

NST3946DXV6T1, NST3946DXV6T5

Dual General Purpose Transistor

The NST3946DXV6T1 device is a spin-off of our popular SOT-23/SOT-323 three-leaded device. It is designed for general purpose amplifier applications and is housed in the SOT-563 six-leaded surface mount package. By putting two discrete devices in one package, this device is ideal for low-power surface mount applications where board space is at a premium.

- h_{FE} , 100-300
- Low $V_{CE(sat)}$, ≤ 0.4 V
- Simplifies Circuit Design
- Reduces Board Space
- Reduces Component Count
- Lead-Free Solder Plating

MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|--|-----------|-----------------------|------|
| Collector- Emitter Voltage (NPN) (PNP) | V_{CEO} | 40 -40 | Vdc |
| Collector- Base Voltage (NPN) (PNP) | V_{CBO} | 60 -40 | Vdc |
| Emitter- Base Voltage (NPN) (PNP) | V_{EBO} | 6.0 -5.0 | Vdc |
| Collector Current - Continuous (NPN) (PNP) | I_C | 200 -200 | mAdc |
| Electrostatic Discharge | ESD | HBM>16000, MM>2000 | V |

THERMAL CHARACTERISTICS

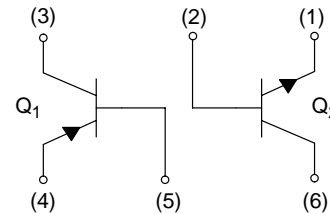
| Characteristic (One Junction Heated) | Symbol | Max | Unit |
|--|-----------------|------------------------------------|----------------------------|
| Total Device Dissipation $T_A = 25^\circ\text{C}$ Derate above 25°C | P_D | 357 (Note 1) 2.9 (Note 1) | mW mW/ $^\circ\text{C}$ |
| Thermal Resistance Junction-to-Ambient | $R_{\theta JA}$ | 350 (Note 1) | $^\circ\text{C/W}$ |
| Characteristic (Both Junctions Heated) | Symbol | Max | Unit |
| Total Device Dissipation $T_A = 25^\circ\text{C}$ Derate above 25°C | P_D | 500 (Note 1) 4.0 (Note 1) | mW mW/ $^\circ\text{C}$ |

1. FR-4 @ Minimum Pad



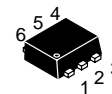
ON Semiconductor®

<http://onsemi.com>



NST3946DXV6T1*

*Q1 PNP
Q2 NPN



SOT-563
CASE 463A
PLASTIC

MARKING DIAGRAM



46 = Specific Device Code
D = Date Code

ORDERING INFORMATION

| Device | Package | Shipping |
|---------------|---------|--------------------------------|
| NST3946DXV6T1 | SOT-563 | 4 mm pitch 4000/Tape & Reel |
| NST3946DXV6T5 | SOT-563 | 2 mm pitch 8000/Tape & Reel |

NST3946DXV6T1, NST3946DXV6T5

| Characteristic (Both Junctions Heated) | Symbol | Max | Unit |
|---|-----------------|-----------------|------|
| Thermal Resistance Junction-to-Ambient | $R_{\theta JA}$ | 250 (Note 1) | °C/W |
| Junction and Storage Temperature Range | T_J, T_{stg} | - 55 to +150 | °C |

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

| Characteristic | Symbol | Min | Max | Unit |
|----------------|--------|-----|-----|------|
|----------------|--------|-----|-----|------|

OFF CHARACTERISTICS

| | | | | |
|--|---------------|-------------|-----------|------|
| Collector - Emitter Breakdown Voltage (Note 2) ($I_C = 1.0 \text{ mAdc}, I_B = 0$) (NPN) ($I_C = -1.0 \text{ mAdc}, I_B = 0$) (PNP) | $V_{(BR)CEO}$ | 40 -40 | - - | Vdc |
| Collector - Base Breakdown Voltage ($I_C = 10 \mu\text{Adc}, I_E = 0$) (NPN) ($I_C = -10 \mu\text{Adc}, I_E = 0$) (PNP) | $V_{(BR)CBO}$ | 60 -40 | - - | Vdc |
| Emitter - Base Breakdown Voltage ($I_E = 10 \mu\text{Adc}, I_C = 0$) (NPN) ($I_E = -10 \mu\text{Adc}, I_C = 0$) (PNP) | $V_{(BR)EBO}$ | 6.0 -5.0 | - - | Vdc |
| Base Cutoff Current ($V_{CE} = 30 \text{ Vdc}, V_{EB} = 3.0 \text{ Vdc}$) (NPN) ($V_{CE} = -30 \text{ Vdc}, V_{EB} = -3.0 \text{ Vdc}$) (PNP) | I_{BL} | - - | 50 -50 | nAdc |
| Collector Cutoff Current ($V_{CE} = 30 \text{ Vdc}, V_{EB} = 3.0 \text{ Vdc}$) (NPN) ($V_{CE} = -30 \text{ Vdc}, V_{EB} = -3.0 \text{ Vdc}$) (PNP) | I_{CEX} | - - | 50 -50 | nAdc |

ON CHARACTERISTICS (Note 2)

| | | | | |
|---|---------------|--|--|-----|
| DC Current Gain ($I_C = 0.1 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$) (NPN) ($I_C = 1.0 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 10 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 50 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = 100 \text{ mAdc}, V_{CE} = 1.0 \text{ Vdc}$) ($I_C = -0.1 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc}$) (PNP) ($I_C = -1.0 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc}$) ($I_C = -10 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc}$) ($I_C = -50 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc}$) ($I_C = -100 \text{ mAdc}, V_{CE} = -1.0 \text{ Vdc}$) | h_{FE} | 40 70 100 60 30 60 80 100 60 30 | - - 300 - - - - 300 - - | - |
| Collector - Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc}$) (NPN) ($I_C = 50 \text{ mAdc}, I_B = 5.0 \text{ mAdc}$) ($I_C = -10 \text{ mAdc}, I_B = -1.0 \text{ mAdc}$) (PNP) ($I_C = -50 \text{ mAdc}, I_B = -5.0 \text{ mAdc}$) | $V_{CE(sat)}$ | - - - - | 0.2 0.3 -0.25 -0.4 | Vdc |
| Base - Emitter Saturation Voltage ($I_C = 10 \text{ mAdc}, I_B = 1.0 \text{ mAdc}$) (NPN) ($I_C = 50 \text{ mAdc}, I_B = 5.0 \text{ mAdc}$) ($I_C = -10 \text{ mAdc}, I_B = -1.0 \text{ mAdc}$) (PNP) ($I_C = -50 \text{ mAdc}, I_B = -5.0 \text{ mAdc}$) | $V_{BE(sat)}$ | 0.65 - -0.65 - | 0.85 0.95 -0.85 -0.95 | Vdc |

