

# 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

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Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number	Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number
BDT63A	BDW41		3-328	BDW51C	2N5882		3-123
BDT63B	BDW42		3-328	BDW52	2N3791		3-56
BDT63C	BDW43		3-328	BDW52A	2N3792		3-56
BDT64	BDW44		3-328	BDW52B	2N3792		3-56
BDT64A	BDW45		3-328	BDW52C	2N5880		3-123
BDT64B	BDW46		3-328	BDW53	TIP120		3-1098
BDT64C	BDW47		3-328	BDW53A	TIP120		3-1098
BDT65	BDW40		3-328	BDW53B	TIP121		3-1098
BDT65A	BDW41		3-328	BDW53C	BDX53C		3-338
BDT65B	BDW42		3-328	BDW53D	BDX53D		3-338
BDT65C	BDW43		3-328	BDW54	TIP125		3-1098
BDT91	BD807		3-316	BDW54A	TIP125		3-1098
BDT92	BD808		3-318	BDW54B	TIP126		3-1098
BDT93	BD809		3-316	BDW54C	BDX54C		3-338
BDT94	BD810		3-318	BDW54D	BDX54D		3-338
BDV64	BDV64		3-324	BDW55	BD135		3-258
BDV64A	BDV64A		3-324	BDW56	BD136		3-260
BDV64B	BDV64B	BDV64B	3-324	BDW57	BD137		3-258
BDV64C			3-324	BDW58	BD138		3-260
BDV65	BDV65		3-324	BDW59	BD139		3-258
BDV65A	BDV65A		3-324	BDW60	BD140		3-260
BDV65B	BDV65B		3-324	BDW63	BDX53		3-338
BDV65C		BDV65B	3-324	BDW63A	BDX53A		3-338
BDV66C	MJH11018		3-1034	BDW63B	BDX53B		3-338
BDV66C	MJH11017		3-1034	BDW63C	BDX53C		3-338
BDV66D	MJH11019		3-1034	BDW63D	BDX53D		3-338
BDV67D	MJH11020		3-1034	BDW64	BDX54		3-338
BDV91	MJE3055T		3-904	BDW64A	BDX54A		3-338
BDV92	TIP34B		3-1077	BDW64B	BDX54B		3-338
BDV93	TIP34C		3-1077	BDW64C	BDX54C		3-338
BDV94	TIP2955		3-1108	BDW73	BD895		3-320
BDV95	TIP33B		3-1077	BDW73A	BD897		3-320
BDV96	TIP33C		3-1077	BDW73B	BD899		3-320
BDW21	2N3714		3-26	BDW73C	BD901		3-320
BDW21A	2N3714		3-26	BDW73D	BDX33D		3-334
BDW21B				BDW74	BD896		3-322
BDW21C	2N3714	2N5882	3-123	BDW74A	BD898		3-322
BDW22	2N3789		3-56	BDW74B	BD900		3-322
BDW22A	2N3789		3-56	BDW74C	BD902		3-322
BDW22B	2N3790		3-56	BDW74D	BDX34D		3-334
BDW22C	2N5880		3-123	BDW83	BDV65		3-324
BDW23	BDX53		3-338	BDW83A	BDV65		3-324
BDW23A	BDX53A		3-338	BDW83B	BDV65A		3-324
BDW23B	BDX53B		3-338	BDW83C	BDV65B		3-324
BDW23C	BDX53C		3-338	BDW84	BDV64		3-324
BDW24	BDX54		3-338	BDW84A	BDV64		3-324
BDW24A	BDX54A		3-338	BDW84B	BDV64A		3-324
BDW24B	BDX54B		3-338	BDW84C	BDV64B		3-324
BDW24C	BDX54C		3-338	BDW93	BDW39		3-328
BDW39	BDW39		3-328	BDW93A	BDW40		3-328
BDW40	BDW40		3-328	BDW93B	BDW41		3-328
BDW41	BDW41		3-328	BDW93C	BDW42		3-328
BDW42	BDW42		3-328	BDW94	BDW44		3-328
BDW44	BDW44		3-328	BDW94A	BDW45		3-328
BDW45	BDW45		3-328	BDW94B	BDW46		3-328
BDW46	BDW46		3-328	BDW94C	BDW47		3-328
BDW47	BDW47		3-328	BDX10	2N3055A		3-9
BDW51	2N3715		3-26	BDX10-4	2N3055A		3-9
BDW51A	2N3715		3-26	BDX10-6	2N3055A		3-9
BDW51B	2N3716		3-26	BDX10-7	2N3055A		3-9

\*Consult Motorola if a direct replacement is necessary.



