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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 $^\circ\text{C/W}$
Thermal Resistance, Junction to Ambient, R_{thJA}	200 $^\circ\text{C/W}$

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 = 10mA, I _B = 1mA	–	–	0.2	V
		I _C = 50mA, I _B = 5mA	–	–	0.3	V
Base–Emitter Saturation Voltage	V _{BE(sat)}	I _C = 10mA, I _B = 1mA	0.65	–	0.85	V
		I _C = 50mA, I _B = 5mA	–	–	0.95	V
Small–Signal Characteristics						
Current Gain–Bandwidth Product	f _T	I _C = 10mA, V _{CE} = 20V, f = 100MHz	300	–	–	MHz
Output Capacitance	C _{obo}	V _{CB} = 5V, I _E = 0, f = 1MHz	–	–	4.0	pF
Input Capacitance	C _{ibo}	V _{CB} = 0.5V, I _C = 0, f = 1MHz	–	–	8.0	pF
Input Impedance	h _{ie}	I _C = 1mA, V _{CE} = 10V, f = 1kHz	1.0	–	10	kΩ
Voltage Feedback Ratio	h _{re}	I _C = 1mA, V _{CE} = 10V, f = 1kHz	0.5	–	8.0	x 10 ^{–4}
Small–Signal Current Gain	h _{fe}	I _C = 1mA, V _{CE} = 10V, f = 1kHz	100	–	400	
Output Admittance	h _{oe}	I _C = 1mA, V _{CE} = 10V, f = 1kHz	1.0	–	30	μmhos
Noise Figure	NF	I _C = 100μA, V _{CE} = 5V, R _S = 1kΩ, f = 10Hz to 15.7kHz	–	–	5.0	db
Switching Characteristics						
Delay Time	t _d	V _{CC} = 3V, V _{EB} = 0.5V, I _C = 10mA, I _{B1} = 1mA	–	–	35	ns
Rise Time	t _r		–	–	35	ns
Storage Time	t _s	V _{CC} = 3V, I _C = 10mA, I _{B1} = I _{B2} = 1mA	–	–	200	ns
Fall Time	t _f		–	–	50	ns

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

