

Complementary Darlington Silicon Power Transistors

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

- High DC Current Gain @ 10 A_{dc} —
 $h_{FE} = 400$ Min (All Types)
- Collector–Emitter Sustaining Voltage
 $V_{CE(sus)} = 150$ V_{dc} (Min) — MJH11018, 17
 $= 200$ V_{dc} (Min) — MJH11020, 19
 $= 250$ V_{dc} (Min) — MJH11022, 21
- Low Collector–Emitter Saturation Voltage
 $V_{CE(sat)} = 1.2$ V (Typ) @ $I_C = 5.0$ A
 $= 1.8$ V (Typ) @ $I_C = 10$ A
- Monolithic Construction

MAXIMUM RATINGS

Rating	Symbol	MJH			Unit
		11018 11017	11020 11019	11022 11021	
Collector–Emitter Voltage	V_{CEO}	150	200	250	V _{dc}
Collector–Base Voltage	V_{CB}	150	200	250	V _{dc}
Emitter–Base Voltage	V_{EB}	5.0			V _{dc}
Collector Current — Continuous — Peak (1)	I_C	15 30			A _{dc}
Base Current	I_B	0.5			A _{dc}
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate Above 25°C	P_D	150 1.2			Watts W/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–65 to +150			$^\circ\text{C}$

THERMAL CHARACTERISTICS

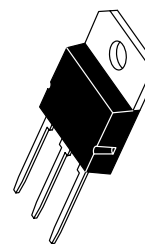
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.83	$^\circ\text{C/W}$

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

PNP
MJH11017*
MJH11019*
MJH11021*
NPN
MJH11018*
MJH11020*
MJH11022*

*ON Semiconductor Preferred Device

**15 AMPERE
 DARLINGTON
 COMPLEMENTARY SILICON
 POWER TRANSISTORS
 150, 200, 250 VOLTS
 150 WATTS**



CASE 340D–02

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

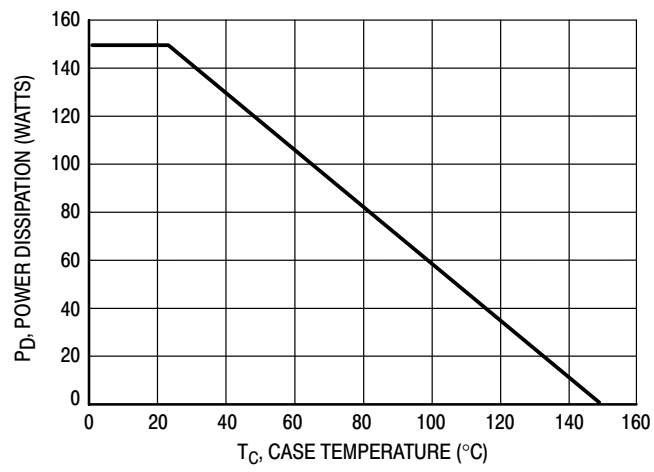


Figure 1. Power Derating

MJH11017 MJH11019 MJH11021 MJH11018 MJH11020 MJH11022

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Sustaining Voltage (1) ($I_C = 0.1 \text{ Adc}$, $I_B = 0$)	$V_{CEO(sus)}$	150 200 250	— — —	Vdc
Collector Cutoff Current ($V_{CE} = 75 \text{ Vdc}$, $I_B = 0$) ($V_{CE} = 100 \text{ Vdc}$, $I_B = 0$) ($V_{CE} = 125 \text{ Vdc}$, $I_B = 0$)	I_{CEO}	— — —	1.0 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 ($I_C = 10 \text{ Adc}$, $V_{CE} = 5.0 \text{ Vdc}$) ($I_C = 15 \text{ Adc}$, $V_{CE} = 5.0 \text{ Vdc}$)	h_{FE}	400 100	15,000 —	—
Collector–Emitter Saturation Voltage ($I_C = 10 \text{ Adc}$, $I_B = 100 \text{ mA}$) ($I_C = 15 \text{ Adc}$, $I_B = 150 \text{ mA}$)	$V_{CE(sat)}$	— —	2.5 4.0	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 ($I_C = 15 \text{ Adc}$, $I_B = 150 \text{ mA}$)	$V_{BE(sat)}$	—	3.8	Vdc

