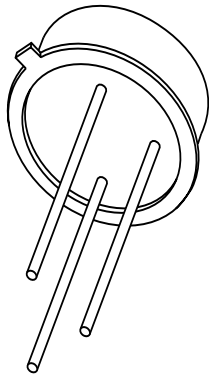


# DATA SHEET



## **2N2222; 2N2222A** NPN switching transistors

Product specification  
Supersedes data of September 1994  
File under Discrete Semiconductors, SC04

1997 May 29

# NPN switching transistors

# 2N2222; 2N2222A

### FEATURES

- High current (max. 800 mA)
- Low voltage (max. 40 V).

### APPLICATIONS

- Linear amplification and switching.

### DESCRIPTION

NPN switching transistor in a TO-18 metal package.  
PNP complement: 2N2907A.

### PINNING

| PIN | DESCRIPTION                  |
|-----|------------------------------|
| 1   | emitter                      |
| 2   | base                         |
| 3   | collector, connected to case |

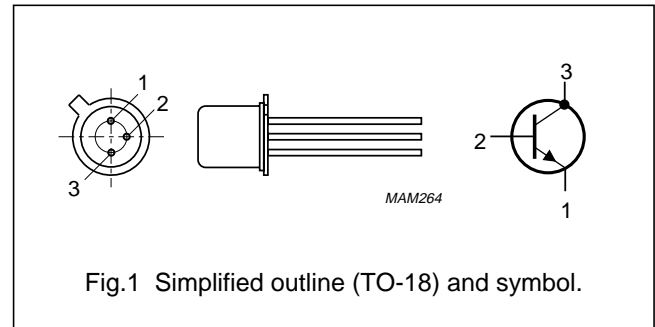


Fig.1 Simplified outline (TO-18) and symbol.

### QUICK REFERENCE DATA

| SYMBOL    | PARAMETER                                      | CONDITIONS  | MIN. | MAX. | UNIT |
|-----------|--|---|------|------|------|
| $V_{CBO}$ | collector-base voltage<br>2N2222<br>2N2222A    | open emitter  | –    | 60   | V    |
|           |  |   | –    | 75   | V    |
| $V_{CEO}$ | collector-emitter voltage<br>2N2222<br>2N2222A | open base   | –    | 30   | V    |
|           |  |   | –    | 40   | V    |
| $I_C$     | collector current (DC)                         |   | –    | 800  | mA   |
| $P_{tot}$ | total power dissipation                        | $T_{amb} \leq 25\text{ °C}$   | –    | 500  | mW   |
| $h_{FE}$  | DC current gain                                | $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$                                  | 75   | –    |      |
| $f_T$     | transition frequency<br>2N2222<br>2N2222A      | $I_C = 20\text{ mA}; V_{CE} = 20\text{ V}; f = 100\text{ MHz}$              | 250  | –    | MHz  |
|           |  |   | 300  | –    | MHz  |
| $t_{off}$ | turn-off time                                  | $I_{Con} = 150\text{ mA}; I_{Bon} = 15\text{ mA}; I_{Boff} = -15\text{ mA}$ | –    | 250  | ns   |

## NPN switching transistors

## 2N2222; 2N2222A

**LIMITING VALUES**

In accordance with the Absolute Maximum Rating System (IEC 134).

| SYMBOL           | PARAMETER                     | CONDITIONS                | MIN. | MAX. | UNIT |
|------------------|-------------------------------|---------------------------|------|------|------|
| V <sub>CBO</sub> | collector-base voltage        | open emitter              | –    | 60   | V    |
|                  | 2N2222                        |                           |      | 75   | V    |
| V <sub>CEO</sub> | collector-emitter voltage     | open base                 | –    | 30   | V    |
|                  | 2N2222A                       |                           |      | 40   | V    |
| V <sub>EBO</sub> | emitter-base voltage          | open collector            | –    | 5    | V    |
|                  | 2N2222A                       |                           |      | 6    | V    |
| I <sub>C</sub>   | collector current (DC)        |                           | –    | 800  | mA   |
| I <sub>CM</sub>  | peak collector current        |                           | –    | 800  | mA   |
| I <sub>BM</sub>  | peak base current             |                           | –    | 200  | mA   |
| P <sub>tot</sub> | total power dissipation       | T <sub>amb</sub> ≤ 25 °C  | –    | 500  | mW   |
|                  |                               | T <sub>case</sub> ≤ 25 °C | –    | 1.2  | W    |
| T <sub>stg</sub> | storage temperature           |                           | –65  | +150 | °C   |
| T <sub>j</sub>   | junction temperature          |                           | –    | 200  | °C   |
| T <sub>amb</sub> | operating ambient temperature |                           | –65  | +150 | °C   |

**THERMAL CHARACTERISTICS**

| SYMBOL              | PARAMETER                                   | CONDITIONS  | VALUE | UNIT |
|---------------------|---|-------------|-------|------|
| R <sub>th j-a</sub> | thermal resistance from junction to ambient | in free air | 350   | K/W  |
| R <sub>th j-c</sub> | thermal resistance from junction to case    |             | 146   | K/W  |

