BD364, BD366, BD368 (NPN)
BD365, BD367, BD369 (PNP)

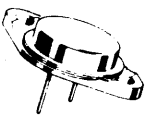
COMPLEMENTARY SILICON HIGH-POWER TRANSISTORS

. . . designed for high quality amplifiers operating up to 100 Watts into 4 ohm load in regular complementary operation or up to several hundred watts in 4 or 8 ohms in series connected mode

- High DC Current Gain $h_{FE\ min.}$ = 20 @ I_C = 10 A
- Excellent Safe Operating Area
- High Current Gain – Bandwidth Product:
  f_T = 4.0 MHz @ I_C = 1.0 A
- Low Collector-Emitter Saturation Voltage:
  $V_{CE\ sat}$ = 1 Vdc (max.) @ 10 A

20 AMPERES
COMPLEMENTARY SILICON
POWER TRANSISTORS

50, 60, 80 VOLTS
200 WATTS



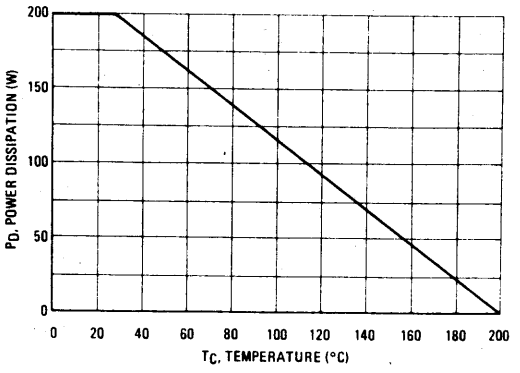
MAXIMUM RATINGS

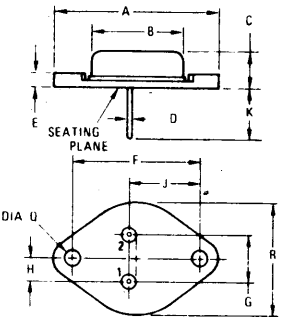
Rating	Symbol	BD364 BD365	BD366 BD367	BD368 BD369	Unit
Collector-Emitter Voltage	V_{CEO}	50	60	80	Vdc
Collector-Base Voltage	V_{CB}	50	60	80	Vdc
Emitter-Base Voltage	V_{EB}	5.0			Vdc
Collector Current – Continuous Peak	I_C	20 30			Adc
Base Current – Continuous	I_B	7.5			Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	200 1.14			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	θ_{JC}	0.875	°C/W

FIGURE 1 – POWER DERATING





STYLE 1:
PIN 1. BASE
2. EMITTER
CASE: COLLECTOR

NOTE
1. DIM "Q" IS DIA

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A		39.37		1.550
B		21.08		0.830
C	6.35	7.62	0.250	0.300
D	0.99	1.09	0.039	0.043
E		3.43		0.135
F	29.90	30.40	1.177	1.197
G	10.67	11.18	0.420	0.440
H	5.33	5.59	0.210	0.220
J	16.64	17.15	0.655	0.675
K	11.18	12.19	0.440	0.480
Q	3.84	4.09	0.151	0.161
R		26.67		1.050

Collector connected to case

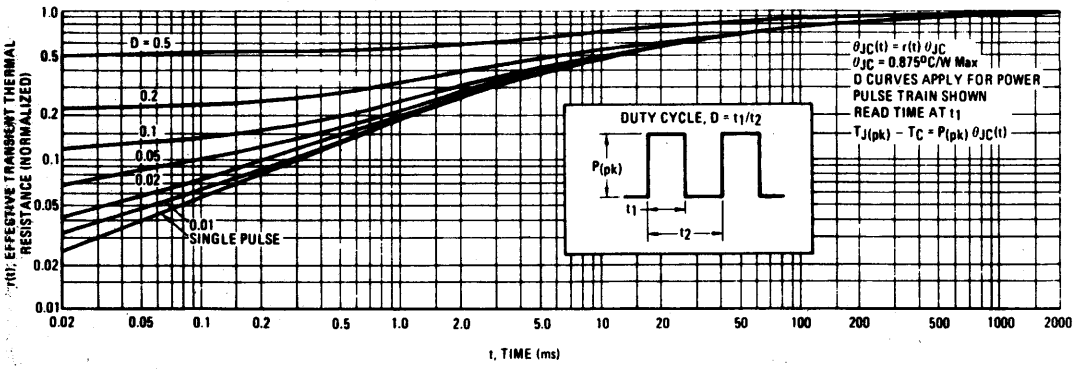
CASE 11 (TO-3)

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (1) (I_C = 200 mAdc, I_B = 0)	BD364, BD365 BD366, BD367 BD368, BD369	V_{CEO} (sus)	50 60 80		Vdc
Collector-Base Cutoff Current (V_{CB} = Rated V_{CB}, I_E = 0)		I_{CBO}	–	1.0	mAdc
Emitter-Base Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)		I_{EBO}	–	1.0	mAdc
ON CHARACTERISTIC (1)					
DC Current Gain I_C = 5.0 Adc, V_{CE} = 4.0 Vdc I_C = 8.0 Adc, V_{CE} = 4.0 Vdc I_C = 10 Adc, V_{CE} = 4.0 Vdc	All types	H_{FE}	25 25 20		–
Collector-Emitter Saturation Voltage (I_C = 10 Adc, I_B = 1 Adc)		V_{CE} (sat)	–	1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 10 Adc, I_B = 1 Adc)		V_{BE} (sat)		1.8	Vdc
Base-Emitter On Voltage (I_C = 10 Adc, V_{CE} = 2.0 Vdc)		V_{BE} (on)	–	1.8	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain – Bandwidth Product (2) (I_C = 1.0 Adc, V_{CE} = 1 Vdc, f_{test} = 1 MHz)		f_T	4.0	–	MHz

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) $f_T = |h_{fe}| \cdot f_{test}$.

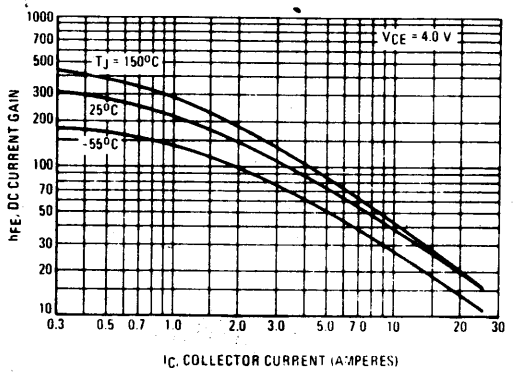
FIGURE 2 – THERMAL RESPONSE



PNP DEVICES
BD365, BD367, BD369

NPN DEVICES
BD364, BD366, BD368

FIGURE 3 – DC CURRENT GAIN



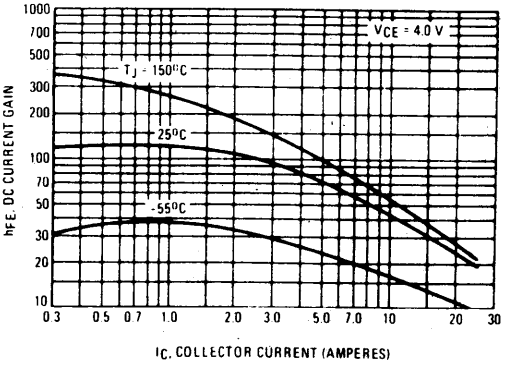
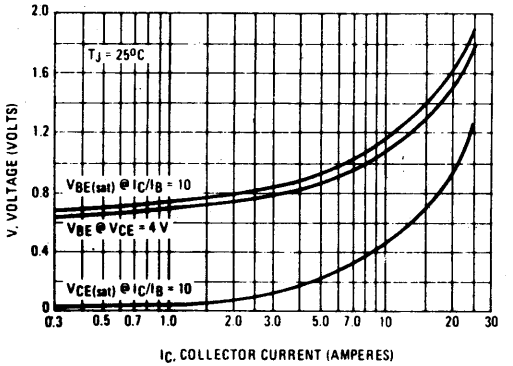


FIGURE 4 – "ON" VOLTAGES



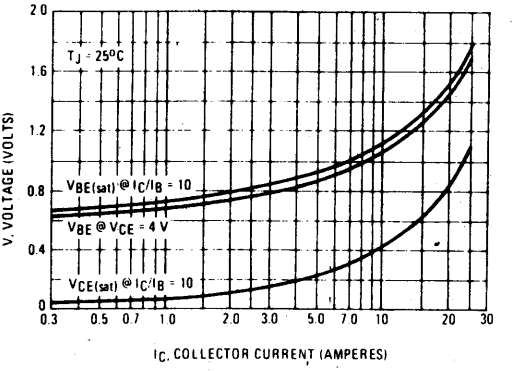
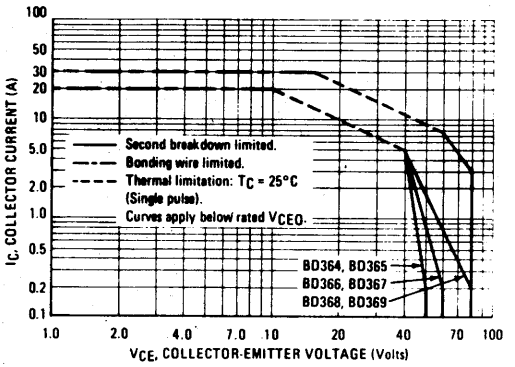


FIGURE 5 – ACTIVE REGION SAFE OPERATING AREA



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 5 is based on $T_{J(pk)} = 200°C$: T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leq 200°C$. $T_{J(pk)}$ may be calcualted from the data in Figure 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 Motorola Application Note AN-415).

