**Important notice**

Dear Customer,

On 7 February 2017 the former NXP Standard Product business became a new company with the tradename **Nexperia**. Nexperia is an industry leading supplier of Discrete, Logic and PowerMOS semiconductors with its focus on the automotive, industrial, computing, consumer and wearable application markets

In data sheets and application notes which still contain NXP or Philips Semiconductors references, use the references to Nexperia, as shown below.

Instead of http://www.nxp.com, http://www.philips.com/ or http://www.semiconductors.philips.com/, use **http://www.nexperia.com**

Instead of sales.addresses@www.nxp.com or sales.addresses@www.semiconductors.philips.com, use **salesaddresses@nexperia.com** (email)

Replace the copyright notice at the bottom of each page or elsewhere in the document, depending on the version, as shown below:
- © NXP N.V. (year). All rights reserved or © Koninklijke Philips Electronics N.V. (year). All rights reserved
Should be replaced with:
- **© Nexperia B.V. (year). All rights reserved**.

If you have any questions related to the data sheet, please contact our nearest sales office via e-mail or telephone (details via **salesaddresses@nexperia.com**). Thank you for your cooperation and understanding,

Kind regards,

Team Nexperia

## LETTER SYMBOLS

The letter symbols for transistors detailed in this section are based on IEC publication number 148.

### Letter symbols for currents, voltages and powers

BASIC LETTERS

I, i current

V, v voltage

P, p power.

Upper-case letter symbols are used to represent all values except instantaneous values that vary with time, these are represented by lower-case letters.

SUBSCRIPTS

| | |
|---|---|
| A, a | anode terminal |
| (AV), (av) | average value |
| B, b | base terminal |
| C, c | collector terminal |
| D, d | drain terminal |
| E, e | emitter terminal |
| F, f | forward |
| G, g | gate terminal |
| K, k | cathode terminal |
| M, m | peak value |
| O, o | as third subscript: the terminal not mentioned is open-circuit |
| R, r | as first subscript: reverse. As second subscript: repetitive. As third subscript: with a specified resistance between the terminal not mentioned and the reference terminal |
| (RMS), (rms) | root-mean-square value |
| S, s | as first or second subscript: source terminal (FETs only). As second subscript: non-repetitive (not FETs). As third subscript: short circuit between the terminal not mentioned and the reference terminal |
| X, x | specified circuit |
| Z, z | replaces R to indicate the actual working voltage, current or power of voltage reference and voltage reference diodes. |

No additional subscript is used for DC values.

Upper-case subscripts are used for the indication of:

- Continuous (DC) values (without signal), e.g. $I_B$
- Instantaneous total values, e.g. $i_B$
- Average total values, e.g. $I_{B(AV)}$
- Peak total values, e.g. $I_{BM}$
- Root-mean-square total values, e.g. $I_{B(RMS)}$.

Lower-case subscripts are used for the indication of values applying to the varying component alone:

- Instantaneous values, e.g. $i_b$
- Root-mean-square values, e.g. $I_{b(rms)}$
- Peak values, e.g. $I_{bm}$
- Average values, e.g. $I_{b(av)}$.

If more than one subscript is used, the subscript for which both styles exist are either all upper-case or all lower-case.

ADDITIONAL RULES FOR SUBSCRIPTS

*Transistor currents*

If it is necessary to indicate the terminal carrying the current, this should be done by the first subscript (conventional current flow from the external circuit into the terminal is positive).

Examples: $I_B$, $i_B$, $i_b$, $I_{bm}$.

*Transistor voltages*

If it is necessary to indicate the points between which a voltage is measured, this should be done by the first two subscripts. The first subscript indicates the terminal at which the voltage is measured and the second the reference terminal or the circuit node. Where there is no possibility of confusion, the second subscript may be omitted.

Examples: $V_{BE}$, $v_{BE}$, $v_{be}$, $V_{bem}$.

*Supply voltages or currents*

Supply voltages or supply currents are indicated by repeating the appropriate terminal subscript.

Examples: $V_{CC}$, $I_{EE}$.

If it is necessary to indicate a reference terminal, this should be done by a third subscript.

Example: $V_{CCE}$.

*Subscripts for devices with more than one terminal of the same kind*

If a device has more than one terminal of the same kind, the subscript is formed by the appropriate letter for the terminal, followed by a number. In the case of multiple subscripts, hyphens may be necessary to avoid confusion.

