

# Complementary Darlington Silicon Power Transistors

... designed for use as general purpose amplifiers, low frequency switching and motor control applications.

- High dc Current Gain @ 10 Adc —  $h_{FE} = 400$  Min (All Types)
- Collector–Emitter Sustaining Voltage  
 $V_{CEO(sus)} = 150$  Vdc (Min) – MJ11018, 17  
 $= 250$  Vdc (Min) – MJ11022, 21
- Low Collector–Emitter Saturation  
 $V_{CE(sat)} = 1.0$  V (Typ) @  $I_C = 5.0$  A  
 $= 1.8$  V (Typ) @  $I_C = 10$  A
- Monolithic Construction
- 100% SOA Tested @  $V_{CE} = 44$  V,  $I_C = 4.0$  A,  $t = 250$  ms.

## MAXIMUM RATINGS

Rating	Symbol	MJ11018 MJ11017	MJ11022 MJ11021	Unit
Collector–Emitter Voltage	$V_{CEO}$	150	250	Vdc
Collector–Base Voltage	$V_{CB}$	150	250	Vdc
Emitter–Base Voltage	$V_{EB}$	50		Vdc
Collector Current — Continuous Peak	$I_C$	15 30		Adc
Base Current	$I_B$	0.5		Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate Above $25^\circ\text{C}$	$P_D$	175 1.16		Watts W/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	–65 to +175 –65 to +200		$^\circ\text{C}$

## THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.86	$^\circ\text{C}/\text{W}$

(1) Pulse Test: Pulse Width 5.0 ms, Duty Cycle  $\leq 10\%$ .

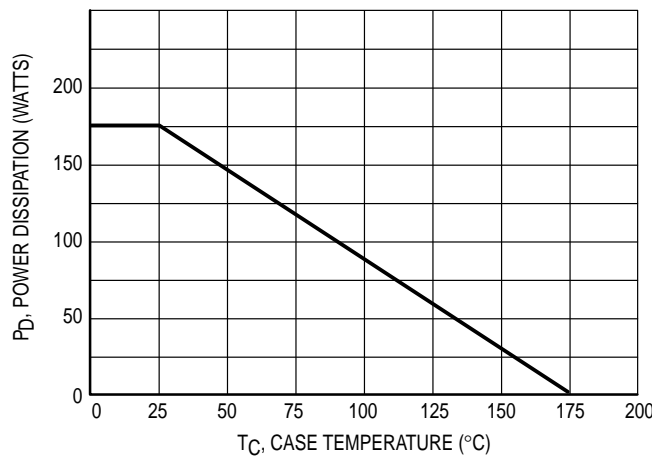


Figure 1. Power Derating

Preferred devices are Motorola recommended choices for future use and best overall value.

**PNP**  
**MJ11017**

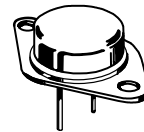
**MJ11021\***

**NPN**  
**MJ11018\***

**MJ11022**

\*Motorola Preferred Device

**30 AMPERE  
DARLINGTON  
POWER TRANSISTORS  
COMPLEMENTARY  
SILICON  
60–120 VOLTS  
200 WATTS**



**CASE 1–07  
TO–204AA  
(TO–3)**

**MJ11017 MJ11021 MJ11018 MJ11022**

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

Characteristic	Symbol	Min	Max	Unit
<b>OFF CHARACTERISTICS</b>				
Collector–Emitter Sustaining Voltage (1) ( $I_C = 0.1 \text{ A dc}, I_B = 0$ )	$V_{CE(sus)}$	150 250	— —	Vdc
Collector Cutoff Current ( $V_{CE} = 75, I_B = 0$ ) ( $V_{CE} = 125, I_B = 0$ )	$I_{CEO}$	— —	1.0 1.0	mAdc
Collector Cutoff Current ( $V_{CE} = \text{Rated } V_{CB}, V_{BE(off)} = 1.5 \text{ Vdc}$ ) ( $V_{CE} = \text{Rated } V_{CB}, V_{BE(off)} = 1.5 \text{ Vdc}, T_J = 150^\circ\text{C}$ )	$I_{CEV}$	— —	0.5 5.0	mAdc
Emitter Cutoff Current ( $V_{BE} = 5.0 \text{ Vdc}, I_C = 0$ )	$I_{EBO}$	—	2.0	mAdc

