

Bipolar Power Transistors

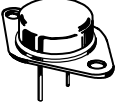
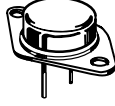
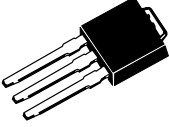
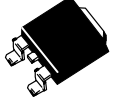
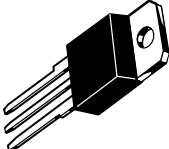
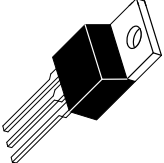
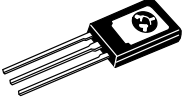
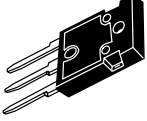
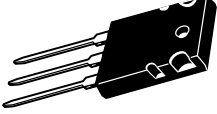
In Brief . . .

Motorola's broad line of Bipolar Power Transistors includes discrete and Darlington transistors in a variety of packages from the popular surface mount DPAK at 1.75 watts to the 250 watt TO-3 and TO-264. New products include the MJE/MJF 18000 series for lamp ballast and power supplies, MJW16212 — a new 1500 V deflection transistor for video monitor applications, and high performance audio output devices in the TO-264 package. We have the broadest line of Bipolar Power Transistors in the industry and the Motorola commitment to quality and total customer satisfaction to go with them.

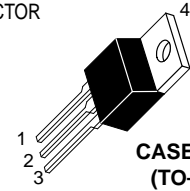
	Page
Bipolar Power Transistors	5.5-2
Selection by Package	5.5-2
Plastic TO-220AB	5.5-3
Plastic TO-218 Type	5.5-6
Plastic TO-247 Type	5.5-7
Large Plastic TO-264	5.5-8
Plastic TO-225AA Type (Formerly TO-126 Type)	5.5-8
DPAK — Surface Mount Power Packages	5.5-10
Metal TO-204AA (Formerly TO-3), TO-204AE	5.5-11
Audio	5.5-15
Electronic Lamp Ballasts	5.5-16

Bipolar Power Transistors

Selection by Package

Package	I_C Range (Amps)	V_{CE} Range (Volts)	P_D (Watts)	Page #
	4-30	40-1500	90-250	5.5-11
	50-80	60-1000	150-300	5.5-11
	0.5-10	40-400	12.5-20	5.5-10
	0.5-10	40-400	12.5-20	5.5-10
	5.0-25	60-1500	80-150	5.5-6
	0.5-15	30-1800	30-125	5.5-3
	0.3-5.0	25-400	12.5-40	5.5-8
	10-30	400-1500	125-180	5.5-7
	15-16	200-650	250	5.5-8

STYLE 1:
 PIN 1. BASE
 2. COLLECTOR
 3. EMITTER
 4. COLLECTOR



CASE 221A-06
(TO-220AB)

Table 1. Plastic TO-220AB

I _C Cont Amps Max	V _{CEO(sus)} Volts Min ⁽⁸⁾	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	350	MJE2360T		15 min	0.1				10 typ	30
		MJE2361T		40 min	0.1				10 typ	30
1	100	TIP29C	TIP30C	15/75	1	0.6 typ	0.3 typ	1	3	30
	250	TIP47		30/150	0.3	2 typ	0.18 typ	0.3	10	40
	300	TIP48	MJE5730	30/150	0.3	2 typ	0.18 typ	0.3	10	40
	350	TIP49	MJE5731	30/150	0.3	2 typ	0.18 typ	0.3	10	40
	400	TIP50	MJE5731A⁽⁷⁾	30/150	0.3	2 typ	0.18 typ	0.3	10	40
2	100	TIP112⁽²⁾	TIP117⁽²⁾	500 min	2	1.7 typ	1.3 typ	2	25 ⁽¹⁾	50
	400/700	BUL44		14/36	0.4	2.75 ⁽³⁾	0.175 ⁽³⁾	1	13 typ	50
	450/1000	BUX85		30	0.1	3.5	1.4	1	4	50
	450/1000	MJE18002		14/34	0.2	3 ⁽³⁾	0.17 ⁽³⁾	1	12 typ	40
	900/1800	MJE1320		3 min	1	4 typ	0.8 typ	1		80
3	80	BD241B	BD242B	25 min	1				3	40
	100	BD241C	BD242C	25 min	1				3	40
		TIP31C	TIP32C	25 min	1	0.6 typ	0.3 typ	1	3	40
	150		MJE9780	50/200	0.5				5 typ	40

(1) |h_{FE}| @ 1 MHz

(2) Darlington

(3) Switching tests performed w/special application simulator circuit. See data sheet for details.

(7) V_{CEO} = 375 V

(8) When 2 voltages are given, the format is V_{CEO(sus)}/V_{CES}.

Devices listed in bold, italic are Motorola preferred devices.

Table 1. Plastic TO-220AB (continued)

I _C Cont Amps Max	V _{CEO(sus)} Volts Min ⁽⁸⁾	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		
4	40		<i>MJE1123</i>	45/100	4				5	75
	60	<i>MJE800</i> ⁽²⁾	<i>MJE700</i> ⁽²⁾	750 min	1.5				1 ⁽¹⁾	40
	80	<i>D44C12</i>	<i>D45C12</i>	40/120	0.2			1	40 typ	30
	400/700	<i>MJE13005</i>		6/30	3	3	0.7	3	4	60
5	100	<i>TIP122</i> ⁽²⁾	<i>TIP127</i> ⁽²⁾	1k min	3	1.5 typ	1.5 typ	4	4 ⁽¹⁾	75
	250	2N6497		10/75	2.5	1.8	0.8	2.5	5	80
	300	<i>2N6498</i>		10/75	2.5	1.8	0.8	2.5	5	80
	400/700	<i>BUL45</i>		14/34	0.3	1.7 ⁽³⁾	0.15 ⁽³⁾	1	12 typ	75
	450/1000	MJE16002		5 min	5	3	0.3	3		80
	450/850	<i>MJE16004</i>		7 min	5	2.7	0.35	3		80
	450/1000	<i>MJE18004</i>		14/34	0.3	1.7	0.15	1.0	13	75
	550/1200	<i>MJE18204</i>		18/35	0.5	2.75 ⁽³⁾	0.2 ⁽³⁾	2	12	75
6	80	<i>BD243B</i>	<i>BD244B</i>	15 min	3	0.4 typ	0.15 typ	3	3	65
	100	<i>BD243C</i>	<i>BD244C</i>	15 min	3	0.4 typ	0.15 typ	3	3	65
		<i>TIP41C</i>	<i>TIP42C</i>	15/75	3	0.4 typ	0.15 typ	3	3	65
	250/550	<i>MJE16204</i>		5 min	6	1.5 ⁽²⁾	0.15 ⁽²⁾	1	10	80
	400/700	<i>BUL146</i>		14/34	0.5	1.75 ⁽³⁾	0.15 ⁽³⁾	3	14 typ	100
	450/1000	<i>MJE18006</i>		14/34	0.5	3.2 ⁽³⁾	0.13 ⁽³⁾	3	14 typ	100
7	30	2N6288	2N6111	30/150	3	0.4 typ	0.15 typ	3	4	40
	50		2N6109	30/150	2.5	0.4 typ	0.15 typ	3	4	40
	70	<i>2N6292</i>	<i>2N6107</i>	30/150	2	0.4 typ	0.15 typ	3	4	40
	100	<i>BD801</i>	<i>BD802</i>	15 min	3				3	65
	150	BU407		30 min	1.5		0.75	5	10	60
	200	<i>BU406</i>		30 min	1.5		0.75	5	10	60
	450	<i>BU522B</i> ⁽²⁾		250 min	2.5				7.5	75

