



SANYO Semiconductors

## DATA SHEET

An ON Semiconductor Company

NPN Epitaxial Planar Silicon Transistor

# 2SC5415A — High-Frequency Low-Noise Amplifier Applications

## Features

- High gain :  $|S_{21e}|^2 = 9\text{dB typ (f=1GHz)}$
- High cut-off frequency :  $f_T = 6.7\text{GHz typ}$

## Specifications

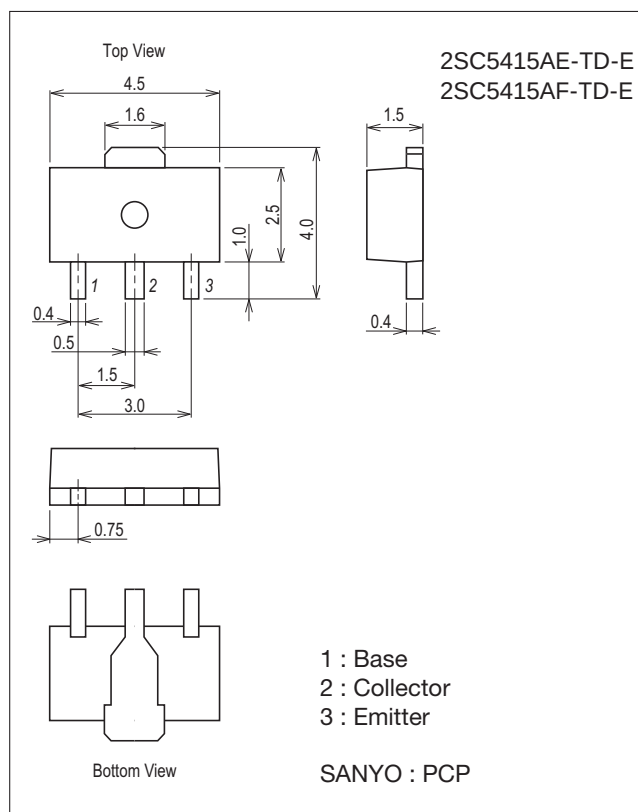
Absolute Maximum Ratings at  $T_a = 25^\circ\text{C}$ 

| Parameter                    | Symbol    | Conditions                                                    | Ratings     | Unit |
|------------------------------|-----------|---------------------------------------------------------------|-------------|------|
| Collector-to-Base Voltage    | $V_{CBO}$ |                                                               | 20          | V    |
| Collector-to-Emitter Voltage | $V_{CEO}$ |                                                               | 12          | V    |
| Emitter-to-Base Voltage      | $V_{EBO}$ |                                                               | 2           | V    |
| Collector Current            | $I_C$     |                                                               | 100         | mA   |
| Collector Dissipation        | $P_C$     | When mounted on ceramic substrate (250mm <sup>2</sup> ×0.8mm) | 800         | mW   |
| Junction Temperature         | $T_j$     |                                                               | 150         | °C   |
| Storage Temperature          | $T_{stg}$ |                                                               | -55 to +150 | °C   |

## Package Dimensions

unit : mm (typ)

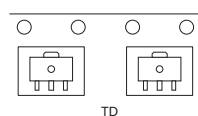
7007B-004



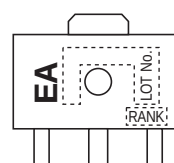
## Product & Package Information

- Package : PCP
- JEITA, JEDEC : SC-62, SOT-89, TO-243
- Minimum Packing Quantity : 1,000 pcs./reel