**ON CHARACTERISTICS (1)**

DC Current Gain ( $I_C = 10 \text{ A dc}, V_{CE} = 5.0 \text{ Vdc}$ ) ( $I_C = 15 \text{ A dc}, V_{CE} = 5.0 \text{ Vdc}$ )	$h_{FE}$	400 100	15,000 —	—
Collector–Emitter Saturation Voltage ( $I_C = 10 \text{ A dc}, I_B = 100 \text{ mA}$ ) ( $I_C = 15 \text{ A dc}, I_B = 150 \text{ mA}$ )	$V_{CE(sat)}$	— —	2.0 3.4	Vdc
Base–Emitter On Voltage $I_C = 10 \text{ A}, V_{CE} = 5.0 \text{ Vdc}$	$V_{BE(on)}$	—	2.8	Vdc
Base–Emitter Saturation Voltage ( $I_C = 15 \text{ A dc}, I_B = 150 \text{ mA}$ )	$V_{BE(sat)}$	—	3.8	Vdc

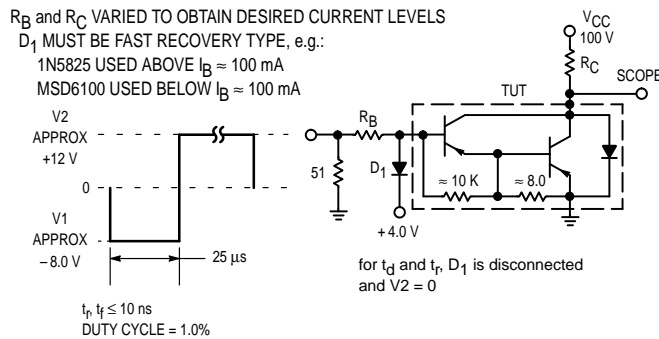
**DYNAMIC CHARACTERISTICS**

Current–Gain Bandwidth Product ( $I_C = 10 \text{ A dc}, V_{CE} = 3.0 \text{ Vdc}, f = 1.0 \text{ MHz}$ )	$[h_{fe}]$	3.0	—	Mhz
Output Capacitance ( $V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 0.1 \text{ MHz}$ )	$C_{ob}$	— —	400 600	pF
Small–Signal Current Gain ( $I_C = 10 \text{ A dc}, V_{CE} = 3.0 \text{ Vdc}, f = 1.0 \text{ kHz}$ )	$h_{fe}$	75	—	—

**SWITCHING CHARACTERISTICS**

Characteristic	Symbol	Typical		Unit
		NPN	PNP	
Delay Time	$t_d$	150	75	ns
Rise Time	$t_r$	1.2	0.5	$\mu\text{s}$
Storage Time	$t_s$	4.4	2.7	$\mu\text{s}$
Fall Time	$t_f$	10.0	2.5	$\mu\text{s}$

(1) Pulsed Test: Pulse Width = 300  $\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .



For NPN test circuit reverse diode and voltage polarities.

