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2N5301	2N5301		3-93	2N5559		MJ15001	3-710
2N5302	2N5302		3-93	2N5575		2N5685	3-112
2N5302JAN	2N5302JAN		3-93	2N5578		2N5685	3-112
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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
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*Consult Motorola if a direct replacement is necessary.

TABLE 7 — PLASTIC TO-225 Type (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		
3	45		BD176 BD176.6 BD176.10 BD176.16	40/250 40/100 63/160 100/250	0.15 0.15 0.15 0.15				3 3 3 3	30 30 30 30
		MJE181	MJE171	50/250	0.1	0.6 typ	0.12 typ	0.1	50	12.5
		BD179 BD179.6 BD179.10 BD179.16 MJE182	BD180 BD180.6 BD180.10 BD180.16 MJE172	40/250 40/100 63/160 100/250 50/250	0.15 0.15 0.15 0.15 0.1				3 3 3 3 50	30 30 30 30 12.5
		BUY49P		30 min	0.5				25	20
	200									
4	30	BD185		15 min	2				20	40
	40	2N5190 MJE521 2N6037##	2N5193 MJE371 2N6034##	25/100 40 min 750/18k	1.5 1 2	0.4 typ 1 1.7 typ	0.4 typ 1 1.2 typ	1.5 1 2	2 2 25	40 40 40
		BD437 BD675## BD675A## BD785	BD438 BD676## BD676A## BD786 BD776##	40 min 750 min 750 min 20 min 750 min	2 1.5 2 2 2				3 50 20	36 40 40 15 15
	60	BD189		15 min	2				20	40
		BD677## BD677A## BD787 BD777## 2N5191 MJE800## MJE801## 2N6038##	BD440 BD678## BD678A## BD788 BD778## 2N5194 MJE700## MJE701## 2N6035##	25 min 750 min 750 min 20 min 750 min 25/100 750 min 750 min 750/18k	2 1.5 2 2 2 1.5 1.5 2 2				3 50 20 2 1# 1# 25	36 40 40 15 15 40 40 40
						0.4 typ	0.4 typ	1.5		
						1.7 typ	1.2 typ	2		
		2N5192 BD441 BD679## BD679A## BD789 BD779## MJE240 MJE241 MJE802## MJE803## 2N6039##	2N5195 BD442 BD680## BD680A## BD790 BD780## MJE250 MJE251 MJE702## MJE703## 2N6036##	25/100 15 min 750 min 750 min 10 min 750 min 40/200 40/120 750 min 750 min 750/18k	1.5 2 1.5 2 2 2 0.2 0.2 1.5 2 2	0.4 typ 1.5 1.5 2 2 0.15 typ 0.15 typ 1.7 typ	0.4 typ 1.5 1.5 2 2 0.07 typ 0.07 typ 1.2 typ	1.5 2 2 2 2 2 2	2 3 40 20 40 40 1# 1# 25	40 36 40 40 15 15 15 15 40 40 40
	100	BD681## BD791 MJE243 MJE244	BD682## BD792 MJE253 MJE254	750 min 10 min 40/120 25 min	1.5 2 0.2 0.2				40 40 40 40	40 15 15 15
						0.15 typ 0.15 typ	0.07 typ 0.07 typ	2 2		
5	25	MJE200	MJE210	45/180	2	0.13 typ	0.035 typ	2	65	15

● Case 77 (Style 3), # |h_{FE}| @ 1 MHz, ## Darlington

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

2N5190 thru 2N5192

SILICON NPN POWER TRANSISTORS

... for use in power amplifier and switching circuits, — excellent safe area limits. Complement to PNP 2N5193, 2N5194, 2N5195

*MAXIMUM RATINGS

Rating	Symbol	2N5190	2N5191	2N5192	Unit
Collector-Emitter Voltage	V_{CE0}	40	60	80	Vdc
Collector-Base Voltage	V_{CB}	40	60	80	Vdc
Emitter-Base Voltage	V_{EB}	5.0	5.0	5.0	Vdc
Collector Current	I_C	4.0	4.0	4.0	Adc
Base Current	I_B	1.0	1.0	1.0	Adc
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	40	320	320	Watts mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +150	-65 to +150	-65 to +150	$^\circ\text{C}$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	3.12	$^\circ\text{C/W}$

