

## Rad Hard PNP Silicon Switching Transistor

### Screened per MIL-PRF-19500 & ESCC 22900

Screened Levels:  
MSR

| QPL RANGE and RAD LEVEL |              |
|-------------------------|--------------|
| Radiation Level         | MSR2N2907AUB |
| TID                     | 100 Krad     |
| ELDRS                   | 100 Krad     |

#### DESCRIPTION

This RHA level PNP switching transistor, 2N2907A device in a UB package, is ideal to drive many high-reliability applications. This device is constructed and screened to a JANSR performance level with radiation test method 1019 wafer lot acceptance conducted on all die lots. Fully compliant to **GSFC EEE-INST-002** reliability, screening and radiation hardness assurance requirements for space flight projects

**Important:** For the latest information, visit our website <http://www.microsemi.com>.

#### FEATURES

- JEDEC registered 2N2907A
- TID level screened per MIL-PRF-19500
- Also available with ELDRS testing to 0.01 Rad(s)/ sec
- MKCR/MHCR chip die available
- RHA (Radiation hardness assured) lot by lot validation testing via ELDR 0.1 Rad (SI)/sec dose rate

#### APPLICATIONS / BENEFITS

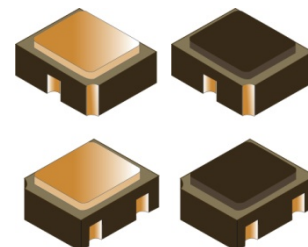
- Rad-Hard power supplies
- Rad-Hard motor controls
- General purpose switching
- Instrumentation Amps
- EPS Satellite switching power applications

#### MAXIMUM RATINGS @ $T_A = +25^\circ\text{C}$ unless otherwise noted

| Parameters/Test Conditions                                                                | Symbol               | Value       | Unit               |
|-------------------------------------------------------------------------------------------|----------------------|-------------|--------------------|
| Junction and Storage Temperature                                                          | $T_J$ and $T_{STG}$  | -65 to +200 | $^\circ\text{C}$   |
| Thermal Resistance Junction-to-Solder Pad (Infinite Sink) (see <a href="#">Figure 2</a> ) | $R_{\theta JSP(IS)}$ | 90          | $^\circ\text{C/W}$ |
| Thermal Resistance Junction-to-Ambient (see <a href="#">Figure 3</a> ) <sup>(1)</sup>     | $R_{\theta JA}$      | 325         | $^\circ\text{C/W}$ |
| Total Power Dissipation: @ $T_A = +25^\circ\text{C}$ <sup>(1)</sup>                       | $P_T$                | 0.5         | W                  |
| (see <a href="#">Figure 1</a> ) @ $T_{SP(IS)} = +25^\circ\text{C}$                        |                      | 1.0         |                    |
| Collector-Base Voltage, Emitter Open                                                      | $V_{CBO}$            | -60         | V                  |
| Emitter-Base Voltage, Collector Open                                                      | $V_{EBO}$            | -5          | V                  |
| Collector-Emitter Voltage, Base Open                                                      | $V_{CEO}$            | -60         | V                  |
| Collector Current, dc                                                                     | $I_C$                | -600        | mA                 |
| Solder Temperature @ 10 s                                                                 | $T_{SP}$             | 260         | $^\circ\text{C}$   |

#### Notes:

1. For non-thermal conductive PCB or unknown PCB surface mount conditions in free air, substitute MIL-PRF-19500/291 Figures 6 and 11 and use  $R_{\theta JA}$ .



