

## 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  
 $V_{CEO(sus)} = 60$  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			Adc
Base Current — Continuous	$I_B$	0.5			Adc
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

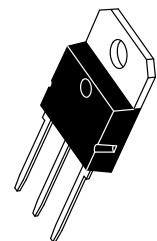
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	$^\circ\text{C/W}$
Thermal Resistance, Case to Ambient	$R_{\theta JA}$	35.7	$^\circ\text{C/W}$

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

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

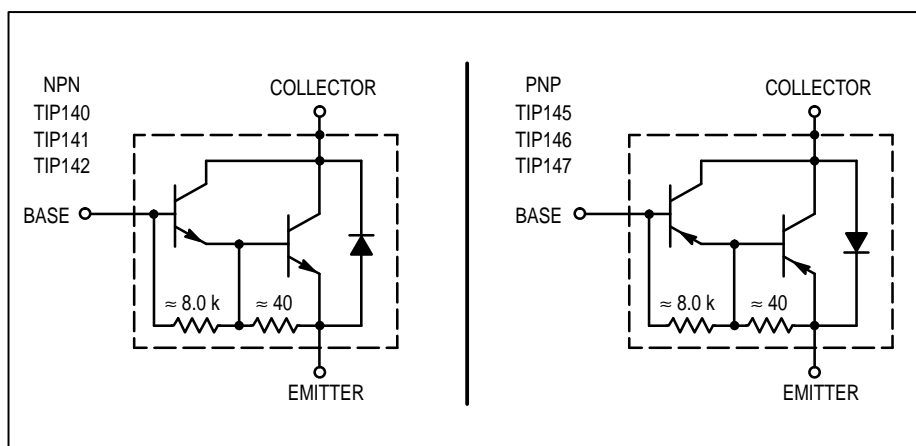
\*Motorola Preferred Device

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



CASE 340D-02

### 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

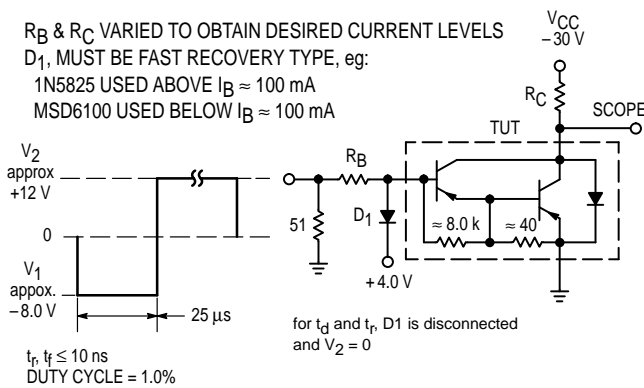
**ON CHARACTERISTICS (1)**

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**

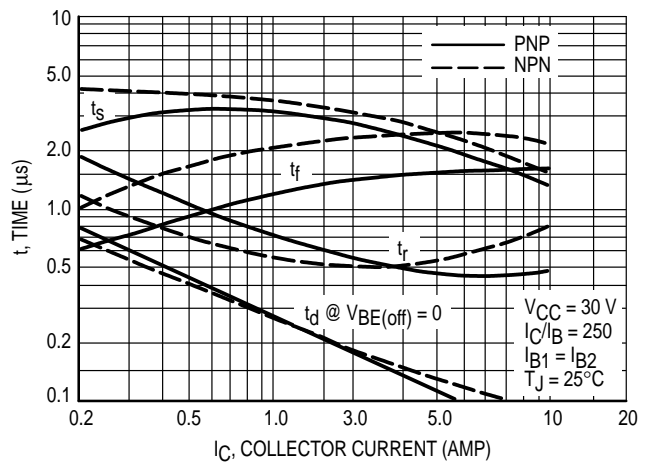
Resistive Load (See Figure 1)						
Delay Time	$(V_{CC} = 30\text{ V}$ , $I_C = 5.0\text{ A}$ , $I_B = 20\text{ mA}$ , Duty Cycle $\leq 2.0\%$ , $I_{B1} = I_{B2}$ , $R_C$ & $R_B$ Varied, $T_J = 25^\circ\text{C}$ )	$t_d$	—	0.15	—	$\mu\text{s}$
Rise Time		$t_r$	—	0.55	—	$\mu\text{s}$
Storage Time		$t_s$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



For NPN test circuit reverse diode and voltage polarities.

