

# NPN Silicon Power Darlington Transistors

The MJE5740, 41, 42 Darlington transistors are designed for high-voltage power switching in inductive circuits. They are particularly suited for operation in applications such as:

- Small Engine Ignition
- Switching Regulators
- Inverters
- Solenoid and Relay Drivers
- Motor Controls

## MAXIMUM RATINGS

Rating	Symbol	MJE5740	MJE5741	MJE5742	Unit
Collector–Emitter Voltage	$V_{CEO(sus)}$	300	350	400	Vdc
Collector–Emitter Voltage	$V_{CEV}$	600	700	800	Vdc
Emitter Base Voltage	$V_{EB}$	8			Vdc
Collector Current — Continuous	$I_C$	8			Adc
— Peak (1)	$I_{CM}$	16			
Base Current — Continuous	$I_B$	2.5			Adc
— Peak (1)	$I_{BM}$	5			
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	2			Watts
		16			mW/ $^\circ\text{C}$
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	80			Watts
		640			mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	-65 to +150			$^\circ\text{C}$

(1) Pulse Test: Pulse Width = 5 ms, Duty Cycle = 10%.

## THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.56	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	$^\circ\text{C}/\text{W}$
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	$T_L$	275	$^\circ\text{C}$

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

Characteristic	Symbol	Min	Typ	Max	Unit
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### OFF CHARACTERISTICS (2)

Collector–Emitter Sustaining Voltage ( $I_C = 50\text{ mA}$ , $I_B = 0$ )	MJE5740 MJE5741 MJE5742	$V_{CEO(sus)}$	300 350 400	— — —	— — —	Vdc
Collector Cutoff Current ( $V_{CEV} = \text{Rated Value}$ , $V_{BE(off)} = 1.5\text{ Vdc}$ ) ( $V_{CEV} = \text{Rated Value}$ , $V_{BE(off)} = 1.5\text{ Vdc}$ , $T_C = 100^\circ\text{C}$ )		$I_{CEV}$	— —	— —	1 5	mAdc
Emitter Cutoff Current ( $V_{EB} = 8\text{ Vdc}$ , $I_C = 0$ )		$I_{EBO}$	—	—	75	mAdc

### SECOND BREAKDOWN

Second Breakdown Collector Current with Base Forward Biased	$I_{S/b}$	See Figure 6
Clamped Inductive SOA with Base Reverse Biased	RBSOA	See Figure 7

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

(continued)

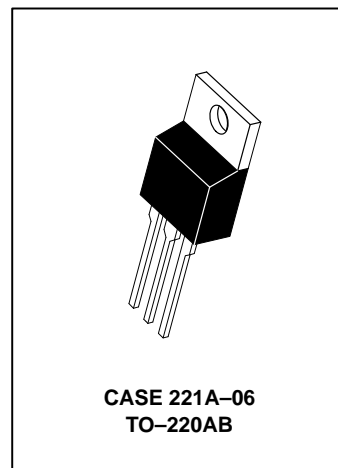
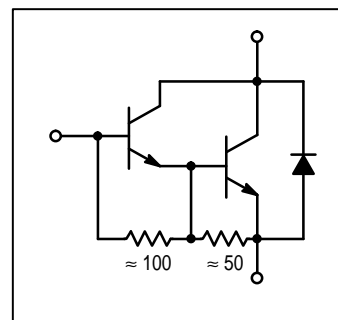
Preferred devices are Motorola recommended choices for future use and best overall value.