**UB & UBC Package**

Also available in:



**TO-206AA (TO-18) package**  
(leaded top-hat)  
MSR2N2907A(L)



**UA package**  
(surface mount)  
MSR2N2907AUA

#### MSC – Lawrence

6 Lake Street,  
Lawrence, MA 01841  
Tel: 1-800-446-1158 or  
(978) 620-2600  
Fax: (978) 689-0803

#### MSC – Ireland

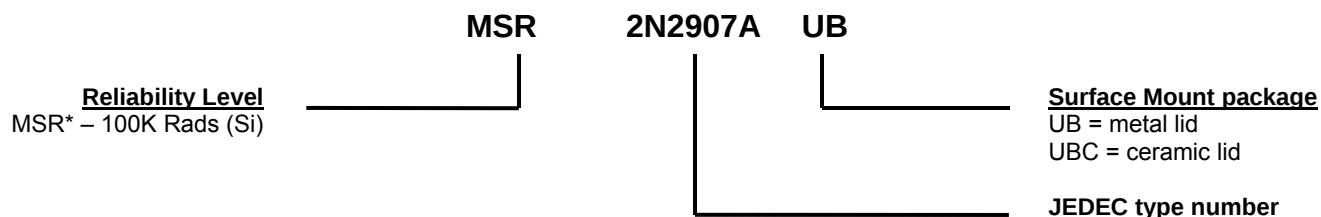
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Ennis, Co. Clare, Ireland  
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#### Website:

[www.microsemi.com](http://www.microsemi.com)

**MECHANICAL and PACKAGING**

- CASE: Ceramic with metal lid. UBC is ceramic with ceramic lid.
- TERMINALS: Gold plating over nickel under plate.
- MARKING: Part number, date code, manufacturer's ID.
- TAPE & REEL option: Standard per EIA-418D. Consult factory for quantities.
- WEIGHT: < 0.04 grams
- See [Package Dimensions](#) on last page.

**PART NOMENCLATURE**


\*The MSR designator is our internal part nomenclature assigned to this family of parts, in lieu of pending JANSR submissions through DLA (Defense Logistic Agency).

**SYMBOLS & DEFINITIONS**

| Symbol    | Definition                                                                                                                                  |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------|
| $I_B$     | Base current: The value of the dc current into the base terminal.                                                                           |
| $I_C$     | Collector current: The value of the dc current into the collector terminal.                                                                 |
| $I_E$     | Emitter current: The value of the dc current into the emitter terminal.                                                                     |
| $R_G$     | Gate drive impedance or Gate resistance                                                                                                     |
| $V_{CB}$  | Collector-base voltage: The dc voltage between the collector and the base.                                                                  |
| $V_{CBO}$ | Collector-base voltage, base open: The voltage between the collector and base terminals when the emitter terminal is open-circuited.        |
| $V_{CE}$  | Collector-emitter voltage: The dc voltage between the collector and the emitter.                                                            |
| $V_{CEO}$ | Collector-emitter voltage, base open: The voltage between the collector and the emitter terminals when the base terminal is open-circuited. |
| $V_{EB}$  | Emitter-base voltage: The dc voltage between the emitter and the base                                                                       |
| $V_{EBO}$ | Emitter-base voltage, collector open: The voltage between the emitter and base terminals with the collector terminal open-circuited.        |

