

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

DARLINGTON COMPLEMENTARY SILICON POWER TRANSISTORS

... designed for general purpose and low speed switching applications.

- High DC Current Gain — $h_{FE} = 2500$ (typ.) @ $I_C = 5.0$ Adc.
- Collector-Emitter Sustaining Voltage @ 30 mAdc:
 $V_{CE(sus)} = 45$ Vdc (min.) — BDW39/BDW44
 60 Vdc (min.) — BDW40/BDW45
 80 Vdc (min.) — BDW41/BDW46
 100 Vdc (min.) — BDW42/BDW47
 120 Vdc (min.) — BDW43/BDW48
- Low Collector-Emitter Saturation Voltage:
 $V_{CE(sat)} = 2.0$ Vdc (max.) @ $I_C = 5.0$ Adc
 3.0 Vdc (max.) @ $I_C = 10.0$ Adc
- Monolithic Construction with Built-In Base-Emitter Shunt resistors
- TO-220AB Compact Package
- TO-66 Lead form also available ordered with "-66" suffix.

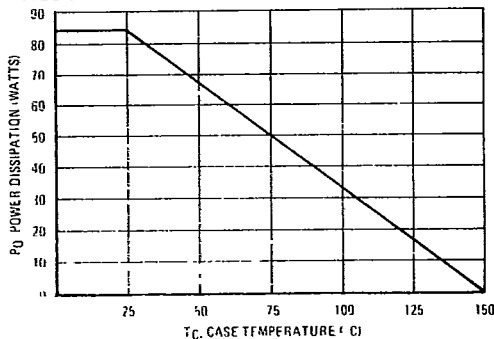
MAXIMUM RATINGS

Rating	Symbol	BDW39 BDW44	BDW40 BDW45	BDW41 BDW46	BDW42 BDW47	BDW43 BDW48	Unit
Collector-Emitter Voltage	V_{CE}	45	60	80	100	120	Vdc
Collector-Base Voltage	V_{CB}	45	60	80	100	120	Vdc
Emitter-Base Voltage	V_{EB}	5.0					Vdc
Collector Current — Continuous	I_C	15					Adc
Base Current	I_B	0.5					Adc
Total Device Dissipation † $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	85 0.68					Watts W/C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to -150					$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max.	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.47	$^\circ\text{C/W}$

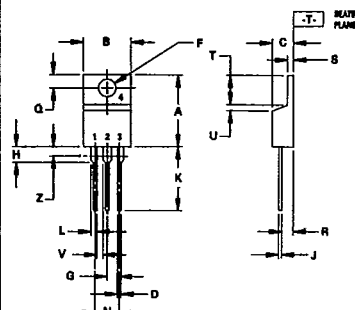
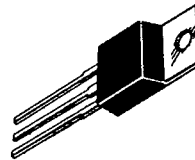
FIGURE 1 — POWER TEMPERATURE DERATING CURVE



NPN
BDW39
thru
BDW43

PNP
BDW44
thru
BDW48

DARLINGTON
15 AMPERE
COMPLEMENTARY SILICON
POWER TRANSISTORS
45-60-80-100-120 VOLTS
85 WATTS



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION INCH.
3. DIM Z DETERMINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.65	10.29	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.81	3.73	0.142	0.147
G	2.42	2.68	0.095	0.105
H	2.80	3.30	0.110	0.155
J	0.46	0.71	0.018	0.028
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

