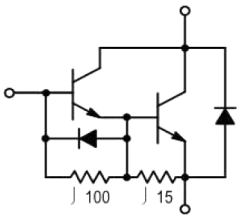
NPN Silicon Darlington Power Transistor
V_{CEO} 250V, I_C 60A, 250W, TO-3

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_a = 25 °C)

Rating	Symbol	MJ10021	Units
Collector - Emitter Voltage	V_{CEO}	250	V DC
Collector - Emitter Voltage	V_{CEV}	350	V DC
Emitter Base Voltage	V_{EB}	8	V DC
Collector Current - Continuous Peak (1)	I_C I_{CM}	60 100	A_{DC}
Base Current - Continuous Peak	I_B I_{BM}	20 30	A_{DC}
Total Power Dissipation @ TC = 25°C @ TC = 100°C Derate above 25°C	P_D	250 143 1.43	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65°C to +200°C	°C

Thermal Characteristics

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to case	R_{JC}	0.7	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8 from Case for 5 Seconds	T_L	275	°C

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

Electrical Characteristics at T_a = 25°C unless otherwise specified)

Characteristic		Symbol	Min	Typ	Max	Units
Off Characteristics						
Collector Emitter Sustaining Voltage (Table1) (I_C = 200mA, I_B = 0) L = 25 mH MJ10021		$V_{CEO(sus)}$	200 250	- -	- -	V DC
Collector Cut Off Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc) (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc, Tc = 125°C		I_{CEV}	- -	- -	0.25 5	mA DC
Collector Cut Off Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50) Tc = 100°C		I_{CER}	-	-	5	mA DC
Emitter Cut Off Current (V_{EB} = 5V DC, I_C = 0)		I_{EBO}	-		0.1	mA DC
Second Breakdown						
Second Breakdown Collector Current with Base Forward Biased		$I_{S/b}$	See Figure 13			
Clamped Inductive SOA with Base Reverse Biased		RBSOA	See Figure 14			
On Characteristics						
DC Current Gain (I_C = 15A DC, V_{CE} = 5 V)		h_{FE}	75	-	1000	-
Collector Emitter Saturation Voltage (I_C = 30A DC, I_B = 1.2 A_{DC}) (I_C = 60A DC, I_B = 4 A_{DC}) (I_C = 30A DC, I_B = 1.2 A_{DC}, T_C = 100°C)		$V_{CE(sat)}$	- - -	- - -	2.2 4 2.4	V DC
Base Emitter Saturation Voltage (I_C = 30A DC, I_B = 1.2 A_{DC}) (I_C = 30A DC, I_B = 1.2 A_{DC}, T_C = 100°C)		$V_{BE(sat)}$	- -	- -	3 3.5	V DC
Diode Forward Voltage (I_F = 30 Adc)		V_f	-	2.5	5	V DC
***Dynamic Characteristics**						
Output Capacitance (V_{CB} = 10 Vdc, I_E= 0, f_{test} = 1 kHz)		C_{ob}	175	-	700	pF
Switching Characteristics						
Resistive Load (Table 1)						
Delay Time	(V_{CC} = 175 V_{DC}, I_C = 30A I_{B1} = A_{DC}, $V_{BE(off)}$ = 5V, t_p= 25 s Duty Cycle ≤ 2 %)	t_d	-	0.02	0.2	s
Rise Time		t_r	-	0.3	1	
Storage Time		t_s	-	1	3.5	
Fall Time		t_f	-	0.07	0.5	
Inductive Load, Clamped (Table 1)						
Storage Time	I_{CM} = 30A (pk), V_{CEM} = 200 V, I_{B1} = 1.2 A $V_{BE(off)}$ = 5V, T_C = 100°C	t_{sv}	-	1.2	3.5	s
Crossover Time		t_C	-	0.45	2	
Storage Time	I_{CM} = 30A (pk), V_{CEM} = 200 V, I_{B1} = 1.2 A $V_{BE(off)}$ = 5V, T_C = 25°C	t_{sv}	-	0.75	-	
Crossover Time		t_c	-	0.25	-	
Fall Time		t_{fi}	-	0.15	-	

