

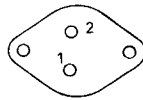
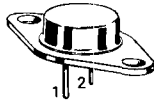
ALPHANUMERIC INDEX — CROSS-REFERENCE

The following table represents an index and cross-reference guide for all low-frequency power transistors which are either manufactured directly by Motorola or for which Motorola manufactures a suitable equivalent. Where the Motorola part num-

ber differs from the industry part number, the Motorola device is a "form, fit and function" replacement for the industry type number — however, subtle differences in characteristics and/or specifications may exist.

Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number	Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number
1S110A-100		MJ16018	3-782	2N3441	2N3441		3-13
2N1487		2N5877	3-120	2N3442	2N3442		3-15
2N1488		2N5878	3-120	2N3445	2N3447		3-18
2N1489		2N5877	3-120	2N3446	2N3448		3-18
2N1490		2N5878	3-120	2N3447	2N3447		3-18
2N1702		2N5877	3-120	2N3448	2N3448		3-18
2N3016		2N5337	3-97	2N3583	2N3583		3-20
2N3021		2N3789	3-56	2N3584	2N3584		3-20
2N3022		2N3789	3-56	2N3585	2N3585		3-20
2N3023		2N3789	3-56	2N3667		2N5881	3-123
2N3024		2N3791	3-56	2N3713		2N5881	3-123
2N3025		2N3791	3-56	2N3714	2N3714		3-26
2N3026		2N3791	3-56	2N3715	2N3715		3-26
2N3054	2N3054		3-2	2N3715JAN	2N3715JAN		3-26
2N3054A	2N3054A		3-2	2N3715JTX	2N3715JTX		3-26
2N3055	2N3055		3-6	2N3715JTXV	2N3715JTXV		3-26
2N3055A	2N3055A		3-9	2N3716	2N3716		3-26
2N3055H		2N3055A	3-9	2N3716JAN	2N3716JAN		3-26
2N3055H		2N5302JAN	3-93	2N3716JTX	2N3716JTX		3-26
2N3055JAN		2N3055A	3-9	2N3716JTXV	2N3716JTXV		3-26
2N3055SD							
2N3055SUB		2N3055A	3-9	2N3719	2N3719		3-32
2N3076		2N6249	3-164	2N3720	2N3720		3-32
2N3079		2N6308	3-181	2N3738	2N3738		3-37
2N3080		2N6543	3-215	2N3739	2N3739		3-37
2N3171		2N3789	3-56	2N3739JAN	2N3739JAN		3-37
2N3172		2N3789	3-56	2N3739JTX	2N3739JTX		3-37
2N3173		2N3790	3-56	2N3739JTXV	2N3739JTXV		3-37
2N3174		MJ15016	3-9	2N3740	2N3740		3-41
2N3183		2N3789	3-56	2N3740A		2N3740	3-41
2N3184		2N3789	3-56	2N3740JAN	2N3740JAN		3-41
2N3185		2N3790	3-56	2N3740JTX	2N3740JTX		3-41
2N3186		MJ15016	3-9	2N3740JTXV	2N3740JTXV		3-41
2N3195		2N3789	3-56	2N3741	2N3741		3-41
2N3196		2N3790	3-56	2N3741A	2N3741A		3-41
2N3198		MJ15016	3-9	2N3741JAN	2N3741JAN		3-41
2N3202		2N3719	3-32	2N3741JTX	2N3741JTX		3-41
2N3203		2N3720	3-32	2N3741JTXV	2N3741JTXV		3-41
2N3204		2N6303	3-32	2N3766	2N3766		3-44
2N3232		2N5877	3-120	2N3766JAN	2N3766JAN		3-44
2N3233		2N5882	3-123	2N3766JTX	2N3766JTX		3-44
2N3234		2N5760	3-116	2N3766JTXV	2N3766JTXV		3-44
2N3235		2N3055	3-6	2N3767	2N3767		3-44
2N3236		2N5882	3-123	2N3767JAN	2N3767JAN		3-44
2N3237		2N5302	3-93	2N3767JTX	2N3767JTX		3-44
2N3238		2N5882	3-123	2N3767JTXV	2N3767JTXV		3-44
2N3239		2N5882	3-123	2N3771	2N3771		3-48
2N3240		2N5882	3-123	2N3772	2N3772		3-48
2N3419		2N5336	3-97	2N3773	2N3773		3-52
2N3420		2N5336	3-97	2N3788		2N6543	3-215
2N3421		2N5336	3-97	2N3789	2N3789		3-56

