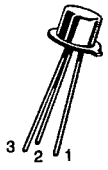
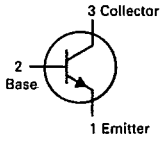
2N4013
2N4014

CASE 22-03, STYLE 1
TO-18 (TO-206AA)





SWITCHING TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N4013	2N4014	Unit
Collector-Emitter Voltage	V_{CEO}	30	50	Vdc
Collector-Base Voltage	V_{CBO}	50	80	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous — Peak	I_C	1.0 2.0		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.5 28.6		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.4 6.8		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	2N4014	$V_{(BR)CEO}$	50	—	—	Vdc
	2N4013		30	—	—	
Collector-Emitter Breakdown Voltage (I_C = 10 μAdc, V_{BE} = 0)	2N4014	$V_{(BR)CES}$	80	—	—	Vdc
	2N4013		50	—	—	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	2N4014	$V_{(BR)CBO}$	80	—	—	Vdc
	2N4013		50	—	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current		I_{CBO}				μAdc
(V_{CB} = 60 Vdc, I_E = 0)	2N4014		—	0.12	1.7	
(V_{CB} = 40 Vdc, I_E = 0)	2N4013		—	0.12	1.7	
(V_{CB} = 60 Vdc, I_E = 0, T_A = 100°C)	2N4014		—	—	120	
(V_{CB} = 40 Vdc, I_E = 0, T_A = 100°C)	2N4013		—	—	120	
Collector Cutoff Current		I_{CES}				μAdc
(V_{CE} = 80 Vdc, V_{EB} = 0)	2N4014		—	0.15	10	
(V_{CE} = 50 Vdc, V_{EB} = 0)	2N4013		—	0.15	10	
ON CHARACTERISTICS(1)						
DC Current Gain		h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			30	—	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)			60	—	150	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc, T_A = −55°C)			30	—	—	
(I_C = 300 mAdc, V_{CE} = 1.0 Vdc)			40	—	—	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)			35	—	—	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc, T_A = −55°C)			20	—	—	
(I_C = 800 mAdc, V_{CE} = 2.0 Vdc)	2N4014		20			
	2N4013		25	—	—	
(I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	2N4014		25			
	2N4013		30	—	—	

(continued)

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

Characteristic		Symbol	Min	Typ	Max	Unit
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	2N4014		—	0.17	0.25	
	2N4013		—	0.17	0.25	
(I_C = 100 mAdc, I_B = 10 mAdc)	2N4014		—	0.19	0.26	
	2N4013		—	0.19	0.20	
(I_C = 300 mAdc, I_B = 30 mAdc)	2N4014		—	0.25	0.40	
	2N4013		—	0.25	0.32	
(I_C = 500 mAdc, I_B = 50 mAdc)	2N4014		—	0.30	0.52	
	2N4013		—	0.30	0.42	
(I_C = 800 mAdc, I_B = 80 mAdc)	2N4014		—	0.43	0.80	
	2N4013		—	0.43	0.65	
(I_C = 1.0 Adc, I_B = 100 mAdc)	2N4014		—	0.55	0.95	
	2N4013		—	0.55	0.75	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			—	—	0.76	
(I_C = 100 mAdc, I_B = 10 mAdc)			—	—	0.86	
(I_C = 300 mAdc, I_B = 30 mAdc)			—	—	1.1	
(I_C = 500 mAdc, I_B = 50 mAdc)			0.8	—	1.1	
(I_C = 800 mAdc, I_B = 80 mAdc)			—	—	1.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)			—	—	1.7	

SMALL-SIGNAL CHARACTERISTICS

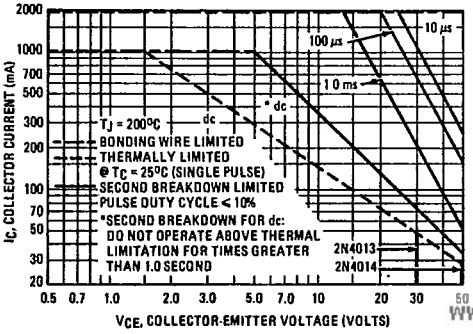
Current-Gain — Bandwidth Product(2) (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	300	—	—	MHz
Output Capacitance		C_{obo}				pF
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	2N4014		—	—	10	
	2N4013		—	—	12	
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	—	55	pF

SWITCHING CHARACTERISTICS

Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 3.8 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc) (Figures 8, 10)	t_d	—	5.0	10	ns
Rise Time		t_r	—	15	30	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc) (Figures 9, 10) 2N4014 2N4013	t_s	—	30	50	ns
Fall Time		t_f	—	20 25	25 30	ns
Turn-On Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 3.8 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc) (Figures 8, 10)	t_{on}	—	20	35	ns
Turn-Off Time	(V_{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc) (Figures 9, 10) 2N4014 2N4013	t_{off}	—	50	60	ns

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 1.0%.
(2) f_T = |hfe| • f_{test}.

