

## NPN SILICON SWITCHING TRANSISTOR

Qualified per MIL-PRF-19500/255

### DEVICES

|                     |                     |
|---------------------|---------------------|
| <b>2N2221A</b>      | <b>2N2222A</b>      |
| <b>2N2221AL</b>     | <b>2N2222AL</b>     |
| <b>2N2221AUA</b>    | <b>2N2222AUA</b>    |
| <b>2N2221AUB</b>    | <b>2N2222AUB</b>    |
| <b>2N2221AUBC *</b> | <b>2N2222AUBC *</b> |

\* Available to JANS quality level only.

### LEVELS

**JAN**  
**JANTX**  
**JANTXV**  
**JANS**

### ABSOLUTE MAXIMUM RATINGS ( $T_C = +25^\circ\text{C}$ unless otherwise noted)

| Parameters / Test Conditions                        | Symbol            | Value       | Unit             |
|---|-------------------|-------------|------------------|
| Collector-Emitter Voltage                           | $V_{CEO}$         | 50          | Vdc              |
| Collector-Base Voltage                              | $V_{CBO}$         | 75          | Vdc              |
| Emitter-Base Voltage                                | $V_{EBO}$         | 6.0         | Vdc              |
| Collector Current                                   | $I_C$             | 800         | mAdc             |
| Total Power Dissipation @ $T_A = +25^\circ\text{C}$ | $P_T$             | 0.5         | W                |
| Operating & Storage Junction Temperature Range      | $T_{op}, T_{stg}$ | -65 to +200 | $^\circ\text{C}$ |

### THERMAL CHARACTERISTICS

| Parameters / Test Conditions            | Symbol          | Max. | Unit                      |
|---|-----------------|------|---------------------------|
| Thermal Resistance, Junction-to-Ambient | $R_{\theta JA}$ | 325  | $^\circ\text{C}/\text{W}$ |
| 2N2221A, L                              |                 |      |                           |
| 2N2221AUA                               |                 |      |                           |
| 2N2221AUB, UBC                          |                 |      |                           |
| 2N2222A, L                              | 210             | 325  | $^\circ\text{C}/\text{W}$ |
| 2N2222AUA                               |                 |      |                           |
| 2N2222AUB, UBC                          |                 |      |                           |

**Note:** Consult 19500/255 for thermal performance curves.

- Derate linearly 3.08mW/ $^\circ\text{C}$  above  $T_A > +37.5^\circ\text{C}$
- Derate linearly 4.76mW/ $^\circ\text{C}$  above  $T_A > +63.5^\circ\text{C}$

### ELECTRICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ , unless otherwise noted)

| Parameters / Test Conditions  | Symbol        | Min. | Max.     | Unit                                |
|---|---------------|------|----------|-------------------------------------|
| <b>OFF CHARACTERISTICS</b>  |               |      |          |                                     |
| Collector-Emitter Breakdown Voltage<br>$I_C = 10\text{mA}$                          | $V_{(BR)CEO}$ | 50   |          | Vdc                                 |
| Collector-Base Cutoff Current<br>$V_{CB} = 75\text{Vdc}$<br>$V_{CB} = 60\text{Vdc}$ | $I_{CBO}$     |      | 10<br>10 | $\mu\text{Adc}$<br>$\eta\text{Adc}$ |
| Emitter-Base Cutoff Current<br>$V_{EB} = 6.0\text{Vdc}$<br>$V_{EB} = 4.0\text{Vdc}$ | $I_{EBO}$     |      | 10<br>10 | $\mu\text{Adc}$<br>$\eta\text{Adc}$ |
| Collector-Emitter Cutoff Current<br>$V_{CE} = 50\text{Vdc}$                         | $I_{CES}$     |      | 50       | $\eta\text{Adc}$                    |