TABLE 3 — METAL TO-213 (Formerly TO-66)



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

CASE 80-02 (TO-213AA)

I _C Cont Amps Max	V _{CE0} (sus) Volts Min	Device Type		hFE Min/Max	@ I _C Amp	Resistive Switching			f _T MHz Min	P _D (Case) Watts @ 25°C
		NPN	PNP			t _s μs Max	t _f μs Max	@ I _C Amp		
1	80	2N4912		20/100	0.5	0.6 typ	0.3 typ	0.5	3	25
	175	2N3583	2N6420	40/200	0.5	2 typ	0.23 typ	0.5	10	35
	225	2N3738		40/200	0.1	3 typ	0.3 typ	0.1	10	20
	300	2N3739		40/200	0.1	3 typ	0.3 typ	0.1	10	20
2	225		2N6211	10/100	1	2.5	0.6	1	20	35
	250	2N3584	2N6421	25/100	1	4	3	1	10	35
	300	2N3585 2N4240	2N6212	10/100	1	2.5	0.6	1	20	35
			2N6422	25/100	1	4	3	1	10	35
350		2N6213	30/150	0.75	6	3	0.75	15	35	
3	140	2N3441		25/100	0.5				0.2	25
4	60	2N3054.A 2N3766 2N6294##	2N3740	30/100	0.25	1.3 typ	0.27 typ	0.25	4	25
				25/100	0.5	1 typ	0.3 typ	0.5	3	75
				40/160	0.5	0.9 typ	0.09 typ	0.5	10	20
			2N6296##	750/18k	2	0.9 typ	0.7 typ	2	4#	50
	80	2N3767 2N6295##	2N3741	30/100	0.25	1.3 typ	0.27 typ	0.25	4	25
				40/160	0.5	0.9 typ	0.09 typ	0.5	10	20
		2N6297##	750/18k	2	0.9 typ	0.7 typ	2	4	50	
5	80	2N4233A		25/100	1.5	0.5 typ	0.2 typ	1.5	4	75
7	60		2N6317	20/100	2.5	1	0.8	2.5	4	90
	80	2N5428		60/240	2	2	0.2	2	30	40
			2N6318	20/100	2.5	1	0.8	2.5	4	90
	100	2N5429 2N5430		30/120 60/240	2 2	2 2	0.2 0.2	2 2	30 30	40 40
8	60	2N6300##	2N6298##	750/18k	4	1.5 typ	1.5 typ	4	4#	75
	80	2N6301##	2N6299##	750/18k	4	1.5 typ	1.5 typ	4	4#	75

|h_{FE}| @ 1 MHz, ## Darlington

JAN, JTX, JTXV Available

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TABLE 14 — SWITCHMODE POWER TRANSISTORS (continued)