(1)|h_{FE}| @ 1 MHz

(2)Darlington

(3)Switching tests performed w/special application simulator circuit. See data sheet for details.

(7)V_{CEO} = 375 V

(8)When 2 voltages are given, the format is V_{CEO(sus)}/V_{CES}.

Devices listed in bold, italic are Motorola preferred devices.

Table 1. Plastic TO-220AB (continued)

I _C Cont Amps Max	V _{CEO(sus)} Volts Min ⁽⁸⁾	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		
8	60	2N6043 ⁽²⁾	2N6040 ⁽²⁾	1k/10k	4	1.5 typ	1.5 typ	3	4 ⁽¹⁾	75
	80	2N6044 ⁽²⁾	2N6041 ⁽²⁾	1k/10k	4	1.5 typ	1.5 typ	3	4 ⁽¹⁾	75
		BDX53B ⁽²⁾	BDX54B ⁽²⁾	750 min	3				4 ⁽¹⁾	60
	100	2N6045 ⁽²⁾	2N6042 ⁽²⁾	1k/10k	3	1.5 typ	1.5 typ	3	4 ⁽¹⁾	75
		BDX53C ⁽²⁾	BDX54C ⁽²⁾	750 min	3					
		TIP102 ⁽²⁾	TIP107 ⁽²⁾	1k/20k	3	1.5 typ	1.5 typ	3	4 ⁽¹⁾	80
	120	MJE15028	MJE15029	20 min	4				30	50
	150	MJE15030	MJE15031	20 min	4				30	50
	200	BU806 ⁽²⁾		100 min	5	0.55 typ	0.2 typ	5		60
	300/600	MJE5740 ⁽²⁾		200 min	4	8 typ	2 typ	6	4	80
			MJE5850	15 min	2	2	0.5	4		80
	350	MJE5741 ⁽²⁾		200 min	4	8 typ	2 typ	6		80
			MJE5851	15 min	2	2	0.5	4		80
		MJE5742 ⁽²⁾		200 min	4	8 typ	2 typ	6		80
		MJE13007		5/30	5	3	0.7	5		80
				MJE5852	15 min	2	2	0.5	4	
400/650	MJE16106		6/22	8	2 typ	0.1 typ	5		100	
400/700	BUL147		14/34	1	2.5 ⁽³⁾	0.18 ⁽³⁾	2	14 typ	125	
450/1000	MJE18008		16/34	1	2.75 ⁽³⁾	0.18 ⁽³⁾	2	13 typ	125	
10	20		BD808	15 min	4				1.5	90
	60	D44H8	D45H8	40 min	4					50
		MJE3055T	MJE2955T	20/70	4					75
		2N6387 ⁽²⁾	2N6667 ⁽²⁾	1k/20k	5				20 ⁽¹⁾	65
	80	BDX33B ⁽²⁾	BDX34B ⁽²⁾	750 min	3				3	70
		BD809	BD810	15 min	4				1.5	90
		2N6388 ⁽²⁾	2N6668 ⁽²⁾	1k/20k	5				20 ⁽¹⁾	65
		D44H10	D45H10	20 min	4	0.5 typ	0.14 typ	5	50 typ	50
D44H11		D45H11	40 min	4	0.5 typ	0.14 typ	5	50 typ	50	

(1) |h_{FE}| @ 1 MHz

(2) Darlington

(3) Switching tests performed w/special application simulator circuit. See data sheet for details.

(7) V_{CEO} = 375 V

(8) When 2 voltages are given, the format is V_{CEO(sus)}/V_{CES}.

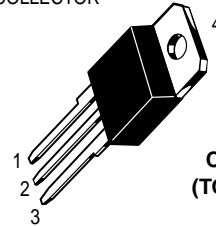
(9) Self protected Darlington

Devices listed in bold, italic are Motorola preferred devices.

Table 1. Plastic TO-220AB (continued)

I _C Cont Amps Max	V _{CEO(sus)} Volts Min(8)	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		
10	100	<i>BDX33C</i> (2)	<i>BDX34C</i> (2)	750 min	3				3	70
	450/1000	<i>MJE18009</i>		14/34	1.5	2.75(3)	0.2(3)	3	12	150
12	400/700	<i>MJE13009</i>		6/30	8	3	0.7	8	4	100
15	80	<i>2N6488</i>	<i>2N6491</i>	20/150	5	0.6 typ	0.3 typ	5	5	75
		<i>D44VH10</i>	<i>D45VH10</i>	20 min	4	0.5	0.09	8	50 typ	83
	100	<i>BDW42</i> (2)	<i>BDW47</i> (2)	1k min	5	1 typ	1.5 typ	5	4	85

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR



CASE 340D
(TO-218 Type,
SOT-93)

Table 2. Plastic TO-218 Type

I _C Cont Amps Max	V _{CEO(sus)} Volts Min(8)	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		
8	500/1000	<i>MJH16006A</i>		5 min	8	2.5	0.25	5		125
10	60	TIP140(2)	TIP145(2)	500 min	10	2.5 typ	2.5 typ	5	4(1)	125
		TIP141(2)	TIP146(2)	500 min	10	2.5 typ	2.5 typ	5	4(1)	125
	100	<i>BDV65B</i> (2)	<i>BDV64B</i> (2)	1k min	5					125
		TIP33C	TIP34C	20/100	3				3	80
		<i>TIP142</i> (2)	<i>TIP147</i> (2)	500 min	10	2.5 typ	2.5 typ	5	4(1)	125
	400	<i>BU323AP</i> (2)		150/100	6	15	15	6		125
<i>MJH10012</i> (2)			100/2k	6	15	15	6		118	

(1)|h_{FE}| @ 1 MHz

(2)Darlington

(8)When 2 voltages are given, the format is V_{CEO(sus)}/V_{CES}.