**TO-18 (TO-206AA)**  
 2N2221A, 2N2222A



**4 PIN**  
 2N2221AUA, 2N2222AUA



**3 PIN**  
 2N2221AUB, 2N2222AUB  
 2N2221AUBC, 2N2222AUBC  
 (UBC = Ceramic Lid Version)

## ELECTRICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ , unless otherwise noted)

| Parameters / Test Conditions   | Symbol   | Min.      | Max.       | Unit |
|--|--|-----------|------------|------|
| <b>ON CHARACTERISTICS <sup>(2)</sup></b>   |  |           |            |      |
| Forward-Current Transfer Ratio<br>$I_C = 0.1\text{mA}$ , $V_{CE} = 10\text{Vdc}$   | 2N2221A, L, UA, UB, UBC<br>2N2222A, L, UA, UB, UBC | 30<br>50  |            |      |
| $I_C = 1.0\text{mA}$ , $V_{CE} = 10\text{Vdc}$   | 2N2221A, L, UA, UB, UBC<br>2N2222A, L, UA, UB, UBC | 35<br>75  | 150<br>325 |      |
| $I_C = 10\text{mA}$ , $V_{CE} = 10\text{Vdc}$  | 2N2221A, L, UA, UB, UBC<br>2N2222A, L, UA, UB, UBC | 40<br>100 |            |      |
| $I_C = 150\text{mA}$ , $V_{CE} = 10\text{Vdc}$   | 2N2221A, L, UA, UB, UBC<br>2N2222A, L, UA, UB, UBC | 40<br>100 | 120<br>300 |      |
| $I_C = 500\text{mA}$ , $V_{CE} = 10\text{Vdc}$   | 2N2221A, L, UA, UB, UBC<br>2N2222A, L, UA, UB, UBC | 20<br>30  |            |      |
| Collector-Emitter Saturation Voltage<br>$I_C = 150\text{mA}$ , $I_B = 15\text{mA}$<br>$I_C = 500\text{mA}$ , $I_B = 50\text{mA}$ | $V_{CE(sat)}$                                      |           | 0.3<br>1.0 | Vdc  |
| Base-Emitter Voltage<br>$I_C = 150\text{mA}$ , $I_B = 15\text{mA}$<br>$I_C = 500\text{mA}$ , $I_B = 50\text{mA}$                 | $V_{BE(sat)}$                                      | 0.6       | 1.2<br>2.0 | Vdc  |

## DYNAMIC CHARACTERISTICS

| Parameters / Test Conditions  | Symbol   | Min.     | Max. | Unit |
|---|--|----------|------|------|
| Small-Signal Short-Circuit Forward Current Transfer Ratio<br>$I_C = 1.0\text{mA}$ , $V_{CE} = 10\text{Vdc}$ , $f = 1.0\text{kHz}$             | 2N2221A, L, UA, UB, UBC<br>2N2222A, L, UA, UB, UBC | 30<br>50 |      |      |
| Magnitude of Small-Signal Short-Circuit Forward Current Transfer Ratio<br>$I_C = 20\text{mA}$ , $V_{CE} = 20\text{Vdc}$ , $f = 100\text{MHz}$ | $ h_{fe} $   | 2.5      |      |      |
| Output Capacitance<br>$V_{CB} = 10\text{Vdc}$ , $I_E = 0$ , $100\text{kHz} \leq f \leq 1.0\text{MHz}$   | $C_{obo}$  |          | 8.0  | pF   |
| Input Capacitance<br>$V_{EB} = 0.5\text{Vdc}$ , $I_C = 0$ , $100\text{kHz} \leq f \leq 1.0\text{MHz}$   | $C_{ibo}$  |          | 25   | pF   |

## SWITCHING CHARACTERISTICS

| Parameters / Test Conditions                       | Symbol    | Min. | Max. | Unit |
|--|-----------|------|------|------|
| Turn-On Time<br>See figure 8 of MIL-PRF-19500/255  | $t_{on}$  |      | 35   | ns   |
| Turn-Off Time<br>See Figure 9 of MIL-PRF-19500/255 | $t_{off}$ |      | 300  | ns   |

(2) Pulse Test: Pulse Width = 300 $\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

