ALPHANUMERIC INDEX — CROSS-REFERENCE (Continued)

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MJ802	MJ802		3-526
MJ804		MJ12004	3-644
MJ8100		2N6193	3-158
MJ8500	MJ8501		3-546
MJ8501	MJ8501		3-546
MJ8502	MJ8502		3-552
MJ8503	MJ8503		3-552
MJ8504	MJ8504		3-558
MJ8505	MJ8505		3-558
MJ900	MJ900		3-528
MJ901	MJ901		3-528
MJ920		2N6298	3-147
MJ921		2N6299	3-147
MJD112	MJD112		3-816
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MJD117	MJD117		3-816
MJD117-1	MJD117-1		3-816
MJD122	MJD122		3-822
MJD122-1	MJD122-1		3-822
MJD127	MJD127		3-822
MJD127-1	MJD127-1		3-822
MJD13003	MJD13003		3-854
MJD13003-1	MJD13003-1		3-822
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MJD200	MJD200		3-832
MJD200-1	MJD200-1		3-832
MJD210	MJD210		3-832
MJD210-1	MJD210-1		3-832
MJD29	MJD31		3-797
MJD29-1	MJD31-1		3-797
MJD2955	MJD2955		3-844
MJD2955-1	MJD2955-1		3-844
MJD29C	MJD31C		3-797
MJD29C1	MJD31C1		3-797
MJD30	MJD32		3-797
MJD30-1	MJD32-1		3-797
MJD3055	MJD3055		3-844
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MJD31	MJD31		3-797
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MJD32-1	MJD32-1		3-797
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MJD44E3	MJD44E3		3-805
MJD44E3-1	MJD44E3-1		3-805

Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number
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MJD45H11	MJD45H11		3-808
MJD45H11-1	MJD45H11-1		3-808
MJD47	MJD47		3-812
MJD47-1	MJD47-1		3-812
MJD50	MJD50		3-812
MJD50-1	MJD50-1		3-812
MJD6036	MJD6036		3-848
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MJD6039	MJD6039		3-848
MJD6039-1	MJD6039-1		3-848
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MJE102		MJE2955	3-904
MJE103		MJE2955	3-904
MJE104		MJE2955	3-904
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MJE1090	MJE1090		—
MJE1091	MJE1093		—
MJE1092	MJE1092		—
MJE1093	MJE1093		—
MJE1100	MJE1100		—
MJE1101	MJE1101		—
MJE1102	MJE1102		—
MJE1103	MJE1103		—
MJE12007	MJE12007		3-936
MJE1290		2N5988	3-131
MJE1291		2N5988	3-131
MJE13002	MJE13002		3-938
MJE13003	MJE13003		3-938
MJE13004	MJE13004		3-944
MJE13005	MJE13005		3-944
MJE13006	MJE13006		3-950
MJE13007	MJE13007		3-950
MJE13008	MJE13008		3-958
MJE13009	MJE13009		3-958
MJE13070	MJE13070		3-966
MJE13071		MJE16002	3-976
MJE1320	MJE1320		3-892
MJE15028	MJE15028		3-972
MJE15029	MJE15029		3-972
MJE15030	MJE15030		3-972
MJE15031	MJE15031		3-972
MJE16002	MJE16002		3-976
MJE16004	MJE16004		3-976
MJE16032	MJE16032		3-984
MJE16034	MJE16034		3-984
MJE1660	MJE1660		3-898
MJE1661	MJE1661		3-898
MJE170	MJE170		3-862
MJE171	MJE171		3-862
MJE172	MJE172		3-862
MJE180	MJE180		3-862
MJE181	MJE181		3-862
MJE182	MJE182		3-862
MJE200	MJE200		3-866
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MJE2011		TIP42A	3-1083