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

I <sub>C</sub> Cont Amps Max	V <sub>CEO</sub> (sus) Volts Min	Device Type		h <sub>FE</sub> Min/Max	@ I <sub>C</sub> Amp	Resistive Switching			f <sub>T</sub> MHz Min	P <sub>D</sub> (Case) Watts @ 25°C	
		NPN	PNP			t <sub>s</sub> μs Max	t <sub>f</sub> μs Max	@ I <sub>C</sub> Amp			
10	250	MJ15011	MJ15012	20/100	2					200	
	300	MJ3041##		250 min	2.5					175	
	325	MJ413 MJ423 MJ431			20/80	0.5				2.5	125
					30/90	1				2.5	125
					15/35	2.5				2.5	125
	350	BU323## MJ3042## MJ13014 MJ10002## MJ10006##			150 min	6	7.5 typ	5.2 typ	6		175
					250 min	2.5					175
					8/20	5	2	0.5	5		150
					3/300	5	2.5	1	5	10#	150
	400	BU323A## MJ10007## MJ10012## MJ13015			30/300	5	1.5	0.5	5	10#	150
				100/2k	6	15	15	6		175	
				8/20	5	2	0.5	5		150	
				10/250	10	2.5	0.8	10		175	
700	MJ8504			7.5 min	1.5	4	2	5		175	
800	MJ8505 MJ16018			7.5 min	1.5	4	2	5		175	
				4 min	5	4.5 typ	0.2 typ	5		150	
950*	MJ12010			4.2 min	5		1	5		100	
12	60	2N6057##	2N6050##	750/18k	6	1.6 typ	1.5 typ	6	4#	150	
	80	2N6058##	2N6051##	750/18k	6	1.6 typ	1.5 typ	6	4#	150	
	100	2N6059##	2N6052##	750/18k	6	1.6 typ	1.5 typ	6	4#	150	
15	60	2N3055 2N3055A 2N6576## 2N5881	MJ2955 MJ2955A  2N5879	20/70	4	0.7 typ	0.3 typ	4	2.5	115	
				20/70	4			0.8	115		
				2k/20k	4	2	7	10	10-200#	120	
				20/100	6	1	0.8	6	4	160	
	80	2N5882	2N5880	20/100	6	1	0.8	6	4	160	
	90	2N6577##			2k/20k	4	2	7	10	10-200#	120
					2k/20k	4	2	7	10	10-200#	120
	140	MJ15001	MJ15002	25/150	4				2	200	
	150	MJ11018##	MJ11017##	100 min	15				3#	175	
	200	BUX41 2N6249 MJ11020##	MJ11019##		8 min	8	1.5	0.4	8	8	120
					10/50	10	3.5	1	10	2.5	175
					100 min	15				3#	175
	250	MJ11022##	MJ11021##	100 min	15				3#	175	
	275	2N6250		8/50	10	3.5	1	10	2.5	175	
	300	2N6546		6/30	10	4	0.7	10	6 to 24	175	
325	BUX13		8 min	8	2.5	0.8	8	8	150		
400	BUX48 2N6547 MJ13090 MJ16110			8 min	10	2	0.4	10		175	
				6/30	10	4	0.7	10	6 to 24	175	
				8 min	10	2.5	0.5	10		175	
				6/20	15	0.8 typ	0.1 typ	10		175	
450	BUX48A MJ16010			8 min	8	2	0.4	10		175	
				5 min	15	1.2 typ	0.2 typ	10		175	

\* V<sub>BR</sub>/I<sub>C</sub>EX. # |h<sub>FE</sub>| @ 1 MHz, ## Darlington

(continued)