Devices listed in bold, italic are Motorola preferred devices.

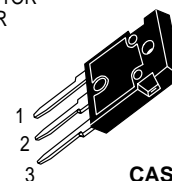
Table 2. Plastic TO-218 Type (continued)

I _C Cont Amps Max	V _{CEO(sus)} Volts Min ⁽⁸⁾	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		
15	60	<i>TIP3055</i>	<i>TIP2955</i>	5 min	10				2.5	80
	150	MJH11018 ⁽²⁾	MJH11017 ⁽²⁾	400/15k	10				3	150
	200	MJH11020 ⁽²⁾	MJH11019 ⁽²⁾	400/15k	10				3	150
	250	<i>MJH11022</i> ⁽²⁾	<i>MJH11021</i> ⁽²⁾	400/15k	10				3	150
	400	BUV48		8 min	10	2	0.4	10		150
	450	<i>BUV48A</i>		8 min	8	2	0.4	10		150
16	140	MJE4342	MJE4352	15 min	8	1.2 typ	1.2 typ	8	1	125
	160	<i>MJE4343</i>	<i>MJE4353</i>	15 min	8	1.2 typ	1.2 typ	8	1	125
20	60	MJH6282 ⁽²⁾	MJH6285 ⁽²⁾	750/18k	10				4	125
	100	<i>MJH6284</i> ⁽²⁾	<i>MJH6287</i> ⁽²⁾	750/18k	10				4	125
25	80	TIP35A	TIP36A	15/75	15	0.6 typ	0.3 typ	10	3	125
	100	<i>BD249C</i>	<i>BD250C</i>	10 min	15				3	125
		<i>TIP35C</i>	<i>TIP36C</i>	15/75	15	0.6 typ	0.3 typ	10	3	125

⁽²⁾Darlington

⁽⁸⁾When 2 voltages are given, the format is V_{CEO(sus)}/V_{CES}.

STYLE 2:
PIN 1. BASE
2. COLLECTOR
3. EMITTER



**CASE 340F
(TO-247 Type)**

Table 3. Isolated Mounting Hole — Plastic TO-247 Type

I _C Cont Amps Max	V _{CEO(sus)} Volts Min	V _{CES} 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		
10	650	1500	<i>MJW16212</i>		4/10	10	4 ⁽³⁾	0.5 ⁽³⁾	5.5		150
	800	1500	<i>MJW16018</i>		4 min	5	4.5 typ	0.2 typ	5	3 typ	150
12	500	1200	<i>MJW16206</i>		5/13	10	2.25	0.25	6.5	3 typ	150
15	450	850	<i>MJW16010</i>		5 min	15	1.2 typ	0.2 typ	10		150
		850	<i>MJW16012</i>		7 min	15	0.9 typ	0.15 typ	10		150
	500	1000	<i>MJW16010A</i>		5 min	15	3	0.4	10		150

⁽³⁾Switching tests performed w/special application simulator circuit. See data sheet for details.

⁽¹⁰⁾Tested in Applications simulator: see Data Sheet.

Devices listed in bold, italic are Motorola preferred devices.

STYLE 2:
 PIN 1. BASE
 2. COLLECTOR
 3. EMITTER

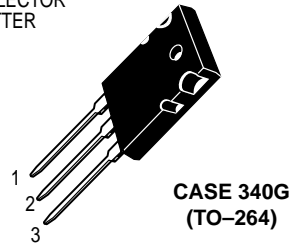


Table 4. Large Plastic TO-264

I _C Cont Amps Max	V _{CEO(sus)} Volts Min	Device Type		hFE 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		
15	200	MJL3281A	MJL1302A	60/175	0.1				30 typ	200
	650/1500	MJL16218		4/11	12				2.5 typ	170
16	250	MJL21194	MJL21193	25/75	8				4	200

STYLE 1:
 PIN 1. EMITTER
 2. COLLECTOR
 3. BASE

STYLE 3:
 PIN 1. BASE
 2. COLLECTOR
 3. EMITTER

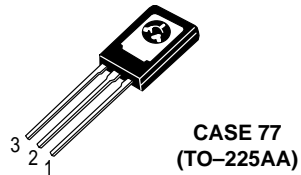


Table 5. Plastic TO-225AA Type (Formerly TO-126 Type)

I _C Cont Amps Max	V _{CEO(sus)} Volts Min	Device Type		hFE 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		
0.3	350	MJE3439		40/160	0.02				15	15
0.5	150	MJE341		25/200	0.05				15	20.8
	200	MJE344		30/300	0.05				15	20.8
	250	2N5655		30/250	0.1	3.5 typ	0.24 typ	0.1	10	20
		BD157		30/240	0.05					20
	300	BD158		30/240	0.05					20
		MJE340	MJE350	30/240	0.05					20.8
2N5656			30/250	0.1	3.5 typ	0.24 typ	0.1	10	20	

Devices listed in bold, italic are Motorola preferred devices.

Table 5. Plastic TO-225AA Type (Formerly TO-126 Type) (continued)

