

TYPE	MATERIAL	POLARITY	REPLACE- MENT	PAGE NUMBER	USE	MAXIMUM RATINGS					ELECTRICAL CHARACTERISTICS									
						P _D @ 25°C	Ref Point	T _J °C	V _{CB} (volts)	V _{CE} — (volts)	Subscript	h _{FE} @ I _C		Units	V _{CE(SAT)} @ I _C	Units	h _{FE} —	Subscript	f _T —	Units
2N2968	S	P			BMS	150M	A	140	30	10	15		100*	0.6	10M			8.0M	T	
2N2969	S	P			BMS	150M	A	140	30	10	15		100*	0.6	10M			8.0M	T	
2N2970	S	P			BMS	150M	A	140	30	20	10		100*	0.8	10M			4.0M	T	
2N2971	S	P			BMS	150M	A	140	30	20	10		100*	0.8	10M			4.0M	T	
2N2972	S	N		11-27	DFA	0.25W	A	200	45	45	60	240	10*	0.35	1.0M			60M	T	
2N2973	S	N		11-27	DFA	0.25W	A	200	45	45	150	600	10*	0.35	1.0M			60M	T	
2N2974	S	N		11-27	DFA	0.25W	A	200	45	45	60	240	10*	0.35	1.0M			60M	T	
2N2975	S	N		11-27	DFA	0.25W	A	200	45	45	150	600	10*	0.35	1.0M			60M	T	
2N2976	S	N		11-27	DFA	250M	A	200	45	45	60	240	10*	0.35	1.0M			60M	T	
2N2977	S	N		11-27	DFA	250M	A	200	45	45	150	600	10*	0.35	1.0M			60M	T	
2N2978	S	N		11-27	DFA	250M	A	200	60	60	60	240	10*	0.35	1.0M			60M	T	
2N2979	S	N		11-27	DFA	0.25W	A	200	60	60	150	600	10*	0.35	1.0M			60M	T	
2N2980	S	N	2N2060A	11-6	DFA	0.25W	A	200	100	60	25	75	10*	1.2	50M	50	E	60M	T	
2N2981	S	N	2N2223	11-6	DFA	0.25W	A	200	100	60	50	200	10M	1.2	50M	40	E	50M	T	
2N2982	S	N	2N2223A	11-6	DFA	0.25W	A	200	100	60	50	200	10M	1.2	50M	40	E	50M	T	
2N2983	S	N			LPA	1.0W	A	175	155	80	20	60	500M	0.6	1.0A	20	E	60M	T	
2N2984	S	N			LPA	1.0W	A	175	185	120	20	60	500M	0.8	200M	20	E	60M	T	
2N2985	S	N			LPA	1.0W	A	175	155	80	40	120	500M	0.8	200M	40	E	60M	T	
2N2986	S	N			LPA	1.0W	A	175	185	120	40	120	500M	0.8	200M	40	E	60M	T	
2N2987	S	N			LPA	1.0W	A	200	95	80	25	75	200M	0.8	200M	25	E	30M	T	
2N2988	S	N			LPA	1.0W	A	200	155	100	25	75	200M	0.8	200M	25	E	30M	T	
2N2989	S	N			LPA	1.0W	A	200	95	80	60	120	200M	0.8	200M	50	E	30M	T	
2N2990	S	N			LPA	1.0W	A	200	155	100	60	120	200M	0.8	200M	50	E	30M	T	
2N2991	S	N			LPA	2.0W	A	200	95	80	25	75	200M	0.8	200M	25	E	30M	T	
2N2992	S	N			LPA	2.0W	A	200	155	100	20	120	200M	0.8	200M	50	E	30M	T	
2N2993	S	N			LPA	2.0W	A	200	155	100	60	120	200M	0.8	200M	50	E	30M	T	
2N2994	S	N			LPA	2.0W	A	200	155	100	60	120	200M	0.8	200M	50	E	30M	T	
2N2995	S	N			HPA	1.5W	A	175	120	100	25	90	0.2A	1.7	0.2A	30	E	10M	T	
2N2996	G	P	2N3283	9-51	RFA	75M	A	100	15	10	25	500	4.0M			35	E	400M	T	
2N2997	G	P	2N3279	9-49	RFA	75M	A	100	30	15	40	500	4.0M			50	E	400M	T	
2N2998	G	P	2N3284	9-51	RFA	75M	A	100	15	12	15	300	3.0M			20	E	600M	T	
2N2999	G	P	2N3283	9-51	RFA	75M	A	100	15	10	10	300	3.0M			15	E	1.4G	T	
2N3001 thru 2N3008	Thyristors, see Table on Page 1-154																			
2N3009	S	N		8-181	HSS	360M	A	200	40	15	30	120	30M	0.18	30M			350M	T	
2N3010	S	N		8-183	HSS	300M	A	200	15	6.0	25	125	10M	0.25	10M			600M	T	
2N3011	S	N		8-183	HSS	360M	A	200	30	12	30	120	10M	0.2	10M			400M	T	