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

Characteristic	Symbol	Min	Max	Unit
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OFF CHARACTERISTICS

Collector-Emitter Sustaining Voltage (1) ($I_C = 0.1 \text{ Adc}, I_B = 0$)	2N5190 2N5191 2N5192	$V_{CE0(sust)}$	40 60 80	Vdc
Collector Cutoff Current ($V_{CE} = 40 \text{ Vdc}, I_B = 0$) ($V_{CE} = 60 \text{ Vdc}, I_B = 0$) ($V_{CE} = 80 \text{ Vdc}, I_B = 0$)	2N5190 2N5191 2N5192	I_{CEO}	— 1.0 1.0	mAdc
Collector Cutoff Current ($V_{CE} = 40 \text{ Vdc}, V_{EB}(\text{off}) = 1.5 \text{ Vdc}$) ($V_{CE} = 60 \text{ Vdc}, V_{EB}(\text{off}) = 1.5 \text{ Vdc}$) ($V_{CE} = 80 \text{ Vdc}, V_{EB}(\text{off}) = 1.5 \text{ Vdc}$) ($V_{CE} = 40 \text{ Vdc}, V_{EB}(\text{off}) = 1.5 \text{ Vdc}, T_C = 125^\circ\text{C}$) ($V_{CE} = 60 \text{ Vdc}, V_{EB}(\text{off}) = 1.5 \text{ Vdc}, T_C = 125^\circ\text{C}$) ($V_{CE} = 80 \text{ Vdc}, V_{EB}(\text{off}) = 1.5 \text{ Vdc}, T_C = 125^\circ\text{C}$)	2N5190 2N5191 2N5192 2N5190 2N5191 2N5192	I_{CEX}	0.1 0.1 0.1 2.0 2.0 2.0	mAdc
Collector Cutoff Current ($V_{CB} = 40 \text{ Vdc}, I_E = 0$) ($V_{CB} = 60 \text{ Vdc}, I_E = 0$) ($V_{CB} = 80 \text{ Vdc}, I_E = 0$)	2N5190 2N5191 2N5192	I_{CBO}	0.1 0.1 0.1	mAdc
Emitter Cutoff Current ($V_{BE} = 5.0 \text{ Vdc}, I_C = 0$)	2N5190 2N5191 2N5192	I_{EBO}	1.0	mAdc

ON CHARACTERISTICS

DC Current Gain(1) ($I_C = 1.5 \text{ Adc}, V_{CE} = 2.0 \text{ Vdc}$) ($I_C = 4.0 \text{ Adc}, V_{CE} = 2.0 \text{ Vdc}$)	2N5190 2N5191 2N5192 2N5190 2N5191 2N5192	h_{FE}	25 25 20 10 10 7.0	100 100 80 — — —
Collector-Emitter Saturation Voltage(1) ($I_C = 1.5 \text{ Adc}, I_B = 0.15 \text{ Adc}$) ($I_C = 4.0 \text{ Adc}, I_B = 1.0 \text{ Adc}$)	2N5190 2N5191 2N5192	$V_{CE(sat)}$	0.6 1.4	Vdc
Base-Emitter On Voltage(1) ($I_C = 1.5 \text{ Adc}, V_{CE} = 2.0 \text{ Vdc}$)	2N5190 2N5191 2N5192	$V_{BE(on)}$	1.2	Vdc

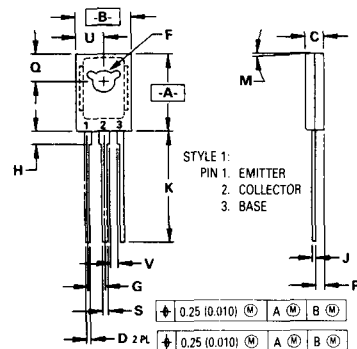
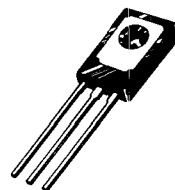
DYNAMIC CHARACTERISTICS

Current-Gain-Bandwidth Product ($I_C = 1.0 \text{ Adc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ MHz}$)	2N5190 2N5191 2N5192	f_T	2.0	MHz
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(1) Pulse Test: Pulse Width $\leq 300 \mu\text{s}$, Duty Cycle $\leq 2.0\%$.
*Indicates JEDEC Registered Data