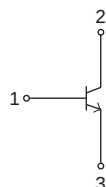
## Packing Type: TD



## Marking



## Electrical Connection



# 2SC5415A

## Electrical Characteristics at Ta=25°C

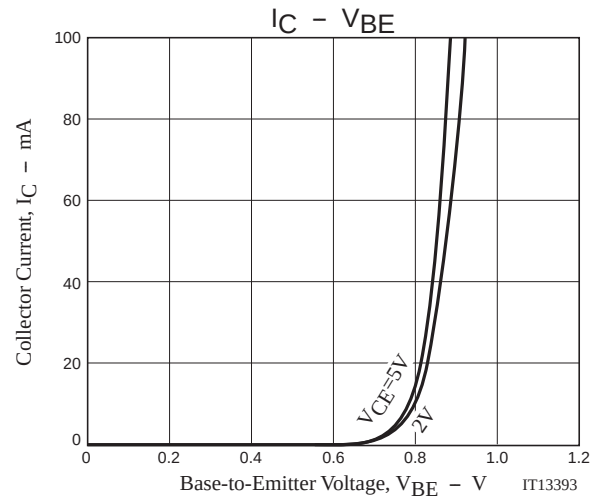
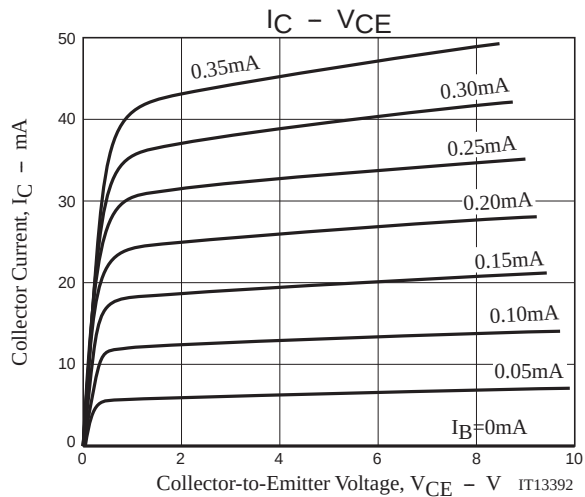
| Parameter                    | Symbol                          | Conditions                                        | Ratings |      |      | Unit |
|------------------------------|---------------------------------|---------------------------------------------------|---------|------|------|------|
|                              |                                 |                                                   | min     | typ  | max  |      |
| Collector Cutoff Current     | ICBO                            | V <sub>CB</sub> =10V, I <sub>E</sub> =0A          |         |      | 1.0  | μA   |
| Emitter Cutoff Current       | IEBO                            | V <sub>EB</sub> =1V, I <sub>C</sub> =0A           |         |      | 10   | μA   |
| DC Current Gain              | h <sub>FE1</sub>                | V <sub>CE</sub> =5V, I <sub>C</sub> =30mA         | 90*     |      | 270* |      |
|                              | h <sub>FE2</sub>                | V <sub>CE</sub> =5V, I <sub>C</sub> =70mA         | 70      |      |      |      |
| Gain-Bandwidth Product       | f <sub>T</sub>                  | V <sub>CE</sub> =5V, I <sub>C</sub> =30mA         | 5       | 6.7  |      | GHz  |
| Output Capacitance           | C <sub>ob</sub>                 | V <sub>CB</sub> =5V, f=1MHz                       |         | 1.2  | 1.8  | pF   |
| Reverse Transfer Capacitance | C <sub>re</sub>                 |                                                   |         | 0.65 |      | pF   |
| Forward Transfer Gain        | S <sub>21e</sub>   <sup>2</sup> | V <sub>CE</sub> =5V, I <sub>C</sub> =30mA, f=1GHz | 7.5     | 9    |      | dB   |
| Noise Figure                 | NF                              | V <sub>CE</sub> =5V, I <sub>C</sub> =7mA, f=1GHz  |         | 1.1  | 2.0  | dB   |