**PACKAGE DIMENSIONS**

**NOTES:**

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Beyond r (radius) maximum, TL shall be held for a minimum length of .011 inch (0.28 mm).
4. Dimension TL measured from maximum HD.
5. Body contour optional within zone defined by HD, CD, and Q.
6. Leads at gauge plane  $.054 + .001 - .000$  inch ( $1.37 + 0.03 - 0.00$  mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC.
7. Dimension LU applies between  $L_1$  and  $L_2$ . Dimension LD applies between  $L_2$  and LL minimum. Diameter is uncontrolled in  $L_1$  and beyond LL minimum.
8. All three leads.
9. The collector shall be internally connected to the case.
10. Dimension r (radius) applies to both inside corners of tab.
11. In accordance with ASME Y14.5M, diameters are equivalent to  $\phi x$  symbology.
12. Lead 1 = emitter, lead 2 = base, lead 3 = collector.
13. For L suffix devices, dimension LL = 1.5 inches (38.10 mm) min. and 1.75 inches (44.45 mm) max.

| Symbol              | Dimensions |      |             |       | Note   |
|---------------------|------------|------|-------------|-------|--------|
|                     | Inches     |      | Millimeters |       |        |
|                     | Min        | Max  | Min         | Max   |        |
| CD                  | .178       | .195 | 4.52        | 4.95  |        |
| CH                  | .170       | .210 | 4.32        | 5.33  |        |
| HD                  | .209       | .230 | 5.31        | 5.84  |        |
| LC                  | .100 TP    |      | 2.54 TP     |       | 6      |
| LD                  | .016       | .021 | 0.41        | 0.53  | 7,8    |
| LL                  | .500       | .750 | 12.70       | 19.05 | 7,8,13 |
| LU                  | .016       | .019 | 0.41        | 0.48  | 7,8    |
| $L_1$               |            | .050 |             | 1.27  | 7,8    |
| $L_2$               | .250       |      | 6.35        |       | 7,8    |
| P                   | .100       |      | 2.54        |       |        |
| Q                   |            | .030 |             | 0.76  | 5      |
| TL                  | .028       | .048 | 0.71        | 1.22  | 3,4    |
| TW                  | .036       | .046 | 0.91        | 1.17  | 3      |
| r                   |            | .010 |             | 0.25  | 10     |
| $\alpha$            | 45° TP     |      | 45° TP      |       | 6      |
| 1, 2, 9, 11, 12, 13 |            |      |             |       |        |

**FIGURE 1. Physical dimensions (similar to TO-18).**

6 Lake Street, Lawrence, MA 01841  
 1-800-446-1158 / (978) 620-2600 / Fax: (978) 689-0803  
 Website: <http://www.microsemi.com>



**NOTES:**

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Dimension CH controls the overall package thickness. When a window lid is used, dimension CH must increase by a minimum of .010 inch (0.254 mm) and a maximum of .040 inch (1.020 mm).
4. The corner shape (square, notch, radius) may vary at the manufacturer's option, from that shown on the drawing.
5. Dimensions LW2 minimum and L3 minimum and the appropriate castellation length define an unobstructed three-dimensional space traversing all of the ceramic layers in which a castellation was designed. (Castellations are required on the bottom two layers, optional on the top ceramic layer.) Dimension LW2 maximum and L3 maximum define the maximum width and depth of the castellation at any point on its surface. Measurement of these dimensions may be made prior to solder dipping.
6. The co-planarity deviation of all terminal contact points, as defined by the device seating plane, shall not exceed .006 inch (0.15mm) for solder dipped leadless chip carriers.
7. In accordance with ASME Y14.5M, diameters are equivalent to  $\phi x$  symbology.

| Symbol | Dimensions |      |             |      | Note |
|--------|------------|------|-------------|------|------|
|        | Inches     |      | Millimeters |      |      |
|        | Min        | Max  | Min         | Max  |      |
| BL     | .215       | .225 | 5.46        | 5.71 |      |
| BL2    |            | .225 |             | 5.71 |      |
| BW     | .145       | .155 | 3.68        | 3.93 |      |
| BW2    |            | .155 |             | 3.93 |      |
| CH     | .061       | .075 | 1.55        | 1.90 | 3    |
| L3     | .003       | .007 | 0.08        | 0.18 | 5    |
| LH     | .029       | .042 | 0.74        | 1.07 |      |
| LL1    | .032       | .048 | 0.81        | 1.22 |      |
| LL2    | .072       | .088 | 1.83        | 2.23 |      |
| LS     | .045       | .055 | 1.14        | 1.39 |      |
| LW     | .022       | .028 | 0.56        | 0.71 |      |
| LW2    | .006       | .022 | 0.15        | 0.56 | 5    |

| Pin no.    | 1         | 2       | 3    | 4   |
|------------|-----------|---------|------|-----|
| Transistor | Collector | Emitter | Base | N/C |

