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*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 12 — POWER DARLINGTONS (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	$\|h_{fe}\|$ @ 1 MHz Min	P_D (Case) Watts @ 25°C	Case JEDEC/MOT
10	400	MJ10012		100/2k	6	15	15	6		175	TO-204/1
	600	MJ10014•		10/250	10	2.5	0.8	10		175	TO-204/1
12	60	2N6057	2N6050	750/18k	6	1.6 typ	1.5 typ	6	4	150	TO-204/1
	80	2N6058	2N6051	750/18k	6	1.6 typ	1.5 typ	6	4	150	TO-204/1
	100	2N6059	2N6052	750/18k	6	1.6 typ	1.5 typ	6		150	TO-204/1
	1000	BUT16•		5 min	8	3.3	1.5	8		150	TO-204/1
15	60	2N6576		2k/20k	4	2	7	10	10/200	120	TO-204/1
	90	2N6577		2k/20k	4	2	7	10	10/200	120	TO-204/1
	120	2N6578		2k/20k	4	2	7	10	10/200	120	TO-204/1
	150	MJ11018 MJH11018	MJ11017 MJH11017	100 min 100 min	15 15				3 3	175 150	TO-204/1 TO-218/340
	200	MJ11020 MJH11020	MJ11019 MJH11019	100 min 100 min	15 15				3 3	175 150	TO-204/1 TO-218/340
	250	MJ11022 MJH11022	MJ11021 MJH11021	100 min 100 min	15 15				3 3	175 150	TO-204/1 TO-218/340
	500	BUT51P		40 min	5	1.1	0.16	10		125	TO-218/340D
20	60	2N6282 MJH6282	2N6285 MJH6285	750/18k 750/18k	10 10	2.5 typ 2.5 typ	2.5 typ 2.5 typ	10 10	4 4	160 125	TO-204/1 TO-218/340
	80	2N6283 MJH6283	2N6286 MJH6286	750/18k 750/18k	10 10	2.5 typ 2.5 typ	2.5 typ 2.5 typ	10 10	4 4	160 125	TO-204/1 TO-218/340
	100	2N6284 MJH6284	2N6287 MJH6287	750/18k 750/18k	10 10	2.5 typ 2.5 typ	2.5 typ 2.5 typ	10 10	4 4	160 125	TO-204/1 TO-218/340
	350	MJ10000 MJ10004•		40/400 40/400	10 10	3 1.5	1.8 0.5	10	10 10	175 175	TO-204/1 TO-204/1
	400	MJ10001 MJ10005•		40/400 40/400	10 10	3 1.5	1.8 0.5	10	10 10	175 175	TO-204/1 TO-204/1
	450	MJ10008•		30/300	10	2	0.6	10	8	175	TO-204/1
	500	MJ10009•		30/300	10	2	0.6	10	8	175	TO-204/1
	700	BUT15•		15 min	12	2.5	0.8	12		175	TO-204/1
	750	MJ10024•		50/600	5	5	1.8	10		250	TO-204/1
	850	MJ10025•		50/600	5	5	1.8	10		250	TO-204/1
25	500	BUT14•		15 min	16	2.8	0.8	16		175	TO-204/1
28	400	BUT13•		20 min	20	2.6	0.8	18		175	TO-204/1
30	60	MJ11012	MJ11011	1k min	20				4	200	TO-204/1
	90	MJ11014	MJ11013	1k min	20				4	200	TO-204/1
	120	MJ11016	MJ11015	1k min	20				4	200	TO-204/1
40	350	MJ10022•		50/600	10	2.5	0.9	20		250	TO-204/197
	400	MJ10023•		50/600	10	2.5	0.9	20		250	TO-204/197
	700	BUT35•		15 min	24	4	1.2	24		250	TO-204/197
50	60	MJ11028	MJ11029	400 min	50					300	TO-204/197

• Darlington with speed-up diode.

(continued)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

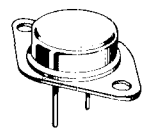
PNP
2N6050 thru 2N6052
NPN
2N6057 thru 2N6059

DARLINGTON COMPLEMENTARY SILICON POWER TRANSISTORS

. . . designed for general-purpose amplifier and low frequency switching applications.

