# POWER DATA BOOK

POWER
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POWER

FAIRCHILD

464 Ellis Street, Mountain View, California 94042

# INTRODUCTION

You, the customer, and your needs have dictated the format and contents of this Power Handbook. To be responsive to the changing requirements of the power market, Fairchild will commit resources to maintain a leading position in technology, quality, commitment to delivery schedule and service to customers.

Fairchild has long been a major supplier of bipolar power transistors. However, the thousands of EIA registered and house-numbered devices makes it impossible to second source or even cross reference all of the industry devices. This book contains popular industry preferred numbers. If a device you are using or intend to use is not contained in this handbook, please contact the factory through your local sales office or representative for Fairchild information on your requirement. The Company's broad technology base enables the manufacturing of devices to most industry numbers.

This book has been sectioned for your convenience—quick reference charts, technical information and complete data sheets—and organized as follows:

*Selection Guides*
Quick reference guides for designers seeking devices to meet their needs. These selection guides are arranged in several ways to make location of information easy. They also contain basic parameter information for each device plus the page number where the complete data sheet can be located.

*Industry Cross Reference*
Industry type number vs Fairchild's nearest equivalent, an aid to locating replacement parts for old designs.

*Chapters 1 through 5*
Technical information to aid the designer in selecting the correct device for his application—Technology, Safe Operating Area, Manufacturing, Packaging and Heat Sinking, and Reliability.

*Product Information*
Fairchild devices arranged numerically and containing electrical characteristics, SOA and electrical characteristic curves on each device. Information on processing and ordering of Fairchild power dice.

*Standard Definitions of Symbols and Terms used in Specifying Power Devices*

*Addresses of Fairchild Sales Offices, Representatives and Distributors*

As well as supplying a full line of standard devices, Fairchild has the capability of supplying custom devices tailored to your application. A complete service organization is available to assist you—a sales force consisting of sales engineers, representatives and distributors, field application engineers to help you with circuit design or device application, and customer service coordinators to resolve and expedite your order. Our goal is to give you cost-effective power transistors, timely delivery and excellent service while maintaining a top position in this field of expanding technology.

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# SELECTION GUIDE BY DEVICE NUMBER

| DEVICE | POLARITY | $I_C$ Max A | $V_{CEO}$ Max V | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$=25°C W | PACKAGE | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2N3054 | NPN | 4.0 | 55 | 25/150 | 0.5 | 1.0 | 0.5 | - | 25 | TO-66 | 6-3 |
| 2N3055 | NPN | 15 | 60 | 20/70 | 4.0 | 1.1 | 4.0 | - | 117 | TO-3 | 6-6 |
| 2N3055SD | NPN | 15 | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 0.8 | 115 | TO-3 | 6-8 |
| 2N3439 | NPN | 1.0 | 350 | 40/160 | 0.02 | 0.5 | 0.05 | 15 | 10 | TO-39 | 6-10 |
| 2N3440 | NPN | 1.0 | 250 | 40/160 | 0.02 | 0.5 | 0.05 | 15 | 10 | TO-39 | 6-10 |
| 2N3713 | NPN | 10 | 60 | 25/75 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-13 |
| 2N3714 | NPN | 10 | 80 | 25/75 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-13 |
| 2N3715 | NPN | 10 | 60 | 50/150 | 1.0 | 0.8 | 5.0 | 4.0 | 150 | TO-3 | 6-13 |
| 2N3716 | NPN | 10 | 80 | 50/150 | 1.0 | 0.8 | 5.0 | 2.5 | 150 | TO-3 | 6-13 |
| 2N3740 | PNP | 1.0 | 60 | 30/100 | 0.25 | 0.6 | 1.0 | 4.0 | 25 | TO-66 | 6-16 |
| 2N3741 | PNP | 1.0 | 80 | 30/100 | 0.25 | 0.6 | 1.0 | 4.0 | 25 | TO-66 | 6-16 |
| 2N3766 | NPN | 3.0 | 60 | 40/160 | 0.5 | 1.0 | 0.5 | 10 | 20 | TO-66 | 6-19 |
| 2N3767 | NPN | 3.0 | 80 | 40/160 | 0.5 | 1.0 | 0.5 | 10 | 20 | TO-66 | 6-19 |
| 2N3771 | NPN | 30 | 40 | 15/60 | 15 | 2.0 | 15 | 0.2 | 150 | TO-3 | 6-22 |
| 2N3772 | NPN | 20 | 60 | 15/60 | 10 | 1.4 | 10 | 0.2 | 150 | TO-3 | 6-22 |
| 2N3789 | PNP | 10 | 60 | 25/90 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-25 |
| 2N3790 | PNP | 10 | 80 | 25/90 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-25 |
| 2N3791 | PNP | 10 | 60 | 50/180 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-25 |
| 2N3792 | PNP | 10 | 80 | 50/180 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-25 |
| 2N4231 | NPN | 4.0 | 40 | 25/100 | 1.5 | 0.7 | 1.5 | 4.0 | 35 | TO-66 | 6-28 |
| 2N4232 | NPN | 4.0 | 60 | 25/100 | 1.5 | 0.7 | 1.5 | 4.0 | 35 | TO-66 | 6-28 |
| 2N4233 | NPN | 4.0 | 80 | 25/100 | 1.5 | 0.7 | 1.5 | 4.0 | 35 | TO-66 | 6-28 |
| 2N4234 | PNP | 3.0 | 40 | 30/150 | 0.25 | 0.6 | 1.0 | 3.0 | 6.0 | TO-39 | 6-31 |
| 2N4235 | PNP | 3.0 | 60 | 30/150 | 0.25 | 0.6 | 1.0 | 3.0 | 6.0 | TO-39 | 6-31 |
| 2N4236 | PNP | 3.0 | 80 | 30/150 | 0.25 | 0.6 | 1.0 | 3.0 | 6.0 | TO-39 | 6-31 |
| 2N4237 | NPN | 4.0 | 40 | 30/150 | 0.25 | 0.6 | 1.0 | 1.0 | 6.0 | TO-39 | 6-34 |
| 2N4238 | NPN | 4.0 | 60 | 30/150 | 0.25 | 0.6 | 1.0 | 1.0 | 6.0 | TO-39 | 6-34 |
| 2N4239 | NPN | 4.0 | 80 | 30/150 | 0.25 | 0.6 | 1.0 | 1.0 | 6.0 | TO-39 | 6-34 |
| 2N4398 | PNP | 30 | 40 | 15/60 | 15 | 1.0 | 15 | 4.0 | 200 | TO-3 | 6-37 |
| 2N4399 | PNP | 30 | 60 | 15/60 | 15 | 1.0 | 15 | 4.0 | 200 | TO-3 | 6-37 |
| 2N4895 | NPN | 5.0 | 60 | 40/120 | 2.0 | 1.0 | 5.0 | 50 | 7.0 | TO-39 | 6-40 |
| 2N4896 | NPN | 5.0 | 60 | 100/300 | 2.0 | 1.0 | 5.0 | 80 | 7.0 | TO-39 | 6-40 |
| 2N4897 | NPN | 5.0 | 80 | 40/120 | 2.0 | 1.0 | 5.0 | 50 | 7.0 | TO-39 | 6-40 |
| 2N4898 | PNP | 1.0 | 40 | 20/100 | 0.5 | 0.6 | 1.0 | 3.0 | 25 | TO-66 | 6-43 |
| 2N4899 | PNP | 1.0 | 60 | 20/100 | 0.5 | 0.6 | 1.0 | 3.0 | 25 | TO-66 | 6-43 |
| 2N4900 | PNP | 1.0 | 80 | 20/100 | 0.5 | 0.6 | 1.0 | 3.0 | 25 | TO-66 | 6-43 |
| 2N4901 | PNP | 5.0 | 40 | 20/80 | 1.0 | 1.5 | 5.0 | 4.0 | 87.5 | TO-3 | 6-46 |
| 2N4902 | PNP | 5.0 | 60 | 20/80 | 1.0 | 1.5 | 5.0 | 4.0 | 87.5 | TO-3 | 6-46 |
| 2N4903 | PNP | 5.0 | 80 | 20/80 | 1.0 | 1.5 | 5.0 | 4.0 | 87.5 | TO-3 | 6-46 |
| 2N4904 | PNP | 5.0 | 40 | 25/100 | 2.5 | 1.5 | 5.0 | 4.0 | 87.5 | TO-3 | 6-49 |
| 2N4905 | PNP | 5.0 | 60 | 25/100 | 2.5 | 1.5 | 5.0 | 4.0 | 87.5 | TO-3 | 6-49 |
| 2N4906 | PNP | 5.0 | 80 | 25/100 | 2.5 | 1.5 | 5.0 | 4.0 | 87.5 | TO-3 | 6-49 |
| 2N4907 | PNP | 10 | 40 | 20/80 | 4.0 | 0.75 | 4.0 | 4.0 | 150 | TO-3 | 6-52 |
| 2N4908 | PNP | 10 | 60 | 20/80 | 4.0 | 0.75 | 4.0 | 4.0 | 150 | TO-3 | 6-52 |
| 2N4909 | PNP | 10 | 80 | 20/80 | 4.0 | 2.0 | 10 | 4.0 | 150 | TO-3 | 6-52 |
| 2N4910 | NPN | 1.0 | 40 | 20/100 | 0.5 | 0.6 | 1.0 | 4.0 | 25 | TO-66 | 6-54 |
| 2N4911 | NPN | 1.0 | 60 | 20/100 | 0.5 | 0.6 | 1.0 | 4.0 | 25 | TO-66 | 6-54 |
| 2N4912 | NPN | 1.0 | 80 | 20/100 | 0.5 | 0.6 | 1.0 | 4.0 | 25 | TO-66 | 6-54 |
| 2N4913 | NPN | 5.0 | 40 | 25/100 | 2.5 | 1.5 | 5.0 | 4.0 | 87.5 | TO-3 | 6-57 |
| 2N4914 | NPN | 5.0 | 60 | 25/100 | 2.5 | 1.5 | 5.0 | 4.0 | 87.5 | TO-3 | 6-57 |

# SELECTION GUIDE BY DEVICE NUMBER

| DEVICE | POLARITY | $I_C$ Max A | $V_{CEO}$ Max V | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$=25°C W | PACKAGE | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2N4915 | NPN | 5.0 | 80 | 25/100 | 2.5 | 1.5 | 5.0 | 4.0 | 87.5 | TO-3 | 6-57 |
| 2N5038 | NPN | 20 | 90 | 20/100 | 12 | 1.0 | 12 | 60 | 140 | TO-3 | 6-60 |
| 2N5039 | NPN | 20 | 75 | 20/100 | 10 | 1.0 | 10 | 60 | 140 | TO-3 | 6-60 |
| 2N5058 | NPN | 0.15 | 300 | 35/150 | .03 | 1.0 | .03 | 30 | 1.0 | TO-39 | 6-63 |
| 2N5059 | NPN | 0.15 | 250 | 30/150 | .03 | 1.0 | .03 | 30 | 1.0 | TO-39 | 6-63 |
| 2N5067 | NPN | 5.0 | 40 | 20/80 | 1.0 | 0.4 | 1.0 | 4.0 | 87.5 | TO-3 | 6-66 |
| 2N5068 | NPN | 5.0 | 60 | 20/80 | 1.0 | 0.4 | 1.0 | 4.0 | 87.5 | TO-3 | 6-66 |
| 2N5069 | NPN | 5.0 | 80 | 20/80 | 1.0 | 0.4 | 1.0 | 4.0 | 87.5 | TO-3 | 6-66 |
| 2N5301 | NPN | 30 | 40 | 15/60 | 15 | 2.0 | 20 | 2.0 | 200 | TO-3 | 6-69 |
| 2N5302 | NPN | 30 | 60 | 15/60 | 15 | 2.0 | 20 | 2.0 | 200 | TO-3 | 6-69 |
| 2N5303 | NPN | 20 | 80 | 15/60 | 10 | 2.0 | 20 | 2.0 | 200 | TO-3 | 6-69 |
| 2N5320 | NPN | 2.0 | 75 | 30/130 | 0.5 | 0.5 | 0.5 | 50 | 10 | TO-39 | 6-72 |
| 2N5321 | NPN | 2.0 | 50 | 40/250 | 0.5 | 0.8 | 0.5 | 50 | 10 | TO-39 | 6-72 |
| 2N5322 | PNP | 2.0 | 75 | 30/130 | 0.5 | 0.5 | 0.5 | 50 | 10 | TO-39 | 6-75 |
| 2N5323 | PNP | 2.0 | 50 | 40/250 | 0.5 | 0.8 | 0.5 | 50 | 10 | TO-39 | 6-75 |
| 2N5334 | NPN | 3.0 | 60 | 30/150 | 1.0 | 0.7 | 2.0 | 40 | 6.0 | TO-39 | 6-78 |
| 2N5335 | NPN | 3.0 | 80 | 30/150 | 1.0 | 0.7 | 2.0 | 40 | 6.0 | TO-39 | 6-78 |
| 2N5336 | NPN | 5.0 | 80 | 30/120 | 2.0 | 0.7 | 2.0 | 30 | 6.0 | TO-39 | 6-81 |
| 2N5337 | NPN | 5.0 | 80 | 60/240 | 2.0 | 0.7 | 2.0 | 30 | 6.0 | TO-39 | 6-81 |
| 2N5338 | NPN | 5.0 | 100 | 30/120 | 2.0 | 0.7 | 2.0 | 30 | 6.0 | TO-39 | 6-84 |
| 2N5339 | NPN | 5.0 | 100 | 60/240 | 2.0 | 0.7 | 2.0 | 30 | 6.0 | TO-39 | 6-84 |
| 2N5415 | PNP | 1.0 | 200 | 30/150 | 0.05 | 2.5 | 0.05 | 15 | 10 | TO-39 | 6-87 |
| 2N5416 | PNP | 1.0 | 300 | 30/120 | 0.05 | 2.0 | 0.05 | 15 | 10 | TO-39 | 6-87 |
| 2N5629 | NPN | 16 | 100 | 25/100 | 8.0 | 1.0 | 10 | 0.5 | 200 | TO-3 | 6-90 |
| 2N5630 | NPN | 16 | 120 | 20/80 | 8.0 | 1.0 | 10 | 0.5 | 200 | TO-3 | 6-90 |
| 2N5631 | NPN | 16 | 140 | 15/60 | 8.0 | 1.0 | 10 | 0.5 | 200 | TO-3 | 6-90 |
| 2N5679 | PNP | 1.0 | 100 | 40/150 | 0.25 | 1.0 | 0.5 | 30 | 10 | TO-39 | 6-92 |
| 2N5680 | PNP | 1.0 | 120 | 40/150 | 0.25 | 1.0 | 0.5 | 30 | 10 | TO-39 | 6-92 |
| 2N5681 | NPN | 1.0 | 100 | 40/150 | 0.25 | 1.0 | 0.5 | 30 | 10 | TO-39 | 6-95 |
| 2N5682 | NPN | 1.0 | 120 | 40/150 | 0.25 | 1.0 | 0.5 | 30 | 10 | TO-39 | 6-95 |
| 2N5683 | PNP | 50 | 60 | 15/60 | 25 | 1.0 | 25 | 2.0 | 300 | TO-3 | 6-98 |
| 2N5684 | PNP | 50 | 80 | 15/60 | 25 | 1.0 | 25 | 2.0 | 300 | TO-3 | 6-98 |
| 2N5685 | NPN | 50 | 60 | 15/60 | 25 | 1.0 | 25 | 2.0 | 300 | TO-3 | 6-101 |
| 2N5686 | NPN | 50 | 80 | 15/60 | 25 | 1.0 | 25 | 2.0 | 300 | TO-3 | 6-101 |
| 2N5838 | NPN | 3.0 | 250 | 8/40 | 3.0 | 1.0 | 3.0 | 5.0 | 100 | TO-3 | 6-105 |
| 2N5839 | NPN | 3.0 | 275 | 10/50 | 2.0 | 1.5 | 2.0 | 5.0 | 100 | TO-3 | 6-105 |
| 2N5840 | NPN | 3.0 | 350 | 10/50 | 2.0 | 1.5 | 2.0 | 5.0 | 100 | TO-3 | 6-105 |
| 2N5871 | PNP | 7.0 | 60 | 20/100 | 2.5 | 1.0 | 4.0 | 4.0 | 115 | TO-3 | 6-108 |
| 2N5872 | PNP | 7.0 | 80 | 20/100 | 2.5 | 1.0 | 4.0 | 4.0 | 115 | TO-3 | 6-108 |
| 2N5873 | NPN | 7.0 | 60 | 20/100 | 2.5 | 1.0 | 4.0 | 4.0 | 115 | TO-3 | 6-111 |
| 2N5874 | NPN | 7.0 | 80 | 20/100 | 2.5 | 1.0 | 4.0 | 4.0 | 115 | TO-3 | 6-111 |
| 2N5875 | PNP | 8.0 | 60 | 20/100 | 4.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-114 |
| 2N5876 | PNP | 8.0 | 80 | 20/100 | 4.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-114 |
| 2N5877 | NPN | 8.0 | 60 | 20/100 | 4.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-117 |
| 2N5878 | NPN | 8.0 | 80 | 20/100 | 4.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-117 |
| 2N5879 | PNP | 12 | 60 | 20/100 | 6.0 | 1.0 | 7.0 | 4.0 | 160 | TO-3 | 6-120 |
| 2N5880 | PNP | 12 | 80 | 20/100 | 6.0 | 1.0 | 7.0 | 4.0 | 160 | TO-3 | 6-120 |
| 2N5881 | NPN | 12 | 60 | 20/100 | 6.0 | 1.0 | 7.0 | 4.0 | 160 | TO-3 | 6-123 |
| 2N5882 | NPN | 12 | 80 | 20/100 | 6.0 | 1.0 | 7.0 | 4.0 | 160 | TO-3 | 6-123 |
| 2N5883 | PNP | 20 | 60 | 20/100 | 10 | 1.0 | 15 | 4.0 | 200 | TO-3 | 6-126 |

# SELECTION GUIDE BY DEVICE NUMBER

| DEVICE | POLARITY | $I_C$ Max A | $V_{CEO}$ Max V | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$=25°C W | PACKAGE | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2N5884 | PNP | 20 | 80 | 20/100 | 10 | 1.0 | 15 | 4.0 | 200 | TO-3 | 6-126 |
| 2N5885 | NPN | 20 | 60 | 20/100 | 10 | 1.0 | 15 | 4.0 | 200 | TO-3 | 6-129 |
| 2N5886 | NPN | 20 | 80 | 20/100 | 10 | 1.0 | 15 | 4.0 | 200 | TO-3 | 6-129 |
| 2N6029 | PNP | 16 | 100 | 25/100 | 8.0 | 2.0 | 16 | 1.0 | 200 | TO-3 | 6-132 |
| 2N6030 | PNP | 16 | 120 | 20/80 | 8.0 | 2.0 | 16 | 1.0 | 200 | TO-3 | 6-132 |
| 2N6031 | PNP | 16 | 140 | 15/60 | 8.0 | 2.0 | 16 | 1.0 | 200 | TO-3 | 6-132 |
| 2N6050 | PNP | 12 | 60 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | TO-3 | 6-134 |
| 2N6051 | PNP | 12 | 80 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | TO-3 | 6-134 |
| 2N6052 | PNP | 12 | 100 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | TO-3 | 6-134 |
| 2N6053 | PNP | 8.0 | 60 | 750/18K | 4.0 | 2.0 | 4.0 | 4.0 | 100 | TO-3 | 6-137 |
| 2N6054 | PNP | 8.0 | 80 | 750/18K | 4.0 | 2.0 | 4.0 | 4.0 | 100 | TO-3 | 6-137 |
| 2N6055 | NPN | 8.0 | 60 | 750/18K | 4.0 | 2.0 | 4.0 | 4.0 | 100 | TO-3 | 6-140 |
| 2N6056 | NPN | 8.0 | 80 | 750/18K | 4.0 | 2.0 | 4.0 | 4.0 | 100 | TO-3 | 6-140 |
| 2N6057 | NPN | 12 | 60 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | TO-3 | 6-143 |
| 2N6058 | NPN | 12 | 80 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | TO-3 | 6-143 |
| 2N6059 | NPN | 12 | 100 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | TO-3 | 6-143 |
| 2N6121 | NPN | 4.0 | 45 | 25/100 | 1.5 | 0.6 | 1.5 | 2.5 | 40 | TO-220 | 6-146 |
| 2N6122 | NPN | 4.0 | 60 | 25/100 | 1.5 | 0.6 | 1.5 | 2.5 | 40 | TO-220 | 6-146 |
| 2N6123 | NPN | 4.0 | 80 | 20/80 | 1.5 | 0.6 | 1.5 | 2.5 | 40 | TO-220 | 6-146 |
| 2N6124 | PNP | 4.0 | 45 | 25/100 | 1.5 | 0.6 | 1.5 | 2.5 | 40 | TO-220 | 6-149 |
| 2N6125 | PNP | 4.0 | 60 | 25/100 | 1.5 | 0.6 | 1.5 | 2.5 | 40 | TO-220 | 6-149 |
| 2N6126 | PNP | 4.0 | 80 | 20/80 | 1.5 | 0.6 | 1.5 | 2.5 | 40 | TO-220 | 6-149 |
| 2N6129 | NPN | 7.0 | 40 | 20/100 | 2.5 | 1.4 | 7.0 | 2.5 | 50 | TO-220 | 6-152 |
| 2N6130 | NPN | 7.0 | 60 | 20/100 | 2.5 | 1.4 | 7.0 | 2.5 | 50 | TO-220 | 6-152 |
| 2N6131 | NPN | 7.0 | 80 | 20/100 | 2.5 | 2.0 | 7.0 | 2.5 | 50 | TO-220 | 6-152 |
| 2N6132 | PNP | 7.0 | 40 | 20/100 | 2.5 | 1.4 | 7.0 | 2.5 | 50 | TO-220 | 6-155 |
| 2N6133 | PNP | 7.0 | 60 | 20/100 | 2.5 | 1.4 | 7.0 | 2.5 | 50 | TO-220 | 6-155 |
| 2N6134 | PNP | 7.0 | 80 | 20/100 | 2.5 | 2.0 | 7.0 | 2.5 | 50 | TO-220 | 6-155 |
| 2N6249 | NPN | 10 | 200 | 10/50 | 10 | 1.5 | 10 | 2.5 | 100 | TO-3 | 6-158 |
| 2N6250 | NPN | 10 | 275 | 8/50 | 10 | 1.5 | 10 | 2.5 | 100 | TO-3 | 6-158 |
| 2N6251 | NPN | 10 | 350 | 6/50 | 10 | 1.5 | 10 | 2.5 | 100 | TO-3 | 6-158 |
| 2N6282 | NPN | 20 | 60 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | TO-3 | 6-161 |
| 2N6283 | NPN | 20 | 80 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | TO-3 | 6-161 |
| 2N6284 | NPN | 20 | 100 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | TO-3 | 6-161 |
| 2N6285 | PNP | 20 | 60 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | TO-3 | 6-164 |
| 2N6286 | PNP | 20 | 80 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | TO-3 | 6-164 |
| 2N6287 | PNP | 20 | 100 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | TO-3 | 6-164 |
| 2N6306 | NPN | 8.0 | 250 | 15/75 | 3.0 | 0.8 | 3.0 | 5.0 | 125 | TO-3 | 6-167 |
| 2N6307M | NPN | 8.0 | 300 | 15/75 | 3.0 | 1.0 | 3.0 | 5.0 | 125 | TO-3 | 6-167 |
| 2N6308M | NPN | 8.0 | 350 | 12/60 | 3.0 | 1.5 | 3.0 | 5.0 | 125 | TO-3 | 6-167 |
| 2N6383 | NPN | 10 | 40 | 1K/20K | 5.0 | 2.0 | 5.0 | 20 | 100 | TO-3 | 6-170 |
| 2N6384 | NPN | 10 | 60 | 1K/20K | 5.0 | 2.0 | 5.0 | 20 | 100 | TO-3 | 6-170 |
| 2N6385 | NPN | 10 | 80 | 1K/20K | 5.0 | 2.0 | 5.0 | 20 | 100 | TO-3 | 6-170 |
| 2N6386 | NPN | 10 | 40 | 1K/20K | 3.0 | 2.0 | 3.0 | 20 | 40 | TO-220 | 6-173 |
| 2N6387 | NPN | 10 | 60 | 1K/20K | 3.0 | 2.0 | 3.0 | 20 | 40 | TO-220 | 6-173 |
| 2N6388 | NPN | 10 | 80 | 1K/20K | 3.0 | 2.0 | 3.0 | 20 | 40 | TO-220 | 6-173 |
| 2N6473 | NPN | 4.0 | 100 | 15/150 | 1.5 | 1.2 | 1.5 | 10 | 40 | TO-220 | 6-176 |
| 2N6474 | NPN | 4.0 | 120 | 15/150 | 1.5 | 1.2 | 1.5 | 10 | 40 | TO-220 | 6-176 |
| 2N6475 | PNP | 4.0 | 100 | 15/150 | 1.5 | 1.2 | 1.5 | 10 | 40 | TO-220 | 6-178 |
| 2N6476 | PNP | 4.0 | 120 | 15/150 | 1.5 | 1.2 | 1.5 | 10 | 40 | TO-220 | 6-178 |
| 2N6486 | NPN | 15 | 40 | 20/150 | 5.0 | 1.3 | 5.0 | 5.0 | 75 | TO-220 | 6-180 |

# SELECTION GUIDE BY DEVICE NUMBER

| DEVICE | POLARITY | $I_C$ Max A | $V_{CEO}$ Max V | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$=25°C W | PACKAGE | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2N6487 | NPN | 15 | 60 | 20/150 | 5.0 | 1.3 | 5.0 | 5.0 | 75 | TO-220 | 6-180 |
| 2N6488 | NPN | 15 | 80 | 20/150 | 5.0 | 1.3 | 5.0 | 5.0 | 75 | TO-220 | 6-180 |
| 2N6489 | PNP | 15 | 40 | 20/150 | 5.0 | 1.3 | 5.0 | 5.0 | 75 | TO-220 | 6-182 |
| 2N6490 | PNP | 15 | 60 | 20/150 | 5.0 | 1.3 | 5.0 | 5.0 | 75 | TO-220 | 6-182 |
| 2N6491 | PNP | 15 | 80 | 20/150 | 5.0 | 1.3 | 5.0 | 5.0 | 75 | TO-220 | 6-182 |
| 2N6569 | NPN | 12 | 40 | 15/200 | 4.0 | 1.5 | 4.0 | 1.5 | 100 | TO-3 | 6-184 |
| 2N6576 | NPN | 15 | 60 | 2K/20K | 4.0 | 4.0 | 15 | 10 | 120 | TO-3 | 6-186 |
| 2N6577 | NPN | 15 | 90 | 2K/20K | 4.0 | 4.0 | 15 | 10 | 120 | TO-3 | 6-186 |
| BC323 | NPN | 5.0 | 60 | 50/250 | 0.5 | 0.15 | 0.5 | - | 7.0 | TO-39 | 6-189 |
| BD220 | NPN | 4.0 | 70 | 30/120 | 0.5 | 1.0 | 0.5 | 0.8 | 36 | TO-220 | 6-191 |
| BD221 | NPN | 4.0 | 40 | 30/120 | 1.0 | 1.0 | 1.0 | 0.8 | 36 | TO-220 | 6-191 |
| BD222 | NPN | 4.0 | 60 | 20/80 | 1.5 | 1.0 | 1.5 | 0.8 | 36 | TO-220 | 6-191 |
| BD223 | PNP | 4.0 | 70 | 30/120 | 0.5 | 1.0 | 0.5 | 0.8 | 36 | TO-220 | 6-194 |
| BD224 | PNP | 4.0 | 40 | 30/120 | 1.0 | 1.0 | 1.0 | 0.8 | 36 | TO-220 | 6-194 |
| BD225 | PNP | 4.0 | 60 | 20/80 | 1.5 | 1.0 | 1.5 | 0.8 | 36 | TO-220 | 6-194 |
| BFX34 | NPN | 5.0 | 60 | 40/150 | 2.0 | 1.0 | 5.0 | 70 | 5.0 | TO-39 | 6-197 |
| BF257 | NPN | 0.1 | 160 | 25/- | 0.03 | 1.0 | 0.03 | 75* | 1.0 | TO-39 | 6-200 |
| BF258 | NPN | 0.1 | 250 | 25/- | 0.03 | 1.0 | 0.03 | 75* | 1.0 | TO-39 | 6-200 |
| BF259 | NPN | 0.1 | 300 | 25/- | 0.03 | 1.0 | 0.03 | 75* | 1.0 | TO-39 | 6-200 |
| BF336 | NPN | 0.1 | 180 | 20/- | 0.03 | - | - | 50 | 1.0 | TO-39 | 6-202 |
| BF337 | NPN | 0.1 | 200 | 20/- | 0.03 | - | - | 50 | 1.0 | TO-39 | 6-202 |
| BF338 | NPN | 0.1 | 225 | 20/- | 0.03 | - | - | 50 | 1.0 | TO-39 | 6-202 |
| FT47 | NPN | 1.0 | 250 | 30/150 | 0.3 | 1.0 | 1.0 | 10 | 40 | TO-220 | 6-204 |
| FT48 | NPN | 1.0 | 300 | 30/150 | 0.3 | 1.0 | 1.0 | 10 | 40 | TO-220 | 6-204 |
| FT49 | NPN | 1.0 | 350 | 30/150 | 0.3 | 1.0 | 1.0 | 10 | 40 | TO-220 | 6-204 |
| FT50 | NPN | 1.0 | 400 | 30/150 | 0.3 | 1.0 | 1.0 | 10 | 40 | TO-220 | 6-204 |
| FT317 | NPN | 4.0 | 100 | 35/- | 1.0 | 0.5 | 1.0 | 20 | 40 | TO-220 | 6-206 |
| FT317A | NPN | 4.0 | 120 | 35/- | 1.0 | 0.5 | 1.0 | 20 | 40 | TO-220 | 6-206 |
| FT317B | NPN | 4.0 | 140 | 35/- | 1.0 | 0.5 | 1.0 | 20 | 40 | TO-220 | 6-206 |
| FT359 | NPN | 10 | 350 | 250/- | 3.0 | 2.5 | 7.0 | - | 125 | TO-3 | 6-208 |
| FT401 | NPN | 2.0 | 300 | 20/100 | 0.5 | 0.8 | 0.5 | 2.0 | 100 | TO-3 | 6-210 |
| FT402 | NPN | 3.5 | 325 | 20/100 | 0.5 | 2.0 | 3.0 | 2.0 | 100 | TO-3 | 6-210 |
| FT410 | NPN | 7.5 | 200 | 30/90 | 1.0 | 0.8 | 1.0 | - | 100 | TO-3 | 6-212 |
| FT411 | NPN | 7.5 | 300 | 30/90 | 1.0 | 0.8 | 1.0 | - | 100 | TO-3 | 6-212 |
| FT413 | NPN | 7.5 | 325 | 20/80 | 0.5 | 0.8 | 0.5 | - | 100 | TO-3 | 6-214 |
| FT417 | PNP | 4.0 | 100 | 35/- | 1.0 | 0.5 | 1.0 | 20 | 40 | TO-220 | 6-216 |
| FT417A | PNP | 4.0 | 120 | 35/- | 1.0 | 0.5 | 1.0 | 20 | 40 | TO-220 | 6-216 |
| FT417B | PNP | 4.0 | 140 | 35/- | 1.0 | 0.5 | 1.0 | 20 | 40 | TO-220 | 6-216 |
| FT423 | NPN | 7.5 | 325 | 30/90 | 1.0 | 0.8 | 1.0 | - | 100 | TO-3 | 6-214 |
| FT430 | NPN | 10 | 300 | 15/45 | 2.5 | 0.9 | 2.5 | - | 125 | TO-3 | 6-218 |
| FT431 | NPN | 10 | 325 | 15/35 | 2.5 | 0.7 | 2.5 | - | 125 | TO-3 | 6-218 |
| FT2955 | PNP | 10 | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 2.0 | 70 | TO-220 | 6-220 |
| FT3055 | NPN | 10 | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 2.0 | 70 | TO-220 | 6-222 |
| FT5415 | PNP | 1.0 | 200 | 30/150 | 0.05 | - | - | 15 | 10 | TO-39 | |
| FT5416 | PNP | 1.0 | 300 | 30/120 | 0.05 | - | - | 15 | 10 | TO-39 | |
| MJ802 | NPN | 30 | 90 | 25/100 | 7.5 | 0.8 | 7.5 | 2.0 | 200 | TO-3 | 6-224 |
| MJ4502 | PNP | 30 | 90 | 25/100 | 7.5 | 0.8 | 7.5 | 2.0 | 200 | TO-3 | 6-226 |
| MJE3055F | NPN | 10 | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 2.0 | 70 | TO-220 | 6-228 |
| SE7055 | NPN | 0.5 | 220 | 40/- | 0.01 | 1.0 | 0.02 | 50 | 1.0 | TO-39 | 6-232 |
| SE7056 | NPN | 0.5 | 300 | 40/- | 0.01 | 1.0 | 0.02 | 50 | 1.0 | TO-39 | 6-232 |

*TYPICAL

# SELECTION GUIDE BY DEVICE NUMBER

| DEVICE | POLARITY | $I_C$ Max A | $V_{CEO}$ Max V | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$=25°C W | PACKAGE | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SE9300 | NPN | 10 | 60 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | TO-220 | 6-235 |
| SE9301 | NPN | 10 | 80 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | TO-220 | 6-235 |
| SE9302 | NPN | 10 | 100 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | TO-220 | 6-235 |
| SE9303 | NPN | 10 | 60 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | TO-3 | 6-237 |
| SE9304 | NPN | 10 | 80 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | TO-3 | 6-237 |
| SE9305 | NPN | 10 | 100 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | TO-3 | 6-237 |
| SE9331 | NPN | 1.0 | 300 | 30/250 | 0.1 | 2.5 | 10 | 10 | 20 | TO-66 | 6-239 |
| SE9400 | PNP | 10 | 60 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | TO-220 | 6-241 |
| SE9401 | PNP | 10 | 80 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | TO-220 | 6-241 |
| SE9402 | PNP | 10 | 100 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | TO-220 | 6-241 |
| SE9403 | PNP | 10 | 60 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | TO-3 | 6-243 |
| SE9404 | PNP | 10 | 80 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | TO-3 | 6-243 |
| SE9405 | PNP | 10 | 100 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | TO-3 | 6-243 |
| TIP29 | NPN | 3.0 | 40 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | TO-220 | 6-245 |
| TIP29A | NPN | 3.0 | 60 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | TO-220 | 6-245 |
| TIP29B | NPN | 3.0 | 80 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | TO-220 | 6-245 |
| TIP29C | NPN | 3.0 | 100 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | TO-220 | 6-245 |
| TIP30 | PNP | 3.0 | 40 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | TO-220 | 6-248 |
| TIP30A | PNP | 3.0 | 60 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | TO-220 | 6-248 |
| TIP30B | PNP | 3.0 | 80 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | TO-220 | 6-248 |
| TIP30C | PNP | 3.0 | 100 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | TO-220 | 6-248 |
| TIP31 | NPN | 5.0 | 40 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | TO-220 | 6-251 |
| TIP31A | NPN | 5.0 | 60 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | TO-220 | 6-251 |
| TIP31B | NPN | 5.0 | 80 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | TO-220 | 6-251 |
| TIP31C | NPN | 5.0 | 100 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | TO-220 | 6-251 |
| TIP32 | PNP | 5.0 | 40 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | TO-220 | 6-254 |
| TIP32A | PNP | 5.0 | 60 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | TO-220 | 6-254 |
| TIP32B | PNP | 5.0 | 80 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | TO-220 | 6-254 |
| TIP32C | PNP | 5.0 | 100 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | TO-220 | 6-254 |
| TIP41 | NPN | 6.0 | 40 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | TO-220 | 6-257 |
| TIP41A | NPN | 6.0 | 60 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | TO-220 | 6-257 |
| TIP41B | NPN | 6.0 | 80 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | TO-220 | 6-257 |
| TIP41C | NPN | 6.0 | 100 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | TO-220 | 6-257 |
| TIP42 | PNP | 6.0 | 40 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | TO-220 | 6-259 |
| TIP42A | PNP | 6.0 | 60 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | TO-220 | 6-259 |
| TIP42B | PNP | 6.0 | 80 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | TO-220 | 6-259 |
| TIP42C | PNP | 6.0 | 100 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | TO-220 | 6-259 |
| TIP61 | NPN | 0.5 | 40 | 40/- | 0.05 | 0.7 | 0.5 | 3.0 | 15 | TO-220 | 6-261 |
| TIP61A | NPN | 0.5 | 60 | 40/- | 0.05 | 0.7 | 0.5 | 3.0 | 15 | TO-220 | 6-261 |
| TIP61B | NPN | 0.5 | 80 | 40/- | 0.05 | 0.7 | 0.5 | 3.0 | 15 | TO-220 | 6-261 |
| TIP61C | NPN | 0.5 | 100 | 40/- | 0.05 | 0.7 | 0.5 | 3.0 | 15 | TO-220 | 6-261 |
| TIP62 | PNP | 0.5 | 40 | 40/- | 0.05 | 0.7 | 0.5 | 3.0 | 15 | TO-220 | 6-263 |
| TIP62A | PNP | 0.5 | 60 | 40/- | 0.05 | 0.7 | 0.5 | 3.0 | 15 | TO-220 | 6-263 |
| TIP62B | PNP | 0.5 | 80 | 40/- | 0.05 | 0.7 | 0.5 | 3.0 | 15 | TO-220 | 6-263 |
| TIP62C | PNP | 0.5 | 100 | 40/- | 0.05 | 0.7 | 0.5 | 3.0 | 15 | TO-220 | 6-263 |
| TIP110 | NPN | 2.0 | 60 | 1K/- | 1.0 | 2.5 | 2.0 | - | 50 | TO-220 | 6-265 |
| TIP111 | NPN | 2.0 | 80 | 1K/- | 1.0 | 2.5 | 2.0 | - | 50 | TO-220 | 6-265 |
| TIP112 | NPN | 2.0 | 100 | 1K/- | 1.0 | 2.5 | 2.0 | - | 50 | TO-220 | 6-265 |
| TIP115 | PNP | 2.0 | 60 | 1K/- | 1.0 | 2.5 | 2.0 | - | 50 | TO-220 | 6-267 |
| TIP116 | PNP | 2.0 | 80 | 1K/- | 1.0 | 2.5 | 2.0 | - | 50 | TO-220 | 6-267 |

# SELECTION GUIDE BY DEVICE NUMBER

| DEVICE | POLARITY | $I_C$ Max A | $V_{CEO}$ Max V | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$=25°C W | PACKAGE | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TIP117 | PNP | 2.0 | 100 | 1K/- | 1.0 | 2.5 | 2.0 | - | 50 | TO-220 | 6-267 |
| TIP120 | NPN | 5.0 | 60 | 1K/- | 0.5 | 2.0 | 3.0 | - | 65 | TO-220 | 6-269 |
| TIP121 | NPN | 5.0 | 80 | 1K/- | 0.5 | 2.0 | 3.0 | - | 65 | TO-220 | 6-269 |
| TIP122 | NPN | 5.0 | 100 | 1K/- | 0.5 | 2.0 | 3.0 | - | 65 | TO-220 | 6-269 |
| TIP125 | PNP | 5.0 | 60 | 1K/- | 0.5 | 2.0 | 3.0 | - | 65 | TO-220 | 6-271 |
| TIP126 | PNP | 5.0 | 80 | 1K/- | 0.5 | 2.0 | 3.0 | - | 65 | TO-220 | 6-271 |
| TIP127 | PNP | 5.0 | 100 | 1K/- | 0.5 | 2.0 | 3.0 | - | 65 | TO-220 | 6-271 |

# SELECTION GUIDE BY $I_{C(max)}$, POLARITY AND ASCENDING $V_{CEO}$

| DEVICE POLARITY NPN | PNP | $V_{CEO}$ Max V | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$ = 25°C W | PACKAGE | DATA SHEET PAGE NO |
|---|---|---|---|---|---|---|---|---|---|---|
| **$I_C$ = 0.1 A Max Continuous** | | | | | | | | | | |
| BF257 | | 160 | 25/- | 0.03 | 1.0 | 0.03 | *75 | 1.0 | TO-39 | 6-200 |
| BF336 | | 180 | 20/- | 0.03 | | | 50 | 1.0 | TO-39 | 6-202 |
| BF337 | | 200 | 20/- | 0.03 | | | 50 | 1.0 | TO-39 | 6-202 |
| BF338 | | 225 | 20/- | 0.03 | | | 50 | 1.0 | TO-39 | 6-202 |
| BF258 | | 250 | 25/- | 0.03 | 1.0 | 0.03 | *75 | 1.0 | TO-39 | 6-200 |
| BF259 | | 300 | 25/- | 0.03 | 1.0 | 0.03 | *75 | 1.0 | TO-39 | 6-200 |
| **$I_C$ = 0.15 A Max Continuous** | | | | | | | | | | |
| 2N5059 | | 250 | 30/150 | 0.03 | 1.0 | 0.03 | 30 | 1.0 | TO-39 | 6-63 |
| 2N5058 | | 300 | 35/150 | 0.03 | 1.0 | 0.03 | 30 | 1.0 | TO-39 | 6-63 |
| **$I_C$ = 0.5 A Max Continuous** | | | | | | | | | | |
| TIP61 | TIP62 | 40 | 40/- | 0.05 | 0.07 | 0.5 | 3.0 | 15 | TO-220 | 6-261 |
| TIP61A | TIP62A | 60 | 40/- | 0.05 | 0.07 | 0.5 | 3.0 | 15 | TO-220 | 6-261 |
| TIP61B | TIP62B | 80 | 40/- | 0.05 | 0.07 | 0.5 | 3.0 | 15 | TO-220 | 6-261 |
| TIP61C | TIP62C | 100 | 40/- | 0.05 | 0.07 | 0.5 | 3.0 | 15 | TO-220 | 6-261 |
| SE7055 | | 220 | 40/- | 0.03 | 1.0 | 0.02 | 50 | 1.0 | TO-39 | 6-232 |
| SE7056 | | 300 | 40/- | 0.03 | 1.0 | 0.02 | 50 | 1.0 | TO-39 | 6-232 |
| **$I_C$ = 1.0 A Max Continuous** | | | | | | | | | | |
| | 2N4898 | 40 | 20/100 | 0.5 | 0.6 | 1.0 | 3.0 | 25 | TO-66 | 6-43 |
| 2N4910 | | 40 | 20/100 | 0.5 | 0.6 | 1.0 | 4.0 | 25 | TO-66 | 6-54 |
| | 2N3740 | 60 | 30/100 | 0.25 | 0.6 | 1.0 | 4.0 | 25 | TO-66 | 6-16 |
| 2N4911 | | 60 | 20/100 | 0.5 | 0.5 | 1.0 | 4.0 | 25 | TO-66 | 6-54 |
| | 2N4899 | 60 | 20/100 | 0.5 | 0.6 | 1.0 | 3.0 | 25 | TO-66 | 6-43 |
| | 2N3741 | 80 | 30/100 | 0.25 | 0.6 | 1.0 | 4.0 | 25 | TO-66 | 6-16 |
| | 2N4900 | 80 | 20/100 | 0.5 | 0.6 | 1.0 | 3.0 | 25 | TO-66 | 6-43 |
| 2N4912 | | 80 | 20/100 | 0.5 | 0.6 | 1.0 | 4.0 | 25 | TO-66 | 6-54 |
| 2N5681 | 2N5679 | 100 | 40/150 | 0.25 | 1.0 | 0.5 | 30 | 10 | TO-39 | 6-95 |
| 2N5682 | 2N5680 | 120 | 40/150 | 0.25 | 1.0 | 0.5 | 30 | 10 | TO-39 | 6-95 |
| | 2N5415 | 200 | 30/150 | 0.05 | 2.5 | 0.5 | 15 | 10 | TO-39 | 6-87 |
| 2N3440 | | 250 | 40/160 | 0.02 | 0.5 | 0.05 | 15 | 10 | TO-39 | 6-10 |
| FT47 | | 250 | 30/150 | 0.3 | 1.0 | 1.0 | 10 | 40 | TO-220 | 6-204 |
| SE9331 | | 300 | 30/250 | 0.1 | 2.5 | 0.1 | 10 | 20 | TO-66 | 6-239 |
| FT48 | | 300 | 30/150 | 0.3 | 1.0 | 1.0 | 10 | 40 | TO-220 | 6-204 |
| | 2N5416 | 300 | 30/120 | 0.05 | 2.0 | 0.05 | 15 | 10 | TO-39 | 6-87 |
| 2N3439 | | 350 | 40/160 | 0.02 | 0.5 | 0.05 | 15 | 10 | TO-39 | 6-10 |
| FT49 | | 350 | 30/150 | 0.3 | 1.0 | 1.0 | 10 | 40 | TO-220 | 6-204 |
| FT50 | | 400 | 30/150 | 0.3 | 1.0 | 1.0 | 10 | 40 | TO-220 | 6-204 |
| **$I_C$ = 2.0 A Max Continuous** | | | | | | | | | | |
| 2N5321 | | 50 | 40/250 | 0.5 | 0.8 | 0.5 | 50 | 10 | TO-39 | 6-72 |
| | 2N5323 | 50 | 40/250 | 0.5 | 0.8 | 0.5 | 50 | 10 | TO-39 | 6-75 |
| TIP110 | TIP115 | 60 | 1K/- | 1.0 | 2.5 | 2.0 | | 50 | TO-220 | 6-265 |
| 2N5320 | 2N5322 | 75 | 30/130 | 0.5 | 0.5 | 0.5 | 50 | 10 | TO-39 | 6-72,75 |
| TIP111 | TIP116 | 80 | 1K/- | 1.0 | 2.5 | 2.0 | | 50 | TO-220 | 6-265,267 |
| TIP112 | TIP117 | 100 | 1K/- | 1.0 | 2.5 | 2.0 | | 50 | TO-220 | 6-265,267 |
| FT401 | | 300 | 20/100 | 0.5 | 0.8 | 0.5 | 2.0 | 100 | TO-3 | 6-210 |
| **$I_C$ = 3.0 A Max Continuous** | | | | | | | | | | |
| | 2N4234 | 40 | 30/150 | 0.25 | 0.6 | 1.0 | 3.0 | 6.0 | TO-39 | 6-31 |
| TIP29 | TIP30 | 40 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | TO-220 | 6-245,248 |
| | 2N4235 | 60 | 30/150 | 0.25 | 0.6 | 1.0 | 3.0 | 6.0 | TO-39 | 6-31 |
| 2N3766 | | 60 | 40/160 | 0.5 | 1.0 | 0.5 | 10 | 20 | TO-66 | 6-19 |

*TYPICAL VALUE

# SELECTION GUIDE BY $I_{C(max)}$, POLARITY AND ASCENDING $V_{CEO}$

| DEVICE POLARITY NPN | DEVICE POLARITY PNP | $V_{CEO}$ Max V | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$ = 25°C W | PACKAGE | DATA SHEET PAGE NO |
|---|---|---|---|---|---|---|---|---|---|---|
| **$I_C$ = 3.0 A Max Continuous** (Cont'd) | | | | | | | | | | |
| TIP29A | TIP30A | 60 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | TO-220 | 6-245,248 |
| 2N5334 | | 60 | 30/150 | 1.0 | 0.7 | 2.0 | 40 | 6.0 | TO-39 | 6-78 |
| | 2N4236 | 80 | 30/150 | 0.25 | 0.6 | 1.0 | 3.0 | 6.0 | TO-39 | 6-31 |
| 2N3767 | | 80 | 40/160 | 0.5 | 1.0 | 0.5 | 10 | 20 | TO-66 | 6-19 |
| TIP29B | TIP30B | 80 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | TO-220 | 6-245,248 |
| 2N5335 | | 80 | 30/150 | 1.0 | 0.7 | 2.0 | 40 | 6.0 | TO-39 | 6-78 |
| TIP29C | TIP30C | 100 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | TO-220 | 6-245,248 |
| 2N5838 | | 250 | 8/40 | 3.0 | 1.0 | 3.0 | 5.0 | 100 | TO-3 | 6-105 |
| 2N5839 | | 275 | 10/50 | 2.0 | 1.5 | 2.0 | 5.0 | 100 | TO-3 | 6-105 |
| FT402 | | 325 | 20/100 | 0.5 | 2.0 | 3.0 | 2.0 | 100 | TO-3 | 6-210 |
| 2N5840 | | 350 | 10/50 | 2.0 | 1.5 | 2.0 | 5.0 | 100 | TO-3 | 6-105 |
| **$I_C$ = 4.0 A Max Continuous** | | | | | | | | | | |
| BD221 | BD224 | 40 | 30/120 | 1.0 | 1.0 | 1.0 | 0.8 | 36 | TO-220 | 6-191 |
| 2N4231 | | 40 | 25/100 | 1.5 | 0.7 | 1.5 | 4.0 | 35 | TO-66 | 6-28 |
| 2N4237 | | 40 | 30/150 | 0.25 | 0.6 | 1.0 | 1.0 | 6.0 | TO-39 | 6-34 |
| 2N6121 | 2N6124 | 45 | 25/100 | 1.5 | 0.6 | 1.5 | 2.5 | 40 | TO-220 | 6-146,149 |
| 2N3054 | | 55 | 25/150 | 0.5 | 1.0 | 0.5 | | 25 | TO-66 | 6-3 |
| BD222 | BD225 | 60 | 20/80 | 1.5 | 1.0 | 1.5 | 0.8 | 36 | TO-220 | 6-191,194 |
| 2N6122 | 2N6125 | 60 | 25/100 | 1.5 | 0.6 | 1.5 | 2.5 | 40 | TO-220 | 6-146,149 |
| 2N4232 | | 60 | 25/100 | 1.5 | 0.7 | 1.5 | 4.0 | 35 | TO-66 | 6-28 |
| 2N4238 | | 60 | 30/150 | 0.25 | 0.6 | 1.0 | 1.0 | 6.0 | TO-39 | 6-34 |
| BD220 | BD223 | 70 | 30/120 | 0.5 | 1.0 | 0.5 | 0.8 | 36 | TO-220 | 6-191,194 |
| 2N6123 | 2N6126 | 80 | 20/80 | 1.5 | 0.6 | 1.5 | 2.5 | 40 | TO-220 | 6-146,149 |
| 2N4233 | | 80 | 25/100 | 1.5 | 0.7 | 1.5 | 4.0 | 35 | TO-66 | 6-28 |
| 2N4239 | | 80 | 30/150 | 0.25 | 0.6 | 1.0 | 1.0 | 6.0 | TO-39 | 6-34 |
| FT317 | FT417 | 100 | 35/- | 1.0 | 0.5 | 1.0 | 20 | 40 | TO-220 | 6-206,216 |
| 2N6473 | 2N6475 | 100 | 15/150 | 1.5 | 1.2 | 1.5 | 10 | 40 | TO-220 | 6-176,178 |
| FT317A | FT417A | 120 | 35/- | 1.0 | 0.5 | 1.0 | 20 | 40 | TO-220 | 6-206,216 |
| 2N6474 | 2N6476 | 120 | 15/150 | 1.5 | 1.2 | 1.5 | 10 | 40 | TO-220 | 6-176,178 |
| FT317B | FT417B | 140 | 35/- | 1.0 | 0.5 | 1.0 | 20 | 40 | TO-220 | 6-206,216 |
| **$I_C$ = 5.0 A Max Continuous** | | | | | | | | | | |
| 2N5067 | 2N4901 | 40 | 20/80 | 1.0 | 0.4 | 1.0 | 4.0 | 87.5 | TO-3 | 6-66,46 |
| 2N4913 | 2N4904 | 40 | 25/100 | 2.5 | 1.5 | 5.0 | 4.0 | 87.5 | TO-3 | 6-57,49 |
| TIP31 | TIP32 | 40 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | TO-220 | 6-251,254 |
| TIP120 | TIP125 | 60 | 1K/- | 0.5 | 2.0 | 3.0 | | 65 | TO-220 | 6-269,271 |
| BC323 | | 60 | 50/250 | 0.5 | 0.15 | 0.5 | | 7.0 | TO-39 | 6-189 |
| 2N5068 | 2N4902 | 60 | 20/80 | 1.0 | 0.4 | 1.0 | 4.0 | 87.5 | TO-3 | 6-66,46 |
| 2N4895 | | 60 | 40/120 | 2.0 | 1.0 | 5.0 | 50 | 7.0 | TO-39 | 6-40 |
| BFX34 | | 60 | 40/150 | 2.0 | 1.0 | 0.5 | 70 | 5.0 | TO-39 | 6-197 |
| 2N4896 | | 60 | 100/300 | 2.0 | 1.0 | 5.0 | 80 | 7.0 | TO-39 | 6-40 |
| 2N4914 | 2N4905 | 60 | 25/100 | 2.5 | 1.5 | 5.0 | 4.0 | 87.5 | TO-3 | 6-57,49 |
| TIP31A | TIP32A | 60 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | TO-220 | 6-251,254 |
| TIP121 | TIP126 | 80 | 1K/- | 0.5 | 2.0 | 3.0 | | 65 | TO-220 | 6-269,271 |
| 2N5069 | 2N4903 | 80 | 20/80 | 1.0 | 0.4 | 1.0 | 4.0 | 87.5 | TO-3 | 6-66,46 |
| 2N4897 | | 80 | 40/120 | 2.0 | 1.0 | 5.0 | 50 | 7.0 | TO-39 | 6-40 |
| 2N5336 | | 80 | 30/120 | 2.0 | 0.7 | 2.0 | 30 | 6.0 | TO-39 | 6-81 |
| 2N5337 | | 80 | 60/240 | 2.0 | 0.7 | 2.0 | 30 | 6.0 | TO-39 | 6-81 |
| 2N4915 | 2N4906 | 80 | 25/100 | 2.5 | 1.5 | 5.0 | 4.0 | 87.5 | TO-3 | 6-57,49 |
| TIP31B | TIP32B | 80 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40.0 | TO-220 | 6-251,254 |
| TIP122 | TIP127 | 100 | 1K/- | 0.5 | 2.0 | 3.0 | | 65 | TO-220 | 6-269,271 |
| 2N5338 | | 100 | 30/120 | 2.0 | 0.7 | 2.0 | 30 | 6.0 | TO-39 | 6-84 |

*TYPICAL VALUE

# SELECTION GUIDE BY $I_{C(max)}$, POLARITY AND ASCENDING $V_{CEO}$

| DEVICE POLARITY NPN | PNP | $V_{CEO}$ Max V | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C = 25°C$ W | PACKAGE | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| **$I_C$ = 5.0 A Max Continuous** (Cont'd) | | | | | | | | | | |
| 2N5339 | | 100 | 60/240 | 2.0 | 0.7 | 2.0 | 30 | 6.0 | TO-39 | 6-84 |
| TIP31C | TIP32C | 100 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | TO-220 | 6-251,254 |
| **$I_C$ = 6.0 A Max Continuous** | | | | | | | | | | |
| TIP41 | TIP42 | 40 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | TO-220 | 6-257,259 |
| TIP41A | TIP42A | 60 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | TO-220 | 6-257,259 |
| TIP41B | TIP42B | 80 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | TO-220 | 6-257,259 |
| TIP41C | TIP42C | 100 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | TO-220 | 6-257,259 |
| **$I_C$ = 7.0 A Max Continuous** | | | | | | | | | | |
| 2N6129 | 2N6132 | 40 | 20/100 | 2.5 | 1.4 | 7.0 | 2.5 | 50 | TO-220 | 6-152,155 |
| 2N5873 | 2N5871 | 60 | 20/100 | 2.5 | 1.0 | 4.0 | 4.0 | 115 | TO-3 | 6-111,108 |
| 2N6130 | 2N6133 | 60 | 20/100 | 2.5 | 1.4 | 7.0 | 2.5 | 50 | TO-220 | 6-152,155 |
| 2N5874 | 2N5872 | 80 | 20/100 | 2.5 | 1.0 | 4.0 | 4.0 | 115 | TO-3 | 6-111,108 |
| 2N6131 | 2N6134 | 80 | 20/100 | 2.5 | 2.8 | 7.0 | 2.5 | 50 | TO-220 | 6-152,155 |
| **$I_C$ = 7.5 A Max Continuous** | | | | | | | | | | |
| FT410 | | 200 | 30/90 | 1.0 | 0.8 | 1.0 | *5.0 | 100 | TO-3 | 6-212 |
| FT411 | | 300 | 30/90 | 1.0 | 0.8 | 1.0 | *5.0 | 100 | TO-3 | 6-212 |
| FT413 | | 325 | 20/80 | 0.5 | 0.8 | 0.5 | *5.0 | 100 | TO-3 | 6-214 |
| FT423 | | 325 | 30/90 | 1.0 | 0.8 | 1.0 | *5.0 | 100 | TO-3 | 6-214 |
| **$I_C$ = 8.0 A Max Continuous** | | | | | | | | | | |
| 2N5877 | 2N5875 | 60 | 20/100 | 4.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-117,114 |
| 2N6055 | 2N6053 | 60 | 750/18K | 4.0 | 2.0 | 4.0 | 4.0 | 100 | TO-3 | 6-140,137 |
| 2N5878 | 2N5876 | 80 | 20/100 | 4.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-117,137 |
| 2N6056 | 2N6054 | 80 | 750/18K | 4.0 | 2.0 | 4.0 | 4.0 | 100 | TO-3 | 6-140,137 |
| 2N6306 | | 250 | 15/75 | 3.0 | 0.8 | 3.0 | 5.0 | 125 | TO-3 | 6-167 |
| 2N6307M | | 300 | 15/75 | 3.0 | 1.0 | 3.0 | 5.0 | 125 | TO-3 | 6-167 |
| 2N6308M | | 350 | 12/60 | 3.0 | 1.5 | 3.0 | 5.0 | 125 | TO-3 | 6-167 |
| **$I_C$ = 10.0 A Max Continuous** | | | | | | | | | | |
| 2N6386 | | 40 | 1K/20K | 3.0 | 2.0 | 3.0 | 20 | 40 | TO-220 | 6-173 |
| | 2N4907 | 40 | 20/80 | 4.0 | 0.75 | 4.0 | 4.0 | 150 | TO-3 | 6-52 |
| 2N6383 | | 40 | 1K/20K | 5.0 | 2.0 | 5.0 | 20 | 100 | TO-3 | 6-170 |
| 2N3713 | | 60 | 25/75 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-13 |
| | 2N3789 | 60 | 25/90 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-25 |
| 2N3715 | | 60 | 50/150 | 1.0 | 0.8 | 5.0 | 4.0 | 150 | TO-3 | 6-13 |
| | 2N3791 | 60 | 50/180 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-25 |
| 2N6387 | | 60 | 1K/20K | 3.0 | 2.0 | 3.0 | 20 | 40 | TO-220 | 6-173 |
| MJE3055F | | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 2.0 | 70 | TO-220 | 6-228 |
| | 2N4908 | 60 | 20/80 | 4.0 | 0.75 | 4.0 | 4.0 | 150 | TO-3 | 6-52 |
| SE9300 | SE9400 | 60 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | TO-220 | 6-235,241 |
| SE9303 | SE9403 | 60 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | TO-3 | 6-237,243 |
| 2N6384 | | 60 | 1K/20K | 5.0 | 2.0 | 5.0 | 20 | 100 | TO-3 | 6-170 |
| 2N3714 | | 80 | 25/75 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-13 |
| | 2N3790 | 80 | 25/90 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-25 |
| 2N3716 | | 80 | 50/150 | 1.0 | 0.8 | 5.0 | 4.0 | 150 | TO-3 | 6-13 |
| | 2N3792 | 80 | 50/180 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | TO-3 | 6-25 |
| 2N6388 | | 80 | 1K/20K | 3.0 | 2.0 | 3.0 | 20 | 40 | TO-220 | 6-173 |
| | 2N4909 | 80 | 20/80 | 4.0 | 0.75 | 4.0 | 4.0 | 150 | TO-3 | 6-52 |
| SE9304 | SE9404 | 80 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | TO-3 | 6-237,243 |
| SE9301 | SE9401 | 80 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | TO-220 | 6-235,241 |

*TYPICAL VALUE

# SELECTION GUIDE BY $I_{C(max)}$, POLARITY AND ASCENDING $V_{CEO}$

| DEVICE POLARITY NPN | PNP | $V_{CEO}$ Max V | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C = 25°C$ W | PACKAGE | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| **$I_C$ = 10.0 A Max Continuous** (Cont'd) | | | | | | | | | | |
| 2N6385 | | 80 | 1K/20K | 5.0 | 2.0 | 5.0 | 20 | 100 | TO-3 | 6-170 |
| SE9302 | SE9402 | 100 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | TO-220 | 6-235,241 |
| SE9305 | SE9405 | 100 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | TO-3 | 6-237,243 |
| 2N6249 | | 200 | 10/50 | 10 | 1.5 | 10 | 2.5 | 100 | TO-3 | 6-158 |
| 2N6250 | | 275 | 8/50 | 10 | 1.5 | 10 | 2.5 | 100 | TO-3 | 6-158 |
| FT430 | | 300 | 15/45 | 2.5 | 0.9 | 2.5 | | 125 | TO-3 | 6-218 |
| FT431 | | 325 | 15/35 | 2.5 | 0.7 | 2.5 | | 125 | TO-3 | 6-218 |
| FT359 | | 350 | 250/- | 3.0 | 2.8 | 7.0 | | 125 | TO-3 | 6-208 |
| 2N6251 | | 350 | 6/50 | 10 | 1.5 | 10 | 2.5 | 100 | TO-3 | 6-158 |
| **$I_C$ = 12.0 A Max Continuous** | | | | | | | | | | |
| 2N6569 | | 40 | 15/200 | 0.2 | 1.5 | 4.0 | 1.5 | 100 | TO-3 | 6-184 |
| 2N6057 | 2N6050 | 60 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | TO-3 | 6-143,134 |
| 2N5881 | 2N5879 | 60 | 20/100 | 6.0 | 1.0 | 7.0 | 4.0 | 160 | TO-3 | 6-123,120 |
| 2N5882 | 2N5880 | 80 | 20/100 | 6.0 | 1.0 | 7.0 | 4.0 | 160 | TO-3 | 6-123,120 |
| 2N6058 | 2N6051 | 80 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | TO-3 | 6-143,134 |
| 2N6059 | 2N6052 | 100 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | TO-3 | 6-143,134 |
| **$I_C$ = 15.0 A Max Continuous** | | | | | | | | | | |
| 2N6486 | 2N6489 | 40 | 20/150 | 5.0 | 1.3 | 5.0 | 5.0 | 75 | TO-220 | 6-180,182 |
| 2N6576 | | 60 | 2K/20K | 4.0 | 4.0 | 15 | 10 | 120 | TO-3 | 6-186 |
| 2N3055SD | | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 0.8 | 115 | TO-3 | 6-8 |
| FT3055 | FT2955 | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 2.0 | 70 | TO-220 | 6-222,220 |
| 2N3055 | | 60 | 20/70 | 4.0 | 1.1 | 4.0 | | 117 | TO-3 | 6-6 |
| 2N6487 | 2N6490 | 60 | 20/150 | 5.0 | 1.3 | 5.0 | 5.0 | 75 | TO-220 | 6-180,182 |
| 2N6488 | 2N6491 | 80 | 20/150 | 5.0 | 1.3 | 5.0 | 5.0 | 75 | TO-220 | 6-180,182 |
| 2N6577 | | 90 | 2K/20K | 4.0 | 4.0 | 15 | 10 | 120 | TO-3 | 6-186 |
| **$I_C$ = 16.0 A Max Continuous** | | | | | | | | | | |
| 2N5629 | | 100 | 25/100 | 8.0 | 1.0 | 10 | 0.5 | 200 | TO-3 | 6-90 |
| | 2N6029 | 100 | 25/100 | 8.0 | 2.0 | 16 | 1.0 | 200 | TO-3 | 6-132 |
| 2N5630 | | 120 | 20/80 | 8.0 | 1.0 | 10 | 0.5 | 200 | TO-3 | 6-90 |
| | 2N6030 | 120 | 20/80 | 8.0 | 2.0 | 16 | 1.0 | 200 | TO-3 | 6-132 |
| 2N5631 | | 140 | 15/60 | 8.0 | 1.0 | 10 | 0.5 | 200 | TO-3 | 6-90 |
| | 2N6031 | 140 | 15/60 | 8.0 | 2.0 | 16 | 1.0 | 200 | TO-3 | 6-132 |
| **$I_C$ = 20.0 A Max Continuous** | | | | | | | | | | |
| 2N3772 | | 60 | 15/60 | 10 | 1.4 | 10 | 0.2 | 150 | TO-3 | 6-22 |
| 2N5885 | 2N5883 | 60 | 20/100 | 10 | 1.0 | 15 | 4.0 | 200 | TO-3 | 6-129,126 |
| 2N6282 | 2N6285 | 60 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | TO-3 | 6-161,164 |
| 2N5039 | | 75 | 20/100 | 10 | 1.0 | 10 | 60 | 140 | TO-3 | 6-60 |
| 2N6283 | 2N6286 | 80 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | TO-3 | 6-161,164 |
| 2N5886 | 2N5884 | 80 | 20/100 | 10 | 1.0 | 15 | 4.0 | 200 | TO-3 | 6-129,126 |
| 2N5303 | | 80 | 15/60 | 10 | 2.0 | 20 | 2.0 | 200 | TO-3 | 6-69 |
| 2N5038 | | 90 | 20/100 | 12 | 1.0 | 12 | 60 | 140 | TO-3 | 6-60 |
| 2N6284 | 2N6287 | 100 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | TO-3 | 6-161,164 |
| **$I_C$ = 30.0A Max Continuous** | | | | | | | | | | |
| 2N3771 | | 40 | 15/60 | 15 | 2.0 | 15 | 0.2 | 150 | TO-3 | 6-22 |
| | 2N4398 | 40 | 15/60 | 15 | 1.0 | 15 | 4.0 | 200 | TO-3 | 6-37 |
| 2N5301 | | 40 | 15/60 | 15 | 2.0 | 20 | 2.0 | 200 | TO-3 | 6-69 |
| | 2N4399 | 60 | 15/60 | 15 | 1.0 | 15 | 4.0 | 200 | TO-3 | 6-37 |
| 2N5302 | | 60 | 15/60 | 15 | 2.0 | 20 | 2.0 | 200 | TO-3 | 6-69 |
| MJ802 | MJ4502 | 90 | 25/100 | 7.5 | 0.8 | 7.5 | 2.0 | 200 | TO-3 | 6-224,226 |

*TYPICAL VALUE

# SELECTION GUIDE BY $I_{C(max)}$, POLARITY AND ASCENDING $V_{CEO}$

| DEVICE POLARITY NPN | DEVICE POLARITY PNP | $V_{CEO}$ Max V | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C = 25°C$ W | PACKAGE | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| **$I_C$ = 50.0 A Max Continuous** | | | | | | | | | | |
| 2N5685 | 2N5683 | 60 | 15/60 | 25 | 1.0 | 25 | 2.0 | 300 | TO-3 | 6-101,98 |
| 2N5686 | 2N5684 | 80 | 15/60 | 25 | 1.0 | 25 | 2.0 | 300 | TO-3 | 6-101,98 |

*TYPICAL VALUE

# SELECTION GUIDE BY PACKAGE, ASCENDING $I_{C(max)}$ AND $V_{CEO(max)}$

| DEVICE POLARITY NPN | PNP | $I_C$ Max A | $V_{CEO}$ Max A | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$=25°C W | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| **TO-220 Package** | | | | | | | | | | |
| TIP61 | TIP62 | 0.5 | 40 | 40/- | 0.5 | 0.7 | 0.5 | 3.0 | 15 | 6-261,263 |
| TIP61A | TIP62A | 0.5 | 60 | 40/- | 0.5 | 0.7 | 0.5 | 3.0 | 15 | 6-261,263 |
| TIP61B | TIP62B | 0.5 | 80 | 40/- | 0.5 | 0.7 | 0.5 | 3.0 | 15 | 6-261,263 |
| TIP61C | TIP62C | 0.5 | 100 | 40/- | 0.5 | 0.7 | 0.5 | 3.0 | 15 | 6-261,263 |
| FT47 | | 1.0 | 250 | 30/150 | 0.3 | 1.0 | 1.0 | 10 | 40 | 6-204 |
| FT48 | | 1.0 | 300 | 30/150 | 0.3 | 1.0 | 1.0 | 10 | 40 | 6-204 |
| FT49 | | 1.0 | 350 | 30/150 | 0.3 | 1.0 | 1.0 | 10 | 40 | 6-204 |
| FT50 | | 1.0 | 400 | 30/150 | 0.3 | 1.0 | 1.0 | 10 | 40 | 6-204 |
| TIP110 | TIP115 | 2.0 | 60 | 1K/- | 1.0 | 2.5 | 2.0 | - | 50 | 6-265,267 |
| TIP111 | TIP116 | 2.0 | 80 | 1K/- | 1.0 | 2.5 | 2.0 | - | 50 | 6-265,267 |
| TIP112 | TIP117 | 2.0 | 100 | 1K/- | 1.0 | 2.5 | 2.0 | - | 50 | 6-265,267 |
| TIP29 | TIP30 | 3.0 | 40 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | 6-245,248 |
| TIP29A | TIP30A | 3.0 | 60 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | 6-245,248 |
| TIP29B | TIP30B | 3.0 | 80 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | 6-245,248 |
| TIP29C | TIP30C | 3.0 | 100 | 15/75 | 1.0 | 0.7 | 1.0 | 3.0 | 30 | 6-245,248 |
| BD221 | BD224 | 4.0 | 40 | 30/120 | 1.0 | 1.0 | 1.0 | 0.8 | 36 | 6-191,194 |
| 2N6121 | 2N6124 | 4.0 | 45 | 25/100 | 1.5 | 0.6 | 1.5 | 2.5 | 40 | 6-146,149 |
| BD222 | BD225 | 4.0 | 60 | 20/80 | 1.5 | 1.0 | 1.5 | 0.8 | 36 | 6-191,194 |
| 2N6122 | 2N6125 | 4.0 | 60 | 25/100 | 1.5 | 0.6 | 1.5 | 2.5 | 40 | 6-146,149 |
| BD220 | BD223 | 4.0 | 70 | 30/120 | 0.5 | 1.0 | 0.5 | 0.8 | 36 | 6-191,194 |
| 2N6123 | 2N6126 | 4.0 | 80 | 20/80 | 1.5 | 0.6 | 1.5 | 2.5 | 40 | 6-146,149 |
| 2N6473 | 2N6475 | 4.0 | 100 | 15/150 | 1.5 | 1.2 | 1.5 | 10 | 40 | 6-176,178 |
| FT317 | FT417 | 4.0 | 100 | 35/- | 1.0 | 0.5 | 1.0 | 20 | 40 | 6-206,216 |
| 2N6474 | 2N6476 | 4.0 | 120 | 15/150 | 1.5 | 1.2 | 1.5 | 10 | 40 | 6-176,178 |
| FT317A | FT417A | 4.0 | 120 | 35/- | 1.0 | 0.5 | 1.0 | 20 | 40 | 6-206,216 |
| FT317B | FT417B | 4.0 | 140 | 35/- | 1.0 | 0.5 | 1.0 | 20 | 40 | 6-206,216 |
| TIP31 | TIP32 | 5.0 | 40 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | 6-251,254 |
| TIP120 | TIP125 | 5.0 | 60 | 1K/- | 0.5 | 2.0 | 3.0 | - | 65 | 6-269,271 |
| TIP31A | TIP32A | 5.0 | 60 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | 6-251,254 |
| TIP121 | TIP126 | 5.0 | 80 | 1K/- | 0.5 | 2.0 | 3.0 | - | 65 | 6-269,271 |
| TIP31B | TIP32B | 5.0 | 80 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | 6-251,254 |
| TIP122 | TIP127 | 5.0 | 100 | 1K/- | 0.5 | 2.0 | 3.0 | - | 65 | 6-269,271 |
| TIP31C | TIP32C | 5.0 | 100 | 10/50 | 3.0 | 1.2 | 3.0 | 3.0 | 40 | 6-251,254 |
| TIP41 | TIP42 | 6.0 | 40 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | 6-257,259 |
| TIP41A | TIP42A | 6.0 | 60 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | 6-257,259 |
| TIP41B | TIP42B | 6.0 | 80 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | 6-257,259 |
| TIP41C | TIP42C | 6.0 | 100 | 30/- | 0.3 | 1.5 | 6.0 | 3.0 | 65 | 6-257,259 |
| 2N6129 | 2N6132 | 7.0 | 40 | 20/100 | 2.5 | 1.4 | 7.0 | 2.5 | 50 | 6-152,155 |
| 2N6130 | 2N6133 | 7.0 | 60 | 20/100 | 2.5 | 1.4 | 7.0 | 2.5 | 50 | 6-152,155 |
| 2N6131 | 2N6134 | 7.0 | 80 | 20/100 | 2.5 | 2.0 | 7.0 | 2.5 | 50 | 6-152,155 |
| 2N6386 | | 10 | 40 | 1K/20K | 3.0 | 2.0 | 3.0 | 20 | 40 | 6-180 |
| FT3055 | FT2955 | 10 | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 2.0 | 70 | 6-222,220 |
| MJE3055F | | 10 | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 2.0 | 70 | 6-228 |
| SE9300 | SE9400 | 10 | 60 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | 6-235,241 |
| 2N6387 | | 10 | 60 | 1K/20K | 3.0 | 2.0 | 3.0 | 20 | 40 | 6-173 |

# SELECTION GUIDE BY PACKAGE, ASCENDING $I_{C(max)}$ AND $V_{CEO(max)}$

| DEVICE POLARITY NPN | PNP | $I_C$ Max A | $V_{CEO}$ Max A | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$=25°C W | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| **TO-220 Package** | | | | | | | | | | |
| SE9301 | SE9401 | 10 | 80 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | 6-235,241 |
| 2N6388 | | 10 | 80 | 1K/20K | 3.0 | 2.0 | 3.0 | 20 | 40 | 6-173 |
| SE9302 | SE9402 | 10 | 100 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | 6-235,241 |
| 2N6486 | 2N6489 | 15 | 40 | 20/150 | 5.0 | 1.3 | 5.0 | 5.0 | 75 | 6-180,182 |
| 2N6487 | 2N6490 | 15 | 60 | 20/150 | 5.0 | 1.3 | 5.0 | 5.0 | 75 | 6-180,182 |
| 2N6488 | 2N6491 | 15 | 80 | 20/150 | 5.0 | 1.3 | 5.0 | 5.0 | 75 | 6-180,182 |
| **TO-39 Package** | | | | | | | | | | |
| BF257 | | 0.1 | 160 | 25/- | 0.03 | 1.0 | 0.03 | 75* | 1.0 | 6-200 |
| BF336 | | 0.1 | 180 | 20/- | 0.03 | - | - | 50 | 1.0 | 6-202 |
| BF337 | | 0.1 | 200 | 20/- | 0.03 | - | - | 50 | 1.0 | 6-202 |
| BF338 | | 0.1 | 225 | 20/- | 0.03 | - | - | 50 | 1.0 | 6-202 |
| BF258 | | 0.1 | 250 | 25/- | 0.03 | 1.0 | 0.03 | 75* | 1.0 | 6-200 |
| BF259 | | 0.1 | 300 | 25/- | 0.03 | 1.0 | 0.03 | 75* | 1.0 | 6-200 |
| 2N5058 | | 0.15 | 300 | 35/150 | 0.03 | 1.0 | 0.03 | 30 | 1.0 | 6-63 |
| 2N5059 | | 0.15 | 250 | 30/150 | 0.03 | 1.0 | 0.03 | 30 | 1.0 | 6-63 |
| SE7055 | | 0.5 | 220 | 40/- | 0.01 | 1.0 | 0.02 | 50 | 1.0 | 6-232 |
| SE7056 | | 0.5 | 300 | 40/- | 0.01 | 1.0 | 0.02 | 50 | 1.0 | 6-232 |
| 2N5681 | 2N5679 | 1.0 | 100 | 40/150 | 0.25 | 1.0 | 0.5 | 30 | 10 | 6-94,92 |
| 2N5682 | 2N5680 | 1.0 | 120 | 40/150 | 0.25 | 1.0 | 0.5 | 30 | 10 | 6-95,92 |
| | 2N5415 | 1.0 | 200 | 30/150 | 0.05 | 2.5 | 0.05 | 15 | 10 | 6-87 |
| 2N3440 | | 1.0 | 250 | 40/160 | 0.02 | 0.5 | 0.05 | 15 | 10 | 6-10 |
| | 2N5416 | 1.0 | 300 | 30/120 | 0.05 | 2.0 | 0.05 | 15 | 10 | 6-87 |
| 2N3439 | | 1.0 | 350 | 40/160 | 0.02 | 0.5 | 0.05 | 15 | 10 | 6-10 |
| 2N5321 | 2N5323 | 2.0 | 50 | 40/250 | 0.5 | 0.8 | 0.5 | 50 | 10 | 6-72,75 |
| 2N5320 | 2N5322 | 2.0 | 75 | 30/130 | 0.5 | 0.5 | 0.5 | 50 | 10 | 6-72,75 |
| 2N4237 | 2N4234 | 4.0/3.0 | 40 | 30/150 | 0.25 | 0.6 | 1.0 | 1.0 | 6.0 | 6-34,31 |
| 2N5334 | | 3.0 | 60 | 30/150 | 1.0 | 0.7 | 2.0 | 40 | 6.0 | 6-78 |
| 2N4238 | 2N4235 | 4.0/3.0 | 60 | 30/150 | 0.25 | 0.6 | 1.0 | 1.0 | 6.0 | 6-34,31 |
| 2N4239 | 2N4236 | 4.0/3.0 | 80 | 30/150 | 0.25 | 0.6 | 1.0 | 1.0 | 6.0 | 6-34,31 |
| 2N5335 | | 3.0 | 80 | 30/150 | 1.0 | 0.7 | 2.0 | 40 | 6.0 | 6-78 |
| BC323 | | 5.0 | 60 | 50/250 | 0.5 | 0.15 | 0.5 | - | 7.0 | 6-189 |
| BFX34 | | 5.0 | 60 | 40/150 | 2.0 | 1.0 | 5.0 | 70 | 5.0 | 6-197 |
| 2N4895 | | 5.0 | 60 | 40/120 | 2.0 | 1.0 | 5.0 | 50 | 7.0 | 6-40 |
| 2N4896 | | 5.0 | 60 | 100/300 | 2.0 | 1.0 | 5.0 | 80 | 7.0 | 6-40 |
| 2N4897 | | 5.0 | 80 | 40/120 | 2.0 | 1.0 | 5.0 | 50 | 7.0 | 6-40 |
| 2N5336 | | 5.0 | 80 | 30/120 | 2.0 | 0.7 | 2.0 | 30 | 6.0 | 6-81 |
| 2N5337 | | 5.0 | 80 | 60/240 | 2.0 | 0.7 | 2.0 | 30 | 6.0 | 6-81 |
| 2N5338 | | 5.0 | 100 | 30/120 | 2.0 | 0.7 | 2.0 | 30 | 6.0 | 6-84 |
| 2N5339 | | 5.0 | 100 | 60/240 | 2.0 | 0.7 | 2.0 | 30 | 6.0 | 6-84 |
| **TO-66 Package** | | | | | | | | | | |
| | 2N4898 | 1.0 | 40 | 20/100 | 0.5 | 0.6 | 1.0 | 3.0 | 25 | 6-43 |
| 2N4910 | | 1.0 | 40 | 20/100 | 0.5 | 0.6 | 1.0 | 4.0 | 25 | 6-54 |
| | 2N3740 | 1.0 | 60 | 30/100 | 0.25 | 0.6 | 1.0 | 4.0 | 25 | 6-16 |
| 2N4911 | | 1.0 | 60 | 20/100 | 0.5 | 0.5 | 1.0 | 4.0 | 25 | 6-54 |
| | 2N4899 | 1.0 | 60 | 20/100 | 0.5 | 0.6 | 1.0 | 3.0 | 25 | 6-43 |

*TYPICAL VALUE

# SELECTION GUIDE BY PACKAGE, ASCENDING $I_{C(max)}$ AND $V_{CEO(max)}$

| DEVICE POLARITY NPN | DEVICE POLARITY PNP | $I_C$ Max A | $V_{CEO}$ Max A | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$=25°C W | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| **TO-66 Package** | | | | | | | | | | |
| | 2N3741 | 1.0 | 80 | 30/100 | 0.25 | 0.6 | 1.0 | 4.0 | 25 | 6-16 |
| | 2N4900 | 1.0 | 80 | 20/100 | 0.5 | 0.6 | 1.0 | 3.0 | 25 | 6-43 |
| 2N4912 | | 1.0 | 80 | 20/100 | 0.5 | 0.6 | 1.0 | 5.0 | 25 | 6-54 |
| SE9331 | | 1.0 | 300 | 30/250 | 0.1 | 2.5 | 0.1 | 10 | 20 | 6-239 |
| 2N3766 | | 3.0 | 60 | 40/160 | 0.5 | 1.0 | 0.5 | 10 | 20 | 6-19 |
| 2N3767 | | 3.0 | 80 | 40/160 | 0.5 | 1.0 | 0.5 | 10 | 20 | 6-19 |
| 2N4231 | | 4.0 | 40 | 25/100 | 1.5 | 0.7 | 1.5 | 4.0 | 35 | 6-28 |
| 2N3054 | | 4.0 | 55 | 25/150 | 0.5 | 1.0 | 0.5 | - | 25 | 6-3 |
| 2N4232 | | 4.0 | 60 | 25/100 | 1.5 | 0.7 | 1.5 | 4.0 | 35 | 6-28 |
| 2N4233 | | 4.0 | 80 | 25/100 | 1.5 | 0.7 | 1.5 | 4.0 | 35 | 6-28 |
| **TO-3 Package** | | | | | | | | | | |
| FT401 | | 2.0 | 300 | 20/100 | 0.5 | 0.8 | 0.5 | 2.0 | 100 | 6-210 |
| 2N5838 | | 3.0 | 250 | 8/40 | 3.0 | 1.0 | 3.0 | 5.0 | 100 | 6-105 |
| 2N5339 | | 3.0 | 275 | 10/50 | 2.0 | 1.5 | 2.0 | 5.0 | 100 | 6-84 |
| 2N5840 | | 3.0 | 350 | 10/50 | 2.0 | 1.5 | 2.0 | 5.0 | 100 | 6-105 |
| FT402 | | 3.5 | 325 | 20/100 | 0.5 | 2.0 | 3.0 | 2.0 | 100 | 6-210 |
| | 2N4901 | 5.0 | 40 | 20/80 | 1.0 | 1.5 | 5.0 | 4.0 | 87.5 | 6-46 |
| 2N5067 | | 5.0 | 40 | 20/80 | 1.0 | 0.4 | 1.0 | 4.0 | 87.5 | 6-66 |
| 2N4913 | 2N4904 | 5.0 | 40 | 25/100 | 2.5 | 1.5 | 5.0 | 4.0 | 87.5 | 6-57,49 |
| 2N5068 | | 5.0 | 60 | 20/80 | 1.0 | 0.4 | 1.0 | 4.0 | 87.5 | 6-66 |
| | 2N4902 | 5.0 | 60 | 20/80 | 1.0 | 1.5 | 5.0 | 4.0 | 87.5 | 6-46 |
| 2N4914 | 2N4905 | 5.0 | 60 | 25/100 | 2.5 | 1.5 | 5.0 | 4.0 | 87.5 | 6-57,49 |
| | 2N4903 | 5.0 | 80 | 20/80 | 1.0 | 1.5 | 5.0 | 4.0 | 87.5 | 6-46 |
| 2N5069 | | 5.0 | 80 | 20/80 | 1.0 | 0.4 | 1.0 | 4.0 | 87.5 | 6-66 |
| 2N4915 | 2N4906 | 5.0 | 80 | 25/100 | 2.5 | 1.5 | 5.0 | 4.0 | 87.5 | 6-57,49 |
| 2N5873 | 2N5871 | 7.0 | 60 | 20/100 | 2.5 | 1.0 | 4.0 | 4.0 | 115 | 6-111,108 |
| 2N5874 | 2N5872 | 7.0 | 80 | 20/100 | 2.5 | 1.0 | 4.0 | 4.0 | 115 | 6-111,108 |
| FT410 | | 7.5 | 200 | 30/90 | 1.0 | 0.8 | 1.0 | - | 100 | 6-210 |
| FT411 | | 7.5 | 300 | 30/90 | 1.0 | 0.8 | 1.0 | - | 100 | 6-212 |
| FT413 | | 7.5 | 325 | 20/80 | 0.5 | 0.8 | 0.5 | - | 100 | 6-214 |
| FT423 | | 7.5 | 325 | 30/90 | 1.0 | 0.8 | 1.0 | - | 100 | 6-214 |
| 2N5877 | 2N5875 | 8.0 | 60 | 20/100 | 4.0 | 1.0 | 5.0 | 4.0 | 150 | 6-117,114 |
| 2N6055 | 2N6053 | 8.0 | 60 | 750/18K | 4.0 | 2.0 | 4.0 | 4.0 | 100 | 6-140,137 |
| 2N5878 | 2N5876 | 8.0 | 80 | 20/100 | 4.0 | 1.0 | 5.0 | 4.0 | 150 | 6-117,114 |
| 2N6056 | 2N6054 | 8.0 | 80 | 750/18K | 4.0 | 2.0 | 4.0 | 4.0 | 100 | 6-140,137 |
| 2N6306 | | 8.0 | 250 | 15/75 | 3.0 | 0.8 | 3.0 | 5.0 | 125 | 6-137 |
| 2N6307M | | 8.0 | 300 | 15/75 | 3.0 | 1.0 | 3.0 | 5.0 | 125 | 6-167 |
| 2N6308M | | 8.0 | 350 | 12/60 | 3.0 | 1.5 | 3.0 | 5.0 | 125 | 6-167 |
| | 2N4907 | 10 | 40 | 20/80 | 4.0 | 0.75 | 4.0 | 4.0 | 150 | 6-52 |
| 2N6383 | | 10 | 40 | 1K/20K | 5.0 | 2.0 | 5.0 | 20 | 100 | 6-170 |
| | 2N3789 | 10 | 60 | 25/90 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | 6-25 |
| 2N3713 | | 10 | 60 | 25/75 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | 6-13 |
| | 2N4908 | 10 | 60 | 20/80 | 4.0 | 0.75 | 4.0 | 4.0 | 150 | 6-52 |
| 2N3715 | | 10 | 60 | 50/150 | 1.0 | 0.8 | 5.0 | 2.5 | 150 | 6-13 |
| | 2N3791 | 10 | 60 | 50/180 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | 6-25 |
| 2N6384 | | 10 | 60 | 1K/20K | 5.0 | 2.0 | 5.0 | 20 | 100 | 6-170 |

# SELECTION GUIDE BY PACKAGE, ASCENDING $I_{C(max)}$ AND $V_{CEO(max)}$

| DEVICE POLARITY NPN | PNP | $I_C$ Max A | $V_{CEO}$ Max A | $h_{FE}$ Min/Max | @ $I_C$ A | $V_{CE(sat)}$ Max V | @ $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$=25°C W | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| **TO-3 Package** | | | | | | | | | | |
| | 2N3792 | 10 | 80 | 50/180 | 1.0 | 1.0 | 5.0 | 4.0 | 150 | 6-25 |
| SE9304 | SE9404 | 10 | 80 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | 6-237,243 |
| 2N6385 | | 10 | 80 | 1K/20K | 5.0 | 2.0 | 5.0 | 20 | 100 | 6-170 |
| SE9305 | SE9405 | 10 | 100 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | 6-237,243 |
| 2N6249 | | 10 | 200 | 10/50 | 10 | 1.5 | 10 | 2.5 | 100 | 6-158 |
| 2N6250 | | 10 | 275 | 8/50 | 10 | 1.5 | 10 | 2.5 | 100 | 6-158 |
| FT431 | | 10 | 325 | 15/35 | 2.5 | 0.7 | 2.5 | - | 125 | 6-218 |
| 2N6251 | | 10 | 350 | 6/50 | 10 | 1.5 | 10 | 2.5 | 100 | 6-158 |
| FT359 | | 10 | 350 | 250/- | 3.0 | 2.8 | 7.0 | - | 125 | 6-208 |
| FT430 | | 10 | 300 | 15/45 | 2.5 | 0.9 | 2.5 | - | 125 | 6-218 |
| 2N6569 | | 12 | 40 | 15/200 | 4.0 | 1.5 | 4.0 | 1.5 | 100 | 6-184 |
| 2N5881 | 2N5879 | 12 | 60 | 20/100 | 6.0 | 1.0 | 7.0 | 4.0 | 160 | 6-123,120 |
| 2N6057 | 2N6050 | 12 | 60 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | 6-134,143 |
| 2N5882 | 2N5880 | 12 | 80 | 20/100 | 6.0 | 1.0 | 7.0 | 4.0 | 160 | 6-123,120 |
| 2N6058 | 2N6051 | 12 | 80 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | 6-143,134 |
| 2N6059 | 2N6052 | 12 | 100 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | 6-143,134 |
| 2N3055 | | 15 | 60 | 20/70 | 4.0 | 1.1 | 4.0 | - | 117 | 6-6 |
| 2N3055SD | | 15 | 60 | 20/70 | 4.0 | 1.1 | 4.0 | 0.8 | 115 | 6-8 |
| 2N6576 | | 15 | 60 | 2K/20K | 4.0 | 4.0 | 15 | 10 | 120 | 6-186 |
| 2N6577 | | 15 | 90 | 2K/20K | 4.0 | 4.0 | 15 | 10 | 120 | 6-186 |
| | 2N6029 | 16 | 100 | 25/100 | 8.0 | 2.0 | 16 | 1.0 | 200 | 6-132 |
| 2N5629 | | 16 | 100 | 25/100 | 8.0 | 1.0 | 10 | 0.5 | 200 | 6-90 |
| | 2N6030 | 16 | 120 | 20/80 | 8.0 | 2.0 | 16 | 1.0 | 200 | 6-132 |
| 2N5630 | | 16 | 120 | 20/80 | 8.0 | 1.0 | 10 | 0.5 | 200 | 6-90 |
| | 2N6031 | 16 | 140 | 15/60 | 8.0 | 2.0 | 16 | 1.0 | 200 | 6-132 |
| 2N5631 | | 16 | 140 | 15/60 | 8.0 | 1.0 | 10 | 0.5 | 200 | 6-90 |
| 2N3772 | | 20 | 60 | 15/60 | 10 | 1.4 | 10 | 0.2 | 150 | 6-22 |
| 2N5885 | 2N5883 | 20 | 60 | 20/100 | 10 | 1.0 | 15 | 4.0 | 200 | 6-129,126 |
| 2N6282 | 2N6285 | 20 | 60 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | 6-161,164 |
| 2N5039 | | 20 | 75 | 20/100 | 10 | 1.0 | 10 | 60 | 140 | 6-60 |
| 2N5886 | 2N5884 | 20 | 80 | 20/100 | 10 | 1.0 | 15 | 4.0 | 200 | 6-129,126 |
| 2N6283 | 2N6286 | 20 | 80 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | 6-161,164 |
| 2N5303 | | 20 | 80 | 15/60 | 10 | 2.0 | 20 | 2.0 | 200 | 6-69 |
| 2N5038 | | 20 | 90 | 20/100 | 12 | 1.0 | 12 | 60 | 140 | 6-60 |
| 2N6284 | 2N6287 | 20 | 100 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | 6-161,164 |
| | 2N4398 | 30 | 40 | 15/60 | 15 | 1.0 | 15 | 4.0 | 200 | 6-37 |
| | 2N4399 | 30 | 60 | 15/60 | 15 | 1.0 | 15 | 4.0 | 200 | 6-37 |
| 2N3771 | | 30 | 40 | 15/60 | 15 | 2.0 | 15 | 0.2 | 150 | 6-22 |
| 2N5301 | | 30 | 40 | 15/60 | 15 | 2.0 | 20 | 2.0 | 200 | 6-69 |
| 2N5302 | | 30 | 60 | 15/60 | 15 | 2.0 | 20 | 2.0 | 200 | 6-69 |
| MJ802 | MJ4502 | 30 | 90 | 25/100 | 7.5 | 0.8 | 7.5 | 2.0 | 200 | 6-224,226 |
| 2N5685 | 2N5683 | 50 | 60 | 15/60 | 25 | 1.0 | 25 | 2.0 | 300 | 6-98,101 |
| 2N5686 | 2N5684 | 50 | 80 | 15/60 | 25 | 1.0 | 25 | 2.0 | 300 | 6-98,101 |

# DARLINGTON SELECTION GUIDE BY $I_{C(max)}$ AND $V_{CEO(max)}$

| DEVICE POLARITY NPN | PNP | $V_{CEO}$ Max V | $h_{FE}$ Min/Max | at $I_C$ A | $V_{CE(sat)}$ Max V | at $I_C$ A | $f_T$ Min MHz | $P_{D(Max)}$ $T_C$=25°C W | PACK-AGE | DATA SHEET PAGE NO. |
|---|---|---|---|---|---|---|---|---|---|---|
| **$I_C$ = 2.0 A Max Continuous** | | | | | | | | | | |
| TIP110 | TIP115 | 60 | 1K/- | 1.0 | 2.5 | 2.0 | - | 50 | TO-220 | 6-265 |
| TIP111 | TIP116 | 80 | 1K/- | 1.0 | 2.5 | 2.0 | - | 50 | TO-220 | 6-265 |
| TIP112 | TIP117 | 100 | 1K/- | 1.0 | 2.5 | 2.0 | - | 50 | TO-220 | 6-265 |
| **$I_C$ = 5.0 A Max Continuous** | | | | | | | | | | |
| TIP120 | TIP125 | 60 | 1K/- | 0.5 | 2.0 | 3.0 | - | 65 | TO-220 | 6-267,271 |
| TIP121 | TIP126 | 80 | 1K/- | 0.5 | 2.0 | 3.0 | - | 65 | TO-220 | 6-269,271 |
| TIP122 | TIP127 | 100 | 1K/- | 0.5 | 2.0 | 3.0 | - | 65 | TO-220 | 6-269,271 |
| **$I_C$ = 8.0 A Max Continuous** | | | | | | | | | | |
| 2N6055 | 2N6053 | 60 | 750/18K | 4.0 | 2.0 | 4.0 | 4.0 | 100 | TO-3 | 6-140,137 |
| 2N6056 | 2N6054 | 80 | 750/18K | 4.0 | 2.0 | 4.0 | 4.0 | 100 | TO-3 | 6-140,137 |
| **$I_C$ = 10.0 A Max Continuous** | | | | | | | | | | |
| 2N6386 | | 40 | 1K/20K | 3.0 | 2.0 | 3.0 | 20 | 40 | TO-220 | 6-173 |
| 2N6383 | | 40 | 1K/20K | 5.0 | 2.0 | 5.0 | 20 | 100 | TO-3 | 6-170 |
| 2N6387 | | 60 | 1K/20K | 3.0 | 2.0 | 3.0 | 20 | 40 | TO-220 | 6-173 |
| SE9300 | SE9400 | 60 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | TO220 | 6-235,241 |
| SE9303 | SE9403 | 60 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | TO-3 | 6-237,243 |
| 2N6384 | | 60 | 1K/20K | 5.0 | 2.0 | 5.0 | 20 | 100 | TO-3 | 6-170 |
| 2N6388 | | 80 | 1K/20K | 3.0 | 2.0 | 3.0 | 20 | 40 | TO-220 | 6-173 |
| SE9304 | SE9404 | 80 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | TO-3 | 6-237,243 |
| SE9301 | SE9401 | 80 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | TO-220 | 6-235,241 |
| 2N6385 | | 80 | 1K/20K | 5.0 | 2.0 | 5.0 | 20 | 100 | TO-3 | 6-170 |
| SE9302 | SE9402 | 100 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 70 | TO-220 | 6-235,241 |
| SE9305 | SE9405 | 100 | 1K/- | 4.0 | 2.0 | 4.0 | 1.0 | 100 | TO-3 | 6-237,243 |
| FT359 | | 350 | 250/- | 3.0 | 2.5 | 7.0 | - | 125 | TO-3 | 6-208 |
| **$I_C$ = 12 A Max Continuous** | | | | | | | | | | |
| 2N6057 | 2N6050 | 60 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | TO-3 | 6-143,134 |
| 2N6058 | 2N6051 | 80 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | TO-3 | 6-143,134 |
| 2N6059 | 2N6052 | 100 | 750/18K | 6.0 | 2.0 | 6.0 | 4.0 | 150 | TO-3 | 6-143,134 |
| **$I_C$ = 15 A Max Continuous** | | | | | | | | | | |
| 2N6576 | | 60 | 2K/20K | 4.0 | 4.0 | 15 | 10 | 120 | TO-3 | 6-186 |
| 2N6577 | | 90 | 2K/20K | 4.0 | 4.0 | 15 | 10 | 120 | TO-3 | 6-186 |
| **$I_C$ = 20 A Max Continuous** | | | | | | | | | | |
| 2N6282 | 2N6285 | 60 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | TO-3 | 6-161,164 |
| 2N6283 | 2N6286 | 80 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | TO-3 | 6-161,164 |
| 2N6284 | 2N6287 | 100 | 750/18K | 10 | 2.0 | 10 | 4.0 | 160 | TO-3 | 6-161,164 |

# INDUSTRY CROSS REFERENCE

| Industry Type Number | Fairchild Nearest Standard |
|---|---|
| 2N2987 | 2N5335 |
| 2N2988 | 2N5681 |
| 2N2989 | 2N5681 |
| 2N2990 | 2N5681 |
| 2N3016 | 2N5337 |
| 2N3021 | 2N4901 |
| 2N3023 | 2N4902 |
| 2N3024 | 2N4904 |
| 2N3026 | 2N4905 |
| 2N3054 | 2N3054 |
| 2N3055 | 2N3055 |
| 2N3171 | 2N3789 |
| 2N3172 | 2N3789 |
| 2N3173 | 2N3790 |
| 2N3174 | 2N3790 |
| 2N3183 | 2N3789 |
| 2N3184 | 2N3789 |
| 2N3185 | 2N3790 |
| 2N3186 | 2N3790 |
| 2N3195 | 2N3789 |
| 2N3196 | 2N3789 |
| 2N3197 | 2N3790 |
| 2N3198 | 2N3790 |
| 2N3202 | 2N4234 |
| 2N3203 | 2N4235 |
| 2N3204 | 2N4236 |
| 2N3208 | 2N4234 |
| 2N3226 | 2N4913/ 2N3717 |
| 2N3232 | 2N5877 |
| 2N3235 | 2N3055 |
| 2N3237 | 2N5302 |
| 2N3238 | 2N5882 |
| 2N3239 | 2N5882 |
| 2N3240 | 2N5631 |
| 2N3418 | 2N5334 |
| 2N3419 | 2N5335 |
| 2N3420 | 2N3536 |
| 2N3421 | 2N5336 |
| 2N3439 | 2N3439 |
| 2N3440 | 2N3440 |
| 2N3442 | 2N5631 |
| 2N3445 | 2N5877 |
| 2N3446 | 2N5878 |
| 2N3447 | 2N5877 |
| 2N3448 | 2N5878 |
| 2N3469 | 2N5337 |
| 2N3506 | 2N5337 |
| 2N3507 | 2N5336 |
| 2N3583 | SE9331 |
| 2N3589 | SE9331 |
| 2N3634 | FT5415 |
| 2N3636 | FT5416 |
| 2N3660 | 2N4234 |
| 2N3661 | 2N4235 |
| 2N3675 | 2N4238 |
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| 2N3879 | 2N5874 |
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| 2N5157 | FT423 |
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| 2N5338 | 2N5338 |
| 2N5339 | 2N5339 |
| 2N5415 | 2N5415 |

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| Industry Type Number | Fairchild Nearest Standard | Industry Type Number | Fairchild Nearest Standard | Industry Type Number | Fairchild Nearest Standard | Industry Type Number | Fairchild Nearest Standard |
|---|---|---|---|---|---|---|---|
| 2N5416 | 2N5416 | 2N5839 | 2N5839 | 2N6053 | 2N6053 | 2N6289 | 2N6129 |
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| 2N5491 | 2N6121 | 2N5867 | 2N4905 | 2N6055 | 2N6055 | 2N6291 | 2N6130 |
| 2N5492 | 2N6130 | 2N5868 | 2N4906 | 2N6056 | 2N6056 | 2N6292 | 2N6131 |
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| 2N5495 | 2N6121 | 2N5871 | 2N5871 | 2N6059 | 2N6059 | 2N6301 | SE9304 |
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| 2N5498 | 2N5498 | 2N5874 | 2N5874 | 2N6106 | 2N6134 | 2N6307 | 2N6307 |
| 2N5622 | 2N5881 | 2N5875 | 2N5875 | 2N6107 | 2N6134 | 2N6308 | 2N6308 |
| 2N5623 | 2N5880 | 2N5876 | 2N5876 | 2N6108 | 2N6133 | 2N6309 | TIP30A |
| 2N5624 | 2N5878 | 2N5877 | 2N5877 | 2N6109 | 2N6133 | 2N6315 | 2N5873 |
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| 2N5629 | 2N5629 | 2N5880 | 2N5880 | 2N6121 | 2N6121 | 2N6318 | 2N5872 |
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| 2N5656 | FT48 | 2N5971 | 2N5302 | 2N6131 | 2N6131 | 2N6384 | 2N6384 |
| 2N5657 | FT49 | 2N5972 | 2N5302 | 2N6132 | 2N6132 | 2N6385 | 2N6385 |
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| 2N5671 | MJ802 | 2N5975 | TIP32A | 2N6175 | FT47 | 2N6388 | 2N6388 |
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| 2N5683 | 2N5683 | 2N5981 | 2N6133 | 2N6234 | 2N6234 | 2N6415 | BD225 |
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| 2N5737 | 2N5875/ 2N5879 | 2N5987 | FT2955 | 2N6251 | 2N6251 | 2N6486 | 2N6486 |
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| 2N5745 | 2N5884 | 2N6040 | SE9400 | 2N6260 | 2N4231 | 2N6496 | 2N5630 |
| 2N5781 | 2N4236 | 2N6041 | SE9401 | 2N6261 | 2N3767/ 2N4233 | 2N6542 | FT411 |
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| 2N5805 | FT411 | 2N6051 | 2N6051 | 2N6287 | 2N6287 | 40250 | 2N4913 |
| 2N5838 | 2N5838 | 2N6052 | 2N6052 | 2N6288 | 2N6129 | 40251 | 2N6569 |

# INDUSTRY CROSS REFERENCE

| Industry Type Number | Fairchild Nearest Standard | Industry Type Number | Fairchild Nearest Standard | Industry Type Number | Fairchild Nearest Standard | Industry Type Number | Fairchild Nearest Standard |
|---|---|---|---|---|---|---|---|
| 40309 | 2N5321 | 40885 | FT47 | BD205 | 2N6569 | BD700 | SE9401 |
| 40310 | 2N3054 | 40886 | FT48 | BD207 | FT3055 | BD700A | SE9401 |
| 40311 | 2N5321 | 40887 | FT49 | BD208 | FT2955 | BDX10 | 2N3055 |
| 40312 | 2N3054 | 40910 | 2N4231 | BD213/60 | FT3055 | BDX11 | 2N5631 |
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| 40317 | 2N5321 | 41503 | 2N4234 | BD236 | TIP30A | BDX50 | 2N5631 |
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| 40321 | 2N3440 | 43104 | 2N5631 | BD261 | FT411 | BDX70 | FT3055 |
| 40322 | SE9331 | BD111A | 2N3715 | BD283 | BD221 | BDX71 | FT3055 |
| 40323 | 2N5321 | BD117 | 2N3713 | BD284 | BD224 | BU100A | 2N5629 |
| 40324 | 2N3054 | BD124 | 2N3054 | BD285 | 2N6121 | BU102 | 2N5631 |
| 40325 | 2N6569 | BD127 | FT48 | BD286 | 2N6124 | BU120 | 2N6249 |
| 40326 | 2N5321 | BD128 | FT49 | BD311 | 2N5881 | BU125 | 2N4895 |
| 40327 | 2N3440 | BD129 | FT50 | BD312 | 2N5879 | BU127 | 2N5630 |
| 40328 | SE9331 | BD135 | TIP29 | BD313 | 2N5882 | BU128 | 2N6249 |
| 40346 | 2N3440 | BD136 | TIP30 | BD314 | 2N5880 | BUY24 | 2N5068 |
| 40347 | 2N5321 | BD137 | TIP29A | BD315 | 2N5882 | BUY38 | 2N3054 |
| 40348 | 2N4238 | BD138 | TIP30A | BD316 | 2N5880 | BUY46 | 2N3054 |
| 40360 | 2N5320 | BD139 | TIP29B | BD317 | 2N5629 | BUY68 | 2N4895/96 |
| 40361 | 2N5320 | BD140 | TIP30B | BD318 | 2N6020 | B133000 | BD221 |
| 40362 | 2N5322 | BD141 | 2N5631 | BD361 | TIP29 | B133001 | BD221 |
| 40363 | 2N3055 | BD142 | 2N6569 | BD361A | TIP29 | B133002 | BD221 |
| 40366 | 2N5320 | BD157 | FT47 | BD362 | TIP30 | B133003 | 2N6122 |
| 40367 | 2N4238 | BD158 | FT48 | BD362A | TIP30 | B133004 | 2N6122 |
| 40369 | 2N5873 | BD159 | FT49 | BD561 | 2N2161 | B133005 | 2N6122 |
| 40372 | 2N3054 | BD163 | 2N5054 | BD562 | 2N2164 | B133006 | 2N6123 |
| 40375 | 2N5873 | BD165 | TIP29 | BD575 | TIP29 | B133007 | 2N6123 |
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| 40390 | 2N3440 | BD167 | TIP29A | BD577 | TIP29A | B170000 | 2N6569 |
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| 40394 | 2N5323 | BD169 | TIP29B | BD579 | TIP29B | B170002 | 2N6569 |
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| 40412 | 2N3440 | BD175 | 2N6121 | BD585 | 2N6121 | B170004 | 2N5882 |
| 40594 | 2N5338 | BD176 | 2N6124 | BD586 | 2N6124 | B170005 | 2N5882 |
| 40613 | TIP29 | BD177 | TIP29A | BD587 | 2N6122 | B170006 | 2N5629 |
| 40618 | BD221 | BD178 | TIP30A | BD588 | 2N6125 | B170007 | 2N5629 |
| 40621 | BD221 | BD179 | TIP29B | BD589 | 2N6123 | B170008 | 2N5629 |
| 40622 | BD221 | BD180 | TIP30B | BD590 | 2N6126 | B170009 | 2N6569 |
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| 40632 | 2N6131 | BD195 | 2N6129 | BD607 | FT3055 | B170016 | 2N5629 |
| 40636 | 2N5630 | BD196 | 2N6132 | BD608 | FT2955 | B170017 | 2N5629 |
| 40850 | FT401 | BD197 | 2N6129 | BD697 | SE9300 | B170018 | 2N6569 |
| 40851 | 2N6251 | BD198 | 2N6132 | BD697A | SE9300 | B170019 | 2N6569 |
| 40852 | 2N6251 | BD199 | 2N6130 | BD699 | SE9301 | B170020 | 2N6569 |
| 40853 | FT430 | BD200 | 2N6133 | BD699A | SE9301 | B170021 | 2N5882 |

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| Industry Type Number | Fairchild Nearest Standard |
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| B170022 | 2N5882 |
| B170023 | 2N5882 |
| B170024 | 2N5629 |
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| B176006 | FT423 |
| B176007 | FT423 |
| B176024 | FT423 |
| B176025 | FT423 |
| DTS401 | FT401 |
| DTS402 | FT402 |
| DTS403 | FT402 |
| DTS409 | FT402 |
| DTS410 | FT410 |
| DTS411 | FT411 |
| DTS413 | FT413 |
| DTS423 | FT423 |
| DTS424 | 2N6251 |
| DTS430 | FT430 |
| DTS431 | FT431 |
| DTS515 | 2N6250 |
| DTS516 | 2N6250 |
| DTS517 | 2N6250 |
| DTS519 | FT430 |
| DTS1010 | SE9304 |
| DTS1020 | SE9304 |
| DTS4010 | FT430 |
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| D45H12 | 2N6134 |
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| MJE30 | TIP30 |
| MJE30A | TIP30A |
| MJE30B/C | TIP30B/C |
| MJE31 | TIP31 |
| MJE31A | TIP31A |
| MJE31B/C | TIP31B/C |
| MJE32 | TIP32 |
| MJE32A | TIP32A |
| MJE32B/C | TIP32B/C |
| MJE105 | TIP32A |
| MJE105K | TIP32A |
| MJE170 | TIP30 |
| MJE171 | TIP30A |
| MJE172 | TIP30B |
| MJE180 | TIP29 |
| MJE181 | TIP29A |
| MJE182 | TIP29B |
| MJE200 | TIP31 |
| MJE205 | TIP31A |
| MJE205K | TIP31A |
| MJE210 | TIP32 |
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| MJE221 | BD221 |
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| MJE340 | FT48 |
| MJE340K | FT48 |
| MJE344 | FT47 |
| MJE344K | FT47 |
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| MJE2050 | 2N6121 |
| MJE2150 | TIP32 |
| MJE2360 | FT49 |
| MJE2361 | FT49 |
| MJE2370 | TIP30 |
| MJE2480 | BD221 |
| MJE2481 | BD222 |
| MJE2482 | BD221 |
| MJE2483 | BD222 |
| MJE2490 | BD224 |
| MJE2491 | BD225 |
| MJE2520 | TIP29 |
| MJE2801 | FT3055 |
| MJE2801K | FT3055 |
| MJE2901 | FT2955 |
| MJE2901K | FT2955 |
| MJE2955 | FT2955 |
| MJE2955K | FT2955 |
| MJE3055 | FT3055 |
| MJE3055F | MJE3055F |
| MJE3055K | FT3055 |
| MJE3370 | TIP30 |
| MJE3371 | BD224 |
| MJE3439 | FT49 |
| MJE3440 | FT47 |
| MJE3520 | TIP29 |
| MJE3521 | BD221 |
| MJE3738 | FT43 |
| MJE3839 | FT48 |
| MJE4918 | TIP30 |
| MJE4919 | TIP30A |
| MJE4920 | TIP30B |
| MJE4921 | TIP29 |
| MJE4922 | TIP29A |
| MJE4923 | TIP29B |
| MJE5190 | BD221 |
| MJE5191 | BD222/ 2N6122 |
| MJE5192 | 2N6123 |
| MJE5193 | BD224 |
| MJE5194 | BD225/ 2N6125 |
| MJE5195 | 2N6126 |
| MJE5655 | FT47 |
| MJE5656 | FT48 |
| MJE5657 | FT49 |
| MJE5974 | TIP32 |
| MJE5975 | TIP32A |
| MJE5976 | TIP32B |
| MJE5977 | TIP31 |
| MJE5978 | TIP31A |
| MJE5979 | TIP31B |
| MJE5980 | 2N6132 |
| MJE5981 | 2N6133 |
| MJE5982 | 2N6134 |
| MJE5983 | 2N6129 |
| MJE5984 | 2N6130 |
| MJE5985 | 2N6131 |
| MJE6040 | SE9300 |
| MJE6041 | SE9301 |
| MJE6042 | SE9302 |
| MJE6043 | SE9300 |
| MJE6044 | SE9301 |
| MJE6045 | SE9302 |
| MJ400 | 2N5338 |
| MJ410 | FT410 |
| MJ411 | FT411 |
| MJ413 | FT413 |
| MJ420 | 2N5059 |
| MJ421 | 2N3439 |
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| MJ424 | 2N6251 |
| MJ430 | FT430 |
| MJ431 | FT431 |
| MJ450 | 2N4398 |
| MJ480 | 2N5067 |
| MJ481 | 2N5068 |
| MJ490 | 2N4901 |
| MJ491 | 2N4902 |

# INDUSTRY CROSS REFERENCE

| Industry Type Number | Fairchild Nearest Standard | Industry Type Number | Fairchild Nearest Standard | Industry Type Number | Fairchild Nearest Standard | Industry Type Number | Fairchild Nearest Standard |
|---|---|---|---|---|---|---|---|
| MJ802 | MJ802 | RCA1A15 | 2N3440 | SDT3551 | 2N4236 | SDT9706 | 2N5630 |
| MJ900 | SE9403 | RCA1A16 | FT5416 | SDT3552 | 2N4234 | SDT9707 | 2N5887 |
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| MJ1000 | SE9303 | RCA1B01 | 2N5629 | SDT3554 | 2N4236 | SDT9802 | 2N3055 |
| MJ1001 | SE9304 | RCA1B04 | FT410 | SDT3575 | 2N4898 | SDT9803 | 2N5878 |
| MJ1800 | 2N6250 | RCA1B05 | 2N6250 | SDT3576 | 2N4899 | SDT9901 | 2N6569 |
| 2N2249 | 2N3766 | RCA1B06 | FT410 | SDT3577 | 2N4900 | SDT9902 | 2N3055 |
| 2N2250 | 2N3767 | RCA1B07 | SE9305 | SDT3578 | 2N4898 | SDT9903 | 2N5878 |
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| MJ2254 | 2N3767 | RCA1C06 | 2N6130 | SDT3750 | 2N4904 | TIP29A | TIP29A |
| MJ2268 | 2N5879 | RCA1C07 | 2N6131 | SDT3751 | 2N4905 | TIP29B/C | TIP29B/C |
| MJ2500 | SE9403 | RCA1C08 | 2N6134 | SDT3752 | 2N4901 | TIP30 | TIP30 |
| MJ2801 | 2N6569 | RCA1C09 | FT3055 | SDT3753 | 2N4902 | TIP30A | TIP30A |
| MJ2840 | 2N5881 | RCA1C10 | 2N6129 | SDT3754 | 2N4903 | TIP30B/C | TIP30B/C |
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| MJ2940 | 2N5879 | RCA29 | TIP29 | SDT3758 | 2N4905 | TIP31B/C | TIP31B/C |
| MJ2941 | 2N5880 | RCA29A | TIP29A | SDT3759 | 2N4906 | TIP32 | TIP32 |
| MJ2955 | FT2955 | RCA29B/C | TIP29B/C | SDT3761 | 2N4904 | TIP32A | TIP32A |
| MJ3000 | SE9303 | RCA30 | TIP30 | SDT3762 | 2N4904 | TIP32B/C | TIP32B/C |
| MJ3001 | SE9304 | RCA30A | TIP30A | SDT3763 | 2N4905 | TIP33A | 2N3715 |
| MJ3026 | 2N5839 | RCA30B/C | TIP30B/C | SDT3764 | 2N4906 | TIP33B | 2N3716 |
| MJ3027 | FT401 | RCA31 | TIP31 | SDT3766 | 2N4904 | TIP33C | 2N5629 |
| MJ3028 | FT402 | RCA31A | TIP31A | SDT3826 | 2N5880 | TIP34A | 2N3791 |
| MJ3029 | FT411 | RCA31B/C | TIP31B/C | SDT3875 | 2N4398 | TIP34B | 2N3792 |
| MJ3030 | FT413 | RCA32 | TIP32 | SDT3876 | 2N5884 | TIP34C | 2N6020 |
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| MJ3202 | SE9331 | RCA32B/C | TIP32B/C | SDT4301 | 2N4237 | TIP35A | 2N5302 |
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| MJ4052 | MJ4502 | RCA120 | TIP120 | SDT4308 | 2N5334 | TIP41B/C | TIP41B/C |
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| MJ6257 | 2N3771 | RCA423 | FT423 | SDT7734 | 2N5629 | TIP49 | FT49 |
| MJ6302 | 2N5631 | RCA431 | FT431 | SDT9201 | 2N6569 | TIP50 | FT50 |
| MJ7160 | FT430 | RCA1000 | SE9303 | SDT9202 | 2N5882 | TIP51 | 2N5838 |
| MJ8100 | 2N4895 | RCA1001 | SE9304 | SDT9203 | 2N5629 | TIP52 | FT401 |
| MJ8101 | 2N4897 | RCA3054 | BD225 | SDT9204 | 2N5630 | TIP53 | 2N5840 |
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| RCA1A02 | 2N5322 | RCA8203A | SE9400 | SDT9206 | 2N3055 | TIP61A | TIP61A |
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| RCA1A05 | 2N5322 | SDT1050 | FT410 | SDT9208 | 2N5629 | TIP61C | TIP61C |
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| RCA1A07 | 2N5321 | SDT1055 | 2N5838 | SDT9701 | 2N5303 | TIP62A | TIP62A |
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| RCA1A09 | 2N3439 | SDT1060 | 2N5838 | SDT9703 | 2N5630 | TIP62C | TIP62C |
| RCA1A10 | FT5416 | SDT1061 | FT431 | SDT9704 | 2N5886 | TIP110 | TIP110 |
| RCA1A11 | 2N3439 | SDT3550 | 2N4235 | SDT9705 | 2N5629 | TIP111 | TIP111 |

# INDUSTRY CROSS REFERENCE

| Industry Type Number | Fairchild Nearest Standard | Industry Type Number | Fairchild Nearest Standard | Industry Type Number | Fairchild Nearest Standard | Industry Type Number | Fairchild Nearest Standard |
|---|---|---|---|---|---|---|---|
| TIP112 | TIP112 | TIP121 | TIP121 | TIP140 | SE9300 | TIP147 | SE9402 |
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| | | | | | | TIP2955 | FT2955 |
| | | | | | | TIP3055 | FT3055 |

# CHAPTER 1

- Structures
- Geometries
- *Design Consideration*
- Conclusion

# Chapter 1
# POWER TRANSISTOR TECHNOLOGY

Advances in power transistor design are continuously providing higher power output, improved efficiency and better frequency response. Power transistors can handle currents in excess of 100 A, voltages up to 3000 V, large power dissipation, and drastic current and voltage surges. In addition, they exhibit several phenomena which are of little importance in small signal transistors—conductivity modulation, base widening, emitter current crowding, second breakdown, high voltage surface effects and thermal fatigue.

