

**ALPHANUMERIC INDEX — CROSS-REFERENCE (Continued)**

Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number	Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number
BU806	BU806		3-380	BUW12A	BUW12A		3-476
BU807	BU807		3-380	BUW13	BUV48P		3-469
BU111		MJE16002	3-976	BUW13A	BUV48A		3-469
BUS12	BUX47		3-499	BUW24	BU326A		3-363
BUS12A	BUX47A		3-499	BUW25	BU326A		3-363
BUS13	BUX48		3-506	BUW26	BUS326A		—
BUS13A	BUX48A		3-506	BUW34	BUX47		3-499
BUS14	BUX98		—	BUW35	BUX47		3-499
BUS14A	BUX98A		—	BUW36	BUX47A		3-499
BUS46P		MJE16002	3-976	BUW44	BUX48		3-506
BUS47	BUX47		3-499	BUW45	BUX48		3-506
BUS47A	BUX47A		3-499	BUW46	BUX48A		3-506
BUS47AP	BUV47A		3-462	BUW72		MJE13008	3-950
BUS47P	BUV47		3-462	BUW74	BUX47		3-499
BUS48	BUX48		3-506	BUW75	BUX47		3-499
BUS48A	BUX48A		3-506	BUW76	BUX47		3-499
BUS48AP	BUV48A		3-469	BUW77	BUX47		3-499
BUS48P	BUV48		3-469	BUW81	MJ10014		3-600
BUS50	BUS50		3-382	BUW81A	MJ10014		3-600
BUS51	BUS51		3-384	BUW84	MJE13003		3-938
BUS52		BUS51	3-384	BUW85	MJE13003		3-938
BUS97	MJ16010		3-758	BUX13	BUX13		3-484
BUS97A	MJ16010A		3-766	BUX14	BUX14		—
BUS98	BUX98		—	BUX14CECCF	BUX14		—
BUS98A	BUX98A		—	BUX14CECCL	BUX14		—
BUT13	BUT13		3-393	BUX15	BUX47A		3-499
BUT14	BUT14		3-399	BUX15CECCF	BUX47A		3-499
BUT15	BUT15		3-405	BUX15CECCL	BUX47A		3-499
BUT33	BUT33		3-411	BUX16	2N6543		3-215
BUT34	BUT34		3-417	BUX16A	2N6543		3-215
BUT35	BUT35		3-423	BUX16B	2N6543		3-215
BUT50P	BUT50P		3-429	BUX16C	2N6543		3-215
BUT51P	BUT51P		3-431	BUX17	BUX48		3-506
BUT90	BUS50		3-382	BUX17A	BUX48		3-506
BUT91	BUS51		3-384	BUX17B	BUX48		3-506
BUT92		BUS51	3-384	BUX17C	BUX48		3-506
BUV10		BUV10N	3-432	BUX18	2N6545		3-221
BUV10N	BUV10N		3-432	BUX18A	2N6545		3-221
BUV11	BUV11		3-435	BUX18B	2N6545		3-221
BUV11N		BUV11	3-435	BUX18C	2N6545		3-221
BUV12	BUV12		3-441	BUX39	BUX39		3-487
BUV18		BUS50	3-382	BUX40	BUX40		3-490
BUV19		BUS50	3-382	BUX41	BUX41		3-493
BUV20	BUV20		3-444	BUX41N		BUX41	3-493
BUV21	BUV21		3-447	BUX42		BUX13	3-484
BUV21N		BUV21	3-447	BUX43		BUX13	3-484
BUV22	BUV22		3-453	BUX47	BUX47		3-499
BUV23	BUV23		3-456	BUX47A	BUX47A		3-499
BUV24		BUS98	3-386	BUX48	BUX48		3-506
BUV25		BUS98A	3-386	BUX48A	BUX48A		3-506
BUV44	BUX47		3-499	BUX48S	BUX48		3-506
BUV45	BUX47A		3-499	BUX66	2N6211		3-161
BUV46	2N6543		3-215	BUX66A	2N6212		3-161
BUV47	BUV47		3-462	BUX66B	2N6212		3-161
BUV47A	BUV47A		3-462	BUX66C	2N6213		3-161
BUV48	BUV48		3-469	BUX67	2N3584		3-20
BUV48A	BUV48A		3-469	BUX67A	2N3584		3-20
BUW11	BUW11		3-476	BUX67B	2N3585		3-20
BUW11A	BUW11A		3-476	BUX67C	2N4240		3-20
BUW12	BUW12		3-476	BUX81		MJ13335	3-700

