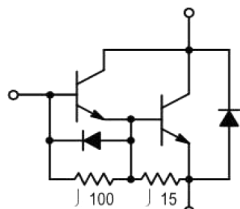


# NPN Silicon Darlington Power Transistor

**V<sub>CEO</sub> 250V, I<sub>c</sub> 60A, 250W, TO-3**

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**RoHS  
Compliant**



## GENERAL DESCRIPTION

The Darlington transistors are designed for high-voltage, high-speed, power switching in inductive circuits where fall time is critical. They are particularly suited for line operated switch mode applications

## Applications

1. AC and DC Motor Controls
2. Switching Regulators
3. Solenoid and Relay Drivers

## Features

1. Fast Turn-Off Times
  - 150 ns Inductive Fall Time- 25°C (Typ)
  - 750 ns Inductive Crossover Time- 25°C (Typ)
2. Operating Temperature Range -65°C to +200°C
3. 100° C Performance Specified for:
  - Reverse-Biased SOA with Inductive Loads
  - Switching Times with Inductive Loads
  - Saturation Voltage

## Absolute Maximum Ratings (T<sub>a</sub> = 25 °C)

Rating	Symbol	MJ10021	Units
Collector - Emitter Voltage	V <sub>CEO</sub>	250	V DC
Collector - Emitter Voltage	V <sub>CEV</sub>	350	V DC
Emitter Base Voltage	V <sub>EB</sub>	8	V DC
Collector Current - Continuous Peak (1)	I <sub>c</sub> I <sub>CM</sub>	60 100	A <sub>DC</sub>
Base Current - Continuous Peak	I <sub>B</sub> I <sub>BM</sub>	20 30	A <sub>DC</sub>
Total Power Dissipation @ TC = 25°C @ TC = 100°C Derate above 25°C	P <sub>D</sub>	250 143 1.43	Watts W/°C
Operating and Storage Junction Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	-65°C to +200°C	°C

## Thermal Characteristics

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to case	R <sub>Jc</sub>	0.7	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8" from Case for 5 Seconds	T <sub>L</sub>	275	°C

(1) Pulse Test: Pulse Width = 5 ms, Duty ≤ Cycle10%.

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## V<sub>CE0</sub> 250V, I<sub>c</sub> 60A, 250W, TO-3

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### Electrical Characteristics at T<sub>a</sub> = 25°C unless otherwise specified)