2. Pulse Test: Pulse Width $\leq 300 \mu\text{s}$; Duty Cycle $\leq 2.0\%$.

NST3946DXV6T1, NST3946DXV6T5

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) (Continued)

| Characteristic | Symbol | Min | Max | Unit |
|--|------------------|------------|-------------|--------------------|
| SMALL- SIGNAL CHARACTERISTICS | | | | |
| Current - Gain - Bandwidth Product (I _C = 10 mA _{dc} , V _{CE} = 20 V _{dc} , f = 100 MHz) (NPN) (I _C = -10 mA _{dc} , V _{CE} = -20 V _{dc} , f = 100 MHz) (PNP) | f _T | 300 250 | - - | MHz |
| Output Capacitance (V _{CB} = 5.0 V _{dc} , I _E = 0, f = 1.0 MHz) (NPN) (V _{CB} = -5.0 V _{dc} , I _E = 0, f = 1.0 MHz) (PNP) | C _{obo} | - - | 4.0 4.5 | pF |
| Input Capacitance (V _{EB} = 0.5 V _{dc} , I _C = 0, f = 1.0 MHz) (NPN) (V _{EB} = -0.5 V _{dc} , I _C = 0, f = 1.0 MHz) (PNP) | C _{ibo} | - - | 8.0 10.0 | pF |
| Input Impedance (V _{CE} = 10 V _{dc} , I _C = 1.0 mA _{dc} , f = 1.0 kHz) (NPN) (V _{CE} = -10 V _{dc} , I _C = -1.0 mA _{dc} , f = 1.0 kHz) (PNP) | h _{ie} | 1.0 2.0 | 10 12 | k Ω |
| Voltage Feedback Ratio (V _{CE} = 10 V _{dc} , I _C = 1.0 mA _{dc} , f = 1.0 kHz) (NPN) (V _{CE} = -10 V _{dc} , I _C = -1.0 mA _{dc} , f = 1.0 kHz) (PNP) | h _{re} | 0.5 0.1 | 8.0 10 | X 10 ⁻⁴ |
| Small - Signal Current Gain (V _{CE} = 10 V _{dc} , I _C = 1.0 mA _{dc} , f = 1.0 kHz) (NPN) (V _{CE} = -10 V _{dc} , I _C = -1.0 mA _{dc} , f = 1.0 kHz) (PNP) | h _{fe} | 100 100 | 400 400 | - |
| Output Admittance (V _{CE} = 10 V _{dc} , I _C = 1.0 mA _{dc} , f = 1.0 kHz) (NPN) (V _{CE} = -10 V _{dc} , I _C = -1.0 mA _{dc} , f = 1.0 kHz) (PNP) | h _{oe} | 1.0 3.0 | 40 60 | μmhos |
| Noise Figure (V _{CE} = 5.0 V _{dc} , I _C = 100 μA _{dc} , R _S = 1.0 k Ω, f = 1.0 kHz) (NPN) (V _{CE} = -5.0 V _{dc} , I _C = -100 μA _{dc} , R _S = 1.0 k Ω, f = 1.0 kHz) (PNP) | NF | - - | 5.0 4.0 | dB |

SWITCHING CHARACTERISTICS

| | | | | | |
|--------------|--|----------------|--------|------------|----|
| Delay Time | (V _{CC} = 3.0 V _{dc} , V _{BE} = -0.5 V _{dc}) (NPN) (V _{CC} = -3.0 V _{dc} , V _{BE} = 0.5 V _{dc}) (PNP) | t _d | - - | 35 35 | ns |
| Rise Time | (I _C = 10 mA _{dc} , I _{B1} = 1.0 mA _{dc}) (NPN) (I _C = -10 mA _{dc} , I _{B1} = -1.0 mA _{dc}) (PNP) | t _r | - - | 35 35 | |
| Storage Time | (V _{CC} = 3.0 V _{dc} , I _C = 10 mA _{dc}) (NPN) (V _{CC} = -3.0 V _{dc} , I _C = -10 mA _{dc}) (PNP) | t _s | - - | 200 225 | ns |
| Fall Time | (I _{B1} = I _{B2} = 1.0 mA _{dc}) (NPN) (I _{B1} = I _{B2} = -1.0 mA _{dc}) (PNP) | t _f | - - | 50 75 | |

NST3946DXV6T1, NST3946DXV6T5

(NPN)

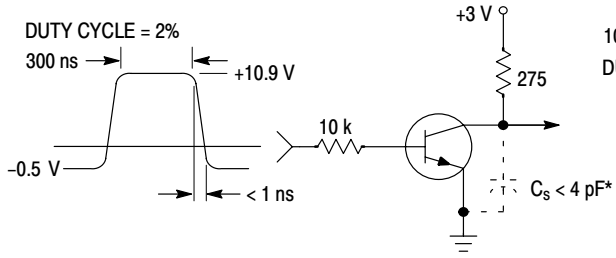


Figure 1. Delay and Rise Time Equivalent Test Circuit

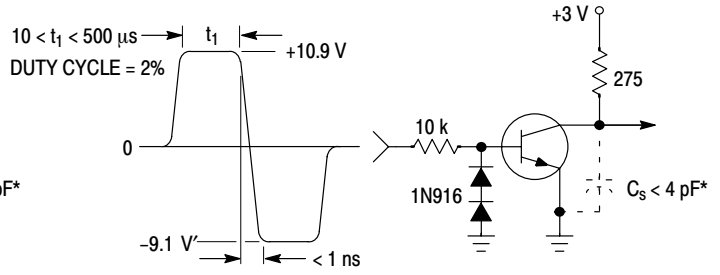


Figure 2. Storage and Fall Time Equivalent Test Circuit

* Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

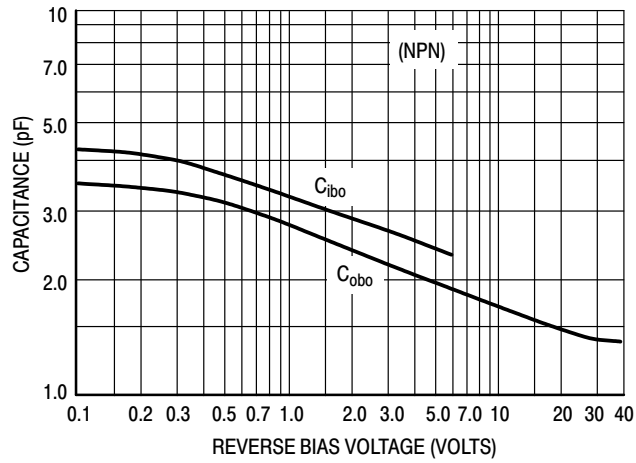


Figure 3. Capacitance

NST3946DXV6T1, NST3946DXV6T5

(NPN)