BD385
BD387
BD389

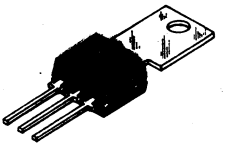
NPN SILICON ANNULAR♦ AMPLIFIER TRANSISTORS

. . . designed for general-purpose, medium-voltage, medium power amplifier and driver applications; series, shunt and switching regulators, and low and high frequency inverters and converters.

- High Collector-Emitter Breakdown Voltage – BV_{CEO} = 100 Vdc (Min.) @ I_C = 1.0 mAdc – BD389
- Duowatt Package – 2 Watts Free Air Dissipation @ T_A = 25°C
- Complements to PNP BD386, BD388, BD390

DUOWATT

NPN SILICON AMPLIFIER TRANSISTORS



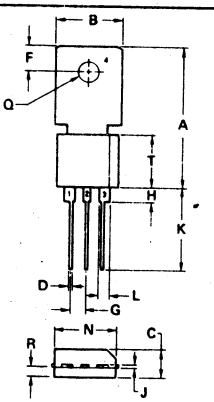
MAXIMUM RATINGS

Rating	Symbol	BD385	BD387	BD389	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	100	Vdc
Collector-Base Voltage	V_{CBO}	60	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	← 5.0 →			Vdc
Collector Current – Continuous – Peak (1)	I_C	← 1.0 → ← 2.0 →			Adc
Base Current	I_B	← 100 →			mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	← 2.0 → ← 16 →			Watts mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	← 10 → ← 80 →			Watts mW/°C
Operating and Storage Junction Temperature Range	T_J,T_{stg}	← -55 to +150 →			°C
Solder Temperature, 1/16" from Case for 10 Seconds	–	← 260 →			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R\theta JA$	62.5	°C/W
Thermal Resistance, Junction to Case	$R\theta JC$	12.5	°C/W

(1) ≤10 ms, ≤ 50% Duty Cycle



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

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	21.84	22.35	0.860	0.880
B	9.91	10.41	0.390	0.410
C	4.39	4.65	0.173	0.183
D	0.58	0.74	0.023	0.029
F	3.56	4.06	0.140	0.160
G	2.41	2.67	0.095	0.105
H	1.70	1.96	0.067	0.077
J	0.48	0.66	0.019	0.026
K	12.19	12.95	0.480	0.510
L	1.65	2.03	0.065	0.080
N	9.91	10.16	0.390	0.400
Q	3.56	3.81	0.140	0.150
R	1.07	1.75	0.042	0.069
T	7.87	9.14	0.310	0.360

CASE 306-04

***ELECTRICAL CHARACTERISTICS** (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BD385	BV_{CEO}	60	–	Vdc
	BD387		80	–	
	BD389		100	–	
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BD385	BV_{CBO}	60	–	Vdc
	BD387		80	–	
	BD389		100	–	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		BV_{EBO}	5.0	–	Vdc
Collector Cutoff Current		I_{CBO}			nAdc
(V_{CB} = 40 Vdc, I_E = 0)	BD385		–	100	
(V_{CB} = 60 Vdc, I_E = 0)	BD387		–	100	
(V_{CB} = 80 Vdc, I_E = 0)	BD389		–	100	
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	–	100	nAdc
ON CHARACTERISTICS (1)					
DC Current Gain		h_{FE}			–
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			60	–	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)			80	300	
(I_C = 250 mAdc, V_{CE} = 1.0 Vdc)			60	–	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)			25	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 250 mAdc, I_B = 10 mAdc)			–	0.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)			–	1.0	
Base-Emitter On Voltage (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	–	1.2	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain – Bandwidth Product (I_C = 100 mAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	75	350	MHz
Collector-Base Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	–	18	pF

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

TYPICAL CHARACTERISTICS

FIGURE 1 – CURRENT-GAIN – BANDWIDTH PRODUCT

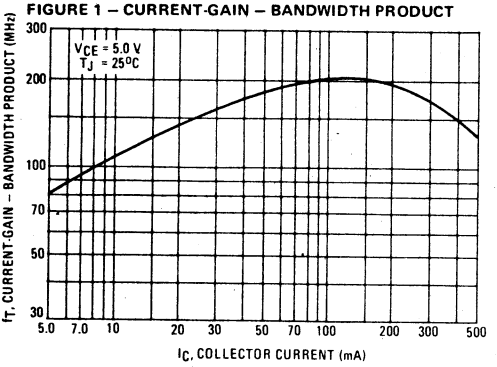
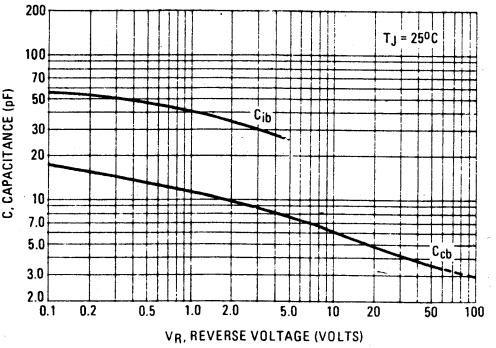


FIGURE 2 – CAPACITANCES



TYPICAL CHARACTERISTICS (continued)