DYNAMIC CHARACTERISTICS

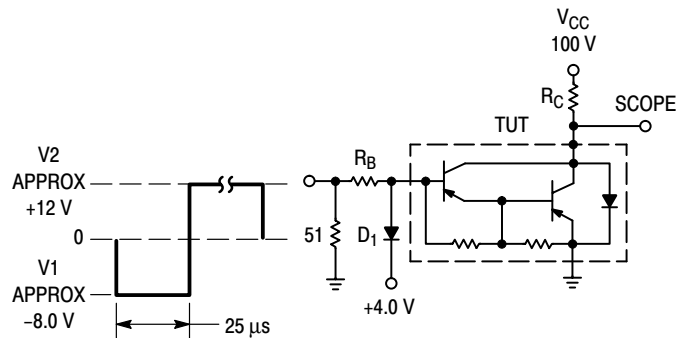
Current–Gain Bandwidth Product ($I_C = 10 \text{ Adc}$, $V_{CE} = 3.0 \text{ Vdc}$, $f = 1.0 \text{ MHz}$)	f_T	3.0	—	—
Output Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_E = 0$, $f = 0.1 \text{ MHz}$)	C_{ob}	— —	400 600	pF
Small–Signal Current Gain ($I_C = 10 \text{ Adc}$, $V_{CE} = 3.0 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	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	μs
Storage Time	t_s	4.4	2.7	μs
Fall Time	t_f	2.5	2.5	μs

(1) Pulse Test: Pulse Width = 300 μs , Duty Cycle $\leq 2.0\%$.

R_B & R_C varied to obtain desired current levels
 D_1 , must be fast recovery types, e.g.:
 1N5825 used above $I_B \approx 100 \text{ mA}$
 MSD6100 used below $I_B \approx 100 \text{ mA}$



$t_r, t_f \leq 10 \text{ ns}$
 Duty Cycle = 1.0%

For t_d and t_r , D_1 is disconnected
 and $V_2 = 0$

For NPN test circuit, reverse diode and voltage polarities.