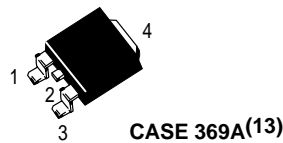
I _C Cont Amps Max	V _{CEO(sus)} Volts Min	Device Type		h _{FE} Min/Max	@ I _C Amp	Resistive Switching			f _T MHz Min	P _D (Case) Watts @ 25°C
		NPN	PNP			t _s μs Max	t _f μs Max	@ I _C Amp		
0.5	350	2N5657		30/250	0.1	3.5 typ	0.24 typ	0.1	10	20
		BD159		30/240	0.05					20
1	40	2N4921	2N4918	20/100	0.5	0.6 typ	0.3 typ	0.5	3	30
	60	2N4922	2N4919	20/100	0.5	0.6 typ	0.3 typ	0.5	3	30
	80	2N4923	2N4920	20/100	0.5	0.6 typ	0.3 typ	0.5	3	30
1.5	45	BD165	BD166	15 min	0.5				6	20
		BD135	BD136	40/250	0.15					12.5
	60	BD137	BD138	40/250	0.15					12.5
	80	BD169		15 min	0.5				6	20
		BD139	BD140	40/250	0.15					12.5
			BD140-10	63/160	0.15					12.5
	300	MJE13002 ⁽¹¹⁾		5/25	1	4	0.7	1	5	40
400	MJE13003 ⁽¹¹⁾		5/25	1	4	0.7	1	5	40	
2	80	BD237	BD238	25 min	1				3	25
	100	MJE270 ⁽²⁾⁽¹¹⁾	MJE271 ⁽²⁾⁽¹¹⁾	1.5k min	0.12				6	15
3	60	MJE181	MJE171	50/250	0.1	0.6 typ	0.12 typ	0.1	50	12.5
	80	BD179	BD180	40/250	0.15				3	30
		MJE182	MJE172	50/250	0.1	0.6 typ	0.12 typ	0.1	50	12.5
	200	BUY49P		30 min	0.5				25	20
4	40	MJE521	MJE371	40 min	1					40
	45	BD437	BD438	40 min	2				3	36
			BD776 ⁽²⁾	750 min	2				20	15
	60		BD440	25 min	2				3	36
		BD677 ⁽²⁾	BD678 ⁽²⁾	750 min	1.5					40
		BD677A ⁽²⁾	BD678A ⁽²⁾	750 min	2					40
		BD787	BD788	20 min	2				50	15
		BD777 ⁽²⁾	BD778 ⁽²⁾	750 min	2				20	15
		2N5191	2N5194	25/100	1.5	0.4 typ	0.4 typ	1.5	2	40
		MJE800 ⁽²⁾	MJE700 ⁽²⁾	750 min	1.5				1 ⁽¹⁾	40
	2N6038 ⁽²⁾	2N6035 ⁽²⁾	750/18k	2	1.7 typ	1.2 typ	2	25	40	
	80	2N5192	2N5195	25/100	1.5	0.4 typ	0.4 typ	1.5	2	40
		BD441	BD442	15 min	2				3	36
		BD679 ⁽²⁾	BD680 ⁽²⁾	750 min	1.5					40
BD679A ⁽²⁾		BD680A ⁽²⁾	750 min	2					40	
BD789		BD790	10 min	2				40	15	

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

Devices listed in bold, italic are Motorola preferred devices.

Table 5. Plastic TO–225AA Type (Formerly TO–126 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		
4	80	<i>BD779</i> (2)	<i>BD780</i> (2)	750 min	2				20	15
		MJE802(2)	MJE702(2)	750 min	1.5				1(1)	40
		<i>MJE803</i> (2)	<i>MJE703</i> (2)	750 min	2				1(1)	40
		<i>2N6039</i> (2)	<i>2N6036</i> (2)	750/18k	2	1.7 typ	1.2 typ	2	25	40
	100	<i>BD681</i> (2)	<i>BD682</i> (2)	750 min	1.5					40
		<i>BD791</i>	<i>BD792</i>	10 min	2				40	15
<i>MJE243</i>		<i>MJE253</i>	40/120	0.2	0.15 typ	0.07 typ	2	40	15	
5	25	<i>MJE200</i>	<i>MJE210</i>	45/180	2	0.13 typ	0.035 typ	2	65	15



STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

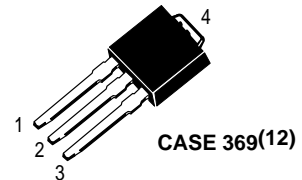


Table 6. DPAK – Surface Mount Power Packages

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	<i>MJD340</i>	<i>MJD350</i>	30/240	0.05					15
1	250	MJD47		30/150	0.3	2	0.2	0.3	10	15
	375		<i>MJD5731</i>	TBD	TBD	TBD	TBD	TBD	TBD	TBD
	400	<i>MJD50</i>		30/150	0.3	2	0.2	0.3	10	15
1.5	400	<i>MJD13003</i>		5/25	1	4	0.7	1	4	15

(1)|h_{FE}| @ 1 MHz

(2)Darlington

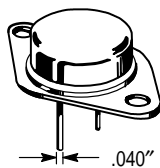
(12)Case 369–07 may be ordered by adding –1 suffix to part number.

(13)Case 369A–13 may be ordered as tape and reel by adding a “T4” suffix; 2500 units/reel.

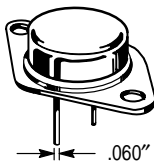
Devices listed in bold, italic are Motorola preferred devices.

Table 6. DPAK – Surface Mount Power Packages (continued)

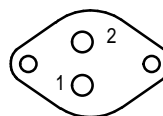
I _C Cont Amps Max	V _{CEO(sus)} Volts Min	Device Type		h _{FE} Min/Max	@ I _C Amp	Resistive Switching			f _T MHz Min	P _D (Case) Watts @ 25°C
		NPN	PNP			t _s μs Max	t _f μs Max	@ I _C Amp		
2	100	<i>MJD112</i> (2)	<i>MJD117</i> (2)	1000 min	2	1.7	1.3	2	25(1)	20
3	40	MJD31	MJD32	10 min	1	0.6	0.3	1	3	15
	100	<i>MJD31C</i>	<i>MJD32C</i>	10 min	1	0.6	0.3	1	3	15
4	80	<i>MJD6039</i> (2)	<i>MJD6036</i> (2)	1k/12k	2	1.7	1.2	2	25	20
	100	<i>MJD243</i>	<i>MJD253</i>	40/180	0.2	0.16	0.04	1	40	12.5
5	25	<i>MJD200</i>	<i>MJD210</i>	45/180	2	0.15	0.04	2	65	12.5
6	100	<i>MJD41C</i>	<i>MJD42C</i>	15/75	3	0.4	0.15	3	3	20
8	80	<i>MJD44H11</i>	<i>MJD45H11</i>	40 min	4	0.5	0.14	5	50 typ	20
	100	<i>MJD122</i> (2)	<i>MJD127</i> (2)	1k/12k	4	1.5	2	4	4(1)	20
10	60	<i>MJD3055</i>	<i>MJD2955</i>	20/100	4	1.5	1.5	3	2	20
	80	<i>MJD44E3</i> (2)		1k min	5	2	0.5	10		20



CASE 1-07
TO-204AA



CASE 197A TO-204AE
(Used for high current types at end of
table. See types w/footnote(16).)