FIGURE 3 – DC CURRENT GAIN

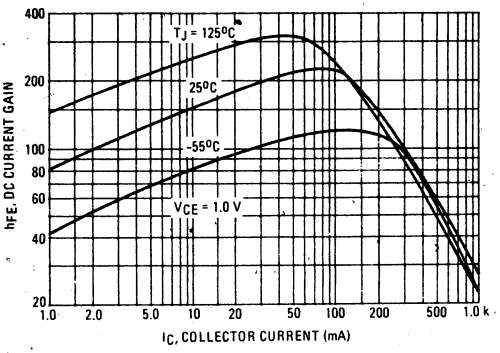


FIGURE 4 – "ON" VOLTAGE

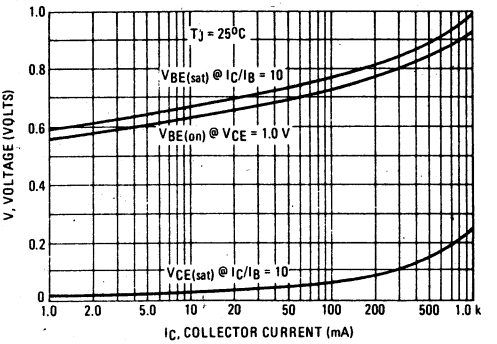


FIGURE 5 – COLLECTOR SATURATION REGION

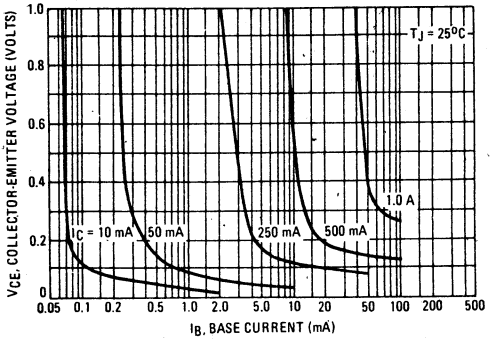


FIGURE 6 – TEMPERATURE COEFFICIENTS

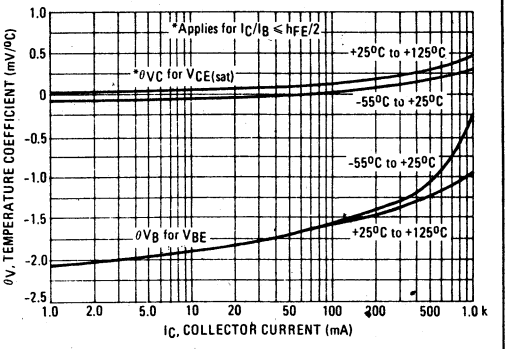


FIGURE 7 – COLLECTOR CHARACTERISTICS

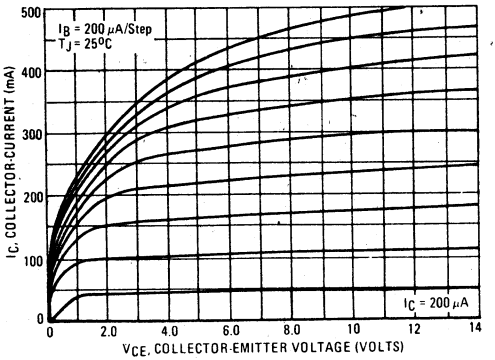
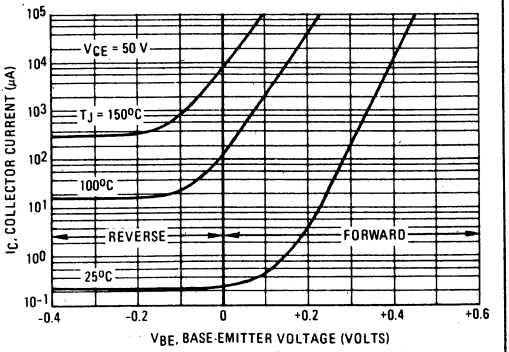


FIGURE 8 – COLLECTOR CUTOFF REGION



TYPICAL CHARACTERISTICS (continued)

FIGURE 9 – THERMAL RESPONSE

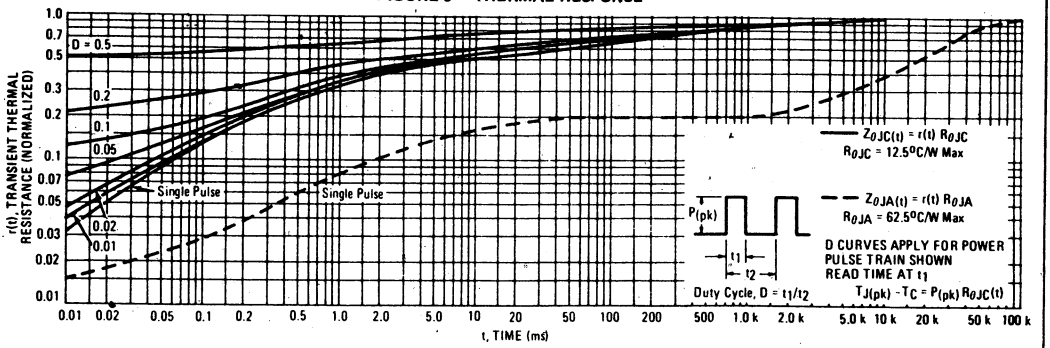
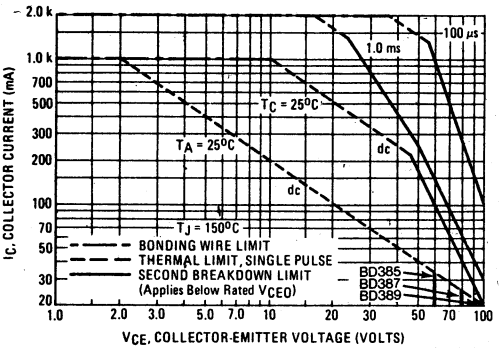


FIGURE 10 – ACTIVE-REGION SAFE-OPERATING AREA

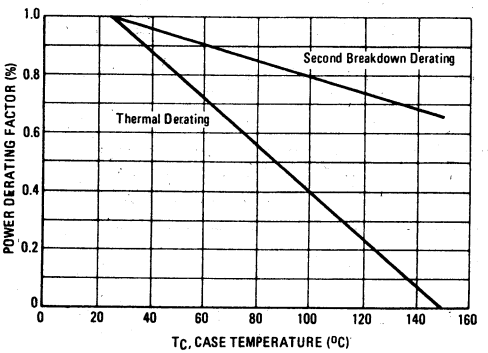


There are two limitations on the power handling ability of a transistor: average junction temperature and second breakdown. Safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The data of Figure 10 is based on $T_C = 25^{\circ}C$; $T_{J(pk)}$ is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% but must be derated when $T_C \geq 25^{\circ}C$. Second breakdown limitations do not derate the same as thermal limitations. Allowable current at the voltages shown on Figure 10 may be found at any case temperature by using the appropriate curve on Figure 11.

$T_{J(pk)}$ may be calculated from the data in Figure 9. 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 11 – POWER DERATING



BD386
BD388
BD390

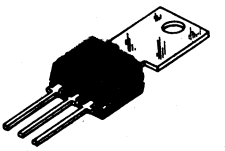
PNP SILICON ANNULAR◆ AMPLIFIER TRANSISTORS

. . . designed for general-purpose, medium-voltage, medium power amplifier and driver applications; series, shunt and switching regulators, and low and high frequency inverters and converters.

- High Collector-Emitter Breakdown Voltage – BV_{CEO} = 100 Vdc (Min) @ I_C = 1.0 mAdc – BD390
- Duowatt Package – 2 Watts Free Air Dissipation @ T_A = 25°C
- Complements to NPN BD385/BD387/BD389

DUOWATT

PNP SILICON AMPLIFIER TRANSISTORS

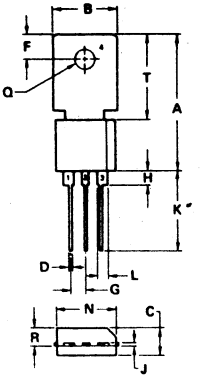


MAXIMUM RATINGS

Rating	Symbol	BD386	BD388	BD390	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	100	Vdc
Collector-Base Voltage	V_{CBO}	60	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current – Continuous Peak	I_C	1.0 2.0			Adc
Base Current	I_B	100			mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	2.0 16			Watts mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	10 80			Watts mW/°C
Operating and Storage Junction Temperature Range	T_J,T_{stg}	−55 to +150			°C
Solder Temperature, 1/16" from Case for 10 Seconds	–	260			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12.5	°C/W



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

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	21.84	22.35	0.860	0.880
B	9.91	10.41	0.390	0.410
C	4.39	4.65	0.173	0.183
D	0.58	0.74	0.023	0.029
F	3.56	4.06	0.140	0.160
G	2.41	2.67	0.095	0.105
H	1.70	1.96	0.067	0.077
J	0.48	0.66	0.019	0.026
K	12.19	12.95	0.480	0.510
L	1.65	2.03	0.065	0.080
N	9.91	10.16	0.390	0.400
Q	3.56	3.81	0.140	0.150
R	1.07	1.75	0.042	0.069
T	7.87	9.14	0.310	0.360

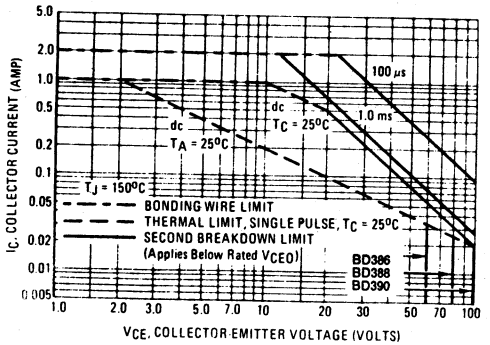
CASE 306-04

***ELECTRICAL CHARACTERISTICS** (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)		BV_{CEO}			Vdc
	BD386		60	–	
	BD388		80	–	
	BD390		100	–	
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)		BV_{CBO}			Vdc
	BD386		60	–	
	BD388		80	–	
	BD390		100	–	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		BV_{EBO}	5.0	–	Vdc
Collector Cutoff Current		I_{CBO}			nAdc
(V_{CB} = 40 Vdc, I_E = 0)	BD386		–	100	
(V_{CB} = 60 Vdc, I_E = 0)	BD388		–	100	
(V_{CB} = 80 Vdc, I_E = 0)	BD390		–	100	
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	–	100	nAdc
ON CHARACTERISTICS (1)					
DC Current Gain		h_{FE}			
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			60	–	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)			80	300	
(I_C = 250 mAdc, V_{CE} = 1.0 Vdc)			60	–	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)			25	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 250 mAdc, I_B = 10 mAdc)			–	0.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)			–	1.0	
Base-Emitter On Voltage (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	–	1.2	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain – Bandwidth Product (I_C = 100 mAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	75	350	MHz
Collector-Base Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}		18	pF

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

TYPICAL CHARACTERISTICS



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 1 is based on $T_{J(pk)}$ = 150°C; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 6. 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-415A).