Power transistor fabrication methods vary. Small-signal transistors and integrated circuits are generally constructed using many steps of rather shallow diffusions into an epitaxial layer supported by a low resistivity substrate. Power transistors are manufactured using at least six basically different technologies—double-diffused epitaxial Planar*, triple-diffused Planar, single epitaxial-base mesa, multiple epitaxial-base mesa, multiple-epitaxial double-diffused mesa and single diffused (hometaxial). Each structure eliminates one or more of the phenomena mentioned above and differs significantly from the others in characteristics and performance. The structure and geometry of each technique have an important impact on deciding which power transistor will give the optimum performance in a particular application. Fairchild uses four of these processing technologies—double-diffused epitaxial Planar, single epitaxial-base mesa, multiple epitaxial-base mesa and multiple-epitaxial double-diffused mesa—to provide highly reliable low-cost power transistors with maximum performance capabilities.

## STRUCTURES *(Figure 1-1)*
### Double-Diffused Epitaxial Planar

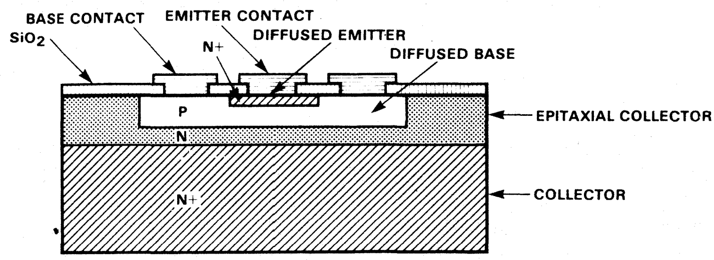
These power transistors, made by the same process used for small-signal transistors, are characterized by shallow diffusions into an epitaxial layer. The junctions are normally passivated with silicon dioxide to ensure low leakage currents and optimum stability. This is the most common form of Planar power transistor and both npn and pnp types can easily be made. The devices typically have very low leakage, high gain, low saturation voltage and high gain-bandwidth product. Typical values for the latter range from 20 to 200 MHz. Double-diffused epitaxial Planar transistors are primarily used in high frequency, high reliability switching and amplifying applications with $f_T$ ratings greater than 30 MHz and maximum collector current ratings up to 10 A.

These transistors have a relatively poor safe operating area because of the narrow base region and the depletion of the entire voltage into the collector region. Maximum die yield depends on expert photoresist techniques for diffusing impurities through an opening etched in the surface oxide. The oxide-masked and phosphorous-passivated Planar structures allow lower leakage than mesa junction devices. The structure is limited to approximately 400 V breakdown voltage. This is a result of uncontrolled surface charge introduced into the high field region associated with the finite radius of curvature of the impurity diffusion front. This results in premature breakdown. The use of metallic overlay (junction field plate) and resistive films is employed to combat these effects.

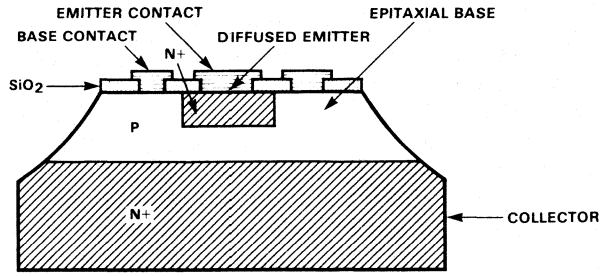
### Single Epitaxial-Base Mesa

These transistors are manufactured by diffusing an emitter into an epitaxial base region deposited on the collector substrate. The collector voltage depletes into the base region. The device is fairly rugged with reasonable gain and medium $f_T$. The safe operating area capability is between Planar triple diffused and single diffused mesa. Epitaxial base devices gain ruggedness as a result of the wide and homogeneous base region. Both npn and pnp-type transistors can be made by this process. Performance is somewhat limited by low voltage ratings imposed by the abrupt base-collector junction formed between the heavily doped collector substrate and the epitaxially deposited base layer, and by the thickness of this layer.

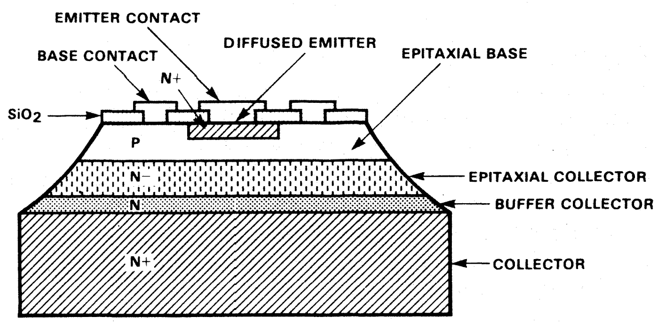
*Planar is a patented Fairchild process.



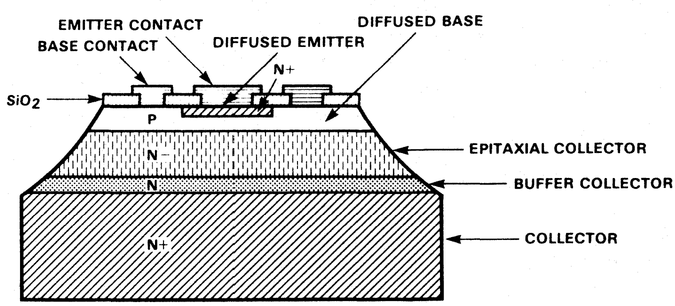

**Double-Diffused Epitaxial Planar**




**Single Epitaxial-Base Mesa**




**Multiple Epitaxial-Base Mesa**




**Multiple-Epitaxial Double-Diffused Base Mesa**

**Fig. 1-1 Basic Power Transistor Structures**

### Multiple Epitaxial-Base Mesa

This process uses two epitaxial layers to form the collector and base regions, a mesa etch to define the collector-base junction, and Planar processing to form the emitter-base junction. This produces low-cost, high-current devices with excellent safe-area capabilities. Epitaxial-base transistors gain ruggedness as the result of the wide homogeneous base region. When compared to conventional single-diffused devices, epitaxial-base mesa transistors exhibit higher working voltage capabilities, lower saturation voltages, and lower leakage currents. Beta linearity is also improved and npn and pnp complementary devices are readily produced. Maximum current ratings extend to 50 A and $f_T$ ratings to 15 MHz.

### Multiple-Epitaxial Double-Diffused Base Mesa

This structure is identical to the double-diffused epitaxial except that multiple-epitaxial layers are used in the collector region and the collector-base junction is formed by a mesa etch. A low resistivity thin layer is epitaxially grown between the highly doped substrate and the low-epitaxial collector region. The advantages of the multiple-epitaxial double-diffused structure are high speed ($f_T$ = 50 MHz), low saturation voltage and increased $E_{SB}$ capability due to the epitaxial intermediate collector.

## GEOMETRIES

The transistor geometry, in conjunction with its structure, establishes most of the fundamental electrical, thermal, and economic properties. Proper geometric design of a transistor provides for many compromises that can result in a variety of advantages and disadvantages from different structures.

The basic objective for most power-transistor geometry designs is to obtain the highest current handling per unit area of die. This results in lower cost designs or, as in high-frequency transistors, higher speed as a result of the smaller device areas.

Power-transistor geometries have evolved from the very early inefficient line-geometry configurations to the present-day sophisticated discrete-emitter concepts (*Figure 1-2*). Current crowding, which causes high current density, is the greatest contributor to reductions in current gain. Emitter periphery is the crucial design factor in minimizing this problem, therefore, emitter geometry is designed for high periphery-to-area ratio. The device structure dictates, to some extent, how much periphery can be made.

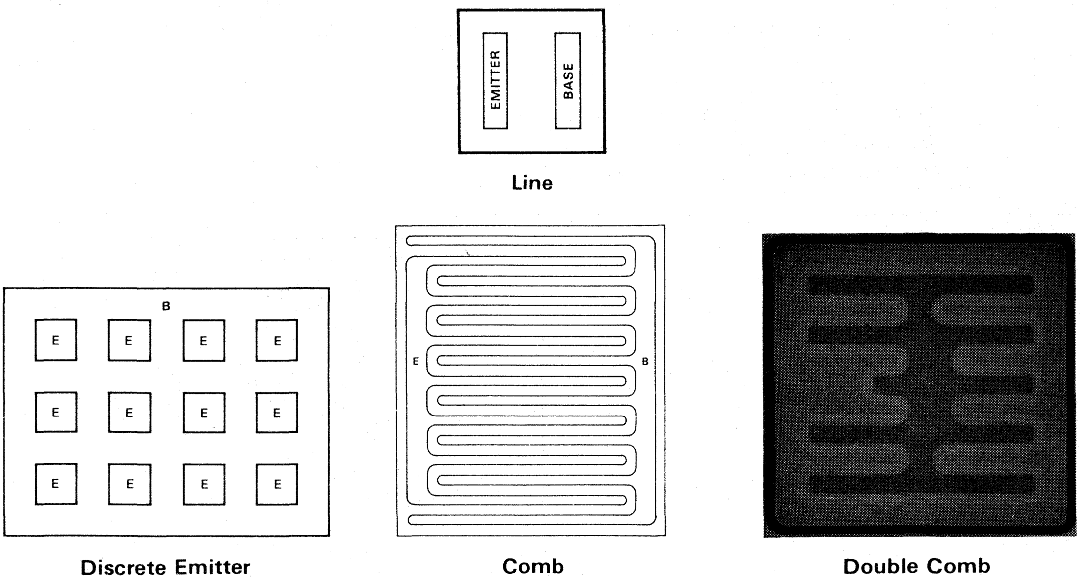



Fig. 1-2. Emitter Geometries

## DESIGN CONSIDERATIONS

Power transistors, manufactured by the methods outlined above, differ in gain characteristic, frequency response, power capability and cost. Therefore, the selection of the best power transistor for any particular application amounts to a trade off among many crucial design parameters. Design considerations for power transistors are generally more complex than for small signal devices. Some generally accepted simplifications in the transistor theory are no longer valid under conditions of high voltage or high current. However, the knowledgeable device engineer can optimize the performance of a power transistor for its intended application. The design parameters may be divided into four classes—electrical, thermal, mechanical and cost.

### Electrical

The electrical parameters of a power transistor are not only of importance for device performance as a switch or amplifier, but they also determine the reliability and durability of the device under various operating conditions.

*Saturation*

Saturation, mainly caused by collector-layer resistance, is present in all transistors but is more pronounced for high-voltage devices due to inherently higher collector resistivity (*Figure 1-3*). Low saturation voltage means low power loss for a given collector current ($P = V_{CE(sat)} \times I_C$). Low saturation voltage can be achieved by

- an epitaxial collector,
- decreased collector thickness,
- decreased collector resistivity,
- interdigitated design,
- large chip size.

*Quasi Saturation*

Quasi saturation, only apparent in high-voltage transistors, is evidenced by the slope of the collector current vs collector voltage (*Figure 1-3*). This effect is caused by a distortion of the collector-base density, where the density of the minority carriers approaches that of the fixed charges in the semiconductor. This leads to reduced gain due to base widening (*Figure 1-4*). The effects of quasi saturation can be minimized by

- measuring gain at higher voltages,
- decreasing collector resistivity,
- decreasing collector thickness.

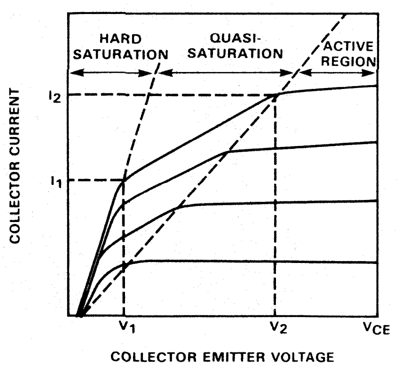



**Fig. 1-3. Quasi-Saturation Region**

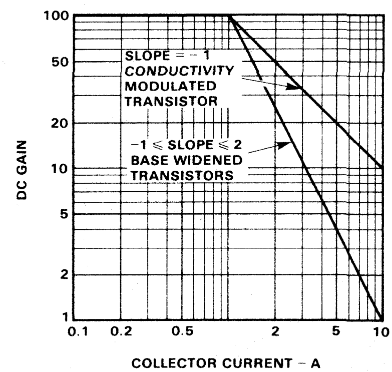



**Fig. 1-4. Gain Fall**

*High Current Gain*
High current gain is reduced by conductivity modulation and current crowding. Conductivity modulation occurs mainly in wide, high-resistivity-base transistors. It is caused by high level injection of mobile carriers in the base, thus temporarily decreasing the effective resistivity of the base and, therefore, the emitter efficiency, giving lower current gain at higher current. The negative effect of conductivity modulation on high current gain can be reduced by

- decreasing base resistivity,
- decreasing base width.

Current crowding is caused by two types of resistive debiasing. One is due to the lateral voltage drop in the base region beneath the emitter. This causes a higher base potential along the edge of the emitter and, consequently, a higher emitter current density along the emitter periphery. Since most transistors have relatively thin base structures of high resistivity, the current concentration continues through the collector-base junction and through most of the collector. Thus the effective area of the transistor is reduced and the high current gain drops off. The lateral debiasing effect can be minimized by

- reducing base resistivity beneath the emitter,
- increasing base width,
- interdigitated emitter with low width/length ratio.

Resistive debiasing along the metalization over the emitter fingers is another limiting factor on high current gain. The emitter current causes a longitudinal voltage drop in the metalization, which decreases the emitter-base voltage as the distance from the emitter bond increases. The resulting longitudinal current crowding in the vicinity of the emitter bond also reduces the effective area of the transistor. The voltage drop in the metalization can be reduced by

- lower resistivity metalization (aluminum),
- thicker metalization,
- emitter fingers with high width/length ratio.

It is evident from this discussion that the required width/length ratio of the emitter fingers to minimize both sources of current crowding are in conflict. Aside from its ill effect on current gain, current crowding is also one major cause for overheating and possible destruction. To achieve high current capability, the emitter must have a large area, be highly efficient, and inject uniformly. The interdigitated structure with many long thin fingers and aluminum metalization meets these requirements.

*Non-Linear Gain*
Non-linear gain in the active region is caused by the Early effects (*Figure 1-3*), *i.e.*, the gain increases with higher collector voltages. The cause of this phenomenon is the expansion of the depletion region into the base and, consequently, the narrowing of the neutral base width.

*High-Voltage Surface Effects*
Mesa power transistors can be made with high breakdown voltages because collector-base junctions are not seriously affected by radius effects and field-induced distortions. Leakage is highly dependent on the proper preparation of the exposed junction in the mesa groove prior to varnish passivation in the package. Any surface contamination in the mesa obviously increases the leakage current of the device.

In Planar* devices, both junctions are covered with silicon dioxide to eliminate the problems of outside contamination. Therefore, they have very low leakage currents. The breakdown voltage, however, can be limited by distortions of the depletion region from radius effects and fields induced by static charges in the oxide. Since the diffusion of the impurities in the silicon occurs laterally as well as vertically, the ra-

*Planar is a patented Fairchild process.

dius of the junction edge is equal to the depth of the diffusion. This dimension is in the order of microns, thus the electric-field strength at the curved edge of the junction is considerably increased for any given voltage. This leads to premature breakdown for curved junctions compared to plane junctions.

The presence of fixed and mobile charges in the oxide, or at the silicon-oxide interface, can induce considerable changes in the density of mobile carriers in the silicon close to the surface. Since positive charges usually dominate in the oxide, the charges tend to enhance the electron concentration in n-type silicon and to reduce the hole concentration in p-type silicon. As a consequence, the depletion region close to the surface is reduced in width on the n-side of a junction (lower breakdown voltage). Conversely, the depletion region close to the surface may be increased in width through a field-induced channel on the p-side of a junction (higher leakage through channel). In most cases these effects are only of importance for the collector-base junction, which requires higher breakdown voltage. The collector-base breakdown voltage can be increased by

- using a field plate, or
- using a voltage ring.

**Thermal**

Thermal design must combat thermal instability and second breakdown. Thermal instability is caused by unintentional temperature difference between various emitter locations. Current density is strongly dependent upon the temperature of the emitter-base junction. If current density is higher in some particular part of the structure, due to a defect of some sort such as a hot spot in the base layer, local temperature rise then occurs. At constant forward bias across the emitter junction, an approximately 10% increase in current occurs for every 1 °C increase in temperature. Thus, the local temperature rise further increases the local current and a positive feedback situation occurs. If the gain around this feedback loop is greater than one, *i.e.*, if temperature rise produces a larger increase in current than that which originally caused the temperature rise, an unstable situation exists. Current and temperature build up locally and destroy the device. Thermal instability can be minimized by

- thinner transistor chips to allow heat in the device to be more efficiently dissipated by a heat sink,
- increased base width and decreased emitter-finger width to provide more uniform current distribution,
- increased base doping which also improves current distribution,
- a number of separate discrete emitters each with a ballasting resistor placed in series. These resistors insert a voltage drop in each emitter proportional to the current passing through the emitter, inserting current feed-back and equalizing current among the emitters.

Thermal instability can cause a serious reliability problem in power transistors, namely second breakdown. Second breakdown occurs when a bipolar transistor is operated at high power density and the emitter-collector voltage suddenly drops to a low value. Unless power is removed, overheating either destroys or materially degrades the transistor. Second breakdown (SB) is a thermal hot-spot phenomenon within the transistor die with two stages of development. The first is constriction where, because of thermal regeneration, current tends to concentrate in a small area. The second stage, destruction, occurs when local temperatures and temperature gradients increase until they cause permanent device damage.

The constriction can start any number of ways. One section of the emitter-base junction need only have a higher temperature than another. Such a hot spot might be caused by resistive debiasing, divergent heat flow to the device heat sink, an inhomogeneity in the thermal part, or other irregularities or imperfections within the device. Once a slightly hotter emitter-base region is present, positive thermal feedback begins; the hot region injects more and therefore gets hotter and the device goes into second breakdown. Forward biased second-breakdown current $I_{SB}$ can be controlled by either emitter or base ballasting, which effectively equalizes drive conditions within the device and maintains uniformity. Ballasting against reverse-biased second breakdown $E_{SB}$ can be achieved by the addition of a resistive layer in the collector which decreases the collector-emitter voltage in the affected region.

**Mechanical**

Power transistors are subjected to a large number of temperature changes during fabrication, screening and storage. Also, they are often used in applications where cycling the power causes repeated temperature cycling. Because transistors are constructed of materials that have different thermal coefficients of expansion, stress can be induced in the chip. Stress is a function of the difference between coefficients of expansion, the change in temperature, the respective moduli of elasticity, and the thickness. Power transistors, therefore, are made with materials having close thermal coefficients of expansion to minimize stress. Power transistors, however, require that the heat generated during operation be conducted away from the die. Material used for this heat conduction generally has a much higher coefficient of expansion than semiconductor material, especially silicon. Several techniques are used to minimize thermal fatigue. One method is to mount the chip on a metal such as molybdenum, which has a thermal coefficient of expansion similar to silicon, and braze it on a metal such as copper with very high thermal conductivity. The rate of degradation of the metallurgical bond under stress is also proportional to the average and peak temperature excursions of the bond. The most economical way to obtain reliability in a power transistor, therefore, is to reduce the temperature by careful consideration of heat flow during equipment design.

**Cost Reduction**

The cost of silicon power transistors is often a factor in the manufacturing method chosen. For large area devices (200 x 200 mil), cost is principally in the dice. Package cost, assembling and testing are secondary, therefore, cost reduction must be made in the wafer fabrication area. Early silicon wafers were small, only one inch in diameter, thus costs were high since each wafer undergoes the same number of processing steps regardless of size. It was obvious that increased wafer diameter would reduce cost, yields being equal. Now, most manufacturers have converted to 2-1/2- or 3-inch wafers to reduce processing cost per die. As an example, only 16 dice (200 x 200 mil) can be obtained from a 1-inch wafer while 145 dice can be obtained from a 3-inch wafer. The die cost is not reduced by this order of magnitude, however, since the raw-wafer cost is somewhat higher.

Lower die cost is often a reason for choosing a mesa approach if reliability is not the prime objective. The wafer fabrication process is shorter and the number of electrically good dice per wafer generally higher when using mesa technoloty instead of Planar. The Planar process can suffer from low yields as a result of pin holes in the passivating oxide, oxide islands left in the base cut, and accumulation of impurities along the oxide edges.

For military applications that require large transistors and high reliability, the cost of packaging, testing and processing far exceeds the cost of the dice. Even in a TO-5 package, the die cost often becomes an insignificant factor of the total transistor cost. Using a die size smaller than 80 x 80 mil and large wafers, it matters little which approach, mesa or Planar, is used as far as die cost is concerned.

## CONCLUSION

The transistor designer is faced with the problem of trying to optimize transistor parameters to attain performance as close to the ideal as possible; unfortunately, this is not easy. Since each specific parameter is related to the properties and geometry of the actual transistor structure, it is not possible to optimize without getting into conflicting requirements. This is best illustrated in *Table 1-1* and *1-2* which show the behavior of the basic electrical parameters when the transistor properties are changed. Furthermore, although the design theory may show that it is conceivable to obtain a near-ideal junction transistor, it may not be practical to fabricate such a device within the limitations of the transistor state-of-the-art.

Several basic processes exist today for making junction transistors, each yielding different impurity structures. For each type, however, certain electrical parameters must be sacrificed for the sake of others. Therefore, for some circuit applications, one process type may be more suitable than another.

| Physical Parameter | | Electrical Parameter | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $f_T$ | $t_d$, $t_r$ $t_f$, $t_s$ | $V_{CEO(sus)}$ | $V_{CE(sat)}$ | $V_{BE}$ | $h_{FE}$ (peak) | $I_{C(max)}$ | $I_{SB}$ | $E_{SB}$ |
| Base width | ↑ | ↓ | ↑ | ↑ | ↑ | ↑ | ↓ | ↓ | ↑ | ↑ |
| Base resistivity | ↑ | – | ↑ | – | ↓ | ↑ | ↑ | ↓ | ↓ | ↓ |
| Collector width | ↑ | ↓ | ↑ | ↑ | ↑ | ↑ | – | ↓ | – | ↑ |
| Collector resistivity | ↑ | ↓ | ↑ | ↑ | ↑ | ↑ | – | ↓ | ↓ | ↓ |
| Emitter width (finger) | ↑ | ↓ | ↑ | – | – | ↑ | – | ↓ | ↓ | ↓ |
| Emitter ballast | ↑ | ↑ | ↓ | – | ↑ | ↑ | – | ↑ | ↑ | – |
| Collector ballast | ↑ | ↓ | ↑ | – | ↑ | – | – | ↓ | – | ↑ |

**Table 1-1. Interrelation Among Physical and Electrical Parameters**

| Physical Parameter | | Electrical Parameter | | | | | |
|---|---|---|---|---|---|---|---|
| | | $f_T$ | $t_d$, $t_r$ $t_f$, $t_s$ | $V_{CE(sat)}$ | $h_{FE}$ (Peak) | $I_{C(max)}$ | Cost |
| $I_{SB}$ | ↑ | ↓ | ↑ | ↑ | ↓ | ↑ | ↑ |
| $E_{SB}$ | ↑ | ↓ | ↑ | ↑ | ↓ | ↓ | ↑ |
| $V_{CEO(sus)}$ | ↑ | ↓ | ↑ | ↑ | – | ↓ | ↑ |

**Table 1-2. Interrelation Among Electrical Parameters**

**Symbols for Tables 1 and 2**

$f_T$—current gain bandwidth
$t_d$—delay time
$t_r$—rise time
$t_f$—fall time
$t_s$—storage time
$I_{SB}$—forward second breakdown current
$h_{FE}$—dc current gain
$V_{CEO(sus)}$—collector to emitter voltage, base open
$V_{CE(sat)}$—collector to emitter saturation voltage
$I_C$—collector current (current handling)
$E_{SB}$—reverse second breakdown energy
↑ Increase
↓ Decrease

POWER

## CHAPTER 2

- DC Forward-Biased Safe Operating Area
- Pulsed SOA
- *Testing of Forward Biased SOA*
- Reverse-Biased Safe Operating Area

# Chapter 2
# SAFE OPERATING AREA

A number of factors such as second breakdown, dissipation capability, current and voltage ratings, and ambient temperature critically affect the performance of power transistors in circuit applications. These factors define the safe operating areas (SOA) for the forward-biased and reverse-biased modes, within which each device can be safely operated without failure or degradation. Most manufacturers publish SOA curves to provide the circuit designer with an easy method for specifying power transistors.

## DC FORWARD-BIASED SAFE OPERATING AREA

A transistor working in the active region is subjected to voltage and current at the same time and dissipates power. Figure 2-1 shows a typical safe operating area (SOA) for the active region. This is called forward-biased SOA since the base of the transistor is positive with respect to the emitter. Collector current $I_C$ is shown as a function of collector-to-emitter voltage $V_{CE}$. Each curve is labeled with the duration of the on pulse — from the worst-case dc condition to a minimum duration of 5 $\mu$s — at $T_C = 25°C$ and a 1% duty cycle. The four factors limiting the dc forward-biased SOA of a particular power transistor are the collector current (1), thermal limitations (2), second breakdown (3), and open base breakdown voltage, $V_{CEO(sus)}$ (4).

**IC - Limit** (1 on the SOA curve in Figure 2-1)

The $I_C$ is limited by the current handling capability of the bonding wires. For current pulses, the limit is higher than for dc since the thermal capacitance of the wire prevents instantaneous heating.

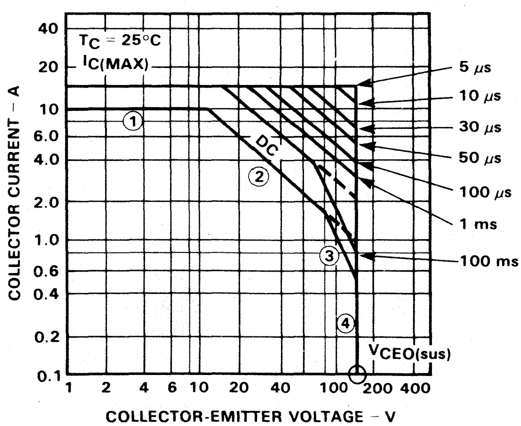



**Fig. 2-1. Typical Safe Area**

**Thermal Limit** (2 in Figure 2-1)
The maximum permissible power dissipation is determined by the maximum operating temperature of the transistor. In Figure 2-1, the case temperature $T_C$ is constant, normally 25°C; therefore the power limitation is

$$P_D = \frac{T_{J(max)} - 25°C}{\theta_{JC}}$$

where $T_{J(max)}$ is maximum junction temperature.
$\theta_{JC}$ is junction-to-case thermal resistance.

Maximum operating temperature and thermal resistance can be found in the data sheets. $T_{J(max)}$ is normally 150°C for plastic transistors, 200°C for hermetic (metal can) types. If power is applied in excess of this limit, the transistor is not necessarily destroyed, but the mounting system of the die or the plastic can deteriorate. For power pulses, the limit is higher than for dc especially for short pulses due again to thermal capacitance.

**$I_{SB}$ Limit** (3 in Figure 2-1)
At higher voltages, the SOA of the transistor is limited by its forward-biased second breakdown capability, $I_{SB}$. *In this mode, current crowding occurs at the emitter periphery.* The higher the operating voltage, the more the base is pinched and the sheet resistance increases. Accordingly, the $V_{BE}$ on the edges of the emitter is higher than in the middle because the base current is pushed under the emitter (Figure 2-2). Therefore emitter-current density increases on the emitter edges. This leads to localized heating, which in turn lowers the $V_{BE}$ characteristic causing more crowding. Localized thermal runaway (hotspot) may occur. The process of temperature build-up along the emitter periphery takes some time; therefore the SOA limits for pulses are higher than for dc.

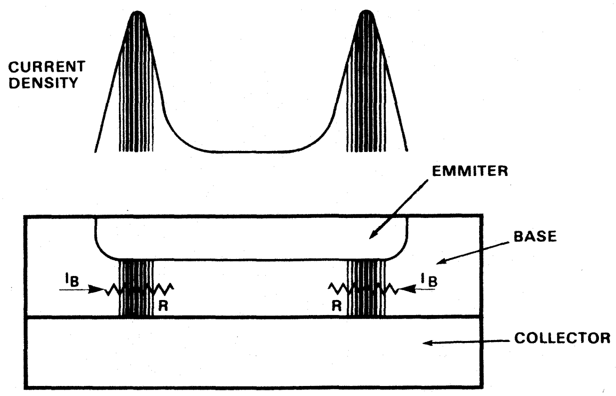



**Fig. 2-2. Current Crowding During Forward-Biased Operation**

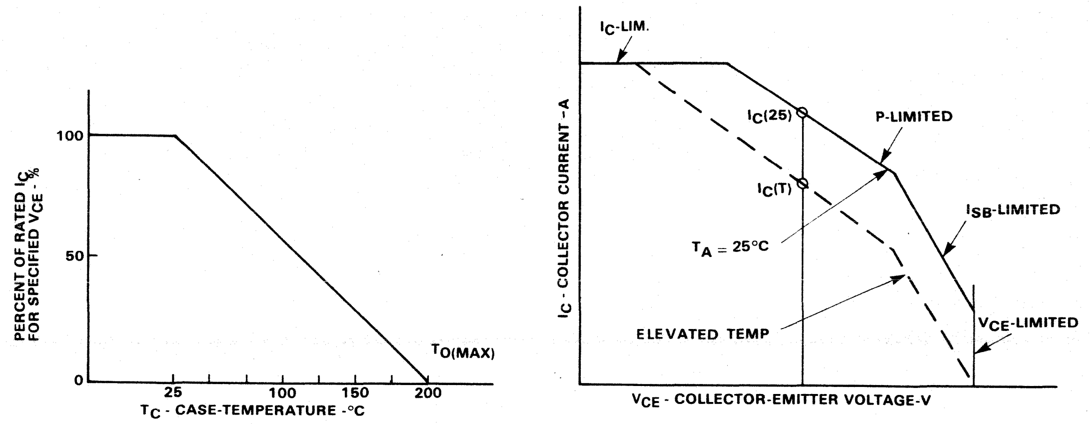



**Fig. 2-3. Linear Temperature Derating to 200°C**

**Voltage Limit** (4 in Figure 2-1)
The collector-emitter voltage $V_{CE}$ should never surpass the maximum limit; not even a very short pulse is permissable. If this should happen, the collector current, which is governed by the circuit rather than the transistor, is likely to rise to a high value. This may destroy the transistor.

**SOA at Elevated Temperature**
Figure 2-1 shows the SOA for room temperature, i.e., the transistor case is at 25°C. A power transistor normally runs at a higher temperature and the data sheet specifies a derating factor. Figure 2-3 shows linear derating to 200°C. The permissable collector current must be derated as well as the power and $I_{SB}$ - limited segments of the SOA curve and the dc and pulse curves. The maximum collector current is not derated and stays the same for all operating temperatures ($I_C$-limited part of SOA curve).

The formula for linear derating is

$$I_{C(T)} = I_{C(25°C)} \frac{T_O - T}{T_O - 25°C}$$

$I_{C(25°C)}$ permissable $I_C$ at 25°C

$I_{C(T)}$ permissable $I_C$ at temperature T

$T_O$ operating temperature, eg. 200°C in Figure 2-3

There are instances when the power-limited and the $I_{SB}$-limited parts of the SOA are derated differently. This is because the $I_{SB}$ failure occurs at a localized hotspot of about 400°C. It should be noted in the example in Figure 2-4 that, in derating power and $I_{SB}$-limited parts of the SOA differently, the dotted part of the power-limit line must be used; the knee of the curve moves towards higher voltage. The pulse curves are temperature derated in the same manner as for dc.

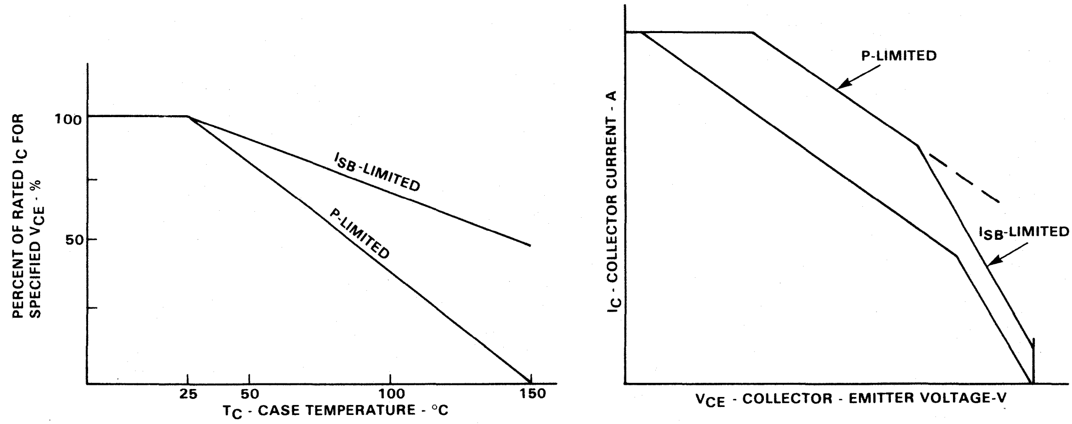



Fig. 2-4. **Temperature Derating to Different Temperature for Power and $I_{SB}$-Limited SOA**

## PULSED SOA

Figure 2-1 shows pulsed SOA curves as well as dc SOA curves. They apply to a single pulse and to 25°C case temperature. The following procedure is used to determine whether or not a pulse train is safe.

- Find the average temperature of the die.

$$T_{J(avg)} = \frac{P_{avg}}{\theta_{JX}} + T_X$$

$$P_{avg} = \frac{1}{t}\int_t P(t)dt$$

where $P_{avg}$ is the average dissipation of the transistor, $T_X$ is the temperature of the area where T is constant, $\theta_{JX}$ is the thermal resistance from the junction to $T_X$; this may be the case, the heat sink or the ambient.

This average temperature is the result of all the dissipated power. Theoretically, this power can be eliminated by assuming a $T_C$ equal to $T_{J(avg)}$. Now, one single pulse at $T_C = T_{J(avg)}$ can be evaluated to determine whether or not the whole pulse train is safe.

- Derate the SOA curves to $T_{J(avg)}$ and evaluate the single pulse.

This method is somewhat conservative, because the temperature immediately before the pulse is lower than the average temperature (Figure 2-5).

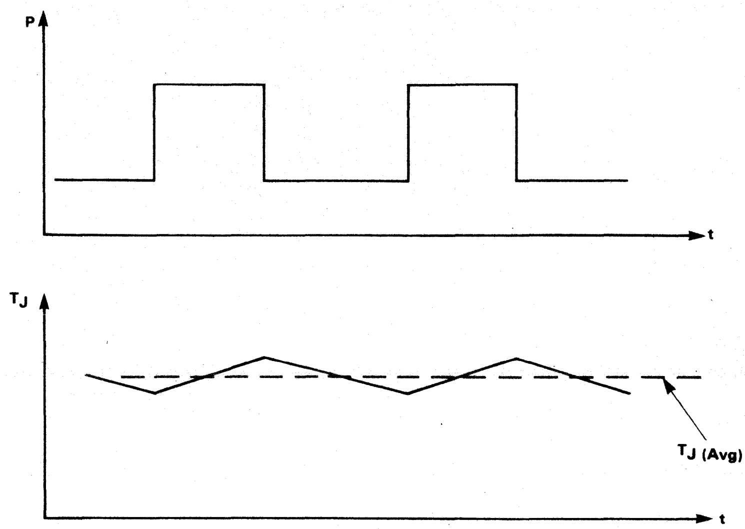


Fig. 2-5. Die Temperature During Pulse Train

**Pulse Evaluation**
Up to now, only square pulses have been considered. Precise handling of non-square pulses is difficult, but in most cases, good approximations can be achieved.

Example 1
If a pulse as shown in Figure 2-6 is evaluated, the best approximation is a square pulse (a). But, since there is no easy way to get this pulse, a pulse (b) that is as high as the maximum power and has the same area as the original pulse is used. If this pulse (b) is safe, then the original pulse is certainly safe.

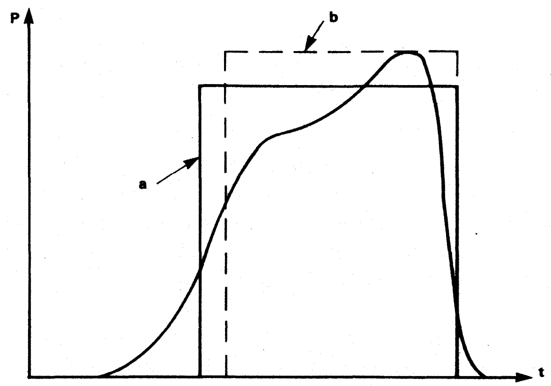


Fig. 2-6. Pulse Evaluation (Example 1)

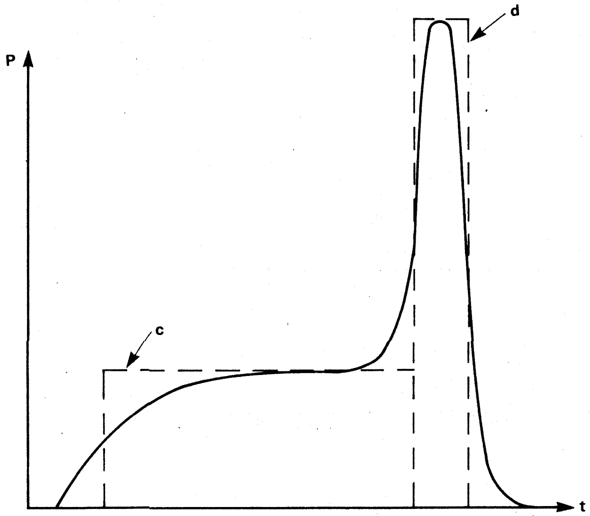



Fig. 2-7. Pulse Evaluation (Example 2)

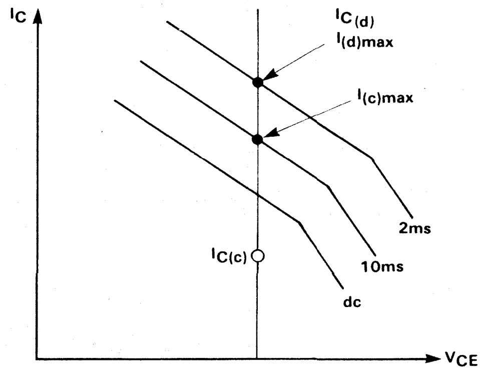



Fig. 2-8. SOA Diagram (Example 2)

Example 2
For a pulse as shown in Figure 2-7, the above method would be too stringent. In this example, the pulse is approximated by two square pulses dividing along the broken line; pulse (c) is evaluated first. In Figure 2-8, $I_{C(c)}$ is the collector current that pulse (c) carries, while $I_{C(c)max}$ is the capability of the transistor. The fraction of the transistor $I_C$ capability used by this pulse, which is also the amount of localized heating that has occurred, is determined by a simple formula.

$$X_c = \frac{I_{C(c)}}{I_{C(c)max}}$$

The second pulse (d) is then evaluated in the same manner. The application is safe if the following condition can be met.

$$X_c + X_d = \frac{I_{C(c)}}{I_{C(c)max}} + \frac{I_{C(d)}}{I_{C(d)max}} \leqslant 100\,\%$$

Example 3
Figure 2-9 is another example of a non-square pulse. First, pulse (e) is evaluated using the method in example 1. Note that the hotspot formed by pulse (e) by the time pulse (f) starts; this is taken into account when transforming pulse (e) into a square pulse (g) of equal area that ends where pulse (f) begins. Pulse (f) is then transformed into a square pulse (h) and (g) and (h) are evaluated by the same method used in example 2. Temperature derated SOA curves must be used.

If the power occurs at different voltages, it is safe to evaluate the pulses as if they all occurred at the highest voltage. A less conservative approach would be to segment the pulses and evaluate each segment at its voltage by the method described in example 2.

Although this method is not exact, it results in a decision as to the safety of the pulse in most cases. An area exists in between where more exact methods or experiments must be used.

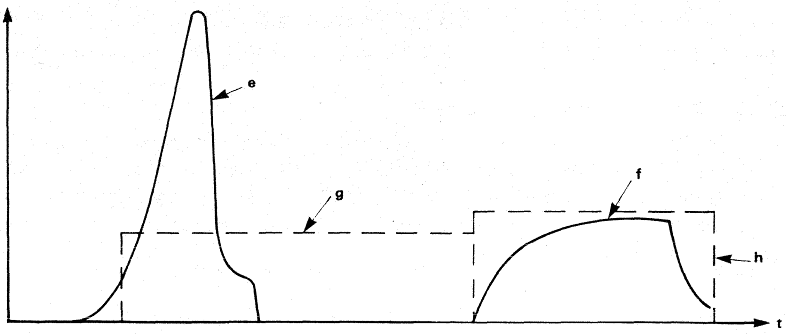



Fig. 2-9. Pulse Evaluation (Example 3)

## TESTING OF FORWARD BIASED SOA

SOA testing is basically a destructive test. A power pulse, with a specified current, voltage and duration is applied to the transistor under test TUT. In case of failure, the TUT destroys itself. To avoid this, a protection circuit is used, to sense the failure and remove the power from the TUT. Protection time is different for each transistor; 25 $\mu$s may be satisfactory for a slow, rugged device, while a fast transistor, specially when tested at high voltage, needs 1 $\mu$s or less.

The basic circuit of the test set should provide reasonable accuracy; 5% accuracy in a working test set is better than 0.1% in one prone to false triggering, 1-2% is probably a happy medium. It should be able to apply the power pulse quickly for testing pulsed SOA (50-100 $\mu$s settling time gives a 1 ms test capability). The power pulse should not cause ringing, that is apt to trigger the protection circuit. A test set must be capable of testing a variety of power transistors having different $f_T$s.

The simple $I_{SB}$ test set in Figure 2-10 operates up to 1 A and 300 V. The TUT is in series with a current source, Q2, Q1 and associated circuitry. $I_C$ is set by the 250 Ω pot. The TUT base current is supplied by a 20V Zener diode D1 and is effectively in a common-base mode. This makes the circuit very stable since it takes the beta of the TUT out of the feedback loop. The test voltage is set by the main power supply which must be set 20V higher than $V_{CE}$ since the Zener D1 pulls the base up 20V.

The timing pulse switches the TUT while the current source, Q2 and R2, is primed all the time. This holds point A low at all times, especially during turn-on, which is important to avoid "false triggering" of the protection circuit.

When the TUT fails, the collector-emitter voltage $V_{CE}$ of the TUT collapses, and point A goes positive in respect to the reference voltage at point B. The differential amplifier Q4 - Q5 flips over, turning Q5 on, which in turn switches Q3 on. Transistor Q3 removes the base drive from the pass transistor Q2, and the current through the TUT is interrupted. Point A is held high and thus the protection circuit is latched until it is reset by the button which temporarily turns Q4 on.

The speed of the protection circuit depends largely on how fast Q2 can be switched off. Since Q2 operates with a $V_{CE}$ of about 10 V, it is not in saturation and has very little storage time. Also, the base charge is actively removed by Q3 thus providing low fall time.

The pass transistor Q2 and its 10 Ω emitter resistor dissipates a maximum of 10W each. In a test set, it is good practice to design the circuit for double the dissipation. The diodes are used for slight level shifts and essentially trim threshold of the protection circuit to an optimum value.

To operate the tester, first set $I_C$, preferably at reduced collector voltage to reduce dissipation during repeated testing. Next, set the collector voltage by setting the supply voltage about 10V above the desired $V_{CE}$. The fine trimming is done while testing. To facilitate testing, provisions could be added to set current and voltage as well as sample and hold circuitry to freeze the actual test values.

## REVERSE-BIASED SAFE OPERATING AREA

When the emitter-base junction of a transistor is reverse biased, the device begins to turn off. In an unclamped inductive circuit, an electrical stress occurs that can result in reverse-biased second breakdown. When the load is resistive or a clamped inductance, the transistor sees very little energy in the reverse-biased mode; but, when the load is an unclamped inductance, almost all of the energy contained in the coil is dumped into the transistor, *i.e.*,

$$E = 1/2\, LI_C^2$$

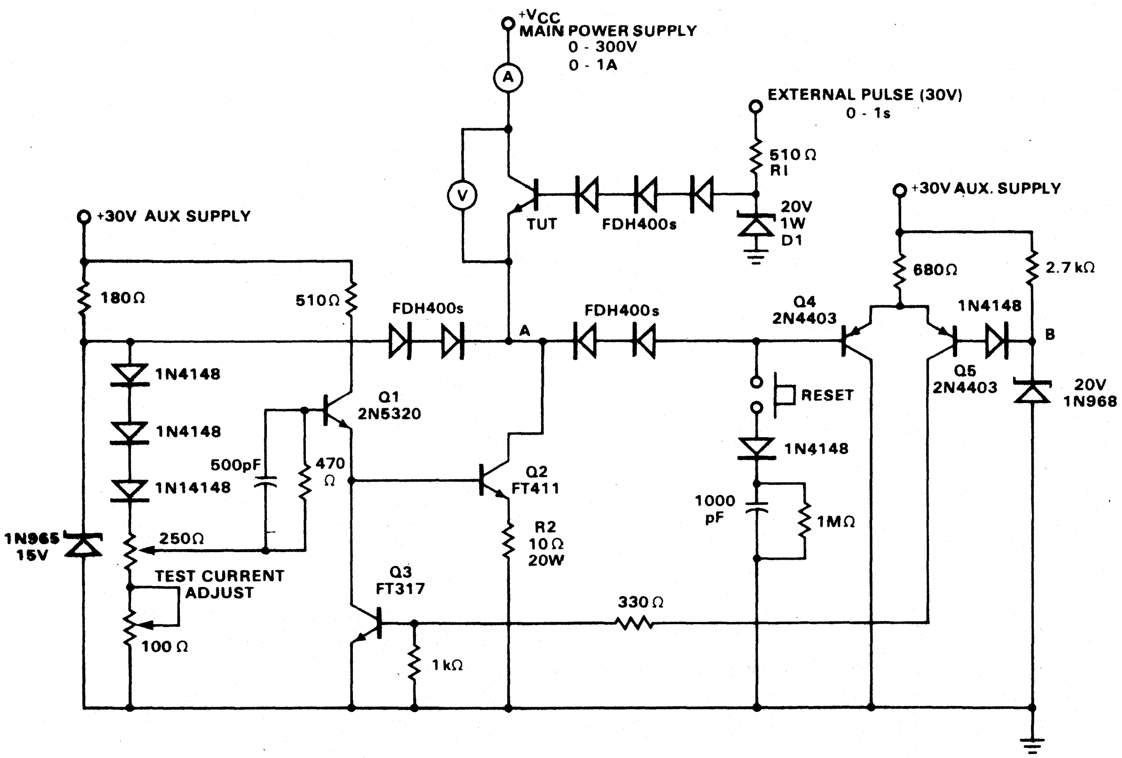



Fig. 2-10 Fairchild Power 300V 1A $I_{SB}$ Tester

Second breakdown energy $E_{SB}$ is the guaranteed reverse-biased energy the transistor is capable of withstanding. When the emitter-base junction is reverse biased, a transverse voltage gradient appears in the base region forcing severe current crowding under the center of the emitter (*Figure 2-11*). This condition is further aggravated by thermal feedback. If the energy in this hot spot raises the temperature of the silicon above approximately 400°C, the emitter-base junction goes into avalanche and the sustaining voltage collapses within nanoseconds. Usually, the transistor is destroyed.

During reverse-bias operation, current is concentrated in a small centralized area rather than in a relatively larger area under the emitter periphery as is the case during forward-biased operation. Therefore, since the current crowding is greater, $E_{SB}$ is much less than the energy capability when the transistor is forward biased.

The $E_{SB}$ capability of a power transistor depends on both the transistor and the circuit design. For low $E_{SB}$ stress, the transistor design must include a large emitter area, a high resistive collector and graded collector doping to reduce current crowding. The circuit should be designed with low inductance (*Figure 2-12*) and low $I_C$ to maintain low energy, keeping in mind that for a specified energy level, as L increases, second breakdown stress on the transistor becomes more severe. To reduce the transverse voltage gradient in the base, and therefore reduce current crowding, low reverse bias $V_{BE}$ and large base resistance $R_{BE}$ are required.

The effective capacitance $C_{eff}$ on the collector should be low, otherwise it takes too long for the $C_{eff}$ to charge to $V_{CE(sus)}$ and the device turns off completely (curve 3a in *Figure 2-13*). When this happens, the voltage rises to the blocking voltage and the $C_{eff}$ discharges into the transistor (snap back). This is a very stressing situation since the collector current goes high during total cutoff thus causing extreme current crowding. Generally, an $E_{SB}$ stress is safe as long as the dissipated energy is less than that specified on the data sheet and provided $L \leqslant L_{spec}$, $R_{BE} \geqslant R_{BE(spec)}$, $|V_{BE}| < |V_{BE(spec)}|$, and the device is operated in the sustaining mode and snapback is avoided by holding $C_{eff}$ low (See *Figure 2-14*). When $L > L_{spec}$, the SOA limit follows an approximate curve, $LI_C^{\vartheta}$ = constant; it is usually safe to consider $\vartheta = 1$.

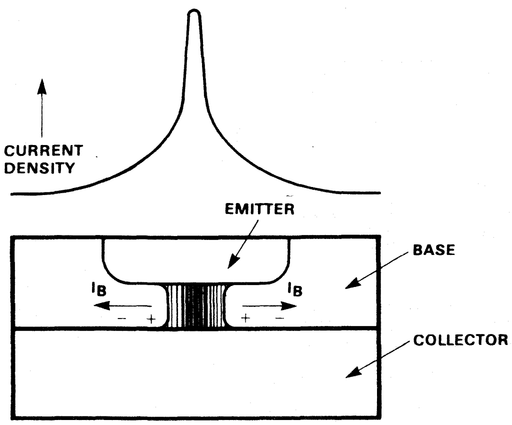



**Fig. 2-11. Current Crowding During Reverse-Biased Cutoff**

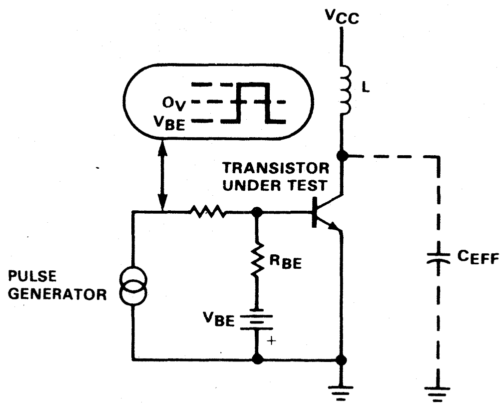
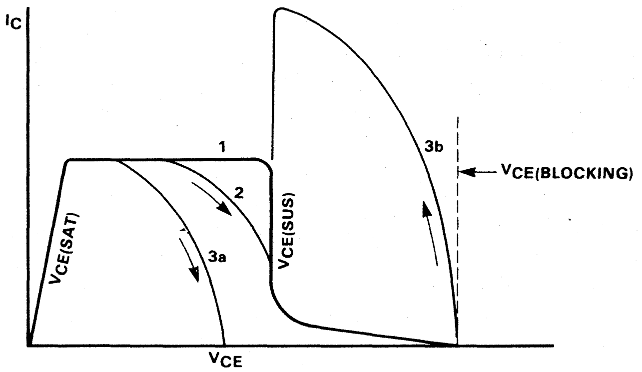



**Fig. 2-12. Reverse-Biased Transistor with Inductive Load**




NOTES:

Curve 1: Turn off with very small $C_{eff}$

Curve 2: $C_{eff}$ softens the curve; it must be charged before $V_{CE(sus)}$ is reached.

Curve 3: Large $C_{eff}$ allows the transistor to turn off (3a) before the energy stored in L is discharged. Snap back occurs at 3b.

**Fig. 2-13. Inductive Turn Off**

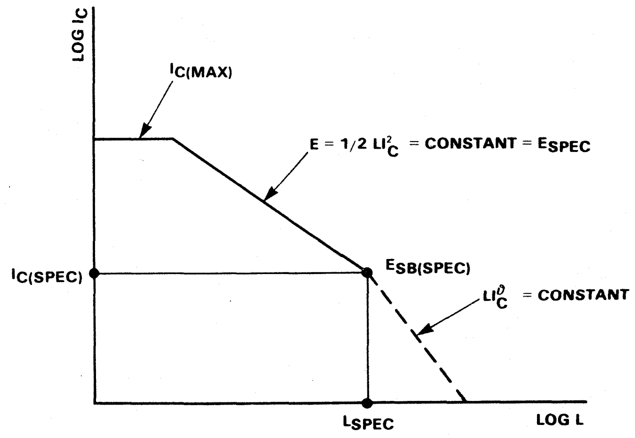



**Fig. 2-14. Reverse-Biased Safe-Operating Area**

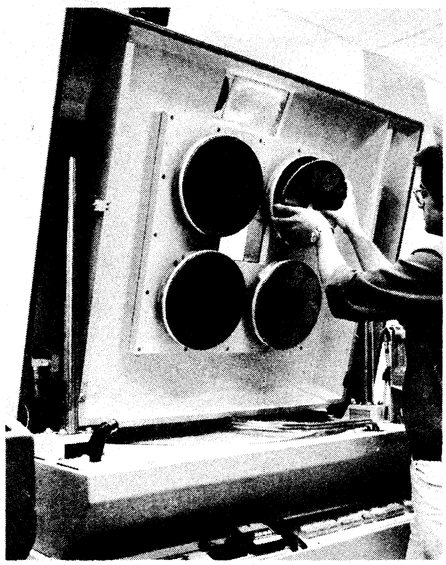
Although this is a valid rating system, it is good design practice to avoid reverse-biased stress by clamping or waveshaping. While the power-transistor manufacturer can guarantee an $E_{SB}$ rating, it must be kept in mind that non-destructive testing is difficult, lot-to-lot and unit-to-unit variations are significant and the fast high voltage power transistors, in particular, have limited $E_{SB}$ capabilities.

# POWER

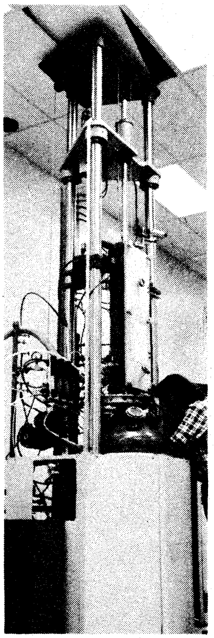
CHAPTER 3

# Chapter 3
# MANUFACTURING

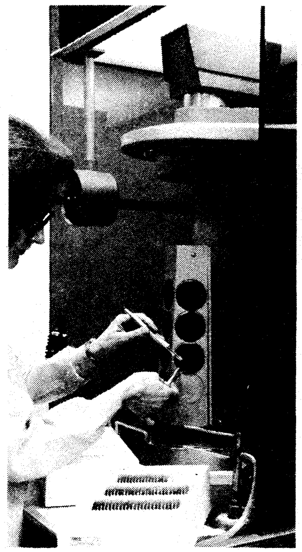
Modern equipment plus state-of-the art technology enables Fairchild to build competitive high reliability, high volume power devices. Important stages of manufacture are illustrated. The Fairchild Power Group does not depend upon outside sources for critical materials or processing.



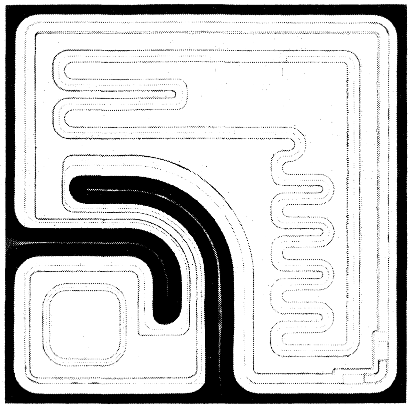
Lapping



Crystal Puller



Epi Reactor



Mask

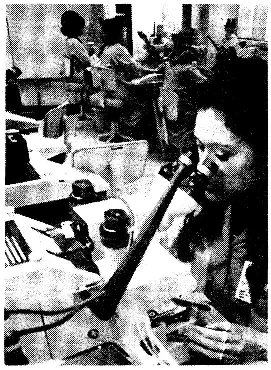
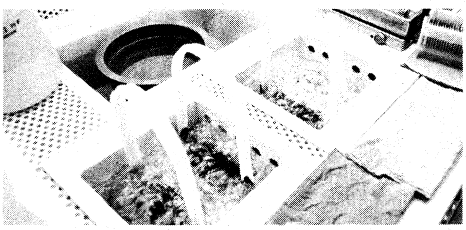
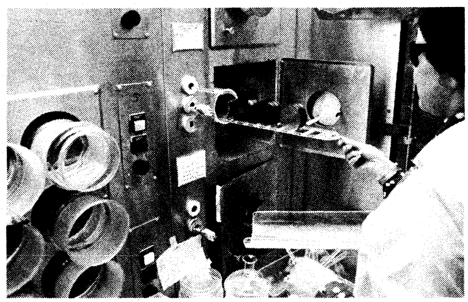


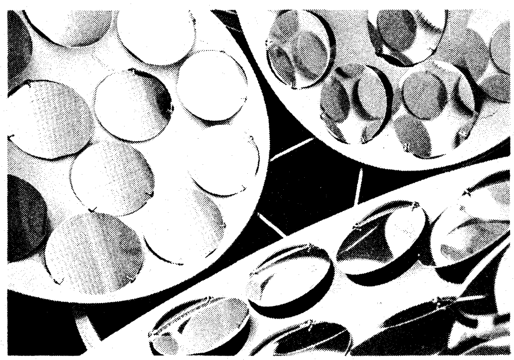
Photo Mask Alignment



Etching

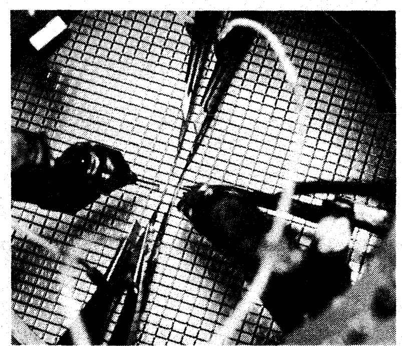


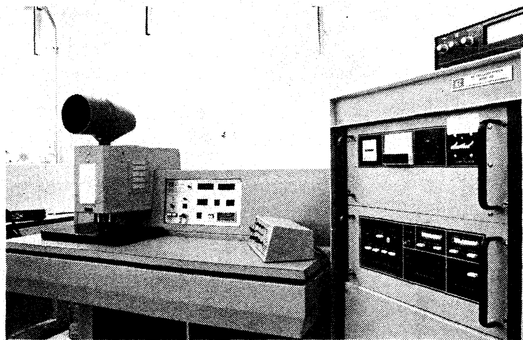
Automatic Diffusion Furnace

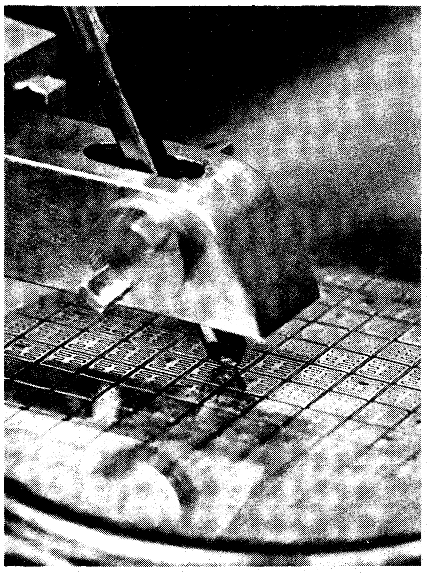


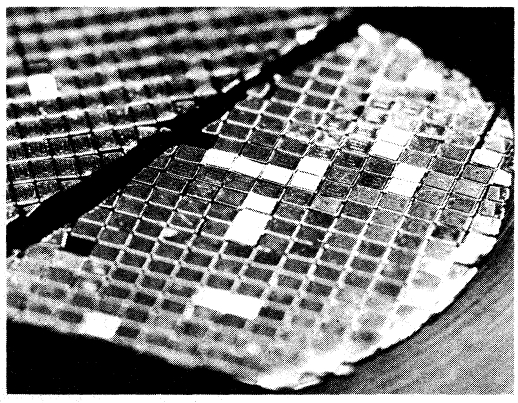
Wafers Mounted for Evaporator

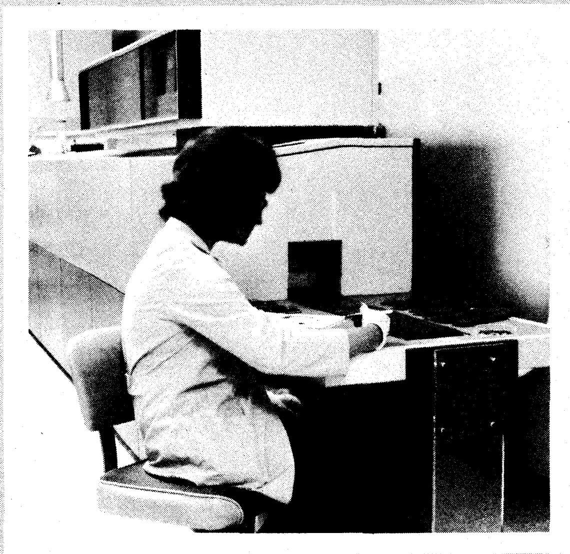
Completed Wafers Ready for Assembly


Probing the Die

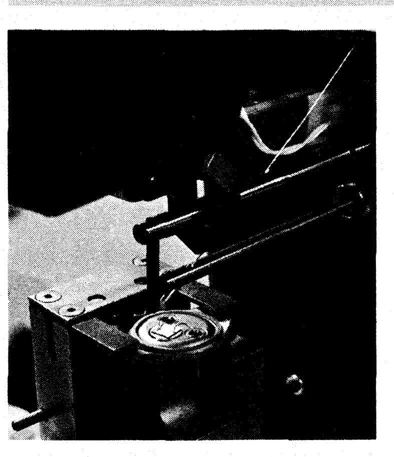

Laser Scriber


Diamond Scribing

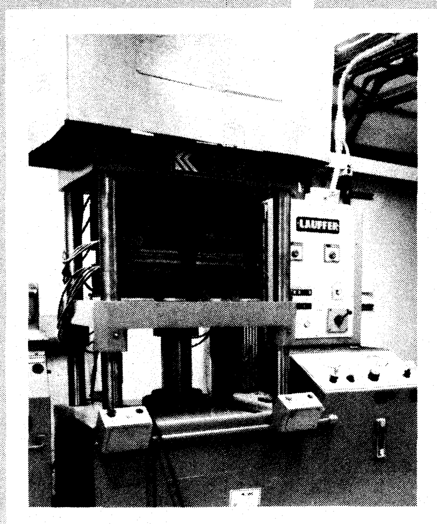

Broken Wafer



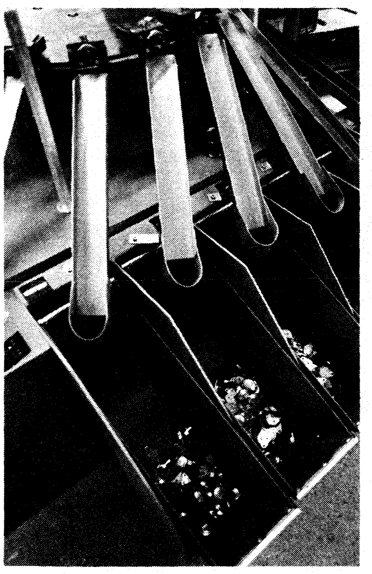
**TO-220/TO-3 Die Attach Furnace**



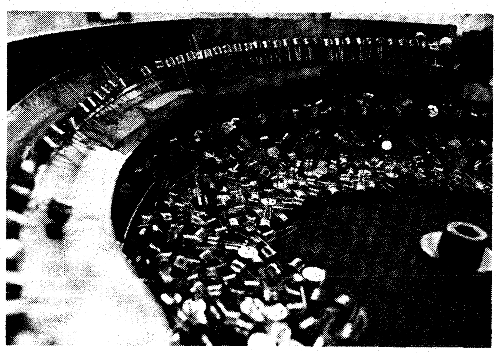
**Heavy Duty Stitch Bonder**



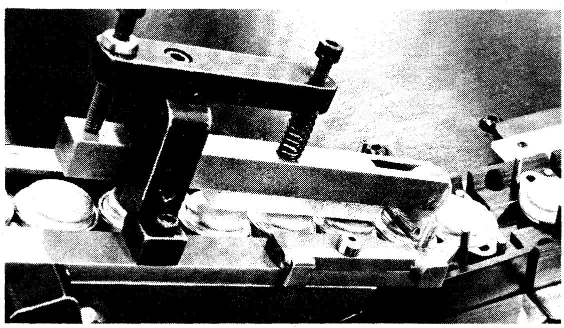

**TO-220 Plastic Mold**



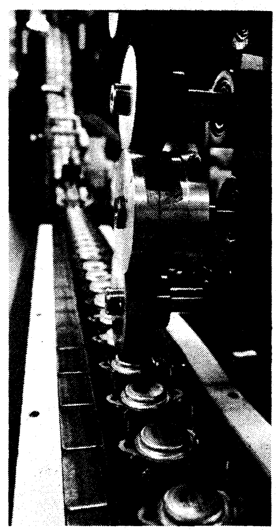
**TO-3 Tester**



**TO-39 Lead Straightener**



**Automated TO-3 Handling**



**Marker and Drier**

**Automatic Tray Pack**

POWER
POWER
POWER
POWER

## CHAPTER 4

- Thermal Resistance
- Heat Sinking
- Mounting Techniques
- TO-220 Lead Bending
- Tips for Better Heat Sinking

# Chapter 4
# POWER TRANSISTOR PACKAGING AND HEAT SINKING

Fairchild offers a wide variety of power packages to fill every power-transistor requirement (*Figure 4-1*). For low and medium power applications, the TO-39 and TO-66 hermetic packages are available. Their sturdy construction ensures high reliability in virtually any environment. For high power and high reliability requirements, a wide range of dice is provided in the TO-3 package. The plastic TO-220 gives the best trade-off between cost and reliability and can be confidently designed into applications where cost is a major factor.

After the designer has considered all the power-transistor requirements based on maximum ratings, reliability, cost and design dimensions, he reaches the point where a decision must be made on package. Usually, more than one will meet the power requirement.

## THERMAL RESISTANCE

The most useful design tool is thermal resistance. This figure of merit is an electrical analogy of the heat flow from the transistor junction. *Figure 4-2* shows a simplified equivalent circuit for a typical semiconductor device in equilibrium. The power dissipation, which is analogous to current flow in electrical terms, is caused by a heat source similar to a voltage source. Temperature is analogous to voltage potential and thermal resistance to ohmic resistance. Extending the analogy of Ohm's law to *Figure 4-2*.

$$\theta_{JA(tot)} = \theta_{JC} + \theta_{CS} + \theta_{SA} = \frac{T_J - T_A}{P_D}$$

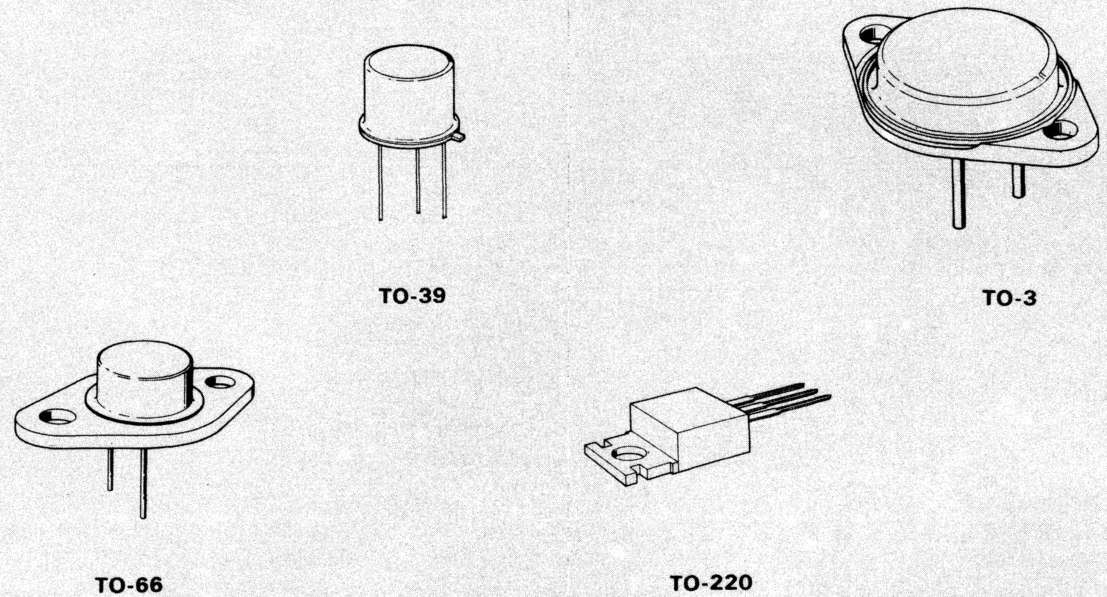
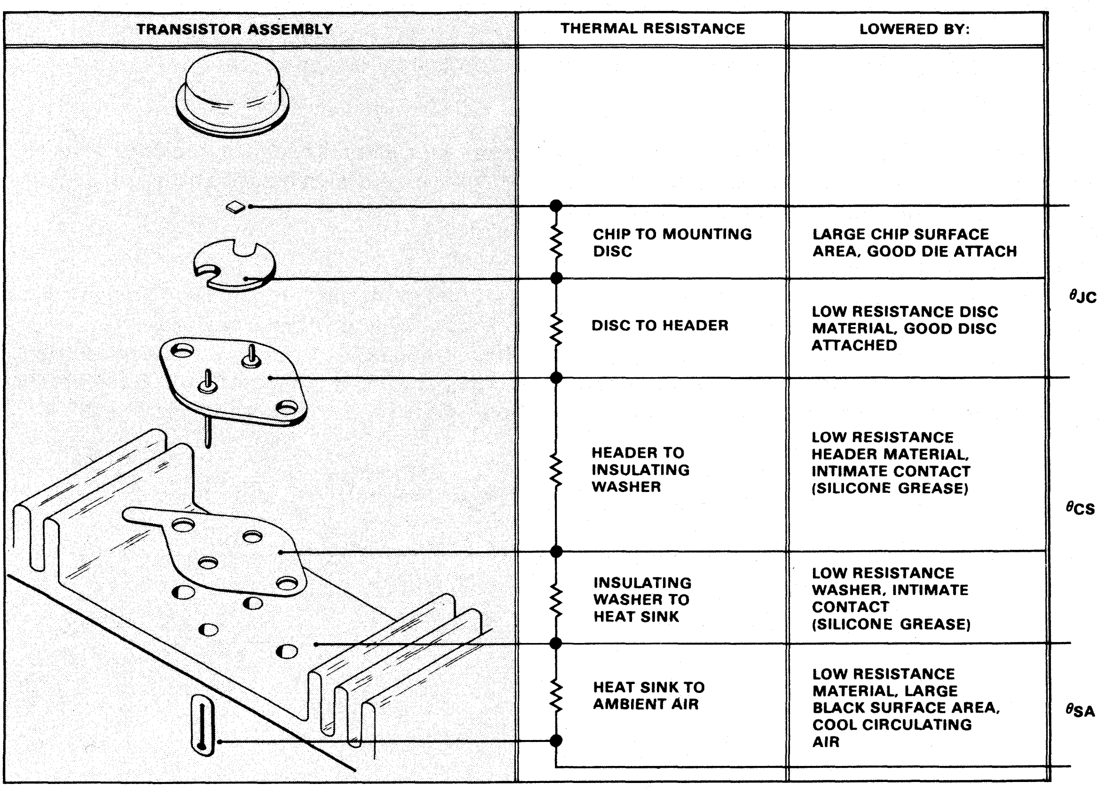
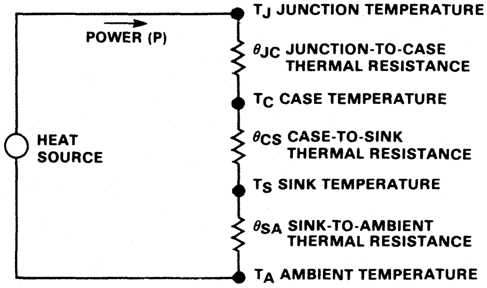



**Fig. 4-1. Power Transistor Packages**

Thermal resistance, then, is the rise in the temperature of a package above some reference level per unit of power dissipation in that package, usually expressed in degrees centigrade per watt. The reference temperature may be ambient or it may be the temperature of a heat sink to which the package is connected. There are several factors that affect thermal resistance including die size, the size of the heat source on the die, die-attach material and thickness, leadframe material, construction and thickness.




Thermal Circuit




Thermal Circuit Model

**Fig. 4-2 Simplified Thermal Circuit**

| PACKAGE | $\theta_{JC}$ (°C/W) | $\theta_{CA}$ (°C/W) |
|---|---|---|
| TO-5/39 | 25 – 40 | 150 |
| TO-220 | 1.5 – 3.0 | 70 |
| TO-66 | 5 – 15 | 66 |
| TO-3 | 0.8 – 6 | 30 |

**Table 4-1. Thermal Resistance Ranges Junction to Case**

Some typical values of junction-to-case thermal resistance $\theta_{JC}$ for different packages are shown in *Table 4-1*. Note that many packages have overlapping thermal resistance values. There are limitations to the thermal resistance model because junction temperature is never spatially uniform and there is no unique value that can be defined for all operating conditions; therefore, the model must be used for a first approximation. The manufacturer's safe operating area curves must be referenced for secondary breakdown limitations and pulsed characteristics.

In general, a reliable design has the lowest calculated junction temperature, therefore it is good practice to make a decision based on the calculated temperature for a package. The choice can be made between using a small package at a high junction temperature versus a larger package at a lower temperature. There is an obvious trade off between cost and reliability. In many applications, plastic power transistors can be used to accomplish the best trade off. Plastic power transistors are less expensive because of the strip assembly which lends itself more readily to automated assembly. As die costs continue to improve, the package becomes a higher percentage of the total device cost. With plastic power devices, the designer can achieve the minimum cost per watt. Their small size make them particularly good for designs that require high peak power for a relatively small amount of space.

## HEAT SINKING

The failure rate of silicon semiconductors decreases approximately one order of magnitude for every 40°C decrease in junction temperature. Therefore, transistor mounting and heat sinking is critical for the best utilization of the power transistor. In general two types of commercial heat sinks are used, the extruded type with a specified thermal resistance and the clip-on heat sink. Thermal resistance information on commercially available heat sinks is normally provided by the heat sink manufacturer; a summary is shown in *Table 4-2*. Once the heat sink thermal resistance is known, then for any ambient temperature, the maximum available power dissipation for a particular device may be calculated using the following formula.

$$P_{D(max)} = \frac{T_{J(max)} - T_{A(max)}}{\theta_{JC} + \theta_{CS} + \theta_{SA}}$$

where:

$\theta_{JC}$ = Thermal resistance from junction to case.

$\theta_{CS}$ = Thermal resistance from case to heat sink.

$\theta_{SA}$ = Thermal resistance from heat sink to ambient.

Thermal resistance decreases as the thickness of the mounting material increases. The $\theta_{CS}$ varies with the device-heat-sink interface—the use or absence of a zinc-filled silicone grease to help remove surface voids, the inclusion or absence of an electrical isolating mica, beryllia, or anodized aluminum washer, and finally the degree of mounting pressure which is applied through the device hold-down mechanism. Applicable package torque specifications should be observed to further minimize the case-to-heat sink thermal resistance. A comparison of thermal resistances $\theta_{CS}$ for various mounting techniques is given in

*Table 4-3.* The maximum power dissipation capability of a device can be calculated for the following electrical and thermal conditions:

| | |
|---|---|
| Power device | 2N3055 |
| Maximum ambient temperature | 65°C |
| Heat sink thermal resistance* | 2.5°C/W at 10 W |
| Mica washer with silicone grease** | 0.4°C/W |
| $\theta_{JC}$ (from data sheet) | 1.5°C/W |

*Thermal resistance decreases slightly with increasing power dissipation.
**Silicone grease applied to both sides of washer.

This list is only representative. No attempt has been made to provide a complete list of all heat sink manufacturers. All values are typical as given by manufacturer or as determined from characteristic curves supplied by manufacturer.

| $\theta_{SA}$ Approx. (°C/W) | Manufacturer and Type |
|---|---|
| | **TO-3 Packages** |
| 0.4 (9" length) | Thermalloy (Extruded) 6590 Series |
| 0.4 — 0.5 (6" length) | Thermalloy (Extruded) 6660, 6560 Series |
| 0.56 — 3.0 | Wakefield 400 Series |
| 0.6 (7.5" length) | Thermalloy (Extruded) 6470 Series |
| 0.7 — 1.2 (5 — 5.5" length) | Thermalloy (Extruded) 6423, 6443, 6441, 6450 Series |
| 1.0 — 5.4 (3" length) | Thermalloy (Extruded) 6427, 6500, 6123, 6401, 6403, 6421, 6463, 6176, 6129, 6141, 6169, 6135, 6442 Series |
| 1.9 | IERC E2 Series (Extruded) |
| 2.1 | IERC E1, E3 Series (Extruded) |
| 2.3 — 4.7 | Wakefield 600 Series |
| 4.2 | IERC HP3 Series |
| 4.5 | Staver V3-5-2 |
| 4.8 — 7.5 | Thermalloy 6001 Series |
| 5 — 6 | IERC HP3 Series |
| 5 — 10 | Thermalloy 6013 Series |
| 5.6 | Staver V3-3-2 |
| 5.9 — 10 | Wakefield 680 Series |
| 6 | Wakefield 390 Series |
| 6.4 | Staver V3-7-224 |
| 6.5 — 7.5 | IERC UP Series |
| 8 | Staver V1-5 |
| 8.1 | Staver V3-5 |
| 8.8 | Staver V3-7-96 |
| 9.5 | Staver V3-3 |
| 9.5 — 10.5 | IERC LA Series |
| 9.8 — 13.9 | Wakefield 630 Series |
| 10 | Staver V1-3 |
| 11 | Thermalloy 6103, 6117 Series |
| | **TO-220 Packages** * |
| 4.2 | IERC HP3 Series |
| 5 — 6 | IERC HP1 Series |
| 6.4 | Staver V3-7-225 |
| 6.5 — 7.5 | IERC VP Series |
| 7.1 | Thermalloy 6070 Series |
| 8.1 | Staver V3-5 |

* Most TO-3 heat sinks can also be used with TO-220 packages with appropriate hole patterns.

| $\theta_{SA}$ Approx. (°C/W) | Manufacturer and Type |
|---|---|
| | **TO-220 Packages** * |
| 8.8 | Staver V3-7-96 |
| 9.5 | Staver V3-3 |
| 10 | Thermalloy 6032, 6034 Series |
| 12.5 — 14.2 | Staver V4-3-192 |
| 13 | Staver V5-1 |
| 15 | Thermalloy 6030 Series |
| 15.1 — 17.2 | Staver V4-3-128 |
| 16 | Thermalloy 6072, 6106 Series |
| 18 | Thermalloy 6038, 6107 Series |
| 19 | IERC PB Series |
| 20 | Staver V6-2 |
| 20 | Thermalloy 6025 Series |
| 25 | IERC PA Series |
| | **TO-5 and TO-39 Packages** |
| 12 | Thermalloy 1101, 1103 Series |
| 12 — 16 | Wakefield 260-5 Series |
| 15 | Staver V3A-5 |
| 22 | Thermalloy 1116, 1121, 1123 Series |
| 22 | Thermalloy 1130, 1131, 1132 Series |
| 24 | Staver F5-5C |
| 25 | Thermalloy 2227 Series |
| 26 — 30 | IERC Thermal Links |
| 27 — 83 | Wakefield 200 Series |
| 28 | Staver F5-5B |
| 34 | Thermalloy 2228 Series |
| 35 | IERC Clip Mount Thermal Link |
| 39 | Thermalloy 2215 Series |
| 41 | Thermalloy 2205 Series |
| 42 | Staver F5-5A |
| 42 — 65 | Wakefield 296 Series |
| 46 | Staver F6-5, F6-5L |
| 50 | Thermalloy 2225 Series |
| 50 — 55 | IERC Fan Tops |
| 53 | Thermalloy 2211 Series |
| 55 | Thermalloy 2210 Series |
| 56 | Thermalloy 1129 Series |
| 58 | Thermalloy 2230, 2235 Series |
| 60 | Thermalloy 2226 Series |
| 68 | Staver F1-5 |
| 72 | Thermalloy 1115 Series |

IERC: 135 W. Magnolia Blvd., Burbank, CA 91502
Staver Co. Inc.: 41-51 N. Saxon Ave., Bay Shore, N.Y. 11706
Thermalloy Inc.: 2021 W. Valley View Lane, Dallas, TX 75234
Wakefield Engineering, Inc.: Audubon Rd., Wakefield, MA 01880

**Table 4-2. Heat Sink Selection Guide**

| PACKAGE | METAL TO METAL DRY | METAL TO METAL COMPOUND | INSULATOR DRY | INSULATOR COMPOUND |
|---|---|---|---|---|
| TO-220 | 1.2 − 2.0 | 0.6 − 1.2 | − | 2.1 − 2.6 |
| TO-66 | 0.8 − 1.5 | 0.4 − 0.9 | − | 1.4 − 1.7 |
| TO-3 | 0.05 − 0.2 | 0.005 − 0.10 | 0.55 − 0.8 | 0.28 − 0.40 |

**Table 4-3. Thermal Resistance Case to Heat Sink**

Maximum power dissipation is:

$$P_{D(max)} = \frac{200°C - 65°C}{1.5 + 0.4 + 2.5} = \frac{135}{4.4} = 30.7\ W$$

Similarly, if the heat sink thermal resistance is required for the following conditions:

$\theta_{JC} = 3°C/W$ $\quad T_{A(max)} = 55°C$

$T_{J(max)} = 200°C$ $\quad P_D = 15\ W$

Anodized aluminum washer with silicone grease

then:

$$\theta_{SA} = \frac{T_{J(max)} - T_A}{P_D} - (\theta_{JC} + \theta_{CS}) = \frac{200 - 55}{15} - (3 + 0.3) = 9.7 - 3.3 = 6.4°C/W$$

For TO-39 devices, mechanically mounted, *i.e.,* without heat sinks, case-to-ambient thermal resistance, $\theta_{CA}$, must be considered. This resistance is typically much greater than $\theta_{JC}$ since the mode of heat transfer is by convection and radiation into the surrounding ambient air, rather than by direct conduction. The total resistance to heat transfer out of the chip is the sum of $\theta_{JA}$ and $\theta_{CA}$. The sum is junction-to-ambient thermal resistance $\theta_{JA}$. A typical value for a TO-39 device is 175°C/W.

## MOUNTING TECHNIQUES

To take full advantage of the power handling capability of power transistors, it is imperative to follow proper mounting procedures − preparation of the mounting surface, application of a thermal compound and use of correct fastening techniques.

In general, the package should be as flat and smooth as the transistor die. For low-power applications, the heat-sink surface is satisfactory if it is flat when held against a straightedge and there are no deep scratches. For high-power applications, a more stringent examination of the surface is required.

Most commercially available heat sinks require spotfacing. Generally, milled or machined surfaces are satisfactory. Furthermore, the surface must be free from all foreign material, film and oxide. Freshly bared aluminum forms an oxide layer in a few seconds. If the heat sink is not used immediately after machining, the mounting area should be polished with No. 000 steel wool and rinsed with alcohol or acetone. This is followed immediately with thermal grease.

Thermal joint compounds are used to fill air voids between mating surfaces to improve contacts. They are a formulation of fine zinc particles in a silicone oil that maintains a grease-like consistency with temperature and time. The compounds are applied in a very thin coat with a spatula or lintless brush and wiped lightly to remove excess material. Or, a minimal amount may be placed around the center of the contact area; during mounting, rotation and pressure forces the compound over the contact area. Excess compound can be removed with acetone or alcohol. For good thermal conduction use a joint lubricant such as Dow Corning DC-340, General Electric 662 or Thermacote by Thermalloy.

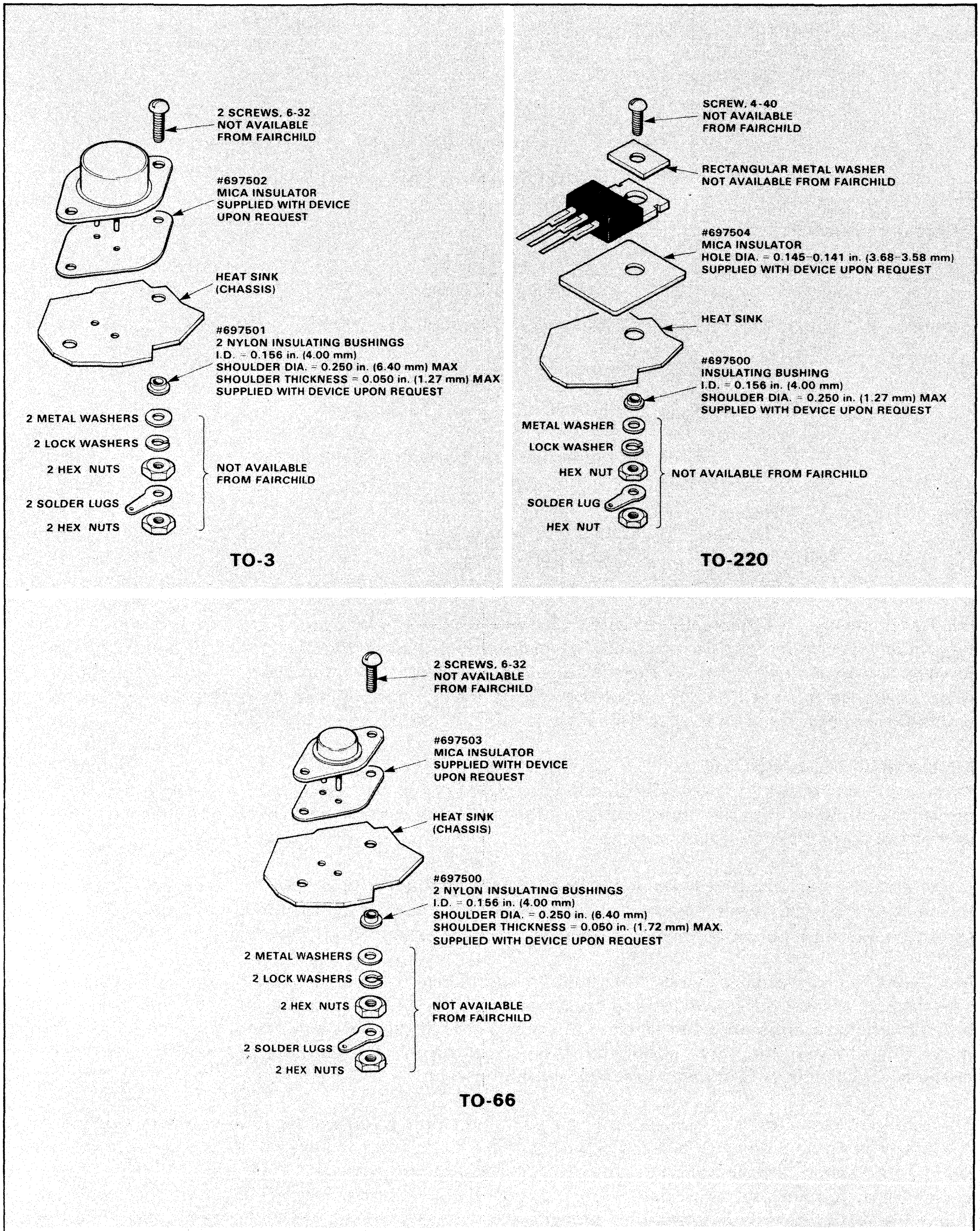



**Fig. 4-3. Mounting Hardware**

In some applications, it is desirable to electrically insulate the regulator case from the heat sink. Hardware kits for this purpose are commercially available for such packages as the TO-3 and TO-220. They generally consist of a 0.003 to 0.005 inch thick piece of mica or bonded fiberglass to electrically isolate the two surfaces, yet provide a thermal path between them. As expected, the thermal resistance will increase but, as in the direct metal-to-metal joint, some improvement can be realized by using thermal lubricant on each side of the mica.

**TO-3 and TO-66**

TO-3 and TO-66 packages are mounted as shown in *Figure 4-3*. When tightening the nuts, the screw threads should be free of grease to prevent inconsistent torque readings. Maximum allowable torque should be used to reduce $\theta_{CS}$; torque ratings of the parts should never be exceeded.

**TO-220** (Figures 4-3 and 4-4)

The TO-220 devices can be mounted by bolting, soldering, riveting or clamping. Each method has advantages and disadvantages. Choose the best method for the application. For small-volume applications, either bolting or clamping is the most practical because less investment in equipment is required. For larger volume applications, direct solder or riveting could be more economical. Regardless of method, the following precautions should be observed.

The plastic TO-220 package cannot be subjected to mechanical shock.

Mounting holes must not be oversized.

Proper hardware should be used (see *Figure 4-3*).

Spacers, insulators and washers should be resistent to cold flow under pressure.

Chassis or heat sink should fit smoothly in the mounting area.

A thermal compound should be used on all unsoldered interfaces between the device and the heat sink.

*Bolting*

The mounting holes in the TO-220 package are clearance holes for a 4-40 screw, however, a small head diameter screw is required to avoid damage to the plastic package. If a nylon shoulder washer such as FSC part #697500 is used, a 4-40 screw can be used. An 8 in. lb maximum torque on the mounting screw is sufficient to insure good thermal contact. Do not exceed this pressure or damage to the device may occur. Also do not allow the screw or screwdriver to contact the plastic package. Damage to the plastic package generally indicates damage to the device.

*Clamping*

TO-220 devices may be attached to heat sinks using spring clamps to apply spring pressure on the tab. These spring-clamp heat sinks are currently available from several manufacturers.

*Soldering*

The leads and tabs of the TO-220 package may be soldered. The leads should be soldered no closer than 0.065" to the plastic package at a maximum temperature of 260°C for 10 seconds or less. The heat-sink tabs can be soldered using a hot plate or tunnel oven at a maximum temperature of 225°C for 25 seconds. To solder successfully, parts must be cleaned with a solvent such as acetone, freon or alcohol, if necessary. Rosin flux may be used to improve solderability; acid or activated flux are not recommended.

*Riveting*

In large-volume operations, riveting is often desirable. The TO-200 has been mounted in large volume using an 1/8-inch brass eyelet rivet. The unit is clinched using an air-operated setting machine. The machine should be adjusted so the force applied (250 lb max) is just sufficient to achieve a good, tight fit without deforming the heat sink or the device tab.

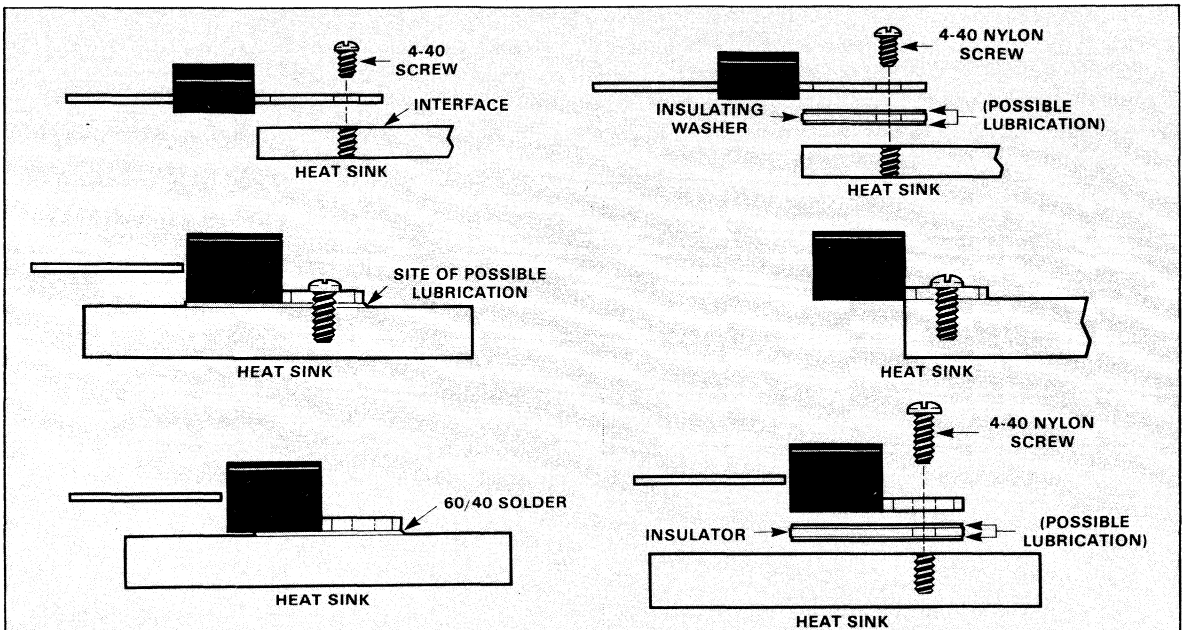



**Fig. 4-4. Mounting Methods**

## TO-220 LEAD BENDING

Fairchild offers nine standard lead-bend variations (*Figure 4-5*). Special lead bends are available for a nominal tooling cost. The TO-220 leads are designed to allow a moderate amount of twisting and pulling and can withstand a maximum tension of six pounds during forming and assembly. The tension limit is only for circuit assembly. Strain relief should be provided if the unit is to be subjected to lead tension over a long period. Within limits, the leads may also be twisted. However, the leads must be firmly supported between the case and the twist and the twist should not exceed 90° in either direction. Avoid repeated bending and twisting since metal fatigue may occur and cause broken leads. Fairchild bends leads mechanically using special tooling. Leads may be hand formed using needle-nosed pliers; however, the leads must be clamped at a point between the plastic package and the bend to protect the package. The TO-220 device fits the same socket as the TO-66 and can be used as a direct replacement. The collector lead is trimmed and the emitter and base leads are formed as shown in *Figure 4-5* (TO-220-02).

## TIPS FOR BETTER HEAT SINKING

When using low dissipation packages such as TO-5 and TO-39, keep lead lengths to a minimum and use the largest possible area of the printed board traces or mounting hardware to provide a heat dissipation path.

When using larger packages, be sure the heat sink surface is flat and free from ridges or high spots. Check the package for burrs or peened-over corners. Regardless of the smoothness and flatness of the package and heat-sink contact, air pockets between them are unavoidable unless a lubricant is used. Therefore, for good thermal conduction, use a thin layer of thermal lubricant.

If it is necessary to electrically insulate the case from the heat sink, use available hardware kits that usually consist of a thin piece of mica or bonded fiberglass to electrically isolate the two surfaces.

If the device is mounted on a heat sink with fins, the most efficient heat transfer takes place when the fin is in a vertical plane, as this type of mounting forces the heat transfer from fin to air in a combination of radiation and convection.

If it is necessary to bend any of the leads, handle them carefully to avoid straining the package. Furthermore, lead bending should be restricted since repeated bending will fatigue and eventually break the leads.

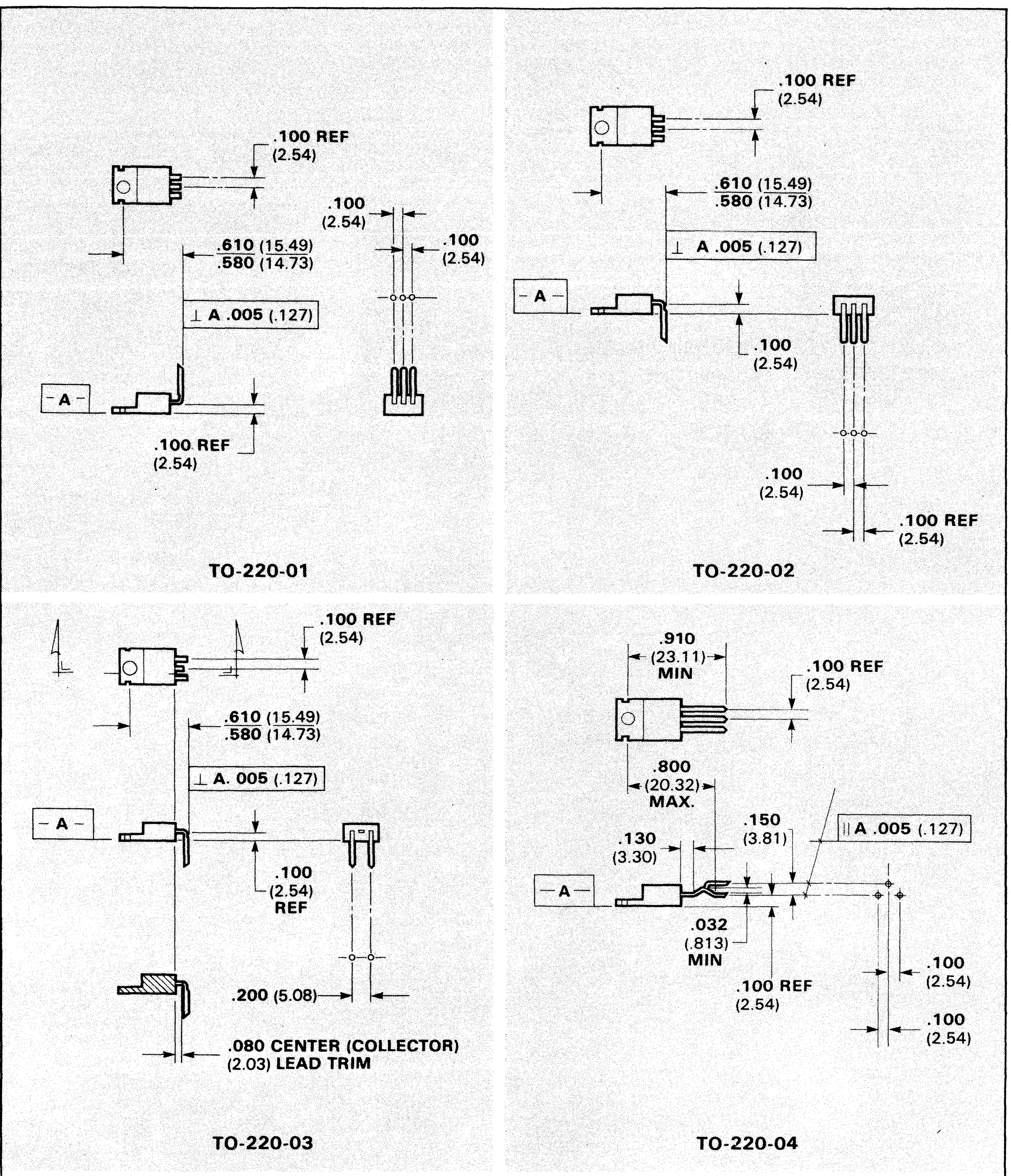



Fig. 4-5. TO-220 Standard Lead Bends

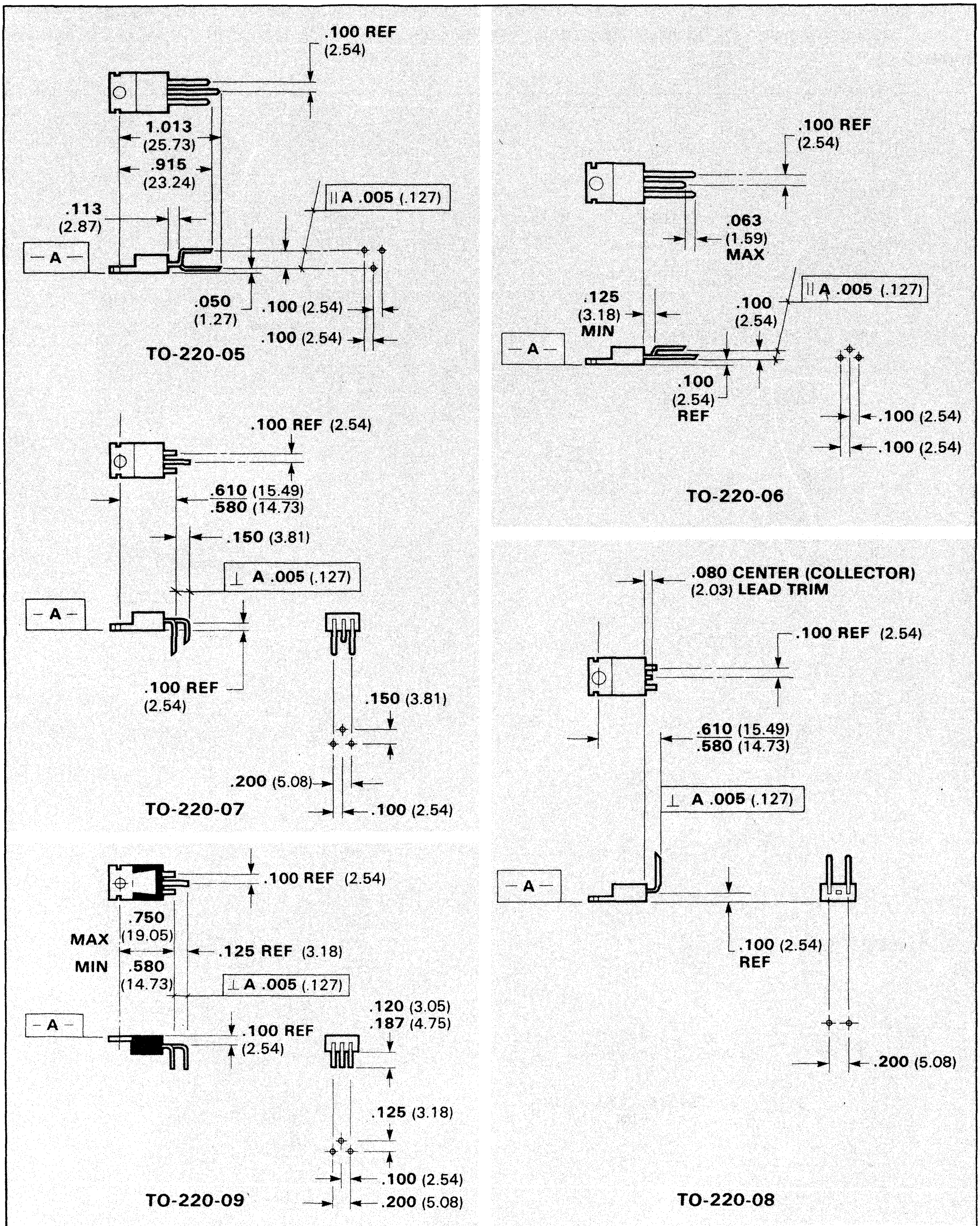



**Fig. 4-5. TO-220 Standard Lead Bends** (Cont'd)

# CHAPTER 5

- Areas of Consideration
- Wafer Manufacture
- *Failure Analysis*
- Reliability Monitor and Control
- JAN Power Devices

# Chapter 5
# POWER TRANSISTOR RELIABILITY

## INTRODUCTION

There are three basic ingredients in the manufacture of reliable power transistors. First, the device must be designed with the user's applications and reliability requirements in mind. Secondly, the device must be manufactured with the optimum technology for the application. Thirdly, controls must be established to assure maintenance of the quality/reliability levels established in the design of the device. Consideration is given to the reliability influence of each part of the manufacturing and testing cycle with constant feedback from internal reliability monitoring; customer feedback on the results is a vital factor. The Fairchild power reliability concept can be presented as a constant feedback system which begins and ends with the customer. *(Figure 5-1).*

## AREAS OF CONSIDERATION

### Device Applications and Reliability

The reliability cycle begins with the customer. His device application, environment for its usage and end-product reliability requirements are major factors in establishing the quality/reliability levels for the power transistor. The customer is the final judge.

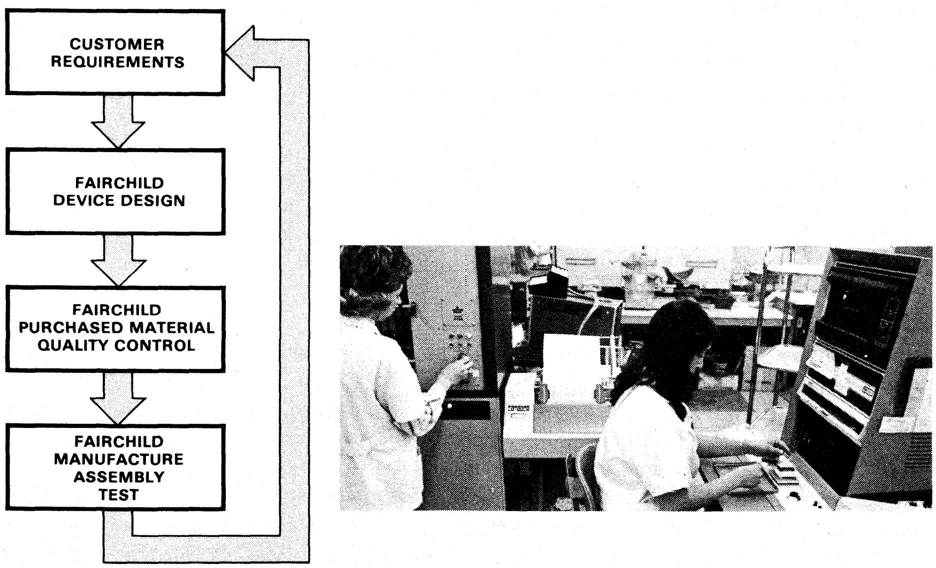
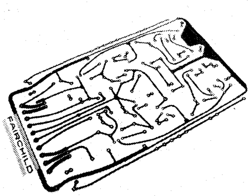



**Fig. 5-1. Customer Feedback System**




Customer Design Breadboard

**Device Design**
Inherent component reliability is a function of the product/process design. Most Fairchild power transistor designs are not totally new, but instead are modifications or extensions of existing designs with known performance and reliability characteristics. Three different aspects of the power device significantly affect its reliability.

*The Silicon Chip*
Impurity profiles determine safe operating area (SOA) trade-offs with other electrical parameters. Fairchild's design-technology capability utilizes multiple epitaxial layers to optimize (SOA) performance while still achieving the desired electrical parameter characteristics. Where severe current distribution problems exist, discrete emitter topology is used to eliminate current crowding and hot spots. The surface influences long term gain and voltage/leakage stability. The metalization determines mechanical integrity and current distribution.

*Assembly of the Chip to the Package.*
The processes and materials used must preserve the inherent reliability of the chip and be reliable in themselves to withstand mechanical and electrical stresses.

*The Package*
The package must effectively transfer heat from the chip to the outside world and protect the chip during handling and use.

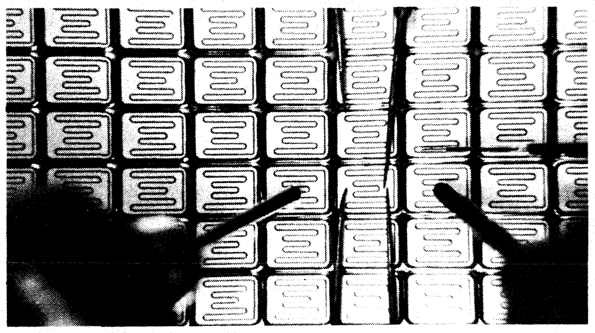
**Incoming Quality Control (IQC)**
All purchased materials for Fairchild power transistors are controlled through central specification control, product engineering and reliability and quality assurance (R&QA) located in Mountain View. Materials are purchased and inspected per control documents using three IQC methods.

Direct inspection
Functional testing
Submission to outside laboratories for chemical and X-ray analysis.

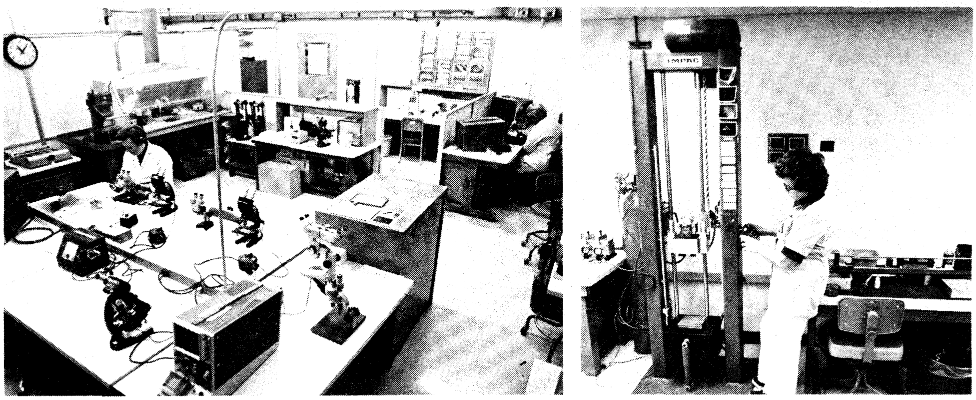
In additon to centralized IQC, each manufacturing facility has a local, fully equipped IQC department. These facilities concentrate on cleanliness, plating quality and functionality. A computer file is made on each vendor's performance and quarterly reports are generated and analyzed.

## WAFER MANUFACTURE
All wafers used to fabricate Fairchild power transistors are made at Fairchild. This includes crystal pulling, slicing, polishing and equitaxial layer growth. Fairchild's power multiple-epitaxial designs rely on tight control of thickness and resistivity over a three-inch diameter wafer. As many as three epi-layers are used to achieve the designed impurity profile. Extreme cleanliness is a must in all operations. All critical operations have laminar-flow clean-air hoods directly over the work areas. Wafer fabrication is essentially a series of furnace masking cycles in which geometries are defined and impurities (doping) introduced to form emitter, base and contact regions. Daily controls are maintained on furnace temperatures to within ±1°C. Resistivities (V/I) of diffused layers are recorded on every run. Each masking cycle, which defines a new area of the geometry to be "worked on", has develop check to assure each wafer has received proper exposure and chemical development. When masking is completed, a final check establishes that the proper areas are clean and properly etched. Since operations in the masking area are automated, sampling of runs is very effective in controlling the process.

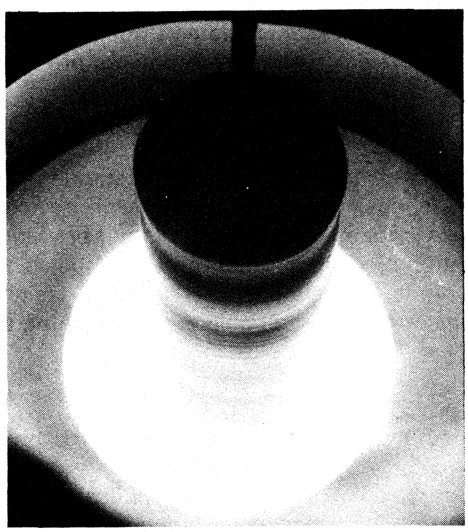
After masking and diffusion, the metalization process completes wafer manufacture. Fairchild uses filament and electron-beam evaporation techniques to deposit gold, chrome, silver, palladium and aluminum. Deposits are controlled through utilization of automated process sequencing, sloan frequency monitors for thickness control and premeasured metal charges which are depleted during the deposition cycle. Every run is gated through a first optical (1st opt.) inspection before it leaves fab. Cleanliness, mask alignment, metal adherence (front and back) and general workmanship are inspected.



**Wafer Probing**



**IQC Area**



**Crystal Puller**

**Wafer Testing**
Before the wafers are scribed and broken into dice for assembly onto headers or shipment to a customer as probed dice, they are electrically sorted. Each wafer is automatically probed with 5 to 7 tests to duplicate or correlate the dice to the final product test requirements. Typical probe tests are $I_{CBO}$, $I_{CES}$, $h_{FE}$, $V_{CEO(sus)}$ and $BV_{EBO}$. Rejected dice are ink marked and later scrapped. A final quality control gate is performed before the probed wafers can be forwarded to assembly.

**Device Assembly**
After the wafers are scribed and broken, a second optical (2nd opt.) QC inspection is performed. The dice are inspected for post wafer fabrication (handling) damage, as well as for defects which may cause assembly problems such as missing metal in a bonding pad.

Monitors are performed on both assembly equipment and operators. Machines are shut down if defect control limits are exceeded and suspect material is rejected and 100% screened. Key items inspected are die orientation, voids under die, proper bond formation, wirepull strength and cleanliness.

A third optical (3rd opt.) gate is performed prior to final device sealing. At this inspection point, each lot is inspected to a 1.5% AQL. If rejected, the lot is 100% screened by production and resubmitted to QC. Accepted lots are sent to the final seal operation, where the packages are monitored for weld strength and hermeticity (except plastic packages). TO-39 packaged devices are temperature aged, temperature cycled and impact shocked before submission to the test area. TO-3/66/220 packaged devices are temperature aged and $I_{SB}$ (Forward Biased Safe Operating Area) tested prior to test.

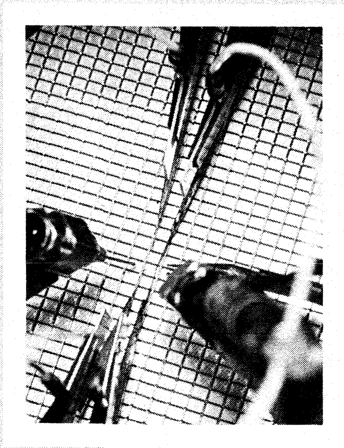
**Device Testing.**
Before shipment, all devices are 100% production tested to the following minimum inspection levels.

| | |
|---|---|
| Catastrophics(0/S) | 0.25% AQL |
| 25°C dc | 0.65% AQL |
| 25°C ac | 2.5 % AQL |
| Temperature dc | 15/2 LTPD |
| Mechanical/Visual | 1.0% AQL |
| Solderability | 15/2 LTPD |
| SOA (TO-3/66/220) | 1.0% AQL |

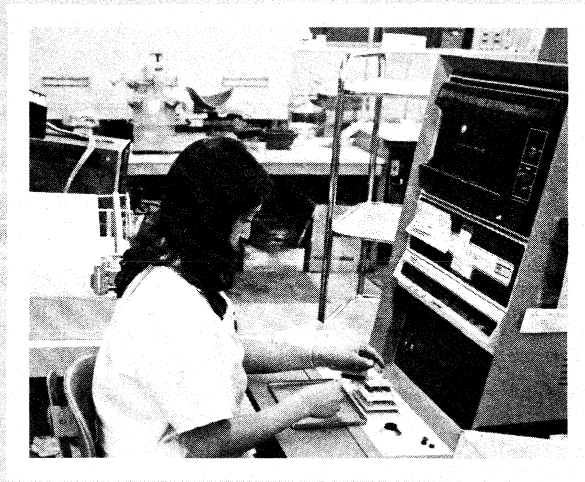
Customers with special requirements are accommodated through an internal specification system. All internal test specifications formatted from customer documents are signed off by QA before they can be issued to the test area.

**Device Application**
The total reliability effort is completed full cycle with the customer. Operation in the customer application is the final consideration in device reliability. How each device is handled during system assembly by the customer, heat-sunk (mounted) and cooled during operation, and the amount of overload stresses (due to the system malfunction or misuse), greatly impacts the device reliability. Thus the customer's specification requirements, the manufacturer's device design, manufacture, test, the actual circuit into which the device is inserted and the equipment containing that circuit in the field all affect the device and reliability.

