

Semiconductor devices —

Part 1: Discrete devices —

Section 1.3 Recommendations for signal (including switching) and regulator diodes

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- British Telecommunications
- Electronic Components Industry Federation
- Electronic Engineering Association
- Ministry of Defence
- National Supervising Inspectorate
- Telecommunication Engineering and Manufacturing Association (TEMA)

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- Engineering Equipment and Materials Users' Association
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Contents

	Page
Committees responsible	Inside front cover
National foreword	ii
Chapter I. General	
1 Introductory note	1
2 Purpose	1
3 Letter symbols	1
Chapter II. Terminology and letter symbols	
Section 1. Signal diodes (including switching diodes)	
1 General terms	1
2 Terms related to ratings and characteristics	1
3 Letter symbols	5
Section 2. Voltage reference diodes and voltage-regulator diodes	
1 General terms	6
2 Terms related to ratings and characteristics	7
3 Letter symbols	8
Section 3. Current regulator diodes	
1 General terms	8
2 Terms related to ratings and characteristics	9
3 Letter symbols	10
Figure 1	3
Figure 2	3
Figure 29 — Forward recovery time, specification method A	4
Figure 30 — Forward recovery time, specification method B	4
Figure 3 — Current-regulator diode characteristic with symbol identification	10
Chapter III. Essential ratings and characteristics	
Section 1. Signal diodes (including switching diodes)	
1 General	11
2 Ratings (limiting values)	11
3 Characteristics	11
4 Application data (under consideration)	13
Section 2. Voltage-reference diodes and voltage-regulator diodes	
1 General	14
2 Ratings (limiting values)	14
3 Characteristics	14
Section 3. Current-regulator diodes	
1 Type	15
2 Semiconductor material	15
3 Outline	15
4 Limiting values (absolute maximum system) over the operating temperature range, unless otherwise specified	15
5 Electrical characteristics	15
Figure 29 — Voltage waveform during forward recovery	13
Chapter IV. Measuring methods	
Section 1. Signal diodes (including switching diodes)	
1 Reverse current	16
2 Forward voltage	17
3 Total capacitance	18

	Page
4 Switching parameters	18
5 Detector efficiency	25
6 Noise	27
Section 2. Voltage-reference diodes and voltage-regulator diodes	
1 Working voltage	28
2 Differential resistance	30
3 Temperature coefficient of working voltage	32
4 Reverse current	33
5 Forward voltage	33
6 Junction capacitance	33
7 Noise voltage	33
Section 3. Current-regulator diodes	
1 Regulator current	35
2 Temperature coefficient of regulator current	35
3 Regulator current variation	36
4 Limiting voltage	36
5 Small-signal regulator conductance	36
6 Knee conductance	36
Figure 4 — Circuit diagram for the measurement of I_R	16
Figure 5 — Circuit diagram for the measurement of V_F	17
Figure 6 — Circuit diagram for the measurement for C_{tot}	18
Figure 31 — Circuit diagram	19
Figure 32 — Current and voltage waveforms	19
Figure 8 — Circuit diagram for the measurement of Q_r	21
Figure 9 — Circuit diagram for the measurement of t_{rr}	22
Figure 10 — Diode current waveform in the measurement of t_{rr}	23
Figure 11 — Circuit diagram for the measurement of t_{rr}	24
Figure 12 — Diode current waveform in the measurement of t_{rr}	25
Figure 13 — Circuit diagram for the measurement of η_v	25
Figure 14 — Circuit diagram for the measurement of η_p	26
Figure 15 — Circuit for the representation of the noise in a diode	27
Figure 16 — Circuit for the measurement of noise current	28
Figure 17 — Circuit diagram for the measurement of V_Z (d.c. method)	28
Figure 18 — Circuit diagram for the measurement of V_Z (pulse method)	29
Figure 19 — Circuit diagram for the measurement of r_z (d.c. method)	30
Figure 20 — Circuit diagram for the measurement of r_z (pulse method)	31
Figure 21 — Circuit diagram for the measurement of α_{VZ} (d.c. method)	32
Figure 22 — Circuit diagram for the measurement of α_{VZ} (pulse method)	33
Figure 23 — Noise voltage V_n as a function of I_Z	34
Figure 24 — Circuit diagram for the measurement of V_n	34
Figure 25 — Circuit diagram for the measurement of I_S	35
Figure 26 — Circuit diagram for the measurement of V_L	37
Figure 27 — Circuit diagram for the measurement of g_s (two-voltmeter method)	38
Figure 28 — Circuit diagram for the measurement of g_s (two-terminal bridge method)	39