\*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	20/70	4	0.7 typ	0.3 typ	4	2.5	115	
			MJ2955A	20/70	4			0.8	115		
				2k/20k	4	2	7	10	10-200#	120	
			2N5879	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	
	120	MJ15015 2N6578##	MJ15016	20/70	4				1	180	
				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##			8 min	8	1.5	0.4	8	8	120
					10/50	10	3.5	1	10	2.5	175
			MJ11019##	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)CEX</sub>, # |h<sub>FE</sub>| @ 1 MHz, ## Darlington

(continued)

JAN, JTX, JTXV Available

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**TABLE 14 — SWITCHMODE POWER TRANSISTORS (continued)**

V <sub>CEO(sus)</sub> Volts Min	I <sub>C</sub> Cont Amps Max	V <sub>CEV</sub> Volts Min	Device Type NPN unless otherwise noted	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	Case JEDEC/MOT	
						t <sub>s</sub> μs Max	t <sub>f</sub> μs Max	@ I <sub>C</sub> Amp				
400	8	850	2N6545★	7/35	5	4	1	5	6	80 125 50	TO-204/1	
		800	MJE5742#	200/400	4	8 typ	2 typ	6			TO-220/221A	
		800	MJE16080	5 min	8	2	0.5	5			TO-220/221A	
		850	BUW12	6 min	6	4	0.8	5			TO-218/340	
		850	BUX84	30 min	0.1	3.5	1.4	1			4	TO-220/221A
		700	MJE13007★	6/30	5	3	0.7	5			4	TO-220/221A
		650	MJ13080★	8 min	5	1.5	0.5	5			TO-204/1	
		650	MJE16106	6/25	8	2 typ	0.1 typ	5			100	TO-220/221A
		650	MJH16106	6/25	8	2 typ	0.1 typ	5			125	TO-218/340
		450	MJ6503-PNP★	15 min	2	2	0.5	4			TO-204/1	
		450	MJE5852-PNP★	15 min	2	2	0.5	4			TO-220/221A	
		900	BU326A	30 typ	0.6	3.5	1**	2.5			6	90
	900	BU426A	30 typ	0.6	2 typ	0.5 typ	2.5	6 typ	113	TO-218/340D		
	850	2N6543★	7/35	3	4	0.8	3	6	125	TO-204/1		
	850	BUW11	6 min	3	4	0.8	3			TO-218/340		
	650	MJ13070★	8 min	3	1.5	0.5	3			TO-204/1		
	650	MJE13070★	8 min	3	1.5	0.5	3			TO-220/221A		
	700	MJE13005★	6/30	3	3	0.7	3	4	TO-220/221A			
700	MJE13003★	5/25	1	4	0.7	1	5	TO-225AA/77R				
400	MJ4647-PNP	20 min	0.5	0.72*		0.05	40	TO-205AD/79				
375	6	800	BU326	30 typ	0.6	3.5	1**	2.5	6	90	TO-204/1	
	800	BU426	30 typ	0.6	2 typ	0.5 typ	2.5	6 typ	113	TO-218/340D		
350	40	450	MJ10022##★	50/600	10	2.5	0.9	20			TO-204/197	
	20	450	MJ10000#★	40/400	10	3	1.8	10	10**		TO-204/1	
		450	MJ10004##★	40/400	10	1.5	0.5	10	10**		TO-204/1	
	15	375	2N6251	6/50	10	3.5	1	10	2.5		TO-204/1	
	10	450	MJ10002#★	30/300	5	2.5	1	5	10**		TO-204/1	
		450	MJ10006##★	30/300	5	1.5	0.5	5	10**		TO-204/1	
		400	MJ13014★	8/20	5	2	0.5	5			TO-204/1	
	700	2N6308	12/60	3	1.6	0.4	5	5		TO-204/1		
700	MJE5741#	200/400	4	8 typ	2 typ	6			TO-220/221A			
400	MJE5851-PNP	15 min	2	2	0.5	4			TO-220/221A			
400	2N6213-PNP	10/100	1	2.5	0.6	1	4		TO-213AA/80			
325	30	400	BUV23	8 min	16	1.8	0.4	16	8	250	TO-204/197	
	15	400	BUX13	8 min	8	2.5	0.8	8	8	150	TO-204/1	
	5	350	2N6235	25/125	1	3.5	0.5	1	20		TO-213AA/80	
300	15	650	2N6546★	6/30	10	4	0.7	10	6 to 24		TO-204/1	
	12	600	MJE13008★	6/30	8	3	0.7	8	4**		TO-220/221A	
	8	600	2N6307	15/75	3	1.6	0.4	3	5		TO-204/1	
		600	MJE13006★	6/30	5	3	0.7	5	4		TO-220/221A	
		600	MJE5740	200/400	4	8 typ	2 typ	6			TO-220/221A	
		350	MJE5850-PNP★	15 min	2	2	0.5	4			TO-220/221A	
	400	2N6498	10/75	2.5	1.8	0.8	2.5	5		TO-220/221A		
	4	600	MJE13004★	6/30	3	3	0.7	3	4		TO-220/221A	
	2	500	2N3585	25/100	1	4	3	1	10		TO-213AA/80	
		500	2N6422-PNP	25/100	1	4	3	1	10		TO-213AA/80	
350		2N6212-PNP	10/100	1	2.5	0.6	1	4		TO-213AA/80		
1.5	600	MJE13002★	5/25	1	4	0.7	1	5		TO-225AA/77R		