2N3012	S	P	MM2894	8-328	MSS	360M	A	200	12	12	30	120	30M	0.15	10M			400M	T	
2N3013	S	N		8-187	HSS	360M	A	200	40	15	30	120	30M	0.18	30M			350M	T	
2N3014	S	N		8-187	HSS	360M	A	200	40	20	30	120	30M	0.18	10M			350M	T	
2N3015	S	N		8-187	HSS	800M	A	200	60	30	30	120	150M	0.4	150M			250M	T	
2N3016	S	N			HFA	3.33W	C	150	100	50	60	150	1.0A	0.75	1.0A			200M	T	
2N3017	S	N			HFA	3.33W	C	150	100	50	60	150	1.0A	0.75	5.0A			200M	T	
2N3018	S	N			HFA	25W	C	150	100	50	60	150	1.0A	0.75	5.0A			200M	T	
2N3019	S	N		8-189	RFA	0.8W	A	200	140	80	100	300	0.15A	0.2	0.15A	80	E	100M	T	
2N3020	S	N		8-189	RFA	0.8W	A	200	140	80	40	120	0.15A	0.2	0.15A	30	E	80M	T	
2N3021	S	P		7-99	PHS	25W	C	175	30	30	20	60	1.0A	1.5	3.0A			60M	T	
2N3022	S	P		7-99	PHS	25W	C	175	45	45	20	60	1.0A	1.5	3.0A			60M	T	
2N3023	S	P		7-99	PHS	25W	C	175	60	60	20	60	1.0A	1.5	3.0A			60M	T	
2N3024	S	P		7-99	PHS	25W	C	175	30	30	50	180	1.0A	1.0	3.0A			60M	T	
2N3025	S	P		7-99	PHS	25W	C	175	45	45	50	180	1.0A	1.0	3.0A			60M	T	
2N3026	S	P		7-99	PHS	25W	C	175	60	60	50	180	1.0A	1.0	3.0A			60M	T	
2N3027 thru 2N3032	Thyristors, see Table on Page 1-154																			
2N3033	S	N			SPP	300M	A	175	100	100			1.0	100M						
2N3034	S	N			SPP	300M	A	175	70	70			1.0	100M						
2N3035	S	N			SPP	300M	A	175	50	50			1.0	100M						
2N3036	S	N			AFA	800M	A	200	120	80	50	150	150M	0.25	150M	40	E	50M	T	
2N3037	S	N			AFA	360M	A	175	120	70	40	120	150M	0.2	10M	30	E	50M	T	
2N3038	S	N			AFA	360M	A	175	100	60	80	240	150M	0.2	10M	60	E	50M	T	
2N3039	S	P			AFA	360M	A	175	50	35	20	80	150M			20	E	50M	T	
2N3040	S	P			AFA	360M	A	175	40	30	40	160	150M	0.2	10M	40	E	50M	T	
2N3043	S	N		11-29	DFA	250M	A	200	45	45	100	300	10*	1.0	10M	130	E	30M	T	
2N3044	S	N		11-29	DFA	250M	A	200	45	45	100	300	10*	1.0	10M	130	E	30M	T	
2N3045	S	N		11-29	DFA	250M	A	200	45	45	100	300	10*	1.0	10M	130	E	30M	T	
2N3046	S	N		11-29	DFA	250M	A	200	45	45	50	200	10*	1.0	10M	65	E	30M	T	
2N3047	S	N		11-29	DFA	250M	A	200	45	45	50	200	10*	1.0	10M	65	E	30M	T	
2N3048	S	N		11-29	DFA	250M	A	200	45	45	50	200	10*	1.0	10M	65	E	30M	T	
2N3049	S	P		11-31	DFA	250M	A	200	25	20	20	120	10*	0.2	10M	30	E	60M	T	
2N3050	S	P		11-31	DFA	250M	A	200	25	20	20	120	10*	0.2	10M	30	E	60M	T	
2N3051	S	P			AFA	250M	A	175	25	20	20	120	10*	0.2	10M	30	E	60M	T	
2N3052	S	N			HSS	250M	A	175	35	15	25	130	10M	0.25	10M			200M	T	
2N3053	S	N		8-191	HSS	5.0W	C	200	60	40	50	250	0.15A	1.4	0.15A			100M	T	
2N3054	S	N			LPA	25W	C	200	90	60	25	100	0.5A	1.0	0.5A	25	E	30K	T	
2N3055	S	N			LPA	115W	C	200	100	70	20	70	4.0A	1.1	4.0A	15	E	20K	T	
2N3056	S	N			RFA	0.4W	A	200	100	60	40	120	0.15A	0.25	0.15A	30	E	80M	T	
2N3056A	S	N			RFA	0.4W	A	200	140	80	40	120	0.15A	0.2	0.15A	30	E	80M	T	
2N3057	S	N			RFA	0.4W	A	200	100	60	100	300	0.15A	0.25	0.15A	80	E	100M	T	
2N3057A	S	N			RFA	0.4W														