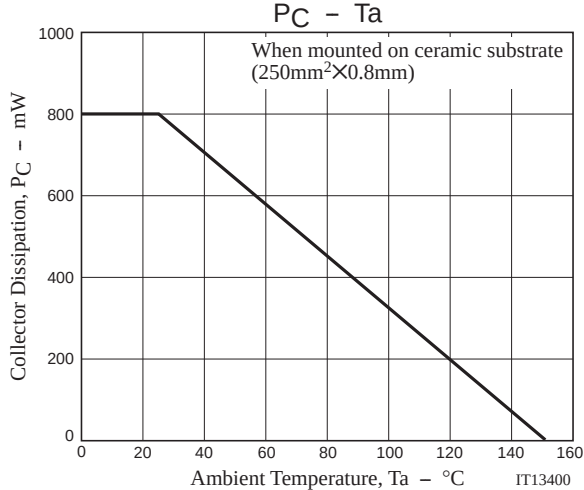
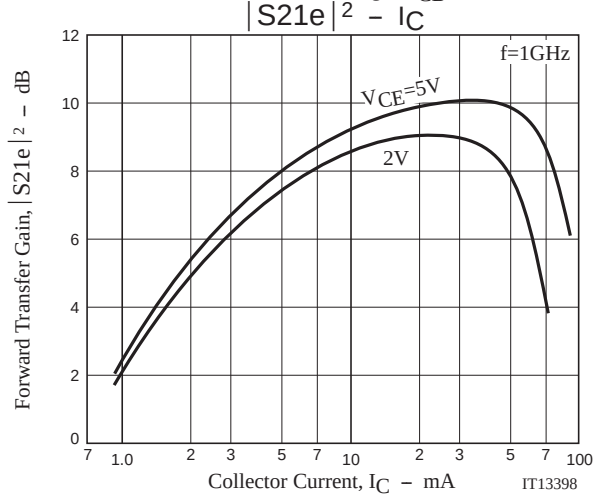
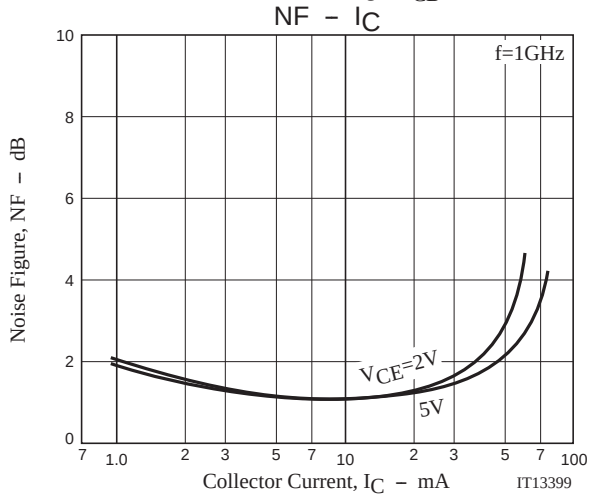
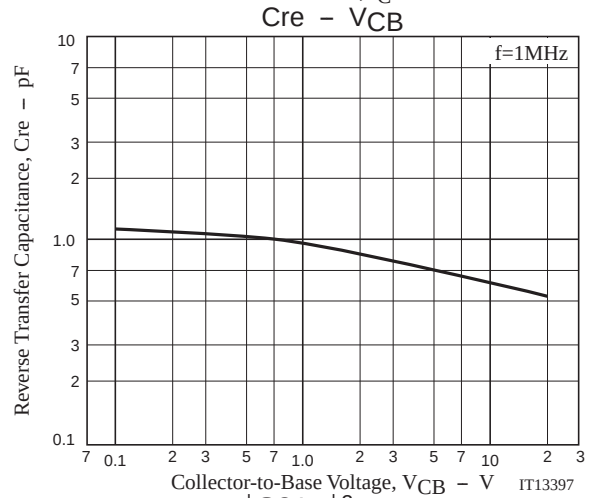
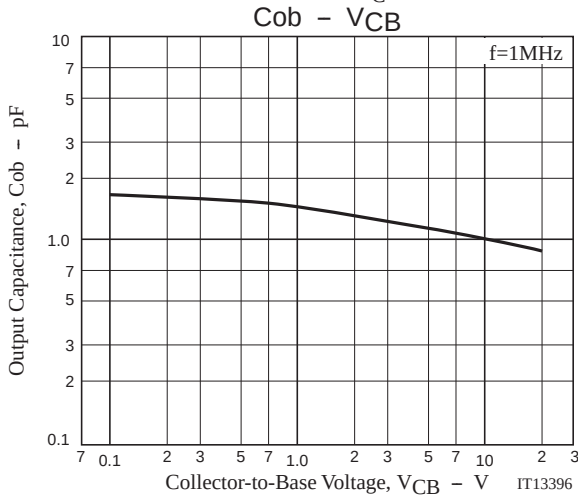
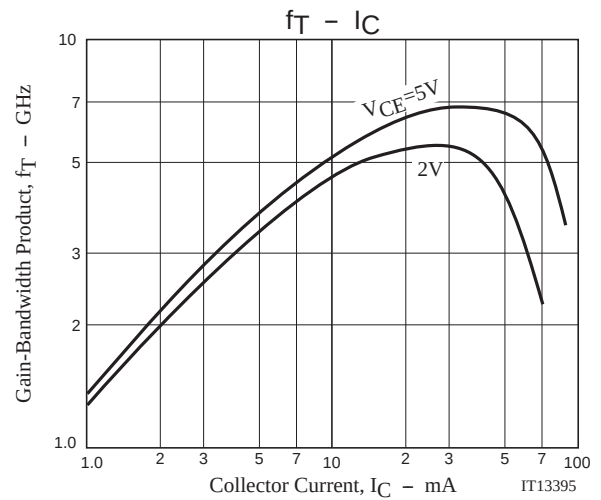
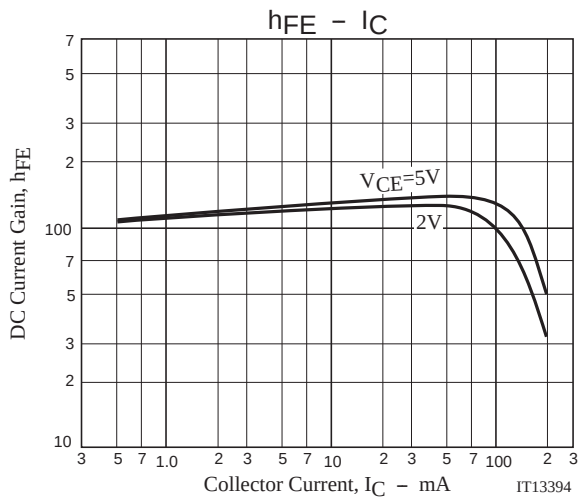
\* : The 2SC5415A is classified by 30mA h<sub>FE</sub> as follows :

| Rank            | E         | F          |
|-----------------|-----------|------------|
| h <sub>FE</sub> | 90 to 180 | 135 to 270 |

## Ordering Information

| Device         | Package | Shipping       | memo    |
|----------------|---------|----------------|---------|
| 2SC5415AE-TD-E | PCP     | 1,000pcs./reel | Pb Free |
| 2SC5415AF-TD-E | PCP     | 1,000pcs./reel |         |