	Page
Chapter V. Acceptance and reliability	
Section 1. Electrical endurance tests	
1 General requirements	40
2 Specific requirements	40
Table I — Failure-defining characteristics for acceptance after endurance tests	40
Table II — Conditions for the endurance tests	41
Publications referred to	Inside back cover

National foreword

This Section of this BS 6493 has been prepared under the direction of the Electronic Components Standards Committee. It is identical with IEC Publication 747-3 “*Semiconductor devices. Discrete devices — Part 3: Signal (including switching) and regulator diodes*”, as amended by Amendment No. 1 published in October 1991 and Amendment No. 2 published in November 1993, published in 1985 by the International Electrotechnical Commission (IEC).

This British Standard constitutes Section 1.3 of the British Standard For semiconductor devices (BS 6493). (See national foreword of BS 6493-1.1:1984.)

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

Cross-references

International Standard	Corresponding British Standard
IEC 747-1:1983	BS 6493 <i>Semiconductor devices: discrete devices and integrated circuits</i> Section 1.1:1984 <i>General</i> (Identical)

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.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 42, 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 Introductory note

As a rule, it will be necessary to use Publication 747-1 together with the present publication. In 747-1, the user will find all basic information on:

- terminology;
- letter symbols;
- essential ratings and characteristics;
- measuring methods;
- acceptance and reliability.

The sequence of the different chapters is in accordance with Publication 747-1, Chapter III, Sub-clause 2.1.

2 Purpose

The present publication gives standards for the following categories and sub-categories of devices:

- signal diodes (including switching diodes);
- voltage-reference diodes and voltage-regulator diodes;
- current-regulator diodes.

3 Letter symbols

Mostly, existing letter symbols are added to the terms in titles. When several distinctive forms exist, the most commonly used form is given.

Chapter II. Terminology and letter symbols

Section 1. Signal diodes (including switching diodes)

1 General terms

The relevant terms and definitions given in Publication 747-1 apply. The term in Sub-clause 1.1 below is repeated from this publication, Chapter IV, Sub-clause 4.8.

1.1 Signal diode

A diode used for the purpose of extracting or processing information contained in an electronic signal which varies with time and may be either analogue or digital in nature.

2 Terms related to ratings and characteristics

The relevant terms and definitions given in Publications 747-1, Chapter IV, Clause 5, apply.

Additional terms and definitions are given below.

2.1 Voltages

2.1.1

continuous (direct) reverse voltage (V_R)

the value of the constant voltage applied to a diode in the reverse direction

2.1.2

mean reverse voltage ($V_{R(AV)}$)

the value of the reverse voltage averaged over a specified time

2.1.3

peak reverse voltage (V_{RM})

the highest instantaneous value of the reverse voltage occurring across a diode, including all repetitive and non-repetitive transients

2.1.4

detector voltage efficiency (η_v)

the ratio of the d.c. load voltage to the peak sinusoidal input voltage under specified circuit conditions

2.1.5**forward recovery voltage (v_{FR})**

the varying voltage occurring during the forward recovery time after instantaneous switching from zero or a specified reverse voltage to a specified forward current

2.2 Currents**2.2.1****mean forward current ($I_{F(AV)}$)**

the value of the forward current averaged over a specified time

2.2.2**peak forward current (I_{FM})**

the highest instantaneous value of the forward current, including all repetitive and non-repetitive transients

2.3 Power dissipation**2.3.1****detector power efficiency (η_p)**

the ratio of the change in d.c. power in the load resistance produced by the a.c. signal, to the available power from a sinusoidal voltage generator when the diode is operated under specified conditions

2.3.2**single-pulse energy (E_p) (applied to a detector diode)**

the energy of a pulse of short duration applied to a diode in the forward direction

NOTE For maximum rating purposes, the pulse duration is normally specified to be less than 10 ms.