FIGURE 1 – ACTIVE-REGION SAFE OPERATING AREA



TYPICAL DC CHARACTERISTICS

FIGURE 2 – DC CURRENT GAIN

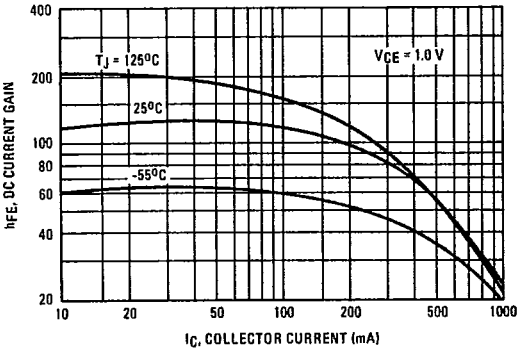


FIGURE 3 – "ON" VOLTAGES

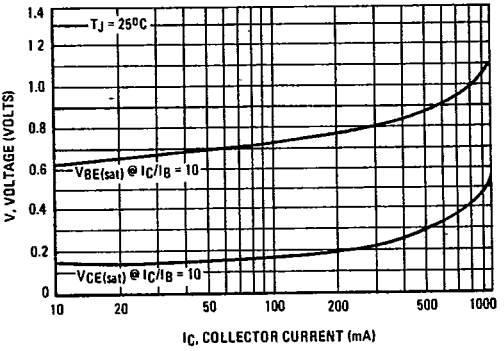


FIGURE 4 – COLLECTOR SATURATION REGION

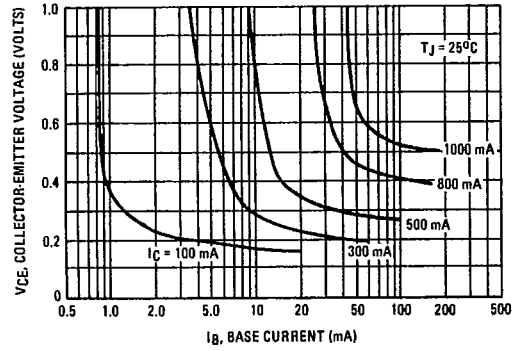
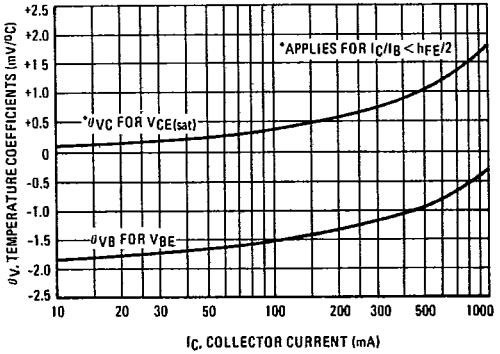


FIGURE 5 – TEMPERATURE COEFFICIENTS



TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 6 – CURRENT-GAIN – BANDWIDTH PRODUCT

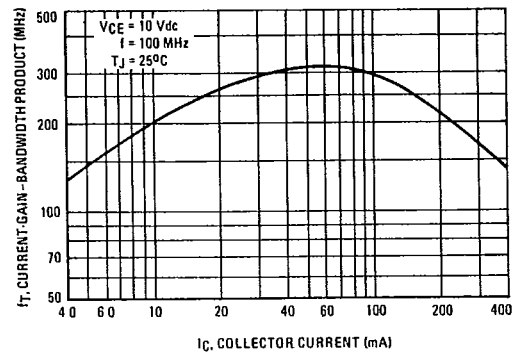


FIGURE 7 – CAPACITANCE

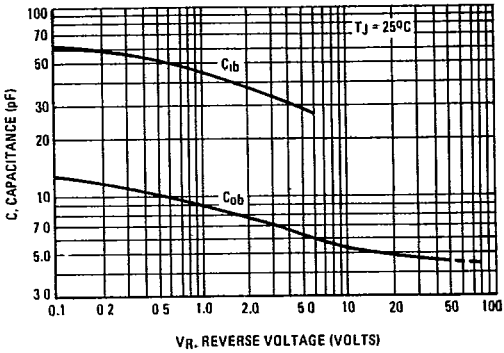


FIGURE 8 – TURN-ON TIME

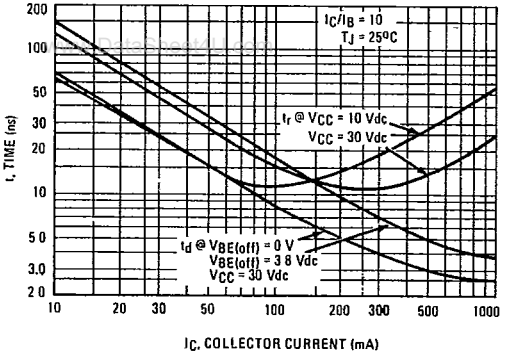


FIGURE 9 – TURN-OFF TIME

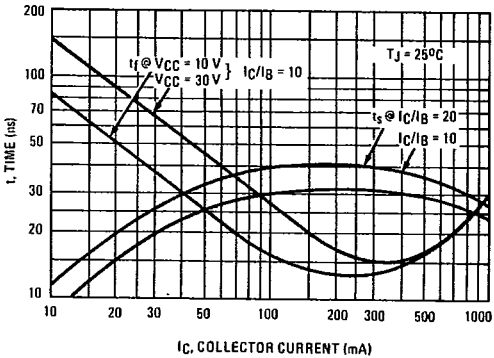
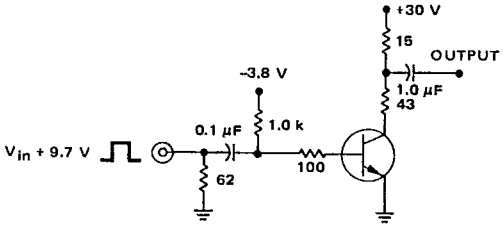


FIGURE 10 – SWITCHING TIME TEST CIRCUIT



$t_r \leq 1.0$ ns
PW ≥ 200 ns
Duty Cycle ≤ 2.0%
Generator Source Impedance = 50 Ω
Pulse Generator EH1421 Timing Unit and 1121 Pulse Driver
Oscilloscope Tektronix 661 Sampling Scope

FIGURE 11 – COLLECTOR CUTOFF CURRENT