*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
7	45	BD795	BD796	25 min	3				3	65
	50	2N6290	2N6109	30/150	2.5	0.4 typ	0.15 typ	3	4	40
	60	BD797	BD798	25 min	3				3	65
	70	2N6292	2N6107	30/150	3	0.4 typ	0.15 typ	3	4	40
	80	BD799	BD800	15 min	3				3	65
	100	BD801	BD802	15 min	3				3	65
	150	BU407,D		30 min	1.5		0.75	5	10	60
	200	BU406,D		30 min	1.5		0.75	5	10	60
	375	BU522##		250 min	2.5				7.5	75
	425	BU522A##		250 min	2.5				7.5	75
	450	BU522B##		250 min	2.5				7.5	75
8	40	2N6386##		1k/20k	3				20#	65
	45	BDX53##	BDX54##	750 min	3				4#	60
		BD895##	BD896##	750 min	3				1#	70
		BD895A##	BD896A##	750 min	4				1#	70
	60	2N6043##	2N6040##	1k/10k	4	1.5 typ	1.5 typ	3	4#	75
		BDX53A##	BDX54A##	750 min	3				4#	60
		BD897##	BD898##	750 min	3				1#	70
		BD897A##	BD898A##	750 min	4				1#	70
		TIP100##	TIP105##	1k/20k	3	1.5 typ	1.5 typ	3	4#	80
	80	2N6044##	2N6041##	1k/10k	4	1.5 typ	1.5 typ	3	4#	75
		BDX53B##	BDX54B##	750 min	3				4#	60
		BD899##	BD900##	750 min	3				1#	70
		BD899A##	BD900A##	750 min	4				1#	70
		TIP101##	TIP106##	1k/20k	3	1.5 typ	1.5 typ	3	4#	80
	100	2N6045##	2N6042##	1k/10k	3	1.5 typ	1.5 typ	3	4#	75
		BDX53C##	BDX54C##	750 min	3				4#	60
		BD901##	BD902##	750 min	3				1#	70
		TIP102##	TIP107##	1k/20k	3	1.5 typ	1.5 typ	3	4#	80
	120	BDX53D##	BDX54D##	750 min	3				4#	60
		MJE15028	MJE15029	20 min	4				30	50
	150	MJE15030	MJE15031	20 min	4				30	50
		BU807##		100 min	5	0.55 typ	0.2 typ	5		60
	200	BU806##		100 min	5	0.55 typ	0.2 typ	5		60
	300	MJE13006		5/30	5	3	0.7	5	4	80
		MJE5740##		200 min	4	8 typ	2 typ	6		80
			MJE5850	15 min	2	2	0.5	4		80
	350	MJE5741##		200 min	4	8 typ	2 typ	6		80
			MJE5851	15 min	2	2	0.5	4		80
	400	MJE5742##		200 min	4	8 typ	2 typ	6		80
		MJE13007		5/30	5	3	0.7	5	4	80
			MJE5852	15 min	2	2	0.5	4		80
		MJE16080		5 min	8	2	0.5	5		80
		MJE16106		6/25	8	2 typ	0.1 typ	5		100
	450	MJE16081		5 min	8	2	0.5	5		80
10	30		D45H1	20 min	4					50
			D45H2	40 min	4					50
	40	D44E1##		1000 min	5	2 typ	0.5 typ	10		50
	45	BDX33##	BDX34##	750 min	4				3	70
		BD805	BD806	15 min	4				1.5	90
			D45H4	20 min	4					50
		D44H5	D45H5	40 min	4					50
	60	BDX33A##	BDX34A##	750 min	4				3	70
		BD807	BD808	15 min	4				1.5	90

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

(continued)

TABLE 13 — POWER SWITCHING TRANSISTORS (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	Case JEDEC/MOT
4	30	BD185		15 min	2				20	40	TO-225AA/77
	45	BD785	BD786	20 min	2				50	15	TO-225AA/77
	60	2N4877		20/100	4	1.5	0.5	4	30	10	TO-205AD/79
		BD189		15 min	2				20	40	TO-225AA/77
		BD787	BD788	20 min	2				50	15	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		60/240	2	2	0.2	2	30	60	TO-213AA/80
		2N6316	2N6318	20/100	2.5	1	0.8	2.5	4	90	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	20/100	10	1	0.8	10	4	200	TO-204/1
			2N6436	30/120	10	1	0.25	10	40	200	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		10 min	20	1.2	0.25	20	8	150	TO-204/1
		BUV10N		10 min	20	1.55	0.45	15	10	175	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

NPN **PNP**
MJE15028 MJE15029
MJE15030 MJE15031

COMPLEMENTARY SILICON PLASTIC POWER TRANSISTORS

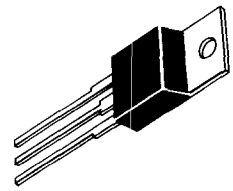
. . . designed for use as high-frequency drivers in audio amplifiers.