2.3.3**repetitive pulse energy ($E_{p(rep)}$)**

the energy contained in a single pulse that occurs in a repetitive series of pulses

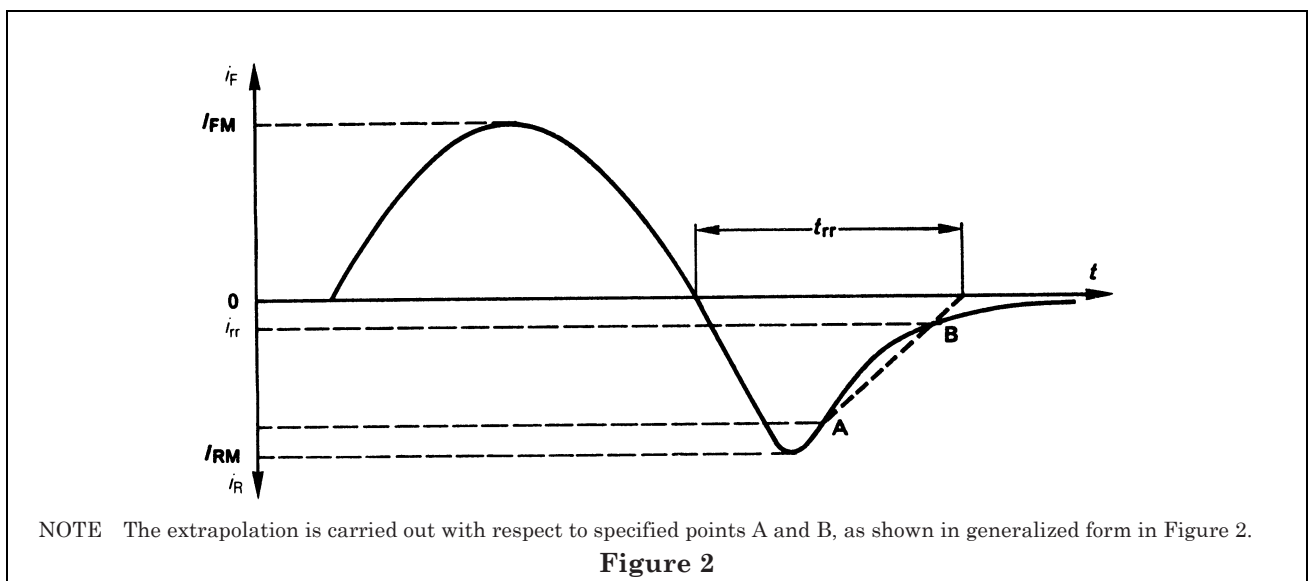
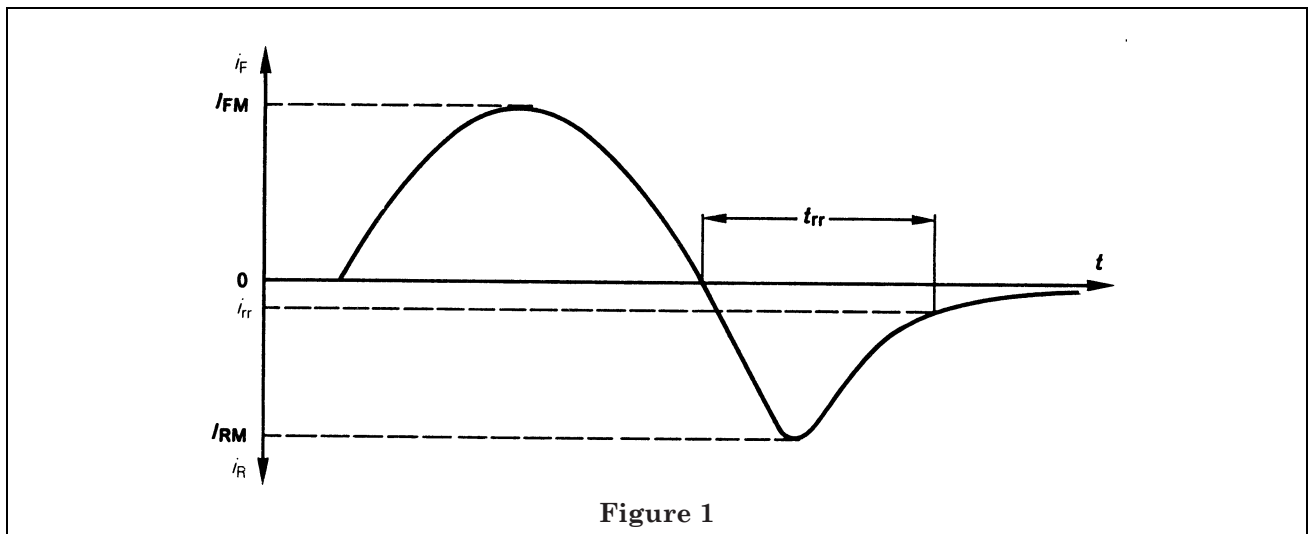
2.4 Sundry characteristics**2.4.1****recovered charge (Q_r)**

the total charge recovered from the diode after switching from a specified forward current condition to a specified reverse condition

NOTE This charge includes components due to both carrier storage and depletion layer capacitance.

