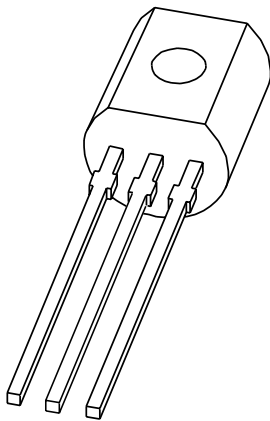


# DATA SHEET



## **2N3904** NPN switching transistor

Product specification  
Supersedes data of 1999 Apr 23

2004 Oct 11

## NPN switching transistor

2N3904

## FEATURES

- Low current (max. 200 mA)
- Low voltage (max. 40 V).

## APPLICATIONS

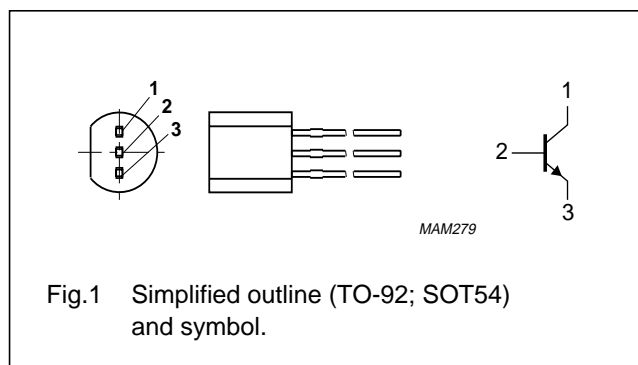
- High-speed switching.

## DESCRIPTION

NPN switching transistor in a TO-92; SOT54 plastic package. PNP complement: 2N3906.

## PINNING

PIN	DESCRIPTION
1	collector
2	base
3	emitter



## ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
2N3904	SC-43A	plastic single-ended leaded (through hole) package; 3 leads	SOT54

## LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 60134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{CBO}$	collector-base voltage	open emitter	—	60	V
$V_{CEO}$	collector-emitter voltage	open base	—	40	V
$V_{EBO}$	emitter-base voltage	open collector	—	6	V
$I_C$	collector current (DC)		—	200	mA
$I_{CM}$	peak collector current		—	300	mA
$I_{BM}$	peak base current		—	100	mA
$P_{tot}$	total power dissipation	$T_{amb} \leq 25\text{ °C}$ ; note 1	—	500	mW
$T_{stg}$	storage temperature		–65	+150	°C
$T_j$	junction temperature		—	150	°C
$T_{amb}$	ambient temperature		–65	+150	°C

## Note

1. Transistor mounted on an FR4 printed-circuit board.

## NPN switching transistor

2N3904

## THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient	note 1	250	K/W

## Note

1. Transistor mounted on an FR4 printed-circuit board.

## CHARACTERISTICS

 $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$I_{CBO}$	collector-base cut-off current	$V_{CB} = 30\text{ V}$ ; $I_E = 0\text{ A}$	–	50	nA
$I_{EBO}$	emitter-base cut-off current	$V_{EB} = 6\text{ V}$ ; $I_C = 0\text{ A}$	–	50	nA
$h_{FE}$	DC current gain	$V_{CE} = 1\text{ V}$ ; note 1 $I_C = 0.1\text{ mA}$ $I_C = 1\text{ mA}$ $I_C = 10\text{ mA}$ $I_C = 50\text{ mA}$ $I_C = 100\text{ mA}$	60 80 100 60 30	– – 300 – –	
$V_{CEsat}$	collector-emitter saturation voltage	$I_C = 10\text{ mA}$ ; $I_B = 1\text{ mA}$ ; note 1	–	200	mV
		$I_C = 50\text{ mA}$ ; $I_B = 5\text{ mA}$ ; note 1	–	200	mV
$V_{BEsat}$	base-emitter saturation voltage	$I_C = 10\text{ mA}$ ; $I_B = 1\text{ mA}$ ; note 1	–	850	mV
		$I_C = 50\text{ mA}$ ; $I_B = 5\text{ mA}$ ; note 1	–	950	mV
$C_c$	collector capacitance	$V_{CB} = 5\text{ V}$ ; $I_E = i_e = 0\text{ A}$ ; $f = 1\text{ MHz}$	–	4	pF
$C_e$	emitter capacitance	$V_{EB} = 500\text{ mV}$ ; $I_C = i_c = 0\text{ A}$ ; $f = 1\text{ MHz}$	–	8	pF
$f_T$	transition frequency	$V_{CE} = 20\text{ V}$ ; $I_C = 10\text{ mA}$ ; $f = 100\text{ MHz}$	300	–	MHz
$F$	noise figure	$V_{CE} = 5\text{ V}$ ; $I_C = 100\text{ }\mu\text{A}$ ; $R_S = 1\text{ k}\Omega$ ; $f = 10\text{ Hz to }15.7\text{ kHz}$	–	5	dB

## Switching times (between 10 % and 90 % levels); see Fig.2

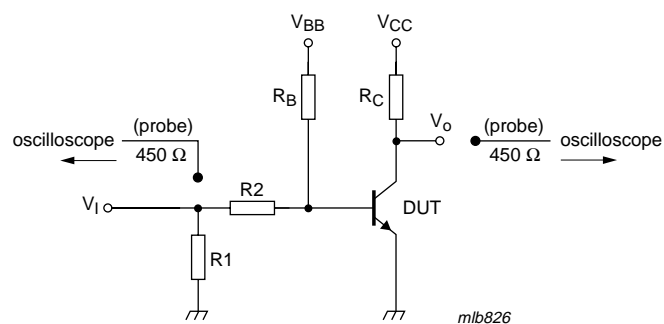
$t_{on}$	turn-on time	$I_{Con} = 10\text{ mA}$ ; $I_{Bon} = 1\text{ mA}$ ; $I_{Boff} = -1\text{ mA}$	–	65	ns
$t_d$	delay time		–	35	ns
$t_r$	rise time		–	35	ns
$t_{off}$	turn-off time		–	240	ns
$t_s$	storage time		–	200	ns
$t_f$	fall time		–	50	ns

