NPN Silicon Power DarligtonTransistor

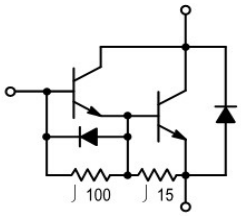
with Base-Emitter Speedup Diode

60 AMPERE, 200 AND 250 VOLTS, 250 WATTS

MJ10020
MJ10021

TO-3
Metal Can Package
RoHS compliant

TO-3



GENERAL DESCRIPTION

The MJ10020 and MJ10021 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 switchmode applications

FEATURES:

1. Fast Turn–Off Times
   - 150 ns Inductive Fall Time at 25º C (Typ)
   - 750 ns Inductive Storage Time at 25 ºC (Typ)
2. Operating Temperature Range –65 to +200º C
3. 100º C Performance Specified for:
   - Reversed Biased SOA with Inductive Loads
   - Switching Times with Inductive Loads
   - Saturation Voltages

APPLICATIONS:

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

ABSOLUTE MAXIMUM RATING (T_A=25 ° C unless otherwise specified)

Rating	Symbol	MJ10020	MJ10021	Unit
Collector–Emitter Voltage	V_{CEO}	200	250	Vdc
Collector–Emitter Voltage	V_{CEV}	300	350	Vdc
Emitter Base Voltage	V_{EB}	8.0		Vdc
Collector Current — Continuous — Peak (1)	I_C I_{CM}	60 100		Adc
Base Current — Continuous — Peak (1)	I_B I_{BM}	20 30		Adc
Total Power Dissipation @ T_C = 25°C @ T_C = 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 to +200		°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 Cycle ≤ 10%.

ELECTRICAL CHARACTERISTICS (T_A=25 ° C unless otherwise specified)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector–Emitter Sustaining Voltage (Table 1) (I_C = 100 mA, I_B = 0)	MJ10020 MJ10021	$V_{CEO(sus)}$	200 250	— —	— —	Vdc
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc) (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc, T_C = 150°C)		I_{CEV}	 — —	 — —	 0.25 5.0	mAdc
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 50 , T_C = 100°C)		I_{CER}	—	—	5.0	mAdc
Emitter Cutoff Current (V_{EB} = 2.0 V, I_C = 0)		I_{EBO}	—	—	175	mAdc
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 (1)						
DC Current Gain (I_C = 15 Adc, V_{CE} = 5.0 V)		h_{FE}	75	—	1000	—
Collector–Emitter Saturation Voltage (I_C = 30 Adc, I_B = 1.2 Adc) (I_C = 60 Adc, I_B = 4.0 Adc) (I_C = 30 Adc, I_B = 1.2 Adc, T_C = 100°C)		$V_{CE(sat)}$	 — — —	 — — —	 2.2 4.0 2.4	Vdc
Base–Emitter Saturation Voltage (I_C = 30 Adc, I_B = 1.2 Adc) (I_C = 30 Adc, I_B = 1.2 Adc, T_C = 100°C)		$V_{BE(sat)}$	 — —	 — —	 3.0 3.5	Vdc
Diode Forward Voltage (I_F = 30 Adc)		V_f	—	2.5	5.0	Vdc
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f_{test} = 1.0 kHz)		C_{ob}	175	—	700	pF
SWITCHING CHARACTERISTICS						
Resistive Load (Table 1)						
Delay Time	(V_{CC} = 175 Vdc, I_C = 30 A, I_{B1} = Adc, $V_{BE(off)}$ = 5.0 V, t_p = 25 s Duty Cycle ≤ 2.0%).	t_d	—	0.02	0.2	s
Rise Time		t_r	—	0.30	1.0	s
Storage Time		t_s	—	1.0	3.5	s
Fall Time		t_f	—	0.07	0.5	s
Inductive Load, Clamped (Table 1)						
Storage Time	(I_{CM} = 30 A(pk), V_{CEM} = 200 V, I_{B1} = 1.2 A, $V_{BE(off)}$ = 5 V, T_C = 100ºC)	t_{sv}	—	1.2	3.5	s
Crossover Time		t_c	—	0.45	2.0	s
Storage Time	(I_{CM} = 30 A(pk), V_{CEM} = 200 V, I_{B1} = 1.2 A, $V_{BE(off)}$ = 5 V, T_C = 25ºC)	t_{sv}	—	0.75	—	s
Crossover Time		t_c	—	0.25	—	s
Fall Time		t_{fi}	—	0.15	—	s

