NEC

# SILICON TRANSISTOR
# 2SC3604

## NPN EPITAXIAL SILICON TRANSISTOR FOR MICROWAVE LOW-NOISE AMPLIFICATION

The 2SC3604 is an NPN epitaxial transistor designed for low-noise amplification at 1.0 to 6.0 GHz. This transistor has low-noise and high-gain characteristics in a wide collector current region, and has a wide dynamic range.

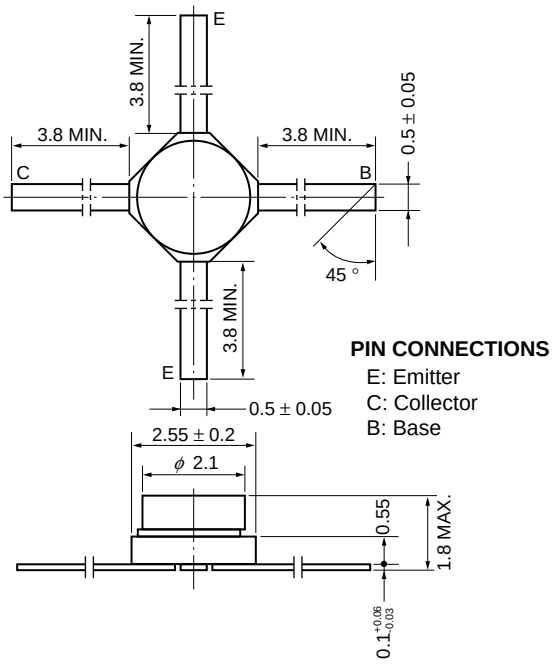
### FEATURES

- Low noise : NF = 1.6 dB TYP. @ f = 2.0 GHz
- High power gain : $G_A$ = 12 dB TYP. @ f = 2.0 GHz

### ABSOLUTE MAXIMUM RATINGS ($T_A$ = 25 °C)

| PARAMETER | SYMBOL | RATING | UNIT |
|---|---|---|---|
| Collector to Base Voltage | $V_{CBO}$ | 20 | V |
| Collector to Emitter Voltage | $V_{CEO}$ | 10 | V |
| Emitter to Base Voltage | $V_{EBO}$ | 1.5 | V |
| Collector Current | $I_C$ | 65 | mA |
| Total Power Dissipation | $P_{T\ (T_C = 25\ °C)}$ | 580 | mW |
| Junction Temperature | $T_j$ | 200 | °C |
| Storage Temperature | $T_{stg}$ | -65 to +150 | °C |

### PACKAGE DIMENSIONS (in mm)




**PIN CONNECTIONS**
E: Emitter
C: Collector
B: Base

### ELECTRICAL CHARACTERISTICS ($T_A$ = 25 °C)

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Collector Cut-off Current | $I_{CBO}$ | $V_{CB}$ = 10 V, $I_E$ = 0 | | | 1.0 | μA |
| Emitter Cut-off Current | $I_{EBO}$ | $V_{EB}$ = 1 V, $I_C$ = 0 | | | 1.0 | μA |
| DC Current Gain | $h_{FE}$ | $V_{CE}$ = 8 V, $I_C$ = 20 mA Pulse | 50 | 100 | 250 | |
| Gain Bandwidth Product | $f_T$ | $V_{CE}$ = 8 V, $I_C$ = 20 mA | | 8 | | GHz |
| Reverse Transfer Capacitance | $C_{re}$ | $V_{CB}$ = 10 V, $I_E$ = 0, f = 1 MHz | | 0.2 | 0.7 | pF |
| Noise Figure | $NF^{Note}$ | $V_{CE}$ = 8 V, $I_C$ = 7 mA, f = 2.0 GHz | | 1.6 | 2.3 | dB |
| Insertion Gain | $\|S_{21e}\|^2$ | $V_{CE}$ = 8 V, $I_C$ = 20 mA, f = 2.0 GHz | 9.0 | 11 | | dB |
| Maximum Available Gain | MAG | $V_{CE}$ = 8 V, $I_C$ = 20 mA, f = 2.0 GHz | | 13 | | dB |
| Power Gain | $G_A$ | $V_{CE}$ = 8 V, $I_C$ = 7 mA, f = 2.0 GHz | | 12 | | dB |

