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2N5284		2N5339	3-97	2N5490		MJE3055T	3-904
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2N5286		2N6191	3-158	2N5492		2N6292	3-151
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2N5295		2N6121	3-154	2N5496		2N6292	3-151
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2N5297		2N6122	3-154	2N5508		2N5428	3-101
2N5298		2N6122	3-154	2N5539		2N6379	3-191
2N5301	2N5301		3-93	2N5559		MJ15001	3-710
2N5302	2N5302		3-93	2N5575		2N5685	3-112
2N5302JAN	2N5302JAN		3-93	2N5578		2N5685	3-112
2N5302JTX	2N5302JTX		3-93	2N5598		2N5428	3-101
2N5302JTXV	2N5302JTXV		3-93	2N5600		2N5428	3-101
2N5303	2N5303		3-93	2N5602		2N5428	3-101
2N5303JAN	2N5303JAN		3-93	2N5604		2N5430	3-101
2N5303JTX	2N5303JTX		3-93	2N5606		2N5428	3-101
2N5303JTXV	2N5303JTXV		3-93	2N5610		2N5428	3-101
2N5325		2N5339	3-97	2N5612		2N5430	3-101
2N5333		2N6303	3-32	2N5614		2N3448	3-18
2N5334		2N5337	3-97	2N5616		2N3448	3-18
2N5335		2N5337	3-97	2N5618		2N3448	3-18
2N5336	2N5336		3-97	2N5629	2N5629		3-105
2N5337	2N5337		3-97	2N5630	2N5630		3-105
2N5338	2N5338		3-97	2N5631	2N5631		3-105
2N5339	2N5339		3-97	2N5632		2N5882	3-123
2N5339JAN	2N5339JAN		3-97	2N5633		MJ15001	3-710
2N5339JTX	2N5339JTX		3-97	2N5634		MJ15001	3-710
2N5339JTXV	2N5339JTXV		3-97	2N5651		2N3585	3-20
2N5344		2N6211	3-161	2N5655	2N5655		3-109
2N5345		2N6212	3-161	2N5656	2N5656		3-109
2N5346		2N5339	3-97	2N5657	2N5657		3-109
2N5347		2N5339	3-97	2N5660		2N3585	3-20
2N5348		2N5339	3-97	2N5661		2N3584	3-20

*Consult Motorola if a direct replacement is necessary.

TABLE 1 — METAL TO-204, TO-204AE (continued)

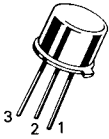
I _C Cont Amps Max	V _{CEO(sus)} Volts Min	Device Type		h _{FE} Min/Max	@ I _C Amp	Resistive Switching			f _T MHz Min	P _D (Case) Watts @ 25°C
		NPN	PNP			t _s μs Max	t _f μs Max	@ I _C Amp		
50	200	BUS51●		15 min	50					350
	400	MJ10015●##		10 min	40	2.5	1	20		250
	500	BUT34●## MJ10016●##		15 min 10 min	32 40	3 2.5	1.5 1	32 20		250 250
56	400	BUT33●##		20 min	36	3.3	1.6	36		250
60	60	MJ14000●	MJ14001●	15/100	50					300
	80	MJ14002●	MJ14003●	15/100	50					300
	200	MJ10020●##		75 min	15	3.5	0.5	30		250
	250	MJ10021●##		75 min	15	3.5	0.5	30		250
70	125	BUS50●		15 min	50					350

● Modified TO-3, 60 mil pins, # |h_{FE}| @ 1 MHz, ## Darlington

TABLE 2 — METAL TO-205 (Formerly TO-39)



STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
(Pin 3 connected to case)



CASE 79-04 (TO-205AD)

I _C Cont Amps Max	V _{CEO(sus)} Volts Min	Device Type		h _{FE} 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		
0.5	300		MJ4646	20 min	0.5	0.72*		0.05	40	5
	400		MJ4647	20 min	0.5	0.72*		0.05	30	5
3	40		2N3719 2N3867	25/180 40/200	1 1.5	0.4* 0.4*		1 1.5	60 60	6 6
	60		2N3720 2N3868	25/180 30/150	1 1.5	0.4* 0.4*		1 1.5	60 60	6 6
	80		2N6303	30/150	1.5	0.4*		1.5	60	6
4	60	2N4877		20/100	4	1.5	0.5	4	4	10
5	80	2N5336 2N5337	2N6190 2N6191	30/120 60/240	2 2	2 2	0.2 0.2	2 2	30 30	6 6
	100	2N5338 2N5339	2N6193	30/120 60/240	2 2	2 2	0.2 0.2	2 2	30 30	10 6

