2N3009 (SILICON)

2N3013

2N3013 JAN AVAILABLE

2N3014

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

CASE 27
(TO-52)

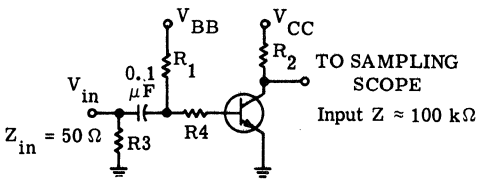
Collector Connected to Case

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 μs pulse) Peak	I_C	200 500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.36 2.06	Watt mW/°C
Total Device Dissipation @ T_C = 25°C @ T_C = 100°C Derate above 25°C	P_D	1.20 0.68 6.85	Watts Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

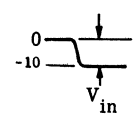
* Applicable from 0.01 mA to 10 mA (Pulsed)

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

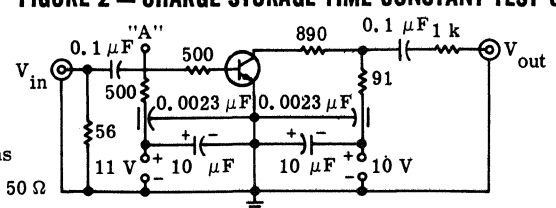


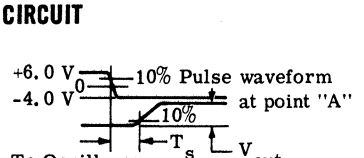
Type	Test	SWITCHING TEST CIRCUIT VALUES							INPUT PULSE		
		V_{in}	V_{BB}	V_{CC}	R_1	R_2	R_3	R_4	t_r	t_f	Pulse Width
2N3009 2N3013	t_{on} & t_{off}	(volts)			(ohms)				(nanoseconds)		
		11	-5.0	15	300	50	75	170	<1.0	<1.0	>100
2N3014	t_{on}	7.0	GND	2.0	100	62	100	2.0 k	<1.0	-	>200
	t_{off}	-13	7.0	2.0							

FIGURE 2 — CHARGE STORAGE TIME CONSTANT TEST CIRCUIT



Pulse Generator
V_{in} Rise Time = 1 ns
Source Impedance = 50 Ω





To Oscilloscope
Input Impedance = 50 Ω
Rise Time = 1 ns

V_{in} Rise Time less than 1 ns PW = 300 ns Duty Cycle = 2%

2N3009, 2N3013, 2N3014 (continued)

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (1) (I_C = 10 mAdc, I_B = 0)	2N3009, 2N3013	$BV_{CEO(sus)}$	15	-	Vdc
	2N3014		20	-	
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)		BV_{CES}	40	-	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)		BV_{CBO}	40	-	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	2N3009	BV_{EBO}	4.0	-	Vdc
	2N3013, 2N3014		5.0	-	
Collector-Cutoff Current (V_{CE} = 20 Vdc, V_{BE} = 0)	2N3009	I_{CES}	-	0.5	μAdc
(V_{CE} = 20 Vdc, V_{BE} = 0, T_A = +85°C)	2N3009		-	15	
(V_{CE} = 20 Vdc, V_{BE} = 0)	2N3013, 2N3014		-	0.3	
(V_{CE} = 20 Vdc, V_{BE} = 0, T_A = +125°C)	2N3013, 2N3014		-	40	
Base Current (V_{CE} = 20 Vdc, V_{BE} = 0)	2N3009	I_B	-	0.5	μAdc
	2N3013, 2N3014		-	0.3	
ON CHARACTERISTICS (1)					
DC Current Gain (I_C = 30 mAdc, V_{CE} = 0.4 Vdc)	All Types	h_{FE}	30	120	
(I_C = 10 mAdc, V_{CE} = 0.4 Vdc)	2N3014		25	-	
(I_C = 100 mAdc, V_{CE} = 0.5 Vdc)	2N3009, 2N3013		25	-	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	2N3014		25	-	
(I_C = 300 mAdc, V_{CE} = 1.0 Vdc)	2N3009, 2N3013		15	-	
(I_C = 30 mAdc, V_{CE} = 0.4 Vdc, T_A = -55°C)	2N3013, 2N3014		12	-	
Collector-Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 3.0 mAdc)	All Types	$V_{CE(sat)}$	-	0.18	Vdc
(I_C = 100 mAdc, I_B = 10 mAdc)	2N3009, 2N3013		-	0.28	
(I_C = 100 mAdc, I_B = 10 mAdc)	2N3014		-	0.35	
(I_C = 300 mAdc, I_B = 30 mAdc)	2N3009, 2N3013		-	0.50	
(I_C = 10 mAdc, I_B = 1.0 mAdc)	2N3014		-	0.18	
(I_C = 30 mAdc, I_B = 3.0 mAdc, T_A = +85°C)	2N3009		-	0.30	
(I_C = 30 mAdc, I_B = 3.0 mAdc, T_A = +125°C)	2N3013, 2N3014		-	0.25	
Base-Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 3.0 mAdc)	All Types	$V_{BE(sat)}$	0.75	0.95	Vdc
(I_C = 100 mAdc, I_B = 10 mAdc)	All Types		-	1.20	
(I_C = 300 mAdc, I_B = 30 mAdc)	2N3009, 2N3013		-	1.70	
(I_C = 10 mAdc, I_B = 1.0 mAdc)	2N3014		0.70	0.80	
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	350	-	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz)		C_{ob}	-	5.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)		C_{ib}	-	8.0	pF
Turn-On Time (Figure 1) ($V_{EB(off)}$ = 5.0 V, V_{CC} = 15 V, I_C = 300 mAdc, I_{B1} ≈30 mAdc)	2N3009, 2N3013	t_{on}	-	15	ns
($V_{EB(off)}$ = 0, V_{CC} = 2.0 V, I_C = 30 mAdc, I_{B1} ≈3.0 mAdc)	2N3014		-	16	
Turn-Off Time (Figure 1) (V_{CC} = 15 V, I_C = 300 mAdc, I_{B1} ≈ I_{B2} ≈30 mAdc)	2N3009, 2N3013	t_{off}	-	25	ns
(V_{CC} = 2.0 V, I_C = 30 mAdc, I_{B1} ≈ I_{B2} ≈3.0 mAdc)	2N3014		-	25	
Charge-Storage Time (Figure 2) (I_C ≈ I_{B1} ≈ I_{B2} ≈ 10 mAdc)		t_s	-	18	ns

(1) Pulse Test: Pulse Width = 300 μs; Duty Cycle ≤ 2%.