4 AMPERE POWER TRANSISTORS SILICON NPN

40-80 VOLTS
40 WATTS



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.80	11.04	0.425	0.435
B	7.50	7.74	0.295	0.305
C	2.42	2.66	0.095	0.105
D	0.51	0.66	0.020	0.026
F	2.93	3.17	0.115	0.125
G	2.39 BSC	0.094 BSC		
H	1.27	2.41	0.050	0.095
J	0.39	0.63	0.015	0.025
K	14.61	16.63	0.575	0.655
M	3° TYP	3° TYP		
Q	3.76	4.01	0.148	0.158
R	1.15	1.39	0.045	0.055
S	0.64	0.88	0.025	0.035
U	3.69	3.93	0.145	0.155
V	1.02	—	0.040	—

CASE 77-06
TO-225AA TYPE

FIGURE 1 – DC CURRENT GAIN

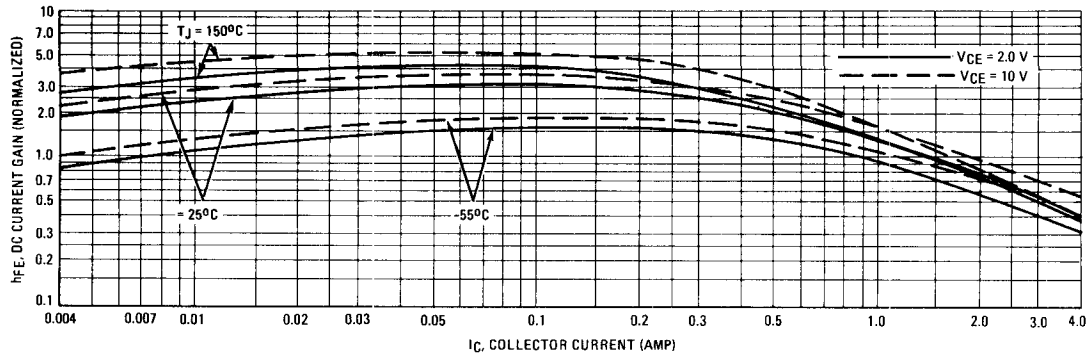


FIGURE 2 – COLLECTOR SATURATION REGION

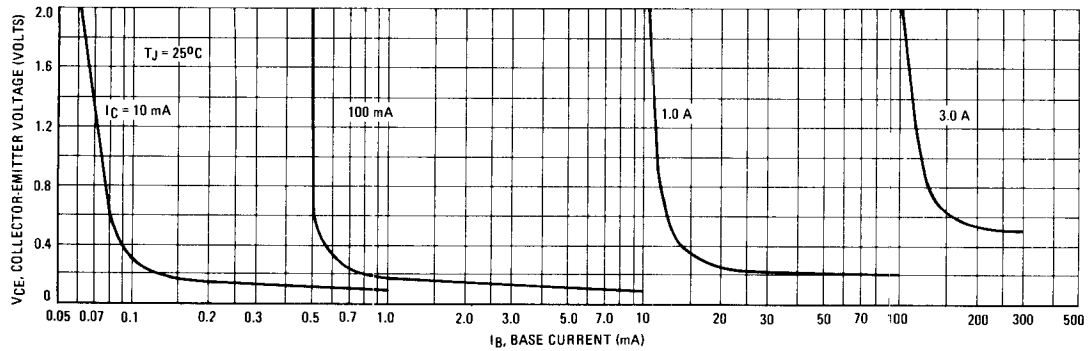


FIGURE 3 – "ON" VOLTAGES

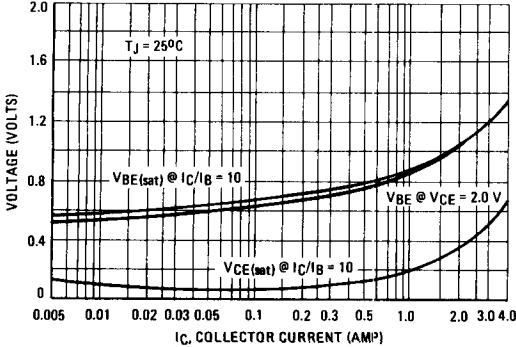
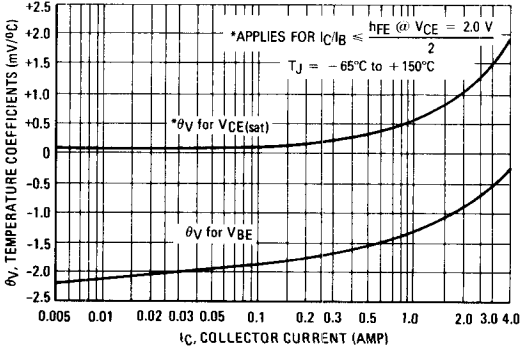
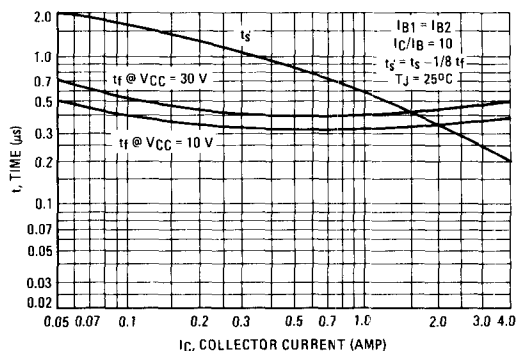
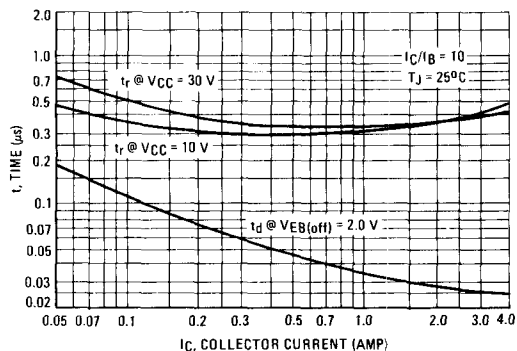
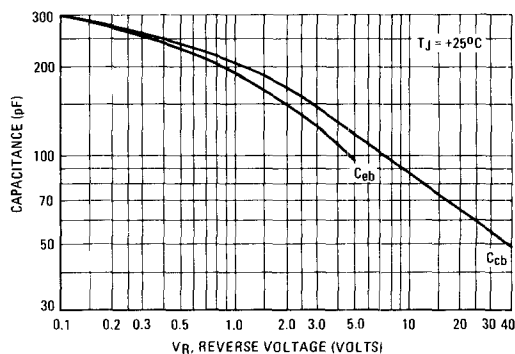
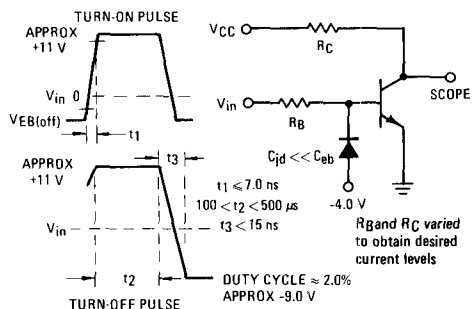
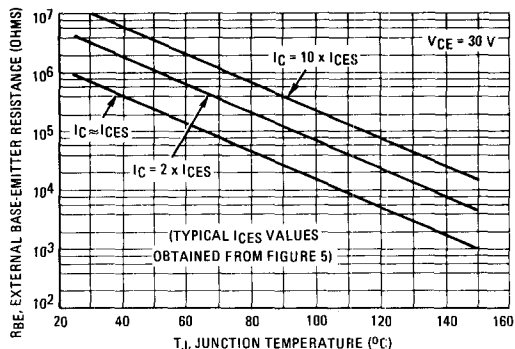
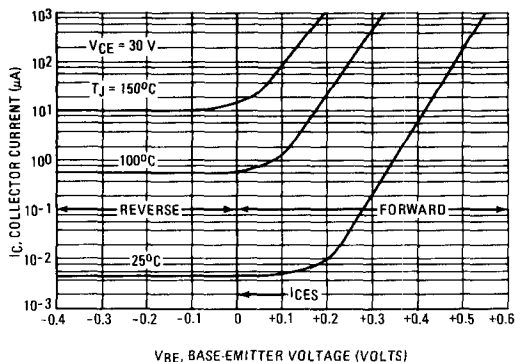