STYLE 1:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

Table 7. Metal TO-204AA (Formerly TO-3), TO-204AE

I _C Cont Amps Max	V _{CEO(sus)} Volts Min(8)	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		
4	200	MJ15018		30 min	1				20	150
	250	<i>MJ15020</i>	<i>MJ15021</i>	30 min	1				20	150
5	700/1500	<i>BU208A</i>		2.5 min	4.5	8 typ	0.4 typ	4.5	4 typ	90
8	60	MJ1000(2)		1k min	3					90
		2N6055(2)		750/18k	4	1.5 typ	1.5 typ	4	4(1)	100
	80	<i>MJ1001</i> (2)		1k min	3					90
		<i>2N6056</i> (2)		750/18k	4	1.5 typ	1.5 typ	4	4(1)	100

(1)|h_{FE}| @ 1 MHz

(2)Darlington

(8)When 2 voltages are given, the format is V_{CEO(sus)}/V_{CES}.

(12)Case 369 may be ordered by adding -1 suffix to part number.

(13)Case 369A may be ordered as tape and reel by adding a "T4" suffix; 2500 units/reel.

Devices listed in bold, italic are Motorola preferred devices.

Table 7. Metal TO-204AA (Formerly TO-3), TO-204AE (continued)

I _C Cont Amps Max	V _{CEO(sus)} Volts Min(8)	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		
10	60	2N3715	2N3791	30 min	3	0.3 typ	0.4 typ	5	4	150
		MJ3000(2)	MJ2500(2)	1k min	5					150
	80	2N3716	2N3792	30 min	3	0.3 typ	0.4 typ	5	4	150
		2N5878		20/100	4	1	0.8	4	4	150
		MJ3001(2)	MJ2501(2)	1k min	5					150
	140	2N3442		20/70	4					117
	250	MJ15011	MJ15012	20/100	2					200
	325	MJ413		20/80	0.5				2.5	125
		MJ423		30/90	1				2.5	125
	400	BU323A(2)		150 min	6	7.5 typ	5.2 typ	6		175
MJ10007(2)			30/300	5	1.5	0.5	5	10(1)	150	
MJ10012(2)			100/2k	6	15	15	6		175	
12	60	2N6057(2)	2N6050(2)	750/18k	6	1.6 typ	1.5 typ	6	4(1)	150
	80	2N6058(2)	2N6051(2)	750/18k	6	1.6 typ	1.5 typ	6	4(1)	150
	100	2N6059(2)	2N6052(2)	750/18k	6	1.6 typ	1.5 typ	6	4(1)	150
15	60	2N3055	MJ2955	20/70	4	0.7 typ	0.3 typ	4	2.5	115
		2N3055A	MJ2955A	20/70	4				0.8	115
		2N6576(2)		2k/20k	4	2	7	10	10-200(1)	120
		2N5881	2N5879	20/100	6	1	0.8	6	4	160
	80	2N5882	2N5880	20/100	6	1	0.8	6	4	160
	90	2N6577(2)		2k/20k	4	2	7	10	10-200(1)	120
	120	MJ15015	MJ15016	20/70	4	0.7 typ	0.3 typ	4	1	180
		2N6578(2)		2k/20k	4	2	7	10	10-200(1)	120
	140	MJ15001	MJ15002	25/150	4				2	200
	150	MJ11018(2)	MJ11017(2)	100 min	15				3(1)	175
	200	MJ11020(2)		100 min	15				3(1)	175
		MJ3281A	MJ1302A	60/175	0.1				30 typ	250
	250	MJ11022(2)	MJ11019(2)	100 min	15				3(1)	175
			MJ11021(2)	6/30	10	4	0.7	10	6 to 24	175
	400/850	BUX48		8 min	10	2	0.4	10		175
		2N6547		6/30	10	4	0.7	10	6 to 24	175
	400/650	MJ16110		6/20	15	0.8 typ	0.1 typ	10		175
450/1000	BUX48A		8 min	8	2	0.4	10		175	

(1)|h_{FE}| @ 1 MHz

(2)Darlington

(8)When 2 voltages are given, the format is V_{CEO(sus)}/V_{CES}.

Devices listed in bold, italic are Motorola preferred devices.

Table 7. Metal TO-204AA (Formerly TO-3), TO-204AE (continued)

I _C Cont Amps Max	V _{CEO(sus)} Volts Min(8)	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		
15	450/850	MJ16010		5 min	15	1.2 typ	0.2 typ	10		175
		MJ16012		7 min	15	0.9 typ	0.15 typ	10		175
16	140	2N3773	2N6609	15/60	8	1.1 typ	1.5 typ	8	4	150
		2N5631	2N6031	15/60	8	1.2 typ	1.2 typ	8	1	200
	200	MJ15022	MJ15023	15/60	8				5	250
	250	MJ15024	MJ15025	15/60	8				5	250
		MJ21194	MJ21193	25/75	8				4	250
20	60	2N3772		15/60	10				2	150
		2N6282(2)	2N6285(2)	750/18k	10	2.5 typ	2.5 typ	10	4(1)	160
	75	2N5039		20/100	10	1.5	0.5	10	60	140
	80	2N6283(2)	2N6286(2)	750/18k	10	2.5 typ	2.5 typ	10	4(1)	160
	90	2N5038		20/100	12	1.5	0.5	12	60	140
	100	2N6284(2)	2N6287(2)	750/18k	10	2.5 typ	2.5 typ	10	4(1)	160
	140	MJ15003	MJ15004	25/150	5				2	250
	200	BUV11		10 min	12	1.8	0.4	12	8	150
	350	MJ10000(2)		40/400	10	3	1.8	10	10(1)	175
	400	MJ10005(2)		40/400	10	1.5	0.5	10	10(1)	175
		MJ13333		10/60	5	4	0.7	10		175
500	MJ10009(2)		30/300	10	2	0.6	10	8(1)	175	
25	60	2N5885	2N5883	20/100	10	1	0.8	10	4	200
	80	2N5886	2N5884	20/100	10	1	0.8	10	4	200
			2N6436	30/120	10	1	0.25	10	40	200
	100	2N6338	2N6437	30/120	10	1	0.25	10	40	200
	120	2N6339	2N6438	30/120	10	1	0.25	10	40	200
	140	2N6340		30/120	10	1	0.25	10	40	200
30	40	2N3771		15/60	15				2	150
		2N5301	2N4398	15/60	15	2	1	10	2	200
	60	2N5302	2N4399	15/60	15	2	1	10	2	200
		MJ11012(2)	MJ11011(2)	1k min	20				4(1)	200
	90	MJ11014(2)	MJ11013(2)	1k min	20				4(1)	200
	100	2N6328		6/30	30				3	200
		MJ802	MJ4502	25/100	7.5				2	200
	120	MJ11016(2)	MJ11015(2)	1k min	20				4(1)	200

(1) |h_{FE}| @ 1 MHz

(2) Darlington

(8) When 2 voltages are given, the format is V_{CEO(sus)}/V_{CES}.