## 2SC5415A

### S Parameters (Common emitter)

$V_{CE}=2V$ ,  $I_C=5mA$ ,  $Z_O=50\Omega$

| Freq(MHz) | S11   | $\angle S11$ | S21    | $\angle S21$ | S12   | $\angle S12$ | S22   | $\angle S22$ |
|-----------|-------|--------------|--------|--------------|-------|--------------|-------|--------------|
| 100       | 0.737 | -51.3        | 11.929 | 142.2        | 0.046 | 65.0         | 0.836 | -27.1        |
| 200       | 0.564 | -86.8        | 8.854  | 118.5        | 0.070 | 54.3         | 0.649 | -39.5        |
| 400       | 0.408 | -129.5       | 5.231  | 95.2         | 0.097 | 51.5         | 0.454 | -48.4        |
| 600       | 0.366 | -155.0       | 3.667  | 82.0         | 0.121 | 53.7         | 0.394 | -52.3        |
| 800       | 0.348 | -175.8       | 2.811  | 70.0         | 0.147 | 55.3         | 0.370 | -56.6        |
| 1000      | 0.338 | 169.4        | 2.332  | 62.6         | 0.175 | 56.2         | 0.368 | -60.5        |
| 1200      | 0.346 | 156.6        | 2.000  | 54.2         | 0.205 | 55.7         | 0.361 | -66.7        |
| 1400      | 0.350 | 145.7        | 1.739  | 47.3         | 0.235 | 54.9         | 0.363 | -72.2        |
| 1600      | 0.360 | 136.1        | 1.557  | 40.6         | 0.267 | 53.7         | 0.371 | -77.7        |
| 1800      | 0.365 | 126.2        | 1.428  | 34.4         | 0.300 | 51.7         | 0.383 | -83.4        |
| 2000      | 0.369 | 116.9        | 1.306  | 29.3         | 0.334 | 49.2         | 0.385 | -89.5        |

$V_{CE}=2V$ ,  $I_C=10mA$ ,  $Z_O=50\Omega$

| Freq(MHz) | S11   | $\angle S11$ | S21    | $\angle S21$ | S12   | $\angle S12$ | S22   | $\angle S22$ |
|-----------|-------|--------------|--------|--------------|-------|--------------|-------|--------------|
| 100       | 0.580 | -67.4        | 17.590 | 130.8        | 0.040 | 62.8         | 0.715 | -36.9        |
| 200       | 0.414 | -104.9       | 11.116 | 109.3        | 0.059 | 58.5         | 0.490 | -48.3        |
| 400       | 0.311 | -145.7       | 6.099  | 90.2         | 0.091 | 60.9         | 0.338 | -53.5        |
| 600       | 0.291 | -168.2       | 4.213  | 79.2         | 0.125 | 62.4         | 0.294 | -56.9        |
| 800       | 0.286 | 172.9        | 3.212  | 69.7         | 0.159 | 61.8         | 0.279 | -61.6        |
| 1000      | 0.281 | 159.6        | 2.634  | 62.4         | 0.194 | 60.3         | 0.277 | -65.9        |
| 1200      | 0.292 | 148.3        | 2.248  | 54.9         | 0.228 | 57.7         | 0.281 | -71.7        |
| 1400      | 0.297 | 138.5        | 1.973  | 48.5         | 0.261 | 55.2         | 0.284 | -77.2        |
| 1600      | 0.305 | 129.7        | 1.767  | 42.4         | 0.295 | 52.6         | 0.290 | -82.7        |
| 1800      | 0.311 | 120.5        | 1.605  | 36.4         | 0.328 | 49.6         | 0.297 | -88.5        |
| 2000      | 0.313 | 111.7        | 1.473  | 31.2         | 0.362 | 46.3         | 0.303 | -93.9        |

$V_{CE}=2V$ ,  $I_C=20mA$ ,  $Z_O=50\Omega$

| Freq(MHz) | S11   | $\angle S11$ | S21    | $\angle S21$ | S12   | $\angle S12$ | S22   | $\angle S22$ |
|-----------|-------|--------------|--------|--------------|-------|--------------|-------|--------------|
| 100       | 0.432 | -85.5        | 21.435 | 121.4        | 0.034 | 63.6         | 0.585 | -45.4        |
| 200       | 0.313 | -123.5       | 12.390 | 102.7        | 0.052 | 64.6         | 0.375 | -54.0        |
| 400       | 0.263 | -160.5       | 6.547  | 87.0         | 0.090 | 67.4         | 0.260 | -57.1        |
| 600       | 0.257 | -179.7       | 4.481  | 77.4         | 0.129 | 67.0         | 0.231 | -60.9        |
| 800       | 0.260 | 163.3        | 3.408  | 68.8         | 0.168 | 64.8         | 0.224 | -66.3        |
| 1000      | 0.258 | 151.6        | 2.792  | 62.1         | 0.206 | 62.3         | 0.224 | -70.9        |
| 1200      | 0.271 | 141.6        | 2.378  | 55.1         | 0.243 | 58.7         | 0.231 | -77.2        |
| 1400      | 0.270 | 133.1        | 2.085  | 49.1         | 0.278 | 55.4         | 0.236 | -82.9        |
| 1600      | 0.282 | 124.5        | 1.867  | 43.2         | 0.313 | 52.2         | 0.242 | -88.4        |
| 1800      | 0.288 | 115.4        | 1.697  | 37.5         | 0.346 | 48.7         | 0.249 | -94.2        |
| 2000      | 0.290 | 107.0        | 1.558  | 32.3         | 0.380 | 45.0         | 0.256 | -99.4        |

