

# Bipolar Transistor

(-)100 V, (-)1 A, Low  $V_{CE(sat)}$ ,  
(PNP)NPN Single PCP

## 2SA1416, 2SC3646

### Features

- Adoption of FBET and MBIT Processes
- High Breakdown Voltage and Large Current Capacity
- Fast Switching Speed
- Ultrasmall Size Making it Easy to Provide High-Density Small-Sized Hybrid IC's
- These Devices are Pb-Free and are RoHS Compliant

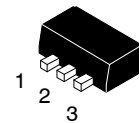
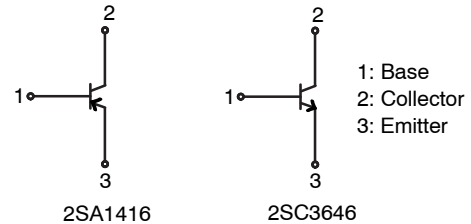
**SPECIFICATIONS ( ): 2SA1416**  
**ABSOLUTE MAXIMUM RATINGS** at  $T_a = 25^\circ\text{C}$

| Parameter                      | Symbol    | Value       | Unit             |
|--------------------------------|-----------|-------------|------------------|
| Collector to Base Voltage      | $V_{CBO}$ | (-) 120     | V                |
| Collector to Emitter Voltage   | $V_{CEO}$ | (-) 100     | V                |
| Emitter to Base Voltage        | $V_{EBO}$ | (-) 6       | V                |
| Collector Current              | $I_C$     | (-) 1       | A                |
| Collector Current (Pulse)      | $I_{CP}$  | (-) 2       | A                |
| Collector Dissipation          | $P_C$     | 500         | mW               |
| Collector Dissipation (Note 1) |           | 1.3         | W                |
| Junction Temperature           | $T_J$     | 150         | $^\circ\text{C}$ |
| Storage Temperature            | $T_{STG}$ | -55 to +150 | $^\circ\text{C}$ |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

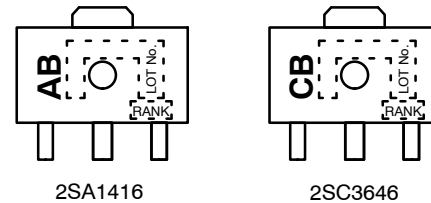
1. Surface mounted on ceramic substrate (250 mm<sup>2</sup> x 0.8 mm).

### ELECTRICAL CONNECTION



**SOT-89 / PCP-1**  
**CASE 419AU**

### MARKING DIAGRAM



### ORDERING INFORMATION

See detailed ordering and shipping information on page 6 of this data sheet.