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

Typical Characteristic Curves

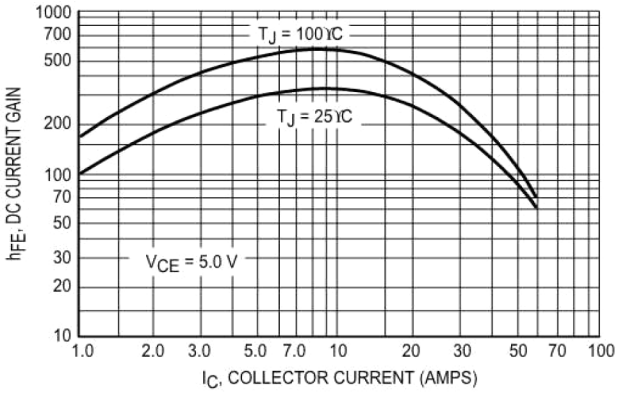


Figure 1. DC Current Gain

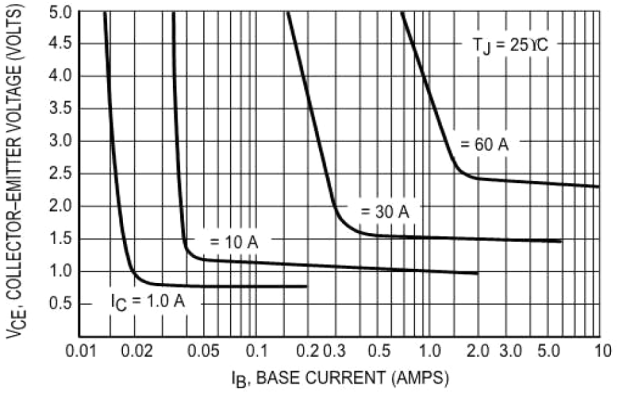


Figure 2. Collector Saturation Region

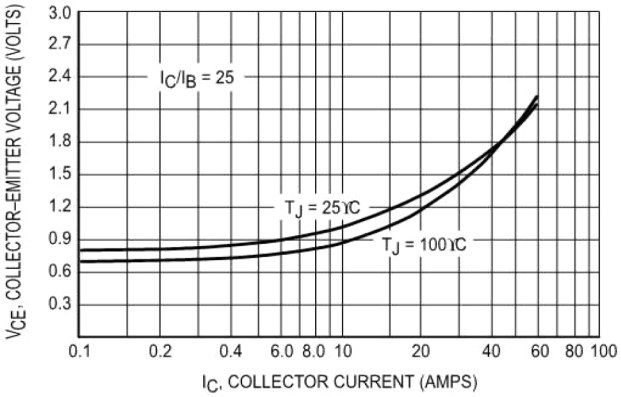


Figure 3. Collector–Emitter Saturation Voltage

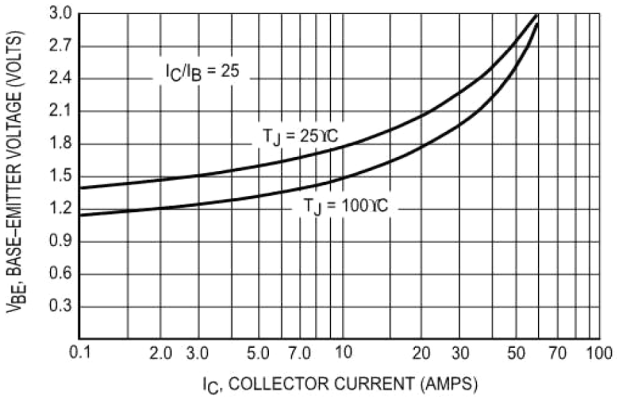


Figure 4. Base–Emitter Voltage

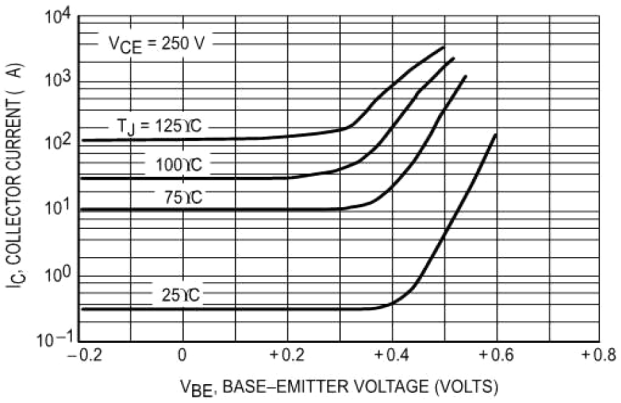


Figure 5. Collector Cutoff Region

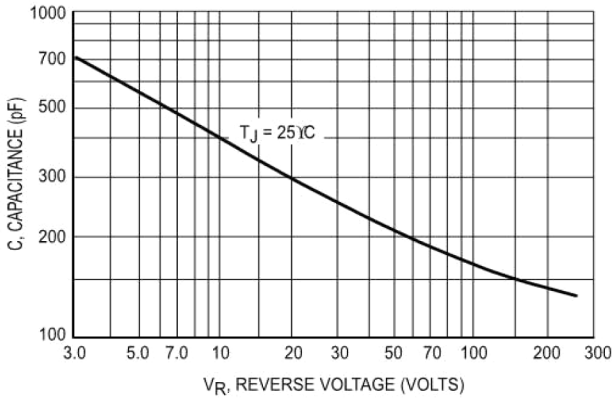


Figure 6. Output Capacitance

Table 1. Test Conditions for Dynamic Performance

	$V_{CEO(sus)}$	RBSOA AND INDUCTIVE SWITCHING	RESISTIVE SWITCHING