**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>$I_C = 10\text{ mA}$                                                                                                                                                                                                                                       | $V_{(BR)CEO}$ | -60                           |              | V                   |
| Collector-Base Cutoff Current<br>$V_{CB} = -60\text{ V}$<br>$V_{CB} = -50\text{ V}$                                                                                                                                                                                                               | $I_{CBO}$     |                               | -10<br>-10   | $\mu\text{A}$<br>nA |
| Emitter-Base Cutoff Current<br>$V_{EB} = -5.0\text{ V}$<br>$V_{EB} = -4.0\text{ V}$                                                                                                                                                                                                               | $I_{EBO}$     |                               | -10<br>-50   | $\mu\text{A}$<br>nA |
| Collector-Emitter Cutoff Current<br>$V_{CE} = -50\text{ V}$                                                                                                                                                                                                                                       | $I_{CES}$     |                               | -50          | nA                  |
| <b>ON CHARACTERISTICS <sup>(1)</sup></b>                                                                                                                                                                                                                                                          |               |                               |              |                     |
| Forward-Current Transfer Ratio<br>$I_C = -0.1\text{ mA}$ , $V_{CE} = -10\text{ V}$<br>$I_C = -1.0\text{ mA}$ , $V_{CE} = -10\text{ V}$<br>$I_C = -10\text{ mA}$ , $V_{CE} = -10\text{ V}$<br>$I_C = -150\text{ mA}$ , $V_{CE} = -10\text{ V}$<br>$I_C = -500\text{ mA}$ , $V_{CE} = -10\text{ V}$ | $h_{FE}$      | 75<br>100<br>100<br>100<br>50 | 450<br>300   |                     |
| Collector-Emitter Saturation Voltage<br>$I_C = -150\text{ mA}$ , $I_B = -15\text{ mA}$<br>$I_C = -500\text{ mA}$ , $I_B = -50\text{ mA}$                                                                                                                                                          | $V_{CE(sat)}$ |                               | -0.4<br>-1.6 | V                   |
| 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                          | -1.3<br>-2.6 | V                   |

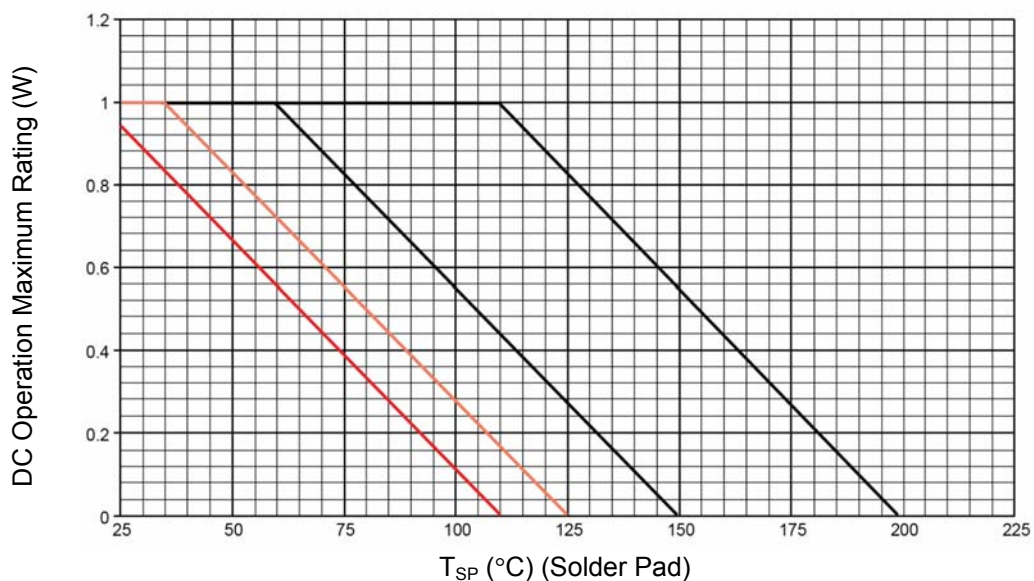
**DYNAMIC CHARACTERISTICS**

| Parameters / Test Conditions                                                                                                                     | Symbol     | Min. | Max. | Unit |
|--------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|------|------|
| Small-Signal Short-Circuit Forward Current Transfer Ratio<br>$I_C = -1.0\text{ mA}$ , $V_{CE} = -10\text{ V}$ , $f = 1.0\text{ kHz}$             | $h_{fe}$   | 100  |      |      |
| Magnitude of Small-Signal Short-Circuit Forward Current Transfer Ratio<br>$I_C = -20\text{ mA}$ , $V_{CE} = -20\text{ V}$ , $f = 100\text{ MHz}$ | $ h_{fe} $ | 2.0  |      |      |
| Output Capacitance<br>$V_{CB} = -10\text{ V}$ , $I_E = 0$ , $100\text{ kHz} \leq f \leq 1.0\text{ MHz}$                                          | $C_{obo}$  |      | 8.0  | pF   |
| Input Capacitance<br>$V_{EB} = -2.0\text{ V}$ , $I_C = 0$ , $100\text{ kHz} \leq f \leq 1.0\text{ MHz}$                                          | $C_{ibo}$  |      | 30   | pF   |

