ALPHANUMERIC INDEX — CROSS-REFERENCE (Continued)

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BDX33	BDX33		3-334
BDX33A	BDX33A		3-334
BDX33B	BDX33B		3-334
BDX33C	BDX33C		3-334
BDX33D	BDX33D		3-334
BDX34	BDX34		3-334
BDX34A	BDX34A		3-334
BDX34B	BDX34B		3-334
BDX34C	BDX34C		3-334
BDX34D	BDX34D		3-334
BDX35	TIP42C		3-1083
BDX36	TIP42D		3-1083
BDX37	TIP42D		3-1083
BDX42	BD775		—
BDX43	BD777		3-302
BDX44	BD779		3-302
BDX45	BD776		3-302
BDX46	BD778		3-302
BDX47	BD779		3-302
BDX53	BDX53		3-338
BDX53A	BDX53A		3-338
BDX53B	BDX53B		3-338
BDX53C	BDX53C		3-338
BDX53D	BDX53D		3-338
BDX54	BDX54		3-338
BDX54A	BDX54A		3-338
BDX54B	BDX54B		3-338
BDX54C	BDX54C		3-338
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BDX70		2N6487	3-207
BDX71		2N6487	3-207
BDX72		2N6488	3-207
BDX73		2N6488	3-207
BDX74		2N6486	3-207
BDX75		2N6486	3-207
BDX77	BD799		3-312
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BDX94	2N3792		3-56
BDX95		2N5882	3-123
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BDY29	2N5303		3-93
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Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number
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BDY94/01	BU326A		3-363
BDY96	BUX47		3-499
BDY96-1	BUX47		3-499
BDY96/01	BUX47		3-499
BDY97	BUX47		3-499
BDY97-1	BUX47		3-499
BF380	MPS-U10		3-1052
BF380-5	MPS-U10		3-1052
BF381	MPS-U10		3-1052
BF382	MPS-U10		3-1052
BF382-5	MPS-U10		3-1052
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BU105		MJ12003	3-642
BU108	BU208		3-343
BU109P	BU407		3-366
BU124	BU426		3-368
BU126		MJE13005	3-944
BU126A		MJE13005	3-944
BU134	MJ423		3-524
BU137		MJ10025	3-623
BU157		MJ10025	3-623
BU180		MJE5741	3-914
BU180A		MJE5742	3-914
BU204	BU207		3-343
BU205	BU208		3-343
BU205A		MJ12003	3-642
BU207	BU207		3-343
BU208	BU208		3-343
BU208A	BU208A		3-348
BU208D	BU208D		3-353
BU221	BU326A		3-363
BU222	BU326A		3-363
BU223	MJ431		3-524
BU223A	MJ431		3-524
BU322	BU323		3-355
BU322A	BU323A		3-355
BU323	BU323A		3-355
BU323A	BU323A		3-355
BU323AP	BU323AP		3-359
BU323P	BU323P		3-359
BU326	BU326A		3-363
BU326A	BU326A		3-363
BU406	BU406		3-366
BU406D	BU406D		3-366
BU407	BU407		3-366
BU407D	BU407D		3-366
BU426	BU426		3-368
BU426A	BU426A		3-368
BU433	BU426		3-368
BU500		MJ12005	3-650
BU508	BU508		3-372
BU508A	BU508A		3-372
BU508AD	BU508AD		3-372
BU508D	BU508D		3-372
BU522	BU522		3-377
BU522A	BU522A		3-377
BU522B	BU522B		3-377

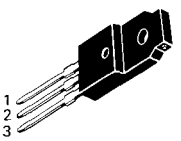
*Consult Motorola if a direct replacement is necessary.