Figure 2. Switching Times Test Circuit

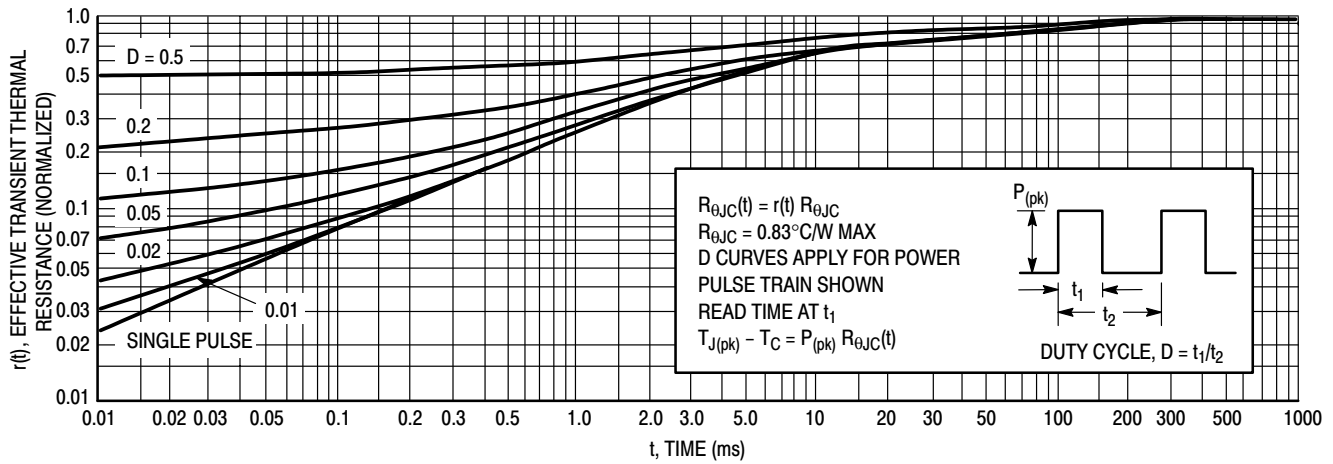


Figure 3. Thermal Response

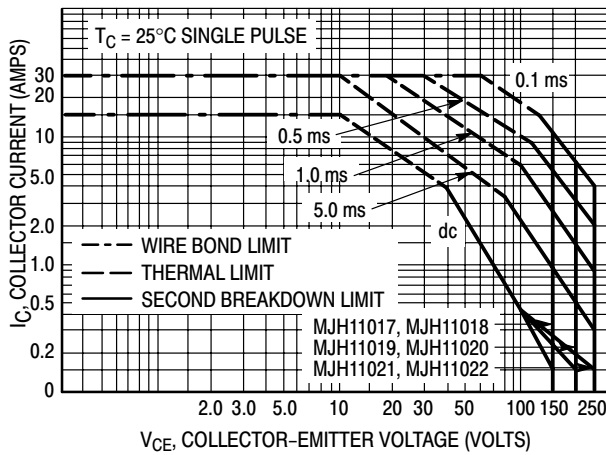


Figure 4. Maximum Rated Forward Bias Safe Operating Area (FBSOA)

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 $T_{J(pk)} = 150^\circ\text{C}$; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150^\circ\text{C}$. $T_{J(pk)}$ 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.

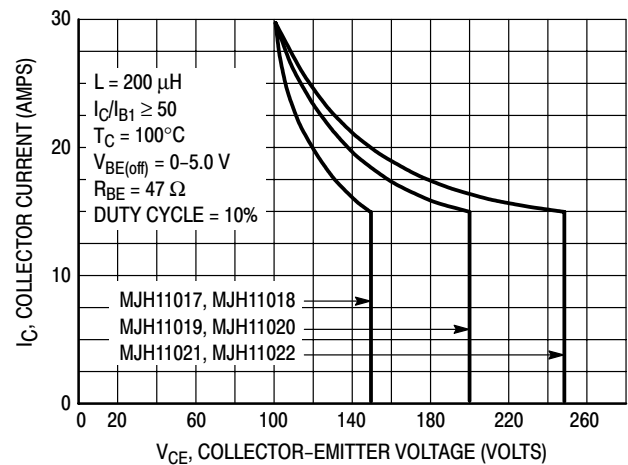


Figure 5. Maximum Rated Reverse Bias Safe Operating Area (RBSOA)

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 RBSOA characteristics.