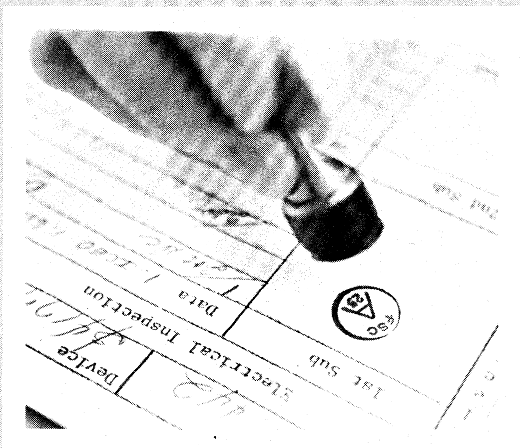
**FAILURE ANALYSIS**
Failure analysis results performed by customers and by Fairchild on returned devices provide one of the most important inputs for consideration in Fairchild's total power reliability concept.
Failures generated by line monitors, life tests and field applications are analyzed to provide corrective action in terms of product design, assembly and testing methods. A scanning electron microscope (SEM) and an Auger electron microscope for chemical analysis are available for inspection of materials. The basic failure modes include the following.



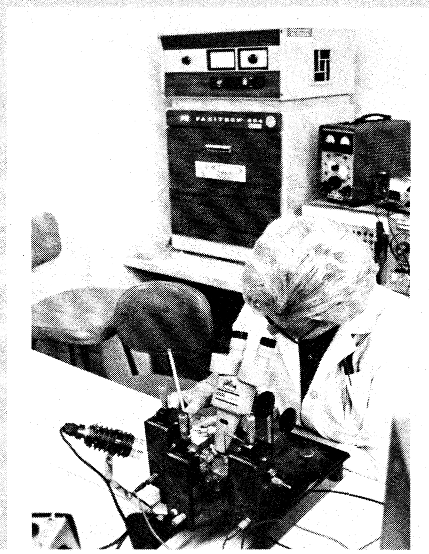
Die Probing

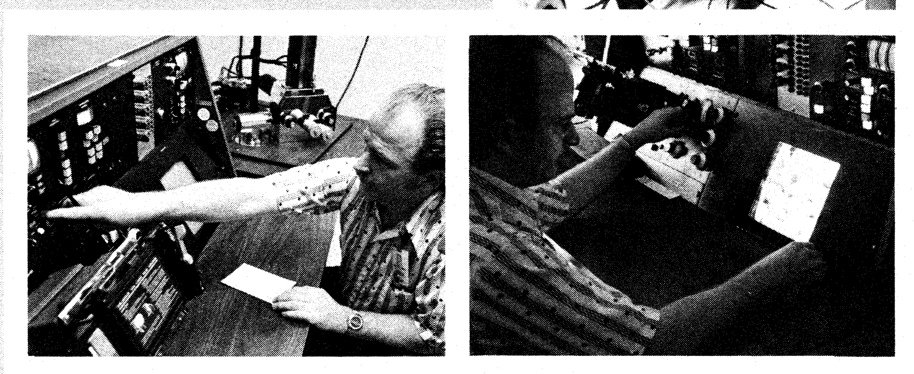


Device Testing




IQC Sign-off





Failure Analysis

**Collector-Emitter Shorts**
This is the most frequently reported failure mode of power transistors in the field. Collector-to-emitter shorts can result from a number of causes but the end result is usually chip overheating, and subsequent alloying of the aluminum metal through the active regions of the chip resulting in a shorted device.

Failure analysis involves:

Looking for foreign contamination which may have shorted the collector-base junction.

Looking for evidence of alloyed aluminum and its location. If failure occurred during forward-bias operation of the emitter-base junction, the failure will usually occur away from the emitter bond. If the emitter-base junction was reverse biased, the alloyed region is more typically adjacent to or under the emitter bond.

Removing the chip and looking for evidence of voids in the die-attach interface, which could have caused excessive chip temperature even though the header temperature remained within acceptable limits.

**$I_{SB}/E_{SB}$/SOA**
$I_{SB}$ is forward-biased second breakdown or "current snapback"; $E_{SB}$ is reverse-biased second breakdown. Each results in chip overheating and alloyed aluminum problems. SOA is safe-operating area and refers to both $I_{SB}/E_{SB}$ in general. For most design considerations, once the SOA of a device is exceeded, catastrophic heating failure occurs immediately.

**$I_{CEO}/I_{CBO}$**
This leakage can be caused by any contamination on or near the collector-base junction. The contamination may be wafer related, assembly related or package related. The leakage affects subsequent circuit stages and causes $V_{CE} \times I_{CE}$ to generate excess heat in the power transistor.

**$I_{EBO}$ Drift**
This is normally caused by ionic contamination of the wafer oxide. Because of the lower voltage involved, external contamination is usually not a factor. Main concern is loss of low current-gain performance.

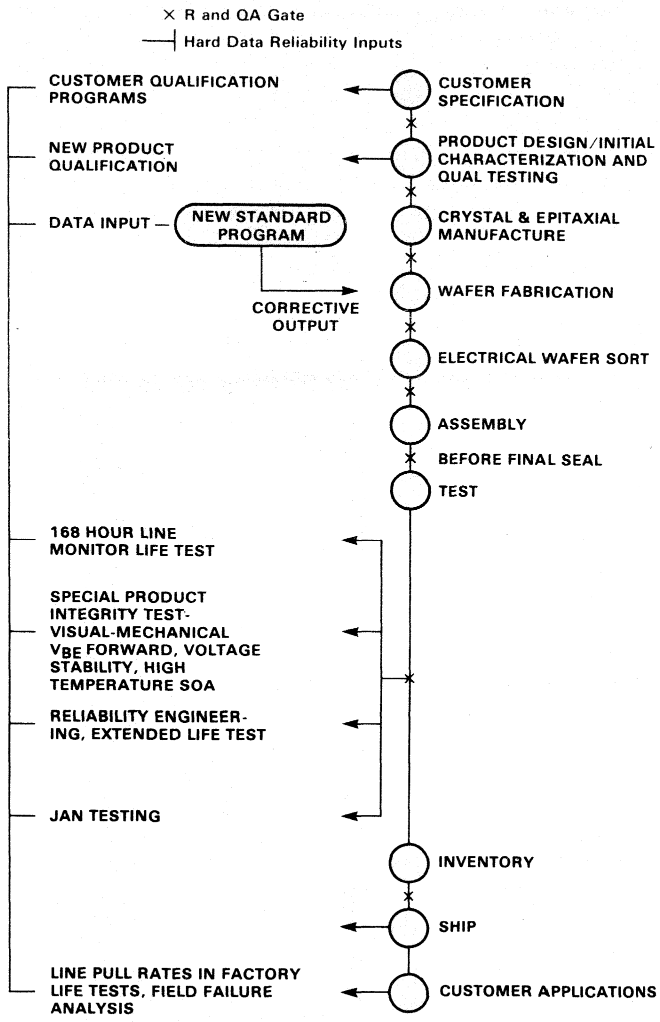
**$h_{FE}$ Degradation**
This is essentially the same as $I_{EBO}$ drift, but bulk degradation, usually near the surface, can occur from high $I_{EBO}$ leakage or if the emitter-base junction is sustained in avalanche.

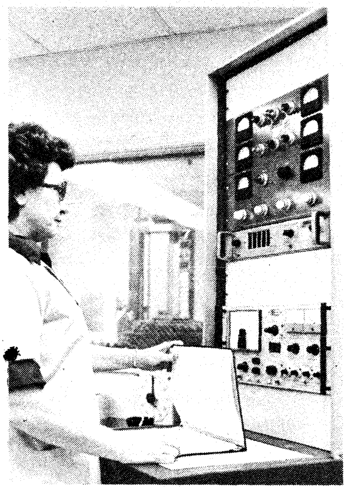
**Opens**
Opens can occur in the base or emitter circuits due to wires breaking or becoming detached and in the collector circuit if the die becomes separated from the header. The most common open failures are found in the emitter circuit since it usually has the highest current density.

## RELIABILITY MONITOR AND CONTROL

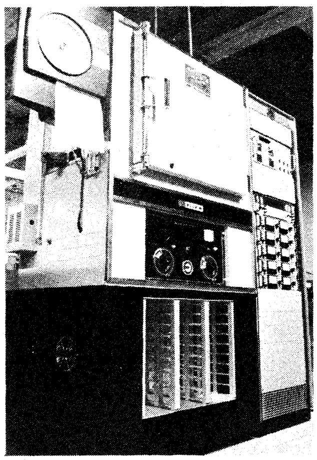
Through a central product filing review system, inputs from the areas discussed above are compared with life test data being continually generated. From this review system, necessary actions can be defined, documented and initiated. The reliability program using this review system is called the *new standard* program. The new standard program recognizes the total reliability concept and results in giving better definition of each product's reliability characteristics to enable the customer to use the product more effectively.

**Life Cycle Flow Chart** *(Figure 5-2)*
As part of the new standard program, Fairchild employs a product life-cycle monitor and test system, planned to define control and improve device reliability.



**Line Monitor**



**HTRB System**

**Fig. 5-2. Product Reliability Life Cycle Flow Chart**

## Line Monitors

Line monitors are used to monitor the production line on a weekly basis. These tests are accelerated and targeted to generate 10-20% failures. The following five test monitors are conducted on a routine basis.

High Temperature Reverse Bias
Intermittent Operating Life (Power Cycling)
High Temperature Storage
Temperature Cycling
Pressure Pot*

*applies to TO-220 devices only

**Power Cycling** *(Figure 5-3.)*

Fairchild has the capability of running power cycling tests under a wide variety of test conditions. The power cycle system utilizes unique circuitry for obtaining any $\Delta T_C$. Base-to-emitter voltage in a transistor consists of the forward diode drop, which decreases at about 2 mV per °C, and the IR drop due to the emitter current and the bulk resistance of the silicon which increases at a rate of about 0.7% per °C. Consequently the base-to-emitter voltage is a reasonably accurate measure of junction temperature. As each device under test heats up with the application of emitter current and, as the base-to-emitter voltage lowers to a preselected reference voltage, the collector voltage for each device is lowered to maintain the $V_{BE}$ and the junction temperature at a constant level. This means that any given case temperature can be maintained for any length of time within device limitations.

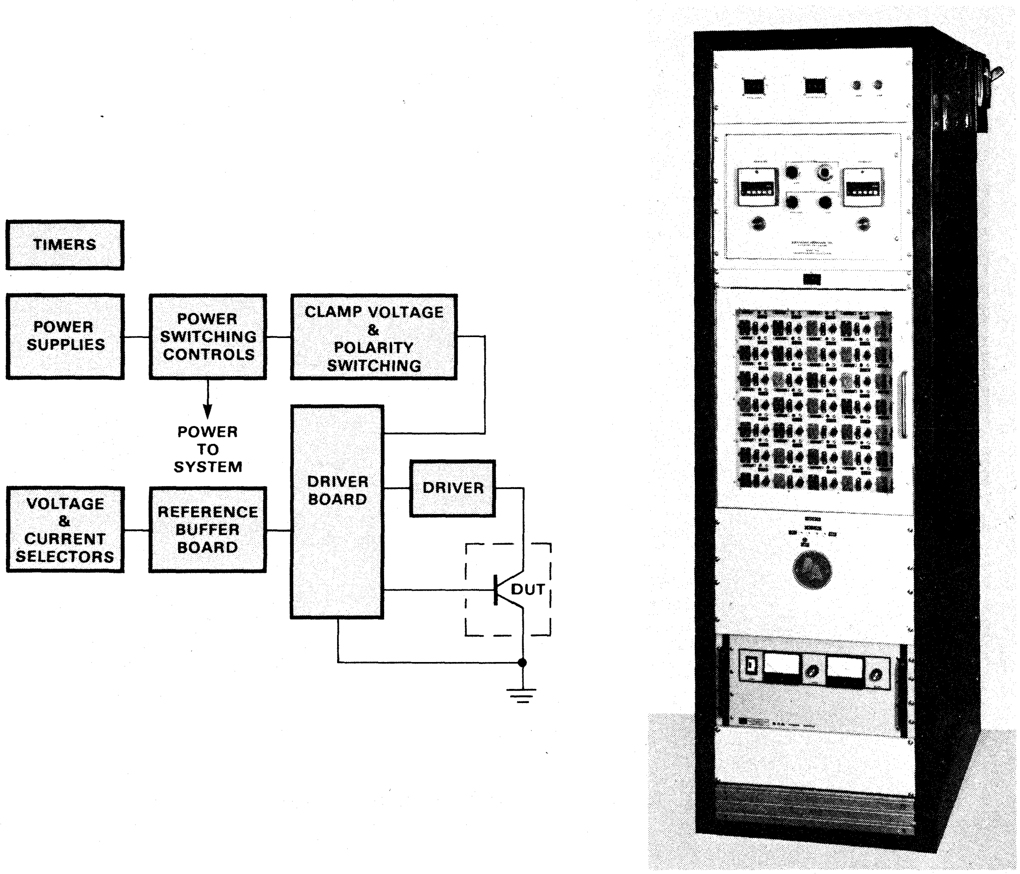



**Fig. 5-3. Power Cycling System**

**Reliability Engineering Extended Life Testing**

*Figure 5-4* gives recent failure rates experienced on the various package types for the indicated stress condition. This data is used extensively to improve process control. For example, high-temperature reverse-bias results from testing a Planar* chip in a TO-5 package are used as indicators of similarly processed products. Fairchild has a selection of basic Planar chips in TO-5 packages. By using line monitor results on each individual product line, common factors can be eliminated, and unique problem areas quickly defined. *Figure 5-5* indicates Fairchild's current reliability program.

**METAL CAN POWER**

| STRESS TEST | CONDITIONS | STRESS UNITS | FAILURE (RATES)* |
|---|---|---|---|
| Intermittent Operating Life (IOPL) TO-3 | $\Delta T_C = 53°C$<br>$P = 20$ W, $t_{on} = 35$ s<br>VCE = 7 V, $t_{off} = 5$ min. | 34,600/wk.<br>Device Cycles<br>Line Monitor Lot Data | ( .71) |
| (IOPL) TO-5 | $\Delta T_C = 35°C$<br>$P = 600$ mW, $t_{on} = 2$ min.<br>$V_{CC} = 20$ V, $t_{off} = 2$ min. | 250,000/wk.<br>Device Cycles<br>Line Monitor Lot Data | (1.23) |
| High Temperature Reverse Bias (HTRB) | $T_A = 150°C$<br>$V_{CE}$ = 80% rated voltage | 140,000 Device Hours<br>Line Monitor Lot Data | (2.62) |
| High Temperature Storage (HTS) | $T_A = 200°C$ | $7.012 \times 10^6$ Dev. Hours<br>Line Monitor Lot Data | ( .29) |
| Temperature Cycle | $T_A = -40°C$ to $+125°C$ | 17,500 Device Cycles | (4.0 ) |
| Operating Life (OPL) TO-5 | P = 600 mW | 140,000 Device Hours<br>Line Monitor Lot Data | (1.93) |

*Failures defined as inoperatives and degradation greater than specification limit +20%. Failure rates are best estimate, % per 1000 hours (cycles).

**PLASTIC POWER**

| STRESS TEST | CONDITIONS | STRESS UNITS | FAILURE (RATES)* |
|---|---|---|---|
| Intermittent Operating Life (IOPL) | $\Delta T_C = 90°C$<br>$P = 0.8$ W, $t_{on} = 45$ s<br>$V_{CE} = 8$ V, $t_{off} = 90$ s | $2.1 \times 10^6$ cycles/week<br>(100% Line Monitor Lot Data) | 10% at 9,255 cycles |
| High Temperature Reverse Bias (HTRB) | $T_C = 150°C$<br>$V_{CE}$ = 80% rated voltage | 4,320 Device Hours | 0 |
| Wet High Temperature Reverse Bias (WHTRB) | $T_A = 85°C$<br>RH = 85% | 17,336 Device Hours | 0 |
| High Temperature Storage (HTS) | $T_A = 150°C$ | $1 \times 10^6$ Device Hours | (.37) |
| Temperature Cycle | $T_A = -40°C$ to $+100°C$ | 12,500 Device Cycles | Four Failures |
| Temperature Shock | $T_A = 0$ to $+100°C$ | 2,500 Device Cycles | 0 |
| Moisture Resistance | $T_A = 40°C$<br>RH = 95% | 3,000 Device Hours | 0 |
| Pressure Pot | $T_A = 138°C$<br>P = 15 psi<br>t = 4 hours | 4,000 Device Hours | Two Failures |

*Where applicable, actual results are stated where data is insufficient to project meaningful failure rates. Failures defined as inoperatives. Failure rates are best estimate, % per 1000 hours (cycles).

**Fig. 5-4. Extended Life Test Data**

*Planar is a patented Fairchild process.

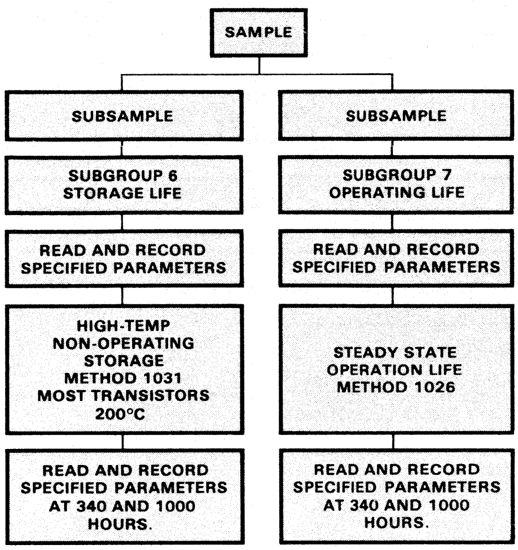
| TEST | TO-3 | TO-66 | TO-5 | TO-220 |
|---|---|---|---|---|
| **High Temperature Storage** $T_A$ = 200°C<br>(MIL-STD-750, Method 1031)<br>Readout at 0, 168, 500, 1000 Hours | X | X | X | X |
| **Intermittent Operating Life**<br>(MIL-STD-750, Method 1036) $\Delta T_C$ = 90°C<br>Readouts at 0, 5K, 10K, 15K, 20K Cycles | X | X | X | |
| **Intermittent Operating Life**<br>$\Delta T_C$ = 100°C<br>Readouts at 1, 5K, 10K, 20K Cycles | | | | X |
| **High Temperature Reverse Bias**<br>$T_A$ = 150°C, 80% $BV_{CEO}$<br>Readouts at 0, 168, 500, 1000 Hours | X | X | X | X |
| **Temperature Cycling** -65°C to +200°C<br>(MIL-STD-750, Method 1051, Cond. C)<br>Readouts at 0, 25 Cycles<br>Hermiticity ($1 \times 10^{-7}$) | X | X | X | |
| **Steady State Operating Life**<br>$T_J$ = 187.5°C ± 12.5°C<br>(MIL-STD-750, Method 1026)<br>Readouts at 0, 168, 500, 1000 Hours | X | X | X | |
| **Constant Acceleration**<br>F = 20K g<br>1 Min. Ea. 6 Axis<br>(MIL-STD-750, Method 2006) | X | X | X | |
| **Impact Shock**<br>1500 g x 5 Blows<br>(MIL-STD-750, Method 2016) | X | X | X | |
| **Vibration, Variable Frequency**<br>10 g<br>(MIL-STD-750, Method 2056) | X | X | X | |
| **Wet HTRB**<br>$T_A$ = 85°C, RH = 80% $BV_{CEO}$<br>Readouts at 0, 168, 500, 1000 Hours | | | | X |
| **Temperature Cycling** -40°C to +150°C<br>Readouts at 0, 25 Cycles | | | | X |
| **Pressure Pot**<br>$T_A$ = 123°C ± 2°C<br>15 PSI, 4 Hours | | | | X |
| **Shelf Life**<br>$T_A$ = 25°C<br>Readouts at 0, 1K, 2K, 10K Hours | | | | X |

**Fig. 5-5. Reliability Program 1976**

## JAN POWER DEVICES

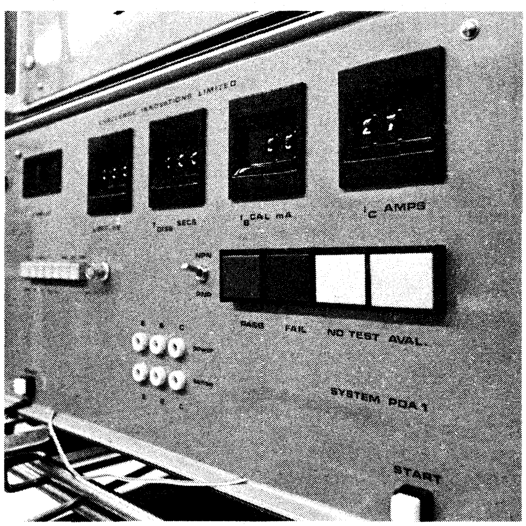
Fairchild power devices have the capability of meeting JAN performance criteria when subjected to the rigid requirements of JAN military specifications. The chart in *Figure 5-6* shows typical JAN acceptance testing.

LIFE TESTS




LTPD = LOT TOLERANCE PERCENT DEFECTIVE:
$\lambda$ = FAILURE RATE IN % PER 1000 HOURS

**Fig. 5-6. Typical JAN Acceptance Testing**




**Voltage-Monitoring System for JAN Devices**

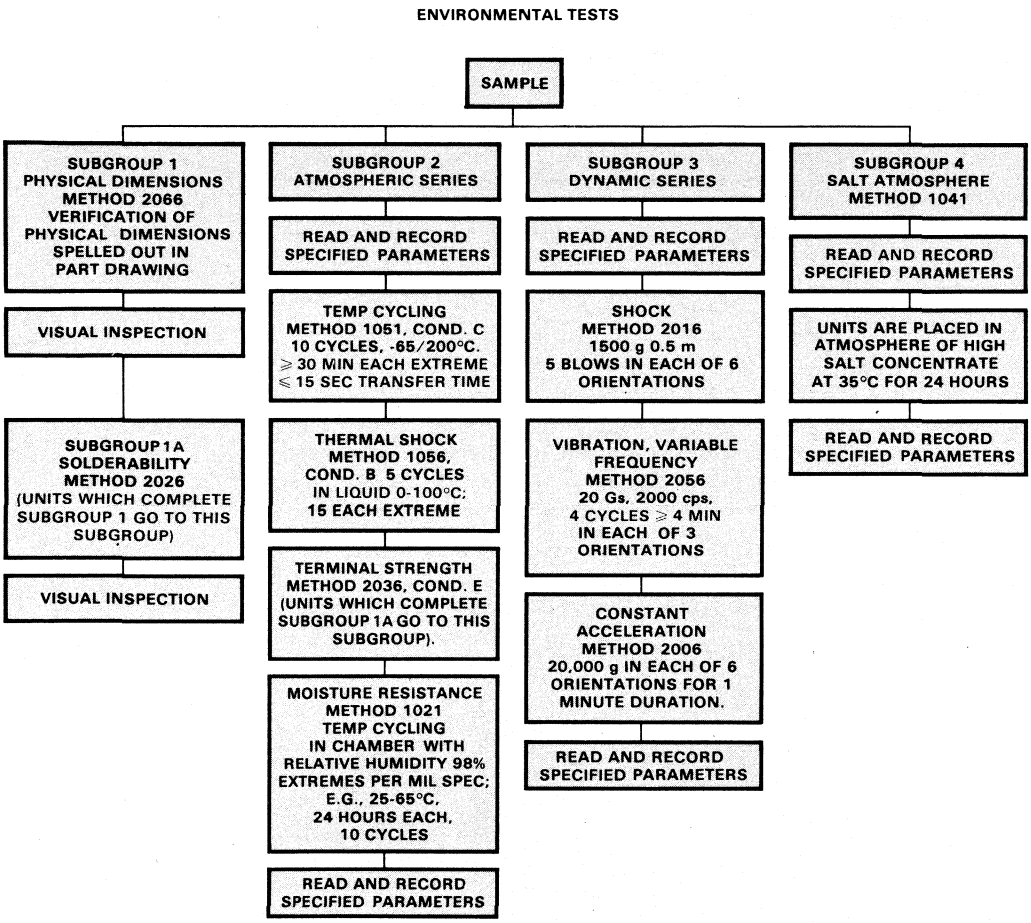



**Fig. 5-6. Typical JAN Acceptance Testing** (Cont'd)

POWER
POWER
POWER
POWER

# POWER TRANSISTOR

## NPN SILICON

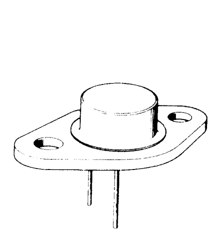
## 2N3054

### DESIGNED FOR INTERMEDIATE POWER APPLICATIONS IN INDUSTRIAL AND COMMERCIAL EQUIPMENT

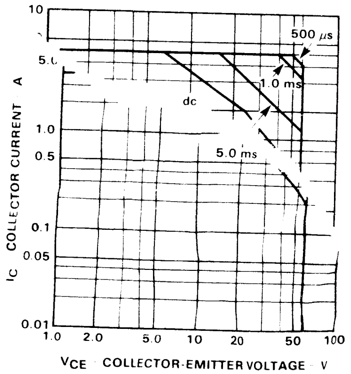
- 25 W DISSIPATION AT 25°C CASE
- 4.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 55 V MINIMUM $V_{CEO}$

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

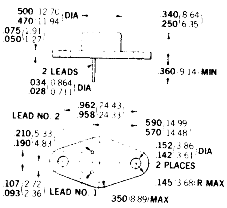
| | | 2N3054 |
|---|---|---|
| **Maximum Voltages and Currents** | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 55 V |
| $V_{CBO}$ | Collector to Base Voltage | 90 V |
| $V_{EBO}$ | Emitter to Base Voltage | 7.0 V |
| $I_C$ | Continuous Collector Current | 4.0 A |
| $I_B$ | Continuous Base Current | 2.0 A |
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 25 W |
| | Derate Linearly from 25°C | 0.143 W/°C |
| **Maximum Temperatures** | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +200°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 7.0°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-66) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated kovar
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Nickel-plated steel base and cap
Package weight is 6.5 grams

6

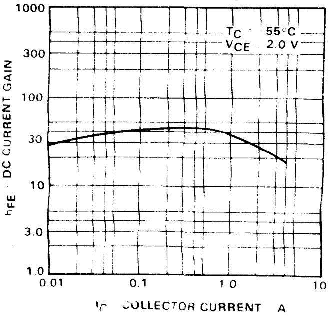
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N3054 MIN | 2N3054 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 55 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | V | $I_C = 100$ mA, $R_{BE} = 100\ \Omega$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0<br>6.0 | mA<br>mA | $V_{CE} = 90$ V, $V_{BE} = -1.5$ V<br>$V_{CE} = 90$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | mA | $V_{EB} = 7.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 25<br>5.0 | 150 | | $I_C = 500$ mA, $V_{CE} = 4.0$ V<br>$I_C = 3.0$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0<br>6.0 | V<br>V | $I_C = 500$ mA, $I_B = 50$ mA<br>$I_C = 3.0$ A, $I_B = 1.0$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.7 | V | $I_C = 500$ mA, $V_{CE} = 4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| $h_{fe}$ | Small Signal Current Gain | 25 | 180 | | $I_C = 100$ mA, $V_{CE} = 4.0$ V, f = 1.0 kHz |
| fhfe | Common-Emitter Cutoff Frequency | 30 | | kHz | $I_C = 100$ mA, $V_{CE} = 4.0$ V |

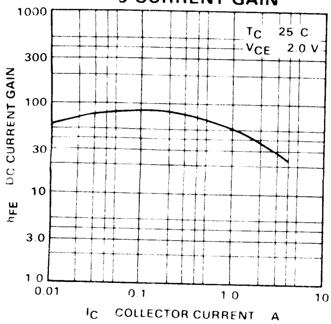
NOTE: 1. Pulse condition; Length = 300μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

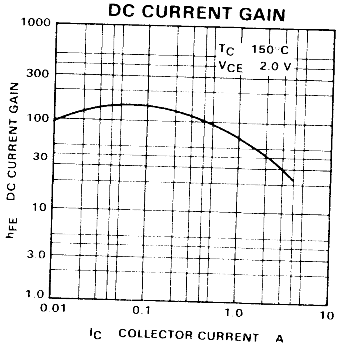
### DC CURRENT GAIN



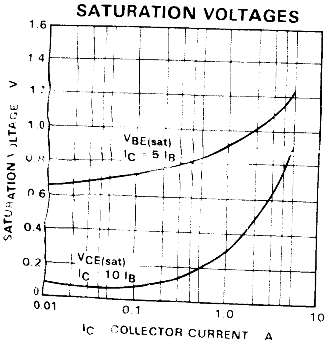

### DC CURRENT GAIN



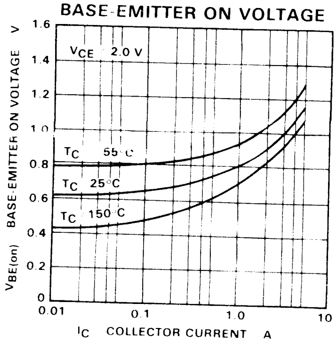

### DC CURRENT GAIN



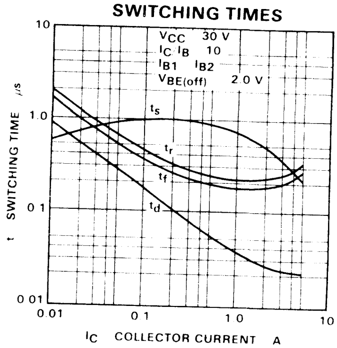

### SATURATION VOLTAGES



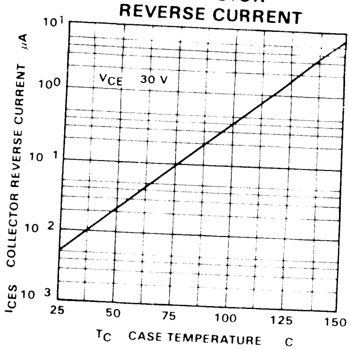

### BASE-EMITTER ON VOLTAGE



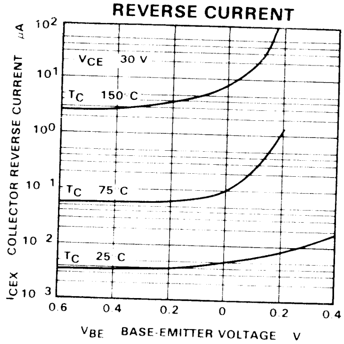

### SWITCHING TIMES




### COLLECTOR REVERSE CURRENT




### COLLECTOR REVERSE CURRENT




6

# POWER TRANSISTOR

## NPN SILICON

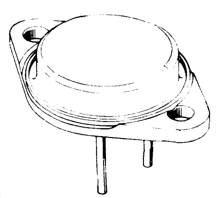
# 2N3055

### DESIGNED FOR GENERAL PURPOSE AMPLIFIER AND SWITCHING APPLICATIONS

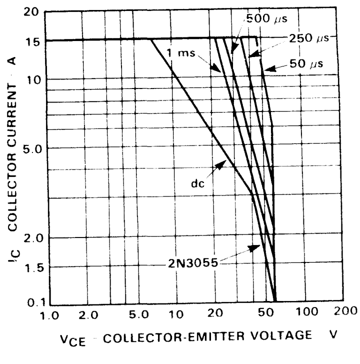
- 115 W DISSIPATION AT 25°C CASE
- 15 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- DC CURRENT GAIN SPECIFIED TO 10 A

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

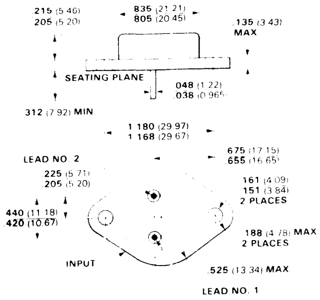
| | | |
|---|---|---|
| **Maximum Voltages and Currents** | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V |
| $V_{CBO}$ | Collector to Base Voltage | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 7.0 V |
| $I_C$ | Continuous Collector Current | 15 A |
| $I_B$ | Continuous Base Current | 7.0 A |
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 115 W |
| | Derate Linearly from 25°C | 0.65 W/°C |
| **Maximum Temperatures** | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +200°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.5°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10 s) | 235°C |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

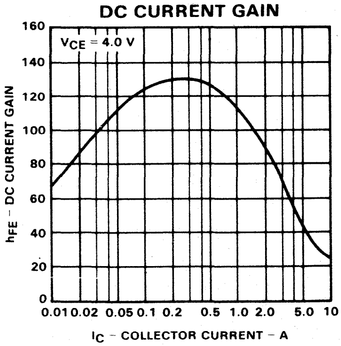
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N3055 MIN | 2N3055 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 70 | | V | $I_C = 200$ mA, $R_{BE} = 100\ \Omega$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.7 | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 5.0<br>30 | mA<br>mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V<br>$V_{CE} = 100$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | mA | $V_{EB} = 7.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 5.0<br>20 | <br>70 | | $I_C = 10$ A, $V_{CE} = 4.0$ V<br>$I_C = 4.0$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | 1.1<br>8.0 | | V<br>V | $I_C = 4.0$ A, $I_B = 400$ mA<br>$I_C = 10$ A, $I_B = 3.3$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.8 | V | $I_C = 4.0$ A, $V_{CE} = 4.0$ V |
| **SECOND BREAKDOWN** | | | | | |
| $I_{S/b}$ | Second Breakdown Collector Current with base forward biased | 2.5 | | A | t = 1.0s (non repetitive), $V_{CE} = 40$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| $h_{fe}$ | Small Signal Current Gain | 15 | 120 | | $I_C = 10$ A, $V_{CE} = 4.0$ V, f = 1.0 kHz |
| $f_{hfe}$ | Small Signal Cutoff Frequency | 10 | | kHz | $I_C = 1.0$ A, $V_{CE} = 4.0$ V |

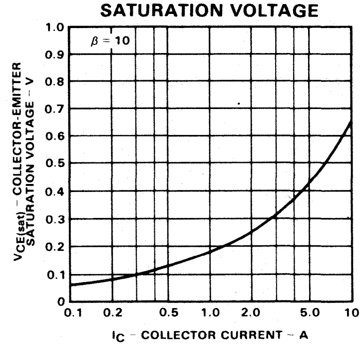
NOTE: 1. Pulse conditions: Length = 300 $\mu$s, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

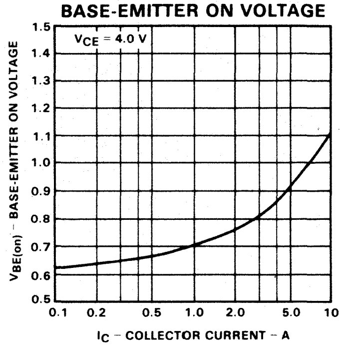
**DC CURRENT GAIN**




**COLLECTOR-EMITTER SATURATION VOLTAGE**




**BASE-EMITTER ON VOLTAGE**



# POWER TRANSISTOR

## NPN SILICON

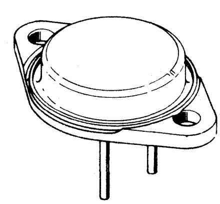
# 2N3055SD

### DESIGNED FOR SERIES AND SHUNT REGULATORS POWER-SWITCHING CIRCUITS AND SOLENOID DRIVER APPLICATIONS IDEAL FOR A BROAD RANGE OF INDUSTRIAL AND COMMERCIAL USES

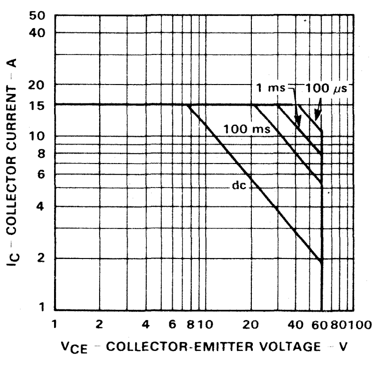
- 115 W DISSIPATION AT 25°C CASE
- 15 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- SOA (60 V, 1.95 A) GUARANTEED
- EQUIVALENT SINGLE DIFFUSED 2N3055

## ABSOLUTE MAXIMUM RATINGS

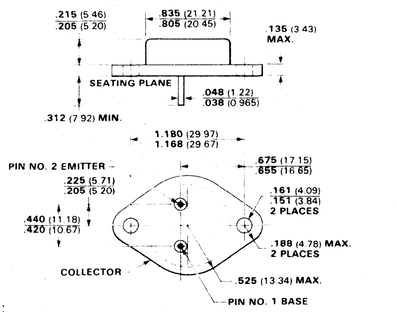
| | | |
|---|---|---|
| **Maximum Voltages and Currents** | | |
| $V_{CE}$ | Collector to Emitter Voltage | 60 V |
| $V_{CB}$ | Collector to Base Voltage | 100 V |
| $V_{EB}$ | Emitter to Base Voltage | 7 V |
| $I_C$ | Continuous Collector Current | 15 A |
| $I_B$ | Continuous Base Current | 7 A |
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 115 W |
| | Derate Linearly from 25°C | .657 W/°C |
| **Maximum Temperatures** | | |
| $T_J$, $T_{stg}$ | Storage and Operating Junction Temperatures | −65°C to +200°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.55°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 5 s) | 235°C |



SAFE OPERATING AREA




JEDEC (TO-3) Outline




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | MIN | MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 70 | | V | $I_C = 200$ mA, $R_{BE} = 100\ \Omega$ |
| $V_{CEX(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 90 | | V | $I_C = 100$ mA, $V_{BE(off)} = -1.5$ V |
| $I_{CEO}$ | Collector Cutoff Current | | 0.7 | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 5.0<br>30 | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V<br>$V_{CE} = 100$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | mA | $V_{EB} = 7.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20<br>5.0 | 70 | | $I_C = 4.0$ A, $V_{CE} = 4.0$ V<br>$I_C = 10$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.1<br>8.0 | V | $I_C = 4.0$ A, $I_B = 0.4$ A<br>$I_C = 10$ A, $I_B = 3.3$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.8 | V | $I_C = 4.0$ A, $V_{CE} = 4.0$ V |
| **SECOND BREAKDOWN** | | | | | |
| $I_{s/b}$ | Second Breakdown Collector Current with Base Forward Biased | 1.95 | | A | t = 1.0 s (non-repetitive) $V_{CE} = 60$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 800 | | kHz | $I_C = 1.0$ A, $V_{CE} = 4.0$ V, f = 0.4 MHz |
| $f_{hfe}$ | Common Emitter Small Signal Cutoff Frequency | 10 | | kHz | $I_C = 1.0$ A, $V_{CE} = 4.0$ V |
| $h_{fe}$ | Small Signal Current Gain | 15 | 120 | | $I_C = 1.0$ A, $V_{CE} = 4.0$ V, f = 1 kHz |

NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

# POWER TRANSISTOR

## NPN SILICON

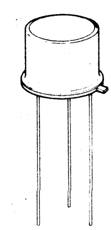
# 2N3439
# 2N3440

### HIGH VOLTAGE POWER TRANSISTORS DESIGNED FOR USE IN CONSUMER AND INDUSTRIAL LINE-OPERATED APPLICATIONS

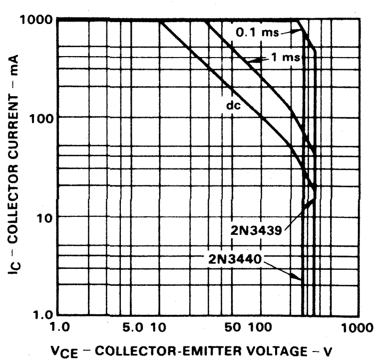
- 10 W DISSIPATION AT 25°C CASE
- 1.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 350 V MINIMUM $V_{CEO}$ (2N3439)

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

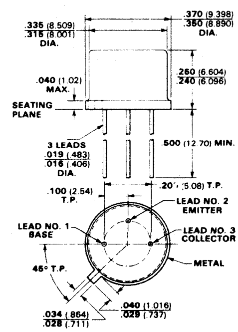
| | | 2N3439 | 2N3440 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 350 V | 250 V |
| $V_{CBO}$ | Collector to Base Voltage | 450 V | 300 V |
| $V_{EBO}$ | Emitter to Base Voltage | 7.0 V | 7.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A | 1.0 A |
| $I_B$ | Continuous Base Current | 0.5 A | 0.5 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 10 W |
| | Derate Linearly from 25°C | | 0.57 W/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 17.5°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) outline**



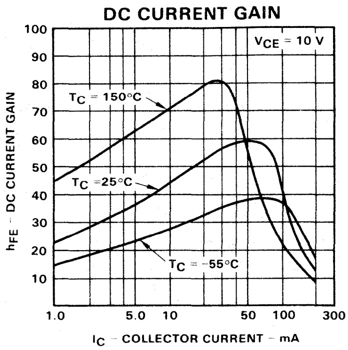

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

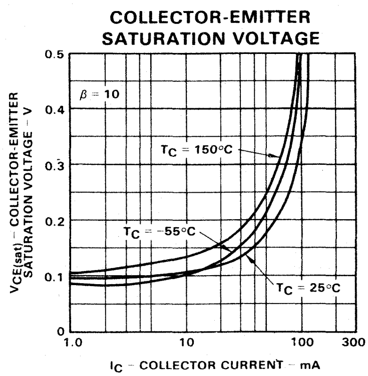
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

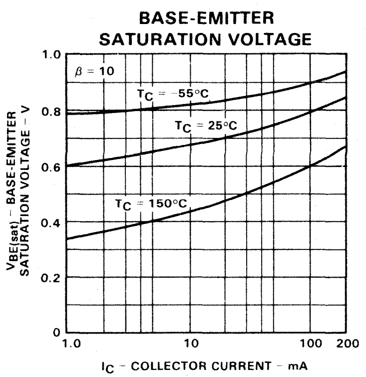
| SYMBOL | CHARACTERISTIC | 2N3439 MIN | 2N3439 MAX | 2N3440 MIN | 2N3440 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 350 | | 250 | | V | $I_C = 50$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 20 | | | μA | $V_{CE} = 300$ V, $I_B = 0$ |
| | | | | | 50 | μA | $V_{CE} = 200$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 500 | | | μA | $V_{CE} = 450$ V, $V_{BE} = -1.5$ V |
| | | | | | 500 | μA | $V_{CE} = 300$ V, $V_{BE} = -1.5$ V |
| $I_{CBO}$ | Collector Cutoff Current | | 20 | | | μA | $V_{CB} = 360$ V, $I_E = 0$ |
| | | | | | 20 | μA | $V_{CB} = 250$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 20 | | 20 | μA | $V_{EB} = 6.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30 | | | | | $I_C = 2.0$ mA, $V_{CE} = 10$ V |
| | | 40 | 160 | 40 | 160 | | $I_C = 20$ mA, $V_{CE} = 10$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.5 | | 0.5 | V | $I_C = 50$ mA, $I_B = 4.0$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.3 | | 1.3 | V | $I_C = 50$ mA, $I_B = 4.0$ mA |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 15 | | 15 | | MHz | $I_C = 10$ mA, $V_{CE} = 10$ V, $f = 5.0$ MHz |
| $C_{ob}$ | Output Capacitance | | 10 | | 10 | pF | $V_{CB} = 10$ V, $I_E = 0$, $f = 1.0$ MHz |
| $C_{ib}$ | Input Capacitance | | 75 | | 75 | pF | $V_{EB} = 5.0$ V, $I_C = 0$, $f = 1.0$ MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | | $I_C = 5.0$ mA, $V_{CE} = 10$ V, $f = 1.0$ kHz |

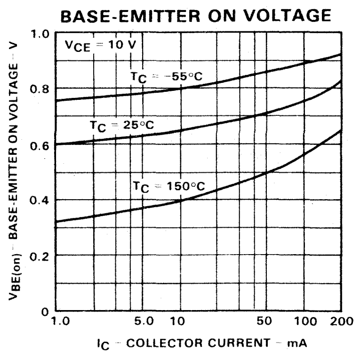
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

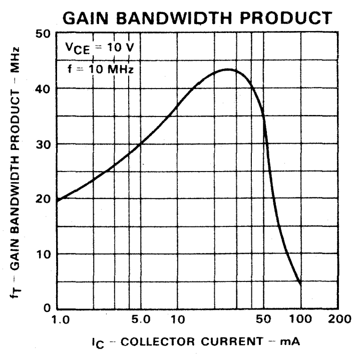
## TYPICAL ELECTRICAL CHARACTERISTICS



# POWER TRANSISTOR

NPN SILICON

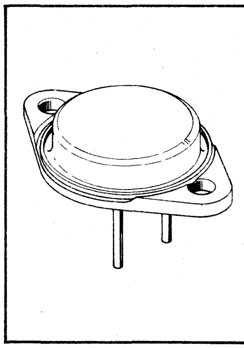
**2N3713**
**2N3714**
**2N3715**
**2N3716**

## DESIGNED FOR MEDIUM-SPEED SWITCHING AND AMPLIFIER APPLICATIONS

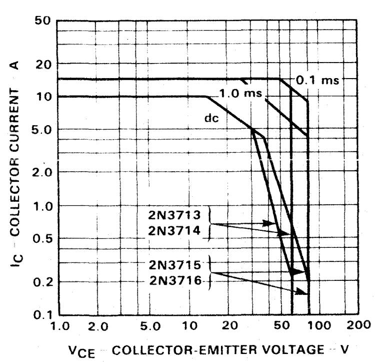
- 150 W DISSIPATION AT 25°C CASE
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS 2N3789 THRU 2N3792

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

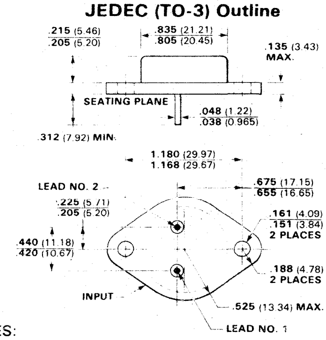
| Maximum Voltages and Currents | | 2N3713 | 2N3714 | 2N3715 | 2N3716 |
|---|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V | 80 V | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 80 V | 100 V | 80 V | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 7.0 V | 7.0 V | 7.0 V | 7.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A | 10 A | 10 A |
| $I_B$ | Continuous Base Current | 4.0 A | 4.0 A | 4.0 A | 4.0 A |
| **Maximum Power Dissipation** | | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | | 150 W |
| | Derate Linearly from 25°C | | | | 0.86 W/°C |
| **Maximum Temperatures** | | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | | −65°C to 200°C |
| **Thermal Characteristics** | | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | | 1.17°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**



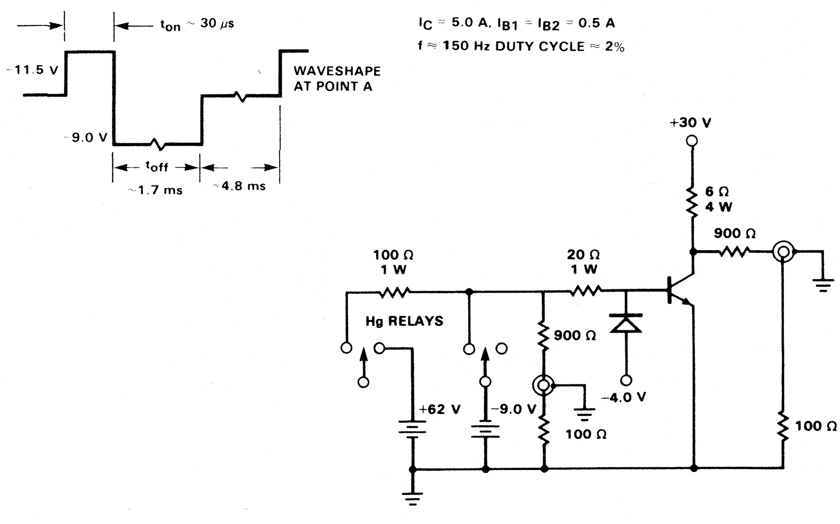

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N3713 | | 2N3714 | | 2N3715 | | 2N3716 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | 60 | | 80 | | V | $I_C$ = 200 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 0.7 | | | | 0.7 | | | mA | $V_{CE}$ = 30 V, $I_B$ = 0 |
| | | | | | 0.7 | | | | 0.7 | mA | $V_{CE}$ = 40 V, $I_B$ = 0 |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0 | | | | 1.0 | | | mA | $V_{CE}$ = 80 V, $V_{BE}$ = −1.5 V |
| | | | | | 1.0 | | | | 1.0 | mA | $V_{CE}$ = 100 V, $V_{BE}$ = −1.5 V |
| | | | 10 | | | | 10 | | | mA | $V_{CE}$ = 60 V, $V_{BE}$ = −1.5 V, $T_C$ = 150°C |
| | | | | | 10 | | | | 10 | mA | $V_{CE}$ = 80 V, $V_{BE}$ = −1.5 V, $T_C$ = 150°C |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = 7.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 5.0 | | 5.0 | | 5.0 | | 5.0 | | | $I_C$ = 10 A, $V_{CE}$ = 4.0 V |
| | | 25 | 75 | 25 | 75 | 50 | 150 | 50 | 150 | | $I_C$ = 1.0 A, $V_{CE}$ = 2.0 V |
| | | 15 | | 15 | | 30 | | 30 | | | $I_C$ = 3.0 A, $V_{CE}$ = 2.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | | 0.8 | | 0.8 | V | $I_C$ = 5.0 A, $I_B$ = 500 mA |
| | | | 4.0 | | 4.0 | | 4.0 | | 4.0 | V | $I_C$ = 10 A, $I_B$ = 2.0 A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.0 | | 2.0 | | 1.8 | | 1.8 | V | $I_C$ = 5.0 A, $V_{CE}$ = 2.0 V |
| | | | 4.0 | | 4.0 | | 4.0 | | 4.0 | V | $I_C$ = 10 A, $V_{CE}$ = 4.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 250 | | 250 | | 250 | | 250 | pF | $V_{CB}$ = 10 V, $I_E$ = 0, f = 0.1 MHz |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 4.0 | | 4.0 | | 4.0 | | 4.0 | | | $I_C$ = 500 mA, $V_{CE}$ = 10 V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | 250 | 25 | 250 | 25 | 250 | 25 | 250 | | $I_C$ = 500 mA, $V_{CE}$ = 10 V, f = 1.0 kHz |
| $f_{hfe}$ | Small Signal Cutoff Frequency | 30 | | 30 | | 30 | | 30 | | kHz | $I_C$ = 500 mA, $V_{CE}$ = 10 V |

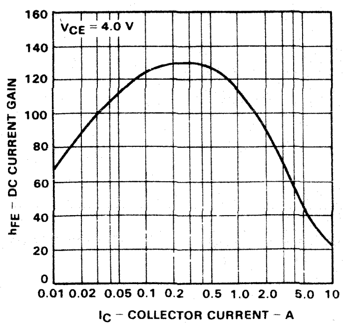
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

**TEST CIRCUIT**

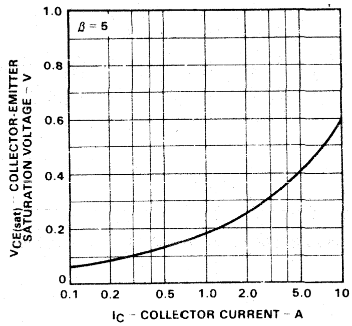


## TYPICAL ELECTRICAL CHARACTERISTICS

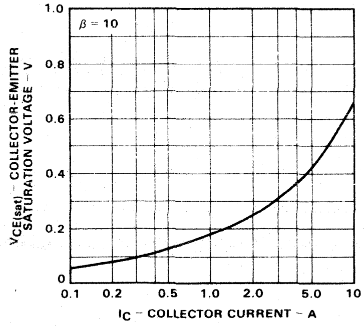
### DC CURRENT GAIN



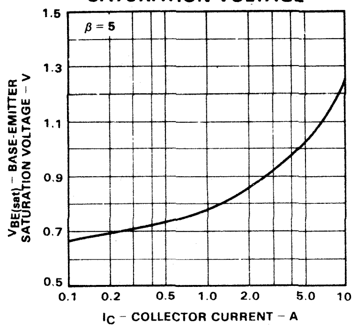

### COLLECTOR-EMITTER SATURATION VOLTAGE



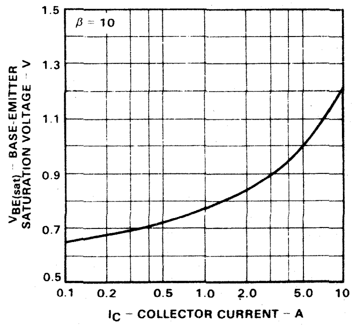

### COLLECTOR-EMITTER SATURATION VOLTAGE



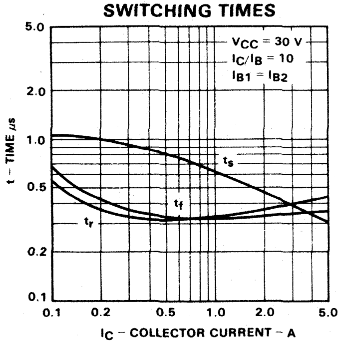

### BASE-EMITTER SATURATION VOLTAGE



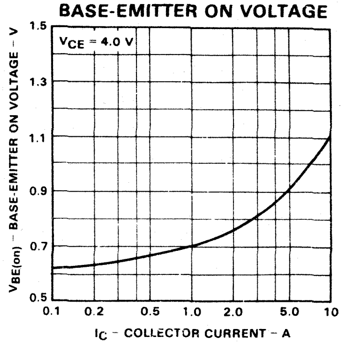

### BASE-EMITTER SATURATION VOLTAGE




### SWITCHING TIMES




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

## PNP SILICON

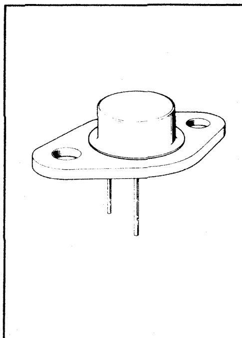
## 2N3740
## 2N3741

### MEDIUM POWER DEVICES, IDEAL FOR USE AS DRIVERS, SWITCHES AND DIRECT REPLACEMENT OF GERMANIUM TRANSISTORS

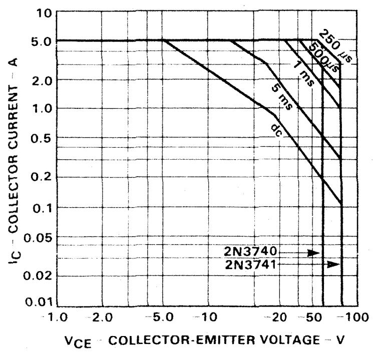
- **25 W DISSIPATION AT 25°C CASE**
- **1.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **COMPLEMENTS 2N3766, 2N3767**

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

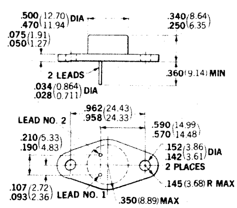
| | | 2N3740 | 2N3741 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −7.0 V | −7.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A | 1.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 25 W |
| | Derate Linearly from 25°C | | 0.14 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 7.0°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-66) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated kovar
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Nickel-plated steel base and cap
Package weight is 6.5 grams

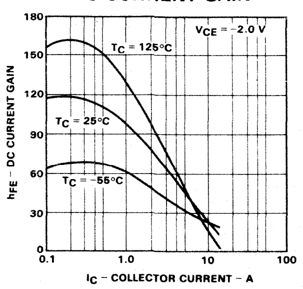
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N3740 MIN | 2N3740 MAX | 2N3741 MIN | 2N3741 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | −80 | | V | $I_C$ = 100 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CE}$ = −40 V, $I_B$ = 0 |
| | | | | | 1.0 | mA | $V_{CE}$ = −60 V, $I_B$ = 0 |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 1.5 V |
| | | | | | 0.1 | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 1.5 V |
| | | | 1.0 | | | mA | $V_{CE}$ = −40 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| | | | | | 1.0 | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| $I_{CBO}$ | Collector Cutoff Current | | 0.1 | | | mA | $V_{CB}$ = −60 V, $I_E$ = 0 |
| | | | | | 0.1 | mA | $V_{CB}$ = −80 V, $I_E$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.5 | | 0.5 | mA | $V_{EB}$ = 7.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | | 40 | | | $I_C$ = 100 mA, $V_{CE}$ = −1.0 V |
| | | 30 | 100 | 30 | 100 | | $I_C$ = 250 mA, $V_{CE}$ = −1.0 V |
| | | 20 | | 20 | | | $I_C$ = 500 mA, $V_{CE}$ = −1.0 V |
| | | 10 | | 10 | | | $I_C$ = 1.0 A, $V_{CE}$ = −1.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −0.6 | | −0.6 | V | $I_C$ = 1.0 A, $I_B$ = 125 mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.0 | | −1.0 | V | $I_C$ = 250 mA, $V_{CE}$ = −1.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | MHz | $I_C$ = 100 mA, $V_{CE}$ = −10 V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 100 | | 100 | pF | $V_{CB}$ = −10 V, $I_E$ = 0, f = 0.1 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | | $I_C$ = 50 mA, $V_{CE}$ = −10 V, f = 1.0 kHz |

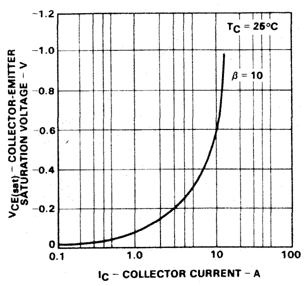
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

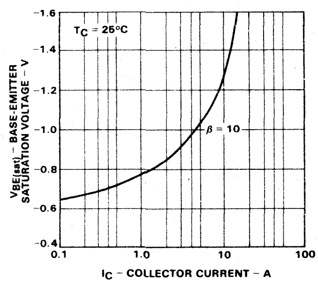
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

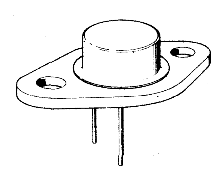
# 2N3766
# 2N3767

### MEDIUM POWER SILICON TRANSISTOR FOR USE IN DRIVER CIRCUITS, SWITCHING AND MEDIUM POWER AMPLIFIERS APPLICATIONS

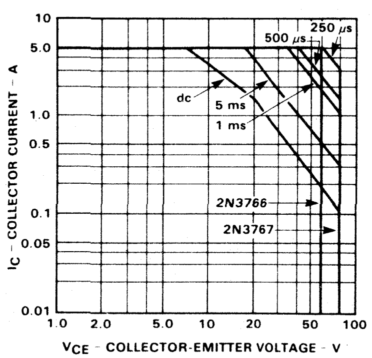
- 20 W DISSIPATION AT 25°C CASE
- 4.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENT 2N3740, 2N3741

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

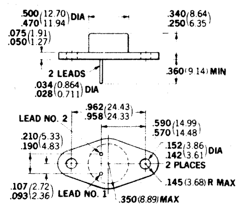
| | | 2N3766 | 2N3767 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 80 V | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 6.0 V | 6.0 V |
| $I_C$ | Continuous Collector Current | 4.0 A | 4.0 A |
| $I_B$ | Continuous Base Current | 2.5 A | 2.5 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 20 W |
| | Derate Linearly from 25°C | | 0.133 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to 175°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 7.5°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-66) Outline**



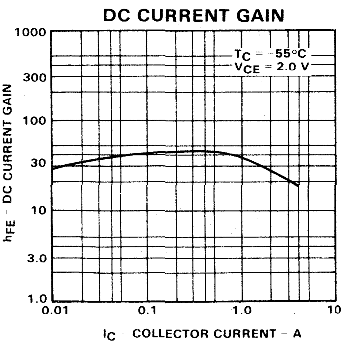

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated kovar
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Nickel-plated steel base and cap
Package weight is 6.5 grams

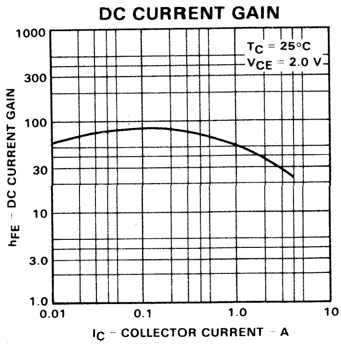
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

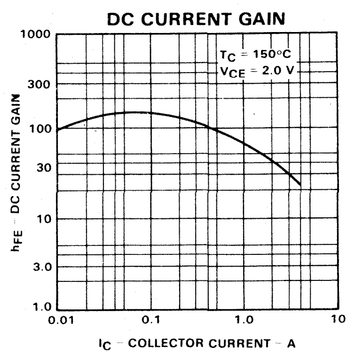
| SYMBOL | CHARACTERISTIC | 2N3766 | | 2N3767 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.7 | | | mA | $V_{CE} = 60$ V, $I_B = 0$ |
| | | | | | 0.7 | mA | $V_{CE} = 80$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.1 | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V |
| | | | 1.0 | | | mA | $V_{CE} = 50$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 1.0 | mA | $V_{CE} = 70$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.1 | | | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| | | | | | 0.1 | mA | $V_{CB} = 100$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.75 | | 0.75 | mA | $V_{EB} = 6.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30 | | 30 | | | $I_C = 50$ mA, $V_{CE} = 10$ V |
| | | 40 | 160 | 40 | 160 | | $I_C = 500$ mA, $V_{CE} = 5.0$ V |
| | | 20 | | 20 | | | $I_C = 1.0$ A, $V_{CE} = 5.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | V | $I_C = 500$ mA, $I_B = 50$ mA |
| | | | 2.5 | | 2.5 | V | $I_C = 1.0$ A, $I_B = 100$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.5 | | 1.5 | V | $I_C = 1.0$ A, $V_{CE} = 10$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 10 | | 10 | | MHz | $I_C = 500$ mA, $V_{CE} = 10$ V |
| $C_{ob}$ | Output Capacitance | | 50 | | 50 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $h_{fe}$ | Small Signal Current Gain | 40 | | 40 | | | $I_C = 100$ mA, $V_{CE} = 10$ V, f = 1.0 kHz |

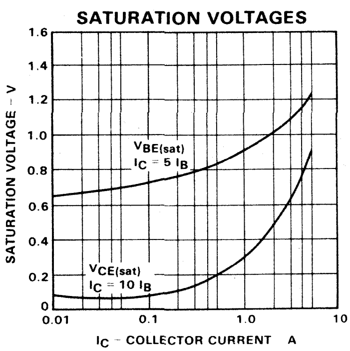
NOTE: 1. Pulse conditions: Length = 300 $\mu s$, Duty Cycle = 2%.

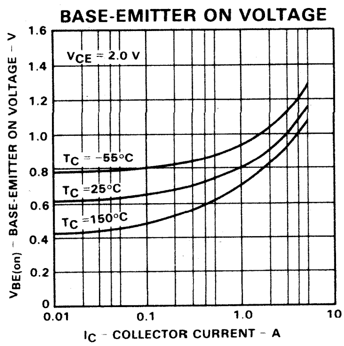
## TYPICAL ELECTRICAL CHARACTERISTICS

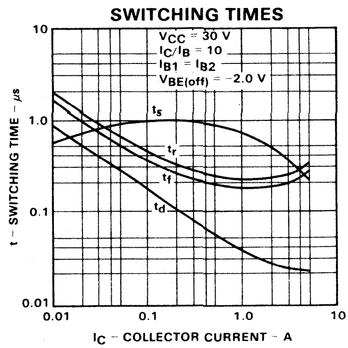


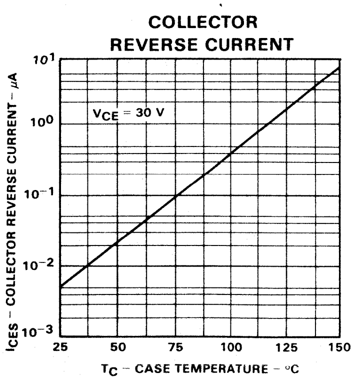



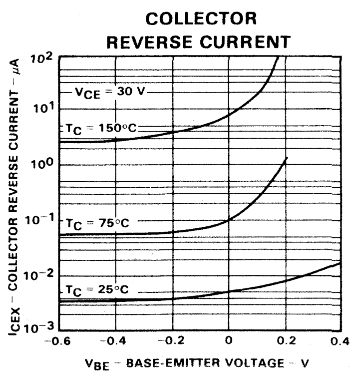



# POWER TRANSISTOR

## NPN SILICON

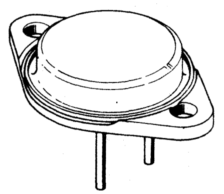
# 2N3771
# 2N3772

## HIGH CURRENT, HIGH POWER DEVICES FOR USE IN AUDIO AMPLIFIERS, SERIES AND SHUNT REGULATOR DRIVER AND OUTPUT STAGES

- 150 W DISSIPATION AT 25°C CASE
- 30 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- LOW SATURATION VOLTAGE WITH HIGH BETA

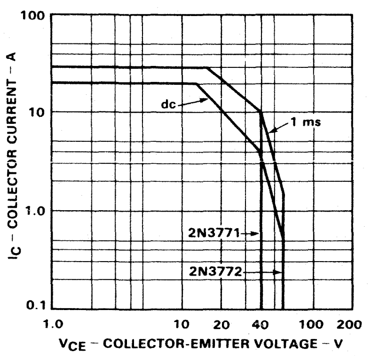
**ABSOLUTE MAXIMUM RATINGS** (Note 1)

| | | 2N3771 | 2N3772 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V |
| $V_{CBO}$ | Collector to Base Voltage | 50 V | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 30 A | 20 A |
| $I_C$ | Peak Collector Current | 30 A | 30 A |
| $I_B$ | Continuous Base Current | 7.5 A | 5.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @25°C Case Temperature | | 150 W |
| | Derate Linearly from 25°C | | 0.857 W/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 1.17°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 5.0 s) | | 230°C |

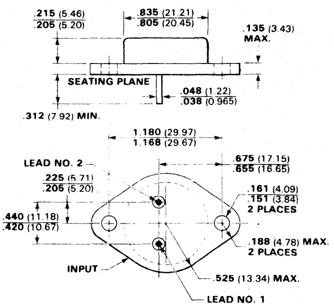


6

### SAFE OPERATING AREA




### JEDEC (TO-3) Outline




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

# FAIRCHILD • 2N3771 • 2N3772

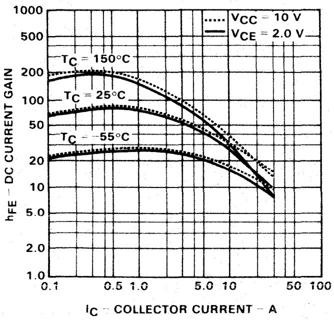
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N3771 MIN | 2N3771 MAX | 2N3772 MIN | 2N3772 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 10 | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | 10 | mA | $V_{CE} = 50$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 2.0 | | | mA | $V_{CE} = 50$ V, $V_{BE} = -1.5$ V |
| | | | | | 5.0 | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V |
| | | | 10 | | 10 | mA | $V_{CE} = 30$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 2.0 | | | mA | $V_{CB} = 50$ V, $I_E = 0$ |
| | | | | | 5.0 | mA | $V_{CB} = 100$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| | | | | | 5.0 | mA | $V_{EB} = 7.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 15 | 60 | | | | $I_C = 15$ A, $V_{CE} = 4.0$ V |
| | | 5.0 | | | | | $I_C = 30$ A, $V_{CE} = 4.0$ V |
| | | | | 15 | 60 | | $I_C = 10$ A, $V_{CE} = 4.0$ V |
| | | | | 5.0 | | | $I_C = 20$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 2.0 | | | V | $I_C = 15$ A, $I_B = 1.5$ A |
| | | | 4.0 | | | V | $I_C = 30$ A, $I_B = 6.0$ A |
| | | | | | 1.4 | V | $I_C = 10$ A, $I_B = 1.0$ A |
| | | | | | 4.0 | V | $I_C = 20$ A, $I_B = 4.0$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.7 | | | V | $I_C = 15$ A, $V_{CE} = 4.0$ V |
| | | | | | 2.2 | V | $I_C = 10$ A, $V_{CE} = 4.0$ V |
| **SECOND BREAKDOWN** | | | | | | | |
| $I_{S/b}$ | Second Breakdown Collector Current With Base Forward Biased | 3.75 | | | | A | $V_{CE} = 40$ V, t = 1.0 s (non-repetitive) |
| | | | 2.5 | | | A | $V_{CE} = 60$ V, t = 1.0 s (non-repetitive) |
| $E_{S/b}$ | Second Breakdown Energy With Base Reversed Biased | 500 | | 500 | | mJ | $I_C = 5.0$ A, $V_{BE(off)} = -1.5$ V, L = 40 mH, $R_{BE} = 100\ \Omega$ |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 4.0 | | 4.0 | | | $I_C = 1.0$ A, $V_{CE} = 4.0$ V, f = 50 kHz |
| $h_{fe}$ | Small Signal Current Gain | 40 | | 40 | | | $I_C = 1.0$ A, $V_{CE} = 4.0$ V, f = 1.0 kHz |

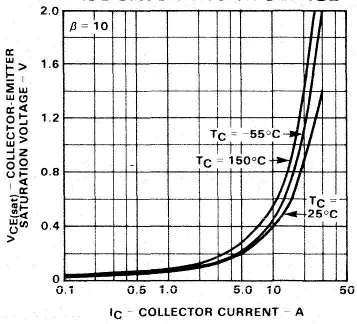
NOTE: 1. Pulse conditions: Length = 300 $\mu$s, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

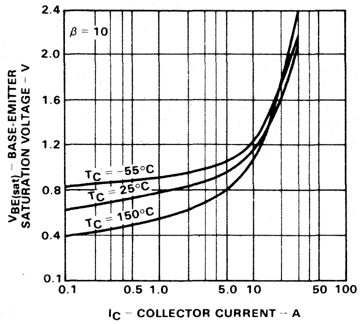
### DC CURRENT GAIN



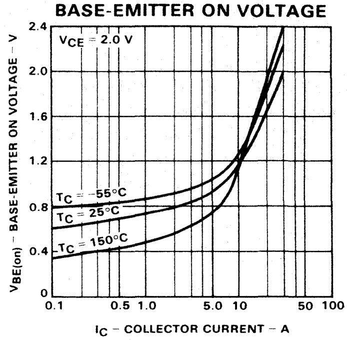

### BASE SATURATION VOLTAGE



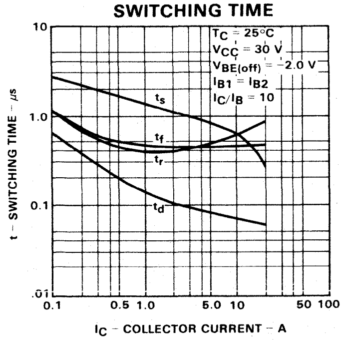

### COLLECTOR SATURATION VOLTAGE



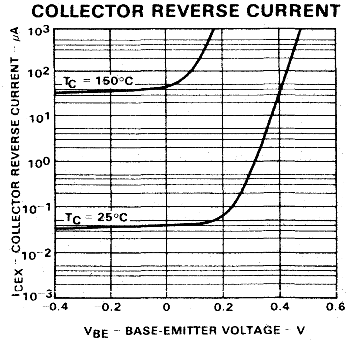

### BASE-EMITTER ON VOLTAGE



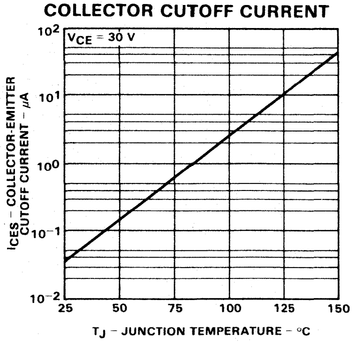

### SWITCHING TIME




### COLLECTOR REVERSE CURRENT




### COLLECTOR CUTOFF CURRENT



# POWER TRANSISTOR

## PNP SILICON

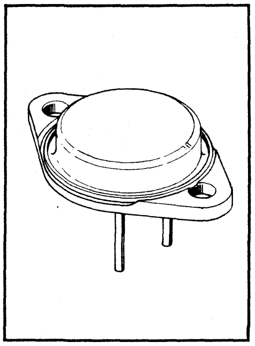
## 2N3789 2N3790 2N3791 2N3792

### DESIGNED FOR MEDIUM-SPEED SWITCHING AND AMPLIFIER APPLICATIONS

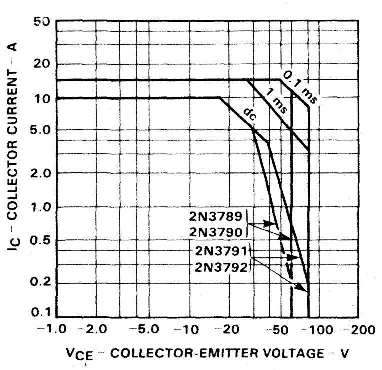
- 150 W DISSIPATION AT 25°C CASE
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS 2N3713 THRU 2N3716

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

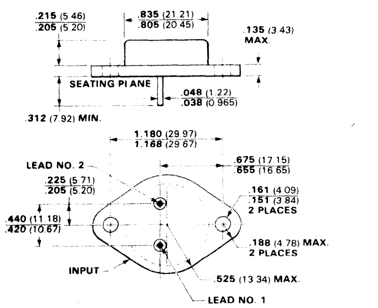
| Maximum Voltages and Currents | | 2N3789 | 2N3790 | 2N3791 | 2N3792 |
|---|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | −60 V | −80 V | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −60 V | −80 V | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −7.0 V | −7.0 V | −7.0 V | −7.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A | 10 A | 10 A |
| $I_B$ | Continuous Base Current | 4.0 A | 4.0 A | 4.0 A | 4.0 A |
| **Maximum Power Dissipation** | | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | | 150 W |
| | Derate Linearly from 25°C | | | | 0.86 W/°C |
| **Maximum Temperatures** | | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | | −65°C to 200°C |
| **Thermal Characteristics** | | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | | 1.17°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**



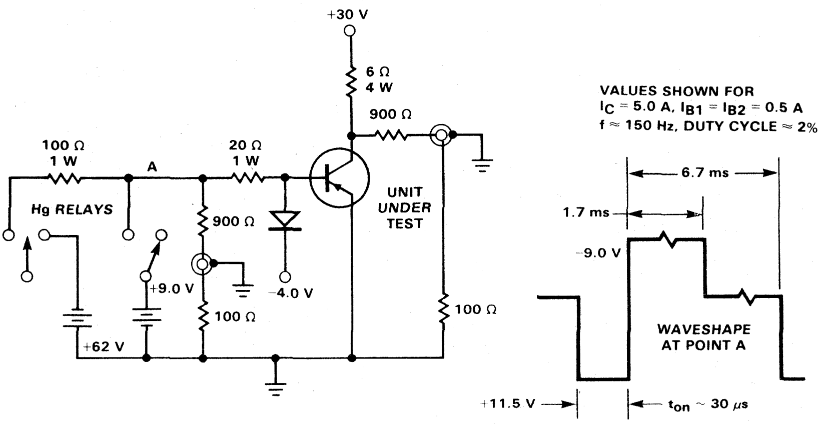

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

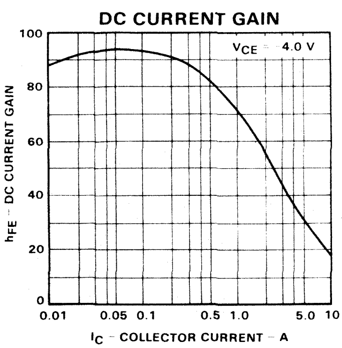
| SYMBOL | CHARACTERISTIC | 2N3789 | | 2N3790 | | 2N3791 | | 2N3792 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | −80 | | −60 | | −80 | | V | $I_C$ = 200 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 10 | | | | 10 | | | mA | $V_{CE}$ = −30 V, $I_B$ = 0 |
| | | | | | 10 | | | | 10 | mA | $V_{CE}$ = −40 V, $I_B$ = 0 |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0 | | | | 1.0 | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 1.5 V |
| | | | | | 1.0 | | | | 1.0 | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 1.5 V |
| | | | 5.0 | | | | 5.0 | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| | | | | | 5.0 | | | | 5.0 | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | | 5.0 | | 5.0 | mA | $V_{EB}$ = −7.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 25 | 90 | 25 | 90 | 50 | 150 | 50 | 150 | | $I_C$ = 1.0 A, $V_{CE}$ = −2.0 V |
| | | 15 | | 15 | | 30 | | 30 | | | $I_C$ = 3.0 A, $V_{CE}$ = −2.0 V |
| | | 4.0 | | 4.0 | | 4.0 | | 4.0 | | | $I_C$ = 10 A, $V_{CE}$ = −4.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −1.0 | | −1.0 | | −1.0 | | −1.0 | V | $I_C$ = 5.0 A, $I_B$ = 0.5 A |
| | | | −4.0 | | −4.0 | | −4.0 | | −4.0 | V | $I_C$ = 10 A, $I_B$ = 2.0 A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −2.0 | | −2.0 | | | | | V | $I_C$ = 4.0 A, $I_B$ = 0.4 A |
| | | | | | | | −1.5 | | −1.5 | V | $I_C$ = 5.0 A, $I_B$ = 0.5 A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −2.0 | | −2.0 | | −1.8 | | −1.8 | V | $I_C$ = 5.0 A, $V_{CE}$ = −2.0 V |
| | | | −4.0 | | −4.0 | | −4.0 | | −4.0 | V | $I_C$ = 10 A, $V_{CE}$ = −4.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 500 | | 500 | | 500 | | 500 | pF | $V_{CB}$ = −10 V, $I_E$ = 0, f = 0.1 MHz |
| $h_{fe}$ | Magnitude of Common Emitter Small Signal Current Gain | 4.0 | | 4.0 | | 4.0 | | 4.0 | | | $I_C$ = 500 mA, $V_{CE}$ = −10 V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | 250 | 25 | 250 | 25 | 250 | 25 | 250 | | $I_C$ = 500 mA, $V_{CE}$ = −10 V, f = 1.0 kHz |
| $f_{hfe}$ | Small Signal Cutoff Frequency | 30 | | 30 | | 30 | | 30 | | kHz | $I_C$ = 500 mA, $V_{CE}$ = −10 V |

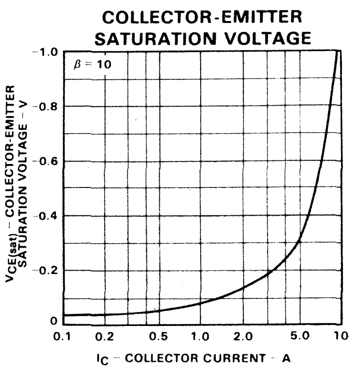
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

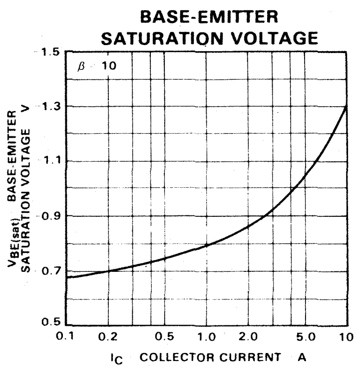
*TEST CIRCUIT*



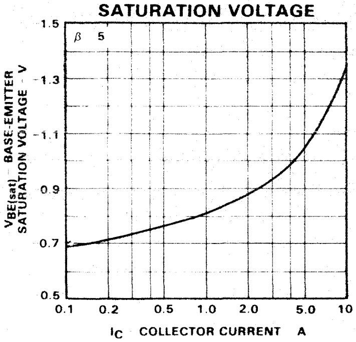

## TYPICAL ELECTRICAL CHARACTERISTICS

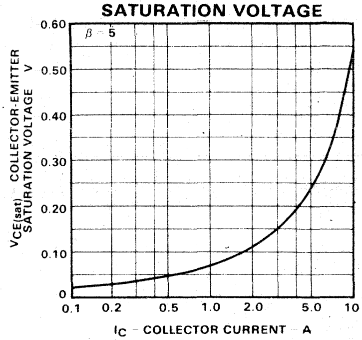


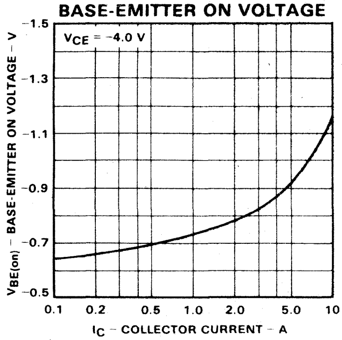



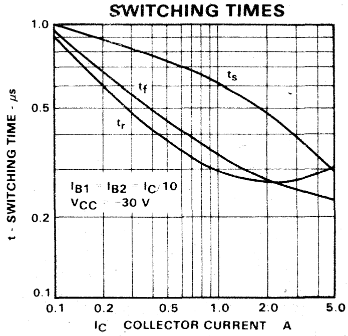



## TYPICAL ELECTRICAL CHARACTERISTICS (Cont'd)



# POWER TRANSISTOR

## NPN SILICON

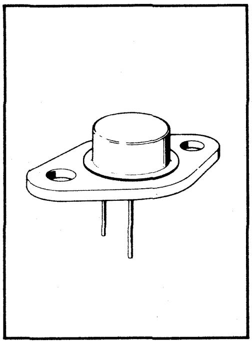
# 2N4231
# 2N4232
# 2N4233

### MEDIUM POWER TRANSISTORS DESIGNED FOR DRIVER CIRCUITS, SWITCHING, AND AMPLIFIER APPLICATIONS

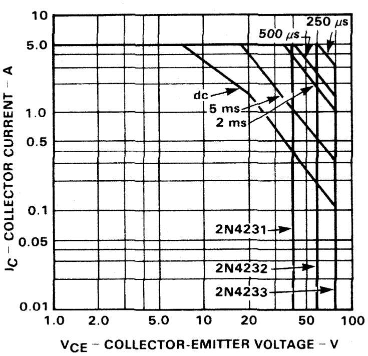
- **35 W DISSIPATION AT 25°C CASE**
- **3.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **25 - 100 $h_{FE}$ @ 1.5 A, 2.0 V**

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

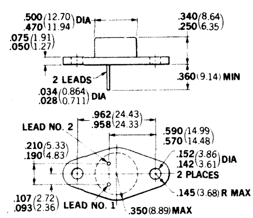
| **Maximum Voltages and Currents** | | **2N4231** | **2N4232** | **2N4233** |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 40 V | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 3.0 A | 3.0 A | 3.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 35 W |
| | Derate Linearly from 25°C | | | 0.2 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 5.0°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-66) Outline**




NOTES:
*All dimensions in inches (bold) and millimeters (parentheses)*
Pins are gold-plated kovar
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Nickel-plated steel base and cap
Package weight is 6.5 grams

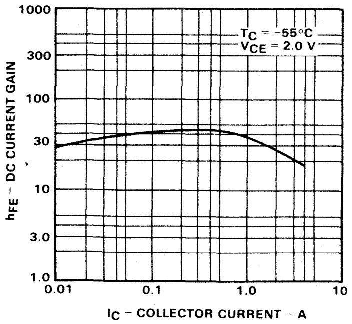
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N4231 MIN | 2N4231 MAX | 2N4232 MIN | 2N4232 MAX | 2N4233 MIN | 2N4233 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 50$ V, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 70$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.1 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | | | 0.1 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | 1.0 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 50 | | | | | μA | $V_{CB} = 40$ V, $I_E = 0$ |
| | | | | | 50 | | | μA | $V_{CB} = 60$ V, $I_E = 0$ |
| | | | | | | | 50 | μA | $V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 500 | | 500 | | 500 | μA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | | 40 | | 40 | | | $I_C = 0.5$ A, $V_{CE} = 2.0$ V |
| | | 25 | 100 | 25 | 100 | 25 | 100 | | $I_C = 1.5$ A, $V_{CE} = 2.0$ V |
| | | 10 | | 10 | | 10 | | | $I_C = 3.0$ A, $V_{CE} = 2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.7 | | 0.7 | | 0.7 | V | $I_C = 1.5$ A, $I_B = 150$ mA |
| | | | 2.0 | | 2.0 | | 2.0 | V | $I_C = 3.0$ A, $I_B = 300$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.4 | | 1.4 | | 1.4 | V | $I_C = 1.5$ A, $V_{CE} = 2.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 200 | | 200 | | 200 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | 20 | | | $I_C = 500$ mA, $V_{CE} = 10$ V, f = 1.0 kHz |

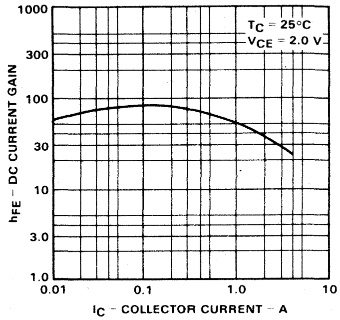
NOTE: Pulse Condition; Length = 300 μs, Duty Cycle = 2%

## TYPICAL ELECTRICAL CHARACTERISTICS

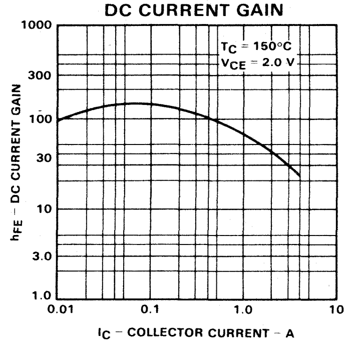
### DC CURRENT GAIN



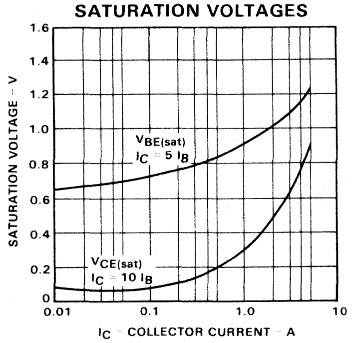

### DC CURRENT GAIN



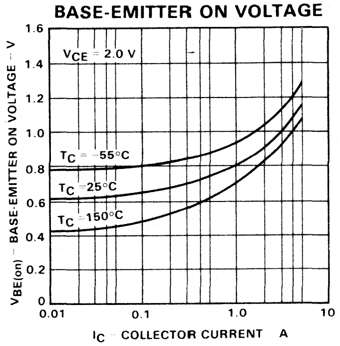

### DC CURRENT GAIN



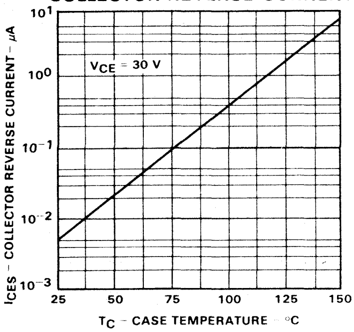

### SATURATION VOLTAGES



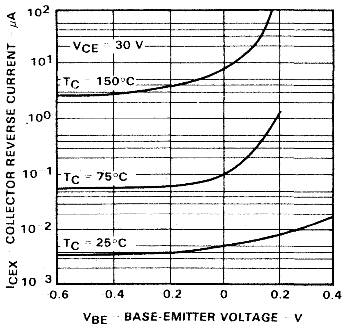

### BASE-EMITTER ON VOLTAGE



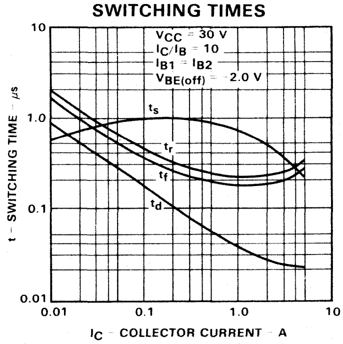

### COLLECTOR REVERSE CURRENT




### COLLECTOR REVERSE CURRENT




### SWITCHING TIMES



# POWER TRANSISTOR

## PNP SILICON

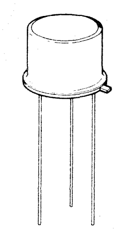
# 2N4234
# 2N4235
# 2N4236

**DESIGNED FOR DRIVER CIRCUITS AND SWITCHING AND AMPLIFIER APPLICATIONS. IDEAL FOR DIRECT REPLACEMENT OF GERMANIUM MEDIUM POWER DEVICES.**

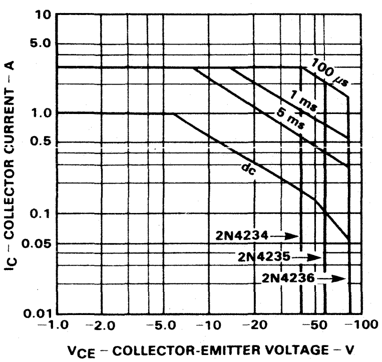
- **6.0 W DISSIPATION AT 25°C CASE**
- **3.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **COMPLEMENT TO 2N4237, 2N4238, 2N4239**

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

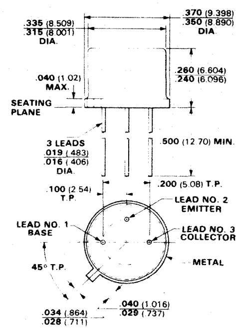
| | | 2N4234 | 2N4235 | 2N4236 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −40 V | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −40 V | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −7.0 V | −7.0 V | −7.0 V |
| $I_C$ | Continuous Collector Current | 3.0 A | 3.0 A | 3.0 A |
| $I_B$ | Continuous Base Current | 0.2 A | 0.2 A | 0.2 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 6.0 W |
| | Derate Linearly from 25°C | | | 0.4 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +175°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 25°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

# FAIRCHILD • 2N4234 • 2N4235 • 2N4236

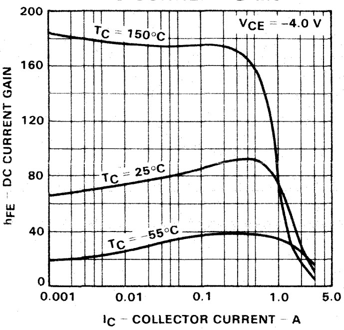
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N4234 | | 2N4235 | | 2N4236 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −40 | | −60 | | −80 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = -30$ V, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = -40$ V, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = -60$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CE} = -40$ V, $V_{BE} = 1.5$ V |
| | | | | | 0.1 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V |
| | | | | | | | 0.1 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V |
| | | | 1.0 | | | | | mA | $V_{CE} = -30$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | 1.0 | | | mA | $V_{CE} = -40$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | | | 1.0 | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CB} = -40$ V, $I_E = 0$ |
| | | | | | 0.1 | | | mA | $V_{CB} = -60$ V, $I_E = 0$ |
| | | | | | | | 0.1 | mA | $V_{CB} = -80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.5 | | 0.5 | | 0.5 | mA | $V_{EB} = -7.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | | 40 | | 40 | | | $I_C = 100$ mA, $V_{CE} = -1.0$ V |
| | | 30 | 150 | 30 | 150 | 30 | 150 | | $I_C = 250$ mA, $V_{CE} = -1.0$ V |
| | | 20 | | 20 | | 20 | | | $I_C = 500$ mA, $V_{CE} = -1.0$ V |
| | | 10 | | 10 | | 10 | | | $I_C = 1.0$ A, $V_{CE} = -1.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −0.6 | | −0.6 | | −0.6 | V | $I_C = 1.0$ A, $I_B = 125$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −1.5 | | −1.5 | | −1.5 | V | $I_C = 1.0$ A, $I_B = 0.1$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.0 | | −1.0 | | −1.0 | V | $I_C = 250$ mA, $V_{CE} = -1.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 3.0 | | 3.0 | | 3.0 | | MHz | $I_C = 100$ mA, $V_{CE} = -10$ V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 100 | | 100 | | 100 | pF | $V_{CB} = -10$ V, $I_E = 0$, f = 100 kHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | 25 | | | $I_C = 50$ mA, $V_{CE} = -10$ V, f = 100 kHz |

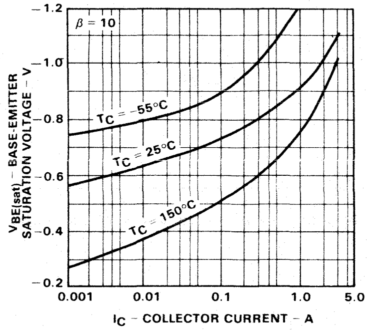
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

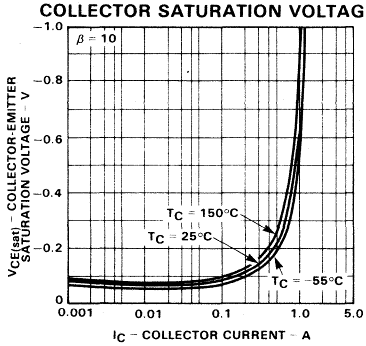
### DC CURRENT GAIN



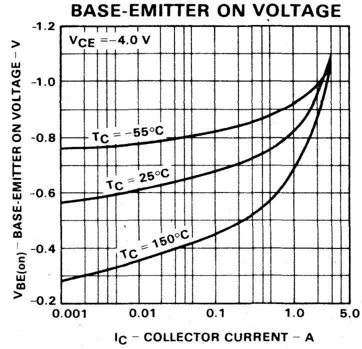

### BASE SATURATION VOLTAGE



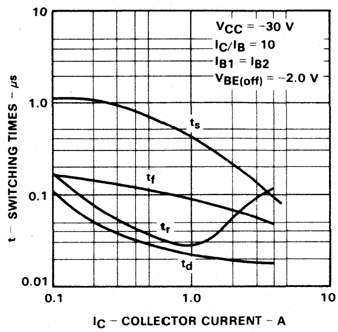

### COLLECTOR SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE




### SWITCHING TIMES



# POWER TRANSISTOR

NPN SILICON

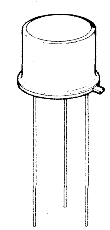
# 2N4237
# 2N4238
# 2N4239

**DESIGNED FOR DRIVER CIRCUITS AND SWITCHING AND AMPLIFIER APPLICATIONS. IDEAL FOR DIRECT REPLACEMENT OF GERMANIUM MEDIUM POWER DEVICE.**

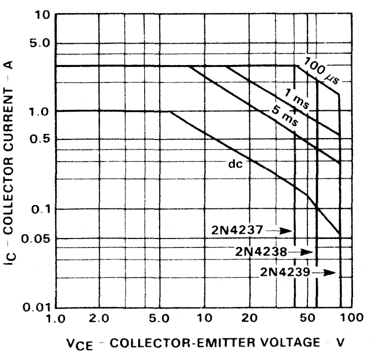
- **5.0 W DISSIPATION AT 25°C CASE**
- **4.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **COMPLEMENT TO 2N4234, 2N4235, 2N4236**

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

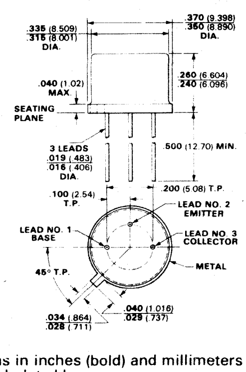
| **Maximum Voltages and Currents** | | 2N4237 | 2N4238 | 2N4239 |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 40 V | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 7.0 V | 7.0 V | 7.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A | 1.0 A | 1.0 A |
| $I_B$ | Continuous Base Current | 0.2 A | 0.2 A | 0.2 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 6.0 W |
| | *Derate Linearly from 25°C* | | | 34.3 mW/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 29.2°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

# FAIRCHILD • 2N4237 • 2N4238 • 2N4239

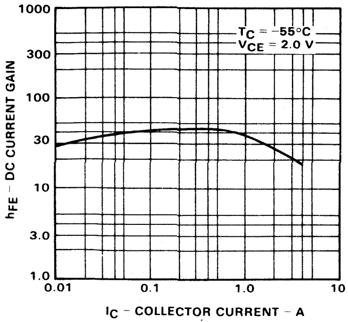
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N4237 | | 2N4238 | | 2N4239 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 60$ V, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 80$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CE} = 45$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.1 | | | mA | $V_{CE} = 75$ V, $V_{BE} = -1.5$ V |
| | | | | | | | 0.1 | mA | $V_{CE} = 90$ V, $V_{BE} = -1.5$ V |
| | | | 1.0 | | | | | mA | $V_{CE} = 45$ V, $V_{BE} = -1.5$ V, $T_A = 150°C$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 75$ V, $V_{BE} = -1.5$ V, $T_A = 150°C$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 90$ V, $V_{BE} = -1.5$ V, $T_A = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CB} = 50$ V, $I_E = 0$ |
| | | | | | 0.1 | | | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| | | | | | | | 0.1 | mA | $V_{CB} = 100$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.5 | | 0.5 | | 0.5 | mA | $V_{EB} = 6.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30 | | 30 | | 30 | | | $I_C = 50$ mA, $V_{CE} = 1.0$ V |
| | | 30 | 150 | 30 | 150 | 30 | 150 | | $I_C = 250$ mA, $V_{CE} = 1.0$ V |
| | | 30 | | 30 | | 30 | | | $I_C = 500$ mA, $V_{CE} = 4.0$ V |
| | | 15 | | 15 | | 15 | | | $I_C = 1.0$ A, $V_{CE} = 1.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.3 | | 0.3 | | 0.3 | V | $I_C = 500$ mA, $I_B = 50$ mA |
| | | | 0.6 | | 0.6 | | 0.6 | V | $I_C = 1.0$ A, $I_B = 100$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.5 | | 1.5 | | 1.5 | V | $I_C = 1.0$ A, $I_B = 100$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.0 | | 1.0 | | 1.0 | V | $I_C = 250$ mA, $V_{CE} = 1.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 2.0 | | 2.0 | | 2.0 | | MHz | $I_C = 100$ mA, $V_{CE} = 10$ V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 100 | | 100 | | 100 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $h_{fe}$ | Small Signal Current Gain | 30 | | 30 | | 30 | | | $I_C = 100$ mA, $V_{CE} = 10$ V, f = 1.0 kHz |

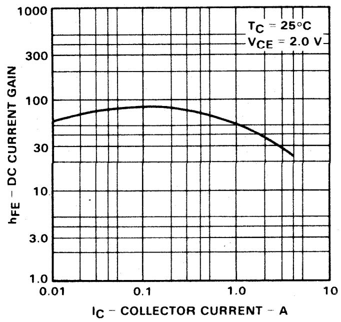
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

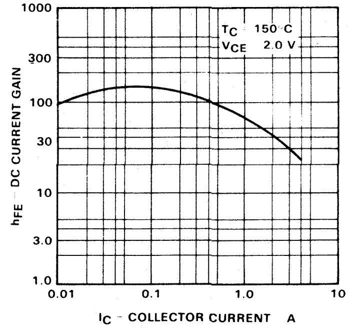
### DC CURRENT GAIN



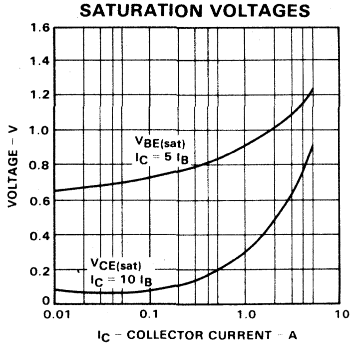

### DC CURRENT GAIN



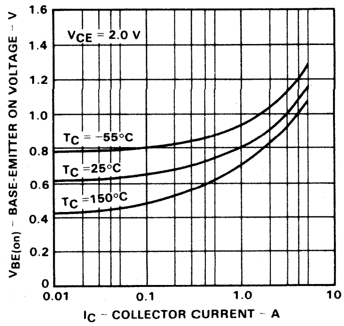

### DC CURRENT GAIN



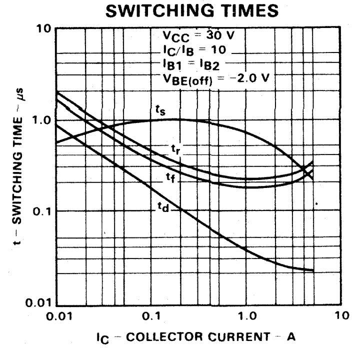

### SATURATION VOLTAGES



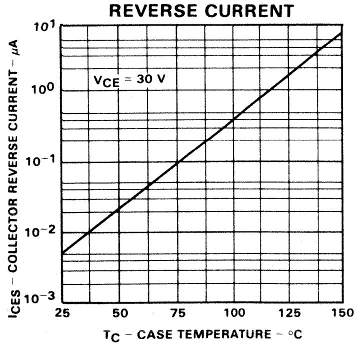

### BASE-EMITTER ON VOLTAGE



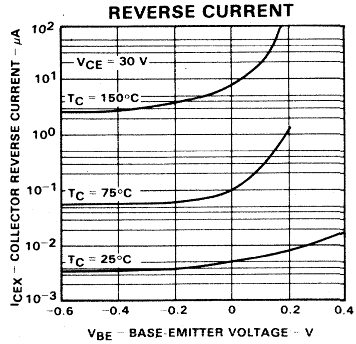

### SWITCHING TIMES




### COLLECTOR REVERSE CURRENT




### COLLECTOR REVERSE CURRENT



# POWER TRANSISTOR

PNP SILICON

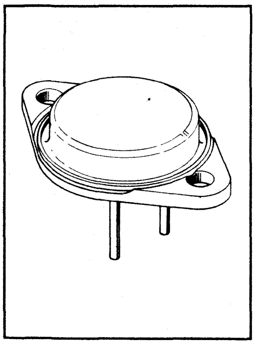
# 2N4398
# 2N4399

**DESIGNED FOR USE IN POWER AMPLIFIER AND SWITCHING CIRCUITS**
**SERVES AS DIRECT REPLACEMENT FOR**
**GERMANIUM HIGH POWER DEVICES**

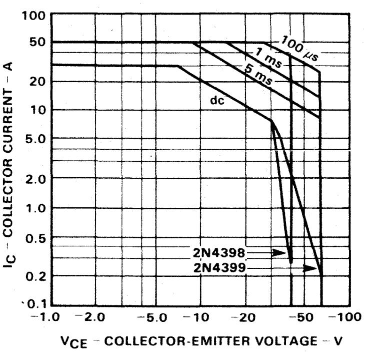
- 200 W DISSIPATION AT 25°C CASE
- 30 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENT TO 2N5301, 2N5302

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

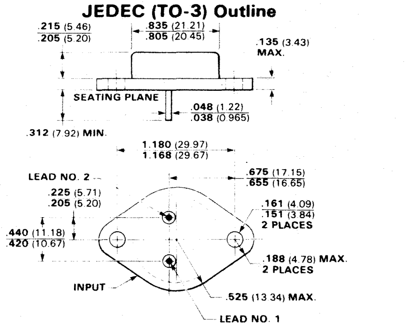
| Symbol | Parameter | 2N4398 | 2N4399 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −40 V | −60 V |
| $V_{CBO}$ | Collector to Base Voltage | −40 V | −60 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 30 A | 30 A |
| $I_B$ | Continuous Base Current | 7.5 A | 7.5 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation A 25°C Case Temperature | | 200 W |
| | Derate Linearly from 25°C | | 1.14 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 0.875°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

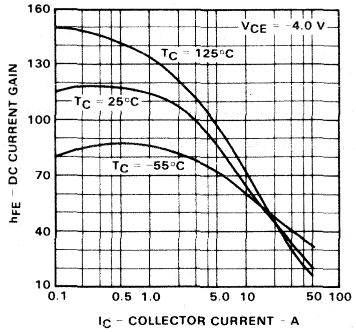
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N4398 MIN | 2N4398 MAX | 2N4399 MIN | 2N4399 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | -40 | | -60 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 5.0 | | | mA | $V_{CE} = -40$ V, $I_B = 0$ |
| | | | | | 5.0 | mA | $V_{CE} = -60$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 5.0 | | | mA | $V_{CE} = -40$ V, $V_{BE} = 1.5$ V |
| | | | | | 5.0 | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V |
| | | | 10 | | 10 | mA | $V_{CE} = -30$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CB} = -40$ V, $I_E = 0$ |
| | | | | | 1.0 | mA | $V_{CB} = -60$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 5.0 | | 5.0 | | | $I_C = 30$ A, $V_{CE} = -4.0$ V |
| | | 15 | 60 | 15 | 60 | | $I_C = 15$ A, $V_{CE} = -4.0$ V |
| | | 40 | | 40 | | | $I_C = 1.0$ A, $V_{CE} = -2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | -4.0 | | -4.0 | V | $I_C = 30$ A, $I_B = 6.0$ A |
| | | | -0.75 | | -0.75 | V | $I_C = 10$ A, $I_B = 1.0$ A |
| | | | -1.0 | | -1.0 | V | $I_C = 15$ A, $I_B = 1.5$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | -1.85 | | 1.85 | V | $I_C = 15$ A, $I_B = 1.5$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | -3.0 | | -3.0 | V | $I_C = 30$ A, $V_{CE} = -4.0$ V |
| | | | -1.8 | | -1.8 | V | $I_C = 15$ A, $V_{CE} = -2.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | MHz | $I_C = 1.0$ A, $V_{CE} = -10$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 40 | | 40 | | | $I_C = 1.0$ A, $V_{CE} = -10$ V, f = 1.0 kHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | |
| $t_r$ | Rise Time | | 0.4 | | 0.4 | μs | $V_{CC} = -30$ V, $I_C = 10$ A, $I_{B1} = 1.0$ A, $t_p = 10$ to 100 μs, Duty Cycle 2% |
| $t_s$ | Storage Time | | 1.5 | | 1.5 | μs | $V_{CC} = -30$ V, $I_C = 10$ A, $I_{B1} = I_{B2} = 1.0$ A, $t_p = 10$ to 100 μs, Duty Cycle = 2% |
| $t_f$ | Fall Time | | 0.6 | | 0.6 | μs | $V_{CC} = -30$ V, $I_C = 10$ A, $I_{B1} = I_{B2} = 1.0$ A, $t_p = 10$ to 100 μs, Duty Cycle 2% |

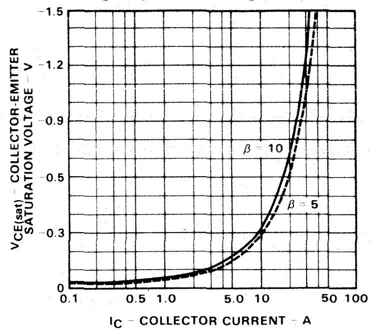
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

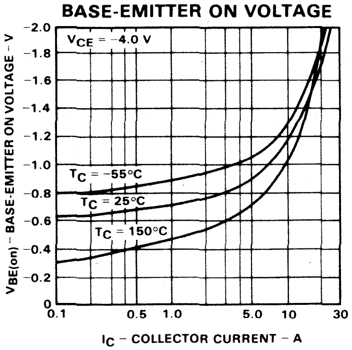
### DC CURRENT GAIN



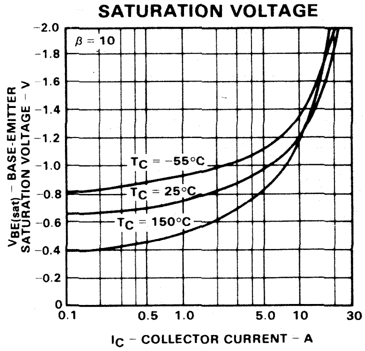

### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

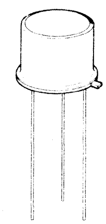
# 2N4895
# 2N4896
# 2N4897

## DESIGNED AS GENERAL PURPOSE MEDIUM POWER DEVICE

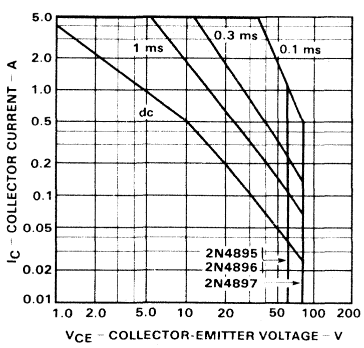
- 4.0 W DISSIPATION AT 25°C CASE
- 5.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 0.7 $V_{CE(sat)}$ AT 2.0 A
- LOW LEAKAGE $I_{CES(MAX)}$ 100 $\mu$A @ $T_C$ = 150°C

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

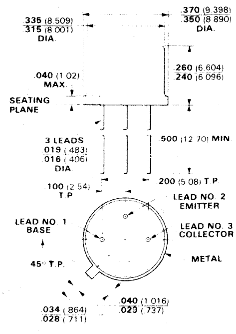
| Maximum Voltages and Currents | | 2N4895 | 2N4896 | 2N4897 |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 120 V | 120 V | 120 V |
| $V_{EBO}$ | Emitter to Base Voltage | 6.0 V | 6.0 V | 6.0 V |
| $I_C$ | Continuous Collector Current | 5.0 A | 5.0 A | 5.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 4.0 W |
| | Derate Linearly from 25°C | | | 22.9 mW/°C |
| **Maximum Temperatures** | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 43.8°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 1.23 grams

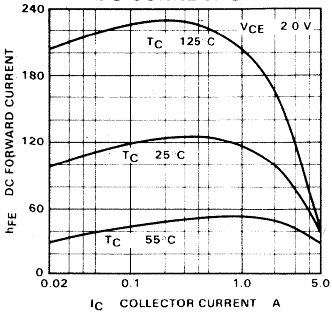
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N4895 | | 2N4896 | | 2N4897 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 60 | | 80 | | V | $I_C = 50$ mA, $I_B = 0$ |
| $I_{CES}$ | Collector Reverse Current | | 1.0 | | 1.0 | | | mA | $V_{CE} = 120$ V, $V_{BE} = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 150$ V, $V_{BE} = 0$ |
| | | | 1.0 | | 1.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 100$ V, $V_{BE} = 0$ |
| | | | 0.1 | | 0.1 | | | mA | $V_{CE} = 60$ V, $V_{BE} = 0$, $T_C = 150°C$ |
| | | | | | | | 0.1 | mA | $V_{CE} = 100$ V, $V_{BE} = 0$, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = 4.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | 120 | 100 | 300 | 40 | 120 | | $I_C = 2.0$ A, $V_{CE} = 2.0$ V |
| | | 15 | | 35 | | 15 | | | $I_C = 2.0$ A, $V_{CE} = 2.0$ V, $T_C = -55°C$ |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | | 1.0 | V | $I_C = 5.0$ A, $I_B = 5.0$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.6 | | 1.6 | | 1.6 | V | $I_C = 5.0$ A, $I_B = 0.5$ A |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 80 | | 80 | | 80 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.14 MHz |
| $C_{ib}$ | Input Capacitance | | 500 | | 500 | | 500 | pF | $V_{EB} = 0.5$ V, $I_C = 0$, f = 0.14 MHz |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 2.5 | | 4.0 | | 2.5 | | | $I_C = 0.5$ A, $V_{CE} = 5.0$ V, f = 20 MHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | | | |
| $t_d$ | Delay Time | | 50 | | 50 | | 50 | μs | $V_{CC} = 20$ V, $I_C = 5.0$ A, $I_{B1} = 0.5$ A, $t_p = 10$ μs, Duty Cycle 1% |
| $t_r$ | Rise Time | | 300 | | 300 | | 300 | μs | |
| $t_s$ | Storage Time | | 350 | | 350 | | 350 | μs | $V_{CC} = 20$ V, $I_C = 5.0$ A, $I_{B1} = I_{B2} = 0.5$ A, $t_p = 10$ μs, Duty Cycle 1% |
| $t_f$ | Fall Time | | 300 | | 300 | | 300 | μs | |

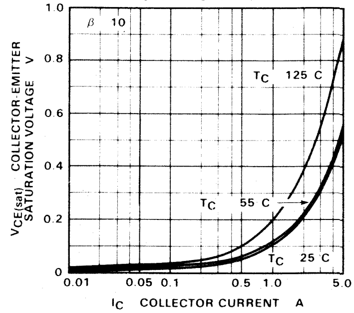
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

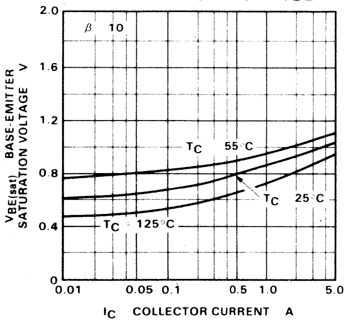
### DC CURRENT GAIN



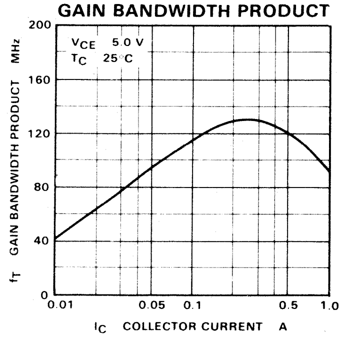

### COLLECTOR-EMITTER SATURATION VOLTAGE



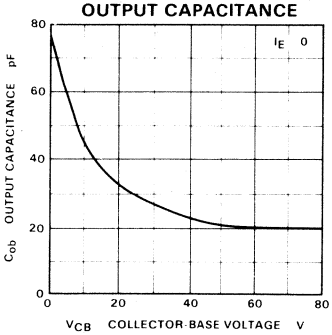

### BASE-EMITTER SATURATION VOLTAGE



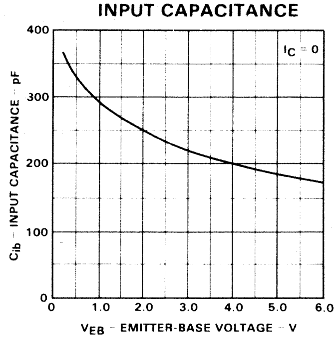

### GAIN BANDWIDTH PRODUCT



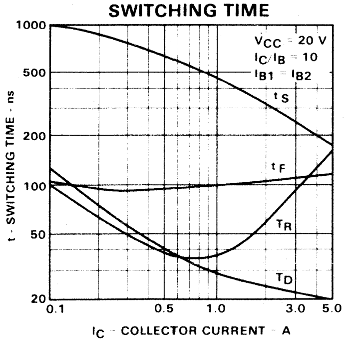

### OUTPUT CAPACITANCE




### INPUT CAPACITANCE




### SWITCHING TIME



# POWER TRANSISTOR

## PNP SILICON

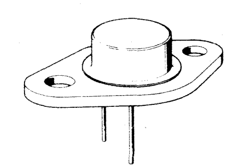
# 2N4898
# 2N4899
# 2N4900

### MEDIUM POWER DEVICE DESIGNED FOR DRIVER CIRCUITS, SWITCHING AND AMPLIFIER APPLICATIONS

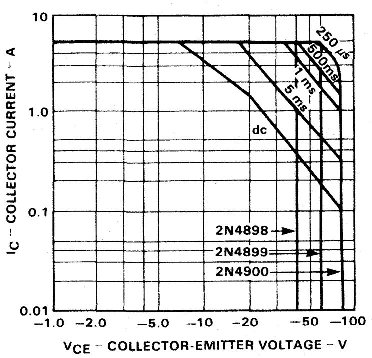
- 25 W DISSIPATION AT 25°C CASE
- 4.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS 2N4910, 2N4911, 2N4912

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

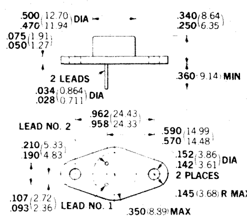
| | | 2N4898 | 2N4899 | 2N4900 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −40 V | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −40 V | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A | 1.0 A | 1.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 25 W |
| | Derate Linearly from 25°C | | | 0.143 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 7.0°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-66) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated kovar
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Nickel-plated steel base and cap
Package weight is 6.5 grams

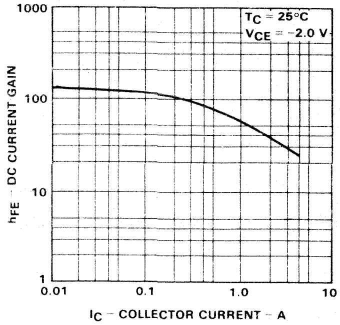
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N4898 | | 2N4899 | | 2N4900 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −40 | | −60 | | −80 | | V | $I_C$ = 100 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE}$ = −20 V, $I_B$ = 0 |
| | | | | | 0.5 | | | mA | $V_{CE}$ = −30 V, $I_B$ = 0 |
| | | | | | | | 0.5 | mA | $V_{CE}$ = −40 V, $I_B$ = 0 |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CE}$ = −40 V, $V_{BE}$ = 1.5 V |
| | | | | | 0.1 | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 1.5 V |
| | | | | | | | 0.1 | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 1.5 V |
| | | | 1.0 | | | | | mA | $V_{CE}$ = −40 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| | | | | | 1.0 | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| | | | | | | | 1.0 | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| $I_{CBO}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CB}$ = −40 V, $I_E$ = 0 |
| | | | | | 0.1 | | | mA | $V_{CB}$ = −60 V, $I_E$ = 0 |
| | | | | | | | 0.1 | mA | $V_{CB}$ = −80 V, $I_E$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = −5.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 10 | | 10 | | 10 | | | $I_C$ = 50 mA, $V_{CE}$ = −1.0 V |
| | | 20 | 100 | 20 | 100 | 20 | 100 | | $I_C$ = 500 mA, $V_{CE}$ = −1.0 V |
| | | 40 | | 40 | | 40 | | | $I_C$ = 1.0 A, $V_{CE}$ = −1.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −0.6 | | −0.6 | | −0.6 | V | $I_C$ = 1.0 A, $I_B$ = 100 mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −1.3 | | −1.3 | | −1.3 | V | $I_C$ = 1.0 A, $I_B$ = 100 mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.3 | | −1.3 | −1.3 | | V | $I_C$ = 1.0 A, $V_{CE}$ = −1.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 3.0 | | 3.0 | | 3.0 | | MHz | $I_C$ = 200 mA, $V_{CE}$ = −10 V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 100 | | 100 | | 100 | pF | $V_{CB}$ = −10 V, $I_E$ = 0, f = 0.1 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | 25 | | | $I_C$ = 250 mA, $V_{CE}$ = −10 V, f = 1.0 kHz |

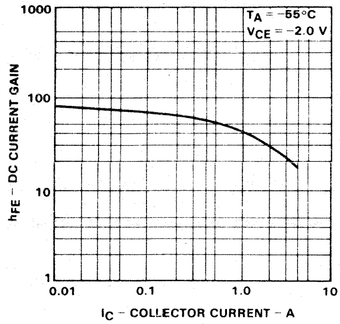
NOTE: Pulse Condition: Length = 300 μs, Duty Cycle = 2%

## TYPICAL ELECTRICAL CHARACTERISTICS

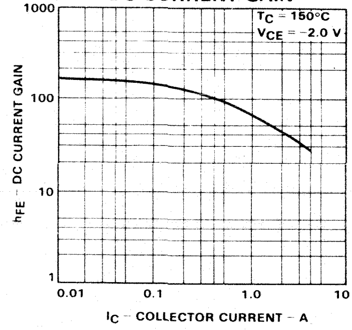
### DC CURRENT GAIN



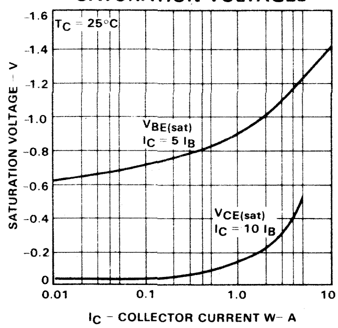

### DC CURRENT GAIN



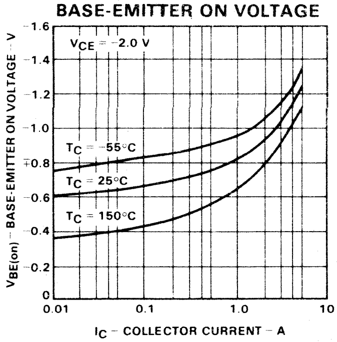

### DC CURRENT GAIN



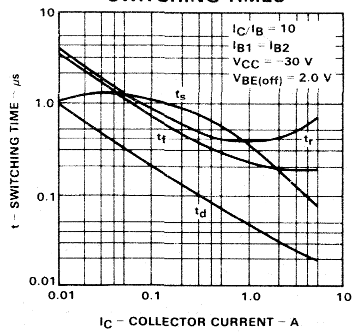

### SATURATION VOLTAGES



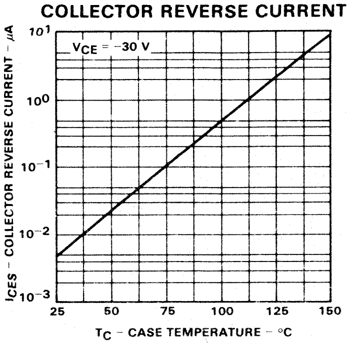

### BASE-EMITTER ON VOLTAGE



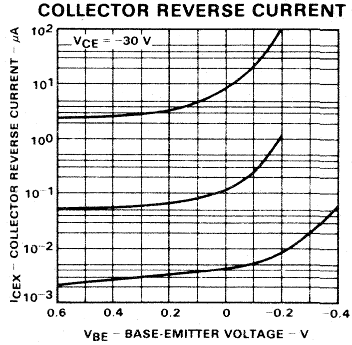

### SWITCHING TIMES




### COLLECTOR REVERSE CURRENT




### COLLECTOR REVERSE CURRENT



# POWER TRANSISTOR

## PNP SILICON

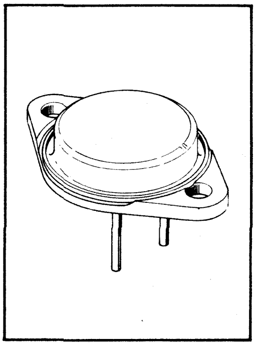
# 2N4901
# 2N4902
# 2N4903

## DESIGNED FOR USE IN POWER AMPLIFIER AND SWITCHING CIRCUITS

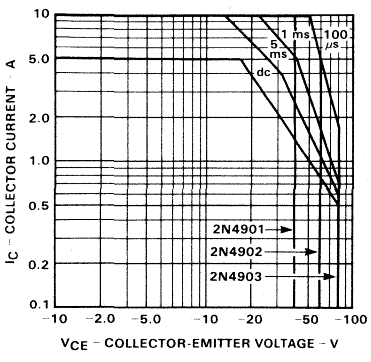
- 87.5 W DISSIPATION AT 25°C CASE
- 5.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS TO 2N5067, 2N5068, 2N5069

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

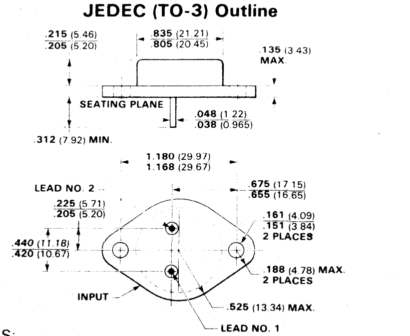
| | | 2N4901 | 2N4902 | 2N4903 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −40 V | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −40 V | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 5.0 A | 5.0 A | 5.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 87.5 W |
| | Derate Linearly from 25°C | | | 0.5 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 2.0°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**



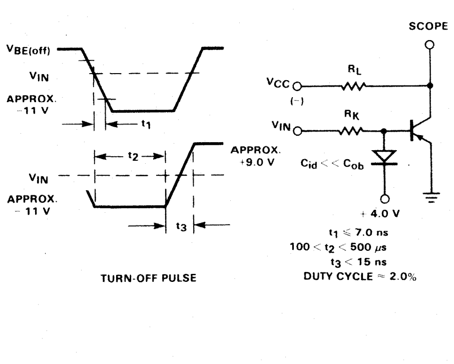

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N4901 MIN | 2N4901 MAX | 2N4902 MIN | 2N4902 MAX | 2N4903 MIN | 2N4903 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| OFF CHARACTERISTICS | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −40 | | −60 | | −80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = -40$ V, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = -60$ V, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = -80$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CE} = -40$ V, $V_{BE} = 1.5$ V |
| | | | | | 0.1 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V |
| | | | | | | | 0.1 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V |
| | | | 2.0 | | | | | mA | $V_{CE} = -40$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | 2.0 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | | | 2.0 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CB} = -40$ V, $I_E = 0$ |
| | | | | | 0.1 | | | mA | $V_{CB} = -60$ V, $I_E = 0$ |
| | | | | | | | 0.1 | mA | $V_{CB} = -80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| ON CHARACTERISTICS | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20 | 80 | 20 | 80 | 20 | 80 | | $I_C = 1.0$ A, $V_{CE} = -2.0$ V |
| | | 7.0 | | 7.0 | | 7.0 | | | $I_C = 5.0$ A, $V_{CE} = -2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −0.4 | | −0.4 | | −0.4 | V | $I_C = 1.0$ A, $I_B = 0.1$ A |
| | | | −1.5 | | −1.5 | | −1.5 | V | $I_C = 5.0$ A, $I_B = 1.0$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.2 | | −1.2 | | −1.2 | V | $I_C = 1.0$ A, $V_{CE} = -2.0$ V |
| DYNAMIC CHARACTERISTICS | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | 4.0 | | MHz | $I_C = 1.0$ A, $V_{CE} = -10$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | 20 | | | $I_C = 0.5$ A, $V_{CE} = -10$ V, f = 1.0 kHz |

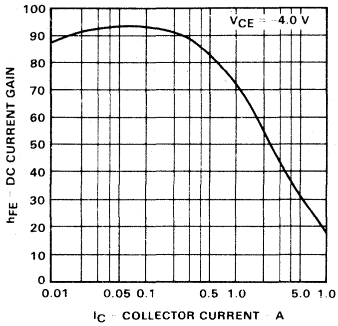
NOTE: 1. Pulse conditions: Length = 300 $\mu$s, Duty Cycle = 2%.