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

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TYPICAL CHARACTERISTIC CIRVES

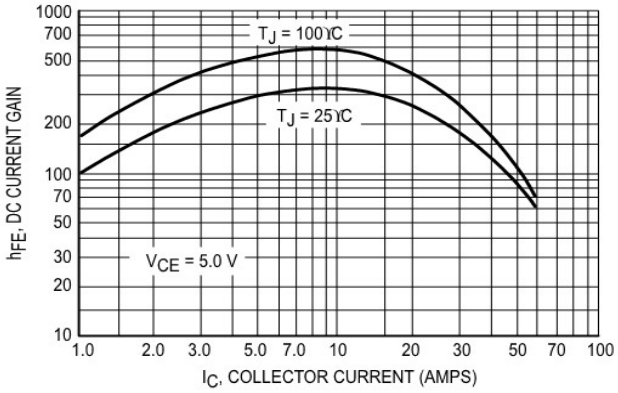

Figure 1. DC Current Gain

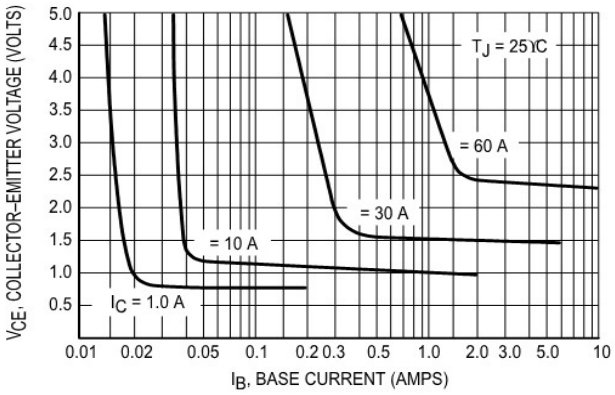

Figure 2. Collector Saturation Region

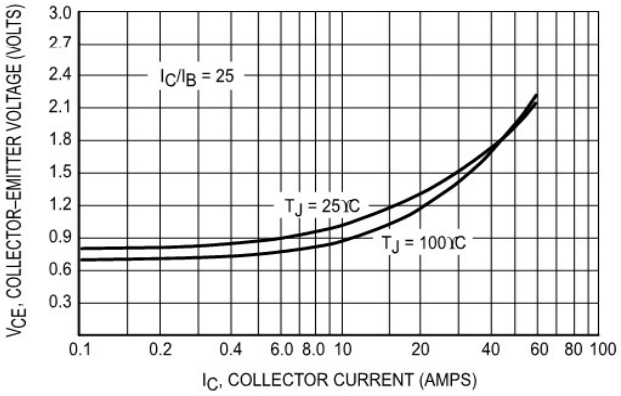

Figure 3. Collector–Emitter Saturation Voltage

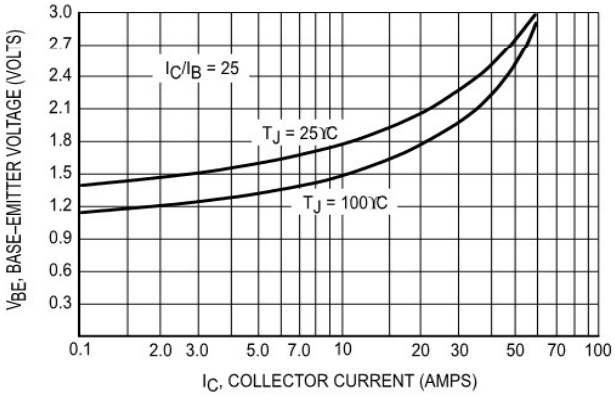

Figure 4. Base–Emitter Voltage

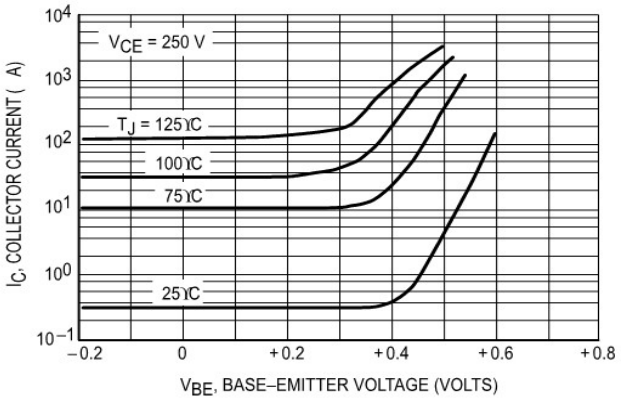

Figure 5. Collector Cutoff Region

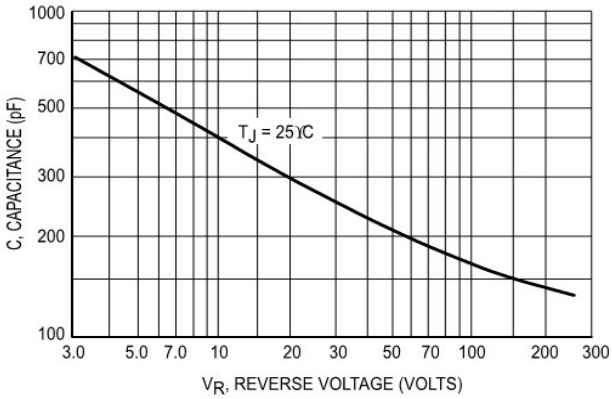

Figure 6. Output Capacitance

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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}, 2, RS = 0.1	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).