QUICK SELECTOR GUIDES — SILICON HIGH-SPEED SWITCHING AND GENERAL PURPOSE TRANSISTORS

The following two tables categorize the silicon devices included in this section into two classifications — those intended for general-purpose switching and amplifier applications, and those recommended primarily for high-speed saturated switching purposes.

Only the preferred devices — those that merit first consideration for new designs — are listed. In each table, the devices are grouped in voltage and current ranges. The voltage given is the minimum collector-emitter breakdown voltage (BV_{CEO}). The current range columns represent operating current values for which optimum current gain (h_{FE}) and/or collector-emitter saturation voltage ($V_{CE(sat)}$) are specified in the data sheets.

SATURATED SWITCHING TRANSISTORS (SILICON) Current versus Voltage

BV_{CEO} Min Volts	OPTIMUM COLLECTOR CURRENT											
	0 to 10 mA		10 mA to 100 mA		100 mA to 500 mA		500 mA to 1.0 A		1.0 A to 3.0 A		3.0 A to 5.0 A	
	NPN	PNP	NPN	PNP	NPN	PNP	NPN	PNP	NPN	PNP	NPN	PNP
0 ↓ 19	2N3010 2N3493 MM709 MM1748	2N2894 2N3546 2N4411	2N2369A 2N3009 2N3010 2N3011 2N3013 2N3210 2N3211	2N2894 2N3546	2N3009 2N3013 2N3510 2N3511 2N3647 2N3648		2N3303		2N3303			
20 ↓ 29	2N702 2N703		2N2501 2N3014 2N3227 2N3508 2N3509		2N2476 2N2477 2N2501 2N2847 2N2848							
30 ↓ 39			2N2537 2N2538 2N2539 2N2540		2N2537 2N2538 2N2539 2N2540 2N2845 2N2846 2N3015 2N3724 2N4013 2N4046		2N3252 2N3724 2N3734 2N3736 2N4013 2N4046		2N3734 2N3736			
40 ↓ 59			2N3725 2N4014		2N3725 2N4014 2N4047	2N3467 2N3468	2N3253 2N3444 2N3725 2N3735 2N3737 2N4014 2N4047	2N3467 2N3468 2N3762 2N3764	2N3444 2N3735 2N3737	2N3762 2N3764	2N3506 2N3507	
60 79								2N3763 2N3765		2N3763 2N3765		

2N3009 (SILICON)
2N3013
2N3014

$V_{CB} = 40 \text{ V}$
 $f_T = 350 \text{ MHz (min)}$



Collector connected to case

NPN silicon epitaxial switching transistor designed for high-speed, medium-power saturated switching applications

