

# Darlington Complementary Silicon Power Transistors

... designed for general-purpose amplifier and low frequency switching applications.

- High DC Current Gain — Min  $h_{FE} = 1000$  @  $I_C = 5$  A,  $V_{CE} = 4$  V
- Collector–Emitter Sustaining Voltage — @ 30 mA
  - $V_{CE(sus)} = 60$  Vdc (Min) — TIP140, TIP145
  - 80 Vdc (Min) — TIP141, TIP146
  - 100 Vdc (Min) — TIP142, TIP147
- Monolithic Construction with Built–In Base–Emitter Shunt Resistor

## MAXIMUM RATINGS

Rating	Symbol	TIP140 TIP145	TIP141 TIP146	TIP142 TIP147	Unit
Collector–Emitter Voltage	$V_{CEO}$	60	80	100	Vdc
Collector–Base Voltage	$V_{CB}$	60	80	100	Vdc
Emitter–Base Voltage	$V_{EB}$	5.0			Vdc
Collector Current — Continuous Peak (1)	$I_C$	10 15			A dc
Base Current — Continuous	$I_B$	0.5			A dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$	$P_D$	125			Watts
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	–65 to +150			$^\circ\text{C}$

## THERMAL CHARACTERISTICS

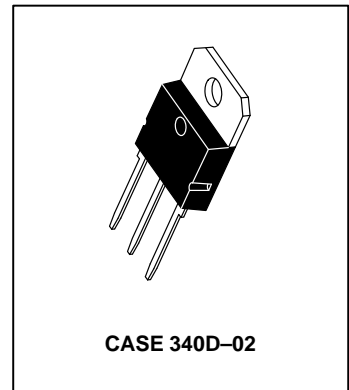
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	$^\circ\text{C}/\text{W}$
Thermal Resistance, Case to Ambient	$R_{\theta JA}$	35.7	$^\circ\text{C}/\text{W}$

(1) 5 ms,  $\leq$  10% Duty Cycle.

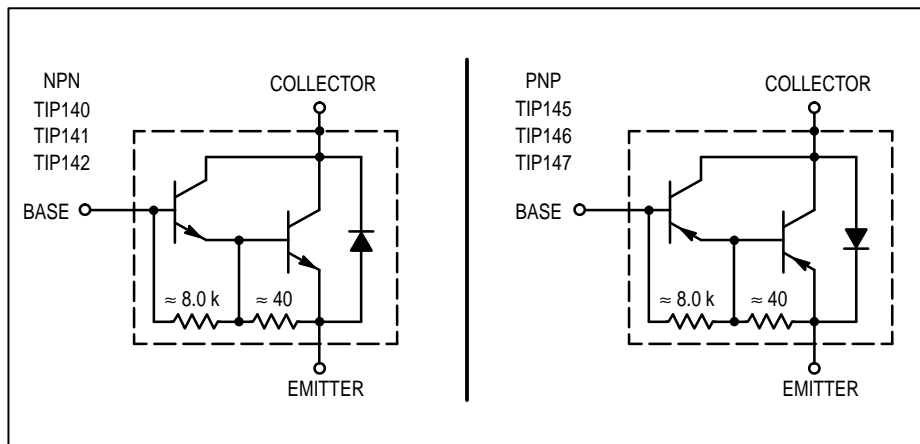
**NPN**  
**TIP140**  
**TIP141\***  
**TIP142\***  
**PNP**  
**TIP145**  
**TIP146\***  
**TIP147\***