V _{CEO(sus)} Volts Min	I _{C Cont} Amps Max	V _{CEV} Volts Min	Device Type NPN unless otherwise noted	h _{FE} Min/Max	@ I _C Amp	Resistive Switching			f _T MHz Min	P _D (Case) Watts @ 25°C	Case JEDEC/MOT
						t _s μs Max	t _f μs Max	@ I _C Amp			
300	0.5	300	MJ4646-PNP	20 min	0.5	0.72*		0.05	40		TO-205AD/79
275	15	300	2N6250	8/50	10	3.5	1	10	2.5		TO-204/1
250	60	350	MJ10021##★	25 min	30	3.5	0.5	30			TO-204/197
	40	300	BUV22	10 min	20	1.1	0.35	20	8	250	TO-204/1
		350	BUS52	15 min	40					350	TO-204/1
	20	300	BUV12	10 min	10	1.5	0.5	10	8	150	TO-204/1
		450	MJ13331★	8/40	10	3.5	0.7	10	5/40		TO-204/1
	15	250	MJ11021#-PNP	100 min	15				3#		TO-204/1
		250	MJ11022#	100 min	15				3#		TO-204/1
	8	500	2N6306	15/75	3	1.6	0.4	3	5		TO-204/1
		400	MJ6502-PNP★	15 min	2	2	0.5	4			TO-204/1
5	500	MJ3029	30 min	0.4	0.4	1	3			TO-204/1	
	350	2N6497	10/75	2.5	1.8	0.8	2.5	5		TO-220/221A	
2	375	2N3584	25/100	1	4	3	1	10		TO-213AA/80	
	375	2N6421-PNP	25/100	1	4	3	1	10		TO-213AA/80	
1	250	2N5344-PNP	25/100	0.5	0.6	0.1	0.5	60		TO-213AA/80	
225	2	275	2N6211	10/100	1	2.5	0.6	1	20		TO-213AA/80
200	60	300	MJ10020##★	25 min	30	3.5	0.5	30			TO-204/197
	50	300	BUS51	15 min	50					350	TO-204/1
	40	250	BUV21	10 min	25	1.8	0.4	25	8	150	TO-204/1
	20	250	BUV11	10 min	12	1.8	0.4	12	8	150	TO-204/1
		400	MJ13330★	8/40	10	3.5	0.7	10	5/40		TO-204/1
	15	225	2N6249	10/50	10	3.5	1	10	2.5		TO-204/1
250		BUX41	8 min	8	1.5	0.4	8	8	120	TO-204/1	
200		MJ11019#-PNP	100 min	15				3#		TO-204/1	
200		MJ11020#	100 min	15				3#		TO-204/1	
3	250	BUY49P	30 min	0.5				25	20	TO-225AA/77	

★ Designers Data Sheet characterization

Darlington

Darlington with speed-up diode

* t_{off}

** |h_{FE}| @ 1 MHz

MOTOROLA
SEMICONDUCTOR
 TECHNICAL DATA

NPN
2N3583 thru 2N3585
2N4240
PNP
2N6420 thru 2N6422

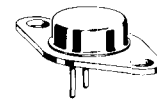
**COMPLEMENTARY MEDIUM-POWER HIGH VOLTAGE
 POWER TRANSISTORS**

... designed for high-speed switching and linear amplifier applications for high-voltage operational amplifiers, switching regulators, converters, inverters, deflection stages and high fidelity amplifiers.

- Collector-Emitter Sustaining Voltage –
 $V_{CEO(sus)} = 175$ to 300 Vdc @ $I_C = 200$ mAdc
- Second Breakdown Collector Current –
 $I_{s/b} = 350$ mAdc @ $V_{CE} = 100$ Vdc – NPN
 $= 150$ mAdc @ $V_{CE} = 100$ Vdc – PNP
- Usable DC Current Gain to 2.0 Adc

1.0 AND 2.0 AMPERE
POWER TRANSISTORS
COMPLEMENTARY SILICON

250-500 VOLTS
35 WATTS



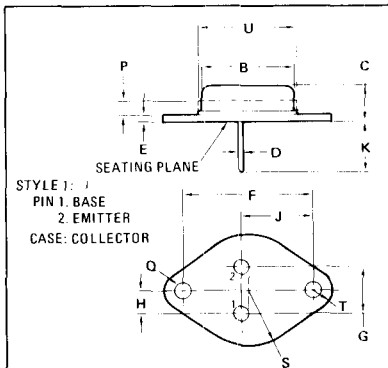
***MAXIMUM RATINGS**

Rating	Symbol	2N3583 2N6420	2N3584 2N6421	2N3585 2N6422	2N4240	Unit
Collector-Emitter Voltage	V_{CEO}	175	250	300	300	Vdc
Collector-Base Voltage	V_{CB}	250	375	500	500	Vdc
Emitter-Base Voltage	V_{EB}	6.0				Vdc
Collector Current—Continuous —Peak (1)	I_C	1.0 5.0	2.0 5.0			Adc
Base Current	I_B	1.0				Adc
Total Power Dissipation @ $T_C = 25^\circ\text{C}$, Derate above 25°C	P_D	35 0.2				Watts W/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200				$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	5.0	$^\circ\text{C}/\text{W}$

*Indicates JEDEC Registered Data
 (1) Pulse Test: Pulse Width = 5.0 ms, Duty Cycle < 10%.