Examples:

$I_{B2}$ continuous (DC) current flowing into the second base terminal

$V_{B2-E}$ continuous (DC) voltage between the terminals of second base and emitter terminals.

*Subscripts for multiple devices*

For multiple unit devices, the subscripts are modified by a number preceding the letter subscript. In the case of multiple subscripts, hyphens may be necessary to avoid confusion.

Examples:

$I_{2C}$ continuous (DC) current flowing into the collector terminal of the second unit

$V_{1C-2C}$ continuous (DC) voltage between the collector terminals of the first and second units.

**Application of the rules**

Figure 1 represents a transistor collector current as a function of time. It comprises a continuous (DC) current and a varying component.

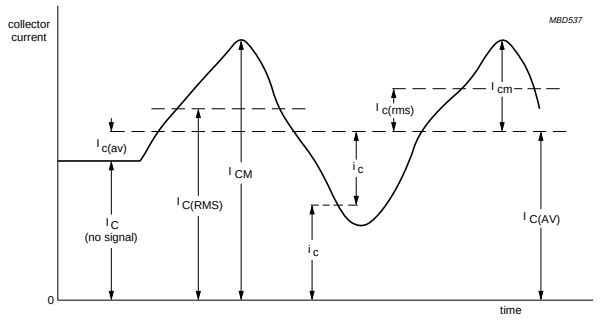


Fig.1 Collector current as a function of time.

**Letter symbols for electrical parameters**

DEFINITION

For the purpose of this publication, the term ‘electrical parameter’ applies to four-pole matrix parameters, elements of electrical equivalent circuits, electrical impedances and admittances, inductances and capacitances.

BASIC LETTERS

The following list comprises the most important basic letters used for electrical parameters of semiconductor devices.

B, b susceptance (imaginary part of an admittance)

C capacitance

G, g conductance (real part of an admittance)

H, h hybrid parameter

L inductance

R, r resistance (real part of an impedance)

X, x reactance (imaginary part of an impedance)

Y, y admittance

Z, z impedance.

Upper-case letters are used for the representation of:

- Electrical parameters of external circuits and of circuits in which the device forms only a part
- All inductances and capacitances.

Lower-case letters are used for the representation of electrical parameters inherent in the device, with the exception of inductances and capacitances.

SUBSCRIPTS

*General subscripts*

The following list comprises the most important general subscripts used for electrical parameters of semiconductor devices.

F, f forward (forward transfer)

I, i (or 1) input

L, l load

O, o (or 2) output

R, r reverse (reverse transfer)

S, s source.

Examples: $Z_s$, $h_f$, $h_F$.

The upper-case variant of a subscript is used for the designation of static (DC) values.

Examples:

$h_{FE}$ static value of forward current transfer ratio in common-emitter configuration (DC current gain)

$R_E$ DC value of the external emitter resistance.

The static value is the slope of the line from the origin to the operating point on the appropriate characteristic curve, i.e. the quotient of the appropriate electrical quantities at the operating point.

The lower-case variant of a subscript is used for the designation of small-signal values.

Examples:

| | |
|---|---|
| $h_{fe}$ | small-signal value of the short-circuit forward current transfer ratio in common-emitter configuration |
| $Z_e = R_e + jX_e$ | small-signal value of the external impedance. |

If more than one subscript is used, subscripts for which both styles exist are either all upper-case or all lower-case.

Examples: $h_{FE}$, $y_{RE}$, $h_{fe}$.

*Subscripts for four-pole matrix parameters*

The first letter subscript (or double numeric subscript) indicates input, output, forward transfer or reverse transfer.

Examples: $h_i$ (or $h_{11}$), $h_o$ (or $h_{22}$), $h_f$ (or $h_{21}$), $h_r$ (or $h_{12}$).

A further subscript is used for the identification of the circuit configuration. When no confusion is possible, this further subscript may be omitted.

Examples: $h_{fe}$ (or $h_{21e}$), $h_{FE}$ (or $h_{21E}$).

DISTINCTION BETWEEN REAL AND IMAGINARY PARTS

If it is necessary to distinguish between real and imaginary parts of electrical parameters, no additional subscripts should be used. If basic symbols for the real and imaginary parts exist, these may be used.

Examples: $Z_i = R_i + jX_i$, $y_{fe} = g_{fe} + jb_{fe}$.

If such symbols do not exist, or if they are not suitable, the following notation is used:

Examples:

Re ($h_{ib}$) etc. for the real part of $h_{ib}$

Im ($h_{ib}$) etc. for the imaginary part of $h_{ib}$.