\*Motorola Preferred Device

**10 AMPERE**  
**DARLINGTON**  
**COMPLEMENTARY SILICON**  
**POWER TRANSISTORS**  
**60–100 VOLTS**  
**125 WATTS**



## DARLINGTON SCHEMATICS



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

REV 1

**TIP140 TIP141 TIP142 TIP145 TIP146 TIP147**

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
Collector–Emitter Sustaining Voltage (1) ( $I_C = 30\text{ mA}$ , $I_B = 0$ )	$V_{CE(sus)}$	60 80 100	— — —	— — —	Vdc
Collector Cutoff Current ( $V_{CE} = 30\text{ Vdc}$ , $I_B = 0$ ) ( $V_{CE} = 40\text{ Vdc}$ , $I_B = 0$ ) ( $V_{CE} = 50\text{ Vdc}$ , $I_B = 0$ )	$I_{CEO}$	— — —	— — —	2.0 2.0 2.0	mA
Collector Cutoff Current ( $V_{CB} = 60\text{ V}$ , $I_E = 0$ ) ( $V_{CB} = 80\text{ V}$ , $I_E = 0$ ) ( $V_{CB} = 100\text{ V}$ , $I_E = 0$ )	$I_{CBO}$	— — —	— — —	1.0 1.0 1.0	mA
Emitter Cutoff Current ( $V_{BE} = 5.0\text{ V}$ )	$I_{EBO}$	—	—	2.0	mA

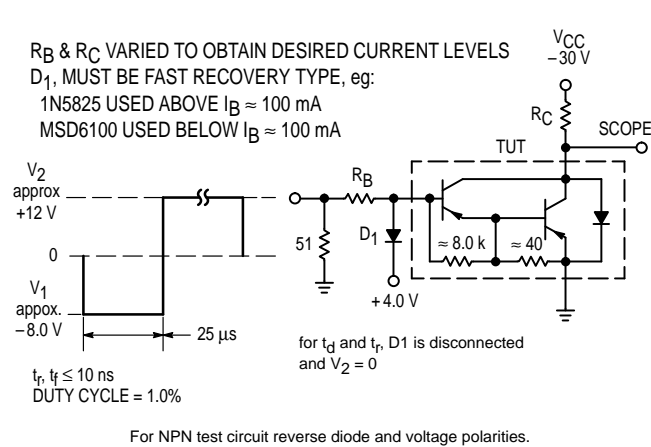
**ON CHARACTERISTICS (1)**

DC Current Gain ( $I_C = 5.0\text{ A}$ , $V_{CE} = 4.0\text{ V}$ ) ( $I_C = 10\text{ A}$ , $V_{CE} = 4.0\text{ V}$ )	$h_{FE}$	1000 500	— —	— —	—
Collector–Emitter Saturation Voltage ( $I_C = 5.0\text{ A}$ , $I_B = 10\text{ mA}$ ) ( $I_C = 10\text{ A}$ , $I_B = 40\text{ mA}$ )	$V_{CE(sat)}$	— —	— —	2.0 3.0	Vdc
Base–Emitter Saturation Voltage ( $I_C = 10\text{ A}$ , $I_B = 40\text{ mA}$ )	$V_{BE(sat)}$	—	—	3.5	Vdc
Base–Emitter On Voltage ( $I_C = 10\text{ A}$ , $V_{CE} = 4.0\text{ Vdc}$ )	$V_{BE(on)}$	—	—	3.0	Vdc