## Note

1. Pulse test:  $t_p \leq 300\text{ }\mu\text{s}$ ;  $\delta \leq 0.02$ .

## NPN switching transistor

2N3904



$V_I = 5\text{ V}$ ;  $T = 500\text{ }\mu\text{s}$ ;  $t_p = 10\text{ }\mu\text{s}$ ;  $t_r = t_f \leq 3\text{ ns}$ .  
 $R_1 = 56\text{ }\Omega$ ;  $R_2 = 2.5\text{ k}\Omega$ ;  $R_B = 3.9\text{ k}\Omega$ ;  $R_C = 270\text{ }\Omega$ .  
 $V_{BB} = -1.9\text{ V}$ ;  $V_{CC} = 3\text{ V}$ .  
Oscilloscope input impedance  $Z_i = 50\text{ }\Omega$ .

Fig.2 Test circuit for switching times.

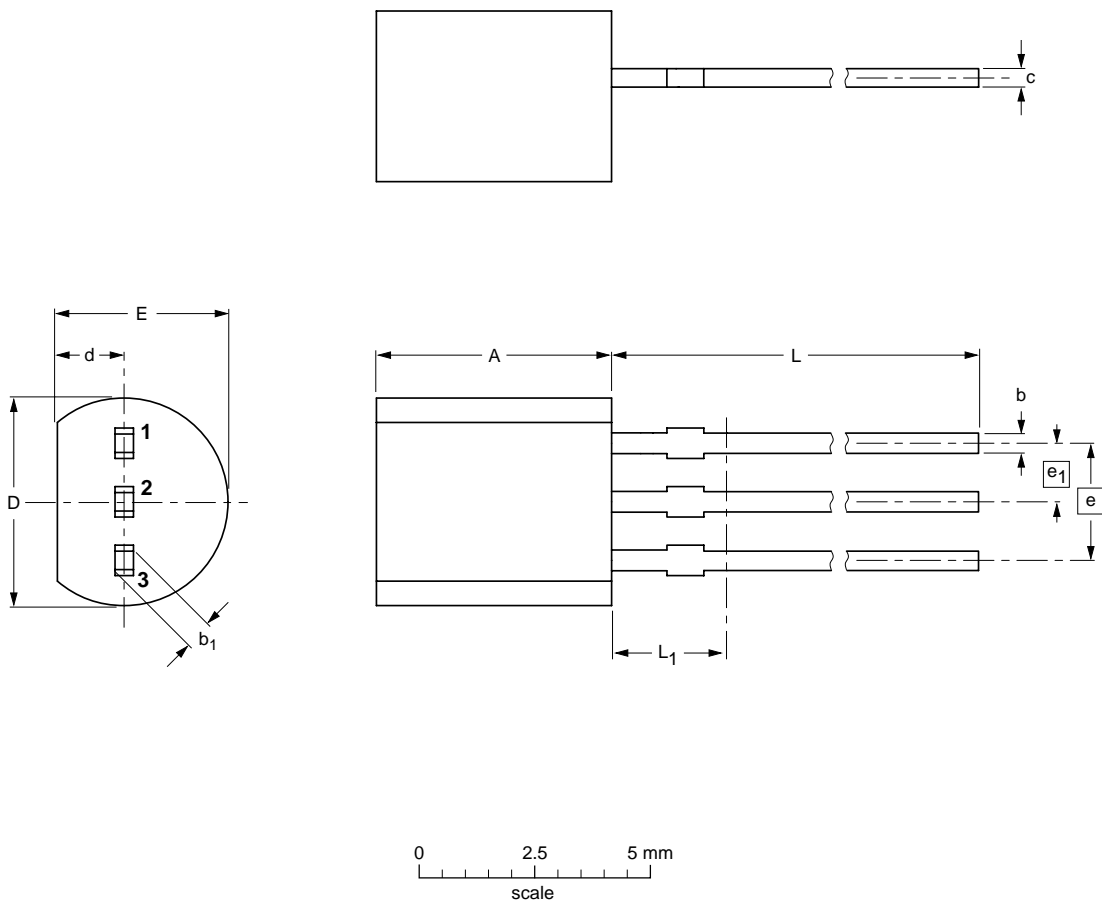
NPN switching transistor

2N3904

PACKAGE OUTLINE

Plastic single-ended leaded (through hole) package; 3 leads

SOT54




DIMENSIONS (mm are the original dimensions)

UNIT	A	b	b <sub>1</sub>	c	D	d	E	e	e <sub>1</sub>	L	L <sub>1</sub> <sup>(1)</sup> max.
mm	5.2 5.0	0.48 0.40	0.66 0.55	0.45 0.38	4.8 4.4	1.7 1.4	4.2 3.6	2.54	1.27	14.5 12.7	2.5

Note

1. Terminal dimensions within this zone are uncontrolled to allow for flow of plastic and terminal irregularities.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT54		TO-92	SC-43A			97-02-28 04-06-28

## NPN switching transistor

2N3904

## DATA SHEET STATUS

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