INPUT CONDITIONS	20, 1, 5 V, 0, 2 PW Varied to Attain I_C = 100 mA	INDUCTIVE TEST CIRCUIT TUT, 1, INPUT, SEE ABOVE FOR DETAILED CONDITIONS, 1N4937 OR EQUIVALENT, R_{coil}, L_{coil}, V_{clamp}, V_{CC}, RS = 0.1, 2	TURN–ON TIME 1, 2, I_{B1} I_{B1} adjusted to obtain the forced h_{FE} desired TURN–OFF TIME Use inductive switching driver as the input to the resistive test circuit.
CIRCUIT VALUES	L_{coil} = 10 mH, V_{CC} = 10 V R_{coil} = 0.7 V_{clamp} = $V_{CEO(sus)}$	L_{coil} = 180 H R_{coil} = 0.05 V_{CC} = 20 V	V_{CC} = 175 V R_L = 5.6 Pulse Width = 25 s
TEST CIRCUITS	OUTPUT WAVEFORMS I_{CM}, t_f Clamped, t, t_1, t_f, V_{CEM}, V_{clamp}, TIME, t_2 t_1 Adjusted to Obtain I_C $t_1 \downarrow \frac{L_{coil}(I_{CM})}{V_{CC}}$ $t_2 \downarrow \frac{L_{coil}(I_{CM})}{V_{Clamp}}$ Test Equipment Scope — Tektronix 475 or Equivalent	RESISTIVE TEST CIRCUIT TUT, 1, 2, R_L, V_{CC}