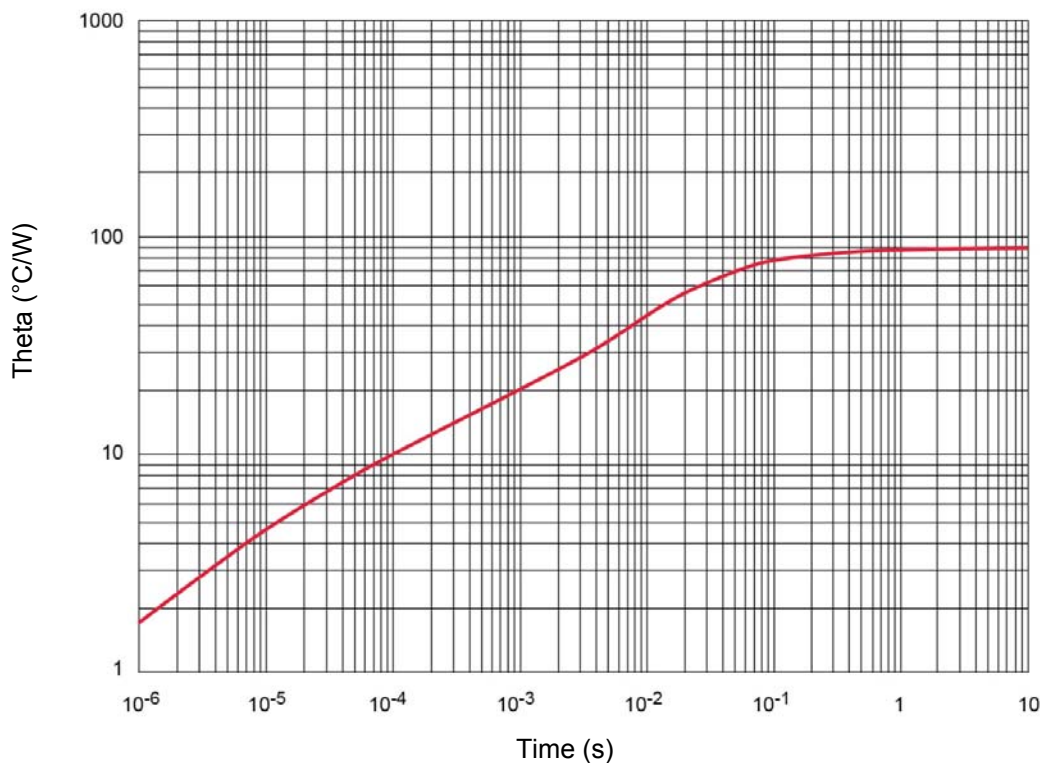
(1) Pulse Test: Pulse Width = 300  $\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$

**SWITCHING CHARACTERISTICS**

| Parameters / Test Conditions | Symbol    | Min. | Max. | Unit |
|------------------------------|-----------|------|------|------|
| Turn-On Time                 | $t_{on}$  |      | 45   | ns   |
| Turn-Off Time                | $t_{off}$ |      | 300  | ns   |

**GRAPHS**


**FIGURE 1**  
Temperature-Power Derating ( $R_{\theta JSP(IS)}$ )



**FIGURE 2**  
Thermal impedance graph ( $R_{\theta JSP(IS)}$ )

### Radiation hardness assurance

The MSR series product are guaranteed in radiation with full compliance to MIL-PRF-19500 specification JANSR level and also guaranteed to meet ESCC 22900 specifications (General specifications).