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
B	11.94	12.70	0.470	0.500
C	6.35	8.64	0.250	0.340
D	0.71	0.86	0.028	0.034
E	1.27	1.91	0.050	0.075
F	24.33	24.43	0.958	0.962
G	4.83	5.33	0.190	0.210
H	2.41	2.67	0.095	0.105
J	14.48	14.99	0.570	0.590
K	9.14	—	0.360	—
P	—	1.27	—	0.050
Q	3.61	3.86	0.142	0.152
S	—	8.89	—	0.350
T	—	3.68	—	0.145
U	—	15.75	—	0.620

All JEDEC Dimensions and and Notes Apply.

CASE 80-02
TO-213AA
(TO-66)

2N3583 thru 2N3585 • 2N4240 — NPN
2N6420 thru 2N6422 — PNP

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

Characteristic	NPN	PNP	Symbol	NPN		PNP		Unit			
				Min	Max	Min	Max				
*OFF CHARACTERISTICS (1)											
Collector-Emitter Sustaining Voltage ($I_C = 200 \text{ mAdc}, I_B = 0$) NPN ($I_C = 50 \text{ mAdc}, I_B = 0$) PNP	2N3583	2N6420	$V_{CE(sus)}$	175	—	175	—	Vdc			
	2N3584	2N6421		250	—	250	—				
	2N3585	2N6422		300	—	300	—				
	2N4240			300	—	300	—				
Collector Cutoff Current ($V_{CE} = 150 \text{ Vdc}, I_B = 0$)	2N3583	2N6420	I_{CEO}	—	10	—	10	mAdc			
	2N3584	2N6421		—	5.0	—	5.0				
	2N3585	2N6422		—	5.0	—	5.0				
	2N4240			—	5.0	—	5.0				
Collector Cutoff Current ($V_{CE} = 225 \text{ Vdc}, V_{BE(off)} = 1.5 \text{ Vdc}$) ($V_{CE} = 340 \text{ Vdc}, V_{BE(off)} = 1.5 \text{ Vdc}$) ($V_{CE} = 450 \text{ Vdc}, V_{BE(off)} = 1.5 \text{ Vdc}$) ($V_{CE} = 225 \text{ Vdc}, V_{BE(off)} = 1.5 \text{ Vdc}, T_C = 150^\circ\text{C}$) ($V_{CE} = 300 \text{ Vdc}, V_{BE(off)} = 1.5 \text{ Vdc}, T_C = 150^\circ\text{C}$)	2N3583	2N6420	I_{CEX}	—	1.0	—	1.0	mAdc			
	2N3584	2N6421		—	1.0	—	1.0				
	2N3585	2N6422		—	1.0	—	1.0				
	2N4240			—	2.0	—	2.0				
	2N3583	2N6420		—	3.0	—	3.0				
	2N3584	2N6421		—	3.0	—	3.0				
	2N3585	2N6422		—	3.0	—	3.0				
	2N4240			—	5.0	—	5.0				
	Emitter Cutoff Current ($V_{BE} = 6.0 \text{ Vdc}, I_C = 0$)	2N3583		2N6420	I_{EBO}	—	5.0		—	5.0	mAdc
		2N3584		2N6421		—	0.5		—	0.5	
2N3585		2N6422	—	0.5		—	0.5				
2N4240			—	0.5		—	0.5				
			—	0.5		—	0.5				
ON CHARACTERISTICS (1)											
DC Current Gain ($I_C = 0.1 \text{ Adc}, V_{CE} = 10 \text{ Vdc}$) * ($I_C = 0.5 \text{ Adc}, V_{CE} = 10 \text{ Vdc}$) * ($I_C = 0.75 \text{ Adc}, V_{CE} = 2.0 \text{ Vdc}$) ($I_C = 0.75 \text{ Adc}, V_{CE} = 10 \text{ Vdc}$) * ($I_C = 1.0 \text{ Adc}, V_{CE} = 2.0 \text{ Vdc}$) ($I_C = 1.0 \text{ Adc}, V_{CE} = 10 \text{ Vdc}$)	All	All	h_{FE}	40	—	40	—	—			
	2N3583	2N6420		40	200	40	200				
	2N4240			10	100	10	100				
	2N4240			30	150	30	150				
	2N3584	2N6421		8.0	80	8.0	80				
	2N3585	2N6422		8.0	80	8.0	80				
	2N3583*	2N6420		10	—	10	—				
	2N3584	2N6421		25	100	25	100				
	2N3585	2N6422		25	100	25	100				
	*Collector-Emitter Saturation Voltage ($I_C = 0.75 \text{ Adc}, I_B = 75 \text{ mAdc}$) ($I_C = 1.0 \text{ Adc}, I_B = 125 \text{ mAdc}$)	2N4240			$V_{CE(sat)}$	—	1.0		—	1.0	Vdc
2N3583		2N6420	—	5.0		—	5.0				
2N3584		2N6421	—	0.75		—	0.75				
2N3585		2N6422	—	0.75		—	0.75				
*Base-Emitter Saturation Voltage ($I_C = 0.75 \text{ Adc}, I_B = 75 \text{ mAdc}$) ($I_C = 1.0 \text{ Adc}, I_B = 100 \text{ mAdc}$)	2N4240		$V_{BE(sat)}$	—	1.8	—	1.8	Vdc			
	2N3584	2N6421		—	1.4	—	1.4				
	2N3585	2N6422		—	1.4	—	1.4				
Base-Emitter On Voltage ($I_C = 1.0 \text{ Adc}, V_{CE} = 10 \text{ Vdc}$)	All	All	$V_{BE(on)}$	—	1.4	—	1.4	Vdc			