JAN, JTX, JTXV Available

2

# 2N3055 NPN/MJ2955 PNP

NPN  
2N3055

PNP  
MJ2955

FIGURE 3 – DC CURRENT GAIN

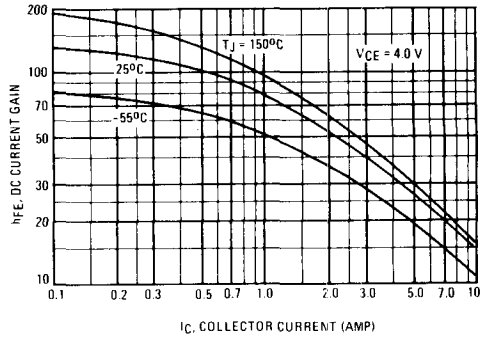
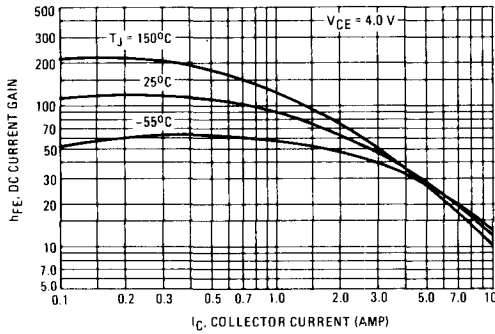


FIGURE 4 – COLLECTOR SATURATION REGION

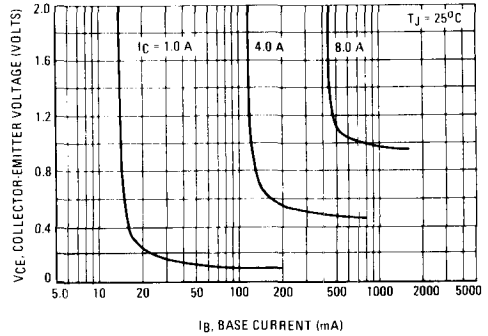
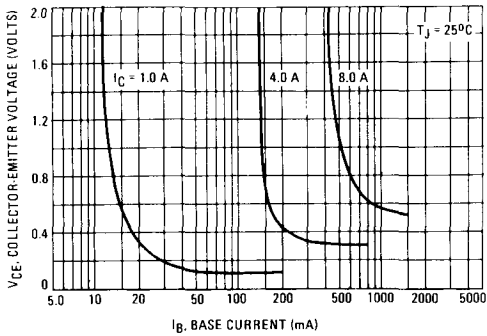
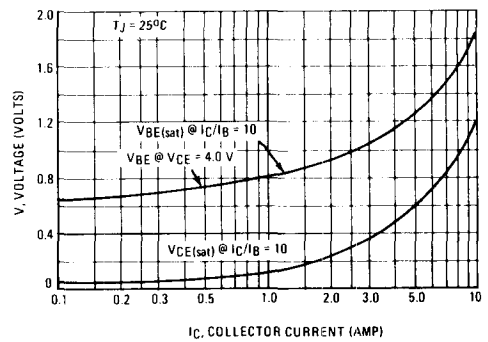
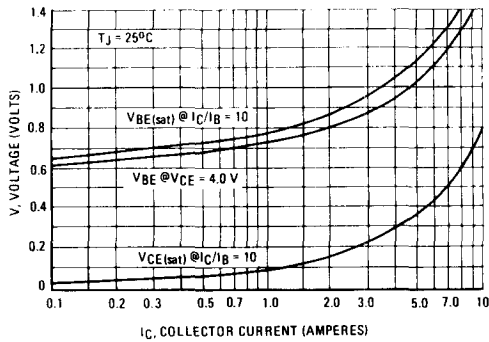


FIGURE 5 – "ON" VOLTAGES



3

**NPN**                      **PNP**  
**2N3055A**                **MJ2955A**  
**MJ15015**                **MJ15016**

**COMPLEMENTARY SILICON  
 HIGH-POWER TRANSISTORS**

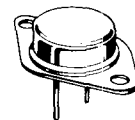
... PowerBase complementary transistors designed for high power audio, stepping motor and other linear applications. These devices can also be used in power switching circuits such as relay or solenoid drivers, dc-to-dc converters, inverters, or for inductive loads requiring higher safe operating area than the 2N3055 and MJ2955.

- Current-Gain — Bandwidth-Product @  $I_C = 1.0 \text{ A dc}$   
 $f_T = 0.8 \text{ MHz (Min) — NPN}$   
 $= 2.2 \text{ MHz (Min) — PNP}$
- Safe Operating Area — Rated to 60 V and 120 V, respectively