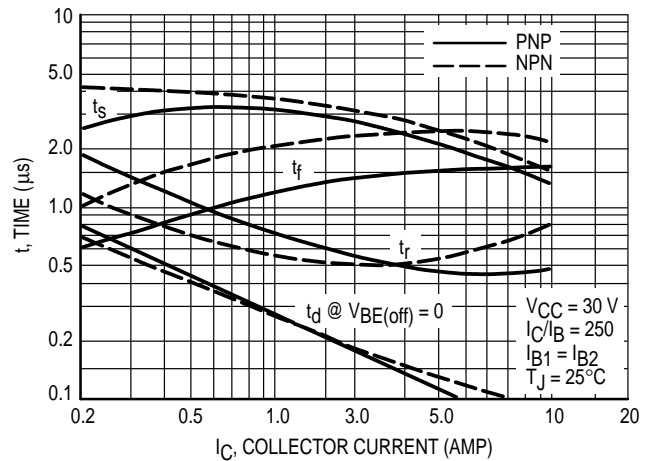
**SWITCHING CHARACTERISTICS**

Resistive Load (See Figure 1)						
Delay Time	$V_{CC} = 30\text{ V}$ , $I_C = 5.0\text{ A}$ , $I_B = 20\text{ mA}$ , Duty Cycle $\leq 2.0\%$ , $I_{B1} = I_{B2}$ , $R_C$ & $R_B$ Varied, $T_J = 25^\circ\text{C}$	$t_d$	—	0.15	—	$\mu\text{s}$
Rise Time		$t_r$	—	0.55	—	$\mu\text{s}$
Storage Time		$t_s$	—	2.5	—	$\mu\text{s}$
Fall Time		$t_f$	—	2.5	—	$\mu\text{s}$

(1) Pulse Test: Pulse Width = 300  $\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .



**Figure 1. Switching Times Test Circuit**



**Figure 2. Switching Times**

TYPICAL CHARACTERISTICS

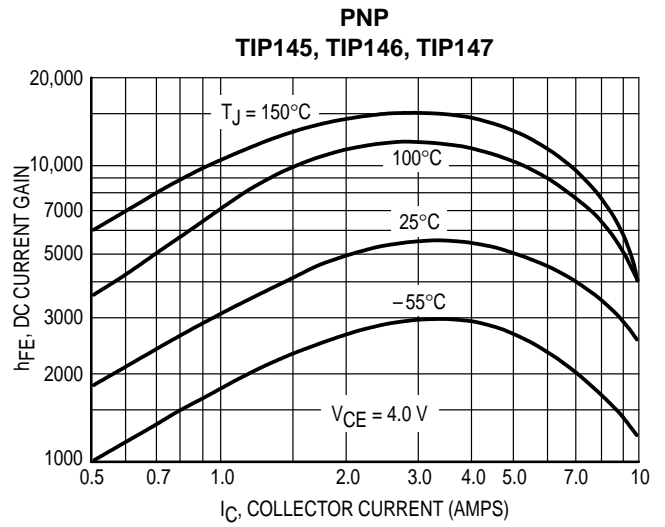
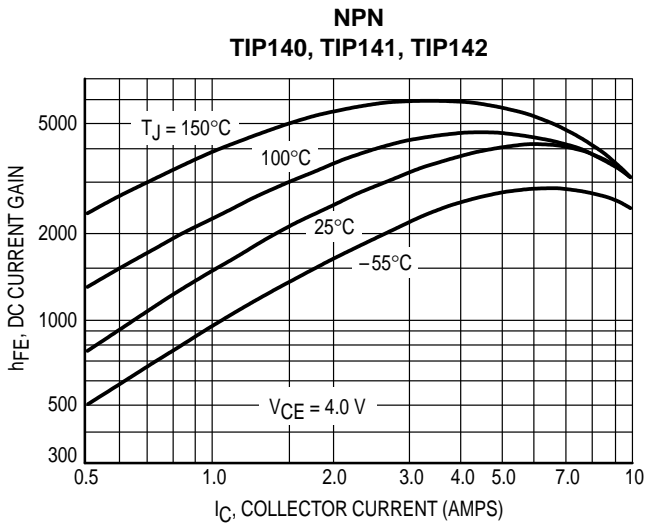