★ Designers Data Sheet characterization  
# Darlington ## Darlington with speed-up diode

\* t<sub>off</sub> \*\* |h<sub>FE</sub>| @ 1 MHz

(continued)



# BUX13

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

Characteristic	Symbol	Min.	Max.	Unit
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### OFF CHARACTERISTICS<sup>1</sup>

Collector-Emitter Sustaining Voltage (I <sub>C</sub> = 200 mA, I <sub>B</sub> = 0, L = 25 mH)	V <sub>CEO(sus)</sub>	325		V <sub>dc</sub>
Collector Cutoff Current at Reverse Bias: (V <sub>CE</sub> = 400 V, V <sub>BE</sub> = -1.5 V) (V <sub>CE</sub> = 400 V, V <sub>BE</sub> = -1.5 V, T <sub>C</sub> = 125°C)	I <sub>CEX</sub>		1.5 6.0	mAdc
Collector-Emitter Cutoff Current (V <sub>CE</sub> = 260 V)	I <sub>CEO</sub>		1.5	mAdc
Emitter-Base Reverse Voltage (I <sub>E</sub> = 50 mA)	V <sub>EBO</sub>	7		V
Emitter-Cutoff Current (V <sub>EB</sub> = 5 V)	I <sub>EBO</sub>		1.0	mAdc

### SECOND BREAKDOWN

Second Breakdown Collector Current with base forward biased (V <sub>CE</sub> = 30 V, t = 1 s) (V <sub>CE</sub> = 140 V, t = 1 s)	I <sub>S/b</sub>	5 0.15		A <sub>dc</sub>
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### ON CHARACTERISTICS<sup>1</sup>

DC Current Gain (I <sub>C</sub> = 4 A, V <sub>CE</sub> = 4 V) (I <sub>C</sub> = 8 A, V <sub>CE</sub> = 4 V)	h <sub>FE</sub>	15 8	60	
Collector-Emitter Saturation Voltage (I <sub>C</sub> = 4 A, I <sub>B</sub> = 0.8 A) (I <sub>C</sub> = 8 A, I <sub>B</sub> = 1.6 A)	V <sub>CE(sat)</sub>		0.8 1.5	V <sub>dc</sub>
Base-Emitter Saturation Voltage (I <sub>C</sub> = 8 A, I <sub>B</sub> = 1.6 A)	V <sub>BE(sat)</sub>		1.5	V <sub>dc</sub>

### DYNAMIC CHARACTERISTICS

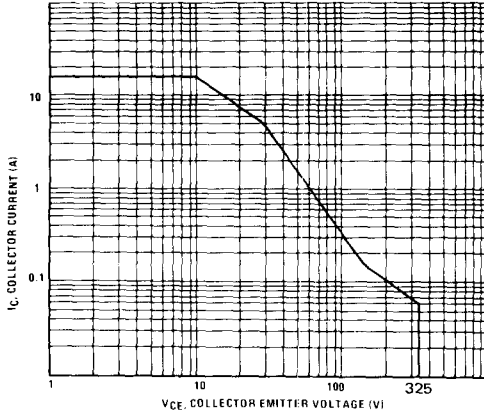
Current Gain - Bandwidth Product (V <sub>CE</sub> = 15 V, I <sub>C</sub> = 1 A, f = 4 MHz)	f <sub>T</sub>	8.0		MHz
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### SWITCHING CHARACTERISTICS (Resistive Load)

Turn on Time	I <sub>C</sub> = 8 A, I <sub>B1</sub> = I <sub>B2</sub> = 1.6 A, (V <sub>CC</sub> = 150 V, R <sub>C</sub> = 18.7 Ω)	t <sub>on</sub>	1.2	μs
Storage Time		t <sub>s</sub>	2.5	
Fall Time		t <sub>f</sub>	0.8	

<sup>1</sup> Pulse Test. Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%

FIGURE 2 – 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 2 is based on  $T_C = 25^\circ\text{C}$ ;  $T_J(\text{pk})$  is variable depending on power level. Second breakdown limitations do not derate the same as thermal limitations. At high case temperatures, thermal limitations will reduce the power that can handled to values less than the limitations imposed by second breakdown. (See AN415A)

