ALPHANUMERIC INDEX — CROSS-REFERENCE (Continued)

Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number
BU806	BU806		3-380
BU807	BU807		3-380
BUS11		MJE16002	3-976
BUS12	BUX47		3-499
BUS12A	BUX47A		3-499
BUS13	BUX48		3-506
BUS13A	BUX48A		3-506
BUS14	BUX98		—
BUS14A	BUX98A		—
BUS46P		MJE16002	3-976
BUS47	BUX47		3-499
BUS47A	BUX47A		3-499
BUS47AP	BUV47A		3-462
BUS47P	BUV47		3-462
BUS48	BUX48		3-506
BUS48A	BUX48A		3-506
BUS48AP	BUV48A		3-469
BUS48P	BUV48		3-469
BUS50	BUS50		3-382
BUS51	BUS51		3-384
BUS52		BUS51	3-384
BUS97	MJ16010		3-758
BUS97A	MJ16010A		3-766
BUS98	BUX98		—
BUS98A	BUX98A		—
BUT13	BUT13		3-393
BUT14	BUT14		3-399
BUT15	BUT15		3-405
BUT33	BUT33		3-411
BUT34	BUT34		3-417
BUT35	BUT35		3-423
BUT50P	BUT50P		3-429
BUT51P	BUT51P		3-431
BUT90	BUS50		3-382
BUT91	BUS51		3-384
BUT92		BUS51	3-384
BUV10		BUV10N	3-432
BUV10N	BUV10N		3-432
BUV11	BUV11		3-435
BUV11N		BUV11	3-435
BUV12	BUV12		3-441
BUV18		BUS50	3-382
BUV19		BUS50	3-382
BUV20	BUV20		3-444
BUV21	BUV21		3-447
BUV21N		BUV21	3-447
BUV22	BUV22		3-453
BUV23	BUV23		3-456
BUV24		BUS98	3-386
BUV25		BUS98A	3-386
BUV44	BUX47		3-499
BUV45	BUX47A		3-499
BUV46	2N6543		3-215
BUV47	BUV47		3-462
BUV47A	BUV47A		3-462
BUV48	BUV48		3-469
BUV48A	BUV48A		3-469
BUW11	BUW11		3-476
BUW11A	BUW11A		3-476
BUW12	BUW12		3-476

Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number
BUW12A	BUW12A		3-476
BUW13	BUV48P		3-469
BUW13A	BUV48A		3-469
BUW24	BU326A		3-363
BUW25	BU326A		3-363
BUW26	BUS326A		—
BUW34	BUX47		3-499
BUW35	BUX47		3-499
BUW36	BUX47A		3-499
BUW44	BUX48		3-506
BUW45	BUX48		3-506
BUW46	BUX48A		3-506
BUW72		MJE13008	3-950
BUW74	BUX47		3-499
BUW75	BUX47		3-499
BUW76	BUX47		3-499
BUW77	BUX47		3-499
BUW81	MJ10014		3-600
BUW81A	MJ10014		3-600
BUW84	MJE13003		3-938
BUW85	MJE13003		3-938
BUX13	BUX13		3-484
BUX14	BUX14		—
BUX14CECCF	BUX14		—
BUX14CECCL	BUX14		—
BUX15	BUX47A		3-499
BUX15CECCF	BUX47A		3-499
BUX15CECCL	BUX47A		3-499
BUX16	2N6543		3-215
BUX16A	2N6543		3-215
BUX16B	2N6543		3-215
BUX16C	2N6543		3-215
BUX17	BUX48		3-506
BUX17A	BUX48		3-506
BUX17B	BUX48		3-506
BUX17C	BUX48		3-506
BUX18	2N6545		3-221
BUX18A	2N6545		3-221
BUX18B	2N6545		3-221
BUX18C	2N6545		3-221
BUX39	BUX39		3-487
BUX40	BUX40		3-490
BUX41	BUX41		3-493
BUX41N		BUX41	3-493
BUX42		BUX13	3-484
BUX43		BUX13	3-484
BUX47	BUX47		3-499
BUX47A	BUX47A		3-499
BUX48	BUX48		3-506
BUX48A	BUX48A		3-506
BUX48S	BUX48		3-506
BUX66	2N6211		3-161
BUX66A	2N6212		3-161
BUX66B	2N6212		3-161
BUX66C	2N6213		3-161
BUX67	2N3584		3-20
BUX67A	2N3584		3-20
BUX67B	2N3585		3-20
BUX67C	2N4240		3-20
BUX81		MJ13335	3-700

*Consult Motorola if a direct replacement is necessary.