2.4.2**reverse recovery time (t_{rr})**

the time interval between the instant when the current passes through zero, when changing from the forward direction to the reverse direction, and the instant when the reverse current is reduced from its peak value I_{RM} to a specified low value (as shown in Figure 1), or when the extrapolated reverse current reaches zero (as shown in Figure 2, page 3)



2.4.3

forward recovery time t_{fr} (of a rectifier diode or signal diode)

the time interval between the instant when the forward voltage rises through a specified first value and the instant when it falls from its peak value V_{FRM} to a specified second value close to the final stable value of forward voltage (specification method A as shown in Figure 29), or when the extrapolated forward voltage reaches zero (specification method B as shown in Figure 30), upon the application of a specified step of forward current following a zero-voltage or other specified reverse-voltage condition

NOTE 1 The specified first and second values referred to in the definition are usually 10 % and 110 %, respectively, of the final stable value (V_F^* in Figure 29 and Figure 30).

NOTE 2 The extrapolation is carried out with respect to specified points A and B as shown in generalized form in Figure 30.

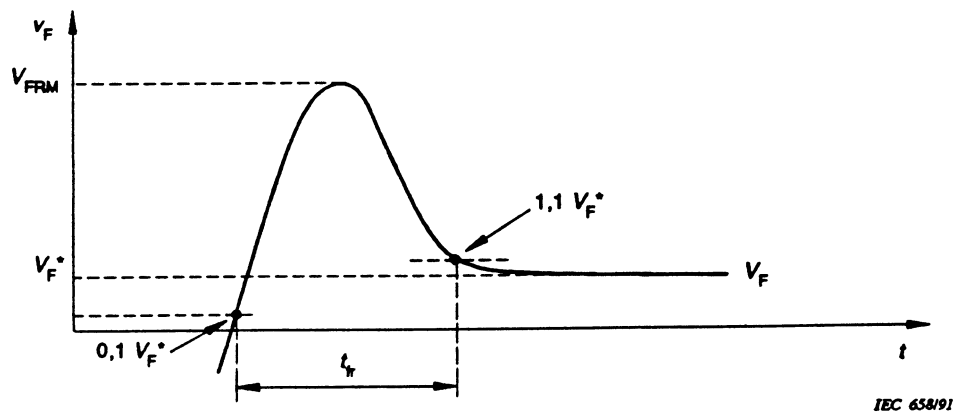


Figure 29 — Forward recovery time, specification method A

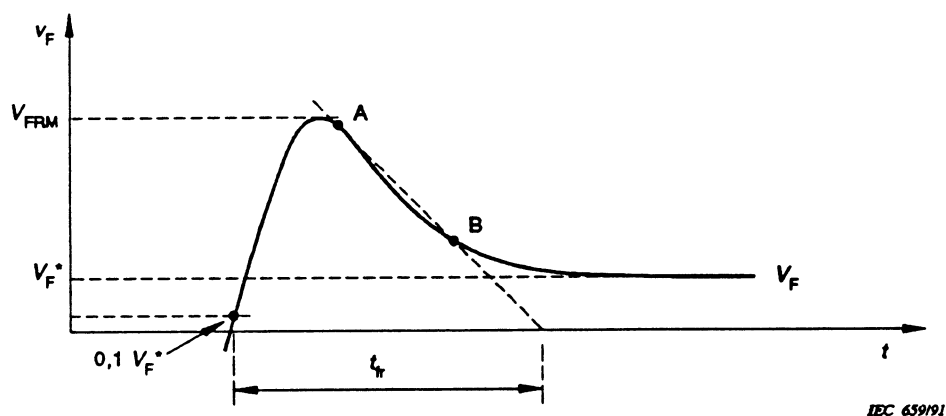


Figure 30 — Forward recovery time, specification method B

2.4.4**differential resistance (r)**

the differential resistance measured between the terminals of the diode under specified conditions of measurement

2.4.5**forward d.c. resistance**

the quotient of d.c. forward voltage across the diode and the corresponding d.c. forward current

2.4.6**reverse d.c. resistance**

the quotient of the d.c. reverse voltage across the diode and the corresponding d.c. reverse current

2.4.7**total capacitance (C_{tot})**

the differential capacitance at the diode terminals, measured under given bias conditions

2.4.8**total current sensitivity (β_I)**

the quotient of:

- 1) the total rectified diode current with a specified load, and
- 2) the total delivered input signal power.