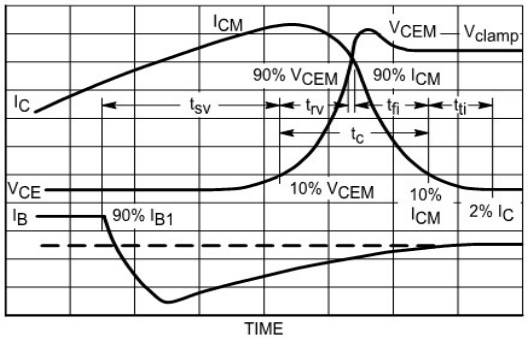


Figure 7. Inductive Switching Measurements

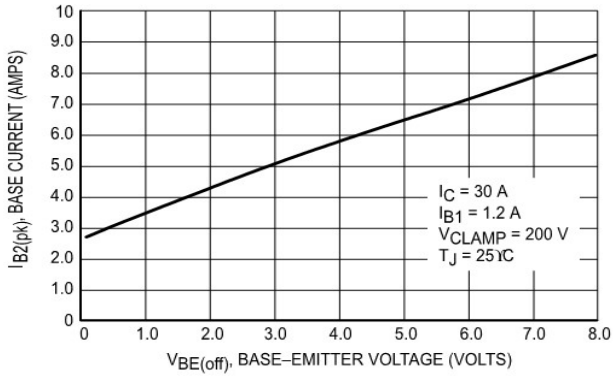


Figure 8. Typical Peak Reverse Base Current

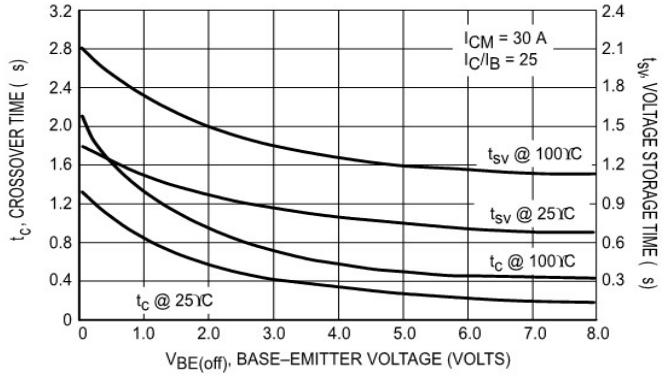


Figure 9. Typical Inductive Switching Times

RESISTIVE SWITCHING

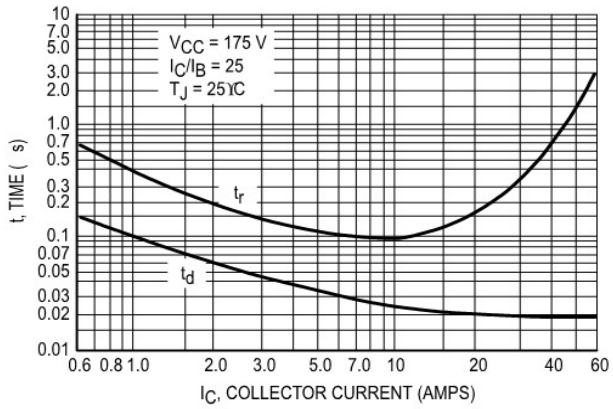