**SWITCHING TIME EQUIVALENT CIRCUIT**

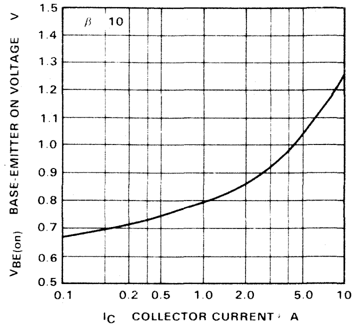


## TYPICAL ELECTRICAL CHARACTERISTICS

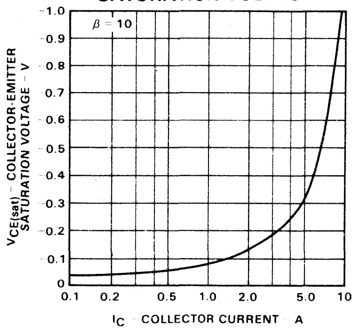
### DC CURRENT GAIN



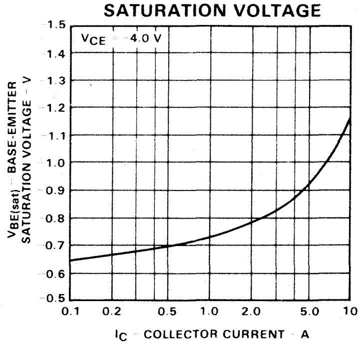

### BASE-EMITTER ON VOLTAGE



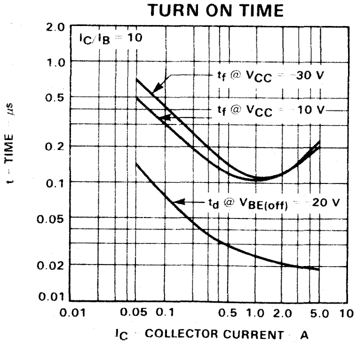

### COLLECTOR-EMITTER SATURATION VOLTAGE



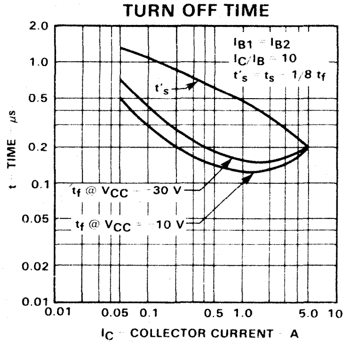

### BASE-EMITTER SATURATION VOLTAGE




### TURN ON TIME




### TURN OFF TIME



# POWER TRANSISTOR

## PNP SILICON

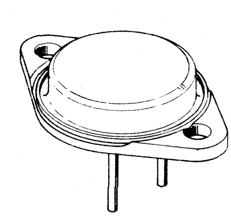
# 2N4904
# 2N4905
# 2N4906

### DESIGNED FOR USE IN POWER AMPLIFIER AND SWITCHING CIRCUITS

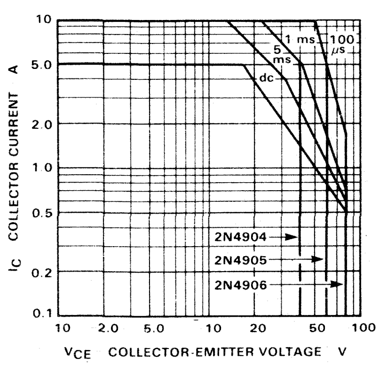
- 87.5 W DISSIPATION AT 25°C CASE
- 5.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS TO 2N4913, 2N4914, 2N4915

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

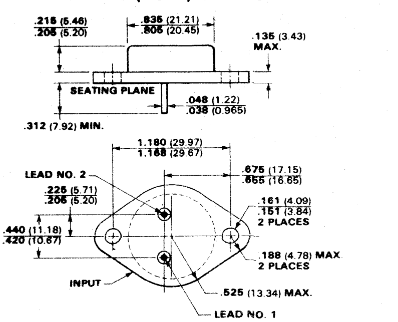
| | | 2N4904 | 2N4905 | 2N4906 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −40 V | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −40 V | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 5.0 A | 5.0 A | 5.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 87.5 W |
| | Derate Linearly from 25°C | | | 0.5 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −165°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 2.0°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**



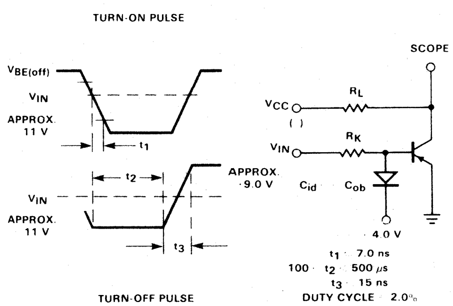

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

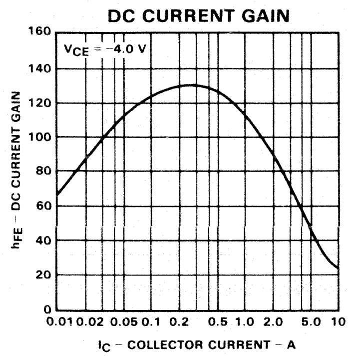
| SYMBOL | CHARACTERISTIC | 2N4904 MIN | 2N4904 MAX | 2N4905 MIN | 2N4905 MAX | 2N4906 MIN | 2N4906 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | –40 | | –60 | | –80 | | V | $I_C$ = 200 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE}$ = –40 V, $I_B$ = 0 |
| | | | | | 1.0 | | | mA | $V_{CE}$ = –60 V, $I_B$ = 0 |
| | | | | | | | 1.0 | mA | $V_{CE}$ = –80 V, $I_B$ = 0 |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CE}$ = –40 V, $V_{BE}$ = 1.5 V |
| | | | | | 0.1 | | | mA | $V_{CE}$ = –60 V, $V_{BE}$ = 1.5 V |
| | | | | | | | 0.1 | mA | $V_{CE}$ = –80 V, $V_{BE}$ = 1.5 V |
| | | | 2.0 | | | | | mA | $V_{CE}$ = –40 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| | | | | | 2.0 | | | mA | $V_{CE}$ = –60 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| | | | | | | | 2.0 | mA | $V_{CE}$ = –80 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| $I_{CBO}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CB}$ = –40 V, $I_E$ = 0 |
| | | | | | 0.1 | | | mA | $V_{CB}$ = –60 V, $I_E$ = 0 |
| | | | | | | | 0.1 | mA | $V_{CB}$ = –80 V, $I_E$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = 5.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 25 | 100 | 25 | 100 | 25 | 100 | | $I_C$ = 2.5 A, $V_{CE}$ = –2.0 V |
| | | 7.0 | | 7.0 | | 7.0 | | | $I_C$ = 5.0 A, $V_{CE}$ = –2.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | –1.5 | | –1.5 | | –1.5 | V | $I_C$ = 5.0 A, $I_B$ = 1.0 A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | –1.4 | | –1.4 | | –1.4 | V | $I_C$ = 2.5 A, $V_{CE}$ = –2.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | 4.0 | | MHz | $I_C$ = 1.0 A, $V_{CE}$ = –10 V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 40 | | 40 | | 40 | | | $I_C$ = 0.5 A, $V_{CE}$ = –10 V, f = 1.0 kHz |

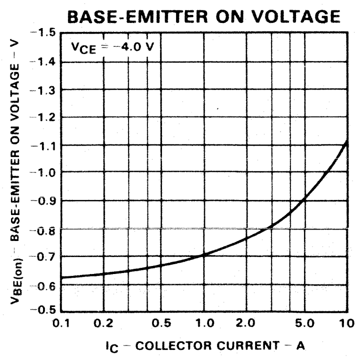
NOTE: 1. Pulse conditions: Length = 300 $\mu$s, Duty Cycle = 2%.

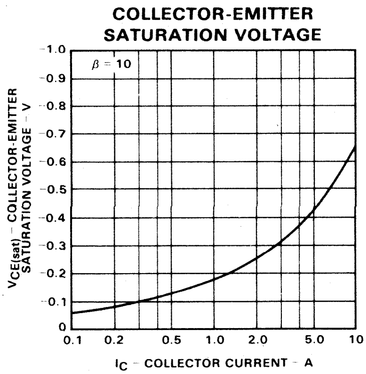
**SWITCHING TIME EQUIVALENT CIRCUIT**

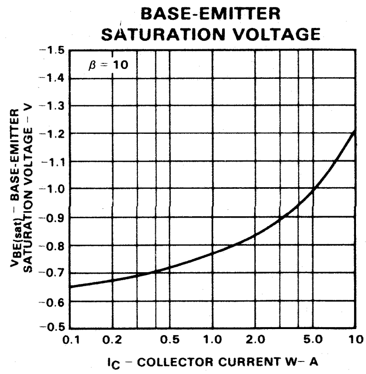


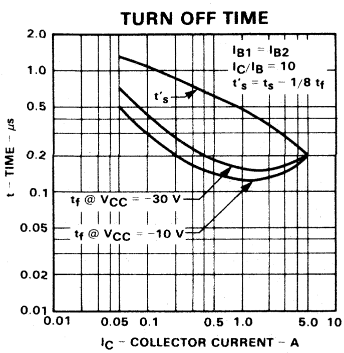
## TYPICAL ELECTRICAL CHARACTERISTICS

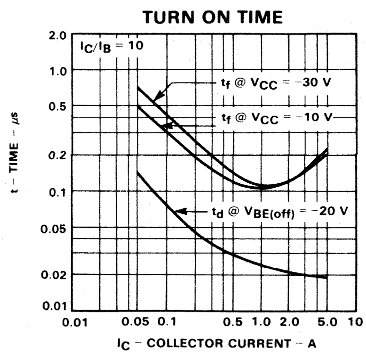


# POWER TRANSISTOR

## PNP SILICON

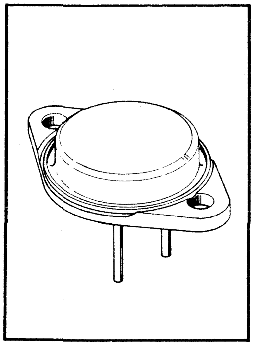
# 2N4907
# 2N4908
# 2N4909

### MESA POWER DEVICE DESIGNED PRIMARILY FOR UNTUNED AMPLIFIER APPLICATIONS

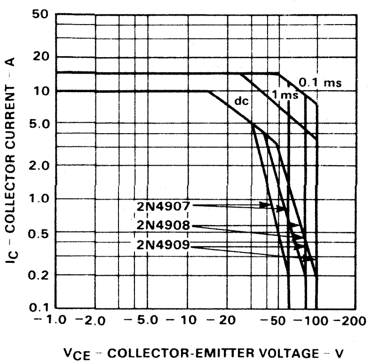
- 150 W DISSIPATION AT 25°C CASE
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

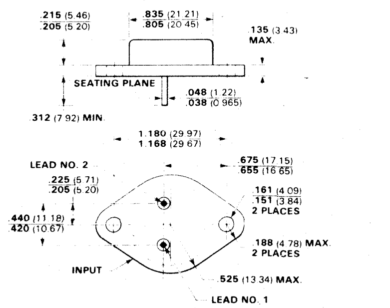
| | | 2N4907 | 2N4908 | 2N4909 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −40 V | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −40 V | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A | 10 A |
| $I_B$ | Continuous Base Current | 7.0 A | 7.0 A | 7.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 150 W |
| | Derate Linearly from 25°C | | | 0.86 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 1.17°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

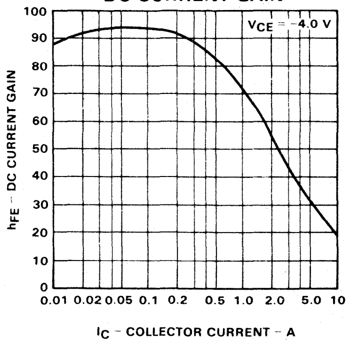
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N4907 MIN | 2N4907 MAX | 2N4908 MIN | 2N4908 MAX | 2N4909 MIN | 2N4909 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −40 | | −60 | | −80 | | V | $I_C$ = 200 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 0.7 | | | | | mA | $V_{CE}$ = −20 V, $I_B$ = 0 |
| | | | | | 0.7 | | | mA | $V_{CE}$ = −30 V, $I_B$ = 0 |
| | | | | | | | 0.7 | mA | $V_{CE}$ = −40 V, $I_B$ = 0 |
| $I_{CEX}$ | Collector Cutoff Current | | 2.0 | | | | | mA | $V_{CE}$ = −40 V, $V_{BE}$ = 1.5 V |
| | | | | | 2.0 | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 1.5 V |
| | | | | | | | 2.0 | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 1.5 V |
| | | | 30 | | | | | mA | $V_{CE}$ = −40 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| | | | | | 30 | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| | | | | | | | 30 | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | | 5.0 | mA | $V_{EB}$ = −5.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 5.0 | | 5.0 | | 5.0 | | | $I_C$ = 10 A, $V_{CE}$ = −4.0 V |
| | | 20 | 80 | 20 | 80 | 20 | 80 | | $I_C$ = 4.0 A, $V_{CE}$ = −4.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −2.0 | | −2.0 | | −2.0 | V | $I_C$ = 10A, $I_B$ = 2.0 A |
| | | | −0.75 | | −0.75 | | −0.75 | V | $I_C$ = 4.0 A, $I_B$ = 400 mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.5 | | −1.5 | | −1.5 | V | $I_C$ = 4.0 A, $V_{CE}$ = −4.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 600 | | 600 | | 600 | pF | $V_{CB}$ = −10 V, $I_E$ = 0, f = 0.1 MHz |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 4.0 | | 4.0 | | 4.0 | | | $I_C$ = 1.0 A, $V_{CE}$ = −10 V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 15 | | 15 | | 15 | | | $I_C$ = 1.0 A, $V_{CE}$ = −4.0 V, f = 1.0 kHz |

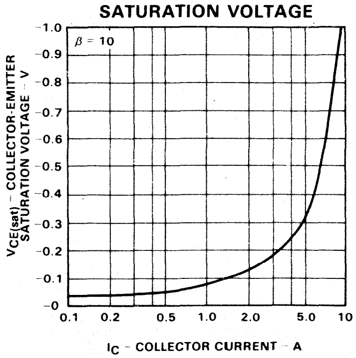
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

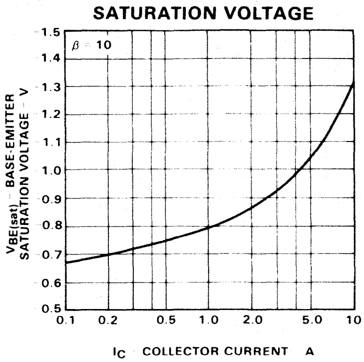
**DC CURRENT GAIN**




**COLLECTOR-EMITTER SATURATION VOLTAGE**




**BASE-EMITTER SATURATION VOLTAGE**



# POWER TRANSISTOR

## NPN SILICON

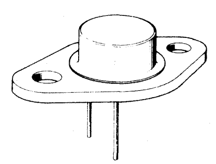
# 2N4910
# 2N4911
# 2N4912

### MEDIUM POWER DEVICE DESIGNED FOR DRIVER CIRCUITS, SWITCHING AND AMPLIFIER APPLICATIONS

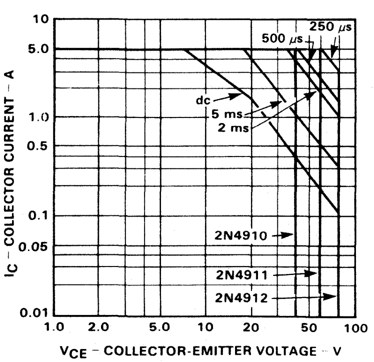
- **25 W DISSIPATION AT 25°C CASE**
- **1.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **COMPLEMENT TO 2N4898, 2N4899, 2N4900**

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

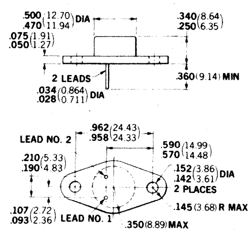
| Symbol | Parameter | 2N4910 | 2N4911 | 2N4912 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 40 V | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A | 1.0 A | 1.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 25 W |
| | Derate Linearly from 25°C | | | 0.143 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 7.0°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-66) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated kovar
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Nickel-plated steel base and cap
Package weight is 6.5 grams

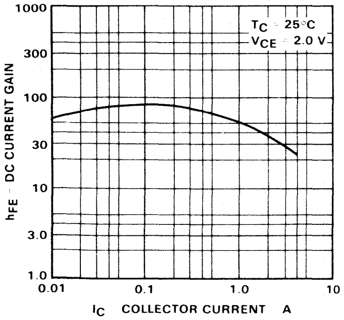
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N4910 | | 2N4911 | | 2N4912 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE} = 20$ V, $I_B = 0$ |
| | | | | | 0.5 | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | | | 0.5 | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.1 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | | | 0.1 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | 1.0 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CB} = 40$ V, $I_E = 0$ |
| | | | | | 0.1 | | | mA | $V_{CB} = 60$ V, $I_E = 0$ |
| | | | | | | | 0.1 | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | | 40 | | 40 | | | $I_C = 50$ mA, $V_{CE} = 1.0$ V |
| | | 20 | 100 | 20 | 100 | 20 | 100 | | $I_C = 500$ mA, $V_{CE} = 1.0$ V |
| | | 10 | | 10 | | 10 | | | $I_C = 1.0$ A, $V_{CE} = 1.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.6 | | 0.6 | | 0.6 | V | $I_C = 1.0$ A, $I_B = 0.1$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.3 | | 1.3 | | 1.3 | V | $I_C = 1.0$ A, $I_B = 0.1$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.3 | | 1.3 | | 1.3 | V | $I_C = 1.0$ A, $V_{CE} = 1.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 100 | | 100 | | 100 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | 25 | | | $I_C = 250$ mA, $V_{CE} = 10$ V, f = 1.0 kHz |

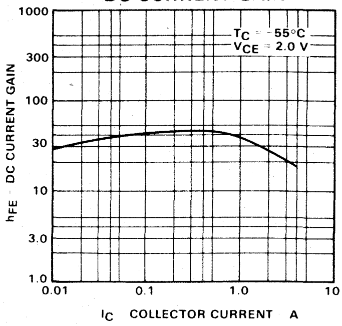
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

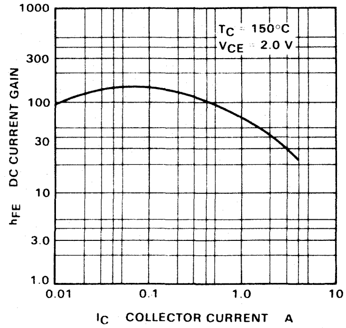
### DC CURRENT GAIN



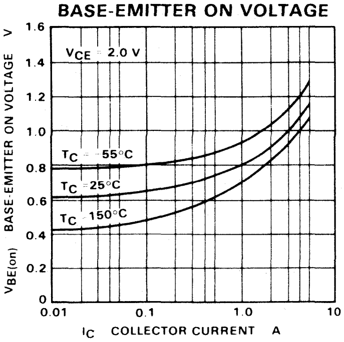

### DC CURRENT GAIN



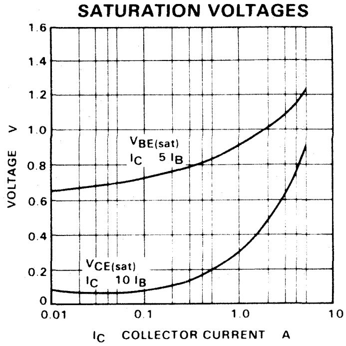

### DC CURRENT GAIN



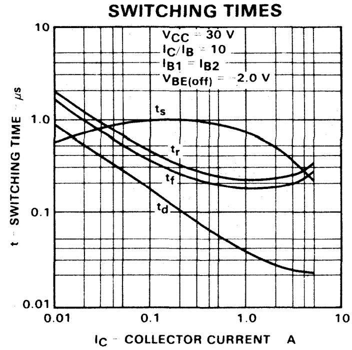

### BASE-EMITTER ON VOLTAGE



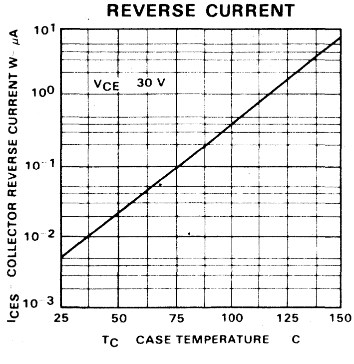

### SATURATION VOLTAGES



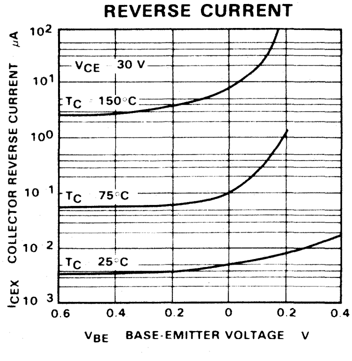

### SWITCHING TIMES




### COLLECTOR REVERSE CURRENT




### COLLECTOR REVERSE CURRENT



# POWER TRANSISTOR

NPN SILICON

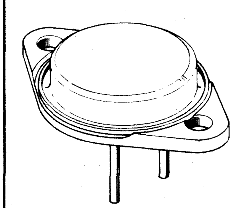
**2N4913**
**2N4914**
**2N4915**

## DESIGNED FOR USE IN POWER AMPLIFIER AND SWITCHING CIRCUITS

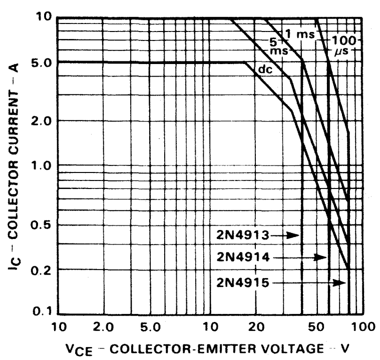
- 87.5 W DISSIPATION AT 25°C CAST
- 5.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS TO 2N4904, 2N4905, 2N4906

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

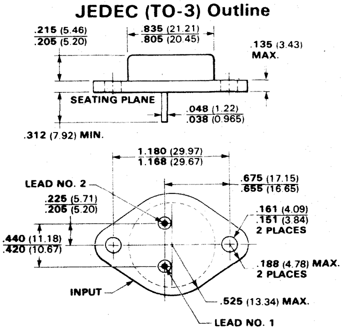
| Maximum Voltages and Currents | | 2N4913 | 2N4914 | 2N4915 |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 40 V | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 5.0 A | 5.0 A | 5.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 87.5 W |
| | Derate Linearly from 25°C | | | 0.5 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 2.0°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**



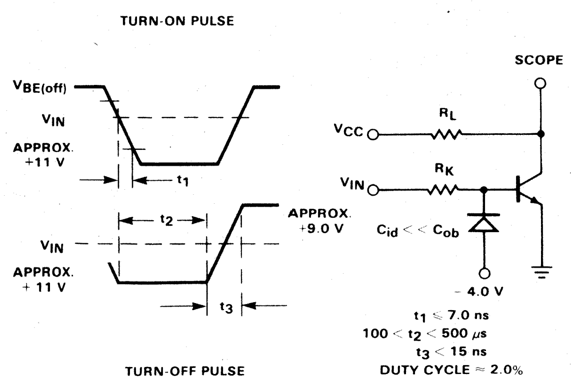

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N4913 MIN | 2N4913 MAX | 2N4914 MIN | 2N4914 MAX | 2N4915 MIN | 2N4915 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 60$ V, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 80$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 40$ V |
| | | | | | 1.0 | | | mA | $V_{CE} = 60$ V |
| | | | | | | | 1.0 | mA | $V_{CE} = 80$ V |
| | | | 2.0 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 2.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | | | 2.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CB} = 40$ V, $I_E = 0$ |
| | | | | | 1.0 | | | mA | $V_{CB} = 60$ V, $I_E = 0$ |
| | | | | | | | 1.0 | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 25 | 100 | 25 | 100 | 25 | 100 | | $I_C = 2.5$ A, $V_{CE} = 2.0$ V |
| | | 7.0 | | 7.0 | | 7.0 | | | $I_C = 5.0$ A, $V_{CE} = 2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | | 1.0 | V | $I_C = 2.5$ A, $I_B = 0.25$ A |
| | | | 1.5 | | 1.5 | | 1.5 | V | $I_C = 5.0$ A, $I_B = 1.0$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.4 | | 1.4 | | 1.4 | V | $I_C = 2.5$ A, $V_{CE} = 2.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | 4.0 | | MHz | $I_C = 1.0$ A, $V_{CE} = 10$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | 20 | | | $I_C = 0.5$ A, $V_{CE} = 10$ V, f = 1.0 kHz |

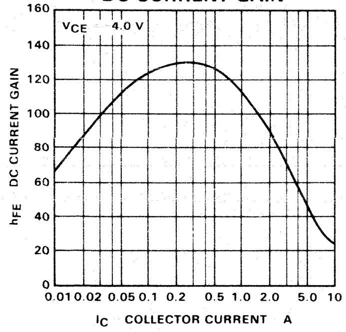
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

**SWITCHING TIME EQUIVALENT CIRCUIT**

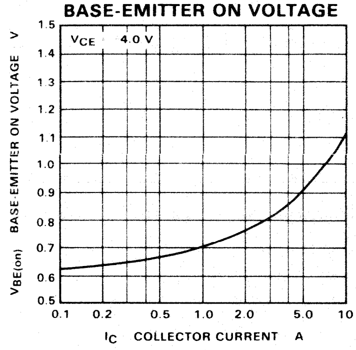


## TYPICAL ELECTRICAL CHARACTERISTICS

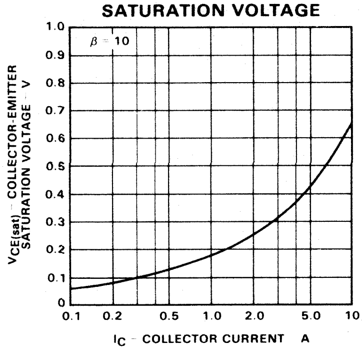
### DC CURRENT GAIN



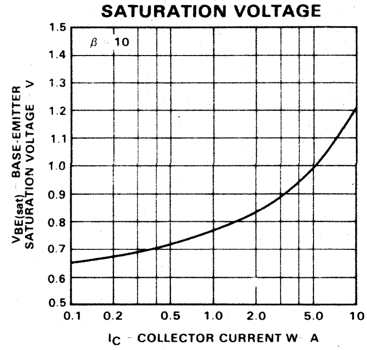

### BASE-EMITTER ON VOLTAGE



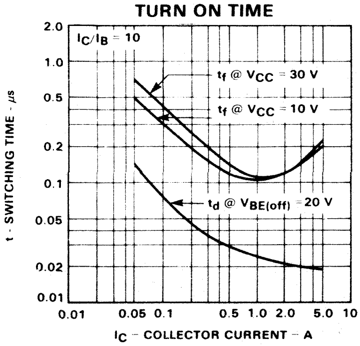

### COLLECTOR-EMITTER SATURATION VOLTAGE



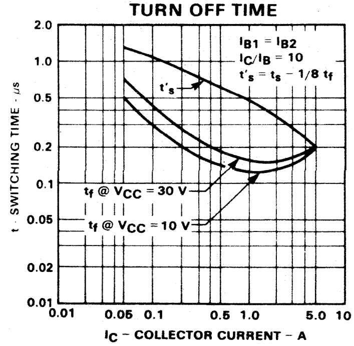

### BASE-EMITTER SATURATION VOLTAGE




### TURN ON TIME




### TURN OFF TIME



# POWER TRANSISTOR

## NPN SILICON

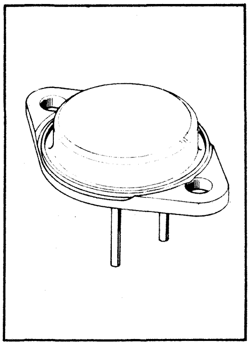
# 2N5038
# 2N5039

### HIGH CURRENT, HIGH POWER, HIGH SPEED SILICON POWER TRANSISTORS

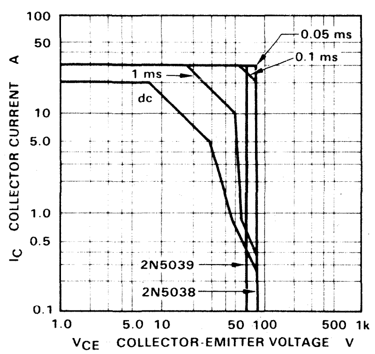
- 140 W DISSIPATION AT 25°C CASE
- 20 A CONTINUOUS COLLECTOR CURRENT
- <1.5 μs $t_s$ @ 12 A (2N5038)

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

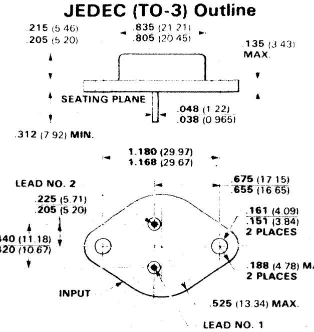
| Maximum Voltages and Currents | | 2N5038 | 2N5039 |
|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 90 V | 75 V |
| $V_{CBO}$ | Collector to Base Voltage | 150 V | 120 V |
| $V_{EBO}$ | Emitter to Base Voltage | 7.0 V | 7.0 V |
| $I_C$ | Continuous Collector Current | 20 A | 20 A |
| $I_C$ | Peak Collector Current | 30 A | 30 A |
| $I_B$ | Continuous Base Current | 5.0 A | 5.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 140 W |
| | Derate linearly from 25°C | | 0.8 W/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to 200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 12.5°C/W |
| $T_P$ | Maximum Pin Temperatures for Soldering Purposes: 1/8″ from Case for 5 seconds | | |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

# FAIRCHILD • 2N5038 • 2N5039

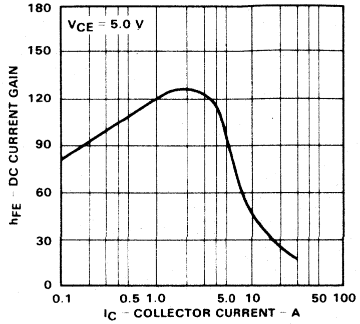
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5038 MIN | 2N5038 MAX | 2N5039 MIN | 2N5039 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 90 | | 75 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 110 | | 95 | | V | $I_C = 200$ mA, $R_{BE} = \leqslant 50\ \Omega$ |
| $V_{CEX(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 150 | | 120 | | V | $I_C = 0.2$ A, $V_{BE(off)} = -1.5$ V |
| $V_{EBO}$ | Emitter-Base Breakdown Voltage | 7.0 | | 7.0 | | V | $I_E = 50$ mA, $I_C = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 20 | | | mA | $V_{CE} = 70$ V, $I_B = 0$ |
| | | | | | 20 | mA | $V_{CE} = 55$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 50 | | | mA | $V_{CE} = 140$ V, $V_{BE} = -1.5$ V |
| | | | | | 50 | mA | $V_{CE} = 110$ V, $V_{BE} = -1.5$ V |
| | | | 10 | | | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 10 | mA | $V_{CE} = 85$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 15 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| | | | 50 | | 50 | mA | $V_{EB} = 7.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 50 | 250 | 30 | 250 | | $I_C = 2.0$ A, $V_{CE} = 5.0$ V |
| | | 20 | 100 | | | | $I_C = 10$ A, $V_{CE} = 5.0$ V |
| | | | | 20 | 100 | | $I_C = 12$ A, $V_{CE} = 5.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | | | 1.0 | V | $I_C = 10$ A, $I_B = 1.0$ A |
| | | | 1.0 | | | V | $I_C = 12$ A, $I_B = 1.2$ A |
| | | | 2.5 | | 2.5 | V | $I_C = 20$ A, $I_B = 5.0$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 3.3 | | 3.3 | V | $I_C = 20$ A, $I_B = 5.0$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | | | 1.8 | V | $I_C = 10$ A, $V_{CE} = 5.0$ V |
| | | | | | 1.8 | V | $I_C = 12$ A, $V_{CE} = 5.0$ V |
| **SECOND BREAKDOWN** | | | | | | | |
| $I_{S/b}$ | Second Breakdown Collector Current with base forward biased | 5.0 | | 5.0 | | A | t = 1.0 s (non repetitive), $V_{CE} = 28$ V |
| | | 0.9 | | 0.9 | | A | $V_{CE} = 45$ V |
| $E_{S/b}$ | Second Breakdown Energy with base reversed biased | 13 | | 13 | | mJ | $I_C = 12$ A, $V_{BE(off)} = -4.0$ V, L = 180 $\mu$H, $R_B = 20\ \Omega$ |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 400 | | 400 | pF | $V_{CB} = 10$ V, $I_E = 0$ |
| $h_{fe}$ | Magnitude of Common Emitter *Small Signal Current Gain* | 12 | | 12 | | | $I_C = 2.0$ A, $V_{CE} = 10$ V, f = 5.0 MHz |
| **SWITCHING CHARACTERISTICS — RESISTIVE LOAD** | | | | | | | |
| $t_r$ | Rise Time | | 0.5 | | | $\mu$s | $V_{CC} = 30$ V, $I_C = 12$ A, $I_{B1} = 1.2$ A |
| | | | | | 0.5 | $\mu$s | $V_{CC} = 30$ V, $I_C = 10$ A, $I_{B1} = 1.0$ A |
| $t_s$ | Storage Time | | 1.5 | | | $\mu$s | $V_{CC} = 30$ V, $I_C = 12$ A, $I_{B1} = I_{B2} = 1.2$ A |
| | | | | | 1.5 | $\mu$s | $V_{CC} = 30$ V, $I_C = 10$ A, $I_{B1} = I_{B2} = 1.0$ A |
| $t_f$ | Fall Time | | 0.5 | | | $\mu$s | $V_{CC} = 30$ V, $I_C = 12$ A, $I_{B1} = I_{B2} = 1.2$ A |
| | | | | | 0.5 | $\mu$s | $V_{CC} = 30$ V, $I_C = 10$ A $I_{B1} = I_{B2} = 1.0$ A |

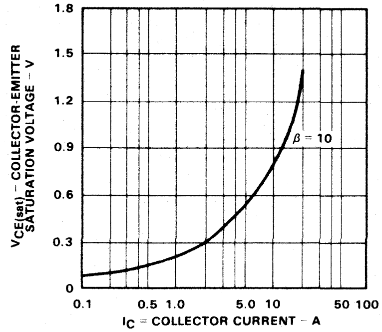
IOTE: 1. Pulse conditions: Length = 300 $\mu$s, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

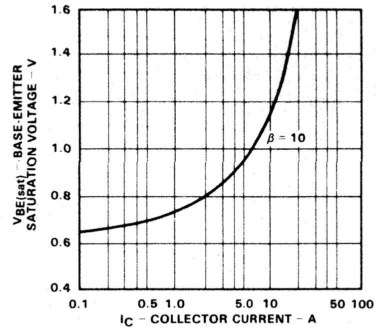
### DC CURRENT GAIN



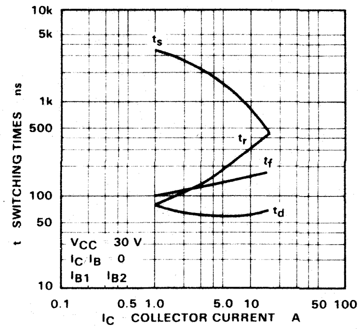

### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE




### SWITCHING TIME



# POWER TRANSISTOR

## NPN SILICON

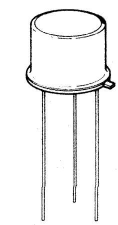
# 2N5058
# 2N5059

### POWER DEVICES DESIGNED PRIMARILY FOR LARGE SIGNAL, LOW POWER, AUDIO FREQUENCY AMPLIFIER APPLICATIONS

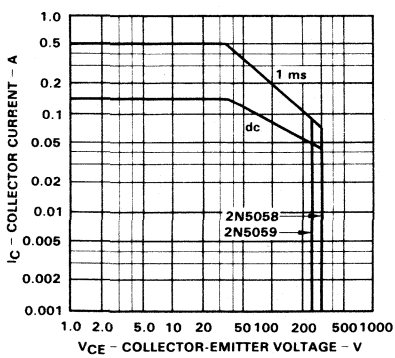
- 5.0 W DISSIPATION AT 25°C CASE
- 150 mA MAXIMUM CONTINUOUS COLLECTOR CURRENT
- HIGH VOLTAGE – $V_{CEO}$ 250 V MIN (2N5059), 300 V MIN (2N5058)

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

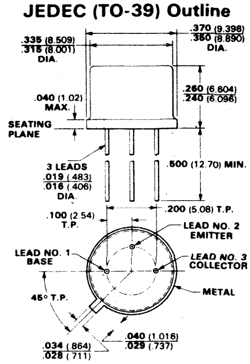
| | | 2N5058 | 2N5059 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 300 V | 250 V |
| $V_{CBO}$ | Collector to Base Voltage | 300 V | 250 V |
| $V_{EBO}$ | Emitter to Base Voltage | 7.0 V | 7.0 V |
| $I_C$ | Continuous Collector Current | 150 mA | 150 mA |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 5.0 W |
| | Derate linearly from 25°C | | 28.6 mW/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | -65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 35°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

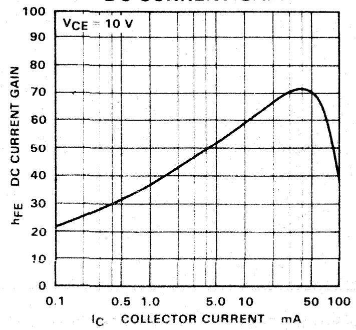
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5058 MIN | 2N5058 MAX | 2N5059 MIN | 2N5059 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 300 | | 250 | | V | $I_C = 30$ mA, $I_B = 0$ |
| $V_{CBO}$ | Collector-Base Breakdown Voltage | 300 | | 225 | | V | $I_C = 0.1$ mA, $I_E = 0$ |
| $V_{EBO}$ | Emitter-Base Breakdown Voltage | 7.0 | | 6.0 | | V | $I_E = 0.1$ mA, $I_C = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.05<br>0.02 | | 0.05<br>0.02 | μA<br>mA | $V_{CB} = 100$ V, $I_E = 0$<br>$V_{CB} = 100$ V, $I_E = 0$, $T_C = 125°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.01 | | 0.01 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 10<br>35<br>35<br>10 | <br>150<br><br> | 10<br>30<br>30<br> | <br>150<br><br> | | $I_C = 5.0$ mA, $V_{CE} = 25$ V<br>$I_C = 30$ mA, $V_{CE} = 25$ V<br>$I_C = 100$ mA, $V_{CE} = 25$ V<br>$I_C = 30$ mA, $V_{CE} = 25$ V, $T_C = -55°C$ |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | V | $I_C = 30$ mA, $I_B = 3.0$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 0.85 | | 0.85 | V | $I_C = 30$ mA, $I_B = 3.0$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 0.82 | | 0.82 | V | $I_C = 30$ mA, $V_{CE} = 25$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $C_{cb}$ | Collector-Base Capacitance | | 10 | | 10 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz |
| $C_{eb}$ | Emitter-Base Capacitance | | 75 | | 75 | pF | $V_{EB} = 0.5$ V, $I_C = 0$, f = 1.0 MHz |
| $h_{fe}$ | Magnitude of Common Emitter Small Signal Current Gain | 1.5 | 8.0 | 1.5 | 8.0 | | $I_C = 10$ mA, $V_{CE} = 25$ V, f = 20 MHz |

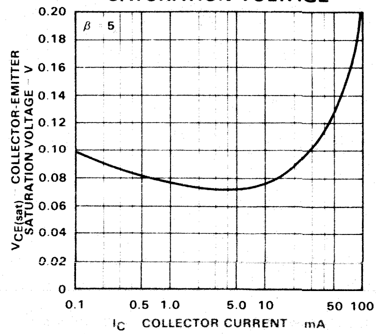
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

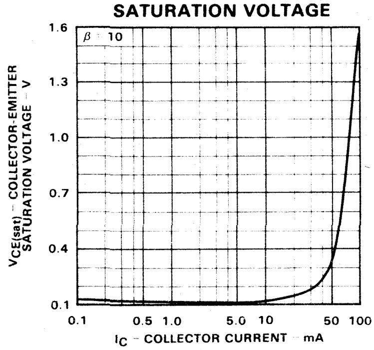
### DC CURRENT GAIN



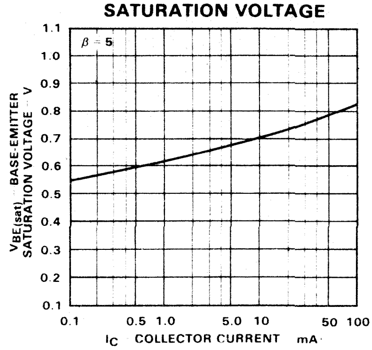

### COLLECTOR-EMITTER SATURATION VOLTAGE



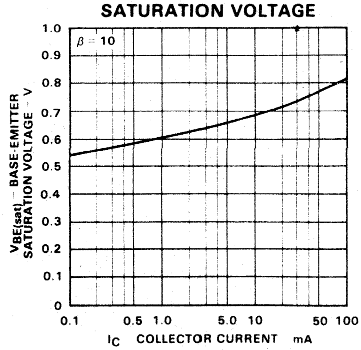

### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE



# POWER TRANSISTOR

NPN SILICON

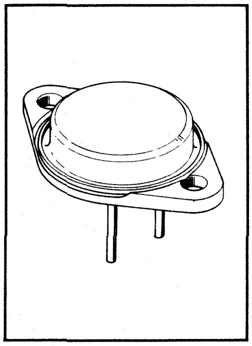
# 2N5067
# 2N5068
# 2N5069

## DESIGNED FOR USE IN POWER AMPLIFIER AND SWITCHING CIRCUITS

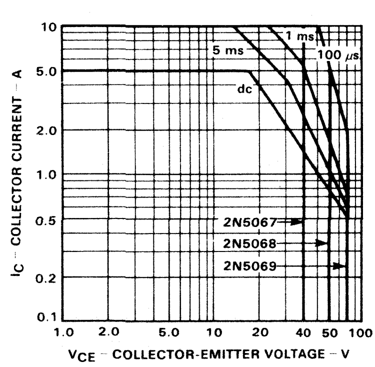
- 87.5 W DISSIPATION AT 25°C CASE
- 5.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS TO 2N4901, 2N4902, 2N4903

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

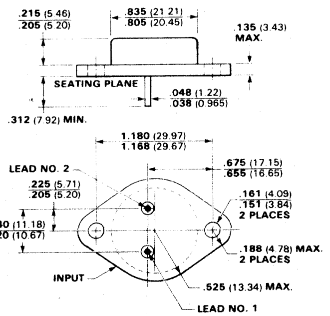
| Maximum Voltages and Currents | | 2N5067 | 2N5068 | 2N5069 |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 40 V | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 5.0 A | 5.0 A | 5.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 87.5 W |
| | Derate Linearly from 25°C | | | 0.5 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 2.0 °C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**



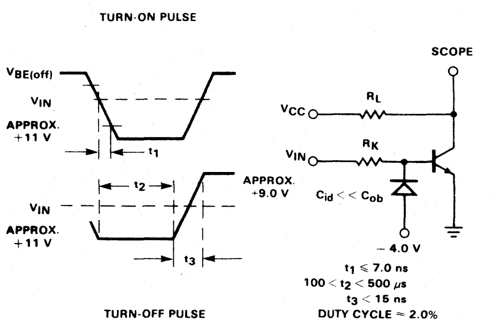

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5067 MIN | 2N5067 MAX | 2N5068 MIN | 2N5068 MAX | 2N5069 MIN | 2N5069 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| OFF CHARACTERISTICS | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 200\ mA$, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 40\ V$, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 60\ V$, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 80\ V$, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 40\ V$, $V_{BE} = -1.5\ V$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 60\ V$, $V_{BE} = -1.5\ V$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 80\ V$, $V_{BE} = -1.5\ V$ |
| | | | 2.0 | | | | | mA | $V_{CE} = 40\ V$, $V_{BE} = -1.5\ V$, $T_C = 150°C$ |
| | | | | | 2.0 | | | mA | $V_{CE} = 60\ V$, $V_{BE} = -1.5\ V$, $T_C = 150°C$ |
| | | | | | | | 2.0 | mA | $V_{CE} = 80\ V$, $V_{BE} = -1.5\ V$, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CB} = 40\ V$, $I_E = 0$ |
| | | | | | 1.0 | | | mA | $V_{CB} = 60\ V$, $I_E = 0$ |
| | | | | | | | 1.0 | mA | $V_{CB} = 80\ V$, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0\ V$, $I_C = 0$ |
| ON CHARACTERISTICS | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20 | 80 | 20 | 80 | 20 | 80 | | $I_C = 1.0\ A$, $V_{CE} = 2.0\ V$ |
| | | 7.0 | | 7.0 | | 7.0 | | | $I_C = 5.0\ A$, $V_{CE} = 2.0\ V$ |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.4 | | 0.4 | | 0.4 | V | $I_C = 1.0\ A$, $I_B = 0.1\ A$ |
| | | | 1.5 | | 1.5 | | 1.5 | V | $I_C = 5.0\ A$, $I_B = 1.0\ A$ |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.2 | | 1.2 | | 1.2 | V | $I_C = 1.0\ A$, $V_{CE} = 2.0\ V$ |
| DYNAMIC CHARACTERISTICS | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | 4.0 | | MHz | $I_C = 1.0\ A$, $V_{CE} = 10\ V$, $f = 1.0\ MHz$ |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | 20 | | | $I_C = 0.5\ A$, $V_{CE} = 10\ V$, $f = 1.0\ kHz$ |

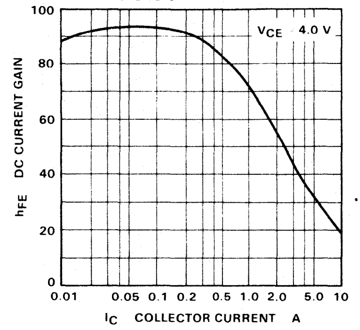
NOTE: 1. Pulse conditions: Length = 300 $\mu s$, Duty Cycle = 2%.

**SWITCHING TIME EQUIVALENT CIRCUIT**

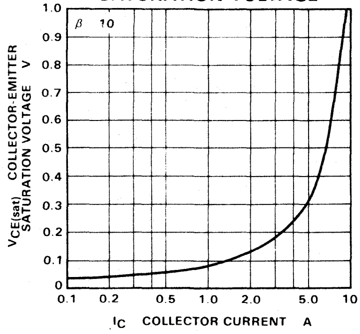


## TYPICAL ELECTRICAL CHARACTERISTICS

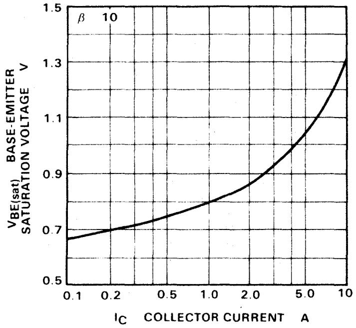
### DC CURRENT GAIN



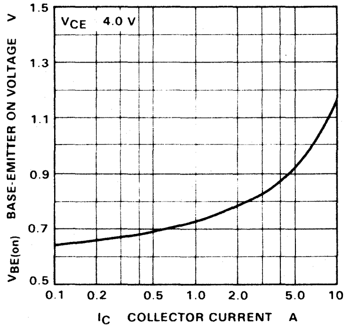

### COLLECTOR-EMITTER SATURATION VOLTAGE



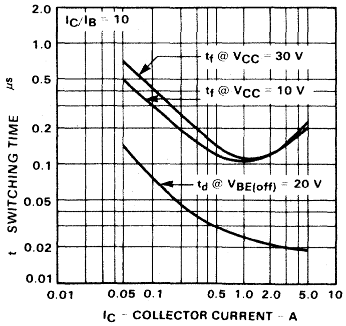

### BASE-EMITTER SATURATION VOLTAGE



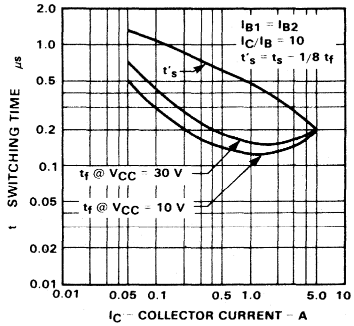

### BASE-EMITTER ON VOLTAGE




### TURN ON TIME




### TURN OFF TIME



# POWER TRANSISTOR

## NPN SILICON

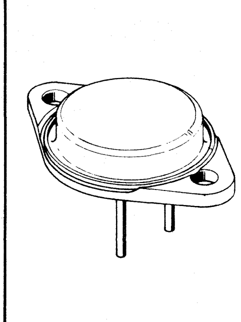
# 2N5301
# 2N5302
# 2N5303

### HIGH POWER TRANSISTORS FOR USE IN POWER AMPLIFIER AND SWITCHING CIRCUITS APPLICATIONS

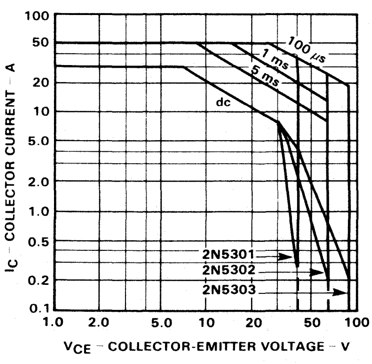
- 200 W DISSIPATION AT 25°C CASE
- 30 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS 2N4398 (2N5301) 2N4399 (2N5302)

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

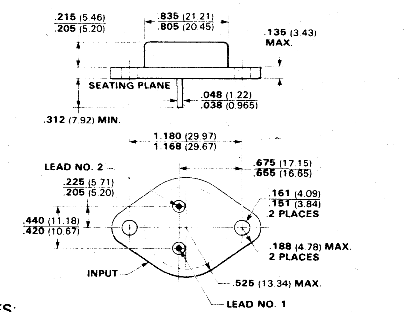
| | | 2N5301 | 2N5302 | 2N5303 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 40 V | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 30 A | 30 A | 30 A |
| $I_B$ | Continuous Base Current | 7.5 A | 7.5 A | 7.5 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 200 W |
| | Derate Linearly from 25°C | | | 1.14 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 0.875°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

# FAIRCHILD • 2N5301 • 2N5302 • 2N5303

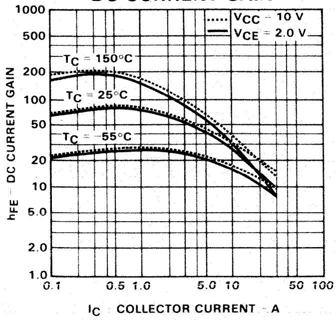
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5301 | | 2N5302 | | 2N5303 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 5.0 | | | | | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| | | | | | 5.0 | | | mA | $V_{CE} = 60$ V, $I_B = 0$ |
| | | | | | | | 5.0 | mA | $V_{CE} = 80$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V |
| | | | | | 1.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | | | 1.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | 10 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V, $T_C = 150$°C |
| | | | | | 10 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150$°C |
| | | | | | | | 10 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150$°C |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CB} = 40$ V, $I_E = 0$ |
| | | | | | 1.0 | | | mA | $V_{CB} = 60$ V, $I_E = 0$ |
| | | | | | | | 1.0 | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | | 5.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 5.0 | | 5.0 | | | | | $I_C = 30$ A, $V_{CE} = 3.0$ V |
| | | | | | | 5.0 | | | $I_C = 20$ A, $V_{CE} = 2.0$ V |
| | | 15 | 60 | 15 | 60 | | | | $I_C = 15$ A, $V_{CE} = 3.0$ V |
| | | | | | | 15 | 60 | | $I_C = 10$ A, $V_{CE} = 2.0$ V |
| | | 40 | | 40 | | 40 | | | $I_C = 1.0$ A, $V_{CE} = 2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.75 | | 0.75 | | 1.0 | V | $I_C = 10$ A, $I_B = 1.0$ A |
| | | | | | | | 1.5 | V | $I_C = 15$ A, $I_B = 1.5$ A |
| | | | 2.0 | | 2.0 | | | V | $I_C = 20$ A, $I_B = 2.0$ A |
| | | | | | | | 2.0 | V | $I_C = 20$ A, $I_B = 4.0$ A |
| | | | 3.0 | | 3.0 | | | V | $I_C = 30$ A, $I_B = 6.0$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.7 | | 1.7 | | 1.7 | V | $I_C = 10$ A, $I_B = 1.0$ A |
| | | | 1.8 | | 1.8 | | 2.0 | V | $I_C = 15$ A, $I_B = 1.5$ A |
| | | | 2.5 | | 2.5 | | | V | $I_C = 20$ A, $I_B = 2.0$ A |
| | | | | | | | 2.5 | V | $I_C = 20$ A, $I_B = 4.0$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.8 | | 1.8 | | | V | $I_C = 15$ A, $V_{CE} = 2.0$ V |
| | | | | | | | 1.5 | V | $I_C = 10$ A, $V_{CE} = 2.0$ V |
| | | | 3.0 | | 3.0 | | | V | $I_C = 30$ A, $V_{CE} = 4.0$ V |
| | | | | | | | 2.5 | V | $I_C = 20$ A, $V_{CE} = 4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 2.0 | | 2.0 | | 2.0 | | MHz | $I_C = 1.0$ A, $V_{CE} = 10$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 40 | | 40 | | 40 | | | $I_C = 1.0$ A, $V_{CE} = 10$ V, f = 1.0 kHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | | | |
| $t_r$ | Rise Time | | 1.0 | | 1.0 | | 1.0 | μs | $V_{CC} = 30$ V, $I_C = 10$ A, $I_{B1} = 1.0$ A, $t_p = 10$-$100$ μs, Duty Cycle = 2.0 % |
| $t_s$ | Storage Time | | 2.0 | | 2.0 | | 2.0 | μs | $V_{CC} = 30$ V, $I_C = 10$ A, $I_{B1} = I_{B2} = 1.0$ A, $t_p = 10$-$100$ μs Duty Cycle = 2.0% |
| $t_f$ | Fall Time | | 1.0 | | 1.0 | | 1.0 | μs | |

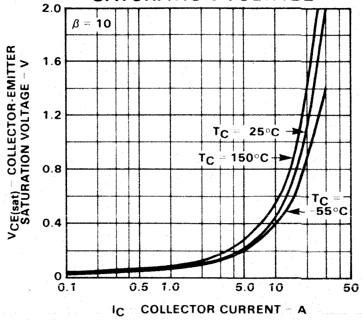
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

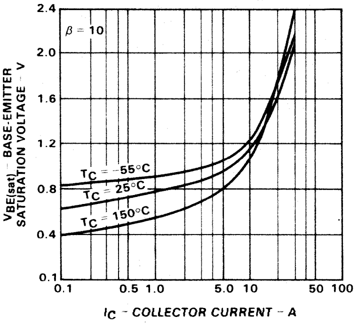
### DC CURRENT GAIN



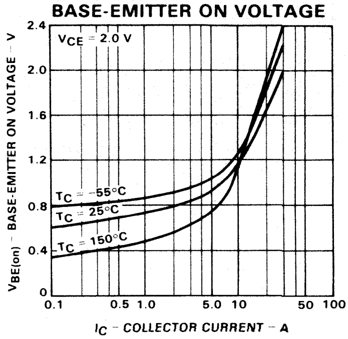

### COLLECTOR-EMITTER SATURATION VOLTAGE



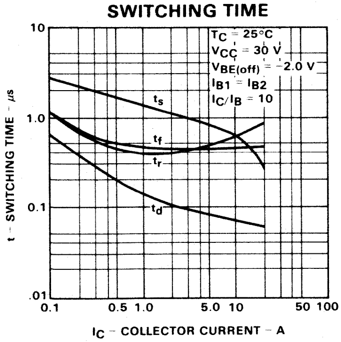

### BASE-EMITTER SATURATION VOLTAGE



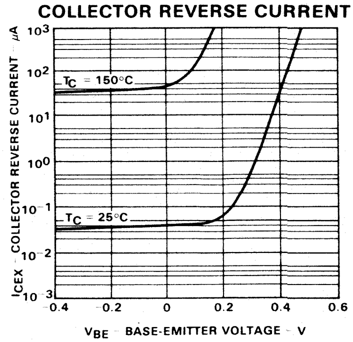

### BASE-EMITTER ON VOLTAGE



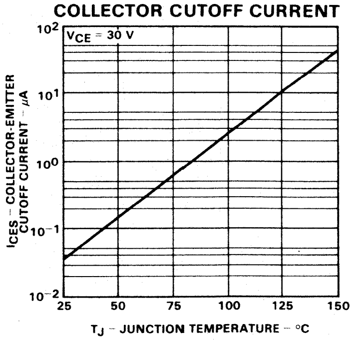

### SWITCHING TIME




### COLLECTOR REVERSE CURRENT




### COLLECTOR CUTOFF CURRENT



# POWER TRANSISTOR

## NPN SILICON

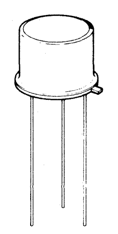
## 2N5320
## 2N5321

### GENERAL PURPOSE POWER DEVICES FOR SMALL SIGNAL, MEDIUM POWER APPLICATIONS

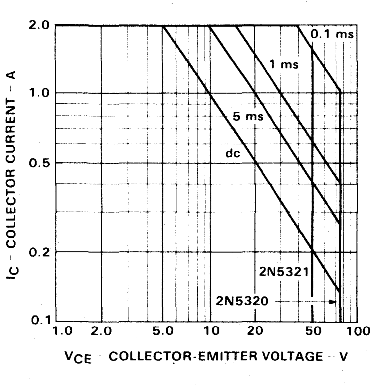
- 10 W DISSIPATION AT 25°C CASE
- 2.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS 2N5322, 2N5323

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

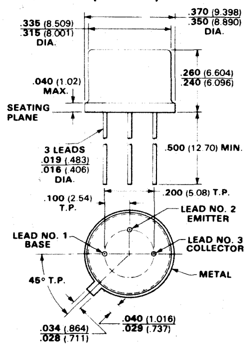
| | | 2N5320 | 2N5321 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 75 V | 50 V |
| $V_{CBO}$ | Collector to Base Voltage | 100 V | 75 V |
| $V_{EBO}$ | Emitter to Base Voltage | 7.0 V | 7.0 V |
| $I_C$ | Continuous Collector Current | 2.0 A | 2.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 10 W |
| | Derate Linearly from 25°C | | 0.057 W/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 17.5°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

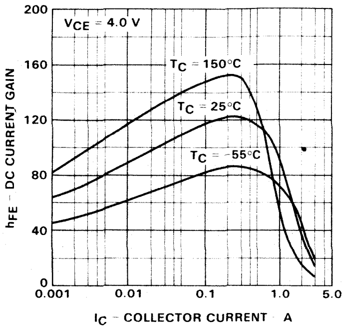
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5320 MIN | 2N5320 MAX | 2N5321 MIN | 2N5321 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 75 | | 50 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.1 | mA | $V_{CE} = 75$ V, $V_{BE} = -1.5$ V |
| | | | 5.0 | | | mA | $V_{CE} = 70$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | mA | $V_{CE} = 45$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.1 | | | mA | $V_{EB} = 7.0$ V, $I_C = 0$ |
| | | | | | 0.1 | mA | $V_{EB} = 5.0$ V |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 10 | | 10 | | | $I_C = 1.0$ A, $V_{CE} = 2.0$ V |
| | | 30 | 130 | 40 | 250 | | $I_C = 0.5$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.5 | | 0.8 | V | $I_C = 0.5$ A, $I_B = 0.05$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.1 | | 1.4 | V | $I_C = 0.5$ A, $V_{CE} = 4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 5.0 | | 5.0 | | MHz | $I_C = 0.05$ A, $V_{CE} = 4.0$ V, f = 10 MHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| $t_{on}$ | Turn On Time | | 80 | | 80 | μs | $I_C = 500$ mA, $V_{CC} = 30$ V, $I_{B1} = 50$ mA |
| $t_{off}$ | Turn Off Time | | 800 | | 800 | μs | $I_C = 500$ mA, $V_{CC} = 30$ V, $I_{B1} = I_{B2} = 50$ mA |

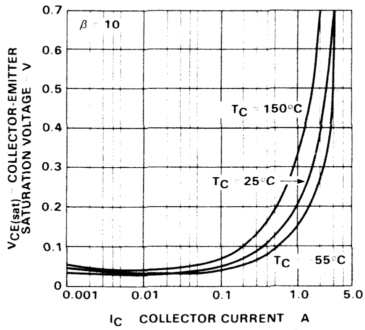
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

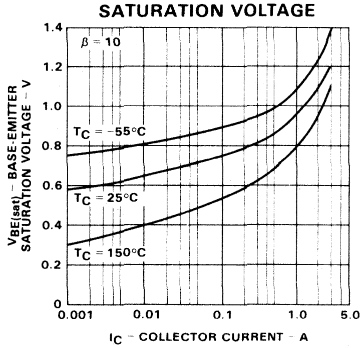
### CURRENT GAIN



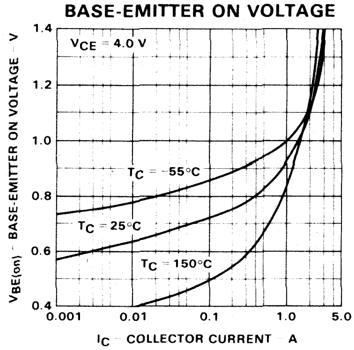

### COLLECTOR-EMITTER SATURATION VOLTAGE



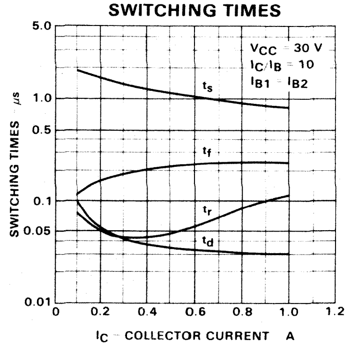

### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE




### SWITCHING TIMES



# POWER TRANSISTOR

## PNP SILICON

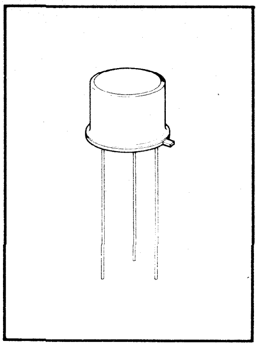
# 2N5322
# 2N5323

## GENERAL PURPOSE POWER DEVICES FOR SMALL SIGNAL, MEDIUM POWER APPLICATIONS

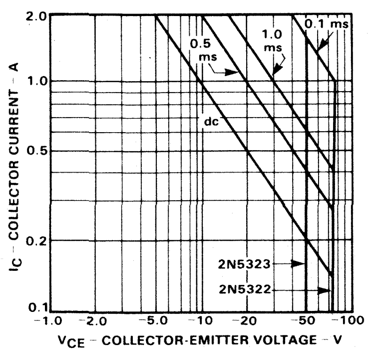
- 10 W DISSIPATION AT 25°C CASE
- 2.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENT 2N5320, 2N5321

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

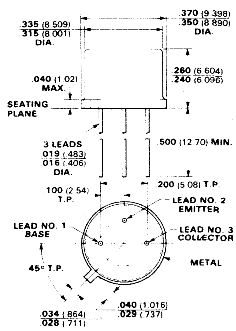
| | | 2N5322 | 2N5323 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −75 V | −50 V |
| $V_{CBO}$ | Collector to Base Voltage | −100 V | −75 V |
| $V_{EBO}$ | Emitter to Base Voltage | −7.0 V | −7.0 V |
| $I_C$ | Continuous Collector Current | −2.0 A | 2.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 10 W |
| | Derate Linearly from 25°C | | 0.057 W/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 17.5°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

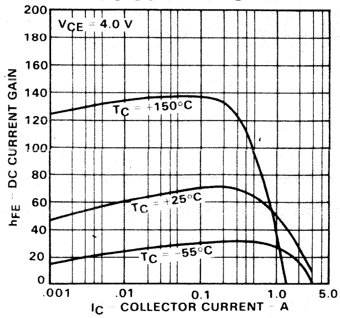
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5322 MIN | 2N5322 MAX | 2N5323 MIN | 2N5323 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −75 | | −50 | | V | $I_C = 0.1$ mA, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | mA | $V_{CE} = -100$ V, $V_{BE} = 1.5$ V |
| | | | | | 0.1 | mA | $V_{CE} = -75$ V, $V_{BE} = 1.5$ V |
| | | | 5.0 | | | mA | $V_{CE} = -70$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | mA | $V_{CE} = -45$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.1 | | | mA | $V_{EB} = -7.0$ V, $I_C = 0$ |
| | | | | | 0.1 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 10 | | 10 | | | $I_C = 1.0$ A, $V_{CE} = -2.0$ V |
| | | 30 | 130 | 40 | 250 | | $I_C = 0.5$ A, $V_{CE} = -4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −0.7 | | −1.2 | V | $I_C = 0.5$ A, $I_B = 0.05$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.1 | | −1.4 | V | $I_C = 0.5$ A, $V_{CE} = -4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 5.0 | | 5.0 | | MHz | $I_C = 0.05$ A, $V_{CE} = -4.0$ V, f = 10 MHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| $t_{on}$ | Turn On Time | | 100 | | 100 | μs | $I_C = 500$ mA, $V_{CC} = -30$ V, $I_{B1} = 50$ mA |
| $t_{off}$ | Turn Off Time | | 1000 | | 1000 | μs | $I_C = 500$ mA, $V_{CC} = -30$ V, $I_{B1} = I_{B2} = 50$ mA |

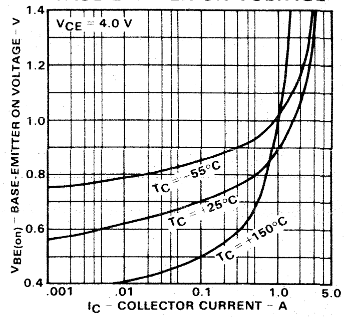
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

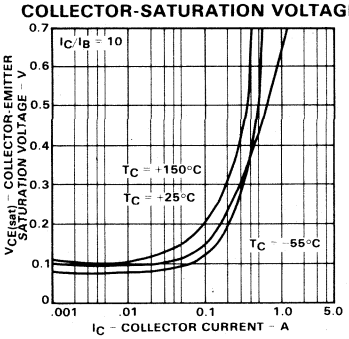
### DC CURRENT GAIN



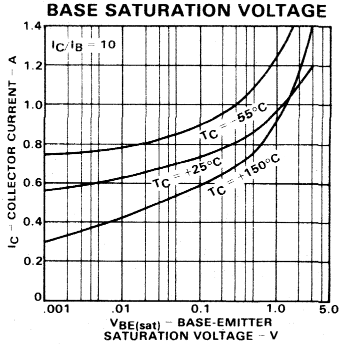

### BASE-EMITTER ON VOLTAGE



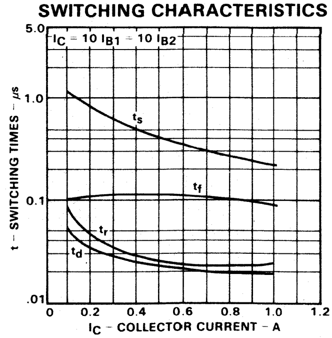

### COLLECTOR-SATURATION VOLTAGE




### BASE SATURATION VOLTAGE




### SWITCHING CHARACTERISTICS



# POWER TRANSISTOR

## NPN SILICON

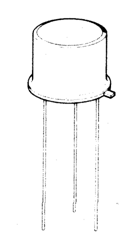
# 2N5334
# 2N5335

### DESIGNED AS GENERAL PURPOSE MEDIUM POWER DEVICE FOR SWITCHING APPLICATIONS

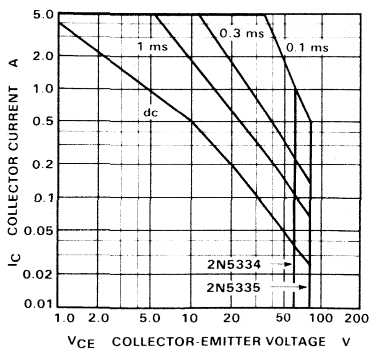
- 6.0 W DISSIPATION AT 25°C CASE
- 3.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- LOW LEAKAGE, $I_{CES(MAX)}$ 100 $\mu$A @ $T_C$ = 150°C

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

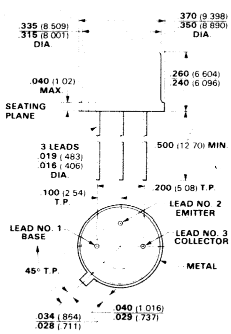
| | | 2N5334 | 2N5335 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 8.0 V | 8.0 V |
| $I_C$ | Continuous Collector Current | 3.0 A | 3.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 6.0 W |
| | Derate Linearly from 25°C | | 34 mW/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 29.1°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**



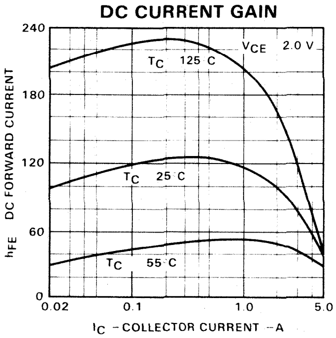

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 1.23 grams

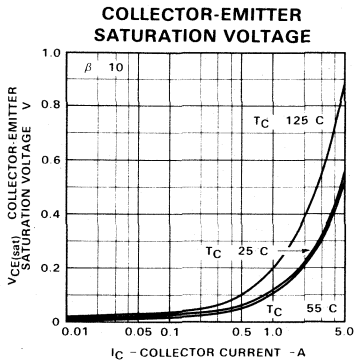
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

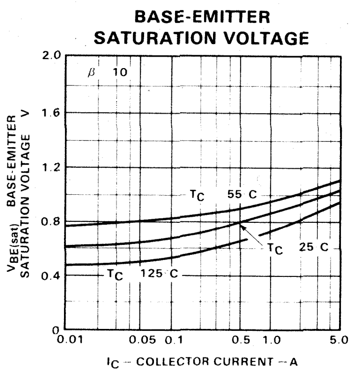
| SYMBOL | CHARACTERISTIC | 2N5334 MIN | 2N5334 MAX | 2N5335 MIN | 2N5335 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | V | $I_C = 50$ mA, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 5.0 | | | μA | $V_{CE} = 55$ V, $V_{BE} = -1.5$ V |
| | | | | | 5.0 | μA | $V_{CE} = 75$ V, $V_{BE} = -1.5$ V |
| | | | 0.5 | | | mA | $V_{CE} = 55$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 0.5 | mA | $V_{CE} = 75$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 5.0 | | | μA | $V_{CB} = 60$ V, $I_E = 0$ |
| | | | | | 5.0 | μA | $V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.1 | | 0.1 | mA | $V_{EB} = 8.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30 | 150 | 30 | 150 | | $I_C = 1.0$ A, $V_{CE} = 2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.7 | | 0.7 | V | $I_C = 2.0$ A, $I_B = 0.2$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.5 | | 1.5 | V | $I_C = 2.0$ A, $I_B = 0.2$ A |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $C_{ib}$ | Input Capacitance | | 250 | | 250 | pF | $V_{EB} = 2.0$ V, $I_C = 0$, f = 0.1 MHz |
| $C_{ob}$ | Output Capacitance | | 75 | | 75 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $h_{fe}$ | Magnitude of Common Emitter Small Signal Current Gain | 4.0 | | 4.0 | | | $I_C = 100$ mA, $V_{CE} = 10$ V, f = 10 MHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | |
| $t_r$ | Rise Time | | 50 | | 50 | μs | $V_{CC} = 20$ V, $I_C = 1.0$ A, $I_{B1} = 100$ mA, $t_p = 10$ μs, Duty Cycle 1 kHz |
| $t_s$ | Storage Time | | 950 | | 950 | μs | $V_{CC} = 20$ V, $I_C = 1.0$ A, $I_{B1} = I_{B2} = 100$ mA, $t_p = 10$ μs, Duty Cycle 1 kHz |
| $t_f$ | Fall Time | | 100 | | 100 | μs | |

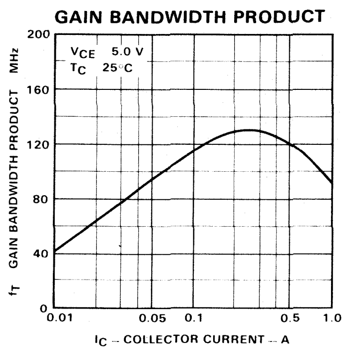
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

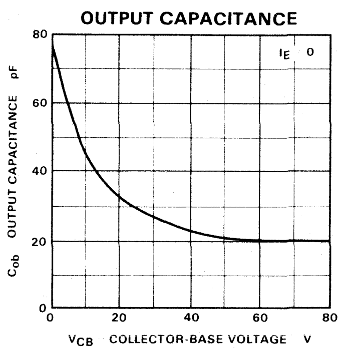
## TYPICAL ELECTRICAL CHARACTERISTICS



# POWER TRANSISTOR

## NPN SILICON

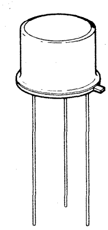
# 2N5336
# 2N5337

### MEDIUM POWER TRANSISTORS DESIGNED FOR SWITCHING AND WIDE BAND AMPLIFIER APPLICATIONS

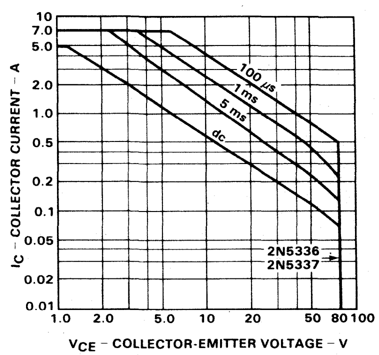
- 6.0 W DISSIPATION AT 25°C CASE
- 5.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 1.2 V $V_{CE(sat)}$ AT 5.0 A

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

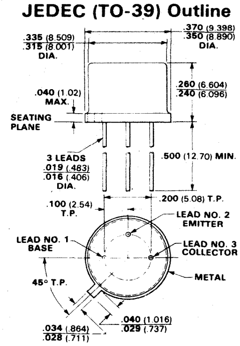
| | | 2N5336 | 2N5337 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 80 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 80 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 6.0 V | 6.0 V |
| $I_C$ | Continuous Collector Current | 5.0 A | 5.0 A |
| $I_C$ | Peak Collector Current | 7.0 A | 7.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 6.0 W |
| | Derate linearly from 25°C | | 34.3 mW/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 29.2°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**

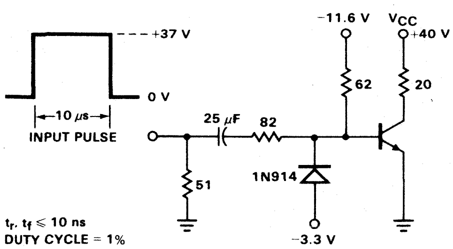



NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Moly disc
High reliability, low thermal resistance
*Dimension the same as JEDEC TO-5 except for lead length
Package weight is 2.9 grams

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

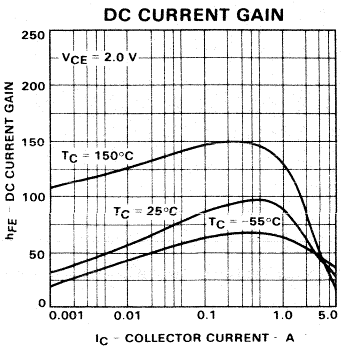
| SYMBOL | CHARACTERISTIC | 2N5336 MIN | 2N5336 MAX | 2N5337 MIN | 2N5337 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 80 | | 80 | | V | $I_C = 50$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.1 | | 0.1 | mA | $V_{CE} = 75$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.01<br>1.0 | | 0.01<br>1.0 | mA<br>mA | $V_{CE} = 75$ V, $V_{BE} = -1.5$ V<br>$V_{CE} = 75$ V, $V_{BE} = -1.5$ V<br>$T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.01 | | 0.01 | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.1 | | 0.1 | mA | $V_{EB} = 6.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30<br>30<br>20 | <br>120<br> | 60<br>60<br>40 | <br>240<br> | | $I_C = 0.5$ A, $V_{CE} = 2.0$ V<br>$I_C = 2.0$ A, $V_{CE} = 2.0$ V<br>$I_C = 5.0$ A, $V_{CE} = 2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.7<br>1.2 | | 0.7<br>1.2 | V<br>V | $I_C = 2.0$ A, $I_B = 0.2$ A<br>$I_C = 5.0$ A, $I_B = 0.5$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.2<br>1.8 | | 1.2<br>1.8 | V<br>V | $I_C = 2.0$ A, $I_B = 0.2$ A<br>$I_C = 5.0$ A, $I_B = 0.5$ A |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 30 | | 30 | | MHz | $I_C = 500$ mA, $V_{CE} = 10$ V, f = 10 MHz |
| $C_{ob}$ | Output Capacitance | | 250 | | 250 | | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $C_{ib}$ | Input Capacitance | | 1000 | | 1000 | pF | $V_{EB} = 2.0$ V, $I_C = 0$, f = 0.1 MHz |
| **SWITCHING CHARACTERISTICS**<br>**RESISTIVE LOAD** | | | | | | | |
| $t_d$ | Delay Time | | 0.1 | | 0.1 | μs | $V_{CC} = 40$ V, $I_C = 2.0$ A, $I_{B1} = 200$ mA, $t_p = 10$ μs, Duty Cycle = 1% |
| $t_r$ | Rise Time | | 0.1 | | 0.1 | μs | |
| $t_s$ | Storage Time | | 2.0 | | 2.0 | μs | $V_{CC} = 40$ V, $I_C = 2.0$ A, $I_{B1} = I_{B2} = 200$ mA, $t_p = 10$ μs, Duty Cycle = 1% |
| $t_f$ | Fall Time | | 0.2 | | 0.2 | μs | |

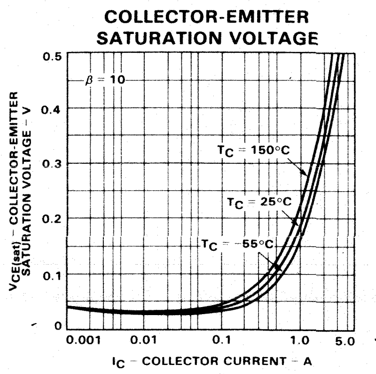
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

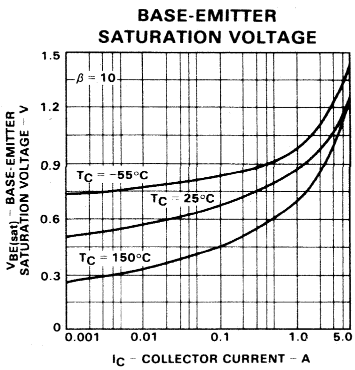


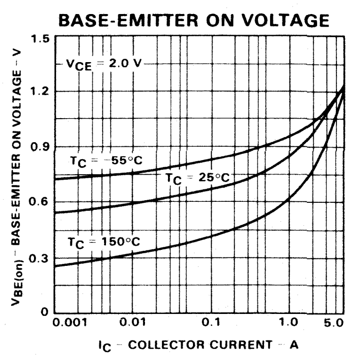

**SWITCHING TIME TEST CIRCUIT**

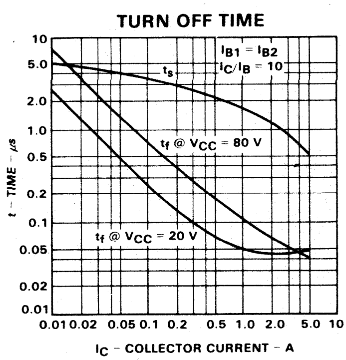
## TYPICAL ELECTRICAL CHARACTERISTICS

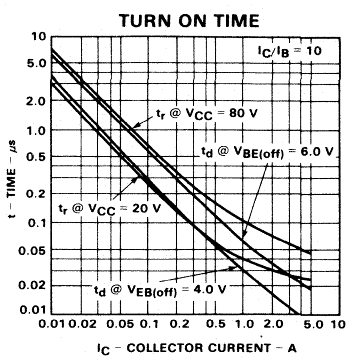


# POWER TRANSISTOR

## NPN SILICON

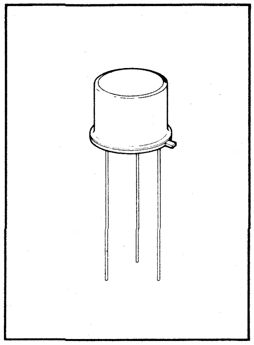
## 2N5338
## 2N5339

### MEDIUM POWER TRANSISTORS DESIGNED FOR SWITCHING AND WIDE BAND AMPLIFIER APPLICATIONS

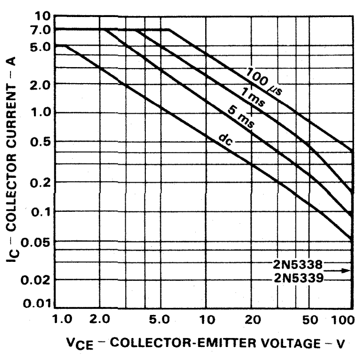
- **6.0 W DISSIPATION AT 25°C CASE**
- **5.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **1.2 V $V_{CE(sat)}$ AT 5.0 A**

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

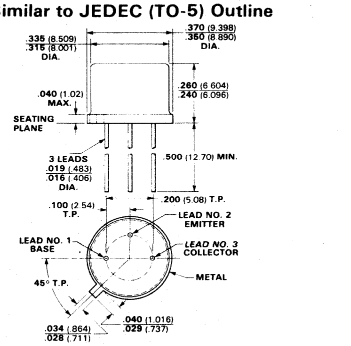
| | | 2N5338 | 2N5339 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 100 V | 100 V |
| $V_{CBO}$ | Collector to Base Voltage | 100 V | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 6.0 V | 6.0 V |
| $I_C$ | Continuous Collector Current | 5.0 A | 5.0 A |
| $I_C$ | Peak Collector Current | 7.0 A | 7.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 6.0 W |
| | Derate linearly from 25°C | | 34.3 mW/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 29.2 °C/W |



**SAFE OPERATING AREA**




***Similar to JEDEC (TO-5) Outline**

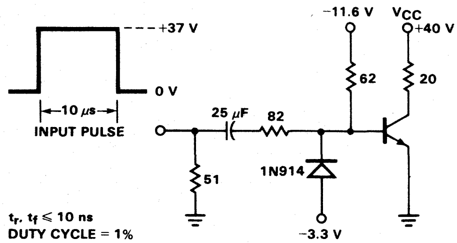



NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Moly disc
High reliability, low thermal resistance
*Dimension the same as JEDEC TO-5 except for lead length
Package weight is 2.9 grams

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

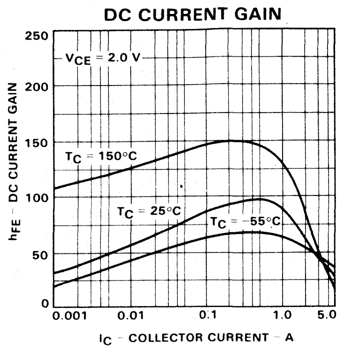
| SYMBOL | CHARACTERISTIC | 2N5338 MIN | 2N5338 MAX | 2N5339 MIN | 2N5339 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 100 | | 100 | | V | $I_C = 50$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.1 | | 0.1 | mA | $V_{CE} = 90$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.01 | | 0.01 | mA | $V_{CE} = 90$ V, $V_{BE} = -1.5$ V |
| | | | 1.0 | | 1.0 | mA | $V_{CE} = 90$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.01 | | 0.01 | mA | $V_{CB} = 100$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.1 | | 0.1 | mA | $V_{EB} = 6.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30 | | 60 | | | $I_C = 0.5$ A, $V_{CE} = 2.0$ V |
| | | 30 | 120 | 60 | 240 | | $I_C = 2.0$ A, $V_{CE} = 2.0$ V |
| | | 20 | | 40 | | | $I_C = 5.0$ A, $V_{CE} = 2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.7 | | 0.7 | V | $I_C = 2.0$ A, $I_B = 0.2$ A |
| | | | 1.2 | | 1.2 | V | $I_C = 5.0$ A, $I_B = 0.5$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.2 | | 1.2 | V | $I_C = 2.0$ A, $I_B = 0.2$ A |
| | | | 1.8 | | 1.8 | V | $I_C = 5.0$ A, $I_B = 0.5$ A |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 30 | | 30 | | MHz | $I_C = 500$ mA, $V_{CE} = 10$ V, f = 10 MHz |
| $C_{ob}$ | Output Capacitance | | 250 | | 250 | | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $C_{ib}$ | Input Capacitance | | 1000 | | 1000 | pF | $V_{EB} = 2.0$ V, $I_C = 0$, f = 0.1 MHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | |
| $t_d$ | Delay Time | | 0.1 | | 0.1 | μs | $V_{CC} = 40$ V, $I_C = 2.0$ A, $I_{B1} = 200$ mA, $t_p = 10$ μs, Duty Cycle = 1% |
| $t_r$ | Rise Time | | 0.1 | | 0.1 | μs | |
| $t_s$ | Storage Time | | 2.0 | | 2.0 | μs | $V_{CC} = 40$ V, $I_C = 2.0$ A, $I_{B1} = I_{B2} = 200$ mA, $t_p = 10$ μs, Duty Cycle = 1% |
| $t_f$ | Fall Time | | 0.2 | | 0.2 | μs | |

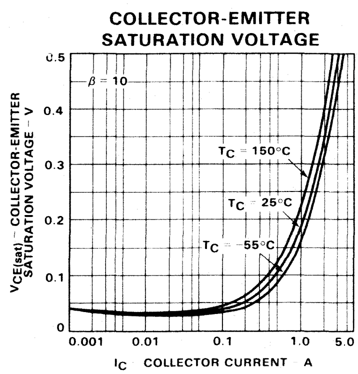
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

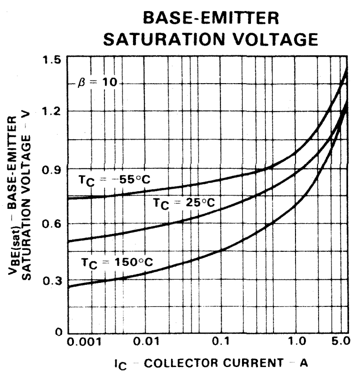


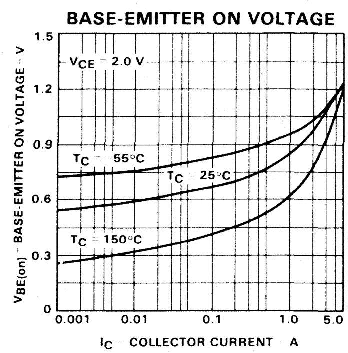

**SWITCHING TIME TEST CIRCUIT**

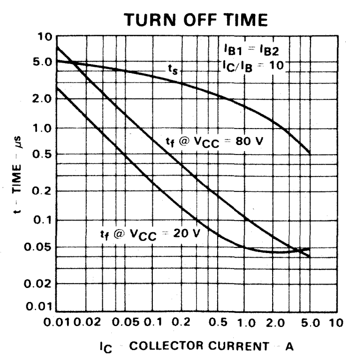
## TYPICAL ELECTRICAL CHARACTERISTICS

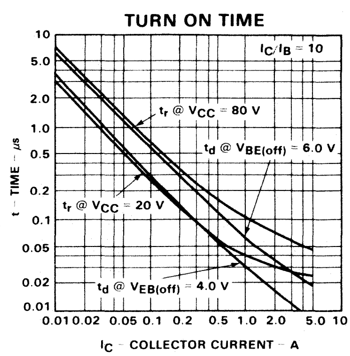


# POWER TRANSISTOR

## PNP SILICON

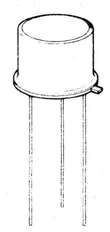
# 2N5415
# 2N5416

### DESIGNED FOR HIGH-SPEED SWITCHING AND LINEAR-AMPLIFIER APPLICATIONS IN MILITARY, INDUSTRIAL AND COMMERCIAL EQUIPMENT

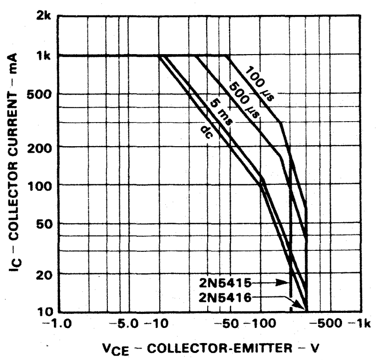
- **10 W DISSIPATION AT 25°C CASE**
- **1 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **UP TO 350 V $V_{CBO}$ RATING (2N5416)**
- **COMPLEMENTS TO 2N3439, 2N3440**

**ABSOLUTE MAXIMUM RATINGS**

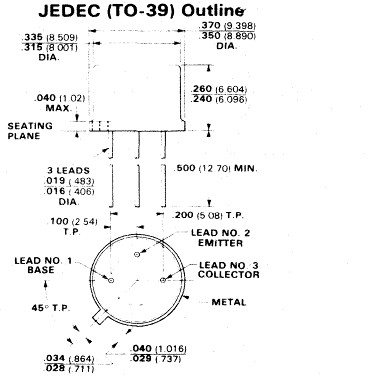
| | | 2N5415 | 2N5416 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CE}$ | Collector to Emitter Voltage | −200 V | −300 V |
| $V_{CB}$ | Collector to Base Voltage | −200 V | −350 V |
| $V_{EB}$ | Emitter to Base Voltage | −4.0 V | −4.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A | 1.0 A |
| $I_B$ | Continuous Base Current | 0.5 A | 0.5 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 10 W |
| | Derate Linearly from 25°C | | 1.14 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 17.5°C/W |
| $T_P$ | Maximum Lead Temperature (Soldering, 10 s) | | 255°C |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

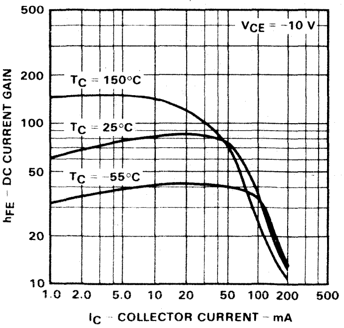
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTICS | 2N5415 MIN | 2N5415 MAX | 2N5416 MIN | 2N5416 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −200 | | −300 | | V | $I_C = 50$ mA, $I_B = 0$ |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | | | −350 | | V | $I_C = 50$ mA, $R_{BE} = 50\ \Omega$ |
| $I_{CEO}$ | Collector Cutoff Current | | 50 | | 50 | μA<br>μA | $V_{CE} = -150$ V, $I_B = 0$<br>$V_{CE} = -250$ V, $I_B = 0$ |
| $I_{CEV}$ | Collector Cutoff Current | | 50 | | 50 | μA<br>μA | $V_{CE} = -200$ V, $V_{BE} = 1.5$ V<br>$V_{CE} = -300$ V, $V_{BE} = 1.5$ V |
| $I_{CBO}$ | Collector Cutoff Current | | 50 | | 50 | μA<br>μA | $V_{CB} = -175$ V, $I_E = 0$<br>$V_{CB} = -280$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 20 | | 20 | μA<br>μA | $V_{EB} = -4.0$ V, $I_C = 0$<br>$V_{EB} = -6.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30 | 150 | 30 | 120 | | $I_C = 50$ mA, $V_{CE} = -10$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −2.5 | | −2.0 | V | $I_C = 50$ mA, $I_B = 5.0$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.5 | | −1.5 | V | $I_C = 50$ mA, $V_{CE} = -10$ V |
| **SECOND BREAKDOWN** | | | | | | | |
| $I_{S/b}$ | Second Breakdown Collector Current with Base Forward Biased | 100 | | 100 | | mA | $V_{CE} = -100$ V, t = 1.0 s (non repetitive) |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 15 | | 15 | pF | $V_{CB} = -10$ V, $I_E = 0$, f = 1.0 MHz |
| $C_{ib}$ | Input Capacitance | | 75 | | 75 | pF | $V_{EB} = -5.0$ V, $I_C = 0$, f = 1.0 MHz |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 3.0 | | 3.0 | | | $I_C = 10$ mA, $V_{CE} = -10$ V, f = 5.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | | $I_C = 5.0$ mA, $V_{CE} = -10$ V, f = 1.0 kHz |
| $R_e(h_{ie})$ | Real Part of Common Emitter Small Signal Short-Circuit Impedance | | 300 | | 300 | Ω | $I_C = 5.0$ mA, $V_{CE} = -10$ V, f = 1.0 MHz |

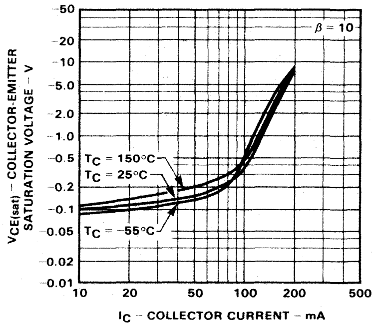
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

### DC CURRENT GAIN

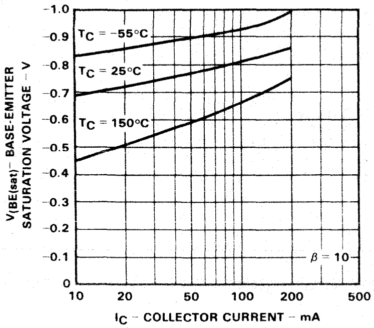



### COLLECTOR-EMITTER SATURATION VOLTAGE

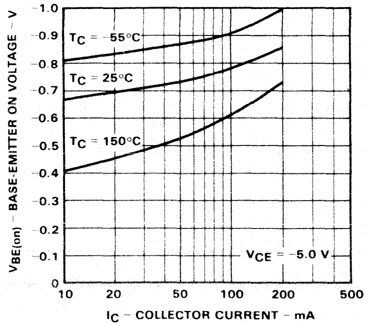


## TYPICAL ELECTRICAL CHARACTERISTICS (Cont'd)

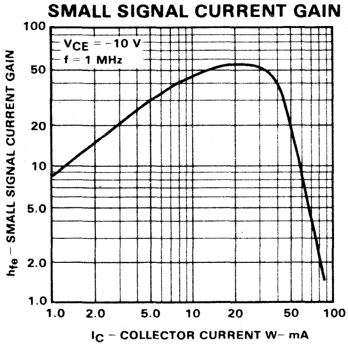
### BASE-EMITTER SATURATION VOLTAGE



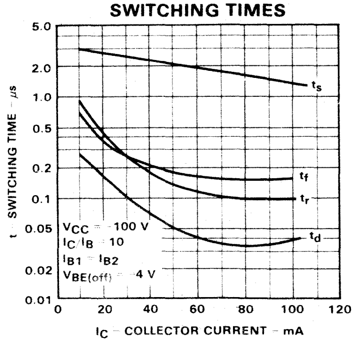

### BASE-EMITTER ON VOLTAGE



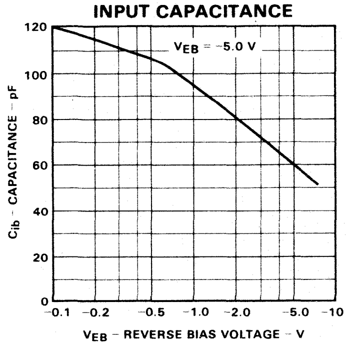

### SMALL SIGNAL CURRENT GAIN



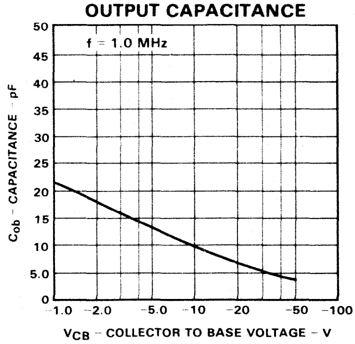

### SWITCHING TIMES




### INPUT CAPACITANCE




### OUTPUT CAPACITANCE



# POWER TRANSISTOR

## NPN SILICON

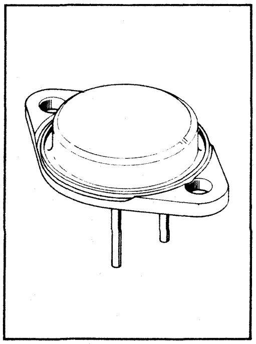
# 2N5629
# 2N5630
# 2N5631

### HIGH VOLTAGE, HIGH POWER TRANSISTORS DESIGNED FOR USE IN HIGH POWER AUDIO AMPLIFIER APPLICATIONS AND HIGH VOLTAGE SWITCHING REGULATOR CIRCUITS

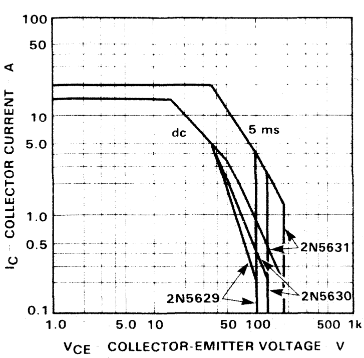
- 200 W DISSIPATION AT 25°C CASE
- 16 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- HIGH CURRENT $h_{FE}$, 25-100 @ 8.0 A, 2.0 V (2N5629)

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

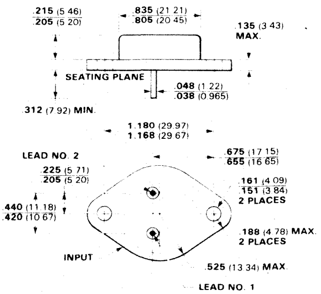
| Maximum Voltages and Currents | | 2N5629 | 2N5630 | 2N5631 |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 100 V | 120 V | 140 V |
| $V_{CBO}$ | Collector to Base Voltage | 100 V | 120 V | 140 V |
| $V_{EBO}$ | Emitter to Base Voltage | 7.0 V | 7.0 V | 7.0 V |
| $I_C$ | Continuous Collector Current | 16 A | 16 A | 16 A |
| $I_B$ | Continuous Base Current | 5.0 A | 5.0 A | 5.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 200 W |
| | Derate linearly from 25°C | | | 1.14 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 0.875°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

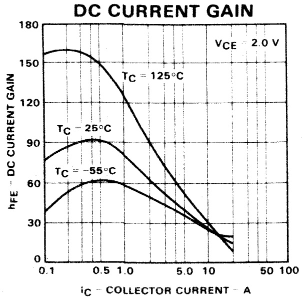
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5629 MIN | 2N5629 MAX | 2N5630 MIN | 2N5630 MAX | 2N5631 MIN | 2N5631 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 100 | | 120 | | 140 | | V | $I_C$ = 200 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE}$ = 50 V, $I_B$ = 0 |
| | | | | | 1.0 | | | mA | $V_{CE}$ = 60 V, $I_B$ = 0 |
| | | | | | | | 1.0 | mA | $V_{CE}$ = 70 V, $I_B$ = 0 |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE}$ = 100 V, $V_{BE}$ = −1.5 V |
| | | | | | 1.0 | | | mA | $V_{CE}$ = 120 V, $V_{BE}$ = −1.5 V |
| | | | | | | | 1.0 | mA | $V_{CE}$ = 140 V, $V_{BE}$ = −1.5 V |
| | | | 5.0 | | | | | mA | $V_{CE}$ = 100 V, $V_{BE}$ = −1.5 V, $T_C$ = 150°C |
| | | | | | 5.0 | | | mA | $V_{CE}$ = 120 V, $V_{BE}$ = −1.5 V, $T_C$ = 150°C |
| | | | | | | | 5.0 | mA | $V_{CE}$ = 140 V, $V_{BE}$ = −1.5 V, $T_C$ = 150°C |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CB}$ = 100 V, $I_E$ = 0 |
| | | | | | 1.0 | | | mA | $V_{CB}$ = 120 V, $I_E$ = 0 |
| | | | | | | | 1.0 | mA | $V_{CB}$ = 140 V, $I_E$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = 7.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20 | 100 | 20 | 80 | 15 | 60 | | $I_C$ = 8.0 A, $V_{CE}$ = 2.0 V |
| | | 4.0 | | 4.0 | | 4.0 | | | $I_C$ = 16 A, $V_{CE}$ = 2.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | | 1.0 | V | $I_C$ = 10 A, $I_B$ = 1.0 A |
| | | | 2.0 | | 2.0 | | 2.0 | V | $I_C$ = 16 A, $I_B$ = 4.0 A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.8 | | 1.8 | | 1.8 | V | $I_C$ = 10 A, $I_B$ = 1.0 A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.5 | | 1.5 | | 1.5 | V | $I_C$ = 8.0 A, $V_{CE}$ = 2.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 500 | | 500 | | 5.0 | pF | $V_{CB}$ = 10 V, $I_E$ = 0, f = 0.1 MHz |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 2.0 | | 2.0 | | 2.0 | | | $I_C$ = 1.0 A, $V_{CE}$ = 20 V, f = 0.5 MHz |
| $h_{fe}$ | Small Signal Current Gain | 15 | | 15 | | 15 | | | $I_C$ = 4.0 A, $V_{CE}$ = 10 V, f = 1.0 kHz |

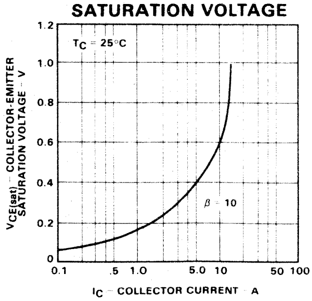
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

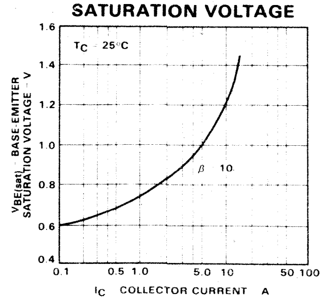
**DC CURRENT GAIN**




**COLLECTOR-EMITTER SATURATION VOLTAGE**




**BASE-EMITTER SATURATION VOLTAGE**



# POWER TRANSISTOR

## PNP SILICON

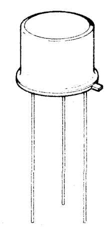
# 2N5679
# 2N5680

## DESIGNED FOR USE AS A DRIVER FOR HIGH POWER TRANSISTORS IN GENERAL PURPOSE AMPLIFIER AND SWITCHING CIRCUIT APPLICATIONS

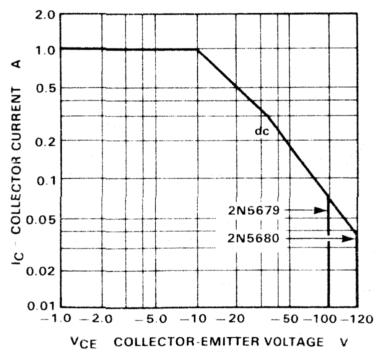
- 10 W DISSIPATION AT 25°C CASE
- 1.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENT 2N5681, 2N5682

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

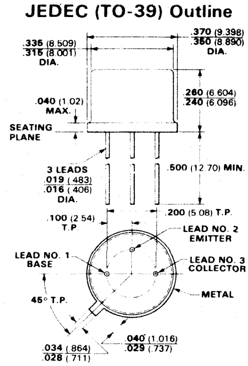
| | | 2N5679 | 2N5680 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −100 V | −120 V |
| $V_{CBO}$ | Collector to Base Voltage | −100 V | −120 V |
| $V_{EBO}$ | Emitter to Base Voltage | −4.0 V | −4.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A | 1.0 A |
| $I_B$ | Continuous Base Current | 0.5 A | 0.5 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 10 W |
| | *Derate Linearly from 25°C* | | 0.057 W/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 17.5°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

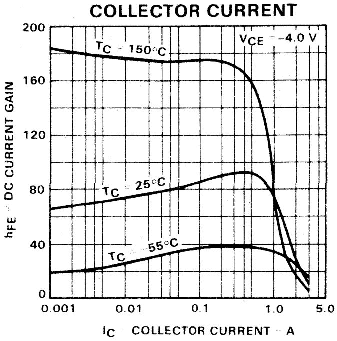
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5679 MIN | 2N5679 MAX | 2N5680 MIN | 2N5680 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −100 | | −120 | | V | $I_C = 10$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 10 | | | μA | $V_{CE} = -70$ V, $I_B = 0$ |
| | | | | | 10 | μA | $V_{CE} = -80$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0 | | | μA | $V_{CE} = -100$ V, $V_{BE} = 1.5$ V |
| | | | | | 1.0 | μA | $V_{CE} = -120$ V, $V_{BE} = 1.5$ V |
| | | | 1.0 | | | mA | $V_{CE} = -100$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | 1.0 | mA | $V_{CE} = -120$ V, $V_{BE} = 1.5$ V $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0 | | | μA | $V_{CB} = -100$ V, $I_E = 0$ |
| | | | | | 1.0 | μA | $V_{CB} = -120$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | μA | $V_{EB} = -4.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | 150 | 40 | 150 | | $I_C = 250$ mA, $V_{CE} = -2.0$ V |
| | | 5.0 | | 5.0 | | | $I_C = 1.0$ A, $V_{CE} = -2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −0.6 | | −0.6 | V | $I_C = 250$ mA, $I_B = 25$ mA |
| | | | −1.0 | | −1.0 | V | $I_C = 500$ mA, $I_B = 50$ mA |
| | | | −2.0 | | −2.0 | V | $I_C = 1.0$ A, $I_B = 200$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.0 | | −1.0 | V | $I_C = 250$ mA, $V_{CE} = -2.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 30 | | 30 | | MHz | $I_C = 100$ mA, $V_{CE} = -10$ V, f = 10 MHz |
| $C_{ob}$ | Output Capacitance | | 50 | | 50 | pF | $V_{CB} = -20$ V, $I_E = 0$, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 40 | | 40 | | | $I_C = 200$ mA, $V_{CE} = -1.5$ V, f = 1.0 kHz |

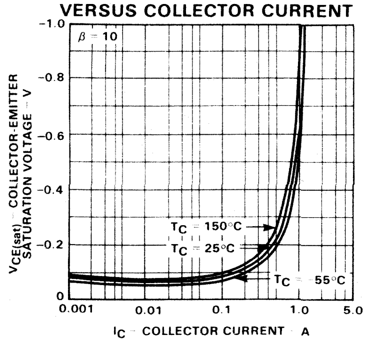
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

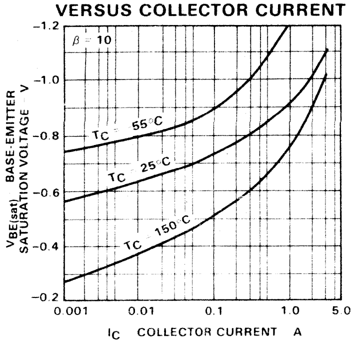
### CURRENT GAIN VERSUS COLLECTOR CURRENT



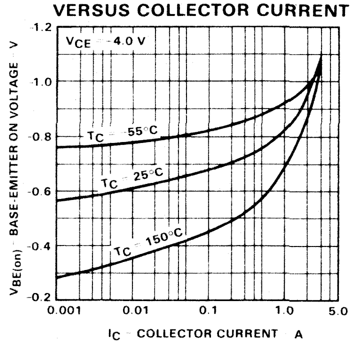

### COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT




### BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT




### BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT



# POWER TRANSISTOR

## NPN SILICON

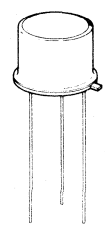
# 2N5681
# 2N5682

### DESIGNED FOR USE AS A DRIVER FOR HIGH POWER TRANSISTORS IN GENERAL PURPOSE AMPLIFIER AND SWITCHING CIRCUIT APPLICATIONS

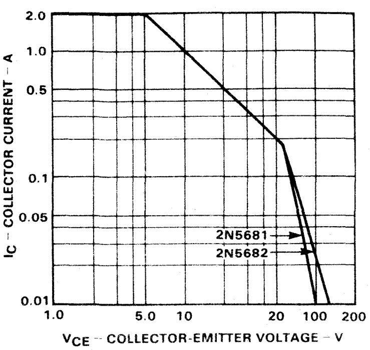
- 10 W DISSIPATION AT 25°C CASE
- 1.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS 2N5679, 2N5680

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

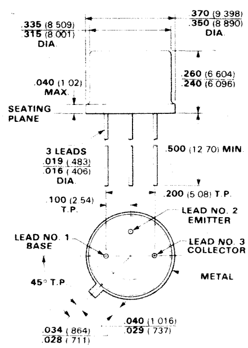
| | | 2N5681 | 2N5682 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 100 V | 120 V |
| $V_{CBO}$ | Collector to Base Voltage | 100 V | 120 V |
| $V_{EBO}$ | Emitter to Base Voltage | 4.0 V | 4.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A | 1.0 A |
| $I_B$ | Continuous Base Current | 0.5 A | 0.5 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 10 W |
| | Derate Linearly from 25°C | | 0.057 W/°C |
| ***Maximum Temperatures*** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 17.5°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