$V_{CE}=2V$ ,  $I_C=30mA$ ,  $Z_O=50\Omega$

| Freq(MHz) | S11   | $\angle S11$ | S21    | $\angle S21$ | S12   | $\angle S12$ | S22   | $\angle S22$ |
|-----------|-------|--------------|--------|--------------|-------|--------------|-------|--------------|
| 100       | 0.370 | -97.4        | 22.555 | 117.0        | 0.031 | 65.1         | 0.518 | -49.0        |
| 200       | 0.288 | -135.1       | 12.614 | 99.9         | 0.051 | 67.4         | 0.326 | -55.8        |
| 400       | 0.260 | -168.5       | 6.590  | 85.5         | 0.090 | 69.9         | 0.229 | -58.1        |
| 600       | 0.259 | 174.8        | 4.499  | 76.4         | 0.131 | 68.6         | 0.207 | -62.3        |
| 800       | 0.263 | 159.3        | 3.419  | 68.1         | 0.172 | 66.0         | 0.204 | -68.3        |
| 1000      | 0.262 | 148.2        | 2.796  | 61.7         | 0.211 | 62.8         | 0.206 | -73.2        |
| 1200      | 0.275 | 138.9        | 2.382  | 54.7         | 0.248 | 59.1         | 0.215 | -79.6        |
| 1400      | 0.279 | 130.4        | 2.089  | 48.8         | 0.284 | 55.6         | 0.220 | -85.4        |
| 1600      | 0.286 | 122.5        | 1.869  | 43.0         | 0.320 | 52.1         | 0.227 | -91.1        |
| 1800      | 0.291 | 113.8        | 1.700  | 37.3         | 0.353 | 48.4         | 0.235 | -97.0        |
| 2000      | 0.293 | 105.4        | 1.562  | 32.2         | 0.387 | 44.7         | 0.242 | -102.2       |

## 2SC5415A

### S Parameters (Common emitter)

V<sub>CE</sub>=5V, I<sub>C</sub>=5mA, Z<sub>O</sub>=50Ω

| Freq(MHz) | S <sub>11</sub> | ∠S <sub>11</sub> | S <sub>21</sub> | ∠S <sub>21</sub> | S <sub>12</sub> | ∠S <sub>12</sub> | S <sub>22</sub> | ∠S <sub>22</sub> |
|-----------|-----------------|------------------|-----------------|------------------|-----------------|------------------|-----------------|------------------|
| 100       | 0.752           | -45.7            | 12.674          | 144.1            | 0.037           | 67.6             | 0.871           | -21.6            |
| 200       | 0.575           | -78.6            | 9.416           | 121.5            | 0.058           | 57.3             | 0.697           | -32.2            |
| 400       | 0.391           | -119.9           | 5.688           | 97.7             | 0.082           | 54.4             | 0.532           | -38.3            |
| 600       | 0.334           | -146.4           | 4.015           | 84.3             | 0.103           | 56.8             | 0.472           | -41.5            |
| 800       | 0.307           | -169.1           | 3.085           | 73.2             | 0.126           | 58.9             | 0.450           | -45.4            |
| 1000      | 0.292           | 174.7            | 2.534           | 65.1             | 0.151           | 60.2             | 0.444           | -49.5            |
| 1200      | 0.303           | 160.6            | 2.164           | 56.8             | 0.177           | 60.0             | 0.449           | -54.6            |
| 1400      | 0.305           | 148.6            | 1.896           | 499.9            | 0.204           | 59.7             | 0.453           | -59.6            |
| 1600      | 0.314           | 137.9            | 1.693           | 43.2             | 0.235           | 58.9             | 0.454           | -65.0            |
| 1800      | 0.321           | 127.3            | 1.530           | 36.9             | 0.267           | 57.1             | 0.460           | -70.0            |
| 2000      | 0.328           | 117.7            | 1.394           | 31.5             | 0.299           | 55.1             | 0.470           | -76.4            |