- DC Current Gain Specified to 4.0 Amperes
  h_{FE} = 40(Min) @ I_C = 3.0 Adc
  = 20(Min) @ I_C = 4.0 Adc
- Collector-Emitter Sustaining Voltage –
  $V_{CEO(sus)}$ = 120 Vdc (Min) – MJE15028, MJE15029
  = 150 Vdc (Min) – MJE15030, MJE15031
- High Current Gain – Bandwidth Product
  f_T = 30 MHz (Min) @ I_C = 500 mAdc
- TO-220AB Compact Package
- TO-66 Leadform Also Available

8 AMPERE

POWER TRANSISTORS COMPLEMENTARY SILICON

120–150 VOLTS
50 WATTS



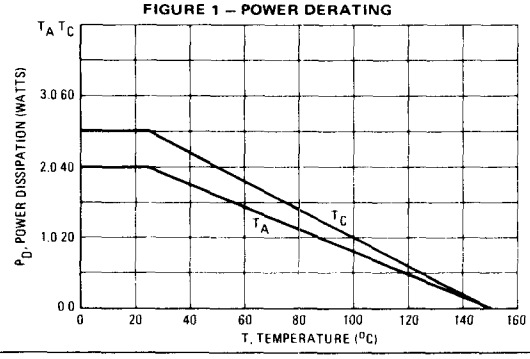
MAXIMUM RATINGS

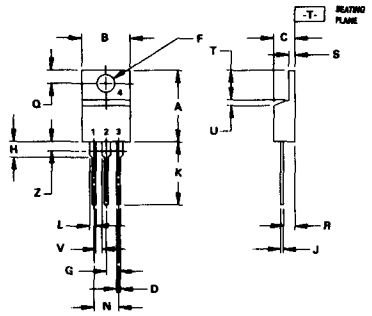
Rating	Symbol	MJE15028 MJE15029	MJE15030 MJE15031	Unit
Collector-Emitter Voltage	V_{CEO}	120	150	Vdc
Collector-Base Voltage	V_{CB}	120	150	Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current – Continuous – Peak	I_C	8.0 16		Adc
Base Current	I_B	2.0		Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	50 0.40		Watts W/°C
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	2.0 0.016		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	$R_{\theta JC}$	2.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	°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	0.86	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