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

I_CCont 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
10	250	MJ15011	MJ15012	20/100	2					200
	300	MJ3041##		250 min	2.5					175
	325	MJ413		20/80	0.5				2.5	125
		MJ423		30/90	1				2.5	125
		MJ431		15/35	2.5				2.5	125
	350	BU323##		150 min	6	7.5 typ	5.2 typ	6		175
		MJ3042##		250 min	2.5					175
		MJ13014		8/20	5	2	0.5	5		150
		MJ10002##		3/300	5	2.5	1	5	10#	150
		MJ10006##		30/300	5	1.5	0.5	5	10#	150
	400	BU323A##		150 min	6	7.5 typ	5.2 typ	6		175
		MJ10007##		30/300	5	1.5	0.5	5	10#	150
		MJ10012##		100/2k	6	15	15	6		175
		MJ13015		8/20	5	2	0.5	5		150
	600	MJ10014##		10/250	10	2.5	0.8	10		175
	700	MJ8504		7.5 min	1.5	4	2	5		175
	800	MJ8505		7.5 min	1.5	4	2	5		175
		MJ16018		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	MJ2955	20/70	4	0.7 typ	0.3 typ	4	2.5	115
		2N3055A	MJ2955A	20/70	4				0.8	115
		2N6576##		2k/20k	4	2	7	10	10–200#	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##		2k/20k	4	2	7	10	10-200#	120
	120	MJ15015	MJ15016	20/70	4				1	180
		2N6578##		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		8 min	8	1.5	0.4	8	8	120
		2N6249		10/50	10	3.5	1	10	2.5	175
		MJ11020##	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		8 min	10	2	0.4	10		175
		2N6547		6/30	10	4	0.7	10	6 to 24	175
		MJ13090		8 min	10	2.5	0.5	10		175
		MJ16110		6/20	15	0.8 typ	0.1 typ	10		175
	450	BUX48A		8 min	8	2	0.4	10		175
		MJ16010		5 min	15	1.2 typ	0.2 typ	10		175

* $V_{(BR)CEX}$, # $|h_{fe}|$ @ 1 MHz, ## Darlington

(continued)

☐ JAN, JTX, JTXV Available

TABLE 14 — SWITCHMODE POWER TRANSISTORS (continued)

$V_{CEO(sus)}$ Volts Min	I_C Cont Amps Max	V_{CEV} Volts Min	Device Type NPN unless otherwise noted	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
300	**0.5**	**300**	**MJ4646-PNP**	20 min	0.5	0.72*		0.05	40		TO-205AD/79
275	**15**	**300**	**2N6250**	8/50	10	3.5	1	10	2.5		TO-204/1
250	**60**	**350**	**MJ10021##★**	25 min	30	3.5	0.5	30			TO-204/197
	40	**300** **350**	**BUV22** **BUS52**	10 min 15 min	20 40	1.1	0.35	20	8	250 350	TO-204/1 TO-204/1
	20	**300** **450**	**BUV12** **MJ13331★**	10 min 8/40	10 10	1.5 3.5	0.5 0.7	10 10	8 5/40	150	TO-204/1 TO-204/1
	15	**250** **250**	**MJ11021#-PNP** **MJ11022#**	100 min 100 min	15 15				3# 3#		TO-204/1 TO-204/1
	8	**500** **400**	**2N6306** ***MJ6502-PNP★***	15/75 *15 min*	3 2	1.6 2	0.4 0.5	3 4	5		TO-204/1 *TO-204/1*
	5	**500** **350**	**MJ3029** **2N6497**	30 min 10/75	0.4 2.5	1.8	1 0.8	3 2.5	5		TO-204/1 TO-220/221A
	2	**375** **375**	**2N3584** **2N6421-PNP**	25/100 25/100	1 1	4 4	3 3	1 1	10 10		TO-213AA/80 TO-213AA/80
	1	**250**	**2N5344-PNP**	25/100	0.5	0.6	0.1	0.5	60		TO-213AA/80
225	**2**	**275**	**2N6211**	10/100	1	2.5	0.6	1	20		TO-213AA/80
200	**60**	**300**	**MJ10020##★**	25 min	30	3.5	0.5	30			TO-204/197
	50	**300**	**BUS51**	15 min	50					350	TO-204/1
	40	**250**	**BUV21**	*10 min*	25	1.8	0.4	25	8	150	*TO-204/1*
	20	**250** **400**	**BUV11** **MJ13330★**	10 min 8/40	12 10	1.8 3.5	0.4 0.7	12 10	8 5/40	150	TO-204/1 TO-204/1
	15	**225** **250** **200** **200**	**2N6249** **BUX41** **MJ11019#-PNP** **MJ11020#**	10/50 8 min 100 min 100 min	10 8 15 15	3.5 1.5	1 0.4	10 8	2.5 8 3# 3#	120	TO-204/1 TO-204/1 TO-204/1 TO-204/1
	3	**250**	**BUY49P**	30 min	0.5				25	20	TO-225AA/77