TABLE 5 — PLASTIC TO-220 (continued)

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	Device Type PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s μs Max	Resistive Switching t_f μs Max	Resistive Switching @ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
10	60	D44H7	D45H7	20 min	4					50
		D44H8	D45H8	40 min	4					50
			D45H9	40 min	4					50
		MJE2801T		25/100	3					75
		MJE3055T	MJE2955T	20/70	4					75
		2N6387##	2N6667##	1k/20k	5				20#	65
		SE9300##	SE9400##	1k min	4				1#	70
	80	BDX33B##	BDX34B##	750 min	3				3	70
		BD809	BD810	15 min	4				1.5	90
		D44E3##		1000 min	5	2 typ	0.5 typ	10		50
			D45H12	40 min	4					50
		2N6388##	2N6668##	1k/20k	5				20#	65
		D44H10	D45H10	20 min	4	0.5 typ	0.14 typ	5	50 typ	50
		D44H11	D45H11	40 min	4	0.5 typ	0.14 typ	5	50 typ	50
		SE9301##	SE9401##	1k min	4				1#	70
	100	BDX33C##	BDX34C##	750 min	3				3	70
		SE9302##	SE9402##	1k min	4				1#	70
12	300	MJE13008		6/30	8	3	0.7	8	4	100
	400	MJE13009		6/30	8	3	0.7	8	4	100
15	30	D44VH1	D45VH1	20 min	4	0.7	0.09	8	50 typ	83
	40	2N6486	2N6489	20/150	5	0.6 typ	0.3 typ	5	5	75
	45	BDW39	BDW44	1 k min	5	1 typ	1.5 typ	5	4	85
		D44VH4	D45VH4	20 min	4	0.5	0.09	8	50 typ	83
	60	2N6487	2N6490	20/150	5	0.6 typ	0.3 typ	5	5	75
		BDW40	BDW45	1 k min	5	1 typ	1.5 typ	5	4	85
		D44VH7		20 min	4	0.5	0.09	8	50 typ	85
	80	2N6488	2N6491	20/150	5	0.6 typ	0.3 typ	5	5	75
		BDW41	BDW46	1 k min	5	1 typ	1.5 typ	5	4	85
		D44VH10	D45VH10	20 min	4	0.5	0.09	8	50 typ	83
	100	BDW42	BDW47	1 k min	5	1 typ	1.5 typ	5	4	85
	120	BDW43	BDW48	1 k min	5	1 typ	1.5 typ	5	4	85

$|h_{fe}|$ @ 1 MHz, ## Darlington

TABLE 6 — PLASTIC Full Pak (TO-220 Type)



CASE 221C-02

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	Device Type PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s μs Max	Resistive Switching t_f μs Max	Resistive Switching @ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
1	250	MJF47		30/150	0.3	2 typ	0.17 typ	0.3	10	28
5	100	MJF122##	MJF127##	2000 min	3	1.5 typ	1.5 typ	3	4#	28
8	80		MJF6107	30/90	2	0.5 typ	0.13 typ	2	4	35
	100	MJF102##	MJF107##	3000 min	3	1.5 typ	1.5 typ	3	4#	35
	150	MJF15030	MJF15031	40 min	3	1 typ	0.15 typ	3	30	35
10	60	MJF3055	MJF2955	20/100	4				2	40

$|h_{fe}|$ @ 1 MHz, ## Darlington

TABLE 12 — POWER DARLINGTONS (continued)