- STYLE 1
PIN 1 BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

CASE 221A-04
TO-220AB

BDW39, BDW40, BDW41, BDW42, BDW43 NPN
BDW44, BDW45, BDW46, BDW47, BDW48 PNP

T-33-31

T-33-29

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage (1) ($I_C = 30\text{ mAdc}$, $I_B = 0$)	$V_{CEO(sus)}$	45 60 80 100 120	— — — — —	Vdc
Collector Cutoff Current ($V_{CE} = 22.5\text{ Vdc}$, $I_B = 0$) ($V_{CE} = 30\text{ Vdc}$, $I_B = 0$) ($V_{CE} = 40\text{ Vdc}$, $I_B = 0$) ($V_{CE} = 50\text{ Vdc}$, $I_B = 0$) ($V_{CE} = 60\text{ Vdc}$, $I_B = 0$)	I_{CEO}	— — — — —	2.0 2.0 2.0 2.0 2.0	mAdc
Collector Cutoff Current ($V_{CB} = 45\text{ Vdc}$, $I_E = 0$) ($V_{CB} = 60\text{ Vdc}$, $I_E = 0$) ($V_{CB} = 80\text{ Vdc}$, $I_E = 0$) ($V_{CB} = 100\text{ Vdc}$, $I_E = 0$) ($V_{CB} = 120\text{ Vdc}$, $I_E = 0$)	I_{CBO}	— — — — —	1.0 1.0 1.0 1.0 1.0	mAdc
Emitter Cutoff Current ($V_{BE} = 5.0\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	2.0	mAdc
ON CHARACTERISTICS (1)				
DC Current Gain ($I_C = 5.0\text{ Adc}$, $V_{CE} = 4.0\text{ Vdc}$) ($I_C = 10\text{ Adc}$, $V_{CE} = 4.0\text{ Vdc}$)	h_{FE}	1000 250	— —	
Collector-Emitter Saturation Voltage ($I_C = 5.0\text{ Adc}$, $I_B = 10\text{ mAdc}$) ($I_C = 10\text{ Adc}$, $I_B = 50\text{ mAdc}$)	$V_{CE(sat)}$	— —	2.0 3.0	Vdc
Base-Emitter On Voltage ($I_C = 10\text{ Adc}$, $V_{CE} = 4.0\text{ Vdc}$)	$V_{BE(on)}$	—	3.0	Vdc
SECOND BREAKDOWN (2)				
Second Breakdown Collector Current with Base Forward Biased BDW39/BDW40/BDW41/BDW42/BDW43 BDW44/BDW45/BDW46/BDW47/BDW48	$I_{S/b}$	3.0 1.2 3.8 1.2	— — — —	Adc
DYNAMIC CHARACTERISTICS				
Magnitude of common emitter small signal short circuit current transfer ratio ($I_C = 3.0\text{ Adc}$, $V_{CE} = 3.0\text{ Vdc}$, $f = 1.0\text{ MHz}$)	f_T	4.0	—	MHz
Output Capacitance ($V_{CB} = 10\text{ Vdc}$, $I_E = 0$, $f = 0.1\text{ MHz}$) BDW39/BDW40/BDW41/BDW42/BDW43 BDW44/BDW45/BDW46/BDW47/BDW48	C_{ob}	— —	200 300	pF
Small-Signal Current Gain ($I_C = 3.0\text{ Adc}$, $V_{CE} = 3.0\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{fe}	300	—	

Indicates JEDEC Registered Data.

(1) Pulse Test: Pulse Width = 300 μs , Duty Cycle = 2.0%.

(2) Pulse Test non repetitive: Pulse Width = 250 ms.