Characteristic		Symbol	Min	Typ	Max	Units
Off Characteristics						
Collector Emitter Sustaining Voltage (Table1) (I <sub>c</sub> = 200mA, I <sub>B</sub> = 0) L = 25 mH	MJ10021	V <sub>CEO(sus)</sub>	200 250	- -	- -	V DC
Collector Cut Off Current (V <sub>CEV</sub> = Rated Value, V <sub>BE(off)</sub> = 1.5 Vdc) (V <sub>CEV</sub> = Rated Value, V <sub>BE(off)</sub> = 1.5 Vdc, T <sub>c</sub> = 125°C		I <sub>CEV</sub>	- -	- -	0.25 5	mA DC
Collector Cut Off Current (V <sub>CE</sub> = Rated V <sub>CEV</sub> , R <sub>BE</sub> = 50) T <sub>c</sub> = 100°C		I <sub>CER</sub>	-	-	5	mA DC
Emitter Cut Off Current (V <sub>EB</sub> = 5V DC, I <sub>c</sub> = 0)		I <sub>EBO</sub>	-		0.1	mA DC
Second Breakdown						
Second Breakdown Collector Current with Base Forward Biased		I <sub>S/b</sub>	See Figure 13			
Clamped Inductive SOA with Base Reverse Biased		RBSOA	See Figure 14			
On Characteristics						
DC Current Gain (I <sub>c</sub> = 15A DC, V <sub>CE</sub> = 5 V)		h <sub>FE</sub>	75	-	1000	-
Collector Emitter Saturation Voltage (I <sub>c</sub> = 30A DC, I <sub>B</sub> = 1.2 A <sub>DC</sub> ) (I <sub>c</sub> = 60A DC, I <sub>B</sub> = 4 A <sub>DC</sub> ) (I <sub>c</sub> = 30A DC, I <sub>B</sub> = 1.2 A <sub>DC</sub> , T <sub>C</sub> = 100°C)		V <sub>CE(sat)</sub>	- - -	- - -	2.2 4 2.4	V DC
Base Emitter Saturation Voltage (I <sub>c</sub> = 30A DC, I <sub>B</sub> = 1.2 A <sub>DC</sub> ) (I <sub>c</sub> = 30A DC, I <sub>B</sub> = 1.2 A <sub>DC</sub> , T <sub>C</sub> = 100°C)		V <sub>BE(sat)</sub>	- -	- -	3 3.5	V DC
Diode Forward Voltage (I <sub>F</sub> = 30 A <sub>dc</sub> )		V <sub>f</sub>	-	2.5	5	V DC
*Dynamic Characteristics						
Output Capacitance (V <sub>CB</sub> = 10 Vdc, I <sub>E</sub> = 0, f <sub>test</sub> = 1 kHz)		C <sub>ob</sub>	175	-	700	pF
Switching Characteristics						
Resistive Load (Table 1)						
Delay Time	(V <sub>CC</sub> = 175 V <sub>DC</sub> , I <sub>c</sub> = 30A I <sub>B1</sub> = A <sub>DC</sub> , V <sub>BE(off)</sub> = 5V, t <sub>p</sub> = 25 s Duty Cycle ≤ 2 %)	t <sub>d</sub>	-	0.02	0.2	s
Rise Time		t <sub>r</sub>	-	0.3	1	
Storage Time		t <sub>s</sub>	-	1	3.5	
Fall Time		t <sub>f</sub>	-	0.07	0.5	
Inductive Load, Clamped (Table 1)						
Storage Time	I <sub>CM</sub> = 30A (pk), V <sub>CEM</sub> = 200 V, I <sub>B1</sub> = 1.2 A V <sub>BE(off)</sub> = 5V, T <sub>C</sub> = 100°C	t <sub>sv</sub>	-	1.2	3.5	s
Crossover Time		t <sub>c</sub>	-	0.45	2	
Storage Time	I <sub>CM</sub> = 30A (pk), V <sub>CEM</sub> = 200 V, I <sub>B1</sub> = 1.2 A V <sub>BE(off)</sub> = 5V, T <sub>C</sub> = 25°C	t <sub>sv</sub>	-	0.75	-	
Crossover Time		t <sub>c</sub>	-	0.25	-	
Fall Time		t <sub>fr</sub>	-	0.15	-	

(1) Pulse Test: Pulse Width = 300s, Duty Cycle ≤ 2%

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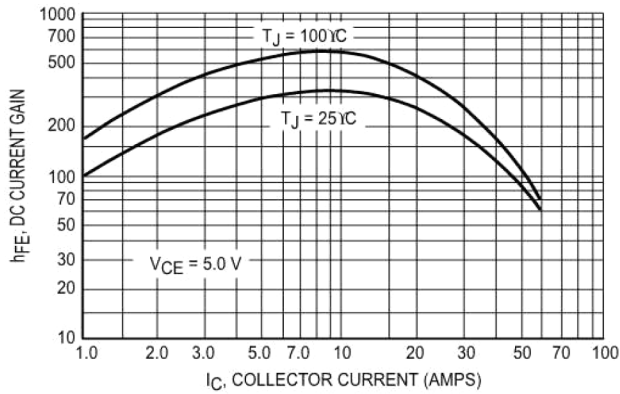
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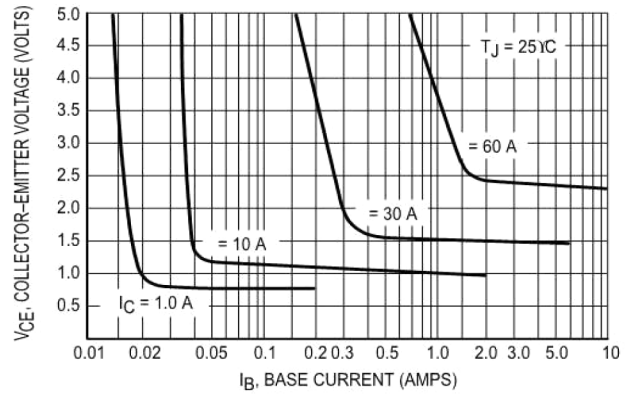
**$V_{CE0}$  250V,  $I_C$  60A, 250W, TO-3**