FIGURE 1 – ACTIVE-REGION SAFE-OPERATING AREA

TYPICAL CHARACTERISTICS (continued)

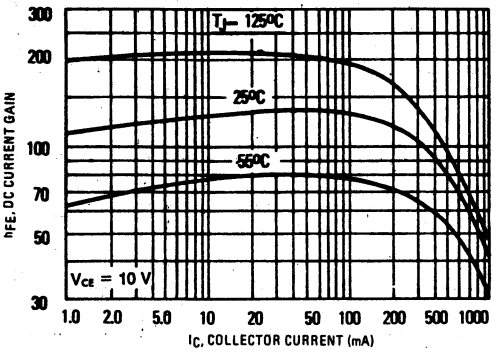


FIGURE 2 – DC CURRENT GAIN

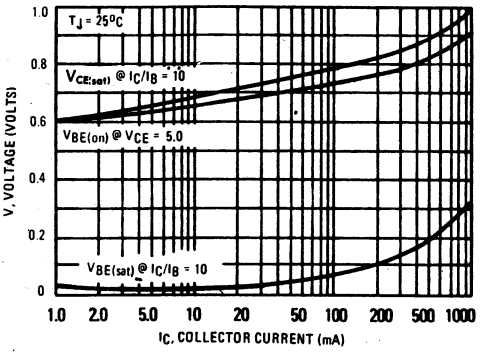


FIGURE 3 – "ON" VOLTAGES

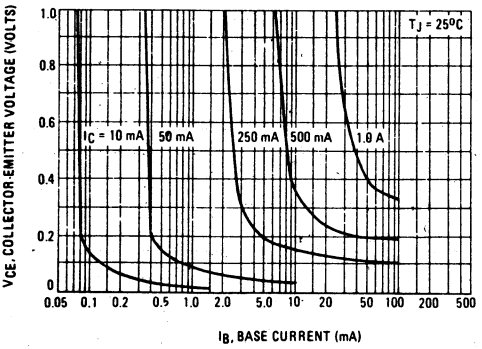


FIGURE 4 – COLLECTOR SATURATION REGION

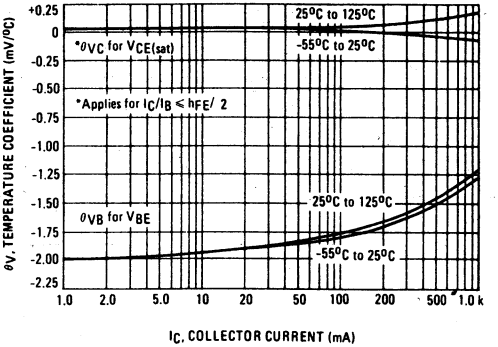


FIGURE 5 – TEMPERATURE COEFFICIENTS

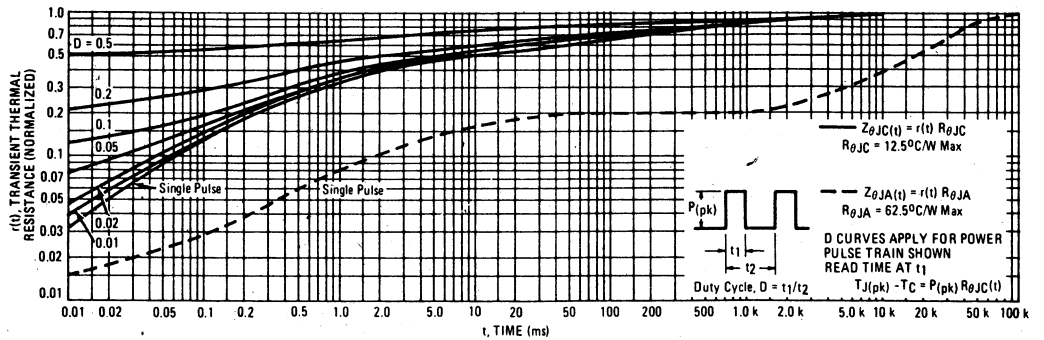


FIGURE 6 – THERMAL RESPONSE

TYPICAL CHARACTERISTICS (continued)

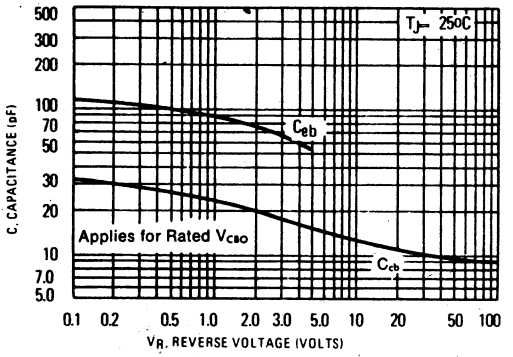


FIGURE 7 – CAPACITANCE

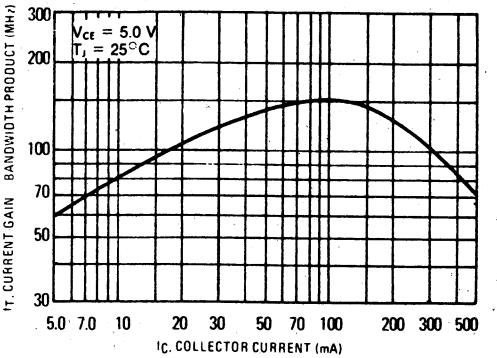


FIGURE 8 – CURRENT-GAIN – BANDWIDTH PRODUCT

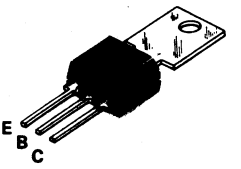
BD411
BD412

NPN SILICON DARLINGTON AMPLIEIER TRANSISTORS

. . . designed for amplifier and driver applications where high gain is an essential requirement, low power lamp and relay drivers and power drivers for high-current applications such as voltage regulators.

- High DC Current Gain –
  h_{FE} = 25,000 (Min) @ I_C = 200 mAdc – BD 411
  = 15,000 (Min) @ I_C = 500 mAdc – BD 411
- Collector-Emitter Breakdown Voltage –
  BV_{CES} = 40 Vdc (Min) @ I_C = 100 μAdc
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 1.5 Vdc (Max) @ I_C = 1.0 Adc
- Duowatt Package –
  2 Watts Free Air Dissipation @ T_A = 25°C
- Complements to PNP BD 413/414

NPN SILICON DARLINGTON AMPLIFIER TRANSISTORS

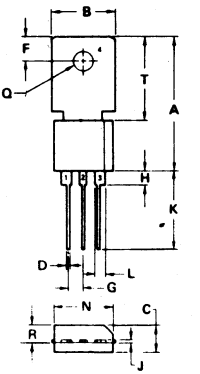


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
*Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Emitter Voltage	V_{CES}	40	Vdc
*Collector-Base Voltage	V_{CBO}	50	Vdc
*Emitter-Base Voltage	V_{EBO}	12	Vdc
*Collector Current – Continuous	I_C	2.0	Adc
*Base Current – Continuous	I_B	100	mAdc
*Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	2.0 16	Watts mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	10 80	Watts mW/°C
*Operating and Storage Junction Temperature Range	T_J,T_{stg}	-55 to +150	°C
*Solder Temperature, 1/16" from Case for 10 Seconds	–	260	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12.5	°C/W



STYLE 1
PIN 1 EMITTER
2 BASE
3 COLLECTOR
4 COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	21.84	22.35	0.860	0.880
B	9.91	10.41	0.390	0.410
C	4.39	4.65	0.173	0.183
D	0.58	0.74	0.023	0.029
F	3.56	4.06	0.140	0.160
G	2.41	2.67	0.095	0.105
H	1.70	1.96	0.067	0.077
J	0.48	0.66	0.019	0.026
K	12.19	12.95	0.480	0.510
L	1.65	2.03	0.065	0.080
N	9.91	10.16	0.390	0.400
Q	3.56	3.81	0.140	0.150
R	1.07	1.75	0.042	0.069
T	7.87	9.14	0.310	0.360