# 2SA1416, 2SC3646

## ELECTRICAL CHARACTERISTICS at $T_A = 25^\circ\text{C}$

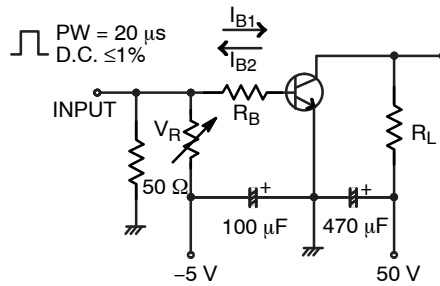
| Parameter                               | Symbol        | Conditions                                              | Ratings  |             |             | Unit |
|-----------------------------------------|---------------|---------------------------------------------------------|----------|-------------|-------------|------|
|                                         |               |                                                         | Min      | Typ         | Max         |      |
| Collector Cutoff Current                | $I_{CBO}$     | $V_{CB} = (-)100\text{ V}$ ,<br>$I_E = 0\text{ A}$      |          |             | $(-)100$    | nA   |
| Emitter Cutoff Current                  | $I_{EBO}$     | $V_{EB} = (-)4\text{ V}$ , $I_C = 0\text{ A}$           |          |             | $(-)100$    | nA   |
| DC Current Gain                         | $h_{FE}$      | $V_{CE} = (-)5\text{ V}$ ,<br>$I_C = (-)100\text{ mA}$  | 100*     |             | 400*        |      |
| Gain-Bandwidth Product                  | $f_T$         | $V_{CE} = (-)10\text{ V}$ ,<br>$I_C = (-)100\text{ mA}$ |          | 120         |             | MHz  |
| Output Capacitance                      | $C_{ob}$      | $V_{CB} = (-)10\text{ V}$ ,<br>$f = 1\text{ MHz}$       |          | (13)8.5     |             | pF   |
| Collector to Emitter Saturation Voltage | $V_{CE(sat)}$ | $I_C = (-)400\text{ mA}$ ,<br>$I_B = (-)40\text{ mA}$   |          | $(-0.2)0.1$ | $(-0.6)0.4$ | V    |
| Base to Emitter Saturation Voltage      | $V_{BE(sat)}$ | $I_C = (-)400\text{ mA}$ ,<br>$I_B = (-)40\text{ mA}$   |          | $(-)0.85$   | $(-)1.2$    | V    |
| Collector to Base Breakdown Voltage     | $V_{(BR)CBO}$ | $I_C = (-)10\text{ }\mu\text{A}$ , $I_E = 0\text{ A}$   | $(-)120$ |             |             | V    |
| Collector to Emitter Breakdown Voltage  | $V_{(BR)CEO}$ | $I_C = (-)1\text{ mA}$ , $R_{BE} = \infty$              | $(-)100$ |             |             | V    |
| Emitter to Base Breakdown Voltage       | $V_{(BR)EBO}$ | $I_E = (-)10\text{ }\mu\text{A}$ , $I_C = 0\text{ A}$   | $(-)6$   |             |             | V    |
| Turn-On Time                            | $t_{on}$      | See specified<br>Test Circuit                           |          | (80)80      |             | ns   |
| Storage Time                            | $t_{stg}$     |                                                         |          | (700)850    |             | ns   |
| Fall Time                               | $t_f$         |                                                         |          | (40)50      |             | ns   |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

\*The 2SA1416/2SC3646 are classified by 100 mA  $h_{FE}$  as follows :

| Rank     | R          | S          | T          |
|----------|------------|------------|------------|
| $h_{FE}$ | 100 to 200 | 140 to 280 | 200 to 400 |

## Switching Time Test Circuit



$I_C = 10\text{ mA}$ ,  $I_{B1} = -10\text{ mA}$ ,  $I_{B2} = 400\text{ mA}$   
(For PNP, the polarity is reversed)