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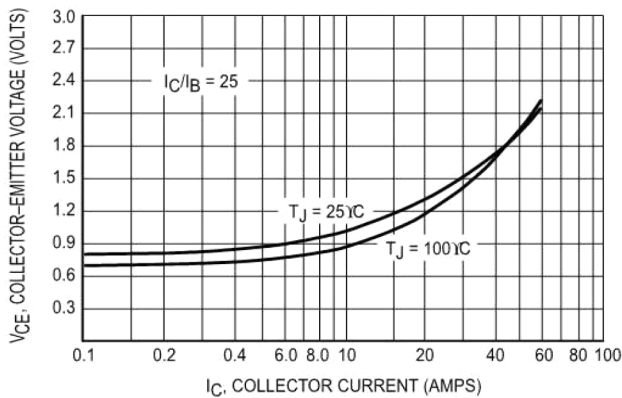
## Typical Characteristic Curves



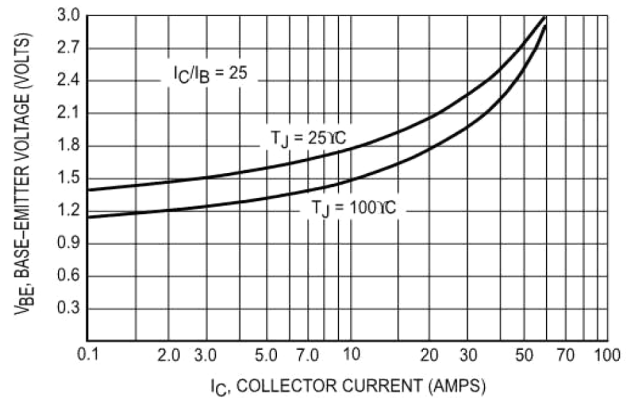
**Figure 1. DC Current Gain**



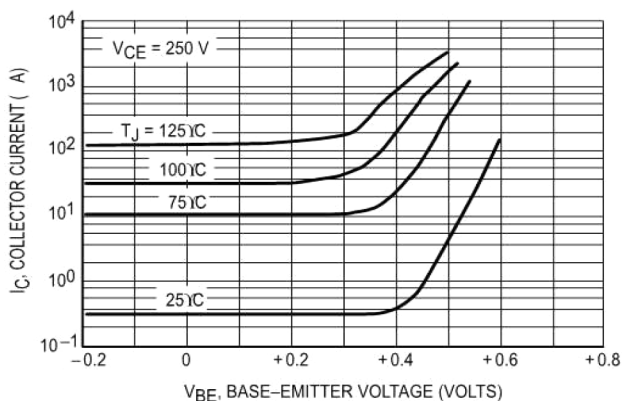
**Figure 2. Collector Saturation Region**



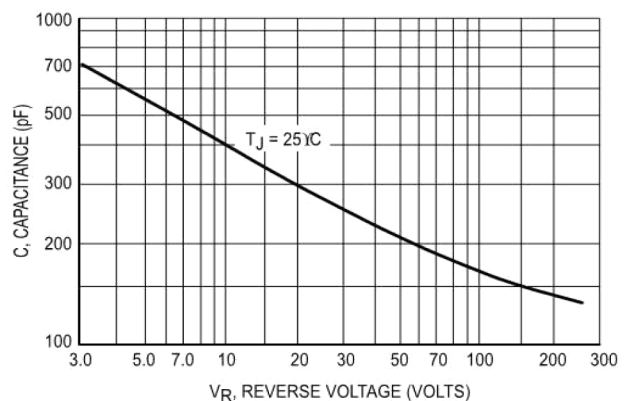
**Figure 3. Collector-Emitter Saturation Voltage**



**Figure 4. Base-Emitter Voltage**



**Figure 5. Collector Cutoff Region**



**Figure 6. Output Capacitance**

# NPN Silicon Darlington Power Transistor

## $V_{CE0}$ 250V, $I_C$ 60A, 250W, TO-3

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Table 1. Test Conditions for Dynamic Performance

