2N404 (GERMANIUM)
2N404A

PNP GERMANIUM SWITCHING TRANSISTORS

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

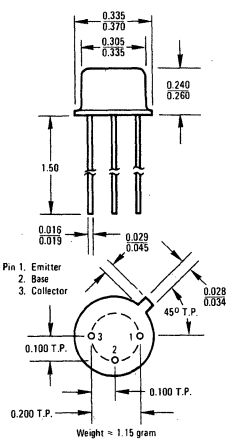
- Low Collector-Emitter Saturation Voltage –
  $V_{CE(sat)}$ = 0.2 Vdc (Max) @ I_C = 24 mAdc
- High Emitter-Base Breakdown Voltage –
  BV_{EBO} = 12 Vdc (Min) @ I_E = 20 μAdc – 2N404
  = 25 Vdc (Min) @ I_E = 20 μAdc – 2N404A

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°C Derate above 25°C	P_D	150 2.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 4.0		mW mW/°C
Operating and Storage Junction Temperature Range	T_J,T_{stg}	-65 to +100		°C

*Indicates JEDEC Registered Data.



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°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Breakdown Voltage (I_C = 20 μAdc, I_E = 0)	2N404	BV_{CBO}	25	–	–	Vdc
	2N404A		40	–	–	
Emitter-Base Breakdown Voltage (I_E = 20 μAdc, I_C = 0)	2N404	BV_{EBO}	12	–	–	Vdc
	2N404A		25	–	–	
Punch-Through Voltage(1) (V_{EBfl} = 1.0 Vdc)	2N404	V_{pt}	24	–	–	Vdc
	2N404A		35	–	–	
Emitter-Base Floating Potential (V_{CB} = 35 Vdc, I_E = 0)	2N404A	V_{EBfl}	–	–	1.0	Vdc
Collector Cutoff Current (V_{CB} = 12 Vdc, I_E = 0)		I_{CBO}	–	0.8	5.0	μAdc
(V_{CB} = 12 Vdc, I_E = 0, T_A = 80°C)			–	20	90	
Emitter Cutoff Current (V_{EB} = 2.5 Vdc, I_C = 0)		I_{EBO}	–	0.5	2.5	μAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 12 mAdc, V_{CE} = 0.15 Vdc)		h_{FE}	30	80	–	–
(I_C = 24 mAdc, V_{CE} = 0.20 Vdc)			24	90	–	
Collector-Emitter Saturation Voltage (I_C = 12 mAdc, I_B = 0.4 mAdc)		$V_{CE(sat)}$	–	0.09	0.15	Vdc
(I_C = 24 mAdc, I_B = 1.0 mAdc)			–	0.09	0.20	
Base-Emitter Voltage (I_C = 12 mAdc, I_B = 0.4 mAdc)		V_{BE}	–	0.27	0.35	Vdc
(I_C = 24 mAdc, I_B = 1.0 mAdc)			–	0.30	0.40	
SMALL-SIGNAL CHARACTERISTICS						
Alpha Cutoff Frequency (I_E = 1.0 mAdc, V_{CB} = 6.0 Vdc)		f_{hfb}	4.0	25	–	MHz
Output Capacitance (V_{CB} = 6.0 Vdc, I_E = 0, f = 1.0 MHz)	2N404	C_{ob}	–	8.0	20	pF
(V_{CB} = 6.0 Vdc, I_E = 1.0 mAdc, f = 2.0 MHz)	2N404A		–	8.0	20	
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 kHz)		h_{ie}	–	3.6	–	k ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 kHz)		h_{re}	–	8.0	–	X 10^{-4}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 kHz)		h_{fe}	–	135	–	–
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 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_{EBfl}, using a voltmeter with 11 megohms minimum input impedance. The collector-base voltage, V_{CB}, is increased until V_{EBfl} = -1.0 Vdc; this value of V_{CB} = (V_{pt} + 1).

FIGURE 1 – SWITCHING TIMES TEST CIRCUIT

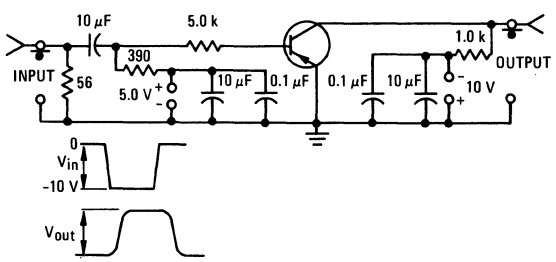
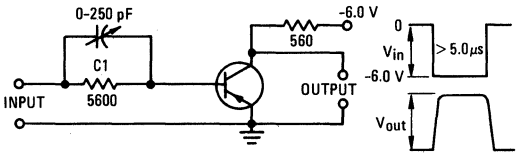


FIGURE 2 – STORED BASE CHARGE TEST CIRCUIT



C1 is increased until the t_{off} time of the output waveform is decreased to 0.2 μs. Q_{sb} is then calculated by Q_{sb} = C1 V_{in}.

NOTES: 1. Input pulse supplied by generator with following characteristics:
   a. Output impedance: 50 Ohms
   b. Repetition rate: 1.0 kHz
   c. Rise and fall time: 20 ns Max
2. Waveforms monitored on scope with following characteristics:
   a. Input resistance – 10 Megohms Min
   b. Input capacitance – 15 pF Max
   c. Rise time – 15 ns Max
3. All resistors ± 1.0% tolerance.