BDW39, BDW40, BDW41, BDW42, BDW43 NPN
BDW44, BDW45, BDW46, BDW47, BDW48 PNP

T-33-3/

T-33-29

FIGURE 2 - SWITCHING TIMES TEST CIRCUIT

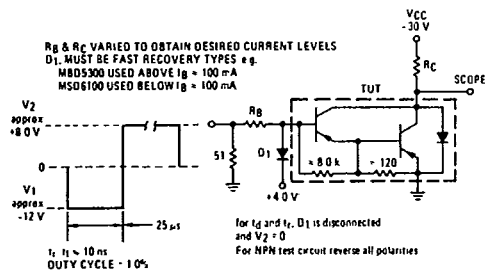


FIGURE 3 - SWITCHING TIMES

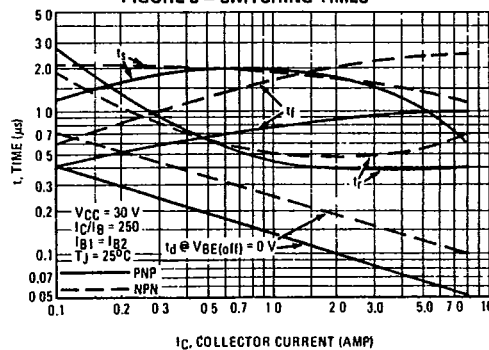
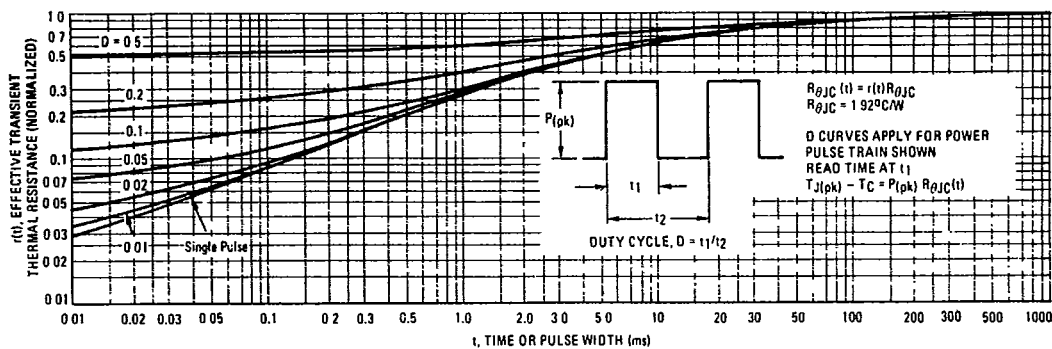
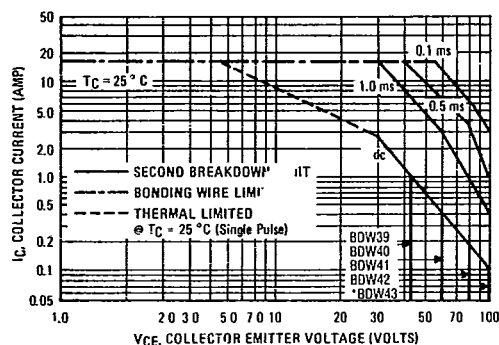


FIGURE 4 - THERMAL RESPONSE



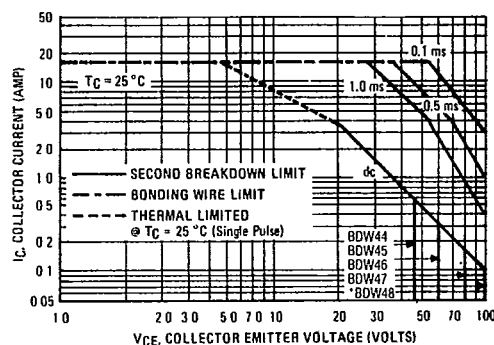
ACTIVE-REGION SAFE OPERATING AREA

FIGURE 5 - BDW39 THRU BDW43



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 Fig. 5 and 6 is based on $T_{J(pk)} =$

FIGURE 6 - BDW44 THRU BDW48



200°C ; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leq 200^\circ\text{C}$. $T_{J(pk)}$ may be calculated from the data in Fig. 4. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown. (See an-415).