	$V_{CEO(sus)}$	RBSOA AND INDUCTIVE SWITCHING	RESISTIVE SWITCHING
INPUT CONDITIONS	<p>PW Varied to Attain <math>I_C = 100 \text{ mA}</math></p>	<p>INDUCTIVE TEST CIRCUIT</p> <p>SEE ABOVE FOR DETAILED CONDITIONS</p>	<p>TURN-ON TIME</p> <p><math>I_{B1}</math> adjusted to obtain the forced <math>h_{FE}</math> desired</p> <p>TURN-OFF TIME</p> <p>Use inductive switching driver as the input to the resistive test circuit.</p>
CIRCUIT VALUES	$L_{\text{coil}} = 10 \text{ mH}$ , $V_{CC} = 10 \text{ V}$ $R_{\text{coil}} = 0.7$ $V_{\text{clamp}} = V_{CEO(sus)}$	$L_{\text{coil}} = 180 \text{ H}$ $R_{\text{coil}} = 0.05$ $V_{CC} = 20 \text{ V}$	$V_{CC} = 175 \text{ V}$ $R_L = 5.6$ Pulse Width = $25 \text{ s}$
TEST CIRCUITS	<p>OUTPUT WAVEFORMS</p> <p><math>t_1</math> Adjusted to Obtain <math>I_C</math></p> $t_1 \propto \frac{L_{\text{coil}} (I_{CM})}{V_{CC}}$ $t_2 \propto \frac{L_{\text{coil}} (I_{CM})}{V_{\text{Clamp}}}$ <p>Test Equipment Scope — Tektronix 475 or Equivalent</p>	<p>RESISTIVE TEST CIRCUIT</p>	

\* Adjust  $-V$  such that  $V_{BE(\text{off})} = 5 \text{ V}$  except as required for RBSOA (Figure 14).