**15 AMPERE**

**COMPLEMENTARY SILICON  
 POWER TRANSISTORS**

**60, 120 VOLTS**  
**115, 180 WATTS**



**\*MAXIMUM RATINGS**

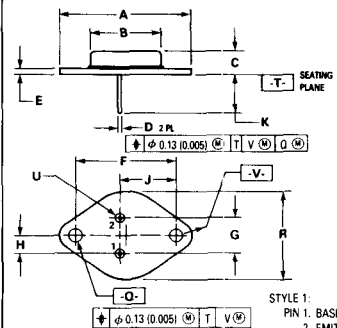
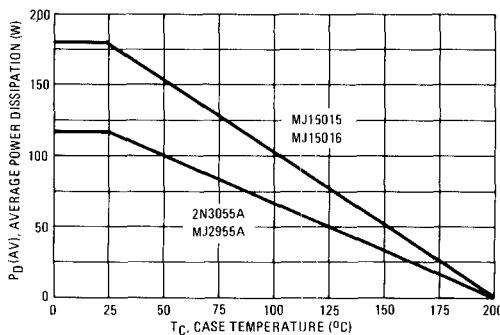
Rating	Symbol	2N3055A MJ2955A	MJ15015 MJ15016	Unit
Collector-Emitter Voltage	$V_{CE0}$	60	120	Vdc
Collector-Base Voltage	$V_{CBO}$	100	200	Vdc
Collector-Emitter Voltage Base Reversed Biased	$V_{CEV}$	100	200	Vdc
Emitter-Base Voltage	$V_{EBO}$	7.0		Vdc
Collector Current — Continuous	$I_C$	15		A dc
Base Current	$I_B$	7.0		A dc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	115 0.65	180 1.03	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	Max	Unit
Thermal Resistance, Junction to Case	$\theta_{JC}$	1.52	0.98	$^\circ\text{C/W}$

\*Indicates JEDEC Registered Data (2N3055A)

**FIGURE 1 — POWER DERATING**



- NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 2. CONTROLLING DIMENSION: INCH  
 3. ALL RULES AND NOTES ASSOCIATED WITH REFERENCED TO-204AA OUTLINE SHALL APPLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	—	39.37	—	1.550
B	—	21.08	—	0.830
C	6.35	8.25	0.250	0.325
D	0.97	1.09	0.038	0.043
E	1.40	1.77	0.055	0.070
F	30.15	BSC	1.187	BSC
G	10.92	BSC	0.430	BSC
H	5.46	BSC	0.215	BSC
J	16.89	BSC	0.665	BSC
K	11.18	12.19	0.440	0.480
Q	3.84	4.19	0.151	0.165
R	—	26.67	—	1.050
U	4.83	5.33	0.190	0.210
V	3.84	4.19	0.151	0.165