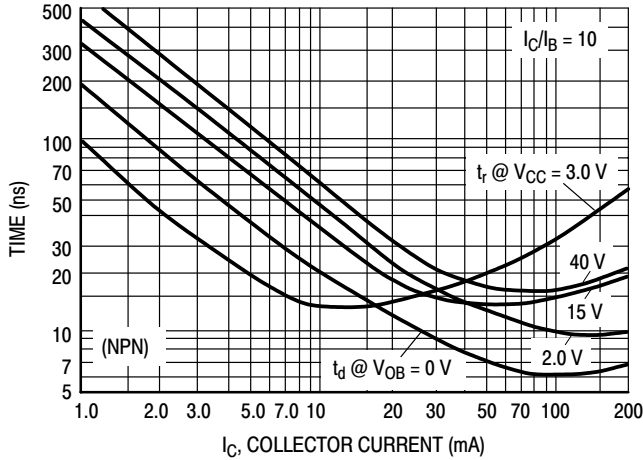


Figure 4. Turn - On Time

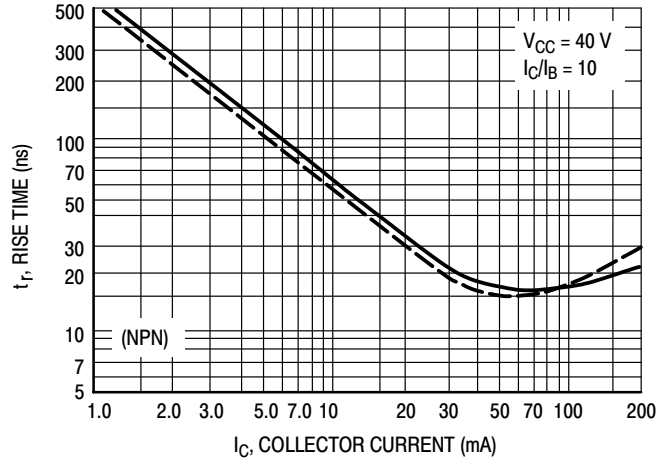


Figure 5. Rise Time

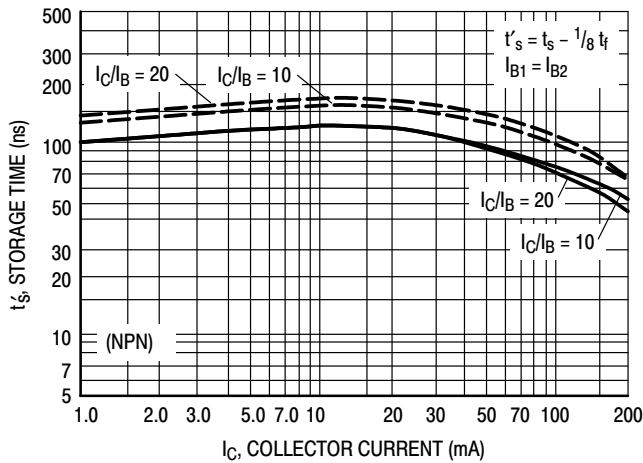


Figure 6. Storage Time

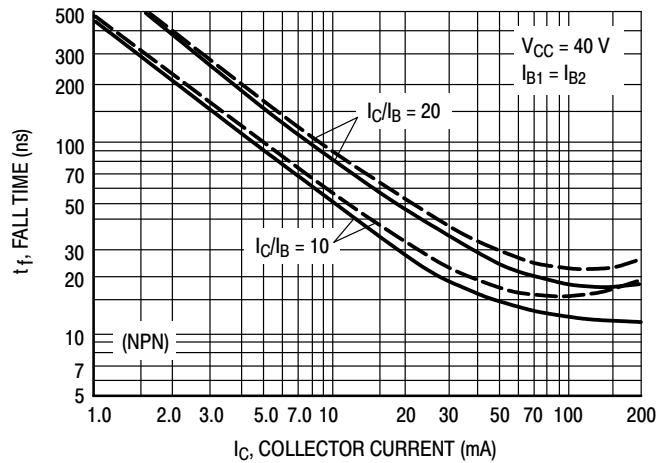


Figure 7. Fall Time

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS NOISE FIGURE VARIATIONS

($V_{CE} = 5.0 \text{ Vdc}$, $T_A = 25^\circ\text{C}$, Bandwidth = 1.0 Hz)

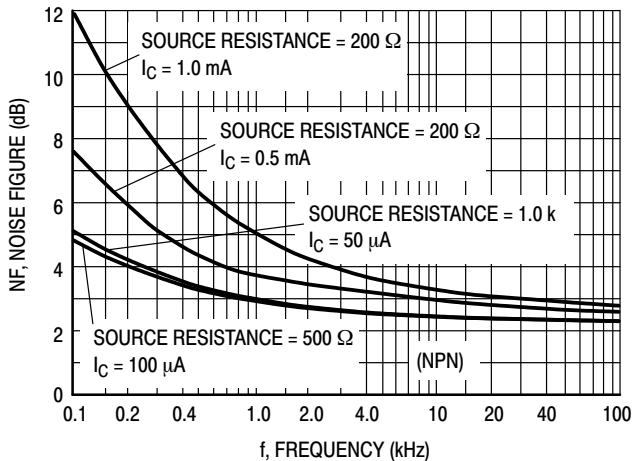


Figure 8. Noise Figure

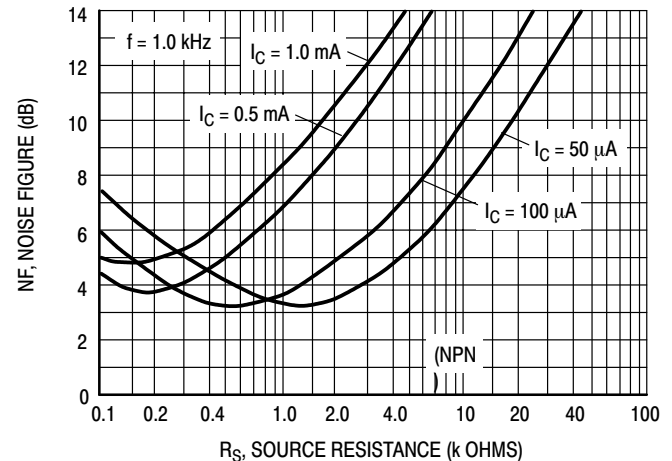


Figure 9. Noise Figure

NST3946DXV6T1, NST3946DXV6T5

(NPN)

h PARAMETERS

($V_{CE} = 10 \text{ Vdc}$, $f = 1.0 \text{ kHz}$, $T_A = 25^\circ\text{C}$)