REV 1

**MJE5740**  
**MJE5741\***  
**MJE5742\***

\*Motorola Preferred Device

**POWER DARLINGTON  
TRANSISTORS**  
**8 AMPERES**  
**300, 350, 400 VOLTS**  
**80 WATTS**



**MJE5740 MJE5741 MJE5742**

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>ON CHARACTERISTICS (1)</b>					
DC Current Gain ( $I_C = 0.5 \text{ Adc}$ , $V_{CE} = 5 \text{ Vdc}$ ) ( $I_C = 4 \text{ Adc}$ , $V_{CE} = 5 \text{ Vdc}$ )	$h_{FE}$	50 200	100 400	— —	—
Collector–Emitter Saturation Voltage ( $I_C = 4 \text{ Adc}$ , $I_B = 0.2 \text{ Adc}$ ) ( $I_C = 8 \text{ Adc}$ , $I_B = 0.4 \text{ Adc}$ ) ( $I_C = 4 \text{ Adc}$ , $I_B = 0.2 \text{ Adc}$ , $T_C = 100^\circ\text{C}$ )	$V_{CE(sat)}$	— — —	— — —	2 3 2.2	Vdc
Base–Emitter Saturation Voltage ( $I_C = 4 \text{ Adc}$ , $I_B = 0.2 \text{ Adc}$ ) ( $I_C = 8 \text{ Adc}$ , $I_B = 0.4 \text{ Adc}$ ) ( $I_C = 4 \text{ Adc}$ , $I_B = 0.2 \text{ Adc}$ , $T_C = 100^\circ\text{C}$ )	$V_{BE(sat)}$	— — —	— — —	2.5 3.5 2.4	Vdc
Diode Forward Voltage (2) ( $I_F = 5 \text{ Adc}$ )	$V_f$	—	—	2.5	Vdc

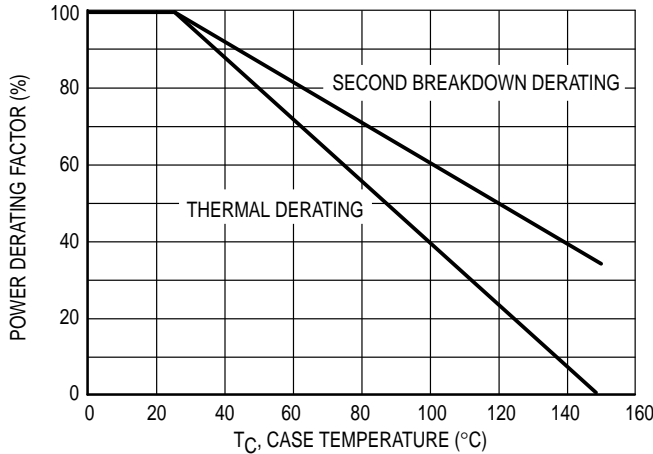
**SWITCHING CHARACTERISTICS**

Typical Resistive Load (Table 1)						
Delay Time	$(V_{CC} = 250 \text{ Vdc}$ , $I_{C(pk)} = 6 \text{ A}$ $I_{B1} = I_{B2} = 0.25 \text{ A}$ , $t_p = 25 \mu\text{s}$ , Duty Cycle $\leq 1\%$ )	$t_d$	—	0.04	—	$\mu\text{s}$
Rise Time		$t_r$	—	0.5	—	$\mu\text{s}$
Storage Time		$t_s$	—	8	—	$\mu\text{s}$
Fall Time		$t_f$	—	2	—	$\mu\text{s}$
Inductive Load, Clamped (Table 1)						
Voltage Storage Time	$(I_{C(pk)} = 6 \text{ A}$ , $V_{CE(pk)} = 250 \text{ Vdc}$ $I_{B1} = 0.06 \text{ A}$ , $V_{BE(off)} = 5 \text{ Vdc}$ )	$t_{sv}$	—	4	—	$\mu\text{s}$
Crossover Time		$t_c$	—	2	—	$\mu\text{s}$

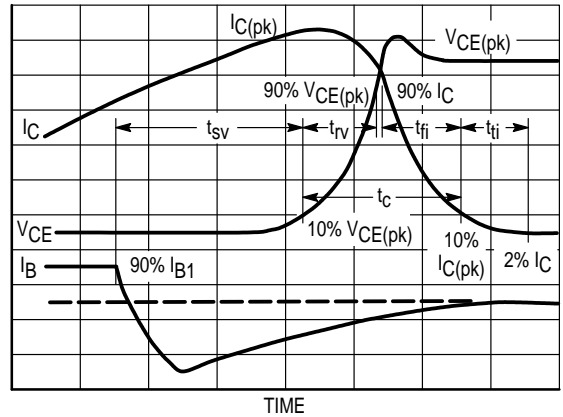
(1) Pulse Test: Pulse Width  $300 \mu\text{s}$ , Duty Cycle = 2%.

