 mA to 1 A, $V_I$ = 27 V to 38 V, $P_D \leq$ 15 W | 25°C | 23 | 24 | 25 | V |
| | | 0°C to 125°C | 22.8 | | 25.2 | |
| Input voltage regulation | $V_I$ = 27 V to 38 V | 25°C | | 18 | 480 | mV |
| | $V_I$ = 30 V to 36 V | | | 6 | 240 | |
| Ripple rejection | $V_I$ = 28 V to 38 V,    f = 120 Hz | 0°C to 125°C | 50 | 66 | | dB |
| Output voltage regulation | $I_O$ = 5 mA to 1.5 A | 25°C | | 12 | 480 | mV |
| | $I_O$ = 250 mA to 750 mA | | | 4 | 240 | |
| Output resistance | f = 1 kHz | 0°C to 125°C | | 0.028 | | Ω |
| Temperature coefficient of output voltage | $I_O$ = 5 mA | 0°C to 125°C | | −1.5 | | mV/°C |
| Output noise voltage | f = 10 Hz to 100 kHz | 25°C | | 170 | | μV |
| Dropout voltage | $I_O$ = 1 A | 25°C | | 2 | | V |
| Bias current | | 25°C | | 4.6 | 8 | mA |
| Bias current change | $V_I$ = 27 V to 38 V | 0°C to 125°C | | | 1 | mA |
| | $I_O$ = 5 mA to 1 A | | | | 0.5 | |
| Short-circuit output current | | 25°C | | 150 | | mA |
| Peak output current | | 25°C | | 2.1 | | 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 0.1-μF capacitor across the output.

TEXAS
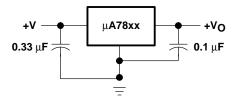INSTRUMENTS

## APPLICATION INFORMATION
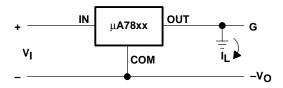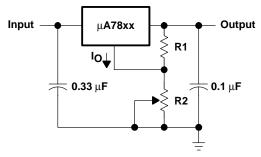
**Figure 1. Fixed-Output Regulator**

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

NOTE A:  The following formula is used when V$_{xx}$ is the nominal output voltage (output to common) of the fixed regulator:

$$V_O = V_{xx} + \left(\frac{V_{xx}}{R1} + I_Q\right)R2$$
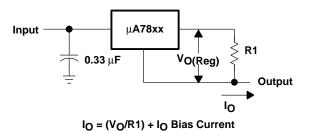
**Figure 3. Adjustable-Output Regulator**

I$_O$ = (V$_O$/R1) + I$_O$ Bias Current

**Figure 4. Current Regulator**

TEXAS
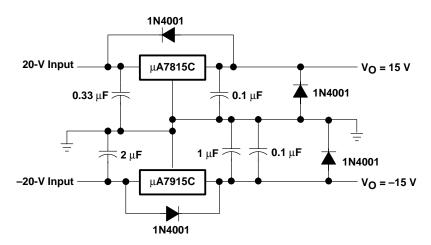INSTRUMENTS

## APPLICATION INFORMATION

**Figure 5. Regulated Dual Supply**

### 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 6. This protects the regulator from output polarity reversals during startup and short-circuit operation.
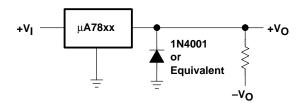
**Figure 6. Output Polarity-Reversal-Protection Circuit**

### 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 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 used as shown in Figure 7.

**Figure 7. Reverse-Bias-Protection Circuit**

**KTE (R-PSFM-G3)**  PowerFLEX™ PLASTIC FLANGE-MOUNT



**4073375/F 12/00**

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

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1

0.156 (3,96)
0.146 (3,71)  DIA

0.420 (10,67)
0.380 (9,65)
⬟G

0.120 (3,05)
0.100 (2,54)

⬟G

0.355 (9,02)
0.330 (8,38)

0.625 (15,88)
0.560 (14,22)

⬟C  0.125 (3,18)

0.155 (3,94)
MAX

0.562 (14,27)
0.500 (12,70)