**Figure 1. Switching Times Test Circuit**



**Figure 2. Switching Times**

TYPICAL CHARACTERISTICS

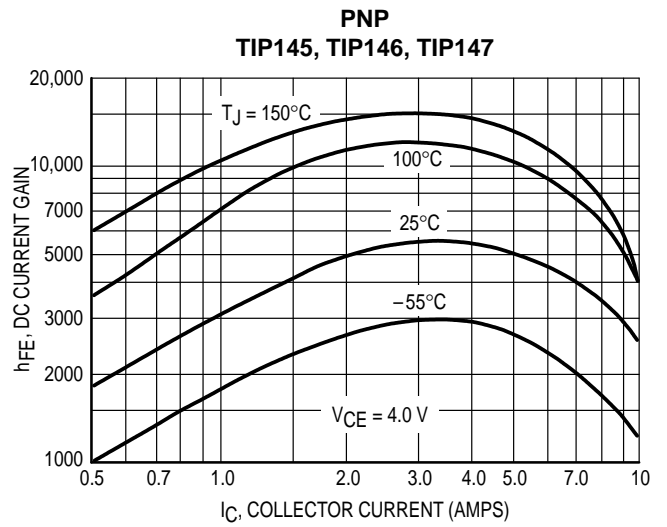
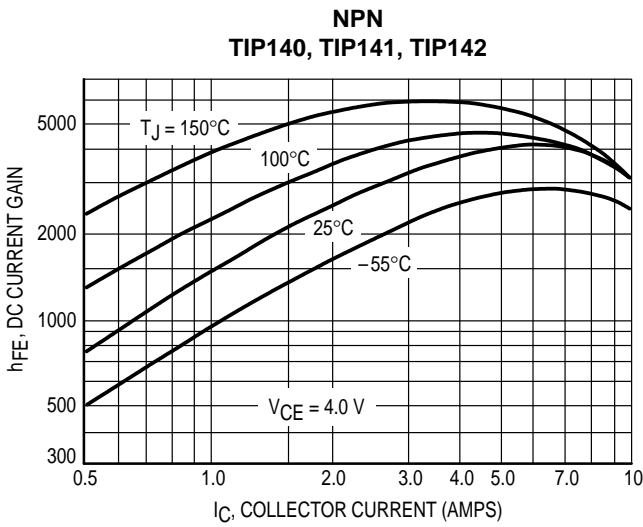