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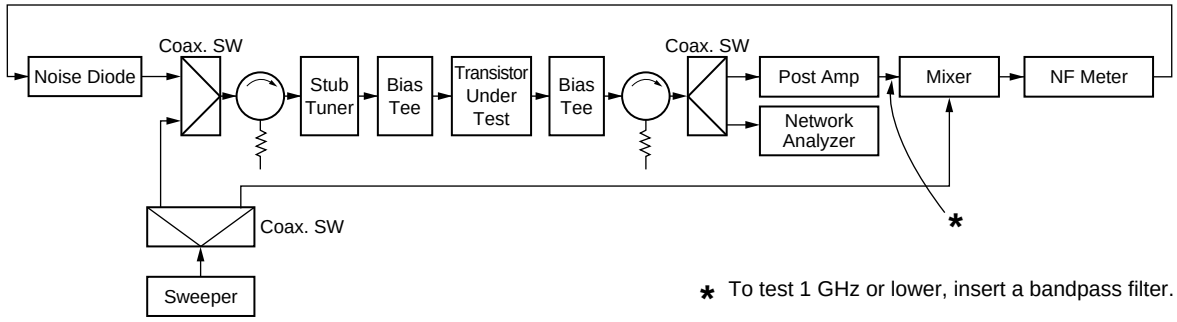
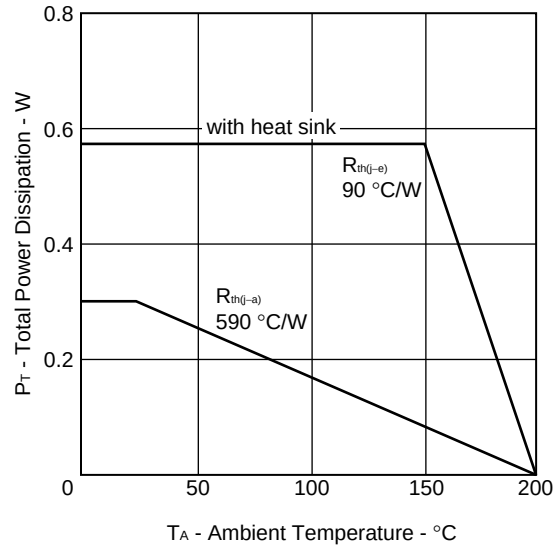
**Note** Test block diagram



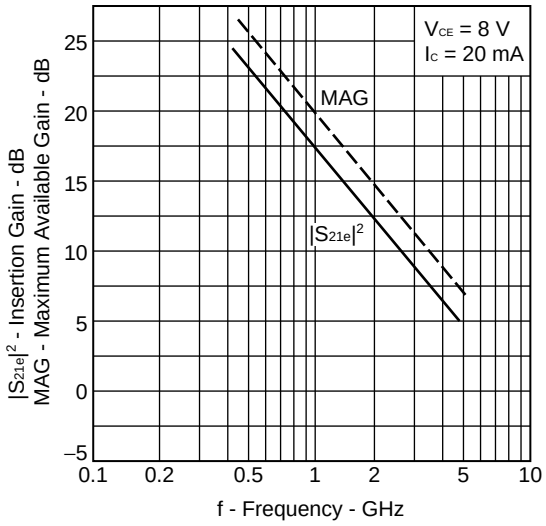

* To test 1 GHz or lower, insert a bandpass filter.

## TYPICAL CHARACTERISTICS ($T_A$ = 25 °C)

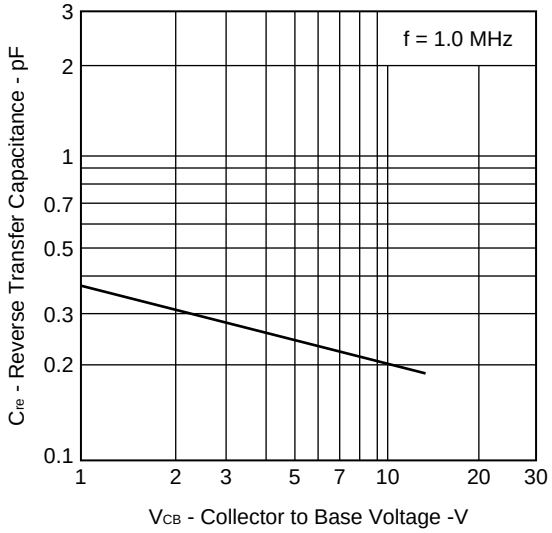
TOTAL POWER DISSIPATION vs. AMBIENT TEMPERATURE