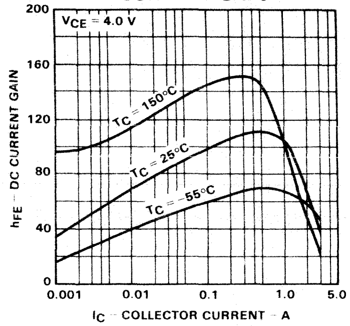
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5681 MIN | 2N5681 MAX | 2N5682 MIN | 2N5682 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 100 | | 120 | | V | $I_C = 10$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 10 | | | μA | $V_{CE} = 70$ V, $I_B = 0$ |
| | | | | | 10 | μA | $V_{CE} = 80$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0 | | | μA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V |
| | | | | | 1.0 | μA | $V_{CE} = 120$ V, $V_{BE} = -1.5$ V |
| | | | 1.0 | | | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 1.0 | mA | $V_{CE} = 120$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0 | | | μA | $V_{CB} = 100$ V, $I_E = 0$ |
| | | | | | 1.0 | μA | $V_{CB} = 120$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | μA | $V_{EB} = 4.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | 150 | 40 | 150 | | $I_C = 250$ mA, $V_{CE} = 2.0$ V |
| | | 5.0 | | 5.0 | | | $I_C = 1.0$ A, $V_{CE} = 2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.6 | | 0.6 | V | $I_C = 250$ mA, $I_B = 25$ mA |
| | | | 1.0 | | 1.0 | V | $I_C = 500$ mA, $I_B = 50$ mA |
| | | | 2.0 | | 2.0 | V | $I_C = 1.0$ A, $I_B = 200$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.0 | | 1.0 | V | $I_C = 250$ mA, $V_{CE} = 2.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 30 | | 30 | | MHz | $I_C = 100$ mA, $V_{CE} = 10$ V, f = 10 MHz |
| $C_{ob}$ | Output Capacitance | | 50 | | 50 | pF | $V_{CB} = 20$ V, $I_E = 0$, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 4.0 | | 4.0 | | | $I_C = 200$ mA, $V_{CE} = 1.5$ V, f = 1.0 kHz |

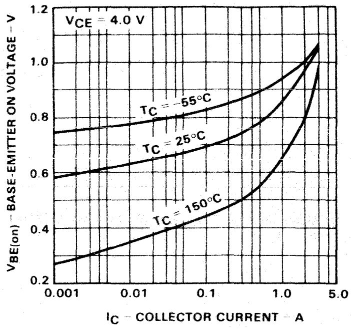
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

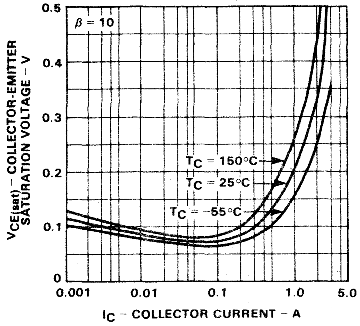
### CURRENT GAIN



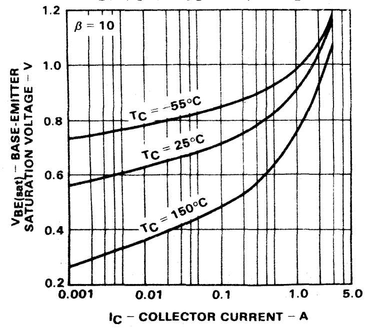

### BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE



# POWER TRANSISTOR

## PNP SILICON

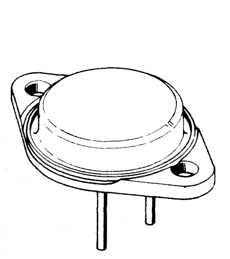
**2N5683**
**2N5684**

### DESIGNED FOR USE IN HIGH-POWER AMPLIFIER AND SWITCHING CIRCUIT APPLICATIONS

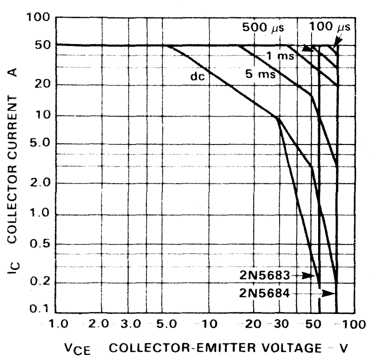
- 300 W DISSIPATION AT 25°C CASE
- 50 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- MAXIMUM DC CURRENT GAIN OF 60 AT 25 A $I_C$
- MAXIMUM COLLECTOR-EMITTER SATURATION VOLTAGE OF 1.0 V AT 25 A $I_C$
- COMPLEMENT TO 2N5685, 2N5686

### ABSOLUTE MAXIMUM RATINGS

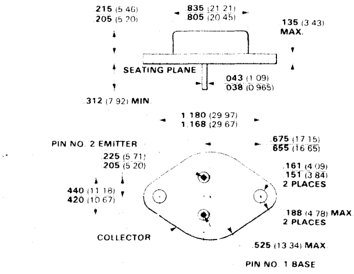
| Maximum Voltages and Currents | | 2N5683 | 2N5684 |
|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | −60 V | −80 V |
| $V_{CB}$ | Collector to Base Voltage | −60 V | −80 V |
| $V_{EB}$ | Emitter to Base Voltage | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 50 A | 50 A |
| $I_B$ | Continuous Base Current | 15 A | 15 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 300 W |
| | Derate Linearly from 25°C | | .085 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 0.584°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are alloy-52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Copper base with soldered in pins
Aluminum cap
Package weight is 17.9 grams

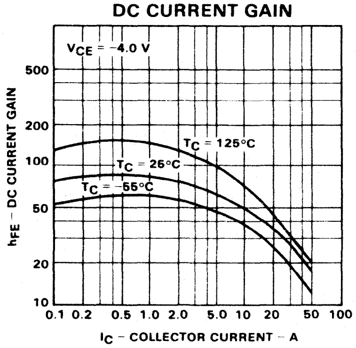
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5683 MIN | 2N5683 MAX | 2N5684 MIN | 2N5684 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | −80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CE} = -30$ V, $I_B = 0$ |
| | | | | | 1.0 | mA | $V_{CE} = -40$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 2.0 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V, |
| | | | | | 2.0 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V, |
| | | | 10 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V, $T_C = 150$°C |
| | | | | | 10 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V, $T_C = 150$°C |
| $I_{CBO}$ | Collector Cutoff Current | | 2.0 | | | mA | $V_{CB} = -60$ V, $I_E = 0$ |
| | | | | | 2.0 | mA | $V_{CB} = -80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 15 | 60 | 15 | 60 | | $I_C = 25$ A, $V_{CE} = -2.0$ V |
| | | 5.0 | | 5.0 | | | $I_C = 50$ A, $V_{CE} = -5.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −1.0 | | −1.0 | V | $I_C = 25$ A, $I_B = 2.5$ mA |
| | | | −5.0 | | −5.0 | V | $I_C = 50$ A, $I_B = 10$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −2.0 | | −2.0 | V | $I_C = 25$ A, $I_B = 2.5$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −2.0 | | −2.0 | V | $I_C = 25$ A, $V_{CE} = -2.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current Gain Bandwidth Product | 2.0 | | 2.0 | | MHz | $I_C = 5.0$ A, $V_{CE} = -10$ V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 2000 | | 2000 | pF | $V_{CB} = -10$ V, $I_E = 0$, f = 0.1 MHz |
| $h_{fe}$ | Small Signal Current Gain | 15 | | 15 | | | $I_C = 10$ A, $V_{CE} = -5.0$ V, f = 1.0 kHz |

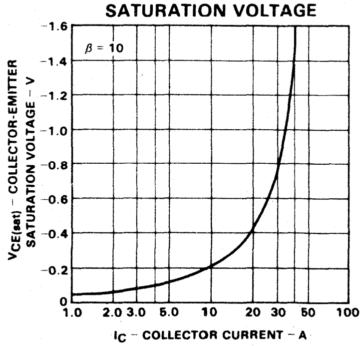
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

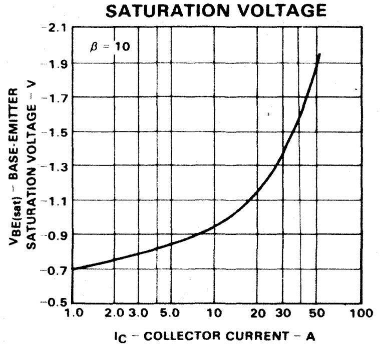
**DC CURRENT GAIN**




**COLLECTOR-EMITTER SATURATION VOLTAGE**

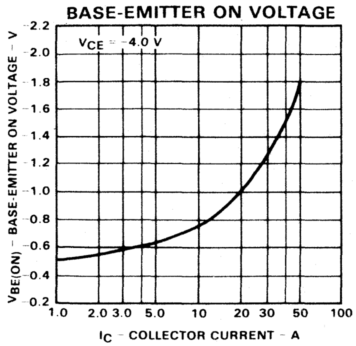


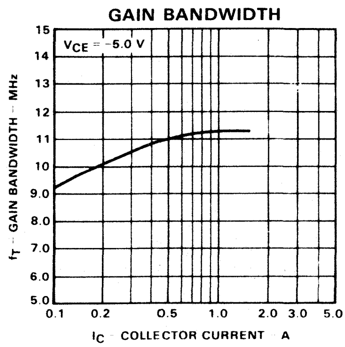

**BASE-EMITTER SATURATION VOLTAGE**

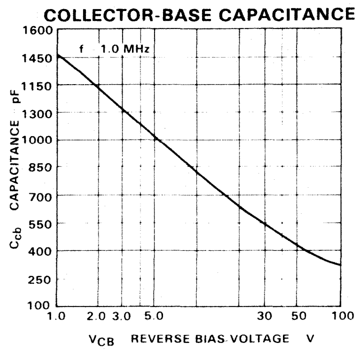


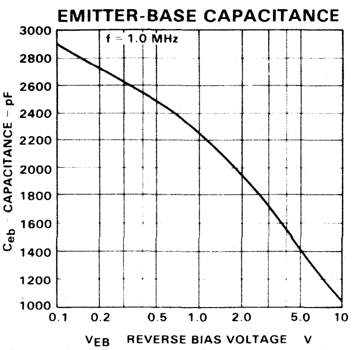

6

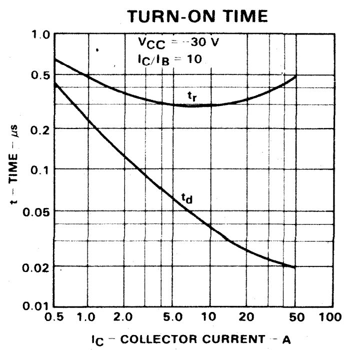
## TYPICAL ELECTRICAL CHARACTERISTICS (Cont'd)

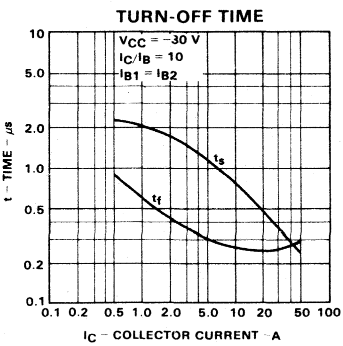


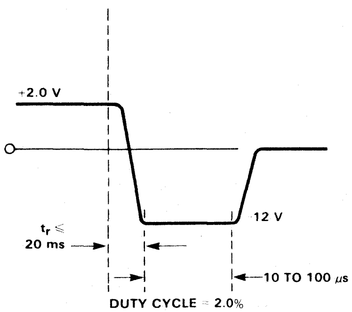



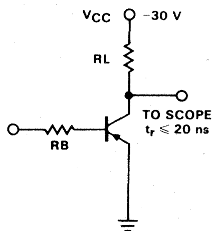



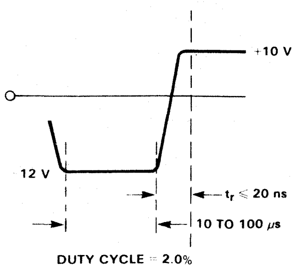



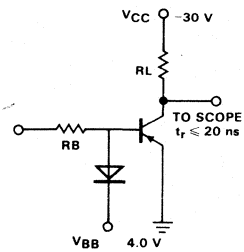




## SWITCHING CIRCUIT



# POWER TRANSISTOR

## NPN SILICON

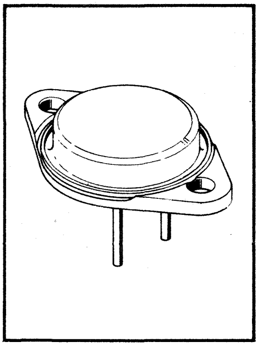
# 2N5685
# 2N5686

### DESIGNED FOR USE IN HIGH-POWER AMPLIFIER AND SWITCHING CIRCUIT APPLICATIONS

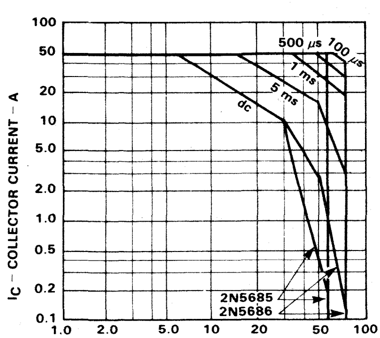
- **300 W DISSIPATION AT 25°C CASE**
- **50 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **MAXIMUM DC CURRENT GAIN OF 60 AT $I_C$ = 25 A**
- **MAXIMUM COLLECTOR-EMITTER SATURATION VOLTAGE OF 1.0 V AT 25 A $I_C$**
- **COMPLEMENT TO 2N5683, 2N5684**

**ABSOLUTE MAXIMUM RATINGS**

| | | 2N5685 | 2N5686 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CE}$ | Collector to Emitter Voltage | 60 V | 80 V |
| $V_{CB}$ | Collector to Base Voltage | 60 V | 80 V |
| $V_{EB}$ | Emitter to Base Voltage | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 50 A | 50 A |
| $I_B$ | Continuous Base Current | 15 A | 15 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 300 W |
| | Derate Linearly from 25°C | | 0.085 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 0.584°C/W |

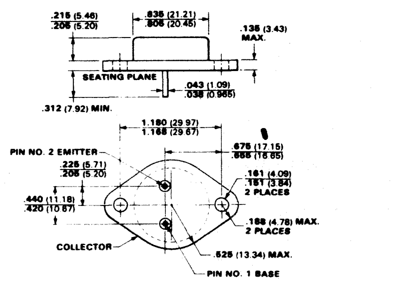


**SAFE OPERATING AREA**




$V_{CE}$ – COLLECTOR EMITTER VOLTAGE – V

**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are alloy-52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Copper base with soldered in pins
Aluminum cap
Package weight is 17.9 grams

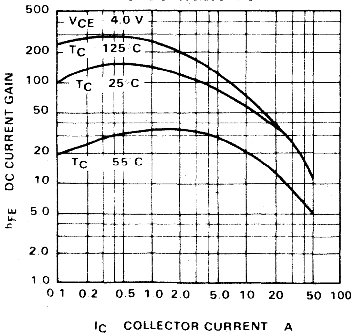
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5685 MIN | 2N5685 MAX | 2N5686 MIN | 2N5686 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | 1.0 | mA | $V_{CE} = 30$ V, $I_B = 0$<br>$V_{CE} = 40$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 2.0<br>1.0 | | 2.0<br>1.0 | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V<br>$V_{CE} = 80$ V, $V_{BE} = -1.5$ V<br>$V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$<br>$V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 2.0 | | 2.0 | mA | $V_{CB} = 60$ V, $I_E = 0$<br>$V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 15<br>5.0 | 60 | 15<br>5.0 | 60 | | $I_C = 25$ A, $V_{CE} = 2.0$ V<br>$I_C = 50$ A, $V_{CE} = 5.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0<br>5.0 | | 1.0<br>5.0 | V | $I_C = 25$ A, $I_B = 2.5$ A<br>$I_C = 50$ A, $I_B = 10$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 2.0 | | 2.0 | V | $I_C = 25$ A, $I_B = 2.5$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage Voltage (Note 1) | | 2.0 | | 2.0 | V | $I_C = 25$ A, $V_{CE} = 2.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current Gain Bandwidth Product | 2.0 | | 2.0 | | MHz | $I_C = 5.0$ A, $V_{CE} = 10$ V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 1.2 k | | 1.2 k | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $h_{fe}$ | Small Signal Current Gain | 15 | | 15 | | | $I_C = 10$ A, $V_{CE} = 5.0$ V, f = 1.0 kHz |

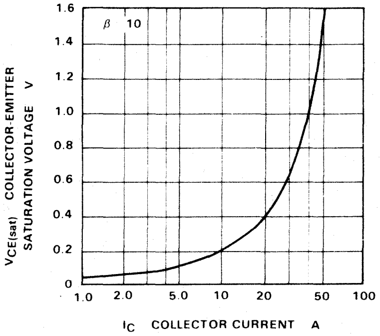
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

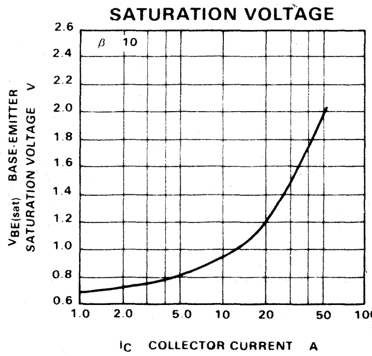
**DC CURRENT GAIN**



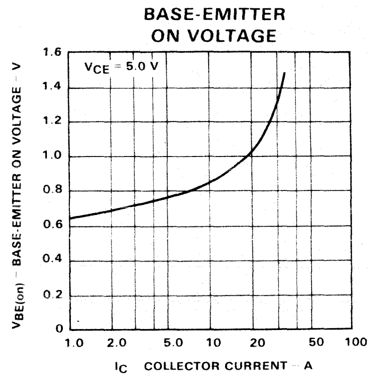

**COLLECTOR-EMITTER SATURATION VOLTAGE**

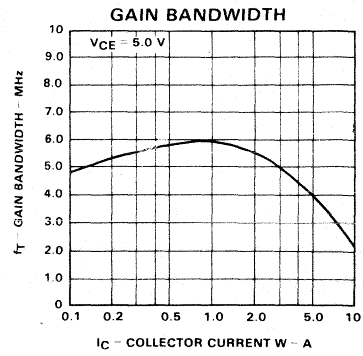


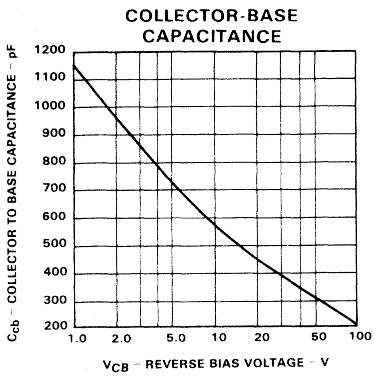

**BASE-EMITTER SATURATION VOLTAGE**

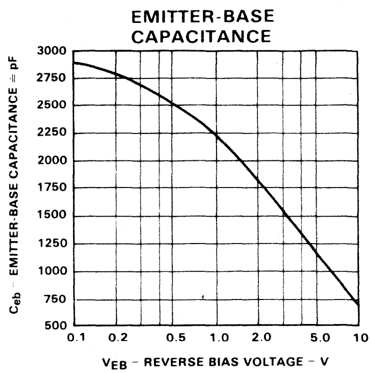


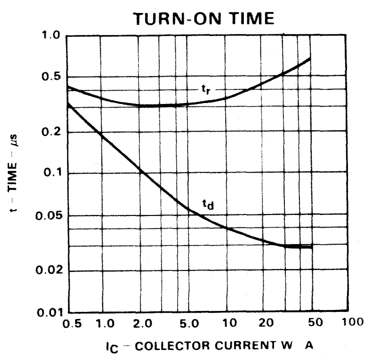
## TYPICAL ELECTRICAL CHARACTERISTICS (Cont'd)

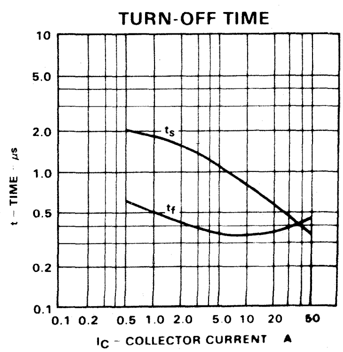


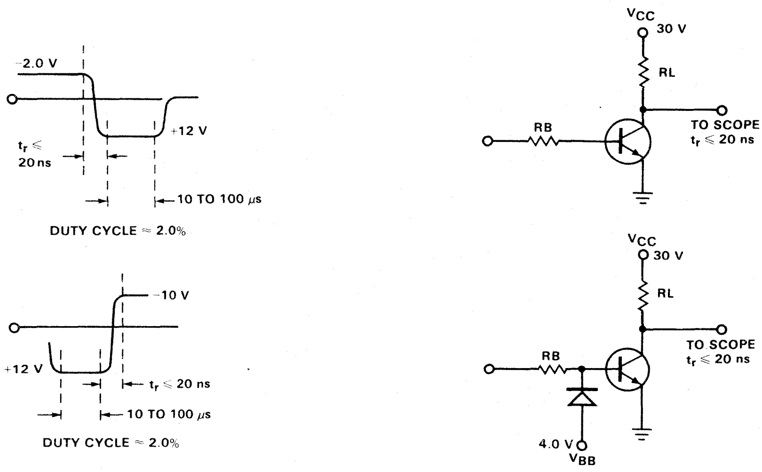



## SWITCHING CIRCUIT



# POWER TRANSISTOR

## NPN SILICON

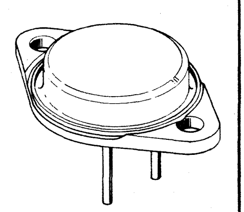
**2N5838**
**2N5839**
**2N5840**

### DESIGNED FOR HIGH VOLTAGE POWER SWITCHING APPLICATIONS

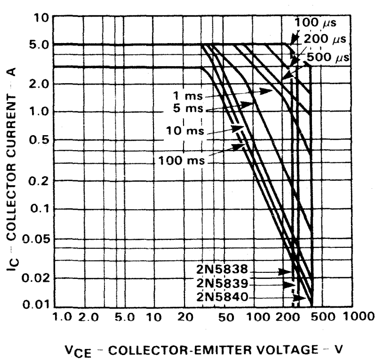
- HIGH SPEED 3.0 A SWITCH
- 3.0 $\mu$s $t_s$ @ 3.0 A (2N5838)
- 100 W DISSIPATION AT 25°C CASE
- 3.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

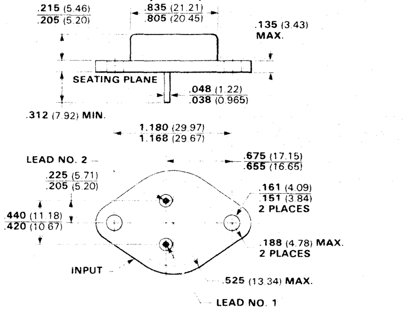
| Maximum Voltages and Currents | | 2N5838 | 2N5839 | 2N5840 |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 250 V | 275 V | 350 V |
| $V_{CBO}$ | Collector to Base Voltage | 275 V | 300 V | 375 V |
| $V_{EBO}$ | Emitter to Base Voltage | 6.0 V | 6.0 V | 6.0 V |
| $I_C$ | Continuous Collector Current | 3.0 A | 3.0 A | 3.0 A |
| $I_C$ | Peak Collector Current | 5.0 A | 5.0 A | 5.0 A |
| $I_B$ | Continuous Base Current | 1.5 A | 1.5 A | 1.5 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 100 W |
| | Derate Linearly from 25°C | | | 0.57 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 1.75°C/W |
| $T_P$ | Maximum Pin Temperature for Soldering Purposes: 1/8″ from Case for 10 seconds | | | 230°C |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

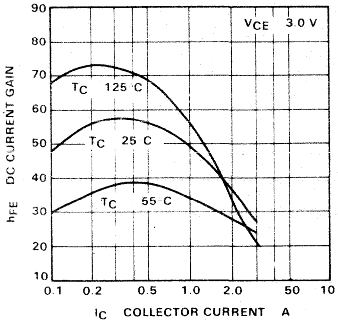
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5838 | | 2N5839 | | 2N5840 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 250 | | 275 | | 350 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $V_{CEX(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 275 | | 300 | | 375 | | V | $I_C = 100$ mA, $V_{BE(off)} = -1.5$ V |
| $I_{CEO}$ | Collector Cutoff Current | | 2.0 | | | | | mA | $V_{CE} = 200$ V, $I_B = 0$ |
| | | | | | 2.0 | | 2.0 | mA | $V_{CE} = 250$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 5.0 | | | | | mA | $V_{CE} = 265$ V, $V_{BE} = -1.5$ V |
| | | | | | 2.0 | | | mA | $V_{CE} = 290$ V, $V_{BE} = -1.5$ V |
| | | | | | | | 2.0 | mA | $V_{CE} = 360$ V, $V_{BE} = -1.5$ V |
| | | | 8.0 | | | | | mA | $V_{CE} = 265$ V, $V_{BE} = -1.5$ V, $T_C = 100°C$ |
| | | | | | 5.0 | | | mA | $V_{CE} = 290$ V, $V_{BE} = -1.5$ V, $T_C = 100°C$ |
| | | | | | | | 5.0 | mA | $V_{CE} = 360$ V, $V_{BE} = -1.5$ V, $T_C = 100°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = 6.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20 | | 20 | | 20 | | | $I_C = 0.5$ A, $V_{CE} = 5.0$ V |
| | | | | 10 | 50 | 10 | 50 | | $I_C = 2.0$ A, $V_{CE} = 3.0$ V |
| | | 8.0 | 40 | | | | | | $I_C = 3.0$ A, $V_{CE} = 2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | | | | V | $I_C = 3.0$ A, $I_B = 375$ mA |
| | | | | | 1.5 | | 1.5 | V | $I_C = 2.0$ A, $I_B = 200$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 2.0 | | | | | V | $I_C = 3.0$ A, $I_B = 375$ mA |
| | | | | | 2.0 | | 2.0 | V | $I_C = 2.0$ A, $I_B = 200$ mA |
| **SECOND BREAKDOWN** | | | | | | | | | |
| $I_{S/b}$ | Second Breakdown Collector Current with base forward biased | 2.5 | | 2.5 | | 2.5 | | A | t = 1.0s (non repetitive) $V_{CE} = 40$ V |
| $E_{S/b}$ | Second Breakdown Energy with base reversed biased | 0.45 | | 0.45 | | 0.45 | | mJ | $V_{BE(off)} = -4.0$ V, $L = 100\ \mu H$, $R_B = 50\ \Omega$ |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 150 | | 150 | | 150 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 5.0 | | 5.0 | | 5.0 | | | $I_C = 200$ mA, $V_{CE} = 10$ V, f = 1.0 MHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | | | |
| $t_r$ | Rise Time | | 1.5 | | | | | μs | $V_{CC} = 200$ V, $I_C = 3.0$ A, $I_{B1} = 375$ mA |
| $t_s$ | Storage Time | | 3.0 | | | | | μs | $V_{CC} = 200$ V, $I_C = 3.0$ A, $I_{B1} = I_{B2} = 375$ mA |
| $t_f$ | Fall Time | | 1.5 | | | | | μs | |
| $t_r$ | Rise Time | | | | 1.5 | | 1.75 | μs | $V_{CC} = 200$ V, $I_C = 2.0$ A, $I_{B1} = 200$ mA, $t_p = 20\ \mu s$, Duty Cycle = 100 Hz |
| $t_s$ | Storage Time | | | | 3.75 | | 3.0 | μs | $V_{CC} = 200$ V, $I_C = 2.0$ A, $I_{B1} = I_{B2} = 200$ mA, $t_p = 20\ \mu s$ Duty Cycle = 100 Hz |
| $t_f$ | Fall Time | | | | 1.5 | | 1.5 | μs | |

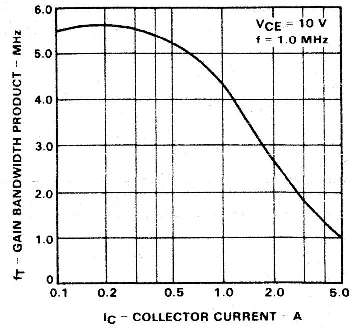
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

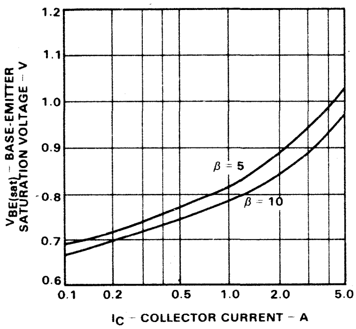
### DC CURRENT GAIN



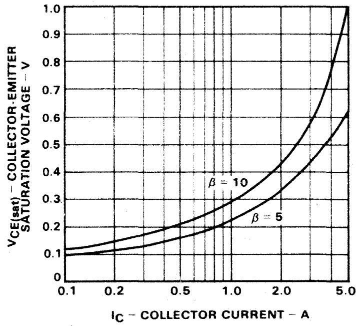

### GAIN BANDWIDTH PRODUCT



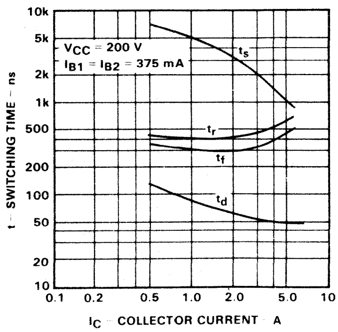

### BASE-EMITTER SATURATION VOLTAGE




### COLLECTOR-EMITTER SATURATION VOLTAGE




### SWITCHING TIMES



# POWER TRANSISTOR

## PNP SILICON

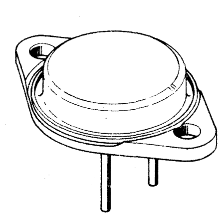
## 2N5871
## 2N5872

### DESIGNED FOR GENERAL PURPOSE POWER AMPLIFIER AND SWITCHING APPLICATIONS

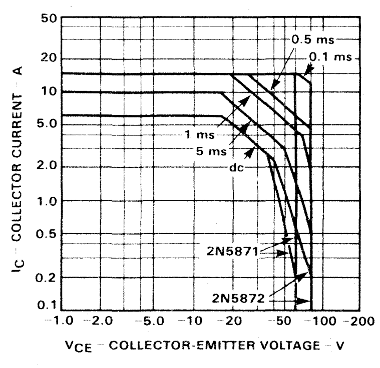
- 115 W DISSIPATION AT 25°C CASE
- 7.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 4.0 MHz $f_T$ AT 0.25 mAdc COLLECTOR CURRENT
- COMPLEMENT TO 2N5873, 2N5874

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

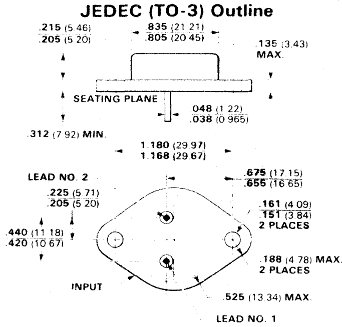
| | | 2N5871 | 2N5872 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 7.0 A | 7.0 A |
| $I_C$ | Peak Collector Current | 15 A | 15 A |
| $I_B$ | Continuous Base Current | 2.0 A | 2.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 115 W |
| | Derate Linearly from 25°C | | 0.66 W/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65 to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 1.52°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

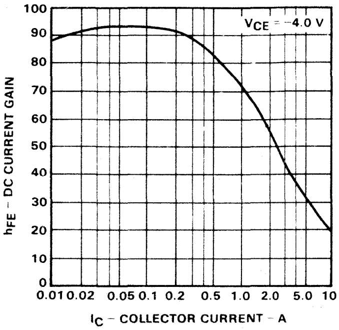
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5871 MIN | 2N5871 MAX | 2N5872 MIN | 2N5872 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | −80 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CE} = -30$ V, $I_B = 0$ |
| | | | | | 0.5 | mA | $V_{CE} = -40$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.25 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V |
| | | | | | 0.25 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V |
| | | | 2.0 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | 2.0 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.25 | | | mA | $V_{CB} = -60$ V, $I_E = 0$ |
| | | | | | 0.25 | mA | $V_{CB} = -80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 35 | | 35 | | | $I_C = 0.5$ A, $V_{CE} = -4.0$ V |
| | | 20 | 100 | 20 | 100 | | $I_C = 2.5$ A, $V_{CE} = -4.0$ V |
| | | 4.0 | | 4.0 | | | $I_C = 7.0$ A, $V_{CE} = -4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −1.0 | | −1.0 | V | $I_C = 4.0$ A, $I_B = 0.4$ A |
| | | | −2.0 | | −2.0 | V | $I_C = 7.0$ A, $I_B = 1.75$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −2.5 | | −2.5 | V | $I_C = 7.0$ A, $I_B = 1.75$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.5 | | −1.5 | V | $I_C = 2.5$ A, $V_{CE} = -4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | MHz | $I_C = 0.25$ A, $V_{CE} = -10$ V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 300 | | 200 | pF | $V_{CB} = -10$ V, $I_E = 0$, f = −1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | | $I_C = 0.5$ A, $V_{CE} = -4.0$ V, f = 1.0 kHz |
| **SWITCHING CHARACTERISTICS RESISTIVE LOAD** | | | | | | | |
| $t_r$ | Rise Time | | 0.7 | | 0.7 | μs | $V_{CC} = -30$ V, $I_C = 2.5$ A, $I_{B1} = 0.25$ A, Duty Cycle = 1.0% |
| $t_s$ | Storage Time | | 1.0 | | 1.0 | μs | $V_{CC} = -30$ V, $I_C = 2.5$ A |
| $t_f$ | Fall Time | | 0.8 | | 0.8 | μs | $I_{B1} = I_{B2} = 0.25$ A, Duty Cycle = 1.0% |

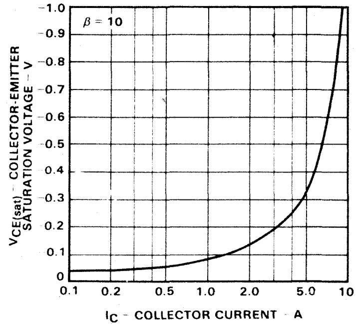
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

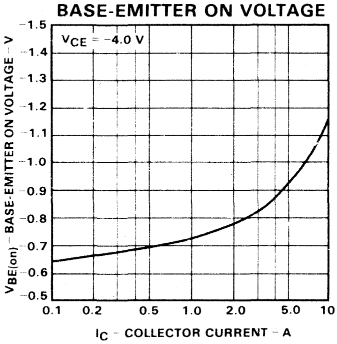
### DC CURRENT GAIN



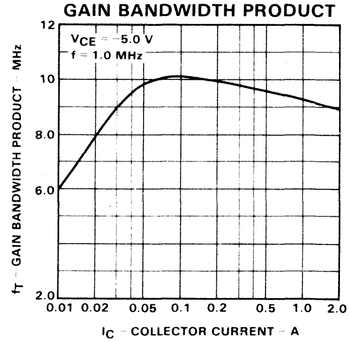

### COLLECTOR-EMITTER SATURATION VOLTAGE



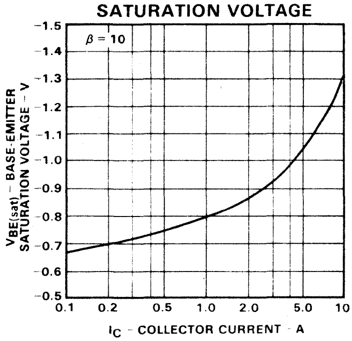

### BASE-EMITTER ON VOLTAGE



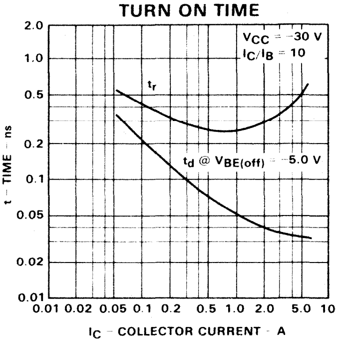

### GAIN BANDWIDTH PRODUCT



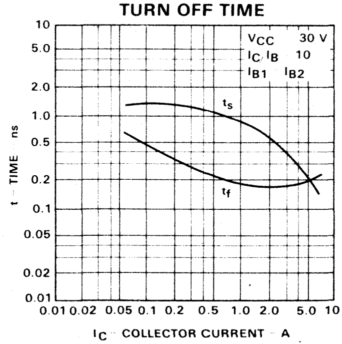

### BASE-EMITTER SATURATION VOLTAGE




### TURN ON TIME




### TURN OFF TIME



# POWER TRANSISTOR

## NPN SILICON

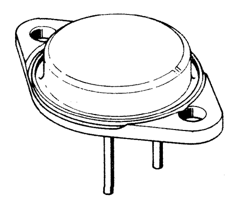
# 2N5873
# 2N5874

### DESIGNED FOR GENERAL PURPOSE POWER AMPLIFIER AND SWITCHING APPLICATIONS

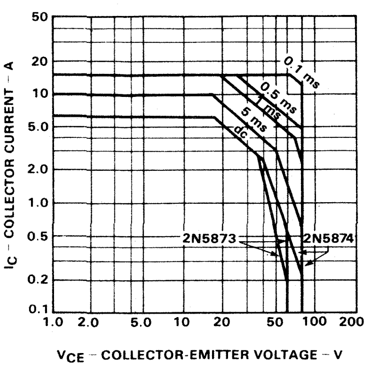
- 115 W DISSIPATION AT 25°C CASE
- 7 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 4 MHz $f_T$ AT 0.25 mAdc COLLECTOR CURRENT
- COMPLEMENT TO 2N5871, 2N5872

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

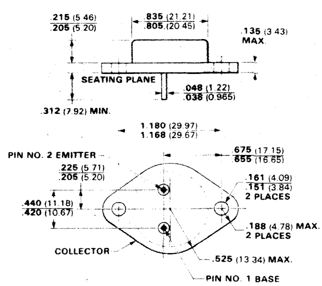
| | | 2N5873 | 2N5874 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 7.0 A | 7.0 A |
| $I_C$ | Peak Collector Current | 15 A | 15 A |
| $I_B$ | Continuous Base Current | 2.0 A | 2.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 115 W |
| | Derate Linearly from 25°C | | 0.66 W/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 1.52°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

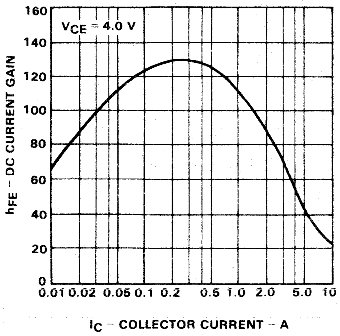
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5873 MIN | 2N5873 MAX | 2N5874 MIN | 2N5874 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | 0.5 | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.25 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.25 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | 2.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 2.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.25 | | | mA | $V_{CB} = 60$ V, $I_E = 0$ |
| | | | | | 0.25 | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 35 | | 35 | | | $I_C = 0.5$ A, $V_{CE} = 4.0$ V |
| | | 20 | 100 | 20 | 100 | | $I_C = 2.5$ A, $V_{CE} = 4.0$ V |
| | | 4.0 | | 4.0 | | | $I_C = 7.0$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | V | $I_C = 4.0$ A, $I_B = 0.4$ A |
| | | | 2.0 | | 2.0 | V | $I_C = 7.0$ A, $I_B = 1.75$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 2.5 | | 2.5 | V | $I_C = 7.0$ A, $I_B = 1.75$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.5 | | 1.5 | V | $I_C = 2.5$ A, $V_{CE} = 4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | MHz | $I_C = 0.25$ A, $V_{CE} = 10$ V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 300 | | 200 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | | $I_C = 0.5$ A, $V_{CE} = 4.0$ V, f = 1.0 kHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| $t_r$ | Rise Time | | 0.7 | | 0.7 | μs | $V_{CC} = 30$ V, $I_C = 2.5$ A, $I_{B1} = 0.25$ A, Duty Cycle = 1.0% |
| $t_s$ | Storage Time | | 1.0 | | 1.0 | μs | $V_{CC} = 30$ V, $I_C = 2.5$ A, $I_{B1} = I_{B2} = 0.25$ A, Duty Cycle = 1.0% |
| $t_f$ | Fall Time | | 0.8 | | 0.8 | μs | |

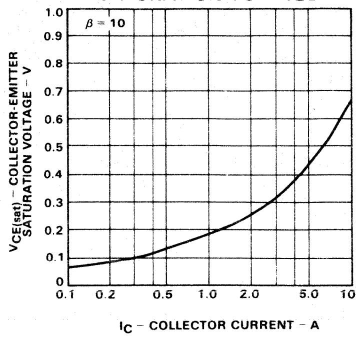
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

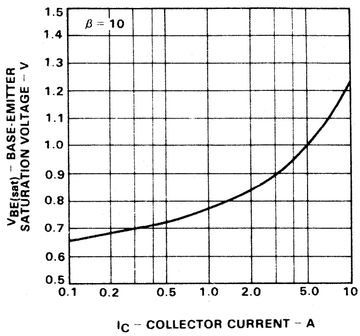
### DC CURRENT GAIN



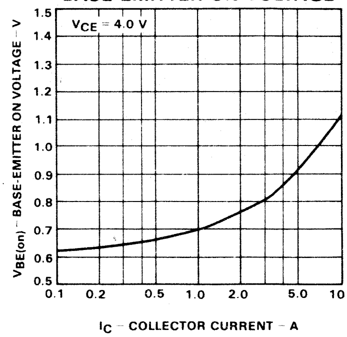

### COLLECTOR-EMITTER SATURATION VOLTAGE



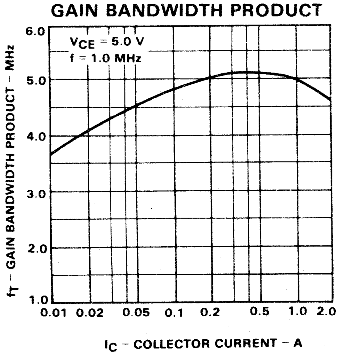

### BASE-EMITTER SATURATION VOLTAGE



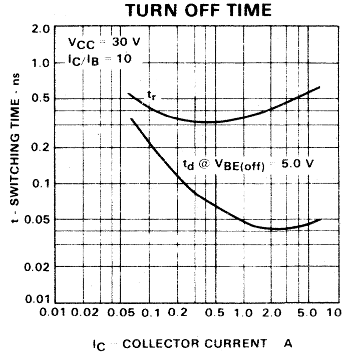

### BASE-EMITTER ON VOLTAGE



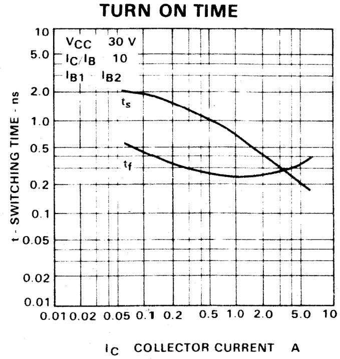

### GAIN BANDWIDTH PRODUCT




### TURN OFF TIME




### TURN ON TIME



# POWER TRANSISTOR

## PNP SILICON

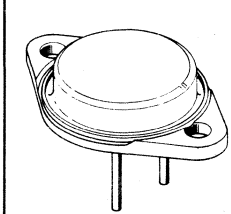
# 2N5875
# 2N5876

### DESIGNED FOR GENERAL PURPOSE POWER AMPLIFIER AND SWITCHING APPLICATIONS

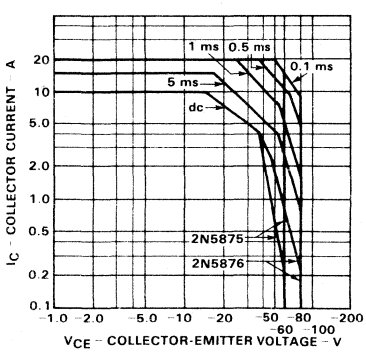
- 150 W DISSIPATION AT 25°C CASE
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 0.5 mAdc $I_{CEX}$ AT RATED VOLTAGE
- 4.0 MHz MINIMUM $f_T$ AT 0.5 A
- COMPLEMENT TO 2N5877, 2N5878

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

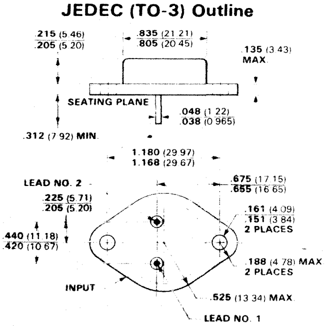
| | | 2N5875 | 2N5876 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A |
| $I_C$ | Peak Collector Current | 20 A | 20 A |
| $I_B$ | Continuous Base Current | 4.0 A | 4.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 150 W |
| | Derate Linearly from 25°C | | 0.88 W/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 1.17°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

# FAIRCHILD • 2N5875 • 2N5876

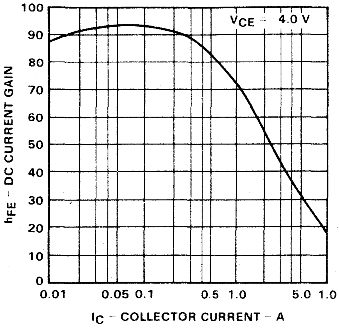
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5875 MIN | 2N5875 MAX | 2N5876 MIN | 2N5876 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | −80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CE} = -30$ V, $I_B = 0$ |
| | | | | | 1.0 | mA | $V_{CE} = -40$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V |
| | | | | | 0.5 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V |
| | | | 5.0 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CB} = -60$ V, $I_E = 0$ |
| | | | | | 0.5 | mA | $V_{CB} = -80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 35 | | 35 | | | $I_C = 1.0$ A, $V_{CE} = -4.0$ V |
| | | 20 | 100 | 20 | 100 | | $I_C = 4.0$ A, $V_{CE} = -4.0$ V |
| | | 4.0 | | 4.0 | | | $I_C = 10$ A, $V_{CE} = -4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −1.0 | | −1.0 | V | $I_C = 5.0$ A, $I_B = 0.5$ A |
| | | | −3.0 | | −3.0 | V | $I_C = 10$ A, $I_B = 2.5$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −2.5 | | | V | $I_C = 10$ A, $I_B = 2.5$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.5 | | −1.5 | V | $I_C = 4.0$ A, $V_{CE} = -4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | MHz | $I_C = 0.5$ A, $V_{CE} = -10$ V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 500 | | 300 | pF | $V_{CB} = -10$ V, $I_E = 0$, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | | $I_C = 1.0$ A, $V_{CE} = -4.0$ V, f = 1.0 kHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | |
| $t_r$ | Rise Time | | 0.7 | | 0.7 | μs | $V_{CC} = -30$ V, $I_C = 4.0$ A, $I_{B1} = 0.4$ A, |
| $t_s$ | Storage Time | | 1.0 | | 1.0 | μs | $V_{CC} = -30$ V, $I_C = 4.0$ A, |
| $t_f$ | Fall Time | | 0.8 | | 0.8 | μs | $I_{B1} = I_{B2} = 0.4$ A, Duty Cycle = 1.0% |

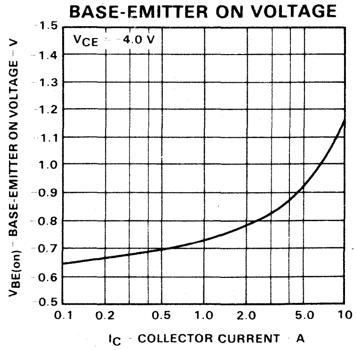
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

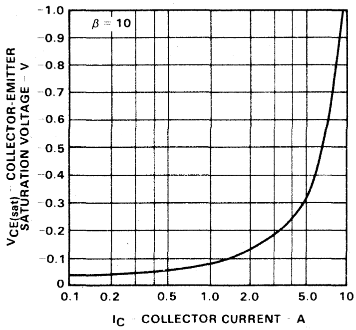
### DC CURRENT GAIN



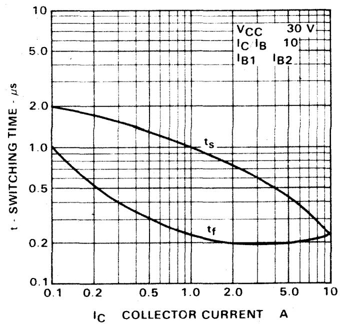

### BASE-EMITTER ON VOLTAGE



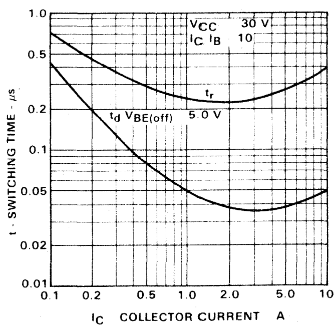

### COLLECTOR-EMITTER SATURATION VOLTAGE




### TURN-OFF TIME




### TURN-ON TIME



# POWER TRANSISTOR

## NPN SILICON

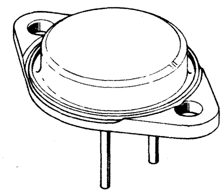
# 2N5877
# 2N5878

### DESIGNED FOR GENERAL PURPOSE AMPLIFIER AND LOW SPEED SWITCHING APPLICATIONS

- 150 W DISSIPATION AT 25°C CASE
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 0.5 mAdc $I_{CEX}$ AT RATED VOLTAGE
- 4.0 MHz MINIMUM $f_T$ at 0.5 A
- COMPLEMENT TO 2N5875, 2N5876

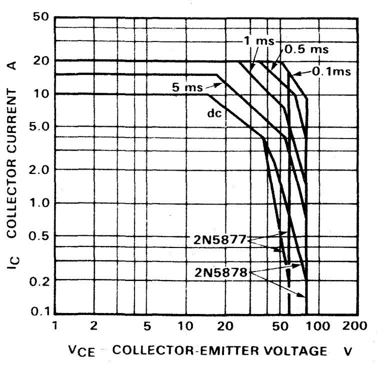
**ABSOLUTE MAXIMUM RATINGS (Note 1)**

| | | 2N5877 | 2N5878 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A |
| $I_C$ | Peak Collector Current | 20 A | 20 A |
| $I_B$ | Continuous Base Current | 4.0 A | 4.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 150 W |
| | Derate Linearly from 25°C | | 0.88 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 1.17°C/W |

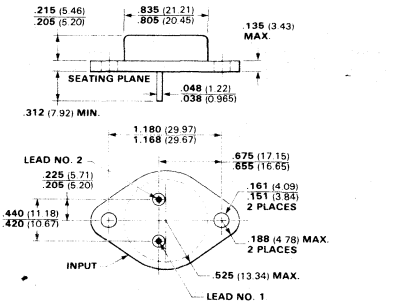


6

**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

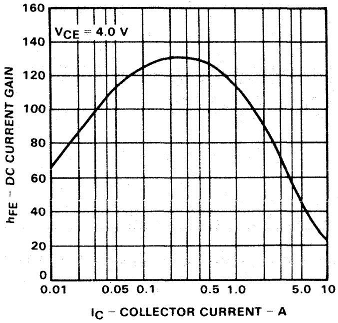
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5877 MIN | 2N5877 MAX | 2N5878 MIN | 2N5878 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | 1.0 | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.5 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | 5.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CB} = 60$ V, $I_E = 0$ |
| | | | | | 0.5 | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 35 | | 35 | | | $I_C = 1.0$ A, $V_{CE} = 4.0$ V |
| | | 20 | 100 | 20 | 100 | | $I_C = 4.0$ A, $V_{CE} = 4.0$ V |
| | | 4.0 | | 4.0 | | | $I_C = 10$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | V | $I_C = 5.0$ A, $I_B = 0.5$ A |
| | | | 3.0 | | 3.0 | V | $I_C = 10$ A, $I_B = 2.5$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 2.5 | | | V | $I_C = 10$ A, $I_B = 2.5$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.5 | | 1.5 | V | $I_C = 4.0$ A, $V_{CE} = 4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current Gain Bandwidth Product | 4.0 | | 4.0 | | MHz | $I_C = 0.5$ A, $V_{CE} = 10$ V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 500 | | 300 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | | $I_C = 1.0$ A, $V_{CE} = 4.0$ V, f = 1.0 kHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | |
| $t_r$ | Rise Time | | 0.7 | | 0.7 | μs | $V_{CC} = 30$ V, $I_C = 4.0$ A, $I_{B1} = 0.4$ A |
| $t_s$ | Storage Time | | 1.0 | | 1.0 | μs | $V_{CC} = 30$ V, $I_C = 4.0$ A, $I_{B1} = I_{B2} = 0.4$ A, Duty Cycle 1.0% |
| $t_f$ | Fall Time | | 0.8 | | 0.8 | μs | $V_{CC} = 30$ V, $I_C = 4.0$ A $I_{B1} = I_{B2} = 0.4$ A, Duty Cycle 1.0% |

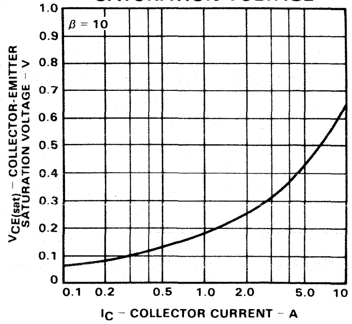
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

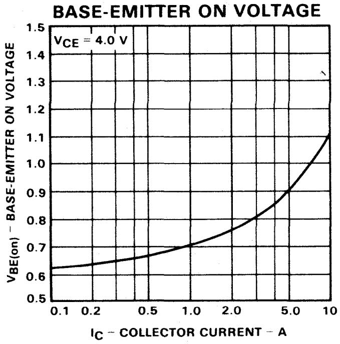
### DC CURRENT GAIN



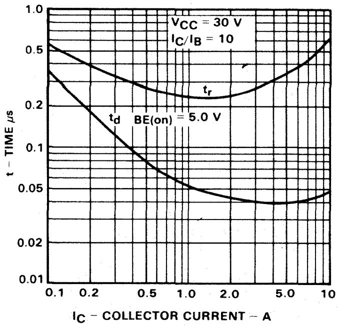

### COLLECTOR-EMITTER SATURATION VOLTAGE



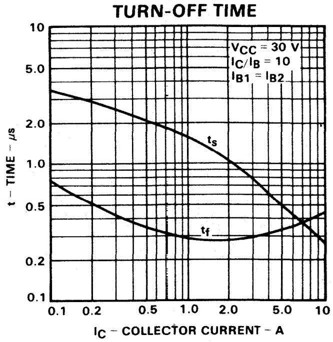

### BASE-EMITTER ON VOLTAGE




### TURN-ON TIME




### TURN-OFF TIME



# POWER TRANSISTOR

## PNP SILICON

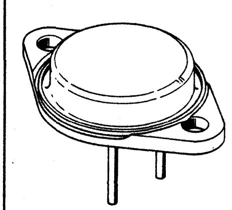
## 2N5879
## 2N5880

### HIGH POWER GENERAL PURPOSE POWER-AMPLIFIER AND SWITCHING APPLICATIONS

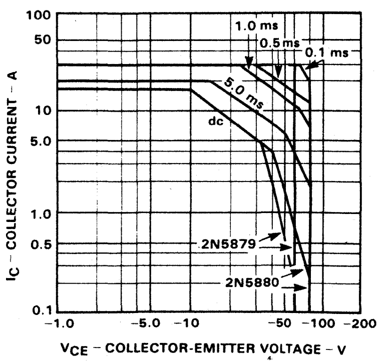
- 160 W DISSIPATION AT 25°C CASE
- 15 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENT 2N5881, 2N5882

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

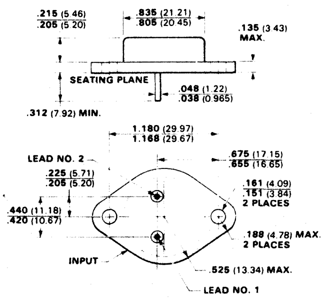
| | | 2N5879 | 2N5880 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 15 A | 15 A |
| $I_C$ | Peak Collector Current | 30 A | 30 A |
| $I_B$ | Continuous Base Current | 5.0 A | 5.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 160 W |
| | Derate Linearly from 25°C | | 0.92 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 1.09°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

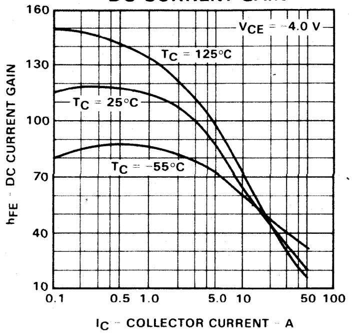
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5879 MIN | 2N5879 MAX | 2N5880 MIN | 2N5880 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | −80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CE} = -30$ V, $I_B = 0$ |
| | | | | | 1.0 | mA | $V_{CE} = -40$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V |
| | | | | | 0.5 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V |
| | | | 5.0 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CB} = -60$ V, $I_E = 0$ |
| | | | | | 0.5 | mA | $V_{CB} = -80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 4.0 | | 4.0 | | | $I_C = 15$ A, $V_{CE} = -4.0$ V |
| | | 20 | 100 | 20 | 100 | | $I_C = 6.0$ A, $V_{CE} = -4.0$ V |
| | | 35 | | 35 | | | $I_C = 2.0$ A, $V_{CE} = -4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −1.0 | | −1.0 | V | $I_C = 7.0$ A, $I_B = 0.7$ A |
| | | | −4.0 | | −4.0 | V | $I_C = 15$ A, $I_B = 3.75$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −2.5 | | −2.5 | V | $I_C = 15$ A, $I_B = 3.75$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.5 | | −1.5 | V | $I_C = 6.0$ A, $V_{CE} = -4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | MHz | $I_C = 1.0$ A, $V_{CE} = -1.0$ V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 600 | | 600 | pF | $V_{CB} = -10$ V, $I_E = 0$, f = 0.1 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | | $I_C = 2.0$ A, $V_{CE} = -4.0$ V, f = 1.0 kHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | |
| $t_r$ | Rise Time | | 0.7 | | 0.7 | μs | $V_{CC} = -30$ V, $I_C = 6.0$ A, $I_{B1} = 0.6$ A, $t_p = 25$ μs, Duty Cycle 1% |
| $t_s$ | Storage Time | | 1.0 | | 1.0 | μs | $V_{CC} = -30$ V, $I_C = 6.0$ A, $I_{B1} = I_{B2} = 0.6$ A, $t_p = 25$ μs, Duty Cycle 1% |
| $t_f$ | Fall Time | | 0.8 | | 0.8 | μs | |

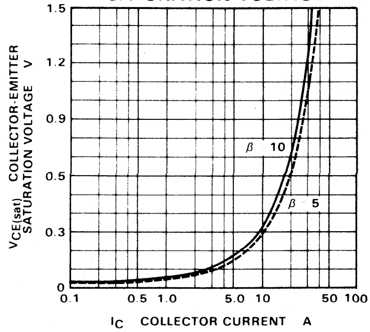
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

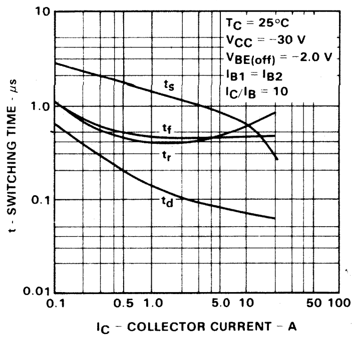
### DC CURRENT GAIN



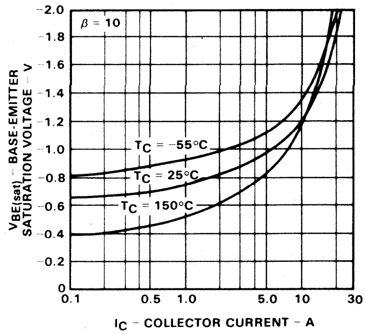

### COLLECTOR-EMITTER SATURATION VOLTAGE



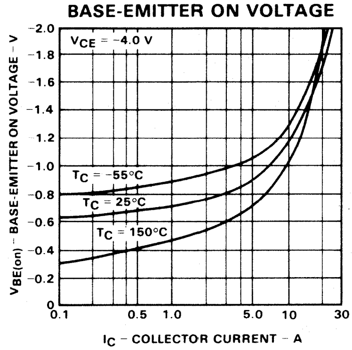

### SWITCHING TIME




### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

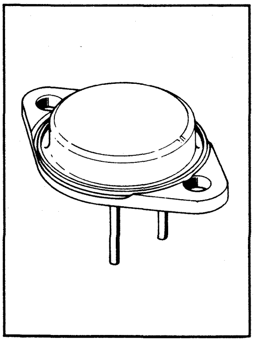
# 2N5881
# 2N5882

## HIGH POWER GENERAL PURPOSE POWER-AMPLIFIER AND SWITCHING APPLICATIONS

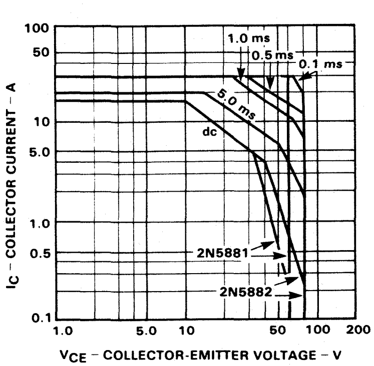
- 160 W DISSIPATION AT 25°C CASE
- 15 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENT 2N5879, 2N5880

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

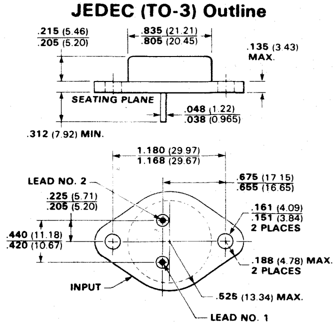
| | | 2N5881 | 2N5882 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 15 A | 15 A |
| $I_C$ | Peak Collector Current | 30 A | 30 A |
| $I_B$ | Continuous Base Current | 5.0 A | 5.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 160 W |
| | Derate Linearly from 25°C | | 0.92 W/°C |
| **Maximum Temperatures** | | | |
| $T_J$,$T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 1.09°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**



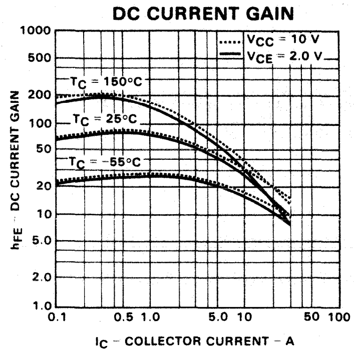

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

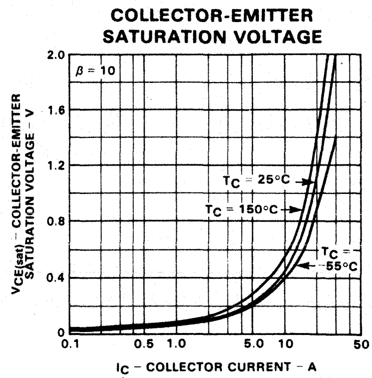
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

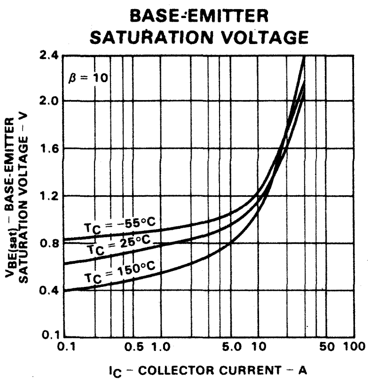
| SYMBOL | CHARACTERISTIC | 2N5881 MIN | 2N5881 MAX | 2N5882 MIN | 2N5882 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | 1.0 | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.5 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | 5.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CB} = 60$ V, $I_E = 0$ |
| | | | | | 0.5 | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 4.0 | | 4.0 | | | $I_C = 15$ A, $V_{CE} = 4.0$ V |
| | | 20 | 100 | 20 | 100 | | $I_C = 6.0$ A, $V_{CE} = 4.0$ V |
| | | 35 | | 35 | | | $I_C = 2.0$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | V | $I_C = 7.0$ A, $I_B = 0.7$ A |
| | | | 4.0 | | 4.0 | V | $I_C = 15$ A, $I_B = 3.75$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 2.5 | | 2.5 | V | $I_C = 15$ A, $I_B = 3.75$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.5 | | 1.5 | V | $I_C = 60$ A, $V_{CE} = 4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | MHz | $I_C = 1.0$ A, $V_{CE} = 10$ V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 400 | | 400 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | | $I_C = 2.0$ A, $V_{CE} = 4.0$ V, f = 1.0 kHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | |
| $t_r$ | Rise Time | | 0.7 | | 0.7 | μs | $V_{CC} = 30$ V, $I_C = 6.0$ A, $I_{B1} = 0.6$ A, $t_p = 25$ μs, Duty Cycle 1% |
| $t_s$ | Storage Time | | 1.0 | | 1.0 | μs | $V_{CC} = 30$ V, $I_C = 6.0$ A, $I_{B1} = I_{B2} = 0.6$ A, $t_p = 25$ μs, Duty Cycle 1% |
| $t_f$ | Fall Time | | 0.8 | | 0.8 | μs | |

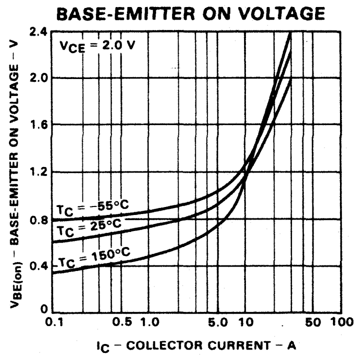
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

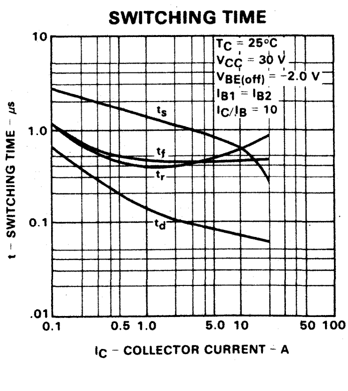
## TYPICAL ELECTRICAL CHARACTERISTICS



# POWER TRANSISTOR

## PNP SILICON

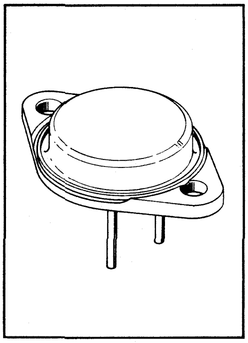
# 2N5883
# 2N5884

### DESIGNED FOR GENERAL PURPOSE POWER AMPLIFIER AND SWITCHING APPLICATIONS

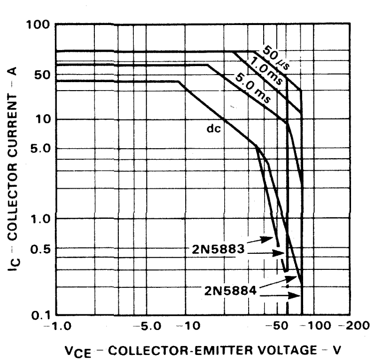
- 200 W DISSIPATION AT 25°C CASE
- 25 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS 2N5885, 2N5886

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

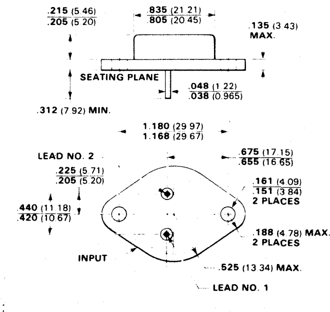
| | | 2N5883 | 2N5884 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 25 A | 25 A |
| $I_C$ | Peak Collector Current | 50 A | 50 A |
| $I_B$ | Continuous Base Current | 7.5 A | 7.5 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 200 W |
| | Derate Linearly from 25°C | | 1.14 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 0.86°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

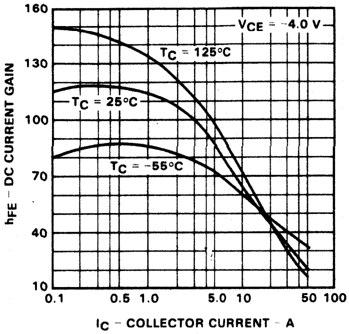
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5883 MIN | 2N5883 MAX | 2N5884 MIN | 2N5884 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | −80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 2.0 | | | mA | $V_{CE} = -30$ V, $I_B = 0$ |
| | | | | | 2.0 | mA | $V_{CE} = -40$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V |
| | | | | | 1.0 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V |
| | | | 10 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | 10 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CB} = -60$ V, $I_E = 0$ |
| | | | | | 1.0 | mA | $V_{CB} = -80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 4.0 | | 4.0 | | | $I_C = 25$ A, $V_{CE} = -4.0$ V |
| | | 20 | 100 | 20 | 100 | | $I_C = 10$ A, $V_{CE} = -4.0$ V |
| | | 35 | | 35 | | | $I_C = 3.0$ A, $V_{CE} = -4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −1.0 | | −1.0 | V | $I_C = 15$ A, $I_B = 1.5$ A |
| | | | −4.0 | | −4.0 | V | $I_C = 25$ A, $I_B = 6.25$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −2.5 | | −2.5 | V | $I_C = 25$ A, $I_B = 6.25$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.5 | | −1.5 | V | $I_C = 10$ A, $V_{CE} = -4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 1000 | | 1000 | pF | $V_{CB} = -10$ V, $I_E = 0$ f = 1.0 MHz |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 4.0 | | 4.0 | | | $I_C = 1.0$ A, $V_{CE} = -10$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | | $I_C = 3.0$ A, $V_{CE} = -4.0$ V, f = 1.0 kHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | |
| $t_r$ | Rise Time | | 0.7 | | 0.7 | μs | $V_{CC} = -30$ V, $I_C = 10$ A, $I_{B1} = 1.0$ A, $t_p = 10$ to 100 μs, Duty Cycle 2% |
| $t_s$ | Storage Time | | 1.0 | | 1.0 | μs | $V_{CC} = -30$ V, $I_C = 10$ A, $I_{B1} = I_{B2} = 1.0$ A, $t_p = 10$ to 100 μs, Duty Cycle 2% |
| $t_f$ | Fall Time | | 0.8 | | 0.8 | μs | |

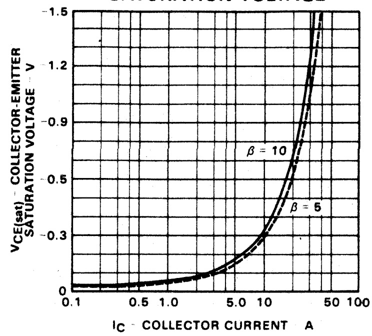
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

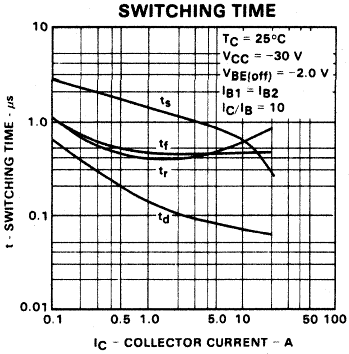
### DC CURRENT GAIN



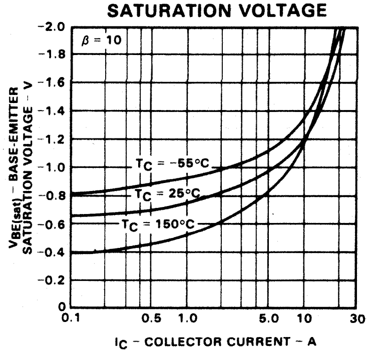

### COLLECTOR-EMITTER SATURATION VOLTAGE



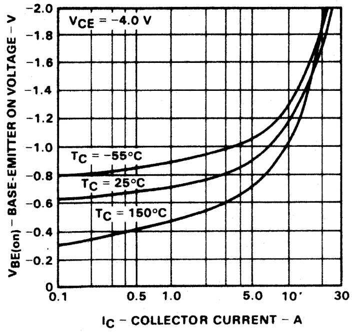

### SWITCHING TIME




### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

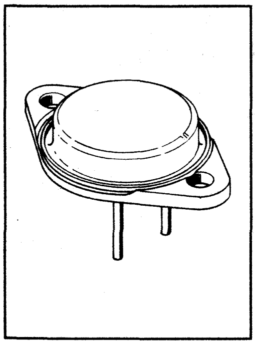
# 2N5885
# 2N5886

### DESIGNED FOR GENERAL PURPOSE POWER AMPLIFIER AND SWITCHING APPLICATIONS

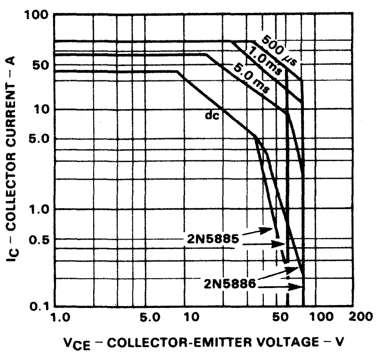
- 200 W DISSIPATION AT 25°C CASE
- 25 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS 2N5883, 2N5884

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

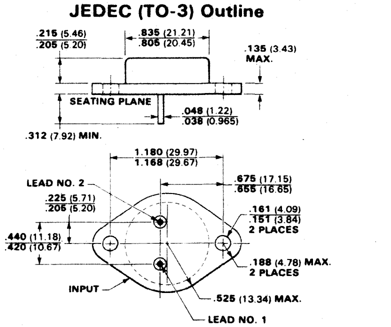
| | | 2N5885 | 2N5886 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 25 A | 25 A |
| $I_C$ | Peak Collector Current | 50 A | 50 A |
| $I_B$ | Continuous Base Current | 7.5 A | 7.5 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 200 W |
| | Derate Linearly from 25°C | | 1.14 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 0.86°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

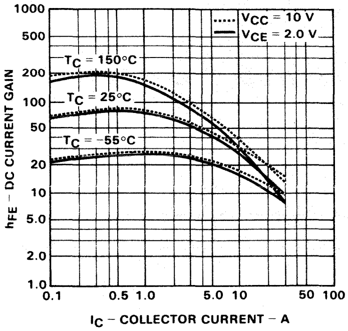
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N5885 MIN | 2N5885 MAX | 2N5886 MIN | 2N5886 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 2.0 | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | 2.0 | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | 1.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | 10 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 10 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CB} = 60$ V, $I_E = 0$ |
| | | | | | 1.0 | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 4.0 | | 4.0 | | | $I_C = 25$ A, $V_{CE} = 4.0$ V |
| | | 20 | 100 | 20 | 100 | | $I_C = 10$ A, $V_{CE} = 4.0$ V |
| | | 35 | | 35 | | | $I_C = 3.0$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | V | $I_C = 15$ A, $I_B = 1.5$ A |
| | | | 4.0 | | 4.0 | V | $I_C = 25$ A, $I_B = 6.25$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 2.5 | | 2.5 | V | $I_C = 25$ A, $I_B = 6.25$ A |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | MHz | $I_C = 1.0$ A, $V_{CE} = 10$ V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 500 | | 500 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | | $I_C = 3.0$ A, $V_{CE} = 4.0$ V, f = 1.0 kHz |

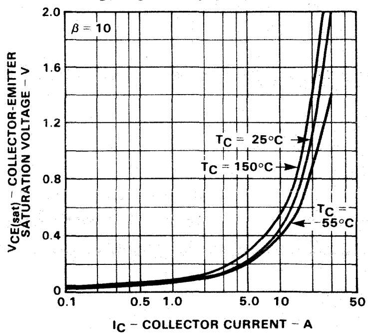
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

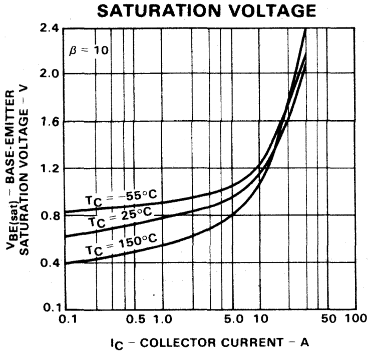
### DC CURRENT GAIN



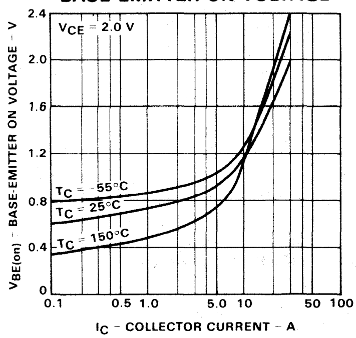

### COLLECTOR-EMITTER SATURATION VOLTAGE



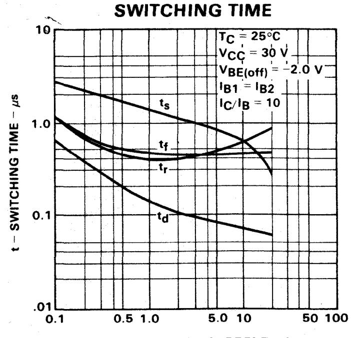

### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE




### SWITCHING TIME



# POWER TRANSISTOR

## PNP SILICON

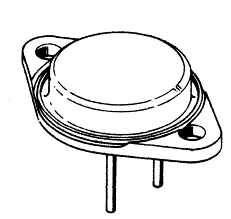
**2N6029**
**2N6030**
**2N6031**

## DESIGNED FOR HIGH POWER AUDIO AND SWITCHING REGULATORS

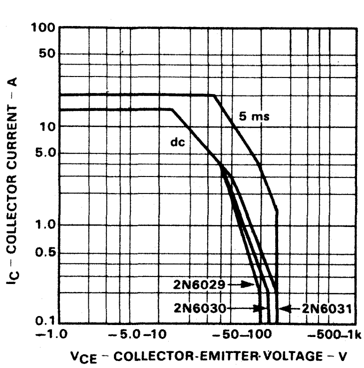
- **200 W DISSIPATION AT 25°C CASE**
- **16 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **25 TO 100 $h_{FE}$ AT 8 A, −2.0 V 2N6029**

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

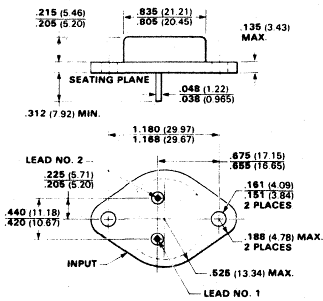
| | | 2N6029 | 2N6030 | 2N6031 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −100 V | −120 V | −140 V |
| $V_{CBO}$ | Collector to Base Voltage | −100 V | −120 V | −140 V |
| $V_{EBO}$ | Emitter to Base Voltage | −7.0 V | −7.0 V | −7.0 V |
| $I_C$ | Continuous Collector Current | 16 A | 16 A | 16 A |
| $I_B$ | Continuous Base Current | 5.0 A | 5.0 A | 5.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 200 W |
| | Derate Linearly from 25°C | | | 1.14 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 0.88°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

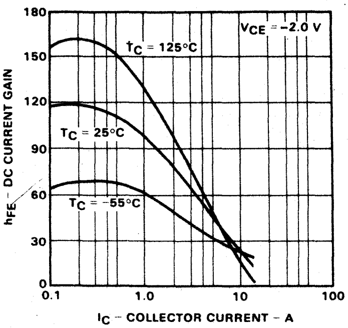
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6029 MIN | 2N6029 MAX | 2N6030 MIN | 2N6030 MAX | 2N6031 MIN | 2N6031 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −100 | | −120 | | −140 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 2.0 | | 2.0 | | 2.0 | mA<br>mA<br>mA | $V_{CE} = -50$ V, $I_B = 0$<br>$V_{CE} = -60$ V, $I_B = 0$<br>$V_{CE} = -70$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 2.0<br>7.0 | | 2.0<br>7.0 | | 2.0<br>7.0 | mA<br>mA<br>mA<br>mA<br>mA<br>mA | $V_{CE} = -100$ V, $V_{BE} = 1.5$ V<br>$V_{CE} = -120$ V, $V_{BE} = 1.5$ V<br>$V_{CE} = -140$ V, $V_{BE} = 1.5$ V<br>$V_{CE} = -100$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$<br>$V_{CE} = -120$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$<br>$V_{CE} = -140$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 2.0 | | 2.0 | | 2.0 | mA<br>mA<br>mA | $V_{CB} = -100$ V, $I_E = 0$<br>$V_{CB} = -120$ V, $I_E = 0$<br>$V_{CB} = -140$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | | 5.0 | mA | $V_{EB} = -7.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 25<br>4.0 | 100 | 20<br>4.0 | 80 | 15<br>4.0 | 60 | | $I_C = 8.0$ A, $V_{CE} = -2.0$ V<br>$I_C = 16.0$ A, $V_{CE} = -2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −1.0<br>−2.0 | | −1.0<br>−2.0 | | −1.0<br>−2.0 | V<br>V | $I_C = 10$ A, $I_B = 1.0$ A<br>$I_C = 16$ A, $I_B = 4.0$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −1.8 | | −1.8 | | −1.8 | V | $I_C = 10$ A, $I_B = 1.0$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.5 | | −1.5 | | −1.5 | V | $I_C = 8.0$ A, $V_{CE} = -2.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 1.0 | | 1.0 | | 1.0 | | MHz | $I_C = 1.0$ A, $V_{CE} = -20$ V, f = 0.5 MHz |
| $C_{ob}$ | Output Capacitance | | 1000 | | 1000 | | 1000 | pF | $V_{CB} = -10$ V, $I_E = 0$, f = 0.1 MHz |

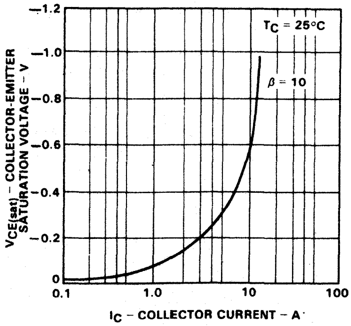
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

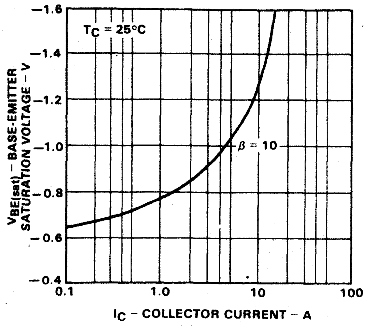
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE

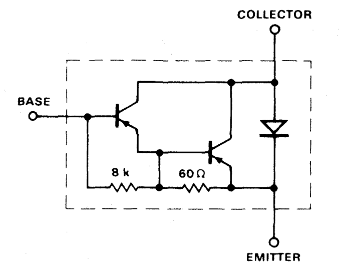


# POWER DARLINGTON

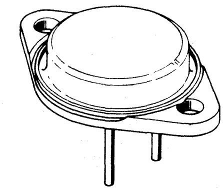
## PNP SILICON

# 2N6050
# 2N6051
# 2N6052

### DESIGNED FOR GENERAL PURPOSE AMPLIFIER AND LOW SPEED SWITCHING APPLICATIONS




- 150 W DISSIPATION AT 25°C CASE
- 12 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- $h_{FE}$ TYPICAL OF 2000 AT 3.0 A

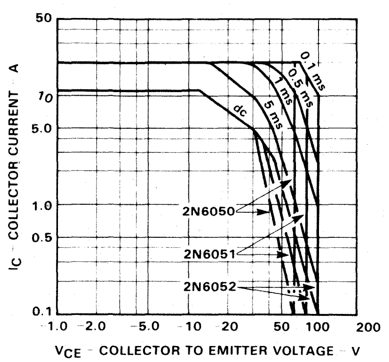


### ABSOLUTE MAXIMUM RATINGS

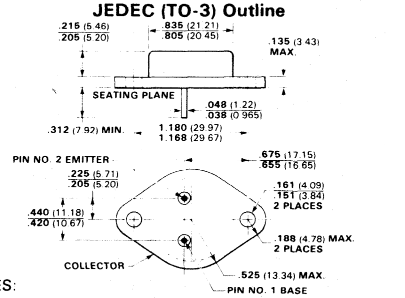
| Maximum Voltages and Currents | | 2N6050 | 2N6051 | 2N6052 |
|---|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | −60 V | −80 V | −100 V |
| $V_{CB}$ | Collector to Base Voltage | −60 V | −80 V | −100 V |
| $V_{EB}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 12 A | 12 A | 12 A |
| $I_B$ | Continuous Base Current | 0.2 A | 0.2 A | 0.2 A |

| | | |
|---|---|---|
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 150 W |
| | Derate Linearly from 25°C | 0.857 W/°C |
| **Maximum Temperatures** | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +200°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.17 °C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10 s) | 235°C |

**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**



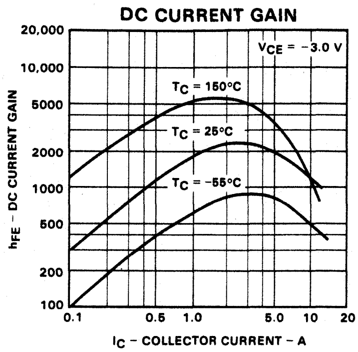

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

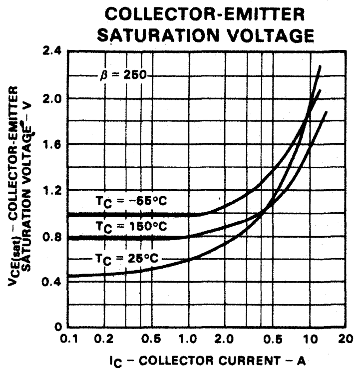
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

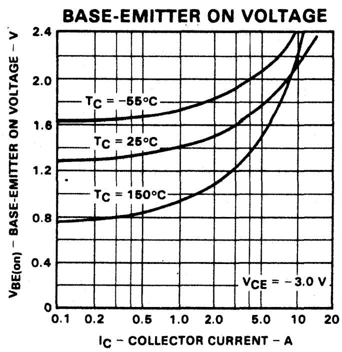
| SYMBOL | PARAMETER | 2N6050 | | 2N6051 | | 2N6052 | | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | −80 | | −100 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = -30$ V, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = -40$ V, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = -50$ V, $I_B = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 2.0 | | 2.0 | | 2.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V |
| | | | | | 0.5 | | | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V |
| | | | | | | | 0.5 | mA | $V_{CE} = -100$ V, $V_{BE} = 1.5$ V |
| | | | 5.0 | | | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | | | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | | | 5.0 | mA | $V_{CE} = -100$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 750 | 18 k | 750 | 18 k | 750 | 18 k | | $I_C = 6.0$ A, $V_{CE} = -3.0$ V |
| | | 100 | | 100 | | 100 | | | $I_C = 12$ A, $V_{CE} = -3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −2.0 | | −2.0 | | −2.0 | V | $I_C = 6.0$ A, $I_B = 24$ mA |
| | | | −3.0 | | −3.0 | | −3.0 | V | $I_C = 12$ A, $I_B = 120$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −4.0 | | −4.0 | | −4.0 | V | $I_C = 12$ A, $I_B = 120$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −2.8 | | −2.8 | | −2.8 | V | $I_C = 6.0$ A, $V_{CE} = -3.0$ V |
| $C_{ob}$ | Output Capacitance | | 500 | | 500 | | 500 | pF | $V_{CB} = -10$ V, $I_E = 0$, f = 0.1 MHz |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Short Circuit Forward Current Transfer Ratio | 4.0 | | 4.0 | | 4.0 | | | $I_C = 5.0$ A, $V_{CE} = -3.0$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 300 | | 300 | | 300 | | | $I_C = 5.0$ A, $V_{CE} = -3.0$ V, f = 1.0 kHz |

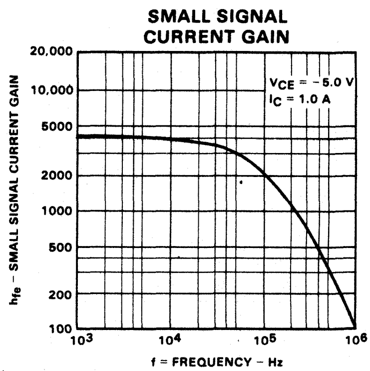
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS



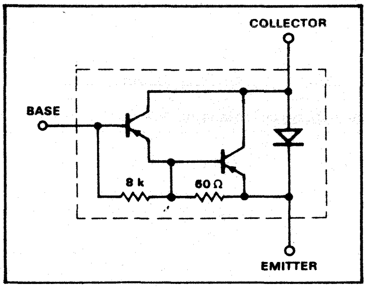



# POWER DARLINGTON

## PNP SILICON

# 2N6053
# 2N6054

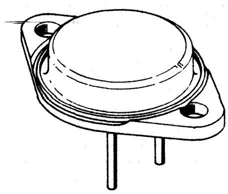
### DESIGNED FOR GENERAL PURPOSE AMPLIFIER AND LOW SPEED SWITCHING APPLICATIONS




- 100 W DISSIPATION AT 25°C CASE
- 8.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- $h_{FE}$ TYPICAL OF 4000 AT 4.0 A
- COMPLEMENT TO 2N6055, 2N6056

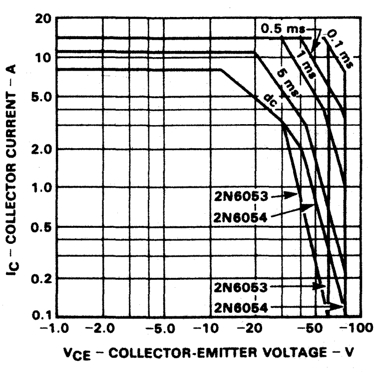
**ABSOLUTE MAXIMUM RATINGS**

| Maximum Voltages and Currents | | 2N6053 | 2N6054 |
|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | −60 V | −80 V |
| $V_{CB}$ | Collector to Base Voltage | −60 V | −80 V |
| $V_{EB}$ | Emitter to Base Voltage | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 8.0 A | 8.0 A |
| $I_C$ | Peak Collector Current | 16 A | 16 A |
| $I_B$ | Continuous Base Current | 0.12 A | 0.12 A |

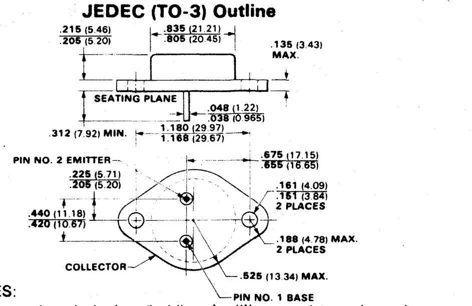


| Maximum Power Dissipation | | |
|---|---|---|
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 100 W |
| | Derate Linearly from 25°C | 0.57 W/°C |
| **Maximum Temperatures** | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +200°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.75°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10 s) | 235°C |

**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

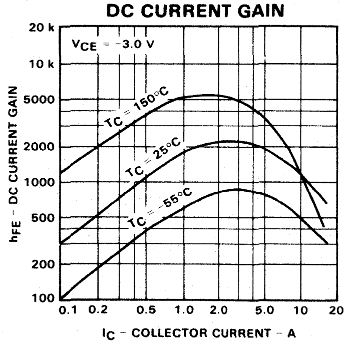
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6053 MIN | 2N6053 MAX | 2N6054 MIN | 2N6054 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | −80 | | V | $I_C$ = 100 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CE}$ = −30 V, $I_B$ = 0 |
| | | | | | 0.5 | | $V_{CE}$ = −40 V, $I_B$ = 0 |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 1.5 V, |
| | | | | | 0.5 | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 1.5 V, |
| | | | 5.0 | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| | | | | | 5.0 | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| $I_{EBO}$ | Emitter Cutoff Current | | 2.0 | | 2.0 | mA | $V_{EB}$ = −5.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 750 | 18 k | 750 | 18 k | | $I_C$ = 4.0 A, $V_{CE}$ = −3.0 V |
| | | 100 | | 100 | | | $I_C$ = 8.0 A, $V_{CE}$ = −3.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −2.0 | | −2.0 | V | $I_C$ = 4.0 A, $I_B$ = 16 mA |
| | | | −3.0 | | −3.0 | V | $I_C$ = 8.0 A, $I_B$ = 80 mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −4.0 | | −4.0 | V | $I_C$ = 8.0 A, $I_B$ = 80 mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −2.8 | | −2.8 | V | $I_C$ = 4.0 A, $V_{CE}$ = −3.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 300 | | 300 | pF | $V_{CB}$ = −10 V, $I_E$ = 0, f = 0.1 MHz |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 4.0 | | 4.0 | | | $I_C$ = 3.0 A, $V_{CE}$ = −3.0 V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 300 | | 300 | | | $I_C$ = 3.0 A, $V_{CE}$ = −3.0 V, f = 1.0 kHz |

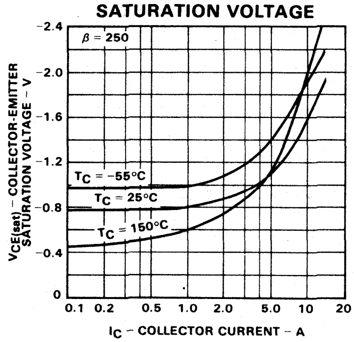
NOTE 1: Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

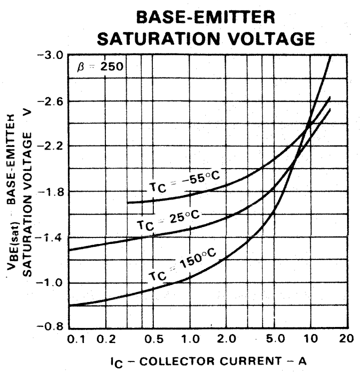
**DC CURRENT GAIN**

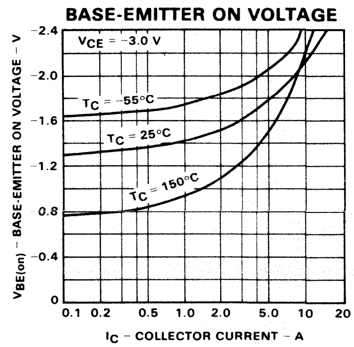


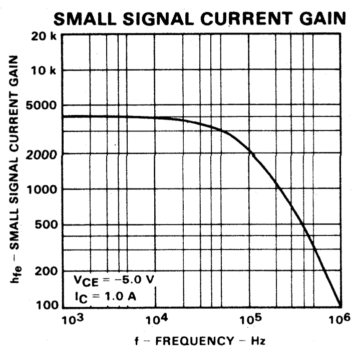

**COLLECTOR-EMITTER SATURATION VOLTAGE**

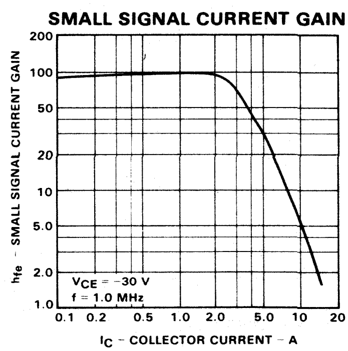


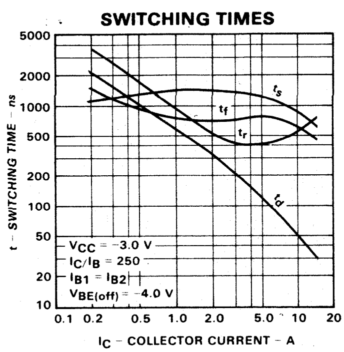
## TYPICAL ELECTRICAL CHARACTERISTICS (Cont'd)

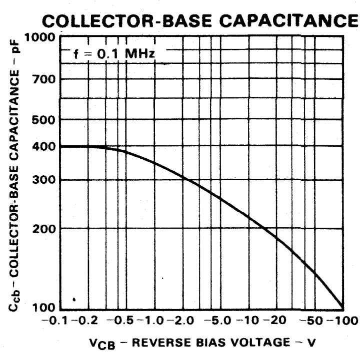


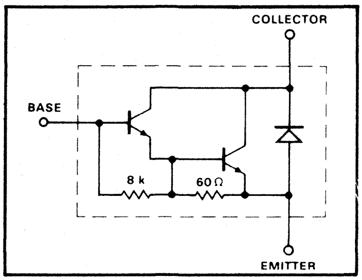
# POWER DARLINGTON

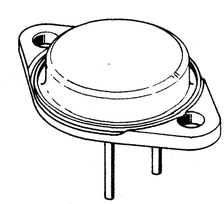
## NPN SILICON

# 2N6055
# 2N6056

### DESIGNED FOR GENERAL PURPOSE AMPLIFIER AND LOW SPEED SWITCHING APPLICATIONS

- 100 W DISSIPATION AT 25°C CASE
- 8.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- $h_{FE}$ TYPICAL OF 4000 AT 4.0 A
- COMPLEMENT TO 2N6053, 2N6054



### ABSOLUTE MAXIMUM RATINGS

**Maximum Voltages and Currents**

| | | 2N6055 | 2N6056 |
|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | 60 V | 80 V |
| $V_{CB}$ | Collector to Base Voltage | 60 V | 80 V |
| $V_{EB}$ | Emitter to Base Voltage | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 8.0 A | 8.0 A |
| $I_C$ | Peak Collector Current | 16 A | 16 A |
| $I_B$ | Continuous Base Current | 0.12 A | 0.12 A |

**Maximum Power Dissipation**

| | | |
|---|---|---|
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 100 W |
| | Derate Linearly from 25°C | 0.57 W/°C |

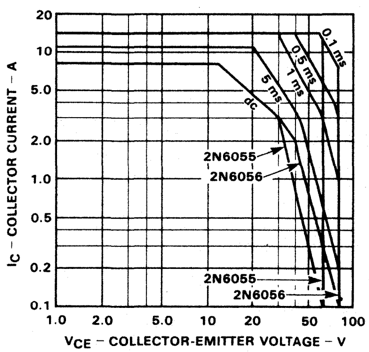
**Maximum Temperatures**

| | | |
|---|---|---|
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +200°C |

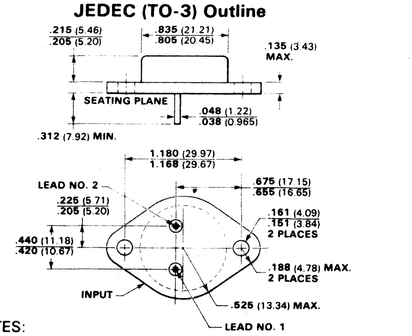
**Thermal Characteristics**

| | | |
|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.75°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10 s) | 235°C |

**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**



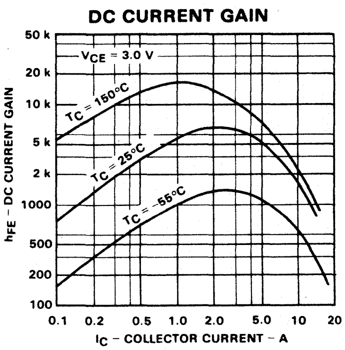

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

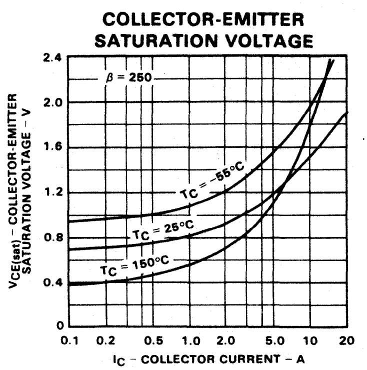
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6055 MIN | 2N6055 MAX | 2N6056 MIN | 2N6056 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | 0.5 | | $V_{CE} = 40$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.5 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | 5.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 2.0 | | 2.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 750 | 18 k | 750 | 18 k | | $I_C = 4.0$ A, $V_{CE} = 3.0$ V |
| | | 100 | | 100 | | | $I_C = 8.0$ A, $V_{CE} = 3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 2.0 | | 2.0 | V | $I_C = 4.0$ A, $I_B = 16$ mA |
| | | | 3.0 | | 3.0 | V | $I_C = 8.0$ A, $I_B = 80$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 4.0 | | 4.0 | V | $I_C = 8.0$ A, $I_B = 80$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.8 | | 2.8 | V | $I_C = 4.0$ A, $V_{CE} = 3.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 200 | | 200 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 4.0 | | 4.0 | | | $I_C = 3.0$ A, $V_{CE} = 3.0$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 300 | | 300 | | | $I_C = 3.0$ A, $V_{CE} = 3.0$ V, f = 1.0 kHz |

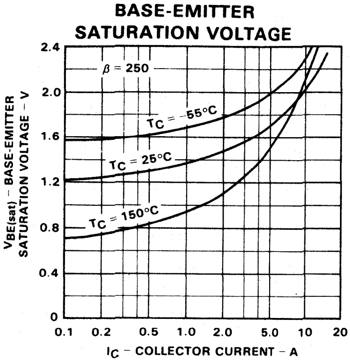
NOTE 1: Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

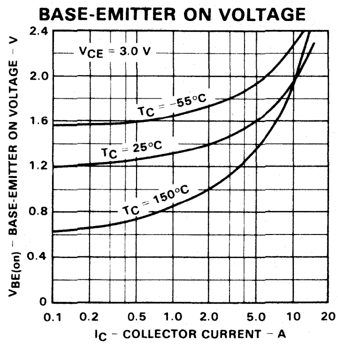
## TYPICAL ELECTRICAL CHARACTERISTICS

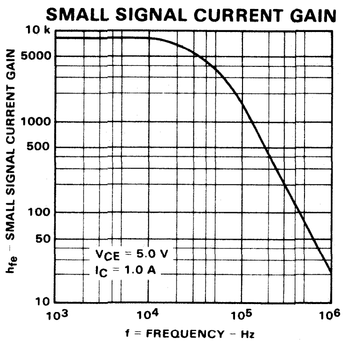


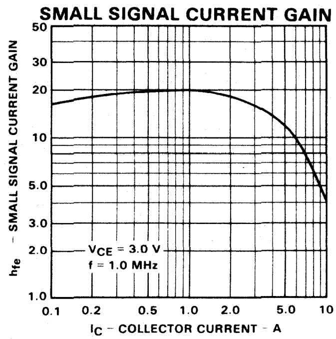



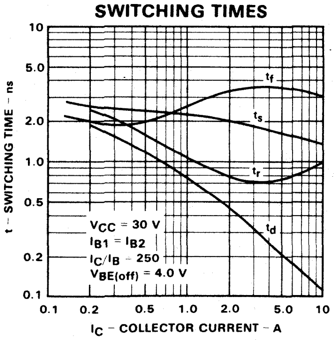
## TYPICAL ELECTRICAL CHARACTERISTICS (Cont'd)

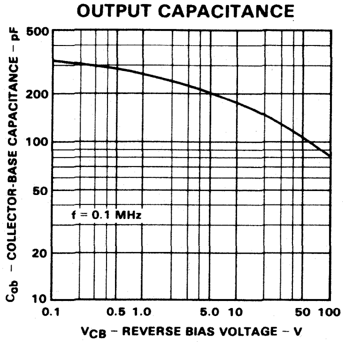


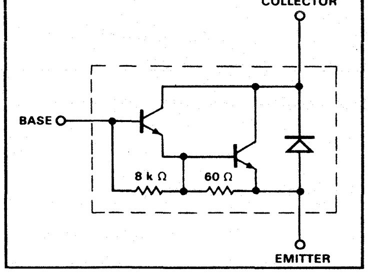
# POWER DARLINGTON

## NPN SILICON

# 2N6057
# 2N6058
# 2N6059

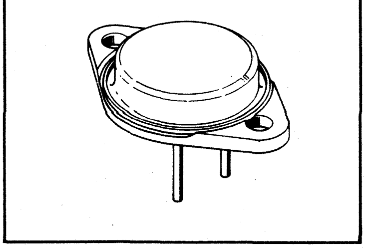
## DESIGNED FOR GENERAL PURPOSE AMPLIFIERS AND LOW SPEED SWITCHING APPLICATIONS

- 150 W DISSIPATION AT 25°C CASE
- 12 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- $h_{FE}$ TYPICAL OF 4000 AT 3.0 A
- COMPLEMENT TO 2N6050, 2N6051, 2N6052




### ABSOLUTE MAXIMUM RATINGS

| Maximum Voltages and Currents | | 2N6057 | 2N6058 | 2N6059 |
|---|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | 60 V | 80 V | 100 V |
| $V_{CB}$ | Collector to Base Voltage | 60 V | 80 V | 100 V |
| $V_{EB}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 12 A | 12 A | 12 A |
| $I_C$ | Peak Collector Current | 20 A | 20 A | 20 A |
| $I_B$ | Continuous Base Current | 0.2 A | 0.2 A | 0.2 A |



**Maximum Power Dissipation**

| | | |
|---|---|---|
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 150 W |
| | Derate Linearly from 25°C | 0.857 W/°C |

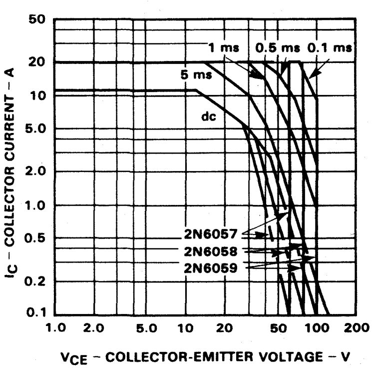
**Maximum Temperatures**

| | | |
|---|---|---|
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +200°C |

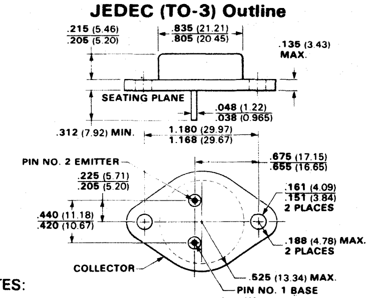
**Thermal Characteristics**

| | | |
|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.17 °C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10 s) | 235°C |

**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

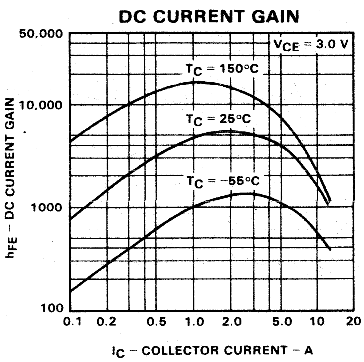
# FAIRCHILD 2N6057 • 2N6058 • 2N6059

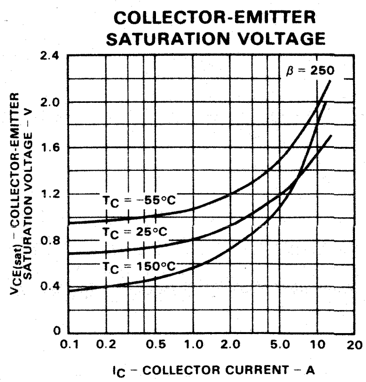
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

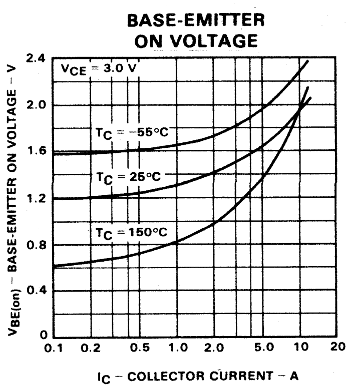
| SYMBOL | CHARACTERISTIC | 2N6057 | | 2N6058 | | 2N6059 | | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | 100 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 50$ V, $I_B = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 2.0 | | 2.0 | | 2.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | 1.0 | | | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | | | | | 1.0 | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V |
| | | | 5.0 | | | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | | | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | | | 5.0 | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 750 | 18 k | 750 | 18 k | 750 | 18 k | | $I_C = 6.0$ A, $V_{CE} = 3.0$ V |
| | | 100 | | 100 | | 100 | | | $I_C = 12$ A, $V_{CE} = 3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 2.0 | | 2.0 | | 2.0 | V | $I_C = 6.0$ A, $I_B = 24$ mA |
| | | | 3.0 | | 3.0 | | 3.0 | V | $I_C = 12$ A, $I_B = 120$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 4.0 | | 4.0 | | 4.0 | V | $I_C = 12$ A, $I_B = 120$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.8 | | 2.8 | | 2.8 | V | $I_C = 6.0$ A, $V_{CE} = 3.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 300 | | 300 | | 300 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Short Circuit Forward Current Transfer Ratio | 4.0 | | 4.0 | | 4.0 | | | $I_C = 5.0$ A, $V_{CE} = 3.0$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 300 | | 300 | | 300 | | | $I_C = 5.0$ A, $V_{CE} = 3.0$ V, f = 1.0 kHz |

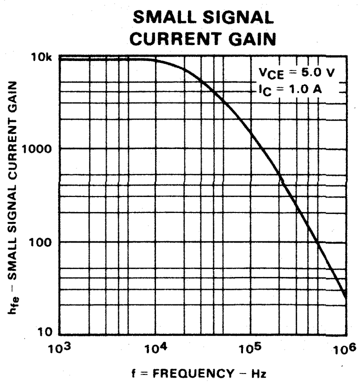
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS



# POWER TRANSISTOR

## NPN SILICON

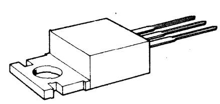
# 2N6121
# 2N6122
# 2N6123

### DESIGNED FOR GENERAL PURPOSE AMPLIFIER APPLICATIONS

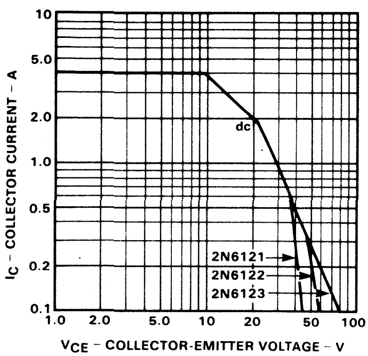
- *40 W DISSIPATION AT 25°C CASE*
- **4.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **0.6 V MAXIMUM $V_{CE(sat)}$ @ 1.5 A**
- **COMPLEMENTS 2N6124, 2N6125, 2N6126**

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

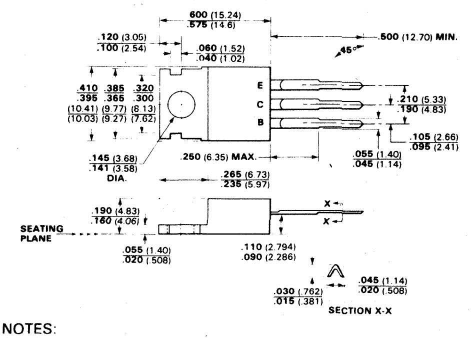
| | | 2N6121 | 2N6122 | 2N6123 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | **2N6121** | **2N6122** | **2N6123** |
| $V_{CEO}$ | Collector to Emitter Voltage | 45 V | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 45 V | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 4.0 A | 4.0 A | 4.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 40 W |
| | Derate Linearly from 25°C | | | 0.32 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 3.12°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

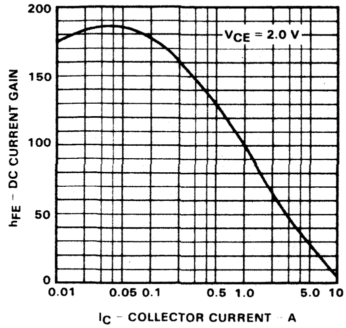
| SYMBOL | CHARACTERISTIC | 2N6121 | | 2N6122 | | 2N6123 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 45 | | 60 | | 80 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 45$ V, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 60$ V, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 80$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CE} = 45$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.1 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | | | 0.1 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | 2.0 | | | | | mA | $V_{CE} = 45$ V, $V_{BE} = -1.5$ V, $T_C = 125°C$ |
| | | | | | 2.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 125°C$ |
| | | | | | | | 2.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 125°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CB} = 45$ V, $I_E = 0$ |
| | | | | | 0.1 | | | mA | $V_{CB} = 60$ V, $I_E = 0$ |
| | | | | | | | 0.1 | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 25 | 100 | 25 | 100 | 20 | 80 | | $I_C = 1.5$ A, $V_{CE} = 2.0$ V |
| | | 10 | | 10 | | 7.0 | | | $I_C = 4.0$ A, $V_{CE} = 2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.6 | | 0.6 | | 0.6 | V | $I_C = 1.5$ A, $I_B = 0.15$ A |
| | | | 1.4 | | 1.4 | | 1.4 | V | $I_C = 4.0$ A, $I_B = 1.0$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.2 | | 1.2 | | 1.2 | V | $I_C = 1.5$ A, $V_{CE} = 2.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $h_{fe}$ | Magnitude of Common Emitter Small Signal Current Gain | 2.5 | | 2.5 | | 2.5 | | | $I_C = 1.0$ A, $V_{CE} = 4.0$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | 25 | | | $I_C = 0.1$ A, $V_{CE} = 2.0$ V, f = 1.0 kHz |

NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

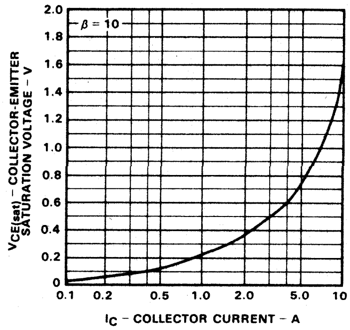
## TYPICAL ELECTRICAL CHARACTERISTICS

### 2N6121 • 2N6122

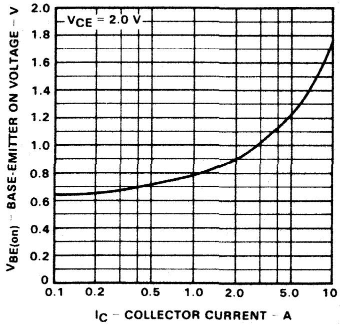
DC CURRENT GAIN




COLLECTOR-EMITTER SATURATION VOLTAGE

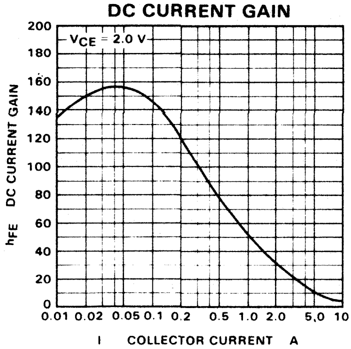



BASE-EMITTER ON VOLTAGE

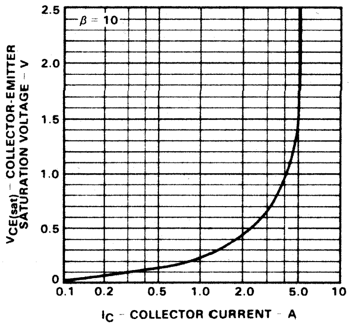



### 2N6123

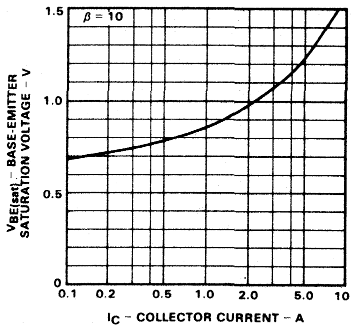
DC CURRENT GAIN



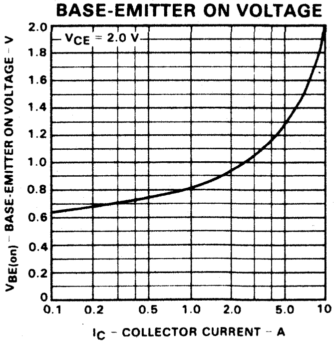

COLLECTOR-EMITTER SATURATION VOLTAGE



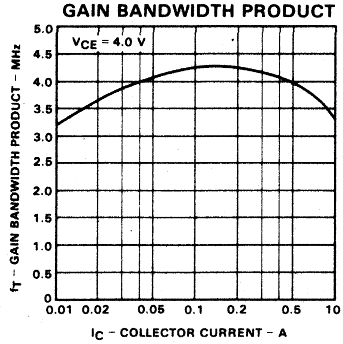

BASE-EMITTER SATURATION VOLTAGE




BASE-EMITTER ON VOLTAGE




GAIN BANDWIDTH PRODUCT



# POWER TRANSISTOR

## PNP SILICON

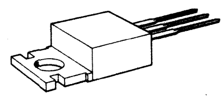
# 2N6124
# 2N6125
# 2N6126

### DESIGNED FOR GENERAL PURPOSE AMPLIFIER APPLICATIONS

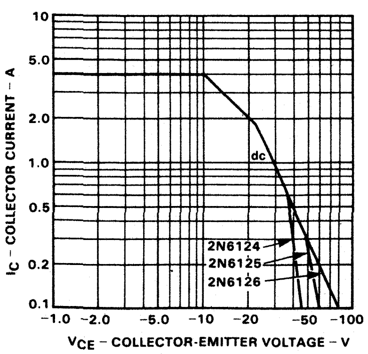
- **40 W DISSIPATION AT 25°C CASE**
- ***4.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT***
- **−0.6 V MAXIMUM $V_{CE(sat)}$ @ 1.5 A**
- **COMPLEMENTS 2N6121, 2N6122, 2N6123**