**CASE 1-06  
 TO-204AA  
 (TO-3)**

**3**

**NPN 2N3055A, MJ15015**  
**PNP MJ2955A, MJ15016**

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

Characteristic	Symbol	Min	Max	Unit	
<b>OFF CHARACTERISTICS (1)</b>					
*Collector-Emitter Sustaining Voltage ( $I_C = 200 \text{ mAdc}$ , $I_B = 0$ )	2N3055A, MJ2955A MJ15015, MJ15016	$V_{CE0(sus)}$	60 120	— —	Vdc
Collector Cutoff Current ( $V_{CE} = 30 \text{ Vdc}$ , $V_{BE(off)} = 0 \text{ Vdc}$ ) ( $V_{CE} = 60 \text{ Vdc}$ , $V_{BE(off)} = 0 \text{ Vdc}$ )	2N3055A, MJ2955A MJ15015, MJ15016	$I_{CEO}$	— —	0.7 0.1	mAdc
*Collector Cutoff Current ( $V_{CEV} = \text{Rated Value}$ , $V_{BE(off)} = 1.5 \text{ Vdc}$ )	2N3055A, MJ2955A MJ15015, MJ15016	$I_{CEV}$	— —	5.0 1.0	mAdc
Collector Cutoff Current ( $V_{CEV} = \text{Rated Value}$ , $V_{BE(off)} = 1.5 \text{ Vdc}$ , $T_C = 150^\circ\text{C}$ )	2N3055A, MJ2955A MJ15015, MJ15016	$I_{CEV}$	— —	30 6.0	mAdc
*Emitter Cutoff Current ( $V_{EB} = 7.0 \text{ Vdc}$ , $I_C = 0$ )	2N3055A, MJ2955A MJ15015, MJ15016	$I_{EBO}$	— —	5.0 0.2	mAdc
<b>*SECOND BREAKDOWN</b>					
Second Breakdown Collector Current with Base Forward Biased ( $t = 0.5 \text{ s non-repetitive}$ ) ( $V_{CE} = 60 \text{ Vdc}$ )	2N3055A, MJ2955A MJ15015, MJ15016	$I_{S/b}$	1.95 3.0	— —	Adc
<b>*ON CHARACTERISTICS (1)</b>					
DC Current Gain ( $I_C = 4.0 \text{ Adc}$ , $V_{CE} = 2.0 \text{ Vdc}$ ) ( $I_C = 4.0 \text{ Adc}$ , $V_{CE} = 4.0 \text{ Vdc}$ ) ( $I_C = 10 \text{ Adc}$ , $V_{CE} = 4.0 \text{ Vdc}$ )		$h_{FE}$	10 20 5.0	70 70 —	—
Collector-Emitter Saturation Voltage ( $I_C = 4.0 \text{ Adc}$ , $I_B = 400 \text{ mAdc}$ ) ( $I_C = 10 \text{ Adc}$ , $I_B = 3.3 \text{ Adc}$ ) ( $I_C = 15 \text{ Adc}$ , $I_B = 7.0 \text{ Adc}$ )		$V_{CE(sat)}$	— — —	1.1 3.0 5.0	Vdc
Base-Emitter On Voltage ( $I_C = 4.0 \text{ Adc}$ , $V_{CE} = 4.0 \text{ Vdc}$ )		$V_{BE(on)}$	0.7	1.8	Vdc
<b>*DYNAMIC CHARACTERISTICS</b>					
Current-Gain—Bandwidth Product ( $I_C = 1.0 \text{ Adc}$ , $V_{CE} = 4.0 \text{ Vdc}$ , $f = 1.0 \text{ MHz}$ )	2N3055A, MJ15015 MJ2955A, MJ15016	$f_T$	0.8 2.2	6.0 18	MHz
Output Capacitance ( $V_{CB} = 10 \text{ Vdc}$ , $I_E = 0$ , $f = 1.0 \text{ MHz}$ )		$C_{ob}$	60	600	pF
<b>*SWITCHING CHARACTERISTICS (2N3055A only)</b>					
<b>RESISTIVE LOAD</b>					
Delay Time	( $V_{CC} = 30 \text{ Vdc}$ , $I_C = 4.0 \text{ Adc}$ , $I_{B1} = I_{B2} = 0.4 \text{ Adc}$ , $t_p = 25 \mu\text{s Duty Cycle} \leq 2\%$ )	$t_d$	—	0.5	$\mu\text{s}$
Rise Time		$t_r$	—	4.0	$\mu\text{s}$
Storage Time		$t_s$	—	3.0	$\mu\text{s}$
Fall Time		$t_f$	—	6.0	$\mu\text{s}$

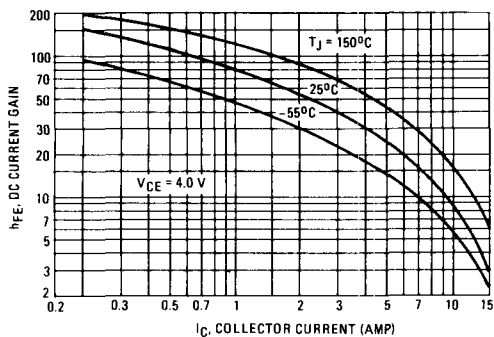
(1) Pulse Test: Pulse Width = 300  $\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

\*Indicates JEDEC Registered Data (2N3055A)