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	Device Type PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s μs Max	Resistive Switching t_f μs Max	Resistive Switching @ I_C Amp	$\|h_{fe}\|$ @ 1 MHz Min	P_D (Case) Watts @ 25°C	Case JEDEC/MOT
8	80	MJ1001	MJ901	1k min	3					90	TO-204/1
		TIP101	TIP106	1k/20k	3	1.5 typ	1.5 typ	3	4	80	TO-220/221A
		2N6044	2N6041	1k/10k	4	1.5 typ	1.5 typ	3	4	75	TO-220/221A
		2N6301	2N6299	750k/18k	4	1.5 typ	1.5 typ	4	4	75	TO-213A/80
		2N6056	2N6054	750k/18k	4	1.5 typ	1.5 typ	4	4	100	TO-204A/1
		MJE6044	MJE6041	1k/20k	4	1.5 typ	1.5 typ	4	2	75	TO-225AB/90
	100	BDX53C	BDX54C	750 min	3				4	60	TO-220/221A
		BD901	BD902	750 min	3				1	70	TO-220/221A
		MJE6045		1k/20k	4	1.5 typ	1.5 typ	4	2	75	TO-225AB/90
		MJD122	MJD127	1k/12k	4	1.5 typ	2 typ	4	4	20	TO-252/369A-04
		MJF102	MJF107	3k min	3	1.5 typ	1.5 typ	3	4	35	—/221C-02
		TIP102	TIP107	1k/20k	3	1.5 typ	1.5 typ	3	4	80	TO-220/221A
		2N6045	2N6042	1k/10k	4	1.5 typ	1.5 typ	3	4	75	TO-220/221A
	120	BDX53D	BDX54D	750 min	3				4	60	TO-220/221A
	150	BU807•		100 min	5	0.55 typ	0.2 typ	5		60	TO-220/221A
	200	BU806•		100 min	5	0.55 typ	0.2 typ	5		60	TO-220/221A
	300	MJE5740		200/400	4	8 typ	2 typ	6		80	TO-220/221A
	350	MJE5741		200/400	4	8 typ	2 typ	6		80	TO-220/221A
	400	MJE5742		200/400	4	8 typ	2 typ	6		80	TO-220/221A
	500	BUT50P•		30 min	2	0.75 typ	0.1 typ	5		100	TO-218/340D
	1400*	MJ10011		20 min	4			1	4	80	TO-204/1
10	40	2N6383	2N6648	1k/20k	5				20	100	TO-204/1
		D44E1		1000 min	5	2 typ	0.5 typ	10		50	TO-220/221A
	45	BDX33	BDX34	750 min	4				3	70	TO-220/221A
	60	BDV65	BDV64	1k min	5					125	TO-218/340D
		BDX33A	BDX34A	750 min	4				3	70	TO-220/221A
		MJ3000	MJ2500	1k min	5					150	TO-204/1
		2N6387	2N6667	1k/20k	5				20	65	TO-220/221A
		2N6384		1k/20k	5				20	100	TO-204/1
		D44E2		1000 min	5	2 typ	0.5 typ	10		50	TO-220/221A
		TIP140	TIP145	500 min	10	2.5 typ	2.5 typ	5	4	125	TO-218/340
	80	2N6388	2N6668	1k/20k	5				20	65	TO-220/221A
		2N6385		1k/20k	5				20	100	TO-204/1
		BDV65A	BDV64A	1k min	5					125	TO-218/340D
		BDX33B	BDX34B	750 min	3				3	70	TO-220/221A
		D44E3		1000 min	5	2 typ	0.5 typ	10		50	TO-220/221A
		MJD44E3		1k min	5	2 typ	0.5 typ	10		20	TO-252/369A-04
		TIP141	TIP146	500 min	10	2.5 typ	2.5 typ	5	4	125	TO-218/340
	100	BDV65B	BDV64B	1k min	5					125	TO-218/340D
		BDX33C	BDX34C	750 min	3				3	70	TO-220/221A
		TIP142	TIP147	500 min	10	2.5 typ	2.5 typ	5	4	125	TO-218/340
	120	BDV65C	BDV64C	1k min	5					125	TO-218/340D
		BDX33D	BDX34D	750 min	3				3	70	TO-220/221A
	200	BU323P		150 min	6	15	15	6		125	TO-218/340D
	250	BU323AP		150 min	6	15	15	6		125	TO-218/340D
	350	BU323		150 min	6	7.5 typ	5.2 typ	6		175	TO-204/1
		MJ10002		30/300	5	2.5	1	5	10	150	TO-204/1
		MJ10006•		30/300	5	1.5	0.5	5	10	150	TO-204/1
	400	BU323A		150 min	6	7.5 typ	5.2 typ	6		175	TO-204/1
		MJH10012		100/2k	6	15	15	6		118	TO-218/340
		MJ10007•		30/300	5	1.5	0.5	5	10	150	TO-204/1

• Darlington with speed-up diode.

(continued)

NPN	PNP
BDX33	BDX34
BDX33A	BDX34A
BDX33B	BDX34B
BDX33C	BDX34C

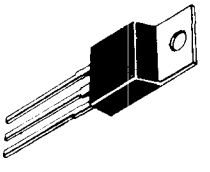
DARLINGTON COMPLEMENTARY SILICON POWER TRANSISTORS

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

- High DC Current Gain — h_{FE} = 2500 (typ.) at I_C = 4.0 Adc
- Collector-Emitter sustaining Voltage at 100 mAdc
  $V_{CEO(sus)}$ = 45 Vdc (min.) — BDX33, 34
  60 Vdc (min.) — BDX33A, 34A
  80 Vdc (min.) — BDX33B, 34B
  100 Vdc (min.) — BDX33C, 34C
- Low Collector-Emitter Saturation Voltage
  $V_{CE(sat)}$ = 2.5 Vdc (max.) at I_C = 4.0 Adc — BDX33, 33A/34, 34A
  2.5 Vdc (max.) at I_C = 3.0 Adc — BDX33B, 33C/34B, 34C
- Monolithic Construction with Built-In Base-Emitter Shunt resistors
- TO-220AB Compact Package
- TO-66 Lead form also available ordered with "-66" suffix.