Figure 3. DC Current Gain versus Collector Current

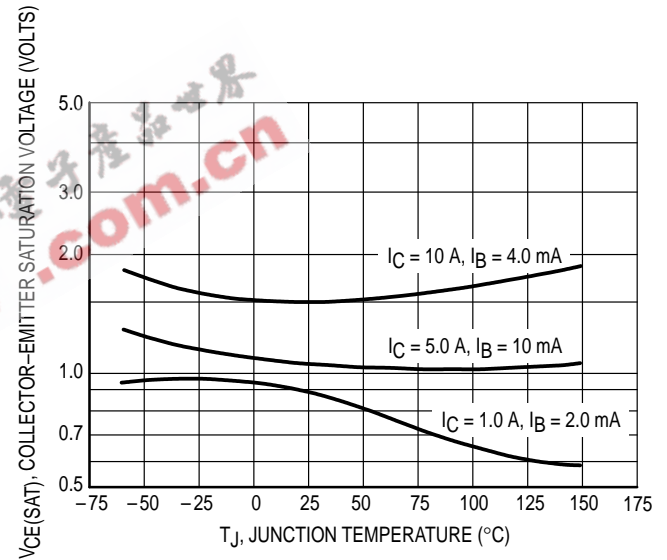
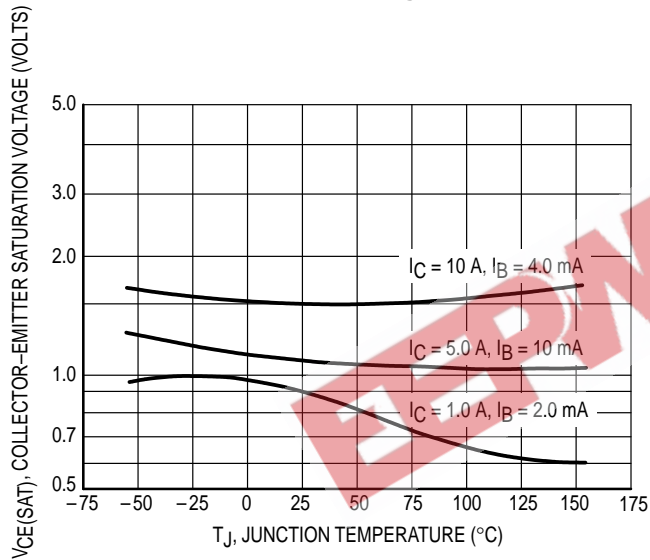


Figure 4. Collector-Emitter Saturation Voltage

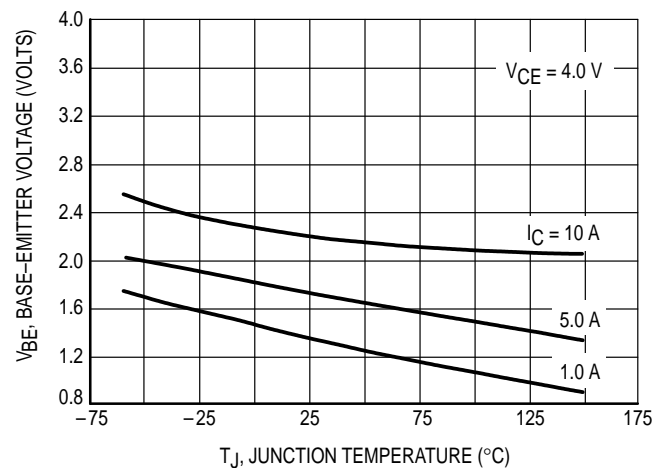
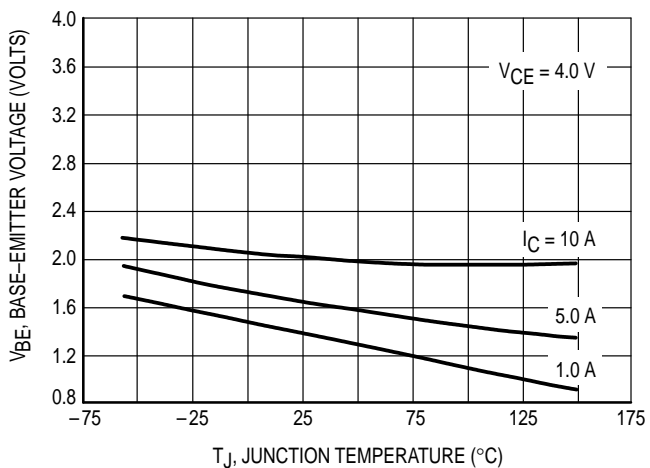