TYPICAL CHARACTERISTICS

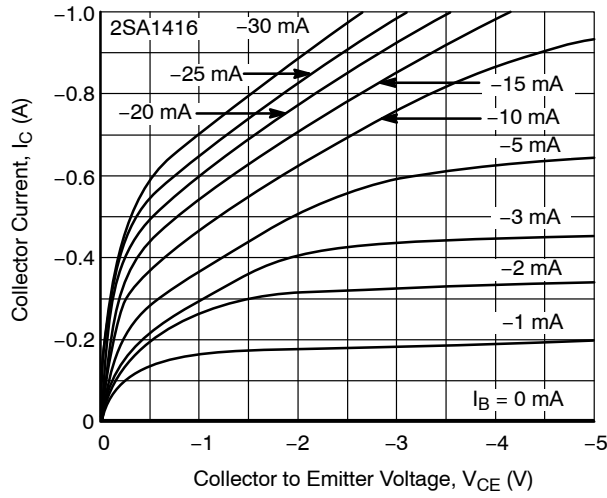


Figure 1.  $I_C - V_{CE}$

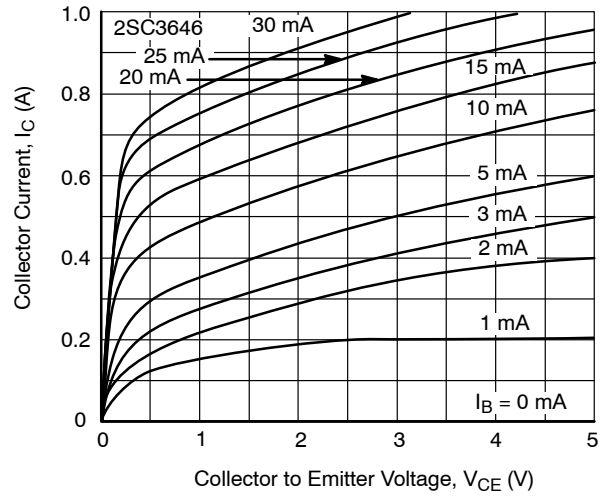


Figure 2.  $I_C - V_{CE}$

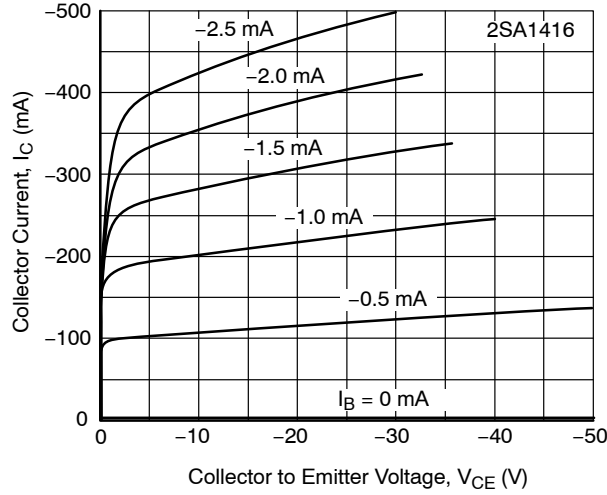


Figure 3.  $I_C - V_{CE}$

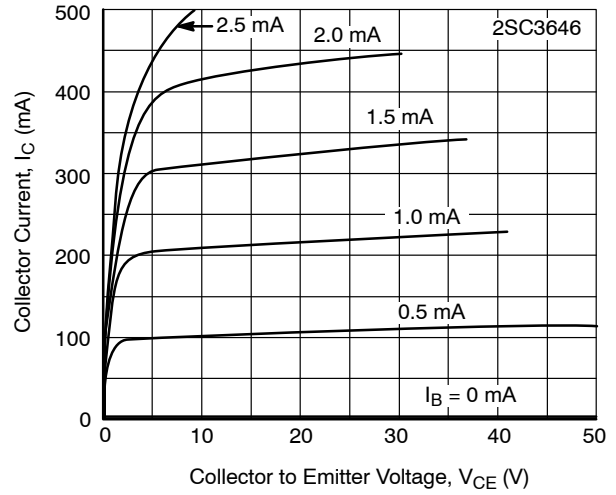


Figure 4.  $I_C - V_{CE}$