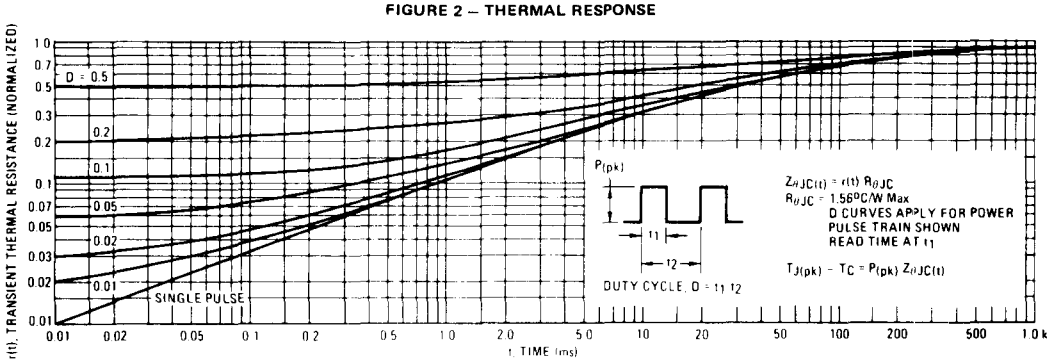
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (1)		$V_{CEO(sus)}$			Vdc
(I_C = 10 mAdc, I_B = 0)	MJE15028, MJE15029		120	–	
	MJE15030, MJE15031		150	–	
Collector Cutoff Current		I_{CEO}			mAdc
(V_{CE} = 120 Vdc, I_B = 0)	MJE15028, MJE15029		–	0.1	
(V_{CE} = 150 Vdc, I_B = 0)	MJE15030, MJE15031		–	0.1	
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 120 Vdc, I_E = 0)	MJE15028, MJE15029		–	10	
(V_{CB} = 150 Vdc, I_E = 0)	MJE15030, MJE15031		–	10	
Emitter Cutoff Current		I_{EBO}	–	10	μAdc
(V_{BE} = 5.0 Vdc, I_C = 0)					
ON CHARACTERISTICS (1)					
DC Current Gain		h_{FE}			–
(I_C = 0.1 Adc, V_{CE} = 2.0 Vdc)			40	–	
(I_C = 2.0 Adc, V_{CE} = 2.0 Vdc)			40	–	
(I_C = 3.0 Adc, V_{CE} = 2.0 Vdc)			40	–	
(I_C = 4.0 Adc, V_{CE} = 2.0 Vdc)			20	–	
DC Current Gain Linearity		h_{FE}	Typ		
(V_{CE} From 2.0V to 20V, I_C From 0.1A to 3A)			2		
(NPN TO PNP)			3		
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	–	0.5	Vdc
(I_C = 1.0 Adc, I_B = 0.1 Adc)					
Base-Emitter On Voltage		$V_{BE(on)}$	–	1.0	Vdc
(I_C = 1.0 Adc, V_{CE} = 2.0 Vdc)					
DYNAMIC CHARACTERISTICS					
Current Gain – Bandwidth Product (2)		f_T	30	–	MHz
(I_C = 500 mAdc, V_{CE} = 10 Vdc, f_{test} = 10 MHz)					

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

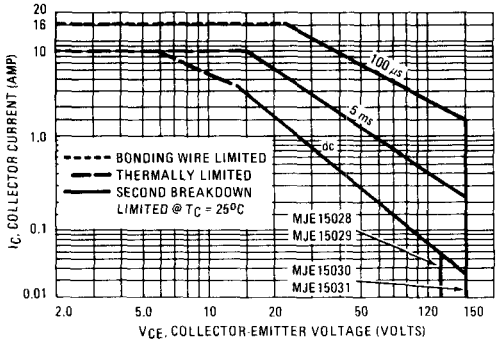
(2)$f_T = |h_{fe}| \cdot f_{test}$

FIGURE 2 – THERMAL RESPONSE



3

FIGURE 3 – FORWARD BIAS 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 Figures 3 and 4 is based on $T_{J(pk)}$ = 150°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 Figure 2. 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 4 – REVERSE-BIAS SWITCHING SAFE OPERATING AREA