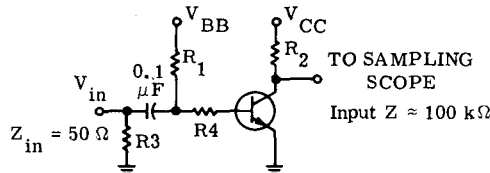
CASE 27
(TO-52)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage* 2N3009, 2N3013 2N3014	V_{CEO}^*	15 20	Vdc
Collector-Emitter Voltage	V_{CES}	40	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage 2N3009 2N3013, 2N3014	V_{EB}	4.0 5.0	Vdc
Collector Current — Continuous (10 μ s pulse) Peak	I_C	200 500	mA dc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	0.36 2.06	Watt mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ @ $T_C = 100^\circ\text{C}$ Derate above 25°C	P_D	1.20 0.68 6.85	Watts Watt mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	$^\circ\text{C}$
Lead Temperature (Soldering, 60 second time limit)	—	300	$^\circ\text{C}$

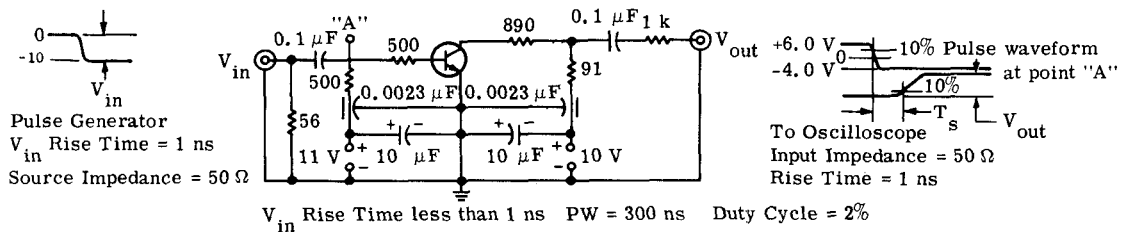
* Applicable from 0.01 mA to 10 mA (Pulsed)

FIGURE 1 — TURN-ON AND TURN-OFF TIME TEST CIRCUIT



		SWITCHING TEST CIRCUIT VALUES							INPUT PULSE		
Type	Test	V _{in}	V _{BB}	V _{CC}	R ₁	R ₂	R ₃	R ₄	t _r	t _f	Pulse Width
2N3009 2N3013	t _{on} & t _{off}	(volts)			(ohms)				(nanoseconds)		
		11	-5.0	15	300	50	75	170	<1.0	<1.0	>100
2N3014	t _{on}	7.0	GND	2.0	100	62	100	2.0 k	<1.0	-	>200
	t _{off}	-13	7.0	2.0							

FIGURE 2 — CHARGE STORAGE TIME CONSTANT TEST CIRCUIT



2N3009, 2N3013, 2N3014 (continued)

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage* ($I_C = 10\text{ mAdc}$, $I_B = 0$)	$BV_{CEO(sus)}^*$	15 20	- -	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100\text{ }\mu\text{Adc}$, $V_{BE} = 0$)	BV_{CES}	40	-	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\text{ }\mu\text{Adc}$, $I_E = 0$)	BV_{CBO}	40	-	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\text{ }\mu\text{Adc}$, $I_C = 0$)	BV_{EBO}	4.0 5.0	- -	Vdc
Collector-Cutoff Current ($V_{CE} = 20\text{ Vdc}$, $V_{BE} = 0$)	I_{CES}	-	0.5	μAdc
($V_{CE} = 20\text{ Vdc}$, $V_{BE} = 0$, $T_A = +85^\circ\text{C}$)		-	15	
($V_{CE} = 20\text{ Vdc}$, $V_{BE} = 0$)		-	0.3	
($V_{CE} = 20\text{ Vdc}$, $V_{BE} = 0$, $T_A = +125^\circ\text{C}$)		-	40	
Base Current ($V_{CE} = 20\text{ Vdc}$, $V_{BE} = 0$)	I_B	-	0.5 0.3	μAdc