JAN, JTX, JTXV Available

*t_{off}

TABLE 13 — POWER SWITCHING TRANSISTORS (continued)

I _C Cont Amps Max	V _{CEO(sus)} Volts Min	Device Type		h _{FE} Min/Max	@ I _C Amp	Resistive Switching			f _T MHz Min	P _D (Case) Watts @ 25°C	Case JEDEC/MOT
		NPN	PNP			t _s μs Max	t _f μs Max	@ I _C Amp			
4	30	BD185		15 min	2				20	40	TO-225AA/77
	45	BD785	BD786	20 min	2				50	15	TO-225AA/77
	60	2N4877 BD189 BD787	BD788	20/100 15 min 20 min	4 2 2	1.5	0.5	4	30 20 50	10 40 15	TO-205AD/79 TO-225AA/77 TO-225AA/77
	80	BD789	BD790	10 min	2				40	15	TO-225AA/77
	100	BD791	BD792	10 min	2				40	15	TO-225AA/77
5	80	2N5337	2N6191	60/240	2	2	0.2	2	30	10	TO-205AD/79
	100	2N5339	2N6193	60/240	2	2	0.2	2	30	10	TO-205AD/79
7	60	2N6315	2N6317	20/100	2.5	1	0.8	2.5	4	90	TO-213AA/80
	80	2N5428 2N6316	2N6318	60/240 20/100	2 2.5	2 1	0.2 0.8	2 2.5	30 4	60 90	TO-213AA/80 TO-213AA/80
	100	2N5430		60/240	2	2	0.2	2	30	60	TO-213AA/80
7.5	60	2N3447		40/120	5	2	0.35	5	10	115	TO-204/1
	80	2N3448		40/120	5	2	0.35	5	10	115	TO-204/1
8	120	MJE15028	MJE15029	20 min	4	0.4 typ	0.18 typ	5	30	50	TO-220/221A
	150	MJE15030	MJE15031	20 min	4	0.4 typ	0.18 typ	5	30	50	TO-220/221A
10	60	2N5877	2N5875	20/100	4	1	0.8	4	4	150	TO-204/1
	80	2N5878	2N5876	20/100	4	1	0.8	4	4	150	TO-204/1
15	60	2N5881	2N5879	20/100	6	1	0.8	6	4	160	TO-204/1
	80	2N5882	2N5880	20/100	6	1	0.8	6	4	160	TO-204/1
18	160	BUX41N		8 min	12	1.2	0.25	12	8	120	TO-204/1
20	75	2N5039		20/100	10	1.5	0.5	10	60	140	TO-204/1
	80	2N5303	2N5745	15/60	10	2	1	10	2	200	TO-204/1
	90	2N5038		20/100	12	1.5	0.5	12	60	140	TO-204/1
	125	BUX40		8 min	15	1	0.25	15	8	120	TO-204/1
	160	BUV11N		10 min	15	1.2	0.25	15	8	150	TO-204/1
25	60	2N5885	2N5883	20/100	10	1	0.8	10	4	200	TO-204/1
	80	2N5886	2N5884 2N6436	20/100 30/120	10 10	1 1	0.8 0.25	10 10	4 40	200 200	TO-204/1 TO-204/1
	100	2N6338	2N6437	30/120	10	1	0.25	10	40	200	TO-204/1
	120	2N6339	2N6438	30/120	10	1	0.25	10	40	200	TO-204/1
	125	BUV10 BUV10N		10 min 10 min	20 20	1.2 1.55	0.25 0.45	20 15	8 10	150 175	TO-204/1 TO-204/1
	140	2N6340		30/120	10	1	0.25	10	40	200	TO-204/1
	150	2N6341		30/120	10	1	0.25	10	40	200	TO-204/1
30	40	2N5301	2N4398	15/60	15	2	1	10	2	200	TO-204/1
	60	2N5302	2N4399	15/60	15	2	1	10	2	200	TO-204/1
	90	BUX39		8 min	20	1	0.25	20	8	120	TO-204/1

(continued)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5336
thru
2N5339

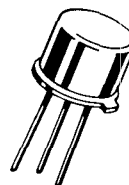
MEDIUM-POWER NPN SILICON TRANSISTORS

... designed for switching and wide band amplifier applications.