FIGURE 4 – TEMPERATURE COEFFICIENTS

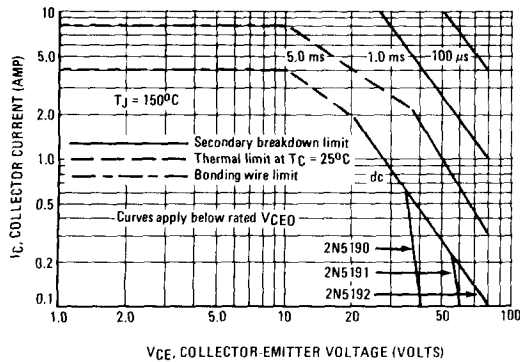


3



2N5190 thru 2N5192

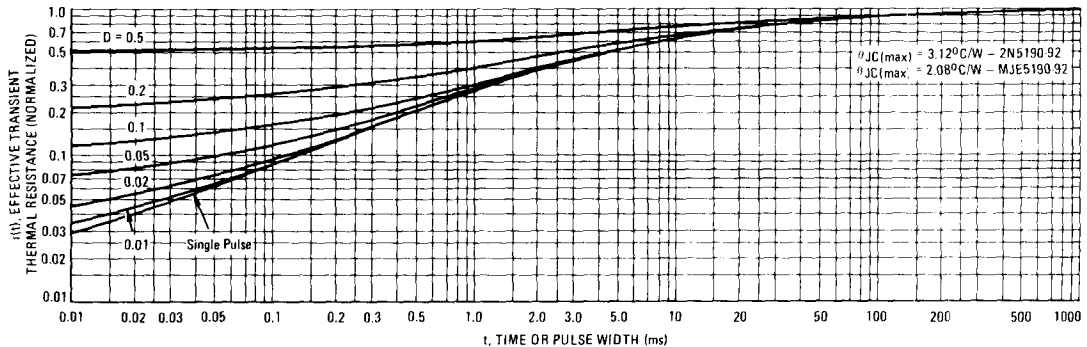
**FIGURE 11 RATING AND THERMAL DATA
ACTIVE-REGION SAFE OPERATING AREA**



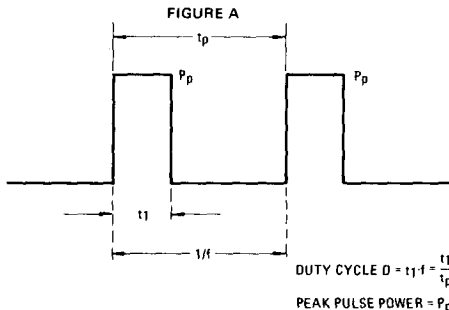
There are two limitations on the power handling ability of a transistor; average junction temperature and second breakdown. Safe operating area curves indicate $I_C - V_{CE}$ limits of the transistor that must be observed for reliable operation, i.e., the transistor must not be subjected to greater dissipation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

The data of Figure 11 is based on $T_{J(pk)} = 150^\circ\text{C}$; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150^\circ\text{C}$. 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 12 – THERMAL RESPONSE



DESIGN NOTE: USE OF TRANSIENT THERMAL RESISTANCE DATA



A train of periodical power pulses can be represented by the model shown in Figure A. Using the model and the device thermal response, the normalized effective transient thermal resistance of Figure 12 was calculated for various duty cycles.

To find $\theta_{JC}(t)$, multiply the value obtained from Figure 12 by the steady state value θ_{JC} .

Example:

The 2N5190 is dissipating 50 watts under the following conditions: $t_1 = 0.1$ ms, $t_p = 0.5$ ms. ($D = 0.2$).

Using Figure 12, at a pulse width of 0.1 ms and $D = 0.2$, the reading of $r(t_1, D)$ is 0.27.

The peak rise in junction temperature is therefore:

$$\Delta T = r(t) \times P_p \times \theta_{JC} = 0.27 \times 50 \times 3.12 = 42.2^\circ\text{C}$$