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Specification for

Letter symbols for semiconductor devices and integrated microcircuits

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- Electronic Engineering Association*
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- Institution of Electronic and Radio Engineers
- Ministry of Defence*
- National Supervising Inspectorate*
- Post Office*
- Society of British Aerospace Companies Limited
- Telecommunications Engineering and Manufacturing Association (TEMA)*

The organizations marked with an asterisk in the above list, together with the following, were directly represented on the Technical Committee entrusted with the preparation of this British Standard:

- British Broadcasting Corporation
- Engineering Equipment Users' Association

This British Standard, having been prepared under the direction of the Electronic Components Standards Committee, was published under the authority of the Executive Board and comes into effect on 28 November 1980

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National foreword

This revised British Standard has been prepared under the direction of the Electronic Components Standards Committee. It is identical with IEC Publication 148 “*Letter symbols for semiconductor devices and integrated microcircuits*” published in 1969 by the International Electrotechnical Commission (IEC).

This British Standard supersedes BS 3363:1968 “*Schedule of letter symbols for semiconductor devices*”, which is therefore withdrawn.

Terminology and conventions. The text of the International Standard has been approved as suitable for publication, without deviation, as a British Standard. Some terminology and certain conventions are not identical with those used in British Standards; attention is especially drawn to the following.

Wherever the word “Recommendation” appears, referring to this standard, it should be read as “British Standard”.

Cross-references

There are no corresponding British Standards for IEC 27, IEC 50 or IEC 147 referred to in the text. Related British Standards are BS 1991 “*Letter symbols, signs and abbreviations*” Part 6 “*Electrical science and engineering*” for IEC 27, BS 4727 “*Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms*” for IEC 50 and BS 9300 “*Semiconductor devices of assessed quality: generic data and methods of test*” and BS 9400 “*Integrated electronic circuits and micro-assemblies of assessed quality: generic data and methods of test*” for IEC 147.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 26, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Chapter I. General

1 Scope

This Recommendation provides a system of letter symbols to be used in the field of semiconductor devices and integrated microcircuits.

2 Definitions of terms used in this Recommendation

The terms and their definitions used in this Publication can be found in existing IEC Publications. Many of them are contained in IEC Publication 147-0, Essential Ratings and Characteristics of Semiconductor Devices and General Principles of Measuring Methods, Part 0: General and Terminology. For general terms and definitions, see also IEC Publication 50, International Electrotechnical Vocabulary.

3 General recommendations for letter symbols

The general recommendations given in IEC Publication 27, Letter Symbols to be used in Electrical Technology, are applicable, except where this Publication gives different recommendations, in which case the latter should be followed.

4 Letter symbols for currents, voltages and powers

4.1 Basic letters

4.1.1 *List of recommended basic letters*

The basic letters to be used are:

I, i = for current
 U, u
 V, v } = for voltage
 P, p = for power.

NOTE IEC Publication 27 recommends the letters V and v only as reserve symbols for voltage; however, in the field of semiconductor devices, they are so widely used that in this Recommendation they are on the same plane as U and u .

4.1.2 *Use of upper-case letters*

Upper-case basic letters shall be used for the representation of:

- a) maximum (peak) values;
- b) average (mean) values;
- c) continuous (d.c.) values;
- d) root-mean-square values.

4.1.3 *Use of lower-case letters*

Lower-case basic letters shall be used for the representation of instantaneous values which vary with time.

4.2 Subscripts

4.2.1 *List of recommended general subscripts*

AV, av = average
 F, f = forward
 M, m = maximum (peak) value
 MIN, min = minimum value
 O, o = open circuit
 R, r = reverse or, as a second subscript, repetitive
 S, s = short-circuit or, as a second subscript, surge and/or non-repetitive
 (BR) = breakdown
 (OV) = overload
 tot = total.

NOTE For other recommended subscripts, see also the specific lists in the following chapters of this Publication.

4.2.2 Choice between upper-case and lower-case subscripts

Where Sub-clause 4.2.1 lists both upper-case and lower-case letters, the choice between these two styles shall be made according to Sub-clauses 4.2.2.1 and 4.2.2.2. If more than one subscript is used, subscripts for which both styles exist shall either be all upper-case or all lower-case.

4.2.2.1 Use of upper-case subscripts

Upper-case subscripts shall be used for the indication of:

- a) continuous (d.c.) values (without signal)
example I_B
- b) instantaneous total values
example i_B
- c) average total values
example I_{BAV}
- d) maximum (peak) total values
example I_{BM}

4.2.2.2 Use of lower-case subscripts

Lower-case subscripts shall be used for the indication of values applying to the varying component alone, i.e.:

- a) instantaneous values
example i_b
- b) root-mean-square values
example I_b
- c) maximum (peak) values
example I_{bm}
- d) average values
example I_{bav}

4.2.3 Additional rules for subscripts

4.2.3.1 Subscripts for currents

If it is necessary to indicate the terminal carrying the current, this should be done by the first subscript

examples: I_B , i_B , i_b , I_b

4.2.3.2 Subscripts for 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 one terminal point of the device and the second the reference terminal or the circuit node. Where there is no possibility of confusion, the second subscript may be omitted

examples: U_{BE} , u_{BE} , u_{be} , U_{be}
 V_{BE} , v_{BE} , v_{be} , V_{be}

4.2.3.3 Subscripts for supply voltages or supply currents

Supply voltages or supply currents shall be indicated by repeating the appropriate terminal subscript

examples: U_{CC} or V_{CC} , I_{EE}

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

examples: U_{CCE} or V_{CCE}

5 Letter symbols for electrical parameters

5.1 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.