V<sub>CE</sub>=5V, I<sub>C</sub>=10mA, Z<sub>O</sub>=50Ω

| Freq(MHz) | S <sub>11</sub> | ∠S <sub>11</sub> | S <sub>21</sub> | ∠S <sub>21</sub> | S <sub>12</sub> | ∠S <sub>12</sub> | S <sub>22</sub> | ∠S <sub>22</sub> |
|-----------|-----------------|------------------|-----------------|------------------|-----------------|------------------|-----------------|------------------|
| 100       | 0.601           | -58.4            | 18.468          | 133.9            | 0.033           | 65.7             | 0.765           | -25.1            |
| 200       | 0.413           | -92.4            | 12.043          | 112.1            | 0.049           | 61.0             | 0.603           | -30.7            |
| 400       | 0.275           | -132.7           | 6.703           | 92.4             | 0.078           | 63.3             | 0.509           | -36.8            |
| 600       | 0.240           | -157.9           | 4.641           | 81.3             | 0.107           | 64.8             | 0.470           | -45.9            |
| 800       | 0.228           | -179.9           | 3.536           | 71.9             | 0.137           | 64.6             | 0.438           | -56.8            |
| 1000      | 0.221           | 164.7            | 2.889           | 64.8             | 0.168           | 63.6             | 0.408           | -69.3            |
| 1200      | 0.232           | 151.6            | 2.462           | 57.2             | 0.199           | 61.5             | 0.371           | -83.9            |
| 1400      | 0.238           | 140.6            | 2.154           | 51.0             | 0.229           | 59.5             | 0.334           | -100.6           |
| 1600      | 0.249           | 131.1            | 1.924           | 44.8             | 0.259           | 57.3             | 0.298           | -120.1           |
| 1800      | 0.257           | 120.9            | 1.740           | 38.8             | 0.290           | 54.6             | 0.265           | -143.5           |
| 2000      | 0.262           | 111.5            | 1.589           | 33.6             | 0.322           | 51.6             | 0.246           | -170.6           |

V<sub>CE</sub>=5V, I<sub>C</sub>=30mA, Z<sub>O</sub>=50Ω

| Freq(MHz) | S <sub>11</sub> | ∠S <sub>11</sub> | S <sub>21</sub> | ∠S <sub>21</sub> | S <sub>12</sub> | ∠S <sub>12</sub> | S <sub>22</sub> | ∠S <sub>22</sub> |
|-----------|-----------------|------------------|-----------------|------------------|-----------------|------------------|-----------------|------------------|
| 100       | 0.373           | -79.4            | 24.799          | 120.4            | 0.026           | 67.6             | 0.598           | -36.8            |
| 200       | 0.245           | -114.8           | 14.190          | 102.5            | 0.043           | 69.5             | 0.418           | -39.2            |
| 400       | 0.183           | -154.3           | 7.472           | 87.6             | 0.077           | 71.8             | 0.331           | -38.5            |
| 600       | 0.174           | -175.8           | 5.102           | 78.5             | 0.112           | 70.9             | 0.310           | -41.3            |
| 800       | 0.177           | 163.8            | 3.872           | 70.4             | 0.147           | 68.7             | 0.305           | -46.3            |
| 1000      | 0.177           | 150.2            | 3.158           | 64.1             | 0.181           | 66.1             | 0.308           | -51.0            |
| 1200      | 0.190           | 139.3            | 2.681           | 57.4             | 0.215           | 62.8             | 0.313           | -57.0            |
| 1400      | 0.197           | 129.5            | 2.343           | 51.6             | 0.247           | 59.6             | 0.317           | -62.4            |
| 1600      | 0.209           | 121.2            | 2.090           | 45.9             | 0.279           | 56.7             | 0.321           | -67.8            |
| 1800      | 0.217           | 111.6            | 1.892           | 40.3             | 0.309           | 53.3             | 0.327           | -73.6            |
| 2000      | 0.222           | 102.6            | 1.727           | 35.2             | 0.340           | 49.9             | 0.333           | -78.9            |

V<sub>CE</sub>=5V, I<sub>C</sub>=50mA, Z<sub>O</sub>=50Ω

| Freq(MHz) | S <sub>11</sub> | ∠S <sub>11</sub> | S <sub>21</sub> | ∠S <sub>21</sub> | S <sub>12</sub> | ∠S <sub>12</sub> | S <sub>22</sub> | ∠S <sub>22</sub> |
|-----------|-----------------|------------------|-----------------|------------------|-----------------|------------------|-----------------|------------------|
| 100       | 0.308           | -92.8            | 25.470          | 116.0            | 0.024           | 69.2             | 0.543           | -36.8            |
| 200       | 0.221           | -129.7           | 14.126          | 99.7             | 0.041           | 72.1             | 0.389           | -36.4            |
| 400       | 0.190           | -165.7           | 7.357           | 85.9             | 0.076           | 73.8             | 0.324           | -35.3            |
| 600       | 0.189           | 176.0            | 5.012           | 77.4             | 0.111           | 72.5             | 0.309           | -38.8            |
| 800       | 0.195           | 158.6            | 3.800           | 69.4             | 0.146           | 69.9             | 0.307           | -44.2            |
| 1000      | 0.195           | 146.5            | 3.097           | 63.2             | 0.180           | 67.2             | 0.311           | -49.3            |
| 1200      | 0.209           | 136.8            | 2.630           | 56.5             | 0.214           | 63.7             | 0.317           | -55.6            |
| 1400      | 0.216           | 127.8            | 2.300           | 50.8             | 0.246           | 60.5             | 0.321           | -61.3            |
| 1600      | 0.227           | 119.9            | 2.050           | 45.1             | 0.279           | 57.5             | 0.325           | -66.9            |
| 1800      | 0.237           | 111.0            | 1.857           | 39.4             | 0.310           | 54.1             | 0.331           | -72.8            |
| 2000      | 0.241           | 102.2            | 1.695           | 34.5             | 0.341           | 50.5             | 0.337           | -78.3            |