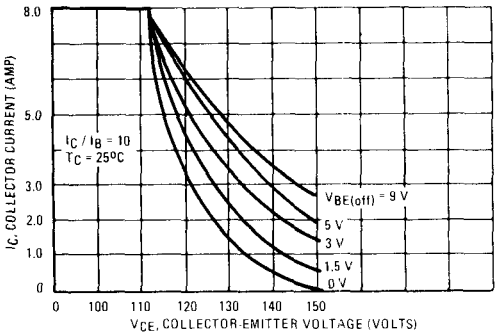


FIGURE 5 – CAPACITANCES

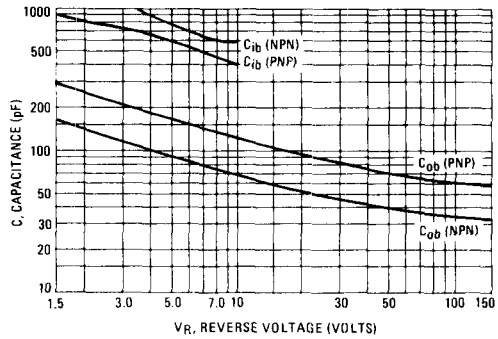


FIGURE 6 – SMALL-SIGNAL CURRENT GAIN

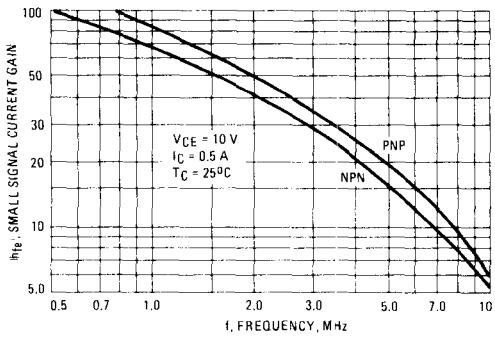


FIGURE 7 – CURRENT GAIN-BANDWIDTH PRODUCT

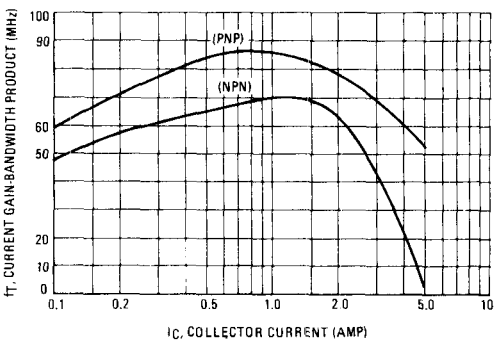
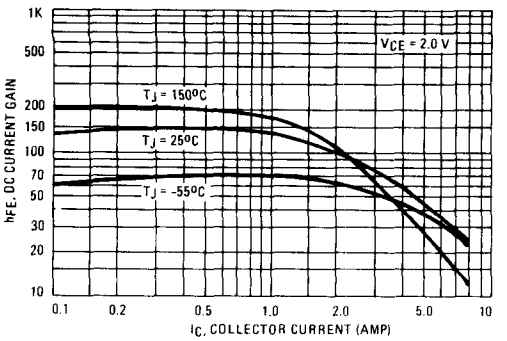


FIGURE 8 – DC CURRENT GAIN

NPN – MJE15028 MJE15030



PNP – MJE15029 MJE15031

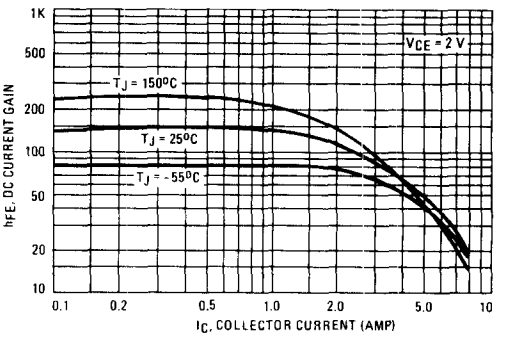
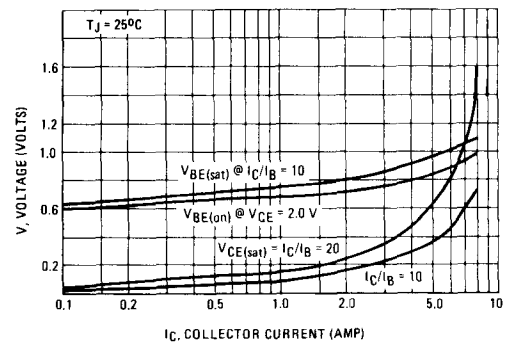