5.2 Basic letters

5.2.1 List of recommended basic letters

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

- B, b = susceptance; imaginary part of an admittance (y) four-pole matrix parameter
- C = capacitance
- G, g = conductance; real part of an admittance (y) four-pole matrix parameter
- H, h = hybrid (h) four-pole matrix parameter
- L = inductance
- R, r = resistance; real part of an impedance (z) four-pole matrix parameter
- X, x = reactance; imaginary part of an impedance (z) four-pole matrix parameter
- Y, y = admittance; admittance (y) four-pole matrix parameter
- Z, z = impedance; impedance (z) four-pole matrix parameter.

5.2.2 Use of upper-case letters

Upper-case letters shall be used for the representation of:

- a) electrical parameters of external circuits and of circuits in which the device forms only a part;
- b) all inductances and capacitances.

5.2.3 Use of lower-case letters

Lower-case letters shall be used for the representation of electrical parameters inherent in the device [with the exception of inductances and capacitances, see Sub-clause 5.2.2., paragraph b)].

5.3 Subscripts

5.3.1 List of recommended general subscripts

The following is a list of the most important general subscripts used for electrical parameters of semiconductor devices:

- F, f = forward; forward transfer
 - I, i = input
 - O, o = output
 - R, r = reverse; reverse transfer
 - T = depletion layer
 - 11 = input
 - 22 = output
 - 12 = reverse transfer
 - 21 = forward transfer
- } applicable to four-pole matrix parameters only, see Sub-clause 5.3.3
-
- 1 = input
 - 2 = output
- } applicable to all electrical parameters except four-pole matrix parameters

NOTE For other recommended subscripts, see also the lists in the following chapters of this Publication.

5.3.2 Choice between upper-case and lower-case subscripts

Where Sub-clause 5.3.1 lists both upper-case and lower-case letters, the choice between these two styles shall be made according to Sub-clauses 5.3.2.1 and 5.3.2.2 hereafter. If more than one subscript is used, subscripts for which both styles exist shall either be all upper-case or all lower-case

examples: h_{FE} , y_{RE} , h_{fe} , but C_{Te} (T has no lower-case variant)

5.3.2.1 Use of upper-case subscripts

The upper-case variant of a subscript shall be used for the designation of static (d.c.) values

examples: h_{21E} or h_{FE} = static value of forward current transfer ratio in common-emitter configuration

R_E = d.c. value of the external emitter resistance

5.3.2.2 Use of lower-case subscripts

The lower-case variant of a subscript shall be used for the designation of small-signal values

examples: h_{21e} or 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

5.3.3 Subscripts for four-pole matrix parameters

Each element of the four-pole matrix is identified according to the following rules.

5.3.3.1 First subscript

The first letter subscript or double numeric subscript indicates input, output, forward or reverse transfer, chosen from the list of subscripts given in Sub-clause 5.3.1

examples: h_{11} or h_i

h_{22} or h_o

h_{21} or h_f

h_{12} or h_r

5.3.3.2 Second subscript

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_{21e} or h_{fe} , h_{21E} or h_{FE}

If only h_f is written, the circuit configuration must be understood. If only h_{21} is written, the circuit configuration must be understood as well as the kind of parameter (small-signal or static value).

5.4 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: $Z_e = R_e + jX_e$

$Y_{fe} = G_{fe} + jB_{fe}$

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

Re (h_{11b}) etc. for the real part

Im (h_{11b}) etc. for the imaginary part.

6 Letter symbols for other quantities

6.1 General

Where the following sub-clauses do not give recommendations for a letter symbol, the general recommendations (IEC Publication 27) should be followed. If there are no IEC Recommendations, the appropriate ISO Recommendations should be followed.

6.2 Times, durations

The basic letter symbol is t

example: rise time t_r

6.3 Temperatures

6.3.1 Basic letter symbol

The basic letter symbol is t . When there is a possibility of confusion with t to represent “time”, e.g. on data sheets, the letter theta (ϑ or θ) should be used instead. If this is not suitable and if there is no risk of confusion, the letter T (usually indicating Kelvin temperature) may be used instead

example: t_{amb} ; ϑ_{amb} ; $T_{\text{amb}} = 25^\circ\text{C}$

6.3.2 List of recommended general subscripts

amb = ambient

case = case

J, j = junction

stg = storage.

6.4 Frequencies

The basic letter symbol is f

example: maximum frequency of oscillation = f_{max}

6.5 Sundry quantities

The following quantities and their letter symbols are recommended:

thermal resistance = R_{th} (Note)

thermal derating factor = K_t

virtual temperature
internal equivalent temperature } = $t_{(\text{vj})}$

transient thermal impedance = $Z_{(\text{th})t}$

thermal impedance under pulse conditions = $Z_{(\text{th})p}$

NOTE When a possibility of misinterpretation exists, because of combination of other letter symbols with the subscript of R_{th} , the subscript th should be enclosed in brackets, as $R_{(\text{th})}$.

Chapter II. Letter symbols for bipolar transistors

1 Letter symbols for currents, voltages and powers

1.1 Basic letters

See Sub-clause 4.1 of Chapter I.

1.2 Subscripts

The general rules of Sub-clause 4.2 of Chapter I apply. In addition to the list of recommended general subscripts given in Sub-clause 4.2.1 of Chapter I, the following special subscripts are recommended for the field of bipolar transistors:

B, b = base terminal

C, c = collector terminal

E, e = emitter terminal

fl = floating

pt = punch-through (penetration, reach through)

R (not as a first subscript) = specified resistance

sat = saturation

X = specified circuit.