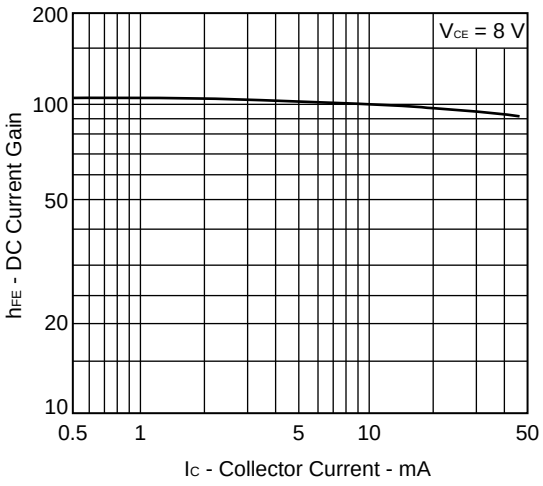

MAG AND INSERTION GAIN vs. FREQUENCY



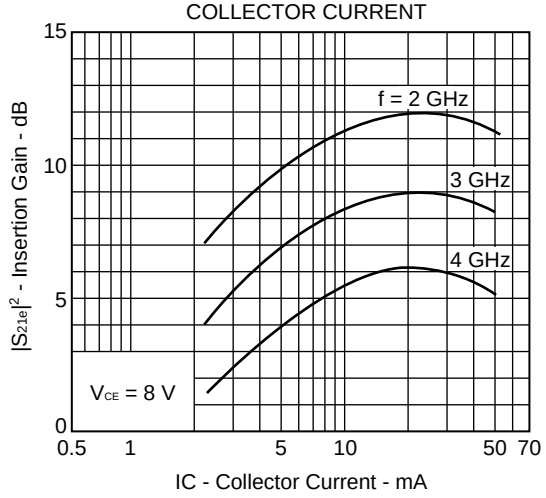

REVERSE TRANSFER CAPACITANCE vs. COLLECTOR TO BASE VOLTAGE



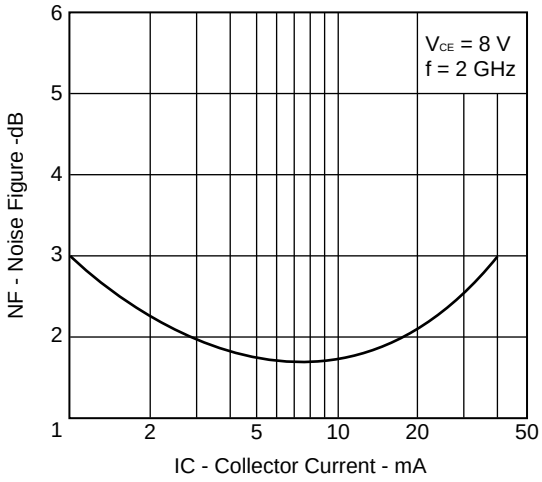

DC CURRENT GAIN vs. COLLECTOR CURRENT



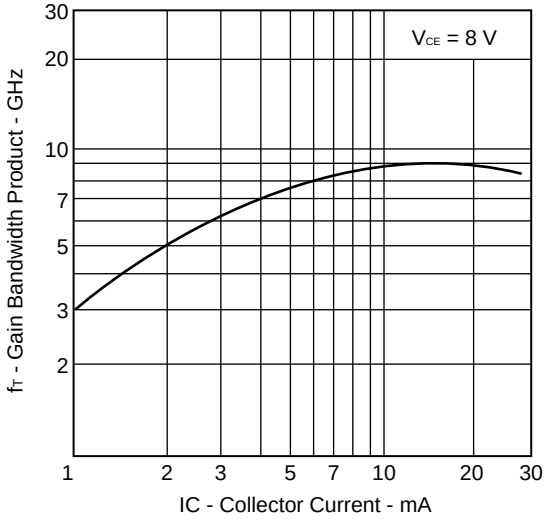
INSERTION GAIN vs.
COLLECTOR CURRENT




NOISE FIGURE vs. COLLECTOR CURRENT




GAIN BANDWIDTH PRODUCT vs.
COLLECTOR CURRENT




**S PARAMETER**

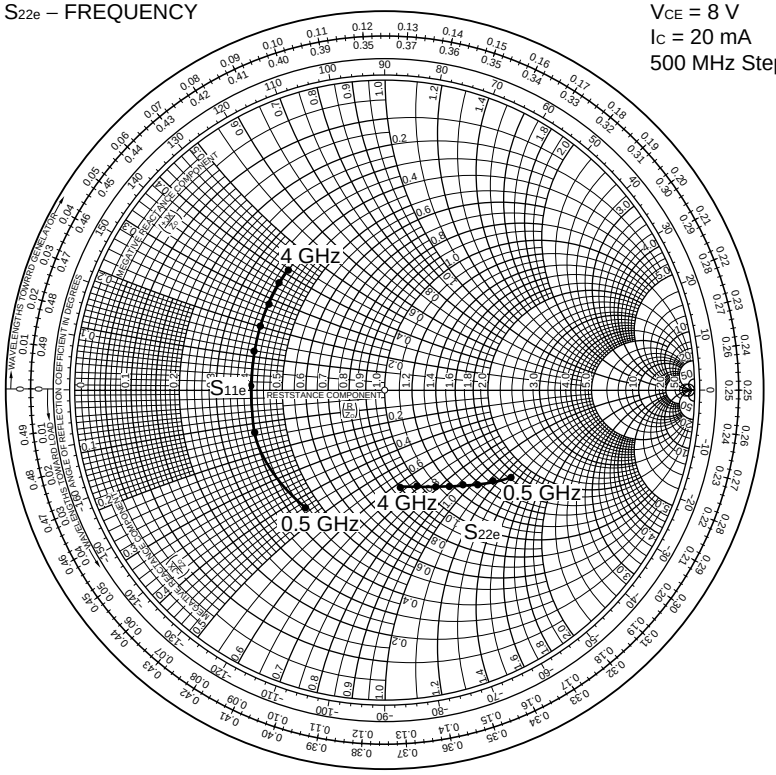
$V_{CE}$ = 6 V, $I_C$ = 10 mA, $Z_O$ = 50 Ω

| f (MHz) | $\|S_{11}\|$ | $\angle S_{11}$ | $\|S_{21}\|$ | $\angle S_{21}$ | $\|S_{12}\|$ | $\angle S_{12}$ | $\|S_{22}\|$ | $\angle S_{22}$ |
|---|---|---|---|---|---|---|---|---|
| 500 | .463 | −125.3 | 13.822 | 106.8 | .027 | 37.9 | .516 | −36.6 |
| 1000 | .432 | −162.7 | 7.901 | 86.2 | .0424 | 48.2 | .463 | −40.7 |
| 1500 | .416 | 178.7 | 5.250 | 71.1 | .0606 | 53.1 | .421 | −46.2 |
| 2000 | .439 | 165.0 | 3.949 | 59.7 | .0758 | 52.0 | .396 | −50.9 |
| 2500 | .451 | 153.6 | 3.151 | 51.7 | .097 | 49.3 | .372 | −56.5 |
| 3000 | .470 | 143.6 | 2.809 | 39.6 | .111 | 45.1 | .345 | −63.7 |
| 3500 | .482 | 135.2 | 2.337 | 28.6 | .124 | 39.5 | .320 | −73.2 |
| 4000 | .494 | 129.1 | 2.022 | 21.3 | .132 | 35.5 | .321 | −82.0 |