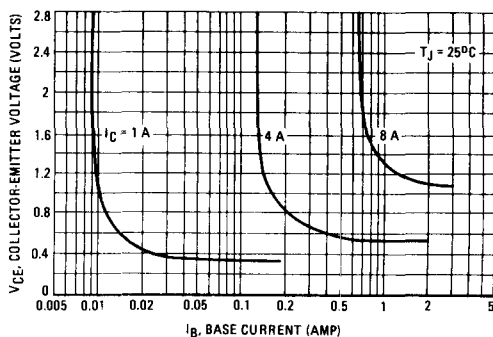
3

**NPN 2N3055A, MJ15015**  
**PNP MJ2955A, MJ15016**

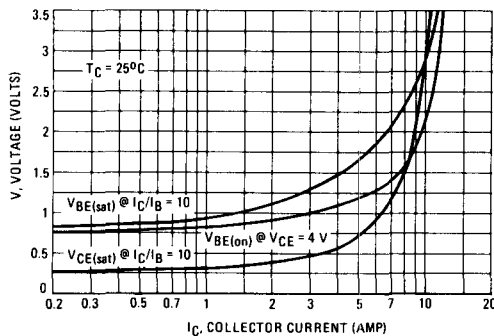
**FIGURE 2 – DC CURRENT GAIN**



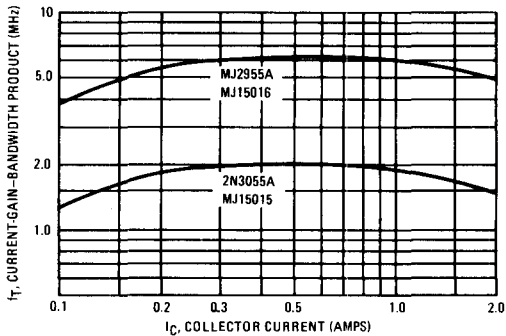
**FIGURE 3 – COLLECTOR SATURATION REGION**



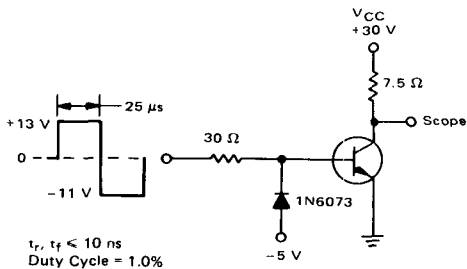
**FIGURE 4 – "ON" VOLTAGES**



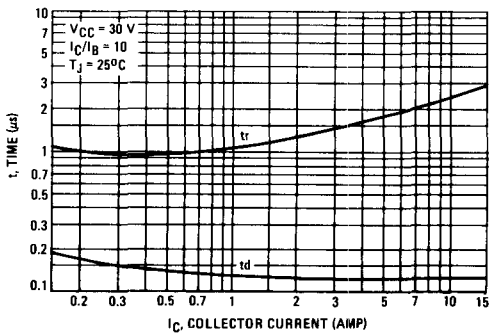
**FIGURE 5 – CURRENT-GAIN-BANDWIDTH PRODUCT**



**FIGURE 6 – SWITCHING TIMES TEST CIRCUIT**  
 (Circuit shown is for NPN)



**FIGURE 7 – TURN-ON TIME**



NPN 2N3055A, MJ15015  
PNP MJ2955A, MJ15016

FIGURE 8 – TURN-OFF TIMES

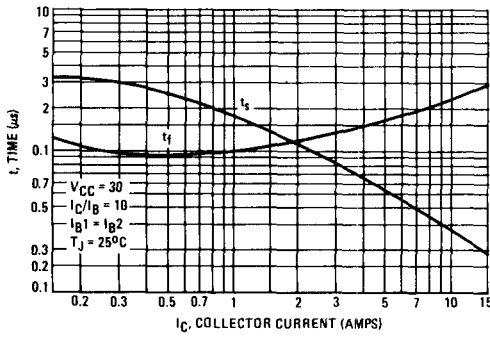
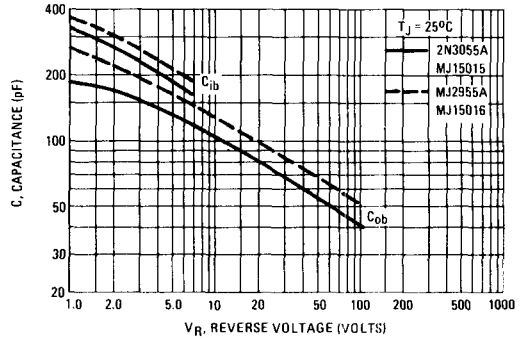
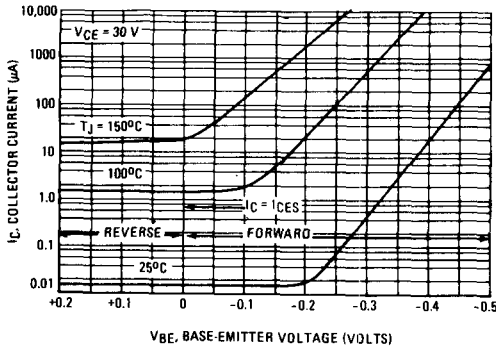