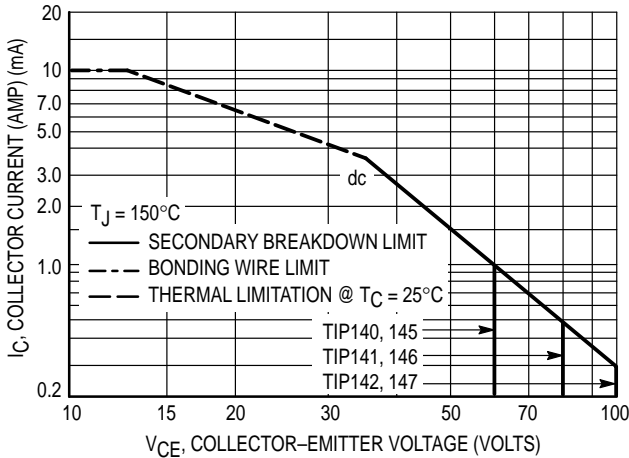
Figure 5. Base-Emitter Voltage

**TIP140 TIP141 TIP142 TIP145 TIP146 TIP147**

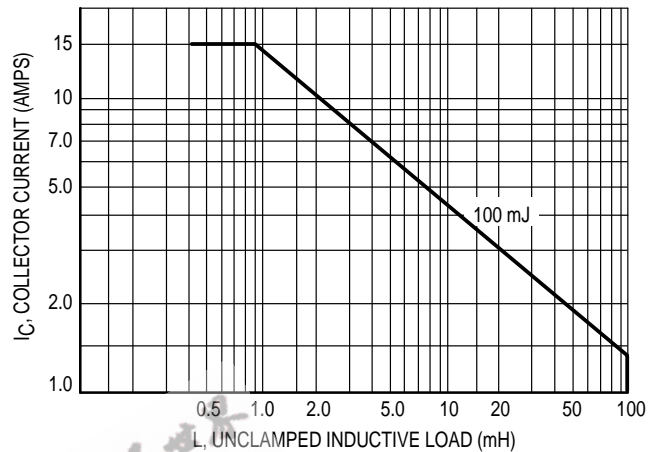
**ACTIVE-REGION SAFE OPERATING AREA**

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.

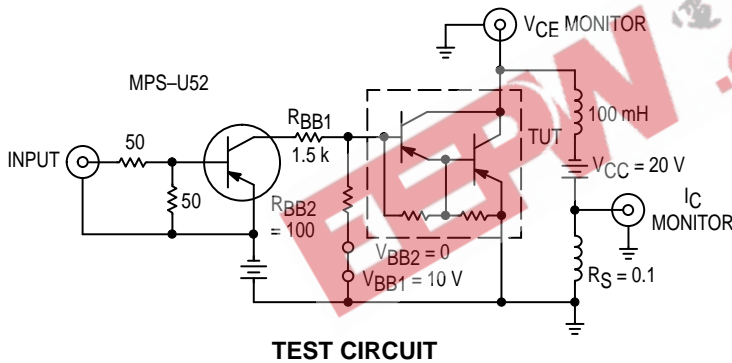
The data of Figure 6 is based on  $T_{J(pk)} = 150^\circ\text{C}$ ;  $T_C$  is variable depending on conditions. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.