## NPN switching transistors

## 2N2222; 2N2222A

## CHARACTERISTICS

$T_j = 25\text{ }^\circ\text{C}$  unless otherwise specified.

| SYMBOL      | PARAMETER                                       | CONDITIONS  | MIN. | MAX. | UNIT          |
|-------------|---|---|------|------|---------------|
| $I_{CBO}$   | collector cut-off current<br>2N2222             | $I_E = 0; V_{CB} = 50\text{ V}$   | –    | 10   | nA            |
|             |   | $I_E = 0; V_{CB} = 50\text{ V}; T_{amb} = 150\text{ }^\circ\text{C}$  | –    | 10   | $\mu\text{A}$ |
| $I_{CBO}$   | collector cut-off current<br>2N2222A            | $I_E = 0; V_{CB} = 60\text{ V}$   | –    | 10   | nA            |
|             |   | $I_E = 0; V_{CB} = 60\text{ V}; T_{amb} = 150\text{ }^\circ\text{C}$  | –    | 10   | $\mu\text{A}$ |
| $I_{EBO}$   | emitter cut-off current                         | $I_C = 0; V_{EB} = 3\text{ V}$  | –    | 10   | nA            |
| $h_{FE}$    | DC current gain                                 | $I_C = 0.1\text{ mA}; V_{CE} = 10\text{ V}$   | 35   | –    |               |
|             |   | $I_C = 1\text{ mA}; V_{CE} = 10\text{ V}$   | 50   | –    |               |
|             |   | $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}$  | 75   | –    |               |
|             |   | $I_C = 150\text{ mA}; V_{CE} = 1\text{ V}; \text{note 1}$   | 50   | –    |               |
|             |   | $I_C = 150\text{ mA}; V_{CE} = 10\text{ V}; \text{note 1}$  | 100  | 300  |               |
| $h_{FE}$    | DC current gain<br>2N2222A                      | $I_C = 10\text{ mA}; V_{CE} = 10\text{ V}; T_{amb} = -55\text{ }^\circ\text{C}$                                       | 35   | –    |               |
| $h_{FE}$    | DC current gain<br>2N2222<br>2N2222A            | $I_C = 500\text{ mA}; V_{CE} = 10\text{ V}; \text{note 1}$  | 30   | –    |               |
|             |   |   | 40   | –    |               |
| $V_{CEsat}$ | collector-emitter saturation voltage<br>2N2222  | $I_C = 150\text{ mA}; I_B = 15\text{ mA}; \text{note 1}$  | –    | 400  | mV            |
|             |   | $I_C = 500\text{ mA}; I_B = 50\text{ mA}; \text{note 1}$  | –    | 1.6  | V             |
| $V_{CEsat}$ | collector-emitter saturation voltage<br>2N2222A | $I_C = 150\text{ mA}; I_B = 15\text{ mA}; \text{note 1}$  | –    | 300  | mV            |
|             |   | $I_C = 500\text{ mA}; I_B = 50\text{ mA}; \text{note 1}$  | –    | 1    | V             |
| $V_{BEsat}$ | base-emitter saturation voltage<br>2N2222       | $I_C = 150\text{ mA}; I_B = 15\text{ mA}; \text{note 1}$  | –    | 1.3  | V             |
|             |   | $I_C = 500\text{ mA}; I_B = 50\text{ mA}; \text{note 1}$  | –    | 2.6  | V             |
| $V_{BEsat}$ | base-emitter saturation voltage<br>2N2222A      | $I_C = 150\text{ mA}; I_B = 15\text{ mA}; \text{note 1}$  | 0.6  | 1.2  | V             |
|             |   | $I_C = 500\text{ mA}; I_B = 50\text{ mA}; \text{note 1}$  | –    | 2    | V             |
| $C_c$       | collector capacitance                           | $I_E = i_e = 0; V_{CB} = 10\text{ V}; f = 1\text{ MHz}$   | –    | 8    | pF            |
| $C_e$       | emitter capacitance<br>2N2222A                  | $I_C = i_c = 0; V_{EB} = 500\text{ mV}; f = 1\text{ MHz}$   | –    | 25   | pF            |
| $f_T$       | transition frequency<br>2N2222<br>2N2222A       | $I_C = 20\text{ mA}; V_{CE} = 20\text{ V}; f = 100\text{ MHz}$  | 250  | –    | MHz           |
|             |   |   | 300  | –    | MHz           |
| F           | noise figure<br>2N2222A                         | $I_C = 200\text{ }\mu\text{A}; V_{CE} = 5\text{ V}; R_S = 2\text{ k}\Omega;$<br>$f = 1\text{ kHz}; B = 200\text{ Hz}$ | –    | 4    | dB            |