Devices listed in bold, italic are Motorola preferred devices.

Table 7. Metal TO-204AA (Formerly TO-3), TO-204AE (continued)

I _C Cont Amps Max	V _{CEO(sus)} Volts Min(8)	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		
30	325	BUV23		8 min	16	1.8	0.4	16	8	250
	400/1000	BUS98		8 min	20	2.3	0.4	20		250
		BUX98		8 min	20	3	0.8	20		250
	450/850	MJ16020(16)		5 min	30	1.8	0.2	20		250
		MJ16022 (16)		7 min	30	1.5	0.15	20		250
	450/1000	BUS98A		8 min	16	2.3	0.4	16		250
BUX98A			8 min	16	3	0.8	16		250	
40	200	BUV21(16)		10 min	25	1.8	0.4	25	8	150
	250	BUV22 (16)		10 min	20	1.1	0.35	20	8	250
	350	MJ10022(2)(16)		50/600	10	2.5	0.9	20		250
	400	MJ10023 (2)(16)		50/600	10	2.5	0.9	20		250
50	60	2N5685(16)		15/60	25	0.5 typ	0.3 typ	25	2	300
	80	2N5686 (16)	2N5684 (16)	15/60	25	0.5 typ	0.3 typ	25	2	300
	90	MJ11030 (2)(16)	MJ11031 (2)(16)	400 min	50					300
	100	2N6274(16)		30/120	20	0.8	0.25	20	30	250
		2N6275(16)	2N6379 (16)	30/120	20	0.8	0.25	20	30	250
	120	MJ11032 (2)(16)	MJ11033 (2)(16)	400 min	50					300
		BUV20 (16)		10 min	50	1.2	0.25	50	8	250
	125	BUV60 (16)		10 min	80	1.1	0.25	80		250
		2N6277 (16)		30/120	20	0.8	0.25	20	30	250
	400	MJ10015 (2)(16)		10 min	40	2.5	1	20		250
500	BUT34 (2)(16)		15 min	32	3	1.5	32		250	
	MJ10016 (2)(16)		10 min	40	2.5	1	20		250	
56	400	BUT33 (2)(16)		20 min	36	3.3	1.6	36		250
60	60		MJ14001(16)	15/100	50					300
	80	MJ14002 (16)	MJ14003 (16)	15/100	50					300
	200	MJ10020(2)(16)		75 min	15	3.5	0.5	30		250
	250	MJ10021 (2)(16)		75 min	15	3.5	0.5	30		250
70	125	BUS50 (16)		15 min	50	1.5	0.3	70		350
80	100	BUV18A (16)		10 min	80	1.1	0.25	80		250

(1)h_{FE} @ 1 MHz

(2)Darlington

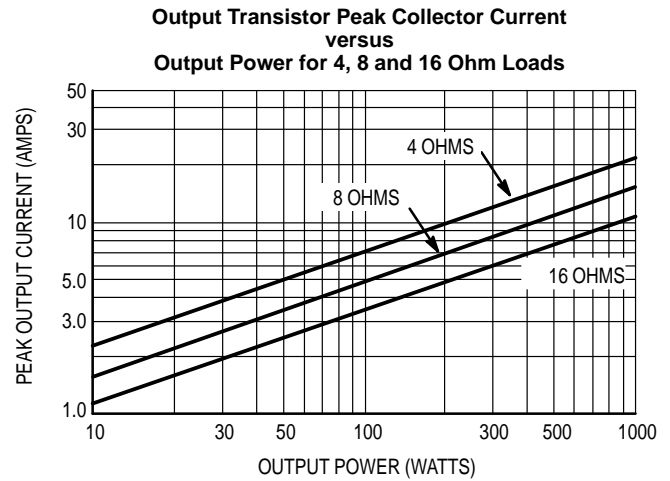
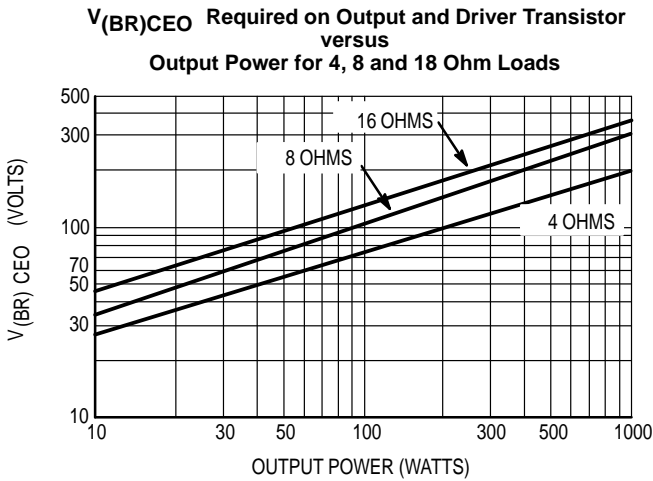
(8)When 2 voltages are given, the format is V_{CEO(sus)}/V_{CES}

(16)Case 197A-03 (TO-204AE)

Devices listed in bold, italic are Motorola preferred devices.

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 see Application Note AN485.

Table 8. 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	50	150	20 min	4	30	14/3.6
	MJE15032	MJE15033	TO-220	50	250	50 min	1	40	50/1
25 to 50W	2N3055A	MJ2955A	TO-204	120	120	20/70	4	3	60/2
	MJ15001	MJ15002	TO-204	200	140	25/150	4	3	40/5
50 to 100W	MJ15015	MJ15016	TO-204	180	120	20/70	4	3	60/3
	MJ15003	MJ15004	TO-204	250	140	25/150	5	3	100/1
	MJ15020	MJ15021	TO-204	150	250	30 min	1	20	50/3
Over 100W	MJ15024	MJ15025	TO-204	250	250	15/60	8	8	80/2.2
	MJ3281A	MJ1302A	TO-204	250	200	60/175	7	30	50/4
	MJL3281A	MJL1302A	340G-01	150	200	60/175	7	30	40/4
	MJ21194	MJ21193	TO-204	250	250	25/75	8	7	100/2
	MJL21194	MJL21193	340G-01	200	200	25/75	8	7	100/2

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.