★ Designers Data Sheet characterization
Darlington ## Darlington with speed-up diode * t_{off} ** $|h_{fe}|$ @ 1 MHz

BUX41

SWITCHMODE® SERIES
NPN SILICON POWER TRANSISTOR

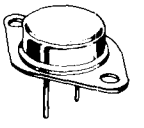
. . . designed for high speed, high current, high power applications.

- Very fast switching times:
  T_F max. = 0.4 μs at Ic = 8 A

15 AMPERES

NPN SILICON POWER METAL TRANSISTOR

200 VOLTS
120 WATTS



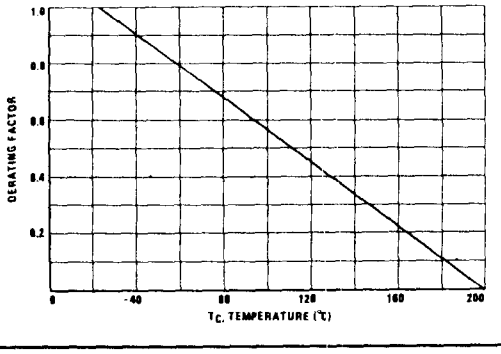
MAXIMUM RATINGS

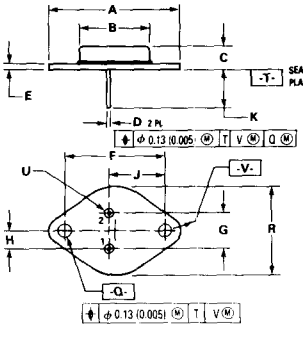
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	$V_{CEO(sus)}$	200	Vdc
Collector-Base Voltage	V_{CBO}	250	Vdc
Emitter-Base Voltage	V_{EBO}	7	Vdc
Collector-Emitter Voltage (V_{BE} = −2.5 V)	V_{CEX}	250	Vdc
Collector-Emitter Voltage (R_{BE} = 100 Ω)	V_{CER}	240	Vdc
Collector-Current — continuous — peak (pw ≤ 10 ms)	I_C I_{CM}	15 20	Adc Apk
Base-Current continuous	I_B	3	Adc
Total Power Dissipation @ T_C = 25°C	P_D	120	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to 200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max.	Unit
Thermal Resistance, Junction to Case	θ_{JC}	1.46	°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 MIN	MILLIMETERS MAX	INCHES MIN	INCHES 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