FIGURE 3 – "ON" VOLTAGES

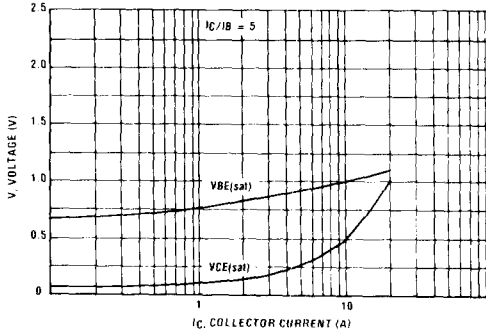


FIGURE 5 – RESISTIVE SWITCHING PERFORMANCE

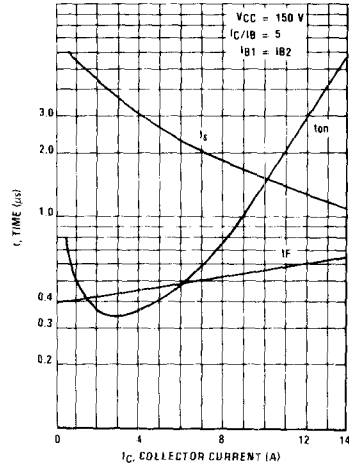


FIGURE 4 – DC CURRENT GAIN

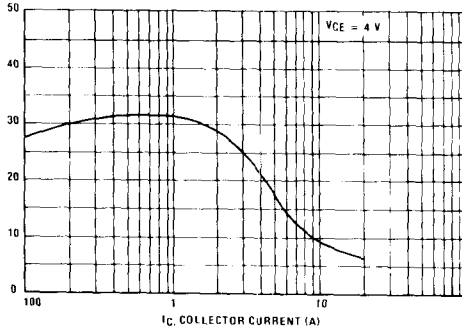
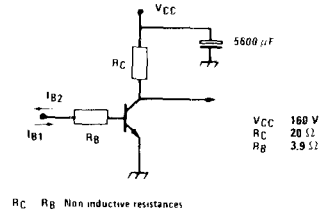


FIGURE 6 – SWITCHING TIMES TEST CIRCUIT



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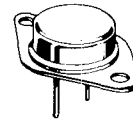
**SWITCHMODE<sup>▲</sup> SERIES**  
**NPN SILICON POWER TRANSISTOR**

... designed for high speed, high voltage, high power applications.

- Low  $V_{CE(sat)}$ ,  $V_{CE(sat)}$  max. = 1.5 V at  $I_C = 8$  A
- Very fast switching times:  
 $T_F$  max. = 0.8  $\mu$ s at  $I_C = 8$  A

**15 AMPERES**  
**NPN SILICON**  
**POWER**  
**METAL TRANSISTOR**

**325 VOLTS**  
**150 WATTS**



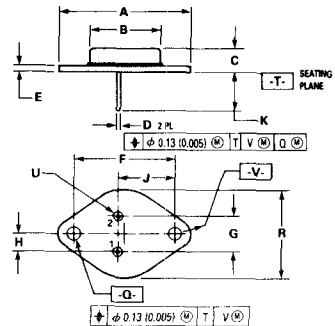
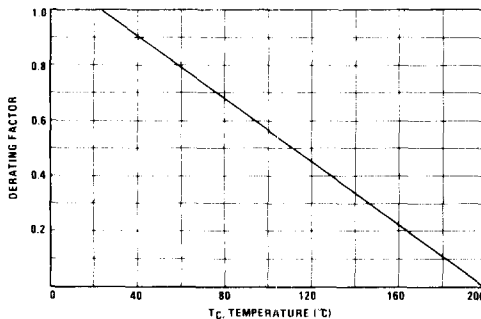
**MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	$V_{CEO(sus)}$	325	Vdc
Collector-Base Voltage	$V_{CBO}$	400	Vdc
Emitter-Base Voltage	$V_{EBO}$	7	Vdc
Collector-Emitter Voltage ( $V_{BE} = -2.5$ V)	$V_{CEX}$	400	Vdc
Collector-Emitter Voltage ( $R_{BE} = 100 \Omega$ )	$V_{CER}$	390	Vdc
Collector-Current - continuous	$I_C$	15	Adc
- peak ( $p_w \leq 10$ ms)	$I_{CM}$	20	Apk
Base-Current continuous	$I_B$	3	Adc
Total Power Dissipation @ $T_C = 25^\circ\text{C}$	$P_D$	150	Watts
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	$\theta_{JC}$	1.17	$^\circ\text{C/W}$

**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	0.065	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
O	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

STYLE 1  
 PIN 1 BASE  
 2 EMITTER  
 CASE COLLECTOR

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