* Indicates JEDEC Registered Data.

(1) Pulse Test: Pulse Width = 300 μs , Duty Cycle \leq 2%.

2N3583 thru 2N3585 • 2N4240 — NPN
2N6420 thru 2N6422 — PNP

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

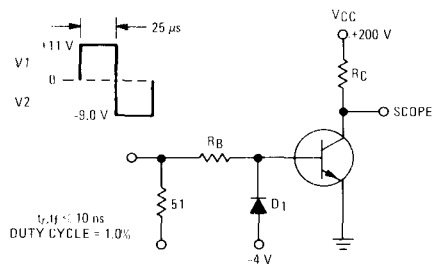
Characteristic	NPN	PNP	Symbol	NPN		PNP		Unit
				Min	Max	Min	Max	
DYNAMIC CHARACTERISTICS								
*Current Gain – Bandwidth Product ⁽¹⁾ ($I_C = 200 \text{ mAdc}$, $V_{CE} = 10 \text{ Vdc}$, $f_{\text{test}} = 5.0 \text{ MHz}$)	2N3583 2N3584 2N3585 2N4240	2N6420 2N6421 2N6422	f_T	10 15	– –	10 15		MHz
Output Capacitance ($V_{CB} = 10 \text{ Vdc}$, $I_E = 0$, $f = 1.0 \text{ MHz}$)	All		C_{ob}	–	120	–	120	pF
*Small-Signal Current Gain ($I_C = 100 \text{ mAdc}$, $V_{CE} = 30 \text{ Vdc}$, $f = 1.0 \text{ kHz}$)	2N3583	2N6420	h_{fe}	25	350	25	350	
*SWITCHING CHARACTERISTICS								
Rise Time ($V_{CC} = 200 \text{ Vdc}$, $I_C = 1.0 \text{ Adc}$, $R_L = 200 \text{ Ohms}$, $I_{B1} = 100 \text{ mAdc}$) ($V_{CC} = 200 \text{ Vdc}$, $I_C = 0.75 \text{ Adc}$, $R_L = 267 \text{ Ohms}$, $I_{B1} = 75 \text{ mAdc}$)	2N3584 2N3585 2N4240	2N6421 2N6422	t_r	– –	3.0 0.5	– –	3.0 0.5	μs
Storage Time ($V_{CC} = 200 \text{ Vdc}$, $I_C = 1.0 \text{ Adc}$, $I_{B1} = I_{B2} = 100 \text{ mAdc}$) ($V_{CC} = 200 \text{ Vdc}$, $I_C = 0.75 \text{ Adc}$, $I_{B1} = I_{B2} = 75 \text{ mAdc}$)	2N3584 2N3585 2N4240	2N6421 2N6422	t_s	– –	4.0 6.0	– –	4.0 6.0	μs
Fall Time ($V_{CC} = 200 \text{ Vdc}$, $I_C = 1.0 \text{ Adc}$, $I_{B1} = I_{B2} = 100 \text{ mAdc}$) ($V_{CC} = 200 \text{ Vdc}$, $I_C = 0.75 \text{ Adc}$, $I_{B1} = I_{B2} = 75 \text{ mAdc}$)	2N3584 2N3585 2N4240	2N6421 2N6422	t_f	– –	3.0 3.0	– –	3.0 3.0	μs
Second Breakdown Collector Current ($V_{CE} = 100 \text{ Vdc}$)	All	All	$I_{s/b}$	350	–	150	–	mAdc