- Low Collector-Emitter Saturation Voltage —
 $V_{CE(sat)} = 1.2 \text{ Vdc (Max) @ } I_C = 5.0 \text{ Amp}$
- DC Current Gain Specified to 5 Amperes
- Excellent Safe Operating Area
- Packaged in the Compact TO-205AD Case for Critical Space-Limited Applications
- Complement to 2N6190 thru 2N6193

5 AMPERE
POWER TRANSISTORS
NPN SILICON

80 - 100 VOLTS
6 WATTS



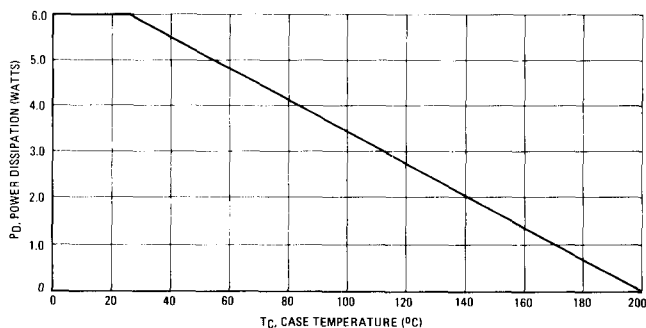
MAXIMUM RATINGS

Rating	Symbol	2N5336 2N5337	2N5338 2N5339	Unit
Collector-Emitter Voltage	V_{CEO}	80	100	Vdc
Collector-Base Voltage	V_{CB}	80	100	Vdc
Emitter-Base Voltage	V_{EB}	6.0		Vdc
Collector Current — Continuous	I_C	5.0		Adc
Base Current	I_B	1.0		Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	6.0 34.3		Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		$^\circ\text{C}$

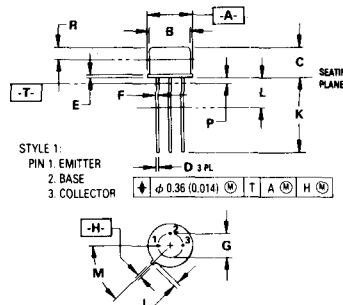
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	29.2	$^\circ\text{C/W}$

FIGURE 1 — POWER-TEMPERATURE DERATING CURVE



Safe Area Curves are indicated by Figure 5. All limits are applicable and must be observed.



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

2N5336 thru 2N5339

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

Characteristic	Fig. No.	Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage* (I _C = 50 mAdc, I _B = 0)	—	V _{CE(sus)} *	80 100	— —	Vdc
Collector Cutoff Current (V _{CE} = 75 Vdc, I _B = 0) (V _{CE} = 90 Vdc, I _B = 0)	—	I _{CEO}	— —	100 100	μAdc
Collector Cutoff Current (V _{CE} = 75 Vdc, V _{EB(off)} = 1.5 Vdc) (V _{CE} = 90 Vdc, V _{EB(off)} = 1.5 Vdc) (V _{CE} = 75 Vdc, V _{EB(off)} = 1.5 Vdc, T _C = 150°C) (V _{CE} = 90 Vdc, V _{EB(off)} = 1.5 Vdc, T _C = 150°C)	12	I _{CEX}	— — — —	10 10 1.0 1.0	μAdc mAdc
Collector Cutoff Current (V _{CB} = 80 Vdc, I _E = 0) (V _{CB} = 100 Vdc, I _E = 0)	—	I _{CBO}	— —	10 10	μAdc
Emitter Cutoff Current (V _{BE} = 6.0 Vdc, I _C = 0)	—	I _{EBO}	—	100	μAdc

ON CHARACTERISTICS

DC Current Gain* (I _C = 500 mAdc, V _{CE} = 2.0 Vdc) (I _C = 2.0 Adc, V _{CE} = 2.0 Vdc) (I _C = 5.0 Adc, V _{CE} = 2.0 Vdc)	8	h _{FE} *	30 60 30 60 20 40	— — 120 240 — —	—
Collector-Emitter Saturation Voltage* (I _C = 2.0 Adc, I _B = 0.2 Adc) (I _C = 5.0 Adc, I _B = 0.5 Adc)	9, 11, 13	V _{CE(sat)} *	— —	0.7 1.2	Vdc
Base-Emitter Saturation Voltage* (I _C = 2.0 Adc, I _B = 0.2 Adc) (I _C = 5.0 Adc, I _B = 0.5 Adc)	11, 13	V _{BE(sat)} *	— —	1.2 1.8	Vdc