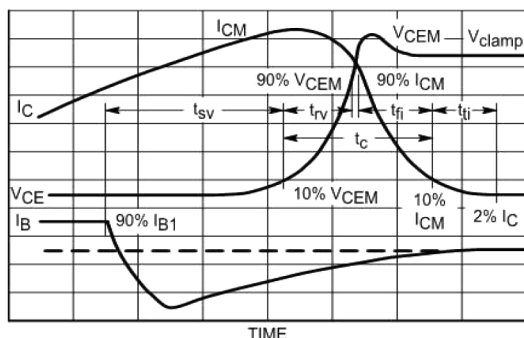


Figure 7. Inductive Switching Measurements

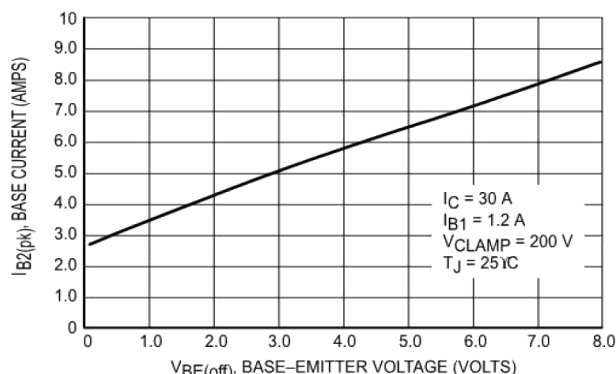


Figure 8. Typical Peak Reverse Base Current

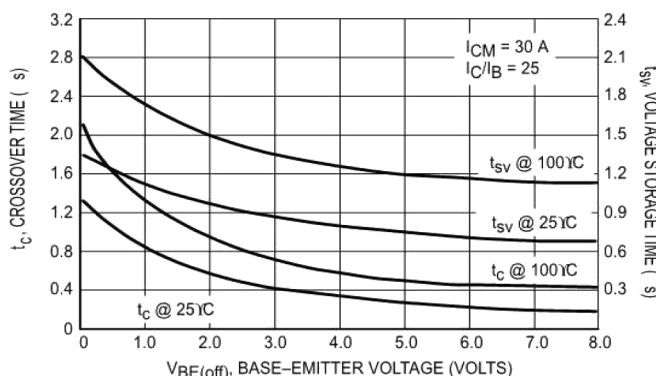


Figure 9. Typical Inductive Switching Times

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## RESISTIVE SWITCHING

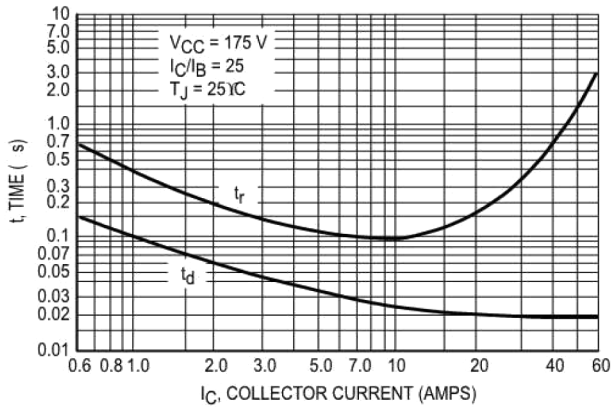


Figure 10. Typical Turn-On Switching Times

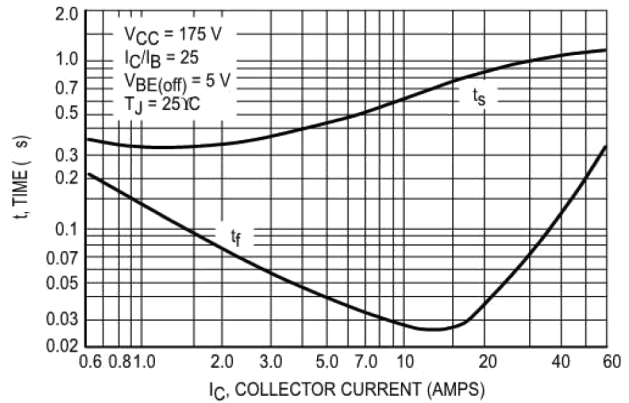


Figure 11. Typical Turn-Off Switching Times

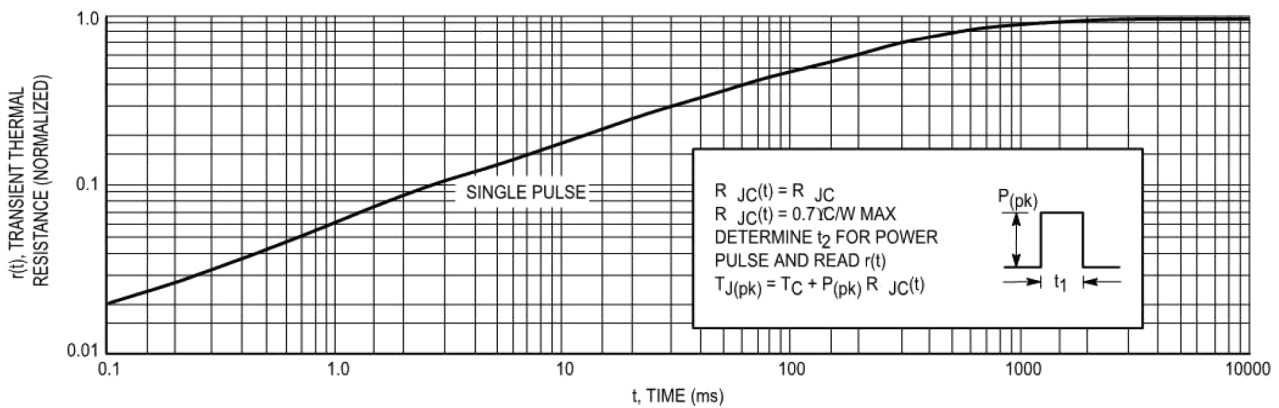


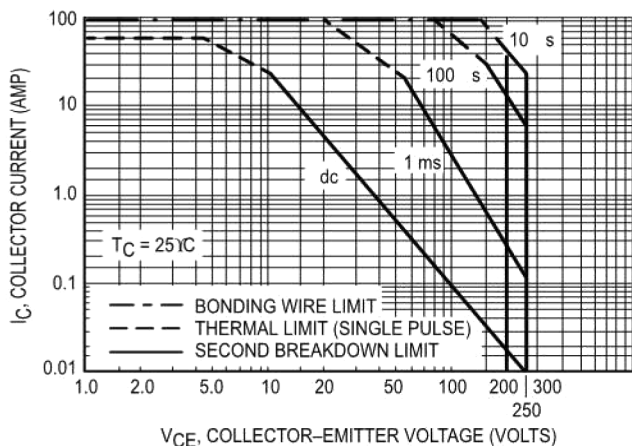
Figure 12. Thermal Response

# NPN Silicon Darlington Power Transistor

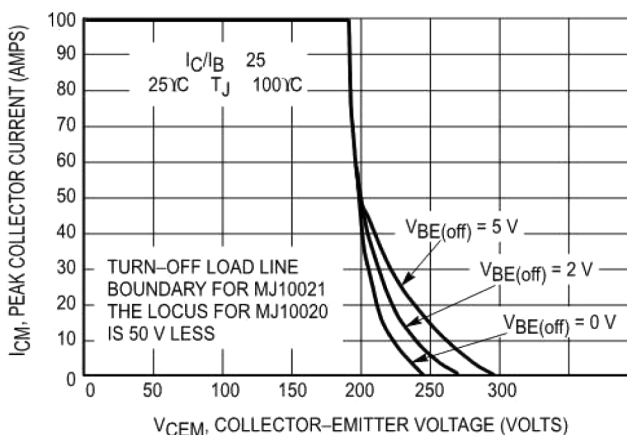
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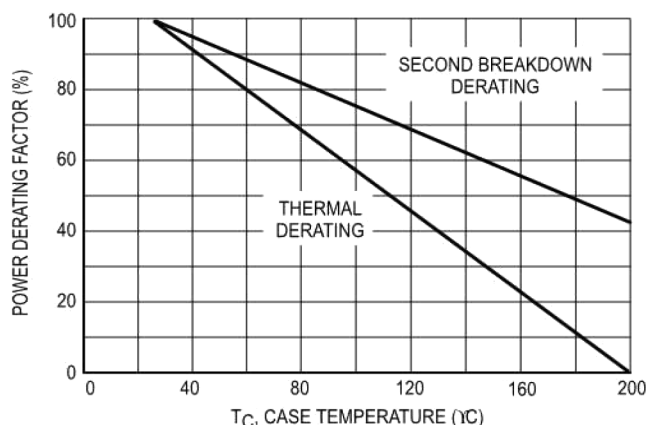