DARLINGTON 10 AMPERE

COMPLEMENTARY SILICON
POWER TRANSISTORS
45-60-80-100 VOLTS
70 Watts



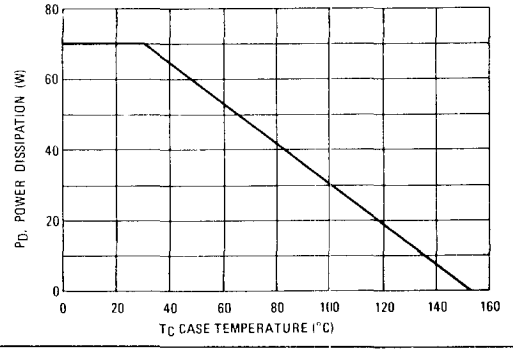
MAXIMUM RATINGS

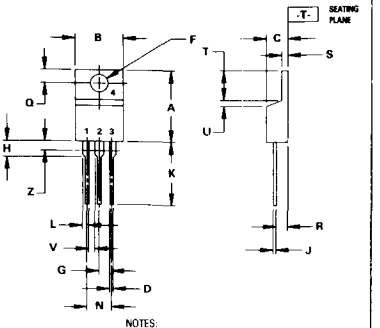
Rating	Symbol	BDX33 BDX34	BDX33A BDX34A	BDX33B BDX34B	BDX33C BDX34C	Unit
Collector-Emitter Voltage	V_{CEO}	45	60	80	100	Vdc
Collector-Base Voltage	V_{CB}	45	60	80	100	Vdc
Emitter-Base Voltage	V_{EB}	5.0				Vdc
Collector Current - Continuous Peak	I_C	10 15				Adc
Base Current	I_B	0.25				Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 70 0.56				Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max.	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.78	°C/W

FIGURE 1 — POWER DERATING





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

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	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

3

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

Characteristic		Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage[1] (I_C = 100 mAdc, I_B = 0)	BDX33/BDX34	$V_{CEO(sus)}$	45		Vdc
	BDX33A/BDX34A		60		
	BDX33B/BDX34B		80		
	BDX33C/BDX34C		100		
Collector-Emitter Sustaining Voltage[1] (I_C = 100 mAdc, I_B = 0, R_{BE} = 100)	BDX33/BDX34	$V_{CER(sus)}$	45		Vdc
	BDX33A/BDX34A		60		
	BDX33B/BDX34B		80		
	BDX33C/BDX34C		100		
Collector-Emitter Sustaining Voltage[1] (I_C = 100 mAdc, I_B = 0, V_{BE} = 1.5 Vdc)	BDX33/BDX34	$V_{CEX(sus)}$	45		Vdc
	BDX33A/BDX34A		60		
	BDX33B/BDX34B		80		
	BDX33C/BDX34C		100		
Collector Cutoff Current (V_{CE} = ½ rated V_{CEO}, I_B = 0)	T_C = 25 °C	I_{CEO}		0.5	mAdc
	T_C = 100 °C			10	
Collector Cutoff Current (V_{CB} = rated V_{CBO}, I_E = 0)	T_C = 25 °C	I_{CBO}		1	mAdc
	T_C = 100 °C			5	
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)		I_{EBO}		10	mAdc
ON CHARACTERISTICS					
DC Current Gain[1] (I_C = 4.0 Adc, V_{CE} = 3.0 Vdc)	BDX33, 33A/34, 34A	h_{FE}	750		–
(I_C = 3.0 Adc, V_{CE} = 3.0 Vdc)	BDX33B, 33C/34B, 34C		750		
Collector-Emitter Saturation Voltage (I_C = 4.0 Adc, I_B = 8 mAdc)	BDX33, 33A/34, 34A	$V_{CE(sat)}$		2.5	Vdc
(I_C = 3.0 Adc, I_B = 6 mAdc)	BDX33B, 33C/34B, 34C			2.5	
Base-Emitter On Voltage (I_C = 4.0 Adc, V_{CE} = 3 V)	BDX33, 33A/34, 34A	$V_{BE(on)}$		2.5	Vdc
(I_C = 3.0 Adc, V_{CE} = 3 Vdc)	BDX33B, 33C/34B, 34C			2.5	
Diode Forward Voltage (I_C = 8 Adc)		V_F		4	Vdc
SECOND BREAKDOWN[2]					
Second Breakdown Collector Current With Base Forward Biased		$I_{S/b}$			Adc
(V_{CE} = 25 Vdc)	BDX33 Series		2.8		
(V_{CE} = 20 Vdc)	BDX34 Series		3.5		
(V_{CE} = 36 Vdc)	BDX33 Series		1.0		
(V_{CE} = 33 Vdc)	BDX34 Series		1.0		
DYNAMIC CHARACTERISTICS					
Small-Signal Current Gain (T_C = 1.0 Adc, V_{CE} = 5.0 Vdc, f = 1 MHz)		h_{FE}	1000		–
Current Gain-Bandwidth product (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc, f = 1.0 MHz)		f_T	3		MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 MHz)	BDX33 Series	C_{ob}		200	pF
	BDX34 Series			300	