Figure 3. DC Current Gain versus Collector Current

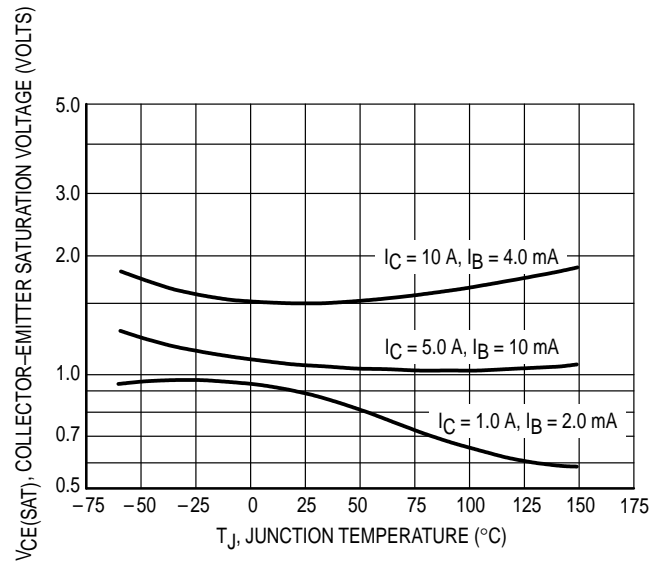
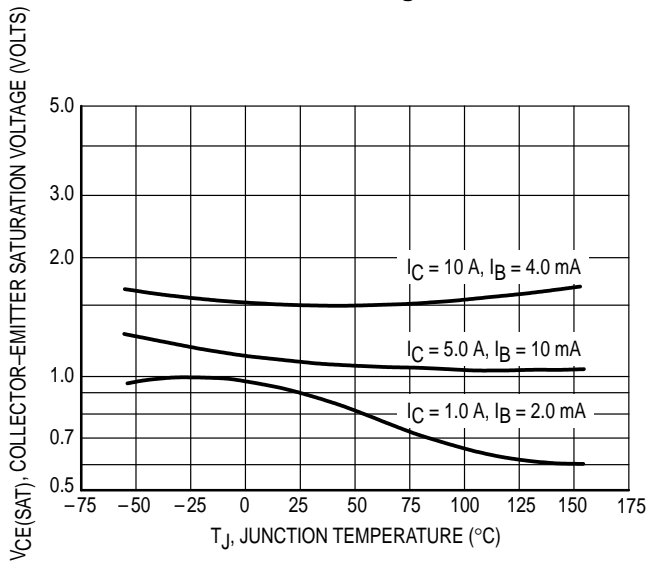


Figure 4. Collector-Emitter Saturation Voltage

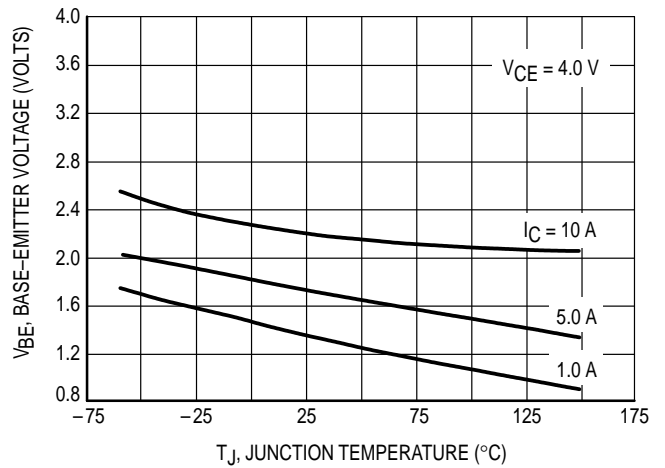
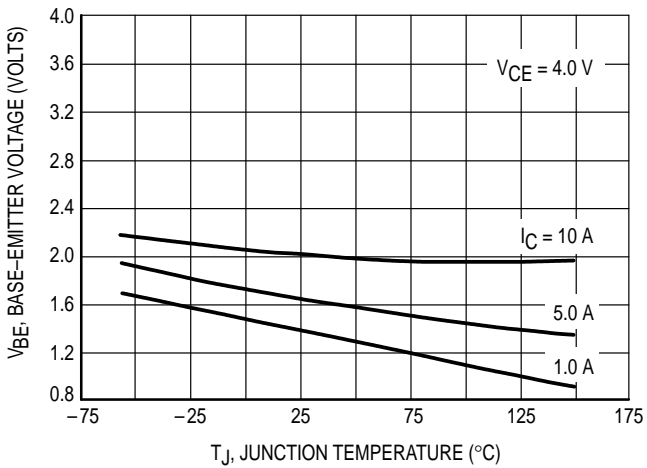