**Figure 2. Switching Times Test Circuit**

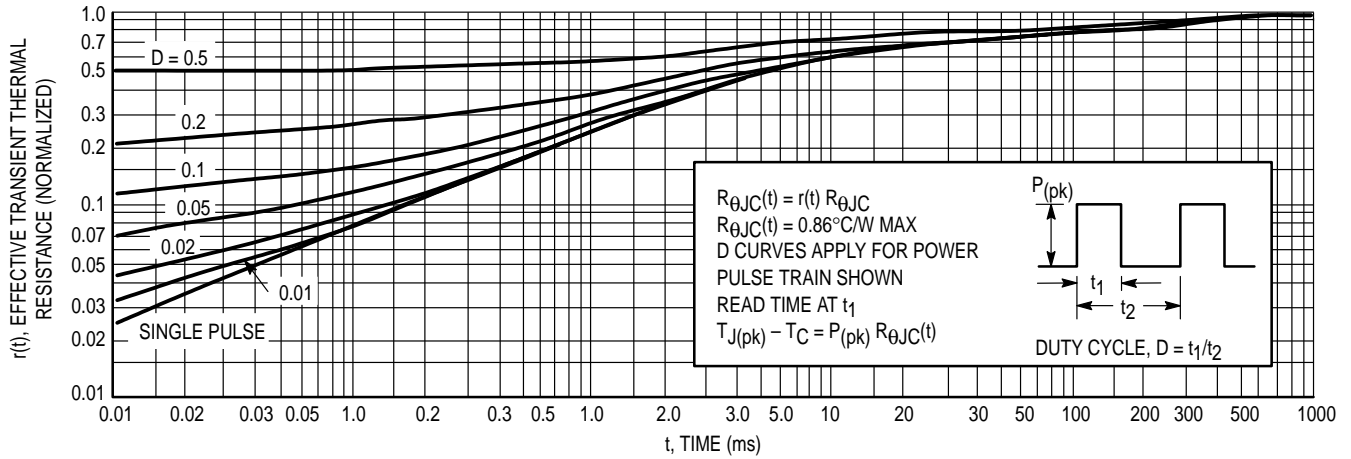


Figure 3. Thermal Response

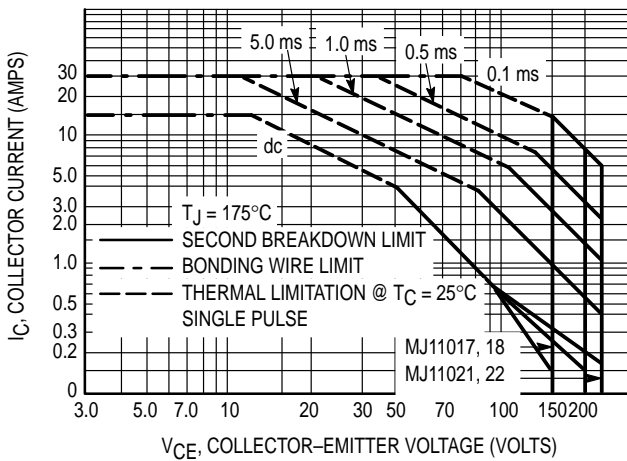


Figure 4. Maximum Rated Forward Bias Safe Operating Area (FBSOA)

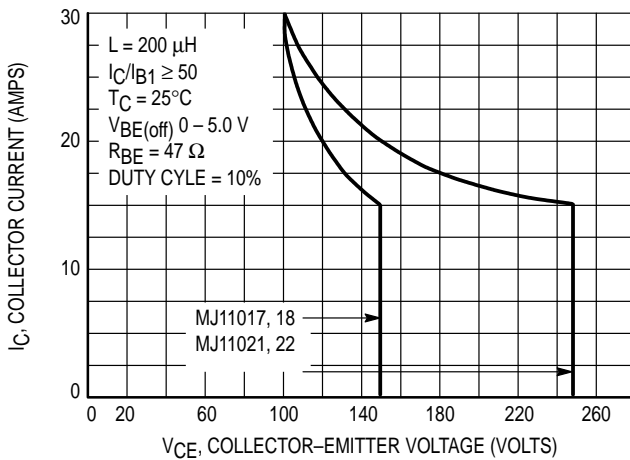


Figure 5. Maximum RBSOA, Reverse Bias Safe Operating Area

**FORWARD BIAS**

There are two limitations on the power handling ability of a transistor average junction temperature and second breakdown. Safe operating area curves indicate  $I_C - V_{CE}$  limits of the transistor that must be observed for reliable operation, i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The data of Figure 4 is based on  $T_{J(pk)} = 175^{\circ}\text{C}$ ,  $T_C$  is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided  $T_{J(pk)} \leq 175^{\circ}\text{C}$ .  $T_{J(pk)}$  may be calculated from the data in Figure 3. At high case temperatures thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

**REVERSE BIAS**

For inductive loads, high voltage and high current must be sustained simultaneously during turn-off, in most cases, with the base to emitter junction reverse biased. Under these conditions the collector voltage must be held to a safe level at or below a specific value of collector current. This can be accomplished by several means such as active clamping, RC snubbing, load line shaping, etc. The safe level for these devices is specified as Reverse Bias Safe Operating Area and represents the voltage-current conditions during reverse biased turn-off. This rating is verified under clamped conditions so that the device is never subjected to an avalanche mode. Figure 5 gives ROSOA characteristics.