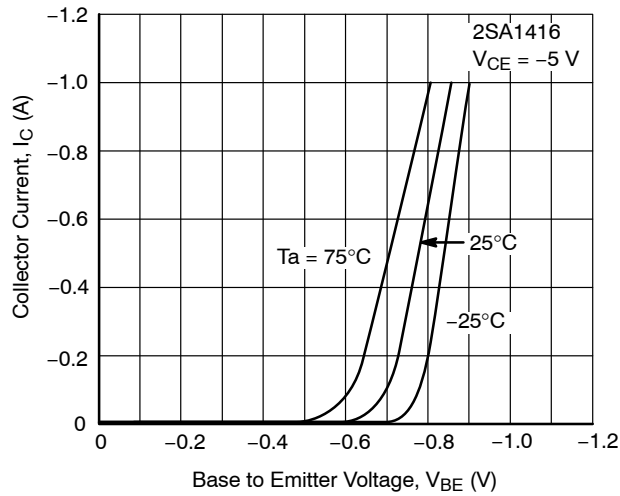


Figure 5.  $I_C - V_{BE}$

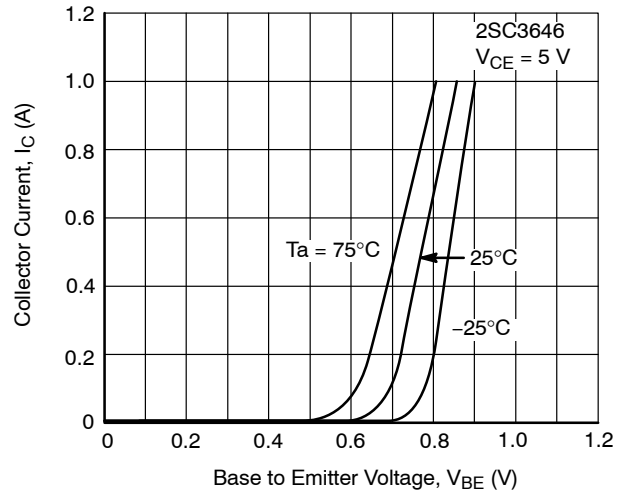


Figure 6.  $I_C - V_{BE}$

# 2SA1416, 2SC3646

## TYPICAL CHARACTERISTICS (continued)

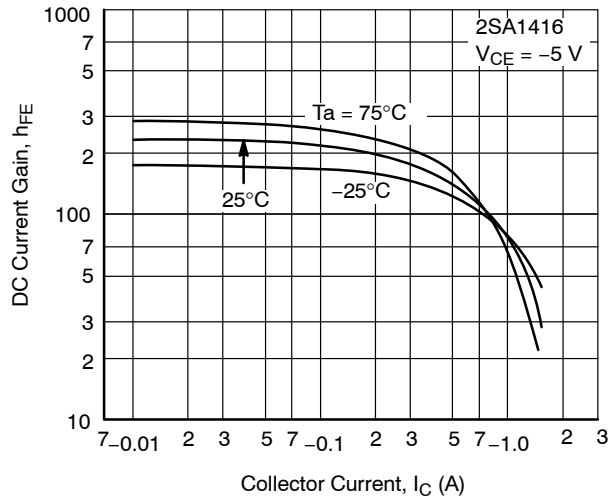


Figure 7.  $h_{FE} - I_C$

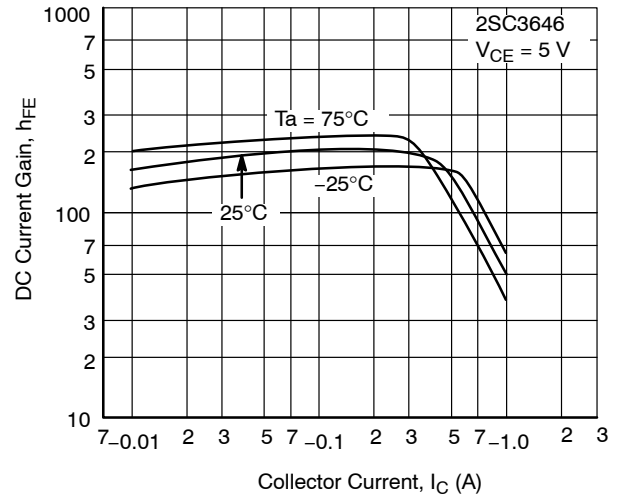


Figure 8.  $h_{FE} - I_C$