**FIGURE 2. Physical dimensions, surface mount (UA version).**

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| Symbol | Dimensions |      |             |      | Note |
|--------|------------|------|-------------|------|------|
|        | Inches     |      | Millimeters |      |      |
|        | Min        | Max  | Min         | Max  |      |
| BH     | .046       | .056 | 1.17        | 1.42 |      |
| BL     | .115       | .128 | 2.92        | 3.25 |      |
| BW     | .085       | .108 | 2.16        | 2.74 |      |
| CL     |            | .128 |             | 3.25 |      |
| CW     |            | .108 |             | 2.74 |      |
| LL1    | .022       | .038 | 0.56        | 0.96 |      |
| LL2    | .017       | .035 | 0.43        | 0.89 |      |

| Symbol          | Dimensions |      |             |      | Note |
|-----------------|------------|------|-------------|------|------|
|                 | Inches     |      | Millimeters |      |      |
|                 | Min        | Max  | Min         | Max  |      |
| LS <sub>1</sub> | .036       | .040 | 0.91        | 1.02 |      |
| LS <sub>2</sub> | .071       | .079 | 1.81        | 2.01 |      |
| LW              | .016       | .024 | 0.41        | 0.61 |      |
| r               |            | .008 |             | .203 |      |
| r <sub>1</sub>  |            | .012 |             | .305 |      |
| r <sub>2</sub>  |            | .022 |             | .559 |      |

**NOTES:**

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Hatched areas on package denote metalized areas.
4. Pad 1 = Base, Pad 2 = Emitter, Pad 3 = Collector, Pad 4 = Shielding connected to the lid.
5. In accordance with ASME Y14.5M, diameters are equivalent to  $\phi x$  symbology.

**FIGURE 3. Physical dimensions, surface mount (UB version)**

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| Symbol | Dimensions |      |             |      | Note |
|--------|------------|------|-------------|------|------|
|        | Inches     |      | Millimeters |      |      |
|        | Min        | Max  | Min         | Max  |      |
| BH     | .046       | .071 | 1.17        | 1.80 |      |
| BL     | .115       | .128 | 2.92        | 3.25 |      |
| BW     | .085       | .108 | 2.16        | 2.74 |      |
| CL     |            | .128 |             | 3.25 |      |
| CW     |            | .108 |             | 2.74 |      |
| LL1    | .022       | .038 | 0.56        | 0.96 |      |
| LL2    | .017       | .035 | 0.43        | 0.89 |      |

| Symbol          | Dimensions |      |             |      | Note |
|-----------------|------------|------|-------------|------|------|
|                 | Inches     |      | Millimeters |      |      |
|                 | Min        | Max  | Min         | Max  |      |
| LS <sub>1</sub> | .036       | .040 | 0.91        | 1.02 |      |
| LS <sub>2</sub> | .071       | .079 | 1.81        | 2.01 |      |
| LW              | .016       | .024 | 0.41        | 0.61 |      |
| r               |            | .008 |             | .203 |      |
| r <sub>1</sub>  |            | .012 |             | .305 |      |
| r <sub>2</sub>  |            | .022 |             | .559 |      |

**NOTES:**

1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. Hatched areas on package denote metalized areas.
4. Pad 1 = Base, Pad 2 = Emitter, Pad 3 = Collector, Pad 4 = Connected to the lid braze ring.
5. In accordance with ASME Y14.5M, diameters are equivalent to  $\phi x$  symbology.

**FIGURE 4. Physical dimensions, surface mount (UBC version, ceramic lid)**