*Indicates JEDEC Registered Data

⁽¹⁾ $f_T = |h_{fe}| \cdot f_{\text{test}}$

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FIGURE 1 – SWITCHING TIME TEST CIRCUIT



R_B and R_C VARIED TO OBTAIN DESIRED CURRENT LEVELS

D1 MUST BE FAST RECOVERY TYPE, eg:
 MBD5300 USED ABOVE $I_B = 100 \text{ mA}$
 MSD6100 USED BELOW $I_B = 100 \text{ mA}$

FOR t_f and t_r , D1 IS DISCONNECTED AND $V_2 > 0$.
 FOR PNP TEST CIRCUIT, REVERSE DIODE AND VOLTAGE POLARITIES.

2N3583 thru 2N3585 • 2N4240 — NPN
 2N6420 thru 2N6422 — PNP

NPN
 2N3583 thru 2N3585, 2N4240

PNP
 2N6420 thru 2N6422

FIGURE 2 — TURN-ON TIME

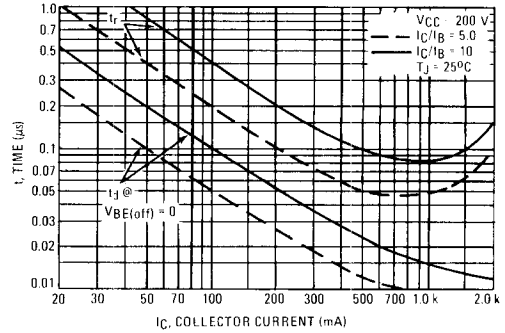
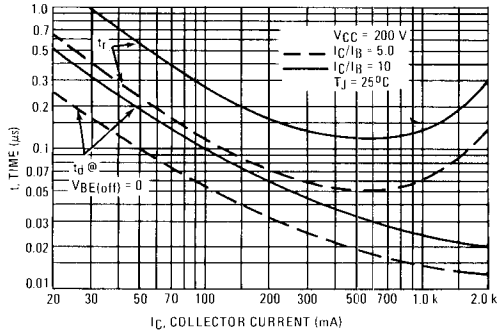


FIGURE 3 — TURN-OFF TIME

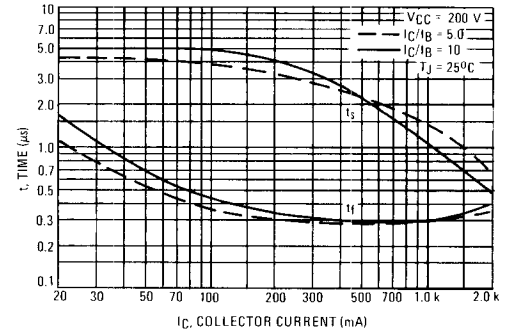
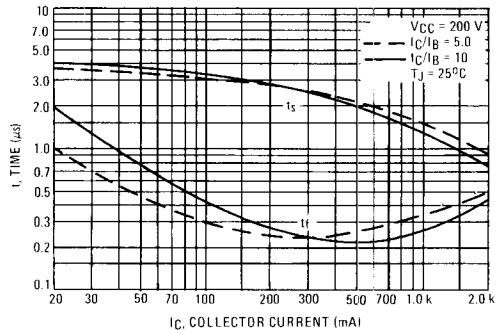