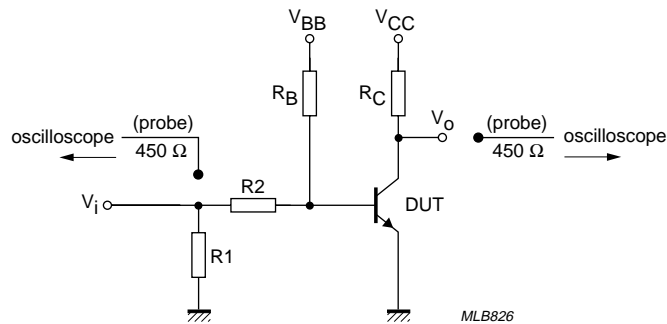
NPN switching transistors

2N2222; 2N2222A

| SYMBOL   | PARAMETER     | CONDITIONS   | MIN. | MAX. | UNIT |
|--|---------------|--|------|------|------|
| <b>Switching times (between 10% and 90% levels); see Fig.2</b> |               |  |      |      |      |
| $t_{on}$   | turn-on time  | $I_{Con} = 150 \text{ mA}; I_{Bon} = 15 \text{ mA}; I_{Boff} = -15 \text{ mA}$ | –    | 35   | ns   |
| $t_d$  | delay time    |  | –    | 10   | ns   |
| $t_r$  | rise time     |  | –    | 25   | ns   |
| $t_{off}$  | turn-off time |  | –    | 250  | ns   |
| $t_s$  | storage time  |  | –    | 200  | ns   |
| $t_f$  | fall time     |  | –    | 60   | ns   |

**Note**

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



$V_i = 9.5 \text{ V}; T = 500 \mu\text{s}; t_p = 10 \mu\text{s}; t_r = t_f \leq 3 \text{ ns}.$   
 $R_1 = 68 \Omega; R_2 = 325 \Omega; R_B = 325 \Omega; R_C = 160 \Omega.$   
 $V_{BB} = -3.5 \text{ V}; V_{CC} = 29.5 \text{ V}.$   
 Oscilloscope input impedance  $Z_i = 50 \Omega.$

Fig.2 Test circuit for switching times.

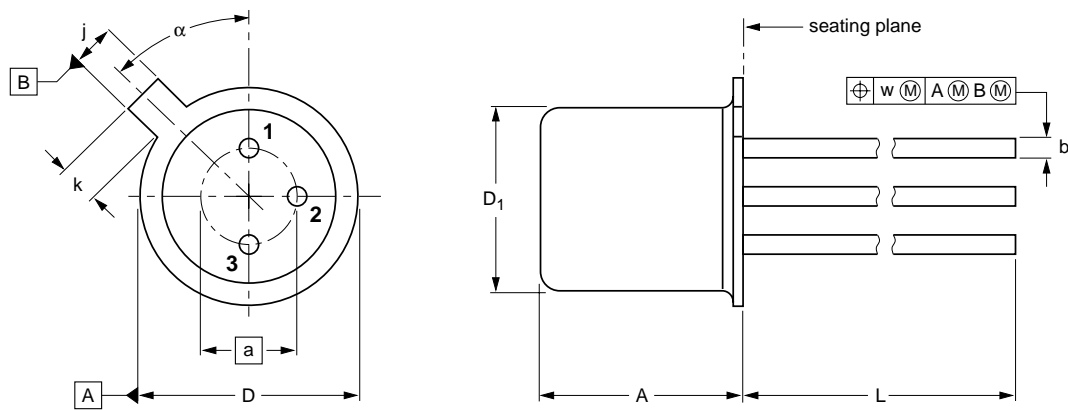
NPN switching transistors

2N2222; 2N2222A

PACKAGE OUTLINE

Metal-can cylindrical single-ended package; 3 leads

SOT18/13



DIMENSIONS (millimetre dimensions are derived from the original inch dimensions)

| UNIT | A            | a    | b            | D            | D <sub>1</sub> | j            | k          | L            | w    | α   |
|------|--------------|------|--------------|--------------|----------------|--------------|------------|--------------|------|-----|
| mm   | 5.31<br>4.74 | 2.54 | 0.47<br>0.41 | 5.45<br>5.30 | 4.70<br>4.55   | 1.03<br>0.94 | 1.1<br>0.9 | 15.0<br>12.7 | 0.40 | 45° |

| OUTLINE VERSION | REFERENCES    |       |      |  | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|---------------|-------|------|--|---------------------|------------|
|                 | IEC           | JEDEC | EIAJ |  |                     |            |
| SOT18/13        | B11/C7 type 3 | TO-18 |      |  |                     | 97-04-18   |

## NPN switching transistors

2N2222; 2N2222A

**DEFINITIONS**

|   |   |
|---|---|
| <b>Data sheet status</b>  |   |
| Objective specification   | This data sheet contains target or goal specifications for product development.       |
| Preliminary specification   | This data sheet contains preliminary data; supplementary data may be published later. |
| Product specification   | This data sheet contains final product specifications.                                |
| <b>Limiting values</b>  |   |
| Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability. |   |
| <b>Application information</b>  |   |
| Where application information is given, it is advisory and does not form part of the specification.   |   |

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