DYNAMIC CHARACTERISTICS

Current-Gain-Bandwidth Product (I _C = 0.5 Adc, V _{CE} = 10 Vdc, f = 10 MHz)	—	f _T	30	—	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz)	7	C _{ob}	—	250	pF
Input Capacitance (V _{BE} = 2.0 Vdc, I _C = 0, f = 100 kHz)	7	C _{ib}	—	1,000	pF

SWITCHING CHARACTERISTICS

Delay Time (V _{CC} = 40 Vdc, V _{EB(off)} = 3.0 Vdc,	2, 3	t _d	—	100	ns
Rise Time (I _C = 2.0 Adc, I _{B1} = 0.2 Adc)		t _r	—	100	ns
Storage Time (V _{CC} = 40 Vdc, I _C = 2.0 Adc,	2, 6	t _s	—	2.0	μs
Fall Time I _{B1} = I _{B2} = 0.2 Adc)		t _f	—	200	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 2 – SWITCHING TIME TEST CIRCUIT

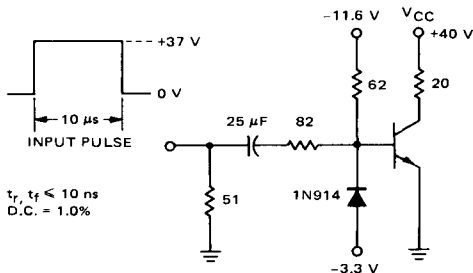


FIGURE 3 – TURN-ON TIME

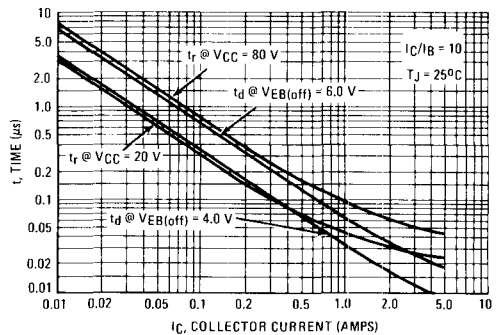


FIGURE 4 — THERMAL RESPONSE

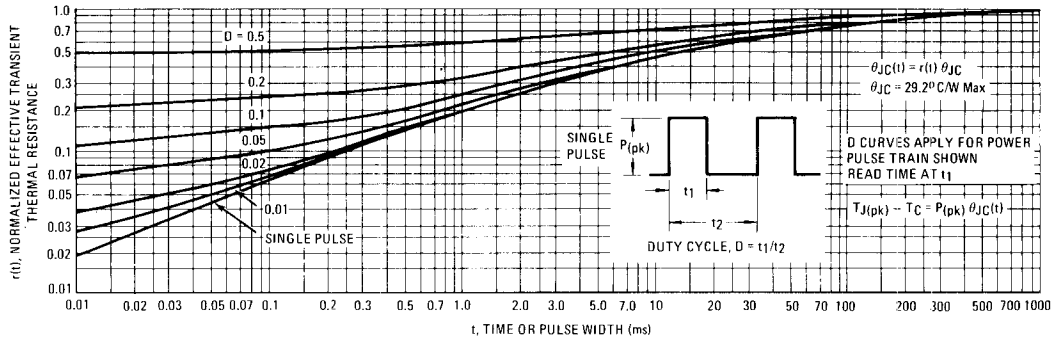
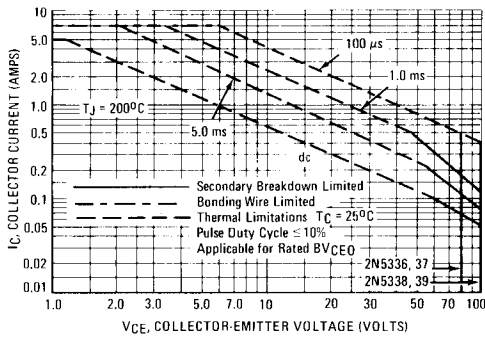


FIGURE 5 — ACTIVE-REGION SAFE OPERATING AREA



There are two limitations on the power handling ability of a transistor: junction temperature and secondary 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 $T_J(pk) = 200^\circ\text{C}$; T_C is variable depending on conditions. Pulse curves are valid for duty cycles of 10% provided $T_J(pk) \leq 200^\circ\text{C}$. $T_J(pk)$ may be calculated 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 secondary breakdown.