FIGURE 4 — CURRENT-GAIN — BANDWIDTH PRODUCT

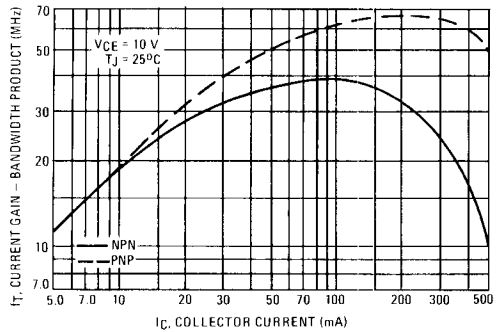
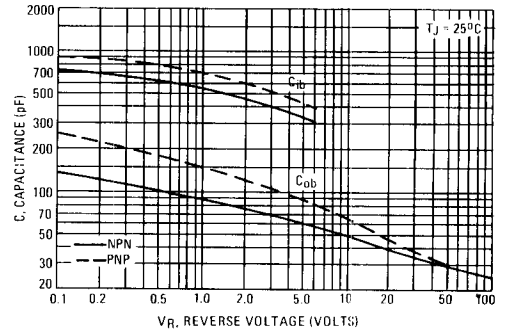
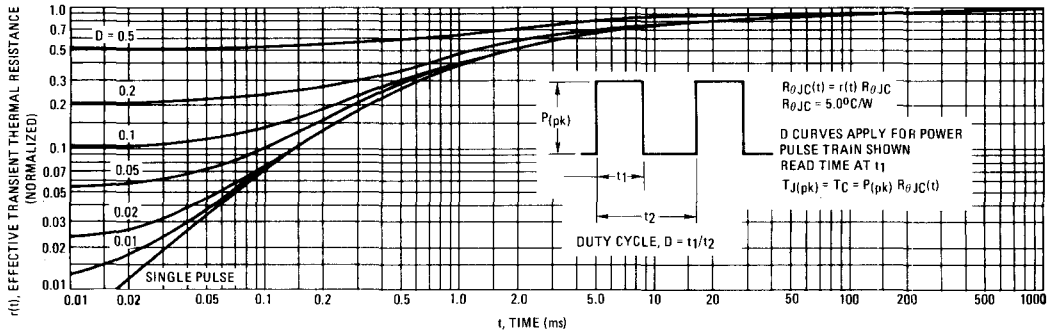


FIGURE 5 — CAPACITANCE



2N3583 thru 2N3585 • 2N4240 — NPN
2N6420 thru 2N6422 — PNP

FIGURE 6 — THERMAL RESPONSE



ACTIVE-REGION SAFE OPERATING AREA

FIGURE 7 — 2N3583 thru 2N3585, 2N4240

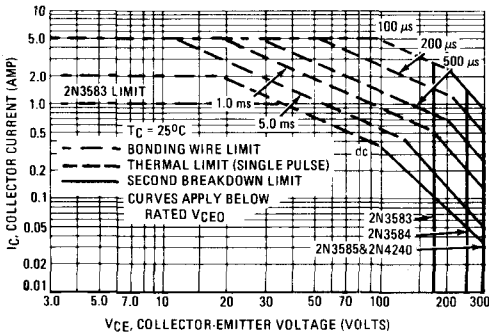


FIGURE 8 — 2N6420 thru 2N6422

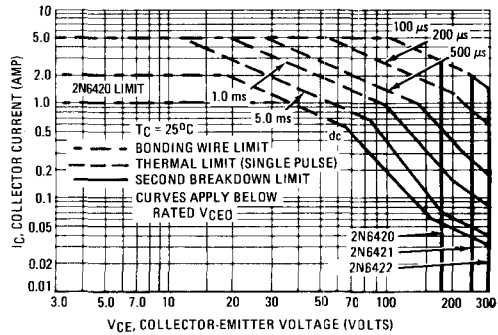
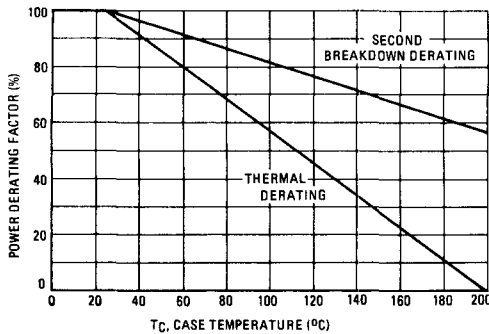


FIGURE 9 — POWER DERATING



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 Figures 7 and 8 is based on $T_C = 25^\circ\text{C}$; $T_J(pk)$ is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% but must be derated for temperature according to Figure 9.

