

2N404 (GERMANIUM)

2N404A

PNP GERMANIUM SWITCHING TRANSISTORS

... designed for medium-speed saturated switching applications.

- Low Collector-Emitter Saturation Voltage –
 $V_{CE(sat)} = 0.2 \text{ Vdc (Max) @ } I_C = 24 \text{ mAdc}$
- High Emitter-Base Breakdown Voltage –
 $BV_{EBO} = 12 \text{ Vdc (Min) @ } I_E = 20 \mu\text{Adc} - 2N404$
 $= 25 \text{ Vdc (Min) @ } I_E = 20 \mu\text{Adc} - 2N404A$

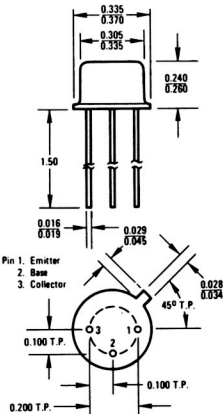
PNP GERMANIUM
SWITCHING
TRANSISTORS



*MAXIMUM RATINGS

Rating	Symbol	2N404	2N404A	Unit
Collector-Emitter Voltage	V_{CES}	24	35	Vdc
Collector-Base Voltage	V_{CB}	25	40	Vdc
Emitter-Base Voltage	V_{EB}	12	25	Vdc
Collector Current – Continuous	I_C	150		mAdc
Emitter Current	I_E	100		mAdc
Total Device Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C	P_D	150	2.0	mW mW/ $^\circ\text{C}$
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	300	4.0	mW mW/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +100		$^\circ\text{C}$

*Indicates JEDEC Registered Data.



Weight ~ 1.15 gram
To convert inches to millimeters multiply by 25.4.
All JEDEC TO-5 dimensions and notes apply.

CASE 31 (1)
TO-5
Collector Connected to Case

2N404, 2N404A (continued)

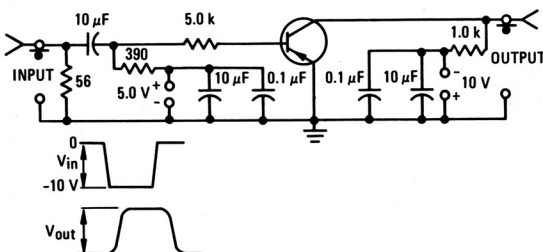
*ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage ($I_C = 20\text{ }\mu\text{A}$, $I_E = 0$)	BV_{CBO}	25 40	— —	— —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 20\text{ }\mu\text{A}$, $I_C = 0$)	BV_{EBO}	12 25	— —	— —	Vdc
Punch-Through Voltage(1) ($V_{EBF} = 1.0\text{ Vdc}$)	V_{pt}	24 35	— —	— —	Vdc
Emitter-Base Floating Potential ($V_{CB} = 35\text{ Vdc}$, $I_E = 0$)	V_{EBf}	—	—	1.0	Vdc
Collector Cutoff Current ($V_{CB} = 12\text{ Vdc}$, $I_E = 0$) ($V_{CB} = 12\text{ Vdc}$, $I_E = 0$, $T_A = 80^\circ\text{C}$)	I_{CBO}	— —	0.8 20	5.0 90	μA
Emitter Cutoff Current ($V_{EB} = 2.5\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	0.5	2.5	μA
ON CHARACTERISTICS					
DC Current Gain ($I_C = 12\text{ mA}$, $V_{CE} = 0.15\text{ Vdc}$) ($I_C = 24\text{ mA}$, $V_{CE} = 0.20\text{ Vdc}$)	h_{FE}	30 24	80 90	— —	—
Collector-Emitter Saturation Voltage ($I_C = 12\text{ mA}$, $I_B = 0.4\text{ mA}$) ($I_C = 24\text{ mA}$, $I_B = 1.0\text{ mA}$)	$V_{CE(sat)}$	— —	0.09 0.09	0.15 0.20	Vdc
Base-Emitter Voltage ($I_C = 12\text{ mA}$, $I_B = 0.4\text{ mA}$) ($I_C = 24\text{ mA}$, $I_B = 1.0\text{ mA}$)	V_{BE}	— —	0.27 0.30	0.35 0.40	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Alpha Cutoff Frequency ($I_E = 1.0\text{ mA}$, $V_{CB} = 6.0\text{ Vdc}$)	f_{hfb}	4.0	25	—	MHz
Output Capacitance ($V_{CB} = 6.0\text{ Vdc}$, $I_E = 0$, $f = 1.0\text{ MHz}$) ($V_{CB} = 6.0\text{ Vdc}$, $I_E = 1.0\text{ mA}$, $f = 2.0\text{ MHz}$)	C_{ob}	— —	8.0 8.0	20 20	pF
Input Impedance ($I_C = 1.0\text{ mA}$, $V_{CE} = 6.0\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{ie}	—	3.6	—	k ohms
Voltage Feedback Ratio ($I_C = 1.0\text{ mA}$, $V_{CE} = 6.0\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{re}	—	8.0	—	$\times 10^{-4}$
Small-Signal Current Gain ($I_C = 1.0\text{ mA}$, $V_{CE} = 6.0\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{fe}	—	135	—	—
Output Admittance ($I_C = 1.0\text{ mA}$, $V_{CE} = 6.0\text{ Vdc}$, $f = 1.0\text{ kHz}$)	h_{oe}	—	50	—	μmhos
SWITCHING CHARACTERISTICS					
Delay Time (Figure 1)	t_d	—	0.07	—	μs
Rise Time (Figure 1)	t_r	—	0.12	—	μs
Storage Time (Figure 1)	t_s	—	0.20	—	μs
Fall Time (Figure 1)	t_f	—	0.10	—	μs
Stored Base Charge (Figure 2)	Q_{sb}	—	300	1400	pC

*Indicates JEDEC Registered Data.

(1) V_{pt} is determined by measuring the emitter-base floating potential V_{EBf} , using a voltmeter with 11 megohms minimum input impedance. The collector-base voltage, V_{CB} , is increased until $V_{EBf} = -1.0\text{ Vdc}$; this value of $V_{CB} = (V_{pt} + 1)$.

FIGURE 1 – SWITCHING TIMES TEST CIRCUIT

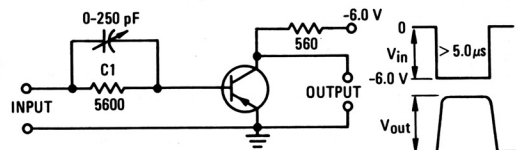


NOTES: 1. Input pulse supplied by generator with following characteristics:

- Output impedance: 50 Ohms
- Repetition rate: 1.0 kHz

- Rise and fall time: 20 ns Max
- Waveforms monitored on scope with following characteristics:
 - Input resistance – 10 Megohms Min

FIGURE 2 – STORED BASE CHARGE TEST CIRCUIT



C_1 is increased until the t_{off} time of the output waveform is decreased to $0.2\text{ }\mu\text{s}$. Q_{sb} is then calculated by $Q_{sb} = C_1 V_{in}$.

- Input capacitance – 15 pF Max
- Rise time – 15 ns Max
- All resistors $\pm 1.0\%$ tolerance.