*Linear extrapolation

BDW39, BDW40, BDW41, BDW42, BDW43 NPN
BDW44, BDW45, BDW46, BDW47, BDW48 PNP

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T-33-29

FIGURE 7 - SMALL-SIGNAL CURRENT GAIN

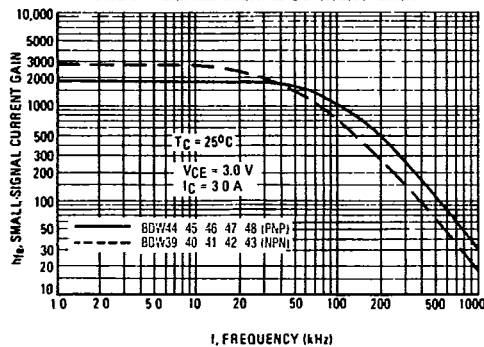
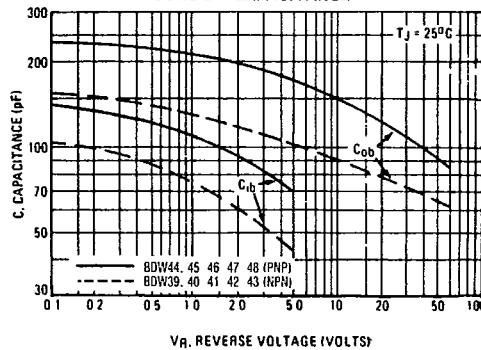


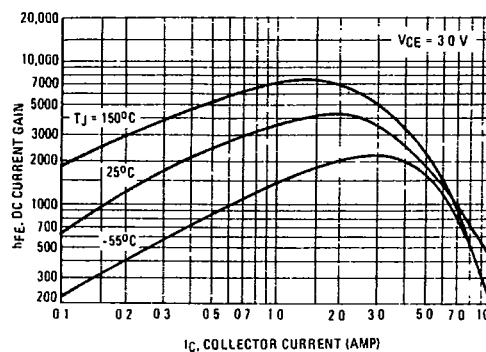
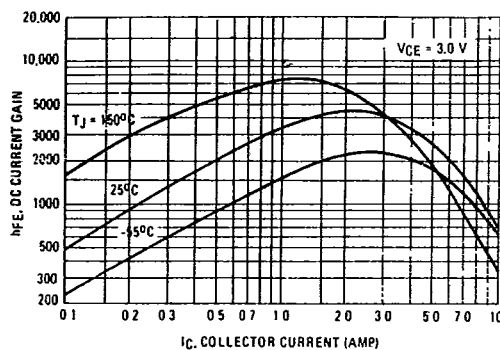
FIGURE 8 - CAPACITANCE



BDW39, 40, 41, 42, 43 (NPN)

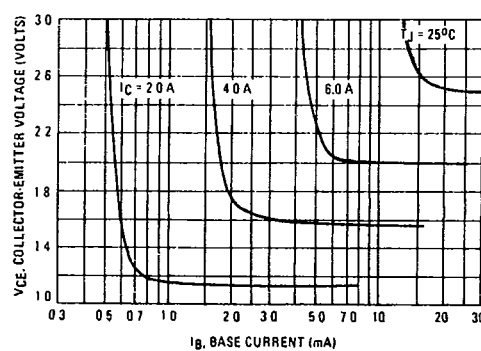
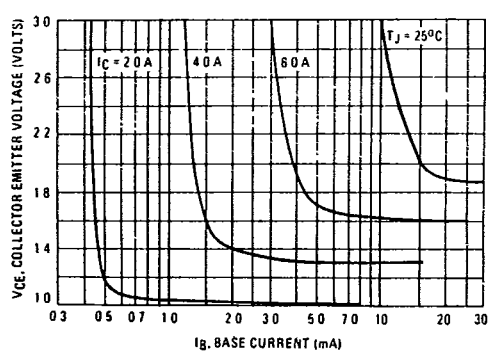
BDW44, 45, 46, 47, 48 (PNP)

FIGURE 9 - DC CURRENT GAIN



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FIGURE 10 - COLLECTOR SATURATION REGION



BDW39, BDW40, BDW41, BDW42, BDW43 NPN
BDW44, BDW45, BDW46, BDW47, BDW48 PNP

T-33-31

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BDW39, 40, 41, 42, 43 (NPN)

BDW44, 45, 46, 47, 48 (PNP)