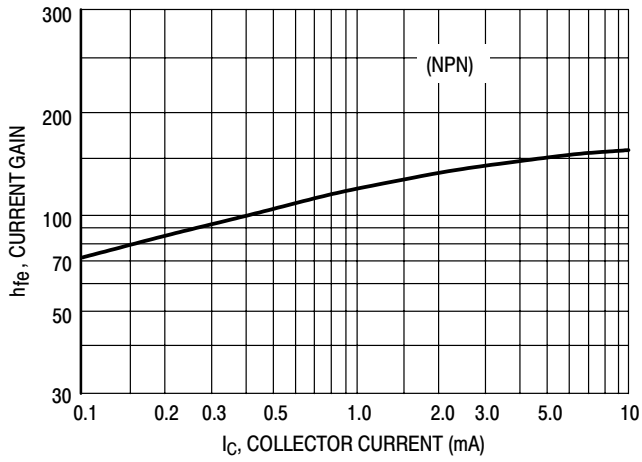


Figure 10. Current Gain

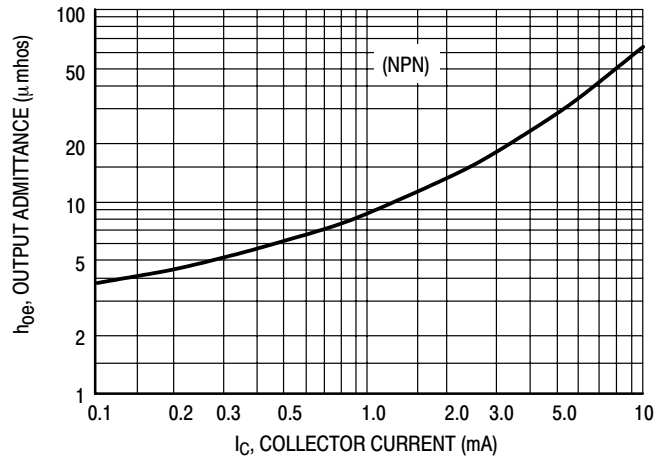


Figure 11. Output Admittance

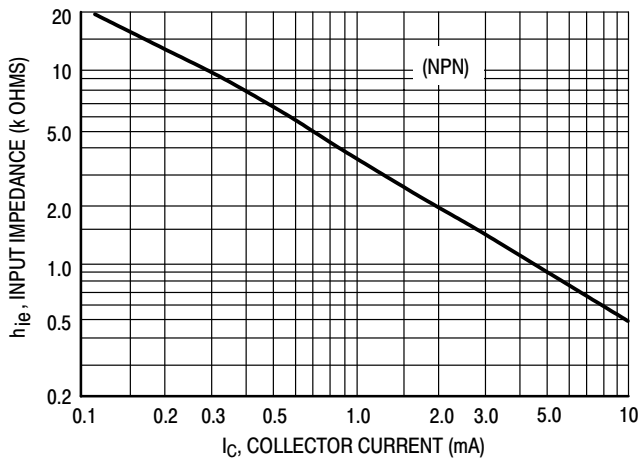


Figure 12. Input Impedance

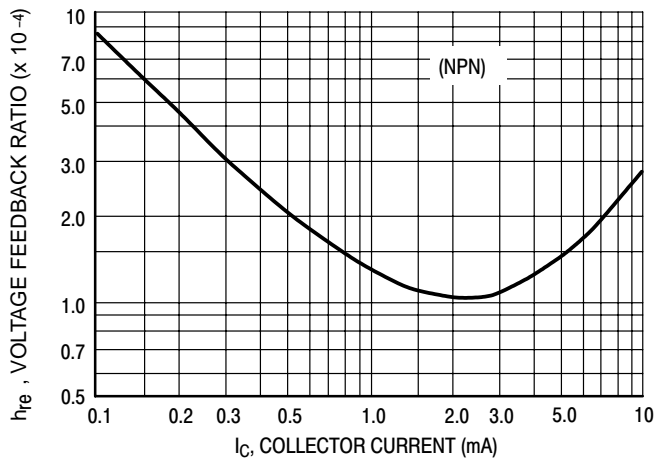


Figure 13. Voltage Feedback Ratio

NST3946DXV6T1, NST3946DXV6T5

(NPN)