Electronic Lamp Ballasts

As in many other areas of its semiconductor activity, Motorola is an industry leader in the fast growing market of Electronic Ballast Semiconductors. We introduced the first dedicated devices for this market in 1988. Today, devices based on advanced technologies such as H2BIP (High Gain, High Frequency Bipolar) and ZPCMOS (Zero Power Control MOS) are leading the way in providing benefits for ballast manufacturers, consumers and the environment.

Two factors make the Electronic Lamp Ballast market grow at an ever increasing rate — Economics and the Environment.

Lamps based on Electronic Ballasts have long lifetimes and very low power consumption, so contributing to the efficient use of energy and to preservation of the environment. Motorola designs silicon solutions specifically for these applications.

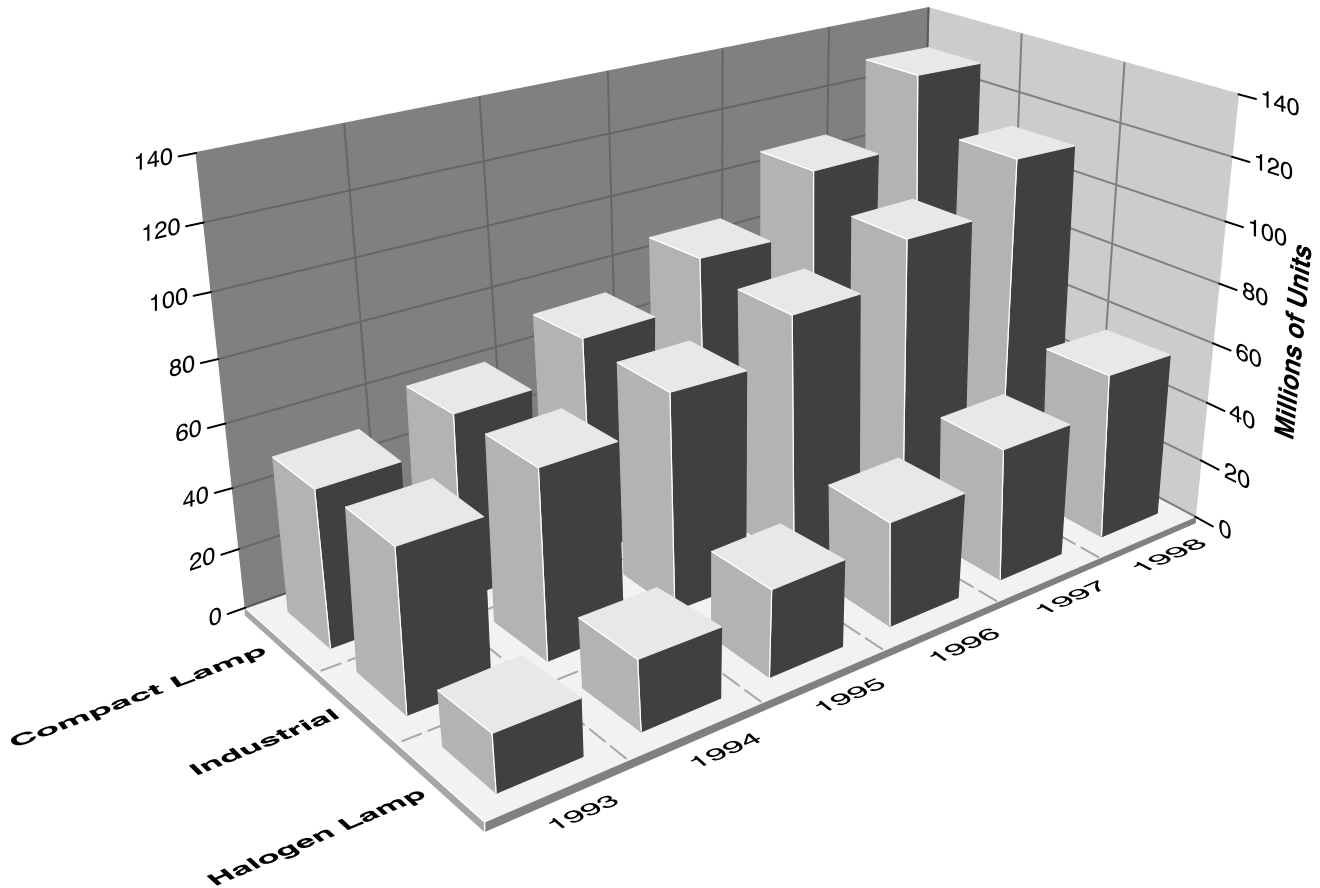
For this growing ballast market Motorola offers optimized devices such as Power MOSFETs, Bipolar Transistors, Linear drive ICs, custom Start-Stop ICs, Diodes and Silicon Bilateral Switches.

Even more important are our efforts to develop the technology for tomorrow in close cooperation with the world's leading manufacturers of Electronic Transformers and Lamp Ballasts, as well as assisting them today in their choice of technology.

This capability is driven from our centre of competence based in Toulouse, France. An important team of Applications, Design, Product, Manufacturing and Marketing Engineers drives our worldwide dedication to this market.

The intention of this section is to provide you with a 'snapshot' of our bipolar transistor products and capabilities. It is a document showing Motorola's professionalism in this area, and illustrating some of the expertise available to *you* — the Electronic Lamp Ballast manufacturer.

World Lamp Ballast Market



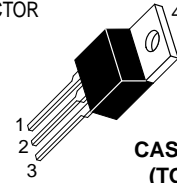
Cross Reference Transistors for Electronic Lamp Ballasts

Industry Part Number	Motorola Direct Replacement	Motorola Nearest Replacement
2SC4053		MJE18004
2SC4546		BUL146F
2SC4630		MJF18004
2SC4820		MJF18002
BU1706A		MJE18604D2
BU1708A		MJE18604D2
BUD43B-1	BUD43B-1	
BUF610		MJE18004D2
BUF654		BUL146
BUH100	BUH100	
BUH150	BUH150	
BUH50	BUH50	
BUH51	BUH51	
BUL146	BUL146	
BUL146F	BUL146F	
BUL147	BUL147	
BUL147F	BUL147F	
BUL213		MJE18204
BUL216		MJE18206
BUL381		BUL45
BUL38D		BUL45D2
BUL410		MJE18006
BUL416		MJE18604D2
BUL43B	BUL43B	
BUL44	BUL44	
BUL44D2	BUL44D2	
BUL44F	BUL44F	
BUL45	BUL45	
BUL45D2	BUL45D2	
BUL45F	BUL45F	
BUL48		MJE18004D2
BUL510		MJE18004D2
BUL57		BUL147
BUL67		BUL147
BUL810		BUV48A
BUL87		BUL147
BULD215		BUL45D2