- High DC Current Gain –
  h_{FE} = 3500 (Typ) @ I_C = 5.0 Adc
- Collector-Emitter Sustaining Voltage – @ 100 mA
  $V_{CEO(sus)}$ = 60 Vdc (Min) – 2N6050, 2N6057
  80 Vdc (Min) – 2N6051, 2N6058
  100 Vdc (Min) – 2N6052, 2N6059
- Monolithic Construction with Built-In Base-Emitter Shunt Resistors

DARLINGTON
12 AMPERE
COMPLEMENTARY SILICON POWER TRANSISTORS
60-80-100 VOLTS
150 WATTS



***MAXIMUM RATINGS**

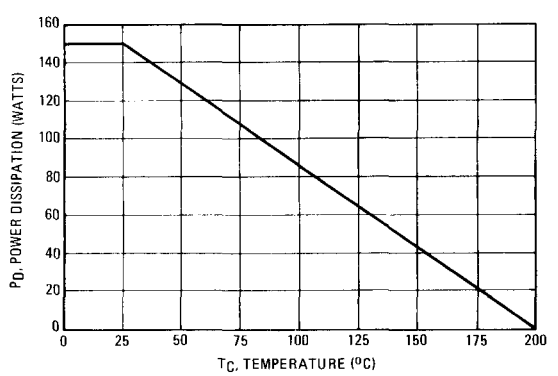
Rating	Symbol	2N6050 2N6057	2N6051 2N6058	2N6052 2N6059	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	100	Vdc
Collector-Base Voltage	V_{CB}	60	80	100	Vdc
Emitter-Base Voltage	V_{EB}	5.0			Vdc
Collector Current – Continuous Peak	I_C	12 20			Adc
Base Current	I_B	0.2			Adc
Total Device Dissipation @T_C = 25°C Derate above 25°C	P_D	150 0.857			Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200°C			°C

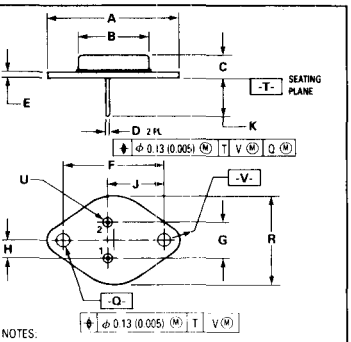
THERMAL CHARACTERISTICS

Characteristic	Symbol	Rating	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.17	°C/W

*Indicates JEDEC Registered Data

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)

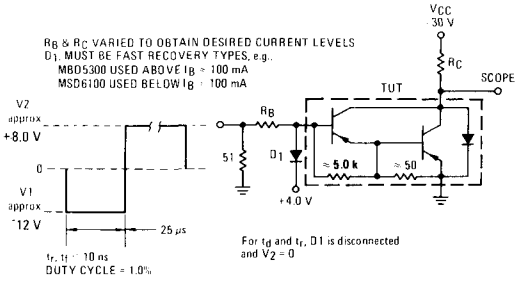
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (1)		$V_{CEO(sus)}$			Vdc
(I_C = 100 mAdc, I_B = 0)	2N6050, 2N6057		60	–	
	2N6051, 2N6058		80	–	
	2N6052, 2N6059		100	–	
Collector Cutoff Current		I_{CEO}			mAdc
(V_{CE} = 30 Vdc, I_B = 0)	2N6050, 2N6057		–	1.0	
(V_{CE} = 40 Vdc, I_B = 0)	2N6051, 2N6058		–	1.0	
(V_{CE} = 50 Vdc, I_B = 0)	2N6052, 2N6059		–	1.0	
Collector Cutoff Current		I_{CEX}			mAdc
(V_{CE} = Rated V_{CEO}, $V_{BE(off)}$ = 1.5 Vdc)			–	0.5	
(V_{CE} = Rated V_{CEO}, $V_{BE(off)}$ = 1.5 Vdc, T_C = 150°C)				5.0	
Emitter Cutoff Current		I_{EBO}	–	2.0	mAdc
(V_{BE} = 5.0 Vdc, I_C = 0)					
ON CHARACTERISTICS (1)					
DC Current Gain		h_{FE}			–
(I_C = 6.0 Adc, V_{CE} = 3.0 Vdc)			750	18,000	
(I_C = 12 Adc, V_{CE} = 3.0 Vdc)			100	–	
Collector-Emitter Saturation Volatage		$V_{CE(sat)}$			Vdc
(I_C = 6.0 Adc, I_B = 24 mAdc)			–	2.0	
(I_C = 12 Adc, I_B = 120 mAdc)			–	3.0	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	–	4.0	Vdc
(I_C = 12 Adc, I_B = 120 mAdc)					
Base-Emitter On Voltage		$V_{BE(on)}$	–	2.8	Vdc
(I_C = 6.0 Adc, V_{CE} = 3.0 Vdc)					
DYNAMIC CHARACTERISTICS					
Magnitude of Common Emitter Small-Signal Short Circuit Forward Current Transfer Ratio		$\|h_{fe}\|$	4.0	–	MHz
(I_C = 5.0 Adc, V_{CE} = 3.0 Vdc, f = 1.0 MHz)					
Output Capacitance	2N6050/2N6052	C_{ob}	–	500	pF
(V_{CB} = 10 Vdc, I_E = 0, f = 0.1 MHz)	2N6057/2N6059		–	300	
Small-Signal Current Gain		h_{fe}	300	–	–
(I_C = 5.0 Adc, V_{CE} = 3.0 Vdc, f = 1.0 kHz)					