TYPICAL STATIC CHARACTERISTICS

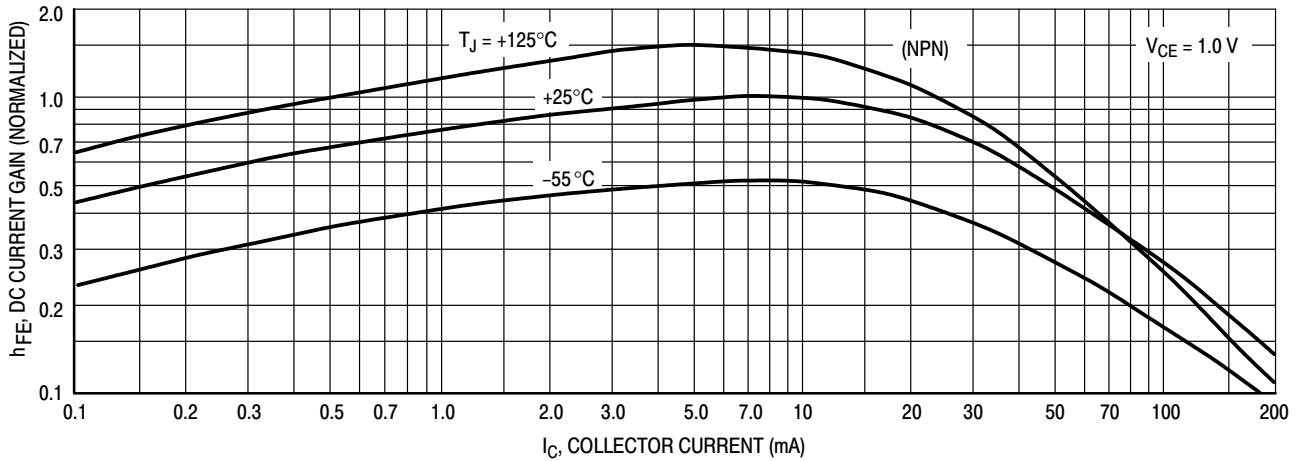


Figure 14. DC Current Gain

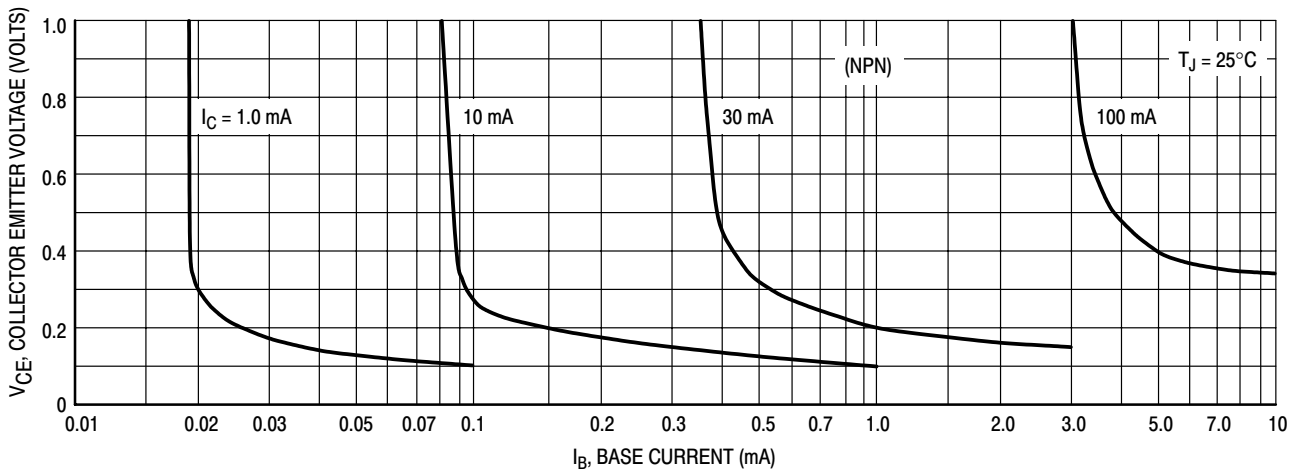


Figure 15. Collector Saturation Region

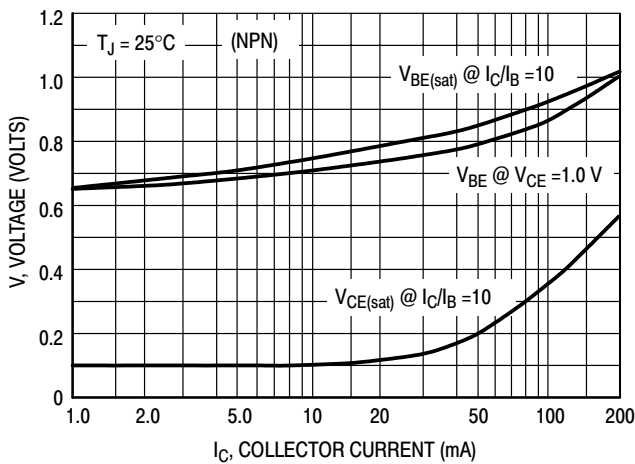


Figure 16. "ON" Voltages

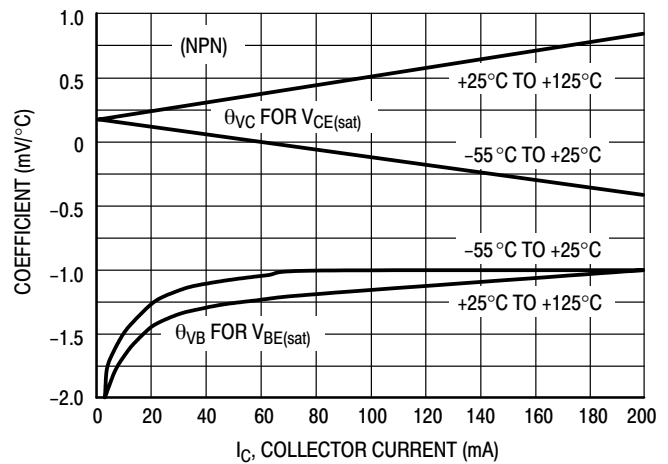


Figure 17. Temperature Coefficients

NST3946DXV6T1, NST3946DXV6T5

(PNP)