## S PARAMETER

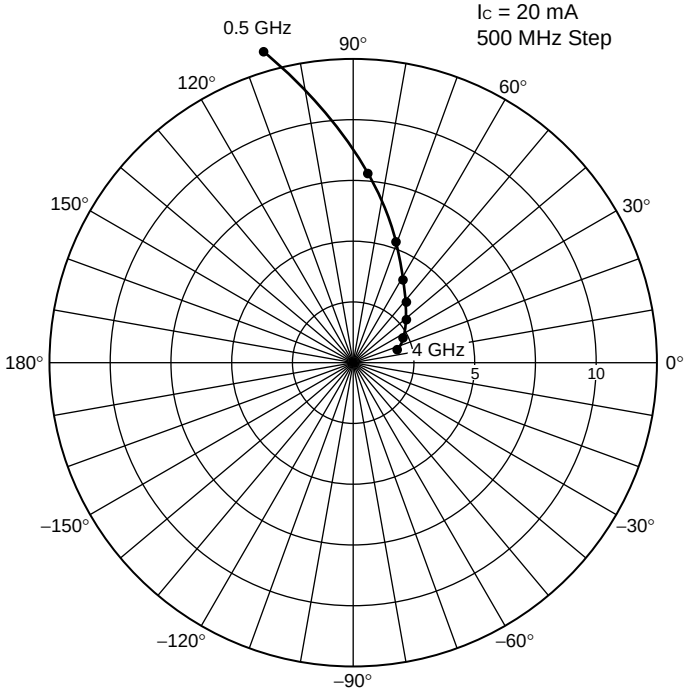
$S_{11e}$, $S_{22e}$ – FREQUENCY

$V_{CE}$ = 8 V
$I_C$ = 20 mA
500 MHz Step



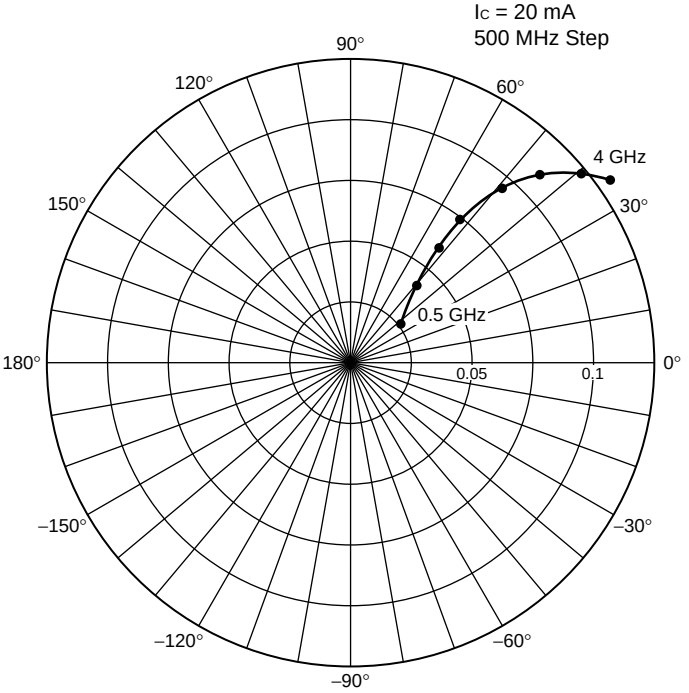

$S_{21e}$ – FREQUENCY

$V_{CC}$ = 8 V
$I_C$ = 20 mA
500 MHz Step




$S_{12e}$ – FREQUENCY

$V_{CE}$ = 8 V
$I_C$ = 20 mA
500 MHz Step

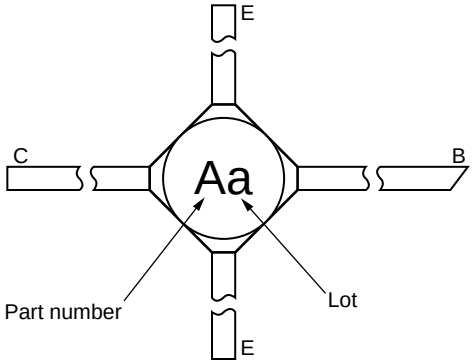


## MARKING

Because the package of the micro X package transistor is too small to be marked, the following indication is employed.

### Part Number

| Part Number | Marking | Part Number | Marking |
|---|---|---|---|
| 2SC2148 | A | 2SC3603 | 0 |
| 2SC2149 | B | 2SC3604 | 2 |
| 2SC2150 | C | 2SC3587 | 1 |
| 2SC2367 | H | | |
| 2SC2585 | K | | |
| 2SC1223 | D | | |




### Lot

Lot indication is colored as shown below.

The sequence black, brown, red, blue, and green, forms one cycle and this cycle is repeated.

| Month \ Year | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | j Black | v | h | t | f | r | d | p | b |
| 2 | k | w | i | u | g | s | e | q | c |
| 3 | l | x | j | v | h | t | f | r | d |
| 4 | m | y | k | w | i | u | g | s | e |
| 5 | n | z | l | x | j | v | h | t | f |
| 6 | o | a Brown | m | y | k | w | i | u | g |
| 7 | p | b | n | z | l | x | j | v | h |
| 8 | q | c | o | a Red | m | y | k | w | i |
| 9 | r | d | p | b | n | z | l | x | j |
| 10 | s | e | q | c | o | a Blue | m | y | k |
| 11 | t | f | r | d | p | b | n | z | l |
| 12 | u | g | s | e | q | c | o | a Green | m |

[MEMO]

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