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

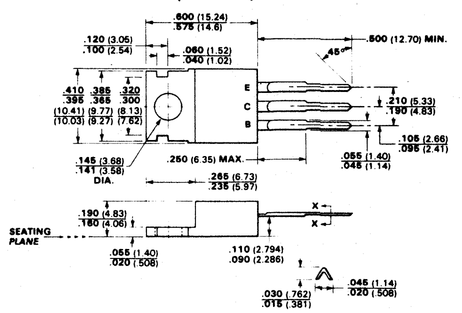
| | | 2N6124 | 2N6125 | 2N6126 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −45 V | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −45 V | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 4.0 A | 4.0 A | 4.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 40 W |
| | Derate Linearly from 25°C | | | 0.32 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 3.12°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

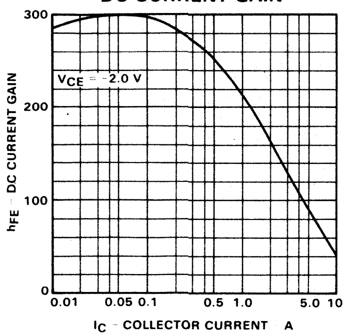
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6124 MIN | 2N6124 MAX | 2N6125 MIN | 2N6125 MAX | 2N6126 MIN | 2N6126 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| OFF CHARACTERISTICS | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −45 | | −60 | | −80 | | V | $I_C$ = 100 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE}$ = −45 V, $I_B$ = 0 |
| | | | | | 1.0 | | | mA | $V_{CE}$ = −60 V, $I_B$ = 0 |
| | | | | | | | 1.0 | mA | $V_{CE}$ = −80 V, $I_B$ = 0 |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CE}$ = −45 V, $V_{BE}$ = 1.5 V |
| | | | | | 0.1 | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 1.5 V |
| | | | | | | | 0.1 | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 1.5 V |
| | | | 2.0 | | | | | mA | $V_{CE}$ = −45 V, $V_{BE}$ = 1.5 V<br>$T_C$ = 125°C |
| | | | | | 2.0 | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 1.5 V<br>$T_C$ = 125°C |
| | | | | | | | 2.0 | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 1.5 V<br>$T_C$ = 125°C |
| $I_{CBO}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CB}$ = −45 V, $I_E$ = 0 |
| | | | | | 0.1 | | | mA | $V_{CB}$ = −60 V, $I_E$ = 0 |
| | | | | | | | 0.1 | mA | $V_{CB}$ = −80 V, $I_E$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = −5.0 V, $I_C$ = 0 |
| ON CHARACTERISTICS | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 25 | 100 | 25 | 100 | 20 | 80 | | $I_C$ = 1.5 A, $V_{CE}$ = −2.0 V |
| | | 10 | | 10 | | 7.0 | | | $I_C$ = 4.0 A, $V_{CE}$ = −2.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −0.6 | | −0.6 | | −0.6 | V | $I_C$ = 1.5 A, $I_B$ = 0.15 A |
| | | | −1.4 | | −1.4 | | −1.4 | V | $I_C$ = 4.0 A, $I_B$ = 1.0 A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.2 | | −1.2 | | −1.2 | V | $I_C$ = 1.5 A, $V_{CE}$ = −2.0 V |
| DYNAMIC CHARACTERISTICS | | | | | | | | | |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 2.5 | | 2.5 | | 2.5 | | | $I_C$ = 1.0 A, $V_{CE}$ = −4.0 V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | 25 | | | $I_C$ = 0.1 A, $V_{CE}$ = −2.0 V, f = 1.0 kHz |

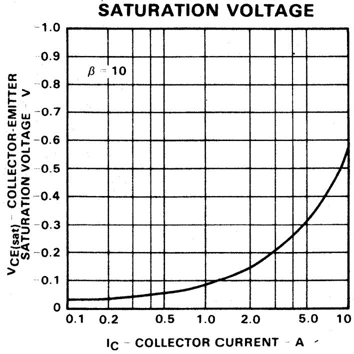
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS
## 2N6124 • 2N6125

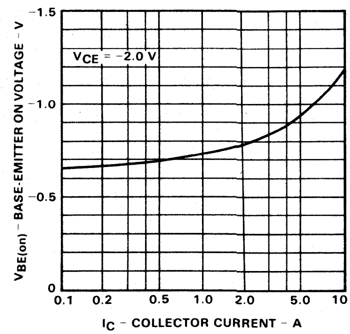
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE

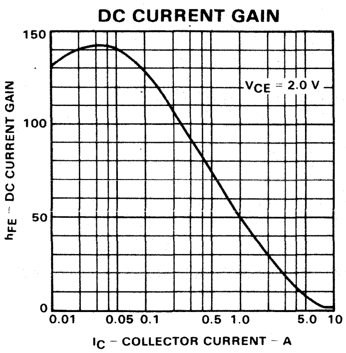


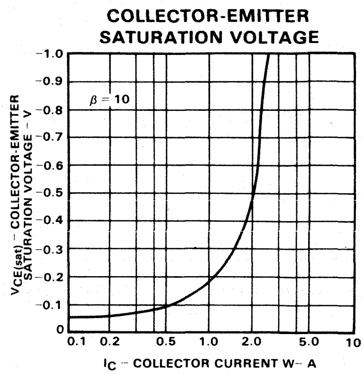

### BASE-EMITTER ON VOLTAGE

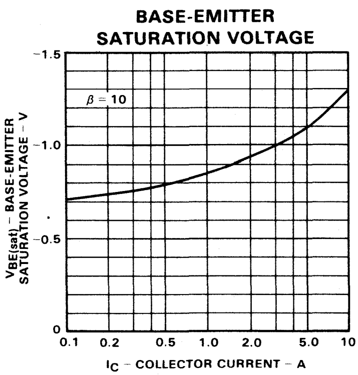


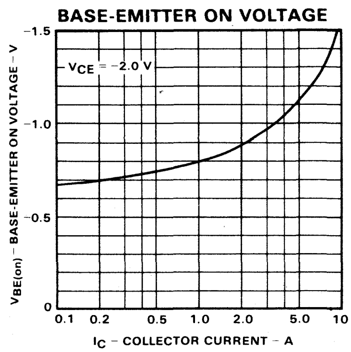
## TYPICAL ELECTRICAL CHARACTERISTICS (Cont'd)

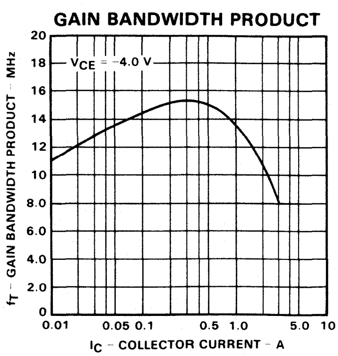
## 2N6126



# POWER TRANSISTOR

NPN SILICON

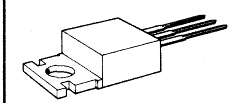
# 2N6129
# 2N6130
# 2N6131

## DESIGNED FOR GENERAL PURPOSE AMPLIFIER APPLICATIONS

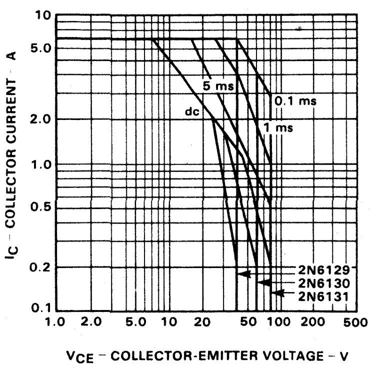
- **50 W DISSIPATION AT 25°C CASE**
- **7.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **20 TO 100 $h_{FE}$ AT $I_C$ 2.5 A**
- **COMPLEMENTS 2N6132, 2N6133, 2N6134**

### ABSOLUTE MAXIMUM RATINGS (Note 1)

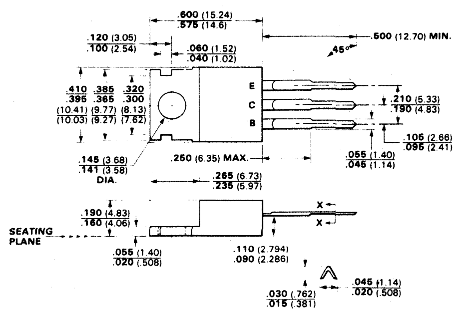
| **Maximum Voltages and Currents** | | **2N6129** | **2N6130** | **2N6131** |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 40 V | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 7.0 A | 7.0 A | 7.0 A |
| $I_B$ | Continuous Base Current | 3.0 A | 3.0 A | 3.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 50 W |
| | Derate Linearly from 25°C | | | 0.4 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 2.5°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

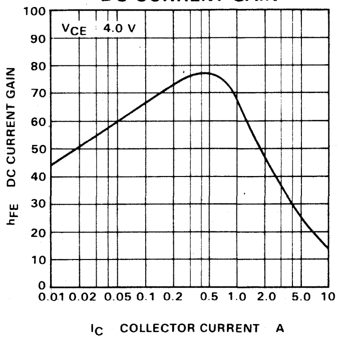
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6129 | | 2N6130 | | 2N6131 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 2.0 | | | | | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| | | | | | 2.0 | | | mA | $V_{CE} = 60$ V, $I_B = 0$ |
| | | | | | | | 2.0 | mA | $V_{CE} = 80$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.2 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.2 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | | | 0.2 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | 2.0 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V, $T_C = 125°$C |
| | | | | | 2.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 125°$C |
| | | | | | | | 2.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 125°$C |
| $I_{CBO}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CB} = 40$ V, $I_E = 0$ |
| | | | | | 0.5 | | | mA | $V_{CB} = 60$ V, $I_E = 0$ |
| | | | | | | | 0.5 | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20 | 100 | 20 | 100 | 20 | 100 | | $I_C = 2.5$ A, $V_{CE} = 4.0$ V |
| | | 7.0 | | 7.0 | | 5.0 | | | $I_C = 7.0$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.4 | | 1.4 | | 1.8 | V | $I_C = 7.0$ A, $I_B = 3.0$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.0 | | 2.0 | | 2.0 | V | $I_C = 2.5$ A, $V_{CE} = 4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 2.5 | | 2.5 | | 2.5 | | | $I_C = 1.0$ A, $V_{CE} = 4.0$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | 25 | | | $I_C = 0.1$ A, $V_{CE} = 4.0$ V, f = 1.0 kHz |

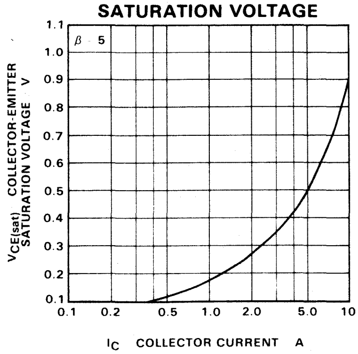
NOTE: 1. Pulse conditions: Length = 300 $\mu$s, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

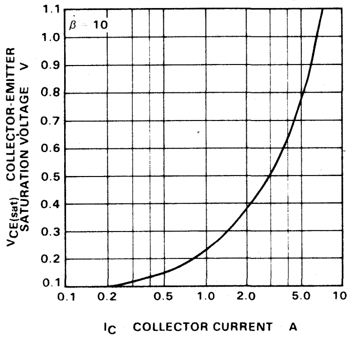
### DC CURRENT GAIN



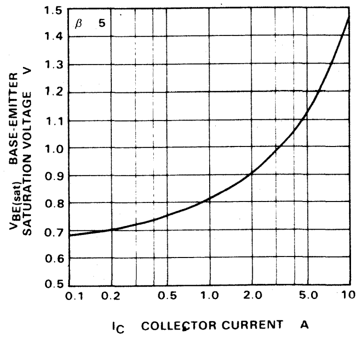

### COLLECTOR-EMITTER SATURATION VOLTAGE



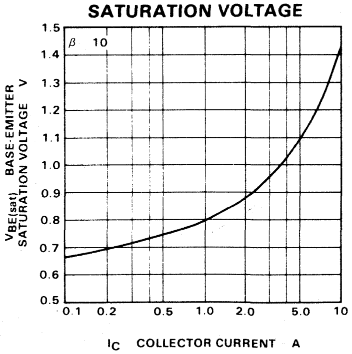

### COLLECTOR-EMITTER SATURATION VOLTAGE



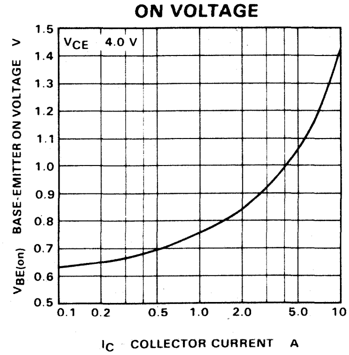

### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

## PNP SILICON

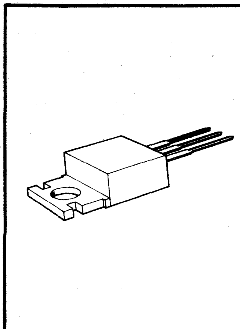
## 2N6132
## 2N6133
## 2N6134

### DESIGNED FOR GENERAL PURPOSE AMPLIFIER APPLICATIONS

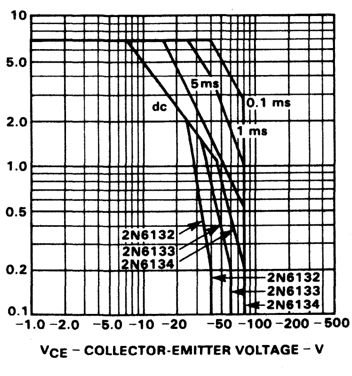
- 50 W DISSIPATION AT 25°C CASE
- 7 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 20 TO 100 $h_{FE}$ AT $I_C$ 2.5 A
- COMPLEMENTS 2N6129, 2N6130, 2N6131

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

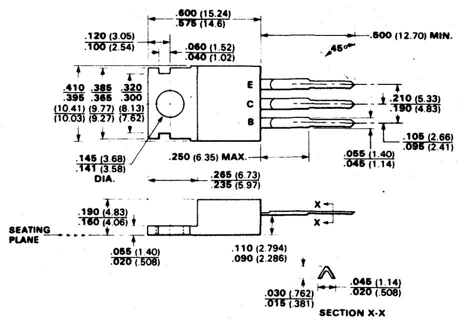
| Maximum Voltages and Currents | | 2N6132 | 2N6133 | 2N6134 |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | −40 V | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −40 V | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 7.0 A | 7.0 A | 7.0 A |
| $I_B$ | Continuous Base Current | 3.0 A | 3.0 A | 3.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 50 W |
| | Derate Linearly from 25°C | | | 0.4 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 2.5°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

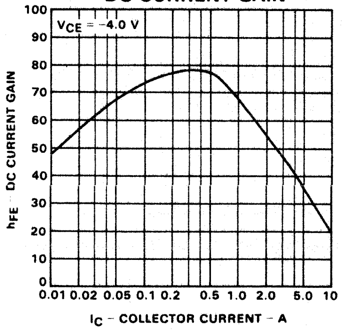
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6132 MIN | 2N6132 MAX | 2N6133 MIN | 2N6133 MAX | 2N6134 MIN | 2N6134 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| OFF CHARACTERISTICS | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −40 | | −60 | | −80 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 2.0 | | | | | mA | $V_{CE} = -40$ V, $I_B = 0$ |
| | | | | | 2.0 | | | mA | $V_{CE} = -60$ V, $I_B = 0$ |
| | | | | | | | 2.0 | mA | $V_{CE} = -80$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.2 | | | | | mA | $V_{CE} = -40$ V, $V_{BE} = 1.5$ V |
| | | | | | 0.2 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V |
| | | | | | | | 0.2 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V |
| | | 2.0 | | | | | | mA | $V_{CE} = -40$ V, $V_{BE} = 1.5$ V, $T_C = 125°C$ |
| | | | | | 2.0 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V, $T_C = 125°C$ |
| | | | | | | | 2.0 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V, $T_C = 125°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CB} = -40$ V, $I_E = 0$ |
| | | | | | 0.5 | | | mA | $V_{CB} = -60$ V, $I_E = 0$ |
| | | | | | | | 0.5 | mA | $V_{CB} = -80$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| ON CHARACTERISTICS | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20 | 100 | 20 | 100 | 20 | 100 | | $I_C = 2.5$ A, $V_{CE} = -4.0$ V |
| | | 7.0 | | 7.0 | | 5.0 | | | $I_C = 7.0$ A, $V_{CE} = -4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −1.4 | | −1.4 | | −1.8 | V | $I_C = 7.0$ A, $I_B = 3.0$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −2.0 | | −2.0 | | −2.0 | V | $I_C = 2.5$ A, $V_{CE} = -4.0$ V |
| DYNAMIC CHARACTERISTICS | | | | | | | | | |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 2.5 | | 2.5 | | 2.5 | | | $I_C = 1.0$ A, $V_{CE} = -4.0$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | 25 | | | $I_C = 0.1$ A, $V_{CE} = -4.0$ V, f = 1.0 kHz |

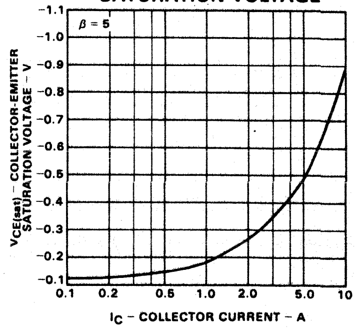
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle= 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

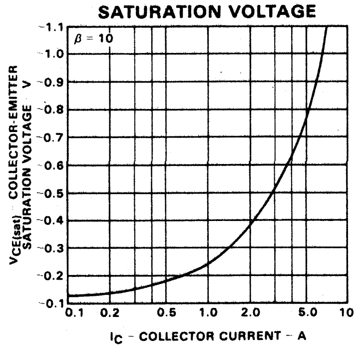
### DC CURRENT GAIN



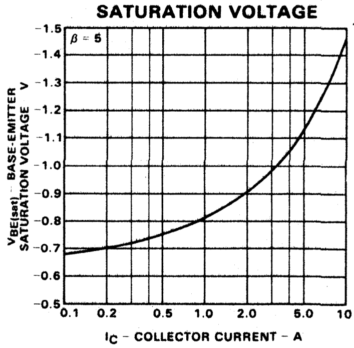

### COLLECTOR-EMITTER SATURATION VOLTAGE



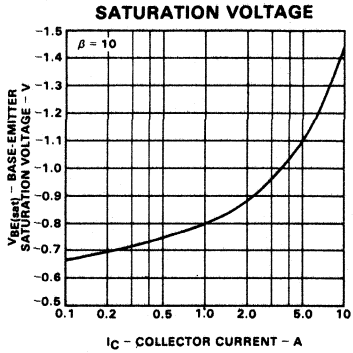

### COLLECTOR-EMITTER SATURATION VOLTAGE



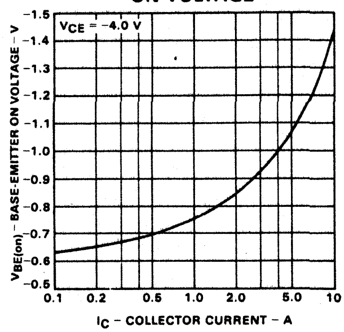

### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

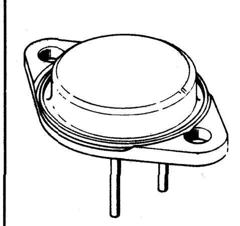
# 2N6249
# 2N6250
# 2N6251

### POWER SWITCHING TRANSISTOR FOR APPLICATIONS IN INDUSTRIAL AND COMMERCIAL EQUIPMENT

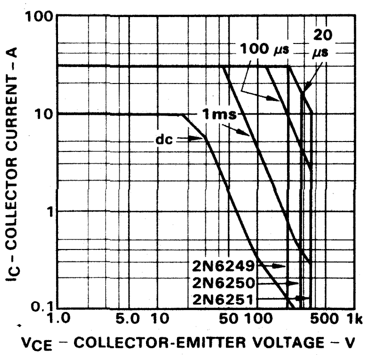
- *100 W DISSIPATION AT 25°C CASE*
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- EXCELLENT IN LINE OPERATED INVERTER AND SWITCHING REGULATOR APPLICATIONS

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

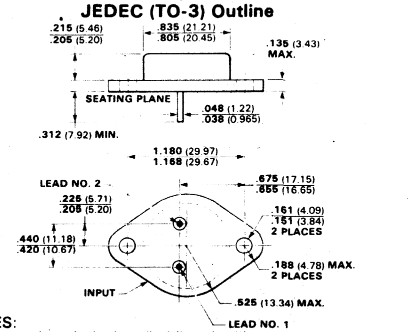
| | | 2N6249 | 2N6250 | 2N6251 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 200 V | 275 V | 350 V |
| $V_{CBO}$ | Collector to Base Voltage | 300 V | 375 V | 450 V |
| $V_{EBO}$ | Emitter to Base Voltage | 6.0 V | 6.0 V | 6.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A | 10 A |
| $I_C$ | Peak Collector Current | 30 A | 30 A | 30 A |
| $I_B$ | Continuous Base Current | 10 A | 10 A | 10 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 175 W |
| | Derate Linearly from 25°C | | | 1.0 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 1.0 °C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6249 MIN | 2N6249 MAX | 2N6250 MIN | 2N6250 MAX | 2N6251 MIN | 2N6251 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 200 | | 275 | | 350 | | V | $I_C$ = 200 mA, $I_B$ = 0 |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 225 | | 300 | | 375 | | V | $I_C$ = 200 mA, $R_{BE}$ = 50 Ω |
| $V_{EBO}$ | Emitter-Base Breakdown Voltage | 6.0 | | 6.0 | | 6.0 | | V | $I_E$ = 1.0 mA, $I_C$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 5.0 | | | | | mA | $V_{CE}$ = 150 V, $I_B$ = 0 |
| | | | | | 5.0 | | | mA | $V_{CE}$ = 225 V, $I_B$ = 0 |
| | | | | | | | 5.0 | mA | $V_{CE}$ = 300 V, $I_B$ = 0 |
| $I_{CEV}$ | Collector Cutoff Current | | 5.0 | | | | | mA | $V_{CE}$ = 225 V, $V_{BE}$ = −1.5 V |
| | | | | | 5.0 | | | mA | $V_{CE}$ = 300 V, $V_{BE}$ = −1.5 V |
| | | | | | | | 5.0 | mA | $V_{CE}$ = 375 V, $V_{BE}$ = −1.5 V |
| | | | 10 | | | | | mA | $V_{CE}$ = 225 V, $V_{BE}$ = −1.5 V, $T_C$ = 125°C |
| | | | | | 10 | | | mA | $V_{CE}$ = 300 V, $V_{BE}$ = −1.5 V, $T_C$ = 125°C |
| | | | | | | | 10 | mA | $V_{CE}$ = 375 V, $V_{BE}$ = −1.5 V, $T_C$ = 125°C |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = 6.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 10 | 50 | 8.0 | 50 | 6.0 | 50 | | $I_C$ = 10 A, $V_{CE}$ = 3.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.5 | | | | | V | $I_C$ = 10 A, $I_B$ = 1.0 A |
| | | | | | 1.5 | | | V | $I_C$ = 10 A, $I_B$ = 1.25 A |
| | | | | | | | 1.5 | V | $I_C$ = 10 A, $I_B$ = 1.67 A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 2.25 | | | | | V | $I_C$ = 10 A, $I_B$ = 1.0 A |
| | | | | | 2.25 | | | V | $I_C$ = 10 A, $I_B$ = 1.25 A |
| | | | | | | | 2.25 | V | $I_C$ = 10 A, $I_B$ = 1.67 A |
| **SECOND BREAKDOWN** | | | | | | | | | |
| $I_{S/b}$ | Second Breakdown Collector Current with base forward biased | 5.8 | | 5.8 | | 5.8 | | A | t = 1.0 s (non repetitive), $V_{CE}$ = 30 V |
| $E_{S/b}$ | Second Breakdown Energy with base reversed biased | 2.5 | | 2.5 | | 2.5 | | mJ | $I_C$ = 10 A, $V_{BE(off)}$ = −4.0 V, L = 50 μh, $R_B$ = 50 Ω |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $h_{fe}$ | Magnitude of Common Emitter Small Signal Current Gain | 2.5 | | 2.5 | | 2.5 | | | $I_C$ = 1.0 A, $V_{CE}$ = 10 V, f = 1.0 MHz |

NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

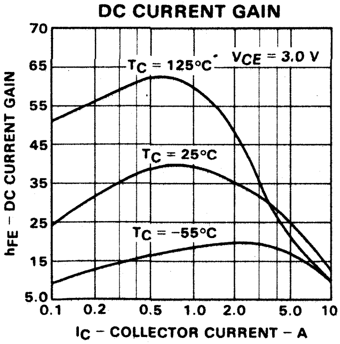
SWITCHING CHARACTERISTICS

RESISTIVE LOAD

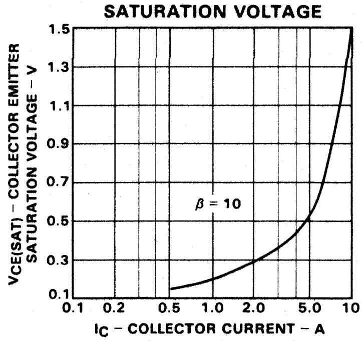
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $t_r$ | Rise Time | | 2.0 | | | | | μs | $V_{CC}$ = 200 V, $I_C$ = 10 A, $I_{B1}$ = 1.0 A, $t_p$ = 20 μs, Duty Cycle = 500 Hz |
| $t_s$<br>$t_f$ | Storage Time<br>Fall Time | | 3.5<br>1.0 | | | | | μs<br>μs | $V_{CC}$ = 200 V, $I_C$ = 10 A, $I_{B1}$ = $I_{B2}$ = 1.0 A, $t_p$ = 20 μs, Duty Cycle = 500 Hz |
| $t_r$ | Rise Time | | | | 2.0 | | | μs | $V_{CC}$ = 200 V, $I_C$ = 10 A, $I_{B1}$ = 1.25 A, $t_p$ = 20 μs, Duty Cycle = 500 Hz |
| $t_s$<br>$t_f$ | Storage Time<br>Fall Time | | | | 3.5<br>1.0 | | | μs<br>μs | $V_{CC}$ = 200 V, $I_C$ = 10 A, $I_{B1}$ = $I_{B2}$ = 1.25 A, $t_p$ = 20 μs, Duty Cycle = 500 Hz |
| $t_r$ | Rise Time | | | | | | 2.0 | μs | $V_{CC}$ = 200 V, $I_C$ = 10 A, $I_{B1}$ = 1.67 A, $t_p$ = 20 μs, Duty Cycle = 500 Hz |
| $t_s$<br>$t_f$ | Storage Time<br>Fall Time | | | | | | 3.5<br>1.0 | μs<br>μs | $V_{CC}$ = 200 V, $I_C$ = 10 A, $I_{B1}$ = $I_{B2}$ = 1.67 A, $t_p$ = 20 μs, Duty Cycle = 500 Hz |

## TYPICAL ELECTRICAL CHARACTERISTICS

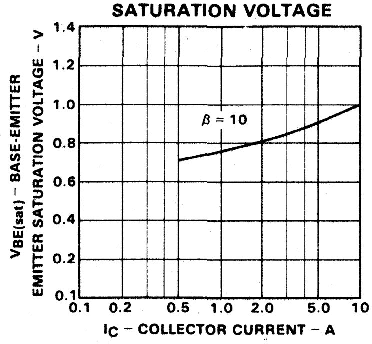
**DC CURRENT GAIN**



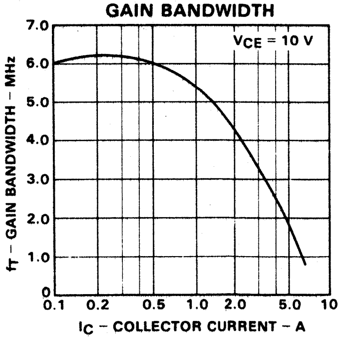

**COLLECTOR-EMITTER SATURATION VOLTAGE**



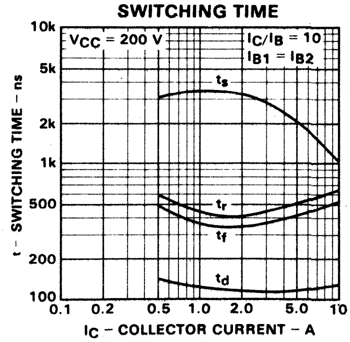

**BASE-EMITTER SATURATION VOLTAGE**




**GAIN BANDWIDTH**




**SWITCHING TIME**



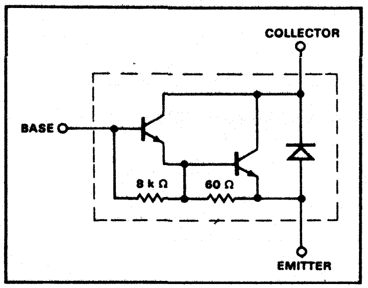
# POWER DARLINGTON

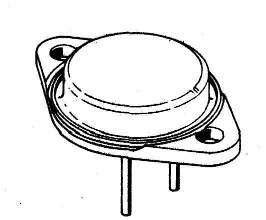
## NPN SILICON

**2N6282**
**2N6283**
**2N6284**

## DESIGNED FOR GENERAL PURPOSE AMPLIFIERS AND LOW SPEED SWITCHING APPLICATIONS

- 160 W DISSIPATION AT 25°C CASE
- 20 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- $h_{FE}$ TYPICAL OF 3000 AT 10 A
- COMPLEMENT TO 2N6285, 2N6286, 2N6287

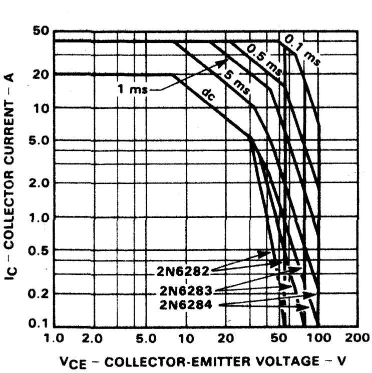


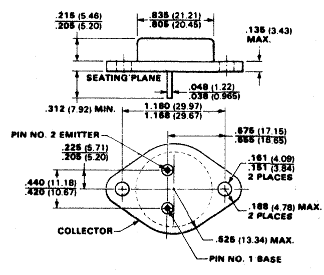
### ABSOLUTE MAXIMUM RATINGS

| Maximum Voltages and Currents | | 2N6282 | 2N6283 | 2N6284 |
|---|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | 60 V | 80 V | 100 V |
| $V_{CB}$ | Collector to Base Voltage | 60 V | 80 V | 100 V |
| $V_{EB}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 20 A | 20 A | 20 A |
| $I_C$ | Peak Collector Current | 40 A | 40 A | 40 A |
| $I_B$ | Continuous Base Current | 0.5 A | 0.5 A | 0.5 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 160 W |
| | *Derate Linearly from 25°C* | | | 0.92 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 1.09 °C/W |

**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

# FAIRCHILD 2N6282 • 2N6283 • 2N6284

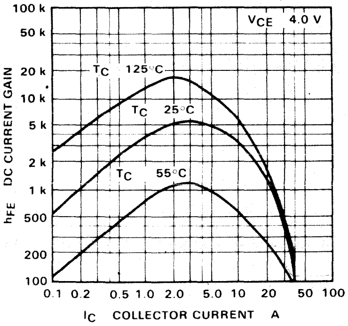
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6282 MIN | 2N6282 MAX | 2N6283 MIN | 2N6283 MAX | 2N6284 MIN | 2N6284 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | 100 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 50$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.5 | | | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | | | | | 0.5 | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V |
| | | | 5.0 | | | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | | | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | | | 5.0 | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 2.0 | | 2.0 | | 2.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 750 | 18 k | 750 | 18 k | 750 | 18 k | | $I_C = 10$ A, $V_{CE} = 3.0$ V |
| | | 100 | | 100 | | 100 | | | $I_C = 30$ A, $V_{CE} = 3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 2.0 | | 2.0 | | 2.0 | V | $I_C = 10$ A, $I_B = 40$ mA |
| | | | 3.0 | | 3.0 | | 3.0 | V | $I_C = 20$ A, $I_B = 200$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 4.0 | | 4.0 | | 4.0 | V | $I_C = 20$ A, $I_B = 200$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.8 | | 2.8 | | 2.8 | V | $I_C = 10$ A, $V_{CE} = 3.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 400 | | 400 | | 400 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 4.0 | | 4.0 | | 4.0 | | | $I_C = 10$ A, $V_{CE} = 3.0$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 300 | | 300 | | 300 | | | $I_C = 10$ A, $V_{CE} = 3.0$ V, f = 1.0 kHz |

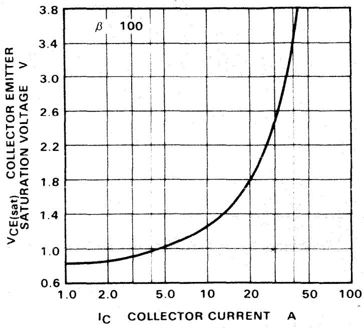
NOTE: 1. Pulse conditions: Length = 300 $\mu$s, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

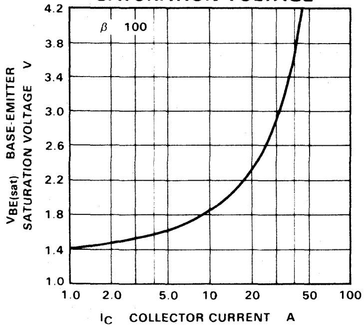
### DC CURRENT GAIN



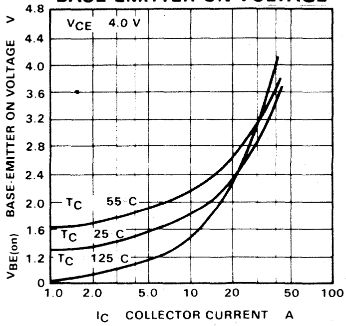

### COLLECTOR-EMITTER SATURATION VOLTAGE



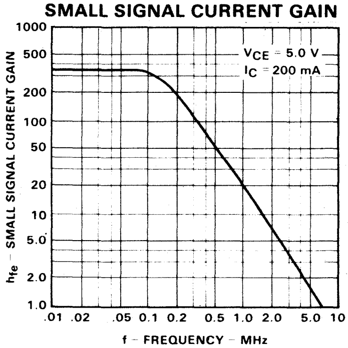

### BASE-EMITTER SATURATION VOLTAGE



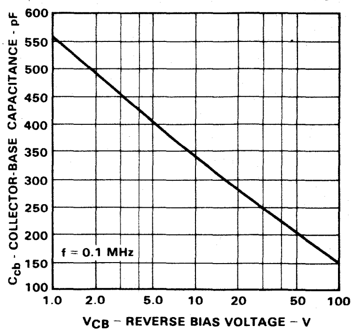

### BASE-EMITTER ON VOLTAGE




### SMALL SIGNAL CURRENT GAIN




### COLLECTOR-BASE CAPACITANCE



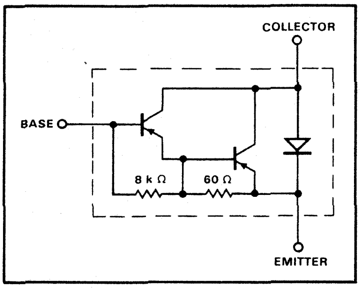
# POWER DARLINGTON

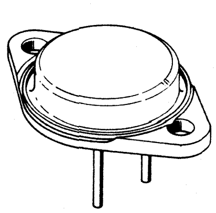
## PNP SILICON

# 2N6285
# 2N6286
# 2N6287

### DESIGNED FOR GENERAL PURPOSE AMPLIFIER AND LOW SPEED SWITCHING APPLICATIONS

- 160 W DISSIPATION AT 25°C CASE
- 20 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- $h_{FE}$ TYPICAL OF 3000 AT 10 A
- COMPLEMENT TO 2N6282, 2N6283, 2N6284



**ABSOLUTE MAXIMUM RATINGS**

| Maximum Voltages and Currents | | 2N6285 | 2N6286 | 2N6287 |
|---|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | −60 V | −80 V | −100 V |
| $V_{CB}$ | Collector to Base Voltage | −60 V | −80 V | −100 V |
| $V_{EB}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 20 A | 20 A | 20 A |
| $I_C$ | Peak Collector Current | 40 A | 40 A | 40 A |
| $I_B$ | Continuous Base Current | 0.5 A | 0.5 A | 0.5 A |

**Maximum Power Dissipation**

| | | |
|---|---|---|
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 160 W |
| | Derate Linearly from 25°C | 0.92 W/°C |

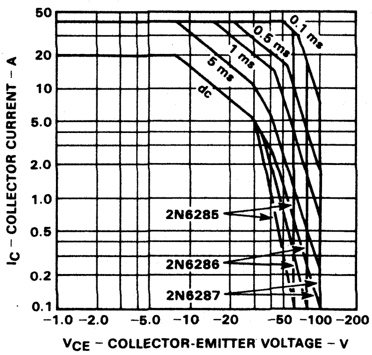
**Maximum Temperatures**

| | | |
|---|---|---|
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +200°C |

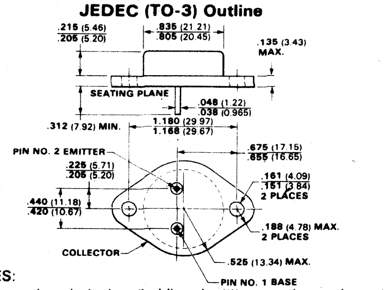
**Thermal Characteristics**

| | | |
|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.09°C/W |

**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

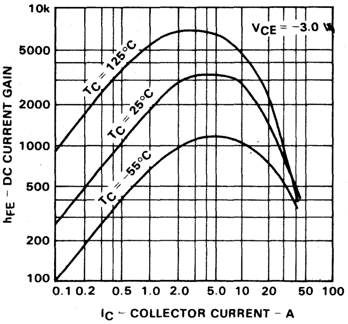
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6285 MIN | 2N6285 MAX | 2N6286 MIN | 2N6286 MAX | 2N6287 MIN | 2N6287 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | −80 | | −100 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = -30$ V, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = -40$ V, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = -50$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V |
| | | | | | 0.5 | | | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V |
| | | | | | | | 0.5 | mA | $V_{CE} = -100$ V, $V_{BE} = 1.5$ V |
| | | | 5.0 | | | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | | | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | | | 5.0 | mA | $V_{CE} = -100$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 2.0 | | 2.0 | | 2.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 750 | 18 k | 750 | 18 k | 750 | 18 k | | $I_C = 10$ A, $V_{CE} = -3.0$ V |
| | | 100 | | 100 | | 100 | | | $I_C = 20$ A, $V_{CE} = -3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −2.0 | | −2.0 | | −2.0 | V | $I_C = 10$ A, $I_B = 40$ mA |
| | | | −3.0 | | −3.0 | | −3.0 | V | $I_C = 20$ A, $I_B = 200$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −4.0 | | −4.0 | | −4.0 | V | $I_C = 20$ A, $I_B = 200$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −2.8 | | −2.8 | | −2.8 | V | $I_C = 10$ A, $V_{CE} = -3.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 600 | | 600 | | 600 | pF | $V_{CB} = -10$ V, $I_E = 0$, f = 0.1 MHz |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 4.0 | | 4.0 | | 4.0 | | | $I_C = 10$ A, $V_{CE} = -3.0$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 300 | | 300 | | 300 | | | $I_C = 10$ A, $V_{CE} = -3.0$ V, f = 1.0 kHz |

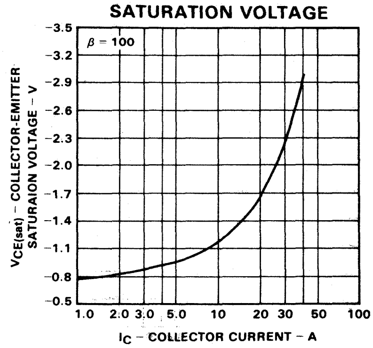
NOTE: 1. Pulse conditions: Length = 300 $\mu$s, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

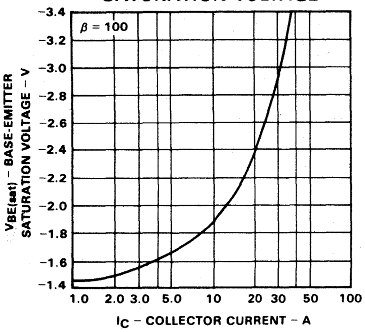
### DC CURRENT GAIN



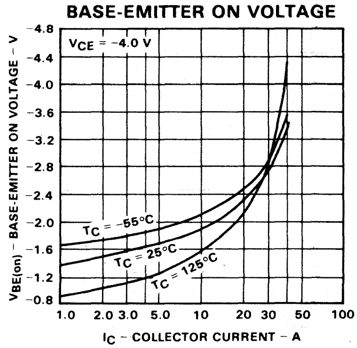

### COLLECTOR-EMITTER SATURATION VOLTAGE



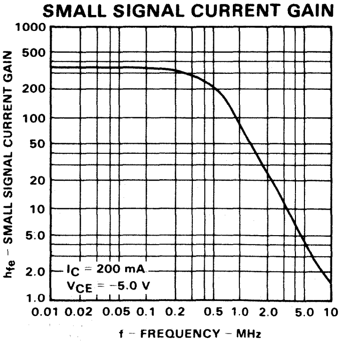

### BASE-EMITTER SATURATION VOLTAGE



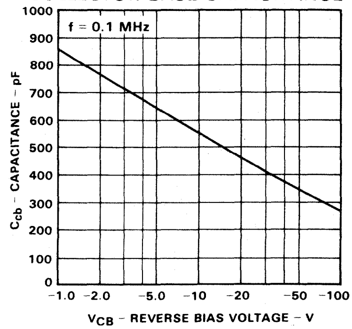

### BASE-EMITTER ON VOLTAGE




### SMALL SIGNAL CURRENT GAIN




### COLLECTOR-BASE CAPACITANCE



# POWER TRANSISTOR

## NPN SILICON

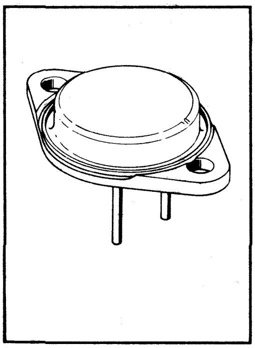
# 2N6306
# 2N6307M
# 2N6308M

## POWER TRANSISTOR DESIGNED FOR HIGH VOLTAGE INVERTERS, SWITCHING REGULATORS AND LINE-OPERATED AMPLIFIER APPLICATIONS

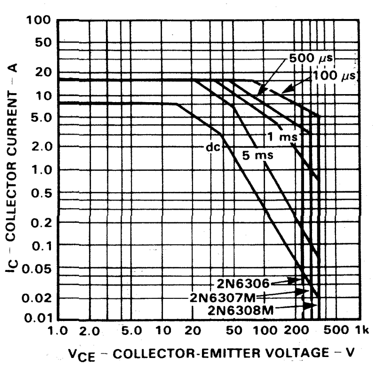
- 125 W DISSIPATION AT 25°C CASE
- 8.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

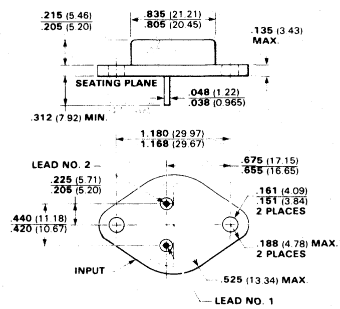
| Maximum Voltages and Currents | | 2N6306 | 2N6307M | 2N6308M |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 250 V | 300 V | 350 V |
| $V_{CBO}$ | Collector to Base Voltage | 500 V | 450 V | 500 V |
| $V_{EBO}$ | Emitter to Base Voltage | 8.0 V | 8.0 V | 8.0 V |
| $I_C$ | Continuous Collector Current | 8.0 A | 8.0 A | 8.0 A |
| $I_C$ | Peak Collector Current | 16 A | 16 A | 16 A |
| $I_B$ | Continuous Base Current | 4.0 A | 4.0 A | 4.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 125 W |
| | Derate Linearly from 25°C | | | 0.714 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 1.4°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10s) | | | 235°C |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

# FAIRCHILD • 2N6306 • 2N6307M • 2N6308M

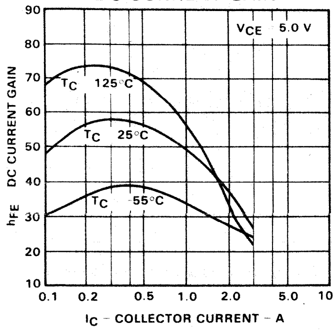
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6306 | | 2N6307M | | 2N6308M | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 250 | | 300 | | 350 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE} = 250$ V, $I_B = 0$ |
| | | | | | 0.5 | | | mA | $V_{CE} = 300$ V, $I_B = 0$ |
| | | | | | | | 0.5 | mA | $V_{CE} = 350$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE} = 500$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.5 | | | mA | $V_{CE} = 450$ V, $V_{BE} = -1.5$ V |
| | | | | | | | 0.5 | mA | $V_{CE} = 500$ V, $V_{BE} = -1.5$ V |
| | | | 2.5 | | | | | mA | $V_{CE} = 450$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 2.5 | | | mA | $V_{CE} = 450$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | | | 2.5 | mA | $V_{CE} = 500$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = 8.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 15 | 75 | 15 | 75 | 12 | 60 | | $I_C = 3.0$ A, $V_{CE} = 5.0$ V |
| | | 4.0 TYP | | 4.0 TYP | | 3.0 TYP | | | $I_C = 8.0$ A, $V_{CE} = 5.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.8 | | 1.0 | | 1.5 | V | $I_C = 3.0$ A, $I_B = 0.6$ A |
| | | | 5.0 | | 5.0 | | | V | $I_C = 8.0$ A, $I_B = 2.0$ A |
| | | | | | | | 5.0 | V | $I_C = 8.0$ A, $I_B = 2.67$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 2.3 | | 2.3 | | | V | $I_C = 8.0$ A, $I_B = 2.0$ A |
| | | | | | | | 2.5 | V | $I_C = 8.0$ A, $I_B = 2.67$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.3 | | 1.3 | | 1.5 | V | $I_C = 3.0$ A, $V_{CE} = 5.0$ V |
| **SECOND BREAKDOWN** | | | | | | | | | |
| $E_{S/b}$ | Second Breakdown Energy with base reversed biased | | 180 | | 180 | | 180 | mJ | $I_C = 3.0$ A, $V_{BE(off)} = -1.5$ V, L = 40 mH, $R_{BE} = 3.0$ kΩ |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 5.0 | | 5.0 | | 5.0 | | MHz | $I_C = 0.3$ A, $V_{CE} = 10$ V, f = 1.0 MHz |
| $C_{ob}$ | Output Capacitance | | 250 | | 250 | | 250 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | | | |
| $t_r$ | Rise Time | | 0.6 | | 0.6 | | 0.6 | μs | $V_{CC} = 125$ V, $I_C = 3.0$ A, $I_{B1} = 0.6$ A, $t_p = 25$ μs |
| $t_s$ | Storage Time @ PW 25 μs | | 1.6 | | 1.6 | | 1.6 | μs | $V_{CC} = 125$ V, $I_C = 3.0$ A, |
| | @ PW 5.0 μs | | 0.8 | | 0.8 | | 0.8 | μs | $I_{B1} = 0.6$ A, $I_{B2} = 1.5$ A |
| $t_f$ | Fall Time | | 0.4 | | 0.4 | | 0.4 | μs | $t_p = 25$ μs |

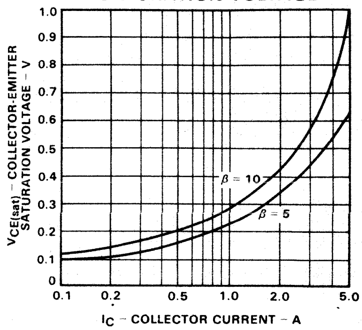
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

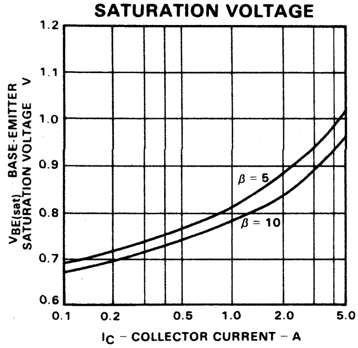
### DC CURRENT GAIN



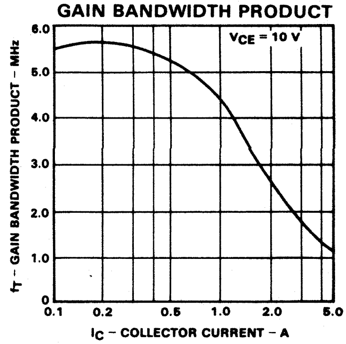

### COLLECTOR-EMITTER SATURATION VOLTAGE



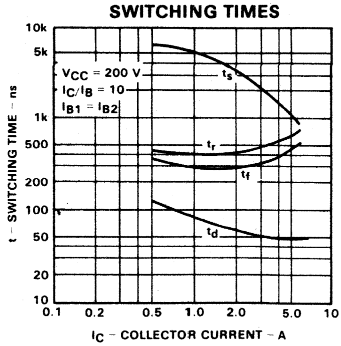

### BASE-EMITTER SATURATION VOLTAGE




### GAIN BANDWIDTH PRODUCT




### SWITCHING TIMES



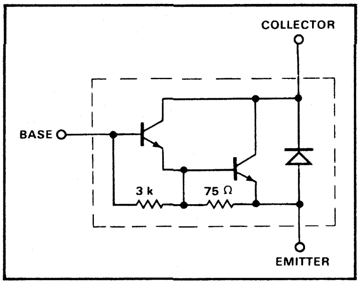
# POWER DARLINGTON

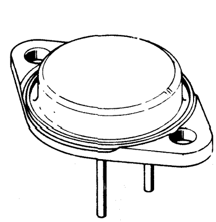
## NPN SILICON

# 2N6383
# 2N6384
# 2N6385

### A GENERAL PURPOSE DARLINGTON FOR USE IN POWER SWITCHING, HAMMER DRIVER AND SERIES AND SHUNT REGULATOR APPLICATIONS

- ***100 W DISSIPATION AT 25°C CASE***
- **10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **GOOD SECOND BREAKDOWN CAPABILITY**
- **HIGH DC CURRENT GAIN**



### ABSOLUTE MAXIMUM RATINGS

**Maximum Voltages and Currents**

| | | 2N6383 | 2N6384 | 2N6385 |
|---|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V |
| $V_{CB}$ | Collector to Base Voltage | 40 V | 60 V | 80 V |
| $V_{EB}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A | 10 A |
| $I_C$ | Peak Collector Current | 15 A | 15 A | 15 A |
| $I_B$ | Continuous Base Current | 0.25 A | 0.25 A | 0.25 A |

**Maximum Power Dissipation**

| | | |
|---|---|---|
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 100 W |
| | Derate Linearly from 25°C | 0.57 W/°C |

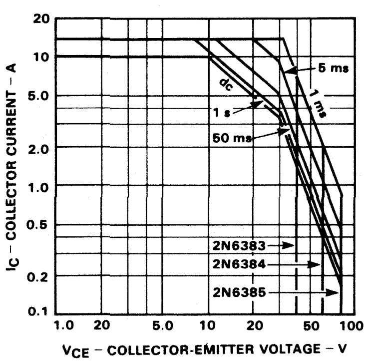
**Maximum Temperatures**

| | | |
|---|---|---|
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +200°C |

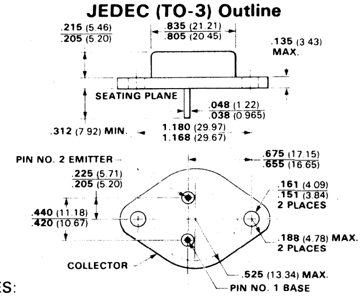
**Thermal Characteristics**

| | | |
|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.75 °C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10 s) | 235°C |

**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

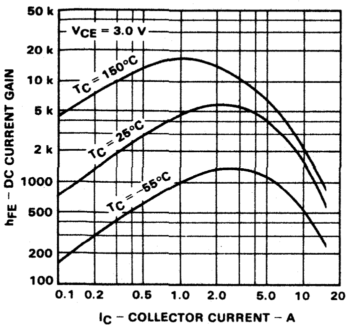
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6383 MIN | 2N6383 MAX | 2N6384 MIN | 2N6384 MAX | 2N6385 MIN | 2N6385 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 200$ mA, $R_{BE} = 100\ \Omega$ |
| $V_{CEV(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 200$ mA, $V_{BE(off)} = -1.5$ V |
| $V_F$ | Parallel Diode Forward Voltage Drop | | 4.0 | | 4.0 | | 4.0 | V | $I_C = -10$ A |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 60$ V, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 80$ V, $I_B = 0$ |
| | | | 10 | | | | | mA | $V_{CE} = 40$ V, $I_B = 0$, $T_C = 150°C$ |
| | | | | | 10 | | | mA | $V_{CE} = 60$ V, $I_B = 0$, $T_C = 150°C$ |
| | | | | | | | 10 | mA | $V_{CE} = 80$ V, $I_B = 0$, $T_C = 150°C$ |
| $I_{CEV}$ | Collector Cutoff Current | | 0.3 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.3 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | | | 0.3 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | 3.0 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 3.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | | | 3.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | | 5.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 1 k | 20 k | 1 k | 20 k | 1 k | 20 k | | $I_C = 5.0$ A, $V_{CE} = 3.0$ V |
| | | 100 | | 100 | | 100 | | | $I_C = 10$ A, $V_{CE} = 3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 2.0 | | 2.0 | | 2.0 | V | $I_C = 5.0$ A, $I_B = 10$ mA |
| | | | 3.0 | | 3.0 | | 3.0 | V | $I_C = 10$ A, $I_B = 100$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.8 | | 2.8 | | 2.8 | V | $I_C = 5.0$ A, $V_{CE} = 3.0$ V |
| | | | 4.5 | | 4.5 | | 4.5 | V | $I_C = 10$ A, $V_{CE} = 3.0$ V |
| **SECOND BREAKDOWN** | | | | | | | | | |
| $I_{S/b}$ | Second Breakdown Collector Current with Base Forward Biased | 2.85 | | | | | | A | $V_{CE} = 35$ V, t = 1.0 s (non repetitive) |
| | | | | 0.62 | | | | A | $V_{CE} = 55$ V, t = 1.0 s (non repetitive) |
| | | | | | | 0.22 | | A | $V_{CE} = 75$ V, t = 1.0 s (non repetitive) |
| $E_{S/b}$ | Second Breakdown Energy with Base Reversed Biased | 120 | | 120 | | 120 | | mj | $I_C = 4.5$ A, $V_{BE(off)} = -1.5$ V, L = 12 mH |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 200 | | 200 | | 200 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Short Circuit Forward Current Transfer Ratio | 20 | | 20 | | 20 | | | $I_C = 1.0$ A, $V_{CE} = 5.0$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 1 k | | 1 k | | 1 k | | | $I_C = 1.0$ A, $V_{CE} = 5.0$ V, f = 1.0 kHz |

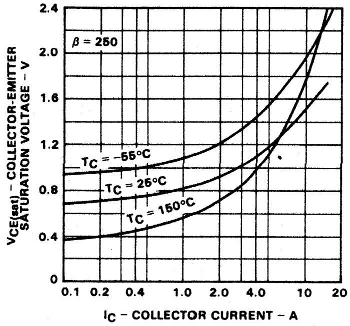
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

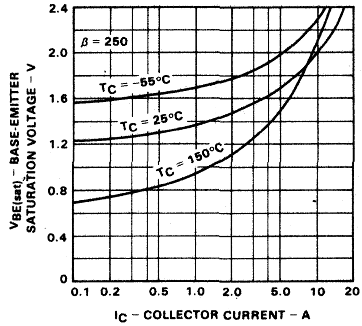
### DC CURRENT GAIN



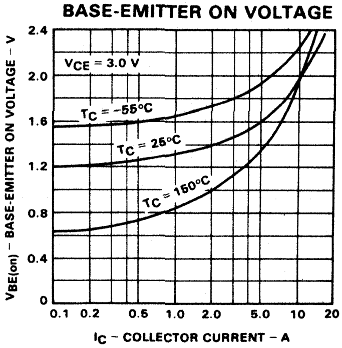

### COLLECTOR-EMITTER SATURATION VOLTAGE



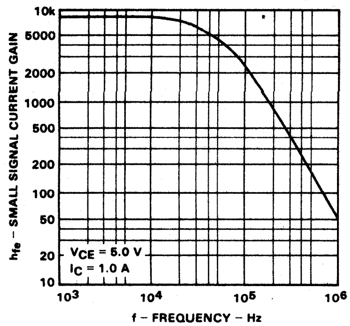

### BASE-EMITTER SATURATION VOLTAGE



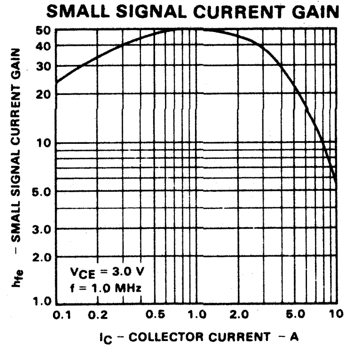

### BASE-EMITTER ON VOLTAGE



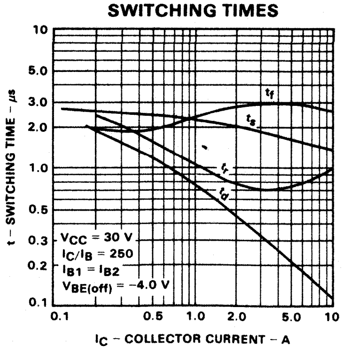

### SMALL SIGNAL CURRENT GAIN



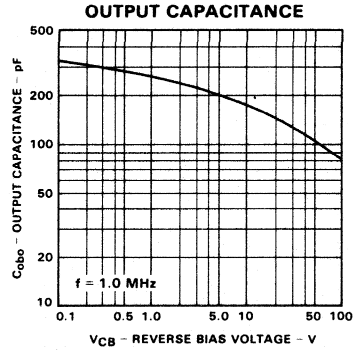

### SMALL SIGNAL CURRENT GAIN




### SWITCHING TIMES




### OUTPUT CAPACITANCE



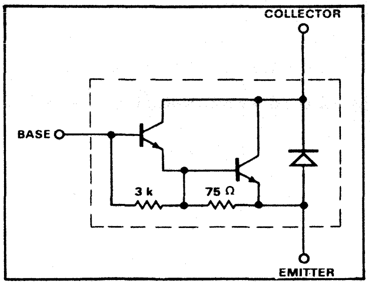
# POWER DARLINGTON

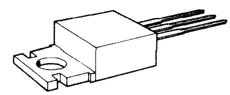
## NPN SILICON

# 2N6386
# 2N6387
# 2N6388

### DESIGNED FOR USE IN POWER SWITCHING, HAMMER DRIVER AND SERIES AND SHUNT REGULATOR APPLICATIONS

- 40 W DISSIPATION AT 25°C CASE
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- GOOD SECOND BREAKDOWN CAPABILITY
- HIGH DC CURRENT GAIN



### ABSOLUTE MAXIMUM RATINGS

**Maximum Voltages and Currents**

| | | 2N6386 | 2N6387 | 2N6388 |
|---|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V |
| $V_{CB}$ | Collector to Base Voltage | 40 V | 60 V | 80 V |
| $V_{EB}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A | 10 A |
| $I_C$ | Peak Collector Current | 15 A | 15 A | 15 A |
| $I_B$ | Continuous Base Current | 0.25 A | 0.25 A | 0.25 A |

**Maximum Power Dissipation**

| | | |
|---|---|---|
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 40 W |
| | Derate Linearly from 25°C | 0.32 W/°C |

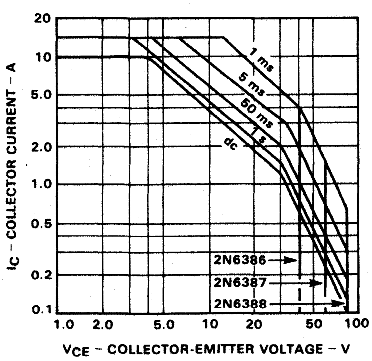
**Maximum Temperatures**

| | | |
|---|---|---|
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +150°C |

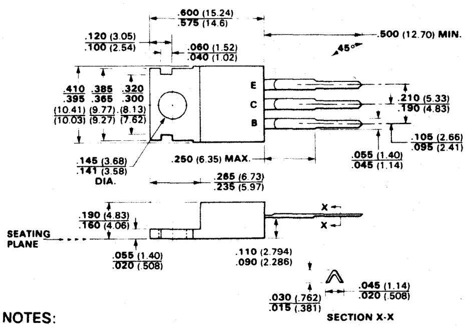
**Thermal Characteristics**

| | | |
|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 3.1 °C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 5 s) | 235°C |

**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline***




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
*Available in various pin configurations

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6386 | | 2N6387 | | 2N6388 | | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 200$ mA, $R_{BE} = 100\ \Omega$ |
| $V_{CEV(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C = 200$ mA, $V_{BE(off)} = -1.5$ V |
| $V_F$ | Parallel Diode Forward Voltage Drop | | 4.0 | | | | | V | $I_C = -8.0$ A |
| | | | | | 4.0 | | 4.0 | V | $I_C = -10$ A |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| | | | | | 1.0 | | | mA | $V_{CE} = 60$ V, $I_B = 0$ |
| | | | | | | | 1.0 | mA | $V_{CE} = 80$ V, $I_B = 0$ |
| | | | 10 | | | | | mA | $V_{CE} = 40$ V, $I_B = 0$, $T_C = 150°C$ |
| | | | | | 10 | | | mA | $V_{CE} = 60$ V, $I_B = 0$, $T_C = 150°C$ |
| | | | | | | | 10 | mA | $V_{CE} = 80$ V, $I_B = 0$, $T_C = 150°C$ |
| $I_{CEV}$ | Collector Cutoff Current | | 0.3 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.3 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | | | | | 0.3 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | 3.0 | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 3.0 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | | | 3.0 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | | 5.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 1 k | 20 k | | | | | | $I_C = 3.0$ A, $V_{CE} = 3.0$ V |
| | | | | 1 k | 20 k | 1 k | 20 k | | $I_C = 5.0$ A, $V_C = 3.0$ V |
| | | 100 | | | | | | | $I_C = 8.0$ A, $V_{CE} = 3.0$ V |
| | | | | 100 | | 100 | | | $I_C = 10$ A, $V_{CE} = 3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 2.0 | | | | | V | $I_C = 3.0$ A, $I_B = 6.0$ mA |
| | | | | | 2.0 | | 2.0 | V | $I_C = 5.0$ A, $I_B = 10$ mA |
| | | | 3.0 | | | | | V | $I_C = 8.0$ A, $I_B = 80$ mA |
| | | | | | 3.0 | | 3.0 | V | $I_C = 10$ A, $I_B = 100$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.8 | | | | | V | $I_C = 3.0$ A, $V_{CE} = 3.0$ V |
| | | | | | 2.8 | | 2.8 | V | $I_C = 5.0$ A, $V_{CE} = 3.0$ V |
| | | | 4.5 | | | | | V | $I_C = 8.0$ A, $V_{CE} = 3.0$ V |
| | | | | | 4.5 | | 4.5 | V | $I_C = 10$ A, $V_{CE} = 3.0$ V |
| **SECOND BREAKDOWN** | | | | | | | | | |
| $I_{S/b}$ | Second Breakdown Collector Current with Base Forward Biased | 1.2 | | 1.2 | | 1.2 | | A | $V_{CE} = 35$ V<br>t = 1.0 s (non repetitive) |
| $E_{S/b}$ | Second Breakdown Energy with Base Reversed Biased | 120 | | 120 | | 120 | | mj | $I_C = 4.5$ A, $V_{BE(off)} = -1.5$ V, L = 12 mH |

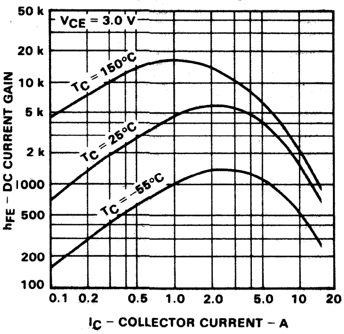
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted) (Cont'd)

| SYMBOL | CHARACTERISTIC | 2N6386 MIN | 2N6386 MAX | 2N6387 MIN | 2N6387 MAX | 2N6388 MIN | 2N6388 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $C_{ob}$ | Output Capacitance | | 200 | | 200 | | 200 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 0.1 MHz |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Short Circuit Forward Current Transfer Ratio | 20 | | 20 | | 20 | | | $I_C = 1.0$ A, $V_{CE} = 5.0$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 1 k | | 1 k | | 1 k | | | $I_C = 1.0$ A, $V_{CE} = 5.0$ V, f = 1.0 kHz |

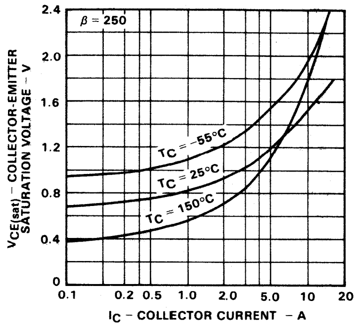
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

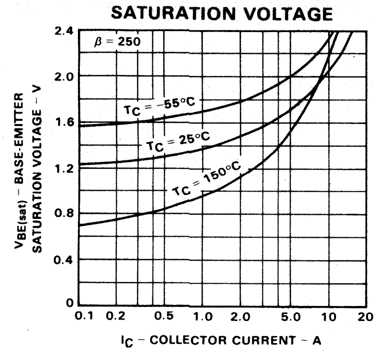
### DC CURRENT GAIN



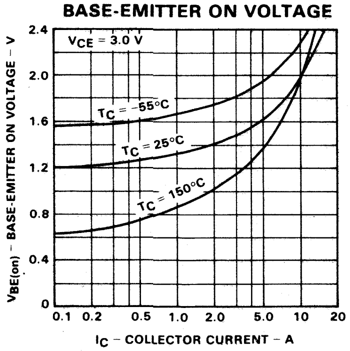

### COLLECTOR-EMITTER SATURATION VOLTAGE



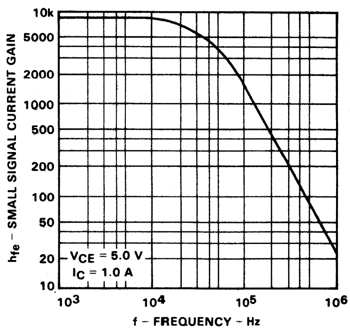

### BASE-EMITTER SATURATION VOLTAGE



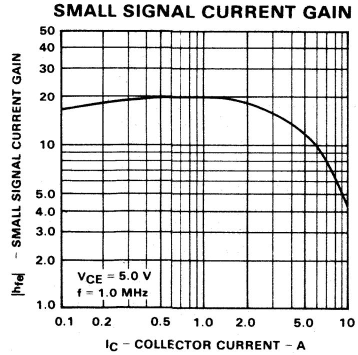

### BASE-EMITTER ON VOLTAGE



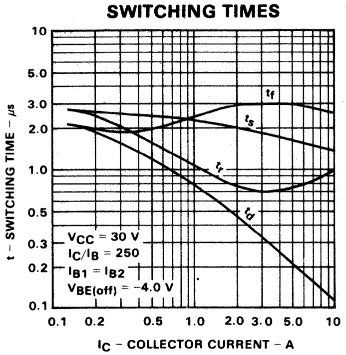

### SMALL SIGNAL CURRENT GAIN



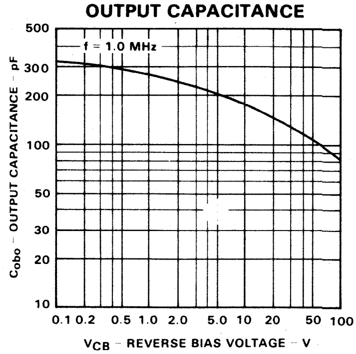

### SMALL SIGNAL CURRENT GAIN




### SWITCHING TIMES




### OUTPUT CAPACITANCE



# POWER TRANSISTOR

## NPN SILICON

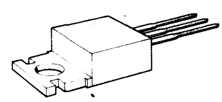
# 2N6473
# 2N6474

## GENERAL PURPOSE MEDIUM POWER TRANSISTORS FOR SWITCHING AND AMPLIFIER APPLICATIONS

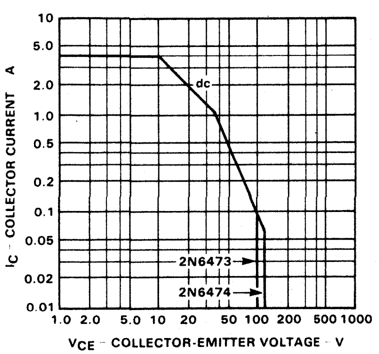
- 40 W DISSIPATION AT 25°C CASE
- 4 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- LOW SATURATION VOLTAGES
- COMPLEMENTS TO 2N6475, 2N6476

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

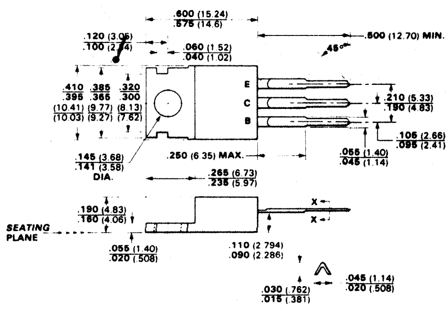
| | | 2N6473 | 2N6474 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 100 V | 120 V |
| $V_{CBO}$ | Collector to Base Voltage | 110 V | 130 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current (≤106°C Case) | 4.0 A | 4.0 A |
| $I_B$ | Continuous Base Current (≤130°C Case) | 2.0 A | 2.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 40 W |
| | Derate Linearly from 25°C | | 0.32 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +150°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 3.125°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10 s) | | 235°C |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

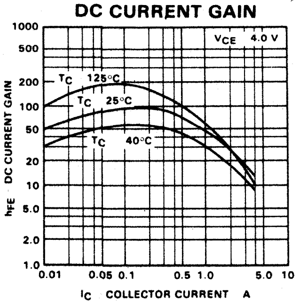
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6473 MIN | 2N6473 MAX | 2N6474 MIN | 2N6474 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 100 | | 120 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 110 | | 130 | | V | $I_C = 100$ mA, $R_{BE} = 100\ \Omega$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CE} = 50$ V, $I_B = 0$ |
| | | | | | 1.0 | mA | $V_{CE} = 60$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V |
| | | | | | 0.1 | mA | $V_{CE} = 120$ V, $V_{BE} = -1.5$ V |
| | | | 2.0 | | | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V, $T_C = 100°C$ |
| | | | | | 2.0 | mA | $V_{CE} = 120$ V, $V_{BE} = -1.5$ V, $T_C = 100°C$ |
| $I_{CER}$ | Collector Cutoff Current | | 0.1 | | | mA | $V_{CE} = 100$ V, $R_{BE} = 100\ \Omega$ |
| | | | | | 0.1 | mA | $V_{CE} = 120$ V, $R_{BE} = 100\ \Omega$ |
| | | | 2.0 | | | mA | $V_{CE} = 100$ V, $R_{BE} = 100\ \Omega$ $T_C = 100°C$ |
| | | | | | 2.0 | mA | $V_{CE} = 120$ V, $R_{BE} = 100\ \Omega$ $T_C = 100°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 15 | 150 | 15 | 150 | | $I_C = 1.5$ A, $V_{CE} = 4.0$ V |
| | | 2.0 | | 2.0 | | | $I_C = 4.0$ A, $V_{CE} = 2.5$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.2 | | 1.2 | V | $I_C = 1.5$ A, $I_B = 0.15$ A |
| | | | 2.5 | | 2.5 | V | $I_C = 4.0$ A, $I_B = 2.0$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.0 | | 2.0 | V | $I_C = 1.5$ A, $V_{CE} = 4.0$ V |
| | | | 3.5 | | 3.5 | V | $I_C = 4.0$ A, $V_{CE} = 2.5$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 4.0 | | 4.0 | | MHz | $I_C = 0.5$ A, $V_{CE} = 4.0$ V |
| $C_{ob}$ | Output Capacitance | | 250 | | 250 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 4.0 | | 4.0 | | | $I_C = 0.5$ A, $V_{CE} = 4.0$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | | $I_C = 0.5$ A, $V_{CE} = 4.0$ V, f = 50 kHz |

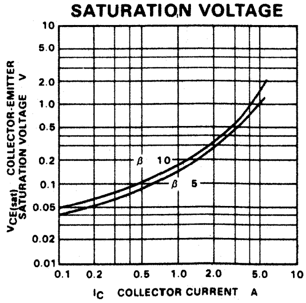
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

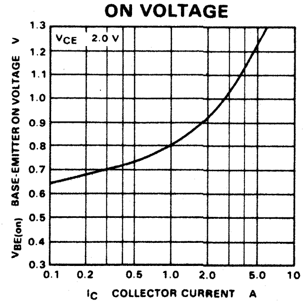
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

PNP SILCON

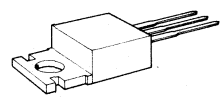
# 2N6475
# 2N6476

## GENERAL PURPOSE MEDIUM-POWER TRANSISTORS FOR SWITCHING AND AMPLIFIER APPLICATIONS

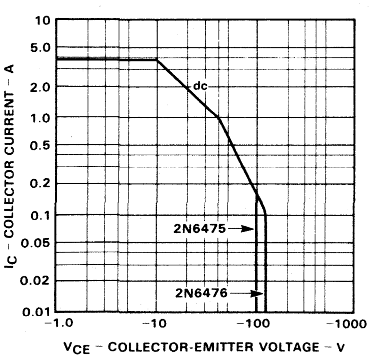
- 40 W DISSIPATION AT 25°C CASE
- 4.0 A MAZIMUM CONTINUOUS COLLECTOR CURRENT
- LOW SATURATION VOLTAGES
- COMPLEMENT TO 2N6473, 2N6474

### ABSOLUTE MAXIMUM RATINGS

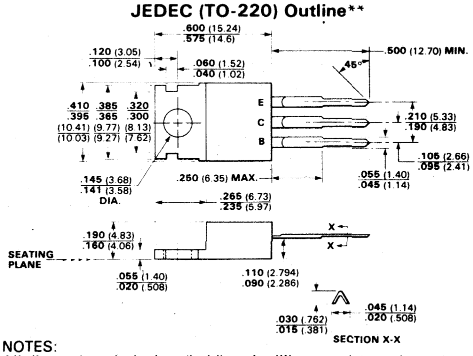
| | | 2N6475 | 2N6476 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CE}$ | Collector to Emitter Voltage | −100 V | −120 V |
| $V_{CB}$ | Collector to Base Voltage | −110 V | −130 V |
| $V_{EB}$ | Emitter to Base Voltage | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current (≤ 106°C Case) | 4.0 A | 4.0 A |
| $I_B$ | Continuous Base Current (≤ 130°C Case) | 2.0 A | 2.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 40 W |
| | Derate Linearly from 25°C | | 0.32 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +150°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 3.125°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10 s) | | 235°C |



### SAFE OPERATING AREA




### JEDEC (TO-220) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

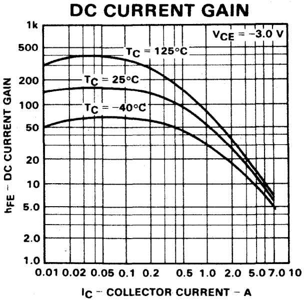
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTICS | 2N6475 MIN | 2N6475 MAX | 2N6476 MIN | 2N6476 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −100 | | −120 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −110 | | −130 | | V | $I_C = 100$ mA, $R_{BE} = 100\ \Omega$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | mA | $V_{CE} = -50$ V, $I_B = 0$ |
| | | | | | 1.0 | mA | $V_{CE} = -60$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.1 | | | mA | $V_{CE} = -100$ V, $V_{BE} = 1.5$ V |
| | | | | | 0.1 | mA | $V_{CE} = -120$ V, $V_{BE} = 1.5$ V |
| | | | 2.0 | | | mA | $V_{CE} = -100$ V, $V_{BE} = 1.5$ V, $T_C = 100°C$ |
| | | | | | 2.0 | mA | $V_{CE} = -120$ V, $V_{BE} = 1.5$ V, $T_C = 100°C$ |
| $I_{CER}$ | Collector Cutoff Current | | 0.1 | | | mA | $V_{CE} = -100$ V, $R_{BE} = 100\ \Omega$ |
| | | | | | 0.1 | mA | $V_{CE} = -120$ V, $R_{BE} = 100\ \Omega$ |
| | | | 2.0 | | | mA | $V_{CE} = -100$ V, $R_{BE} = 100\ \Omega$, $T_C = 100°C$ |
| | | | | | 2.0 | mA | $V_{CE} = -120$ V, $R_{BE} = 100\ \Omega$, $T_C = 100°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 15 | 150 | 15 | 150 | | $I_C = 1.5$ A, $V_{CE} = -4.0$ V |
| | | 2.0 | | 2.0 | | | $I_C = 4.0$ A, $V_{CE} = -2.5$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −1.2 | | −1.2 | V | $I_C = 1.5$ A, $I_B = 0.15$ A |
| | | | −2.5 | | −2.5 | V | $I_C = 4.0$ A, $I_B = 2.0$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −2.0 | | −2.0 | V | $I_C = 1.5$ A, $V_{CE} = -4.0$ V |
| | | | −3.5 | | −3.5 | V | $I_C = 4.0$ A, $V_{CE} = -2.5$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current Gain Bandwidth Product | 10 | | 10 | | MHz | $I_C = 0.5$ A, $V_{CE} = -4.0$ V |
| $C_{ob}$ | Output Capacitance | | 250 | | 250 | pF | $V_{CB} = -10$ V, $I_E = 0$, $f = 1.0$ MHz |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 10 | | 10 | | | $I_C = 0.5$ A, $V_{CE} = -4.0$ V, $f = 1.0$ MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | | $I_C = 0.5$ A, $V_{CE} = -4.0$ V, $f = 1.0$ kHz |

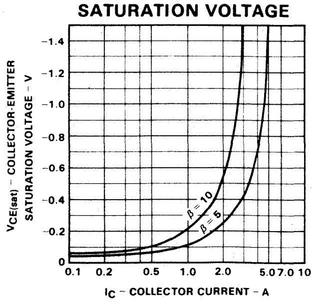
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

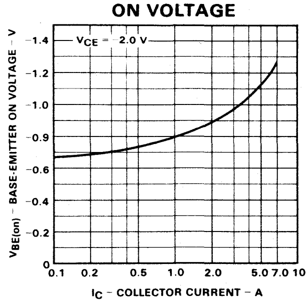
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

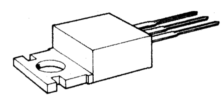
# 2N6486
# 2N6487
# 2N6488

### GENERAL PURPOSE TRANSISTORS DESIGNED FOR MEDIUM POWER SWITCHING AND AMPLIFIER APPLICATIONS

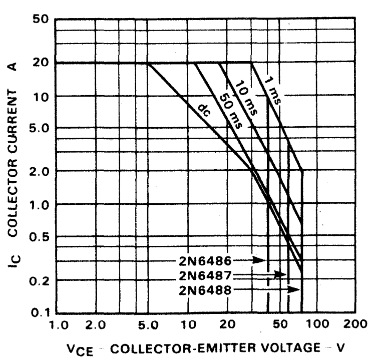
- 75 W DISSIPATION AT 25°C CASE
- 15 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENT TO 2N6489, 2N6490, 2N6491

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

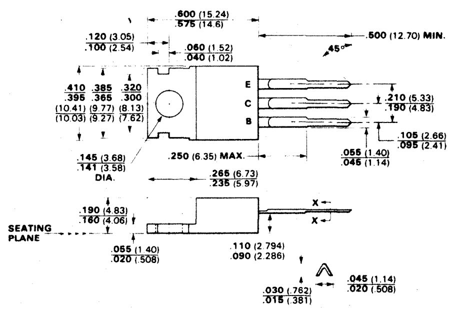
| Maximum Voltages and Currents | | 2N6486 | 2N6487 | 2N6488 |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V |
| $V_{CBO}$ | Collector to Base Voltage | 50 V | 70 V | 90 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 15 A | 15 A | 15 A |
| $I_B$ | Continuous Base Current | 5.0 A | 5.0 A | 5.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 75 W |
| | Derate Linearly from 25°C | | | 0.6 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 1.67°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10 s) | | | 235°C |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

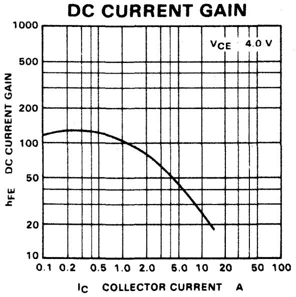
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6486 | | 2N6487 | | 2N6488 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | V | $I_C$ = 200 mA, $I_B$ = 0 |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 45 | | 65 | | 85 | | V | $I_C$ = 200 mA, $R_{BE}$ = 100 Ω |
| $V_{CEX(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 50 | | 70 | | 90 | | V | $I_C$ = 200 mA, $V_{BE(off)}$ = −1.5 V |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA<br>mA<br>mA | $V_{CE}$ = 20 V, $I_B$ = 0<br>$V_{CE}$ = 30 V, $I_B$ = 0<br>$V_{CE}$ = 40 V, $I_B$ = 0 |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5<br>5.0 | | 0.5<br>5.0 | | 0.5<br>5.0 | mA<br>mA<br>mA<br>mA<br>mA<br>mA | $V_{CE}$ = 45 V, $V_{BE}$ = −1.5 V<br>$V_{CE}$ = 65 V, $V_{BE}$ = −1.5 V<br>$V_{CE}$ = 85 V, $V_{BE}$ = −1.5 V<br>$V_{CE}$ = 40 V, $V_{BE}$ = −1.5 V, $T_C$ = 150°C<br>$V_{CE}$ = 60 V, $V_{BE}$ = −1.5 V, $T_C$ = 150°C<br>$V_{CE}$ = 80 V, $V_{BE}$ = −1.5 V, $T_C$ = 150°C |
| $I_{CER}$ | Collector Cutoff Current | | 0.5 | | 0.5 | | 0.5 | mA<br>mA<br>mA | $V_{CE}$ = 35 V, $R_{BE}$ = 100 Ω<br>$V_{CE}$ = 55 V, $R_{BE}$ = 100 Ω<br>$V_{CE}$ = 75 V, $R_{BE}$ = 100 Ω |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = 5.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20<br>5.0 | 150 | 20<br>5.0 | 150 | 20<br>5.0 | 150 | | $I_C$ = 5.0 A, $V_{CE}$ = 4.0 V<br>$I_C$ = 15 A, $V_{CE}$ = 4.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.3<br>3.5 | | 1.3<br>3.5 | | 1.3<br>3.5 | V<br>V | $I_C$ = 5.0 A, $I_B$ = 0.5 A<br>$I_C$ = 15 A, $I_B$ = 5.0 A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.3<br>3.5 | | 1.3<br>3.5 | | 1.3<br>3.5 | V<br>V | $I_C$ = 5.0 A, $V_{CE}$ = 4.0 V<br>$I_C$ = 15 A, $V_{CE}$ = 4.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 5.0 | | 5.0 | | 5.0 | | | $I_C$ = 1.0 A, $V_{CE}$ = 4.0 V<br>f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | 25 | | | $I_C$ = 1.0 A, $V_{CE}$ = 4.0 V<br>f = 1.0 kHz |

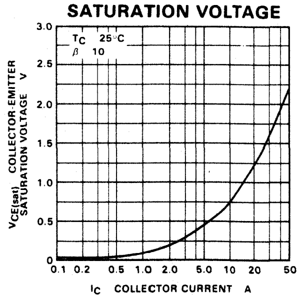
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

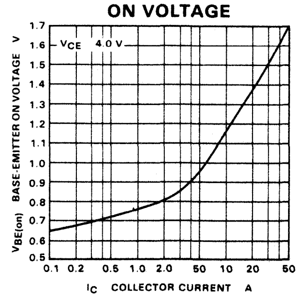
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

## PNP SILICON

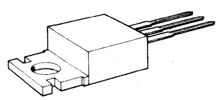
# 2N6489
# 2N6490
# 2N6491

### GENERAL PURPOSE TRANSISTORS DESIGNED FOR MEDIUM POWER SWITCHING AND AMPLIFIER APPLICATIONS

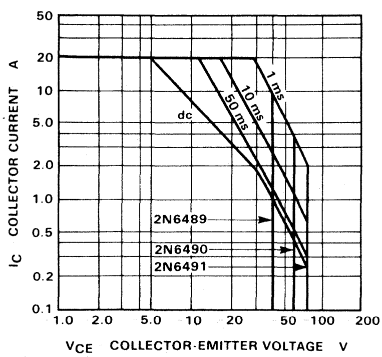
- 75 W DISSIPATION AT 25°C CASE
- 15 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENT TO 2N6486, 2N6487, 2N6488

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

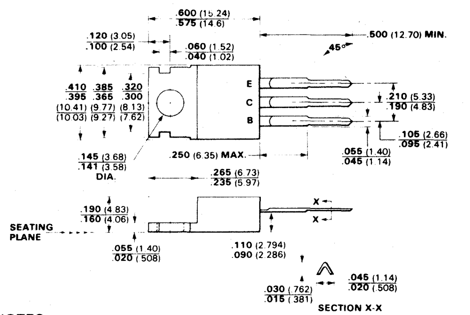
| | | 2N6489 | 2N6490 | 2N6491 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −40 V | −60 V | −80 V |
| $V_{CBO}$ | Collector to Base Voltage | −50 V | −70 V | −90 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 15 A | 15 A | 15 A |
| $I_B$ | Continuous Base Current | 5.0 A | 5.0 A | 5.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 75 W |
| | Derate Linearly from 25°C | | | 0.6 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 1.67°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10 s) | | | 235°C |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

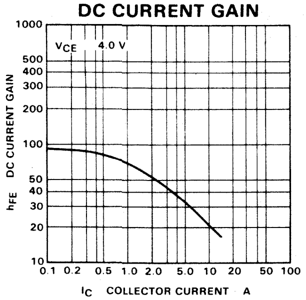
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6489 MIN | 2N6489 MAX | 2N6490 MIN | 2N6490 MAX | 2N6491 MIN | 2N6491 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | –40 | | –60 | | –80 | | V | $I_C$ = 200 mA, $I_B$ = 0 |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | –45 | | –65 | | –85 | | V | $I_C$ = 200 mA, $R_{BE}$ = 100 Ω |
| $V_{CEX(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | –50 | | –70 | | –90 | | V | $I_C$ = 200 mA, $V_{BE(off)}$ = –1.5 V |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CE}$ = –20 V, $I_B$ = 0 |
| | | | | | 1.0 | | | mA | $V_{CE}$ = –30 V, $I_B$ = 0 |
| | | | | | | | 1.0 | mA | $V_{CE}$ = –40 V, $I_B$ = 0 |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE}$ = –45 V, $V_{BE}$ = 1.5 V |
| | | | | | 0.5 | | | mA | $V_{CE}$ = –65 V, $V_{BE}$ = 1.5 V |
| | | | | | | | 0.5 | mA | $V_{CE}$ = –85 V, $V_{BE}$ = 1.5 V |
| | | | 5.0 | | | | | mA | $V_{CE}$ = –40V, $V_{BE}$ = 1.5V, $T_C$ = 150°C |
| | | | | | 5.0 | | | mA | $V_{CE}$ = –60 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| | | | | | | | 5.0 | mA | $V_{CE}$ = –80 V, $V_{BE}$ = 1.5 V, $T_C$ = 150°C |
| $I_{CER}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE}$ = –35 V, $R_{BE}$ = 100 Ω |
| | | | | | 0.5 | | | mA | $V_{CE}$ = –55 V, $R_{BE}$ = 100 Ω |
| | | | | | | | 0.5 | mA | $V_{CE}$ = –75 V, $R_{BE}$ = 100 Ω |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = –5.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20 | 150 | 20 | 150 | 20 | 150 | | $I_C$ = 5.0 A, $V_{CE}$ = –4.0 V |
| | | 5.0 | | 5.0 | | 5.0 | | | $I_C$ = 15 A, $V_{CE}$ = –4.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | –1.3 | | –1.3 | | –1.3 | V | $I_C$ = 5.0 A, $I_B$ = 0.5 A |
| | | | –3.5 | | –3.5 | | –3.5 | V | $I_C$ = 15 A, $I_B$ = 5.0 A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | –1.3 | | –1.3 | | –1.3 | V | $I_C$ = 5.0 A, $V_{CE}$ = –4.0 V |
| | | | –3.5 | | –3.5 | | –3.5 | V | $I_C$ = 15 A, $V_{CE}$ = –4.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 5.0 | | 5.0 | | 5.0 | | | $I_C$ = 1.0 A, $V_{CE}$ = –4.0 V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | 25 | | | $I_C$ = 1.0 A, $V_{CE}$ = –4.0 V, f = 1.0 kHz |

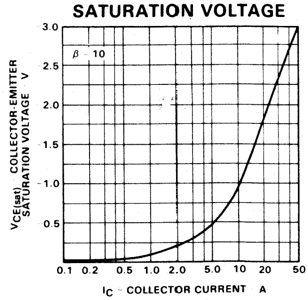
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

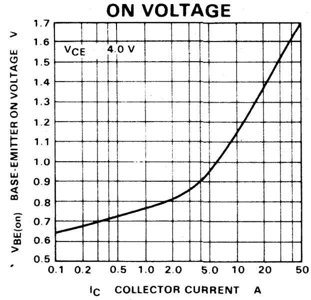
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

## 2N6569

### GENERAL PURPOSE POWER TRANSISTOR DESIGNED FOR LOW VOLTAGE AMPLIFIER AND POWER SWITCHING

- 100 W DISSIPATION AT 25°C CASE
- 12 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- ALL PURPOSE REPLACEMENT FOR INDUSTRY STANDARD 2N3055
- COST EFFECTIVE
- METAL CAN RELIABILITY IN TO-3 PACKAGE

**ABSOLUTE MAXIMUM RATINGS**

**Maximum Voltages and Currents**

| | | |
|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | 40 V |
| $V_{CB}$ | Collector to Base Voltage | 45 V |
| $V_{EB}$ | Emitter to Base Voltage | 5 V |
| $I_C$ | Continuous Collector Current | 12 A |
| $I_C$ | Peak Collector Current | 24 A |
| $I_B$ | Continuous Base Current | 5 A |

**Maximum Power Dissipation**

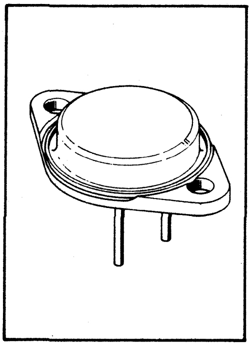
| | | |
|---|---|---|
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 100 W |
| | Derate Linearly from 25°C | 0.8 W/°C |

**Maximum Temperatures**

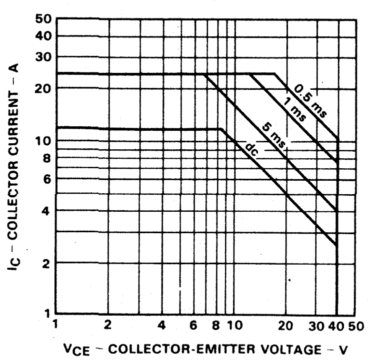
| | | |
|---|---|---|
| $T_J$, $T_{stg}$ | Storage and Operating Junction Temperatures | −65°C to +200°C |

**Thermal Characteristics**

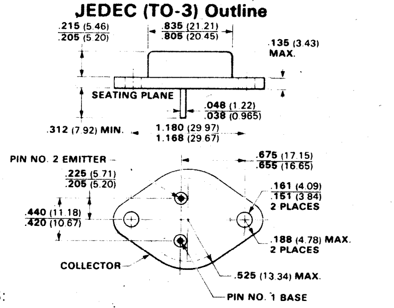
| | | |
|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.75°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 5 s) | 265°C |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

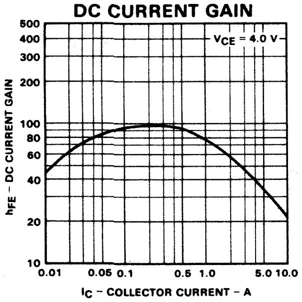
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | MIN | MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEV}$ | Collector Cutoff Current | | 1.0<br>10 | mA | $V_{CE} = 45$ V, $V_{BE} = -1.5$ V<br>$V_{CE} = 45$ V, $V_{BE} = -1.5$ V, $T_C = 100°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 15<br>5.0 | 200<br>100 | | $I_C = 4.0$ A, $V_{CE} = 3.0$ V<br>$I_C = 12$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.5<br>4.0 | V | $I_C = 4.0$ A, $I_B = 0.4$ A<br>$I_C = 12$ A, $I_B = 2.4$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 2.0 | V | $I_C = 4.0$ A, $I_B = 0.4$ A |
| **SECOND BREAKDOWN** | | | | | |
| $I_{s/b}$ | Second Breakdown Collector Current with Base Forward Biased | 2.5 | | A | t = 1.0 s (non-repetitive) $V_{CE} = 40$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 1.5 | 15 | MHz | $I_C = 1.0$ A, $V_{CE} = 4.0$ V, f = 0.5 MHz |
| $C_{ob}$ | Output Capacitance | 75 | 750 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz |
| **SWITCHING CHARACTERISTICS**<br>**RESISTIVE LOAD** | | | | | |
| $t_d$ | Delay Time | | 0.4 | μs | $V_{CC} = 30$ V, $I_C = 2.0$ A, $I_{B1} = 0.2$ A |
| $t_r$ | Rise Time | | 1.5 | μs | $t_p = 25$ μs, Duty Cycle ≤ 1.0% |
| $t_s$ | Storage Time | | 5.0 | μs | $V_{CC} = 30$ V, $I_C = 2.0$ A, $I_{B1} = I_{B2} = 0.2$ A |
| $t_f$ | Fall Time | | 1.5 | μs | $t_p = 25$ μs, Duty Cycle ≤ 1.0% |

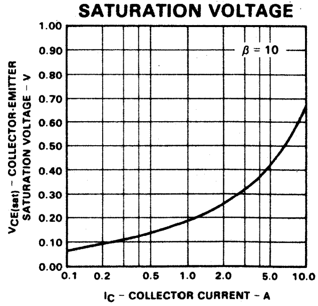
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

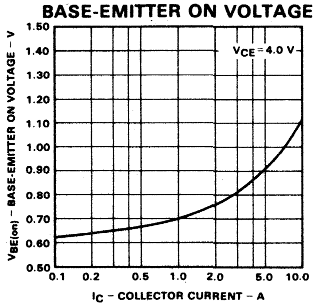
**DC CURRENT GAIN**




**COLLECTOR-EMITTER SATURATION VOLTAGE**




**BASE-EMITTER ON VOLTAGE**



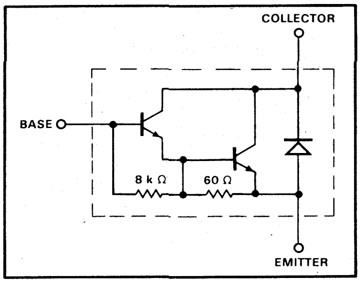
# POWER DARLINGTON

## NPN SILICON

# 2N6576
# 2N6577

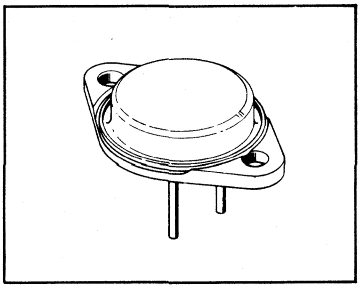
### GENERAL PURPOSE DARLINGTON SUITABLE FOR POWER AMPLIFIER AND SERIES PASS REGULATOR APPLICATIONS

- 120 W DISSIPATION AT 25°C CASE
- 15 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COST EFFECTIVE REPLACEMENT FOR 2N3055 AND DRIVER
- HIGH GAIN DARLINGTON PERFORMANCE
- REVERSE POLARITY DIODE PROTECTION

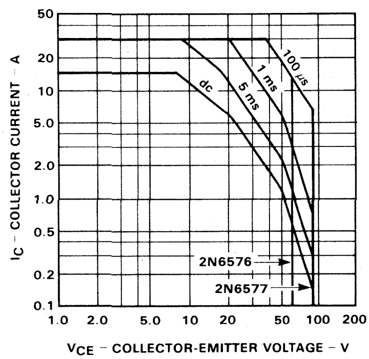



## ABSOLUTE MAXIMUM RATINGS

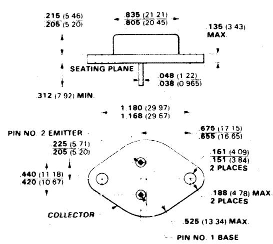
| | | 2N6576 | 2N6577 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CE}$ | Collector to Emitter Voltage | 60 V | 90 V |
| $V_{CB}$ | Collector to Base Voltage | 60 V | 90 V |
| $V_{EB}$ | Emitter to Base Voltage | 7 V | 7 V |
| $I_C$ | Continuous Collector Current | 15 A | 15 A |
| $I_C$ | Peak Collector Current | 30 A | 30 A |
| $I_B$ | Continuous Base Current | .25 A | .25 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 120 W |
| | Derate Linearly from 25°C | | .685 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 1.46°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 5s) | | 265°C |



### SAFE OPERATING AREA




### JEDEC (TO-3) Outline




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

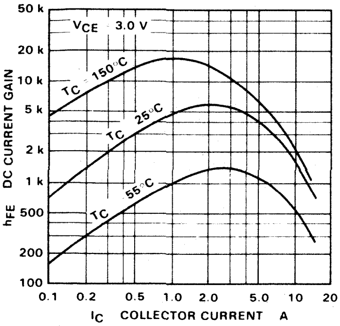
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | 2N6576 MIN | 2N6576 MAX | 2N6577 MIN | 2N6577 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 90 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | 1.0 | mA | $V_{CE} = 60$ V, $I_B = 0$<br>$V_{CE} = 90$ V, $I_B = 0$ |
| $I_{CEV}$ | Collector Cutoff Current | | 5.0 | | 5.0 | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V, $T_C = 175°C$<br>$V_{CE} = 90$ V, $V_{BE} = -1.5$ V, $T_C = 175°C$ |
| $I_{CER}$ | Collector Cutoff Current | | 5.0 | | 5.0 | mA | $V_{CE} = 60$ V, $R_{BE} = 10$ kΩ, $T_C = 150°C$<br>$V_{CE} = 90$ V, $R_{BE} = 10$ kΩ, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.5 | | 0.5 | mA | $V_{CB} = 60$ V, $I_E = 0$<br>$V_{CB} = 90$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 7.5 | | 7.5 | mA | $V_{EB} = 7.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 100<br>500<br>2000<br>200 | <br>5000<br>20,000<br> | 100<br>500<br>2000<br>200 | <br>5000<br>20,000<br> | | $I_C = 15$ A, $V_{CE} = 4.0$ V<br>$I_C = 10$ A, $V_{CE} = 3.0$ V<br>$I_C = 4.0$ A, $V_{CE} = 3.0$ V<br>$I_C = 0.4$ A, $V_{CE} = 3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Voltage (Note 1) | | 4.0<br>2.8 | | 4.0<br>2.8 | V | $I_C = 15$ A, $I_B = 0.15$ A<br>$I_C = 10$ A, $I_B = 0.1$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 4.5<br>3.5 | | 4.5<br>3.5 | V | $I_C = 15$ A, $I_B = 0.15$ A<br>$I_C = 10$ A, $I_B = 0.1$ A |
| $V_{EC}$ | Collector-Emitter Diode Voltage Drop | | 3.5 | | 3.5 | V | $I_{EC} = 15$ A |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 10 | 200 | 10 | 200 | | $I_C = 3.0$ A, $V_{CE} = 3.0$ V, f = 1.0 MHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | |
| **RESISTIVE LOAD** | | | | | | | |
| $t_d$ | Delay Time | | 0.15 | | 0.15 | μs | $V_{CC} = 30$ V, $I_C = 10$ A, $I_{B1} = 0.1$ A |
| $t_r$ | Rise Time | | 1.0 | | 1.0 | μs | $t_p = 300$ μs, Duty Cycle ≤ 2.0% |
| $t_s$ | Storage Time | | 2.0 | | 2.0 | μs | $V_{CC} = 30$ V, $I_C = 10$ A, |
| $t_f$ | Fall Time | | 7.0 | | 7.0 | μs | $I_{B1} = I_{B2} = 0.1$ A<br>$t_p = 300$ μs, Duty Cycle ≤ 2.0% |

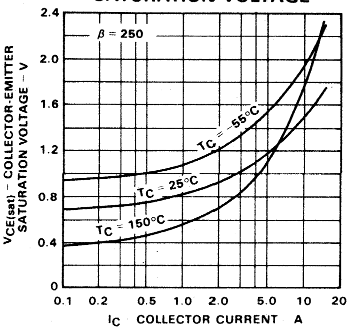
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

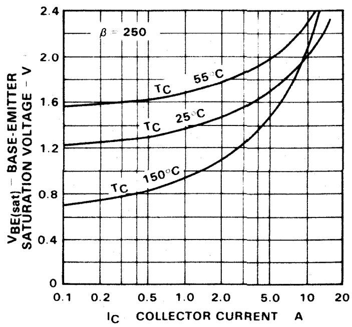
### DC CURRENT GAIN



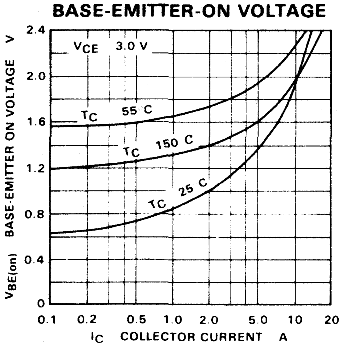

### COLLECTOR-EMITTER SATURATION VOLTAGE



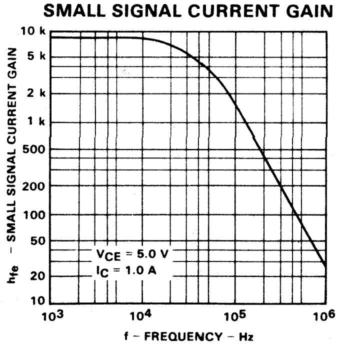

### BASE-EMITTER SATURATION VOLTAGE



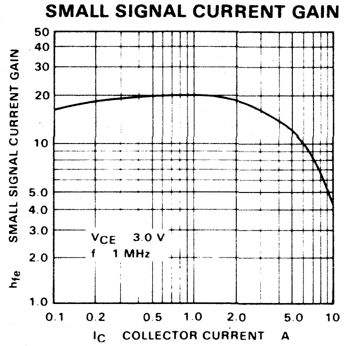

### BASE-EMITTER-ON VOLTAGE



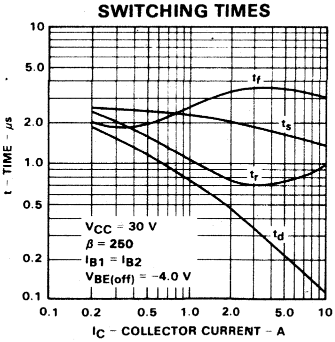

### SMALL SIGNAL CURRENT GAIN



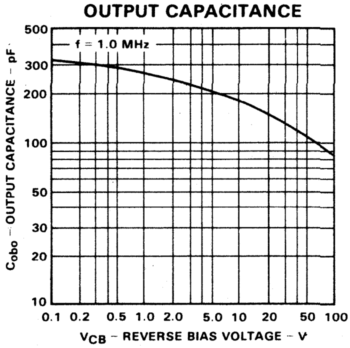

### SMALL SIGNAL CURRENT GAIN




### SWITCHING TIMES




### OUTPUT CAPACITANCE



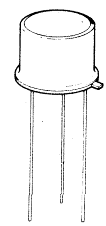
# POWER TRANSISTOR

## NPN SILICON

**BC323**

### GENERAL PURPOSE POWER DEVICE FOR EUROPEAN MARKET

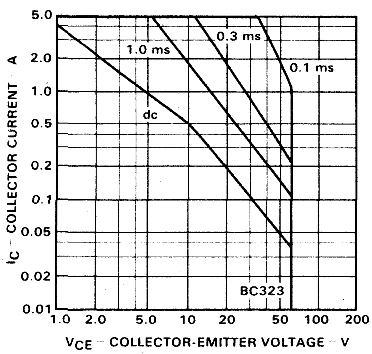
- **7.0 W DISSIPATION AT 25°C CASE**
- **5.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **0.15 $V_{CE(sat)}$ MAXIMUM @ 500 mA**



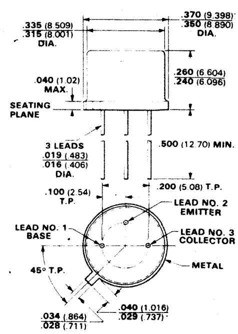
**ABSOLUTE MAXIMUM RATINGS (Note 1)**

| | | |
|---|---|---|
| **Maximum Voltages and Currents** | | **BC323** |
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V |
| $V_{CBO}$ | Collector to Base Voltage | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V |
| $I_C$ | Continuous Collector Current | 5.0 A |
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 7.0 W |
| | Derate Linearly from 25°C | 40 mW/°C |
| **Maximum Temperatures** | | |
| $T_J$,$T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +200°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 25°C/W |

**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 1.23 grams

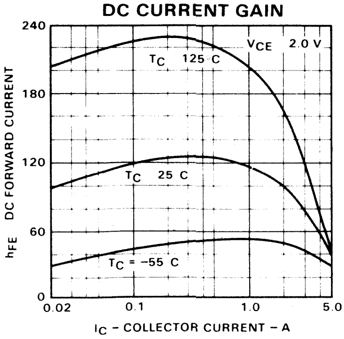
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | BC323 MIN | BC323 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | V | $I_C = 50$ mA, $I_B = 0$ |
| $V_{CES}$ | Collector-Emitter Breakdown Voltage | 100 | | V | $I_C = 1.0$ mA, $V_{BE} = 0$ |
| $V_{EBO}$ | Emitter-Base Breakdown Voltage | 5.0 | | V | $I_E = 1.0$ mA, $I_C = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.1 | mA | $V_{CB} = 100$ V, $I_E = 0$ |
| | | | 0.01 | mA | $V_{CB} = 40$ V, $I_E = 0$ |
| | | 0.35 TYP | | $\mu$A | $V_{CB} = 40$ V, $I_E = 0$, $T_C = 75°$C |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.01 | mA | $V_{EB} = 4.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | 225 | | $I_C = 50$ mA, $V_{CE} = 1.0$ V |
| | | 50 | 250 | | $I_C = 500$ mA, $V_{CE} = 1.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.15 | V | $I_C = 500$ mA, $I_B = 50$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 0.9 | V | $I_C = 500$ mA, $I_B = 50$ mA |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| $C_{ob}$ | Output Capacitance | | 80 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz |
| $C_{eb}$ | Emitter-Transition Capacitance | | 500 | pF | $V_{EB} = 0.5$ V, $I_C = 0$, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 5.0 TYP | | | $I_C = 500$ mA, $V_{CE} = 5.0$ V, f = 20 MHz |

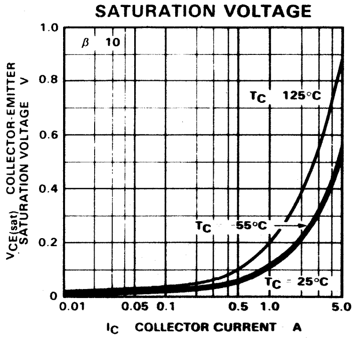
NOTE: 1. Pulse conditions: Length = 300 $\mu$s, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

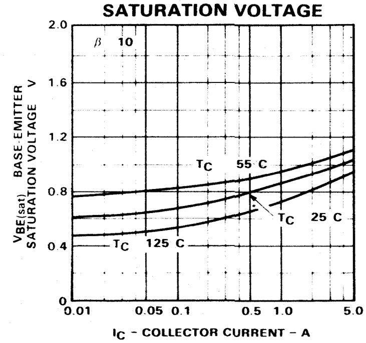
### DC CURRENT GAIN



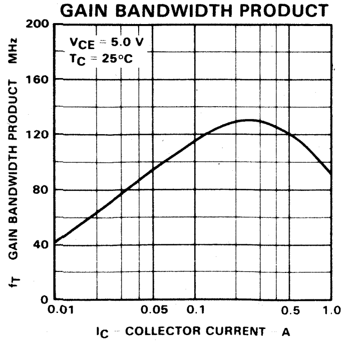

### COLLECTOR-EMITTER SATURATION VOLTAGE



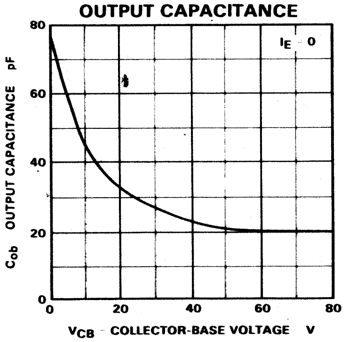

### BASE-EMITTER SATURATION VOLTAGE




### GAIN BANDWIDTH PRODUCT




### OUTPUT CAPACITANCE



# POWER TRANSISTOR

NPN SILICON

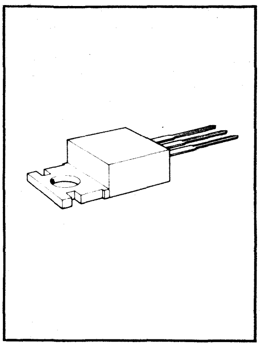
**BD220**
**BD221**
**BD222**

## GENERAL PURPOSE DEVICE FOR EUROPEAN MARKET

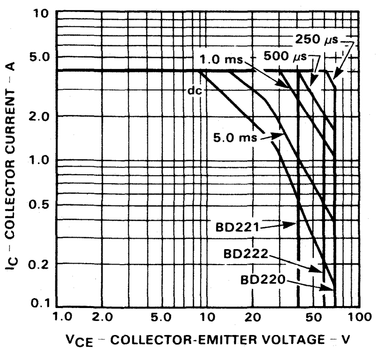
- 36 W DISSIPATION AT 25°C CASE
- 4.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS BD223, BD224, BD225

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

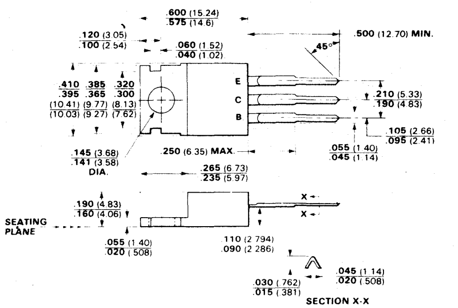
| | | BD220 | BD221 | BD222 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 70 V | 40 V | 60 V |
| $V_{CBO}$ | Collector to Base Voltage | 80 V | 60 V | 80 V |
| $V_{EBO}$ | Emitter to Base Voltage | 7.0 V | 7.0 V | 7.0 V |
| $I_C$ | Continuous Collector Current | 4.0 A | 4.0 A | 4.0 A |
| $I_B$ | Continuous Base Current | 2.0 A | 2.0 A | 2.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 36 W |
| | Derate Linearly from 25°C | | | 288 mW/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 3.47°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220)** Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

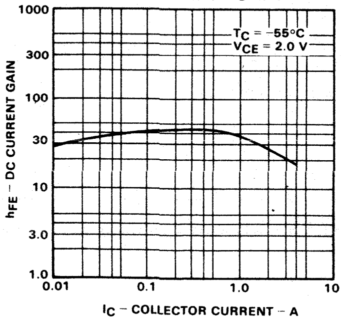
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | BD220 | | BD221 | | BD222 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 70 | | 40 | | 60 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEV}$ | Collector Cutoff Current | | 0.5 | | | | 0.5 | mA | $V_{CE} = 65$ V, $V_{BE} = -1.5$ V |
| | | | | | 2.0 | | | mA | $V_{CE} = 35$ V, $V_{BE} = -1.5$ V |
| | | | 10 | | | | 10 | mA | $V_{CE} = 80$ V, $V_{BE} = -1.5$ V |
| | | | | | 10 | | | mA | $V_{CE} = 60$ V, $V_{BE} = -1.5$ V |
| | | | 3.0 | | | | 3.0 | mA | $V_{CE} = 65$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | | | mA | $V_{CE} = 35$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CER}$ | Collector Cutoff Current | | 0.5 | | | | 0.5 | mA | $V_{CE} = 50$ V, $R_{BE} = 100\ \Omega$ |
| | | | 10 | | | | | mA | $V_{CE} = 75$ V, $R_{BE} = 100\ \Omega$ |
| | | | | | 10 | | | mA | $V_{CE} = 50$ V, $R_{BE} = 100\ \Omega$ |
| | | | | | | | 10 | mA | $V_{CE} = 70$ V, $R_{BE} = 100\ \Omega$ |
| | | | 2.0 | | | | 2.0 | mA | $V_{CE} = 50$ V, $R_{BE} = 100\ \Omega$, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | | | | mA | $V_{EB} = 7.0$ V, $I_C = 0$ |
| | | | | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30 | 120 | | | | | | $I_C = 0.5$ A, $V_{CE} = 4.0$ V |
| | | | | 30 | 120 | | | | $I_C = 1.0$ A, $V_{CE} = 4.0$ V |
| | | | | | | 20 | 80 | | $I_C = 1.5$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | | | | V | $I_C = 0.5$ A, $I_B = 0.05$ A |
| | | | | | 1.0 | | | V | $I_C = 1.0$ A, $I_B = 0.1$ A |
| | | | | | | | 1.0 | V | $I_C = 1.5$ A, $I_B = 0.15$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.1 | | | | | V | $I_C = 0.5$ A, $V_{CE} = 4.0$ V |
| | | | | | 1.3 | | | V | $I_C = 1.0$ A, $V_{CE} = 4.0$ V |
| | | | | | | | 1.5 | V | $I_C = 1.5$ A, $V_{CE} = 4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 0.8 | | 0.8 | | 0.8 | | MHz | $I_C = 0.2$ A, $V_{CE} = 4.0$ V, f = 0.1 MHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | | | |
| $t_{on}$ | Turn On Time | | 0.5 | | | | | μs | $I_C = 0.5$ A, $V_{CC} = 30$ V, $I_{B1} = 50$ mA |
| $t_{off}$ | Turn Off Time | | 15 | | | | | μs | $I_C = 0.5$ A, $V_{CC} = 30$ V, $I_{B1} = I_{B2} = 50$ mA |
| $t_{on}$ | Turn On Time | | | | 0.5 | | | μs | $I_C = 1.0$ A, $V_{CC} = 30$ V, $I_{B1} = 100$ mA |
| $t_{off}$ | Turn Off Time | | | | 15 | | | μs | $I_C = 1.0$ A, $V_{CC} = 30$ V, $I_{B1} = I_{B2} = 100$ mA |
| $t_{on}$ | Turn On Time | | | | | | 0.5 | μs | $I_C = 1.5$ A, $V_{CC} = 30$ V, $I_{B1} = 150$ mA |
| $t_{off}$ | Turn Off Time | | | | | | 15 | μs | $I_C = 1.5$ A, $V_{CC} = 30$ V, $I_{B1} = I_{B2} = 150$ mA |

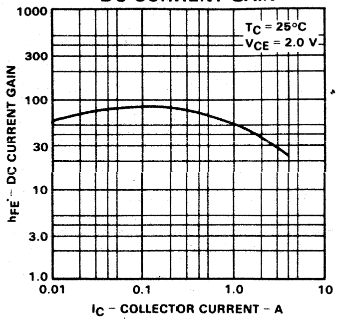
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