FIGURE 11 - "ON" VOLTAGES

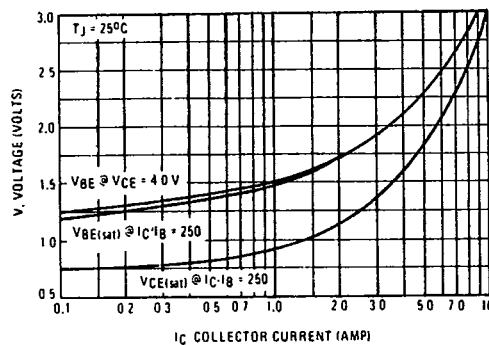
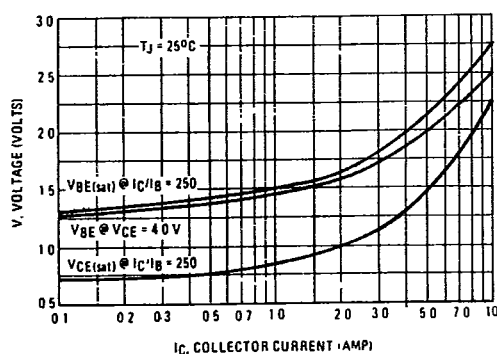


FIGURE 12 - TEMPERATURE COEFFICIENTS

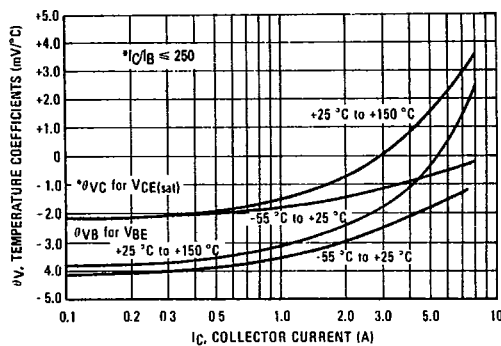
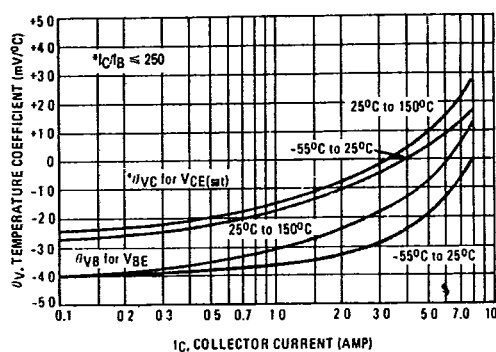
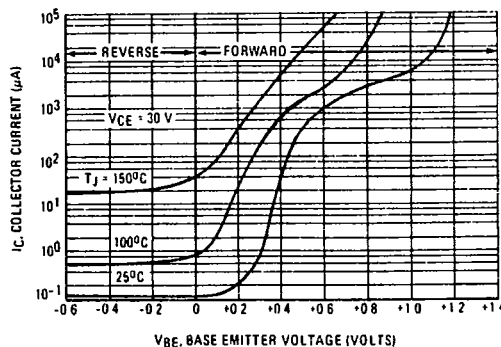
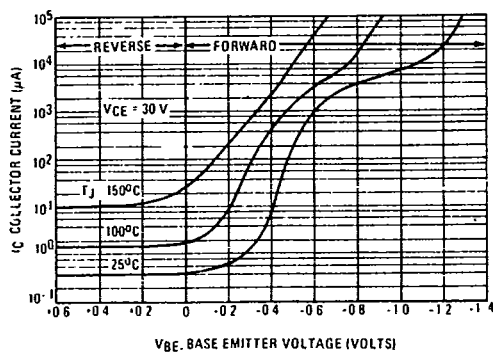


FIGURE 13 - COLLECTOR CUT-OFF REGION



BDW39, BDW40, BDW41, BDW42, BDW43 NPN
BDW44, BDW45, BDW46, BDW47, BDW48 PNP

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T-33-29

FIGURE 14 — DARLINGTON SCHEMATIC