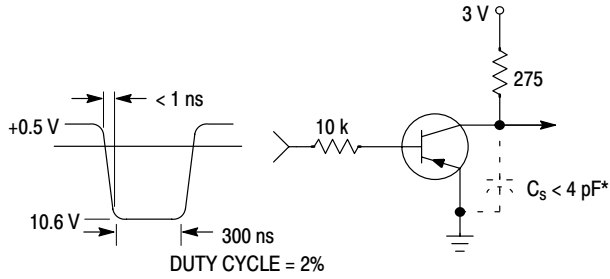


Figure 18. Delay and Rise Time Equivalent Test Circuit

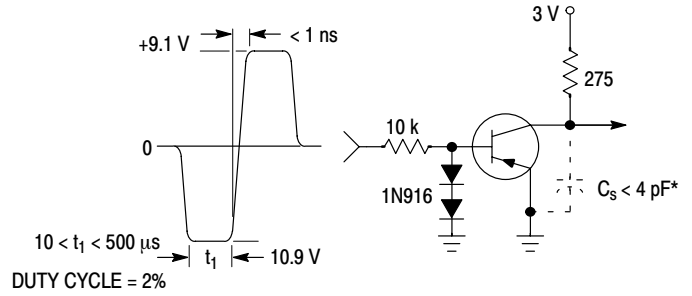


Figure 19. Storage and Fall Time Equivalent Test Circuit

* Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

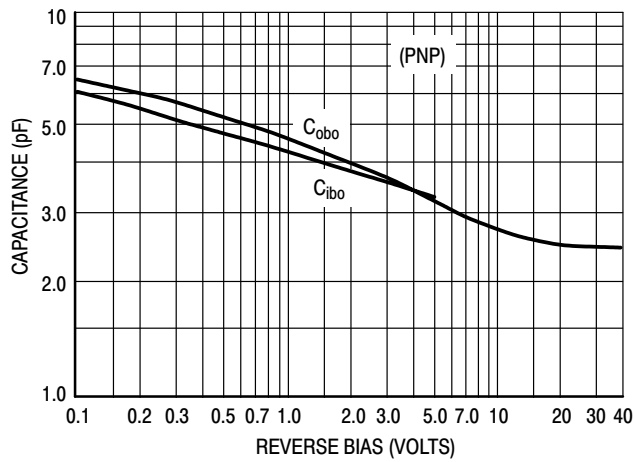


Figure 20. Capacitance

— $T_J = 25^\circ\text{C}$
 - - - $T_J = 125^\circ\text{C}$

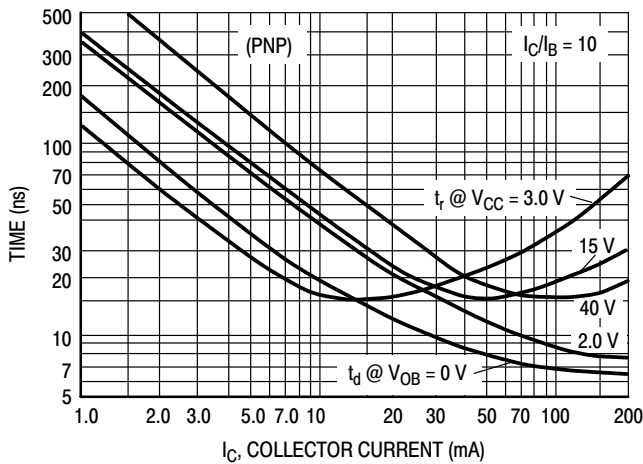


Figure 21. Turn-On Time

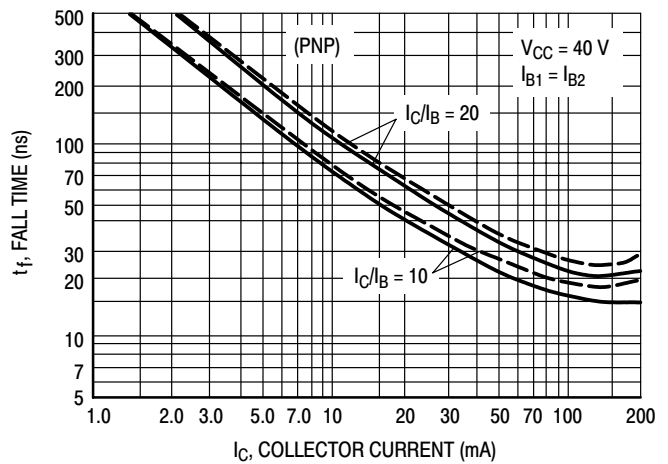


Figure 22. Fall Time

(PNP)

TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

($V_{CE} = -5.0$ Vdc, $T_A = 25^\circ\text{C}$, Bandwidth = 1.0 Hz)

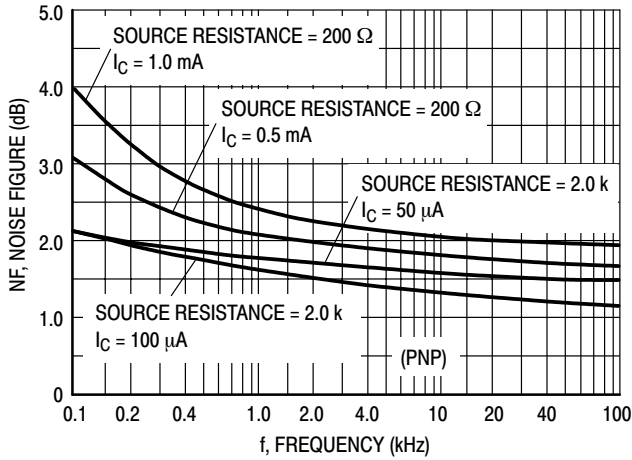


Figure 23.

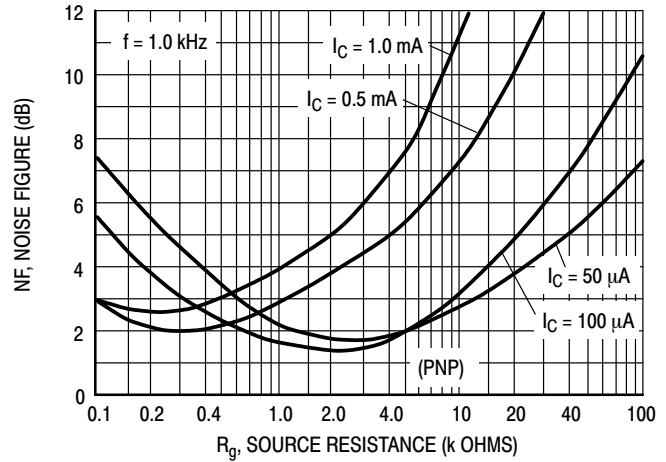


Figure 24.

h PARAMETERS

($V_{CE} = -10$ Vdc, $f = 1.0$ kHz, $T_A = 25^\circ\text{C}$)