### Radiation assurance MIL-PRF-19500

MSR parts are guaranteed at 100 krad (Si), tested, in full compliancy with the MIL-PRF-19500 specification, specifically the Group D, subgroup 2 inspection, between 50 and 300 rad/s. All test are performed in accordance to MIL-PRF-19500 and test method 1019 of MIL-STD-750 for total Ionizing dose.

Each wafer of each lot is tested, (note 1). The table below provides for each monitored parameters of the test conditions and the acceptance criteria

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

#### **POST RADIATION**

| <b>Parameters / Test Conditions</b>                                                                                                                                                                                                                                                               | <b>Symbol</b> | <b>Min.</b>                            | <b>Max.</b>    | <b>Unit</b>                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------------------|----------------|------------------------------|
| Collector to Base Cutoff Current<br>$V_{CB} = -60\text{ V}$<br>$V_{CB} = -50\text{ V}$                                                                                                                                                                                                            | $I_{CBO}$     |                                        | -20<br>-20     | $\mu\text{A}$<br>$\text{nA}$ |
| Emitter to Base Cutoff Current<br>$V_{EB} = -5\text{ V}$<br>$V_{EB} = -4\text{ V}$                                                                                                                                                                                                                | $I_{EBO}$     |                                        | -20<br>-100    | $\mu\text{A}$<br>$\text{nA}$ |
| Collector to Emitter Breakdown Voltage<br>$I_C = -10\text{ mA}$                                                                                                                                                                                                                                   | $V_{(BR)CEO}$ | -60                                    |                | V                            |
| Forward-Current Transfer Ratio <sup>(2)</sup><br>$I_C = -0.1\text{ mA}, V_{CE} = -10\text{ V}$<br>$I_C = -1.0\text{ mA}, V_{CE} = -10\text{ V}$<br>$I_C = -10\text{ mA}, V_{CE} = -10\text{ V}$<br>$I_C = -150\text{ mA}, V_{CE} = -10\text{ V}$<br>$I_C = -500\text{ mA}, V_{CE} = -10\text{ V}$ | $[h_{FE}]$    | [37.5]<br>[50]<br>[50]<br>[50]<br>[25] | 400<br>300     |                              |
| Collector-Emitter Saturation Voltage<br>$I_C = -150\text{ }\mu\text{A}, I_B = -15\text{ mA}$<br>$I_C = -500\text{ mA}, I_B = -50\text{ mA}$                                                                                                                                                       | $V_{CE(sat)}$ |                                        | -0.46<br>-1.84 | V                            |
| Base-Emitter Saturation Voltage<br>$I_C = -150\text{ }\mu\text{A}, I_B = -15\text{ mA}$<br>$I_C = -500\text{ mA}, I_B = -50\text{ mA}$                                                                                                                                                            | $V_{BE(sat)}$ | 0.6                                    | 1.5<br>3.0     | V                            |

- (2) See method 1019 of MIL-STD-750 for how to determine  $[h_{FE}]$  by first calculating the delta ( $1/h_{FE}$ ) from the pre- and post-radiation  $h_{FE}$ . Notice the  $[h_{FE}]$  is not the same as  $h_{FE}$  and cannot be measured directly. The  $[h_{FE}]$  value can never exceed the pre-radiation minimum  $h_{FE}$  that it is based upon.

### ESCC radiation assurance

Each product lot is tested according to the ESCC basic specification 22900, with a minimum of 21 samples per diffusion lot and 10 samples per wafer, one sample being kept as un- irradiated sample, all of them being fully compliant with the applicable ESCC generic and/or detailed specification.