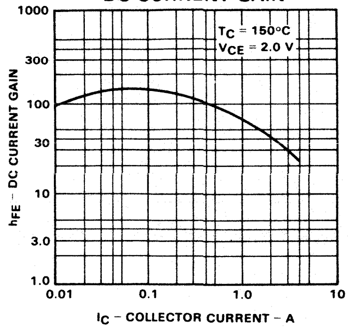
### DC CURRENT GAIN



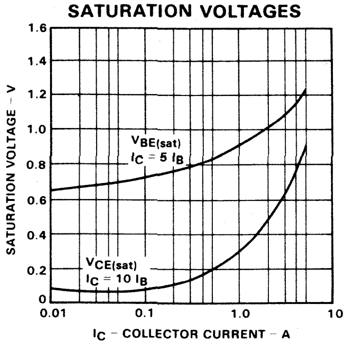

### DC CURRENT GAIN



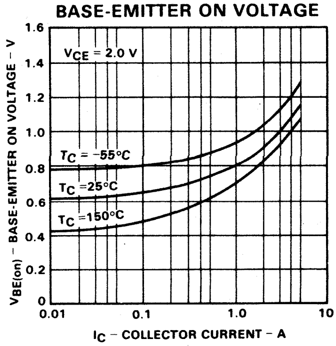

### DC CURRENT GAIN



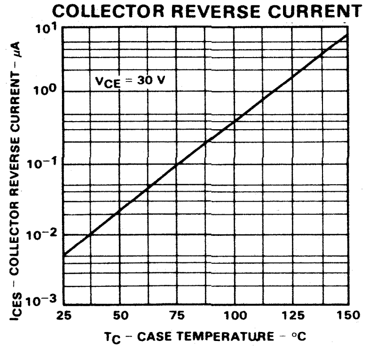

### SATURATION VOLTAGES



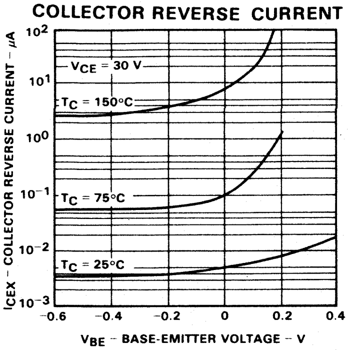

### BASE-EMITTER ON VOLTAGE



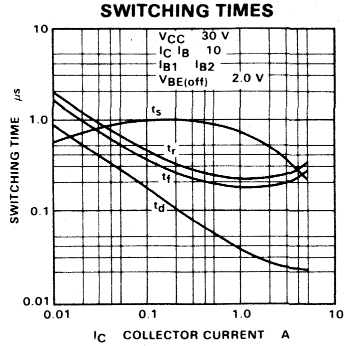

### COLLECTOR REVERSE CURRENT




### COLLECTOR REVERSE CURRENT




### SWITCHING TIMES



# POWER TRANSISTOR

PNP SILICON

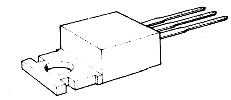
**BD223**
**BD224**
**BD225**

## GENERAL PURPOSE DEVICE FOR EUROPEAN MARKET

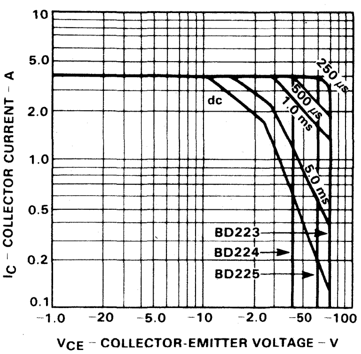
- 36 W DISSIPATION AT 25°C CASE
- 4.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENTS BD220, BD221, BD222

### ABSOLUTE MAXIMUM RATINGS (Note 1)

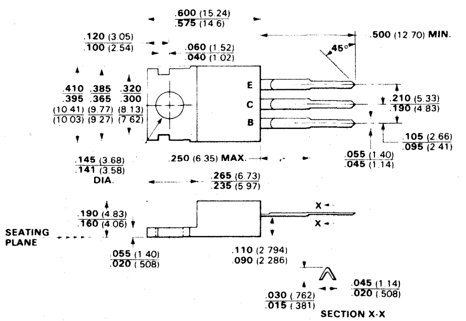
| Maximum Voltages and Currents | | BD223 | BD224 | BD225 |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | −70 V | −40 V | −60 V |
| $V_{CBO}$ | Collector to Base Voltage | −80 V | −60 V | −80 V |
| $V_{EBO}$ | Emitter to Base Voltage | −7.0 V | −7.0 V | −7.0 V |
| $I_C$ | Continuous Collector Current | 4.0 A | 4.0 A | 4.0 A |
| $I_B$ | Continuous Base Current | 2.0 A | 2.0 A | 2.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 36 W |
| | Derate Linearly from 25°C | | | 288 mW/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 3.47°C/W |



### SAFE OPERATING AREA




### JEDEC (TO-220**) Outline




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

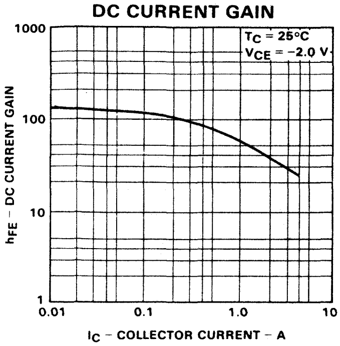
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | BD223 | | BD224 | | BD225 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −70 | | −40 | | −60 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEV}$ | Collector Cutoff Current | | 0.5 | | | | 0.5 | mA | $V_{CE} = -65$ V, $V_{BE} = 1.5$ V |
| | | | | | 2.0 | | | mA | $V_{CE} = -35$ V, $V_{BE} = 1.5$ V |
| | | | 10 | | | | 10 | mA | $V_{CE} = -80$ V, $V_{BE} = 1.5$ V |
| | | | | | 10 | | | mA | $V_{CE} = -60$ V, $V_{BE} = 1.5$ V |
| | | | 3.0 | | | | 3.0 | mA | $V_{CE} = -65$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| | | | | | 5.0 | | | mA | $V_{CE} = -35$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$ |
| $I_{CER}$ | Collector Cutoff Current | | 0.5 | | | | 0.5 | mA | $V_{CE} = -50$ V, $R_{BE} = 100\ \Omega$ |
| | | | 10 | | | | | mA | $V_{CE} = -75$ V, $R_{BE} = 100\ \Omega$ |
| | | | | | 10 | | | mA | $V_{CE} = -50$ V, $R_{BE} = 100\ \Omega$ |
| | | | | | | | 10 | mA | $V_{CE} = -70$ V, $R_{BE} = 100\ \Omega$ |
| | | | 2.0 | | | | 2.0 | mA | $V_{CE} = -50$ V, $R_{BE} = 100\ \Omega$, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | | | | mA | $V_{EB} = -7.0$ V, $I_C = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | | | 1.0 | | 1.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30 | 120 | | | | | | $I_C = 0.5$ A, $V_{CE} = -4.0$ V |
| | | | | 30 | 120 | | | | $I_C = 1.0$ A, $V_{CE} = -4.0$ V |
| | | | | | | 20 | 80 | | $I_C = 1.5$ A, $V_{CE} = -4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −1.0 | | | | | V | $I_C = 0.5$ A, $I_B = 50$ mA |
| | | | | | −1.0 | | | V | $I_C = 1.0$ A, $I_B = 100$ mA |
| | | | | | | | −1.0 | V | $I_C = 1.5$ A, $I_B = 150$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.1 | | | | | V | $I_C = 0.5$ A, $V_{CE} = -4.0$ V |
| | | | | | −1.3 | | | V | $I_C = 1.0$ A, $V_{CE} = -4.0$ V |
| | | | | | | | −1.5 | V | $I_C = 1.5$ A, $V_{CE} = -4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 0.8 | | 0.8 | | 0.8 | | MHz | $I_C = 0.2$ A, $V_{CE} = -4.0$ V, f = 0.1 MHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | | | |
| $t_{on}$ | Turn On Time | | 5.0 | | | | | μs | $I_C = 0.5$ A, $V_{CC} = -30$ V, $I_{B1} = 50$ mA |
| $t_{off}$ | Turn Off Time | | 15 | | | | | μs | $I_C = 0.5$ A, $V_{CC} = -30$ V, $I_{B1} = I_{B2} = 50$ mA |
| $t_{on}$ | Turn On Time | | | | 5.0 | | | μs | $I_C = 1.0$ A, $V_{CC} = -30$ V, $I_{B1} = 100$ mA |
| $t_{off}$ | Turn Off Time | | | | 15 | | | μs | $I_C = 1.0$ A, $V_{CC} = -30$ V, $I_{B1} = I_{B2} = 100$ mA |
| $t_{on}$ | Turn On Time | | | | | | 5.0 | μs | $I_C = 1.5$ A, $V_{CC} = -30$ V, $I_{B1} = 150$ mA |
| $t_{off}$ | Turn Off Time | | | | | | 15 | μs | $I_C = 1.5$ A, $V_{CC} = -30$ V, $I_{B1} = I_{B2} = 150$ mA |

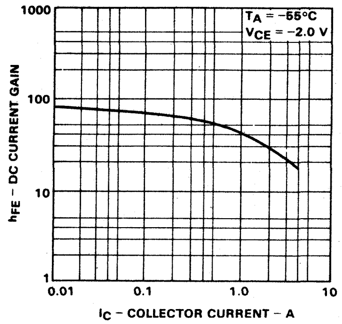
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

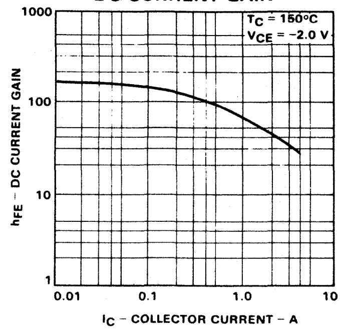
### DC CURRENT GAIN



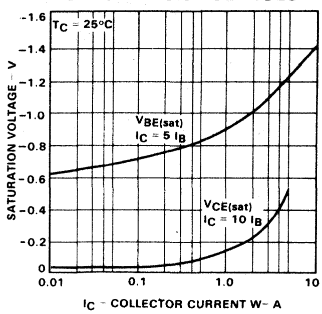

### DC CURRENT GAIN



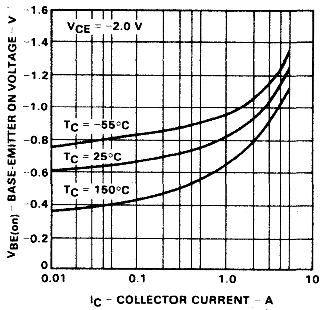

### DC CURRENT GAIN



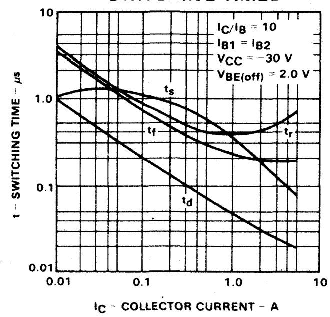

### SATURATION VOLTAGES



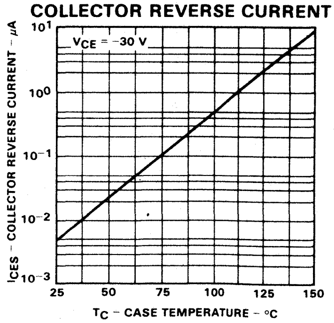

### BASE-EMITTER ON VOLTAGE



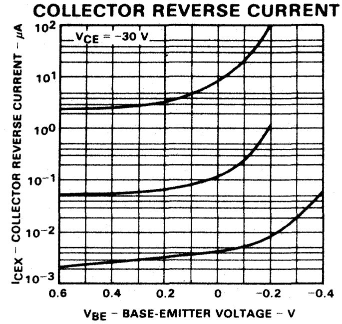

### SWITCHING TIMES




### COLLECTOR REVERSE CURRENT




### COLLECTOR REVERSE CURRENT



# POWER TRANSISTOR

NPN SILICON

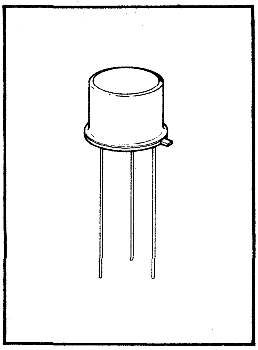
**BF257**
**BF258**
**BF259**

## DESIGNED AS HIGH VOLTAGE VIDEO DRIVERS

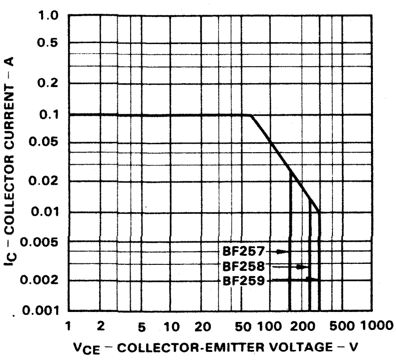
- 7.0 W DISSIPATION AT 25°C CASE
- 100 mA MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 300 V $V_{CEO}$ MINIMUM (BF259)

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

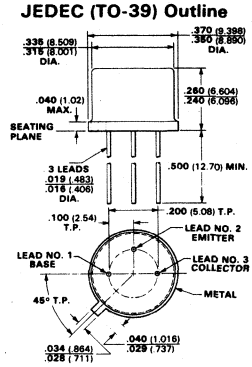
| | | BF257 | BF258 | BF259 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 160 V | 250 V | 300 V |
| $V_{CBO}$ | Collector to Base Voltage | 160 V | 250 V | 300 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 100 mA | 100 mA | 100 mA |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 7.0 W |
| | Derate Linearly from 25°C | | | 40 mW/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 25°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

# FAIRCHILD • BF257 • BF258 • BF259

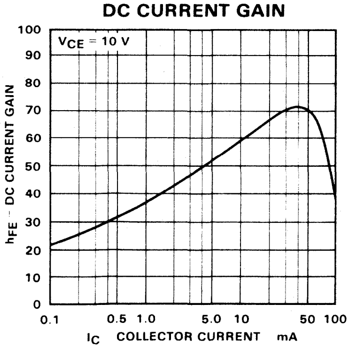
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | BF257 | | BF258 | | BF259 | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 160 | | 250 | | 300 | | V | $I_C = 10\,mA$, $I_B = 0$ |
| $V_{CBO}$ | Collector-Base Breakdown Voltage | 160 | | 250 | | 300 | | V | $I_C = 0.1\,mA$, $I_E = 0$ |
| $V_{EBO}$ | Emitter-Base Breakdown Voltage | 5.0 | | 5.0 | | 5.0 | | V | $I_E = 0.1\,mA$, $I_C = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 50 | | | | | nA | $V_{CB} = 100\,V$, $I_E = 0$ |
| | | | | | 50 | | | nA | $V_{CB} = 200\,V$, $I_E = 0$ |
| | | | | | | | 50 | nA | $V_{CB} = 250\,V$, $I_E = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 25 | | 25 | | 25 | | | $I_C = 30\,mA$, $V_{CE} = 10\,V$ |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | | 1.0 | V | $I_C = 30\,mA$, $I_B = 6.0\,mA$ |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 75 TYP | | 75 TYP | | 75 TYP | | MHz | $I_C = 15\,mA$, $V_{CE} = 10\,V$, $f = 10\,MHz$ |
| $C_{cb}$ | Collector-Base Capacitance | 3.5 TYP | | 3.0 TYP | | 2.5 TYP | | | $V_{CB} = 30\,V$, $I_E = 0$, $f = 1.0\,MHz$ |

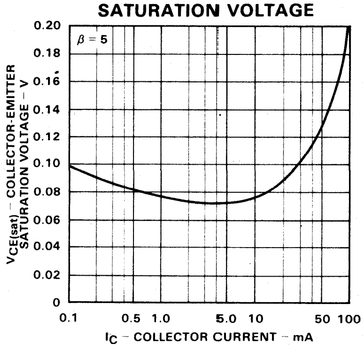
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

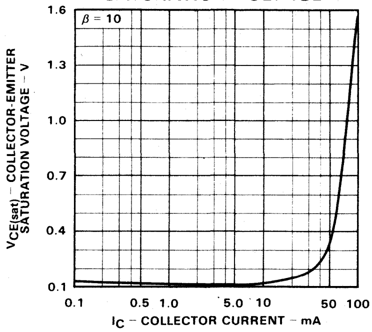
### DC CURRENT GAIN



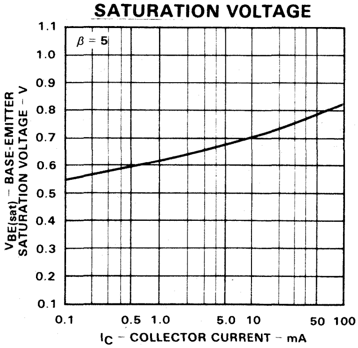

### COLLECTOR-EMITTER SATURATION VOLTAGE



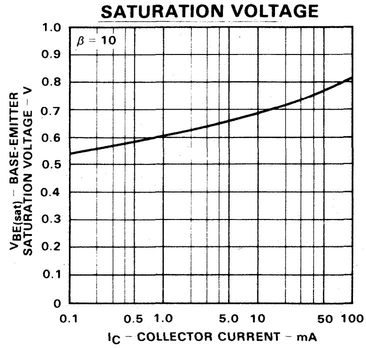

### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

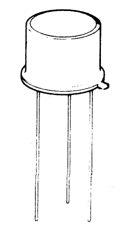
**BF336**
**BF337**
**BF338**

### DESIGNED AS HIGH VOLTAGE VIDEO DRIVERS

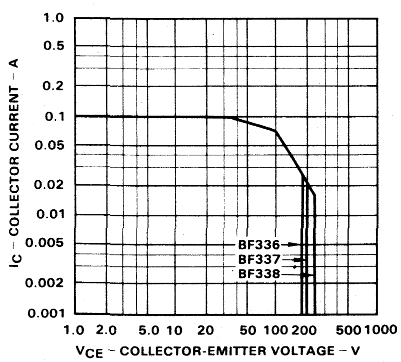
- *1.0 W DISSIPATION AT 25°C CASE*
- 100 mA MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 225 V $V_{CEO}$ MINIMUM BF338

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

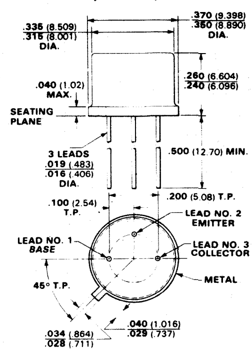
| | | BF336 | BF337 | BF338 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 180 V | 200 V | 225 V |
| $V_{CBO}$ | Collector to Base Voltage | 185 V | 250 V | 300 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 100 mA | 100 mA | 100 mA |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 1.0 W |
| | Derate Linearly from 25°C | | | 50 mW/°C |
| ***Maximum Temperatures*** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 20°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

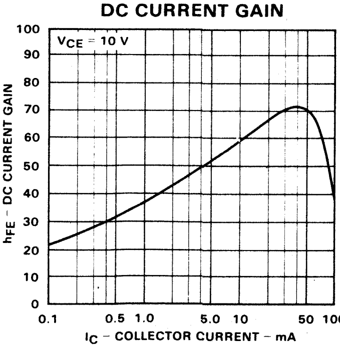
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | BF336 MIN | BF336 MAX | BF337 MIN | BF337 MAX | BF338 MIN | BF338 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| OFF CHARACTERISTICS | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 180 | | 200 | | 225 | | V | $I_C = 4.0$ mA, $I_B = 0$ |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 185 | | 250 | | 300 | | V | $I_C = 1.0$ mA, $R_{BE} = 1.0$ KΩ, $T_A \leq 150°C$ |
| $V_{CBO}$ | Collector-Base Breakdown Voltage | 185 | | 250 | | 300 | | V | $I_C = 1.0$ mA, $I_E = 0$ |
| $V_{EBO}$ | Emitter-Base Breakdown Voltage | 5.0 | | 5.0 | | 5.0 | | V | $I_E = 0.1$ mA, $I_C = 0$ |
| $I_{CER}$ | Collector Cutoff Current | | 0.1 | | | | | mA | $V_{CE} = 150$ V, $R_{BE} = 1.0$ KΩ |
| | | | | | 0.1 | | | mA | $V_{CE} = 200$ V, $R_{BE} = 1.0$ KΩ |
| | | | | | | | 0.1 | mA | $V_{CE} = 250$ V, $R_{BE} = 1.0$ KΩ |
| ON CHARACTERISTICS | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20 | | 20 | | 20 | | | $I_C = 30$ mA, $V_{CE} = 10$ V |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.2 | | 1.2 | | 1.2 | V | $I_C = 30$ mA, $V_{CE} = 10$ V |
| DYNAMIC CHARACTERISTICS | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 50 | | 50 | | 50 | | MHz | $I_C = 30$ mA, $V_{CE} = 20$ V, f = 20 MHz |
| $C_{re}$ | Common Emitter Reverse Transfer Capacitance | | 3.5 | | 3.5 | | 35. | | $V_{CE} = 20$ V, $I_C = 0$, f = 0.5 MHz |
| $r_b, C_c$ | Collector to Base Time Constant | | 100 | | 100 | | 100 | ps | $V_{CB} = 20$ V, $I_E = 30$ mA, f = 10 MHz |

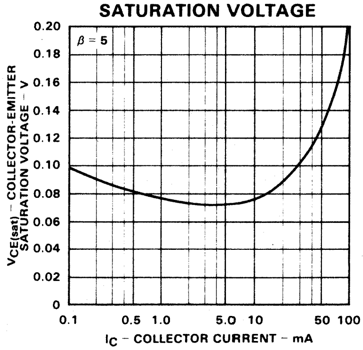
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

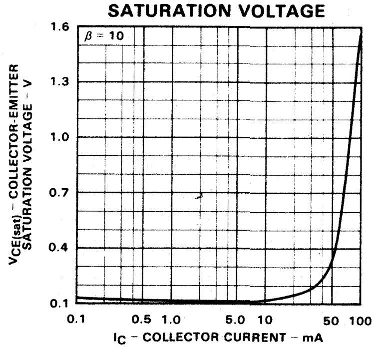
### DC CURRENT GAIN



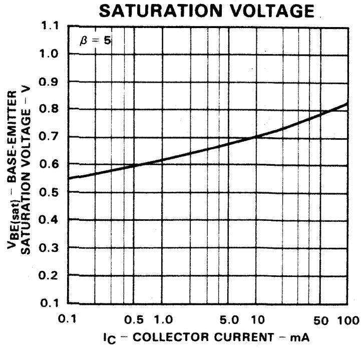

### COLLECTOR-EMITTER SATURATION VOLTAGE



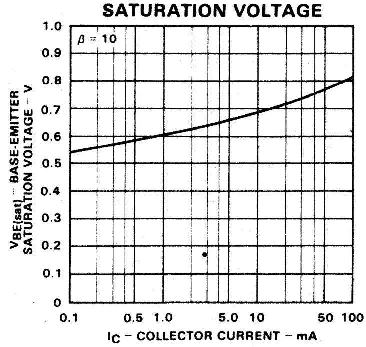

### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

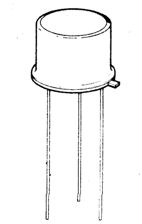
# BFX34

### HIGH CURRENT GENERAL PURPOSE DEVICE FOR EUROPEAN MARKET

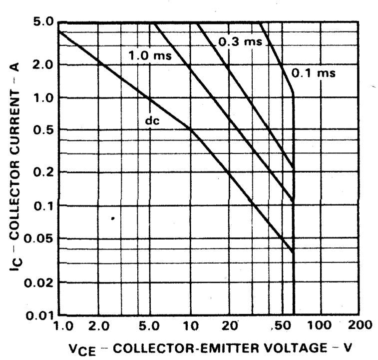
- **5.0 W DISSIPATION AT 25°C CASE**
- **5.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **40 – 150 $h_{FE}$ AT $I_C$ 2.0 A**

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

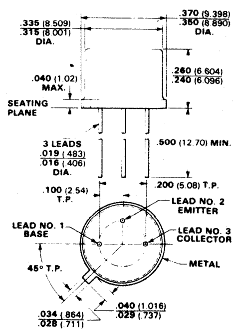
| | | |
|---|---|---|
| **Maximum Voltages and Currents** | | **BFX34** |
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V |
| $V_{CBO}$ | Collector to Base Voltage | 120 V |
| $V_{EBO}$ | Emitter to Base Voltage | 6.0 V |
| $I_C$ | Continuous Collector Current | 5.0 A |
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 5.0 W |
| | Derate Linearly from 25°C | 28.6 mW/°C |
| **Maximum Temperatures** | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −55°C to +200°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 35°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 1.23 grams

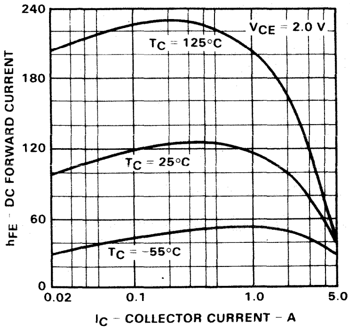
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | BFX34 MIN | BFX34 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $V_{CBO}$ | Collector-Base Breakdown Voltage | 120 | | V | $I_C = 5.0$ mA, $I_E = 0$ |
| $V_{EBO}$ | Emitter-Base Breakdown Voltage | 6.0 | | V | $I_E = 1.0$ mA, $I_C = 0$ |
| $I_{CES}$ | Collector Reverse Current | | 10 | μA | $V_{CE} = 60$ V, $V_{BE} = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 10 | μA | $V_{EB} = 4.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | 150 | | $I_C = 2.0$ A, $V_{CE} = 2.0$ V |
| | | 100 TYP | | | $I_C = 1.0$ A, $V_{CE} = 2.0$ V |
| | | 75 TYP | | | $I_C = 1.5$ A, $V_{CE} = 2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | V | $I_C = 5.0$ A, $I_B = 0.5$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.6 | V | $I_C = 5.0$ A, $I_B = 0.5$ A |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| $C_{ob}$ | Output Capacitance | | 100 | pF | $V_{CB} = 10$ V, $I_E = 0$, f = 1.0 MHz |
| $C_{TE}$ | Emitter-Transition Capacitance | | 400 | pF | $V_{EB} = 0.5$ V, $I_C = 0$, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 3.5 | | | $I_C = 0.5$ A, $V_{CE} = 5.0$ V, f = 20 MHz |
| **SWITCHING CHARACTERISTICS** | | | | | |
| $t_{on}$ | Turn On Time | | 0.6 | μs | $I_C = 5.0$ A, $I_{B1} = 5.0$ A |
| $t_{off}$ | Turn Off Time | | 1.2 | μs | $I_C = 5.0$ A, $I_{B1} = I_{B2} = 0.5$ A |

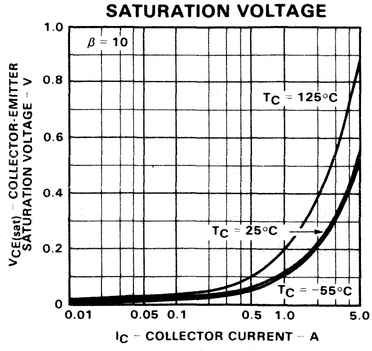
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

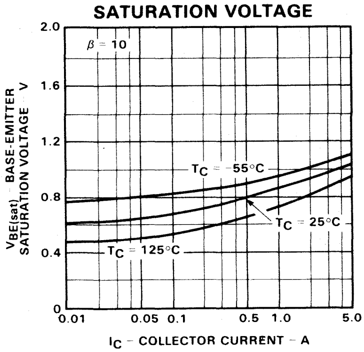
### DC CURRENT GAIN



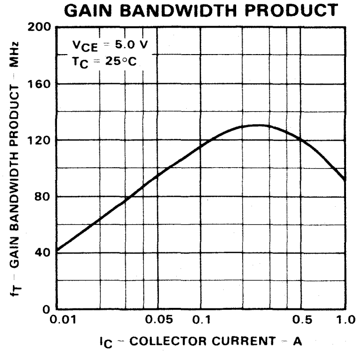

### COLLECTOR-EMITTER SATURATION VOLTAGE



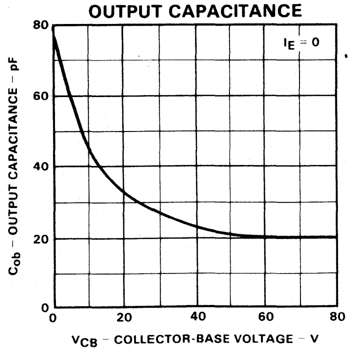

### BASE-EMITTER SATURATION VOLTAGE




### GAIN BANDWIDTH PRODUCT




### OUTPUT CAPACITANCE



# POWER TRANSISTOR

NPN SILICON

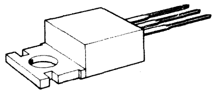
**FT47**
**FT48**
**FT49**
**FT50**

## DESIGNED FOR HIGH VOLTAGE APPLICATIONS

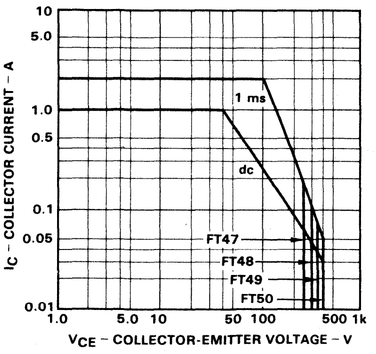
- 40 W DISSIPATION AT 25°C CASE
- 1 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 250 MIN TO 400 V MIN $V_{CEO}$

### ABSOLUTE MAXIMUM RATINGS (Note 1)

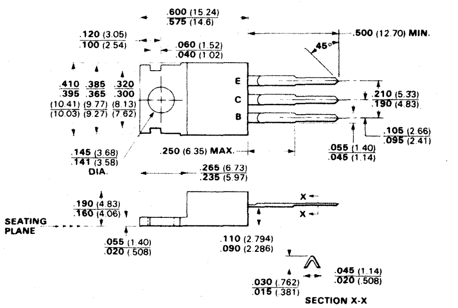
| Maximum Voltages and Currents | | FT47 | FT48 | FT49 | FT50 |
|---|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 250 V | 300 V | 350 V | 400 V |
| $V_{CBO}$ | Collector to Base Voltage | 350 V | 400 V | 450 V | 500 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A | 1.0 A | 1.0 A | 1.0 A |
| $I_C$ | Peak Collector Current | 2.0 A | 2.0 A | 2.0 A | 2.0 A |
| $I_B$ | Continuous Base Current | 0.6 A | 0.6 A | 0.6 A | 0.6 A |
| **Maximum Power Dissipation** | | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | | 40 W |
| | Derate Linearly from 25°C | | | | 0.32 W/°C |
| **Maximum Temperatures** | | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | | 3.13°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220)** Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

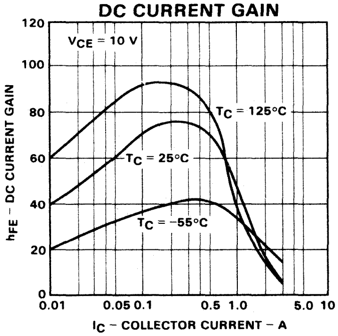
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | FT47 MIN | FT47 MAX | FT48 MIN | FT48 MAX | FT49 MIN | FT49 MAX | FT50 MIN | FT50 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 250 | | 300 | | 350 | | 400 | | V | $I_C = 30$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 1.0 | | | | | | | mA | $V_{CE} = 150$ V, $I_B = 0$ |
| | | | | | 1.0 | | | | | mA | $V_{CE} = 200$ V, $I_B = 0$ |
| | | | | | | | 1.0 | | | mA | $V_{CE} = 250$ V, $I_B = 0$ |
| | | | | | | | | | 1.0 | mA | $V_{CE} = 300$ V, $I_B = 0$ |
| $I_{CES}$ | Collector Reverse Current | | 1.0 | | | | | | | mA | $V_{CE} = 350$ V, $V_{BE} = 0$ |
| | | | | | 1.0 | | | | | mA | $V_{CE} = 400$ V, $V_{BE} = 0$ |
| | | | | | | | 1.0 | | | mA | $V_{CE} = 450$ V, $V_{BE} = 0$ |
| | | | | | | | | | 1.0 | mA | $V_{CE} = 500$ V, $V_{BE} = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30 | 150 | 30 | 150 | 30 | 150 | 30 | 150 | | $I_C = 0.3$ A, $V_{CE} = 10$ V |
| | | 10 | | 10 | | 10 | | 10 | | | $I_C = 1.0$ A, $V_{CE} = 10$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | | 1.0 | | 1.0 | V | $I_C = 1.0$ A, $I_B = 0.2$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.5 | | 1.5 | | 1.5 | | 1.5 | V | $I_C = 1.0$ A, $V_{CE} = 10$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | | | |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 5.0 | | 5.0 | | 5.0 | | 5.0 | | | $I_C = 0.2$ A, $V_{CE} = 10$ V, f = 2.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 25 | | 25 | | 25 | | 25 | | | $I_C = 0.2$ A, $V_{CE} = 10$ V, f = 1.0 KHz |

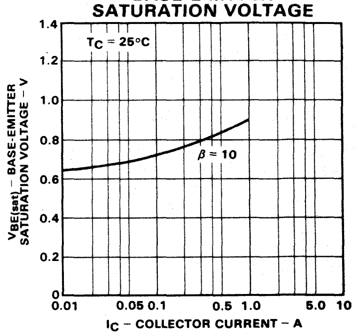
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

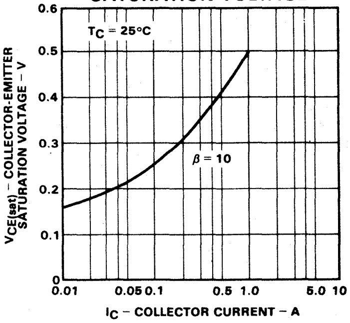
### DC CURRENT GAIN

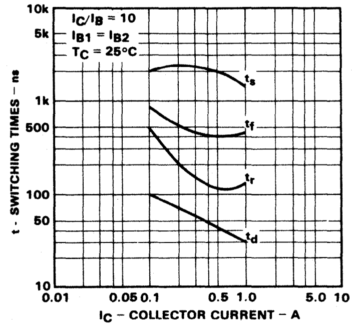



### BASE-EMITTER SATURATION VOLTAGE




### COLLECTOR-EMITTER SATURATION VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

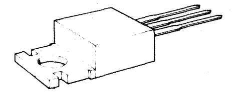
# FT317
# FT317A
# FT317B

### DESIGNED FOR HIGH FREQUENCY DRIVER IN AUDIO AMPLIFIERS

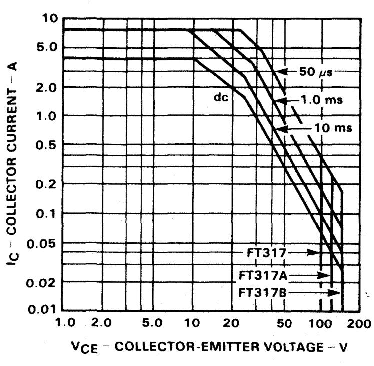
- 40 W DISSIPATION AT 25°C CASE
- 4.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 35 MINIMUM $h_{FE}$ @ 1.0 A
- COMPLEMENT TO FT417, FT417A, FT417B

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

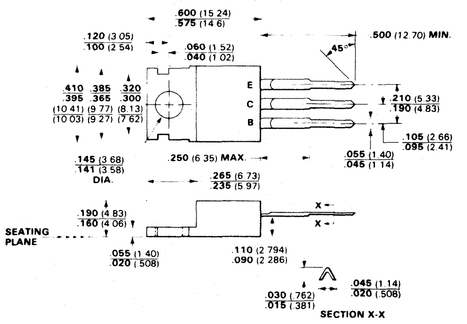
| | | FT317 | FT317A | FT317B |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 100 V | 120 V | 140 V |
| $V_{CBO}$ | Collector to Base Voltage | 100 V | 120 V | 140 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 4.0 A | 4.0 A | 4.0 A |
| $I_C$ | Peak Collector Current | 8.0 A | 8.0 A | 8.0 A |
| $I_B$ | Continuous Base Current | 2.0 A | 2.0 A | 2.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 40 W |
| | Derate Linearly from 25°C | | | 0.32 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 3.13°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

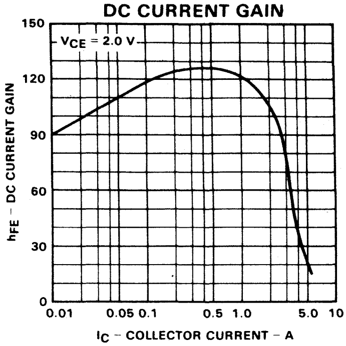
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | FT317 | | FT317A | | FT317B | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 100 | | 120 | | 140 | | V | $I_C$ = 10 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE}$ = 100 V, $I_B$ = 0 |
| | | | | | 0.5 | | | mA | $V_{CE}$ = 120 V, $I_B$ = 0 |
| | | | | | | | 0.5 | mA | $V_{CE}$ = 140 V, $I_B$ = 0 |
| $I_{CBO}$ | Collector Cutoff Current | | 0.01 | | | | | mA | $V_{CB}$ = 100 V, $I_E$ = 0 |
| | | | | | 0.01 | | | mA | $V_{CB}$ = 120 V, $I_E$ = 0 |
| | | | | | | | 0.01 | mA | $V_{CB}$ = 140 V, $I_E$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.1 | | 0.1 | | 0.1 | mA | $V_{EB}$ = –5.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 35 | | 35 | | 35 | | | $I_C$ = 1.0 A, $V_{CE}$ = 2.0 V |
| | | 20 | | 20 | | 20 | | | $I_C$ = 3.0 A, $V_{CE}$ = 2.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.5 | | 0.5 | | 0.5 | V | $I_C$ = 1.0 A, $I_B$ = 0.1 A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.0 | | 1.0 | | 1.0 | V | $I_C$ = 1.0 A, $V_{CE}$ = 2.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 20 | | 20 | | 20 | | MHz | $I_C$ = 200 mA, $V_{CE}$ = 10 V, f = 10 MHz |
| $C_{ob}$ | Output Capacitance | | 100 | | 100 | | 100 | pF | $V_{CB}$ = 20 V, $I_E$ = 0, f = 1.0 MHz |

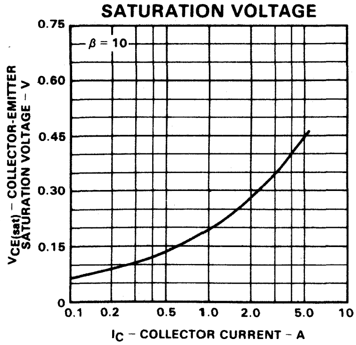
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

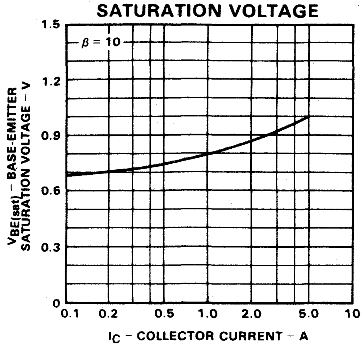
### DC CURRENT GAIN



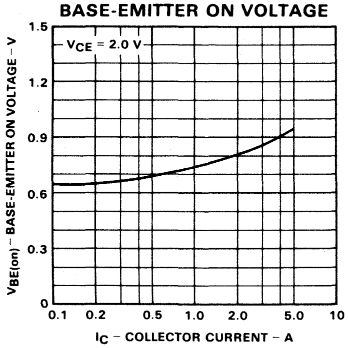

### COLLECTOR-EMITTER SATURATION VOLTAGE



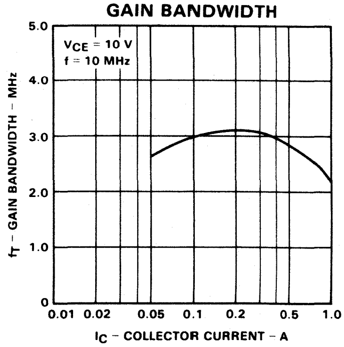

### BASE-EMITTER SATURATION VOLTAGE



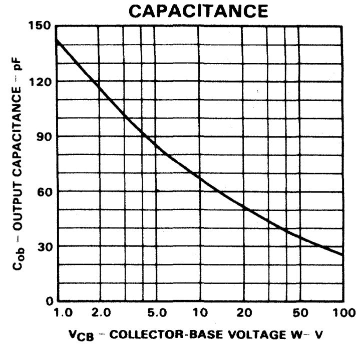

### BASE-EMITTER ON VOLTAGE




### GAIN BANDWIDTH




### CAPACITANCE

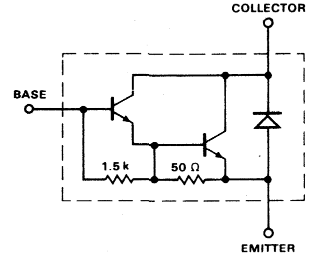


# POWER DARLINGTON

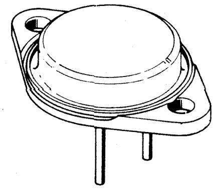
## NPN SILICON

## FT359

### HIGH VOLTAGE, HIGH CURRENT DARLINGTON DEVELOPED FOR IGNITION (COIL DRIVER) APPLICATIONS



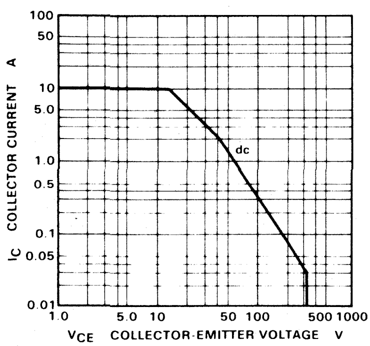

- 125 W DISSIPATION AT 25°C CASE
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 350 V $V_{CEO}$



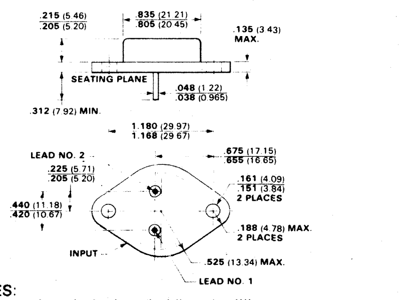
### ABSOLUTE MAXIMUM RATINGS (note 1)

| | | |
|---|---|---|
| **Maximum Voltages and Currents** | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 350 V |
| $V_{CBO}$ | Collector to Base Voltage | 375 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V |
| $I_C$ | Continuous Collector Current | 10 A |
| $I_C$ | Peak Collector Current | 15 A |
| $I_B$ | Continuous Base Current | 2.0 A |
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 125 W |
| | Derate Linearly from 25°C | 1.0 W/°C |
| **Maximum Temperatures** | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | -65°C to +150°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.0°C/W |

**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

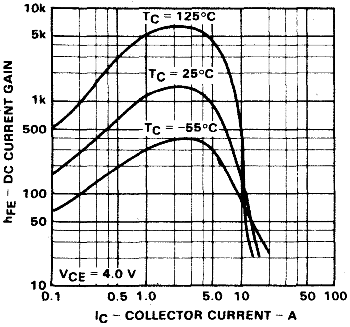
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | FT359 MIN | FT359 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 350 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $V_{CER}$ | Collector-Emitter Breakdown Voltage (Note 1) | 350 | | V | $I_C = 200$ mA, $R_{BE} = 100\ \Omega$ |
| $I_{CEO}$ | Collector Cutoff Current | | 3.0 | mA | $V_{CE} = 375$ V, $I_B = 0$ |
| $I_{CEV}$ | Collector Cutoff Current | | 5.0 | mA | $V_{CE} = 375$ V, $V_{BE} = -1.5$ V |
| $I_{CER}$ | Collector Cutoff Current | | 2.0 | mA | $V_{CE} = 375$ V, $R_{BE} = 100\ \Omega$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 10 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 250 | | | $I_C = 3.0$ A, $V_{CE} = 3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 2.5 | V | $I_C = 7.0$ A, $I_B = 140$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 2.8 | V | $I_C = 7.0$ A, $I_B = 140$ mA |

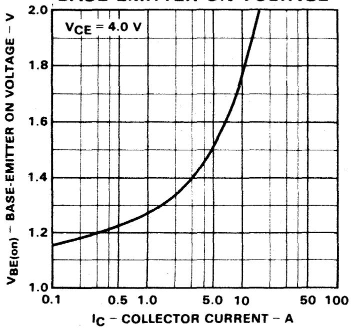
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

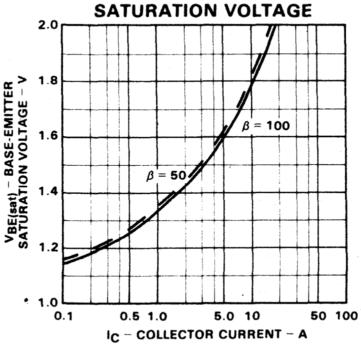
### DC CURRENT GAIN



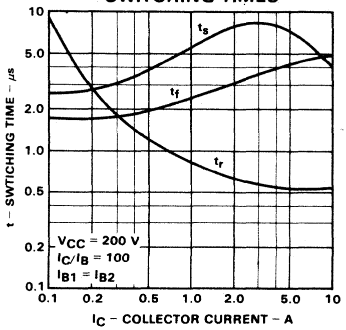

### BASE-EMITTER ON VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE




### SWITCHING TIMES



# POWER TRANSISTOR

## NPN SILICON

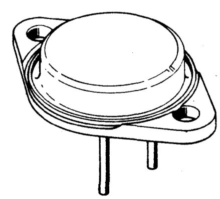
# FT401
# FT402

**HIGH VOLTAGE, HIGH POWER DEVICES SPECIFICALLY DESIGNED FOR IGNITION SYSTEMS AND HIGH VOLTAGE APPLICATIONS REQUIRING RUGGED SOA CHARACTERISTICS**

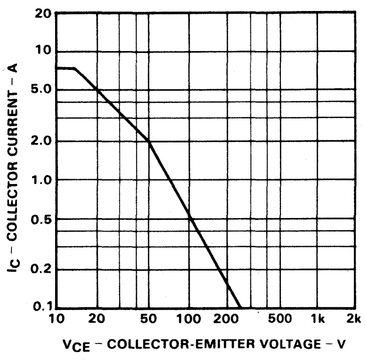
- 100 W DISSIPATION AT 25°C CASE
- 3.5 A MAXIMUM CONTINUOUS COLLECTOR CURRENT (FT402)
- 0.5 mA MAX $I_{CEO}$ AT 400 V

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

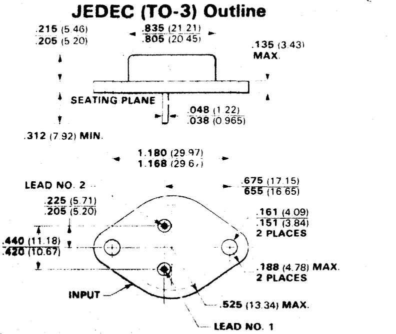
| | | FT401 | FT402 |
|---|---|---|---|
| **Maximum Voltage and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 400 V | 400 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 2.0 A | 2.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 100 W |
| | Derate Linearly from 25°C | | 0.57 W/°C |
| ***Maximum Temperatures*** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 1.75°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

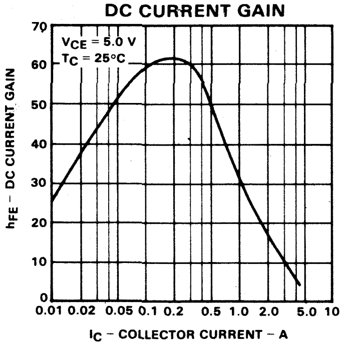
**ELECTRICAL CHARACTERISTICS** *(25°C Case Temperature unless otherwise noted)*

| SYMBOL | CHARACTERISTIC | FT401 MIN | FT401 MAX | FT402 MIN | FT402 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 300 | | 325 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | 0.5 | mA | $V_{CE} = 400$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | 0.5 | mA | $V_{CE} = 400$ V, $V_{BE} = -1.5$ V |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20 | 100 | 20 | 100 | | $I_C = 0.5$ A, $V_{CE} = 5.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.8 | | | V | $I_C = 0.5$ A, $I_B = 0.05$ A |
| | | | | | 2.0 | V | $I_C = 3.0$ A, $I_B = 0.6$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.5 | | 1.5 | V | $I_C = 3.0$ A, $I_B = 0.6$ A |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 2.0 | | 2.0 | | MHz | $I_C = 0.5$ A, $V_{CE} = 5.0$ V, f = 1.0 MHz |

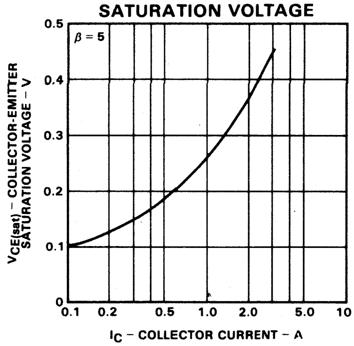
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

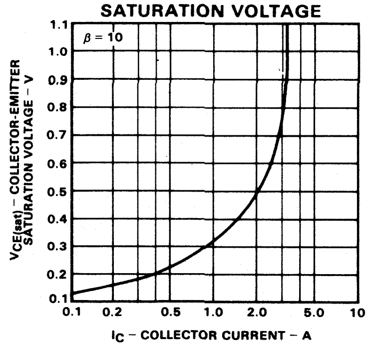
### DC CURRENT GAIN



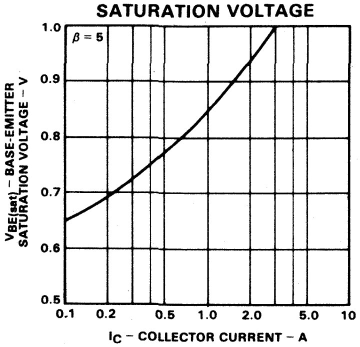

### COLLECTOR-EMITTER SATURATION VOLTAGE



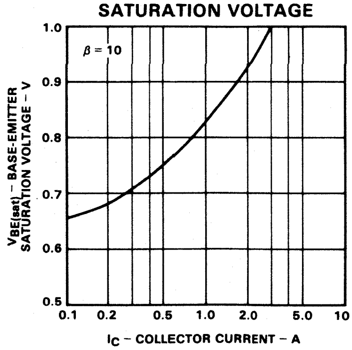

### COLLECTOR-EMITTER SATURATION VOLTAGE



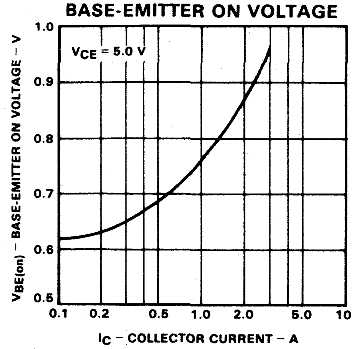

### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

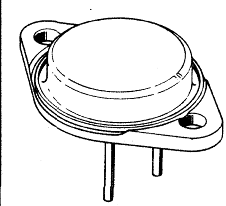
## FT410
## FT411

### HIGH VOLTAGE, HIGH POWER DEVICES SPECIFICALLY DESIGNED FOR IGNITION SYSTEMS AND HIGH VOLTAGE APPLICATIONS REQUIRING RUGGED SOA CHARACTERISTICS

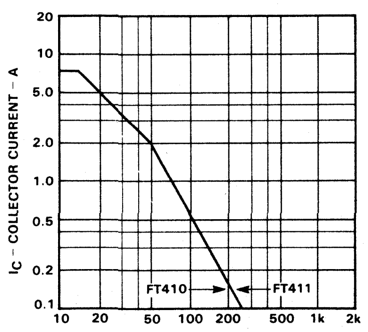
- **100 W DISSIPATION AT 25°C CASE**
- **7.5 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **0.25 mA MAX $I_{CEO}$ AT 300 V (FT411)**

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

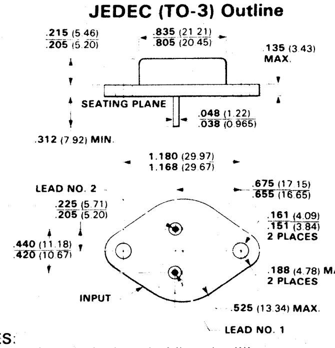
| | | FT410 | FT411 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 200 V | 300 V |
| $V_{CBO}$ | Collector to Base Voltage | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 7.5 A | 7.5 A |
| $I_B$ | Continuous Base Current | 3.75 A | 3.75 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 100 W |
| | Derate Linearly from 25°C | | 0.57 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 1.75°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**



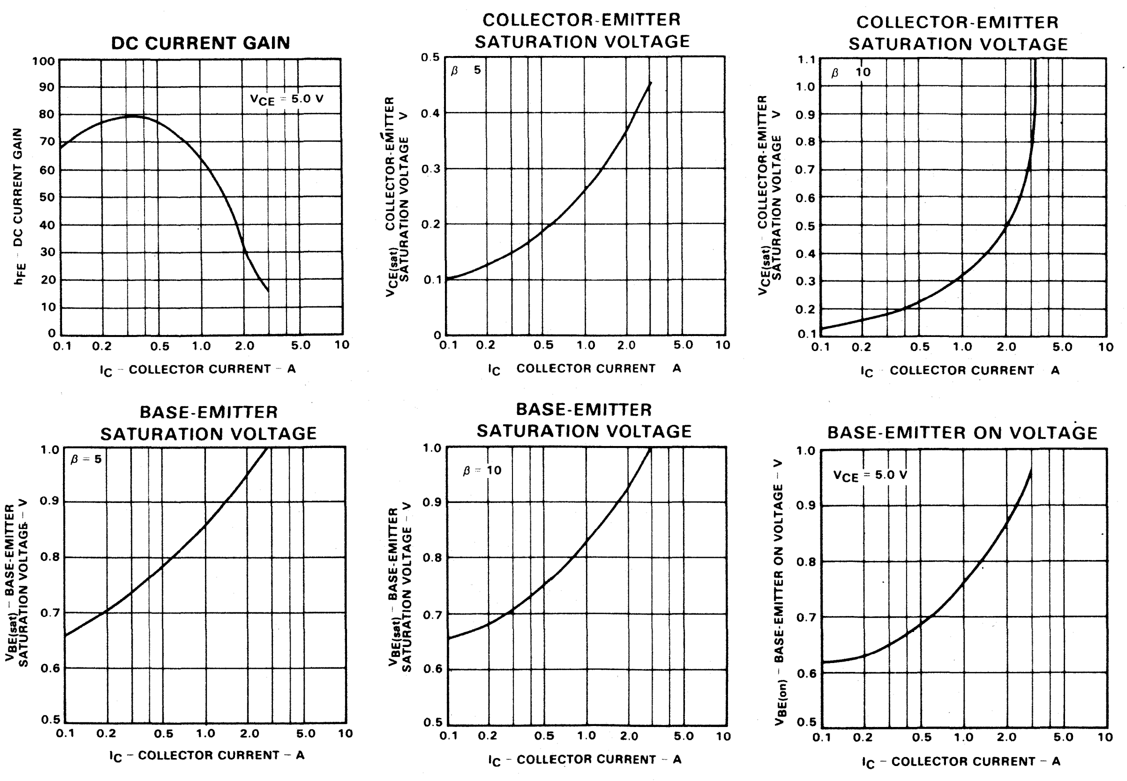

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | FT410 MIN | FT410 MAX | FT411 MIN | FT411 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 200 | | 300 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.25 | | | mA | $V_{CE} = 200$ V, $I_B = 0$ |
| | | | | | 0.25 | mA | $V_{CE} = 300$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff-Current | | 0.5 | | 0.5 | mA | $V_{CEX} = 300$ V, $V_{BE} = -1.5$ V, $T_C = 125°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30 | 90 | 30 | 90 | | $I_C = 1.0$ A, $V_{CE} = 5.0$ V |
| | | 10 | | 10 | | | $I_C = 2.5$ A, $V_{CE} = 5.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.8 | | 0.8 | V | $I_C = 1.0$ A, $I_B = 0.1$ A |
| | | | 5.0 | | 5.0 | V | $I_C = 7.5$ A, $I_B = 3.75$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.5 | | 1.5 | V | $I_C = 1.0$ A, $I_B = 0.1$ A |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 5.0 | | 5.0 | | MHz | $I_C = 0.2$ A, $V_{CE} = 5.0$ V, f = 1.0 MHz |

NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS



# POWER TRANSISTOR

## NPN SILICON

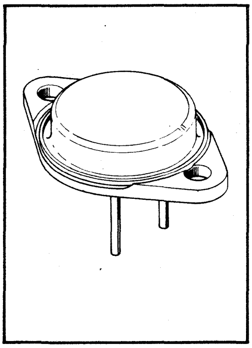
**FT413**
**FT423**

### HIGH POWER, HIGH VOLTAGE DEVICE DESIGNED SPECIFICALLY FOR AUTO IGNITION SYSTEMS

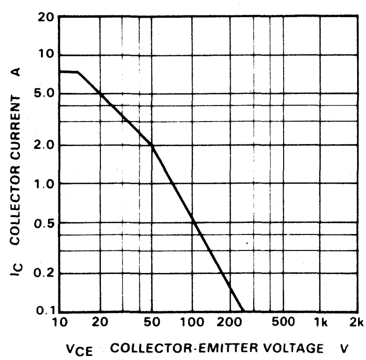
- 100 W DISSIPATION AT 25°C CASE
- 7.5 A MAXIMUM CONTINUOUS COLLECTOR CURRENT

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

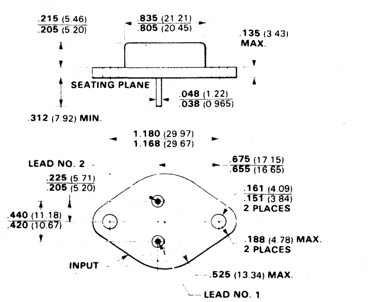
| | | FT413 | FT423 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 400 V | 400 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 7.5 A | 7.5 A |
| $I_B$ | Continuous Base Current | 3.75 A | 3.75 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 100 W |
| | Derate Linearly from 25°C | | 0.57 W/°C |
| **Maximum Temperatures** | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 1.75 W/°C |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

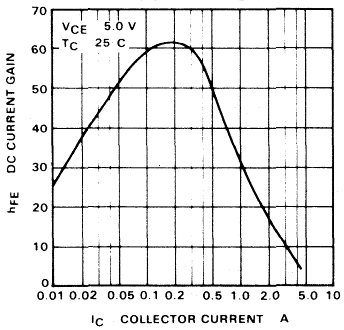
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | FT413 MIN | FT413 MAX | FT423 MIN | FT423 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 325 | | 325 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.25 | | 0.25 | mA | $V_{CE} = 400$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 0.5 | | 0.5 | mA | $V_{CE} = 400$ V, $V_{BE} = -1.5$ V, $T_C = 125°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20 | 80 | | | | $I_C = 0.5$ A, $V_{CE} = 5.0$ V |
| | | | | 30 | 90 | | $I_C = 1.0$ A, $V_{CE} = 5.0$ V |
| | | 15 | | | | | $I_C = 1.0$ A, $V_{CE} = 5.0$ V |
| | | | | 10 | | | $I_C = 2.5$ A, $V_{CE} = 5.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.8 | | | V | $I_C = 0.5$ A, $I_B = 0.05$ A |
| | | | | | 0.8 | V | $I_C = 1.0$ A, $I_B = 0.1$ A |
| | | | 5.0 | | 5.0 | V | $I_C = 7.5$ A, $I_B = 3.75$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.5 | | | V | $I_C = 0.5$ A, $I_B = 0.05$ A |
| | | | | | 1.5 | V | $I_C = 1.0$ A, $I_B = 0.1$ A |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 5.0 TYP | | 5.0 TYP | | MHz | $I_C = 0.2$ A, $V_{CE} = 5.0$ V, f = 1.0 MHz |

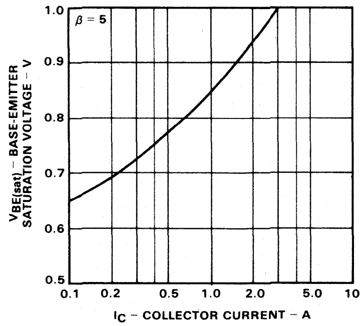
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

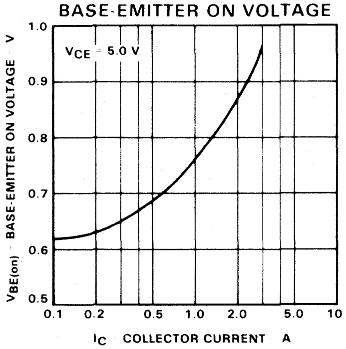
DC CURRENT GAIN



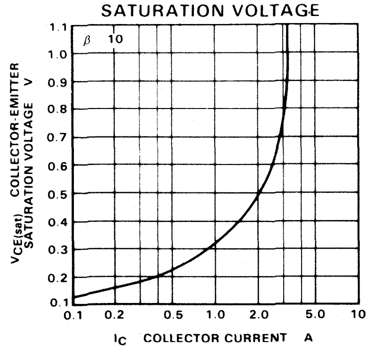

BASE-EMITTER SATURATION VOLTAGE




BASE-EMITTER ON VOLTAGE




COLLECTOR-EMITTER SATURATION VOLTAGE



# POWER TRANSISTOR

## PNP SILICON

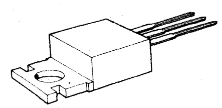
# FT417
# FT417A
# FT417B

### DESIGNED FOR HIGH FREQUENCY DRIVER IN AUDIO AMPLIFIERS

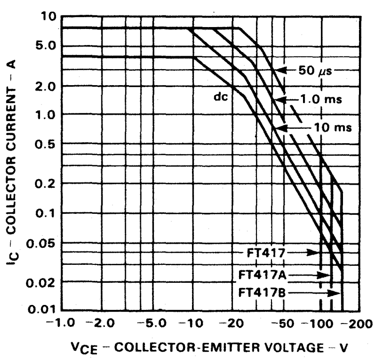
- 40 W DISSIPATION AT 25°C CASE
- 4.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 35 MINIMUM $h_{FE}$ @ 1.0 A
- COMPLEMENT TO FT317, FT317A, FT317B

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

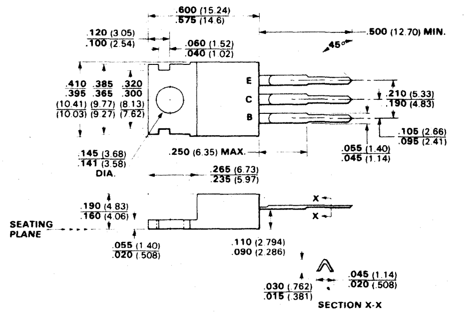
| | | FT417 | FT417A | FT417B |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −100 V | −120 V | −140 V |
| $V_{CBO}$ | Collector to Base Voltage | −100 V | −120 V | −140 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector | 4.0 A | 4.0 A | 4.0 A |
| $I_C$ | Peak Collector Current | 8.0 A | 8.0 A | 8.0 A |
| $I_B$ | Continuous Base Current | 2.0 A | 2.0 A | 2.0 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 40 W |
| | Derate Linearly from 25°C | | | 0.32 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 3.13°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
*All dimensions in inches (bold) and millimeters (parentheses)*
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

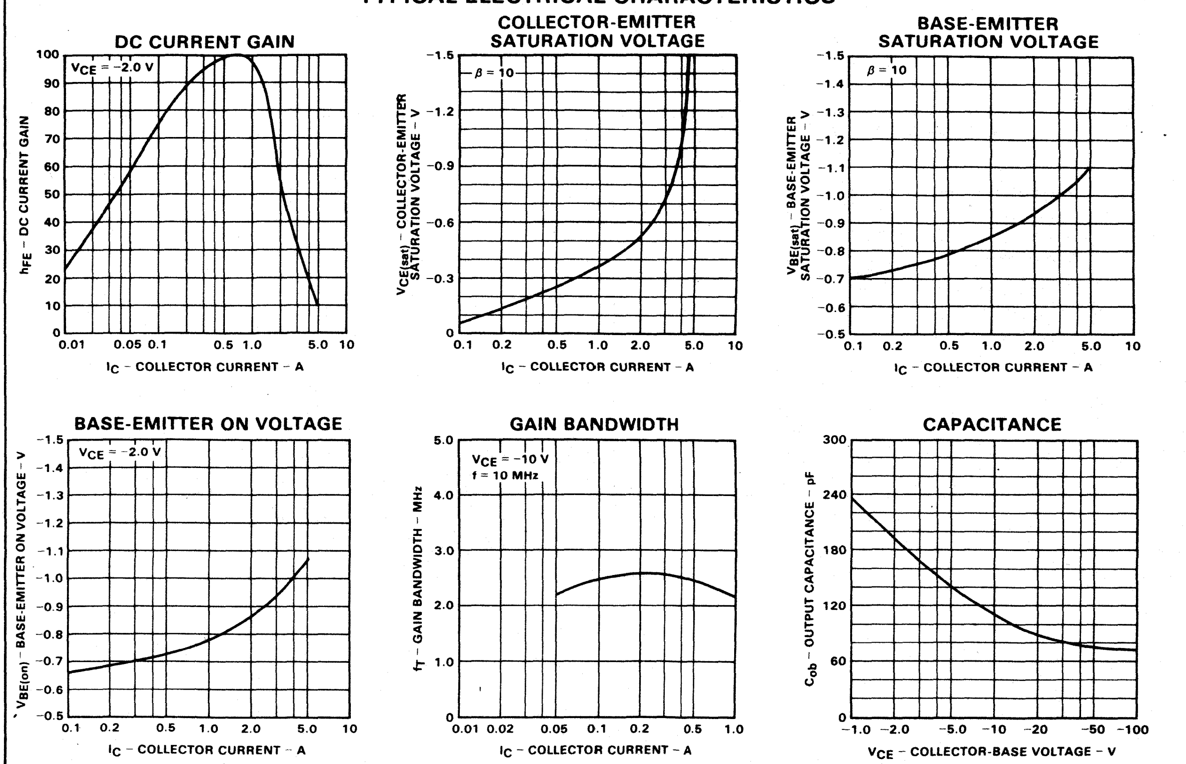
# FAIRCHILD • FT417 • FT417A • FT417B

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | FT417 MIN | FT417 MAX | FT417A MIN | FT417A MAX | FT417B MIN | FT417B MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −100 | | −120 | | −140 | | V | $I_C = 10$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE} = -100$ V, $I_B = 0$ |
| | | | | | 0.5 | | | mA | $V_{CE} = -120$ V, $I_B = 0$ |
| | | | | | | | 0.5 | mA | $V_{CE} = -140$ V, $I_B = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.01 | | | | | mA | $V_{CB} = -100$ V, $I_E = 0$ |
| | | | | | 0.01 | | | mA | $V_{CB} = -120$ V, $I_E = 0$ |
| | | | | | | | 0.01 | mA | $V_{CB} = -140$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.1 | | 0.1 | | 0.1 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 35 | | 35 | | 35 | | | $I_C = 1.0$ A, $V_{CE} = -2.0$ V |
| | | 20 | | 20 | | 20 | | | $I_C = 3.0$ A, $V_{CE} = -2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −0.5 | | −0.5 | | −0.5 | V | $I_C = 1.0$ A, $I_B = 0.1$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.0 | | −1.0 | | −1.0 | V | $I_C = 1.0$ A, $V_{CE} = -2.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 20 | | 20 | | 20 | | MHz | $I_C = 200$ mA, $V_{CE} = -10$ V, f = 10 MHz |
| $C_{ob}$ | Output Capacitance | | 100 | | 100 | | 100 | pF | $V_{CB} = -20$ V, $I_E = 0$, f = 1.0 MHz |

NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS



# POWER TRANSISTOR

## NPN SILICON

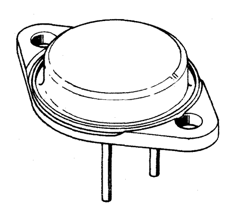
**FT430**
**FT431**

### SUITABLE FOR USE IN INVERTERS, DEFLECTION CIRCUITS, SWITCHING REGULATORS AND IGNITION CIRCUITS

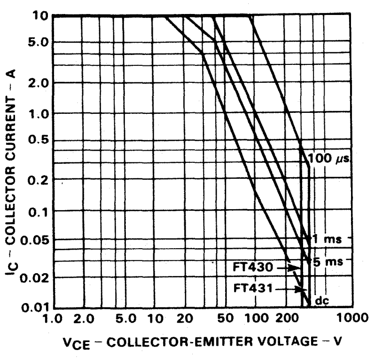
- **125 W DISSIPATION AT 25°C CASE**
- **10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **400 V $V_{CEO}$**

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

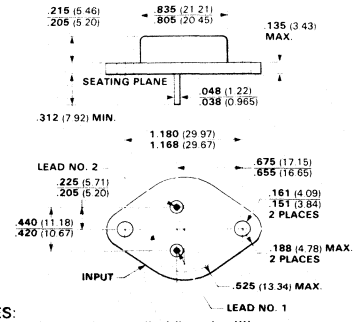
| | | FT430 | FT431 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 400 V | 400 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A |
| $I_B$ | Continuous Base Current | 5.0 A | 5.0 A |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 125 W |
| | Derate Linearly from 25°C | | 0.71 W/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 1.4°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

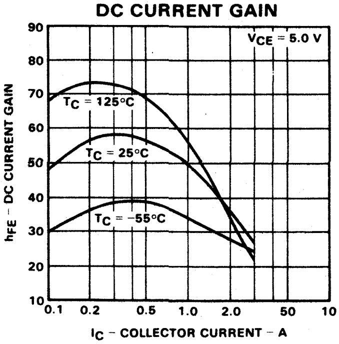
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | FT430 MIN | FT430 MAX | FT431 MIN | FT431 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 300 | | 325 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 2.5 | | 2.5 | mA | $V_{CE} = 400$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 5.0 | | 5.0 | mA | $V_{CE} = 400$ V, $V_{BE} = -1.5$ V<br>$T_C = 125$°C |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | | 5.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 15<br>10 | 45 | 15<br>10 | 35 | | $I_C = 2.5$ A, $V_{CE} = 5.0$ V<br>$I_C = 3.5$ A, $V_{CE} = 5.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.9<br>5.0 | | 0.7<br>5.0 | V<br>V | $I_C = 2.5$ A, $I_B = 0.5$ A<br>$I_C = 10$ A, $I_B = 5.0$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.5 | | 1.5 | V | $I_C = 2.5$ A, $I_B = 0.5$ A |

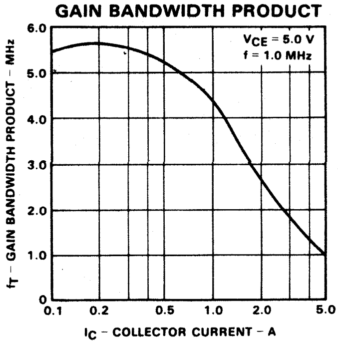
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

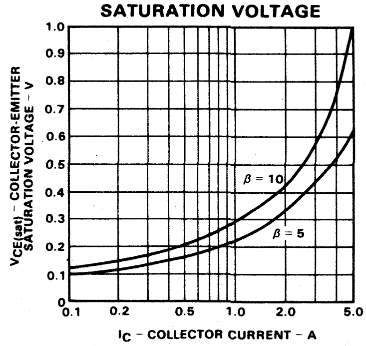
### DC CURRENT GAIN



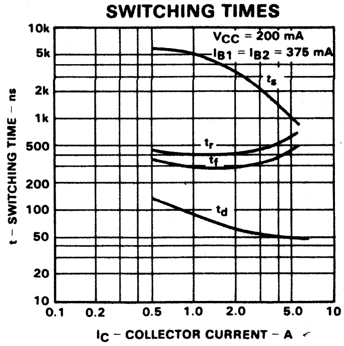

### GAIN BANDWIDTH PRODUCT



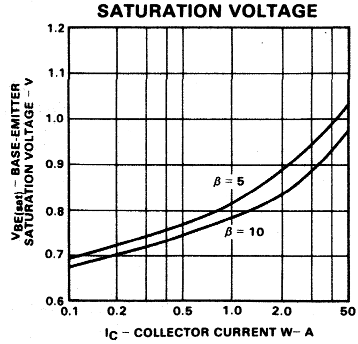

### COLLECTOR-EMITTER SATURATION VOLTAGE




### SWITCHING TIMES




### BASE-EMITTER SATURATION VOLTAGE



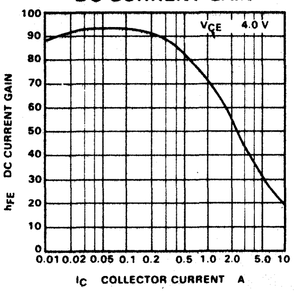
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | FT2955 MIN | FT2955 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | V | $I_C$ = 200 mA, $I_B$ = 0 |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −70 | | V | $I_C$ = 200 mA, $R_{BE}$ = 100 Ω |
| $I_{CEO}$ | Collector Cutoff Current | | 0.7 | mA | $V_{CE}$ = −30 V, $I_B$ = 0 |
| $I_{CEX}$ | Collector Cutoff Current | | 5.0<br>30 | mA<br>mA | $V_{CE}$ = −100 V, $V_{BE}$ = 1.5 V<br>$V_{CE}$ = −100 V, $V_{BE}$ = 1.5 V, $T_C$ = 125°C |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | mA | $V_{EB}$ = −7.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 5.0<br>20 | <br>70 | | $I_C$ = 10 A, $V_{CE}$ = −4.0 V<br>$I_C$ = 4.0 A, $V_{CE}$ = −4.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −1.1<br>−8.0 | V<br>V | $I_C$ = 4.0 A, $I_B$ = 400 mA<br>$I_C$ = 10 A, $I_B$ = 3.3 A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.8 | V | $I_C$ = 4.0 A, $V_{CE}$ = −4.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 2.0 | | MHz | $I_C$ = 500 mA, $V_{CE}$ = −10 V, f = 500 kHz |
| $\lvert h_{fe} \rvert$ | Small Signal Current Gain | 15 | 120 | | $I_C$ = 1.0 A, $V_{CE}$ = −4.0 V, f = 1 kHz |

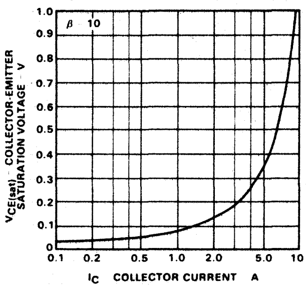
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

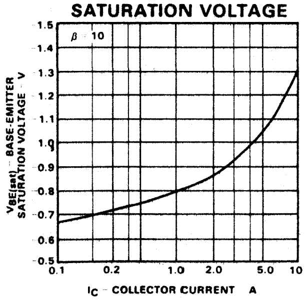
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE



# POWER TRANSISTOR

## PNP SILICON

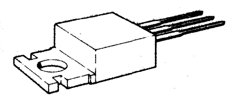
## FT2955

### DESIGNED FOR GENERAL PURPOSE SWITCHING AND AMPLIFIER APPLICATIONS

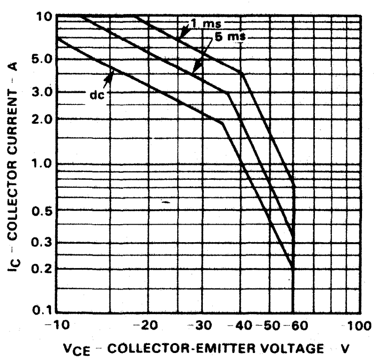
- 70 W DISSIPATION AT 25°C CASE
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 70 MAXIMUM $h_{FE}$ AT 4 Adc
- 1.1 Vdc MAXIMUM $V_{CE(sat)}$ AT 4 Adc

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

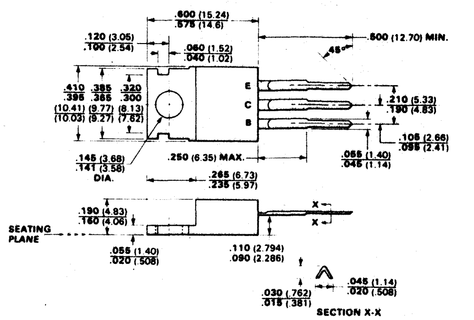
| | | |
|---|---|---|
| **Maximum Voltages and Currents** | | |
| $V_{CEO}$ | Collector to Emitter Voltage | -60 V |
| $V_{CBO}$ | Collector to Base Voltage | -100 V |
| $V_{EBO}$ | Emitter to Base Voltage | -7.0 V |
| $I_C$ | Continuous Collector Current | 10 A |
| $I_C$ | Peak Collector Current | 15 A |
| $I_B$ | Continuous Base Current | 7.0 A |
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 70 W |
| | Derate Linearly from 25°C | 0.56 W/°C |
| **Maximum Temperatures** | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | -65°C to +150°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.79°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

# POWER TRANSISTOR

**FT3055**

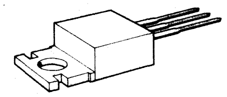
## NPN SILICON

## DESIGNED FOR GENERAL PURPOSE AMPLIFIER AND SWITCHING APPLICATIONS

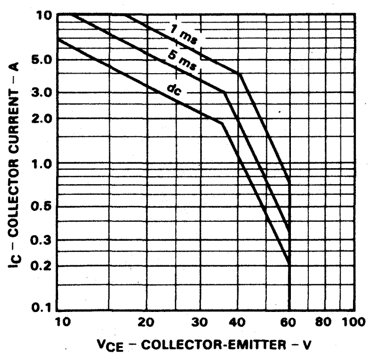
- 70 W DISSIPATION AT 25°C CASE
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- DC CURRENT GAIN SPECIFIED TO 10 A
- HIGH EFFICIENCY COMPACT PACKAGE

### ABSOLUTE MAXIMUM RATINGS

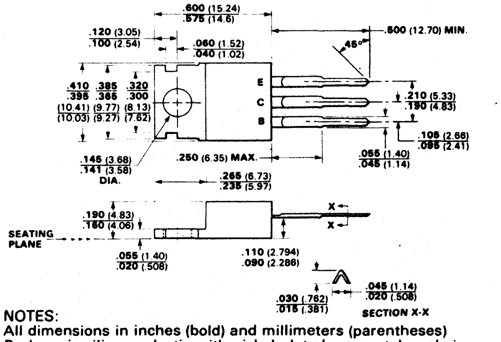
| | | |
|---|---|---|
| **Maximum Voltages and Currents** | | |
| $V_{CE}$ | Collector to Emitter Voltage | 60 V |
| $V_{CB}$ | Collector to Base Voltage | 100 V |
| $V_{EB}$ | Emitter to Base Voltage | 7.0 V |
| $I_C$ | Continuous Collector Current | 10 A |
| $I_B$ | Continuous Base Current | 7.0 A |
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 70 W |
| | Derate Linearly from 25°C | 0.56 W/°C |
| **Maximum Temperatures** | | |
| $T_J$, $T_{stg}$ | Storage and Operating Junction Temperatures | −65°C to +150°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.78°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220**) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

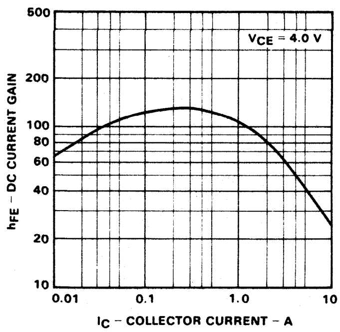
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTICS | MIN | MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $I_{CEX}$ | Collector Cutoff Current | | 5.0<br>30 | mA | $V_{CE} = 100$ V, $V_{BE} = -1.5$ V<br>$V_{CE} = 100$ V, $V_{BE} = -1.5$ V, $T_C = 150°C$ |
| $I_{CBO}$ | Collector Cutoff Current | | 700 | μA | $V_{CB} = 70$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | mA | $V_{EB} = 7.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20<br>5.0 | 70 | | $I_C = 4.0$ A, $V_{CE} = 4.0$ V<br>$I_C = 10$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.1<br>8.0 | V | $I_C = 4.0$ A, $I_B = 0.4$ A<br>$I_C = 10$ A, $I_B = 3.3$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.8 | V | $I_C = 4.0$ A, $V_{CE} = 4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 10 | | MHz | $I_C = 1.0$ A, $V_{CE} = 4.0$ V |

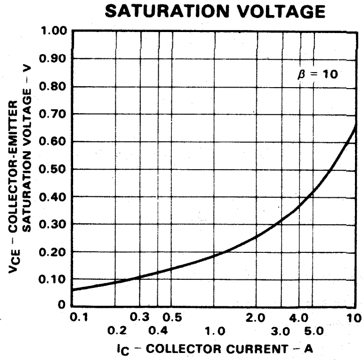
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

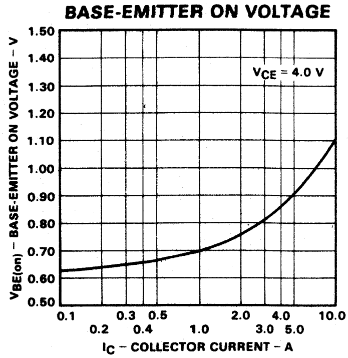
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

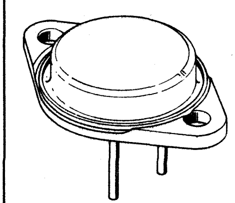
**MJ802**

## HIGH POWER NPN TRANSISTOR FOR USE AS AN OUTPUT DEVICE IN COMPLEMENTARY AUDIO AMPLIFIERS

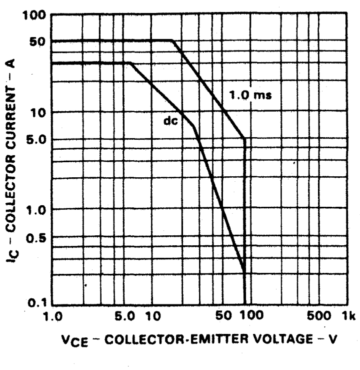
- 200 W DISSIPATION AT 25°C CASE
- 30 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- COMPLEMENT TO MJ4502

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

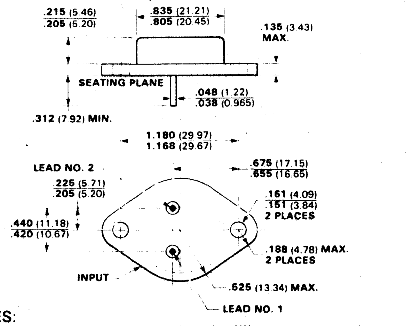
| | | MJ802 |
|---|---|---|
| **Maximum Voltages and Currents** | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 90 V |
| $V_{CBO}$ | Collector to Base Voltage | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 4.0 V |
| $I_C$ | Continuous Collector Current | 30 A |
| $I_B$ | Continuous Base Current | 7.5 A |
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 200 W |
| | Derate linearly from 25°C | 1.14 W/°C |
| **Maximum Temperatures** | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 0.875°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

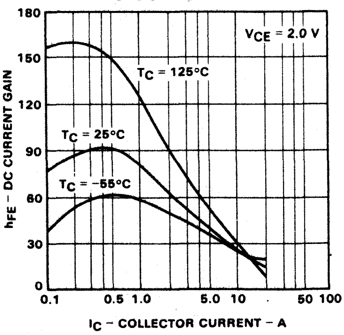
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | MJ802 MIN | MJ802 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|
| OFF CHARACTERISTICS | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 90 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 100 | | V | $I_C = 200$ mA, $R_{BE} = 100\ \Omega$ |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0<br>5.0 | mA<br>mA | $V_{CB} = 100$ V, $I_E = 0$<br>$V_{CB} = 100$ V, $I_E = 0$, $T_C = 150°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | mA | $V_{EB} = 4.0$ V, $I_C = 0$ |
| ON CHARACTERISTICS | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 25 | 100 | | $I_C = 7.5$ A, $V_{CE} = 2.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.8 | V | $I_C = 7.5$ A, $I_B = 0.75$ A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.3 | V | $I_C = 7.5$ A, $I_B = 0.75$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.3 | V | $I_C = 7.5$ A, $V_{CE} = 2.0$ V |
| DYNAMIC CHARACTERISTICS | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 2.0 | | MHz | $I_C = 1.0$ A, $V_{CE} = 10$ V, f = 1.0 MHz |

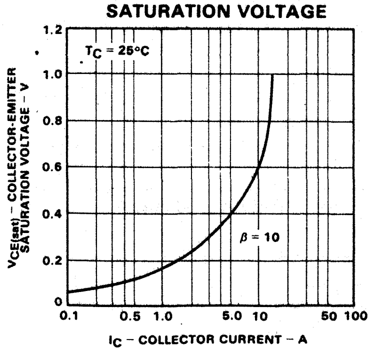
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

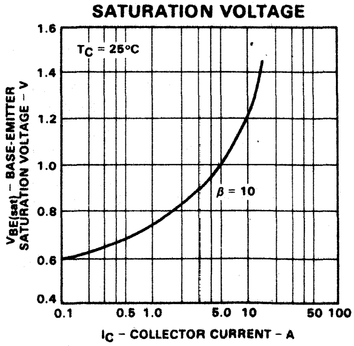
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE



# POWER TRANSISTOR

## PNP SILICON

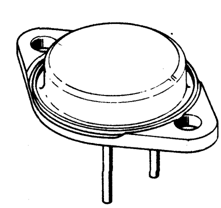
**MJ4502**

### HIGH POWER PNP TRANSISTOR FOR USE AS AN OUTPUT DEVICE IN COMPLEMENTARY AUDIO AMPLIFIERS

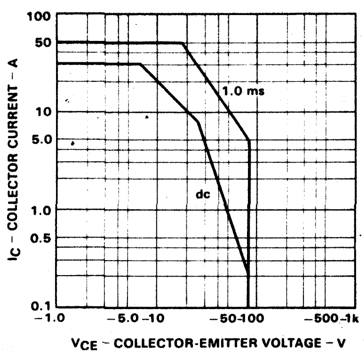
- **200 W DISSIPATION AT 25°C CASE**
- **30 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **COMPLEMENT TO MJ802**

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

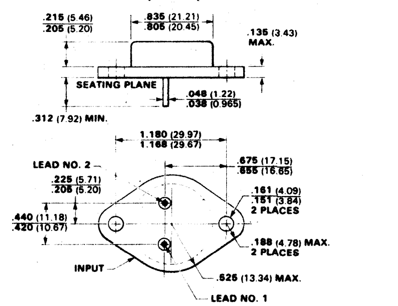
| | | |
|---|---|---|
| **Maximum Voltages and Currents** | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −90 V |
| $V_{CBO}$ | Collector to Base Voltage | −100 V |
| $V_{EBO}$ | Emitter to Base Voltage | −4.0 V |
| $I_C$ | Continuous Collector Current | 30 A |
| $I_B$ | Continuous Base Current | 7.5 A |
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 200 W |
| | *Derate Linearly from 25°C* | 1.14 W/°C |
| **Maximum Temperatures** | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +200°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 0.875°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

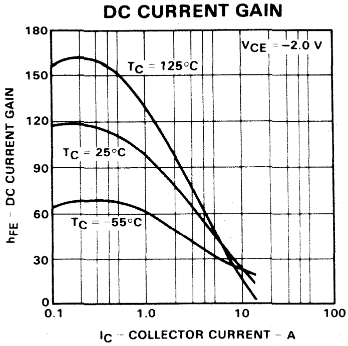
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | MJ4502 MIN | MJ4502 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −90 | | V | $I_C$ = 200 mA, $I_B$ = 0 |
| $V_{CER(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −100 | | V | $I_C$ = 200 mA, $R_{BE}$ = 100 Ω |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0 | mA | $V_{CB}$ = −100 V, $I_E$ = 0 |
| | | | 5.0 | mA | $V_{CB}$ = −100 V, $I_E$ = 0, $T_C$ = 150°C |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | mA | $V_{EB}$ = −4.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 25 | 100 | | $I_C$ = 7.5 A, $V_{CE}$ = −2.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −0.8 | V | $I_C$ = 7.5 A, $I_B$ = 0.75 A |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | −1.3 | V | $I_C$ = 7.5 A, $I_B$ = 0.75 A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.3 | V | $I_C$ = 7.5 A, $V_{CE}$ = −2.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 2.0 | | MHz | $I_C$ = 1.0 A, $V_{CE}$ = −10 V, f = 1.0 MHz |

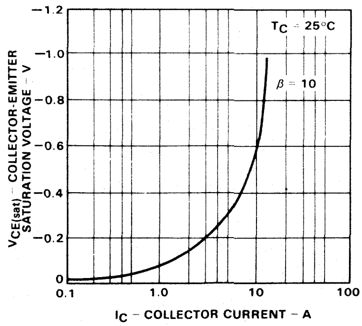
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

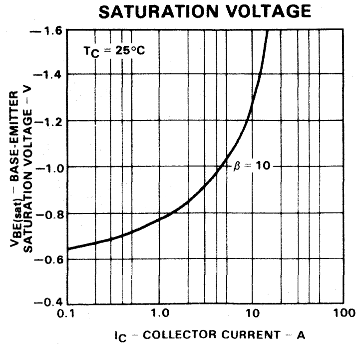
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

# MJE3055F

## DESIGNED FOR GENERAL PURPOSE AMPLIFIER AND SWITCHING APPLICATIONS

- 70 W DISSIPATION AT 25°C CASE
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- PIN OUT COMPATIBLE WITH MJE3055
- DC CURRENT GAIN SPECIFIED TO 10 A
- 2 MHz MINIMUM $f_T$ AT 500 mA
- HIGH EFFICIENCY COMPACT PACKAGE

### ABSOLUTE MAXIMUM RATINGS

**Maximum Voltages and Currents**

| | | |
|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | 60 V |
| $V_{CB}$ | Collector to Base Voltage | 70 V |
| $V_{EB}$ | Emitter to Base Voltage | 5 V |
| $I_C$ | Continuous Collector Current | 10 A |
| $I_B$ | Continuous Base Current | 6 A |

**Maximum Power Dissipation**

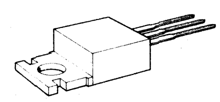
| | | |
|---|---|---|
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 70 W |
| | Derate Linearly from 25°C | 0.56 W/°C |

**Maximum Temperatures**

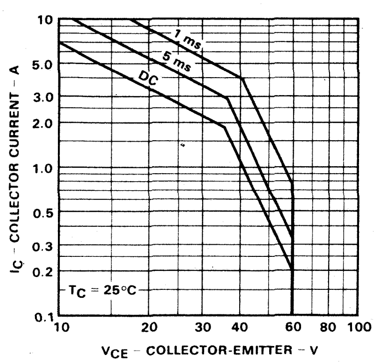
| | | |
|---|---|---|
| $T_J$, $T_{stg}$ | Storage and Operating Junction Temperatures | −55°C to +150°C |

**Thermal Characteristics**

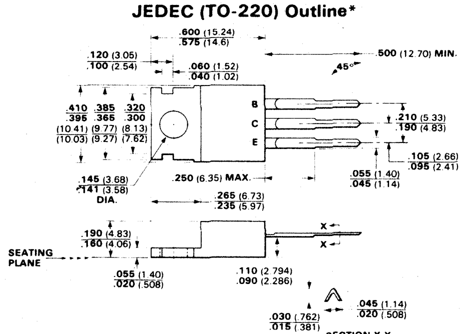
| | | |
|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.78 °C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline***




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
*Available in various pin configurations

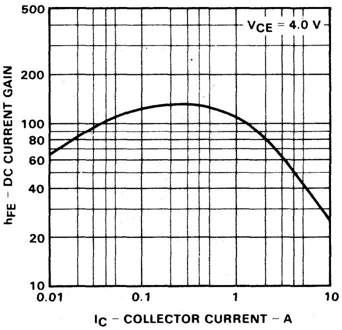
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | PARAMETER | MIN | MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | V | $I_C = 200$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.7 | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| $I_{CEX}$ | Collector Cutoff Current | | 1.0<br>5.0 | mA | $V_{CE} = 70$ V, $V_{BE} = -1.5$ V<br>$V_{CE} = 70$ V, $V_{BE} = -1.5$ V, $T_C = 150$°C |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0<br>10 | mA | $V_{CB} = 70$ V, $I_E = 0$<br>$V_{CB} = 70$ V, $I_E = 0$, $T_C = 150$°C |
| $I_{EBO}$ | Emitter Cutoff Current | | 5.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 20<br>5.0 | 70 | | $I_C = 4.0$ A, $V_{CE} = 4.0$ V<br>$I_C = 10$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.1<br>8.0 | V | $I_C = 4.0$ A, $I_B = 0.4$ A<br>$I_C = 10$ A, $I_B = 3.3$ A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.8 | V | $I_C = 4.0$ A, $V_{CE} = 4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 2.0 | | MHz | $I_C = 500$ mA, $V_{CE} = 10$ V, f = 500 kHz |

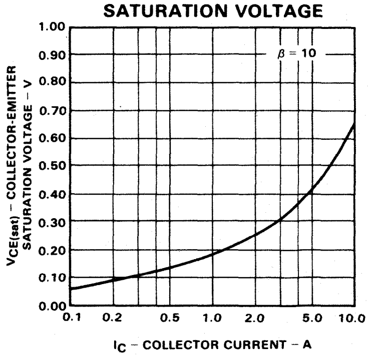
NOTE: 1. Pulse conditions: Length = 300 $\mu$s, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

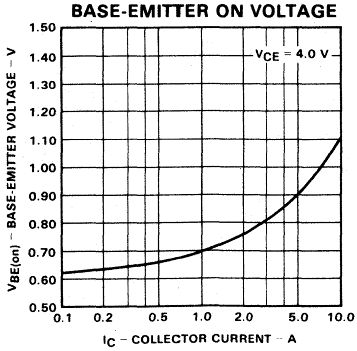
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

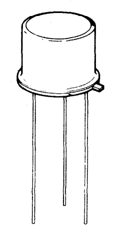
# MRF8004

## DESIGNED PRIMARILY FOR USE IN LARGE SIGNAL OUTPUT AMPLIFIER STAGES

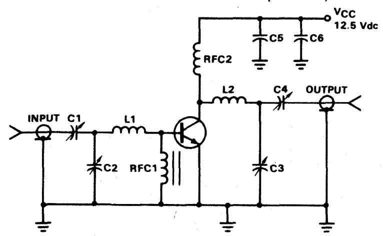
- INTENDED FOR USE IN CITIZEN BAND COMMUNICATION EQUIPMENT OPERATING TO 30 MHz
- HIGH BREAKDOWN VOLTAGES ALLOW A HIGH PERCENTAGE OF UP-MODULATION IN AM CIRCUITS
- SPECIFIED 12.5 V, 27 MHz CHARACTERISTICS
  - 3.5 W - POWER OUTPUT
  - 10 dB - POWER GAIN
  - 70% TYPICAL - EFFICIENCY

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

| | | |
|---|---|---|
| **Maximum Voltages and Currents** | | **MRF8004** |
| $V_{CEO}$ | Collector to Emitter Voltage | 30 V |
| $V_{CBO}$ | Collector to Base Voltage | 60 V |
| $V_{EBO}$ | Emitter to Base Voltage | 3.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A |
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature (Note 1) | 5.0 W |
| | Derate Linearly from 25°C | 28.6 mW/°C |
| **Maximum Temperatures** | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +200°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 35°C/W |

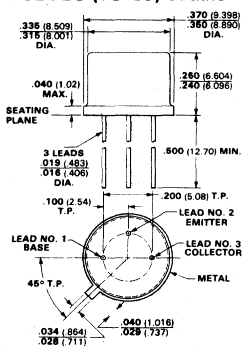


**27 MHz TEST CIRCUIT** (Note 2)




| | |
|---|---|
| RFC2 | 26 Turns #22 Enameled Wire (2 Layers – 13 Turns Each Layer) 1/4″ Inner Diameter |
| L1 | 0.22 µH Molded Choke |
| L2 | 0.68 µH Molded Choke |
| C1, C2 | 9.0–180 pF ARCO 463 or Equivalent |
| C3, C4 | 5.0–80 pF ARCO 462 or Equivalent |
| C5 | 0.02 µF Ceramic Disc |
| C6 | 0.1 µF Ceramic Disc |
| RFC1 | 4 Turns #30 Enameled Wire Wound on Ferroxcube Bead Type 56-590-65/3B |

**JEDEC (TO-39) outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | MRF8004 MIN | MRF8004 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 30 | | V | $I_C = 50$ mA, $I_B = 0$ |
| $V_{CES}$ | Collector-Emitter Breakdown Voltage | 60 | | V | $I_C = 200$ mA, $V_{BE} = 0$ |
| $V_{EBO}$ | Emitter-Base Breakdown Voltage | 3.0 | | V | $I_E = 1.0$ mA, $I_C = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.01 | mA | $V_{CB} = 50$ V, $I_E = 0$ |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 10 | | | $I_C = 400$ mA, $V_{CE} = 2.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| $C_{ob}$ | Output Capacitance | | 70 | pF | $V_{CB} = 12.5$ V, $I_E = 0$, f = 1.0 MHz |
| **FUNCTIONAL TESTS** | | | | | |
| $G_{PE}$ | Common-Emitter Amplifier Power Gain | 10 | | dB | f = 27 MHz, $V_{CC} = 12.5$ V, $P_{out} = 3.5$ W |
| $\eta$ | Collector Efficiency (Note 3) | 62.5 | | % | f = 27 MHz, $V_{CC} = 12.5$ V, $P_{out} = 3.5$ W |
| $R_{in}$ | Parallel Equivalent Input Resistance | | 21 TYP | Ω | $P_{out} = 3.5$ W, $V_{CC} = 12.5$ V, f = 27 MHz |
| $C_{in}$ | Parallel Equivalent Input Capacitance | | 900 TYP | pF | $P_{out} = 3.5$ W, $V_{CC} = 12.5$ V, f = 27 MHz |
| $C_{out}$ | Parallel Equivalent Output Capacitance | | 200 TYP | pF | $P_{out} = 3.5$ W, $V_{CC} = 12.5$ V, f = 27 MHz |

NOTES:

1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.
2. Percentage up-modulation is measured in this test circuit (Figure 1) by setting the Carrier Power ($P_C$) to 3.5 watts with $V_{CC}$ = 12.5 Vdc and noting the power input. Then the peak envelope power (PEP) is noted after doubling the original power input to simulate driver modulation (at a 25% duty cycle for thermal considerations) and raising the $V_{CC}$ to 25 Vdc (to simulate the modulating voltage). Percentage up-modulation is then determined by the relation—

$$\text{Percentage Up-Modulation} = \left[\left(\frac{PEP}{P_C}\right)^{1/2} - 1\right] \cdot 100$$

3. $$\eta = \frac{R_F\ P_{out}}{(V_{CC})\ (I_C)} \cdot 100$$

# POWER TRANSISTOR

## NPN SILICON

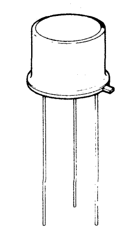
# SE7055
# SE7056

### DESIGNED AS A HIGH VOLTAGE VIDEO OUTPUT

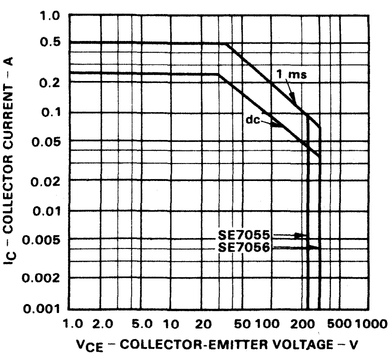
- 7.0 W DISSIPATION AT 25°C
- 500 mA MAXIMUM CONTINUOUS COLLECTOR CURRENT
- $V_{CEO}$ 220 V MIN (SE7055), 300 V MIN (SE7056)

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

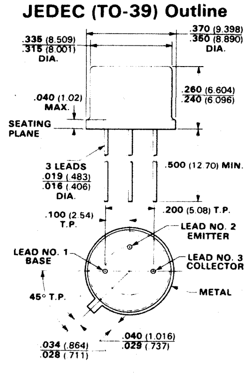
| | | SE7055 | SE7056 |
|---|---|---|---|
| **Maximum Voltages and Currents** | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 220 V | 300 V |
| $V_{CBO}$ | Collector to Base Voltage | 220 V | 300 V |
| $V_{EBO}$ | Emitter to Base Voltage | 7.0 V | 7.0 V |
| $I_C$ | Continuous Collector Current | 500 mA | 500 mA |
| **Maximum Power Dissipation** | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | 7.0 W |
| | Derate Linearly from 25°C | | 28.5 mW/°C |
| **Maximum Temperatures** | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | −65°C to +200°C |
| **Thermal Characteristics** | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | 25°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-39) Outline**



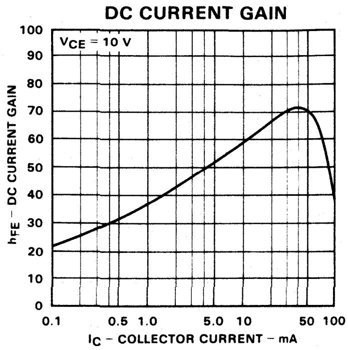

NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Leads are gold-plated kovar
Lead No. 3 connected to case
Package weight is 0.76 gram

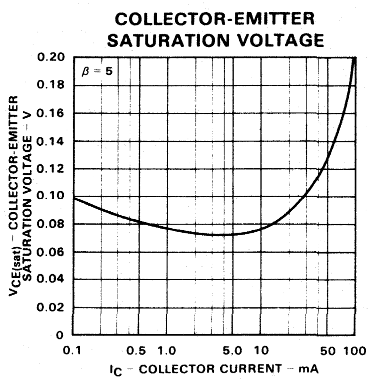
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

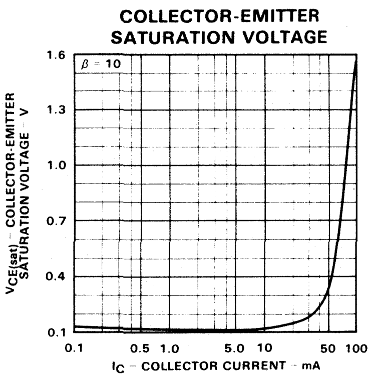
| SYMBOL | CHARACTERISTIC | SE7055 MIN | SE7055 MAX | SE7056 MIN | SE7056 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 220 | | 300 | | V | $I_C = 5.0$ mA, $I_B = 0$ |
| $V_{CBO}$ | Collector-Base Breakdown Voltage | 220 | | 300 | | V | $I_C = 0.1$ mA, $I_E = 0$ |
| $V_{EBO}$ | Emitter-Base Breakdown Voltage | 7.0 | | 7.0 | | V | $I_E = 0.1$ mA, $I_C = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.1 | | | μA | $V_{CB} = 150$ V, $I_E = 0$ |
| | | | | | 0.1 | μA | $V_{CB} = 200$ V, $I_E = 0$ |
| | | | 5.0 | | | μA | $V_{CB} = 150$ V, $I_E = 0$, $T_C = 125°C$ |
| | | | | | 5.0 | μA | $V_{CB} = 200$ V, $I_E = 0$, $T_C = 125°C$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 0.1 | | 0.1 | mA | $V_{EB} = 6.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | | 40 | | | $I_C = 30$ mA, $V_{CE} = 20$ V |
| | | 40 | | 40 | | | $I_C = 10$ mA, $V_{CE} = 20$ V |
| | | 20 | | 20 | | | $I_C = 1.0$ mA, $V_{CE} = 20$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.0 | | 1.0 | V | $I_C = 20$ mA, $I_B = 2.0$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 0.85 | | 0.85 | V | $I_C = 20$ mA, $I_B = 2.0$ mA |
| **DYNAMIC CHARACTERISTICS** | | | | | | | |
| $C_{cb}$ | Collector-Base Capacitance | | 3.5 | | 3.5 | pF | $V_{CB} = 20$ V, $I_E = 0$, f = 1.0 MHz |
| $C_{eb}$ | Emitter-Base Capacitance | | 70 | | 70 | pF | $V_{EB} = 0.5$ V, $I_C = 0$, f = 1.0 MHz |
| $h_{fe}$ | High Frequency Current Gain | 2.5 | | | | | $I_C = 15$ mA, $V_{CE} = 100$ V, f = 20 MHz |
| $h_{fe}$ | High Frequency Current Gain | | | 2.5 | | | $I_C = 15$ mA, $V_{CE} = 150$ V, f = 20 MHz |
| $h_{fe}$ | High Frequency Current Gain | 2.0 | | | | | $I_C = 3.0$ mA, $V_{CE} = 200$ V, f = 20 MHz, $R_L = 6.7$ KΩ |
| | | 2.0 | | | | | $I_C = 30$ mA, $V_{CE} = 20$ V, f = 20 MHz, $R_L = 6.7$ KΩ |
| | | | | 2.0 | | | $I_C = 3.0$ mA, $V_{CE} = 270$ V, f = 20 MHz, $R_L = 9.0$ KΩ |
| | | | | 2.0 | | | $I_C = 30$ mA, $V_{CE} \doteq 30$ V, f = 20 MHz, $R_L = 9.0$ KΩ |

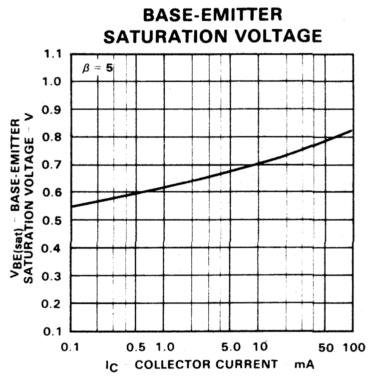
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

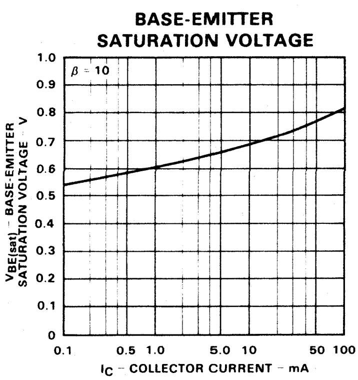
## TYPICAL ELECTRICAL CHARACTERISTICS



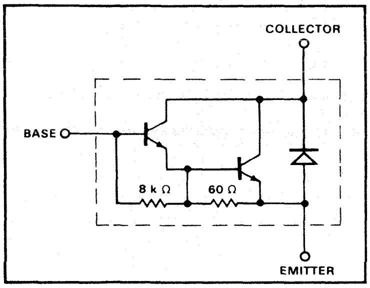



# POWER DARLINGTON

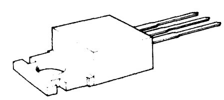
## NPN SILICON

# SE9300
# SE9301
# SE9302

### DESIGNED FOR GENERAL PURPOSE AMPLIFIER AND LOW SPEED SWITCHING APPLICATIONS



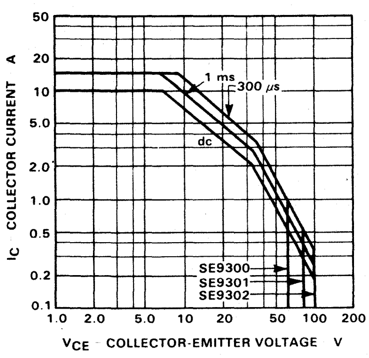

- **70 W DISSIPATION AT 25°C CASE**
- **10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **COMPLEMENT SE9400, SE9401, SE9402**



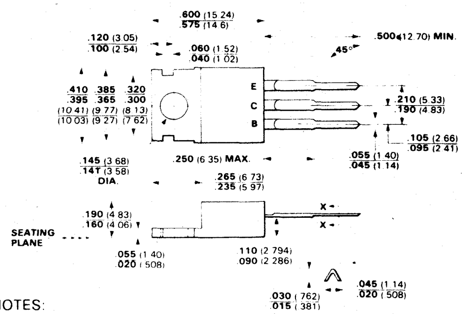
**ABSOLUTE MAXIMUM RATINGS (Note 1)**

| | | SE9300 | SE9301 | SE9302 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V | 80 V | 100 V |
| $V_{CBO}$ | Collector to Base Voltage | 60 V | 80 V | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A | 10 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 70 W |
| | Derate Linearly from 25°C | | | 0.56 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | -65°C to +150°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 1.79°C/W |

**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

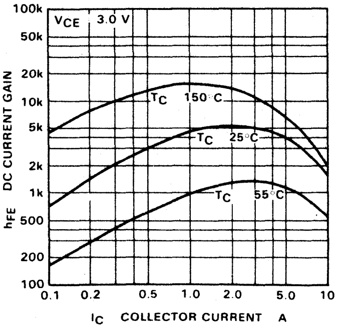
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | SE9300 MIN | SE9300 MAX | SE9301 MIN | SE9301 MAX | SE9302 MIN | SE9302 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | 100 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | 0.5 | | 0.5 | mA<br>mA<br>mA | $V_{CE} = 30$ V, $I_B = 0$<br>$V_{CE} = 40$ V, $I_B = 0$<br>$V_{CE} = 50$ V, $I_B = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.2 | | 0.2 | | 0.2 | mA<br>mA<br>mA | $V_{CB} = 30$ V, $I_E = 0$<br>$V_{CB} = 40$ V, $I_E = 0$<br>$V_{CB} = 50$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 4.0 | | 4.0 | | 4.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 750<br>1000<br>100 | | 750<br>1000<br>100 | | 750<br>1000<br>100 | | | $I_C = 1.0$ A, $V_{CE} = 3.0$ V<br>$I_C = 4.0$ A, $V_{CE} = 3.0$ V<br>$I_C = 7.5$ A, $V_{CE} = 3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 2.0<br>2.5 | | 2.0<br>2.5 | | 2.0<br>2.5 | V<br>V | $I_C = 4.0$ A, $I_B = 16$ mA<br>$I_C = 7.5$ A, $I_B = 150$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.5<br>3.0 | | 2.5<br>3.0 | | 2.5<br>3.0 | V<br>V | $I_C = 4.0$ A, $V_{CE} = 3.0$ V<br>$I_C = 7.5$ A, $V_{CE} = 3.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 1.0 | | 1.0 | | 1.0 | | | $I_C = 4.0$ A, $V_{CE} = 3.0$ V, f = 1.0 MHz |

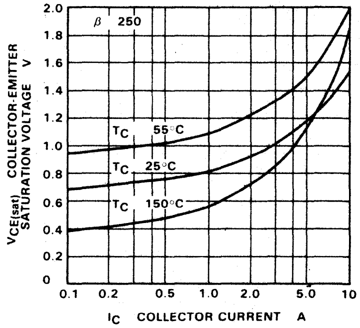
NOTE: 1. Pulse conditions: Length $\leq$ 300 $\mu$s, Duty Cycle $\leq$ 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

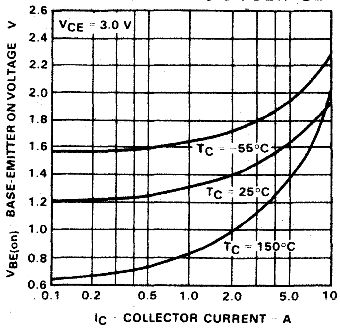
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE

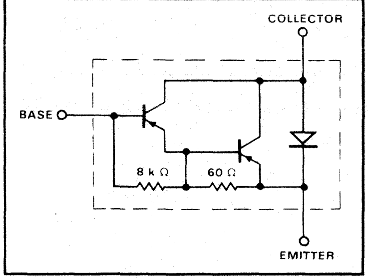


# POWER DARLINGTON

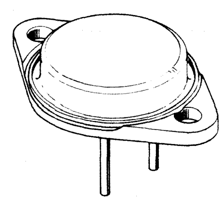
## NPN SILICON

# SE9303
# SE9304
# SE9305

### DESIGNED FOR GENERAL PURPOSE AMPLIFIER AND LOW SPEED SWITCHING APPLICATIONS



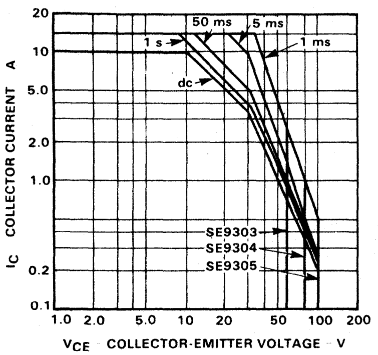

- **100 W DISSIPATION AT 25°C CASE**
- **10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **1000 MINIMUM $h_{FE}$ @ 4 A**
- **COMPLEMENT SE9403, SE9404, SE9405**



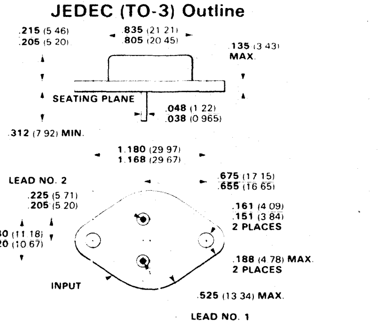
**ABSOLUTE MAXIMUM RATINGS (Note 1)**

| **Maximum Voltages and Currents** | | **SE9303** | **SE9304** | **SE9305** |
|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 60 V | 80 V | 100 V |
| $V_{CBO}$ | Collector to Base Voltage | 60 V | 80 V | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A | 10 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 100 W |
| | Derate Linearly from 25°C | | | 0.57 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | -65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 1.75°C/W |

**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

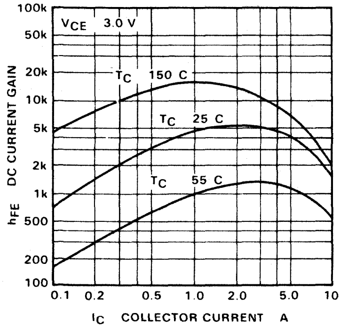
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | SE9303 MIN | SE9303 MAX | SE9304 MIN | SE9304 MAX | SE9305 MIN | SE9305 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | 100 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | 0.5 | | | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| | | | | | | | 0.5 | mA | $V_{CE} = 50$ V, $I_B = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.2 | | | | | mA | $V_{CB} = 30$ V, $I_E = 0$ |
| | | | | | 0.2 | | | mA | $V_{CB} = 40$ V, $I_E = 0$ |
| | | | | | | | 0.2 | mA | $V_{CB} = 50$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 4.0 | | 4.0 | | 4.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 750 | | 750 | | 750 | | | $I_C = 1.0$ A, $V_{CE} = 3.0$ V |
| | | 1000 | | 1000 | | 1000 | | | $I_C = 4.0$ A, $V_{CE} = 3.0$ V |
| | | 100 | | 100 | | 100 | | | $I_C = 7.5$ A, $V_{CE} = 3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 2.0 | | 2.0 | | 2.0 | V | $I_C = 4.0$ A, $I_B = 16$ mA |
| | | | 2.5 | | 2.5 | | 2.5 | V | $I_C = 7.5$ A, $I_B = 150$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.5 | | 2.5 | | 2.5 | V | $I_C = 4.0$ A, $V_{CE} = 3.0$ V |
| | | | 3.0 | | 3.0 | | 3.0 | V | $I_C = 7.5$ A, $V_{CE} = 3.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 1.0 | | 1.0 | | 1.0 | | | $I_C = 4.0$ A, $V_{CE} = 3.0$ V, f = 1.0 MHz |

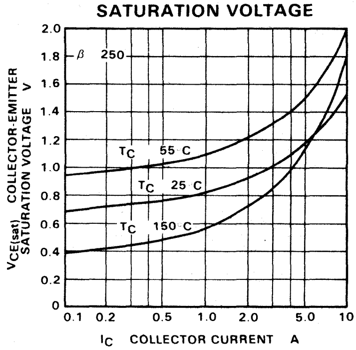
NOTE: 1. Pulse conditions: Length 300 μs, Duty Cycle 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

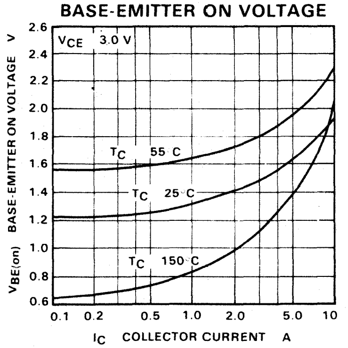
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE



# POWER TRANSISTOR

## NPN SILICON

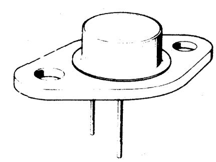
## SE9331

### GENERAL PURPOSE HIGH VOLTAGE POWER DEVICE

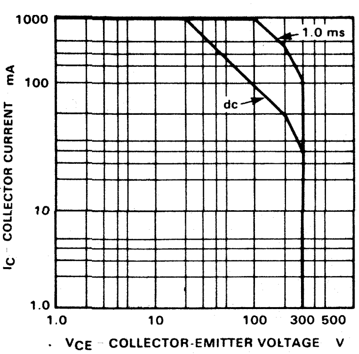
- 20 W DISSIPATION AT 25°C CASE
- 1.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 300 V MINIMUM $V_{CEO}$

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

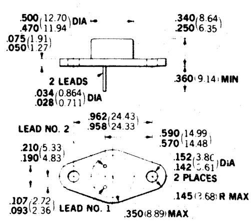
| | | |
|---|---|---|
| **Maximum Voltages and Currents** | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 300 V |
| $V_{CBO}$ | Collector to Base Voltage | 300 V |
| $V_{EBO}$ | Emitter to Base Voltage | 6.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A |
| $I_B$ | Continuous Base Current | 250 mA |
| **Maximum Power Dissipation** | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 20 W |
| | Derate Linearly from 25°C | 0.114 W/°C |
| **Maximum Temperatures** | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +175°C |
| **Thermal Characteristics** | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 8.7 °C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-66) outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated kovar
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Nickel-plated steel base and cap
Package weight is 6.5 grams