CASE 306-04

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

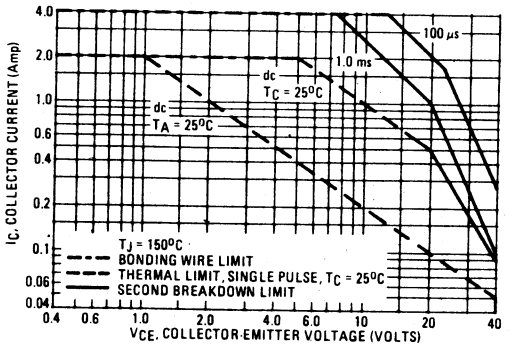
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 100 μAdc, V_{BE} = 0)	BV_{CES}	40	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BV_{CBO}	50	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	BV_{EBO}	12	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	100	nAdc
Emitter Cutoff Current (V_{EB} = 10 Vdc, I_C = 0)	I_{EBO}	–	100	nAdc
ON CHARACTERISTICS (1)				
DC Current Gain	h_{FE}			–
(I_C = 200 mAdc, V_{CE} = 5.0 Vdc) BD411		25,000	150,000	
BD412		15,000	150,000	
(I_C = 500 mAdc, V_{CE} = 5.0 Vdc) BD411		15,000	–	
BD412		10,000	–	
(I_C = 1.0 Adc, V_{CE} = 5.0 Vdc) BD411		5,000	–	
BD412		3,000	–	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = 1.0 Adc, I_B = 2.0 mAdc)		–	1.5	
(I_C = 2.0 Adc, I_B = 4.0 mAdc)		–	2.0	
Base-Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 2.0 mAdc)	$V_{BE(sat)}$	–	2.0	Vdc
Base-Emitter On Voltage (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	–	2.0	Vdc
DYNAMIC CHARACTERISTICS				
High Frequency Current Gain (I_C = 200 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	$\|h_{fe}\|$	1.0	–	–
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	7.0	pF
Small-Signal Current Gain	h_{fe}			–
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) BD411		20,000	–	
BD412		15,000	–	

* Indicates JEDEC Registered Data

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

TYPICAL CHARACTERISTICS

FIGURE 1 – 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 1 is based on $T_{J(pk)}$ = 150°C; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 6. 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-415A).

TYPICAL CHARACTERISTICS (continued)

FIGURE 2 – DC CURRENT GAIN

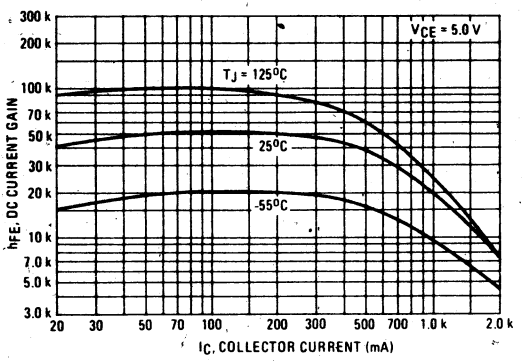


FIGURE 3 – "ON" VOLTAGES

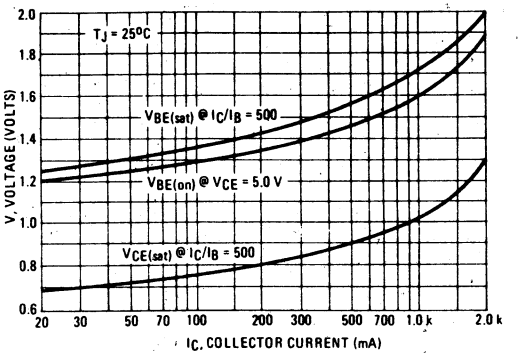


FIGURE 4 – COLLECTOR SATURATION REGION

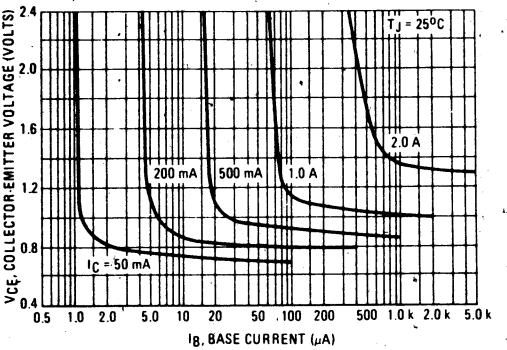


FIGURE 5 – TEMPERATURE COEFFICIENT

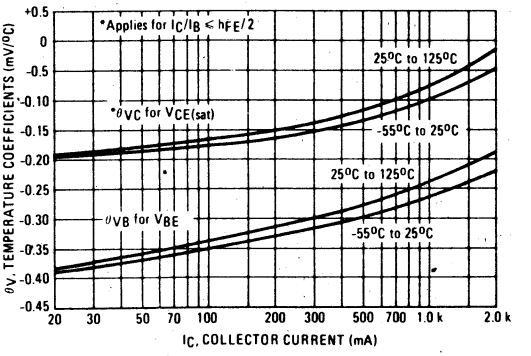
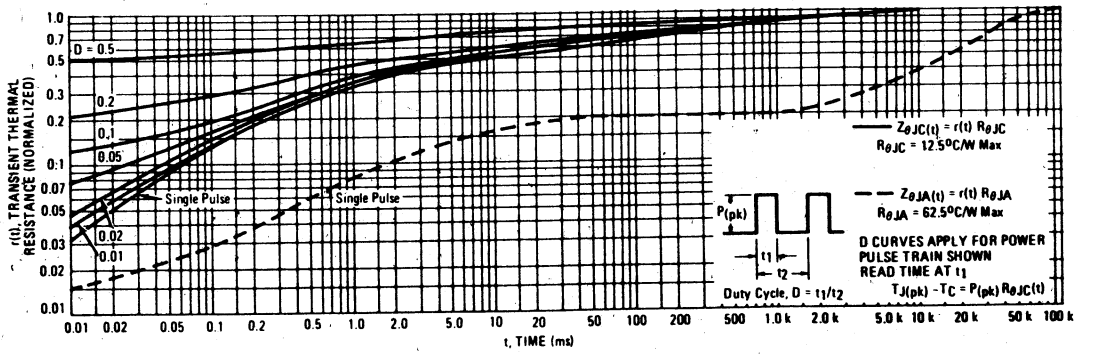


FIGURE 6 – THERMAL RESPONSE



TYPICAL CHARACTERISTICS (continued)

FIGURE 7 – CAPACITANCE

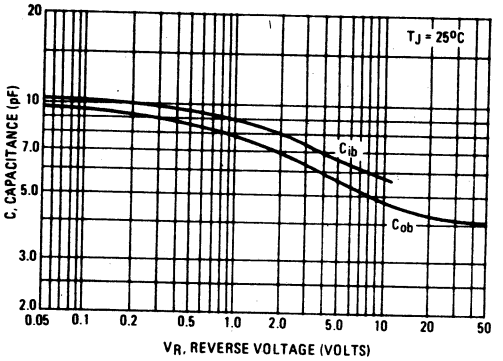
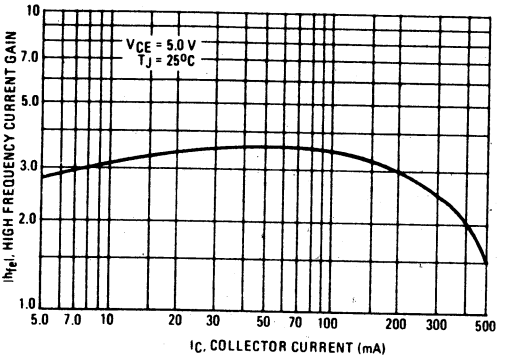


FIGURE 8 – HIGH-FREQUENCY CURRENT GAIN



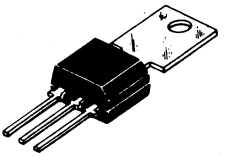
BD413
BD414

PNP SILICON DARLINGTON AMPLIFIER TRANSISTORS

. . . designed for amplifier and driver applications where high gain is an essential requirement, low power lamp and relay drivers and power drivers for high-current applications such as voltage regulators.

- High DC Current Gain –
  h_{FE} = 20,000 (Min) @ I_C = 200 mAdc – BD413
  = 15,000 (Min) @ I_C = 500 mAdc – BD414
- Collector-Emitter Breakdown Voltage –
  BV_{CES} = 40 Vdc (Min) @ I_C = 100 μAdc
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 1.5 Vdc (Max) @ I_C = 1.0 Adc
- Duowatt Package –
  2 Watts Free Air Dissipation @ T_A = 25°C
- Complements to NPN BD411/412

PNP SILICON DARLINGTON AMPLIFIER TRANSISTORS



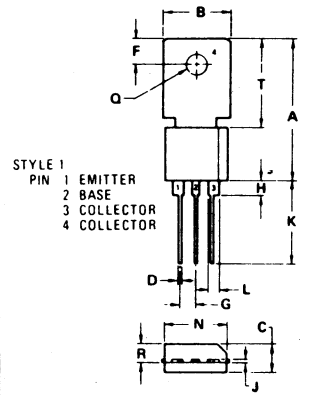
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
*Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Emitter Voltage	V_{CES}	40	Vdc
*Collector-Base Voltage	V_{CBO}	50	Vdc
*Emitter-Base Voltage	V_{EBO}	12	Vdc
*Collector Current – Continuous	I_C	2.0	Adc
*Base Current – Continuous	I_B	100	mAdc
*Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	2.0 16	Watts mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	10 80	Watts mW/°C
*Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C
*Solder Temperature, 1/16" from Case for 10 Seconds	–	260	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12.5	°C/W

*Indicates JEDEC Registered Data.