**Figure 6. Active-Region Safe Operating Area**

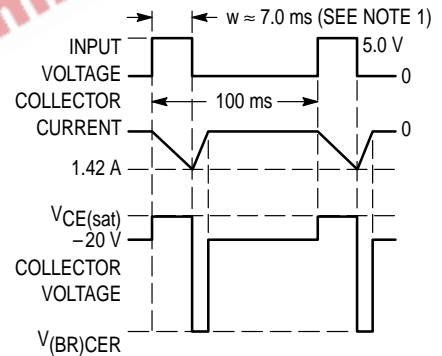


**Figure 7. Unclamped Inductive Load**



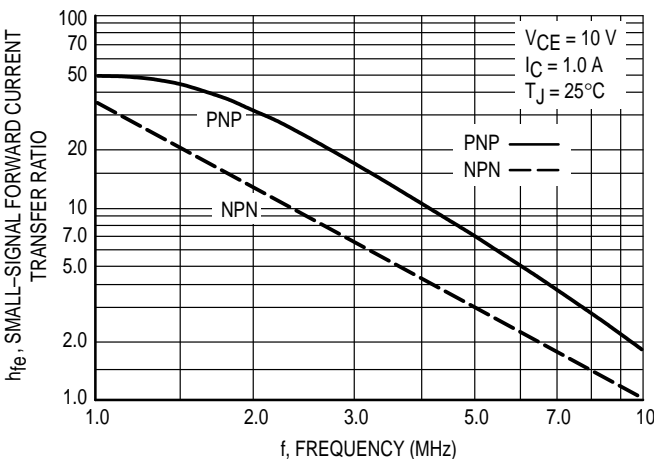
**TEST CIRCUIT**

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

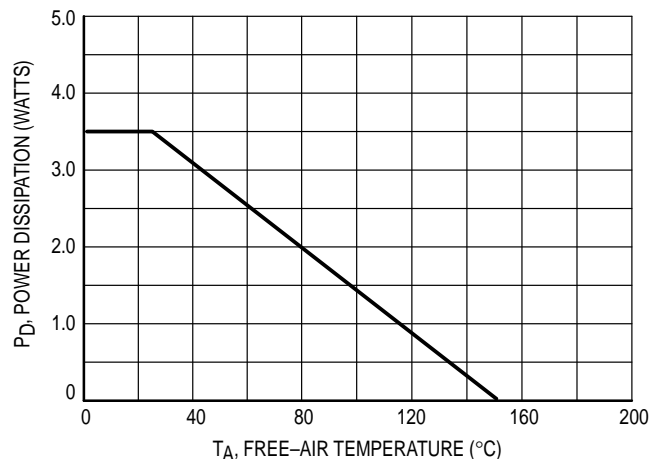


**VOLTAGE AND CURRENT WAVEFORMS**

**Figure 8. Inductive Load**



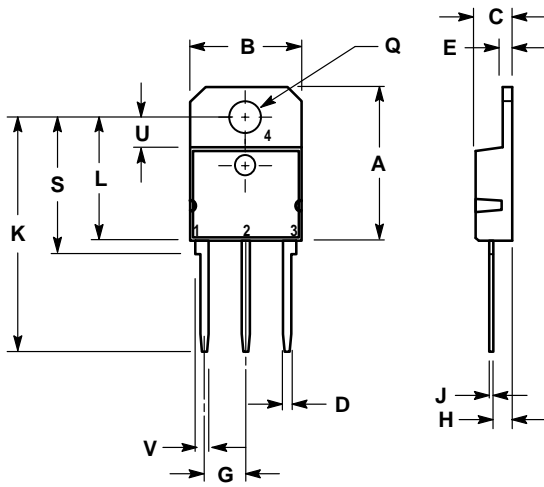
**Figure 9. Magnitude of Common Emitter Small-Signal Short-Circuit Forward Current Transfer Ratio**



**Figure 10. Free-Air Temperature Power Derating**

**TIP140 TIP141 TIP142 TIP145 TIP146 TIP147**

**PACKAGE DIMENSIONS**

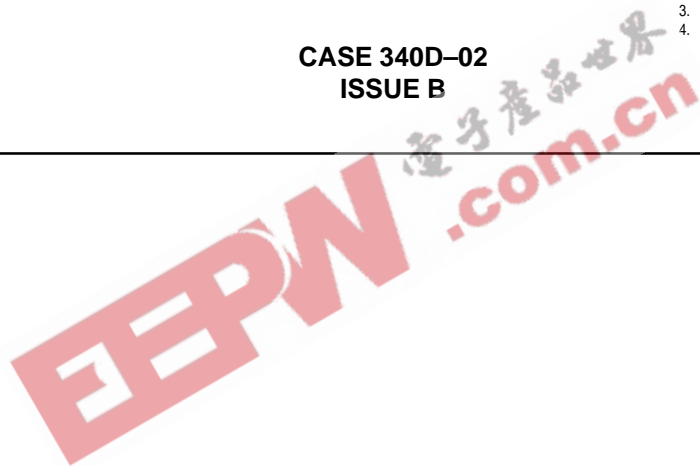


- NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 2. CONTROLLING DIMENSION: MILLIMETER.

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**



**TIP140 TIP141 TIP142 TIP145 TIP146 TIP147**

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TIP140/D