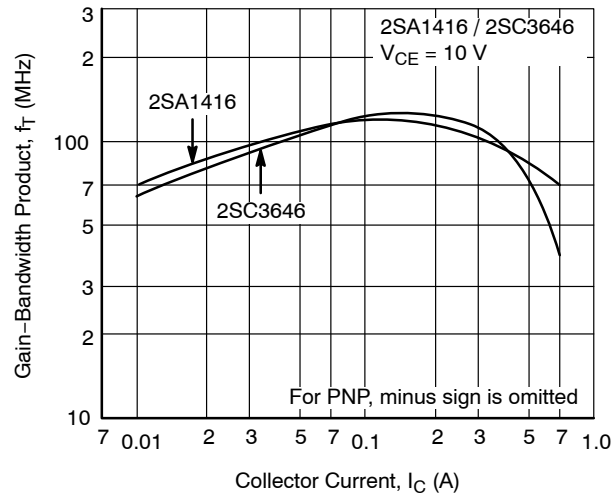


Figure 9.  $f_T - I_C$

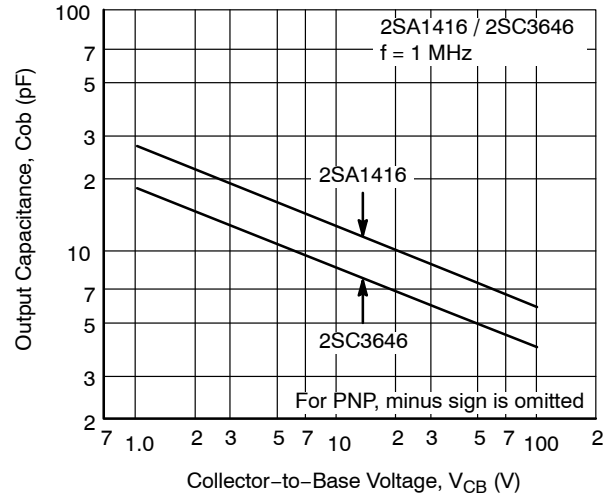


Figure 10.  $C_{ob} - V_{CB}$

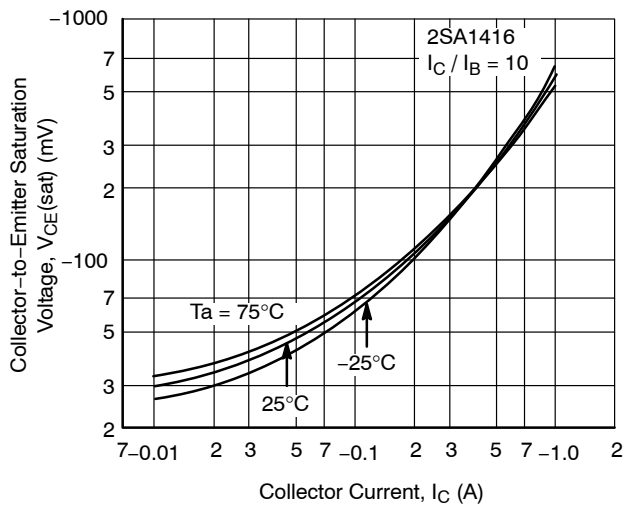


Figure 11.  $V_{CE(sat)} - I_C$

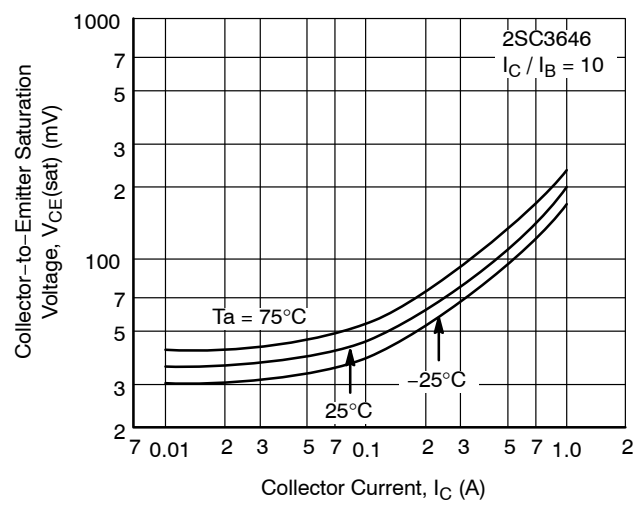


Figure 12.  $V_{CE(sat)} - I_C$

TYPICAL CHARACTERISTICS (continued)