The Safe Operating Area figures shown in Figures 13 and are specified for these devices under the test conditions shown.



**Figure 13. Maximum Forward Bias Safe Operating Area**



**Figure 14. Maximum RBSOA, Reverse Bias Safe Operating Area**



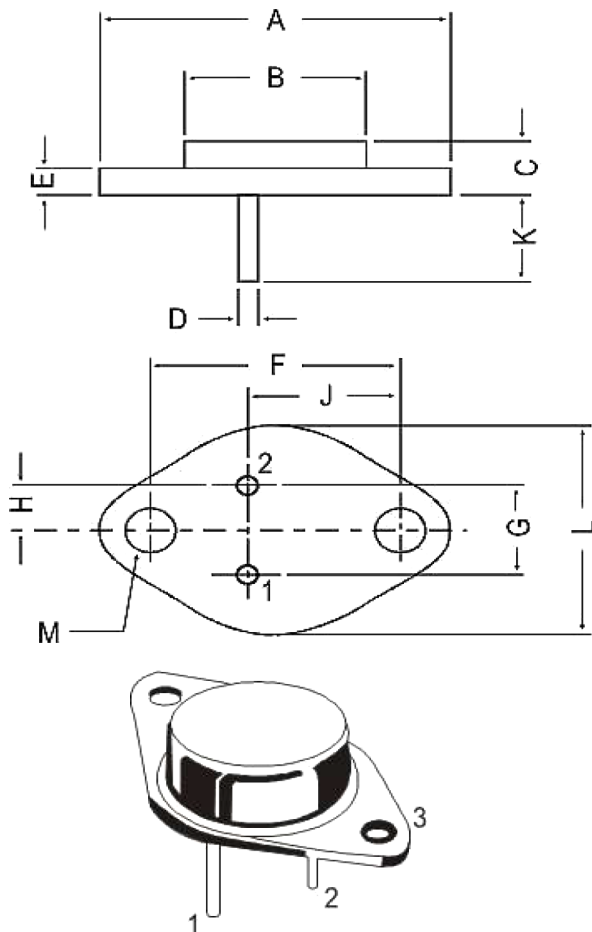
**Figure 15. Power Derating**

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## Package Details



Dimensions : Millimetres

### PIN CONFIGURATION

1. BASE
2. EMITTER
3. COLLECTOR

Dim	Min.	Max.
A	-	39.37
B	-	22.22
C	6.35	8.5
D	0.96	1.09
E	-	1.77
F	29.9	30.4
G	10.69	11.18
H	5.2	5.72
J	16.64	17.15
K	11.15	12.25
L	-	26.67
M	3.84	4.19

## Part Number Table

Description	Part Number
Silicon Darlington Power Transistor, NPN, 250V, 60A, TO-3	MJ10021

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