Figure 5. Base-Emitter Voltage

ACTIVE-REGION SAFE OPERATING AREA

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  $T_{J(pk)} = 150^\circ\text{C}$ ;  $T_C$  is variable depending on conditions. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

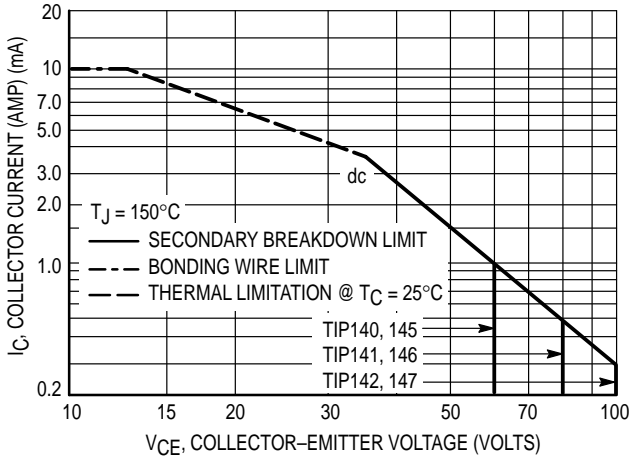


Figure 6. Active-Region Safe Operating Area

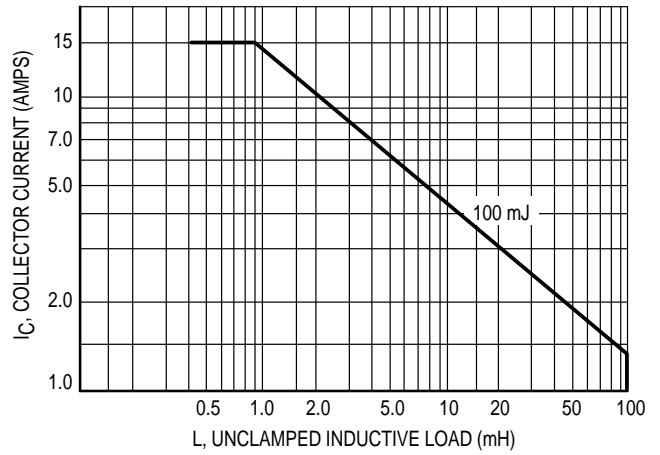
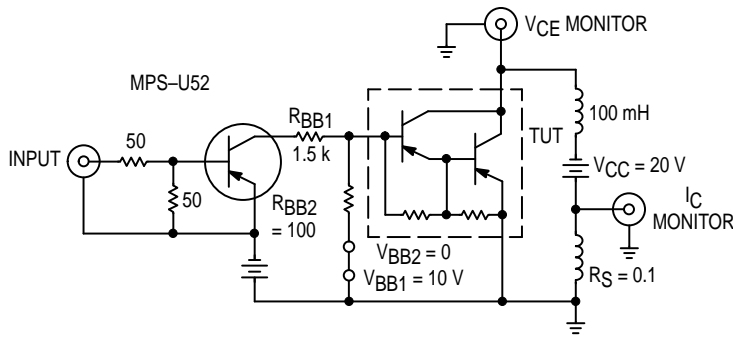
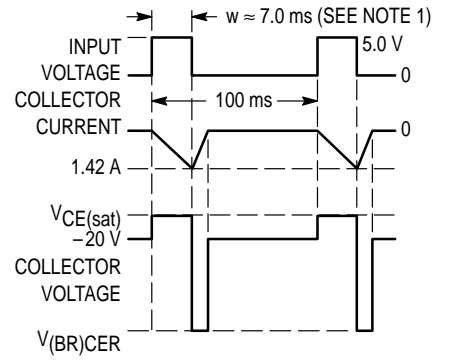


Figure 7. Unclamped Inductive Load



NOTE 1: Input pulse width is increased until  $I_{CM} = 1.42 \text{ A}$ .  
NOTE 2: For NPN test circuit reverse polarities.