FIGURE 6 — TURN-OFF TIME

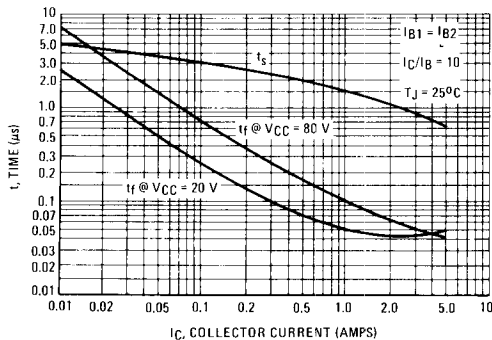


FIGURE 7 — CAPACITANCE versus VOLTAGE

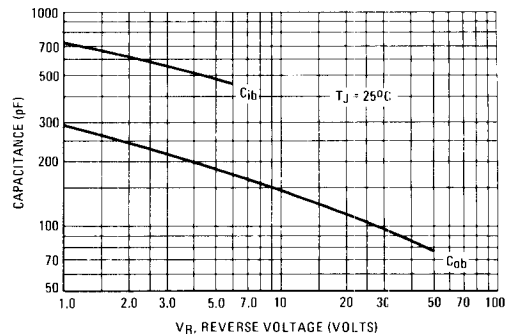


FIGURE 8 — DC CURRENT GAIN

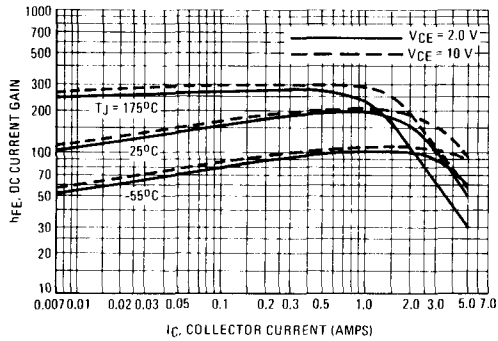


FIGURE 9 — COLLECTOR SATURATION REGION

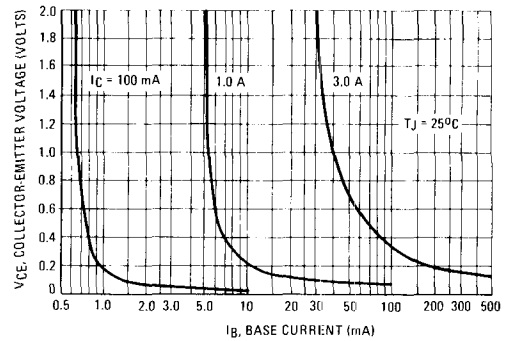


FIGURE 10 — EFFECTS OF BASE-EMITTER RESISTANCE

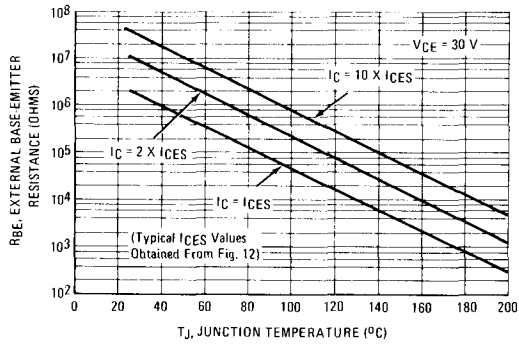


FIGURE 11 — ON VOLTAGES

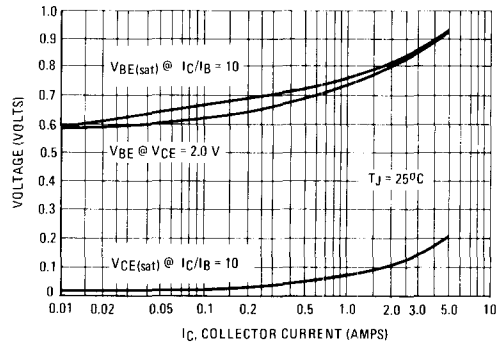


FIGURE 12 — COLLECTOR CUT-OFF REGION

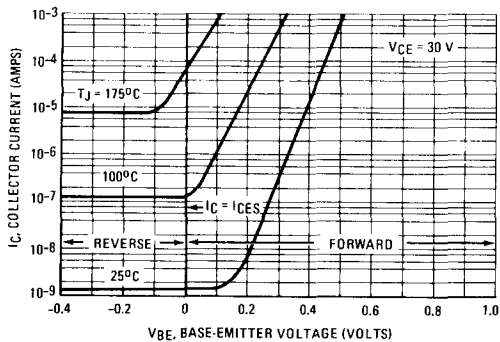


FIGURE 13 — TEMPERATURE COEFFICIENTS