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	21.84	22.35	0.860	0.880
B	9.91	10.41	0.390	0.410
C	4.39	4.65	0.173	0.183
D	0.58	0.74	0.023	0.029
F	3.56	4.06	0.140	0.160
G	2.41	2.67	0.095	0.105
H	1.70	1.96	0.067	0.077
J	0.48	0.66	0.019	0.026
K	12.19	12.95	0.480	0.510
L	1.65	2.03	0.065	0.080
N	9.91	10.16	0.390	0.400
Q	3.56	3.81	0.140	0.150
R	1.07	1.75	0.042	0.069
T	7.87	9.14	0.310	0.360

CASE 306-04

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

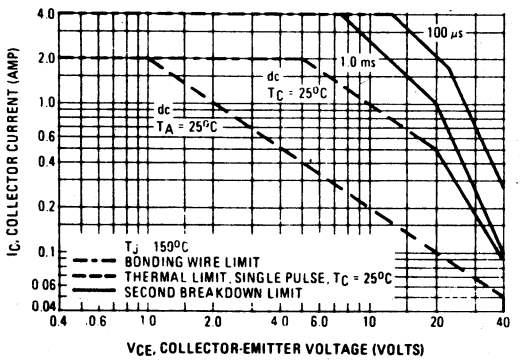
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 100 μAdc, V_{BE} = 0)		BV_{CES}	40	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)		BV_{CBO}	50	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		BV_{EBO}	12	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	–	100	nAdc
Emitter Cutoff Current (V_{EB} = 10 Vdc I_C = 0)		I_{EBO}	–	100	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			–
(I_C = 200 mAdc, V_{CE} = 5.0 Vdc)	BD413		20,000	150,000	
	BD414		15,000	150,000	
(I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	BD413		15,000	–	
	BD414		10,000	–	
(I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	BD413		5,000	–	
	BD414		3,000	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 1.0 Adc, I_B = 2.0 mAdc)			–	1.5	
(I_C = 2.0 Adc, I_B = 4.0 mAdc)			–	2.0	
Base-Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 2.0 mAdc)		$V_{BE(sat)}$	–	2.0	Vdc
Base-Emitter On Voltage (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	–	2.0	Vdc
DYNAMIC CHARACTERISTICS					
High Frequency Current Gain (I_C = 200 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		h_{fe}	0.5		–
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	–	12	pF
Small-Signal Current Gain (I_C = 50 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	BD413	h_{fe}	20,000		
	BD414		15,000		

* Indicates JEDEC Registered Data

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

TYPICAL CHARACTERISTICS

FIGURE 1 – 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 1 is based on $T_{J(pk)}$ = 150°C; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 6. 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-415A).

TYPICAL CHARACTERISTICS (continued)

FIGURE 2 – DC CURRENT GAIN

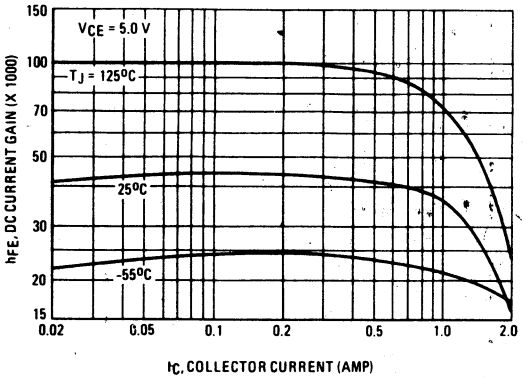


FIGURE 3 – "ON" VOLTAGES

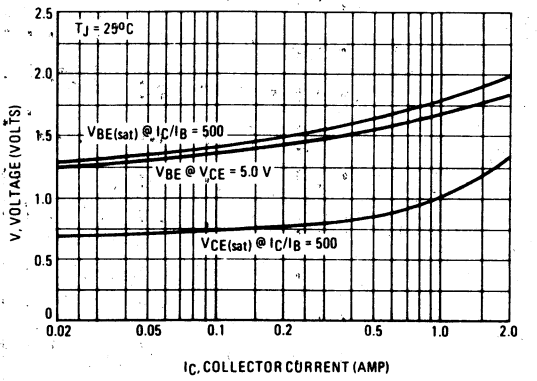


FIGURE 4 – COLLECTOR SATURATION REGION

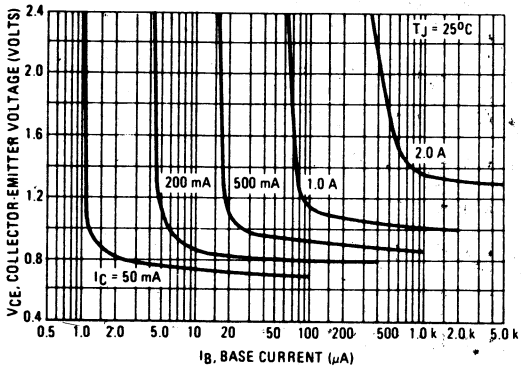


FIGURE 5 – TEMPERATURE COEFFICIENT

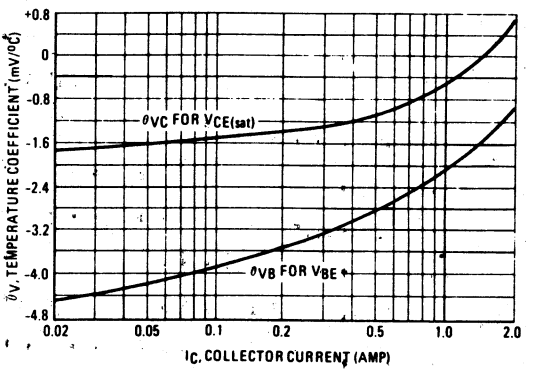
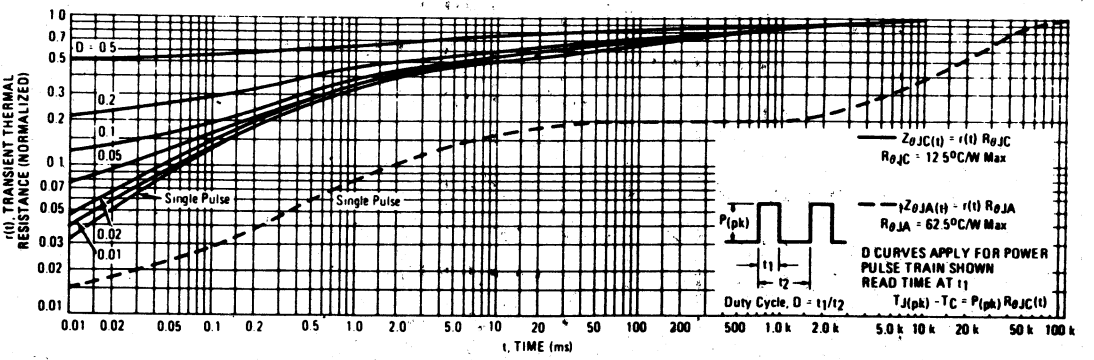


FIGURE 6 – THERMAL RESPONSE



TYPICAL CHARACTERISTICS (continued)

FIGURE 7 – CAPACITANCE

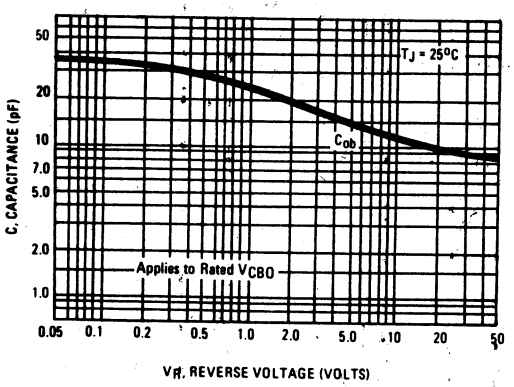
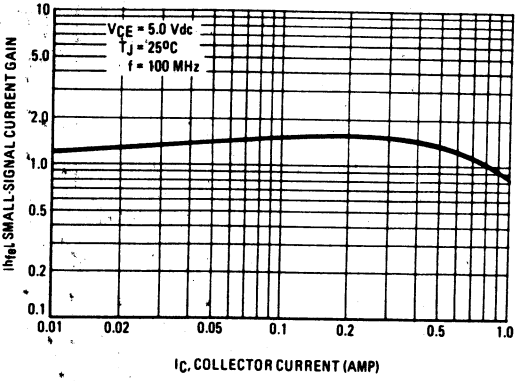


FIGURE 8 – HIGH-FREQUENCY CURRENT GAIN



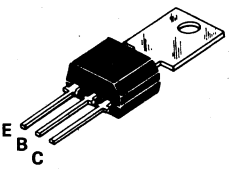
BD415
BD417
BD419

NPN SILICON ANNULAR♦ AMPLIFIER TRANSISTORS

. . . designed for general-purpose, medium-voltage, medium power amplifier and driver applications; series, shunt and switching regulators, and low and high frequency inverters and converters.