- Test of 10 pieces by wafer, 10 biased at least 80% of  $V_{(BR)CEO}$ , 10 unbiased and 1 kept for reference
- Irradiation at 0.1 rad (Si)/s
- Acceptance criteria of each individual wafer if as 100 krad guaranteed if all 20 samples comply with the post radiation electrical characteristics provided in [Table 4](#) (post radiation electrical characteristics for the 2N2907AUB/C)
- Delivery together with the parts of the radiation verification test (RVT) report of the particular wafer used to manufacture the products. This RVT includes the value of each parameter at 30, 50, 70 and 100 krad (Si) and after 24 hour annealing at room temperature and after an additional 168 hour annealing at 100°C.

### *Radiation summary*

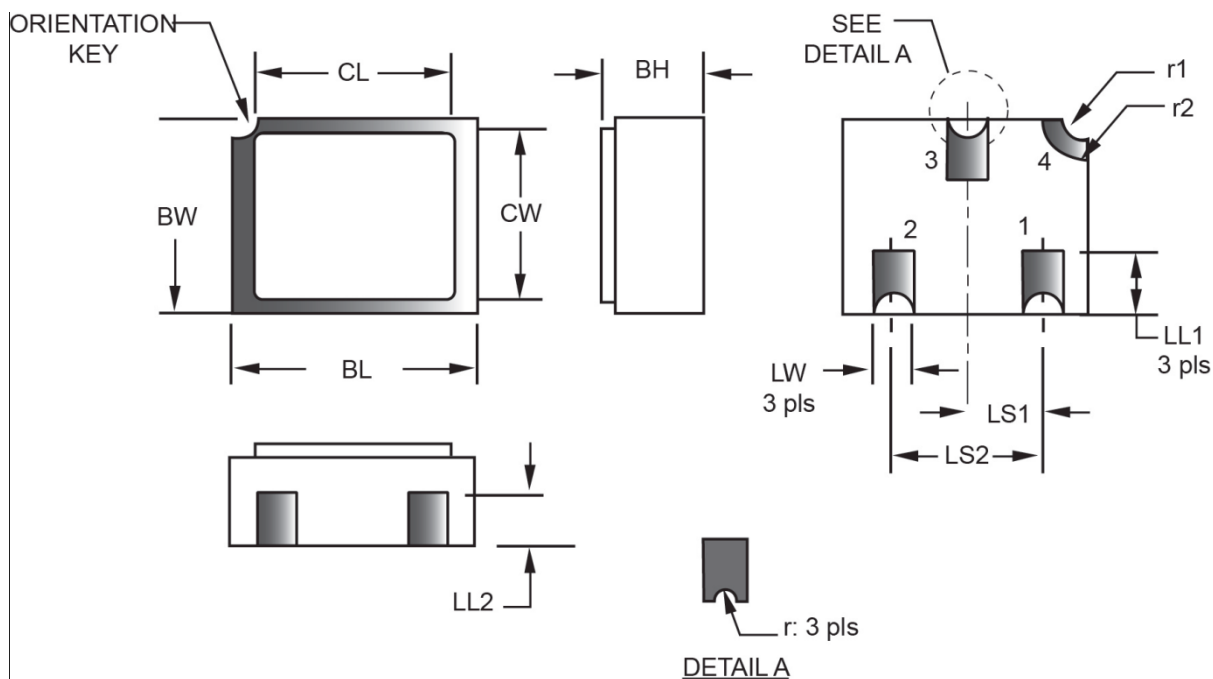
| Radiation test (Note 1) | 100 krad ESCC           |
|-------------------------|-------------------------|
| Wafer test              | each                    |
| Part tested             | 10 biased + 10 unbiased |
| Dose rate               | 0.1 rad/s               |
| Acceptance              | MIL-STD-750 method 1019 |
| Displacement damage     | Optional                |