[1] Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%
[2] Pulse Test non repetitive: Pulse Width = 0.25 s.

3

FIGURE 2 – THERMAL RESPONSE

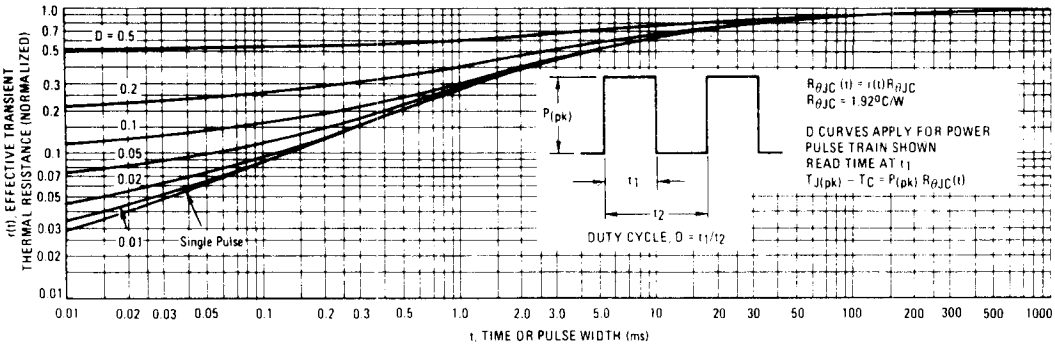
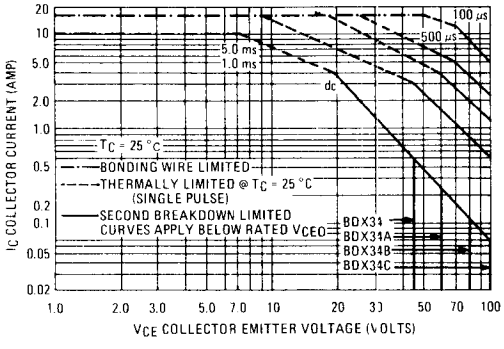
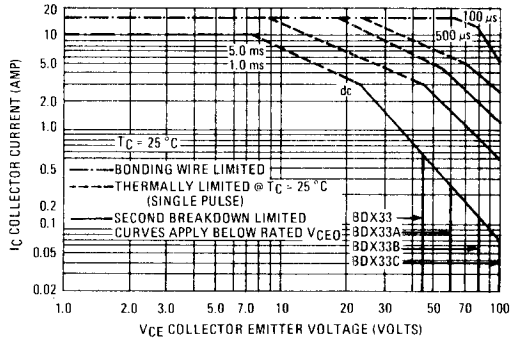