Figure 10. Typical Turn–On Switching Times

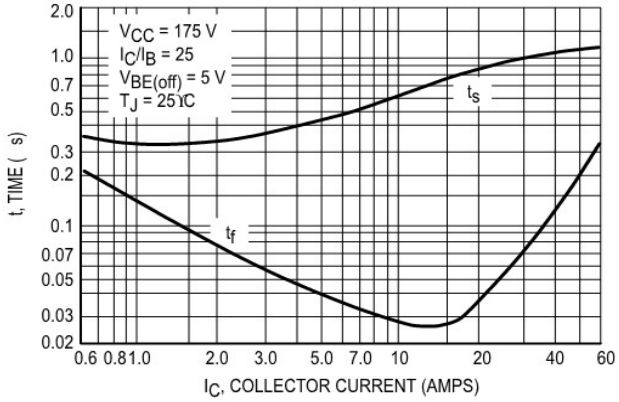


Figure 11. Typical Turn–Off Switching Times

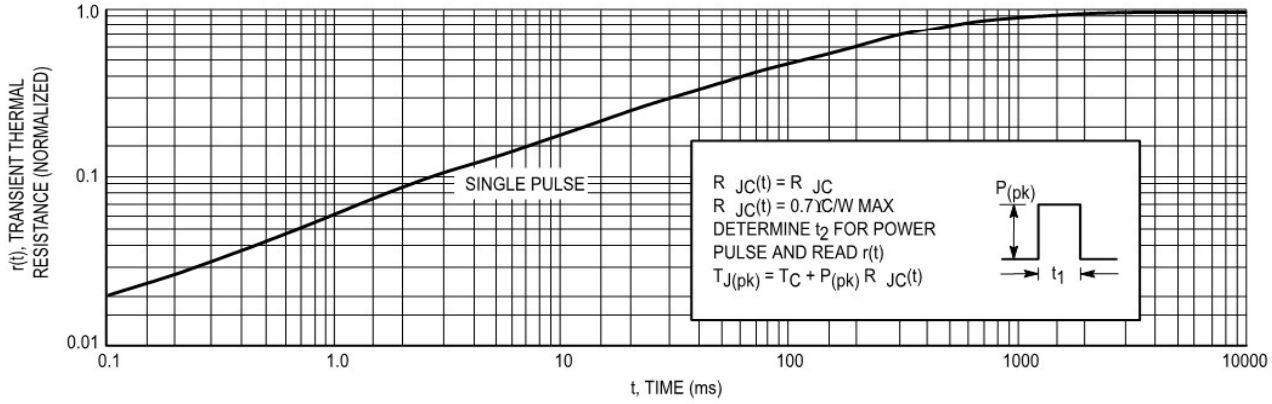


Figure 12. Thermal Response

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

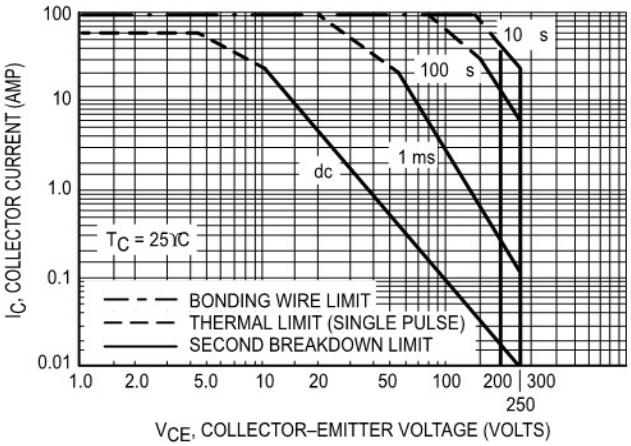