Industry Part Number	Motorola Direct Replacement	Motorola Nearest Replacement
BULD50		BUL44D2
BULD85		BUL45D2
BUT11AF		MJF18004
BUT18		BUH100
BUT93		BUL45
BUT93D		BUL44D2
BUV46		MJE18006
KSC5021F		MJE18004
KSC5027F		MJE18604D2
MJD13003-1	MJE13003-1	
MJE13003	MJE13003	
MJE13005	MJE13005	
MJE13007	MJE13007	
MJE13009	MJE13009	
MJE18002	MJE18002	
MJE18004	MJE18004	
MJE18004D2	MJE18004D2	
MJE18006	MJE18006	
MJE18008	MJE18008	
MJE18009	MJE18009	
MJE18204	MJE18204	
MJE18206	MJE18206	
MJE18604D2	MJE18604D2	
MJF18002	MJF18002	
MJF18004	MJF18004	
MJF18006	MJF18006	
MJF18008	MJF18008	
MJF18009	MJF18009	
MJF18204	MJF18204	
MJF18206	MJF18206	
TD13003		MJD13003-1
TD13004		BUF43B-1
TEO13005D		BUL44D2-1
TEO13007	MJE13007	
TEO13003	MJE13003	
TEO13005	MJE13005	
TEO13009	MJE13009	

Cross Reference Transistors for Electronic Lamp Ballasts

STYLE 1:
 PIN 1. BASE
 2. COLLECTOR
 3. EMITTER
 4. COLLECTOR



CASE 221A-06
(TO-220AB)

Table 9. TO-220AB Bipolar Transistors

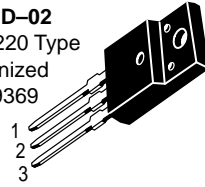
I _C Cont Amps Max	V _{CEO(sus)} Volts Min	V _{CES} Volts Min	Device Type	I _C Operating Amps	h _{FE} min @ I _C Operating V _{CE} = 1 V	Inductive Switching @ I _C Operating T _{SI} Min/Max (μs)	P _D (Case) Watts @ 25°C
2	350	650	BUL43B	0.8	9	1.8 / 3.3	40
	400	700	BUL44	0.8	10	2.6 / 3.8	50
	400	700	BUL44D2*	0.8	20	2.05 / 2.35	50
	450	1000	MJE18002	1	6	/ 2.75	50
4	500	800	BUH50	2	8 typ	/ 2.5	50
5	400	700	BUL45	2	7	2.6 / 3.8	75
	400	700	BUL45D2*	2	10	1.95 / 2.25	75
	450	1000	MJE18004	2	6	/ 2.5	75
	450	1000	MJE18004D2*	2	6	2.1 / 2.4	75
	550	1200	MJE18204	2	5	/ 2.75	75
	600	1600	MJE18604D2*	0.5	15	/ 1.0	75
6	400	700	BUL146	3	8	2.6 / 3.8	100
	450	1000	MJE18006	3	6	/ 3.2	100
8	400	700	BUL147	4.5	8	2.6 / 3.8	125
	450	1000	MJE18008	4.5	6	/ 3.2	125
	550	1200	MJE18206	3	5	/ 2.75	100
10	400	700	BUH100	5	10 typ	/ 3.0	100
	450	1000	MJE18009	7	8	/ 2.75	150
15	400	700	BUH150	10	8 typ	/ 2.75	150

BUHXXX Series are specified for Halogen applications.

* D2 suffix indicates transistor with built in C-E freewheeling diode and antisaturation network.

Cross Reference Transistors for Electronic Lamp Ballasts

CASE 221D-02
Isolated TO-220 Type
UL Recognized
File #E69369

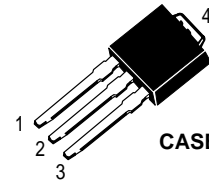


STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER

Table 10. Isolated TO-220 Bipolar Transistors

I _C Cont Amps Max	V _{CEO} (sus) Volts Min	V _{CES} Volts Min	Device Type	I _C Operating Amps	h _{FE} min @ I _C Operating V _{CE} = 1 V	Inductive Switching @ I _C Operating T _{si} Min/Max (μs)	P _D (Case) Watts @ 25°C
2	400	700	BUL44F	0.8	10	2.6 / 3.8	25
	450	1000	MJF18002	1	6	/ 2.75	25
5	400	700	BUL45F	2	7	2.6 / 3.8	35
	450	1000	MJF18004	2	6	/ 2.5	35
	550	1200	MJF18204	2	5	/ 2.75	40
6	400	700	BUL146F	3	8	2.6 / 3.8	40
	450	1000	MJF18006	3	6	/ 3.2	40
8	400	700	BUL147F	4.5	8	2.6 / 3.8	45
	450	1000	MJF18008	4.5	6	/ 3.2	45
	550	1200	MJF18206	5	6	/ 2.75	45
10	450	1000	MJF18009	7	8	/ 2.75	50

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR



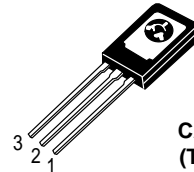
CASE 369-07

Table 11. DPAK Bipolar Transistors

I _C Cont Amps Max	V _{CEO} (sus) Volts Min	V _{CES} Volts Min	Device Type	I _C Operating Amps	h _{FE} min @ I _C Operating V _{CE} = 1 V	Inductive Switching @ I _C Operating T _{si} Min/Max (μs)	P _D (Case) Watts @ 25°C
2	350	650	BUD43B-1	0.8	9 typ	1.8 / 3.3	25
	400	700	BUD44D2-1*	0.8	20 typ	2.05 / 2.35	25

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

STYLE 3:
PIN 1. BASE
2. COLLECTOR
3. EMITTER



CASE 77-08
(TO-225AA)

Table 12. Case 77 (TO-225) Bipolar Transistors

I _C Cont Amps Max	V _{CEO} (sus) Volts Min	V _{CES} Volts Min	Device Type	I _C Operating Amps	h _{FE} min @ I _C Operating V _{CE} = 1 V	Inductive Switching @ I _C Operating T _{si} Min/Max (μs)	P _D (Case) Watts @ 25°C
1.5	400	700	MJE13003	1	6 typ	/ 3.0	40
4	400	700	BUH51	1	8	/ 3.75	50

BUHXXX Series are specified for Halogen applications.

* D2 suffix indicates transistor with built in C-E freewheeling diode and antisaturation network.