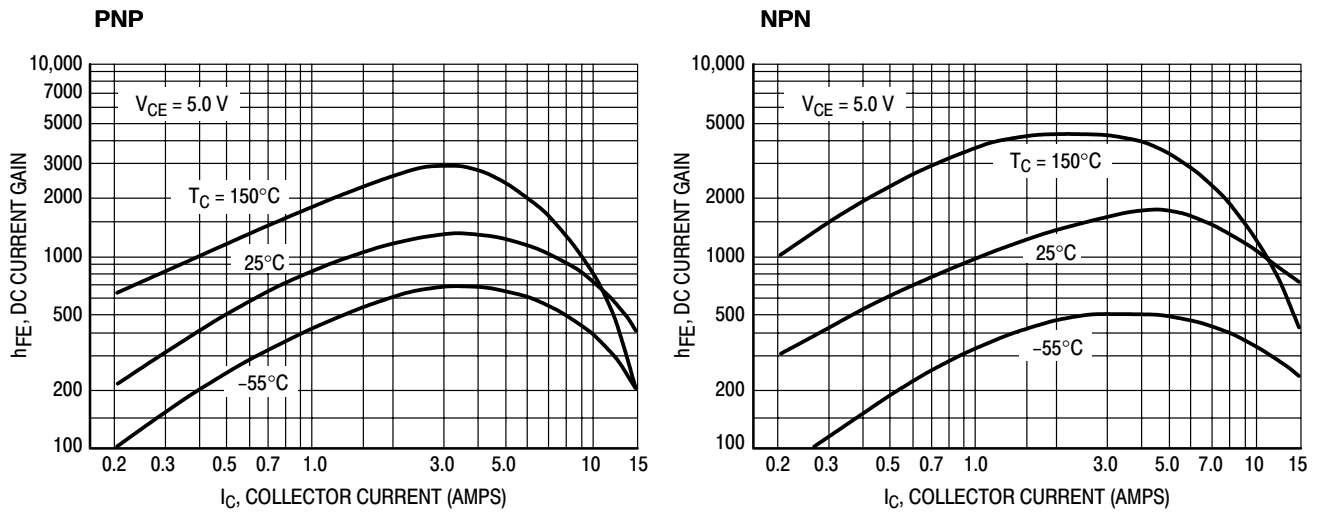


Figure 6. DC Current Gain

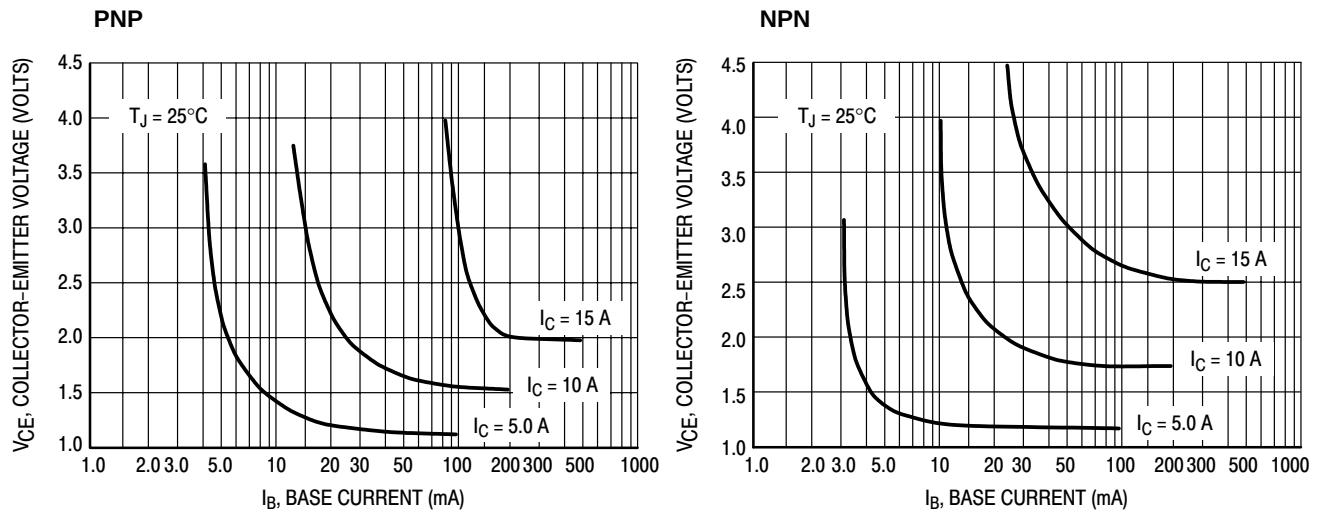


Figure 7. Collector Saturation Region

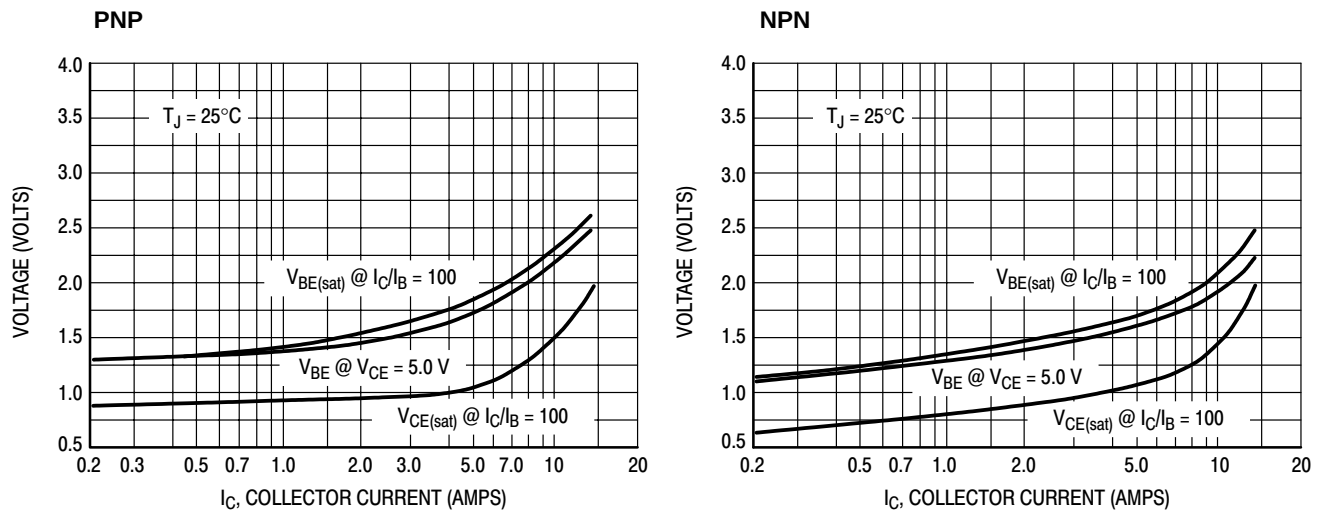
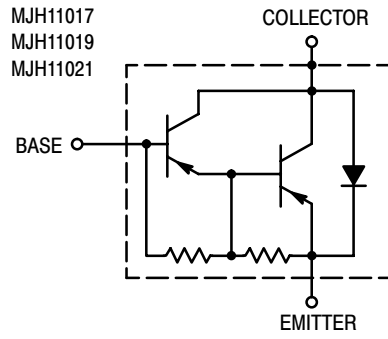


Figure 8. "On" Voltages

PNP



NPN

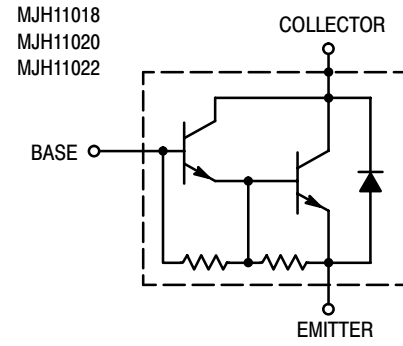
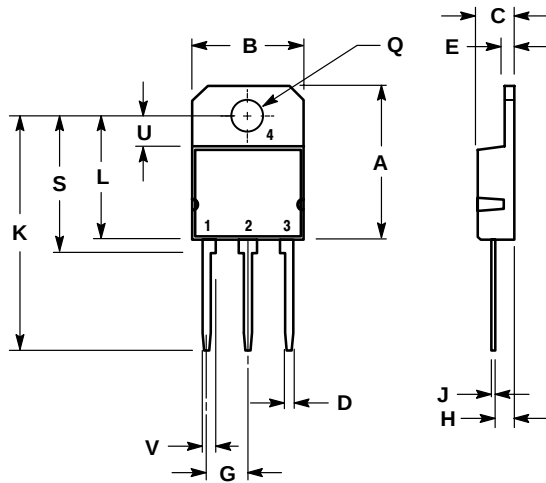


Figure 9. Darlington Schematic

PACKAGE DIMENSIONS

CASE 340D-02
ISSUE E



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	---	20.35	---	0.801
B	14.70	15.20	0.579	0.598
C	4.70	4.90	0.185	0.193
D	1.10	1.30	0.043	0.051
E	1.17	1.37	0.046	0.054
G	5.40	5.55	0.213	0.219
H	2.00	3.00	0.079	0.118
J	0.50	0.78	0.020	0.031
K	31.00 REF		1.220 REF	
L	---	16.20	---	0.638
Q	4.00	4.10	0.158	0.161
S	17.80	18.20	0.701	0.717
U	4.00 REF		0.157 REF	
V	1.75 REF		0.069	

- STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

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