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*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
	80			2N6303	30/150	1.5	0.4*		1.5	60
		4	60	2N4877		20/100	4	1.5	0.5	4
5	80	2N5336	2N6190	30/120	2	2	0.2	2	30	6
		2N5337	2N6191	60/240	2	2	0.2	2	30	6
	100	2N5338		30/120	2	2	0.2	2	30	10
		2N5339	2N6193	60/240	2	2	0.2	2	30	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)

2N6190
2N6191
2N6193

MEDIUM-POWER PNP 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 NPN 2N5336 thru 2N5339

5 AMPERE

POWER TRANSISTORS
PNP SILICON

80-100 VOLTS
10 WATTS

*** MAXIMUM RATINGS**

Rating	Symbol	2N6190 2N6191	2N6193	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 @ $T_C = 25^\circ\text{C}$	P_D	10		Watts
Derate above 25°C		57.1		mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200		$^\circ\text{C}$

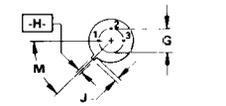
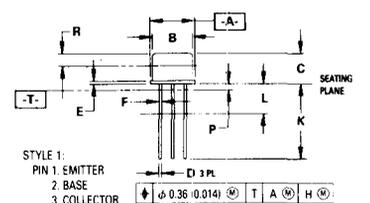
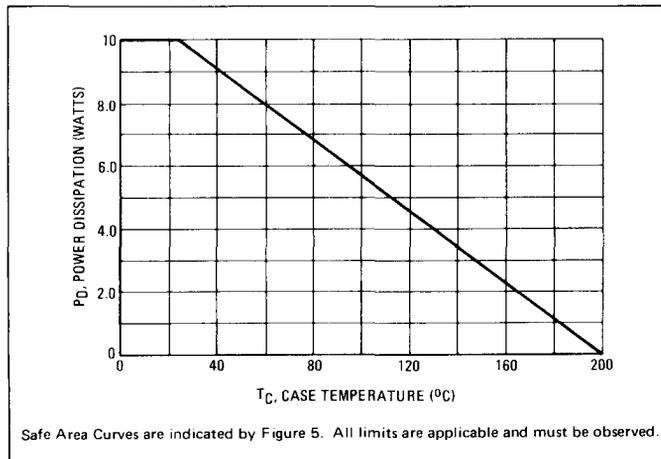


THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	17.5	$^\circ\text{C/W}$

* Indicates JEDEC Registered Data.

FIGURE 1 — POWER-TEMPERATURE DERATING



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)

2N6190, 2N6191, 2N6193

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage (1) (I _C = 50 mA, I _B = 0)	V _{CE0(sus)}	80 100	—	V _{dc}
Collector Cutoff Current (V _{CE} = 75 Vdc, I _B = 0) (V _{CE} = 90 Vdc, I _B = 0)	I _{CEO}	—	100 100	μA _{dc}
Collector Cutoff Current (V _{CE} = 75 Vdc, V _{BE(off)} = 1.5 Vdc) (V _{CE} = 90 Vdc, V _{BE(off)} = 1.5 Vdc) (V _{CE} = 75 Vdc, V _{BE(off)} = 1.5 Vdc, T _C = 150°C) (V _{CE} = 90 Vdc, V _{BE(off)} = 1.5 Vdc, T _C = 150°C)	I _{CEx}	—	10 10 1.0 1.0	μA _{dc} mA _{dc}
Collector Cutoff Current (V _{CB} = 80 Vdc, I _E = 0) (V _{CB} = 100 Vdc, I _E = 0)	I _{CBO}	—	10 10	μA _{dc}
Emitter Cutoff Current (V _{BE} = 6.0 Vdc, I _C = 0)	I _{EBO}	—	100	μA _{dc}
ON CHARACTERISTICS (1)				
DC Current Gain (I _C = 500 mA, V _{CE} = 2.0 Vdc) (I _C = 2.0 A, V _{CE} = 2.0 Vdc) (I _C = 5.0 A, V _{CE} = 2.0 Vdc)	h _{FE}	30 60 30 60 20 40	—	—
Collector-Emitter Saturation Voltage (I _C = 2.0 A, I _B = 0.2 A) (I _C = 5.0 A, I _B = 0.5 A)	V _{CE(sat)}	—	0.7 1.2	V _{dc}
Base-Emitter Saturation Voltage (I _C = 2.0 A, I _B = 0.2 A) (I _C = 5.0 A, I _B = 0.5 A)	V _{BE(sat)}	—	1.2 1.8	V _{dc}
DYNAMIC CHARACTERISTICS				
Current-Gain-Bandwidth Product (2) (I _C = 0.5 A, V _{CE} = 10 Vdc, f _{Test} = 10 MHz)	f _T	30	—	MHz
Output Capacitance (V _{CB} = 10 Vdc, I _E = 0, f = 100 kHz)	C _{ob}	—	300	pF
Input Capacitance (V _{BE} = 2.0 Vdc, I _C = 0, f = 100 kHz)	C _{ib}	—	1250	pF
SWITCHING CHARACTERISTICS				
Delay Time (V _{CC} = 40 Vdc, V _{BE(off)} = 3.0 Vdc, I _C = 2.0 A, I _{B1} = 0.2 A)	t _d	—	100	ns
Rise Time (V _{CC} = 40 Vdc, I _C = 2.0 A, I _{B1} = 0.2 A)	t _r	—	100	ns
Storage Time (V _{CC} = 40 Vdc, I _C = 2.0 A, I _{B1} = I _{B2} = 0.2 A)	t _s	—	2.0	μs
Fall Time (V _{CC} = 40 Vdc, I _C = 2.0 A, I _{B1} = I _{B2} = 0.2 A)	t _f	—	200	ns