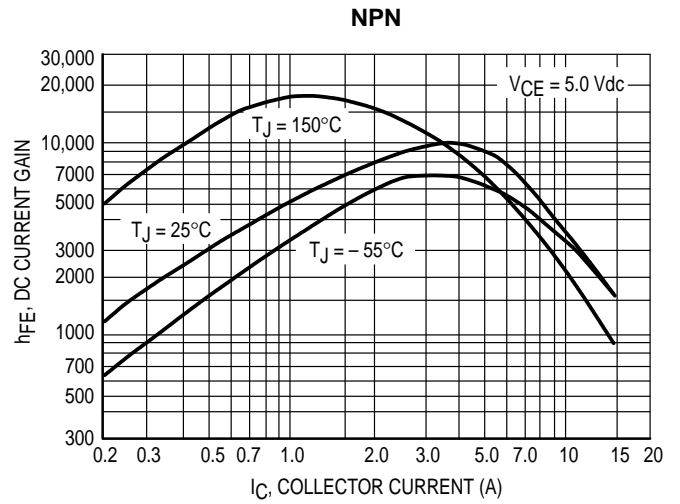
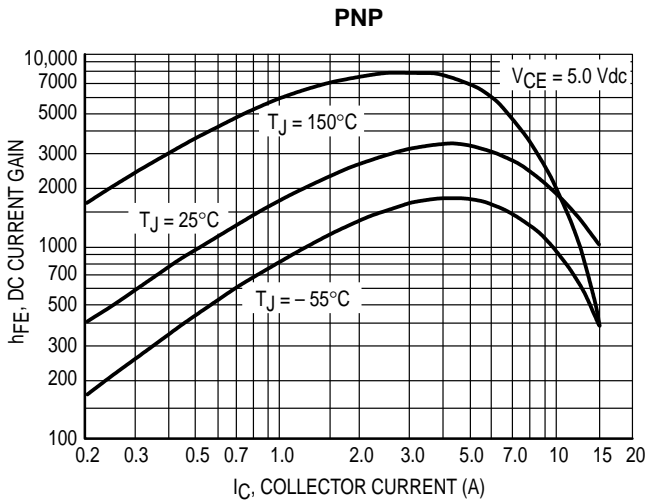


Figure 6. DC Current Gain

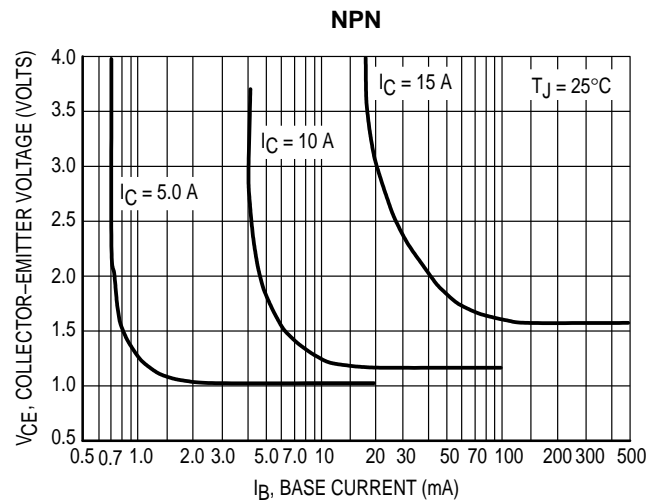
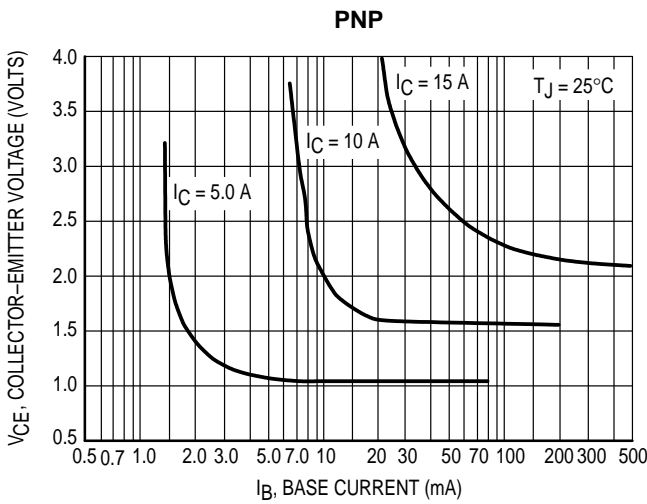