Figure 13. Maximum Forward Bias Safe Operating Area

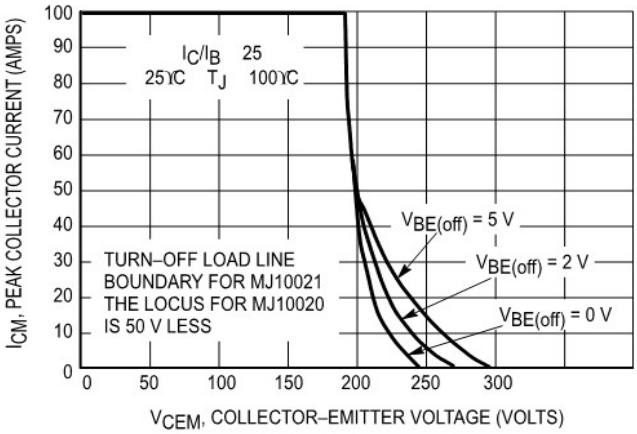


Figure 14. Maximum RBSOA, Reverse Bias Safe Operating Area

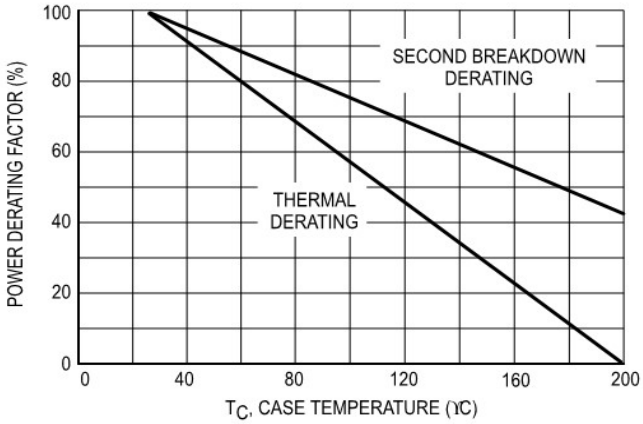
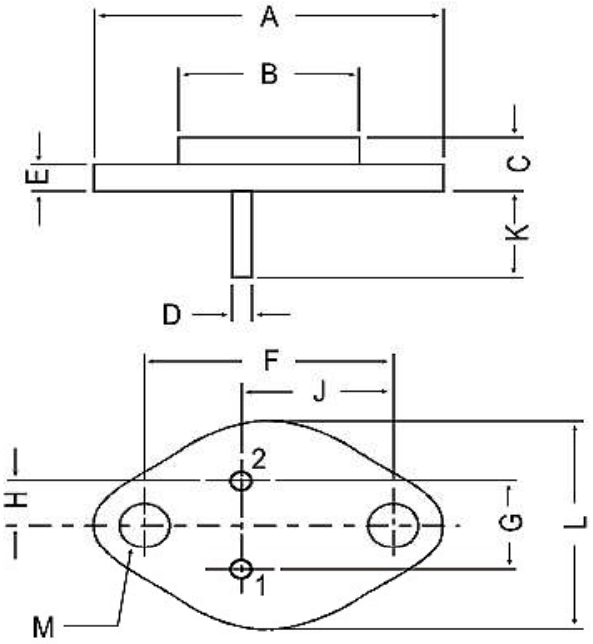


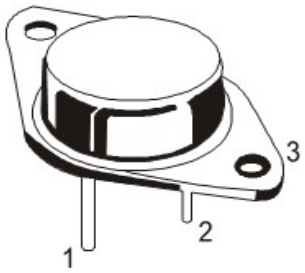
Figure 15. Power Derating

Package Details



All dimensions in mm.