1. Microsemi MSR products will exceed required testing of ESCC basic specification 22900

### **POST RADIATION, Table 4**

| Parameters / Test Conditions                                                                                                                                                                                                                                                                      | Symbol        | Min.                                   | Max.           | Unit                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------------------|----------------|------------------------------|
| Collector to Base Cutoff Current<br>$V_{CB} = -60\text{ V}$<br>$V_{CB} = -50\text{ V}$                                                                                                                                                                                                            | $I_{CBO}$     |                                        | -20<br>-20     | $\mu\text{A}$<br>$\text{nA}$ |
| Emitter to Base Cutoff Current<br>$V_{EB} = -5\text{ V}$<br>$V_{EB} = -4\text{ V}$                                                                                                                                                                                                                | $I_{EBO}$     |                                        | -20<br>-100    | $\mu\text{A}$<br>$\text{nA}$ |
| Collector to Emitter Breakdown Voltage<br>$I_C = -10\text{ mA}$                                                                                                                                                                                                                                   | $V_{(BR)CEO}$ | -60                                    |                | V                            |
| Forward-Current Transfer Ratio <sup>(2)</sup><br>$I_C = -0.1\text{ mA}, V_{CE} = -10\text{ V}$<br>$I_C = -1.0\text{ mA}, V_{CE} = -10\text{ V}$<br>$I_C = -10\text{ mA}, V_{CE} = -10\text{ V}$<br>$I_C = -150\text{ mA}, V_{CE} = -10\text{ V}$<br>$I_C = -500\text{ mA}, V_{CE} = -10\text{ V}$ | $[h_{FE}]$    | [37.5]<br>[50]<br>[50]<br>[50]<br>[25] | 400<br>300     |                              |
| Collector-Emitter Saturation Voltage<br>$I_C = -150\text{ }\mu\text{A}, I_B = -15\text{ mA}$<br>$I_C = -500\text{ mA}, I_B = -50\text{ mA}$                                                                                                                                                       | $V_{CE(sat)}$ |                                        | -0.46<br>-1.84 | V                            |
| Base-Emitter Saturation Voltage<br>$I_C = -150\text{ }\mu\text{A}, I_B = -15\text{ mA}$<br>$I_C = -500\text{ mA}, I_B = -50\text{ mA}$                                                                                                                                                            | $V_{BE(sat)}$ | 0.6                                    | 1.5<br>3.0     | V                            |

2. This value is determined from  $\Delta(1/h_{fe})$  using pre & post radiation values of  $h_{fe}$ .  $[h_{fe}]$  should not exceed the pre-radiation minimum  $h_{fe}$ .

**PACKAGE DIMENSIONS**


| Symbol<br>I | Dimensions |       |             |      | Note | Symbol | Dimensions |       |             |       | Note |
|-------------|------------|-------|-------------|------|------|--------|------------|-------|-------------|-------|------|
|             | inch       |       | millimeters |      |      |        | inch       |       | millimeters |       |      |
|             | Min        | Max   | Min         | Max  |      |        | Min        | Max   | Min         | Max   |      |
| BH          | 0.046      | 0.056 | 1.17        | 1.42 |      | LS1    | 0.035      | 0.039 | 0.89        | 0.99  |      |
| BL          | 0.115      | 0.128 | 2.92        | 3.25 |      | LS2    | 0.071      | 0.079 | 1.80        | 2.01  |      |
| BW          | 0.085      | 0.108 | 2.16        | 2.74 |      | LW     | 0.016      | 0.024 | 0.41        | 0.61  |      |
| CL          | -          | 0.128 | -           | 3.25 |      | r      | -          | 0.008 | -           | 0.20  |      |
| CW          | -          | 0.108 | -           | 2.74 |      | r1     | -          | 0.012 | -           | 0.31  |      |
| LL1         | 0.022      | 0.038 | 0.56        | 0.97 |      | r2     | -          | 0.022 | -           | 0.056 |      |
| LL2         | 0.017      | 0.035 | 0.43        | 0.89 |      |        |            |       |             |       |      |

**NOTES:**

1. Dimensions are in inches. Millimeters are given for information only.
2. Ceramic package only.
3. Hatched areas on package denote metallized 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.