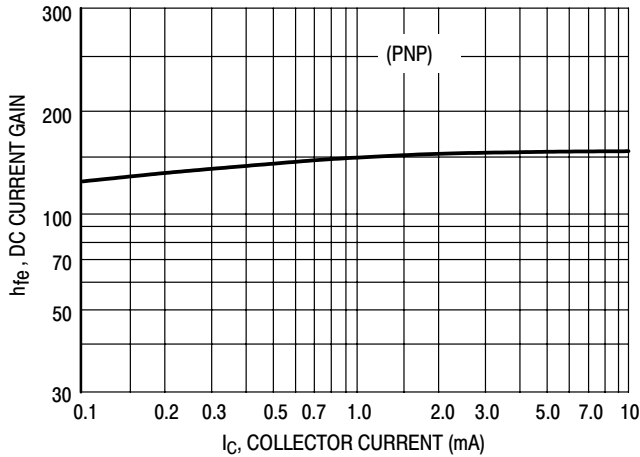


Figure 25. Current Gain

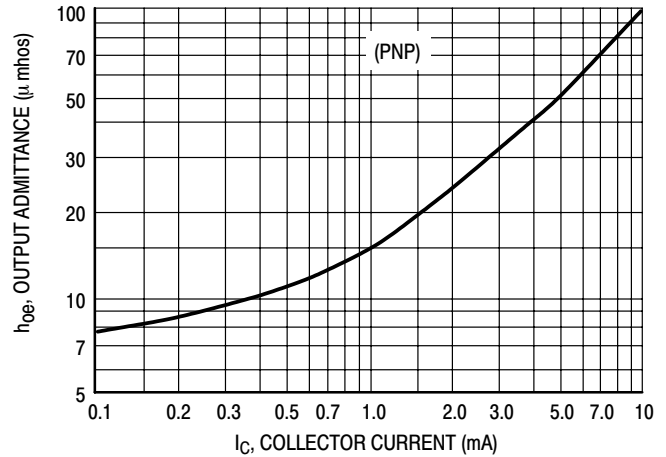


Figure 26. Output Admittance

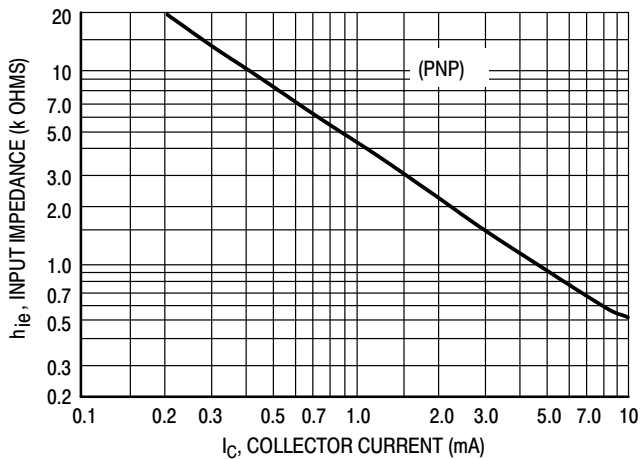


Figure 27. Input Impedance

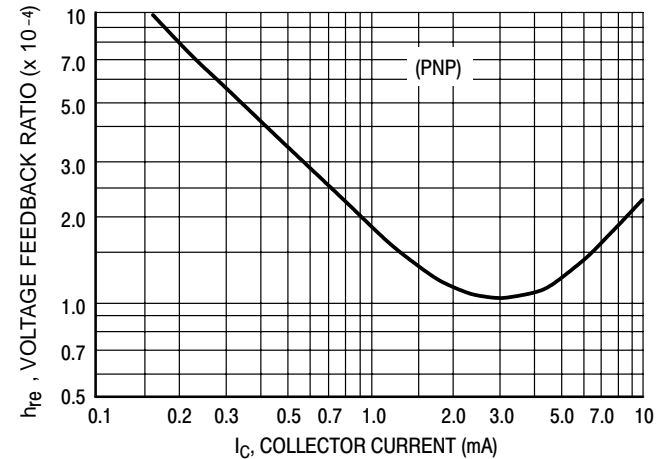


Figure 28. Voltage Feedback Ratio

NST3946DXV6T1, NST3946DXV6T5

(PNP)