(2) The internal Collector–to–Emitter diode can eliminate the need for an external diode to clamp inductive loads. Tests have shown that the Forward Recovery Voltage ( $V_f$ ) of this diode is comparable to that of typical fast recovery rectifiers.

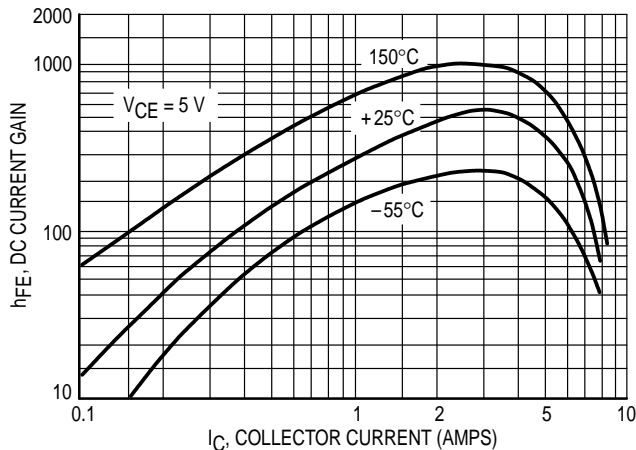
**TYPICAL CHARACTERISTICS**



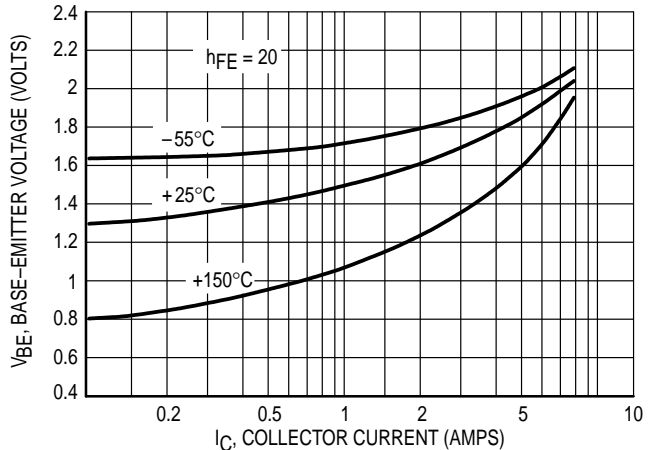
**Figure 1. Power Derating**



**Figure 2. Inductive Switching Measurements**



**Figure 3. DC Current Gain**



**Figure 4. Base–Emitter Voltage**

Table 1. Test Conditions for Dynamic Performance

REVERSE BIAS SAFE OPERATING AREA AND INDUCTIVE SWITCHING		RESISTIVE SWITCHING
TEST CIRCUITS	<p>DUTY CYCLE <math>\leq 10\%</math>  <math>t_r, t_f \leq 10 \text{ ns}</math></p> <p>NOTE:  PW and <math>V_{CC}</math> Adjusted for Desired <math>I_C</math>  <math>R_B</math> Adjusted for Desired <math>I_{B1}</math></p>	
CIRCUIT VALUES	<p>COIL DATA:  FERROXCUBE CORE #6656  FULL BOBBIN (~16 TURNS) #16</p> <p>GAP FOR 200 <math>\mu\text{H}/20 \text{ A}</math>  <math>L_{\text{coil}} = 200 \mu\text{H}</math></p> <p><math>V_{CC} = 30 \text{ V}</math>  <math>V_{CE(\text{pk})} = 250 \text{ Vdc}</math>  <math>I_{C(\text{pk})} = 6 \text{ A}</math></p>	<p><math>V_{CC} = 250 \text{ V}</math>  <math>D1 = 1\text{N}5820 \text{ OR EQUIV.}</math></p>
TEST WAVEFORMS	<p><b>OUTPUT WAVEFORMS</b></p> <p><math>t_1</math> ADJUSTED TO OBTAIN <math>I_C</math></p> $t_1 \approx \frac{L_{\text{coil}} (I_{C\text{pk}})}{V_{CC}}$ $t_2 \approx \frac{L_{\text{coil}} (I_{C\text{pk}})}{V_{\text{clamp}}}$ <p>TEST EQUIPMENT  SCOPE-TEKTRONICS  475 OR EQUIVALENT</p>	<p><math>t_r, t_f &lt; 10 \text{ ns}</math>  DUTY CYCLE = 1%  <math>R_B</math> AND <math>R_C</math> ADJUSTED FOR DESIRED <math>I_B</math> AND <math>I_C</math></p>