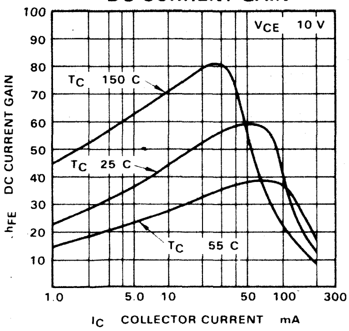
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | SE9331 MIN | SE9331 MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 300 | | V | $I_C = 5.0$ mA, $I_B = 0$ |
| $V_{EBO}$ | Emitter-Base Breakdown Voltage | 6.0 | | V | $I_E = 0.01$ mA, $I_C = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.1 | mA | $V_{CE} = 300$ V, $I_B = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.01<br>0.5 | mA<br>μA | $V_{CB} = 300$ V, $I_E = 0$<br>$V_{CB} = 250$ V, $I_E = 0$ |
| **ON CHARACTERISTICS** | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30<br>30 | <br>250 | | $I_C = 50$ mA, $V_{CE} = 10$ V<br>$I_C = 100$ mA, $V_{CE} = 10$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 2.5 | V | $I_C = 100$ mA, $I_B = 10$ mA |
| $V_{BE(sat)}$ | Base-Emitter Saturation Voltage (Note 1) | | 1.5 | V | $I_C = 100$ mA, $I_B = 10$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.5 | V | $I_C = 100$ mA, $V_{CE} = 10$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | |
| $f_T$ | Current-Gain-Bandwidth Product | 10 | | MHz | $I_C = 50$ mA, $V_{CE} = 10$ V, f = 10 MHz |
| $C_{ob}$ | Output Capacitance | | 20 | pF | $V_{CB} = 100$ V, $I_E = 0$, f = 1.0 MHz |

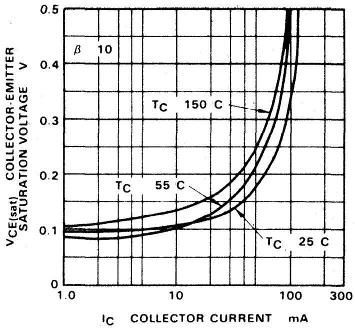
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

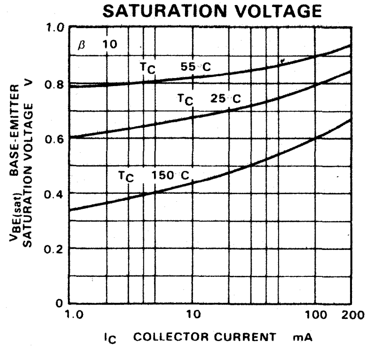
### DC CURRENT GAIN



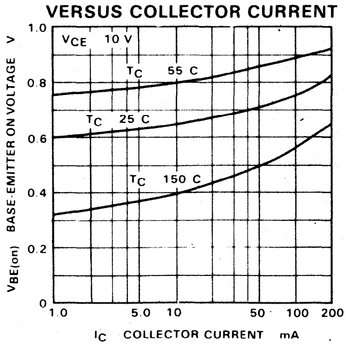

### COLLECTOR-EMITTER SATURATION VOLTAGE



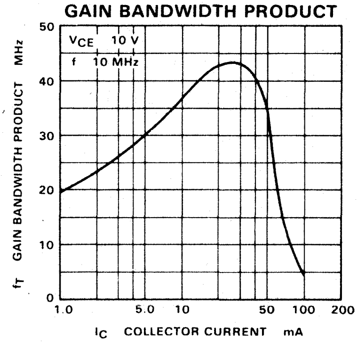

### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT




### GAIN BANDWIDTH PRODUCT

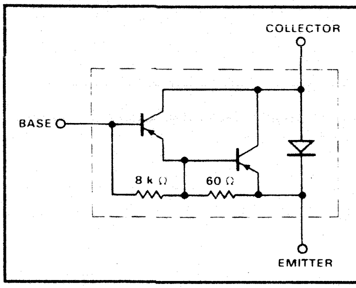


# POWER DARLINGTON

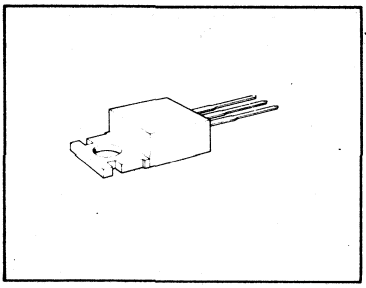
## PNP SILICON

# SE9400
# SE9401
# SE9402

### DESIGNED FOR GENERAL PURPOSE AMPLIFIER AND LOW SPEED SWITCHING APPLICATIONS



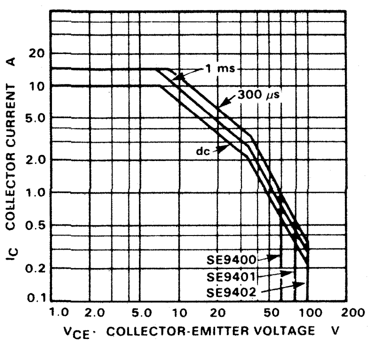

- 70 W DISSIPATION AT 25°C CASE
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 1000 MINIMUM $h_{FE}$ @ 4 A
- COMPLEMENT SE9300, SE9301, SE9302



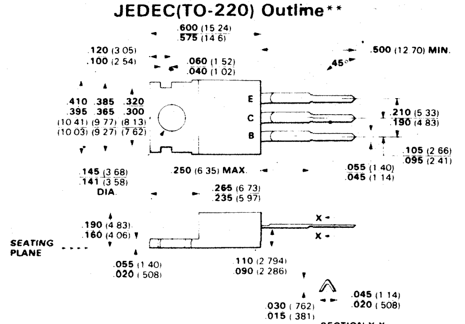
**ABSOLUTE MAXIMUM RATINGS (Note 1)**

| | | SE9400 | SE9401 | SE9402 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −60 V | −80 V | −100 V |
| $V_{CBO}$ | Collector to Base Voltage | −60 V | −80 V | −100 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A | 10 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 70 W |
| | Derate Linearly from 25°C | | | 0.56 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 1.79°C/W |

**SAFE OPERATING AREA**




**JEDEC(TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

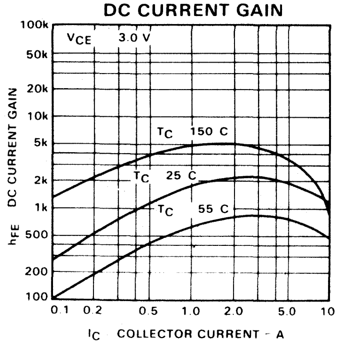
**ELECTRICAL CHARACTERISTICS** (25 C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | SE9400 MIN | SE9400 MAX | SE9401 MIN | SE9401 MAX | SE9402 MIN | SE9402 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector Emitter Sustaining Voltage (Note 1) | -60 | | -80 | | -100 | | V | $I_C$ = 100 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | | | | mA | $V_{CE}$ = -30 V, $I_B$ = 0 |
| | | | | | 0.5 | | | mA | $V_{CE}$ = -40 V, $I_B$ = 0 |
| | | | | | | | 0.5 | mA | $V_{CE}$ = -50 V, $I_B$ = 0 |
| $I_{CBO}$ | Collector Cutoff Current | | 0.2 | | | | | mA | $V_{CB}$ = -30 V, $I_E$ = 0 |
| | | | | | 0.2 | | | mA | $V_{CB}$ = -40 V, $I_E$ = 0 |
| | | | | | | | 0.2 | mA | $V_{CB}$ = -50 V, $I_E$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 4.0 | | 4.0 | | 4.0 | mA | $V_{EB}$ = -5.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 750 | | 750 | | 750 | | | $I_C$ = 1.0 A, $V_{CE}$ = -3.0 V |
| | | 1000 | | 1000 | | 1000 | | | $I_C$ = 4.0 A, $V_{CE}$ = -3.0 V |
| | | 100 | | 100 | | 100 | | | $I_C$ = 7.5 A, $V_{CE}$ = -3.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | -2.0 | | -2.0 | | -2.0 | V | $I_C$ = 4.0 A, $I_B$ = 16 mA |
| | | | -2.5 | | -2.5 | | -2.5 | V | $I_C$ = 7.5 A, $I_B$ = 150 mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | -2.5 | | -2.5 | | -2.5 | V | $I_C$ = 4.0 A, $V_{CE}$ = -3.0 V |
| | | | -3.0 | | -3.0 | | -3.0 | V | $I_C$ = 7.5 A, $V_{CE}$ = -3.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | |
| $\lvert h_{fe}\rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 1.0 | | 1.0 | | 1.0 | | | $I_C$ = 4.0 A, $V_{CE}$ = -3.0 V, f = 1.0 MHz |

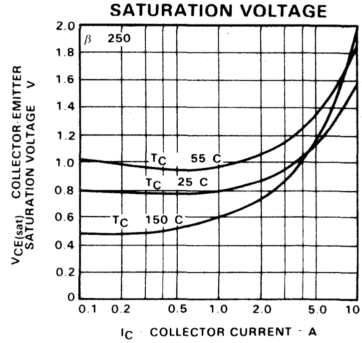
NOTE 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

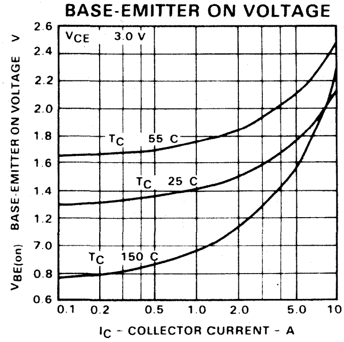
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE

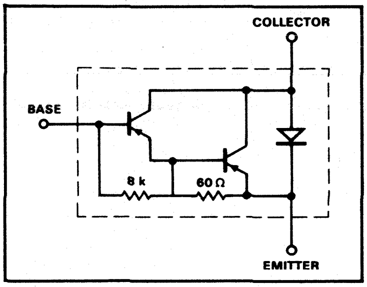


# POWER DARLINGTON

## PNP SILICON

# SE9403
# SE9404
# SE9405

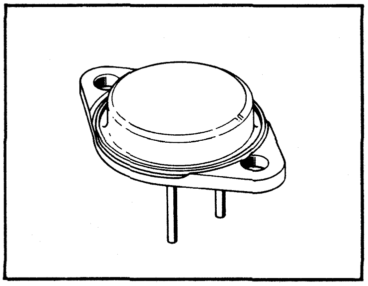
### DESIGNED FOR GENERAL PURPOSE AMPLIFIER AND LOW SPEED SWITCHING APPLICATIONS



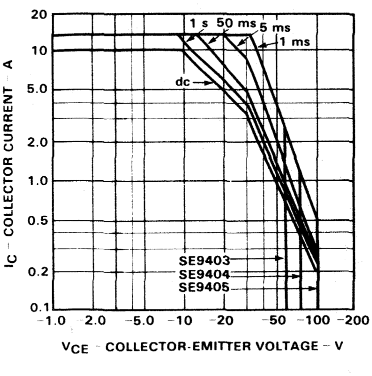

- 100 W DISSIPATION AT 25°C CASE
- 10 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 1000 MINIMUM $h_{FE}$ @ 4 A
- COMPLEMENT SE9303, SE9304, SE9305

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

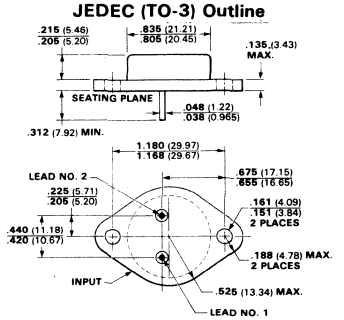
| | | SE9403 | SE9404 | SE9405 |
|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | -60 V | -80 V | -100 V |
| $V_{CBO}$ | Collector to Base Voltage | -60 V | -80 V | -100 V |
| $V_{EBO}$ | Emitter to Base Voltage | -5.0 V | -5.0 V | -5.0 V |
| $I_C$ | Continuous Collector Current | 10 A | 10 A | 10 A |
| **Maximum Power Dissipation** | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | 100 W |
| | Derate Linearly from 25°C | | | 0.57 W/°C |
| **Maximum Temperatures** | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | -65°C to +200°C |
| **Thermal Characteristics** | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | 1.75°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-3) Outline**




*NOTES:*
All dimensions in inches (bold) and millimeters (parentheses)
Pins are gold-plated or solder-dipped alloy 52
Pins 1 and 2 electrically isolated from case
Case is third electrical connection
Aluminum package with copper slug, pins are soldered in
Package weight is 7.4 grams
Aluminum cap

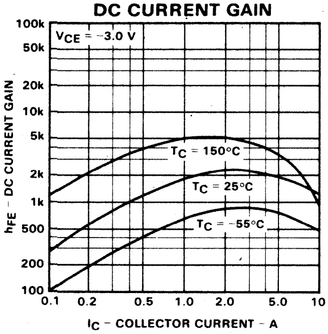
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | SE9403 | | SE9404 | | SE9405 | | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| OFF CHARACTERISTICS | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | -60 | | -80 | | -100 | | V | $I_C = 100$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | 0.5 | | 0.5 | mA<br>mA<br>mA | $V_{CE} = -30$ V, $I_B = 0$<br>$V_{CE} = -40$ V, $I_B = 0$<br>$V_{CE} = -50$ V, $I_B = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.2 | | 0.2 | | 0.2 | mA<br>mA<br>mA | $V_{CB} = -30$ V, $I_E = 0$<br>$V_{CB} = -40$ V, $I_E = 0$<br>$V_{CB} = -50$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 4.0 | | 4.0 | | 4.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| ON CHARACTERISTICS | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 750<br>1000<br>100 | | 750<br>1000<br>100 | | 750<br>1000<br>100 | | | $I_C = 1.0$ A, $V_{CE} = -3.0$ V<br>$I_C = 4.0$ A, $V_{CE} = -3.0$ V<br>$I_C = 7.5$ A, $V_{CE} = -3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | -2.0<br>-2.5 | | -2.0<br>-2.5 | | -2.0<br>-2.5 | V<br>V | $I_C = 4.0$ A, $I_B = 16$ mA<br>$I_C = 7.5$ A, $I_B = 150$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | -2.5<br>-3.0 | | -2.5<br>-3.0 | | -2.5<br>-3.0 | V<br>V | $I_C = 4.0$ A, $V_{CE} = -3.0$ V<br>$I_C = 7.5$ A, $V_{CE} = -3.0$ V |
| DYNAMIC CHARACTERISTICS | | | | | | | | | |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 1.0 | | 1.0 | | 1.0 | | | $I_C = 4.0$ A, $V_{CE} = -3.0$ V, f = 1.0 MHz |

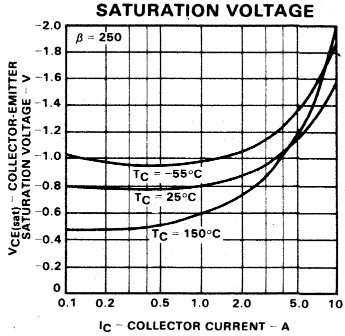
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

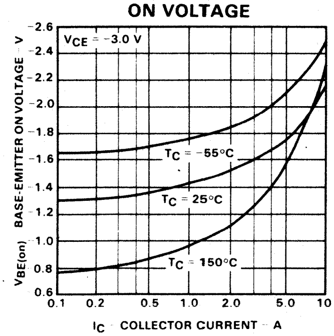
**DC CURRENT GAIN**




**COLLECTOR-EMITTER SATURATION VOLTAGE**




**BASE-EMITTER ON VOLTAGE**



# POWER TRANSISTOR

## NPN SILICON

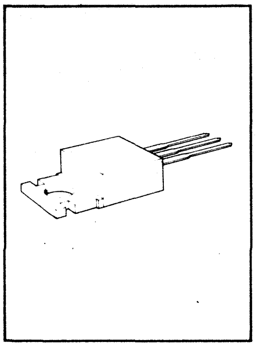
**TIP29**
**TIP29A**
**TIP29B**
**TIP29C**

## DESIGNED FOR POWER AMPLIFIER AND HIGH SPEED SWITCHING APPLICATIONS

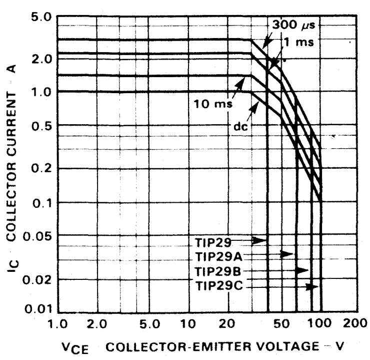
- 30 W DISSIPATION AT 25°C CASE
- 1 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 15 TO 75 $h_{FE}$ AT $I_C$ 1 A
- COMPLEMENTS TIP30, TIP30A, TIP30B, TIP30C

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

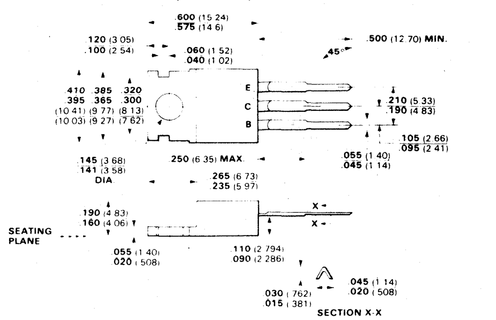
| Maximum Voltages and Currents | | TIP29 | TIP29A | TIP29B | TIP29C |
|---|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V | 100 V |
| $V_{CBO}$ | Collector to Base Voltage | 40 V | 60 V | 80 V | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A | 1.0 A | 1.0 A | 1.0 A |
| $I_C$ | Peak Collector Current | 3.0 A | 3.0 A | 3.0 A | 3.0 A |
| $I_B$ | Continuous Base Current | 0.4 A | 0.4 A | 0.4 A | 0.4 A |
| **Maximum Power Dissipation** | | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | | 30 W |
| | Derate Linearly from 25°C | | | | 0.24 W/°C |
| **Maximum Temperatures** | | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | | 4.16°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

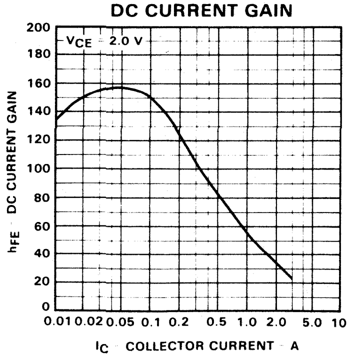
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | TIP29 MIN | TIP29 MAX | TIP29A MIN | TIP29A MAX | TIP29B MIN | TIP29B MAX | TIP29C MIN | TIP29C MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | 100 | | V | $I_C = 30$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.3 | | 0.3 | | | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | | | 0.3 | | 0.3 | mA | $V_{CE} = 60$ V, $I_B = 0$ |
| $I_{CES}$ | Collector Reverse Current | | 0.2 | | | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = 0$ |
| | | | | | 0.2 | | | | | mA | $V_{CE} = 60$ V, $V_{BE} = 0$ |
| | | | | | | | 0.2 | | | mA | $V_{CE} = 80$ V, $V_{BE} = 0$ |
| | | | | | | | | | 0.2 | mA | $V_{CE} = 100$ V, $V_{BE} = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | | 40 | | 40 | | 40 | | | $I_C = 0.2$ A, $V_{CE} = 4.0$ V |
| | | 15 | 75 | 15 | 75 | 15 | 75 | 15 | 75 | | $I_C = 1.0$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.7 | | 0.7 | | 0.7 | | 0.7 | V | $I_C = 1.0$ A, $I_B = 125$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.3 | | 1.3 | | 1.3 | | 1.3 | V | $I_C = 1.0$ A, $V_{CE} = 4.0$ V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | | | |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 3.0 | | 3.0 | | 3.0 | | 3.0 | | | $I_C = 0.2$ A, $V_{CE} = 10$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | 20 | | 20 | | | $I_C = 0.2$ A, $V_{CE} = 10$V, f = 1.0 kHz |

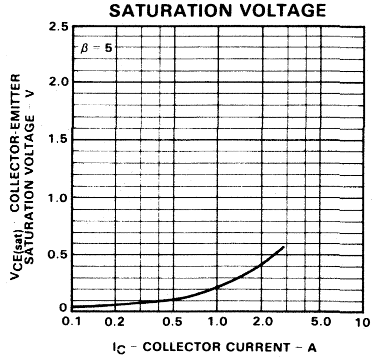
NOTE: 1. Pulse conditions: Length = 300 $\mu$s, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

**DC CURRENT GAIN**

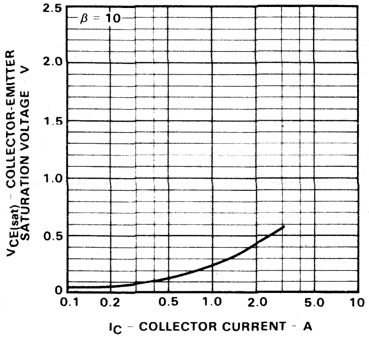



**COLLECTOR-EMITTER SATURATION VOLTAGE**

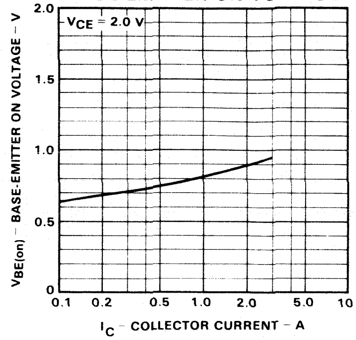


## TYPICAL ELECTRICAL CHARACTERISTICS (Cont'd)

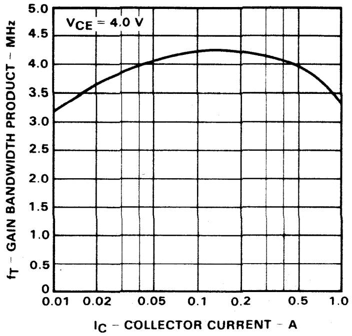
### COLLECTOR-EMITTER SATURATION VOLTAGE



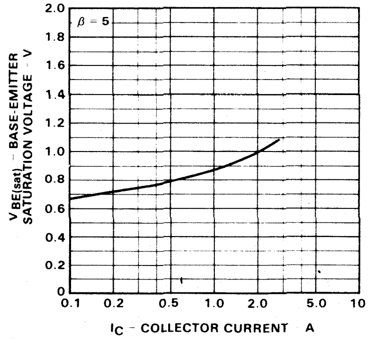

### BASE-EMITTER ON VOLTAGE



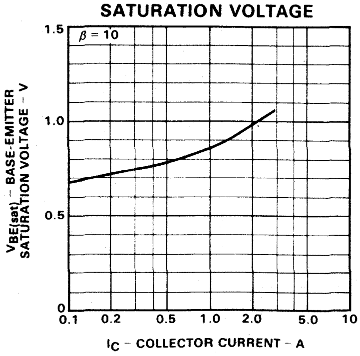

### GAIN BANDWIDTH PRODUCT




### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER SATURATION VOLTAGE



# POWER TRANSISTOR

## PNP SILICON

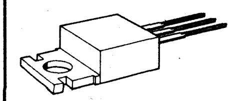
# TIP30
# TIP30A
# TIP30B
# TIP30C

### DESIGNED FOR POWER AMPLIFIER AND HIGH SPEED SWITCHING APPLICATIONS

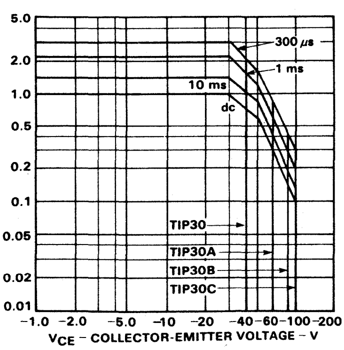
- 30 W DISSIPATION AT 25°C
- 1 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 15 TO 75 $h_{FE}$ AT $I_C$ 1 A
- COMPLEMENTS TIP29, TIP29A, TIP29B, TIP29C

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

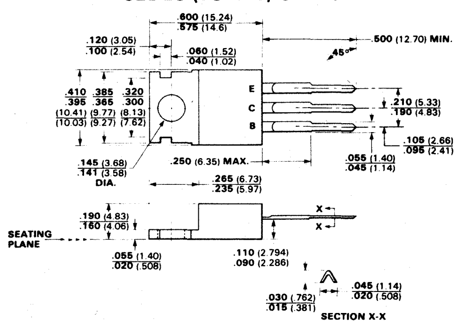
| | | TIP30 | TIP30A | TIP30B | TIP30C |
|---|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | −40 V | −60 V | −80 V | −100 V |
| $V_{CBO}$ | Collector to Base Voltage | −40 V | −60 V | −80 V | −100 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 1.0 A | 1.0 A | 1.0 A | 1.0 A |
| $I_C$ | Peak Collector Current | 3.0 A | 3.0 A | 3.0 A | 3.0 A |
| $I_B$ | Continuous Base Current | 0.4 A | 0.4 A | 0.4 A | 0.4 A |
| **Maximum Power Dissipation** | | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | | 30 W |
| | Derate Linearly from 25°C | | | | 0.24 W/°C |
| **Maximum Temperatures** | | | | | |
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | | 4.16°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

# FAIRCHILD • TIP30 • TIP30A • TIP30B • TIP30C

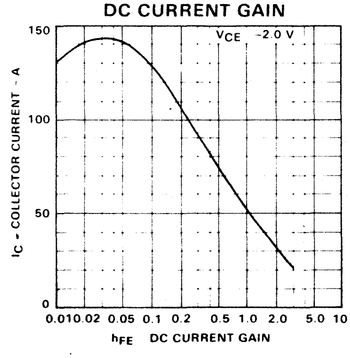
ELECTRICAL CHARACTERISTICS (25 C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | TIP30 MIN | TIP30 MAX | TIP30A MIN | TIP30A MAX | TIP30B MIN | TIP30B MAX | TIP30C MIN | TIP30C MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | -40 | | -60 | | -80 | | -100 | | V | $I_C$ 30 mA, $I_B$ 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 0.3 | | 0.3 | | | | | mA | $V_{CE}$ -30 V, $I_B$ 0 |
| | | | | | | | 0.3 | | 0.3 | mA | $V_{CE}$ -60 V, $I_B$ 0 |
| $I_{CES}$ | Collector Reverse Current | | 0.2 | | | | | | | mA | $V_{CE}$ -40 V, $V_{BE}$ 0 |
| | | | | | 0.2 | | | | | mA | $V_{CE}$ -60 V, $V_{BE}$ 0 |
| | | | | | | | 0.2 | | | mA | $V_{CE}$ -80 V, $V_{BE}$ 0 |
| | | | | | | | | | 0.2 | mA | $V_{CE}$ -100 V, $V_{BE}$ 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ -5.0 V, $I_C$ 0 |
| **ON CHARACTERISTICS** | | | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | | 40 | | 40 | | 40 | | | $I_C$ 0.2 A, $V_{CE}$ -4.0 V |
| | | 15 | 75 | 15 | 75 | 15 | 75 | 15 | 75 | | $I_C$ 1.0 A, $V_{CE}$ -4.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | -0.7 | | -0.7 | | -0.7 | | -0.7 | V | $I_C$ 1.0 A, $I_B$ 125 mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | -1.3 | | -1.3 | | -1.3 | | -1.3 | V | $I_C$ 1.0 A, $V_{CE}$ -4.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | | | |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 3.0 | | 3.0 | | 3.0 | | 3.0 | | | $I_C$ 0.2 A, $V_{CE}$ -10 V, f 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | 20 | | 20 | | | $I_C$ 0.2 A, $V_{CE}$ -10V, f 1.0 kHz |

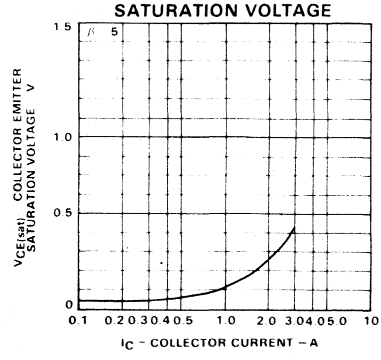
NOTE: 1. Pulse conditions: Length 300 $\mu s$, Duty Cycle 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

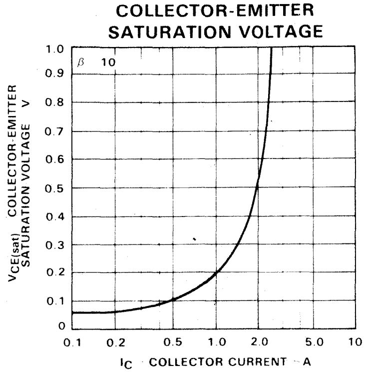
### DC CURRENT GAIN

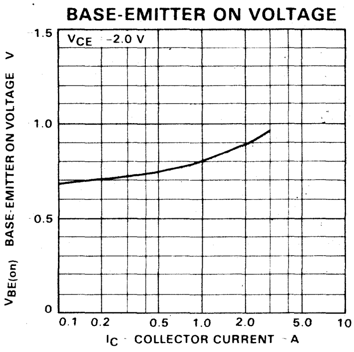


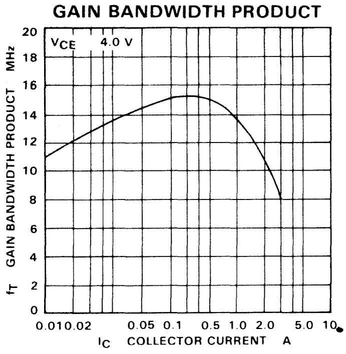

### COLLECTOR-EMITTER SATURATION VOLTAGE

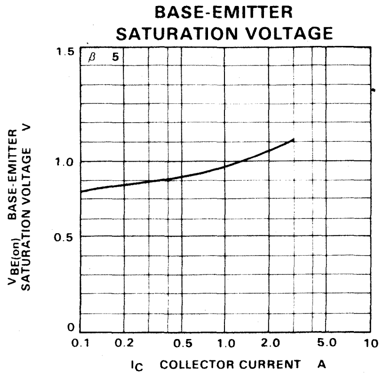


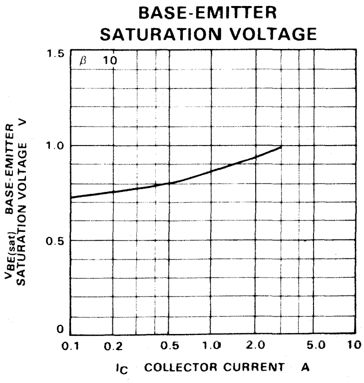
## TYPICAL ELECTRICAL CHARACTERISTICS (Cont'd)



# POWER TRANSISTOR

## NPN SILICON

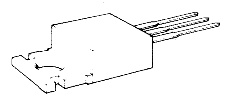
**TIP31**
**TIP31A**
**TIP31B**
**TIP31C**

### DESIGNED FOR POWER AMPLIFIER AND HIGH SPEED SWITCHING APPLICATIONS

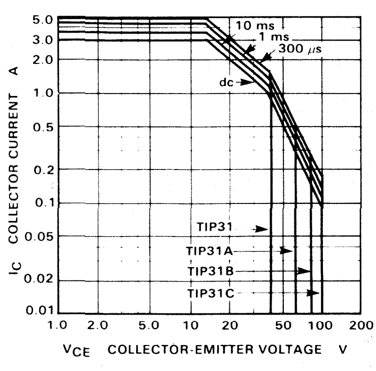
- 40 W DISSIPATION AT 25°C CASE
- 3.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 10 TO 50 $h_{FE}$ AT $I_C$ 3.0 A
- COMPLEMENTS TIP32, TIP32A, TIP32B, TIP32C

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

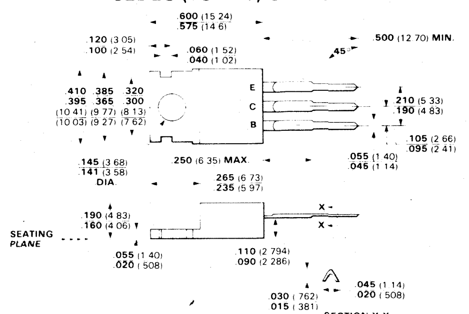
| **Maximum Voltages and Currents** | | TIP31 | TIP31A | TIP31B | TIP31C |
|---|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V | 100 V |
| $V_{CBO}$ | Collector to Base Voltage | 40 V | 60 V | 80 V | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 3.0 A | 3.0 A | 3.0 A | 3.0 A |
| $I_C$ | Peak Collector Current | 5.0 A | 5.0 A | 5.0 A | 5.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | | 40 W |
| | Derate Linearly from 25°C | | | | 0.32 W/°C |
| **Maximum Temperatures** | | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | | 3.12°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

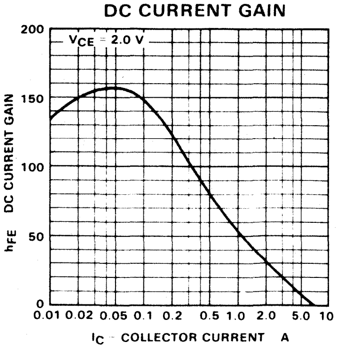
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | TIP31 MIN | TIP31 MAX | TIP31A MIN | TIP31A MAX | TIP31B MIN | TIP31B MAX | TIP31C MIN | TIP31C MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | 100 | | V | $I_C$ = 30 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 0.3 | | 0.3 | | | | | mA | $V_{CE}$ = 30 V, $I_B$ = 0 |
| | | | | | | | 0.3 | | 0.3 | mA | $V_{CE}$ = 60 V, $I_B$ = 0 |
| $I_{CES}$ | Collector Reverse Current | | 0.2 | | | | | | | mA | $V_{CE}$ = 40 V, $V_{BE}$ = 0 |
| | | | | | 0.2 | | | | | mA | $V_{CE}$ = 60 V, $V_{BE}$ = 0 |
| | | | | | | | 0.2 | | | mA | $V_{CE}$ = 80 V, $V_{BE}$ = 0 |
| | | | | | | | | | 0.2 | mA | $V_{CE}$ = 100 V, $V_{BE}$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = 5.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1 | 25 | | 25 | | 25 | | 25 | | | $I_C$ = 1.0 A, $V_{CE}$ = 4.0 V |
| | | 10 | 50 | 10 | 50 | 10 | 50 | 10 | 50 | | $I_C$ = 3.0 A, $V_{CE}$ = 4.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.2 | | 1.2 | | 1.2 | | 1.2 | V | $I_C$ = 3.0 A, $I_B$ = 375 mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.8 | | 1.8 | | 1.8 | | 1.8 | V | $I_C$ = 3.0 A, $V_{CE}$ = 4.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | | | |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 3.0 | | 3.0 | | 3.0 | | 3.0 | | | $I_C$ = 0.5 V, $V_{CE}$ = 10 V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | 20 | | 20 | | | $I_C$ = 0.5 A, $V_{CE}$ = 10 V, f = 1.0 kHz |

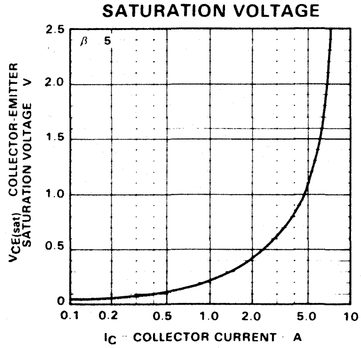
NOTE: 1. Pulse conditions: Length 300 μs, Duty Cycle 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

### DC CURRENT GAIN

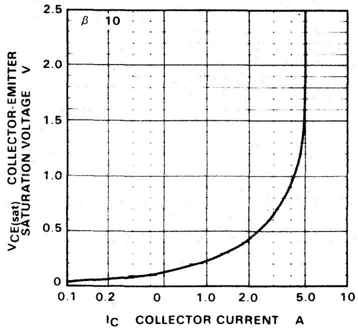



### COLLECTOR-EMITTER SATURATION VOLTAGE

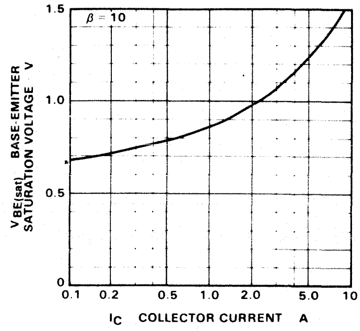


## TYPICAL ELECTRICAL CHARACTERISTICS (Cont'd)

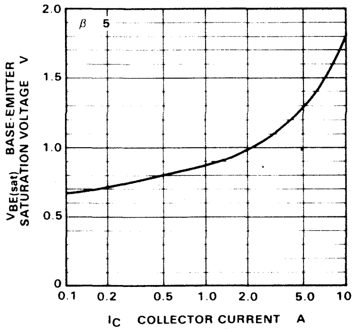
### COLLECTOR-EMITTER SATURATION VOLTAGE



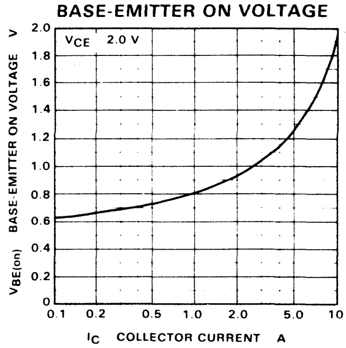

### BASE-EMITTER SATURATION VOLTAGE



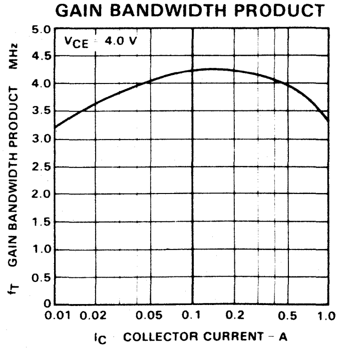

### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE




### GAIN BANDWIDTH PRODUCT



# POWER TRANSISTOR

## PNP SILICON

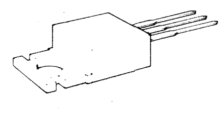
**TIP32**
**TIP32A**
**TIP32B**
**TIP32C**

### DESIGNED FOR POWER AMPLIFIER AND HIGH SPEED SWITCHING APPLICATIONS

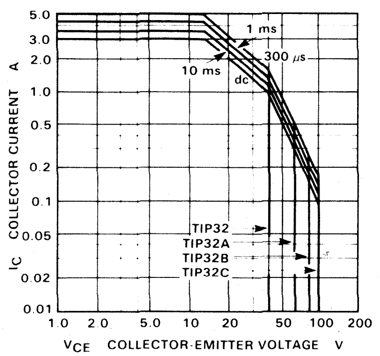
- 40 W DISSIPATION AT 25°C CASE
- 3.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 10 TO 50 $h_{FE}$ AT $I_C$ 3.0 A
- COMPLEMENT TIP31, TIP31A, TIP31B, TIP31C

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

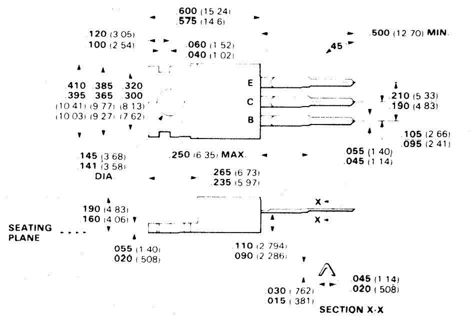
| Maximum Voltages and Currents | | TIP32 | TIP32A | TIP32B | TIP32C |
|---|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | −40 V | −60 V | −80 V | −100 V |
| $V_{CBO}$ | Collector to Base Voltage | −40 V | −60 V | −80 V | −100 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 3.0 A | 3.0 A | 3.0 A | 3.0 A |
| $I_C$ | Peak Collector Current | 5.0 A | 5.0 A | 5.0 A | 5.0 A |
| $I_B$ | Continuous Base Current | 1.0 A | 1.0 A | 1.0 A | 1.0 A |
| **Maximum Power Dissipation** | | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | | 40 W |
| | Derate Linearly from 25°C | | | | 0.32 W/°C |
| **Maximum Temperatures** | | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | | 3.12°C/W |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

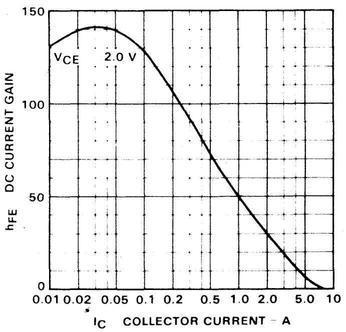
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | TIP 32 MIN | TIP 32 MAX | TIP 32A MIN | TIP 32A MAX | TIP 32B MIN | TIP 32B MAX | TIP 32C MIN | TIP 32C MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −40 | | −60 | | −80 | | −100 | | V | $I_C$ = 30 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 0.3 | | 0.3 | | | | | mA | $V_{CE}$ = −30 V, $I_B$ = 0 |
| | | | | | | | 0.3 | | 0.3 | mA | $V_{CE}$ = −60 V, $I_B$ = 0 |
| $I_{CES}$ | Collector Reverse Current | | 0.2 | | | | | | | mA | $V_{CE}$ = −40 V, $V_{BE}$ = 0 |
| | | | | | 0.2 | | | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 0 |
| | | | | | | | 0.2 | | | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 0 |
| | | | | | | | | | 0.2 | mA | $V_{CE}$ = −100 V, $V_{BE}$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = −5.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 25 | | 25 | | 25 | | 25 | | | $I_C$ = 1.0 A, $V_{CE}$ = −4.0 V |
| | | 10 | 50 | 10 | 50 | 10 | 50 | 10 | 50 | | $I_C$ = 3.0 A, $V_{CE}$ = −4.0 A |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −1.2 | | −1.2 | | −1.2 | | −1.2 | V | $I_C$ = 3.0 A, $I_B$ = 375 mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −1.8 | | −1.8 | | −1.8 | | −1.8 | V | $I_C$ = 3.0 A, $V_{CE}$ = −4.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | | | |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 3.0 | | 3.0 | | 3.0 | | 3.0 | | | $I_C$ = 0.5 A, $V_{CE}$ = −10 V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | 20 | | 20 | | | $I_C$ = 0.5 A, $V_{CE}$ = −10 V, f = 1.0 kHz |

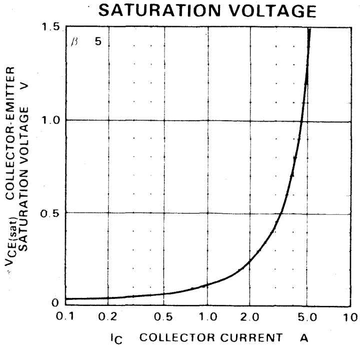
NOTE: 1. Pulse conditions: Length 300 μs, Duty Cycle 2%

## TYPICAL ELECTRICAL CHARACTERISTICS

**DC CURRENT GAIN**

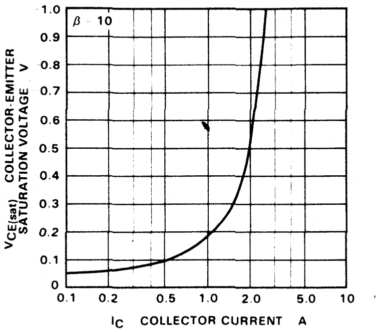



**COLLECTOR-EMITTER SATURATION VOLTAGE**

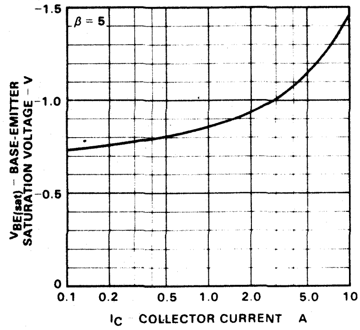


## TYPICAL ELECTRICAL CHARACTERISTICS (Cont'd)

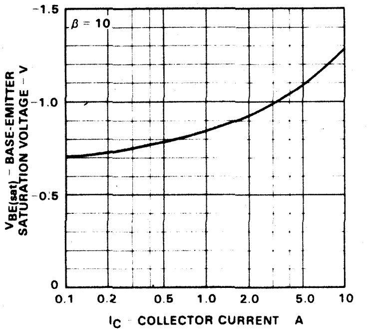
### COLLECTOR-EMITTER SATURATION VOLTAGE



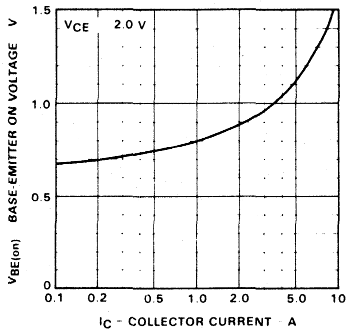

### BASE-EMITTER SATURATION VOLTAGE



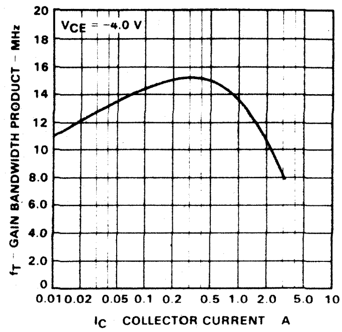

### BASE-EMITTER SATURATION VOLTAGE




### BASE-EMITTER ON VOLTAGE




### GAIN BANDWIDTH PRODUCT



# POWER TRANSISTOR

## NPN SILICON

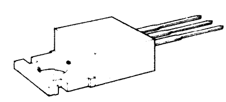
**TIP41**
**TIP41A**
**TIP41B**
**TIP41C**

### DESIGNED FOR POWER AMPLIFIER AND HIGH SPEED SWITCHING APPLICATIONS

- 65 W DISSIPATION AT 25°C
- 6.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 3.0 MHz MINIMUM $f_T$
- 0.7 s TYPICAL $t_{off}$
- COMPLEMENT TO TIP42 SERIES

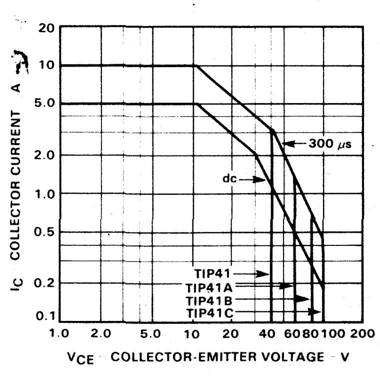
**ABSOLUTE MAXIMUM RATINGS** (Note 1)

| | | TIP41 | TIP41A | TIP41B | TIP41C |
|---|---|---|---|---|---|
| **Maximum Voltages and Currents** | | | | | |
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V | 100 V |
| $V_{CBO}$ | Collector to Base Voltage | 40 V | 60 V | 80 V | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 6.0 A | 6.0 A | 6.0 A | 6.0 A |
| $I_C$ | Peak Collector Current | 10 A | 10 A | 10 A | 10 A |
| $I_B$ | Continuous Base Current | 3.0 A | 3.0 A | 3.0 A | 3.0 A |
| **Maximum Power Dissipation** | | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | | 65 W |
| | Derate Linearly from 25°C | | | | 0.52 W/°C |
| **Maximum Temperatures** | | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | | 1.92°C/W |
| $T_P$ | Maximum Pin Temperature for Soldering Purposes: 1/8″ from Case for 5 seconds | | | | 260°C |

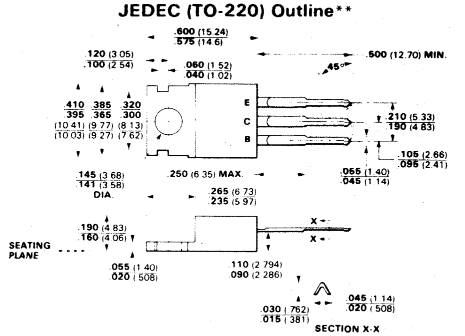


6

**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

# FAIRCHILD • TIP41 • TIP41A • TIP41B • TIP41C

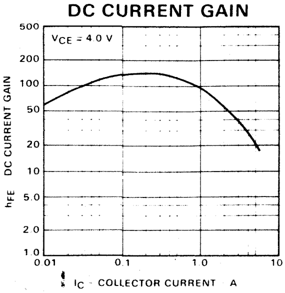
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | TIP41 MIN | TIP41 MAX | TIP41A MIN | TIP41A MAX | TIP41B MIN | TIP41B MAX | TIP41C MIN | TIP41C MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | 100 | | V | $I_C$ = 30 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 0.7 | | 0.7 | | | | | mA | $V_{CE}$ = 30 V, $I_B$ = 0 |
| | | | | | | | 0.7 | | 0.7 | mA | $V_{CE}$ = 60 V, $I_B$ = 0 |
| $I_{CES}$ | Collector Reverse Current | | 0.4 | | | | | | | mA | $V_{CE}$ = 40 V, $V_{BE}$ = 0 |
| | | | | | 0.4 | | | | | mA | $V_{CE}$ = 60 V, $V_{BE}$ = 0 |
| | | | | | | | 0.4 | | | mA | $V_{CE}$ = 80 V, $V_{BE}$ = 0 |
| | | | | | | | | | 0.4 | mA | $V_{CE}$ = 100 V, $V_{BE}$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = 5.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30 | | 30 | | 30 | | 30 | | | $I_C$ = 0.3 A, $V_{CE}$ = 4.0 V |
| | | 15 | 75 | 15 | 75 | 15 | 75 | 15 | 75 | | $I_C$ = 3.0 A, $V_{CE}$ = 4.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 1.5 | | 1.5 | | 1.5 | | 1.5 | V | $I_C$ = 6.0 A, $I_B$ = 0.6 A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.0 | | 2.0 | | 2.0 | | 2.0 | V | $I_C$ = 6.0 A, $V_{CE}$ = 4.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | | | |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Short Circuit Forward Current Transfer Ratio | 3.0 | | 3.0 | | 3.0 | | 3.0 | | | $I_C$ = 0.5 A, $V_{CE}$ = 10 V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | 20 | | 20 | | | $I_C$ = 0.5 A, $V_{CE}$ = 10 V, f = 1.0 kHz |

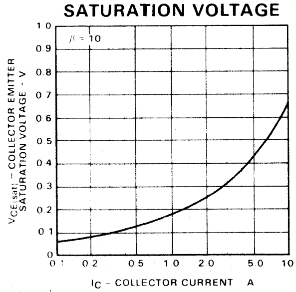
NOTE: 1. Pulse conditions: Length 300 μs, Duty Cycle 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

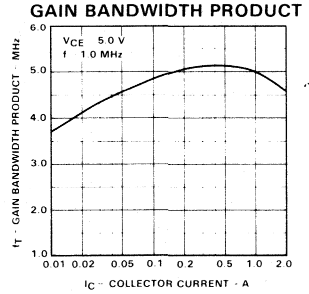
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### GAIN BANDWIDTH PRODUCT



# POWER TRANSISTOR

## PNP SILICON

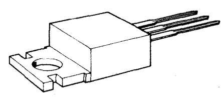
# TIP 42
# TIP 42A
# TIP 42B
# TIP 42C

### DESIGNED FOR POWER AMPLIFIER AND HIGH SPEED SWITCHING APPLICATIONS

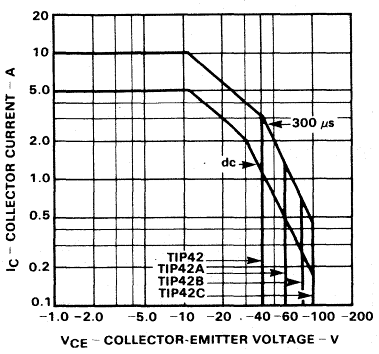
- 65 W DISSIPATION AT 25°C CASE
- 6.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 3.0 MHz MINIMUM $f_T$
- 0.7 s TYPICAL $t_{off}$
- COMPLEMENT TO TIP41 SERIES

**ABSOLUTE MAXIMUM RATINGS** (Note 1)

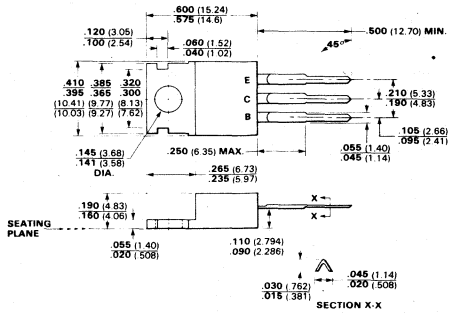
| **Maximum Voltages and Currents** | | **TIP42** | **TIP42A** | **TIP42B** | **TIP42C** |
|---|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | −40 V | −60 V | −80 V | −100 V |
| $V_{CBO}$ | Collector to Base Voltage | −40 V | −60 V | −80 V | −100 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 6.0 A | 6.0 A | 6.0 A | 6.0 A |
| $I_C$ | Peak Collector Current | 10 A | 10 A | 10 A | 10 A |
| $I_B$ | Continuous Base Current | 3.0 A | 3.0 A | 3.0 A | 3.0 A |
| **Maximum Power Dissipation** | | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature | | | | 65 W |
| | Derate Linearly from 25°C | | | | 0.52 W/°C |
| **Maximum Temperatures** | | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | | 1.92°C/W |
| $T_P$ | Maximum Pin Temperature for Soldering Purposes: 1/8" from Case for 5 seconds | | | | 260°C |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline****




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

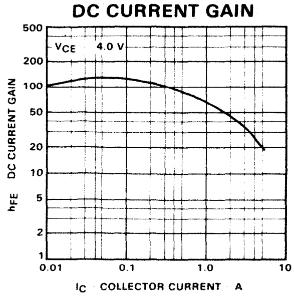
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | TIP 42 MIN | TIP 42 MAX | TIP 42A MIN | TIP 42A MAX | TIP 42B MIN | TIP 42B MAX | TIP 42C MIN | TIP 42C MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| OFF CHARACTERISTICS | | | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | –40 | | –60 | | –80 | | –100 | | V | $I_C$ = 30 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 0.7 | | 0.7 | | | | | mA | $V_{CE}$ = –30 V, $I_B$ = 0 |
| | | | | | | | 0.7 | | 0.7 | mA | $V_{CE}$ = –60 V, $I_B$ = 0 |
| $I_{CES}$ | Collector Reverse Current | | –0.4 | | | | | | | mA | $V_{CE}$ = –40 V, $V_{BE}$ = 0 |
| | | | | | –0.4 | | | | | mA | $V_{CE}$ = –60 V, $V_{BE}$ = 0 |
| | | | | | | | –0.4 | | | mA | $V_{CE}$ = –80 V, $V_{BE}$ = 0 |
| | | | | | | | | | –0.4 | mA | $V_{CE}$ = –100 V, $V_{BE}$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = –5.0 V, $I_C$ = 0 |
| ON CHARACTERISTICS | | | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 30 | | 30 | | 30 | | 30 | | | $I_C$ = 0.3 A, $V_{CE}$ = –4.0 V |
| | | 15 | 75 | 15 | 75 | 15 | 75 | 15 | 75 | | $I_C$ = 3.0 A, $V_{CE}$ = –4.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | –1.5 | | –1.5 | | –1.5 | | –1.5 | V | $I_C$ = 6.0 A, $I_B$ = 0.6 A |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | –2.0 | | –2.0 | | –2.0 | | –2.0 | V | $I_C$ = 6.0 A, $V_{CE}$ = –4.0 V |
| DYNAMIC CHARACTERISTICS | | | | | | | | | | | |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Short Circuit Forward Current Transfer Ratio | 3.0 | | 3.0 | | 3.0 | | 3.0 | | | $I_C$ = 0.5 A, $V_{CE}$ = –10 V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | 20 | | 20 | | | $I_C$ = 0.5 A, $V_{CE}$ = –10 V, f = 1.0 kHz |

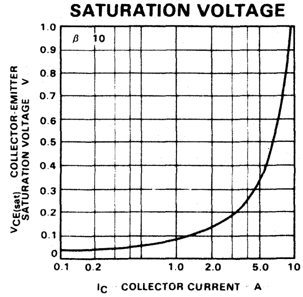
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

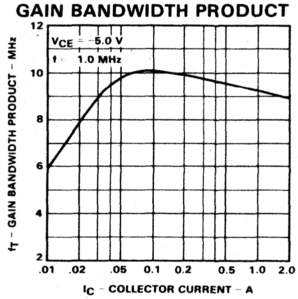
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### GAIN BANDWIDTH PRODUCT



# POWER TRANSISTOR

## NPN SILICON

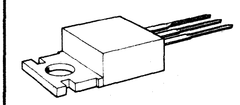
# TIP61
# TIP61A
# TIP61B
# TIP61C

### DESIGNED FOR POWER AMPLIFIER AND HIGH SPEED SWITCHING APPLICATIONS

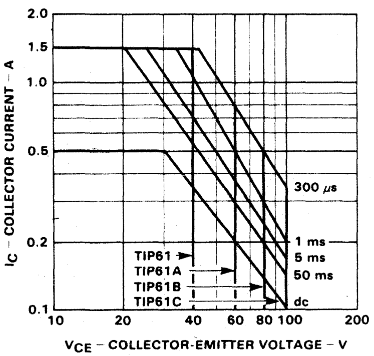
- 15 W DISSIPATION AT 25°C CASE
- 0.5 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- 3.0 MHz MINIMUM $f_T$
- 0.7 μs TYPICAL $t_{off}$
- COMPLEMENT TO TIP62 SERIES

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

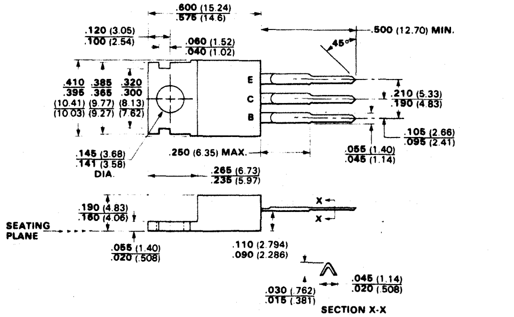
| Maximum Voltages and Currents | | TIP61 | TIP61A | TIP61B | TIP61C |
|---|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | 40 V | 60 V | 80 V | 100 V |
| $V_{CBO}$ | Collector to Base Voltage | 40 V | 60 V | 80 V | 100 V |
| $V_{EBO}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 0.5 A | 0.5 A | 0.5 A | 0.5 A |
| $I_C$ | Peak Collector Current | 1.5 A | 1.5 A | 1.5 A | 1.5 A |
| $I_B$ | Continuous Base Current | 0.4 A | 0.4 A | 0.4 A | 0.4 A |
| **Maximum Power Dissipation** | | | | | |
| $P_D$ | Total Dissipation @25°C Case Temperature | | | | 15 W |
| | Derate Linearly from 25°C | | | | 0.12 W/°C |
| **Maximum Temperatures** | | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | | 8.34°C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10 s) | | | | 260°C |



**SAFE OPERATING AREA**




**JEDEC (TO-220)** Outline**




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

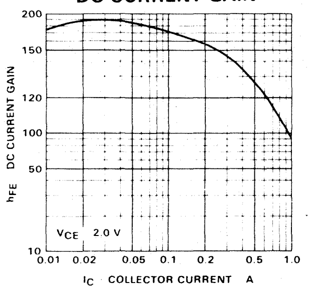
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | TIP61 | | TIP61A | | TIP62B | | TIP62C | | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 40 | | 60 | | 80 | | 100 | | V | $I_C = 30$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.3 | | 0.3 | | | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | | | 0.3 | | 0.3 | mA | $V_{CE} = 60$ V, $I_B = 0$ |
| $I_{CES}$ | Collector Reverse Current | | 0.2 | | | | | | | mA | $V_{CE} = 40$ V, $V_{BE} = 0$ |
| | | | | | 0.2 | | | | | mA | $V_{CE} = 60$ V, $V_{BE} = 0$ |
| | | | | | | | 0.2 | | | mA | $V_{CE} = 80$ V, $V_{BE} = 0$ |
| | | | | | | | | | 0.2 | mA | $V_{CE} = 100$ V, $V_{BE} = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | | 40 | | 40 | | 40 | | | $I_C = 50$ mA, $V_{CE} = 4.0$ V |
| | | 15 | 100 | 15 | 100 | 15 | 100 | 15 | 100 | | $I_C = 0.5$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 0.7 | | 0.7 | | 0.7 | | 0.7 | V | $I_C = 0.5$ A, $I_B = 60$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.3 | | 1.3 | | 1.3 | | 1.3 | V | $I_C = 0.5$ A, $V_{CE} = 4.0$ V |
| $\lvert h_{fe} \rvert$ | Magnitude of Common Emitter Small Signal Current Gain | 3.0 | | 3.0 | | 3.0 | | 3.0 | | | $I_C = 50$ mA, $V_{CE} = 10$ V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | 20 | | 20 | | | $I_C = 50$ mA, $V_{CE} = 10$ V, f = 1.0 kHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | | | | | |
| $t_{on}$ | Turn On Time | 0.12 typ | | 0.12 typ | | 0.12 typ | | 0.12 typ | | μs | $I_C = 0.5$ V, $V_{BE(off)} = -4.2$ V, $I_{B1} = 60$ mA |
| $t_{off}$ | Turn Off Time | 0.7 typ | | 0.7 typ | | 0.7 typ | | 0.7 typ | | μs | $I_C = 0.5$ A, $V_{BE(off)} = -4.2$ V, $I_{B1} = I_{B2} = 60$ mA |

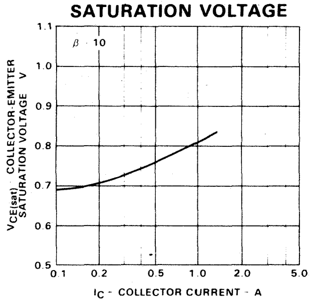
NOTE: 1. Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

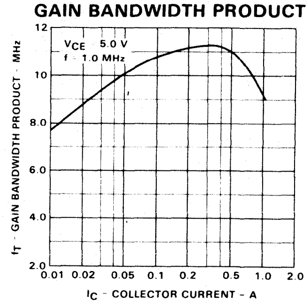
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### GAIN BANDWIDTH PRODUCT



# POWER TRANSISTOR

## PNP SILICON

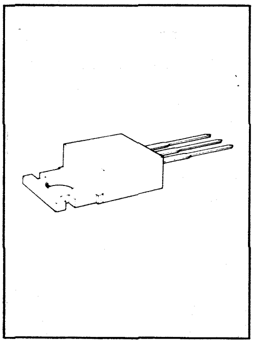
# TIP62
# TIP62A
# TIP62B
# TIP62C

### DESIGNED FOR POWER AMPLIFIER AND HIGH SPEED SWITCHING APPLICATIONS

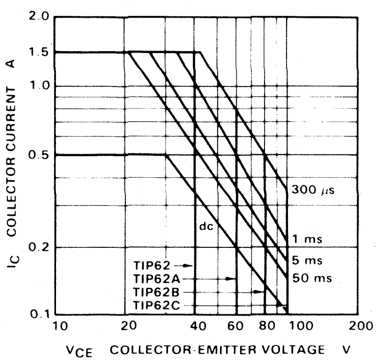
- 15 W DISSIPATION AT 25°C CASE
- 3.0 MHz MINIMUM $f_T$
- 0.7 $\mu$s TYPICAL $t_{off}$
- COMPLEMENT TO TIP61 SERIES

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

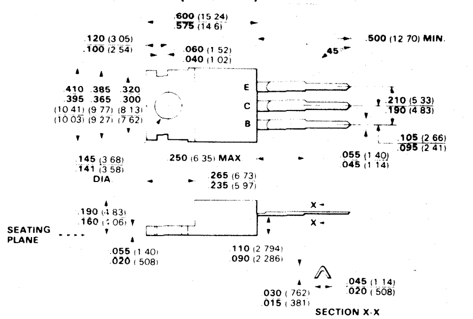
| Maximum Voltages and Currents | | TIP62 | TIP62A | TIP62B | TIP62C |
|---|---|---|---|---|---|
| $V_{CEO}$ | Collector to Emitter Voltage | −40 V | −60 V | −80 V | −100 V |
| $V_{CBO}$ | Collector to Base Voltage | −40 V | −60 V | −80 V | −100 V |
| $V_{EBO}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 0.5 A | 0.5 A | 0.5 A | 0.5 A |
| $I_C$ | Peak Collector Current | 1.5 A | 1.5 A | 1.5 A | 1.5 A |
| $I_B$ | Continuous Base Current | 0.4 A | 0.4 A | 0.4 A | 0.4 A |
| **Maximum Power Dissipation** | | | | | |
| $P_D$ | Total Dissipation @ 25°C Case Temperature (Note 1) | | | | 15 W |
| | Derate Linearly from 25°C | | | | 120 MW/°C |
| **Maximum Temperatures** | | | | | |
| $T_J$, $T_{stg}$ | Storage and Operation Junction Temperatures | | | | −65°C to +150°C |
| **Thermal Characteristics** | | | | | |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | | | | 8.34°C/W |
| $T_P$ | Maximum Pin Temperature for Soldering Purposes: 1/8″ from Case for 10 seconds | | | | 260°C |



**SAFE OPERATING AREA**




**JEDEC (TO-220)** Outline**




NOTES:
All dimensions 62 inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
*Mechanically interchangeable with TO-66
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
**Available in various pin configurations

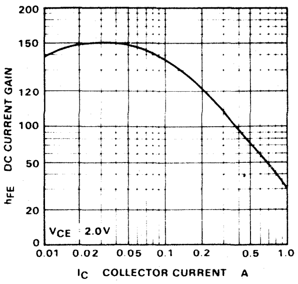
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | TIP62 MIN | TIP62 MAX | TIP62A MIN | TIP62A MAX | TIP62B MIN | TIP62B MAX | TIP62C MIN | TIP62C MAX | UNIT | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | -40 | | -60 | | -80 | | -100 | | V | $I_C$ = 30 mA, $I_B$ = 0 |
| $I_{CEO}$ | Collector Cutoff Current | | 0.3 | | 0.3 | | | | | mA | $V_{CE}$ = −30 V, $I_B$ = 0 |
| | | | | | | | 0.3 | | 0.3 | mA | $V_{CE}$ = −60 V, $I_B$ = 0 |
| $I_{CES}$ | Collector Reverse Current | | 0.2 | | | | | | | mA | $V_{CE}$ = −40 V, $V_{BE}$ = 0 |
| | | | | | 0.2 | | | | | mA | $V_{CE}$ = −60 V, $V_{BE}$ = 0 |
| | | | | | | | 0.2 | | | mA | $V_{CE}$ = −80 V, $V_{BE}$ = 0 |
| | | | | | | | | | 0.2 | mA | $V_{CE}$ = −100 V, $V_{BE}$ = 0 |
| $I_{EBO}$ | Emitter Cutoff Current | | 1.0 | | 1.0 | | 1.0 | | 1.0 | mA | $V_{EB}$ = −5.0 V, $I_C$ = 0 |
| **ON CHARACTERISTICS** | | | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 40 | | 40 | | 40 | | 40 | | | $I_C$ = 50 mA, $V_{CE}$ = −4.0 V |
| | | 15 | 100 | 15 | 100 | 15 | 100 | 15 | 100 | | $I_C$ = 0.5 A, $V_{CE}$ = −4.0 V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | -0.7 | | −0.7 | | -0.7 | | -0.7 | V | $I_C$ = 0.5 A, $I_B$ = 60 mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 1.3 | | 1.3 | | 1.3 | | 1.3 | V | $I_C$ = 0.5 A, $V_{CE}$ = −4.0 V |
| **DYNAMIC CHARACTERISTICS** | | | | | | | | | | | |
| $\|h_{fe}\|$ | Magnitude of Common Emitter Small Signal Current Gain | 3.0 | | 3.0 | | 3.0 | | 3.0 | | | $I_C$ = 50 mA, $V_{CE}$ = −10 V, f = 1.0 MHz |
| $h_{fe}$ | Small Signal Current Gain | 20 | | 20 | | 20 | | 20 | | | $I_C$ = 50 mA, $V_{CE}$ = −10 V, f = 1.0 kHz |
| **SWITCHING CHARACTERISTICS** | | | | | | | | | | | |
| $t_{on}$ | Turn On Time | 0.12 Typ | | 0.12 Typ | | 0.12 Typ | | 0.12 Typ | | μs | $I_C$ = 0.5 A, $V_{BE(off)}$ = −4.2 V, $I_{B1}$ = 60 mA |
| $t_{off}$ | Turn Off Time | 1.0 Typ | | 1.0 Typ | | 1.0 Typ | | 1.0 Typ | | μs | $I_C$ = 0.5 A, $V_{BE(off)}$ = −4.2 V, $I_{B1}$ = $I_{B2}$ = 60 mA |

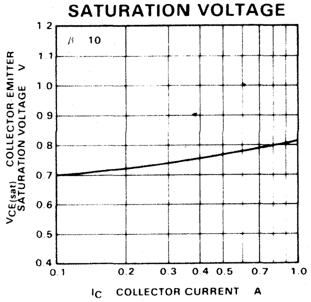
NOTES: (1) Pulse conditions: Length = 300 μs, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTIC

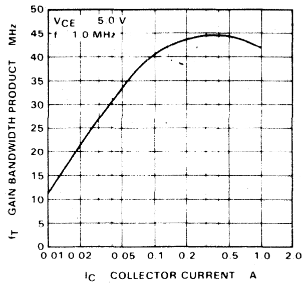
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### GAIN BANDWIDTH PRODUCT

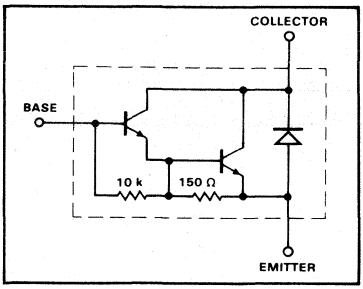


# POWER TRANSISTOR

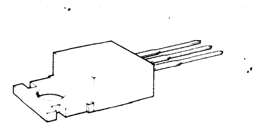
## NPN SILICON

# TIP110
# TIP111
# TIP112

### GENERAL PURPOSE DARLINGTON SUITABLE FOR POWER AMPLIFIER AND SWITCHING APPLICATIONS




- **50 W DISSIPATION AT 25°C CASE**
- **2.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT**
- **$h_{FE}$ TYPICAL OF 3000 AT 1.0 A**
- **COMPLEMENT TO TIP115, TIP116, TIP117**



### ABSOLUTE MAXIMUM RATINGS

| **Maximum Voltages and Currents** | | **TIP110** | **TIP111** | TIP112 |
|---|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | 60 V | 80 V | 100 V |
| $V_{CB}$ | Collector to Base Voltage | 60 V | 80 V | 100 V |
| $V_{EB}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 2.0 A | 2.0 A | 2.0 A |
| $I_C$ | Peak Collector Current | 4.0 A | 4.0 A | 4.0 A |
| $I_B$ | Continuous Base Current | 0.05 A | 0.05 A | 0.05 A |

**Maximum Power Dissipation**

| | | |
|---|---|---|
| $P_D$ | * Total Dissipation @ 25°C Case Temperature | 50 W |
| | Derate Linearly from 25°C | 0.4 W/°C |

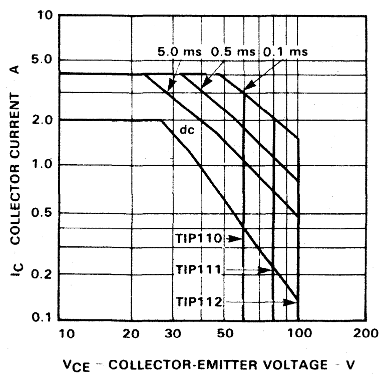
**Maximum Temperatures**

| | | |
|---|---|---|
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +150°C |

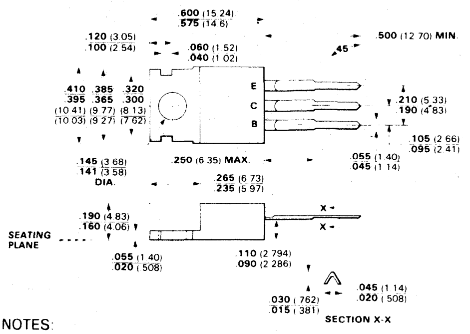
**Thermal Characteristics**

| | | |
|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 2.5 °C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 5 s) | 260°C |

**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline***




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
*Available in various pin configurations

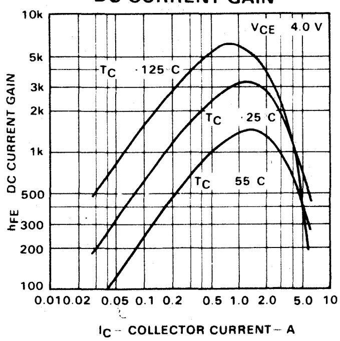
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | TIP110 | | TIP111 | | TIP112 | | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | 100 | | V | $I_C = 30$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 2.0 | | | | | mA | $V_{CE} = 30$ V, $I_B = 0$ |
| | | | | | 2.0 | | | mA | $V_{CE} = 40$ V, $I_B = 0$ |
| | | | | | | | 2.0 | mA | $V_{CE} = 50$ V, $I_B = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CB} = 60$ V, $I_E = 0$ |
| | | | | | 1.0 | | | mA | $V_{CB} = 80$ V, $I_E = 0$ |
| | | | | | | | 1.0 | mA | $V_{CB} = 100$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 2.0 | | 2.0 | | 2.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 1k | | 1k | | 1k | | | $I_C = 1.0$ A, $V_{CE} = 4.0$ V |
| | | 500 | | 500 | | 500 | | | $I_C = 2.0$ A, $V_{CE} = 4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 2.5 | | 2.5 | | 2.5 | V | $I_C = 2.0$ A, $I_B = 8.0$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.8 | | 2.8 | | 2.8 | V | $I_C = 2.0$ A, $V_{CE} = 4.0$ V |

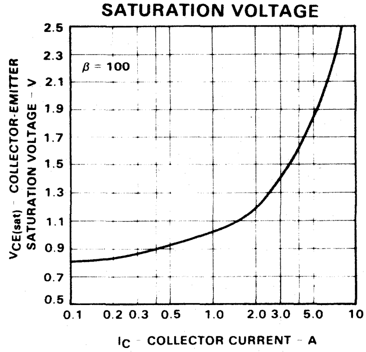
NOTE: 1. Pulse conditions: Length = 300 $\mu$s, Duty Cycle = 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

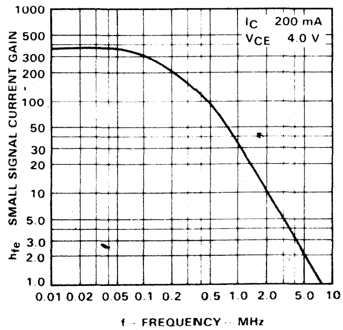
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### SMALL SIGNAL CURRENT GAIN



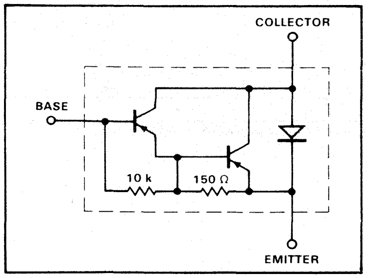
# POWER DARLINGTON

## PNP SILICON

**TIP115**
**TIP116**
**TIP117**

### GENERAL PURPOSE DARLINGTON SUITABLE FOR POWER AMPLIFIER AND SWITCHING APPLICATIONS

- 50 W DISSIPATION AT 25°C CASE
- 2.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- $h_{FE}$ TYPICAL OF 3000 AT 1.0 A
- COMPLEMENTS TO TIP110, TIP111, TIP112




### ABSOLUTE MAXIMUM RATINGS

**Maximum Voltages and Currents**

| | | TIP115 | TIP116 | TIP117 |
|---|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | −60 V | −80 V | −100 V |
| $V_{CB}$ | Collector to Base Voltage | −60 V | −80 V | −100 V |
| $V_{EB}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 2.0 A | 2.0 A | 2.0 A |
| $I_C$ | Peak Collector Current | 4.0 A | 4.0 A | 4.0 A |
| $I_B$ | Continuous Base Current | 0.05 A | 0.05 A | 0.05 A |

**Maximum Power Dissipation**

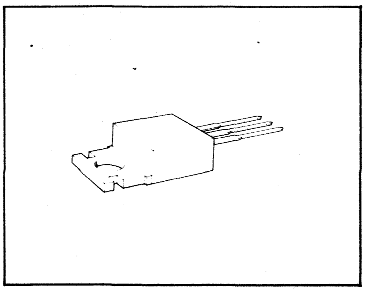
| | | |
|---|---|---|
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 50 W |
| | Derate Linearly from 25°C | 0.4 W/°C |

**Maximum Temperatures**

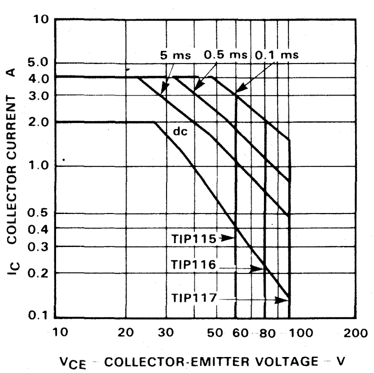
| | | |
|---|---|---|
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +150°C |

**Thermal Characteristics**

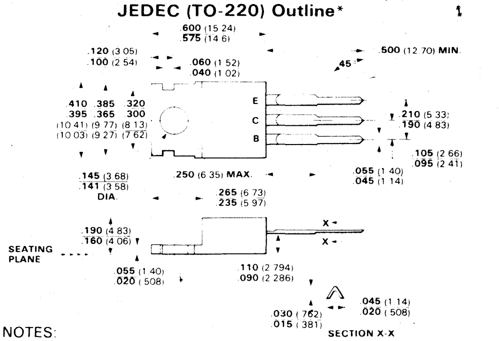
| | | |
|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 2.5 °C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 10 s) | 260°C |



**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline***




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
*Available in various pin configurations

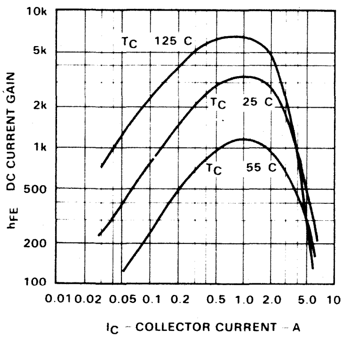
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | TIP115 MIN | TIP115 MAX | TIP116 MIN | TIP116 MAX | TIP117 MIN | TIP117 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | −80 | | −100 | | V | $I_C = 30$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 2.0 | | | | | mA | $V_{CE} = -30$ V, $I_B = 0$ |
| | | | | | 2.0 | | | mA | $V_{CE} = -40$ V, $I_B = 0$ |
| | | | | | | | 2.0 | mA | $V_{CE} = -50$ V, $I_B = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 1.0 | | | | | mA | $V_{CB} = -60$ V, $I_E = 0$ |
| | | | | | 1.0 | | | mA | $V_{CB} = -80$ V, $I_E = 0$ |
| | | | | | | | 1.0 | mA | $V_{CB} = -100$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 2.0 | | 2.0 | | 2.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 1k | | 1k | | 1k | | | $I_C = 1.0$ A, $V_{CE} = -4.0$ V |
| | | 500 | | 500 | | 500 | | | $I_C = 2.0$ A, $V_{CE} = -4.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −2.5 | | −2.5 | | −2.5 | V | $I_C = 2.0$ A, $I_B = 8.0$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −2.8 | | −2.8 | | −2.8 | V | $I_C = 2.0$ A, $V_{CE} = -4.0$ V |

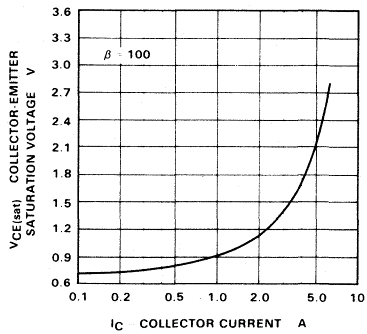
NOTE: 1. Pulse conditions: Length ≤ 300 μs, Duty Cycle ≤ 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

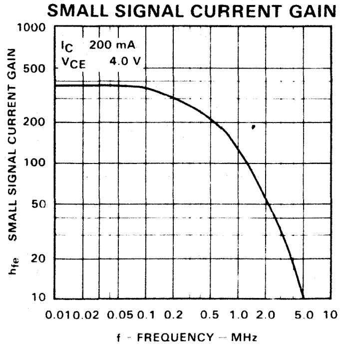
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### SMALL SIGNAL CURRENT GAIN

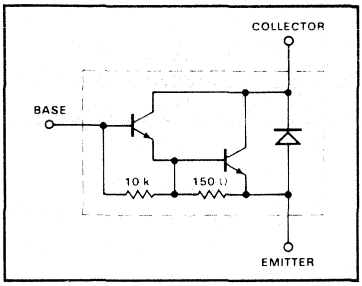


# POWER DARLINGTON

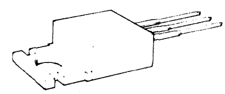
## NPN SILICON

# TIP120
# TIP121
# TIP122

### GENERAL PURPOSE DARLINGTON SUITABLE FOR HAMMER DRIVERS AND VOLTAGE REGULATORS




- 65 W DISSIPATION AT 25°C CASE
- 5.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- $h_{FE}$ TYPICAL OF 4500 AT 4.0 A
- COMPLEMENTS TO TIP125, TIP126, TIP127



## ABSOLUTE MAXIMUM RATINGS

| Maximum Voltages and Currents | | TIP120 | TIP121 | TIP122 |
|---|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | 60 V | 80 V | 100 V |
| $V_{CB}$ | Collector to Base Voltage | 60 V | 80 V | 100 V |
| $V_{EB}$ | Emitter to Base Voltage | 5.0 V | 5.0 V | 5.0 V |
| $I_C$ | Continuous Collector Current | 5.0 A | 5.0 A | 5.0 A |
| $I_C$ | Peak Collector Current | 8.0 A | 8.0 A | 8.0 A |
| $I_B$ | Continuous Base Current | 0.1 A | 0.1 A | 0.1 A |

**Maximum Power Dissipation**

| | | |
|---|---|---|
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 65 W |
| | Derate Linearly from 25°C | 0.52 W/°C |

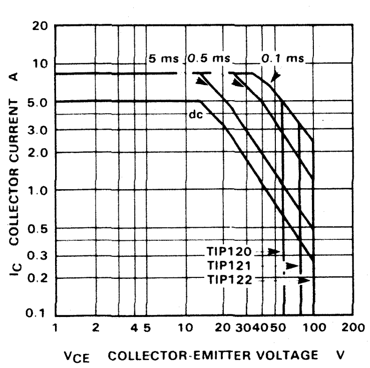
**Maximum Temperatures**

| | | |
|---|---|---|
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +150°C |

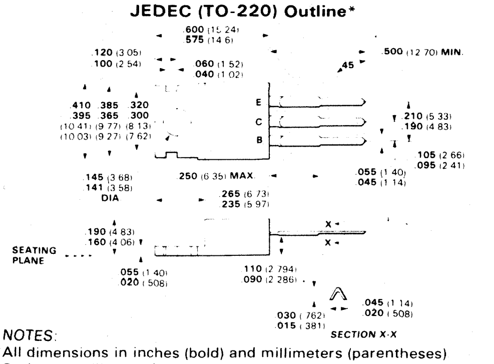
**Thermal Characteristics**

| | | |
|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.92 °C/W |
| $T_P$ | *Maximum Pin Temperature (Soldering, 5 s)* | 260°C |

**SAFE OPERATING AREA**




**JEDEC (TO-220) Outline***




*NOTES:*
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
*Available in various pin configurations

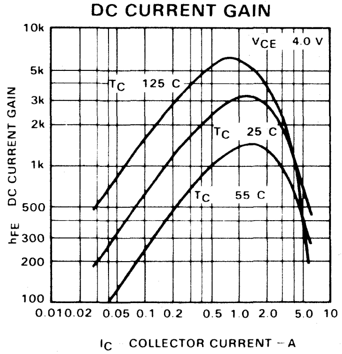
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTIC | TIP120 | | TIP121 | | TIP122 | | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | | |
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | 60 | | 80 | | 100 | | V | $I_C = 30$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | 0.5 | | 0.5 | mA<br>mA<br>mA | $V_{CE} = 30$ V, $I_B = 0$<br>$V_{CE} = 40$ V, $I_B = 0$<br>$V_{CE} = 50$ V, $I_B = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.2 | | 0.2 | | 0.2 | mA<br>mA<br>mA | $V_{CB} = 60$ V, $I_E = 0$<br>$V_{CB} = 80$ V, $I_E = 0$<br>$V_{CB} = 100$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 2.0 | | 2.0 | | 2.0 | mA | $V_{EB} = 5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain (Note 1) | 1k<br>1k | | 1k<br>1k | | 1k<br>1k | | | $I_C = 0.5$ A, $V_{CE} = 3.0$ V<br>$I_C = 3.0$ A, $V_{CE} = 3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | 2.0<br>4.0 | | 2.0<br>4.0 | | 2.0<br>4.0 | V<br>V | $I_C = 3.0$ A, $I_B = 12$ mA<br>$I_C = 5.0$ A, $I_B = 20$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | 2.5 | | 2.5 | | 2.5 | V | $I_C = 3.0$ A, $V_{CE} = 3.0$ V |

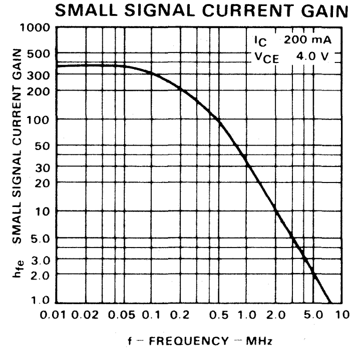
NOTE: 1. Pulse conditions: Length 300 μs, Duty Cycle 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

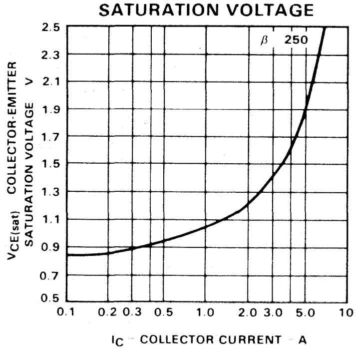
### DC CURRENT GAIN




### SMALL SIGNAL CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE



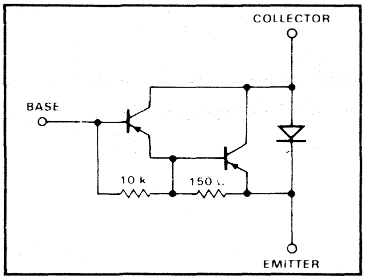
# POWER DARLINGTON

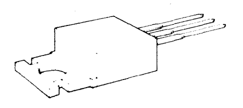
PNP SILICON

# TIP 125
# TIP 126
# TIP 127

## GENERAL PURPOSE DARLINGTON SUITABLE FOR HAMMER DRIVERS AND VOLTAGE REGULATORS

- 65 W DISSIPATION AT 25°C CASE
- 5.0 A MAXIMUM CONTINUOUS COLLECTOR CURRENT
- $h_{FE}$ TYPICAL OF 2000 AT 3.0 A
- COMPLEMENTS TO TIP120, TIP121, TIP122



### ABSOLUTE MAXIMUM RATINGS

**Maximum Voltages and Currents**

| | | TIP125 | TIP126 | TIP127 |
|---|---|---|---|---|
| $V_{CE}$ | Collector to Emitter Voltage | −60 V | −80 V | −100 V |
| $V_{CB}$ | Collector to Base Voltage | −60 V | −80 V | −100 V |
| $V_{EB}$ | Emitter to Base Voltage | −5.0 V | −5.0 V | −5.0 V |
| $I_C$ | Continuous Collector Current | 5.0 A | 5.0 A | 5.0 A |
| $I_C$ | Peak Collector Current | 8.0 A | 8.0 A | 8.0 A |
| $I_B$ | Continuous Base Current | 0.1 A | 0.1 A | 0.1 A |

**Maximum Power Dissipation**

| | | |
|---|---|---|
| $P_D$ | Total Dissipation @ 25°C Case Temperature | 65 W |
| | Derate Linearly from 25°C | 0.52 W/°C |

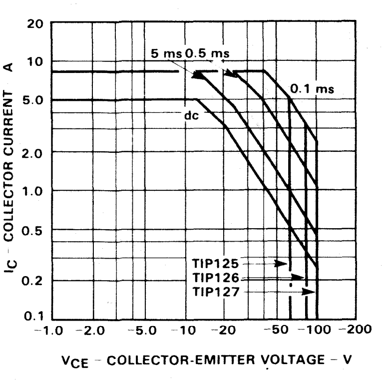
**Maximum Temperatures**

| | | |
|---|---|---|
| $T_J, T_{stg}$ | Storage and Operation Junction Temperatures | −65°C to +150°C |

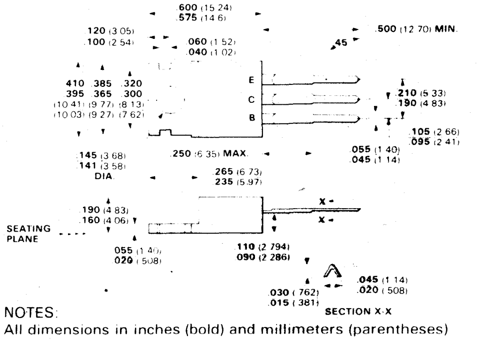
**Thermal Characteristics**

| | | |
|---|---|---|
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case | 1.92 °C/W |
| $T_P$ | Maximum Pin Temperature (Soldering, 5 s) | 260°C |

### SAFE OPERATING AREA




### JEDEC (TO-220) Outline*




NOTES:
All dimensions in inches (bold) and millimeters (parentheses)
Package is silicone plastic with nickel-plated copper tab and pins
Center pin is electrical contact with the mounting tab
Package weight is 2.1 grams
*Available in various pin configurations

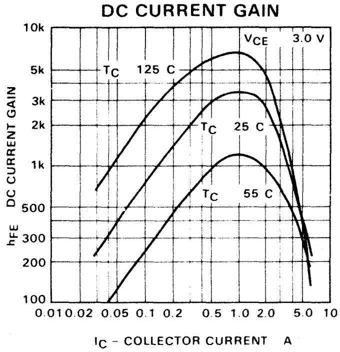
**ELECTRICAL CHARACTERISTICS** (25°C Case Temperature unless otherwise noted)

| SYMBOL | CHARACTERISTICS | TIP125 MIN | TIP125 MAX | TIP126 MIN | TIP126 MAX | TIP127 MIN | TIP127 MAX | UNITS | TEST CONDITIONS |
|---|---|---|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** | | | | | | | | | |
| $V_{CEO(sus)}$ | Collector-Emitter Sustaining Voltage (Note 1) | −60 | | −80 | | −100 | | V | $I_C = 30$ mA, $I_B = 0$ |
| $I_{CEO}$ | Collector Cutoff Current | | 0.5 | | 0.5 | | 0.5 | mA<br>mA<br>mA | $V_{CE} = -30$ V, $I_B = 0$<br>$V_{CE} = -40$ V, $I_B = 0$<br>$V_{CE} = -50$ V, $I_B = 0$ |
| $I_{CBO}$ | Collector Cutoff Current | | 0.2 | | 0.2 | | 0.2 | mA<br>mA<br>mA | $V_{CB} = -60$ V, $I_E = 0$<br>$V_{CB} = -80$ V, $I_E = 0$<br>$V_{CB} = -100$ V, $I_E = 0$ |
| $I_{EBO}$ | Emitter Cutoff Current | | 2.0 | | 2.0 | | 2.0 | mA | $V_{EB} = -5.0$ V, $I_C = 0$ |
| **ON CHARACTERISTICS** | | | | | | | | | |
| $h_{FE}$ | DC Current Gain.(Note 1) | 1k<br>1k | | 1k<br>1k | | 1k<br>1k | | | $I_C = 0.5$ A, $V_{CE} = -3.0$ V<br>$I_C = 3.0$ A, $V_{CE} = -3.0$ V |
| $V_{CE(sat)}$ | Collector-Emitter Saturation Voltage (Note 1) | | −2.0<br>−4.0 | | −2.0<br>−4.0 | | −2.0<br>−4.0 | V<br>V | $I_C = 3.0$ A, $I_B = 12$ mA<br>$I_C = 5.0$ A, $I_B = 20$ mA |
| $V_{BE(on)}$ | Base-Emitter "On" Voltage (Note 1) | | −2.5 | | −2.5 | | −2.5 | V | $I_C = 3.0$ A, $V_{CE} = -3.0$ V |

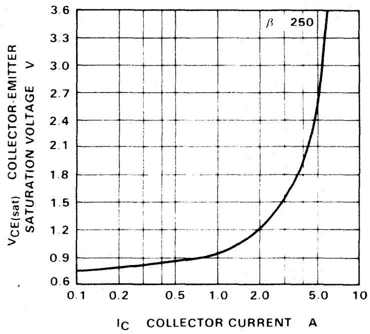
NOTE: 1. Pulse conditions: Length 300 μs, Duty Cycle 2%.

## TYPICAL ELECTRICAL CHARACTERISTICS

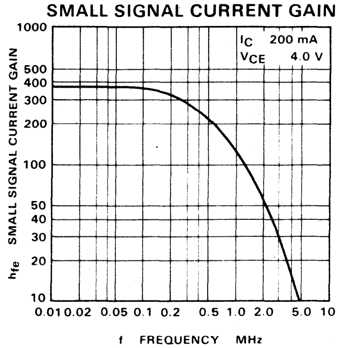
### DC CURRENT GAIN




### COLLECTOR-EMITTER SATURATION VOLTAGE




### SMALL SIGNAL CURRENT GAIN



# POWER TRANSISTOR UNENCAPSULATED CHIPS

## GENERAL INFORMATION:

The Fairchild power transistor chips described are processed in either Planar or Mesa technology.
Planar Power Transistor Chips Have the Following Characteristics.

- Epitaxial collector for high voltage
- Diffused base and emitter
- Fully passivated junctions for low leakage
- 2.5μ thick aluminum metalization on topside for high current handling and excellent wire bonding.
- 0.8μ thick gold metalization on topside for excellent eutectic die attach.
- Chip thickness of 175μ ± 15μ

Mesa Power Transistor Chips Have the Following Characteristics.

- Epitaxial collector for high voltage
- Epitaxial base for high voltage and power capability
- Diffused emitter
- 5μ thick aluminum metalization on topside for high current handling and excellent wire bonding.
- 0.8μ chrome-silver metalization on backside for good soft solder die attach.
- Chip thickness of 200μ ± 15μ

## VISUAL INSPECTION

Fairchild power transistor dice go through extensive visual inspection during die processing (see flow chart). Die are visualed at 40X to 100X magnification using Fairchild's standard visual inspection criteria. Copies of the visual inspection documents are available upon request.

## OPTIONS

All power transistor dice can be procured in either of the two following forms. Cavity Pack is our standard method of packaging, but, the other option is available.

Cavity Pack - wafers are 100% tested, reject dice are inked and removed. Good dice are cleaned, visualed, and shipped in individual cavities (see *Figure 1*).

Wafer Pack - wafer is tested, reject dice are inked, wafer is scribed and fractured. Entire wafer is shipped in wafer form (see *Figure 2*).

## STANDARD DICE SPECIFICATIONS

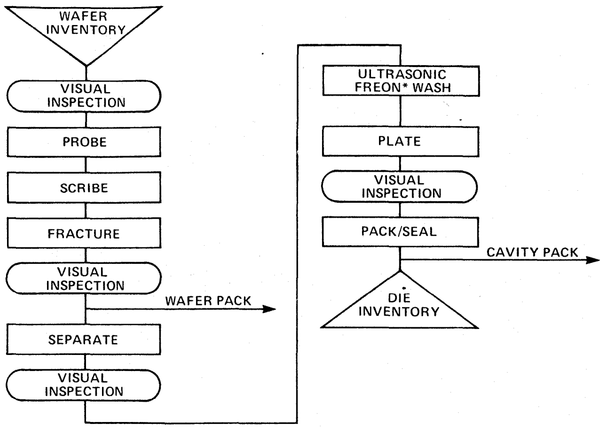
Power transistor dice are assigned an SP number. The dice are identical to those used in the Fairchild assembled devices. Customer requirements will be reviewed by the factory and when the specification is negotiated satisfactorily an SP number will be assigned.

## PARAMETER GUARANTEES

Probing in die form limits testing to 25°C dc parameters only. The factory will correlate tests to be probed to customer requirements. These probed dc tests are guaranteed to an LTPD of 10%.
The ac parameters which will be similar to those on Fairchild data sheets, will be correlated to selected dc parameters and are guaranteed to an LTPD of 20%.

## STANDARD DICE PROCESSING

The power transistor dice listed are produced on the same well-proven production lines that produce Fairchild's standard encapsulated devices.
The following flow chart will show the additional steps that are done once a wafer is selected for processing in die form.




## ORDERING INFORMATION

When ordering be sure to call out the SP number, not the 2N number. Just specify the device type, quantity and the packaging method preferred.

## HANDLING PRECAUTIONS

Extreme care must be used in handling unencapsulated semiconductors to avoid damage to the chip surface. The following precautions apply.

Wafer Pack - Wafers should only be handled near the edge with round ended stainless steel or teflon tweezers.

Cavity Pack - Lid and anti-static mylar should be removed slowly and with extreme care to avoid disturbing position of the dice. Dice should be handled with a smooth tipped vacuum wand only. Do not use tweezers.

In addition, devices should be stored in an environment of not more than 30% relative humidity. Die and wire bonding should not exceed 400°C in an inert atmosphere or 100°C in a non-inert atmosphere.

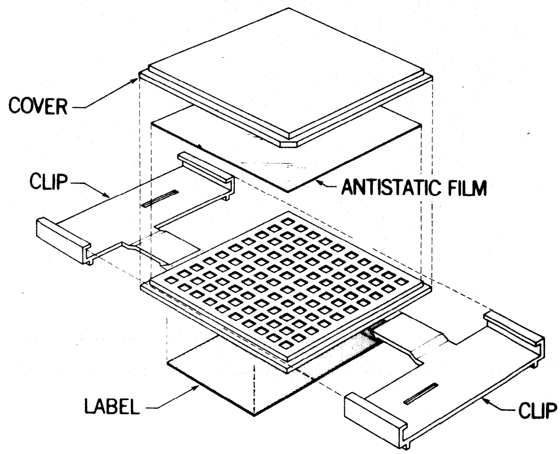



Fig. 1 CAVITY PACK

**Fig. 1**

**CAVITY PACK — Dice are Placed in Individual Compartments. The Plastic Snap Clips Permit Inspection and Resealing.**

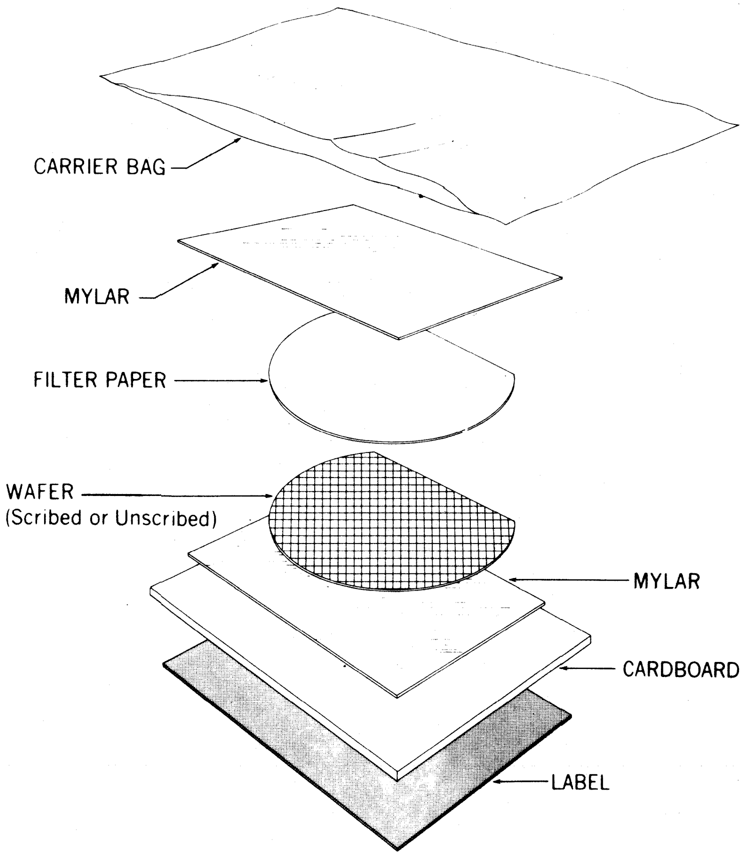



Fig. 2 WAFER PACK

**Fig. 2**

**WAFER PACK — Entire Wafer is Sandwiched Between Two Pieces of Mylar and Vacuum Sealed in a Plastic Envelope.**

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# POWER TRANSISTOR SYMBOLS, TERMS AND DEFINITIONS

| | |
|---|---|
| Base (B,b)* | A region which lies between an emitter and collector of a transistor and into which minority carriers are injected. |
| Breakdown | A phenomenon occuring in a reverse-biased semiconductor junction, the initiation of which is observed as a transition from a region of high small-signal resistance to a region of substantially lower small-signal resistance for an increasing magnitude of reverse current. |
| Breakdown Region | A region of the volt-ampere characteristic beyond the initiation of breakdown for an increasing magnitude of reverse current. |
| Breakdown Voltage | The voltage measured at a specified current in a breakdown region. |
| $BV_{CBO}$ | *Collector-Base Breakdown Voltage:* The breakdown voltage of the collector base junction when reverse biased with the emitter terminal open. |
| $BV_{CEO}$ | *Collector-Emitter Breakdown Voltage:* The collector-to-emitter breakdown voltage with the base terminal open circuited. |
| $BV_{CER}$ | *Collector-Emitter Breakdown Voltage:* The collector-to-emitter breakdown voltage with the base connected to the emitter through a resistor. |
| $BV_{CES}$ | *Collector-Emitter Breakdown Voltage:* The breakdown voltage of the transistor when the collector is reverse biased with respect to the emitter and the base is terminated through a short circuit to the emitter. |
| $C_{cb}$ | *Interterminal Capacitance (Collector-to-Base):* The direct interterminal capacitance between the collector and base with the collector-base junction reverse biased and the emitter terminal open circuited to dc, but ac connected to the guard terminal of a 3-terminal bridge. This capacitance includes the interelement capacitance plus capacitance to the shield where the shield is connected to one of the terminals under measurement. |
| $C_{eb}$ | *Interterminal Capacitance (Emitter to Base):* Capacitance measured with the emitter base reverse biased, the collector open circuited but ac connected to the guard circuit. |
| $C_{ibo}$ | *Open-Circuit Input Capacitance (Common-Base):* The capacitance measured across the emitter and base terminals with the collector open circuited for ac. |
| $C_{obo}$ | *Open-Circuit Output Capacitance (Common-Base):* The capacitance measured across the collector and base terminals with the emitter open circuited to ac. |
| Collector(C,c)* | A region through which a primary flow of charge carriers leaves the base. |
| $C_{rb}$ | *Reverse Transfer Capacitance:* in common-base configuration. |
| $C_{re}$ | *Reverse Transfer Capacitance:* in common-emitter configuration. |
| Emitter(E,e)* | A region from which charge carriers that are minority carriers in the base are injected into the base. |

*Note: References to base, collector, and emitter symbolism (B, b, C, c, E, and e) refer to the device terminals connected to those regions.

| | |
|---|---|
| $f$ | *Frequency.* |
| $f_C$ | *Cut-off frequency.* |
| $f_{hfe}$ | *Small-Signal Short-Circuit Forward-Current Transfer-Ratio Cutoff Frequency (Common-Emitter):* The lowest frequency at which the magnitude of the small-signal short-circuit forward-current transfer ratio is 0.707 of its value at a specified low frequency (usually 1 kHz or less). |
| $f_T$ | *Current-Gain-Bandwidth Product:* Frequency at which small-signal forward-current transfer ratio (common-emitter) extrapolates to unity. The product of the modulus (magnitude) of the common-emitter small-signal short-circuit forward current transfer ratio, $h_{fe}$, and the frequency of measurement when this frequency is sufficiently high so that the modulus of the $h_{fe}$ is decreasing with a slope of approximately 6 dB per octave. |
| $G_{PE}$ | *Large-Signal Insertion Power Gain (Common-Emitter):* The ratio, usually expressed in dB, of the signal power delivered to the input. |
| $h_{FE}$ | *DC Current Gain:* The ratio of collector current ($I_C$) to the base current ($I_B$) at a specified collector-emitter voltage. |
| $h_{fe}$ | *Small-Signal Short-Circuit Forward-Current Transfer Ratio (Common-Emitter):* The ratio of the ac output current to the small-signal ac input current with the output short circuited to ac. This small signal-current gain is measured at a relatively low frequency, usually 1 kHz. |
| $\|h_{fe}\|$ | *Small-Signal Short-Circuit Forward-Current Transfer Ratio (Common-Emitter):* The ratio of the ac output current to the small-signal ac input current with the output short circuited to ac. |
| $h_{IE}$ | *Static Input Resistance (Common-Emitter):* The ratio of the dc base-emitter voltage to the dc base current. |
| $h_{ie}$ | *Small-Signal Short-Circuit Input Impedance (Common-Emitter):* The ratio of the small-signal ac base-emitter voltage to the ac base current with the collector short circuited to the emitter for ac. |
| $h_{ie\,(imag)}$ | *Imaginary Part of the Small-Signal Short-Circuit Input Impedance, (Common-Emitter):* The ratio of the out-of-phase (imaginary) component of the small-signal ac base-emitter voltage to the ac base current with the collector terminal short circuited to the emitter terminal for ac. |
| $h_{ie\,(real)}$ | *Real Part of the Small-Signal Short-Circuit Input Impedance, (Common-Emitter):* The ratio of the in-phase (real) component of the small-signal ac base-emitter voltage to the ac base current with the collector terminal short circuited to the emitter terminal for ac. |
| $h_{oe}$ | *Small-Signal Open-Circuit Output Admittance, (Common-Emitter):* The ratio of the ac collector current to the small-signal ac collector-emitter voltage with the base terminal open circuited to ac. |

$h_{oe}$ (imag) — *Imaginary Part of the Small-Signal Open-Circuit Output Admittance, (Common-Emitter):* The ratio of the ac collector current to the out-of-phase (imaginary) component of the small-signal collector-emitter voltage with the base terminal open circuited to ac.

$h_{oe}$ (real) — *Real Part of the Small-Signal Open-Circuit Output Admittance, Common-Emitter):* The ratio of the ac collector current to the in-phase (real) component of the small-signal collector-emitter voltage with the base terminal open circuited to the ac.

$I_B$ — *Base Current (Continuous):* The maximum base current which the transistor can handle without failure.

$I_{B\,(Peak)}$ — *Base Current (Peak):* The peak base current which the transistor can handle without catastrophic failure. Time must be considered.

$I_C$ — *Collector Current (Continuous):* The maximum dc collector current which the transistor can handle on a continuous basis without failure.

$I_{C\,(peak)}$ — *Collector Current (Peak):* The peak collector current which the transistor can handle without catastrophic failure. Time must be considered.

$I_E$ — *Emitter Current (Continuous):* The maximum continuous emitter current which the transistor can carry without failure.

$I_{CBO}$ — *Collector Cutoff Current:* Collector current measured with the collector-base junction reverse biased and the emitter terminal open.

$I_{CEO}$ — *Collector Cutoff Current:* Collector-emitter current measured with the base terminal open.

$I_{CER}$ — *Collector Cutoff Current:* Collector current measured with the collector-base junction reverse biased and the base terminal connected to the emitter through a resistor.

$I_{CES}$ — *Collector Cutoff Current:* Collector current measured with the collector reverse biased with respect to the emitter and the base terminal shorted to the emitter.

$I_{CEV}$ — *Collector Cutoff Current:* The dc current into the collector terminal when it is biased to the reverse direction with respect to the emitter terminal and the base terminal is returned to the emitter terminal through a specified voltage.

$I_{CEX}$ — *Collector Cutoff Current:* Collector current measured with the collector reverse biased with respect to the emitter and the base terminated with a specified circuit between base and emitter.

$I_{EBO}$ — *Emitter Cutoff Current:* The emitter current as measured when the emitter-base junction is reverse biased and the collector terminal is open.

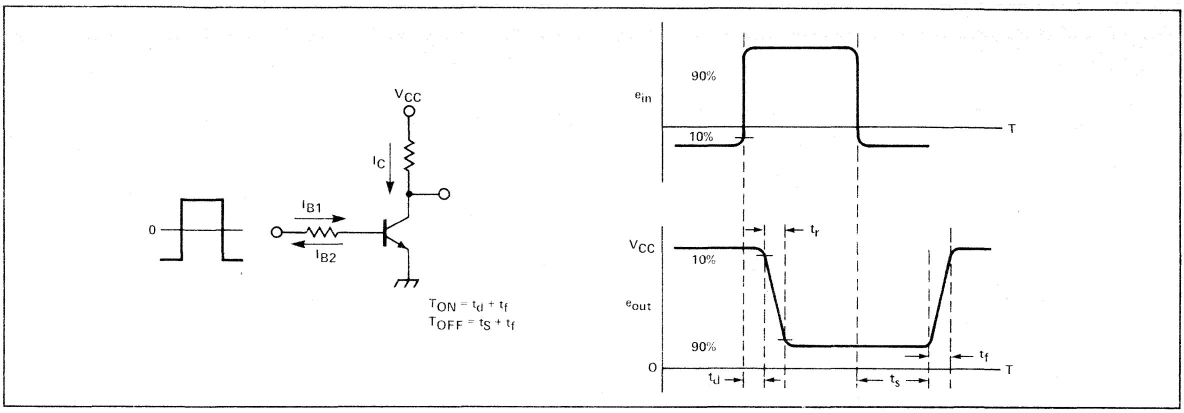
Junction, Collector — A semiconductor junction normally biased in the high-resistance direction, the current through which can be controlled by the introduction of minority carriers into the base.

| | |
|---|---|
| Junction, Emitter | A semiconductor junction normally biased in the low-resistance direction to inject minority carriers into the base. |
| Open Circuit | A circuit shall be considered as open circuited if halving the magnitude of the terminating impedance does not produce a change in the parameter being measured greater than the required accuracy of the measurement. |
| $P_D$ | *Total Device Power Dissipation:* The maximum power which the device can dissipate reliably at the specified case temperature. Case temperature must be controlled and second-breakdown limitations observed. |
| $P_{out}$ | *Output Power.* |
| R | *Resistance.* |
| rb'Cc | *Collector-Base Time Constant:* The product of the intrinsic base resistance and collector capacitance under specified small-signal conditions. |
| $R_{BE}$ | *Base-Emitter Resistance.* |
| Reverse Current | The current that flows through a semiconductor junction in the reverse direction. |
| Reverse Direction | The direction of current flow which results when the n-type semiconductor region is at a positive potential relative to the p-type region. |
| $R\theta_{JA}$ | *Thermal Resistance, Junction-To-Ambient:* The thermal resistance (resistance to heat flow) from the junction of the transistor to the ambient. |
| $R\theta_{CS}$ | *Thermal Resistance, Case-To-Heat-Sink:* The thermal resistance from the case of the transistor to its mounting surface. |
| Safe Operating Area | A defined region of operation which will ensure reliable operation of the transistor. Limits upon current as a function of voltage and time as shown. |
| Saturation | A base-current and a collector-current condition resulting in a forward-biased collector junction. |
| Second Breakdown | A condition of the transistor, resulting from a lateral current instability, in which the electrical characteristics are determined principally by the spreading resistance of a thermally maintained current constriction. The initiation of second breakdown is observed as a decrease in the voltage sustained by the collector. |
| Semiconductor Device | A device whose essential characteristics are due to the flow of charge carriers within a semiconductor. |
| Semiconductor Junction. | A region of transition between semiconductor regions of different electrical properties (e.g., n-n+, p-n, p-p+ semiconductors), or between a metal and a semiconductor. |
| Short Circuit | A circuit in which doubling the magnitude of the terminating impedance does not produce a change in the parameter being measured that is greater than the required accuracy of the measurement. |

**Small Signal** A signal which when doubled in magnitude does not produce a change in the parameter being measured that is greater than the required accuracy of the measurement.

**Static Value** A non-varying value or quantity of measurement at a specified fixed point, or the slope of the line from the origin to the operating point on the appropriate characteristic curve.

**Switching Times** Common-emitter switching parameters consist of $t_d$, $t_r$, $t_s$ and $t_f$. In the following circuit, drive-circuit conditions and collector-circuit conditions must be specified. The transition times of the input must be negligible compared to the measured times.




$t_d$ *Delay Time:* The time interval during turn-on from the point when the input pulse at the base reaches 10% of its full amplitude to the point when the collector pulse changes from 0 to 10% of its maximum amplitude.

$t_r$ *Rise Time:* The time interval during turn-on in which the collector pulse changes from 10% to 90% of its maximum amplitude.

$t_s$ *Storage Time:* The time interval during turn-off from the point when the turn-off pulse at the base changes from 100% to 90% of its full amplitude to the time when the collector current has changed from 100% to 90% of its maximum amplitude.

$t_f$ *Fall Time:* The time interval during turn-off in which the collector pulse decreases from 90% to 10% of its maximum amplitude.

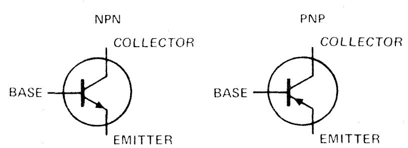
$t_{off}$ *Turn-Off Time:* The sum of $t_s + t_f$

$t_{on}$ *Turn-On Time:* The sum of $t_d + t_r$

$t_p$ *Pulse Time:* The time duration from the point on the leading edge which is 50% of the maximum amplitude to a point on the trailing egde which is 50% of the maximum amplitude.

$t_w$ *Pulse Average Time:* The time duration from the point on the leading edge which is 50% of the maximum amplitude to a point on the trailing edge which is 50% of the maximum amplitude.

| | |
|---|---|
| $T_A$ | *Ambient Temperature or Free Air Temperature:* The air temperature measured below a device, in an environment of substantially uniform temperature cooled only by natural air convection and not materially affected by reflective and radiant surfaces. |
| $T_C$ | *Case Temperature:* The temperature of the transistor package or case, measured at a specific point. |
| $t_d$ | *See Switching Times.* |
| Terminal | An externally available point of connection to one or more electrodes. |
| $t_f$ | *See Switching Times.* |
| Thermal Resistance (Steady State) | The temperature difference between two specified points or regions divided by the power dissipation under conditions of thermal equilibrium. |
| $T_J$ | *Junction Temperature:* The junction temperature of the transistor. |
| $t_{off}$ | *See Switching Times.* |
| $t_{on}$ | *See Switching Times.* |
| $t_p$ | *See Switching Times.* |
| $t_r$ | *See Switching Times.* |
| Transient Thermal Impediance | The change of temperature difference between two specified points or regions at the end of a time interval divided by the step-function change in power dissipation at the beginning of the same time interval causing the change of temperature difference. |
| Transistor | An active semiconductor device capable of providing power amplification and having three or more terminals. |
| Transistor, Junction, Multijunction Type | A transistor having a base and two or more junctions. Below are the graphic symbols for emitter, base, collector transistors. In the graphic symbols, the envelope is optional if no element is connected to the envelope. |
| $T_{stg}$ | *Storage Temperature:* The minimum and maximum storage temperature under which the device can be safely stored without causing damage. |



| | |
|---|---|
| $t_W$ | *See Switching Times.* |
| $V_{BB}$ | *Supply Voltage, dc (Base):* The dc supply voltage applied to a circuit connected to the base. |
| $V_{BE}$ | *Base-Emitter Voltage:* The base-emitter voltage as measured with the collector current and collector-emitter voltage specified. |
| $V_{BE\ (sat)}$ | *Base-Emitter Saturation Voltage:* The base-emitter voltage as measured with conditions as specified for $V_{CE(sat)}$. |
| $V_{CB}$ | *Collector-Base Voltage:* The maximum voltage which may be applied across the collector-base terminals with base termination specified. |
| $V_{CBO}$ | *Collector-Base Voltage:* The maximum voltage which may be applied to the collector-base terminals with the emitter terminal open. |
| $V_{CC}$ | *Supply Voltage DC, (Collector):* The dc supply voltage applied to a circuit connected to the collector. |
| $V_{CEO}$ | *Collector-Emitter Voltage:* The maximum voltage which may be applied to the collector-emitter terminals with the base terminal open. |
| $V_{CEO(sus)}$ | *Collector-Emitter Sustaining Voltage:* Collector-to-emitter breakdown voltage with the base terminal open. The voltage specified is at the lowest portion of any negative resistance region on the voltage-breakdown characteristic curve. |
| $V_{CER}$ | *Collector-Emitter Voltage:* The maximum voltage which may be applied between the collector and the emitter with the base terminal connected through a resistor to the emitter. |
| $V_{CER(sus)}$ | *Collector-Emitter Sustaining Voltage:* The collector-emitter voltage obtained by reverse-biasing the collector with respect to the emitter and the base terminated through a resistor to the emitter. Test current must be the proper magnitude so that the voltage measured is at the lowest point of any negative resistance region on the characteristic breakdown curve. |
| $V_{CES}$ | *Collector-Emitter Voltage:* The maximum voltage which may be applied between the collector and emitter with the base terminal shorted to the emitter terminal. |
| $V_{CE(sat)}$ | *Collector-Emitter Saturation Voltage:* The dc voltage measured between the collector-emitter terminals at specified current conditions. |
| $V_{EBO}$ | *Emitter-Base Voltage:* The maximum voltage which may be applied to the emitter-base terminals with the collector terminal open. |
| $V_{EC}$ | *Emitter-to Collector dc Voltage.* |
| $\eta$ | *Efficiency.* |

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