### Embossed Taping Specification

2SC5415AE-TD-E, 2SC5415AF-TD-E

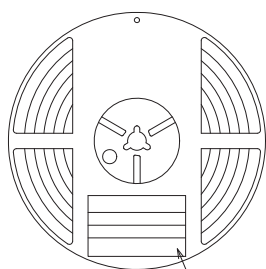
## 1. Packing Format

| Package Name | Carrier Tape<br>Type | Maximum Number of<br>devices contained (pcs) |           |           | Packing format                                              |                                                                    |
|--------------|----------------------|----------------------------------------------|-----------|-----------|-------------------------------------------------------------|--------------------------------------------------------------------|
|              |                      | Reel                                         | Inner box | Outer box | Inner BOX (C-1)                                             | Outer BOX (A-7)                                                    |
| PCP          | PCP                  | 1, 000                                       | 4, 000    | 24, 000   | 4 reels contained<br>Dimensions:mm (external)<br>183×72×185 | 6 inner boxes contained<br>Dimensions:mm (external)<br>440×195×210 |

Reel label, Inner box label  
(unit:mm)

Outer box label  
It is a label at the time of factory shipments.  
The form of a label may change in physical  
distribution process.

### Packing method



Reel label

Type No.

LOT No.

Quantity

## Origin

69

|             |             |
|-------------|-------------|
| (P) TYPE    | 000000000   |
| (1) LOT     | 00          |
| (Q) QTY     | 0,000 (1)   |
| (Z) SPECIAL | LEAD FREE * |

\*Z0722005310C\*

ASSEMBLY:\*\*\*\* (DIFFUSION:\*\*\*\*)

108

|                                                                                                                                                                           |                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| TYPE CODE                                                                                                                                                                 | <br>*0000000000000000* |
| TYPE<br><div style="text-align: center;">○○○○○○○○</div>                                                                                                                   |                                                                                                           |
| QTY<br>0, 000 PCS                                                                                                                                                         | (1)<br>LEAD FREE *                                                                                        |
| LOT<br><div style="text-align: center;">○○○○○○○○</div>                                                                                                                    |                                                                                                           |
| PACKAGE<br><div style="text-align: center;">○○○○○○○○</div>                                                                                                                |                                                                                                           |
| SPECIAL<br><div style="text-align: center;"> <br/>         *207220053100*       </div> |                                                                                                           |

ASSEMBLY:\*\*\*\* ( DIFFUSION :\*\*\*\* )

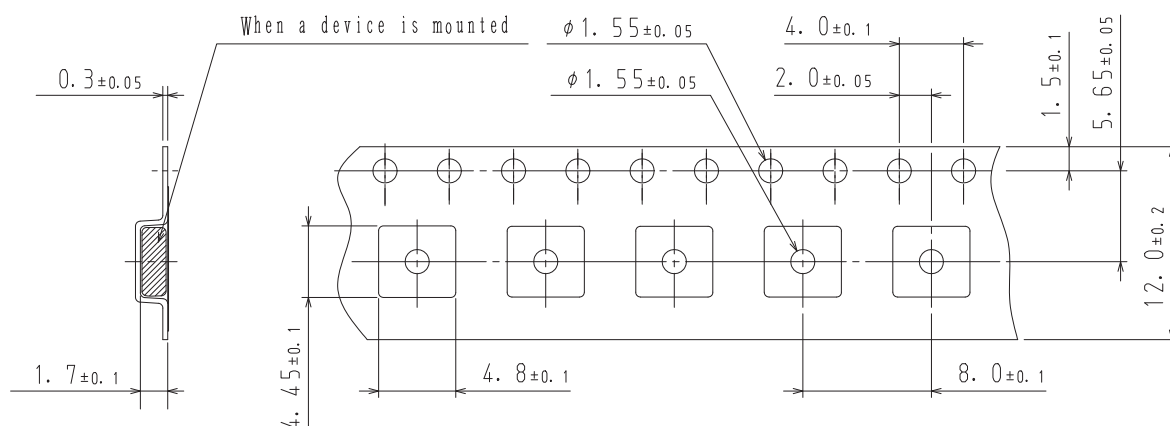
NOTE (1)

The LEAD FREE ✱ description shows that the surface treatment of the terminal is lead free.