* Indicates JEDEC Registered Data

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

(2) f_T = 1/h_{FE} · f_{Test}

FIGURE 2 — SWITCHING TIME TEST CIRCUIT

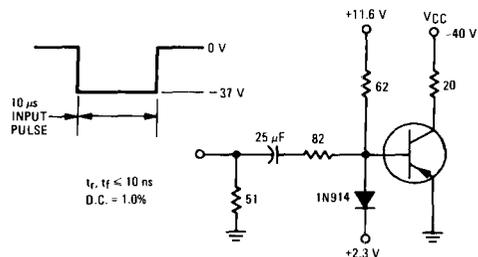


FIGURE 3 — TURN ON TIME

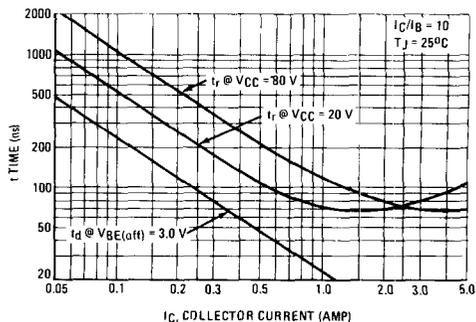


FIGURE 4 – THERMAL RESPONSE

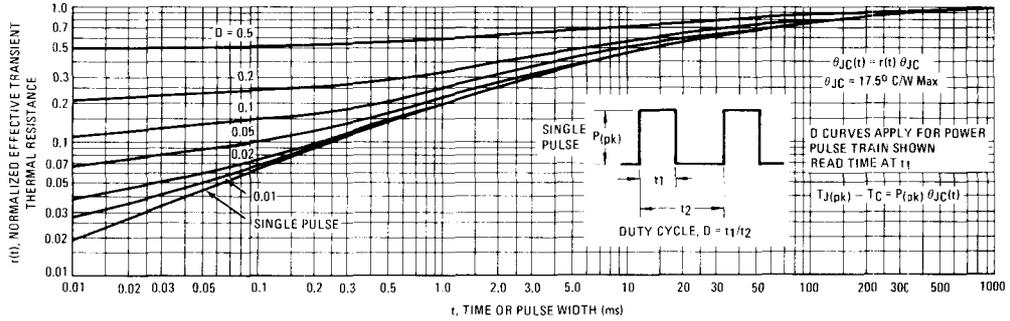
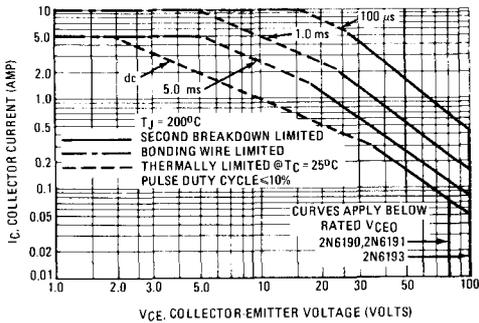


FIGURE 5 – ACTIVE-REGION SAFE OPERATING AREA



There are two limitations on the power handling ability of a transistor: 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 $T_{J(pk)} = 200^\circ\text{C}$; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} < 200^\circ\text{C}$. $T_{J(pk)}$ 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 second breakdown.

FIGURE 6 – TURN-OFF TIME

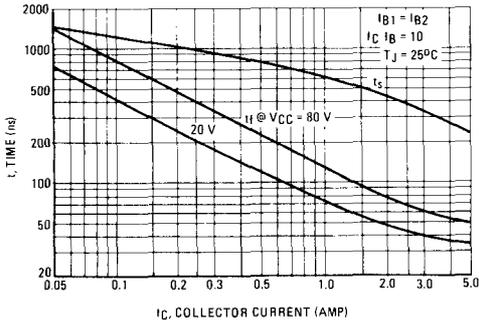


FIGURE 7 – CAPACITANCE versus VOLTAGE