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

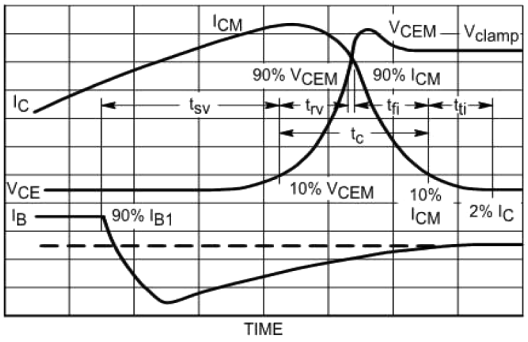


Figure 7. Inductive Switching Measurements

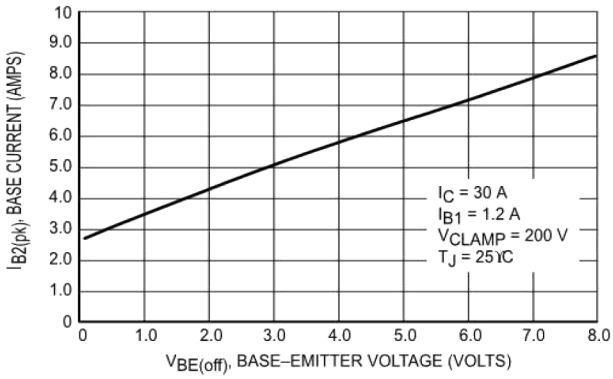


Figure 8. Typical Peak Reverse Base Current

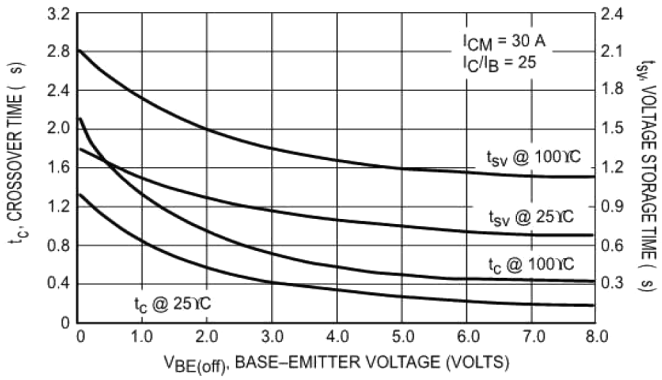


Figure 9. Typical Inductive Switching Times

RESISTIVE SWITCHING

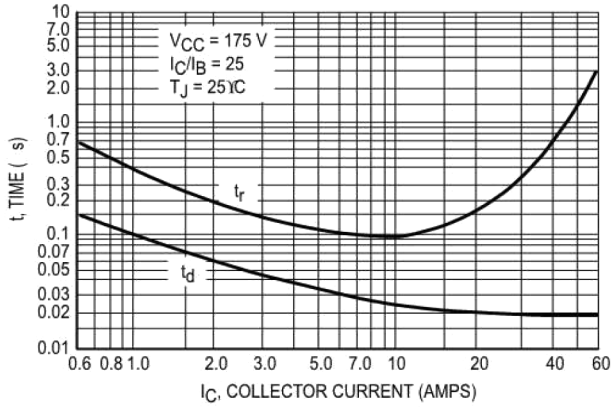


Figure 10. Typical Turn–On Switching Times

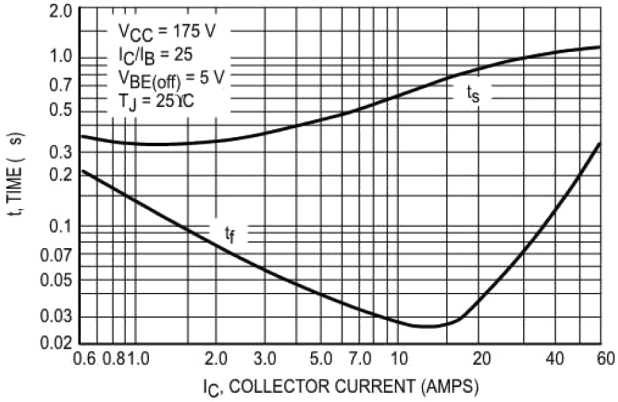


Figure 11. Typical Turn–Off Switching Times

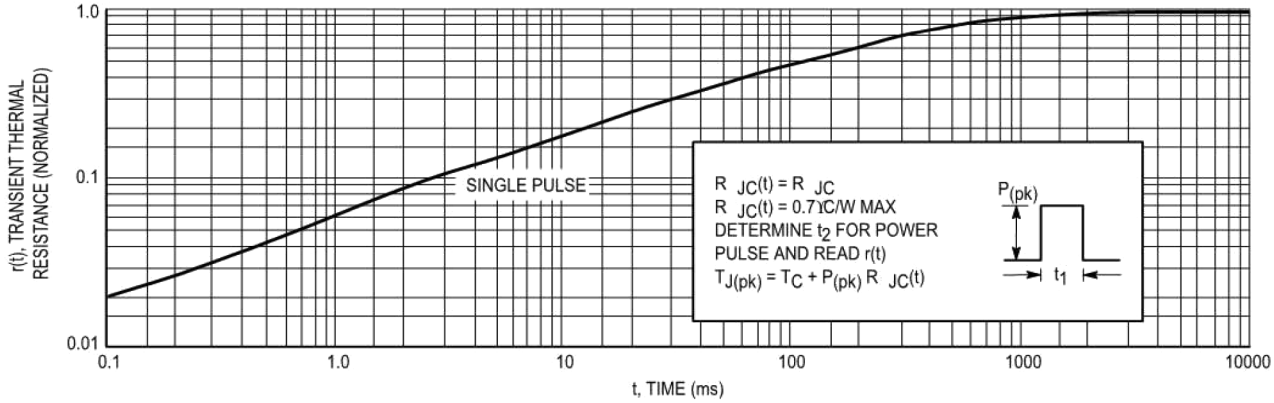