2.4.9**incremental current sensitivity (β_i)**

the quotient of:

- 1) the rectified diode current increment with a specified load, and
- 2) the change in delivered input signal power that induces this increment.

2.4.10**figure of merit (of a detector diode) (M)**

A parameter characterizing the sensitivity of a receiving device and defined by the formula:

$$M = \frac{\beta r_{op}}{\sqrt{N_r r_{op} + R_A}}$$

where:

- β = either incremental current sensitivity (β_i)
or total current sensitivity (β_t)
as appropriate, in either case under short-circuit conditions
- r_{op} = operating point resistance
- N_r = noise ratio of the diode
- R_A = equivalent noise resistance of the high-impedance amplifier that is used to amplify the output of the detector diode

3 Letter symbols**3.1 General**

The general rules of Publication 747-1, Chapter V, apply.

3.2 Additional subscripts

In addition to the relevant recommended general subscripts (see Sub-clauses 2.2.1 and 3.3.1 of Publication 747-1, Chapter V), the following specific subscripts are recommended for:

3.2.1 Currents, voltages and powers:

- A, a = anode
- K, k = cathode
- O = average output rectified

3.2.2 Electrical parameters:

- δ , d = damping
- r = recovery, recovered, rectified
- S, s = storage, stored

3.3 Additional list of letter symbols

The letter symbols contained in the following list are recommended for use in the field of signal diodes; they have been compiled in accordance with the general rules.

Name and designation	Letter symbol	Remarks
3.3.1 Voltages		
Continuous (direct) forward voltage	V_F	
Instantaneous total forward voltage	v_F	
Average forward voltage	$V_{F(AV)}$	
Continuous (direct) reverse voltage	V_R	
Instantaneous total reverse voltage	v_R	
Peak reverse voltage	V_{RM}	
Surge reverse voltage	V_{RSM}	
Breakdown voltage	$V_{(BR)}$	
Forward recovery voltage	v_{FR}	
Peak value of forward recovery voltage	V_{FRM}	

Name and designation	Letter symbol	Remarks
3.3.2 Currents		
Continuous (direct) forward current	I_F	
Instantaneous forward current	i_F	
Peak forward current	I_{FM}	
Surge forward current	I_{FSM}	
Average output rectified current	I_O	
Continuous (direct) reverse current	I_R	
Instantaneous reverse current	i_R	
Peak reverse current	I_{RM}	
3.3.3 Powers		
Surge power	P_{SM}	
R.F. c.w. power dissipation	P_{CW}	For detector diodes
Pulse r.f. power dissipation	P_{RFP}	
3.3.4 Switching parameters		
Forward recovery time	t_{fr}	
Reverse recovery time	t_{rr}	
Reverse recovery current	i_{rr}	
Recovered charge	Q_r	
3.3.5 Sundry quantities		
Differential resistance	r	
Damping coefficient	δ or d	
Damping resistance	r_δ or r_d	
Efficiency	η	
Detector voltage efficiency	η_v	
Incremental current sensitivity	β_i	
Total current sensitivity	β_l	
Single-pulse energy	E_p, W_p	
Repetitive pulse energy	$E_{P(rep)}$	For detector diodes
Operating point differential resistance	r_{op}	
Figure of merit	M	

Section 2. Voltage-reference diodes and voltage-regulator diodes

1 General terms

The relevant terms and definitions given in Publication 747-1, apply. The terms in Sub-clauses 1.1 and 1.2 below are repeated from this publication, Chapter IV, Sub-clauses 4.10 and 4.11.

Further specific terms are given below.

1.1 Voltage-reference diode

A diode which develops across its terminals a reference voltage of specified accuracy, when biased to operate within a specified current range.

1.2 Voltage-regulator diode

A diode which develops across its terminals an essentially constant voltage throughout a specified current range.

1.3 Forward direction

The direction of current that results when the P-type semiconductor region connected to one terminal is at a positive potential relative to the N-type region connected to the other terminal.

NOTE If temperature-compensation diodes are included, these are ignored in the determination of forward direction.

1.4 Reverse direction

The direction of current that results when the N-type semiconductor region connected to one terminal is at a positive potential relative to the P-type region connected to the other terminal.

NOTE If temperature-compensation diodes are included, these are ignored in the determination of reverse direction.

2 Terms related to ratings and characteristics

The relevant terms and definitions given in IEC 747-1, chapter IV, clause 5, apply

Additional terms and definitions are given below.