- High Collector-Emitter Breakdown Voltage – BV_{CEO} = 100 Vdc (Min) @ I_C = 1.0 mAdc – BD419
- Duowatt Package – 2 Watts Free Air Dissipation @ $T_A = 25^oC$
- Complements to PNP BD416/BD418/BD420

NPN SILICON AMPLIFIER TRANSISTORS

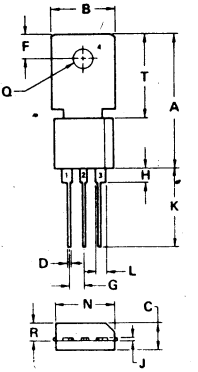


MAXIMUM RATINGS

Rating	Symbol	BD415	BD417	BD419	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	100	Vdc
Collector-Base Voltage	V_{CBO}	60	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current – Continuous	I_C	1.0			Adc
Peak		2.0			
Base Current	I_B	100			mAdc
Total Power Dissipation @ $T_A = 25^oC$	P_D	2.0			Watts
Derate above 25^oC		16			$mW/^oC$
Total Power Dissipation @ $T_C = 25^oC$	P_D	10			Watts
Derate above 25^oC		80			$mW/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			^oC
Solder Temperature, 1/16" from Case for 10 Seconds	–	260			^oC

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	$^oC/W$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12.5	$^oC/W$



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

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	21.84	22.35	0.860	0.880
B	9.91	10.41	0.390	0.410
C	4.39	4.65	0.173	0.183
D	0.58	0.74	0.023	0.029
F	3.56	4.06	0.140	0.160
G	2.41	2.67	0.095	0.105
H	1.70	1.96	0.067	0.077
J	0.48	0.66	0.019	0.026
K	12.19	12.95	0.480	0.510
L	1.65	2.03	0.065	0.080
N	9.91	10.16	0.390	0.400
Q	3.56	3.81	0.140	0.150
R	1.07	1.75	0.042	0.069
T	7.87	9.14	0.310	0.360

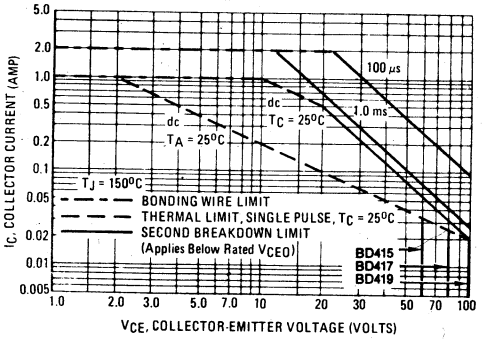
CASE 306-04

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BD415	BV_{CEO}	60	–	Vdc
	BD417		80	–	
	BD419		100	–	
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	BD415	BV_{CBO}	60	–	Vdc
	BD417		80	–	
	BD419		100	–	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		BV_{EBO}	5.0	–	Vdc
Collector Cutoff Current		I_{CBO}			nAdc
(V_{CB} = 40 Vdc, I_E = 0)	BD415		–	100	
(V_{CB} = 60 Vdc, I_E = 0)	BD417		–	100	
(V_{CB} = 80 Vdc, I_E = 0)	BD419		–	100	
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	–	100	nAdc
ON CHARACTERISTICS (1)					
DC Current Gain		h_{FE}			–
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			60	–	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)			80	300	
(I_C = 250 mAdc, V_{CE} = 1.0 Vdc)			60	–	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)			25	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 250 mAdc, I_B = 10 mAdc)			–	0.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)			–	1.0	
Base-Emitter On Voltage (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	–	1.2	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain – Bandwidth Product (I_C = 100 mAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	75	350	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	–	12	pF

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

TYPICAL CHARACTERISTICS



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 1 is based on $T_{J(pk)}$ = 150°C; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 6. 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-415A).

FIGURE 1 – ACTIVE-REGION SAFE-OPERATING AREA

TYPICAL CHARACTERISTICS (continued)

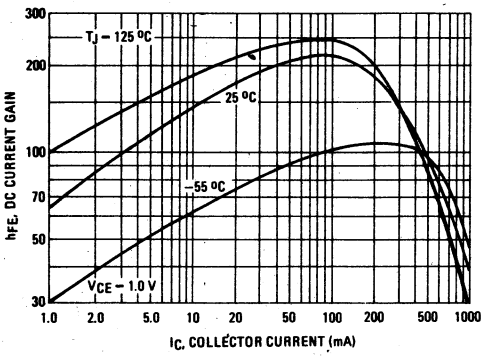


FIGURE 2 – DC CURRENT GAIN

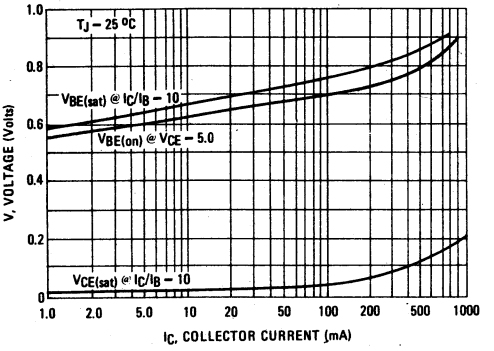


FIGURE 3 – "ON" VOLTAGES

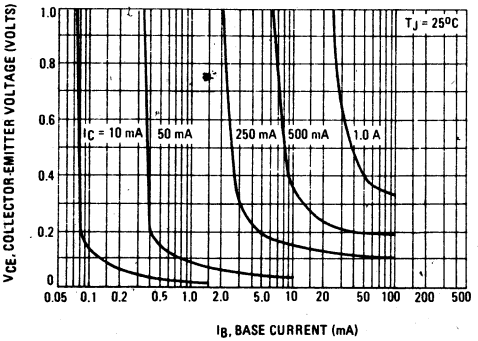


FIGURE 4 – COLLECTOR SATURATION REGION

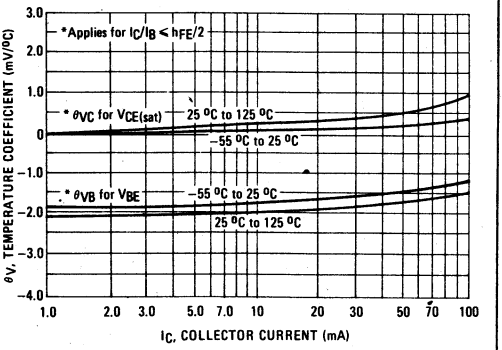


FIGURE 5 – TEMPERATURE COEFFICIENTS

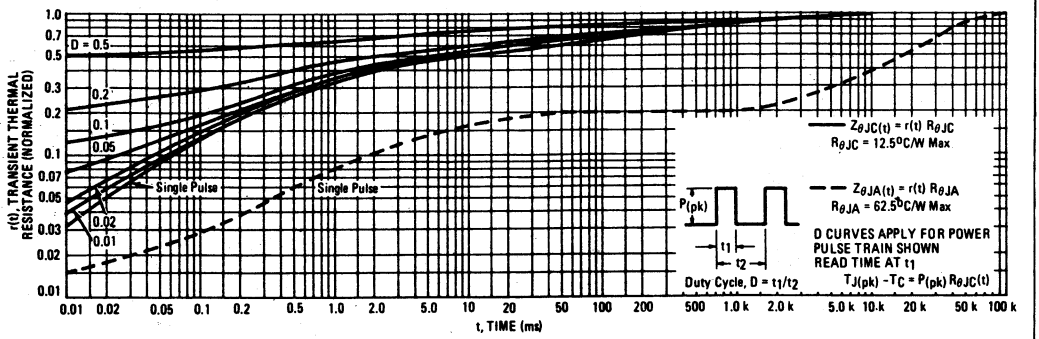


FIGURE 6 – THERMAL RESPONSE

TYPICAL CHARACTERISTICS (continued)