*Indicates JEDEC Registered Data

(1) Pulse test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

3

FIGURE 2 – SWITCHING TIMES TEST CIRCUIT



For NPN test circuit reverse diode and voltage polarities.

FIGURE 3 – SWITCHING TIMES

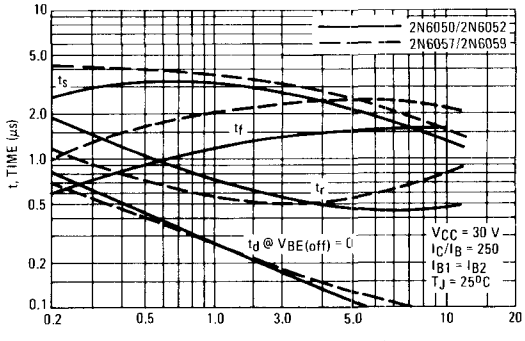
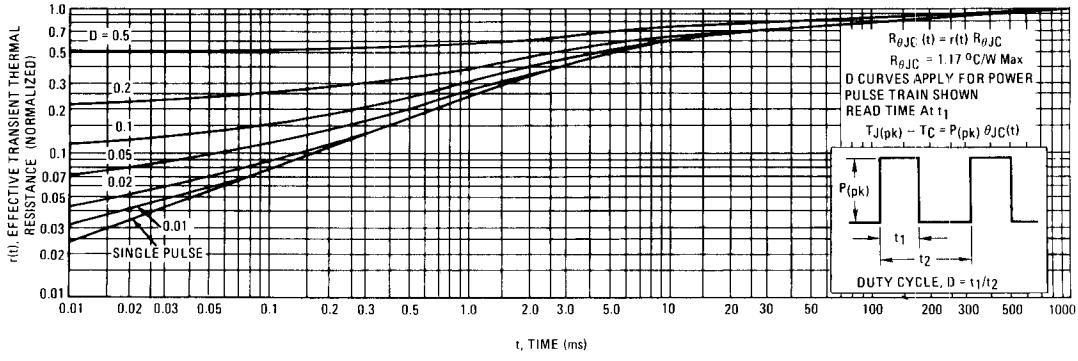


FIGURE 4 – THERMAL RESPONSE



ACTIVE-REGION SAFE OPERATING AREA

FIGURE 5 – 2N6050, 2N6057

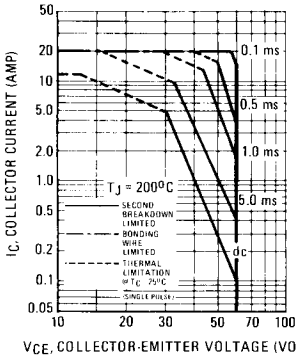


FIGURE 6 – 2N6051, 2N6058

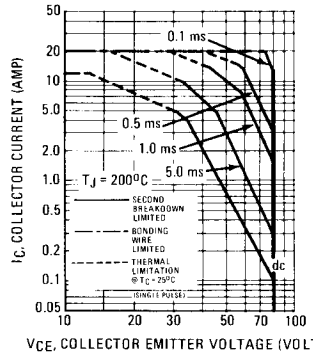
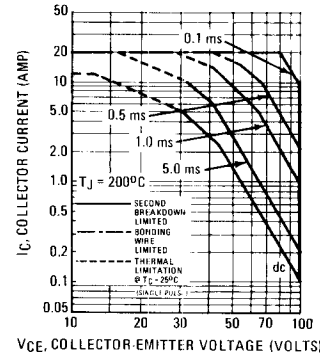