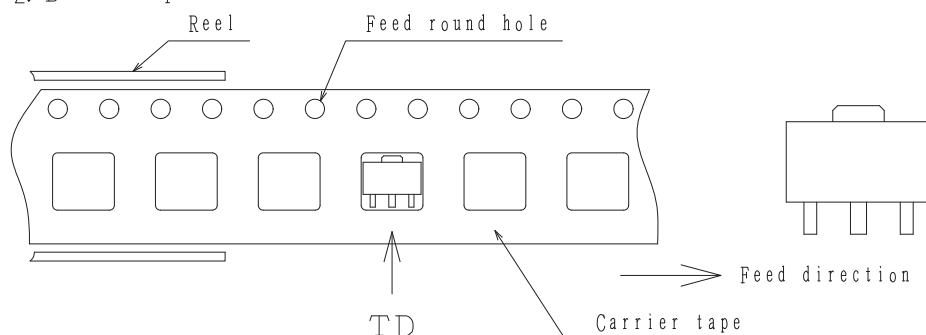
| Label       | JEITA Phase    |
|-------------|----------------|
| LEAD FREE 3 | JEITA Phase 3A |
| LEAD FREE 4 | JEITA Phase 3  |

## 2. Taping configuration

## 2-1. Carrier tape size (unit:mm)



## 2-2. Device placement direction

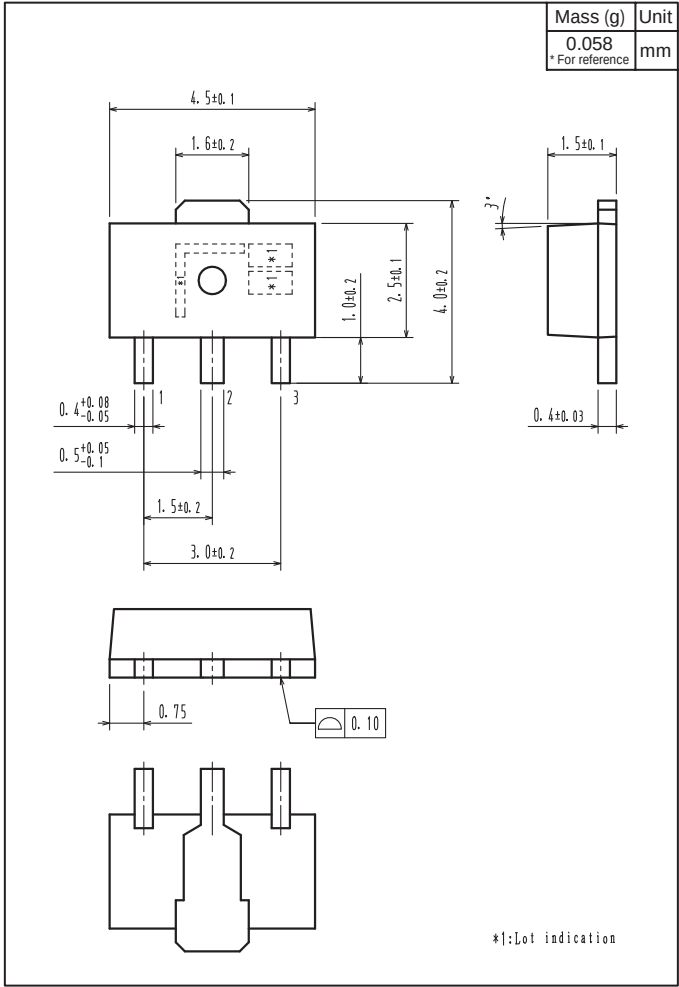


Those with pin 1 index on the feed hole side.....TD

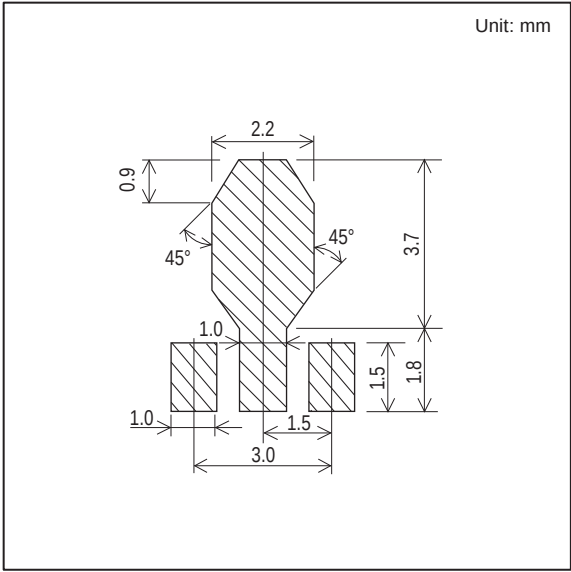
2SC5415A

Outline Drawing

2SC5415AE-TD-E, 2SC5415AF-TD-E



Land Pattern Example



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