DIM	MIN.	MAX.
A	—	39.37
B	—	22.22
C	6.35	8.50
D	0.96	1.09
E	—	1.77
F	29.90	30.40
G	10.69	11.18
H	5.20	5.72
J	16.64	17.15
K	11.15	12.25
L	—	26.67
M	3.84	4.19



PIN CONFIGURATION
1. BASE
2. EMITTER
3. COLLECTOR

Packing Detail

PACKAGE	STANDARD PACK		INNER CARTON BOX		OUTER CARTON BOX		
	Details	Net Weight/Qty	Size	Qty	Size	Qty	Gr Wt
TO-3	100 pcs/pkt	1.3 kg/100 pcs	12.5" x 8" x 1.8"	0.1K	17" x 11.5" x 21"	2K	27.5 kgs

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Recommended Product Storage Environment for Discrete Semiconductor Devices

This storage environment assumes that the Diodes and transistors are packed properly inside the original packing supplied by CDIL.

- Temperature 5 °C to 30 °C
- Humidity between 40 to 70 %RH
- Air should be clean.
- Avoid harmful gas or dust.
- Avoid outdoor exposure or storage in areas subject to rain or water spraying .
- Avoid storage in areas subject to corrosive gas or dust. Product shall not be stored in areas exposed to direct sunlight.
- Avoid rapid change of temperature.
- Avoid condensation.
- Mechanical stress such as vibration and impact shall be avoided.
- The product shall not be placed directly on the floor.
- The product shall be stored on a plane area. They should not be turned upside down. They should not be placed against the wall.

Shelf Life of CDIL Products

The shelf life of products is the period from product manufacture to shipment to customers. The product can be unconditionally shipped within this period. The period is defined as 2 years.
If products are stored longer than the shelf life of 2 years the products shall be subjected to quality check as per CDIL quality procedure.
The products are further warranted for another one year after the date of shipment subject to the above conditions in CDIL original packing.

Floor Life of CDIL Products and MSL Level

When the products are opened from the original packing, the floor life will start.
For this, the following JEDEC table may be referred:

JEDEC MSL Level		
Level	**Time**	**Condition**
1	Unlimited	≤30 °C / 85% RH
2	1 Year	≤30 °C / 60% RH
2a	4 Weeks	≤30 °C / 60% RH
3	168 Hours	≤30 °C / 60% RH
4	72 Hours	≤30 °C / 60% RH
5	48 Hours	≤30 °C / 60% RH
5a	24 Hours	≤30 °C / 60% RH
6	Time on Label(TOL)	≤30 °C / 60% RH

Customer Notes

Component Disposal Instructions

1. CDIL Semiconductor Devices are RoHS compliant, customers are requested to please dispose as per prevailing Environmental Legislation of their Country.
2. In Europe, please dispose as per EU Directive 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE).

Disclaimer

The product information and the selection guides facilitate selection of the CDIL's Semiconductor Device(s) best suited for application in your product(s) as per your requirement. It is recommended that you completely review our Data Sheet(s) so as to confirm that the Device(s) meet functionality parameters for your application. The information furnished in the Data Sheet and on the CDIL Web Site/CD are believed to be accurate and reliable. CDIL however, does not assume responsibility for inaccuracies or incomplete information. Furthermore, CDIL does not assume liability whatsoever, arising out of the application or use of any CDIL product; neither does it convey any license under its patent rights nor rights of others. These products are not designed for use in life saving/support appliances or systems. CDIL customers selling these products (either as individual Semiconductor Devices or incorporated in their end products), in any life saving/support appliances or systems or applications do so at their own risk and CDIL will not be responsible for any damages resulting from such sale(s).
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