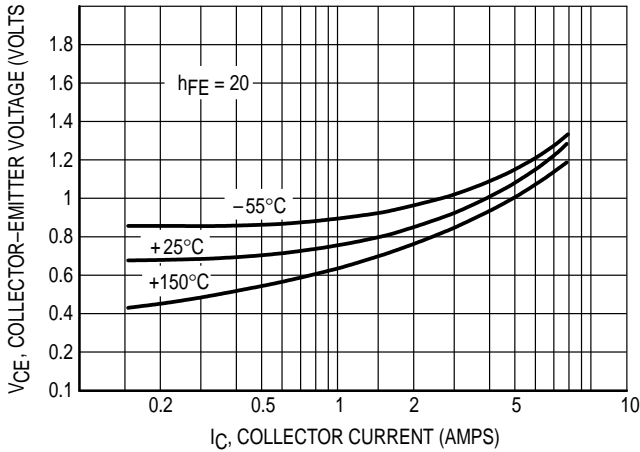


Figure 5. Inductive Switching Measurements

SAFE OPERATING AREA INFORMATION

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 6 is based on  $T_C = 25^\circ\text{C}$ ;  $T_{J(pk)}$  is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% but must be derated when  $T_C \geq 25^\circ\text{C}$ . Second breakdown limitations do not derate the same as thermal limitations. Allowable current at the voltages shown on Figure 6 may be found at any case temperature by using the appropriate curve on Figure 1.

The Safe Operating Area figures shown in Figures 6 and 7 are specified ratings for these devices under the test conditions shown.

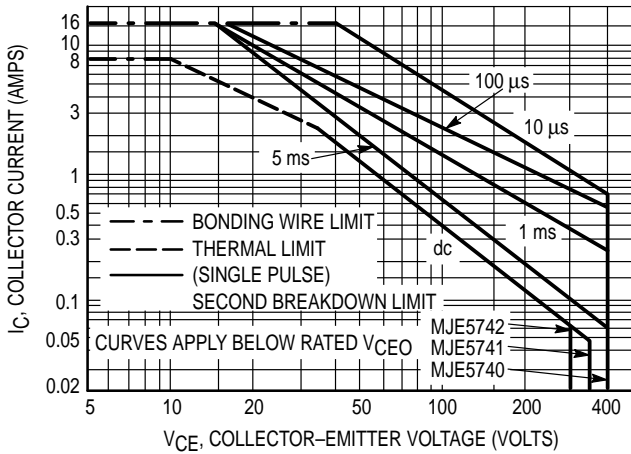


Figure 6. Forward Bias Safe Operating Area

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 condition allowable during reverse biased turnoff. This rating is verified under clamped conditions so that the device is never subjected to an avalanche mode. Figure 7 gives the complete RBSOA characteristics.