FIGURE 7 – 2N6052, 2N6059



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 5, 6 and 7 is based on $T_{J(pk)} = 200^{\circ}C$; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leqslant 200^{\circ}C$ $T_{J(pk)}$ may be calculated from the data in Figure 4. 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 8 – SMALL-SIGNAL CURRENT GAIN

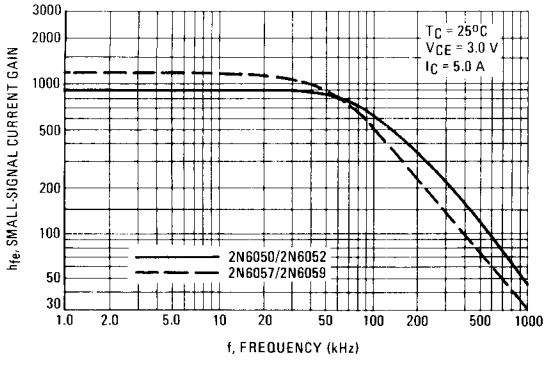
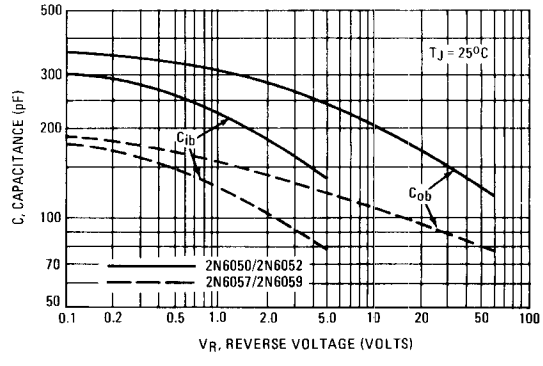


FIGURE 9 – CAPACITANCE



3

PNP
2N6050, 2N6051, 2N6052

NPN
2N6057, 2N6058, 2N6059

FIGURE 10 – DC CURRENT GAIN

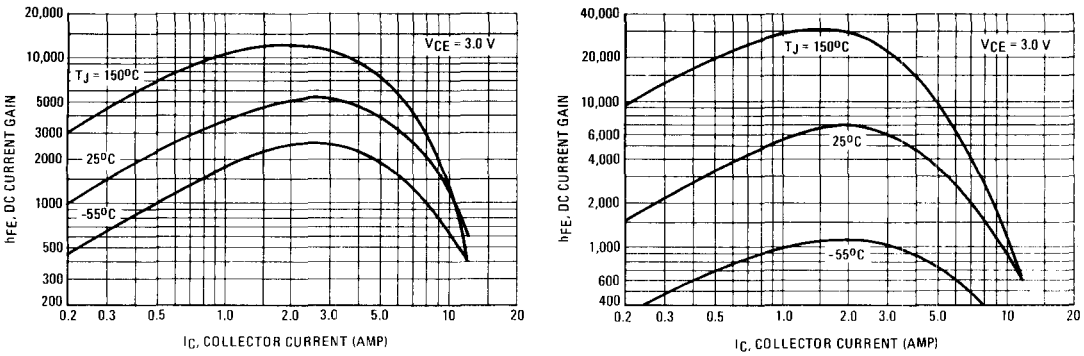


FIGURE 11 – COLLECTOR SATURATION REGION

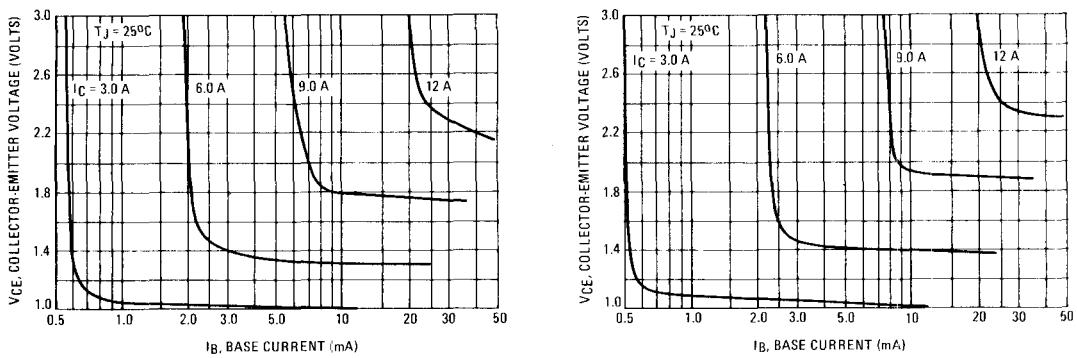


FIGURE 12 – "ON" VOLTAGES