FIGURE 9 – CAPACITANCES



NPN  
FIGURE 10 – 2N3055A, MJ15015



PNP  
FIGURE 11 – MJ2955A, MJ15016

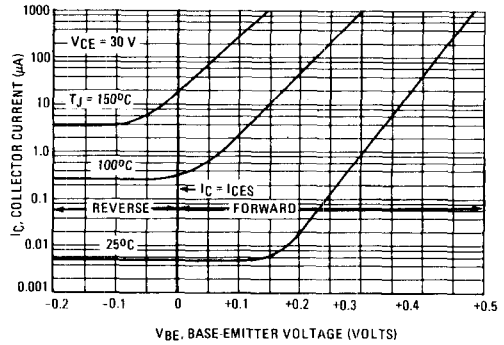


FIGURE 12 – FORWARD BIAS SAFE OPERATING AREA  
2N3055A, MJ2955A

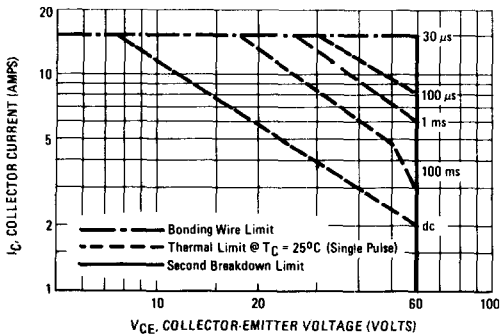
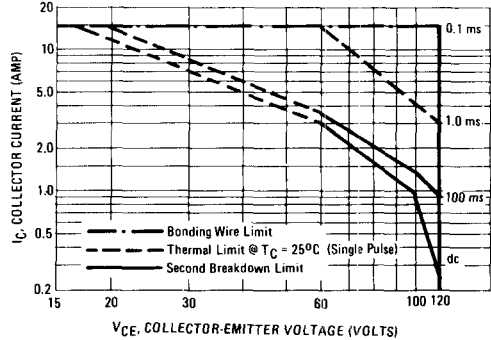


FIGURE 13 – FORWARD BIAS SAFE OPERATING AREA  
MJ15015, MJ15016



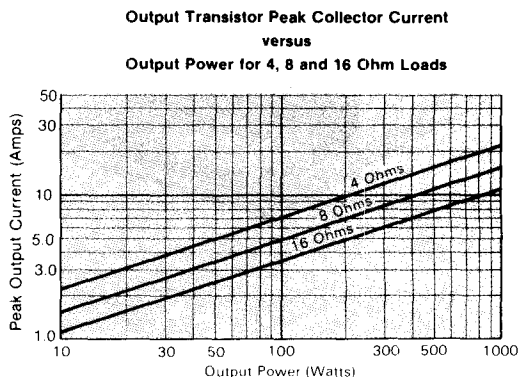
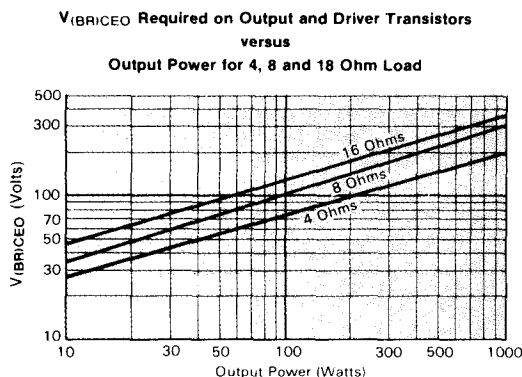
There are two limitations on the power handling ability of a transistor: average junction temperature and second breakdown. Safe operating area curves indicate  $I_C$ - $V_{CE}$  limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater

dissipation than the curves indicate. The data of Figures 12 and 13 is based on  $T_C = 25^\circ C$ ;  $T_{J(pk)}$  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 1.



# Audio

## GENERAL DESIGN CURVES FOR POWER AUDIO OUTPUT STAGES



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	PD Watts @ 25°C	V <sub>CEO</sub>	h <sub>FE</sub> @ Min/Max	I <sub>C</sub> Amps	f <sub>T</sub> 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 MJ15001	MJ2955A MJ15002	TO-204	120W	120 V	20/70	4A	3	60/2
			TO-204	200W	140 V	25/150	4A	3	40/5
50 to 100W	MJ15015 MJ15003 MJ15018 MJ15020	MJ15016 MJ15004 MJ15019 MJ15020	TO-204	180W	120 V	20/70	4A	3	60/3
			TO-204	250W	140 V	25/150	5A	3	100/1
			TO-204	150W	200	30 min	1A	20	50/3
			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.