Figure 12. Thermal Response

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

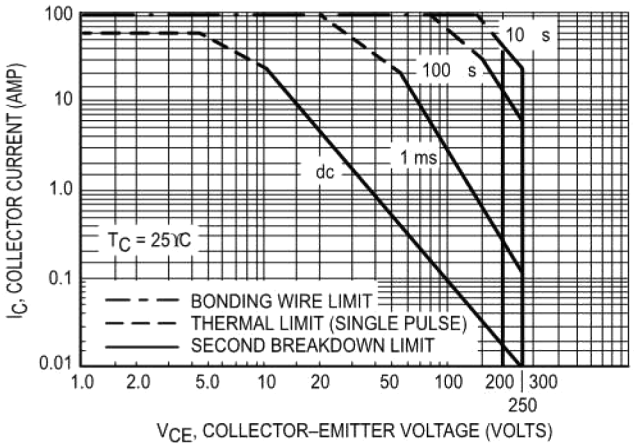


Figure 13. Maximum Forward Bias Safe Operating Area

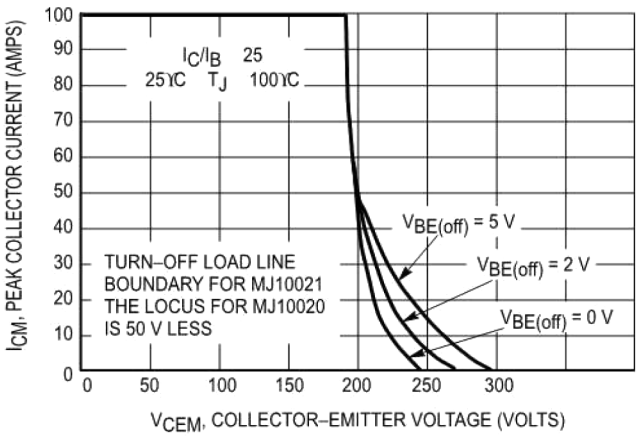


Figure 14. Maximum RBSOA, Reverse Bias Safe Operating Area

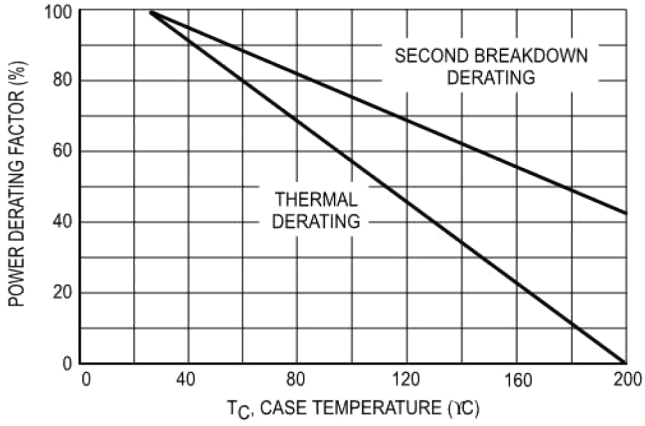
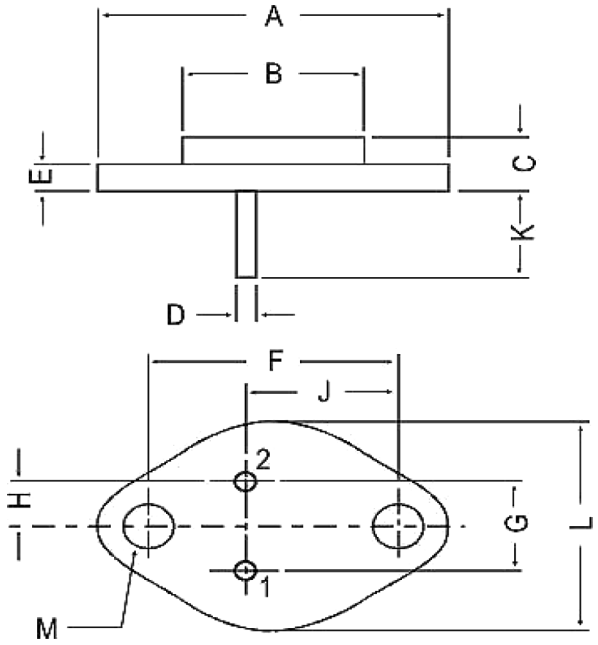


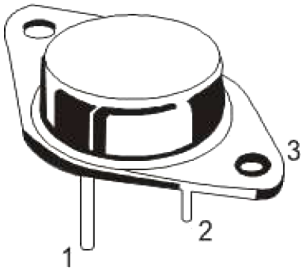
Figure 15. Power Derating

NPN Silicon Darlington Power Transistor
VCEO 250V, IC 60A, 250W, TO-3

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