Figure 7. Collector Saturation Region

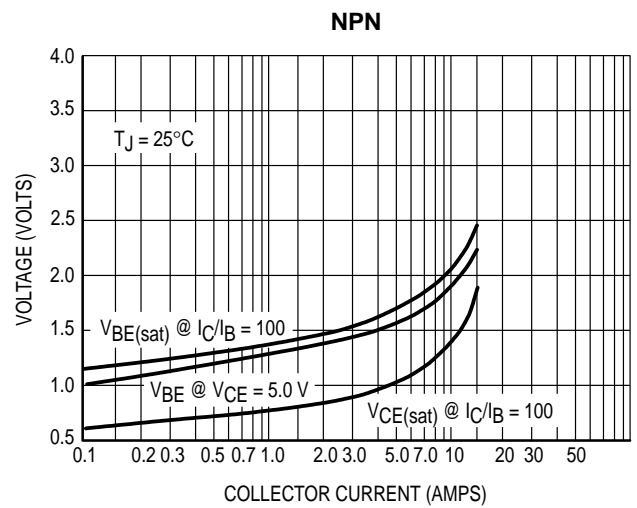
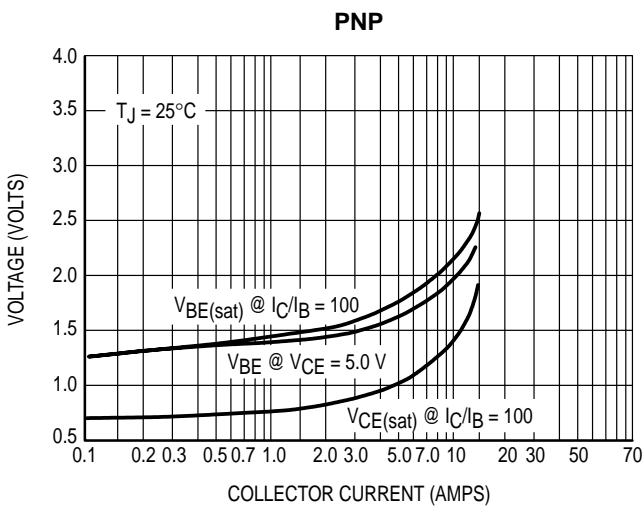
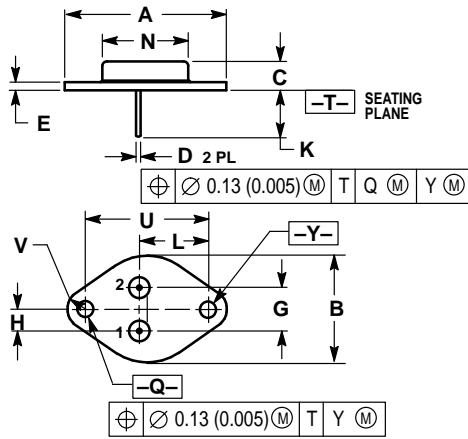


Figure 8. "On" Voltages

PACKAGE DIMENSIONS



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. ALL RULES AND NOTES ASSOCIATED WITH REFERENCED TO-204AA OUTLINE SHALL APPLY.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.550 REF		39.37 REF	
B	—	1.050	—	26.67
C	0.250	0.335	6.35	8.51
D	0.038	0.043	0.97	1.09
E	0.055	0.070	1.40	1.77
G	0.430 BSC		10.92 BSC	
H	0.215 BSC		5.46 BSC	
K	0.440	0.480	11.18	12.19
L	0.665 BSC		16.89 BSC	
N	—	0.830	—	21.08
Q	0.151	0.165	3.84	4.19
U	1.187 BSC		30.15 BSC	
V	0.131	0.188	3.33	4.77

STYLE 1:  
 PIN 1: BASE  
 2: EMITTER  
 CASE: COLLECTOR

CASE 1-07  
 TO-204AA (TO-3)  
 ISSUE Z

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