TYPICAL STATIC CHARACTERISTICS

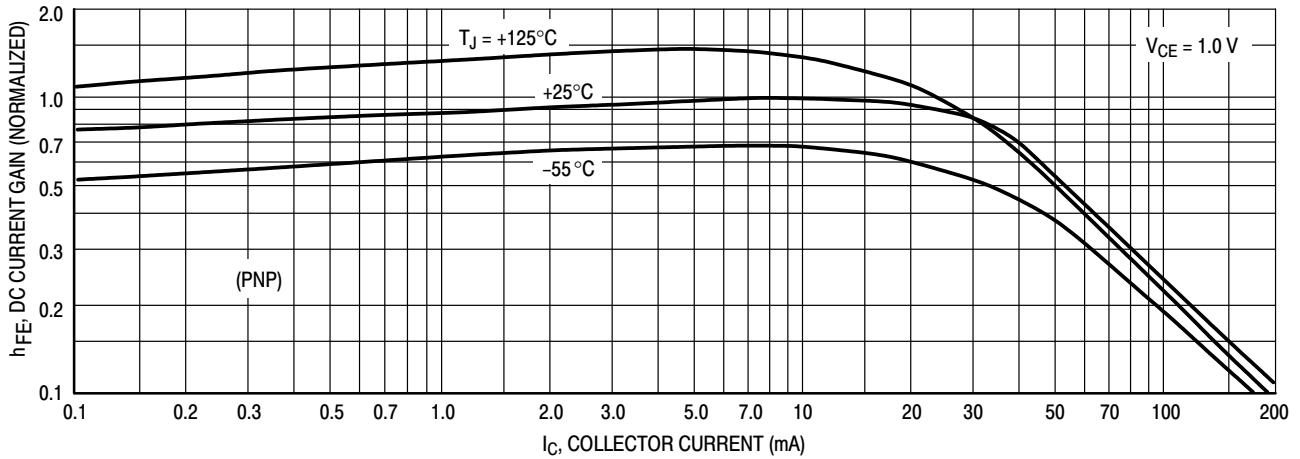


Figure 29. DC Current Gain

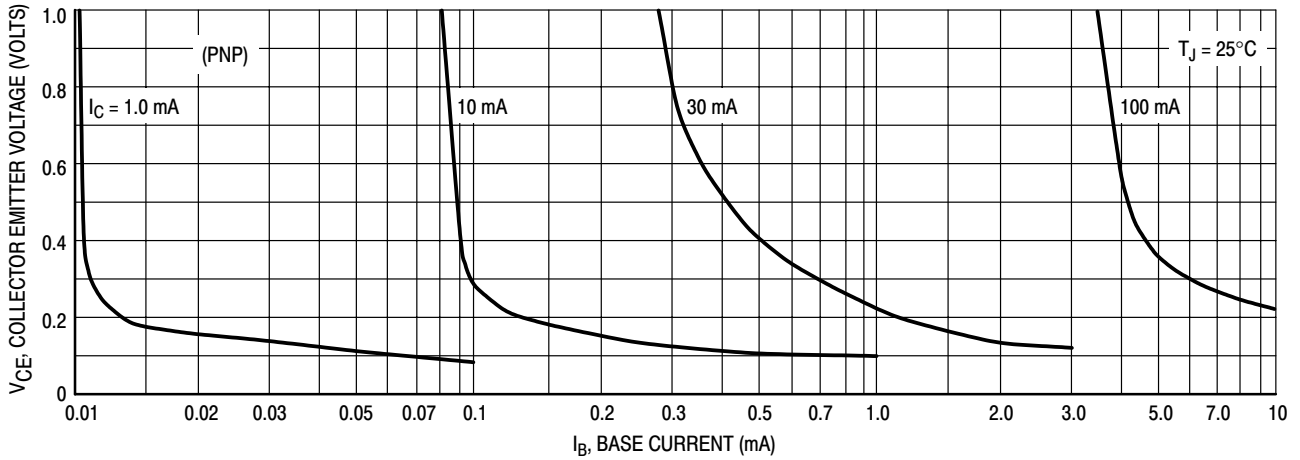


Figure 30. Collector Saturation Region

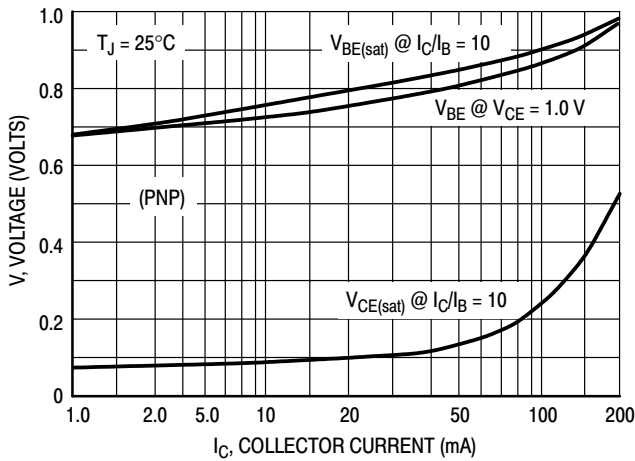


Figure 31. "ON" Voltages

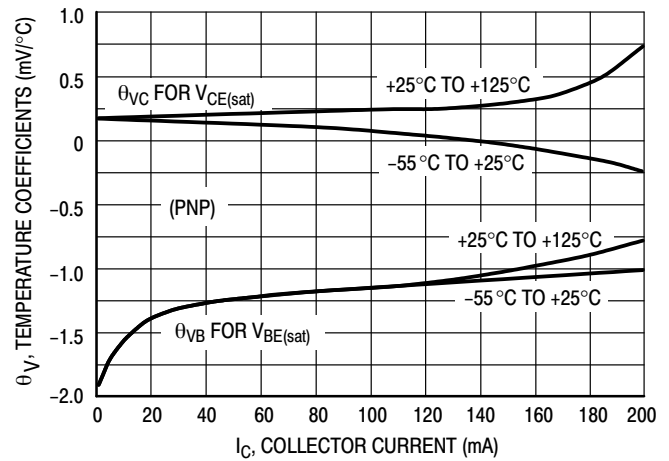
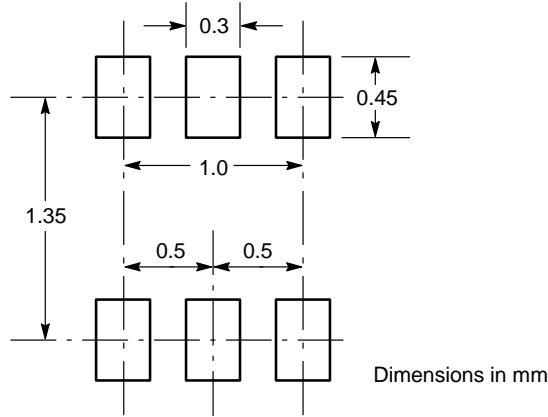


Figure 32. Temperature Coefficients

INFORMATION FOR USING THE SOT-563 SURFACE MOUNT PACKAGE
MINIMUM RECOMMENDED FOOTPRINT FOR SURFACE MOUNTED APPLICATIONS

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection

interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.



SOT-563

SOT-563 POWER DISSIPATION

The power dissipation of the SOT-563 is a function of the pad size. This can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient, and the operating temperature, T_A . Using the values provided on the data sheet for the SOT-563 package, P_D can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device which in this case is 150 milliwatts.

$$P_D = \frac{150^\circ\text{C} - 25^\circ\text{C}}{833^\circ\text{C/W}} = 150 \text{ milliwatts}$$

The 833°C/W for the SOT-563 package assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 150 milliwatts. There are other alternatives to achieving higher power dissipation from the SOT-563 package. Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad®. Using a board material such as Thermal Clad, an aluminum core board, the power dissipation can be doubled using the same footprint.

SOLDERING PRECAUTIONS

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

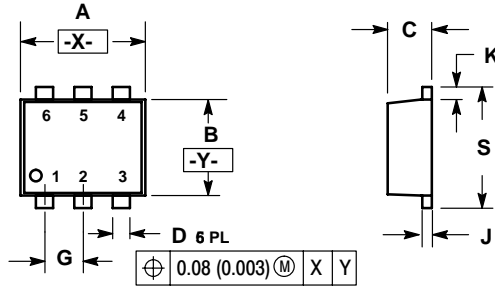
- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference shall be a maximum of 10°C.
- The soldering temperature and time shall not exceed 260°C for more than 10 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient shall be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling.

* Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device

NST3946DXV6T1, NST3946DXV6T5

PACKAGE DIMENSIONS

SOT-563, 6 LEAD
CASE 463A-01
ISSUE O



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETERS
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 1.50 | 1.70 | 0.059 | 0.067 |
| B | 1.10 | 1.30 | 0.043 | 0.051 |
| C | 0.50 | 0.60 | 0.020 | 0.024 |
| D | 0.17 | 0.27 | 0.007 | 0.011 |
| G | 0.50 BSC | | 0.020 BSC | |
| J | 0.08 | 0.18 | 0.003 | 0.007 |
| K | 0.10 | 0.30 | 0.004 | 0.012 |
| S | 1.50 | 1.70 | 0.059 | 0.067 |

STYLE 1:

- PIN 1. EMITTER 1
- 2. BASE 1
- 3. COLLECTOR 2
- 4. EMITTER 2
- 5. BASE 2
- 6. COLLECTOR 1

STYLE 2:

- PIN 1. EMITTER 1
- 2. EMITTER 2
- 3. BASE 2
- 4. COLLECTOR 2
- 5. BASE 1
- 6. COLLECTOR 1


STYLE 3:

- PIN 1. CATHODE 1
- 2. CATHODE 1
- 3. ANODE/ANODE 2
- 4. CATHODE 2
- 5. CATHODE 2
- 6. ANODE/ANODE 1

STYLE 4:

- PIN 1. COLLECTOR
- 2. COLLECTOR
- 3. BASE
- 4. EMITTER
- 5. COLLECTOR
- 6. COLLECTOR

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