1    2    3
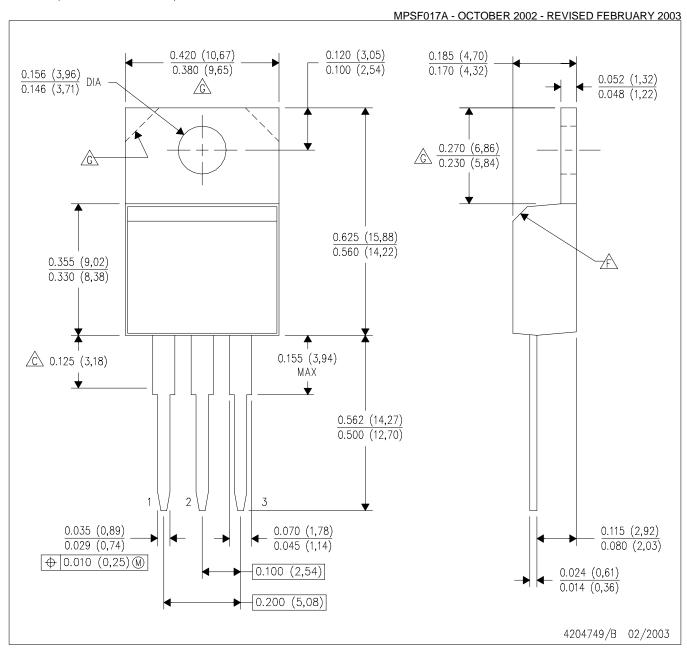
0.035 (0,89)
0.029 (0,74)

⊕ | 0.010 (0,25) Ⓜ

0.070 (1,78)
0.045 (1,14)

0.100 (2,54)

0.200 (5,08)

0.185 (4,70)
0.170 (4,32)

0.052 (1,32)
0.048 (1,22)

⬟G  0.270 (6,86)
     0.230 (5,84)

⬟F

0.115 (2,92)
0.080 (2,03)

0.024 (0,61)
0.014 (0,36)

4204749/B  02/2003

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   Tab contour optional within these dimensions.
          H.   Falls within JEDEC TO–220 variation AB.

SCALE   A SIZE        4204749          B REV   SHEET 2/3

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

0.156 (3,96)
0.146 (3,71)   **DIA**

0.420 (10,67)
0.380 (9,65)
(see Note H)

0.120 (3,05)
0.100 (2,54)

0.185 (4,70)
0.175 (4,46)

0.052 (1,32)
0.048 (1,22)

0.270 (6,86)
0.230 (5,84)
(see Note H)

0.625 (15,88)
0.560 (14,22)

(see Note F)

0.125 (3,18)
(see Note C)

0.250 (6,35)
MAX

0.562 (14,27)
0.500 (12,70)

**1**                    **3**

0.035 (0,89)
0.029 (0,74)

0.070 (1,78)
0.045 (1,14)

⊕ | 0.010 (0,25) | Ⓜ

0.100 (2,54)

0.200 (5,08)

0.122 (3,10)
0.102 (2,59)

0.025 (0,64)
0.012 (0,30)

**4040207 / B 01/95**

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.
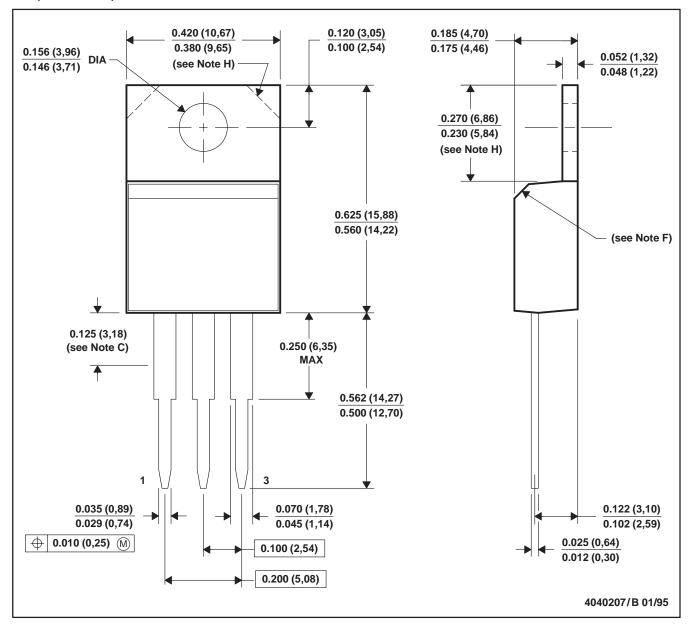      E. The center lead is in electrical contact with the mounting tab.
      F. The chamfer is optional.
      G. Falls within JEDEC TO-220AB
      H. Tab contour optional within these dimensions

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