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

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

3

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

Characteristic	Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS[1]				
Collector-Emitter Sustaining Voltage (I_C = 200 mA, I_B = 0, L = 25 mH)	$V_{CEO(sus)}$	200		Vdc
Collector Cutoff Current at Reverse Biais: (V_{CE} = 250 V, V_{BE} = −1.5 V) (V_{CE} = 250 V, V_{BE} = −1.5 V, T_C = 125°C)	I_{CEX}		1.0 5.0	mAdc
Collector-Emitter Cutoff Current (V_{CE} = 160 V)	I_{CEO}		1.0	mAdc
Emitter-Base Reverse Voltage (I_E = 50 mA)	V_{EBO}	7		V
Emitter-Cutoff Current (V_{EB} = 5 V)	I_{EBO}		1.0	mAdc
SECOND BREAKDOWN				
Second Breakdown Collector Current with base forward biased (V_{CE} = 30 V, t = 1 s) (V_{CE} = 135 V, t = 1 s)	$I_{S/b}$	4.0 0.15		Adc
ON CHARACTERISTICS[1]				
DC Current Gain (I_C = 5 A, V_{CE} = 4 V) (I_C = 8 A, V_{CE} = 4 V)	h_{FE}	15 8	45	
Collector-Emitter Saturation Voltage (I_C = 5 A, I_B = 0.5 A) (I_C = 8 A, I_B = 1 A)	$V_{CE(sat)}$		1.2 1.6	Vdc
Base-Emitter Saturation Voltage (I_C = 8 A, I_B = 1 A)	$V_{BE(sat)}$		2.0	Vdc
DYNAMIC CHARACTERISTICS				
Current Gain – Bandwidth Product (V_{CE} = 15 V, I_C = 1 A, f = 4 MHz)	f_T	8.0		MHz

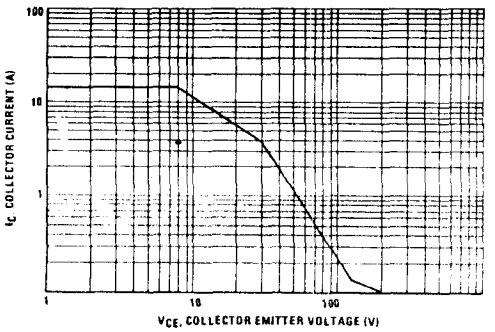
3

SWITCHING CHARACTERISTICS (Resistive Load)

Turn on Time	I_C = 8 A, I_{B1} = I_{B2} = 1 A, (V_{CC} = 150 V, RC = 18.75 Ω)	t_{on}		0.6	μs
Storage Time		t_s		1.5	
Fall Time		t_f		0.4	

[1] 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°C; $T_{J(pk)}$ 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

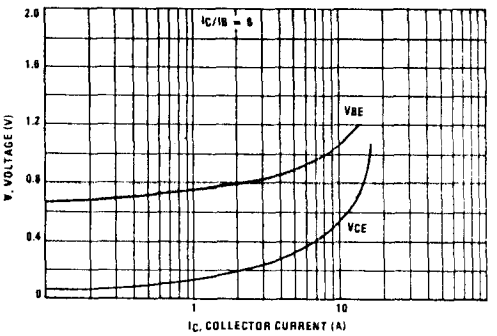


FIGURE 4 – DC CURRENT GAIN

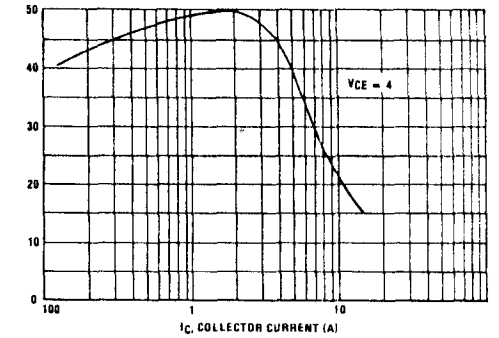


FIGURE 5 – RESISTIVE SWITCHING PERFORMANCE

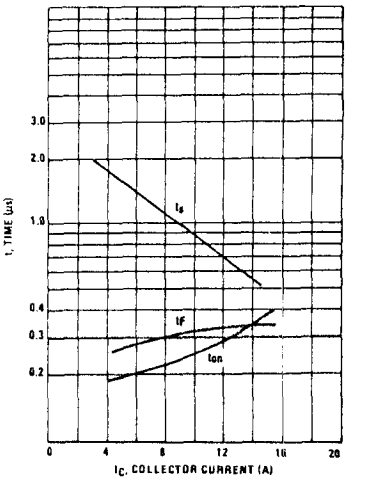
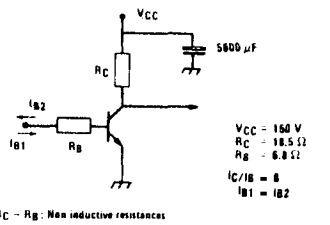


FIGURE 6 – SWITCHING TIMES TEST CIRCUIT



R_C – R_B: Non inductive resistances

3