ON CHARACTERISTICS

DC Current Gain* ($I_C = 30\text{ mAdc}$, $V_{CE} = 0.4\text{ Vdc}$)	All Types	h_{FE}^*	30	120	
($I_C = 10\text{ mAdc}$, $V_{CE} = 0.4\text{ Vdc}$)	2N3014		25	-	
($I_C = 100\text{ mAdc}$, $V_{CE} = 0.5\text{ Vdc}$)	2N3009, 2N3013		25	-	
($I_C = 100\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$)	2N3014		25	-	
($I_C = 300\text{ mAdc}$, $V_{CE} = 1.0\text{ Vdc}$)	2N3009, 2N3013		15	-	
($I_C = 30\text{ mAdc}$, $V_{CE} = 0.4\text{ Vdc}$, $T_A = -55^\circ\text{C}$)	2N3013, 2N3014		12	-	
Collector-Emitter Saturation Voltage* ($I_C = 30\text{ mAdc}$, $I_B = 3.0\text{ mAdc}$)	All Types	$V_{CE(sat)}^*$	-	0.18	Vdc
($I_C = 100\text{ mAdc}$, $I_B = 10\text{ mAdc}$)	2N3009, 2N3013		-	0.28	
($I_C = 100\text{ mAdc}$, $I_B = 10\text{ mAdc}$)	2N3014		-	0.35	
($I_C = 300\text{ mAdc}$, $I_B = 30\text{ mAdc}$)	2N3009, 2N3013		-	0.50	
($I_C = 10\text{ mAdc}$, $I_B = 1.0\text{ mAdc}$)	2N3014		-	0.18	
($I_C = 30\text{ mAdc}$, $I_B = 3.0\text{ mAdc}$, $T_A = +85^\circ\text{C}$)	2N3009		-	0.30	
($I_C = 30\text{ mAdc}$, $I_B = 3.0\text{ mAdc}$, $T_A = +125^\circ\text{C}$)	2N3013, 2N3014		-	0.25	
Base-Emitter Saturation Voltage* ($I_C = 30\text{ mAdc}$, $I_B = 3.0\text{ mAdc}$)	All Types	$V_{BE(sat)}^*$	0.75	0.95	Vdc
($I_C = 100\text{ mAdc}$, $I_B = 10\text{ mAdc}$)	All Types		-	1.20	
($I_C = 300\text{ mAdc}$, $I_B = 30\text{ mAdc}$)	2N3009, 2N3013		-	1.70	
($I_C = 10\text{ mAdc}$, $I_B = 1.0\text{ mAdc}$)	2N3014		0.70	0.80	

DYNAMIC CHARACTERISTICS

Current-Gain — Bandwidth Product ($I_C = 30\text{ mAdc}$, $V_{CE} = 10\text{ Vdc}$, $f = 100\text{ MHz}$)	f_T	350	-	MHz
Output Capacitance ($V_{CB} = 5.0\text{ Vdc}$, $I_E = 0$, $f = 140\text{ kHz}$)	C_{ob}	-	5.0	pF
Input Capacitance ($V_{BE} = 0.5\text{ Vdc}$, $I_C = 0$, $f = 140\text{ kHz}$)	C_{ib}	-	8.0	pF
Turn-On Time (Figure 1) ($V_{EB(off)} = 5.0\text{ V}$, $V_{CC} = 15\text{ V}$, $I_C = 300\text{ mAdc}$, $I_{B1} \approx 30\text{ mAdc}$)	t_{on}	-	15	ns
($V_{EB(off)} = 0$, $V_{CC} = 2.0\text{ V}$, $I_C = 30\text{ mAdc}$, $I_{B1} \approx 3.0\text{ mAdc}$)		-	16	
Turn-Off Time (Figure 1) ($V_{CC} = 15\text{ V}$, $I_C = 300\text{ mAdc}$, $I_{B1} \approx I_{B2} \approx 30\text{ mAdc}$)	t_{off}	-	25	ns
($V_{CC} = 2.0\text{ V}$, $I_C = 30\text{ mAdc}$, $I_{B1} \approx I_{B2} \approx 3.0\text{ mAdc}$)		-	25	
Charge-Storage Time (Figure 2) ($I_C \approx I_{B1} \approx I_{B2} \approx 10\text{ mAdc}$)	t_s	-	18	ns

* Pulse Test: Pulse Width = 300 μs ; Duty Cycle $\leq 2\%$.