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2N3904 Silicon NPN Transistor General Purpose TO-92 Type Package

Absolute Maximum Ratings:

Collector–Emitter Voltage, V_{CEO}	40V
Collector–Base Voltage, V_{CB}	60V
Emitter–Base Voltage, V_{EBO}	6V
Continuous Collector Current, I_C	200mA
Total Device Dissipation ($T_A = +25^\circ\text{C}$), P_D	625mW
Derate Above 25°C	2.8mW/ $^\circ\text{C}$
Total Device Dissipation ($T_C = +25^\circ\text{C}$), P_D	1.5W
Derate Above 25°C	12mW/ $^\circ\text{C}$
Operating Junction Temperature Range, T_J	-55° to $+150^\circ\text{C}$
Storage Temperature Range, T_{stg}	-55° to $+150^\circ\text{C}$
Thermal Resistance, Junction to Case, R_{thJC}	83.3 $^\circ\text{C}/\text{W}$
Thermal Resistance, Junction to Ambient, R_{thJA}	200 $^\circ\text{C}/\text{W}$

Electrical Characteristics: ($T_A = +25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
OFF Characteristics						
Collector–Emitter Breakdown Voltage	$V_{(BR)CEO}$	$I_C = 1\text{mA}$, $I_B = 0$, Note 1	40	–	–	V
Collector–Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C = 10\mu\text{A}$, $I_E = 0$	60	–	–	V
Emitter–Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E = 10\mu\text{A}$, $I_C = 0$	6	–	–	V
Collector Cutoff Current	I_{CEX}	$V_{CE} = 30\text{V}$, $V_{EB} = 3\text{V}$	–	–	50	nA
Base Cutoff Current	I_{BL}	$V_{CE} = 30\text{V}$, $V_{EB} = 3\text{V}$	–	–	50	nA
ON Characteristics (Note 1)						
DC Current Gain	h_{FE}	$V_{CE} = 1\text{V}$, $I_C = 0.1\text{mA}$	40	–	–	
		$V_{CE} = 1\text{V}$, $I_C = 1\text{mA}$	70	–	–	
		$V_{CE} = 1\text{V}$, $I_C = 10\text{mA}$	100	–	300	
		$V_{CE} = 1\text{V}$, $I_C = 50\text{mA}$	60	–	–	
		$V_{CE} = 1\text{V}$, $I_C = 100\text{mA}$	30	–	–	

Note 1. Pulse Test: Pulse Width $\leq 300\mu\text{s}$, Duty Cycle $\leq 2\%$.

Electrical Characteristics (Cont'd): ($T_A = +25^\circ\text{C}$ unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
ON Characteristics (Cont'd) (Note 1)						
Collector–Emitter Saturation Voltage	$V_{CE(sat)}$	$I_C = 10\text{mA}, I_B = 1\text{mA}$	–	–	0.2	V
		$I_C = 50\text{mA}, I_B = 5\text{mA}$	–	–	0.3	V
Base–Emitter Saturation Voltage	$V_{BE(sat)}$	$I_C = 10\text{mA}, I_B = 1\text{mA}$	0.65	–	0.85	V
		$I_C = 50\text{mA}, I_B = 5\text{mA}$	–	–	0.95	V
Small–Signal Characteristics						
Current Gain–Bandwidth Product	f_T	$I_C = 10\text{mA}, V_{CE} = 20\text{V}, f = 100\text{MHz}$	300	–	–	MHz
Output Capacitance	C_{obo}	$V_{CB} = 5\text{V}, I_E = 0, f = 1\text{MHz}$	–	–	4.0	pF
Input Capacitance	C_{ibo}	$V_{CB} = 0.5\text{V}, I_C = 0, f = 1\text{MHz}$	–	–	8.0	pF
Input Impedance	h_{ie}	$I_C = 1\text{mA}, V_{CE} = 10\text{V}, f = 1\text{kHz}$	1.0	–	10	k Ω
Voltage Feedback Ratio	h_{re}	$I_C = 1\text{mA}, V_{CE} = 10\text{V}, f = 1\text{kHz}$	0.5	–	8.0	$\times 10^{-4}$
Small–Signal Current Gain	h_{fe}	$I_C = 1\text{mA}, V_{CE} = 10\text{V}, f = 1\text{kHz}$	100	–	400	
Output Admittance	h_{oe}	$I_C = 1\text{mA}, V_{CE} = 10\text{V}, f = 1\text{kHz}$	1.0	–	30	μhos
Noise Figure	NF	$I_C = 100\mu\text{A}, V_{CE} = 5\text{V}, R_S = 1\text{k}\Omega,$ $f = 10\text{Hz to } 15.7\text{kHz}$	–	–	5.0	db
Switching Characteristics						
Delay Time	t_d	$V_{CC} = 3\text{V}, V_{EB} = 0.5\text{V}, I_C = 10\text{mA},$ $I_{B1} = 1\text{mA}$	–	–	35	ns
Rise Time	t_r		–	–	35	ns
Storage Time	t_s	$V_{CC} = 3\text{V}, I_C = 10\text{mA},$ $I_{B1} = I_{B2} = 1\text{mA}$	–	–	200	ns
Fall Time	t_f		–	–	50	ns

Note 1. Pulse Test: Pulse Width $\leq 300\mu\text{s}$, Duty Cycle $\leq 2\%$.