VOLTAGE AND CURRENT WAVEFORMS

Figure 8. Inductive Load

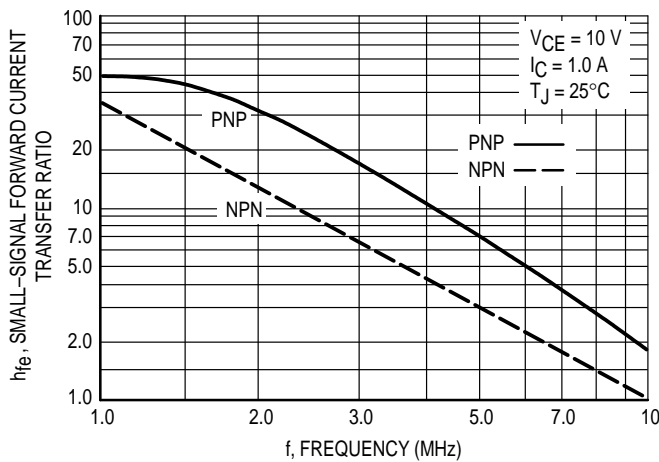


Figure 9. Magnitude of Common Emitter Small-Signal Short-Circuit Forward Current Transfer Ratio

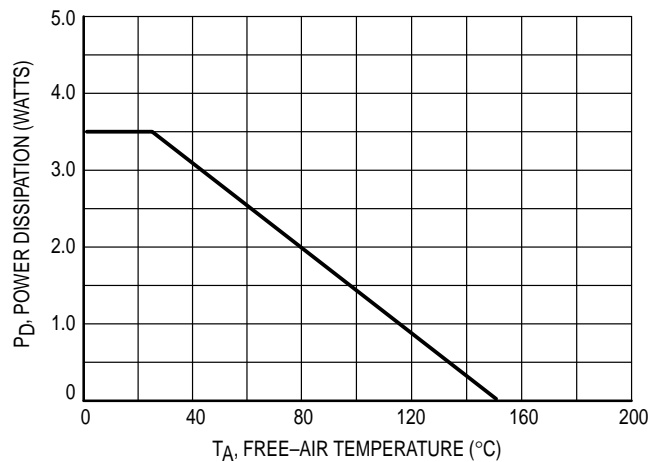
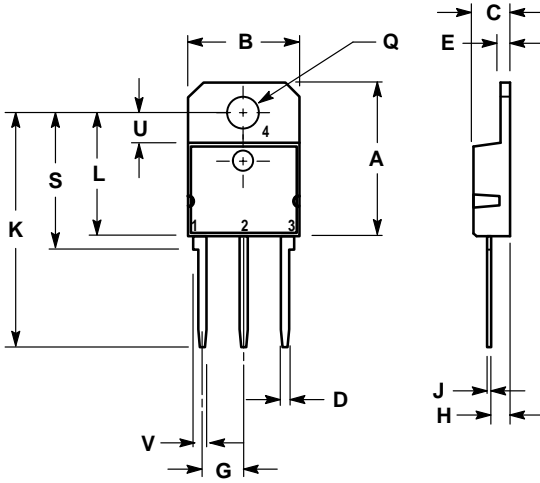


Figure 10. Free-Air Temperature Power Derating

PACKAGE DIMENSIONS




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

CASE 340D-02  
 ISSUE B

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**How to reach us:**

**USA/EUROPE/Locations Not Listed:** Motorola Literature Distribution;  
P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447 or 602-303-5454

**MFAX:** RMFAX0@email.sps.mot.com – TOUCHTONE 602-244-6609  
**INTERNET:** <http://Design-NET.com>

**JAPAN:** Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, 6F Seibu-Butsuryu-Center,  
3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-81-3521-8315

**ASIA/PACIFIC:** Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,  
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298



**MOTOROLA**



TIP140/D