2.1

regulating range

the range of currents within which the voltage is maintained between specified limits

2.2

working current I_Z

a current within the regulating range

2.3

working voltage V_Z

a voltage within the regulating range

2.4

working voltage range V_Z (specific term)

the range of working voltages for a specified range of working currents, under specified measuring conditions (see notes)

NOTE 1 The measuring conditions may be:

- a) measurement after thermal equilibrium has been reached with either T_{case} specified or T_{amb} and mounting details specified (d.c. method described in chapter IV, section 2, 1.1);
- b) measurement at a specified junction temperature (pulse method described in chapter IV, section 2, 1.2).

NOTE 2 Measuring conditions a) are preferred.

2.5

differential working resistance r_Z

the differential resistance at a working current within the regulating range

2.6

(mean) temperature coefficient of working voltage α_{VZ}

the quotient of

- the change in working voltage between two specified values of temperatures, by
 - the difference between these two temperatures,
- for a specified working current and under specified measuring conditions (see notes).

NOTE 1 See note 1 to 2.4.

NOTE 2 Measuring conditions b) are preferred.

NOTE 3 The change in working voltage is usually expressed as a percentage of working voltage.

2.7

working voltage drift $\Delta V_{Z(t)}$

the drift of the working voltage for a specified value of working current, under specified measuring conditions (see notes)

NOTE 1 See note 1 to 2.4.

NOTE 2 Measuring conditions b) are preferred.

3 Letter symbols

3.1 General

The general rules of Publication 747-1, Chapter V, apply.

3.2 Additional subscripts

In addition to the relevant recommended general subscripts (see Sub-clauses 2.2.1 and 3.3.1 of Publication 747-1, Chapter V), the following specific subscripts are recommended for:

3.2.1 Currents, voltages and powers

Z, z = working

3.2.2 Electrical parameters

Z, z = working

3.3 Additional list of letter symbols

The letter symbols contained in the following list are recommended for use in the field of voltage-reference and voltage-regulator diodes; they have been compiled in accordance with the general rules.

Name and designation	Letter symbol	Remarks
3.3.1 Voltages		
Working voltage	V_Z	
Continuous (direct) reverse voltage below the working voltage range	V_R	
Noise voltage within the working voltage range	V_{nz}	The symbol V_n is also acceptable if no misunderstanding is possible
3.3.2 Currents		
Continuous (direct) reverse current within the working voltage range	I_Z	
Continuous (direct) reverse current at a voltage below the working voltage range	I_R	
3.3.3 Sundry quantities		
Differential (working) resistance	r_z	
Temperature coefficient of working voltage	α_{vZ}	Reverse symbol: S_Z
Working voltage drift $\Delta V_{Z(t)}$	δ_{vZ}	For voltage-reference diodes

Section 3. Current-regulator diodes

1 General terms

The relevant terms and definitions given in Publication 747-1, apply. The term in Sub-clause 1.1 below is repeated from this publication, Chapter IV, Sub-clause 4.12.

Further specific terms are given below.

1.1 Current-regulator diode

A diode that limits current to an essentially constant value over a specified voltage range.

1.2 Anode terminal

See publication 747-1, Chapter IV, subclause 3.5.

1.3 Cathode terminal

See Publication 747-1, chapter IV, subclause 3.6.

2 Terms related to ratings and characteristics

The relevant terms and definitions given in Publication 747-1, Chapter IV, Clause 5, apply. Additional terms and definitions are given below.

2.1 Voltages

2.1.1

regulating range

the range of voltages within which the current is maintained between specified narrow limits

2.1.2

regulator voltage (working voltage) (V_S)

a voltage within the regulating range of a current-regulator diode

2.1.3

limiting voltage (V_L)

the voltage at point I_L on the current-regulator characteristic

2.1.4

knee voltage (V_K)

a voltage near the lower knee of the current-voltage characteristic

2.2 Currents

2.2.1

regulator current (working current) (I_S)

a current within the regulating range of a current-regulator diode

2.2.2

limiting current (I_L)

a specified current below the regulating range

2.3 Power dissipation

2.4 Sundry characteristics

2.4.1

small-signal regulator conductance (g_s)

the small-signal conductance within the regulating range of a current-regulator diode

2.4.2

knee conductance (g_k)

the small-signal regulator conductance at the knee voltage

2.4.3

temperature coefficient of regulator current (working current) (α_{IS})

the quotient of the change in regulator current (working current) between two specified values of temperature and that change of temperature

NOTE The change in regulator current (working current) is usually expressed as a percentage of regulator current (working current).