FIGURE 9 – "ON" VOLTAGE

NPN



PNP

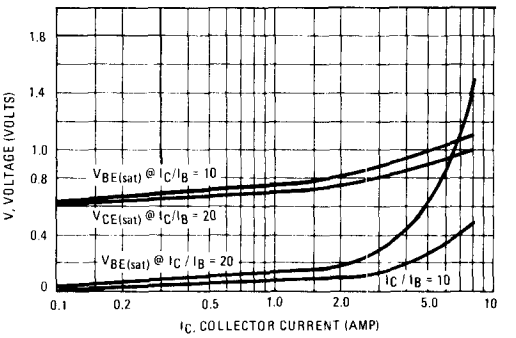


FIGURE 10 – TURN-ON TIMES

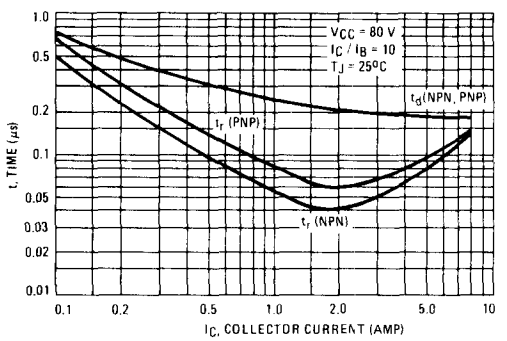
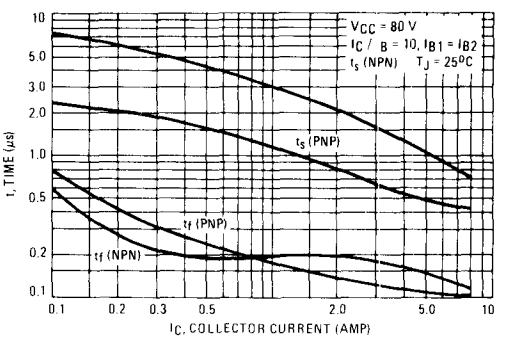


FIGURE 11 – TURN-OFF TIMES

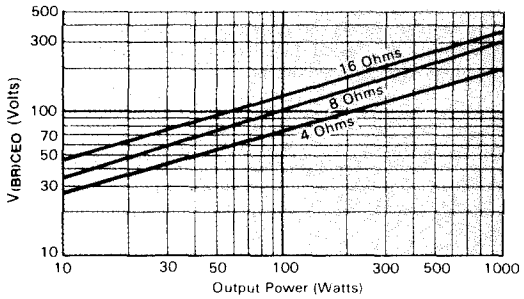


3

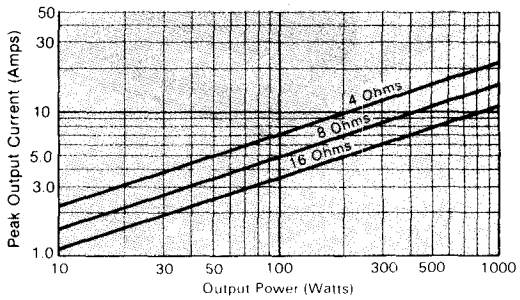
Audio

GENERAL DESIGN CURVES FOR POWER AUDIO OUTPUT STAGES

$V_{(BR)CEO}$ Required on Output and Driver Transistors versus Output Power for 4, 8 and 18 Ohm Load



Output Transistor Peak Collector Current versus Output Power for 4, 8 and 16 Ohm Loads



Another important parameter that must be considered before selecting the output transistors is the safe-operating area these devices must withstand. For a complete discussion on these see Application Notes AN484A and AN485.

TABLE 1 — RECOMMENDED POWER TRANSISTORS FOR AUDIO/SERVO LOADS

RMS Power Output	NPN	PNP	Case	P_D Watts @ 25°C	V_{CEO}	h_{FE}@ Min/Max	I_C Amps	f_T MHz Typ	ISB Volts/Amps
To 25W	MJE15030	MJE15031	TO-220	50W	150 V	20 min	4A	70	14/3.6
25 to 50W	2N3055A	MJ2955A	TO-204	120W	120 V	20/70	4A	3	60/2
	MJ15001	MJ15002	TO-204	200W	140 V	25/150	4A	3	40/5
50 to 100W	MJ15015	MJ15016	TO-204	180W	120 V	20/70	4A	3	60/3
	MJ15003	MJ15004	TO-204	250W	140 V	25/150	5A	3	100/1
	MJ15018	MJ15019	TO-204	150W	200	30 min	1A	20	50/3
	MJ15020	MJ15020	TO-204	150W	250	30 min	1A	20	50/3
Over 100W	MJ15024	MJ15025	TO-204	250W	250 V	15/60	8A	8	80/2.2

The Power Transistors shown are provided for reference only and show device capability. The final choice of the Power Transistors used is left to the circuit designer and depends upon the particular safe-operating area required and the mounting and heat sinking configuration used.