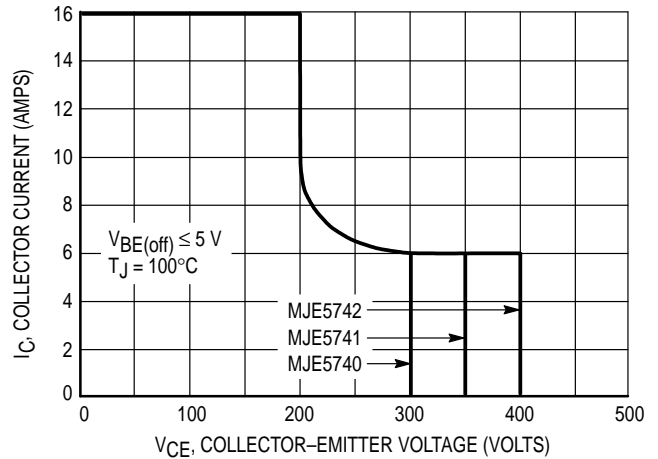


Figure 7. Reverse Bias Safe Operating Area

RESISTIVE SWITCHING PERFORMANCE

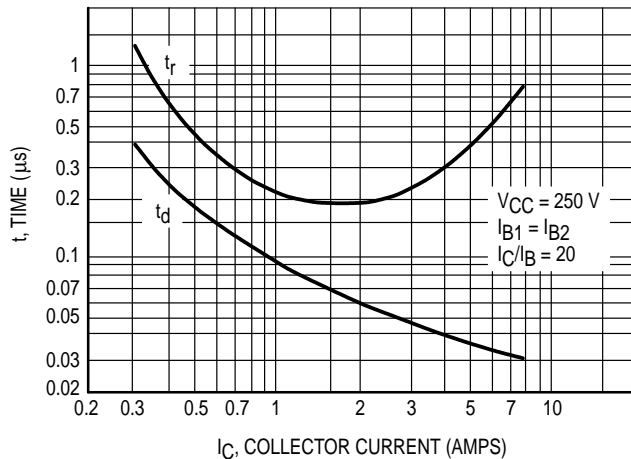


Figure 8. Turn-On Time

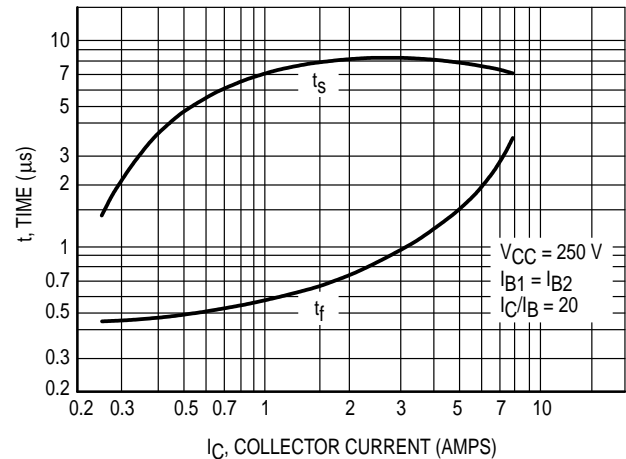
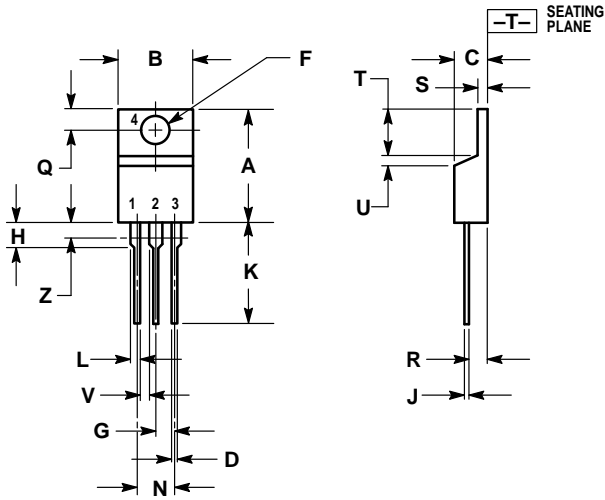


Figure 9. Turn-Off Time

PACKAGE DIMENSIONS




- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.
  3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.570	0.620	14.48	15.75
B	0.380	0.405	9.66	10.28
C	0.160	0.190	4.07	4.82
D	0.025	0.035	0.64	0.88
F	0.142	0.147	3.61	3.73
G	0.095	0.105	2.42	2.66
H	0.110	0.155	2.80	3.93
J	0.018	0.025	0.46	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.060	1.15	1.52
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.110	2.04	2.79
S	0.045	0.055	1.15	1.39
T	0.235	0.255	5.97	6.47
U	0.000	0.050	0.00	1.27
V	0.045	—	1.15	—
Z	—	0.080	—	2.04

- STYLE 1:
- PIN 1. BASE
  - COLLECTOR
  - EMITTER
  - COLLECTOR

CASE 221A-06  
TO-220AB  
ISSUE Y

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