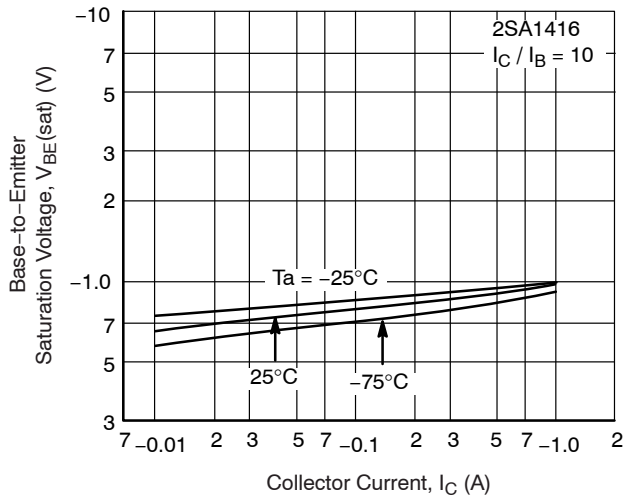


Figure 13.  $V_{BE}(sat) - I_C$

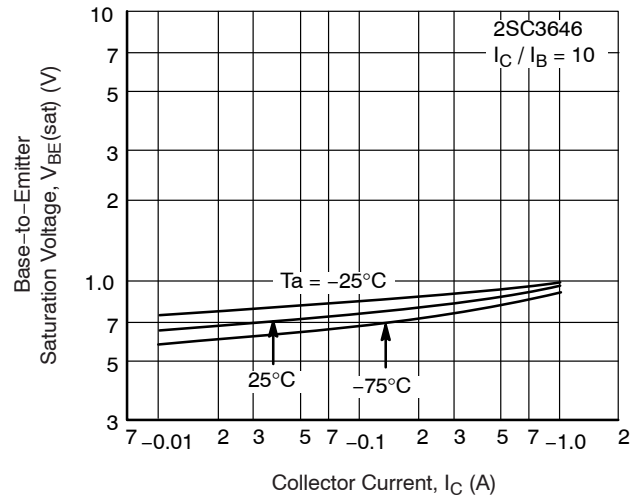


Figure 14.  $V_{BE}(sat) - I_C$

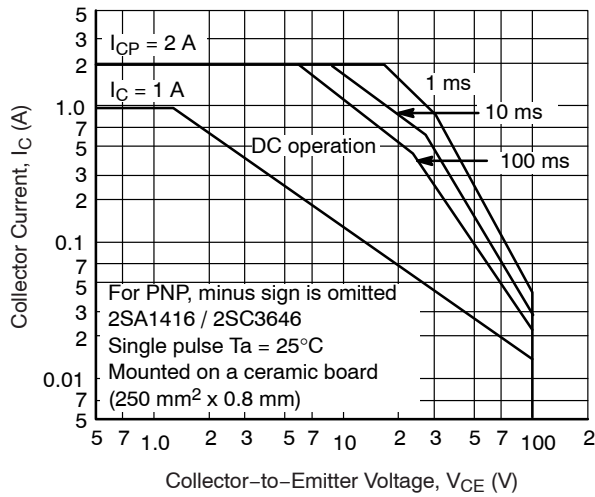


Figure 15. ASO

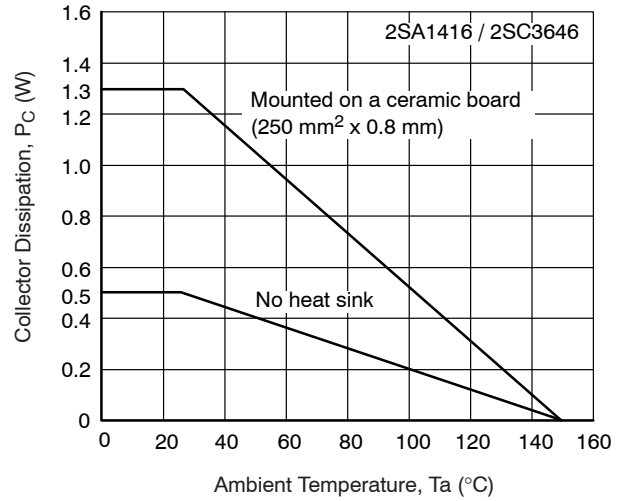


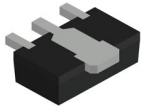
Figure 16.  $P_C - T_a$

## 2SA1416, 2SC3646

### ORDERING INFORMATION

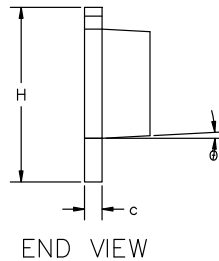
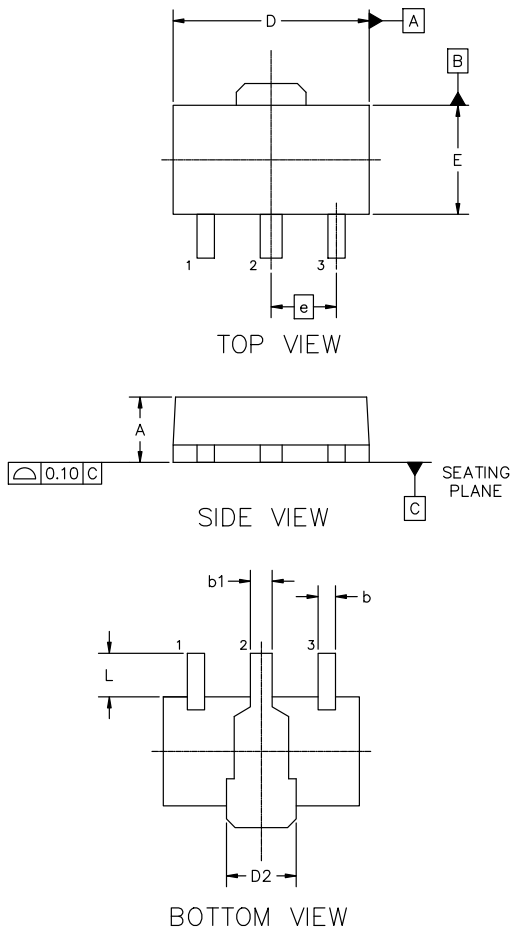
| Device        | Marking | Package                     | Shipping <sup>†</sup> |
|---------------|---------|-----------------------------|-----------------------|
| 2SA1416S–TD–E | AB      | SOT–89 / PCP–1<br>(Pb–Free) | 1000 / Tape & Reel    |
| 2SA1416T–TD–E |         |                             |                       |
| 2SC3646S–TD–E | CB      |                             |                       |
| 2SC3646T–TD–E |         |                             |                       |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



**SOT-89 4.50x2.50x1.50 1.50P**  
**CASE 419AU**  
**ISSUE A**

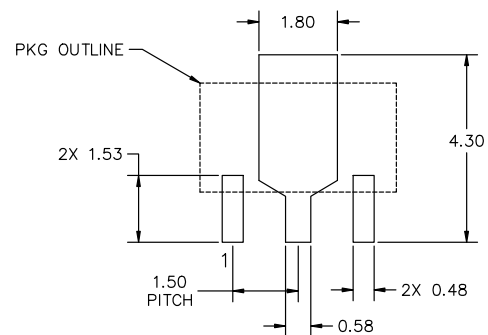
DATE 21 MAY 2025



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. LEAD THICKNESS INCLUDES LEAD FINISH.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

| MILLIMETERS |          |      |      |
|-------------|----------|------|------|
| DIM         | MIN      | NOM  | MAX  |
| A           | 1.40     | 1.50 | 1.60 |
| b           | 0.35     | 0.40 | 0.48 |
| b1          | 0.40     | 0.50 | 0.55 |
| c           | 0.37     | 0.40 | 0.43 |
| D           | 4.40     | 4.50 | 4.60 |
| D2          | 1.40     | 1.60 | 1.80 |
| E           | 2.40     | 2.50 | 2.60 |
| e           | 1.50 BSC |      |      |
| H           | 3.80     | 4.00 | 4.20 |
| L           | 0.80     | 1.00 | 1.20 |
| θ           | 0°       | ---  | 3°   |



RECOMMENDED MOUNTING FOOTPRINT

\*For additional information on our Pb-Free strategy and soldering details, please download the onsemi Soldering and Mounting Techniques Reference Manual, SOLDERM/D.

|                         |                                    |                                                                                                                                                                                     |
|-------------------------|------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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