FIGURE 3 – ACTIVE-REGION SAFE OPERATING AREA





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 Fig. 3 is based on $T_{J(pk)} = 150\,^{\circ}C$; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)}$ 150 °C $T_{J(pk)}$ may be calculated from the data in Fig. . 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 4 – SMALL-SIGNAL CURRENT GAIN

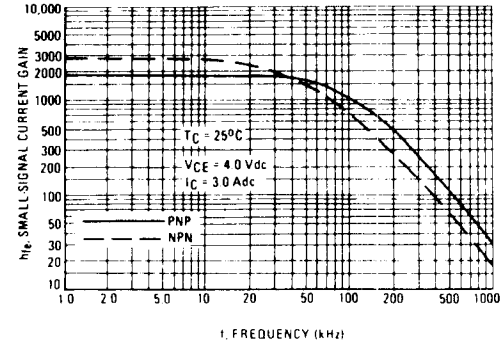
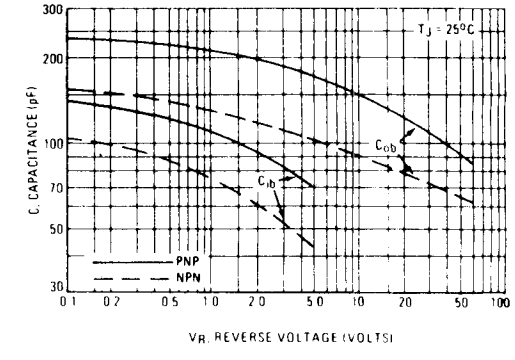


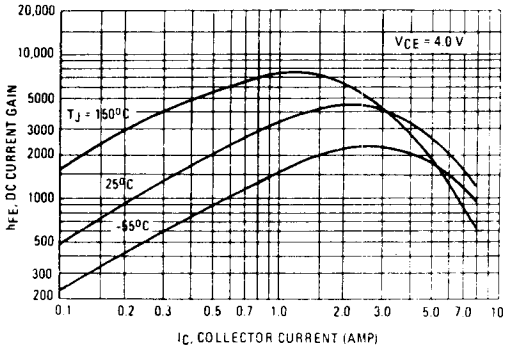
FIGURE 5 – CAPACITANCE



NPN
BDX33, 33A, 33B, 33C

PNP
BDX34, 34A, 34B, 34C

FIGURE 6 – DC CURRENT GAIN



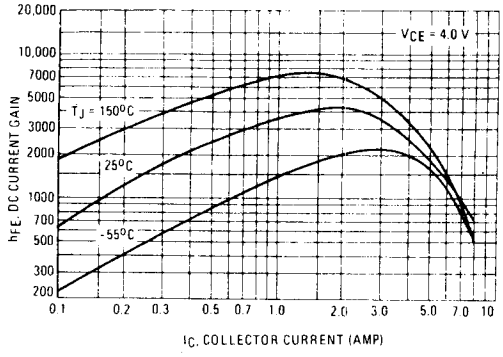
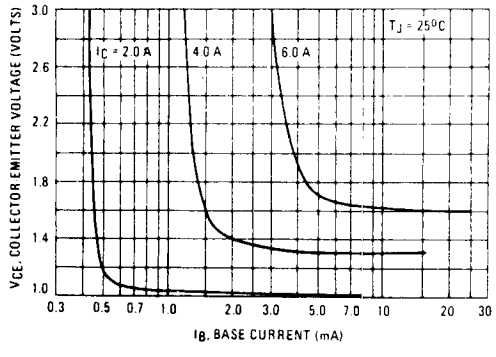


FIGURE 7 – COLLECTOR SATURATION REGION



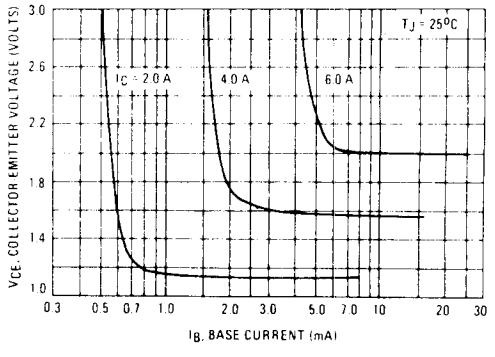


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FIGURE 8 – "ON" VOLTAGES