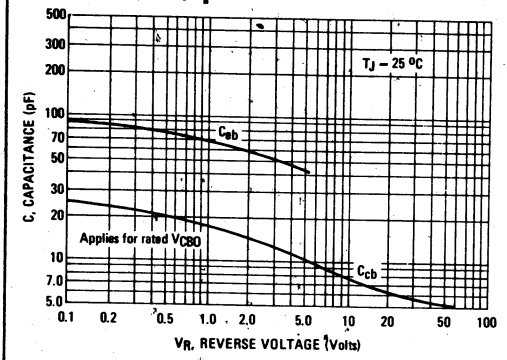


FIGURE 7 – CAPACITANCE

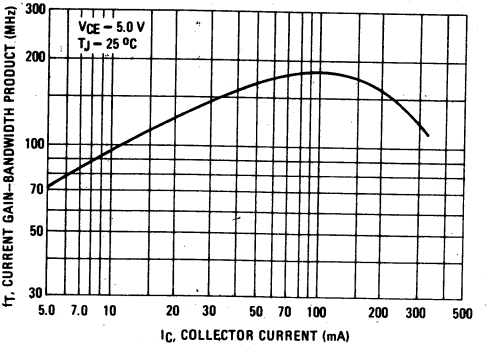


FIGURE 8 – CURRENT-GAIN – BANDWIDTH PRODUCT

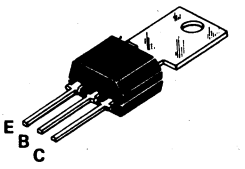
BD416
BD418
BD420

PNP SILICON ANNULAR♦ AMPLIFIER TRANSISTORS

. . . designed for general-purpose, medium-voltage, medium power amplifier and driver applications; series, shunt and switching regulators, and low and high frequency inverters and converters.

- High Collector-Emitter Breakdown Voltage — BV_{CEO} = 100 Vdc (Min) @ I_C = 1.0 mAdc - **BD420**
- Duowatt Package — 2 Watts Free Air Dissipation @ T_A = 25°C
- Complements to NPN BD415/BD417/BD419

PNP SILICON AMPLIFIER TRANSISTORS

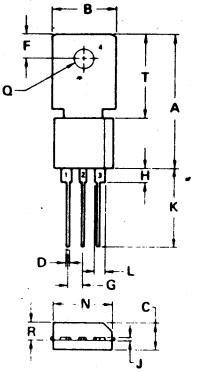


MAXIMUM RATINGS

Rating	Symbol	BD416	BD418	BD420	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	100	Vdc
Collector-Base Voltage	V_{CBO}	60	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current — Continuous Peak	I_C	1.0 2.0			Adc
Base Current	I_B	100			mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	2.0 16			Watts mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	10 80			Watts mW/°C
Operating and Storage Junction Temperature Range	T_J,T_{stg}	−55 to +150			°C
Solder Temperature, 1/16" from Case for 10 Seconds	—	260			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12.5	°C/W



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

DIM	MILLIMETERS MIN	MAX	INCHES MIN	MAX
A	21.84	22.35	0.860	0.880
B	9.91	10.41	0.390	0.410
C	4.39	4.65	0.173	0.183
D	0.58	0.74	0.023	0.029
F	3.56	4.06	0.140	0.160
G	2.41	2.67	0.095	0.105
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J	0.48	0.66	0.019	0.026
K	12.19	12.95	0.480	0.510
L	1.65	2.03	0.065	0.080
N	9.91	10.16	0.390	0.400
Q	3.56	3.81	0.140	0.150
R	1.07	1.75	0.042	0.069
T	7.87	9.14	0.310	0.360

CASE 396-04

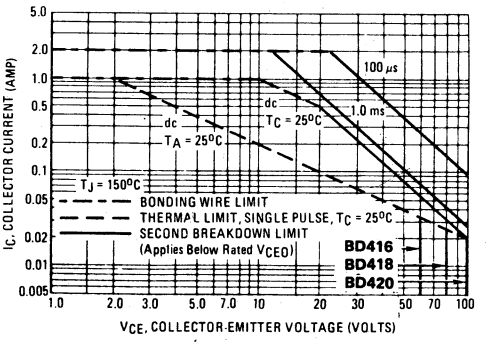
*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		BV_{CEO}			Vdc
(I_C = 1.0 mAdc, I_B = 0)	BD416		60	–	
	BD418		80	–	
	BD420		100	–	
Collector-Base Breakdown Voltage		BV_{CBO}			Vdc
(I_C = 100 μAdc, I_E = 0)	BD416		60	–	
	BD418		80	–	
	BD420		100	–	
Emitter-Base Breakdown Voltage		BV_{EBO}	5.0	–	Vdc
(I_E = 100 μAdc, I_C = 0)					
Collector Cutoff Current		I_{CBO}			nAdc
(V_{CB} = 40 Vdc, I_E = 0)	BD416		–	100	
(V_{CB} = 60 Vdc, I_E = 0)	BD418		–	100	
(V_{CB} = 80 Vdc, I_E = 0)	BD420		–	100	
Emitter Cutoff Current		I_{EBO}	–	100	nAdc
(V_{EB} = 4.0 Vdc, I_C = 0)					
ON CHARACTERISTICS (1)					
DC Current Gain		h_{FE}			–
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			60	–	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)			80	300	
(I_C = 250 mAdc, V_{CE} = 1.0 Vdc)			60	–	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)			25	–	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 250 mAdc, I_B = 10 mAdc)			–	0.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)			–	1.0	
Base-Emitter On Voltage		$V_{BE(on)}$	–	1.2	Vdc
(I_C = 250 mAdc, V_{CE} = 5.0 Vdc)					
DYNAMIC CHARACTERISTICS					
Current-Gain – Bandwidth Product		f_T	75	350	MHz
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)					
Collector-Base Capacitance		C_{cb}	–	18	pF
(V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)					

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

TYPICAL CHARACTERISTICS

FIGURE 1 – 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 1 is based on $T_{J(pk)}$ = 150°C; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 6. 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-415A).

TYPICAL CHARACTERISTICS (continued)

FIGURE 2 – DC CURRENT GAIN

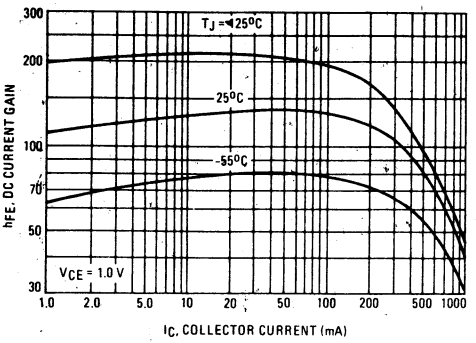


FIGURE 3 – "ON" VOLTAGE

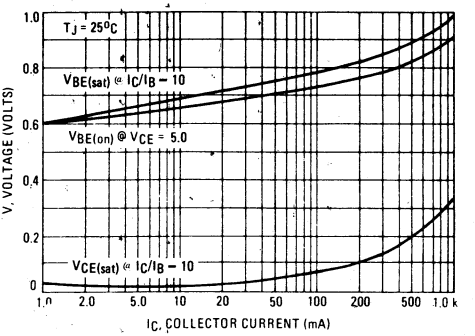


FIGURE 4 – COLLECTOR SATURATION REGION

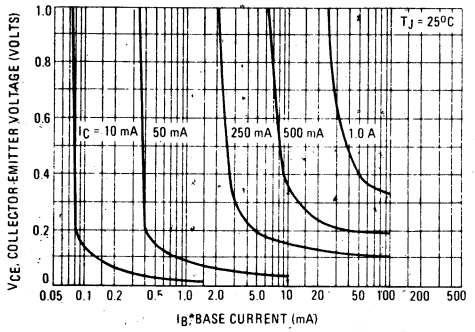


FIGURE 5 – TEMPERATURE COEFFICIENT

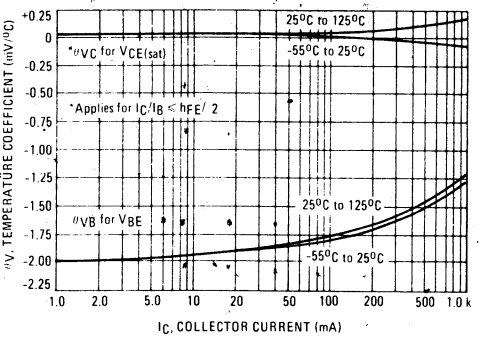


FIGURE 6 – THERMAL RESPONSE