$T_J(pk)$ 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. Second breakdown limitations do not derate the same as thermal limitations. Allowable current at the voltages shown on Figures 7 and 8 may be found at any case temperature by using the appropriate curve on Figure 9.

2N3583 thru 2N3585 • 2N4240 — NPN
2N6420 thru 2N6422 — PNP

NPN
2N3583 thru 2N3585, 2N4240

PNP
2N6420 thru 2N6422

FIGURE 10 — DC CURRENT GAIN

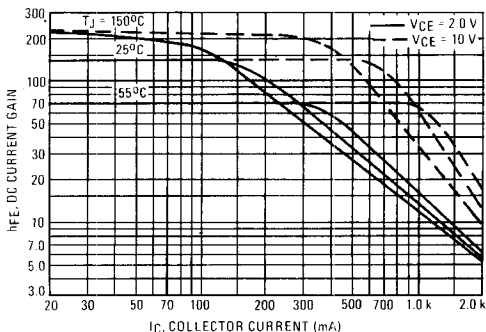
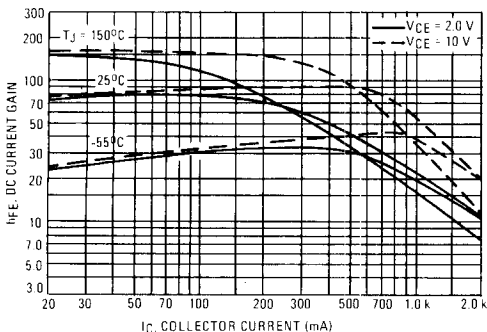


FIGURE 11 — COLLECTOR SATURATION REGION

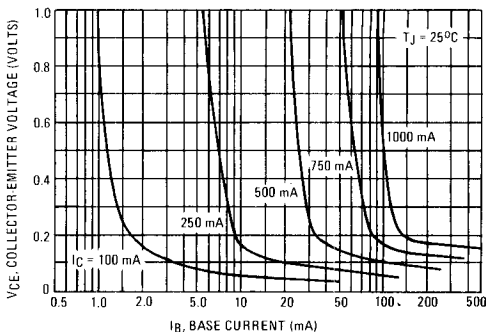
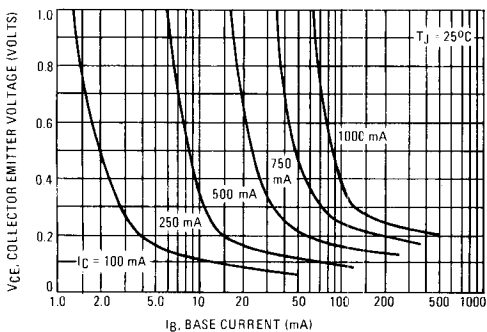
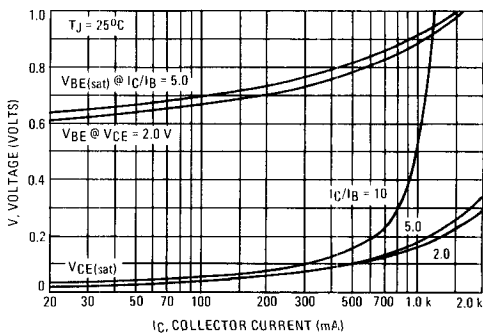
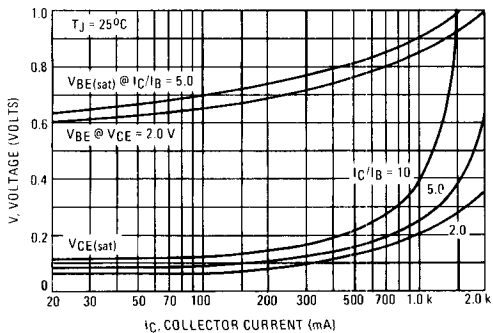


FIGURE 12 — "ON" VOLTAGES



NOTE: DC CURRENT LIMIT FOR 2N3583, 2N6420 is 1.0 Amp.